Contribution of the Spanish Committee to the 35th International Geographical Congress

Celebrating a world of difference

DIVERSITY, DYNAMICS AND RESPONSES TO THE GLOBAL CHANGE

Spanish Committee of the International Geographic Union

GOBIERNO DE ESPAÑA · MINISTERIO DE TRANSPORTES Y MOVILIDAD SOSTENIBLE · INSTITUTO GEOGRÁFICO NACIONAL

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Impacts of global change on the landscape

THE ENERGY TRANSITION IN SPAIN: RENEWABLE ENERGIES AND LANDSCAPE. THE VIEW FROM SPANISH GEOGRAPHY

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ABSTRACT

Electricity generation from renewable sources is one of the manifestations of the energy transition in Spain that has greatest impact in spatial and landscape terms. Despite this, the change towards a sustainable electricity production model, which allows more people to access energy and limits dependence on fossil fuels, is being marred by a lack of planning, social debate and citizen participation. This chapter analyses the technical dimensions of the change in the production model and its spatial imprint, and the different ways in which Spanish geographers have approached this question. It concludes with some reflections on the enormous challenge facing our discipline today, namely to demonstrate its capacity to provide useful responses to one of the problems of most interest to society.

KEY WORDS

Energy transition; electricity generation; landscape; territory.

1. INTRODUCTION

Within the context of the ecological transition required today in the face of climate change, the energy transition (ET) is a process of structural transformation aimed at achieving a reliable, safe and sustainable energy model. This is a complex process which is still very much open to debate. It is of interest to a large section of society and can be approached from different angles depending on which of its many different components one chooses to focus on. As a spatial discipline, Geography is duty-bound to tackle an issue that directly affects its *raison d'être* in that a change of this magnitude enables us to directly investigate the relations between society and space. Within the context of decarbonization and electrification of the

economy, Spain stands out as a country that is fully committed to a transition model based on the efficient use of clean energies. The targets set out in the Integrated National Plan on Energy and Climate established that in 2030 renewable energies should account for 74% of power generation, and by 2023 this figure was already over 50%.

This shows that a new production model is rapidly taking shape, although it follows the same spatial pattern as its predecessor, based on the dissociation between production and consumption, making use of and extending existing energy transport infrastructures (power stations and lines). The result is a highly centralized model with which the government aims to achieve the targets promised at European level by implementing large-scale projects that harness scattered resources (wind, sun, water...) with a low energy density that require vast areas of land. This is radically altering the functions, character and perceptions of the territory and has a notable impact on the landscape. In spite of the magnitude and wide extent of these processes, spatial planning and citizen participation have been practically non-existent. With this in mind, this chapter aims, on the one hand, to clarify the direction being taken by the structural and territorial changes in electricity production linked to the energy transition in Spain, and on the other to explore the various approaches or perspectives from which it is being analysed within the field of Geography in Spain.

2. STRUCTURAL CHANGES IN THE SPANISH ELECTRICITY PRODUCTION SYSTEM

The ET refers to both the process of change in the structure of primary energy supply and the gradual transformation of a specific model of energy provision (Álvarez *et al.*, 2016:7). The aim is to achieve a model of energy supply using efficient systems which not only limit greenhouse gas emissions but are also respectful of biodiversity and sensitive to the territorial impact of the various forms of energy production, transport and distribution. This means that ET is a complex process that can be approached from many different angles: technical, political, economic, social, ethical, environmental or territorial. As regards this last aspect, the spatial and structural logics behind energy production and consumption are supported by well-structured theoretical formulations, in which it is assumed that these changes do not take final form until society as a whole, through important consensus-based political agreements, manages to interiorize the mechanics of the transition. In this sense, for Europe to become the first climate-neutral continent on the planet in 2050, various partial targets, such as those set out in the 2030 Climate and Energy Framework, must be met. Among other goals, this EU Framework has established that renewable energy should account for at least 32% of final energy consumption in 2030, at the same time as obliging each member state to adopt integrated National Energy and Climate Plans (NECP) and draw up National Strategies on this issue.

2.1. THE POLITICAL AND REGULATORY CONTEXT AFFECTING POWER GENERATION IN SPAIN

The Strategic Energy and Climate Framework in Spain (MEEC) is based on three main pillars. Firstly, the Law on Climate Change and Energy Transition passed in May 2021, which became the basic reference legislation covering a range of diverse measures such as mobility, changes in the electricity sector, consumption and use of fossil fuels, energy efficiency or respect for biodiversity. The second pillar is the Fair Transition Strategy (2020), whose main objective is to provide the instruments and tools required to mitigate the social and territorial impact of this transition. Finally, the PNIEC 2021-2030 sets a number of targets that the government aims to meet over the course of this decade: a 23% reduction in greenhouse gas emissions compared to 1990; 42% of renewable energies as a proportion of total final energy consumption (74% in the case of power generation) and a 39.5% improvement in energy efficiency.

After the COVID-19 pandemic, large funds were made available as part of the *NextGeneration EU* project. This coincided with the conflict in the Ukraine, which began in February 2022 and highlighted energy dependency as a vulnerability that was strategically unacceptable for Europe. The objective of the *REPowerEU* Plan was to break this dependency by saving energy, diversifying supply and accelerating the rollout of renewable energies. As a result of all this, in 2023, Spain announced an upward review of the targets for 2030. Should these be achieved, clean energies will cover 48% of final energy consumption and 81% of electricity consumption.

2.2. TECHNOLOGICAL DIMENSION OF THE ENERGY TRANSITION IN SPAIN

Since the 1990s, the installed power capacity in Spain has risen continually – from 43,551 MW in 1997 to 123,564 MW in 2023 –, and a much more diversified, better-balanced structure has been created (Figure 1)[1].

