

Analysing citizens' perceptions of renewable energies in rural areas: A case study on wind farms in Spain

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ABSTRACT

The promotion of rural development can benefit from the advancement of renewable energies as potential sources of growth and income in an integrated economy. Rural areas have attracted a significant proportion of renewable energy installations, mainly wind energy. Moreover, the development of renewables has been explicitly claimed as a key instrument to support rural economies through job creation, new sources of income for landowners and local authorities, and more sustainable industries with the revitalization of their productive systems. However, the installation of renewable energies can have, in the short and long term, different impacts on the territory. This study explores Campo de Belchite citizens' perception of the effects wind energy installations has on the economy, demography, and employment opportunities. The Campo de Belchite county (Aragon) was used as a case study due to its wind-farm development. Citizens perceptions on the socio-economic effects and expectations of renewable energies have been explored on the basis of their responses to an online survey. Findings show a great heterogeneity between agents and territories, both in the evaluation of impacts and in their hopes. The management model plays a critical role for achieving its social acceptance. This work contributes with industrial and energy policy insights that call for a more decentralized, participatory and transparent management models.

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1. Introduction

The change of the energy model, moving from a development based on non-renewable to renewable energy sources, is and will be a key factor reducing climate change, promoting sustainable development, and reaching a just energy transition in Europe (ONZ, 2015; UNFCCC, 2015; European Green Deal, 2022). At the same time, energy independence from politically unstable countries is another recent European objective (European Commission, 2022) in the context of high international volatility and international energy dependence. One of the main pillars of a low-carbon economy is the use and expansion of renewable energies. The objective is that 32% of energy will be supplied by renewable energy sources by 2030 (European Green Deal, 2022). This expansion is observed in rural areas of most of countries due to the geographic characteristics (Munday et al., 2011). For different institutions and groups, the deployment of renewable energies can represent an opportunity for local economic development given the often depopulated nature of the rural regions, and difficulties rural

regions experience related to the social and economic promotion of its inhabitants (Rudolph and Kirkegaard, 2019).

Although renewable energies, besides contributing to decentralized energy systems, and reduction of energy transmission, could represent an opportunity for the economic development in rural regions, this may not be necessarily the case (Tolnov Clausen and Rudolph, 2020). In fact, there is significant debate on whether the benefits of this installation outweigh the costs at this local and regional level (OECD, 2012). As a result, increasing amount of literature claim that the socio-economic impact on the rural population must be evaluated, and that the social acceptance of renewable energies is a crucial factor to successfully implement these infrastructures (IPCC, 2022; Abdullah et al., 2017; Alsabagh, 2019; Rogers et al., 2008; Gargallo et al., 2020; Vuichard et al., 2022; Iuga et al., 2016).

Spain is the fifth country with the greatest accumulated wind power capacity installed in the world, which allows it to cover 19% of electricity demand (AEE, 2019). Specifically, in this study, the perceived economic, demographic and employment effects of wind energy installations are explored in the Campo de Belchite county of Aragón, Spain, which is localized in the Ebro Valley—one of the most important wind-farm regions in Spain. Aragon

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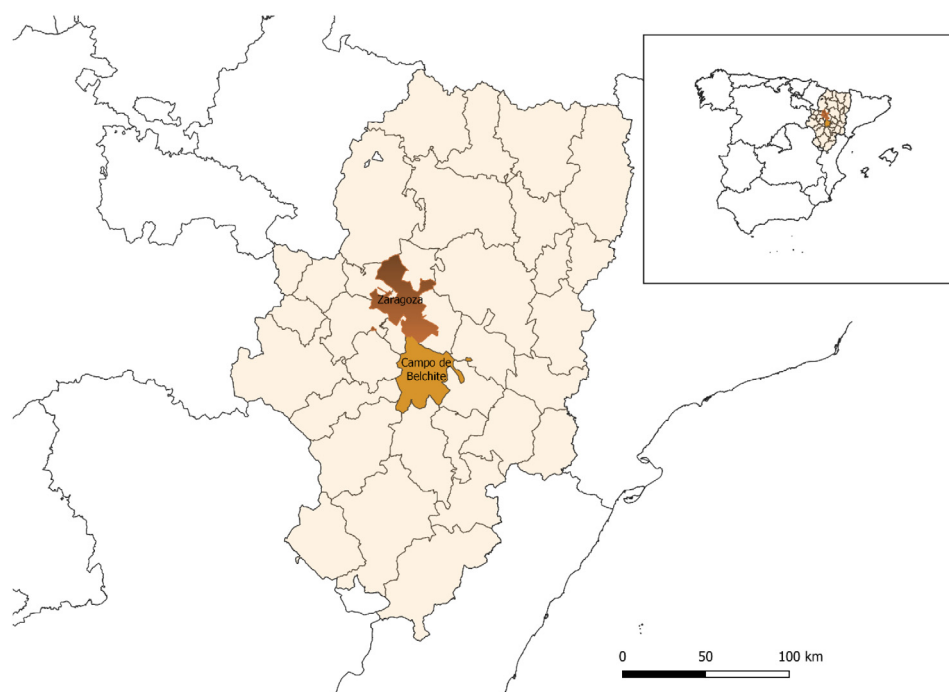


Fig. 1. The geographical situation of the Campo de Belchite county (Aragon, Spain). Note: Zaragoza municipality (dark brown) head of the region.

is one of the regions with the highest installed capacity of renewable energies in Spain; it is the fifth Autonomous Community in terms of the percentage of accumulated wind power in 2018, representing 12.08% of the Spanish market share. In addition, Aragon was the autonomous community that installed the most power during 2019 (AEE, 2019). Currently, the community of Aragon has 155 wind farms, which include 2,539 turbines and a power of 3,420.120 MW (MITECO, 2020). Within Aragon, 80% of the wind farms and 75% of the installed power is concentrated in the province of Zaragoza (Aragón). Moreover, in 2008, Zaragoza was the second province in Spain with the most installed power (MW) (Galdós Urrutia and Madrid Ruiz, 2009).

