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An empirical analysis of the impact of renewable energy deployment on local sustainability

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ABSTRACT

It is usually mentioned that renewable energy sources (RES) have a large potential to contribute to the sustainable development of specific territories by providing them with a wide variety of socioeconomic benefits, including diversification of energy supply, enhanced regional and rural development opportunities, creation of a domestic industry and employment opportunities. The analysis of these benefits has usually been too general (i.e., mostly at the national level) and a focus on the regional and especially the local level has been lacking. This paper empirically analyses those benefits, by applying a conceptual and methodological framework previously developed by the authors to three renewable energy technologies in three different places in Spain. With the help of case studies, the paper shows that the contribution of RES to the economic and social dimensions of sustainable development might be significant. Particularly important is employment creation in these areas. Although, in absolute terms, the number of jobs created may not be high, it may be so with respect to the existing jobs in the areas considered. Socioeconomic benefits depend on several factors, and not only on the type of renewable energy, as has usually been mentioned. The specific socioeconomic features of the territories, including the productive structure of the area, the relationships between the stakeholders and the involvement of the local actors in the renewable energy project may play a relevant role in this regard. Furthermore, other local (socioeconomic) sustainability aspects beyond employment creation should be considered.

Contents

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1. Introduction: aims, scope and methodology

It is usually mentioned that renewable energy sources (RES) have a large potential to contribute to the sustainable development of specific territories by providing them with a wide variety of socioeconomic benefits, including diversification of energy supply, enhanced regional and rural development opportunities, creation of a domestic industry and employment opportunities.[1] The socioeconomic characteristics of some territories in many OCDE countries make them particularly suitable to benefit from RES investments, such as a relatively large share of rural, dispersed population, high dependence on a declining agricultural sector (in a context of reduced agricultural subsidies), high unemployment rates, scarcity of regional development alternatives, declining populations and aging of the remaining population. This is acknowledged by the European Directive on renewable electricity,[2] which "recognises the need to promote renewable energy sources as a priority measure given that their exploitation contributes to sustainable development, create local employment and have a positive impact on social cohesion", among other benefits (p. 1).[3]

Surprisingly, very few empirical studies have focused on the real impact of RES on those socioeconomic variables. Their analysis has been too general (i.e., at the national level) and a focus on the regional and especially the local levels has been absent. This paper tries to close this gap, by empirically analysing those benefits. It applies a conceptual and methodological framework previously developed by the authors (see [7]) to three technologies in three different places in Spain.

Accordingly, the paper is structured as follows. The next section summarises the conceptual framework applied in the empirical study. Some methodological remarks are provided in Section 3, whereas Section 4 includes the main results of the empirical study. A discussion on the comparative impacts of the different RES projects on local sustainability is provided in Section 5. The paper closes with some concluding remarks and policy implications.

2. A theoretical framework to assess the impact of renewable energy deployment on local sustainability

Several papers have empirically analysed the contribution of RES to local sustainability (see, among others, [1–3]).[4] However, the existing empirical literature has either one of two drawbacks: (1) the analysis has been too abstract, generic and aggregated, without descending to the rural level. (2) Other empirical analyses have been carried out without an explicit theoretical framework. We aim to empirically analyse the local sustainability impacts of renewable energy deployment by considering an integrated and comprehensive theoretical approach.

The starting point of our theoretical framework, which was fully developed elsewhere,[5] is the distinction between procedural and substantive sustainability. Both sustainability approaches should be considered when analysing the impacts of renewable energy projects on the sustainability of specific local areas:

(1) *Substantive sustainability* refers to the impact on the renewable energy project on the three dimensions of sustainability (economic, social and environmental).[6]
(2) *Procedural sustainability*. A project should not only be sustainable according to those three dimensions but should also take into account the opinions and interests of all stakeholders ([22]). This calls for a wide social participation process in the implementation of sustainable development (SD) instruments and activities at the local level whereby all interested parties are involved. Therefore, it is as important to consider the different local stakeholders and the economic, social and political relationships between them. The acceptance or rejection of the project by the local population can make its

[1] Throughout this paper, we will use the general term "renewable energy sources" (RES) and the more specific term "electricity from renewable energy sources" (RES-E).

[2] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

[3] The Directive also argues that "when favouring the development of a market for renewable energy sources, it is necessary to take into account the positive impact on regional and local development opportunities, export prospects, social cohesion and employment opportunities" (p. 2).

[4] Another stream of the literature has paid attention to one of the aspects of the impact of renewable energy deployment on local sustainability: employment creation (see, for example, [4–6]). See [7] for an overview of these two streams of the literature.

[5] See a previous article of the authors [7] for further details.

[6] The *environmental dimension* refers to the reduction of local pollution, exploitation of the natural resources in the territory and maintenance of the resilience (ability to adapt to change), integrity and stability of the ecosystem. The *economic dimension* is related to the increase of regional per capita income, improvement in the standard of living of the local population, reduction of energy dependence and increase in the diversification of energy supply. Finally *social sustainability* includes the achievement of peace and social cohesion, stability, social participation, respect for cultural identity and institutional development. Reducing unemployment and improving the quality of jobs, increasing regional cohesion and reducing poverty levels are key actions at local level to achieve social sustainability.

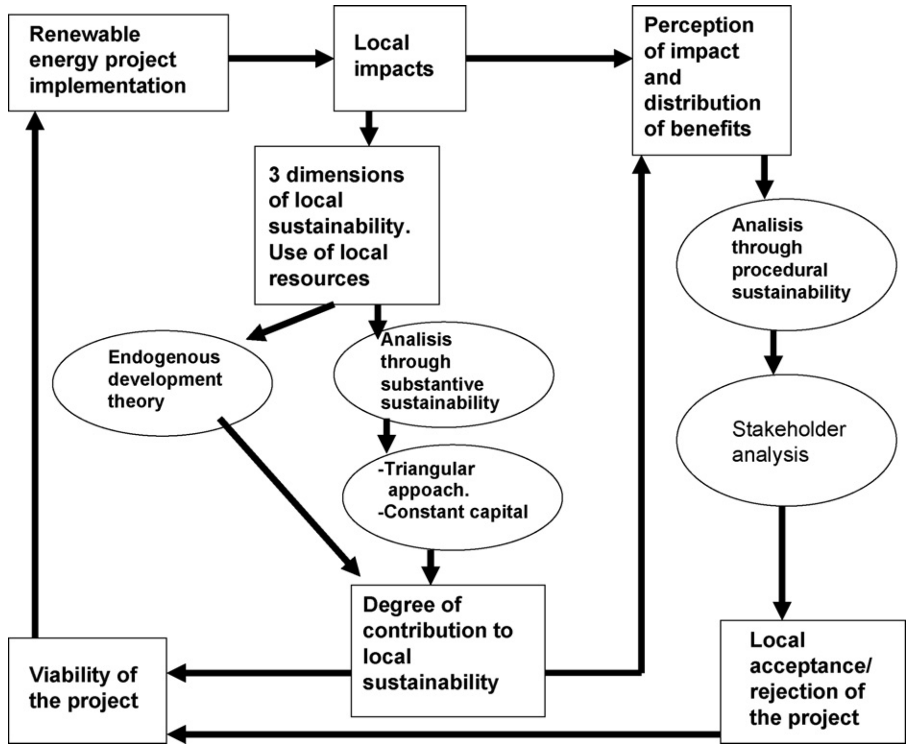

Fig. 1. Theoretical framework. Source: [7].