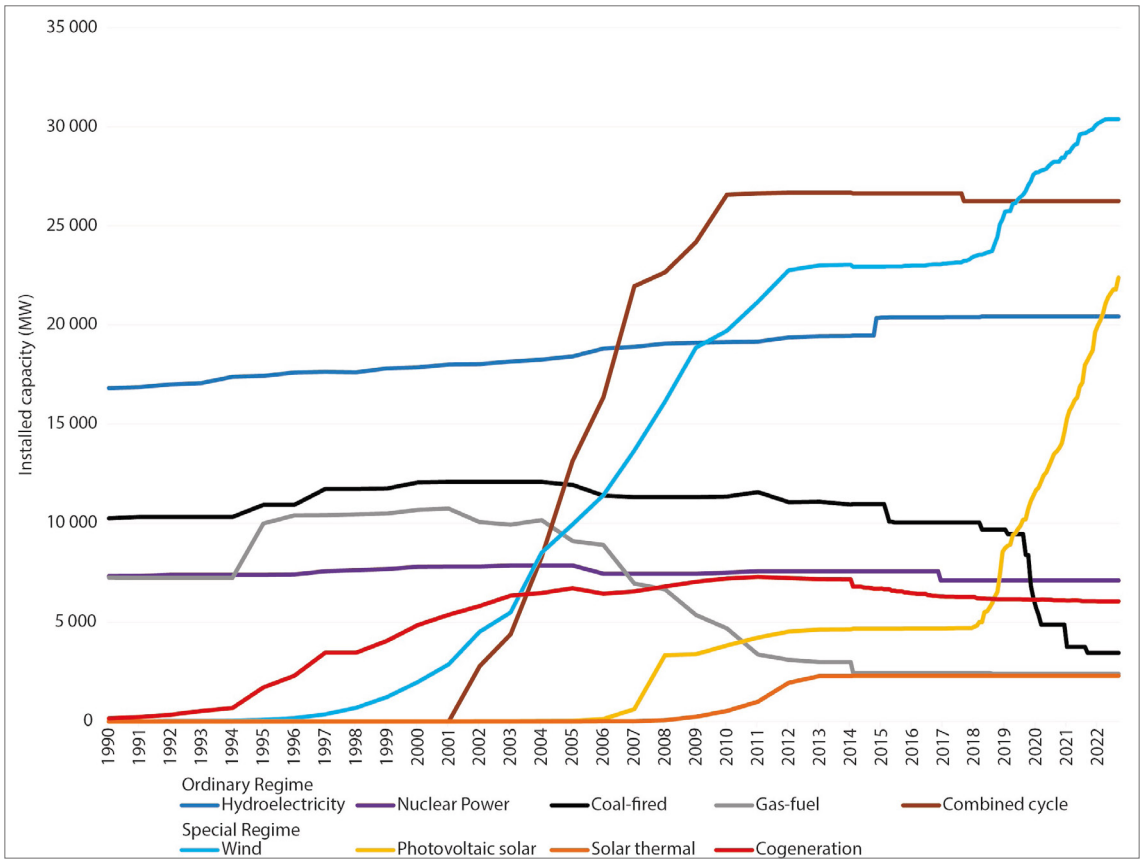

Figure 1. Changes in the installed power capacity in Spain over the period 1997-2023 and its distribution by sources.
Source: Spanish Electricity Grid (REE).

The Law on the Electricity Sector 54/1997 was a milestone in the development of electricity generation in that it opened the door to free competition in the electricity market. Supplying an expanding economy would require a gradual increase in the installed capacity. This was achieved by expanding various nuclear (which produced 35.1% of electricity) and coal-fired (39.5%) power stations. In this way, they guaranteed a production capacity that was complemented by hydroelectricity (21.1%), a technology affected by the variations in rainfall from one water year to the next. At that time, the energy model was defined by two main

1 All the statistical data presented in this article come from the same source: Red Eléctrica Española (Spanish Electricity Grid), available at https://www.ree.es/es/datos/generacion

characteristics: the high levels of concentration in the electricity generation sector in both technical (large power stations) and business terms (the electricity production and distribution business was in the hands of just four companies: Endesa, Iberdrola, Unión Fenosa and Hidro-Cantábrico) and secondly the evident territorial dissociation between the areas in which electricity was produced and those in which it was consumed. This was possible thanks to the connectivity provided by a transport network in continuous expansion. All this gave rise to an industrial, unidirectional, centralized model, in which the market was controlled by a very small number of actors, and in which the energy consumed by the entire country was produced by a small number of centres with a high energy density.

Since then, the pattern of energy generation has changed substantially. Firstly, Spain's commitment to the EU to decarbonize its economy has led to a drastic reduction in conventional energy production, which with the closure of coal-fired power stations has led to a drop in the installed capacity from this source from 10,874 MW in 2011 to 2,061 in 2023. The second, and undoubtedly the most important, factor is the emergence and fast growth of renewable energies or their backups (combined-cycle gas-turbine plants) in order to obtain a more diversified combination with lower emissions. In the case of wind power, the capacity has increased to 30,732 MW at the end of 2023, making it the second most important energy source in the electricity mix in Spain. Solar power has undergone a similar process, in which solar thermal energy generation (2304 MW) has consolidated its position together with hydroelectric pumping as a renewable support or backup technology. For its part, photovoltaic energy is also growing very fast, reaching 24,931 MW in 2023.

Despite these dramatic changes, the spatial pattern that characterized the previous industrial model has been largely repeated in the new scenario: power generation remains concentrated in large plants, now powered by wind or photovoltaic energy, and is still promoted by large companies and investment funds. The main difference is that in the new scenario they are harnessing a much more dispersed resource and using traditional transport and distribution infrastructures to bring it to the end consumers.

2.3. THE SPATIAL DISTRIBUTION OF ENERGY PRODUCTION IN SPAIN

If we look at the map of the spatial distribution of electricity generation in 1997 and we compare it with that for 2023, it is undeniable that the increase in the share of renewable energies in total power generation has been accompanied by large-scale dispersion across the territory. In 1997 (Figure 2), and as a consequence of the concentration in the forms o f generation (large power stations), the 43,551 MW of installed capacity in the Spanish mainland electricity system were produced by a total of 1318 power plants situated in 559 municipalities. In reality however, most of the electricity was produced by around 100 plants, in line with distribution patterns linked either to a local resource or to the import of resources from overseas (ports). Electricity was also produced in certain spaces with low population density situated relatively close to consumption centres, which at some point were considered suitable sites for nuclear power stations.

By contrast the 123,564 MW installed in 2023 (Figure 3) were produced by a total of 67,460 plants shared between 4,687 municipalities. In the case of wind power, the principles governing its rollout are based on the presence of the resource at a particular site (in both mountain regions and high flat inland plateaus to take advantage of laminar winds) and the possibilities for transmission and distribution from this site (reinforcing the network nodes and the capacity of the lines), while in photovoltaic solar power, there is a preference for elevated plains in the south and certain solar "breadbaskets" on those further north.

As a result of this process, municipalities in deep rural areas are acquiring a more important role in power generation, in this case from renewable sources. These are spaces with a limited capacity for protest, in which the development of projects of this kind is seen as a source of additional income for local councils and certain private interests, even at the expense of jeopardizing landscape resources which in the medium to long term could play a key role in

their economic development. Until now, the ET has had an eminently technological dimension and its objectives, based on achieving ever higher levels of installation, have largely ignored the socio-territorial dimension associated with an impact of such magnitude.