Currently, the Campo de Belchite county represents 10% of the installed power in Aragon (MITECO, 2020). However, the first wind farms were installed between 2004 and 2005 resulted in the total installed power reaching 22%. In the last year, the installation of six new wind farms has been authorized and the forecast is to significantly increase the number installation in the coming years (MITECO, 2020). The county only represents 2.18% of the surface of the Aragonese territory, 0.34% of the population, and 0.35% of the GVA (Gross Value-Added), indicating the relative importance of wind energy in this territory (IAEST, 2022). Therefore, due to its representativeness in terms of wind energy and its clear rural nature, we will focus the analysis on this geographical area. In the following figure shows the geographical situation of the county Campo de Belchite in Aragon and Spain (see Fig. 1).

The main objective of this study is to analyse citizens' perceived socio-economic impacts of the installation of renewables in rural areas, and identifying which factors may contribute to the social acceptance of citizens. The novelty of our approach is its focus on the perceptions of the citizens, and on the possibility of comparing the hopes associated to the areas with new projected wind-farms, and the reality for those areas with a past experience of wind-farm development in the same territory. This provides new elements for the debate on the role of some strategies carried out for the development renewable energies that is being carried out rural areas, the differences between hopes and reality generated by this type of installations and the key elements for

social acceptance. Another of the novelties of this work with respect to previous literature is that it attempts to analyse more intangible but important aspects that are not included in the official statistics. In turn, as we analyse in the following section, this work brings together different perspectives (economic, social and environmental), while the usual studies tends to focus on only one of them. To the best of our knowledge, this is the first time that such a comprehensive analysis of these factors is developed in Spain.

From a methodological point of view, a analysis is addressed based on surveys to different groups of citizens in the region. These results allow evaluating, from the point of view of citizens, the perceived socio-economic effects and expectations of renewable energies (Sardaro et al., 2019). In turn, we present a quantitative mean difference analysis to understand different renewable energy attitudes of different classes of respondents. In short, a mixed method approach is used, based on the qualitative and quantitative survey (Korsnes et al., 2018; Songsores and Buzzelli, 2016). In sum, the paper aims to shed light into the analysis of the compatibility of objectives regarding rural development and energy transition. A great heterogeneity is revealed among agents and territories, both in the evaluation of impacts and in their hopes. Additionally, it is observed that the management model plays a fundamental role in achieving social acceptance, advocating more decentralized, participatory and transparent management models.

The rest of the paper is organized as follows. Section 2 presents the literature review, mainly related to previous studies about the factors and dimensions potentially affecting the social acceptance of these installations in the territory. Section 3 presents the material and methods used to approach the questions of interest. In Section 4 the most relevant findings are presented and Section 5 closes the paper with our main concluding remarks.

2. Literature review

The expansion of renewable energies, as we have seen, is unstoppable. In the last ten years the installed capacity (MW) of renewable energies has doubled worldwide, accounting for

27.7% of total energy generation by 2020 (IRENA, 2021). As a result of worldwide, but especially European expansion of renewable sources in the last years (IRENA, 2021), extensive research has emerged describing the positive and negative externalities that renewable energy sources cause on local development (Mattmann et al., 2016; Zerrahn, 2017). Positive externalities include the ability to reduce and mitigate possible consequences of greenhouse gas emissions (Sovacool et al., 2020; Furmankiewicz et al., 2021). The negative externalities include the possible loss of quality of life due to visual and acoustic impact (Buscaino et al., 2019; Ioannidis et al., 2022), the deterioration of natural capital (Taha-Sayed et al., 2021; Rahman et al., 2022), and possible higher electricity costs (Rintamäki et al., 2017; Oosthuizen et al., 2022). Additionally, the effects on employment and local economic activity are questioned (Costa and Veiga, 2021; Fabra et al., 2022).

There are two main lines of research in the literature on the estimation of the effects of wind energy. The first line studies these effects in a qualitative way and focuses on the social acceptance of wind farms. The second is more oriented towards the estimation of quantitative effects on socio-economic magnitudes (see Duarte et al., 2022). This work contributes to the first line of study.

In addition to these more objective effects, sometimes clearly measurable and sometimes of a more marginal nature, there is no doubt that society's acceptance plays a fundamental role in the installation and development of wind farms. In this sense, (Leiren et al., 2020), propose six categories of acceptance of wind energy development at the local level: (i) technical characteristics of the wind energy project; (ii) environmental impact; (iii) economic impact; (iv) social impact; (v) contextual factors; and (vi) individual characteristics. Streimikiene et al. (2021), Romero-Castro et al. (2022) found similar factors that influence the sustainable development of renewable energies in rural areas.

First, technical characteristics include the size of wind farms, the visibility of wind turbines and their distance from residential areas; among others (see Salomon et al., 2020; Landenburg and Dubgaard, 2007).

Next, environmental impacts refer to the capacity to reduce greenhouse gas emissions, but also to the destruction of biodiversity caused by the installation of a wind farms. This varies depending on the characteristics of the different areas. For instance, in the northwest region of the Autonomous Community of Murcia (Spain), the population prefers the implementation of wind energy in their municipality due to the positive environmental impact wind energy generates for society, compared to other energy sources (see Tudela Serrano and Molina Ruiz, 2006). Similarly, the preservation of the rural landscape (Frolova, 2010), the improvement of air quality (Mattmann et al., 2016) and impacts on fauna and flora (Alvarez-Farido and Hanely, 2002; Meyerhoff et al., 2010) have the greatest impact on the well-being of individuals.

