Master in Economics: Empirical Applications and Policies

UPV/EHU

Green jobs in the Spanish renewable energy sectors: an input-output approach

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September 30, 2020

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Contents

Abstract

After the Paris agreement, the transition to a low carbon economy is at the heart of the debate of the European energy and climate policy. One of the central targets of this transformation proposes changes in the energy mix, moving towards a more sustainable one. In the upcoming years, an increase in the share of renewable energy in electricity production is expected, which will create new green employment opportunities in the labor markets all over the world (i.e., along the global value chains). Focusing on Spain, in this master thesis we use a multi-regional input-output model to quantify the green jobs generated in this transition process. We include an installation cost vector and we analyse the employment creation with green investments under different scenarios for two different technologies: wind onshore and solar photovoltaic. Our results show that, at least, Spain may generate 8.6 and 8.1 employments per million invested in wind and solar, respectively. Indeed, we calculate the spillovers of that investment generating 5 jobs in the rest of the world and 2 in Europe for the wind energy technology and, 5.7 and 2.1 green employments for solar energy. Finally, we find that in the solar energy case, the number of jobs generated could increase up to a 53% in the best scenario compared to the benchmark. The findings of this work will contribute to the methodological and empirical basis for understanding and modelling the energy transition in Spain.

Keywords: multi-regional input-output, green jobs, spillovers, renewable energy.

1 Introduction

The necessity of making a change in the productive framework in order to achieve the European 2030 climate and energy targets[1] and entering in the path of a low carbon economy are indisputable. The Intergovernmental Panel on Climate Change (IPCC) has already stated that human influence on the climate system is clear. Observed impacts of climate change are "widespread and consequential", but future effects still largely depend on current actions worldwide to reduce emissions [29]. Moreover, the world has been shaken by the Covid-19 and probably is immersed in the highest crisis since the second world war. In this sense, the consequences are already being perceived, the growth rate of the Eurozone has experimented a decrease of 3.8% (Eurostat) in the first trimester of 2020 in relation to the last one and, according to the National Statistics Institute (INE), the Spanish GDP declined by 5.3%. Therefore, the stimulus that the economies would need are huge.

Both the Kyoto and Paris protocols have established the starting points of the European climate and energy objectives. However, the ambitious of the European Union is higher. The European Green Deal Investment Plan determine that "a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050, where the environment and health of citizens are protected, and where economic growth is decoupled from resource use" [12]. For that purpose, the European Commission (EC) will mobilise at least 1 trillion of EUR during this decade through the EU budget and other instruments. On the other hand, the Covid-19 crisis has pushed the achievement of the objectives forward. In words of Ursula von der Leyen, president of the European Commission, "the stimulus packages after Covid-19 have to reflect our strategic interests and our priorities and these have not changed: the priorities are the de-carbonisation and digitization of the European Union". Along the same idea several Ministers of the EU, including the Vice-president of the Government and Minister for the Ecological Transition and Demographic Challenge of Spain, Teresa Ribera, request the Commission to use the European Green Deal as the instrument for resilient recovery after the Covid-19 crisis.

To the European climate and energy plan, a trillion in a decade, we must add the new instrument called Next Generation EU [11] to deal with the crisis. This instrument is also

[1] The key targets for 2030 are: at least 40% cuts in greenhouse gas emissions (from 1990 levels), at least 32% share for renewable energy and at least 32.5% improvement in energy efficiency.[12]

connected with the priorities of de-decarbonisation and digitalization of the EU and fitted with 750 billion. Spain, as one of the most damaged countries of the crisis, will receive 140 billion. However, the dimension of the plan is higher, as the Commission estimates that investment needs amount to at least 1.5 trillion in 2020-2021.

According to the National Integrated Energy and Climate Plan (PNIEC, in Spanish) three out of every four tons of greenhouse gases originate from the energy system. In this sense, the 38% of the budget of the Plan is going to be invested in renewable energy, and the remaining is going to be invested in energy efficiency and security for the interior energy market, network and electrification [14]. Nevertheless, does investing in the energy system bring out economic growth? Many studies have evaluated and conclude a positive relationship between economic growth and investments in green energy and emissions [6][10][27][3] [20].

The estimation of the macroeconomic factors that shape the green recuperation will thus be essential. Those programs have to be designed as the best approach to quickly convey employments and recoup the harmed economy and, at long last, to build a stronger and resilient society. In Spain, specifically, the first draft of the *Proyecto de Ley de Cambio Climático y Transición Energética*, that follows "The European Green Deal", has just been published in May 2020, so the public debate is already open and new research focusing on the impacts of these prospective measures is needed.