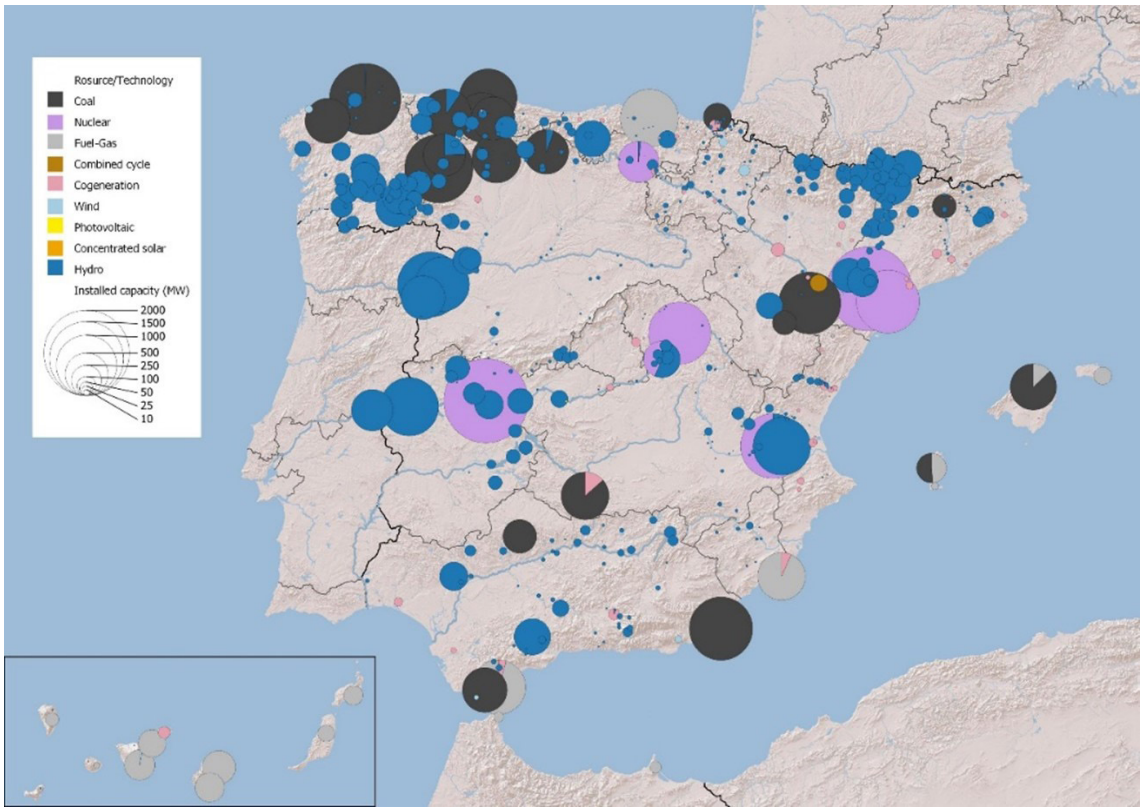

Figure 2. Installed capacity in Spain (1997) and its municipal distribution by type of source. Source: REE.

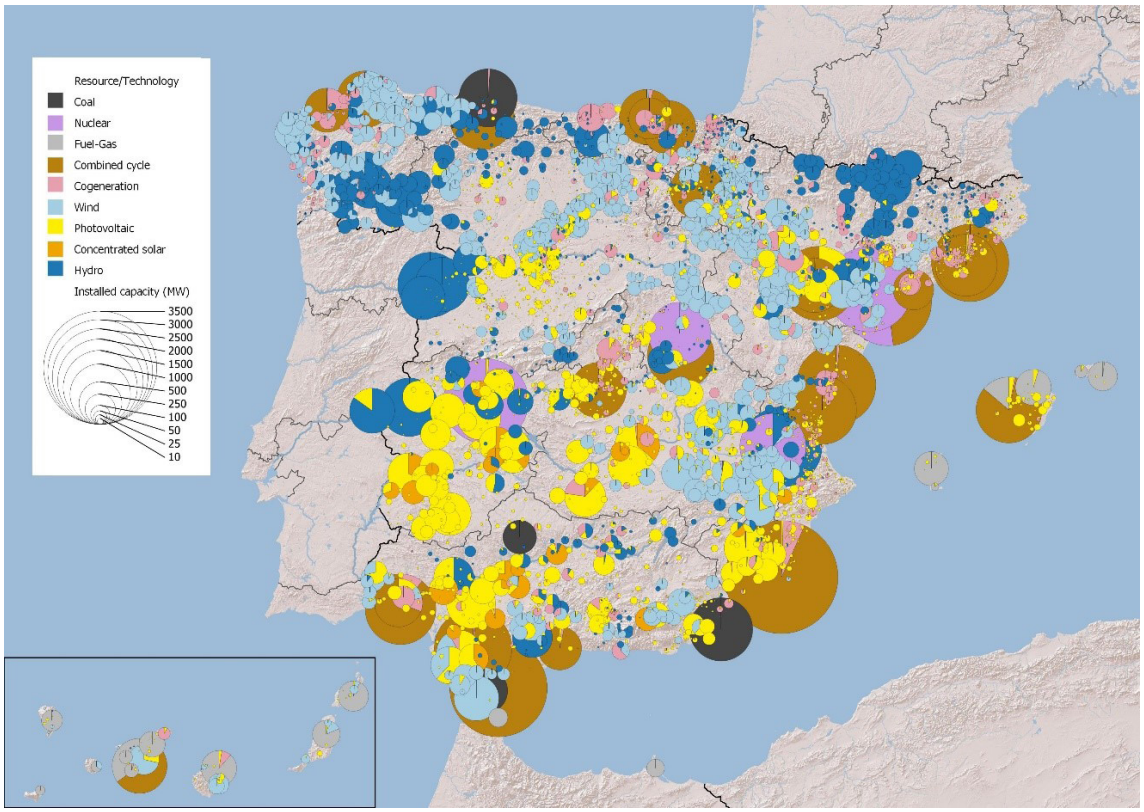

Figure 3. Installed capacity in Spain (2023) and its municipal distribution by type of source. Source: REE.

2.4. THE INTENSE IMPACT OF THE ROLLOUT OF RENEWABLE ENERGIES ON SOCIETY AND THE LANDSCAPE

The lack of planning inherent in the model for the rollout of renewable energies has made the developers the principal actors in the ET in Spain. To develop a project, all that is required are a series of permits from the relevant administrations. In such a decentralized country as Spain, these vary greatly from one region to another, giving rise to quite different situations. However, they all share a similar background: the lack of any debate on this issue and the urgent need to achieve the set targets has meant that the real, perhaps most complex impact, i.e. on the landscape, has not been properly addressed. Instead, discussions about impact have centred almost exclusively on the environmental and/or heritage dimensions. This explains why the mapping by the different administrations of exclusion zones for the installation of renewable energies (demanded urgently by the aforementioned REPowerEU Plan) largely follows the maps of the Natura 2000 Network and the sensitive areas from the perspective of flora and fauna. By contrast, in the "white zones" (those earmarked as suitable for renewables projects), nothing is said about how to install the plant as harmoniously as possible or at least about how to assess its impact on the landscape and on the cultural values of the affected area.

In addition, the ET proposed by the institutions has an unquestionable social component. In theory, the citizens have the chance to stop being mere consumers and become producers of their own energy. They become "prosumers" who opt for different methods of decentralized power generation, of self-generated electricity from nearby renewable sources, quite unlike the traditional, spatially centralized, unidirectional, industrial model controlled by a small number of large companies. Production can be individual or collective in the form of energy communities promoted by cooperatives, associations or local administrations. Since their regulation, photovoltaic installations of this kind, generally on roofs, have enjoyed spectacular growth. While the objective and high penetration scenarios set targets for 2030 of 9 and 14 GW respectively, by 2023 the installed capacity had already reached 6.95 GW. However, the social dimension of the transition also mentioned the need for public opinion to be taken into account. This would be expressed through participative processes in relation to projects that notably alter the spaces in which people live. It seems obvious that without this dialogue, it would be difficult to implement projects that meet the condition of bringing about a fair and democratic energy transition. It is precisely within this framework that the activation of a social consciousness of rejection of this kind of projects should be understood, rekindling the fight for the territory through the defence of its landscapes. This is an increasingly common situation nowadays, given the spatial expansion of transport infrastructures, the increase in the average size of projects and the greater spatial concentration of the installations.