Social impacts refer to the quality of life in the area once the wind farm is installed. There are many possible beneficial economic effects—mainly on employment and economic activity, or more debatable in specific sectors such as agriculture and tourism, as their opportunity costs are made explicit.

In this context, Komor and Bazilian (2005) analysed the socio-economic effects of Ireland's policy commitment to renewable energy. Their study shows that the installation of renewable energies favours productive diversification in less developed regions, thereby increasing their competitiveness and reducing the economic gap between territories. However, Komor and Bazilian (2005) emphasize that not all renewable energy has these effects. Specifically, they note that wind energy only creates temporary employment of individuals from outside the local area. Additionally, a study looked at the retributions received by the owners of

the land where wind farms are installed, was a financial lifeline that improved the economic, social and cultural activity of the area. However, they also observed that there is unfair distribution of profits generated between the wind farm developer and the lessee as a result of asymmetric information in contract negotiations (see Copena and Simón, 2018).

Context factors are characteristics of the national market (location of energy production), the project start-up process (transparency) and the regulatory framework. There is limited literature on type of valuation (Mattmann et al., 2016). An open and transparent process is conducted prior to the installation of the wind farm and the local community is given a voice, a positive effect on the installation of these farms is achieved (see Firestone et al., 2018; Ek and Persson, 2014).

Finally, individual characteristics refer to the political climate, the discourse of wind energy in the public sphere, the socio-cultural values of the community, the identification of the population with these wind farms, etc. The interrelationships between the agents that make up the social ecosystem of the territory can positively or negatively influence the acceptance of the installation of each wind farm (Del Rio and Burguillo, 2008). For example, as a result of the installation of wind energy in the mountain areas of the Valencian Community (Spain), three local associations have emerged against these installations, promoting citizen participation and social pressure in decision-making (see Moragues-Faus and Ortiz-Miranda, 2010), linked to NIMBY ("not in my back yard") movement (Van der Horst, 2007).

All these factors are interdependent, forming an applied theoretical framework for understanding the social acceptance of a wind project. Based on this theoretical framework, a survey was conducted in several European Union member countries that experienced an increase in the installation of wind energy. The results show that reducing visual, landscape, nature and bird impacts, as well as ensuring an open procedure and local participation helped improve local acceptance (Leiren et al., 2020).

Furthermore, Mattmann et al. (2016) conducted a review on non-market economic valuations of external effects associated with wind energy production. The results of the review highlighted that the most valued economic externalities are reduction of emissions in general (Mozumder et al., 2011; Guo et al., 2014); reduction of greenhouse emissions (Botelho et al., 2013; Kontogianni et al., 2013); effects on fauna and birds (Ek and Matti, 2015; Mariel et al., 2015); visual impacts on land and sea (Vecchiato, 2014; Cicia et al., 2012); and to a lesser extent, the type of ownership of wind farms (Firestone et al., 2018).

However, prior works are not conclusive as to the contribution of wind energy facilities on local or regional development and their socio-economic impacts in terms of employment and wealth. Although both positive and negative elements are noted, the fundamental role of social acceptance is highlighted, in turn conditioned by the processes of management, information and participation of citizens in territorial planning. At the same time the literature is not conclusive as to the contribution of wind energy installations on local or regional development, and their socio-economic impacts, the heterogeneity of territories, historical moments, economic conjunctures, ways of managing the project, local sociology, etc., give rise to different results. Rather than a precise definition of their suitability, considerations can be generated on how to evaluate and analyse each specific situation. A high level of idiosyncrasy in relation to each project is present.

3. Methods

This section presents the research approach designed to analyse the potential impacts of wind power installations on the rural territory from a citizens point of view. A series of positive

Table 1
Analytical framework covered in the stakeholder survey.

Perceptions factor category		Related issues
General perceptions		Location of wind farms Link with the wind farm When the activity started Economic Development of the area (in general)
Socio-economic impacts	Impacts on environment	Physical environment Critical groups Biodiversity and wildlife Economic Development of the area (Public aid) Municipal budget
	Impacts on economy	Tourism sector Agricultural sector Labour market Private income (buy new cars, houses, etc.)
	Impacts on society	Quality of life Social financing by promoters Destination of public revenues (Nursing home, Day care centre, etc.) Demography
Governance and management		Local policies: how decisions are made for the application of such revenues Municipal strategy Consultation in the planning and permitting process Information about projects and the transparency of the permitting process Optimal parks management model
Public perceptions		Summary of perceptions

and negative externalities subject to these installations can be present, as well as some factors that affect their potential impacts (Leiren et al., 2020).

Surveying inhabitants of Campo de Belchite county, one of the most depopulated rural areas of Aragon (Spain), and also some counties nearby with different experiences regarding the development of renewables (projected, in development, and without wind-farms) since the possible effects, as well as their social acceptance, go beyond one geographical area.¹ This survey allows us a comprehensive picture of citizens' opinions on the perceived social and economic effects related to the development of renewables. With these ideas in mind, an online survey was carried out among the citizens of this region. The survey contains both, closed questions, which have been later used in the quantitative analysis and open-ended questions (qualitative) where citizens can express their opinions and perceptions about each of the items that we will see below. The online survey was selected as it is inexpensive and time-efficient.

