EXTENDED ABSTRACT

Title: Different impacts at different regional levels: Effects of wind power in a Spanish rural area

Authors and e-mail of all: Langarita, R.[1]; Cazcarro, I.[2]; Almazán-Gómez, M. Á.[1]; Rodríguez, G. [1]; Bielsa, J.[1]

Department:

[1]Department of Economic Analysis, University of Zaragoza, Zaragoza, Spain. Agrifood Institute of Aragon.

[2]ARAID (Aragonese Agency for Research and Development). Agrifood Institute of Aragon (IA2). Department of Economic Analysis, University of Zaragoza, Zaragoza, Spain.

University: University of Zaragoza

Subject area: *S08 – An Inquiry into the Nature and Causes of the Wealth of Municipalities*

Abstract:

The electrification of the economy is a necessity for the decarbonization process, which, at the same time, is needed to mitigate climate change. In line of this Energy transition, everything seems to indicate that an increase of renewable energy is needed. However, as (Cowell, 2010; Nadaï & Labussière, 2009) or (Meyerhoff et al., 2010) point out, sometimes the modification of the territories where the plants are installed is not beneficial for those areas, which are usually rural (landscape, biodiversity, noise, etc.)[1]. As also highlighted by Fabra et al. (2022), deployment of renewable energy is increasingly facing a significant barrier: the opposition of local communities. Thus, it is clear that renewables are needed, but, which is the way for this ecological transition to be at the same time positive for the socioeconomic future of the actual inhabitants of the territory where plants are installed?

[1] Many of the plants are intended to be located in low-productivity agricultural land. These areas have in common the good conditions of solar radiation and/or wind intensity, the relatively low price of land, a low population density and few economic alternatives. However, many of these areas are home to unique natural values, such as steppe birds, which contribute to the attractiveness of Spain as a destination for thriving nature tourism. Several of these species are in a critical situation.

The impacts of the installation of the plants (solar panels, windmills, or even hydropower plants) can have several aspects. In this paper we will focus on windmills and try to shed light on various questions. First, where are we evaluating the impact? The effects for the planet in the sense that at global level emissions will be reduced are not the same that the impact for the area where the plants are installed. Second, time should be taken into account: impacts are different in the short and in the long run. Third, the effects can be analyzed from several perspectives: Economic, social, and environmental. In all of the above levels, impacts could be positive or negative.

From all the possible approaches that can be taken, in this study we will focus mainly in the economic evaluation perspective, although some social and environmental ideas will also be shown. To this end, we will use the input-output methodology to estimate the impacts on production and employment. Input-output methodology (Leontief, 1941) is a good tool because it is able to quantify all the relations among sectors and agents and it can also be used to analyze effects of exogenous changes, because it takes the direct and the indirect effects (derived from the intersectoral relations) into account. Its extensions let also analyze impacts in terms of environment, see (Duarte et al., 2002) or (Cazcarro et al., 2013). For the case of the social impact, surveys should be made.

We particularize the analysis for a case study in Spain, which has also been studied in the literature, e.g. in Álvarez-Farizo and Hanley (2002), where public preferences over the environmental impacts of wind farms are analyzed. Concretely, we analyze the case of the Matarraña region, an Aragonese group of municipalities, sited in the East of the Teruel province, *whose* territory corresponds approximately with the basin of the Matarraña river (tributary of the Ebro river), and the Aragonese part of the basin of the Algars river (which is tributary of the Matarraña river). Thus, most of the 18 municipalities of the Matarraña region (Arens de Lledó, Beceite, Calaceite, Cretas, Fórnoles, La Fresneda, Fuentespalda, Lledó, Mazaleón, Monroyo, Peñarroya de Tastavins, La Portellada, Ráfales, Torre de Arcas, Torre del Compte, Valdeltormo, Valderrobres, and Valjunquera) are within the basin of the Ebro river.

Thus, in line with other studies such as (García-Márquez et al., 2021)[2], the final objective of the paper is the evaluation of the economic impacts of the wind power implementation in the Matarraña region.

For this purpose, we count with two main data sources, namely, aggregated regional data for the economic and demographic variables and census and economic data disaggregated by sectors. Municipal level of the disaggregation has been possible thank to the Aragonese Institute of Statistics (IAEST in its Spanish acronym). Specifically, we have obtained affiliation data by sectors with high spatial (municipality) and sectoral levels.