As Mata and López (2022:92) made clear: "Geography forms part of the scientific consensus that endorses and confirms that an energy transition capable of tackling the challenges of the climate crisis cannot consist merely of a technological transition, as is happening to a large extent today, with little attention being paid to the base on which this technology is being installed: i.e. the territory and its landscape perception". Perhaps this would be a good place to pause for a moment to assess the degree of involvement and the analytical orientation of the contributions being made to this debate by Spanish geographers.

3. METHODOLOGY

With this in mind, we conducted a review of a selection of articles from the databases on the Dialnet and Scopus websites for the dissemination of scientific research. Our analysis also included other important academic initiatives, such as the competitive projects financed by national and international calls for funding, which have contributed to the advance of research on this question. Even so, the scope of our investigation was relatively limited in that it did not cover books, book chapters or a range of different contributions made at congresses of various kinds. In this last case although some studies of the ET can be found under

the thematic umbrella of global processes of transition, they are relatively few in number. By way of example, in the dozen meetings organized by the Spanish Geography Association (Asociación Española de Geografía - AGE) in the first decades of the 21st Century, there has only been one line for discussion oriented specifically towards analysing the relationship between energy and territory. This was at a congress in 2011 organized by the University of Alicante entitled "Geography and Territorial Challenges in the 21st Century". One of the topics analysed was the Dynamics and Processes of Energy Change, about which 36 communications were presented. 20 of these analysed different aspects of the ET related with renewable energies and 5 referred specifically to landscape.

After setting out these initial reservations, we will now describe the procedure we used to select the articles. This was done using a search chain that focused specifically on two terms: "Energy and Landscape". The search was limited to entries in English and Spanish from 1997 onwards (the year in which the Law governing the Electricity Sector in Spain came into force). The ultimate goal was to identify different approaches and perspectives related with the landscape in the context of the development of renewable energies in Spain using a representative, manageable group of sources. This selection enabled us to carry out a more carefully focused analysis, whilst being aware that other important works such as PhD theses and articles in languages other than English and Spanish would remain beyond the scope of our study. The initial search returned 514 references, 17 of which were eliminated to avoid duplication, while a further 11 returned by other generic search engines were included.

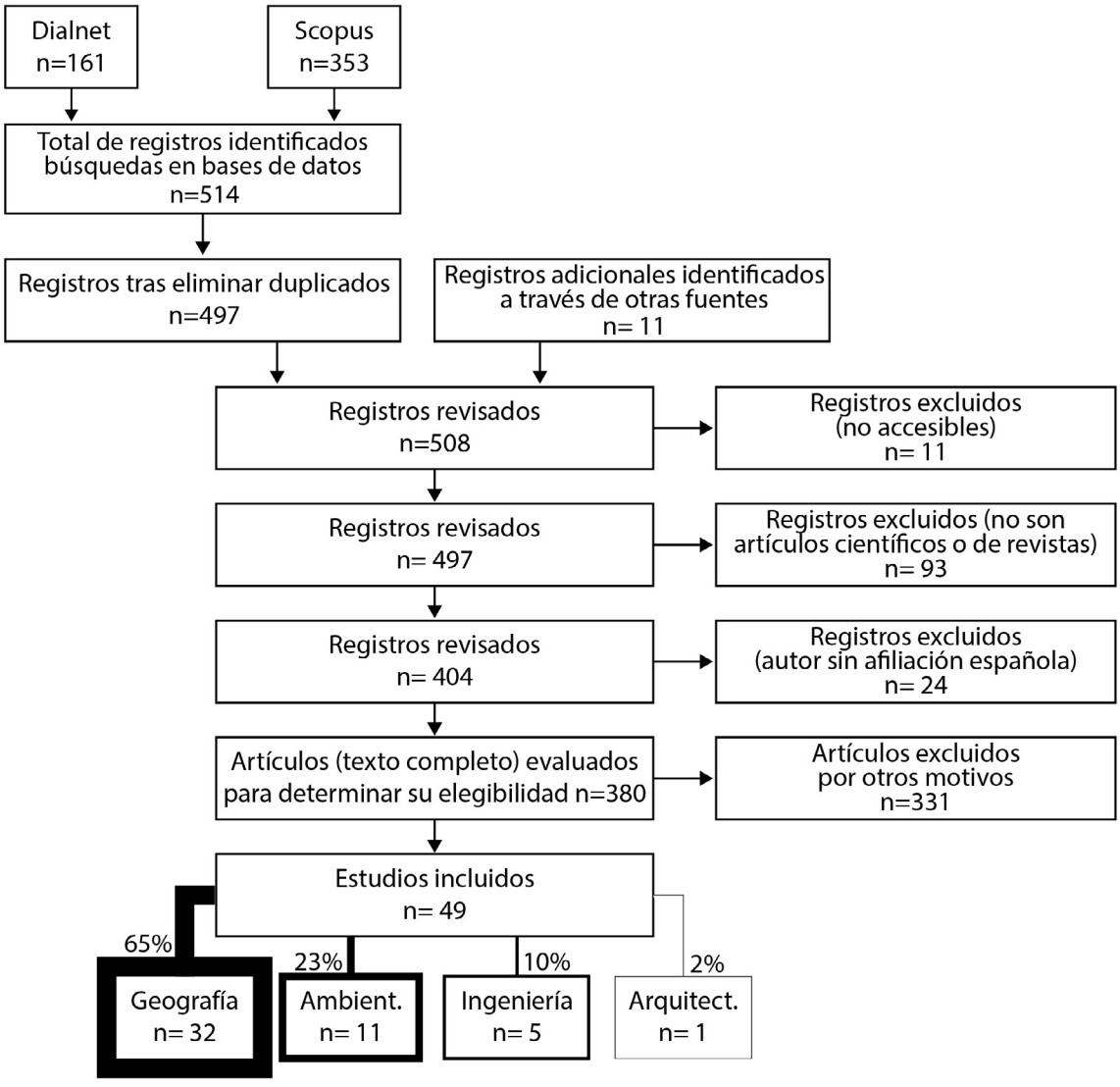

Figure 4. Flow chart describing the article selection process.

The sample group was subjected to a systematic filtration process to ensure the relevance of the articles finally selected for analysis (Figure 4). With this in mind, for example, we excluded articles in which an overly narrow definition of "landscape" was applied or in which the term "energy" was not used in relation to power generation. In this way, the list was reduced to 49 references. These were published from 2005 onwards and covered disciplines such as Geography (32, 65%), Environmental Sciences (11, 13%), Engineering (5) and Architecture (1). The reading and analysis of the content of these references highlights the wide variety of interests, spaces and methodological approaches adopted by Spanish Geography.

4. RESULTS. GEOGRAPHY AND THE DEVELOPMENT OF RENEWABLE ENERGIES IN SPAIN

Geography has traditionally addressed the landscape on the basis of its formal and functional principles, but also in terms of its subjective meanings and components. This enables geographers to develop combinative approaches that can be decisive for understanding the dynamics behind the relation between renewable energy development and the landscape, including aspects such as territorial planning, the visual impact, public opinion, heritage conservation and the socioeconomic implications of this development.