Table 1 shows the analytical framework used in the survey. The survey has six sections. The design of the survey has some common blocks dedicated to analysing general perceptions about the operation of wind farms, socio-economic impacts linked to the development of renewable energies in the territory with special focus on employment, governance and management, and citizen perception of these types of facilities. The survey also included a number of open-ended questions that allowed us to modulate some of the results obtained, as well as to consider additional aspects not discussed or considered in the survey. In particular, the first block addresses perceptions about the technical characteristics of wind farms, which refers to questions on local finances, in relation to revenues and expenditures to examine their categories/modalities, amounts, duration/stability over time, etc. The next three blocks focus on socio-economic impacts. In the second block, stakeholders were asked about the

impacts of wind farms on the environment, focusing on physical environment and the status of the biodiversity and wildlife. The third block presents a set of questions regarding the impacts on the economy, regarding sectoral analysis, labour market, private income and local budget. Similarly, fourth section gathered a set of questions based on society impacts to investigate the quality of life of citizens, demography, destination of public revenues, etc—this is to verify the impacts on the territory. Next, the fifth block tries to capture issues related to the governance and management aspects of wind farms. The final block includes questions related to public's perception of these renewable energy installations.

The objective of this approach is two-fold; to better understand the degree of social acceptance of the projects and citizens' perception of projections in addition to learning about the different implementation processes of the various facilities in the territory.

The final sample consists of 97 responses, most of them corresponding to Campo de Belchite county. The survey does not seek statistical representativeness (which would require a larger sample size, as well as a specific design for population characteristics) but rather to offer a collection of citizens' opinions and perceptions of this issue. Specifically, the survey has 34 questions, but it took no more than 15 min to complete.

Most of the respondents were male (64%) and around 50% were between 45 and 64 years of age. Respondents indicated that their highest level of education is university (37.5). Regarding their direct link to the parks, 86% of the respondents have no direct link. The 7% corresponds to land renters and the remaining 7% to workers linked to the parks. Additionally, almost 90% of the respondents are currently working, with only 6.25% being pensioners and retirees, and 2.08% unemployed. More than 60% of the respondents have children. The composition of the sample, reflects a higher proportion of men than the county average, as well as a higher level of education and employment, with the middle age intervals also being more represented, with these population strata being the most closely linked to the economic, associative and institutional activity of the county. In this regards, the sample cannot be considered as representative of the total population living in the area.

For each of the variables of interest, mean values have been calculated to show individuals' perceptions of the different impacts of renewables in the rural areas. This analysis is followed

¹ The survey was distributed through the local action groups channels of the regions participating in the "Aragón Infoenergía" project (OTRI 2020/0229). These surveys were conducted between August and September 2020. The main channel for responding to these surveys was by telematic means, due to the greater facility and flexibility in sending them, and also because of the Covid-19 pandemic. Note, however, that this procedure tends to exclude those groups with greater difficulties in accessing these means, mainly the elderly.

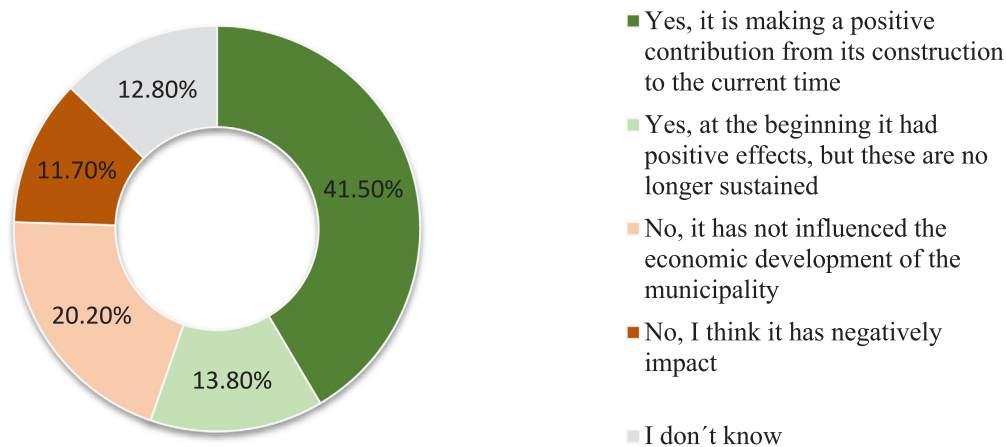


Fig. 2. Contribution to the economic development of the municipality or region.

by ANOVA analysis, to compare the different groups responses in terms of perceptions and awareness. The different situation of the territory in terms of the renewables expansion process is used to conform the groups.

4. Results

In that follows, the most relevant results are presenting regarding the perceptions of citizens about the impacts of renewables in the rural area. As indicated previously, the survey includes several blocks regarding opinions about the overall perception of the wind power farms governance and management of these installations, the perception of the long-term socio-economic effects of renewables in general, and particularly, specific wind farms, and public perceptions.

More than a half (51%) of the participants live in a municipality where there is a renewable energy park, which mainly corresponds to citizens living in Campo de Belchite. Additionally, 22% live in a municipality where a renewable energy park is being built or will be built in the near future; and in 18% of the cases, it exists in a nearby municipality.

With respect to the direct relationship of the respondents with the wind farms, more than 80% have had no direct relationship, 8.5% are landowners in the counties of Campo de Belchite and Jiloca, and 5.3% declare that are or have been working in the wind-farms.

Next, participants were asked questions about the impact of renewable energies to the economic development. More than 40% of the respondents acknowledge that the renewables farms have made a positive impact since it was built. However, 14% of the participant recognized that though it had positive effects, these effects were not sustained over time. Furthermore, 30% of the respondents perceived that the development of renewables had no influence on economic development or may have had a detrimental effect (see Fig. 2).

When asked about the possible nuisance of these parks due to noise interference or unsightly landscapes, 65% considered that renewable energy parks do not bother them, while approximately 35% admitted that they do. It is worth noting that in the Belchite county, only 5% of those surveyed said that they were bothered by the renewable energy parks.

