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Evaluation of the Effects on Regional Production and Employment in Spain of the Renewable Energy Plan 2011–2020

Miguel Blanco [1], Marcos Ferasso [2] and Lydia Bares [1,*]

[1] Department of General Economics, University of Cadiz, Avenue Enrique Villegas Velez, 2, 11002 Cadiz, Spain; miguel.blanco@uca.es

[2] Institute of Scientific Research and Graduate School, Universidad de Lima, Av. Javier Prado Este, 4600, Lima 15023, Peru; admmarcosferasso@gmail.com

* Correspondence: lydia.bares@uca.es

Abstract: The Renewable Energy Plan for the period 2011–2020 established as a general goal to ensure that renewable sources represent at least 20% of final energy consumption in 2020, together with a minimum contribution of 10% from renewable energy sources in transportation for that year. Then, the goal of this research is to evaluate the effects of the regional production of clean energy, identifying the employment generated in the renewable sector. The adopted methodology was the shift-share analysis, frequently used by researchers to analyze territorial differences. Main results showed important differences, at regional level, in the production of this type of energy. Likewise, we used constant shift and constant share methodology to make a forecast on the evolution of the sector from the data of last published years. Pending the approval of the new Renewable Energy Plan for the period 2021–2030, the results obtained in this research allow the identification of the regions that showed a favorable evolution to the energy change and identifies the projects that generate employment and production in the sector.

Keywords: renewable energies; shift-share analysis; regional production; employment; prediction models; regional studies

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1. Introduction

On 11 December 1997, the Kyoto Protocol was approved, by which the United Nations Framework Convention on Climate Change was put into operation. It contained the commitment of the industrialized countries to limit and reduce greenhouse gas emissions. Likewise, a series of binding emission reduction targets were established for 36 countries and the European Union (EU).

As a consequence, the EU approved the Directive 2009/28/EC of the European Parliament and of the Council on 23 April 2009, aiming the promotion of the use of energy from renewable sources. This regulation established, as the main goal, the reduction of CO_2 emissions beyond 2012. Likewise, this regulation favors synergies that could derive from the implementation of this regulation by the EU countries in matters such as security of energy supply, technological development and innovation, and employment opportunities and regional development, especially in rural and isolated areas [1].

The opportunities that the implementation of this directive by the EU member countries may have in generating economic growth based on innovation and a competitive and sustainable energy policy were highlighted. On the economic side, it underlines the positive implications that the change in the use of energy, from the most polluting to the renewable ones, may have on local or regional Small and Medium-sized Enterprises (SMEs). This is due to the effects that strong regional and local investments in energy production have on the generation of growth and employment.

Directive 2009/28/CE defines the different forms of renewable energy. Specific, this regulation underlines that:

(a) Energy from renewable sources, including that from wind, solar, aerothermal, geothermal, hydrothermal and oceanic energy, hydraulics, biomass, landfill gases, gases from treatment plants and biogas.
(b) Aerothermal energy, which is stored as heat in the ambient air.
(c) Geothermal energy, stored in the form of heat under the surface of the solid earth.
(d) Hydrothermal energy, stored in the form of heat in surface waters.
(e) Biomass.
(f) Others, such as gross final energy consumption, urban heating systems or urban cooling systems, bioliquids and biofuels.

It is set as a general quantitative objective that the EU member countries achieve a share of at least 20% of energy from renewable sources in the gross final consumption of energy in the EU by 2020. To achieve this, each country must adopt a national action plan on renewable energy that must be presented to the Commission.

This philosophy of growth, employment and the environment protection has been reflected in various European regulations, as highlight by the European Agenda 2020 [2]. It establishes the need to achieve smart, sustainable and inclusive growth. For this, five objectives are set and one of them dedicates to the environment. Specifically, the third goal aims to reduce greenhouse gas emissions by at least 20%, increasing the percentage of renewable energy sources in final energy consumption by up to 20% and energy efficiency by 20%.

In the specific case of Spain, the Renewable Energy Plan 2011–2020 was approved by Agreement of the Council of Ministers on 11 November 2011, establishing the goals in accordance with Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009. It establishes the general goal of ensuring that renewable sources represent at least 20% of final energy consumption in 2020, together with a minimum contribution of 10% from renewable energy sources in transportation for that year. For this, a series of intermediate goals were established corresponding to each of the years of the application period, related to the gross final consumption of electricity from renewable sources, and gross final consumption of renewable sources for heating and cooling.

In order to make this plan a reality, certain legal, economic, technical and other instruments have been created, aimed at promoting the use of renewable energy sources, favoring their competitiveness against conventional energies and their integration into the production model and in the energy system. Specifically, the following mechanisms have been created:

(a) Special regime for electricity generation.
(b) A new system designed to improve the development of renewable energies for thermal uses called the Renewable Heat Incentive System.
(c) A new system for the promotion of distributed generation and the compensation of balances between the consumer and the supply company.

Currently, the National Integrated Energy and Climate Plan has been approved for the period 2021 to 2030. In it, the achievement of a series of goals related to the reduction of greenhouse gas emissions has been determined, to promote of renewable energies and energy efficiency. However, a study assessing the positive/negative effects on the regional evaluation regarding renewable energy use in the previous period (2011–2020) is still missing.

In compliance with Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the governance of the Energy Union and Climate Action, on 31 March 2020 it was sent to the Commission European the text of the National Integrated Energy and Climate Plan for the period 2021–2030. This plan updates the Renewable Energy Plan 2011–2020 analyzed in this article. In general terms, the new plan aims to reduce greenhouse gas emissions by 23% compared to 1990. This would allow a reduction of one in three tons of greenhouse gases.

This new plan is presented in Brussels at a time of great economic and social uncertainty as a result of the pandemic caused by COVID-19. In 2020, according to data provided by the National Institute of Statistics, the Spanish economy contracted its GDP by 11%, and, according to the Labor Force Survey, 3,719,800 unemployed people were counted.

