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Adaptation to sustainable energy transition in Europe: Environmental, socio-economic and cultural aspects

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Abstract
Adaptation to sustainable energy transition in Europe: Environmental, socio-economic and cultural aspects (ADAPTAS) (No. CSO2017-86975-R) is a project funded by the Ministry of the Economy, Industry and Competitiveness, State Research Agency of Spain, and European Regional Development Fund. It took place between January 2018 and September 2022. This project's challenge was the understanding of transversal aspects of energy transition in four European countries (Spain, Italy, Czech Republic and Hungary) and to show that landscape could be a useful instrument for thinking energy transition and to conceive sustainable renewable energy (RE) projects. In order to achieve this goal interdisciplinary methodologies and strategies were used. We applied a mixed methods research design involving comparative analysis strategy on different levels (national, regional and local), semi-structured interviews and surveys in different study areas and multivariate statistical analysis of quantitative data, multi-criteria spatial approach based on geographical information system, and input-output analysis. The research focused on three renewable energy technologies (wind, solar PV, biomass and biogas) that have been significantly implemented in the studied countries in recent years and that are most likely to be further developed and spatially expanding in next years. The paper presents the results of the project and its policy implications.

Key words: Europe, landscape, policy, renewable energy, spatial planning

Introduction

In response to climate change, limited fossil fuels, and rising global energy demand, renewable energies (RE) have been rapidly developed throughout the European Union (EU). The EU target for 2020 was to cover 20% of final energy consumption by RE, and for 2030 it should reach at least 27%. While these targets are subject to constant evolution, as has happened in the 2030 EU framework, they have already led member States to define, adopt and

implement more or less ambitious renewable energy policy measures. The policy support and development of renewable energy has altered the land use dynamics, brought about new conflicts and disconnections between policy makers and stakeholders (Frolova et al. 2019).

While there are ambitious objectives to boost RE transition, it is more and more evident that it is going differently in various European countries. Thus, the desired end state of energy transition is understood differently in the EU countries. Therefore, it is of utmost importance to understand what is the role of energy policies and landscape planning systems in the EU countries with different heritages of energy systems and political and cultural planning contexts, which have been shaping their energy transitions. This understanding can provide valuable hints for effective policy making and avoid the risk of one-size-fits all energy policies.

Our multidisciplinary international team included geographers, economists, engineers, agronomists, spatial planners and environmental scientists from four European countries.

Aims and objectives

Among general objectives of the project were the following:

- To develop a new theoretical understanding of the nature and dynamics of the renewable energy development, by analysing the existing political, social-economic, spatial and cultural contexts of the RE development in four European countries (Spain, Italy, Czech Republic and Hungary), identifying enablers (success factors) and barriers which hinder a more effective utilisation of the realisable potential of specific renewable energy resources, and studying how these barriers and enablers evolve over time.
- To analyse institutional contexts and acceptability of energy transition in order to provide indications for efficient energy policies.
- To estimate the impact of RE on production using input-output methodology.
- To show that landscape could be a useful instrument for thinking energy transition and to conceive sustainable RE projects.
- To create a database of selected "good-practice" and "bad-practice" case studies of implemented RE projects, which will be a basis for conceptualising key actors (conflict parties) and key controversies

(causes of conflicts), including landscape conflicts, of social conflicts related to RE projects.
– To analyse the technical potential of integrating renewable energies in a given environment and to discern how cultural, socioeconomic and environmental aspects influence the feasibility of achieving this energy potential.
– To analyse factors affecting local acceptance of or opposition to projects through comparative study of public perceptions of social actors of areas with implemented RE projects implemented in selected localities representing different regional and national contexts.

In order to achieve these objectives, we applied a mixed methods research design involving comparative analysis strategy on different levels (national, regional and local), semi-structured interviews and surveys in different study areas and multivariate statistical analysis of quantitative data, multi-criteria spatial approach based on geographical information system (GIS), and input-output analysis. The research focused on three renewable energy technologies (wind, solar photovoltaic (PV), biomass and biogas) that have been significantly implemented in the studied countries in recent years and that are most likely to be further developing and spatially expanding in next years.

Structure of the project

First, a systematic review has been carried out to address whether spatial energy planning studies are considering aspects beyond the techno-economic ones when integrating RE technologies and, if they are being considered, how they are addressed in their analyses and what criteria, factors, and indicators of the aspects that are employed (Osorio-Aravena et al. 2022).

Second, within the national comparative framework, we analysed how diverse energy traditions, institutional frameworks, policies and landscape practices shape the processes and outcomes of the renewable energy transition in the Czech Republic, Hungary, Italy, and Spain, representative of two different energy patterns, the "Southern" one and the "Eastern" one (see Fig. 1).

An extensive, international and interdisciplinary database on the institutional contexts of the energy transition in the four countries has been created (Frolova et al. 2019; Rodríguez Segura and Frolova 2021). At the same time, the energy use patterns of the four countries were explored.