4.1. LANDSCAPE AND RENEWABLE ENERGIES, AN OVERVIEW OF APPROACHES AND METHODS

The bibliographic review enabled us, first of all, to obtain answers to questions such as: i) How do the authors of these papers define the concept of landscape? and ii) What methods do they apply to achieve their objectives? In this way we hoped to gain a deeper insight into the complexity of the idea of landscape in the field of renewable energy, highlighting how the different approaches are intertwined and mutually enriching. The authors do so above all from three main perspectives. Firstly, the idea of landscape as a space that has been altered by energy infrastructures is widely reflected in the selected articles. This approach centres around the objective changes and the new forms and functions that wind or solar power plants can impose on the landscape. In this sense, articles such as Díaz Cuevas *et al.* (2016), emphasize the importance of the planning and assessment of projects as essential tools for mitigating the adverse effects on the landscape, which is understood as a dynamic concept. Secondly, landscape is discussed within the broader context of the ET, initially approached in terms of change towards a "more sustainable model" (Domínguez *et al.*, 2010) and later more explicitly as the "energy transition" in articles such as Codemo *et al.* (2023) and Díaz Pacheco *et al.* (2018). In general, the studies of the energy transition underline the importance of territory not only as a (passive) receiver of changes but also as an (active) factor in the planning and acceptance of projects. In this way, Prados *et al.* (2021) discuss the energy transition in terms of the contribution that renewable energies make to rural development and adaptation to climate change, highlighting the need for a new form of governance to enhance this transition. Frolova *et al.* (2019a) mention the transition to more sustainable energy systems as part of the response to climate change and the need to improve national energy security, focusing on the EU strategy to increase the consumption of renewable energies. Thirdly, Rodríguez and Frolova (2021) analyse how this process is being carried out in Spain and Hungary, focusing on both the institutional context and the associated structural and social challenges. In general, the authors accept that the design and location of the energy infrastructures must consider their harmonious integration into the existing landscape, so as to facilitate a socially acceptable energy transition. Finally, various studies emphasize the role of the European Landscape Convention (ELC) in renewable energy planning, highlighting the framework it provides for making landscape a key aspect of energy policy (Frolova & Pérez, 2008), in that it promotes an approach that takes the opinions and needs of local communities into account (Frolova *et al.*, 2014). The reference to the ELC

in these articles is a sign of a growing recognition of the importance of tackling cultural and perceptual aspects of the landscape in the planning and development of renewable energy projects (Prados *et al.*, 2012)

With different approaches, we are offered, at the particular scale of each study, a rich and subtly nuanced understanding of the process we are studying that covers both the tangible changes in the new forms and functions of the landscape and the subjective perceptions. It also reveals the wide variety of methods used to analyse this question. These methods vary from the use of Geographic Information Systems (GIS) (Díaz *et al.*, 2016; Molina *et al.*, 2011; Tudela & Molina, 2005; Rodrigues *et al.* 2010), to qualitative research (Frolova *et al.*, 2022) and mixed methodologies (Frantál *et al.*, 2023; Frolova *et al.*, 2019; Pérez & Díaz, 2022; Prados, 2010a; Prados *et al.*, 2021; Rodríguez *et al.*, 2023; Rodríguez & Frolova, 2023). Other research studies analyse energy policies, legislation and other related documents, offering an institutional and legislative perspective on the development of alternative energy sources (Frolova & Pérez, 2008; Pérez, 2010; Prados *et al.*, 2012). Lastly, there is a group of studies based on a detailed description of the technologies, rollout models and specific cases studies, but without a clearly defined analytical or quantitative methodological approach (Baraja, 2010; Espejo, 2010; Prados *et al.*, 2012, among others).

4.2 THE DOMINANT ROLE OF CASE STUDIES IN GEOGRAPHIC RESEARCH INTO ENERGY

Geographic research into renewable energies has applied a varied array of methods when studying the interaction between landscape and the rollout of energy technologies. In some cases, they focus on comparative analysis (Frolova *et al.* 2019a; Frolova *et al.* 2019b; Rodríguez & Frolova, 2023), while in others they look at the procedures followed to optimize the location of the plants. However, if there is one type of article that stands out above all others it is the case study. The most frequent scale of analysis is smaller than nationwide studies of Spain as a whole, and so provides a detailed understanding of how energy projects affect and are integrated into specific landscapes. Of these, Andalusia and other regions in the south of the Iberian Peninsula, such as Murcia and Southern Portugal, stand out with studies at a regional scale (Barral *et al.*, 2023; Díaz *et al.*, 2016, 2023; Mérida *et al.*, 2010; Prados, 2010b), at a provincial scale (case studies of Jaén, Rodríguez *et al.*, 2023; Rodríguez and Frolova, 2023), and at a sub-provincial or local scale (Codemo *et al.*, 2023; Frolova at al., 2022; Prados, 2010; Prados *et al.*, 2021). Other territories which have also been the subject of case studies include Catalonia (Saladié, 2011, 2012, 2019; Saladié & Saladié, 2021; Zografos & Saladié, 2012), Castile and León (Baraja & Herrero, 2010), Castile–La Mancha (López, 2023), Aragon (Esteban *et al.*, 2023; Ibarra, 2023; Ibarra *et al.*, 2011, 2022) and Menorca (Silva & Fernández, 2020).

4.3. "RENEWABLES" AS A TYPE OF ENERGY OF INTEREST TO GEOGRAPHERS

Of the 32 articles in our sample group, over 60% discuss renewable energies in general (and in particular wind and solar power), focusing on three aspects as regards landscape: i) the new forms and functions in the landscape (Frolova *et al.*, 2019); ii) public opinions regarding landscape (Frolova & Pérez, 2008; Prados *et al.*, 2012, 2021; Rodríguez *et al.*, 2023; Rodríguez & Frolova, 2023; Tudela & Molina, 2006); and iii) landscape within the framework of energy planning and policies (Barral *et al.*, 2023; Frolova *et al.*, 2019; Frolova *et al.*, 2014, 2019; Silva & Fernández, 2020).

In terms of the different types of renewables, most of the articles focus on wind energy, followed by solar power and lastly hydroelectricity. In these cases, the articles analyse two questions above all in relation with the landscape: i) the impact of renewables on the landscape and their integration into it and ii) social perceptions, showing that the interaction between renewable energies and the landscape is complex and multifaceted.

More specifically, the studies that centre on hydroelectricity (Frolova, 2010a; Pérez & Díaz, 2022) analyse how the different types of policies in energy, water, the environment and land use interact in the creation of Spanish landscapes (Frolova, 2010a) and public acceptance of this form of energy (Pérez & Díaz, 2022).