There are two important budgetary mechanisms—in addition to the ultra-expansive monetary policy of the European Central Bank—to put in place by the European Union to restore economic growth and employment in Europe. On the one hand, there are the European Funds and on the other, the so-called Recovery Plan for Europe.

The European Funds are made up by the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD), and the European Maritime and Fisheries Fund (EMFF). Currently, the funding package for the period 2021–2027 is approved. Five goals have been identified in its distribution: the creation of a smart Europe; more ecological and freer of the emission of CO_2; more connected by promoting strategic transport and developing digital networks; more social; and closer to the citizens.

The Recovery Plan was created aiming to direct the European economy towards the end of the economic, social and health crisis caused by COVID-19 pandemic and laying the foundations for a more ecological, digital and resilient Europe. In fact, this plan represents the largest budget package—1.8 billion euros—approved so far. Of the total amount, more than 50% must be linked to programs aimed at developing research and innovation, facilitating the climate and digital transition, and enabling preparation, recovery and resilience. Specifically, in the environmental section, it is planned to contribute 373.9 billion euros. According to the distribution approved by the European authorities, of the total Recovery Plan, Spain would have access to 140,000 million euros.

These two programs can become the two financial instruments necessary to lay the foundations for the definitive change in the growth model in force so far in Spain, with a significant preponderance of non-renewable energy sources over renewable ones.

This research has had as goal to evaluate the effects of the regional production of clean energy, identifying the employment generated in the renewable sector, in the light of Renewable Energy Plan 2011–2020. Spanish regions were studied in order to identifying important interregional differences in the models of clean energy production. Thus, an analysis of the projects that have been launched in those regions that have obtained the best results could be carried out. In this way, a base of successful programs could be created that could be replicated in other territories.

Taking into account that the new Renewable Energy Plan for the period 2021–2030 is expected to be approved soon, this type of analysis can be used to introduce regulatory changes to improve the efficiency of the sector at the regional level. Additionally, this study contributes to the transformation of the majority growth model that exists at the moment, and which is based, fundamentally, on the use of non-renewable energies.

To do this, after this introduction, a bibliographic search has been carried out to identify the main studies carried out by the different authors on this matter, and to identify a methodology that allows analyzing the effects at the regional level. Subsequently, the evolution by region of the consumption of renewable energies during the analyzed period is presented. In the fourth section the applied methodology is detailed, and in the fifth the results were analyzed. Finally, a debate proposal has been raised.

2. Regional Analysis of the Impact of Renewable Energies

The analysis of the existence of regional differences of an economic and social nature is a topic frequently addressed by researchers. Among the most important studies are those carried out by economists belonging to the neoclassical current [3,4]. More currently, a set of theories have been appearing explaining these differences. Among them are the dependency and center-periphery theory [5,6], the theory of cumulative circular causation [7], the theory of growth pole [8], the theory of the New Economic Geography [9] or the convergence hypothesis [10].

These theoretical analyzes have been applied to different scientific fields. Thus, there are studies on regional inequalities applied to the economic [11], health [12], socioeconomic [13], and those that are related to the evolution of certain indicators related to sustainability, competitiveness and the knowledge economy [14]. Currently, it is observed how most of the scientific literature focuses on the study of the environment issues at a global level and, more particularly, on the development of renewable energy sources in Europe [15–19].

Despite the analysis of the contributions made by the aforementioned researchers, it is necessary to determine a methodology that could be frequently used in studies on regional inequalities but relating to energy matters. Analyzing the existing literature, it was detected that the authors frequently use the so-called shift-share analysis in this type of studies. Among the main contributions using this methodology are the studies of [20–26]. Additional studies were conducted specifically by implementing the shift-share analysis in the energy sector of Asiatic [20,22,27] and European countries [22,28]. The territorial scope of these selected studies is vast, going from China, Japan, Italy, and Romania, to group of countries such as European Community and the OECD countries. Curiously, no specific studies have been found considering Spain and its regions. This study also contributes to the field by focusing in this not studied country.

In the available literature, it was possible to identify that Lin, Jiang, Fu, Wang and Li [20] studied focused the period from 2007 up to 2016 and the energy consumption changes at Chinese regions, i.e., a provincial level approach. They applied the shift-share analysis in order to identify if the neighborhood affects changes in regional energy efficiency. For this, the authors created a spatial weight matrix and calculated geographical and economic proximities. Then, the results revealed significant differences among the spatial decomposition related to efficiency changes when analyzing the Chinese provinces. The shift-share analysis was also applied by Bao and Liu [21], aiming to identify the driving factors for changing electricity consumption in Chinese regions, identifying differences across provinces related to the changes' components regarding electricity consumption.

Focusing the changes on the electricity consumption at regional level, Grossi and Mussini [22] considered the NUTS 3 level into consideration at Italian regions for the period 2000–2013. The same shift-share analysis methodology revealed that the less electricity-intensive industries presented changes in reducing electricity consumption in all studied regions. In the study of Duro, Alcantara and Padilla [23], the inequalities, causes and evolution of energy intensity among OECD countries were analyzed and it was identified that the specialization in a given industry explains the inequality on such energy intensity. Moreover, a trend was identified regarding a convergence of energy efficiency in the analyzed countries. The study of Borozan [24] focused on the changes rates of energy consumption in EU, analyzing the sectoral and competitive effect of such energy consumption from 1998 up to 2015. Using the same methodology, the study identified a low heterogeneity related to an industries' structure concerning energy consumption. The results evidenced a sectoral concentration in the analyzed countries in the same period.

In the research of Goschin [28], the regional approach to studying economic growth using shift-share analysis in different Romanian regions proved to be successful too. In the later research of Otsuka [27], by using the same shift-share analysis, the author determined the need to explore the energy demands across Japanese regions. Otsuka's [27] research and approach proved to be useful for explaining energy demand growth according to different features of Japanese regions.