The survey also explored citizens' perception about the potential benefits of wind farms in terms of developing new infrastructures in the municipality and increasing revenues. Almost half of the respondents considered that they have not been implemented; while only 37% responded that they have been implemented (nursing homes, street repairs, sports centres, and

restoration of heritage have been noted in this case as main destination of these new infrastructures). In relation to this, 60.9% of the respondents consider that public support in the municipality has not increased as result of the revenues linked to the renewables, while 30.4% consider that public support has increased in terms of economic activity, tourism promotions, cultural activities, tariff reductions, etc. Likewise, most of the respondents (60%) consider that the construction of renewable energy parks has not boosted the creation of new businesses in the region or in the municipality in terms of new pubs, tourism, stores, or new industries.

Additionally, majority of the respondents (72%) described that citizens did not receive clear information from the companies and/or institutions about the short- and long- term positive and negative consequences of installing these parks in their territory. Similarly, a high percentage of the respondents (76.3%) said that no consultations were carried out among in the municipalities to understand whether citizens' support the development of these facilities, whereas less than 10% of the respondents mentioned that some consultations had been carried out.

The survey also explored respondents' preferred model for wind farm management. 37% of the respondents considered that the optimal model should be led by the regional authority (Government of Aragon), so that they could implement a renewable energy management plan for the whole region. Alternatively, 20.7% respondents answered that supra-municipal figures should be articulated to maximize the return of benefits of the parks in the territory. Other respondents (12%) indicated that wind farms should be managed through private management without public intervention.

63.4% of respondents perceive that the installation of these parks will not improve the life in municipalities. Moreover, 65% of the citizens do not perceive a greater dynamism in the municipality. Likewise, 60% consider that people do not spend more on home repairs, car changes, vacations and so on. Only 20% of the respondents consider that there is a greater dynamism, which corresponds to 23% of the citizens interviewed in Campo de Belchite mainly. However, despite this negative result, 61.3% of those surveyed consider that workers coming from abroad live in the municipality, or rent houses for a few days, eat and go to pubs and restaurants. But it seems that this effect is temporary, since when asked whether the prices of homes and premises have risen, more than 40% consider that prices have not risen, and 44% consider that old, half-abandoned houses or unused premises have not come onto the market. Moreover, almost 60% of the respondents consider that there are no more people in the municipality, nor has the municipality been rejuvenated with a

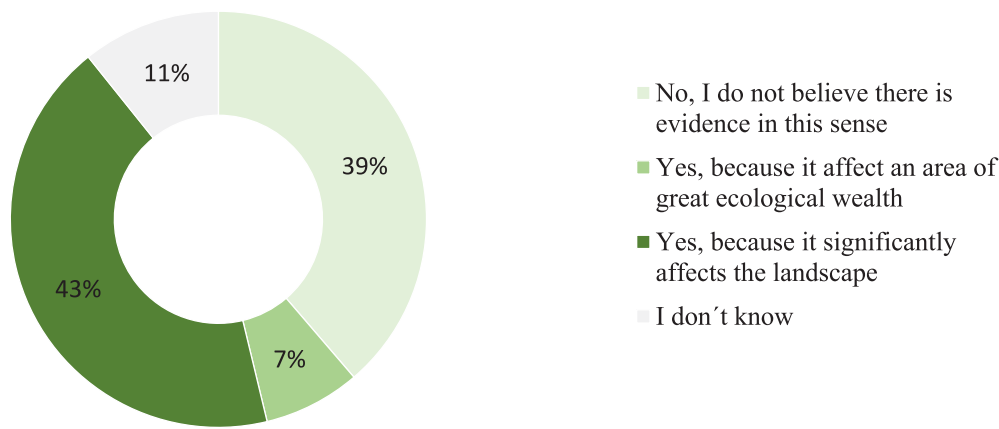


Fig. 3. Long-term environmental effects.

greater number of children, new pupils in school, young people working in the municipality or nearby towns. In sum, the survey does not reflect a significant perception of impact of wind farms on the demographics of the territory.

Next, the survey explored the potential impact wind farms have on the labour market—citizens were asked about the contribution of the wind-farms to the creation, consolidation and employment upgrading. In this regard, 55% of the individuals stated that local workers have been hired during the construction phases of the parks, but these jobs have not been consolidated over time. However, 51% of the respondents consider the employment generated to be precarious and vulnerable. It is important to note that almost 80% of the participants indicated that creating sustainable employment should be a priority when making decisions on the installation of renewable energies. Furthermore, almost 65% do not believe that the activity associated with these parks neither directly nor indirectly reduced the gender gap in the territory. Approximately 40% of the participants consider that specific training courses have been carried out for the inhabitants of the area.

Next, 50% of respondents perceive that wind farms mainly affect the landscape, and to a lesser extent, affect an area of great ecological richness. Conversely, almost 40% indicated that there is no evidence of impact in this regard (see Fig. 3).

Finally, the citizens were asked about their general perceptions on the opportunities that the implementation of renewables may represent for the territory. The main results are summarized in Fig. 4. In general, citizens' perception on various issues related to the improvement of inter- and intra-municipal accessibility conditions is of disagreement with the proposed statements. Specifically, with respect to an improvement in external accessibility, with better access to the regional and provincial capital, more than half of those surveyed totally disagreed and only 15% agreed with this statement. Along the same lines, almost 50% of those surveyed disagreed that these facilities should be accompanied by an improvement in intra-municipal accessibility by means of agricultural roads, new forest tracks, etc.

More than 70% of individuals disagreed that wind farms could potentially improve services such as internet connection, health care, social services and education in the region, more than 70% disagreed with such improvement.

The answers are less conclusive in relation to the potential effects on tourism, although 40% consider that it could harm tourism and the promotion of the municipality and the region, as well as the cultural heritage of the area, 40% agree with this statement. In fact, 75% of the respondents rejected the idea that this type of facilities could lead to a greater tourist attraction by making the territory better known by the citizens.