The main objective of this master thesis is to asses the number of employment that the Spanish economy could generate with investments in green energy, that is to say, in the renewable sector. Furthermore, with our methodology we are able to split this new employment between direct and indirect jobs. Finally, our model allows us to capture the external effect in the employment that this investment is going to generate through the value chains that interface the economies.

Our contribution to the literature is going to be associated to the employments that those green investments are going to generate in Spain. Nevertheless, we are in an integrated world and, thus, we should consider the value chain of the economy. In this context, the calculation of the employments generated by green investments have a twofold aim. On the one hand, how much employment is going to be generated with policies oriented to achieve the climate and energy target proposed by the EU and the PNIEC itself. On the other hand, Europe and the rest of the world economies are going to be benefited as well from the Spanish investment in employment terms.

For that reason, we are going to use a Multi-regional Input-Output (MRIO) model where we can capture the spill-over effects of the policies, the impact in Spain and the sectors in which the investment generates more employment. In fact, there is a growing literature background that analyse the advantages of using this approach to make economic policy [7] [21] [37]. All in all, "input-output models are often used for these studies because they have the advantage of being transparent, having few assumptions built in, are easily replicable and are built from current or recent data from national accounts" [16].

In our MRIO model, the three regions we are going to use are: *Spain*, *The European Union* (excluding Spain) and the *Rest of the World*. We also establish that the green energy technologies we are going to include in the study are wind onshore and solar photovoltaic. This information is essential for the policymakers, in order to design the best cost-benefit policy and prioritize their implementation, with the double objective of maximizing the multiplier effects of policies in terms of employment creation, generation of income or government revenues and, at the same time, investing in the energy that makes us achieve the objectives set by the European Union with greater celerity.

The remainder of this master thesis is structured as follows: First, Section 2 includes a literature review resuming the most important studies related to green jobs. After that, Section 3 describes the methodology employed in this study and the data we used. The outline of the results are explained in Section 4. Finally, Section 5 concludes the master thesis.

2 Literature Review

The economic implications of investing in clean energy technologies is a scope in the literature that has been rising constantly in the previous years. In this section we are going to cover a brief selection of literature on quantification of the economic impact associated with the deployment of the Renewable Energy Sources (RES) in countries and regions and the use that has been given to the input / output methodology in economics. A select results of case studies are shown in the Table 1.

As time passes the application of the input/output tables has evolved to use this methodology to asses the number of employment associated with a demand or supply shock, or to calculate the employment multiplier of an economy, among others.

Several studies (see for example [8] or [2]) provide information about the employment generation (direct, indirect and induced) of policies related with green energies. Both studies, among other, conclude their studies with significant results. While the first estimates more than a hundred of new employment per MW installed for Solar tower technology both in direct and indirect employments, the second study calculates that marine energy creates almost 36 thousand direct and indirect employments and more than 14 thousand of induced employment. Otherwise, there are studies that calculate the net employment effect of renewable energies, for example see [17], [25] or [5]. The three studies end up estimating a highly positive net creation of employment. Both researches focusing on Germany give a clear vision of the evolution in terms of economic impact that renewable energies have had. [17], with an input/output modelling estimate a decrease net employment creation from 2004 to 2008. In that year, the investment in green energy gives a net employment near to 0. On the contrary, [5] use a top-down model [2] based on an econometric approach to calculate the net employment effect of the deployment of renewable energy until 2030 in Germany. In this paper we can see the consequences of the cost reduction for the green energy and now, twelve years later the net employment is higher than 150 thousand of net employment and, in 2030 the quantity rise to 263 thousand.

Under a research point of view, the employment impact of RES can be grouped into three different methodologies. Firstly, the input/output approach; then, the computable general equilibrium (CGE) models and finally, an analytical method which generally rely on extensive

[2]Top-down models focus on feedback and price effects within an economy and,importantly,economic interactions occurring via international markets such as trade in goods and services. [5]

surveys focusing on a specific technology in a territory.

Following with the debate concerning which methodology is more appropriated to analyse the generation of employment through investment in green energy, we have to focus on those methodologies that examined employment outcomes, in order to execute good estimations. Citing [32] there are two macroeconomic models to take into account. Firstly, "Input-output models and SAMs that are models based on social accounting matrices at the national or sub-national level. Otherwise, extensions of input-output model, such as CGE (Computable General Equilibrium) models, which incorporate additional economic relationships and constrains". As we do not have statistical information about the quantification of green jobs, neither a definition agreed upon by the scientific community, "quantitative forecast have proven to be inefficient, so more flexible framework allowing for both sectoral and cross-sectoral studies is preferred". [34]. In this line, [32] suggests that input-output models are useful for estimating employment outcomes for a variety of research objectives such as the estimation of employment outcomes associated with green investments. Moreover, an advantage of using this methodology is that is feasible for the policymakers to understand the mechanisms and outputs that input-output models get. "This can give policymakers much greater confidence in a model's results and predictions" [32].