In the research of Marin and Vona [25], associations among workforce skills, climate policies and proxied energy prices revealed that, in the 15 industries from 14 studied European countries, climate policies were biased against manual workers if compared with skilled professionals, favoring technicians. The analyzed period was 1995–2011. Lastly, the study conducted by Otsuka [26] unfold the determinants of the demand change in energy, aiming to identify factors affecting the Japanese regional energy demands. The author found that energy demands fluctuations are result of regional and compositional effects. Thus, moderating the changes of energy demands at regional level requires the consideration of industrial structure diversification of a given region.

3. Materials and Methods

3.1. Shift-Share Analysis

Shift-share analysis is a technique based on the decomposition by parts (share) of the variations (shifts) experienced in a period relative to various territorial units [29]. Through this methodology, territorial characteristics are incorporated into the evolution of economic variables.

The variable used in this research is the Electrical Energy Balance, that is, the allocation of production units according to primary fuel. For this, those that come from the renewable energy sector have been chosen. Specifically, the research focused on those that are generated by the Hydro, Wind and Solar photovoltaic sectors. These three sources exceed more than 80% of the clean energy generated in Spain nowadays. The territorial units are 17 regions in which the Spanish country is territorially and officially organized.

The shift-share analysis starts from the Equation (1):

$$C_{ij} = n_{ij} + p_{ij} + d_{ij} \tag{1}$$

where:

C_{ij} = Variations in the use of renewable energies during a defined period of time referred to a generation sector (Hydro, Wind and Solar Photovoltaic) i in the region j

n_{ij} = Territorial component at national level (Spain) for the industries producing renewable energies (Hydro, Wind and Solar Photovoltaic) and regions

p_{ij} = Structural displacement

d_{ij} = Differential displacement

The variations experienced between period *1* and period *2* are defined by defining the following variation rates:

r = Variation rate in the number of GWh from renewable energies Hydro, Wind and Solar Photovoltaic at the regional level.

r_i = Variation rate in the number of GWh from renewable energies relative to each of the i-th power generation sources.

r_{ij} = Variation rate in the number of GWh from renewable energies in the region of a given generation sector relative to region j.

Then, the Equation (2) becomes,

$$C_{ij} = V_{ij} \cdot r_{ij} \tag{2}$$

Adding the different sectors of activity, the Equation (3) is:

$$\sum C_{ij} = \sum V_{ij} \cdot r + \sum V_{ij}\,(r_i - r) + \sum V_{ij}\,(r_{ij} - r_i) \tag{3}$$

that can be expressed as Equation (4):

$$r_j - r = \sum (S_{ij} - S_i)\, r_i + \sum S_{ij}\,(r_{ij} - r) \tag{4}$$

where:

$r_j - r$ is the net change: The net change indicates the variation of each region with respect to that experienced in Spain. If the sector at the regional level experiences growth above that developed at the national level, the net change obtained offers positive values.

This has been decomposed into two changes.

$\sum(S_{ij} - S_i)\, r_i$ is the structural change: This structural change shows the effects of the regional productive structure as the difference between each of its sectors and the regional analogue. If r_i is greater than r, it indicates a positive evolution at the regional level. In the opposite case, the evolution of the region is lower than the state evolution.

$\sum S_{ij}\,(r_{ij}\text{-}r)$ is the differential change: The differential change indicates the sectoral differences of each region with respect to the variation experienced at the country level. If r_{ij} is greater than r_i it indicates a faster growth at the regional level than at the state level.

The reference periods have been set to the years 2011 up to 2020. In this way, both the starting year of the Renewable Energy Plan and its completion are considered. The data has been extracted from the information provided by *Red Electrica Española*.

3.2. Prediction Models

The limitations of the model described by authors such as [30,31] have led researchers to use this technique in a purely descriptive character [29]. For the development of a predictive model, other techniques such as the so-called constant shift and constant share have been developed.

The prediction models have been applied to the employment figures in the renewable energy sector. Specifically, the direct and induced jobs in the following industries have been analyzed: Biofuels, Biomass, Wind and Mini-wind, High and low entropy Geothermal, Marine, Mini-hydraulic, and Solar (both photovoltaic, thermal and thermoelectric). All these industries were considered at the regional level.

The constant share prediction model proposed by [32] is based on the application to different regional industries from the variations predicted at the national level [33,34]. In this way, a homogeneous territorial treatment is given to growth, without any type of regional differentiation.

This research has analyzed the variation in employment generated in the renewable energy sector of a production sector i experienced by the region j. This is calculated as a result of applying the Equation (5):

$$E_{ij}^{t+1} = (1 + r_i)E_{ij}^{t} \tag{5}$$

where,

E_{ij}^{t+1} would be the forecast in the amount of employment in year $t + 1$ in sector i for region j. Thus, the data provided by the Association of Renewable Energy Companies (*APPA renovables*), covering the period from 2010 to 2018, have been used. Therefore, the forecasts have been made for the years 2019 to 2022.

r_i would be the national growth rate for that (predicted) year.

Finally, they are the employment data by sectors for year t.

The constant shift model considers that the employment differential remains in a temporal comparison. Thus, its expected number for the period $t + 1$ is calculated by the Equation (6):

$$E_{ij}^{t+1} = \left(1 + r_i^{t+1} + s_i^{t+1}\right)E_{ij}^{t} \tag{6}$$

where, Equation (7) is

$$s_i^{t+1} = r_{ij}^{t+1} - r_j^{t+1} \tag{7}$$

In this research, for the calculation of r_{ij} and r_j, the historical values of employment production have been taken into account. For the growth estimates, the predictions made by the Bank of Spain regarding the evolution of the Spanish economy have been taken into account. Figure 1 summarizes the methodology of our investigation.