The studies of wind power revolve around the impact and integration of wind farms into the landscape and public perceptions of them. For example, Tudela & Molina (2005) emphasize the importance of assessing the landscape impact of wind farms, while Díaz *et al.* (2016) use GIS to quantify their landscape impact in Andalusia. Molina *et al.* (2011) introduce a GIS-assisted methodology to evaluate the impact of wind farms, highlighting the visual absorption capacity and the environmental impact. This enables a more detailed, more effective impact assessment when trying to identify the best possible locations for these infrastructures on the basis of legal considerations, and environmental and land use factors. Pérez (2010) discusses how offshore wind power can be integrated into the Spanish seascape.

Public perceptions of wind power are also a key issue in various studies. For her part, Frolova (2010b) analyses the social perception and management of these developments in Spain, while López (2023) focuses on how wind turbines affect the scenic beauty of the landscape, underlining the importance of understanding how different groups in the population perceive the visual impact of wind power. Frantál *et al.* (2023:7) propose a typology of conflicts related with the development of wind power, highlighting six problematic components: nature conservation, unfair distribution, effects on property and the quality of services, the size of the infrastructures, effects on health, landscape values and functional conflicts. They make clear that the visual impact is normally of secondary importance in decision-making, in which economic factors take priority over sociocultural concerns. Frolova *et al.* (2022) explore the varied responses of coastal communities in southern Spain to the development of offshore wind farms, highlighting the tensions between the perception of landscape, the conservation of marine resources and the socioeconomic benefits. This approach broadens our understanding of the impact of wind power above and beyond the onshore landscape, by focusing on offshore developments in the sea.

For its part, research into solar power emphasizes its impact on the landscape, land use changes and the public perception of these effects. For example, Díaz *et al.* (2023) analyse the distribution of solar energy in Andalusia, focusing on the types of surfaces in which solar plants are installed and their previous uses, the competition with agricultural land uses and the impact on the landscape. For their part, Mérida *et al.* (2010) focus on photovoltaic plants in Andalusia, examining their impact on the landscape. The study highlights the environmental paradox of these installations, which are generally perceived as positive but have significant impacts on the landscape, setting out a series of guidelines for their successful integration. Espejo (2010) examines the solar thermal energy (STE) plants in relation to technological aspects and rollout policies, underlining their visual impact and the vast tracts of land they occupy. Finally, Prados (2010a) explores public perceptions of solar power in the Protected Landscape of Guadiamar in Andalusia.

All these studies emphasize the need for careful assessment of the visual and environmental impact of solar and wind power and their proper integration into the landscape. Social perception and acceptance play a crucial role and it is essential to consider these aspects in territorial planning and management. Furthermore, comparative studies offer valuable perspectives about the energy transition in different geographical and cultural contexts as determined to a large extent by the intentions and objectives of the research projects within which many of these studies are conducted.

4.4. RESEARCH PROJECTS ON RENEWABLE ENERGIES

The initial phase of these projects began in 2005 and established the basis for a line of research that was consolidated from 2010 onwards. The projects mentioned in the papers published during this period include for example the ALTENER programme — by which the Murcia Region committed itself to promoting the development of the Renewable Energy

Plan (PER) drawn up by the Institute for Energy Diversification and Savings (IDEA) –, and the COMPLEX project of the Seventh Framework Programme of the European Commission. Perhaps more important for the field of geography was the creation and consolidation of the Spanish Network on Renewable Energies and Landscape (RESERP), which proved something of a watershed, facilitating fruitful collaborations between researchers and the publication of significant studies. These included the monographic issue of the NIMBUS journal with seven contributions from Spanish geographers, as well as the articles by Prados *et al.* (2012) and Frolova *et al.* (2014), and the book "Renewable Energies and European Landscapes" (Frolova, Prados, *et al.*, 2015) with nine chapters in which Spanish geographers took part.

With the consolidation of the RESERP in 2011, a second phase of expansion and the beginning of specialization were manifested in two research projects funded by the Spanish Ministry of Science and Innovation between 2012 and 2015. These projects were entitled: i) "Wind power and landscape: evaluation of the onshore and offshore landscape for sustainable planning (CSO2011-23670)", which was led by a team from the University of Granada and ii) "Territories on the Frontier: Environmental Costs and Territorial Benefits of Naturbanization processes (CSO2011-28480)", which was led by the University of Seville. Although the two projects applied different approaches, their objectives converged in the publication of the article by Frolova *et al.* (2014). The projects related with the RESERP and the CSO2011-23670 project marked the beginning of collaboration between Spanish and European researchers in multidisciplinary teams, a trend that was encouraged even further in the following years. This led to a project entitled "Ressources paysagères et resources énergétiques dans le montagnes sud-européennes. Histoire, comparaison, expérimentation, 2012-2014", which was part of the IMR Ignis Mutat Res Research Programme funded by the French Ministry of Culture and Communication, Directorate of Research and Innovation of France and the International Workshop of Greater Paris (Atelier international du Grand Paris AIGP), in which the team from the University of Granada were involved. After these projects came to an end, there was a regrouping of Spanish Geographers at an international level around a project entitled "COST Action TU1401 Renewable Energy and Landscape Quality", whose aim was to find out how the protection and management of the European landscape could be harmonized with the rollout of renewable energy systems.

Specialization in the field of energy and landscape and its exploration in greater depth began again in 2018 with the projects entitled "Adaptation to the energy transition in Europe: environmental, socioeconomic and cultural aspects ADAPTAS (CSO2017-86975-R)", "Planning and Engagement Arenas for Renewable Energy Landscapes PEARLS" (H2020 Research Innovation Staff Exchange (RISE) 778039) and "Obstacles and Dynamics of the Energy Transition in Mountain Regions: crossed views of the Alpes du Nord (France) and Sierra Nevada (Spain) VEDETTE", part of the TESLA programme of the Labex ITEM of France, 2019–2020. The ADAPTAS interdisciplinary project, which was led by the University of Granada with the involvement of various different European teams, sought to gain a better understanding of the nature and dynamics of renewable energy development in Europe, tackling both the technical aspects and the social and visual impacts. For its part, the PEARLS project led by the University of Seville centred on spatial planning and social innovation within the context of "Renewable Energy Landscapes".

These projects recently came to an end and we have now entered a new stage that combines geographical research interests and international projects such as "Socio-Territorial Innovation for the Energy Transition in the Iberian Peninsula (STEP)" and other projects with a regional impact such as the Map of the Potential for Renewable Energies in Andalusia. These projects reflect a wide range of approaches and interests, stressing the importance of combining renewable energy production with respect for and improvement of the landscape and the quality of life in local communities. The project "CO-SUSTAIN, Pathways for CO-creation between local authorities and collective actions for a SUSTAINable transition (ID: 101132467)" funded by Horizon-CL2-2023-Democracy-01-05), initiated a change in the focus of interest of Spanish geographers towards questions of social and environmental justice and democracy in the energy transition process: an important aspect of this justice was to reconcile the needs of the transition and the conservation of local landscape values.

These projects reflect a wide range of approaches and interests in the study of renewable energies and the landscape, from socioeconomic and cultural adaptation to specific planning of the landscape, the quality of the landscape and the importance of carrying out the energy transition in a democratic way. The funding of these studies by various different European and Spanish institutions is a sign that they recognize the importance of integrating renewable energy production with respect for and improvement in the landscape and the quality of life of local communities.