Our starting point is a multi-regional input-output table (MRIOT) that consists of five main regions (Almazán-Gómez et al., 2019). However, the information it contains does not fit the proper disaggregation for this study. Therefore, it will be necessary to move from a matrix comprising the 5 key-regions of the Ebro river basin (ERB) to one focused on the 3 sub-counties that encompass the Matarraña county.

---

[2] As a novelty and the main difference with this work is that, in this paper, we analyze the effects in a more specific and small area than the Aragonese Community. To this end, as we will see, we will use a multiregional input-output table downscaled to a municipal level, which will be very useful to see the impact on employment in a lower scale.

To do that, we have constructed an auxiliary matrix that contains the sectoral weightings of each industry included in the MRIOT for each of 1,480 municipalities of the ERB. Then, we aggregate this sectoral-weightings matrix to obtain 8 vectors that represent the 3 sub-counties (Northeast, Center, and Southwest) of Matarraña county, 2 adjacent counties (Bajo Aragon and Bajo Cinca), the rest of Huesca, Rest of Zaragoza, and Rest of Teruel. Seven additional vectors were then added to this vector set to represent the 4 other autonomous communities considered in the base MRIOT, the rest of Spain, the European Union, and the rest of the world.

With this, we have a MRIOT with 27 industries, where Agriculture is disaggregated into Agriculture (which distinguishes 36 crops), livestock and fishing, having finally 69 industries. There, energy sector is aggregated in only one sector, sector of code 35, NACE Rev. 2, comprising Supply of electricity, gas, steam. and air conditioning.

In Langarita et al. (2021a) an input-output table is constructed from the supply and use tables, where a disaggregation of the energy and electricity sectors was previously addressed[3]. Specifically, the starting point was the supply and use tables (SUTs) for Spain of 2016 (NSI, 2019). As in this case, there, the energy industry was initially aggregated in only one sector. Since SUTs distinguish between industries and commodities, we have to clarify that the energy product was disaggregated into Electricity and Gas.

For the case of the industries, the energy sector was first disaggregated into: “Electricity”, and “Gas and steam and air conditioning”. Then, the estimation of the percentage of “Related activities to the electricity sector” was carried out, and Electricity was disaggregated into: “Real electricity”, and “Related activities”. The rest of the electricity was disaggregated, making use mainly of SABI (2017), into: “Generation”, “Transmission”, “Distribution”, and “Commercialization”. Generation of electricity was, at the same time, split into several production technologies: hydropower; conventional thermal: coal, oil, gas; nuclear; wind; and other types (where solar, biomass, and biogas are included). A similar disaggregation was done for commodities. Specifically, in the supply table, Electricity products were disaggregated proportionally to the total production of the industries, except for Nuclear energy. In the use table, electricity sub-products were disaggregated proportionally to their productions. Finally, the GRAS method (Junius & Oosterhaven, 2003; Lenzen et al., 2007) was applied to balance the SUTs. With these two disaggregated supply and use tables, an industry-by-industry symmetric input-output table was constructed by the authors, following model D of (Eurostat, 2008).

The Matarraña region is relatively extensive in the context of Aragon. To carry out a more detailed analysis, has it has been already said, it has been divided into three sub-regions: Northeast, Center, and Southwest. In the North there are more agricultural lands and in the more mountainous South forest land predominates. The central zone presents smoother orography and an equitable distribution of land uses for agriculture and forestry.

The distribution of wind power in the Aragonese territory shows a rapid increase that, according to data from the state decarbonization plans, will continue in the near future.

[3] The objective of that study was completely different, since the input-output table was there used for the calibration of a Computable General Equilibrium (CGE) model.

Specifically, we found 214.5 MW to be installed in the Matarraña region, departing from basically no previous installation.

Parallel work by some of the authors is being developed on the factors driving changes in the municipalities, related to value added and income ("on the nature and Causes of the Wealth of Municipalities"), population and employment changes, studied under different econometric analyses. Also Fabra et al. (2022) have recently addressed the question of whether the deployment of renewables (mainly solar and wind) create or not local jobs, especially in rural areas where this is more clearly happening. Their main findings are that on average, solar investments increase employment by local firms (mainly during the construction phase), but the effects on unemployment of local residents are weak. The effects of wind investments on local employment and unemployment are mostly non-significant.