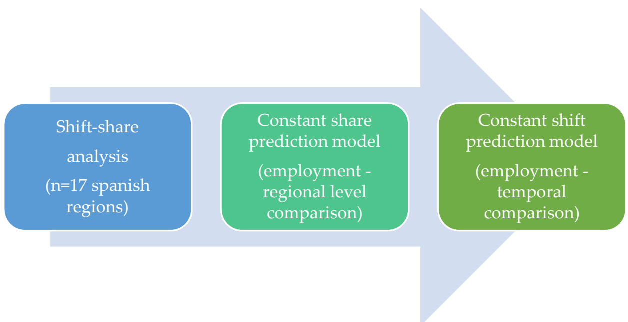

Figure 1. Summary of methodology.

4. Results

In this section, firstly, we will carry out a descriptive analysis of the evolution of the production of renewable energies. Subsequently, we will conduct the shift-share analysis, as well as the constant-shift and constant-share prediction models.

4.1. Evolution of the Production of Renewable Energies by Regions

Figure 2 shows the evolution of energy production in Spain according to its sources.

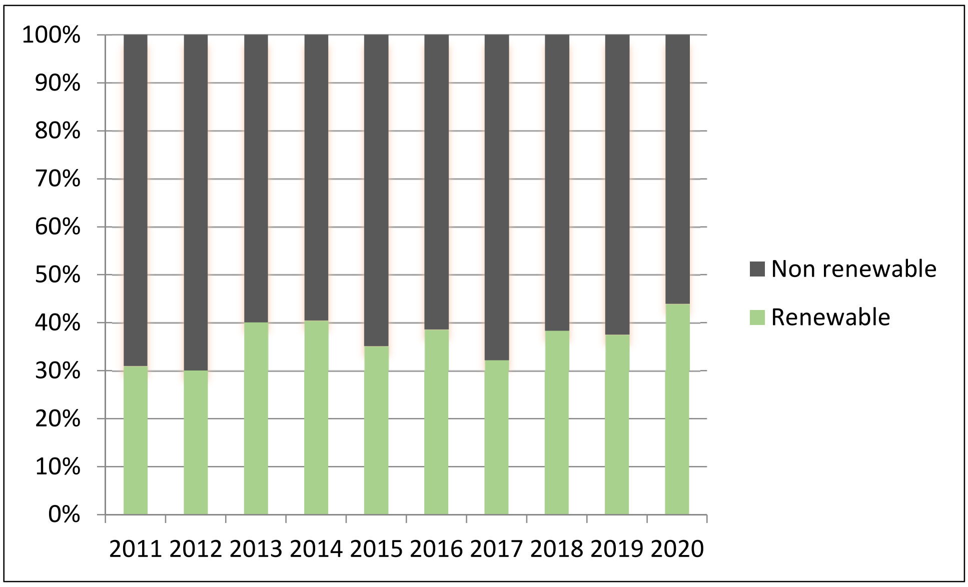

Figure 2. Generation structure of energy by technology used. Units % GWh. Source: Authors' own elaboration based on data from *Red Electrica Española*.

The period begins in 2011. The economic crisis of 2008 begins to be left behind, and a recovery phase begins that would last until 2020, date on which the pandemic caused by COVID-19 has plunged the world economies into a crisis without precedents. During this stage of economic growth, and in accordance with the philosophy of the Renewable Energy Plan 2011–2020, the development of the Spanish economy should have been supported by a sustainable growth. This growth was sustained by a greater contribution from the renewable energy. However, it is observed that this has not been the case. Even in some years like 2015 and 2017 the timid positive trend in the use of this type of energy source breaks. This stoppage has also had negative consequences on the evolution of both direct and induced employment in the renewables sector. Between 2010 and 2014, around 50,000 jobs were lost. The evolution of the job market linked to clean energies is shown in Figure 3.

In Figure 3 it is observed that employment in renewable energy sector undergone a fall from 2011 up to 2014. Since 2016, there has been a change in the trend of job creation. In 2018 it grew by 3.3% and in 2019 by 16.9%.

The following Figure 3 shows the evolution of the structure of the generation of renewable energies in Spain for the period 2011 to 2020. It is noted how the generation of wind and hydro energy accounts for more than 50% (in the average) of the total renewable energy that was generated in Spain.

The following Figures 4 and 5 show the evolution of the main sources of renewable energy at the territorial level.

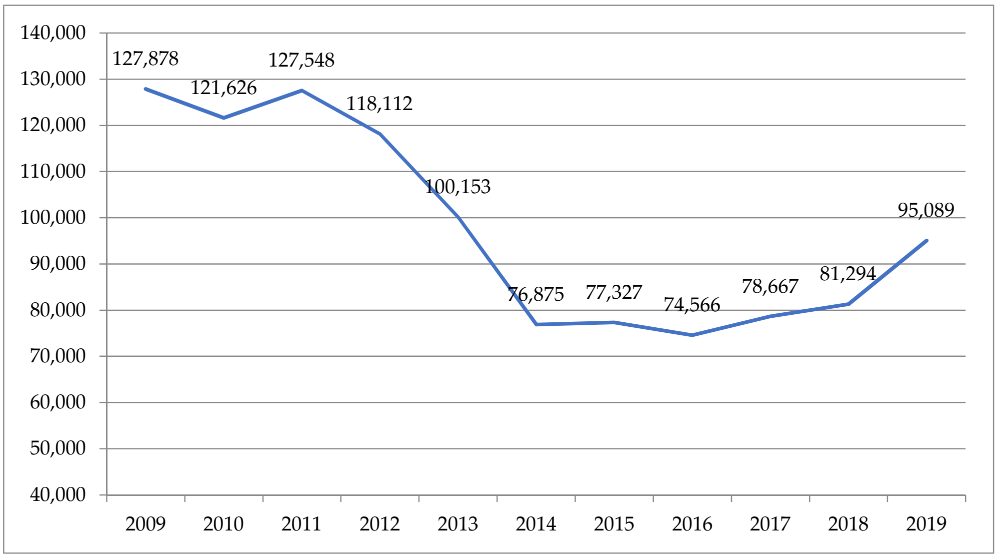

Figure 3. Evolution of employment in the renewable energy sector. Source: Authors' own elaboration from renewable APPA data.