5. DISCUSSION AND CONCLUSIONS. LANDSCAPE PLANNING OF THE ENERGY TRANSITION ON THE BASIS OF A SOCIAL CONSENSUS

In the current scenario of the energy transition, the territory is taking the brunt of the rollout of renewable energy systems, while itself being just a secondary subject of discussion and debate. The rapid expansion of wind and solar power projects has had a particularly strong impact on rural areas, introducing new functional and landscape features with wide-reaching social repercussions in terms of both the impact on society and the response this generates. These issues and their different perspectives have strong, direct links to Geography which, as we have seen, focuses its research efforts not only on studying the effects and conflicts it gives rise to, but also on the search for criteria and proposals for good planning practices that can ensure a successful orderly rollout backed by a broad social consensus. What are the most acceptable locations? In addition to technical criteria, what other aspects must be taken into account in the planning of energy development? What is the hosting capacity of any given space taking into account its wide range of values and its right to non-saturation? What design patterns could be considered in each different project so as to ensure an acceptable – or perhaps on occasions even positive – impact on the landscape? At what scales should energy be planned? These questions are all lines of research that Geography, in its most applied version, is obliged to address at a time of new territorial configurations and profound changes in the landscape.

However, the academic discussion in general, and the geographic debate in particular, are not being taken into consideration in the decision-making for a strategic plan that weighs up all the different effects on the territory as a whole. One of the most direct impacts of these projects is on the landscape. They leave a clear mark, modifying the territory by introducing powerful visual references that tend to take over the scene, to the point of creating landscapes that are dominated by their energy components. However, in the development of wind and photovoltaic energy plants and their associated infrastructures, the landscape dimension is rarely taken into account and even less frequently in all its complexity, in the sense that landscape is a territorial attribute that is influenced by a whole compendium of different factors. In general, in studies of the impact of these projects, impacts on the landscape are normally treated as effects on the territory of an environmental nature, with a clear bias towards the alterations they may cause to the natural or heritage values of the sites, particularly in those in which these attributes are regarded as high-quality. In this way, rules and methods for the treatment and planning of new energy developments in heritage contexts have been established in guideline documents such as the ICOMOS Guide to good practices for the installation of infrastructures and facilities related with renewable energies and their potential effects on cultural heritage (Alonso *et al.*, 2022). This guide, which follows a similar methodology to "Guidance and Toolkit for Impact Assessments in a World Heritage Context" published in 2022 by UNESCO and its three consultative bodies (ICOMOS, UICN, ICCROM), is offered to help ensure compatibility between renewable energy systems and the protection/conservation of cultural heritage values. However, restricting the effects of these infrastructures on the territory and the landscape solely to the most outstanding sites is a partial, incomplete way of proceeding that ignores the much more generalized approach enshrined in the European Landscape Convention (ELC). In this way, planning

is reduced to the vetoing of development in a few protected spaces, leaving the door open to a more opportunistic rollout dominated by the urgency to bring about the ET, taking decisions on the basis of exclusively technical criteria and on the availability of spaces for installation.

It is paradoxical that although the ELC has been in force in Spain since 2008, its impact on the management of an issue with such a severe impact on the landscape has been either very limited or practically non-existent in certain areas. This general statement regarding the treatment of landscape can be nuanced by analysing the differentiated treatment of the Convention in the legislation passed by Spain's 17 regional governments, given its highly decentralized approach to this particular issue. Indeed, the role of the ELC in the laws passed by the different regional governments has varied considerably in terms of commitment, repercussions and the time it was first mentioned. In some regions, landscape has been treated as an individual entity with the development of specific landscape laws, sometimes even prior to the ratification by the Spanish Government of the ELC. In others however, a multidisciplinary approach has been adopted, with varying impact, as a result of the partial incorporation of its principles into a range of other laws (Mata & López, 2022). Some of the more committed regions have finally issued their own guidelines for promoting the proper rollout of these new energy systems. This is the case for example of Catalonia with "Wind power and landscape. Guidelines for a successful rollout in Catalonia" (2013) and "Environmental criteria in Photovoltaic Solar Projects" (2022); and Andalusia with "Guide for the integration of wind parks into the landscape in Andalusia" (2014) and "Solar Landscapes. Integration of photovoltaic plants into the landscape in Andalusia" (2012). These documents are aimed at the main actors in these processes —technical experts, developers, communities, local entities— so as to promote the search for suitable sites and conditions for the installation of power plants that do not impair the quality of the landscape. Within the framework of the ecological transition and the challenges resulting from climate change, achieving a harmonious relationship between landscape and the expansion of renewable energies is a key goal in line with the objectives of the ELC, but the extent to which this is enforced in impact assessment studies remains limited. These guideline documents, which were drawn up with a favourable attitude to sustainable energies of this kind, place the emphasis on the search for territorial compatibility for actions which, although reversible, have an enormous visual impact, accepting the delicate balance that must be struck between the positive and negative effects.

In this way, landscape is being incorporated, to a greater or lesser extent, into the studies assessing the impact of these projects. Some of the Spanish regional governments that have shown greater commitment to the ELC have introduced a specific instrument to achieve this goal, namely a Landscape Integration Study (LIS). This is now part of the Environmental Impact Assessments to which these energy projects are subject pursuant to Law 21/2013 on Environmental Assessment. The objective of the LIS is to study the effects of the execution of the project on the landscape and, when applicable, establish the necessary corrective measures and criteria to bring about acceptable integration. Even so, the landscape is not always understood and analysed in all its manifold expressions. The LIS are often centred on the natural component of the landscape, measuring the impact and the measures that must be proposed to minimize it on the basis of this one single perspective. However, focusing exclusively on this one aspect is a partial approach that fails to encompass the complex nature of the landscape, which also has important cultural and identity-related attributes that must be taken into account in all forms of territorial planning that incorporate the objective of landscape quality. Public participation is also essential given the perceptive and emotional dimensions that landscape can have.

"No wind-power development is necessarily incompatible with the landscape, but equally that does not mean that any landscape can host any project" (Ghislanzoni & Romero, 2014: 5). This will depend on the characteristics of the installation and of the landscape that is hosting it, which is why the siting of the project and its integration into the landscape must necessarily give rise to a debate as to where – "not here" - and how -"not like that" –. As a result, the expansion of renewable energies finds itself in the paradoxical situation of being approved in general as an innovative and sustainable action that can help bring

about the objectives of ecological transition, alternative energy sources and making best use of renewable resources – while at the same time being questioned and sometimes directly rejected at a local level because of its impact on a specific area. These attitudes should not be viewed as opposition to renewable energy in general, but to the form it takes in a particular local area. This is a question of scale and degree that inevitably affects decision-making. While changes in the landscape have obvious local effects, the decisions regarding permits are often taken behind the backs of local people and without giving much consideration to the specific space involved. This is why in the processes for the planning and execution of projects, the principle of landscape quality and the consideration of the territories in all their rich diversity has proved to be an effective strategy for ensuring the social acceptance of energy projects, as demonstrated by the exemplary process of territorial planning and consensus carried out in the island of Menorca (Dubon & Mata, 2022). The energy transition is not just a technical process, it also has crucial territorial and social aspects, and its sustainability lies at the place where these three aspects converge.