implementation and its contribution to local sustainability a success or a failure.[7]

Furthermore, a direct link between the approaches of local sustainability (both substantive and procedural) and endogenous development should be made. Endogenous development is a process which raises the income levels of the population based on the intrinsic resources of society and the respect for community values and traditions [11]. Crucial to the activation of the endogenous resources is the participatory approach to setting goals, procedures, and the implementation and control of economic activities. Thus, the local process of innovative entrepreneurship should meet the opportunities raised by enhancing traditional local sources of income and bringing in new activities and technologies.[8]

Fig. 1 synthesises the comprehensive analytical framework followed in this paper, which can be summarised as follows. The implementation of the renewable energy project would lead to a "substantive" local sustainability impact (three dimensions of local sustainability) and to a local development process based on the use of local resources. The extent to which this is so should be analysed, respectively, with insights from the substantive sustainability approaches and the endogenous development theory.

The "substantive" contribution to sustainability can lead to social benefits whose distribution is uneven across different actors and/or are perceived differently by different stakeholders. This distributional and perception issues should be analysed as part of the procedural sustainability approach. The *stakeholder analysis* is particularly suitable in this context to study actors' interests, incentives and strategies and their mutual relationship and interactions. These interests and perceptions may lead to the acceptance of the project by the local population and, together with the "objective contribution" of the project to local sustainability, they are an essential ingredient in the viability of the project itself.

What are the impacts and stakeholders interests in the context of renewable energy projects? Renewable energy projects affect several dimensions of the socioeconomic sustainability of a given territory (Table 1).[9]

The perceptions of the socioeconomic benefits of the project by the local population and the interests and strategies of actors should be analysed since the public acceptance of the project is directly related to such perceptions.[10] "Stakeholder analysis" is deemed the most suitable methodological tool for this procedural-sustainability related task.[11]

[7] Of course, both issues are interrelated. The local sustainability impacts of a renewable energy project depend on the features of the local actor network and on the conditions and characteristics of the stakeholders themselves. In turn, the greater the benefits for the local communities, the greater the attractiveness of rural areas and the greater the possibilities for the social acceptance and success of the project. At the end, support for RES will depend to a large extent on the perception of its benefits at the territorial/local level.

[8] For further details on the concept of endogenous development applied to rural regions, see [8,9]. [10] has provided the analytical framework for the "local development" approach.

[9] Given that this paper focuses on the socioeconomic variables, environmental impacts are not considered here in detail although, of course, they are very relevant in the assessment of the local sustainability of a renewable energy project.

[10] Relevant stakeholders include: renewable energy generators and investors, local governments, local populations, local NGOs, local organisations and farmers cooperatives.

[11] Stakeholder analysis is a process of systematically gathering and analyzing qualitative information to determine whose interests should be taken into account when developing and/or implementing a policy or program. Stakeholders in a process are actors (persons or organizations) with a vested interest in the policy being promoted. Policymakers and managers can use a stakeholder analysis to identify the key actors and to assess their knowledge, interests, positions, alliances, and importance related to the policy. This allows policymakers and managers to interact more effectively with key stakeholders and to increase support for a given policy or program. When this analysis is conducted *before* a policy or program is implemented, policymakers and managers can detect and act to prevent potential misunderstandings about and/or opposition to the policy or program, increasing the probability that it will succeed [13].

Table 1
Classifying the potential impacts of renewable energy projects on local sustainability

Type of impact	Description
1. Quantitative and qualitative impacts on employment	Both quantitative and qualitative impacts should be considered: as important as the number of jobs created in a specific area is their continuity. This depends on, both, the stage of the renewable energy project and the type of renewable technology considered. In the context of rural sustainable development, other qualitative aspects are highly relevant: First, with the aim to increase social cohesion, a positive impact on the employment rates of specific sectors of the population is desirable and, particularly, on young people, women and long-duration unemployment. Has led the project to the hiring of those unemployed? Has it caused a transfer of workers from agriculture and farming to the renewable energy sector? Has it provided a supplementary source of employment? Has it contributed to an increase in the employment diversification, mitigating an excessive concentration on a declining agricultural activity? What type of employment is being created according to the level of skills (high/average/low)? What part of the jobs as a result of the project is created in the local area?
2. Income generation effects	Payments to local farmers for hiring their land and "compensations" to the local community made by the owner of the renewable plant. These compensations facilitate the acceptance of the project by the local community
3. Demographic impact	How does the project affect migration and immigration? Does it lead to a greater share of younger people?
4. Energy impacts	Is a significant share of the energy consumption in the area covered with the energy produced in the project?
5. Educational impacts	Do local workers in the project receive specific training, which increases the education/training/skills levels of the population?. Does the project provide funds for the construction of local libraries?
6. Impact of the project on productive diversification	RES projects are particularly interesting when a large share of the regional value-added is concentrated in the agricultural sector
7. Social cohesion and human development	Does the project improve the socioeconomic prospects and self-confidence of the young population? Does it increase the level of engagement in associations and improve social relations?
8. Income distribution	Do the benefits of the project fall on low-income groups? Does it contribute to poverty alleviation?
9. Impact on tourism	Does the project attract visitors?
10. Other impacts	Impacts of the project on manufacturing activities in the area and the municipal budget
11. Use of endogenous resources	Integration of the project within the local economy, leading to a backward (local suppliers) and forward productive linkage (final local customers). The greater the integration of the project in the productive structure of the local economy, the greater its socioeconomic impact on the local community

Source: Own elaboration.

3. Methodological remarks

3.1. Quantitative versus qualitative approaches: advantages and drawbacks

The impact of RES projects on local socioeconomic sustainability can be analysed with either quantitative or qualitative approaches. Both methodologies provide useful information and have their advantages and disadvantages. Therefore, they should not be regarded as substitutes.

Quantitative studies have generally focused on employment effects with two types of models: (a) *input–output* approaches; and (b) more simple spreadsheets-based analytical models [4]. The later calculate only the jobs created in the production, construction, installation, management and O&M of the different components of the technology or the electricity generation plant. Ratios of jobs created in all those stages per MW of installed capacity are provided, although these ratios differ across studies (see [12]). In contrast, *input–output* (IO) approaches calculate the direct and indirect employment as a result of induced effects from the project.[12]

Both quantitative approaches have advantages and drawbacks. IO provide a more complete picture of the economy and can capture the multiplier effects on employment and the macroeconomic impacts of shifts between sectors (losses in one sector created by growth in another sector). Analytical models tend to ignore these multiplier effects and, thus, usually undervalue the employment creation effects. However, IO models are opaque and make several brave assumptions to achieve a high level of aggregation (see [4]).