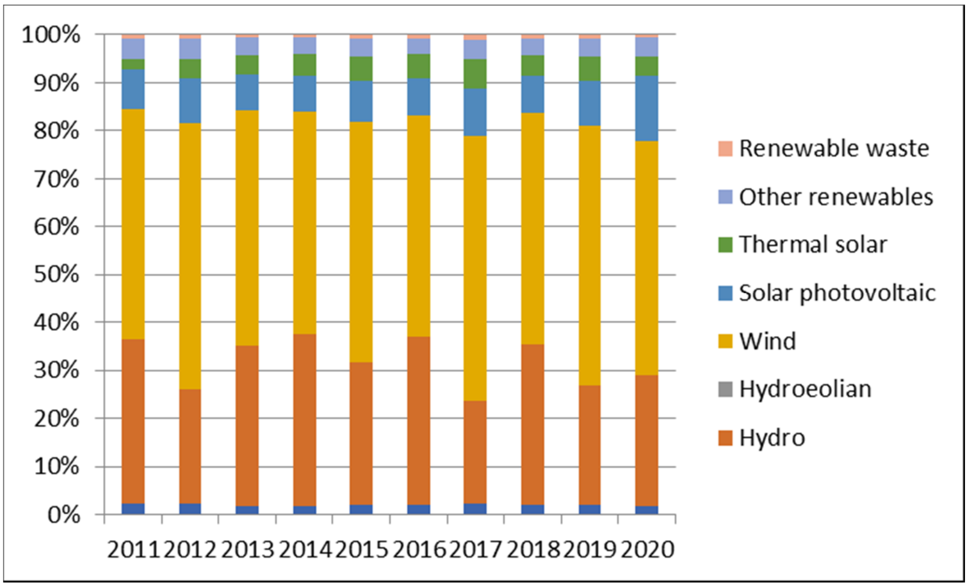

Figure 4. Percentage of the renewable energy generation structure. Source: Authors' own elaboration based on data from *Red Electrica Española*.

It can be seen how 83% of production in Spain is located in the regions of Castilla and Leon, Galicia, Andalucía, Castilla-La Mancha, Aragon, Cataluña and Extremadura. The outstanding results came from the region of Aragon that produces 96% of renewable energy. On the opposite side, there are the regions of the Canary Islands and the Balearic Islands, in which their geographic location of insularity seems to be making it difficult to generate energy from renewable sources.

Figure 6 shows the percentage of the generation structure of renewable energy in Spain broken down at the regional level. In this Figure 5, it is noticed that a fairly high percentage of renewable energy production comes from Hydro, Wind and photovoltaic solar energy. In the case of the Canary Islands, this comes exclusively from the force of the wind in 70%. The situation is totally opposite in the case of the Balearic Islands, in which only 5% is generated by the wind, and 94% of it comes from solar energy.

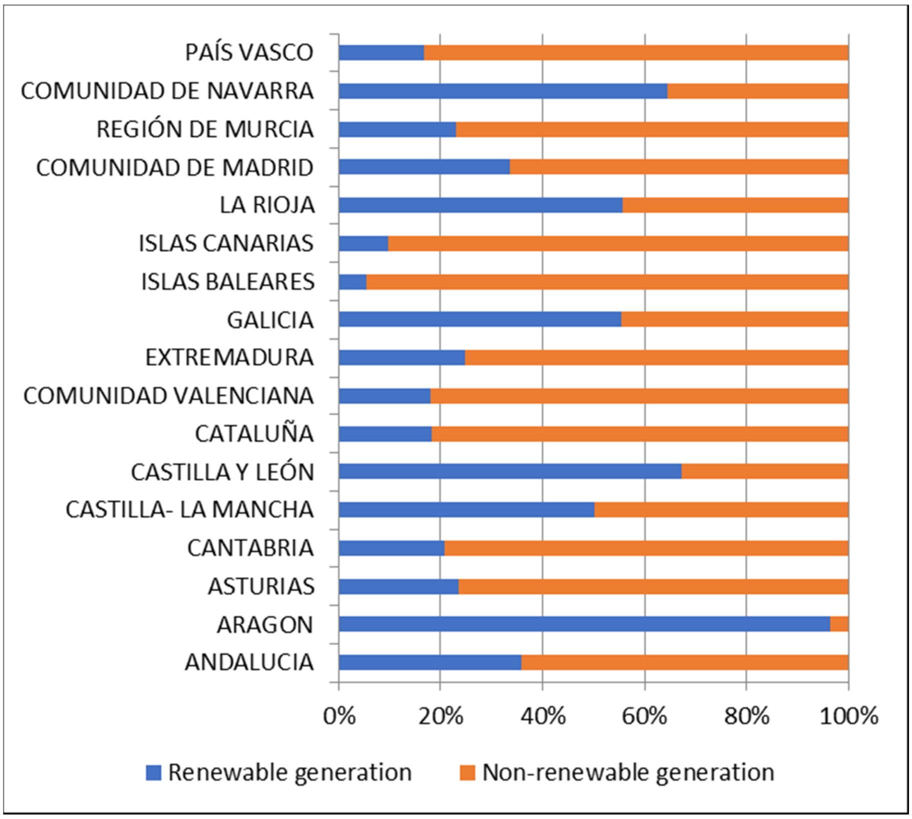

Figure 5. Generation structure of energy by technology used and by region. Units % GWh. Source: Authors' own elaboration based on data from *Red Electrica Española*.