Our review of the contributions made by Spanish geographers to the debate on landscape and its relationship with the expansion of renewable energies, suggests that it can be explored from two different perspectives in terms of approach and objectives. The first is the "Landscape and Energy" (or "Energy and Landscape") perspective. Coupled together in this way, the two terms create a prospective approach that aims towards reflection and the search for the right criteria and options for a correct, successful rollout of renewable energy projects in the territory. As an integrated entity, the territory is not a passive receiver at the mercy of unexpected actions and instead is normally well-structured and functionally active, even in areas suffering from abandonment and a loss of meaning. This means that any new addition is incorporated onto earlier pre-existing structures. Depending on their scale or dominant role in the landscape, these new additions can change the nature of the landscape. Given this situation, it is important to analyse how these changes are to be carried out, their repercussions, which also affect the landscape, and the mechanisms to ensure their social acceptance. Many of the aforementioned geographic research studies refer to the divorce between the modern, cutting-edge identity of the new energy plants and the defining features that identify the landscapes that host them. Conscious of this dilemma, the planning guidelines mentioned earlier propose a "clear and legible" integration into the landscape that springs from an action designed for the particular space in question and which safeguards its symbolic reference points. They mention the possibility of playing around with the distribution of the various elements on the dominant lines of the landscape (topography, field divisions, infrastructures, etc.) and prioritize the balance between compact plants, which reduce the total affected area, and installing excessive numbers of plants in certain landscapes (Mérida et al., 2012).

There is also a second approach aimed at "Energy Landscapes", which involves viewing this question from the perspective of its results, in other words, from the *fait accompli* on the ground of the transforming footprint of new energy models which have to be visible to work. We could also distinguish between "Landscapes with energy" (Landscapes with turbines, for example) and "Energy landscapes" (Wind-power landscapes), according to the dominant role played by these elements in the character of the new landscape. In the former, energy is just one more ingredient in the rich complexity of a landscape, while the latter stresses the dominant role played by energy in an area in which the large number of new elements gives rise to a new landscape category. In both cases, these installations cause brusque changes in the landscape compared to earlier more balanced panoramas, in the case of wind-farms also affecting night-time landscapes. However, their impact does not necessarily have to be considered as harmful for the qualities and values of the host territory. The change could even enhance the value of the landscape by helping create contemporary spaces that could be viewed positively within the objectives of the ecological transition. Here, the job of raising awareness as to the general good in relation to the cost/benefit is crucial for social acceptance and assimilation of the new landscapes. However, in many territories it is a non-existent, non-priority action in a process of expansion in which private interests tend to prevail, territorially fragmenting decisions that in fact should be combined in terms of their effects on the landscape.

This discussion of the two contrasting perspectives is useful when analysing the contributions to the debate entitled "Landscape and alternative energies" coordinated by Riesco Chueca in the PH journal published by the Andalusia Historic Heritage Institute. "The recent switch towards renewables is also a switch towards the visibility and omnipresence [of energy generation sources]: wind and photovoltaic plants spill across the territory, they become embedded within the framework within which people live [...] Comprehensive reintegration is required to adapt this widespread presence to the aspirations of quality and beauty that must preside over the conformation of the environment in which we live" (Riesco, 2023:86). This is a good starting point for a debate on a territorially extensive model that is imposed with very little prior discussion or criteria within a framework of territorial planning and environmental quality, which transcends the purely ecological to also encompass the landscape.

The first challenge lies in understanding the complexity of the rollout process. The decisions that measure the impact and the viability of each project in its specific site do not have a full view of the whole context, given that the nature of the artefacts and the spatial effects of these infrastructures are not confined to the boundaries of the installation itself. The benefits – normally economic profits made by the owners of the plants and the land – do not converge with the costs, which affect a much wider radius of territory. Managing the spatial transformations and their effects in a contextualized manner requires a compensatory overall view, within the context of a strategic rollout that includes social consensus and territorial planning with fairly shared costs and benefits.

The second critical point lies in the rollout models: either replicated over a large dispersed area or concentrated in degraded areas (quarries, old mines, dumps etc) or places whose landscapes are not highly valued (those with highly intensive agricultural uses or traversed by communication infrastructures, irrigation channels, etc.). The first model could potentially have a banalizing effect "given its repetitive nature, with long series of pieces of identical design, which are alien to the local landscape" (Riesco, 2023b); the second runs the risk of imposing a dominant subjective viewpoint which unfairly condemns the worst treated spaces, which are perhaps less appealing in terms of their bare, often treeless relief. Within the first, more scattered model, the impact could also be considered according to the type and scale of the installation: a large-scale business investment or a small-scale self-consumption project. The latter form of energy generation and distribution which benefits private individuals, residential communities and farms etc is widely accepted in that it fulfils the ecological transition and sustainability objectives. However, this model also requires some rethinking due to its disseminated effects on the landscape.

The third topic for debate centres around public attitudes to this question, which range from rejection to assimilation. Emphasis can be placed either on trying to hide or minimize the visual cost of these infrastructures or on trying to assimilate them and give meaning and new value to the landscapes created by a well-planned integration in line with the specific values and character of each landscape, in search of a discourse that socially reconciles the cost of the ecological transition with the benefits. In both cases, opposing positions can be observed. The most critical observers doubt whether it is possible for infrastructures with such a high visual impact to be rolled out in harmony with the landscape. The most optimistic talk of trying to give them an aesthetic meaning and opportunity by exploring their transformative capacity in a positive sense, occasionally becoming evocative or even inspiring landscapes for artistic creation; a good design for integration that encourages a favourable narrative and can transform energy artifacts into reference points in the landscape. If we take a longer historical perspective, it would not be the first time that society has come to appreciate the aesthetic appeal of infrastructures and their contribution to the creation of new landscapes, but this takes time. In this sense, the younger generations already accept renewables as everyday features of the landscape, and take their presence for granted without considering them to be a negative impact, viewing them instead as a present-day image of the territory produced by the cultural and technological development of society.

The general criteria in the planning of new energy developments cannot be applied in any standard, uniform way across a widely diverse territory with an equally wide range of different economic and social circumstances. As Alomar (2023) makes clear, there are no

objective best practices in this field, beyond what societies regard as good and are prepared to accept in terms of integration into the local landscape, heritage and identity. A change in the model of energy production and consumption is now regarded as a priority. This energy transition can best be achieved in a process in which public participation plays a key role. A favourable attitude towards the proposed changes is a good starting-point for the planning of this transition. This is where Geography, as the social science of space, faces two important challenges regarding how best to approach its contribution. Firstly, from an integrative perspective, it must contribute to the definition of the criteria and actions required in the design of planning tools, including the social considerations and the methods for citizen participation; secondly, the inclusion of landscape in the definition of the priority objectives in the energy field. Landscape is an expression of a territorial order whose quality and equilibrium cannot be disassociated from the concept of sustainability that is being sought with the changes being made in the energy model in line with the principles of the ELC: acceptable (integration) and accepted (social consensus) scenarios. As a result, landscape must not be seen as an uncomfortable issue for territorial management, but as a valuable criterion in the design of an energy transition with which society feels identified rather than under attack.

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