[12] The TERES II project and the MITRE initiative are examples of this approach.

Notwithstanding, there are some disadvantages of quantitative studies in the context of this paper. They are not able to capture the relevance of the local context and cannot analyse the interests of local stakeholders and the relationships between them. In the case of RES deployment, these issues can be analysed with the help of qualitative studies in the form of case studies.

Case studies allow the identification of economic and social relationships which are hidden in quantitative studies. The later usually establish general relationships and omit crucial aspects of the impact of the project on the local community. In contrast, case studies adopt an "on the ground" approach, which goes down to the level of local actors and is capable to capture detailed socioeconomic effects which are unnoticed by more aggregated analysis. Most of the data needed to carry out a complete analysis of those local socioeconomic impacts are simply not available. Furthermore, given the generally small dimensions of local communities it is not possible to obtain sufficiently large samples in order to perform an econometric or input–output analysis. This makes case studies an appropriate method to be used in the analysis of those effects, although their main caveats are the difficulty to use them to make generalisations and that the policy implications may be limited.

However, such a choice also has its cons. A quantitative analysis is considered more rigorous and objective. The case study results depend on the opinions of those interviewed and on the choices made by the interviewer when making the questions, collecting and interpreting the information. Scientific rigour is lost, although richness in the identification of relevant details is gained. Care should be taken when treating the information collected from the interviews. General patterns (and exceptions to these patterns) should be found, avoiding a merely a collection of anecdotes. It

Table 2
Contribution of different RES to rural and regional development

Technologies	Main-impact stage	Other stages
Wind	Construction and design of installation	Equipment manufacturing and energy production (maintenance)
Small hydro	Construction and design of installation	Equipment manufacturing and energy production (maintenance)
Solar PV (isolated systems)	Equipment manufacturing	Installation and maintenance of equipment
Solar PV (grid-integrated systems)	Equipment installation	
Solar thermal	Equipment manufacturing	Installation and maintenance
Biomass for electricity and biofuels	Supply and conditioning/transformation of the resource (agricultural stage)	Other stages

Source: Own elaboration.

should be clear beforehand which actors would be interviewed and what type of information would be required.

Finally, the case study should take into account the type of renewable energy technology and the stage of the process. The contribution of RES to local development can occur in any stage of the renewable energy production cycle: supply, transformation and processing of the resource (biomass and biofuels), renewable energy equipment, technology and component manufacturing, design and construction of RES installations and RES production. Distinct technologies will contribute differently to rural and regional development in different stages of the RES production cycle (see Table 2).

3.2. Criteria to select the local areas for the study

Three renewable energy technologies have been chosen in this paper: wind electricity, solar PV electricity and biodiesel for different reasons. Wind electricity is already very relevant in Spain, being the second country in the world in terms of installed capacity and already 10% of electricity demand is met by wind generation. Solar PV and biofuels are expected to be the two renewable energy technologies experiencing the greatest growth rates in the 2004–2010 period, according to the renewable energy plan (see below). The three renewable energy projects selected are very large within their categories (see Section 6) and they are considered by policy makers as one of the most relevant alternatives to traditional agriculture and a key instrument to achieve less carbon-intensive energy and transport systems which allow compliance with the Kyoto Protocol.

Apart from selecting renewable energy technologies, the local areas for the analysis through case studies should be chosen, considering the potential impact of RES on local sustainability. Therefore, we have selected rural areas where relatively large renewable energy projects have been implemented. Furthermore, agriculture plays a dominant role in the productive structure of these local economies, although it is a declining activity and no rural development alternatives exist. In these cases, RES projects can make a significant contribution to the local socioeconomic dimensions of sustainability. It can be expected that the three RES projects will lead to very different local impacts.

4. The empirical study

The previous analytical framework is applied to study the contribution of RES projects in this section. First, a brief context of the situation of these renewable energy technologies in Spain and their promotion policies is provided.

4.1. Wind, biodiesel and solar PV in the world, European and Spanish contexts

4.1.1. Wind

Spain is the second country in the world in terms of wind energy installed capacity, with 10 GW, only behind Germany (18 GW) and above the US (9 GW).[13] The growth rates of wind installed capacity in the last decade are impressive.[14] It currently covers 10% of electricity demand.

A great wind electricity potential, a favourable regulation, a high maturity and technological evolution and a great manufacturing capacity of the domestic industry are factors behind this success ([14]). Indeed, more than 70% of wind installed capacity by the end of 2005 was supplied by Spanish manufacturers. Thus, the territorial impact of wind electricity does not occur only in the generation and construction stages, but also through the manufacturing of wind turbines.

Castilla-La Mancha, the focus of this study, represents one-fifth of the total installed capacity in Spain, only behind Galicia. 63 wind farms (2019 wind turbines) are installed in this region [15].

4.1.2. Biodiesel

With a biodiesel production capacity of 224,000 metric tonnes in 2006, Spain is the fifth country in production capacity in the EU, after Germany, France, Italy and United Kingdom. However, it has experienced the highest growth rates in the last 2 years (almost a 5000% increase), related to the start of operations of two production plants in Castilla-La Mancha.

A great share of Spanish production is exported and only 40% is consumed in Spain. Notwithstanding, biodiesel only represents 0.10% of diesel consumption in this country.

4.1.3. Solar PV

Solar PV has been a very dynamic sector in Spain, with growth rates of 105% in 2006, 54% in 2005 and 39% in 2004. With 118 MWp of accumulated installed capacity, it reached the second place in the EU in 2006 [14]. It represents 1.3% of world installed capacity and it is the fifth country in this regard (behind Germany, Japan, USA and Australia). With 6.06 MWp, the share of Castilla-La Mancha in total installed capacity in Spain is 5%.[15]

Table 3 shows that the three renewable energy technologies considered in this paper are expected to increase significantly in the 2005–2010 period, according to the National Renewable Energy Plan.

4.2. Promotion measures

The relevant regulation concerning the three projects being analysed (wind, solar PV and biodiesel) is European, national and regional and mostly refers to the energy sector, but also to the agricultural sector (in the case of biofuels).

[13] Data for 2005.

[14] In the 1998–2005 period, wind capacity has grown at an average annual rate of 42%, from 835 MW to 9.911 MW by the end of 2005.

[15] This figure is clearly below that which corresponds to the solar PV potential in this region, with high irradiation levels.