Similarly, almost half of the citizens believe that the wind farms will reduce the richness of flora, fauna and ecosystems and, ultimately, have a significant environmental impact on the population. A similar percentage believes that the parks are detrimental to the agricultural and livestock sector in the area because they increase the price of farmland, reducing the availability of land for farming or grazing.

The implementation processes for renewables are also viewed critically by a significant number of respondents. For instance, approximately 50% of the respondent claim that the implementation process has not been carried out in an orderly manner through dialogue, transparency and negotiation with wind farms developers. Furthermore, almost 60% of the participants consider that developers have not carried out an orderly action plan with the territory in mind, and slightly lower percentages show that citizens do not believe that the environmental benefits of renewable energies outweigh the possible negative effects.

Faced with this negative situation, some surveyed, in the open-ended responses, are in favour of renewable energy, but “without destroying the landscape” and with benefits only for companies and not for the territory, showing their concern for agriculture, irrigation, and water. It also calls for a “greater transparency in decision making to give greater importance to the public interest”, and should be accompanied by “improvements in power lines and internet for the municipalities of the region” in which they are implemented, as well as “annual municipal meetings for the ecological and economic monitoring of these facilities”. They point out that “neither jobs nor development are created”, “nor do they fix the population”, and at the same time they affect “tourism development”, since “jobs are minimal and they hire people from outside the territory”. Otherwise, citizens point out that it only “generates wealth for the landowners”, who may even “abandon farmland and emigrate”.

Once the main perceptions of citizens have been presented, the extent to which there are significant differences in the evaluations given by different groups of individuals to the different aspects of the contribution of renewables to territorial development is explored. To do so, we carried out a statistical analysis of the difference in means. Firstly, we will use the variable relating to the existence or non-existence of renewables in the territory as a control variable. This variable allows us to establish four different groups: *Citizens living in a municipality where there is a renewable energy park* (group 1) (which mainly corresponds to citizens living in Campo de Belchite), *Citizens living in municipalities without parks but with parks in nearby municipalities* (group 2), *Citizens living in municipalities where a park is being built or will be built in the short term* (group 3) and *Citizens living in municipalities and areas with no present or future presence of parks* (group 4).

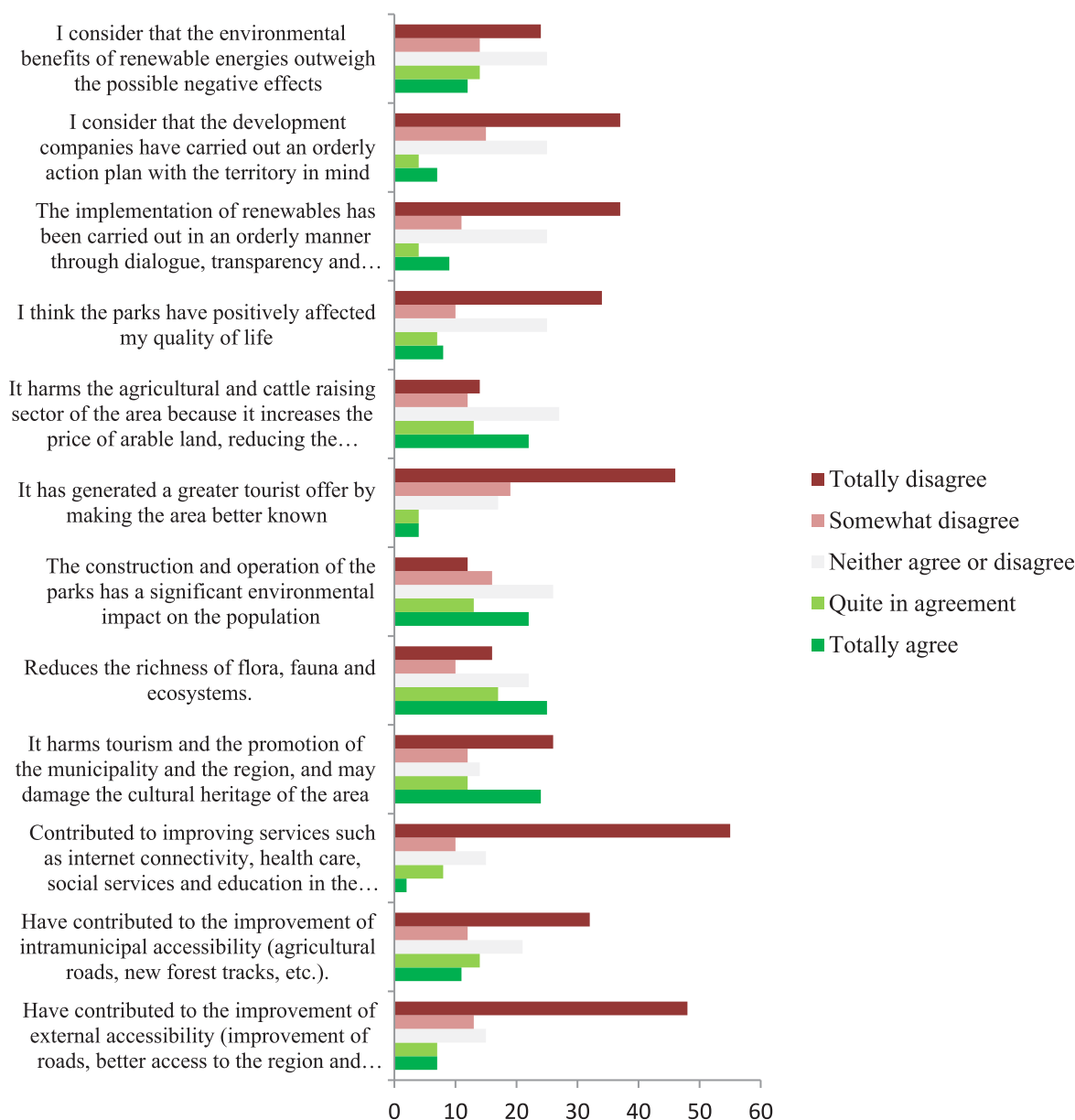


Fig. 4. Summary of respondents' opinions.