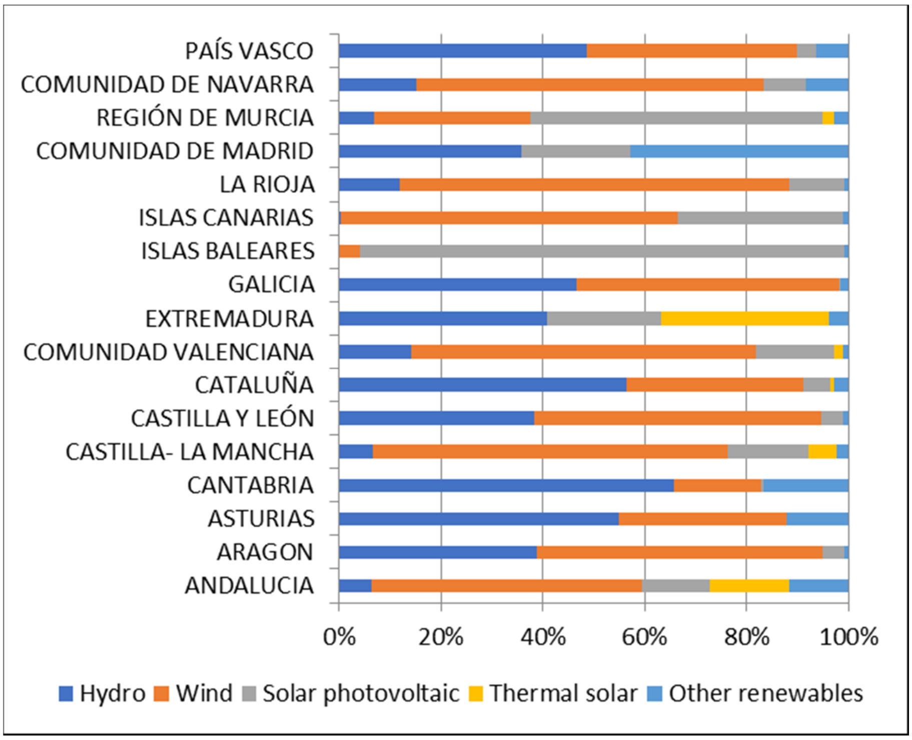

Figure 6. Percentage of the generation structure of renewable energy by region. Source: Authors' own elaboration based on data from *Red Electrica Española*.

4.2. Shift-Share Model

Table 1 shows the results of the application of the Shift-share methodology. The years that have been compared are 2010 and 2020. Thus, in the specific case of Spain, the regional application of the Renewable Energy Plan for the period 2011–2020 is being evaluated.

Table 1. Results of the Shift-share analysis.

	Sikh (%)			Variation R_{ij} (%)			Regional Variation (%) R_{ij}
	Hydro	**Wind**	**Solar Photovoltaic**	**Hydro**	**Wind**	**Solar Photovoltaic**	
Andalusia	13.65	70.45	15.90	−77.33	−47.87	18.22	−41.39
Aragon	38.20	57.91	3.88	−17.40	−27.56	180.28	−15.61
Asturias	65.01	34.96	0.03	−30.21	−14.72	−60.69	−24.80
Balearics	79.26	20.11	0.63	−59.63	−46.60	−46.03	−56.93
Canary islands	9.45	72.83	17.73	−54.93	−49.04	−13.05	−43.22
Cantabria	48.03	47.88	4.08	−53.39	−34.25	−29.99	−43.27
Castilla leon	61.92	32.10	5.98	−12.96	−36.52	−47.18	−22.57
Castilla la mancha	17.21	67.15	15.64	−53.52	−46.32	−41.81	−46.86
Catalonia	77.45	0.00	22.55	−85.66	0.00	0.93	−66.14
Valencian community	45.58	54.31	0.11	−20.51	−35.75	−29.74	−28.79
Estremadura	0.00	5.38	94.62	0.00	−37.08	16.16	13.29
Galicia	0.28	60.25	39.47	110.35	209.35	10.67	130.66
Madrid	12.30	76.62	11.08	−40.08	−62.18	−46.44	−57.72
Murcia	80.04	0.00	19.96	−73.71	0.00	−31.47	−65.28
Navarre	10.76	28.59	60.65	−65.27	−27.38	34.70	6.20
Basque country	12.85	78.03	9.12	−18.78	−56.99	−53.04	−51.72
Rioja	45.87	50.51	3.62	−44.98	−54.73	17.86	−47.63
SPAIN	37.88	52.86	9.26	−41.97	−38.63	−0.31	−36.35

Table 1 shows that only three regions—Extremadura, Galicia and Navarra—had positive values. The rest presented a negative evolution. In Spain there has been a reduction of 36.35%. This behavior had already been detected in Figure 2. The results provided in this table show the negative differences experienced depending on the energy source used and the regions. Thus, on the positive side, the hydro sector experienced an increase of 110.35% in Galicia. In the wind energy sector, Galicia also stands out with an increase in the period of 209.35%. Finally, in the Solar photovoltaic sector, the region of Aragon stands out with a growth of 180.28%.

With this intermediate data it has been calculated:

a. The net change or difference of the variation in the regions with respect to the national total.
b. The structural change that reflects the effect of the specific energy composition.
c. The differential change that reflects the different evolution of the energy sector in the regions with respect to the variation experienced at the national level.

Figure 7 shows the results obtained. It contains the relative position of each region based on two points. The first refers to structural change (blue line) and the second to differential change (orange line). This allows grouping the regions into four groups, depending on the results obtained.