Table 3
Situation and trends in renewable energy deployment in Spain

	Situation in 2004			Target in 2010		
	Installed capacity (MW)	Generation (GWh)	Primary energy production (ktoe)	Installed capacity (MW)	Generation (GWh)	Primary energy production (ktoe)
Wind	8155	19,571	1.683	20,155	45,511	3,914
Solar PV	37	56	5	400	609	52
Biofuels	–	–	228	–	–	2,200
TOTAL RES*	–	–	9739	–	–	20,220

Source: [21]. *Includes the other renewable energy technologies.

Table 4
Support (tariffs and premiums) for solar PV and wind electricity according to RD 661

Installed capacity (IC)	Period	A) Regulated tariff (€cents/kWh)	B) Reference premium (€cents/kWh)	Upper limit (€cents/kWh)	Minimum limit (€cents/kWh)
Solar PV					
IC ≤ 100 KW	First 25 years	440,381			
	After 25 years	352,305			
10 kW < IC ≤ 10 MW	First 25 years	417,500			
	After 25 years	334,000			
10 < IC ≤ 50 MW	First 25 years	229,764			
	After 25 years	183,811			
Wind					
Wind	First 20 years	7.3228	2.9291	8.4944	7.1275
Wind	After 20 years	6.1200	0.0000		

Source: Own elaboration from RD 661.

Following European guidelines and legislation (mostly, the 1997 White Paper on RES[16] and Directive 77/2001/EC on renewable electricity), but also as a result of an internal acknowledgment of the socioeconomic and environmental benefits of RES for the country, RES promotion has been a national priority in Spain for more than a decade. This has come specifically to a generous feed-in tariff system for renewable electricity (RES-E) and a wide political commitment to continue the system and avoid discontinuities in support which negatively affects RES investments.

Concerning RES-E promotion at the national level, the feed-in tariff scheme (FIT) was implemented in 1998 (Royal Decree 2818/1998), and has been subsequently modified in 2004 (Royal Decree 436/2004) and, recently, in June 2007 (Royal Decree 661/2007).

The RES-E generator has one of two options, he can either sell his electricity at a regulated tariff or directly in the power market, receiving the market price plus a premium. In this later case, a cap-and-floor of support levels is introduced for some technologies (wind, but not solar PV). The upper threshold limits windfall profits for RES-E generators and ensures that consumers will not be overburdened. The minimum threshold encourages investments in RES-E by reducing the risks for investors. Table 4 shows the support levels for wind electricity and solar PV under both systems (A and B).

In the case of solar PV, and in addition to the FIT, there are other support mechanisms, including a tax reduction of 10% in corporate taxes, investment subsidies and municipal tax reductions granted voluntarily by regional an municipal governments.[17]

On the other hand, support for biofuels has its roots in different European norms and relates to different stages of the production and consumption cycle for biofuels.

Concerning the production of energy crops for use as biofuels, the Common Agricultural Policy provides a 63 €/ha support to crops. In addition, since 2003, an additional support of 45 €/ha for energy crops was implemented.[18] Sunflower crops receive an additional support for "environmental reasons".

Regarding support for consumption of biofuels in the transport sector, the biofuel Directive[19] sets indicative targets on the share of biofuels in transport (2% in 2005 and 5.75% in 2010) with respect to oil products commercialised in each Member State.[20] This has encouraged the adoption of national measures for biofuel consumption.

However, the most relevant regulation is Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity, which opens the door for a favourable fiscal treatment of biofuels by Member States, allowing them to apply fuel tax exemptions. This has proven to be the main instrument in Member States to promote this RES. In Spain, the Law 53/2002 on the implementation of fiscal, administrative and social measures anticipated Directive 2003/96 and applies a "zero hydrocarbon tax rate" for biofuels.[21]

Finally, legislation at the regional level on RES has had some relevance in certain regions (Autonomous Communities, AACC) and it may be an important source of future RES support. AACC can enact their own legislation regarding the promotion of RES, apart from having competencies in the administrative procedures and authorisation of installations. They can also provide investment subsidies to RES projects, which has proven to be quite relevant in the case of solar PV.

Castilla-La Mancha has recently approved its own RES Law and it includes four plans to promote solar, biomass, hydrogen and wind energy. Furthermore, its Strategic Plan for Energy Development has recently been approved, setting several goals regarding

[16] White Paper for a Community Strategy and Action Plan "Energy for the future: Renewable Energy Sources of Energy" COMM(97)599 final.

[17] Up to 50% in the tax on Economic Activities, up to 95% in the tax on Construction, Installation and Public Works and up to 50% on the real-estate tax.

[18] Energy crops cultivated on eligible land (i.e., not set-aside land) and under a private contract between the farmer and the transformation plant. This support is provided for a maximum total surface of 1.5 million hectares.

[19] Directive 2003/30/EC on the promotion of biofuels in the transport sector.

[20] The EU has recently set a 10% objective for 2020.

[21] This is confirmed by Law 22/2005 on energy taxation which foresees the application of a zero tax rate until 31 December 2012.

RES for 2010: (1) that 100% of electricity demand is met by RES-E (the share was 40% in 2004); (2) that 26% of primary energy consumption is met by RES (2004: 9.7%) and (3) that biofuels represent 7.4% of fuels used in the transport sector (2004: 1.7%) [16].

4.3. The case studies

This section provides a description of the case studies carried out as well as the main results concerning the contribution of RES deployment for the socioeconomic dimensions of local sustainability.[22]

4.3.1. Design of the case studies

Information from several local actors (representatives from the three RES installations, municipal governments and neighbours) has been obtained through interviews in the case studies, according to the *stakeholder analysis* methodology. The interviews were carried out on the project site and complemented by telephone follow-ups. The authors also visited the installations (except the PV installations) and the respective local areas.[23]

The selection of the renewable energy technologies and the local areas for the study took into account the criteria considered in Section 3.2, i.e., relatively large projects with mature renewable energy technologies (solar PV, wind electricity and biodiesel) in areas with few development alternatives.

The large size of the three projects in their respective categories makes them have a significant relevance at the national and even European levels. The Marachón wind farm is the largest in Spain and one of the largest in Europe. The biodiesel plant is the largest in Spain. Finally, the solar PV plant is the second largest in Spain and the 19th largest in Europe.

4.3.2. Wind electricity in Maranchón

4.3.2.1. Socioeconomic situation of the area. The wind farm is located in the Guadalajara province, about 150 km north from Madrid. The socioeconomic influence of Maranchón's wind farm extends to a geographical area of 1074 km^2, 12 towns and a total population of 5425 inhabitants,[24] i.e., a population density of 5.04 inhabitants/km^2. The degree of population aging in the area is very high: 33.7%.

This demographic situation, that follows similar patterns in the other two case studies, leads to a negative feedback impact on the local area. The ageing of the population limits the possibilities to undertake economic activities in the territory which, in turn, has a negative impact on the demographic trends of the area. The working population amounts to 1676 persons and represent 32% of the total population.