As can be seen, these groups represent, a priori, different relationships, hopes and realities, regarding the consequences of the implementation process of renewables in the territory.

The usual Levene test for homogeneity of variances is first undertaken. The assumption of homoscedastic distribution (homogeneity of variances) is a prerequisite for the use of the ANOVA procedure to compare means between different groups. For those variables where homogeneity of variances is rejected, using Welch's robust test for comparing the means of the different groups.

Full definition of variables and results are presented in Annex I. As can be seen in Table 2, significant differences between at least two groups appear in the variables related to the evaluation of the contribution to economic growth, the associated index, the perception on park-related nuisances, the effects on the existence of new opportunities for new houses and refurbished, as well as the opinion on the effects on the territory, the tourism and if the positive effects of the parks development outweigh the potential negative effects. Looking at the specific differences, for most of the variables, these significant differences only appear between

the responses of groups 1 and 3, that is, between those citizens living in a municipality where there is a renewable energy park (reality) and those living in municipalities where a park is being built or will be built in the short term (hopes). A significant result is that the perceptions on the contribution of renewables to economic growth (mainly measured through the index of contribution) are more positive for those inhabitants of municipalities with a previous experience of renewables in the territory than for those living in areas where these parks are projected or under construction. It is noted more positive responses regarding the opinions about positive effects in the territory, compensation of positive and negative effects, among others.

Other control variables have been considered for the group's segmentations such as sex, and educational level. No relevant differences in means are presented for most of the variables according to these groups. In general women reveal more critical with the negative effects of these wind parks on the agriculture, as well as more favourable to a management by supra-territorial institutions than men. Regarding age groups, the main differences appear between those with ages below 35 and between 35 and

Table 2
Analysis of differences in means. Groups according to different factors.

	Living in areas with renewables	Gender	Age	Level of studies	Belchite
	Statistic	Statistic	Statistic	Statistic	Statistic
Contribution to economic growth	4.57 (0.01***)	1.07 (0.3)	0.67 (0.52)	3.48 (0.04**)	26.58 (0***)
Park-related nuisances	3.12 (0.03**)	0 (0.98)	0.28 (0.76)	2.69 (0.1)	26.82 (0***)
Optimal management strategy	1.88 (0.14)	10.84 (0***)	0.1 (0.9)	2.68 (0.11)	1.34 (0.25)
Contribution to local wellbeing	2.6 (0.12)	0.1 (0.78)	0.21 (0.81)	1.77 (0.21)	0.66 (0.42)
Contribution to local dynamism	0.72 (0.55)	0 (0.95)	0.01 (0.99)	1.79 (0.21)	4.3 (0.04**)
Perception employment is better	1.22 (0.34)	0.34 (0.56)	1.31 (0.29)	1.24 (0.32)	27.28 (0***)
Effect on new houses and refurbishing	17.32 (0***)	0.15 (0.7)	3.04 (0.07)	5.21 (0.02**)	22.97 (0***)
Positive effect on people	2.04 (0.16)	0 (0.98)	1.04 (0.36)	0.61 (0.55)	5.22 (0.02**)
Opinion_accessibility	2 (0.12)	0 (0.97)	3.1 (0.05**)	2.98 (0.09)	1.44 (0.23)
Opinion_paths and roads	2.19 (0.1)	0.02 (0.89)	4.22 (0.02**)	2.79 (0.1)	9.68 (0***)
Opinion_services	1.06 (0.37)	1.07 (0.3)	2.92 (0.06)	0.77 (0.47)	0.67 (0.42)
Opinion_good for quality of life	2.56 (0.06)	0.11 (0.74)	1.56 (0.22)	0.54 (0.6)	9.23 (0.00***)
Opinion_ordered process	1.64 (0.19)	0.19 (0.66)	0.99 (0.38)	2.81 (0.11)	6.11 (0.02**)
Opinion_postive on territory	3.19 (0.03**)	0.01 (0.92)	1.39 (0.25)	8.47 (0***)	6.85 (0.01***)
Opinion_positive effects compensate negative	2.85 (0.04**)	0.02 (0.89)	1.47 (0.24)	1.84 (0.17)	10.06 (0.00***)
Opinion_negative effects on tourism	4.38 (0.01***)	0.09 (0.76)	1.78 (0.18)	2.37 (0.1)	21.49 (0.00***)
Opinion_negative effects on natural life	0.74 (0.53)	0.97 (0.33)	2.36 (0.1)	2.26 (0.14)	9.02 (0.00***)
Opinion_negative environmental impact	0.61 (0.61)	0.27 (0.61)	1.88 (0.16)	0.79 (0.46)	8.19 (0.01***)
Opinion_negative effect on agriculture	0.35 (0.79)	5.8 (0.02**)	3.52 (0.03**)	3.43 (0.06)	2.32 (0.13)
Index_socio-economic contribution	4.57 (0.01***)	1.07 (0.3)	0.53 (0.59)	3.48 (0.04**)	26.58 (0.00***)
Index_positive opinion	2.29 (0.09)	0.81 (0.37)	2.93 (0.06)	3.92 (0.07)	13.79 (0.00***)
Index_employment effect	1.77 (0.17)	1.23 (0.27)	0.19 (0.83)	0.83 (0.44)	10.25 (0.00***)
Index_wellbeing	4.47 (0.09)	0 (1)	0.03 (0.97)	2.98 (0.06)	8.32 (0.01***)

Notes: p-values are presented in parentheses. *imply 10% level of significance. **imply 5%. ***imply 1%.