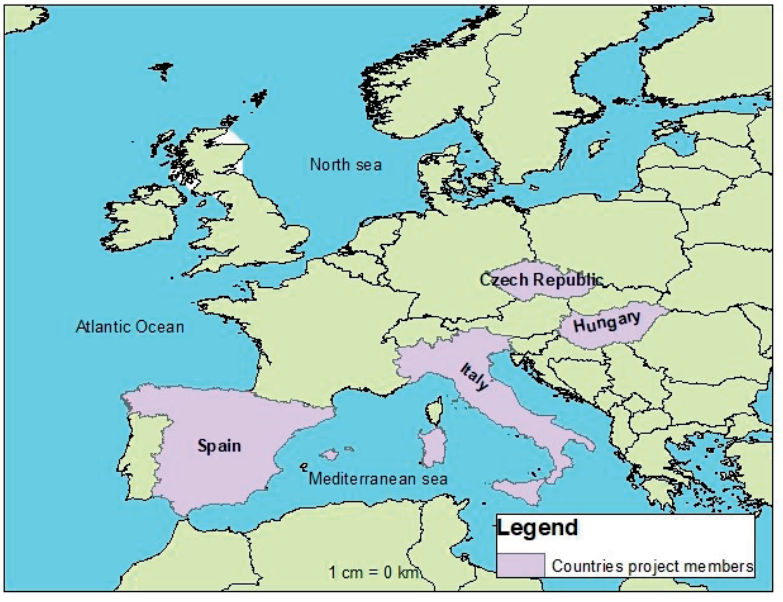

Figure 1. Location map of the ADAPTAS project countries.

In order to do so, we employed a Multi-Regional Input Output model. The results obtained show a certain convergence in energy intensity across the four countries (Camacho et al. 2022a). Parallelly the main driving factors of RE consumption, such as economic and social factors were studied. In this attempt, we estimated a Panel Corrected Standard Error (PCSE) model. The results obtained show that economic factors have a negative effect on renewable energy consumption. In contrast, social factors like education exert a positive effect (Camacho et al. 2022b).

In line with the national comparative perspective, we analysed case studies that are nationally perceived as conflicting projects or bad practices, we also identified and classified relationships among specific conflict parties, conflict issues and project characteristics in onshore wind energy development in the four countries, in particular in Spain and the Czech Republic (see Figures 2, 3, 4 and 5). Our study showed that in spite of essential differences between the countries in geographies and the scale and spatial diffusion of wind farms, most parties and issues emerging in conflicts are common in both countries. We have identified five clusters of conflict parties, six components of issues (nature preservation, distributional injustice, property and conveniences, proportions, health concerns, landscape values and functions) and proposed a generic typology of conflicts (between neighbours, intra-municipal, residents

Figure 2. Case study in Spain: Marquesado solar plant (Province of Granada). Author: Serrano de la Cruz M.A., taken in 2022

Figure 3. Case study in Spain: Zahara de los Atunes wind farms (Province of Cádiz). Author: Frolova, M., taken in 2015

Figure 4. Case study in the Czech Republic: Vitezna. Author: Frantal, B., taken in 2016

Figure 5. Case study in the Czech Republic: Veznice. Author: Frantal, B., taken in 2016

vs. second-home owners, municipalities vs. developers, conflicts of hierarchical powers). While impact on landscape was the most common conflict issue, opponents of wind farms often make use of this argument to justify their opposition to local developments because it may be more persuasive in the battle against developers. However, underlying concerns may be more diverse, e.g. of socioeconomic or political nature (Frantal, Frolova and Liñán-Chacón, in press).

Third, within a regional comparative framework linked to the analysis of the technical potential of integrating RE in a given environment, we proposed a multi-criteria spatial approach based on GIS that included environmental, technical (with economic attributes) and geographical (with social-acceptability attributes) constraints, together with existing local power plants considerations and lessons learnt to estimate the short-term implementable potential of solar PV, wind and biomass energy technologies, in a given territory. We calculated the short-term implementable potential for three RE technologies at the same time considering social-acceptability attributes. This calculation includes both direct jobs creation estimations and greenhouse emission reductions of the implementable potentials by technology in the province of Jaén (Southern Spain) (Osorio-Aravena et al. 2022).

Finally, the surveys on local perception of RE projects and their impacts (Navrátil et al. 2021; Martinát et al. 2022; Rodríguez-Segura, in press), and the role of landscape and seascape in this perception have been analysed (Frolova et al. 2022; Pérez Pérez and Díaz-Cuevas 2022) (See Figure 6). Our study showed that the conflicts surrounding RE are generally linked to the perception of local resources, including landscape and seascape, and the perceived right of local population to use these resources to generate wealth for their communities (Frolova et al. 2022; Pérez Pérez and Díaz-Cuevas 2022). For example, in case of offshore wind farms, the coastal communities' values, perceptions, and practices regarding landscape and seascape have a fundamental influence on their opinions. The changing perceptions of RE projects are linked not only to visual impacts and socioeconomic benefits, but also to fewer tangible aspects of our relationship with the seascape and landscape. These cannot be captured by their purely visual definition and instead require a multidimensional view that encompasses practices, emotions, and mindsets (Frolova et al. 2022).

Results and implications

Our conclusions include recommendations on what planners and developers in the four countries can learn from each other and what measures and practices to put in place to minimise possible conflicts in RE development.

The results of this research could be used as basic information for improving social acceptance of the RE projects currently being processed. Knowledge of citizens' perceptions and attitudes regarding RE installations can be used by policy makers and experts as a strategy for designing projects and campaigns to promote RE projects adapted to the different realities and needs conferred by the local scale. Carrying out our recommendations would also help accelerate the energy transition in a more participative, fairer way which ensures that the public feel that they are participating in all the different stages of energy production and consumption.

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