4.3.2.2. Technical features of the wind farm. Iberdrola is the wind farm owner, which started to operate in April 2006. The 104 wind turbines have been purchased to the Spanish manufacturer Gamesa. Each wind turbine has a unitary capacity of 2 MW and 2500 h functioning per year. 208 MW is thus the installed capacity of the whole wind farm. It represents 1.8% of wind installed capacity in Spain and 13% of that installed in 2006.

4.3.2.3. Investment and income distribution. The total investment in the wind farm amounted to 188 M€.[25] According to the Territorial Planning Law, 2% of this total investment should go to the municipality where the wind farm is situated. This represents 3 M€. Furthermore, land rental fees are 4000 € per wind turbine, which also go to the municipality of Maranchón, since wind turbines are situated in municipal lands.[26]

4.3.2.4. Employment. There are currently 6 jobs related to maintenance activities, in addition to 15 employees of the turbine provider, Gamesa, which are working at the site, since the equipment is under guarantee. In 2 years time, when the guarantee is over, the wind farm will lead to 12 direct, full-time jobs.

Two additional direct jobs have been created in the townhall of Maranchón as a result of the aforementioned income transfer from Iberdrola: one is in charge of the library and another undertakes administrative tasks. Furthermore, an "educational house", funded with such income transfer, will be built in Maranchón and three additional jobs will be created.

Direct but non-permanent jobs during construction should be added to this calculation. This amounted to 150 jobs in a 10-month period. Permanent indirect jobs are virtually impossible to identify, although they are probably very limited.[27] The tourist attraction of the wind farm is also limited, despite the continuous flow of visits (schools) and the creation of the educational house, which will have a positive impact in this regard.

The impact on employment is high in relative terms, considering the low population density and the total employment in the area. Alternative economic activities are limited and include agriculture, cattle raising and rural tourism activities. However, in spite of the recreational value of the site, making a living out of tourism seems difficult in the area.

4.3.2.5. Perception of the benefits of the wind farm by the local community. Rejection of local environmental NGOs to the installation of wind farms have been present in the area (related to visual intrusion, impact on birds and noise), but not specifically in Maranchón. In addition to excellent wind resources, this was a key factor for installing the wind farm.

The local population has in general a favourable opinion of the wind farm, although some consider that its benefits have not been significant. There is a widespread perception that they have not benefited much from this large investment. There is some controversy on the distribution of the benefits of such investments, in a process which obviously has had winners and losers.

The impact of the project on local social cohesion, the quantity and quality of human relations in the area, the forming or engagement in associations or the future prospects of the population is rather modest.

It is difficult to conclude that the wind farm has significantly contributed to fixing population in the territory. There has been a positive impact on the rejuvenation of the area and to limit

[22] A number of papers have analysed in a non-detailed, generic manner the contribution of RES to socioeconomic development and to the reduction of environmental problems in several regions of Spain, one of the leading countries in the world regarding RES deployment. The following are worth mentioning in this regard: [17–19]. These studies conclude that RES may significantly contribute to regional development and focus on positive employment effects. However, they provide very general data but the contribution of RES to local sustainability is not analysed in depth.

[23] In the case of the biodiesel plant, only the general installation was accessed, but not the technological details of the plant.

[24] According to INE data in 1 January 2006.

[25] This involves an investment ratio of 903 €/kW, which is lower than the one calculated by the Renewable Energy Plan for a typical wind farm in this category (947 €/kW).

[26] Furthermore, other taxes are also collected by the municipal government (the tax on economic activities and the tax on property).

[27] This is so because the scale of the maintenance activities of the wind farm is very limited and there is no economic activity related to the supply of the fuel (the wind), which is free.

migration and depopulation.[28] Apart from the employment created and the income transferred, it is difficult to foresee an additional economic impact that leads to a permanent income stream which prevents local people from migrating. People from the area have benefited from the jobs created and people from outside the area have not been attracted.

4.3.3. Biofuels in Tarancón

4.3.3.1. Socioeconomic situation of the area. The OLCESA biofuel plant is located in Tarancón (Cuenca), around 80 km southeast from Madrid. It is an area with a low and decreasing population density (10 inhabitants/km^2). The declining agricultural activity is behind the decreasing population trend, although the share of agricultural employment with respect to total employment is still very high (20%) making this territory a deeply rural one. The loss of agricultural employment has focused on small farmers, who have gradually abandoned the activity.[29]

4.3.3.2. Main features of the project. 50,000 tonnes/year of biodiesel from sunflower seed, obtained in the local area, will be produced with a technology developed by the firm itself.

The firm has been dedicated to the production of olive and sunflower oil since 1840. Therefore, they are not newcomers to the business and biodiesel production seems a logical extension of their traditional activity since knowledge had been accumulated in the firm and the local area. The project investment amounted to 15 million €.

4.3.3.3. Employment created. 23 direct jobs are created in the plant. This should be added to the agricultural jobs that are not lost as a result of the biofuel production providing an alternative to the declining agricultural activity. The company has signed 4522 contracts with farmers in order to ensure the provision of the raw material in 2006–2007. However, the net impact on agricultural employment is difficult to identify, since we do not know how many farmers would leave their activity if the option of energy crops did not exist.

People living in the local area are the ones benefiting from the employment created. The skills required are medium/high (university or technical school degree). Although young people are benefiting from the jobs created, a positive impact on women's unemployment or long-term unemployment has been absent.

4.3.3.4. The benefits of energy crops for the firm and the farmers. Energy crops guarantee the continuity of their business for, both, the firm and the farmers. For the firm, this is an additional line of business to the production of oil for food purposes. Energy crops are between 1.2 and 2.4 €cents/kg more profitable for farmers than traditional, food-related crops.[30] An additional advantage is that they can cultivate energy crops in set-aside land.

However, in spite of such greater profitability, most farmers engaging in the energy-crops business only cultivate 50% of their land with energy crops, leaving the other half for food crops. They aim to diversify and reduce risks and they still do not rely on the emerging energy-crop market.[31] In addition, farmers receive a price for food-related sunflower seeds which is variable, whereas the price for energy crops is fixed (negotiated with the firm). However, changes in world demand may lead to variable prices being above the fixed prices, making the energy crops more profitable (although also more uncertain).

This activity does not really involve a diversification of the activity for farmers, but it rather allows farmers to maintain their activity. It is diversification for the local area with respect to the transformation of the raw material (sunflower seed).[32]

4.3.3.5. Involvement of local actors and perception of the benefits from the project. There seems to be a favourable opinion among the local population on the project, given its embedding within the local economy, the use of local (endogenous) resources and the socioeconomic benefits it entails.

4.3.3.6. Other impacts. Regarding other effects, they are rather limited, particularly, educational, energy and municipal budget impacts.

Finally, and in contrast to other agricultural crops for biofuels, a reduction in the supply of sunflower seeds for food uses does not seem to have had a negative impact on the price of food products, although this impact may be negative in the future, when and if the volume of energy crops is significant.