45 years old, the firsts with a more positive opinion on the effects on accessibility, paths and roads. Regarding the educational level, significant differences in the perception of the contribution to the territory appear mainly between those with intermediate and higher education levels, with a more positive perception of the contribution to the territory among the former than among the latter. Finally, when the control variable is belonging to the county of Belchite, there are significant differences in the means for many of the selected variables, with generally more positive evaluations in terms of contribution to the territory, effects on different economic, employment and social variables and lower environmental effects among those who belong to that county, compared to respondents belonging to other counties. In short, the results suggest that, in the territory analysed, the previous experience of the existence of renewable energy facilities has

been assimilated as a generally positive element of contribution, compared to a less optimistic view expressed by those citizens belonging to areas close to or affected by the current construction or projection of new renewable energy parks.

As we have seen in the literature review, most of the works focus on analysing the impacts or perceptions of renewable energies with respect to a specific issue: from an economic, social or environmental point of view. However, in this paper we give an integrated view of all these aspects, which is a novelty from an academic point of view.

Comparing with the previous studies analysed in the previous section, we observe the importance of the negative environmental, acoustic and visual impacts on the citizens' perception of renewable energies. As previously observed, this type of impact on the territory should be taken into account much more than

the positive impacts on climate change, which are less tangible on the territory. In turn, usually the works analysed in the previous sections focus on analysing the past perception of a park. However, in this work there is the ability to distinguish between expectations and reality, as it is not only analysed from the point of view of the past, but also of the present. As there are different temporal stages in the development of renewable energies, this distinction can be made, as we have seen in this section.

The main difference of our work with respect to those analysed above lies in the perception of individuals on the economic impacts on the territory. We have observed that renewable energies are capable of economically dynamizing the territories. However, as our work shows, this positive impact is not perceived by the citizens of a given rural area, neither in terms of wealth nor in terms of employment.

5. Conclusions

Renewable energies play a fundamental role in achieving the objectives of sustainable development, the battle against climate change and the change of energy model. Under this context, this study, from a qualitative and quantitative point of view, deals with the possible socio-economic impacts and the social acceptance of the installation of this type of infrastructure at the local level.

One of the main novelties of this work is to try to analyse the socio-economic impacts of wind energy on a county scale. Analysing less measurable aspects from official statistics (perceptions, environmental impacts, re-investment effects, etc.) when the usual in the literature is to focus on impacts on employment or GDP per capita (Costa and Veiga, 2021; Fabra et al., 2022; Duarte et al., 2022). It is common to find positive effects on GDP per capita in the literature, but these are not perceived in time or space. There are many other variables when analysing the impacts on the territory, as has been attempted in this paper.

A fundamental factor for the generation of positive community dynamics that foster trust and cooperation is social acceptance, an aspect that has been repeatedly mentioned in this study. In this sense, the results obtained support the need to move from the current “top-down” approach to a “bottom-up” approach, where the projects promoted enjoy public acceptance, the management processes are transparent and the tangible and intangible benefits are clearly perceived for the area in which the renewables are located.

Our results suggest significant discrepancies in the perceptions and opinions on the impacts of the installation of renewable energies between territories. Probably the previous experience of nearby neighbours (where wind farms exist) about the minimal impacts of these installations biases the expectations of the respondents where they are going to be installed in the short term. Having more information at present (than was the case in the first wave of wind farm installation) about the benefits and costs of these installations causes them to have lower expectations.

This heterogeneity between agents and territories in their way of seeing the possible impacts also emphasizes the importance of the idiosyncrasy of each territory. Each territory has a different way of valuing its ecological and artistic. This indicates the importance of the vision that each territory has of itself. In this way, understanding the social actors that make up rural society, it will be possible to mitigate the negative externalities associated with these parks and increase their positive externalities.

In addition, this study shows the need to evolve towards more decentralized, participatory and transparent management models. This may boost the articulation of industrial and energy policies at a regional or functional area level, integrating these activities into the territorial development model and modulating their possible spillovers.

Finally, information, training and awareness are essential to address any process of social transformation, also in relation to the change of production or energy model. The agents of the territory are key actors in the leadership of this process, managing the expectations that accompany them, involving all stakeholders, making explicit the potential positive and negative impacts, and promoting planning from a shared vision of the territory, source and guarantor of long-term sustainability.

Obviously, this work has a number of limitations that need to be taken into account. The results and policy implications of this work should be restricted to the geographical scope of the study. As we have seen, each territory has a different way of perceiving socio-economic impacts. Therefore, this is the perception of the citizens of rural area. Moreover, the point of view of other different actors (investors, engineers, technicians, local and regional institutions, . . .) which is not explicitly considered in this survey, could offer additional views and dimensions, enriching this relevant debate.

What is evident is that this type of work is essential to understand the success or failure of the installation of renewable energies in rural areas, as warned by international institutions (IPCC, 2022). Extend the scope of the study to a regional level, in order to understand the energy management model of different European regions is a further step in the analysis.

CRedit authorship contribution statement

Rosa Duarte: Concept, Design, Analysis, Writing, or revision of the manuscript. **Álvaro García-Riazuelo:** Concept, Design, Analysis, Writing, or revision of the manuscript. **Luis Antonio Sáez:** Concept, Design, Analysis, Writing, or revision of the manuscript. **Cristina Sarasa:** Concept, Design, Analysis, Writing, or revision of the manuscript.

Data availability

The data that has been used is confidential.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.egy.2022.09.173>.

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