Within these two contexts (on the one hand, studying the factors for the evolution, development, population attraction, etc. of municipalities; and on the other, the effects of renewables deployment in territories, especially "rural"), the article aims to tackle the implications for the municipalities in the Matarraña of such deployment, also mainly in terms of emissions, but as regards additional implications (for value added, and other more qualitative aspects, etc.) as well. The approach is methodologically very different from that of Fabra et al. (2022). Theirs is to exploit the variation in the timing and size of the investment projects across more than 2,000 Spanish municipalities from 2006-2020. In our case, the focus is on the actual direct and indirect effects (value added, employment, remuneration of labour and capital, etc.) based on the current final demands, and on those effects of specific investments, especially in wind energy. In order to do that, we convert the MW to be installed to monetary units based on the actual wind parks budgets. Capital matrices and vectors are used to convert to link those expenditures with sectors. Then in order to see the direct and indirect effects of those investments, we use the labour multipliers obtained from the described employment data and MRIO. The effects can be observed both within the municipalities of the Matarraña, as well as in all other regions. Ultimately, policy implications of the findings are derived, especially for the municipalities and subregions of the Matarraña region, but it might also illustrate the results and challenges ahead for many -especially rural- areas being object of these type of deployments.

References

Almazán-Gómez, M. Á., Duarte, R., Langarita, R., & Sánchez-Chóliz, J. (2019). Effects of water re-allocation in the Ebro river basin: A multiregional input-output and geographical analysis. *Journal of Environmental Management*, *In press*.

Álvarez-Farizo, B., & Hanley, N. (2002). Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms. An example from Spain. *Energy Policy*, *30*(2), 107–116. https://doi.org/10.1016/S0301-4215(01)00063-5

Cazcarro, I., Duarte, R., & Sánchez Chóliz, J. (2013). Multiregional Input–Output Model for the Evaluation of Spanish Water Flows. *Environmental Science & Technology*, *47*(21), 12275–12283. https://doi.org/10.1021/es4019964

Cowell, R. (2010). Wind power, landscape and strategic, spatial planning—The construction of 'acceptable locations' in Wales. *Land Use Policy*, *27*(2), 222–232. https://doi.org/10.1016/j.landusepol.2009.01.006

Duarte, R., Sánchez-Chóliz, J., & Bielsa, J. (2002). Water use in the Spanish economy:

An input-output approach. *Ecological Economics*, *43*(1), 71–85. https://doi.org/10.1016/S0921-8009(02)00183-0
Eurostat. (2008). Eurostat Manual of Supply, Use and Input-Output Tables. In *Methodologies and working papers, Economy and finance*. https://doi.org/http://ec.europa.eu/eurostat
Fabra, N., Gutiérrez, E., Lacuesta, A., & Ramos, R. (2022). *Do Renewables Create Local Jobs ? Non-Technical Summary* (Issue April). https://repec.cepr.org/repec/cpr/ceprdp/DP17206.pdf
García-Márquez, S., Bielsa, J., & Cazcarro, I. (2021). *Analysis of the impact on employment of planned investments in wind energy in Aragon. Final master's work*. Universidad de Zaragza.
Junius, T., & Oosterhaven, J. (2003). The Solution of Updating or Regionalizing a Matrix with both Positive and Negative Entries. *Economic Systems Research*, *15*(1), 87–96. https://doi.org/10.1080/0953531032000056954
Langarita, R., Cazcarro, I., Sánchez-Chóliz, J., & Sarasa, C. (2021). The role of fiscal measures in promoting renewable electricity in Spain. *Energy Conversion and Management*, *244*. https://doi.org/10.1016/j.enconman.2021.114480
Lenzen, M., Wood, R., & Gallego, B. (2007). Some Comments on the GRAS Method. *Economic Systems Research*, *19*(4), 461–465. https://doi.org/10.1080/09535310701698613
Leontief, W. (1941). The structure of American economy 1919-1929: An empirical application of equilibrium analysis. *Cambridge, Massachusetts. Harvard University Press.*
Meyerhoff, J., Ohl, C., & Hartje, V. (2010). Landscape externalities from onshore wind power. *Energy Policy*, *38*(1), 82–92. https://doi.org/10.1016/j.enpol.2009.08.055
Nadaï, A., & Labussière, O. (2009). Wind power planning in France (Aveyron), from state regulation to local planning. *Land Use Policy*, *26*(3), 744–754. https://doi.org/10.1016/j.landusepol.2008.10.018
NSI. (2019). *Instituto Nacional de Estadística. Economía. Cuentas económicas. Contabilidad Nacional Anual de España. Año 2016. Marco input-output. Tablas de origen y destino 2016.*
SABI. (2017). *Sistema de Análisis de Balances Ibéricos. Available under license.*

Keywords: *Aragon; Electricity sector; Input-output; Renewable energies; Rural areas; Wind technology.*
JEL codes: C67, Q40.