4.3.4. PV Solar

4.3.4.1. Socioeconomic situation of the local area. The socioeconomic features of the area are similar to the other too cases. It is a "deeply rural" area, highly specialised in a declining agricultural and cattle-raising sector, with few other development alternatives. The structure of the population is relatively and increasingly old.

4.3.4.2. Characteristics of the project. Toledo PV is located in La Puebla de Montalbán (Toledo province). The facility consists of 7936 modules installed in three fields consisting of 25 array strings: Two 450-kW fields comprising fixed structures and one 100-kW solar tracking field.[33]

The project, jointly developed by Unión Fenosa, Endesa and RWE, started to operate in 1994 and it was the largest PV installation in Europe until 1995. Compared with the other 35 PV installations in the world above 1 MW, Toledo PV is the oldest in Europe and the second oldest in the world and it is the 26th largest in the world, the 19th largest in Europe and the second largest in Spain.

4.3.4.3. Qualitative and quantitative impacts on employment. The quantitative impacts in terms of absolute employment created are very small: only 1 full-time job from outside the local area, with several responsibilities: coordination of the visits to the installation, reception of maintenance technicians and surveillance of the installation.[34] However, many activities are already undertaken through electronic devices and computers, including control of the

[28] The town has 65 permanent inhabitants, although there are more than 200 people registered.

[29] Data from the 2006 population census and from the Regional Spanish Accounting System. Data for the South of the Guadalajara area are based on [20].

[30] According to [16], however, this can be as high as high as 5.3 €cents/kg.

[31] This distrusts also manifests in the fact that farmers do not want to sign contracts for more than one year, in contrast to the firm, which would prefer long-term contracts.

[32] The approach followed in this biodiesel plant is different to other biofuel plants as the one in Olmedo (Valladolid), where there is a direct involvement of cooperatives and farmers in the manufacturing of the biofuels. These are owners of the bioethanol plant and control the whole supply chain. The organisation of farmers and the creation of plants with the direct participation of cooperatives/farmers should be promoted.

[33] The site for the plant was chosen on the following grounds: Strong radiation (on a tilted plane, approximately 1.9 kWh/m^2 (latitude 40°N)), existing 15-kV medium voltage grid, size of available lot (area of approximately 30,000 m^2), good infrastructure and ready access via national and regional roads. The total costs of the project has reached 9 million €. Further technical details of the project can be found at http://www.toledopv.com.

[34] Data from the firm suggests that there could be significant economies of scale in this regard since a greater capacity PV installation would not need more than one person either.

Table 5
Summary of the comparison of the local sustainability impacts of different RES projects

Local-impact indicator	Wind electricity	Biodiesel	Solar PV
Investment (M€)	188 M€	15 M€	9 M€
Installed capacity	208 MW	50000 annual tonnes	1 MWp
Primary energy production (ktoe)[a]	33	70	0.13
Direct employment generated	12	23	1
Direct employment generated per ktoe of primary energy generated	0.36	0.32	7,69
Direct employment generated per M€ of investment	0.063	1.53	0,11
Primary energy production per M€ of investment	0.17	4.66	0,13
i. Impact on employment	+	++	++??
ii. Demographical impacts	+/0	++	0
iii. Energy impacts	0	0	0
iv. Educational impacts	+/0	0	0
v. Impacts on the productive diversification of the area	++	+	0
vi. Integration in the local economy (use of local resources)	+/0	++	0
vii. Social cohesion and human development	+/0	+	0
viii. Income distribution and impact on poverty	+/0	+	0
ix. Other economic benefits (unrelated to employment)	+	0	0
x. Involvement of local actors and perception of the benefits of the project	+/0	+	0
xi. Impact on tourism	0	0	0
xii. Creation of a local industry	0	0	0
xiii. Impact on the municipal budget	+	0	0
xiv. Environmental impact	–	–/0	–/0

Note: (++) highly positive influence on the variable considered; (+) positive influence; (+/0) very small positive impact; (0) no impact; (–/0) very small negative impact; (–) very negative influence.
[a] See text for details on the calculation of primary energy production.

functioning of the installation. The installation is visited every 2 months by technicians (mostly from outside the local area) in charge of revisions and corrective and preventive maintenance. This is thus an insignificant source of employment. Other potential sources of employment (and income) are also highly insignificant. One is the jobs created during the construction of the site (land preparation and construction of the main building). These jobs (around 10) were of short duration, although some of them were from the area. Another is the jobs created in the manufacturing of the PV panels. The first devices were manufactured by a German RWE subsidiary. They were replaced by panels manufactured by the Spanish companies BP Solar and Isofotón. These are manufactured far from the project location (in Madrid and Malaga, respectively).

Finally, the project does not seem to have generated significant income for the area (neither directly nor indirectly, for example, by the visitors to the site) to have led to job creation. To sum up, the employment impacts are both quantitative and qualitatively extremely modest in the rural area. This is an unfortunate state of affairs, since the employment in this "deep rural area" is almost completely concentrated in the primary sector.

4.3.4.4. Income generation. Income generation for the area has been almost non-existent. The project is not integrated in the productive structure of the local community, i.e., it does not create neither backward nor forward productive linkages. It is quite separated from the local production system (i.e., a production island) and, thus, has not led to a productive diversification in the area. No compensations to the local community or local farmers have taken place. The land is owned by the electric utility, which is also the project developer and, in contrast to the wind project case, there have not been income transfers (additional to tax payments) to the local municipality. The project has not affected income distribution and has not improved social cohesion or human development (i.e., number 7 in Table 1).

4.3.4.5. Demographic, energy and educational impacts. Given the particular characteristics of the project (relatively small size, no link with the socioeconomic structure of the area), there are no demographic impacts. Since the electricity generated is fed into the general electricity grid and no special price for the neighbours is offered, there are no energy impacts. Finally, education impacts are minor and table place only through the information provided to the visitors of the plant.[35] No increase in the educational levels of the local population as a result of the project is identified.

5. Discussion: comparing the local impacts of renewable energy projects

In order to illustrate the potential influence of different types of RES projects on the socioeconomic dimension of local sustainability, the three RES projects can be compared between each other, taking into account the criteria of Section 2. Table 5 summarises these impacts, which are further discussed in the rest of this section. This comparison is contingent upon the specific features of the projects and the local areas where they are located and may not be representative of the respective RES categories.

In order to compare the three cases, the primary energy produced in kilotons of oil equivalent (ktoe) should first be calculated. If we assume an average ratio of 0.15 ktoe of primary energy production per each MW installed,[36] then the primary energy produced in the wind farm would be around 33 ktoe. Similar calculations are undertaken for the other two projects, leading to 70 ktoe in the biodiesel project and 0.13 ktoe in the solar PV case.[37] The other ratios are calculated considering these results.[38]

[35] In 2004 the installation received around 1900 visitors, of which half where students from secondary schools, 1/4 were students from universities and the other 1/4 were from firms.