The regions of Extremadura, Galicia and Navarra are in the first group with a positive net and structural change. In a second group are the regions that have a positive net change and a negative structural one, such as Andalusia, the Canary Islands, Castilla La Mancha, Catalonia, Madrid, Murcia and the Basque Country. The third group, with a negative net change and a positive structural change, are Aragón, Asturias, Castilla León and the Valencian Community. Finally, the Balearic Islands, Cantabria and La Rioja both have negative indicators.

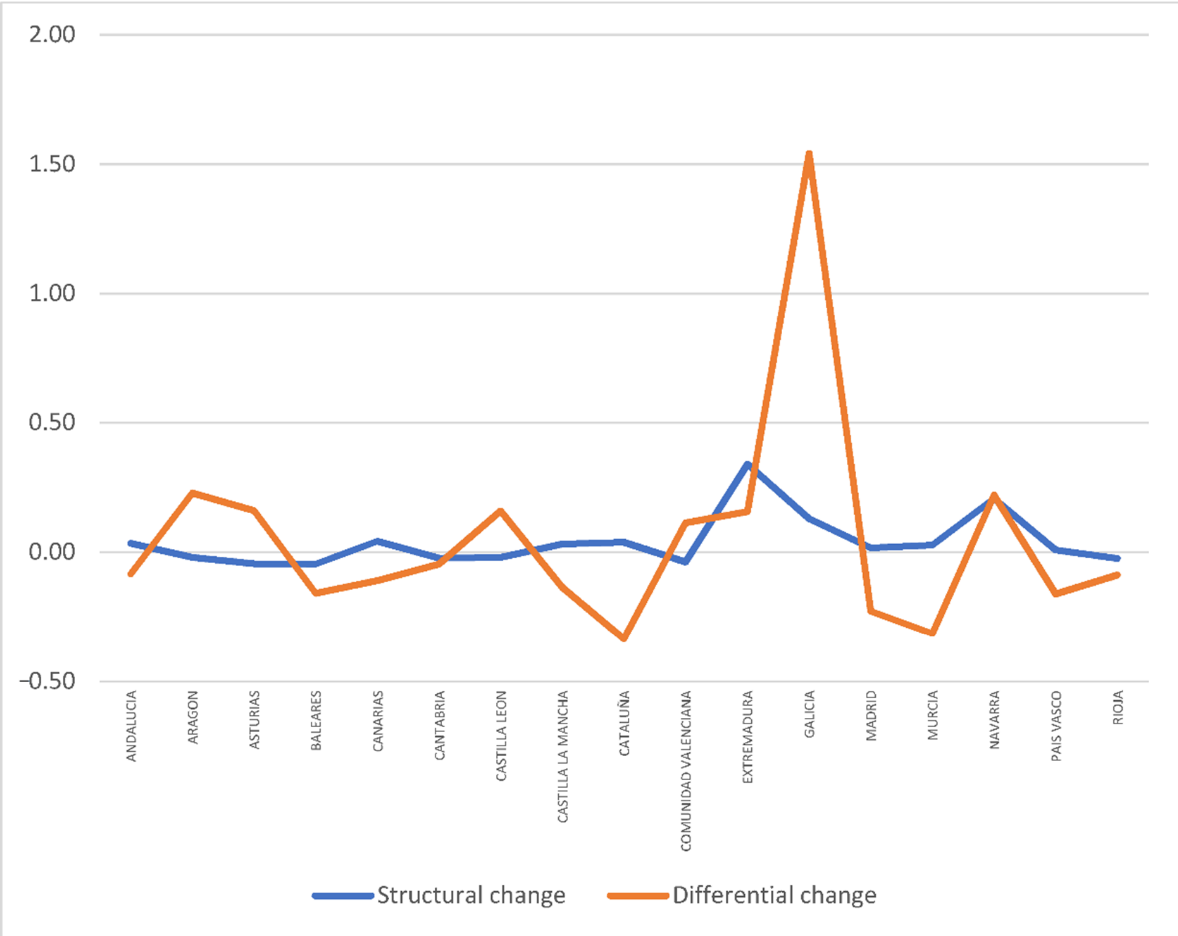

Figure 7. Structural and differential changes among Spanish regions. Source: Author's own elaboration.

4.3. Constant-Shift Prediction Model

The growth structure calculated in the previous section using the Shift-share methodology has been applied to the series of both direct and induced employment data from 2010 to 2018. These are the years for which data published by *APPA renovables* are available.

These calculations have served to project the series for the years 2019 and 2022, taking into account the growth forecasts provided by the Bank of Spain for the Spanish economy. Figure 8 shows the evolution.

In Figure 8 it is noticed little growth in employment generated in the production of clean energy sources sectors. The biomass sector is the one with the highest growth rate (0.26%). On the contrary, the sector that will generate the lowest growth rate is that of marine energy with 0.003%.

As can be seen in Figure 8, the forecast for employment growth in the different non-polluting energy production sectors is very low, yielding values very close to zero. Both forecasting models coincide in ruling out sustained growth in employment over time. They also coincide in pointing out the important contribution of the biomass (42.08%), solar (26.15%) and wind (24.11%) sectors. These three sectors accumulate more than 90% of employment in Spain.