[36] This is assumed by the National Renewable Plan (PER) for a wind farm with 2350 h/year. According to the PER, the 8155 MW of installed capacity in 2004 led to 15,066 GWh of electricity generation and 1295 ktoe of primary energy production.

[37] We identify the primary energy production that would stem from 50,000 annual tonnes of biodiesel production capacity. The PER identifies that the 6 biodiesel projects in 2004 had a combined production capacity of 81000 annual tonnes and led to 115,000 toe of primary energy production. This involves a ratio of 1,38 toe per tonne of production. Thus an installed capacity of 50,000 metric tonnes of biodiesel would lead to 70 ktoe of primary energy production. In the case of solar PV (1 MWp of installed capacity), the PER foresees that 363 MWp of installed capacity will be installed in 2005–2010 leading to a primary energy production of 48 ktoe. Therefore, 0.13 ktoe of primary energy are produced per MWp of installed capacity. Of course, these are approximate figures and should be taken with caution.

[38] It can be observed that the solar PV installation is smaller than the other two plants but, within its category (solar PV), it is relatively large (2nd in Spain, 19th in Europe and 26th in the world). In other words, solar PV installations tend to be of a smaller size compared to the other RES categories.

5.1. Impact on employment

This comparison should consider several aspects.

- *Stages of production*. Whereas the wind and solar PV projects generate employment in construction and in electricity production (in addition to the manufacturing of wind turbines and solar PV panels), the biodiesel project also creates jobs related to the raw material provision (sunflower seed) and its transformation into biodiesel. Few jobs were created in this case, since it was an extension of the existing plant. In addition, the jobs related to agricultural activities that would be lost in the absence of the energy crops alternative should also be considered, although this is very difficult to calculate.
- *Direct employment*. The biodiesel project generates a greater amount of direct jobs than the other two projects (23 jobs versus 12 and 1).
- *Indirect employment*. This is difficult to quantify, although the biodiesel company estimates that the sum of direct and indirect employment could reach 200 jobs. In the case of solar PV, the number of indirect jobs is negligible, but they may have some relevance in the other two cases.
- *Employment linked to income transfers*. This is particularly relevant in the wind project, given the significant income transfers from the company to the local community, which have led to two jobs. They are non-existent in the other two cases.
- *Employment temporariness*. In the three cases, the jobs created in production have a permanent character. However, in the biodiesel case there is an additional impact on the raw material provision stage (contracts with farmers).
- *Type of employment created according to the skills*. In the three cases, the skills required are medium/high (university or technical school degree).
- *Impact on youth, women and long-term employment*. There is a particularly positive influence on young employment in the case of project of wind and biodiesel and solar PV. There is not evidence of the influence on women or long-term unemployment in any of the three areas.
- *Employment created in the local area versus employment created outside the area*. In contrast to the solar PV case, the jobs created in the wind and biodiesel projects are from the local area. The manufacturing of solar PV modules and wind turbines leads to employment creation, although outside the local area.
- *Local employment diversification*. The wind farm and the biodiesel plant lead to a diversification of the local production system. In addition, the biodiesel project favours the continuity of the agricultural activity in the area. The impacts of the solar PV plant are non-existent in this regard.
- *Intensity of employment*. The energy intensity of employment (measured as jobs per toe of primary energy produced) is similar in the wind and biodiesel cases, whereas it is much greater in the PV case. In contrast, the investment intensity of employment (i.e., jobs created per € invested) is much greater in the biodiesel case, even if the jobs related to the agricultural activity are not considered.[39] In addition, the ratio of the number of jobs created in operation and maintenance per MW of installed capacity in the solar PV case study (1) is within the ranges of the studies of employment created in renewable energy projects (0.2–4.8 for solar PV), as surveyed by [12]. In contrast, the ratio for wind (0.06) is lower than the corresponding range (0.1–0.3), probably due to the large size of the wind farm, which leads to significant economies of scale in terms of employment.
- *Relative employment*. With respect to the population of the respective areas (municipalities), the wind farm has had the greatest impact (12 jobs for 69 inhabitants), whereas the effect of solar PV is almost non-existent (1 job for 8500 inhabitants). The biodiesel project is in an intermediate position (23 jobs for 10,000 inhabitants).

To sum up, the contribution of biodiesel and wind electricity to employment creation in rural areas is a very positive aspect of these projects, which is not the case in solar PV. However, although the employment impacts of the biodiesel project are greater in quantity and more integrated in the existing local production system that in the case of wind, the relative impact on employment (with respect to the population of the area) is greater in the wind energy case. The qualitative impacts on employment are very limited in the three cases.[40]

5.2. Demographic impacts

None of the three projects have led to a migratory flow towards the local communities, but they may have contributed to keep some people in the local territory. It is highly difficult to estimate the extent to which this has been so, but it can be expected that these potential impacts have been greatest in the case of biodiesel, given the absolute impact on the jobs created and its additional impact on agriculture. Again, this impact is negligible in the case of solar PV.

5.3. Energy impacts

They are negligible in the three cases. The local population has not benefited from a cheaper energy supply in none of the three cases.[41] There has not been a significant impact on the flexibility or security of energy supply in the area.

5.4. Educational impacts

Non-significant, especially in the biodiesel case. Educational impacts can take place in two cases: (1) regarding the technical training of the staff working in the projects; (2) through information on RES provided to the visitors to the plants. The first type of impact has been very limited in the three cases (especially in the solar PV case). The second type of impact is relevant in the wind and solar PV cases and non-existent in biodiesel.

5.5. Impacts on the productive diversification of the area

In contrast to the solar PV plant, the wind and biodiesel plants positively affect the productive diversification of the local economy, although to a different extent. The wind energy case represents a new activity, different to the traditional productive activities carried out in the area (agriculture and cattle raising). The biodiesel project allows the continuity of an activity that has been traditionally carried out in the area (sunflower crops), but it provides an additional destiny to the existing production capacity. The diversification does not take place with respect to the provision of the resource, but rather with respect to its transformation. We do not know if the people working in the RES projects are able to carry out other professional activity, supplementing their income from the RES projects.

[39] Although the PV project is large in its category, it is much smaller than the other two project. This may bias the results of this analysis.

[40] It should be taken into account that the study focuses on local areas and that the impact on employment creation, particularly for wind and solar PV, can also be felt outside the local area (i.e., in other local areas), especially in the manufacturing of the renewable energy equipment (solar modules and wind turbines).

[41] This has been the case in other places in Spain and, particularly, in the case of the wind energy farm in La Muela (Zaragoza).

5.6. Integration in the local economy (use of endogenous resources)

When analysing the impact of RES projects on local sustainability, a key issue is whether the project has easily integrated in the local productive system and has used its existing resources or, on the contrary, the project has involved a deep rupture with the activities traditionally carried out in the area. Each project represents a different model in this regard. The biodiesel project is quite integrated in the local economy, has a significant influence on its productive structure and leads to strong backward productive linkages (through the provision of the raw material by the farmers). It uses the endogenous resources in the territory (including the accumulated knowledge in the cultivation of sunflower seeds) and leads to a more continuous and integrated impact on their local area than the other two projects.

In contrast, the wind project has had a limited impact on the local economy and has used the socioeconomic resources in the territory to a very limited extent.

Finally, the solar PV case has had a negligible economic impact on the area both in terms of employment and income transfers. There is a clear productive detachment between the project and the human and socioeconomic resources of the area. It is an initiative at odds with the endogenous development approach.

To sum up, whereas the biodiesel project is a case of endogenous development, the wind case is rather an example of exogenous development (although use is made of local human resources) and the PV project is a case of "no-development".[42]

5.7. Standard of living, social cohesion and human development

Positive although modest impacts on the standard of living of the population can be identified in the wind and biodiesel cases and are negligible in the solar PV case. The prospects and the self-confidence of the local population (and particularly, the younger people) are enhanced in the first two cases through their positive impact on employment and a new alternative to traditional agriculture.

These effects are probably greater in the biodiesel than in the wind project, since in this case the impact only occurs in the energy production stage, whereas in the biodiesel case it also occurs in the provision of the raw material (sunflower). In the wind energy case, however, there has been an additional positive impact through the income transfers from the company to the local community (municipal government).

5.8. Income distribution

In contrast to the PV project, which has not had an impact on income distribution, a positive effect can be identified in the other two projects. Young people with relative lower income per capita levels have benefited from the jobs created and the income generated. Notwithstanding, the employment created is of medium/high skills and not low skills. The biodiesel project has benefited all farmers, but it is very difficult to say whether it has benefited low-income or higher-income farmers.

[42] Endogenous development can be understood as local initiatives in which the resources of the territory are used and which generates substantial backward and forward productive linkages in the area. Exogenous development would be an economic activity implanted in an area from outside which does not make an intensive use of the existing resources in the territory and does not lead to significant productive linkages, although it contributes to the development in the area. In contrast, "no-development" involves an economic initiative that has elements of external development. In so far as it is an activity "external to the area", it does not use local human or other socioeconomic resources and does not lead to productive linkages. However, in contrast to external development, it does not contribute to the development of the local area. Instead, it only benefits actors from outside the area.

5.9. Local stakeholder involvement and local acceptance

In the case of biodiesel, there has been a very favourable opinion of the local stakeholders towards the project, given its embedding in the local economy, its use of endogenous resources, the perceived socioeconomic benefits and the small negative impacts. In the wind case, the socioeconomic benefits of the project in a rural area with very limited development alternatives has been highly valued, whereas the environmental impacts have not led to social rejection. In fact, in both cases, the project developers state that the local authorities have supported (although not financially) the deployment of their respective projects. In the solar PV case, the absence of positive or negative impacts (either socioeconomic or environmental) have led to the indifference of the local population, although it was initially welcome, since it is a small pioneering installation which led to positive publicity on the municipality.

5.10. Impacts on tourism

These impacts are very small in the case of the wind and solar PV projects (and mostly related to the school visits to the sites) and non-existent in the biodiesel case.[43] It is highly likely that the opening of the educational house in Maranchón will have a positive although modest impact in this regard.

5.11. Creation of a local industry

In the case of the biodiesel plant, the technology developed by the owner firm has been used. This is in contrast to the other two cases, where a local manufacturing industry has not been created in the local site. The wind turbines and the solar PV modules have been bought to Spanish firms (Gamesa, BP Solar and Isofotón).

5.12. Environmental impacts

The main positive environmental impacts of the three projects (reduction of pollutants from conventional electricity production and transport) are not enjoyed directly by the local population. Indeed, the local population bears some negative externalities from the project and marginally benefit from the positive environmental externalities. In the wind energy case, the negative environmental impacts are: soil occupation, killing of birds, visual intrusion and noise. The environmental impacts from the biodiesel project are mostly related to the cultivation of the raw materials and not to the transformation of these raw materials. An increase in the cultivation of sunflower seeds would result in a reduction in the biodiversity of the area and a greater soil occupation. Finally, the environmental impacts of the solar PV project are very small and very far from the nearest town. There is thus not a negative perception of the environmental impact of the project.

Notwithstanding, there is a positive environmental impact in the three cases (especially in the wind and biodiesel projects): they contribute to the fixing of the population in the territory. It is usually considered that the depopulation of rural areas is behind many environmental problems, including, fires, desertification, erosion, etc.

6. Concluding remarks and policy implications

This paper has applied an integrated theoretical framework to the empirical analysis of the impact of RES on local sustainability,

[43] In contrast to the other two cases, the biodiesel company has completely restricted the visits to the plant.

focusing on the social and economic dimensions. Previous papers have considered only some of the socioeconomic benefits of renewable energy deployment for local communities. With the help of three case studies in three different locations, the paper shows that the contribution of RES to the economic and social dimensions of sustainable development could be significant.

The existing literature has mainly focused on the direct employment effects associated to renewable energy deployment as the most important contribution to local sustainability. Whereas this paper confirms that this is the most relevant benefit from RES projects, it has also shown that a wide array of other tangible and non-tangible benefits should be considered, including income generation which complements and diversifies the sources of income of the local population. An additional development alternative provides them with brighter prospects and, thus, has a positive effect on isolated rural communities.

Although, in absolute terms, the number of jobs created is not high, it is so with respect to the working population and the existing jobs in the areas considered. Socioeconomic benefits depend on several factors, and not only on the type of RES being deployed. The specific socioeconomic features of the territories, including the productive structure of the area, the relationships between the stakeholders and the involvement of the local stakeholders in the renewable energy project may also play a role in this regard.

Although renewable energy projects may make a significant contribution to the sustainability of rural communities, RES should not be regarded as a panacea to solve the serious socioeconomic problems of these areas. Renewable energy promotion is mostly an energy policy (albeit with important ancillary local development benefits) and should not be the only element of a sustainable regional development policy because, as argued by others (i.e. [23]), the case for using a sectoral policy (such as RES promotion) in order to promote social cohesion is a weak one.

Improving the standard of living of regions with a weak economy and reducing their depopulation can be achieved better by implementing integrated regional policies aimed at reducing interregional disparities. However, RES investments may play a role within those policies and they should be part of an integral development policy. If, as shown in this paper, the benefits of RES increase regional cohesion, this would lead to a positive synergy between RES support and local development policies. Indeed, RES could be one of the pillars (but never the only one) on which to base the economic development of countries in the medium and long-term, taking into account that the RES-E sector is highly dynamic and has enormous growth perspectives around the world.

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