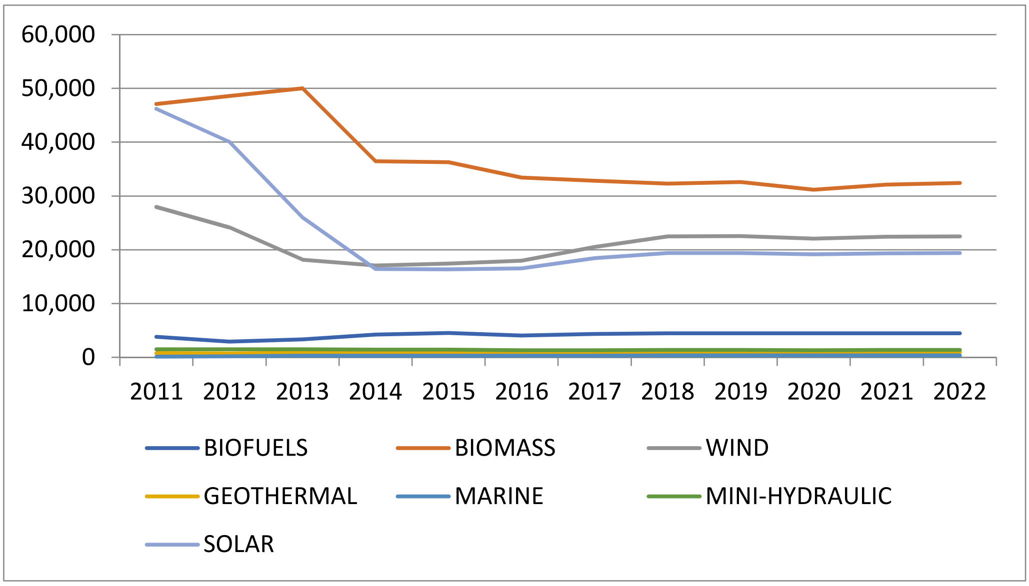

Figure 8. Evolution of employment in Spain in the different renewable energy sectors calculated using the constant-shift prediction model. Source: Author's own elaboration.

4.4. Constant-Share Prediction Model

Figure 9 shows the evolution of employment for the years 2019 and 2022, according to the constant share methodology.

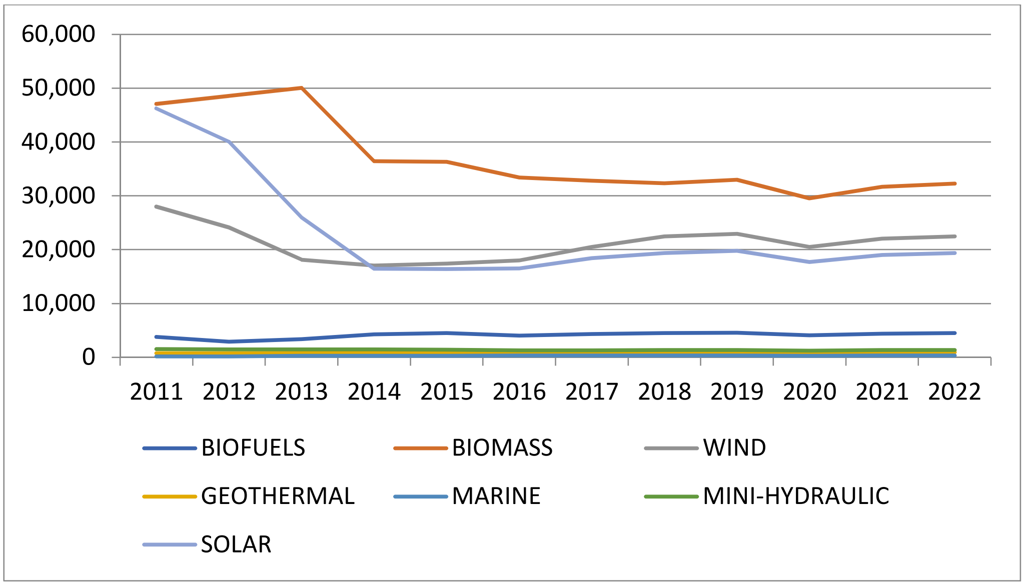

Figure 9. Evolution of employment in Spain in the different renewable energy sectors calculated using the constant-share prediction model. Source: Author's own elaboration.

5. Discussion and Conclusions

In this research, an evaluation of the Renewable Energy Plan 2011–2020 has been carried out from a regional perspective and exploring the Spanish regions. As has been seen, in the first years of the program's implementation, there is a growing interest in the use of clean energy at the national level. However, as of 2015, the situation changed dramatically, experiencing a significant reduction both in terms of production and employment. Once again, since 2018, hopes in the sector seem to have recovered, placing greater confidence in the fulfillment of the goals set in the PER 2011–2020 at the national level. However, these expectations for the development of the sector in the short term do not have an outstanding projection in the generation of employment. If this growth is analyzed at the regional level, it can be seen that the growth in recent years is not homogeneous. Only three regions offer results above the average, such as Extremadura, Galicia and Navarra.

The existence of regional differences had already been shown in the analyzed literature [20,21,35], and, in general, the scholars showed that the standardized economic model is prone to accentuating territorial differences in terms of economic growth and employment, without the intervention of the public sector. For this reason, the EU, aware of this situation, has been developing and implementing mechanisms, generally of a budgetary nature—as is the case of the European Funds—to reduce these differences. Additionally, it is necessary for the next years to develop a common renewable policy in Spain, in order to reduce the inequalities between regions.

In this research, shift-share analysis has been used which, as has been evidenced in the analysis of the previous literature, is a methodology that has a broad consensus among researchers to analyze regional differences. However, in the case of this research, these differences apply to territorial models of renewable energy production. In this way, it has been possible to determine how there are regions (such as Extremadura, Galicia and Navarra) that have made a greater effort than other regions in the use of renewable energies.

Being aware of the limitations of this study, we consider it necessary to direct future research to correlate the patterns of regional economic growth with those of renewable energy production. This would make it possible to quantitatively determine which are the regions that are implementing sustainable economic development and employment models with clean energies. This type of analysis can help define the distribution system for the European Funds and the upcoming Recovery Plan. In this distribution system, public economic resources should be offered as a priority to those projects that generate employment and production based in renewable energy sources. We also consider it necessary to identify which are the regions that are lagging behind in the implementation of a sustainable growth model, and to promote in them the projects that contemplate this environmental dimension [36–38]. If these measures would not be taken, it could increase environmental differences at the territorial level.

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