Direct, indirect and induced are the three categories the researchers can compute in an employment effect study. A direct job refers to the one that is created to support the increase of generation capacity, while the indirect job are those that allow the expansion of the renewable source through the values chain. While both, direct and indirect could be estimated by I/O or CGE, the analytical method can only compute the direct jobs. On the other hand, the induced jobs are those created, in the second stage of the policy, as the effect of the household spending change due to the increase of labor income. It is only computable by I/O but it has been less used in the literature due to "uncertainty and difficulty of measurement, which may lead to the overly optimistic employment estimates of renewable energy expansion" [25]. The differences among the data used, the methodologies and the placement of the policies implemented make that there is not clear what type of RES creates the more employment. Besides, the results are influenced by the economic structure and the level of activity undertaken domestically.

Table 1: Several studies examining the implications of Renewable Energy Sources (RES) development

No	Study	Country/Region	Interventions included	Methodology used	Total spending	Macroeconomic implications
1	Tourkolias, C. and Mirasgedes, S. (2011)	Greece	Wind, PV, Hydro, Geothermal, Biomass deployment according to the EC plan 2020	Input/Output	11.300 euro/kWel	An increase of the employment of 373.6 man-year/MW
2	Hillebrand, B et al. (2005)	Germany	Expansion of Renewable Energies according to EGG law, 2004	Input/Output	2004: 2.603 Billion Euro 2006: 1.855 Billion 2008: 1.411 Billion	Net employment effect of policy (thousands): 2004: 32.6 2006: 14.7 2008: 2.4
3	Cansino, JM., et al. (2014)	Andalusia, Spain	Deployment of 335.9 MW of photovoltaic electricity generation to the electricity grid	CGE	179.397 Million Euros	Total employment generated: 215,148 one-year job Other macroeconomic implications (%): GDP:+10.83 Tax revenues: +10.07 Disposable income: +3.99
4	Moreno, B. and Lopez, A. (2008)	Asturias, Spain	Wind, solar thermal, PV, biofuels, hydro, biomass-thermal, biomass-electric,biogas	Analytical		The following employment ratios have been estimated: Wind: 13.2 jobs/MW Solar thermal: 7.5 jobs/m2 PV: 37.3 jobs/MW Biofuels: 6.5 jobs/kt/year Biomass thermal: 0.13 jobs/tep Biomass electric: 4.14 jobs/MW Biogas: 31 jobs/MW
5	Mu, Y. et al. (2018)	China	Solar PV and Wind Power	CGE	Wind power: 2.295 Billion of Yuan Solar PV: 5.100 Billion	The Lump-sum Tax (LST) scenario estimate the following Net employment effects: Wind power: 13.620/TWh Solar PV: 34.090/TWh
6	Blazejczak, J. et al. (2014)	Germany	Deployment of renewable energy until 2030	SEEEM		Net employment effects: 2010: 72.000 2020: 151.000 2030: 263.000
7	Ragwitz, M., et al. (2009)	European Union	Impact of renewable energy	ASTRA and NEMESIS		New employment generated: 2020: 417.000 2030: 545.000
8	Caldés, N. et al. (2009)	Spain	Solar thermal electricity	Input/Output		Employment ratio (emp/MW): Solar power plant: Direct:111; Indirect: 81 Solar tower: Direct: 189; Indirect: 133
9	Allan, GJ., et al. (2014)	Scotland	Marine energy development	Input/Output	2280 Million libra	Employment generated (person-years): Direct and indirect: 35.819 Induced effect: 14.393

Source: Own elaboration

3 Methodology and Data

3.1 The Input-Output methodology

The Input-Output model was developed by Wassily Leontief[3] in the 30s and it is an analytical framework where we can evaluate, among other, the interdependence of industries in an economy, the relationship between the necessities and destinies of each industries and the trade connections among countries. A set of linear equations are used to analyse the interrelationships between different sectors of the economy. This type of model has been widely used to asses the economic, social and environmental impacts of any type of economic activity [38], from countries [37] [17] or regions [28] [22].

The information contained in the Input-Output tables can be read as follows: "The rows of such a table describe the distribution of a producer's output throughout the economy, while, the columns describe the composition of inputs required by a particular industry to produce its output". [23] The exchange of goods can be shown in the Figure 1 extracted from [23] as the shaded part of the table. In other words, the Table 1 illustrate all the monetary transactions among industries and the final sector. Thus, "they can be used to construct disaggregated multipliers in order to estimate apart from the direct impacts of a particular policy or project, also its indirect and induced impacts". [37]

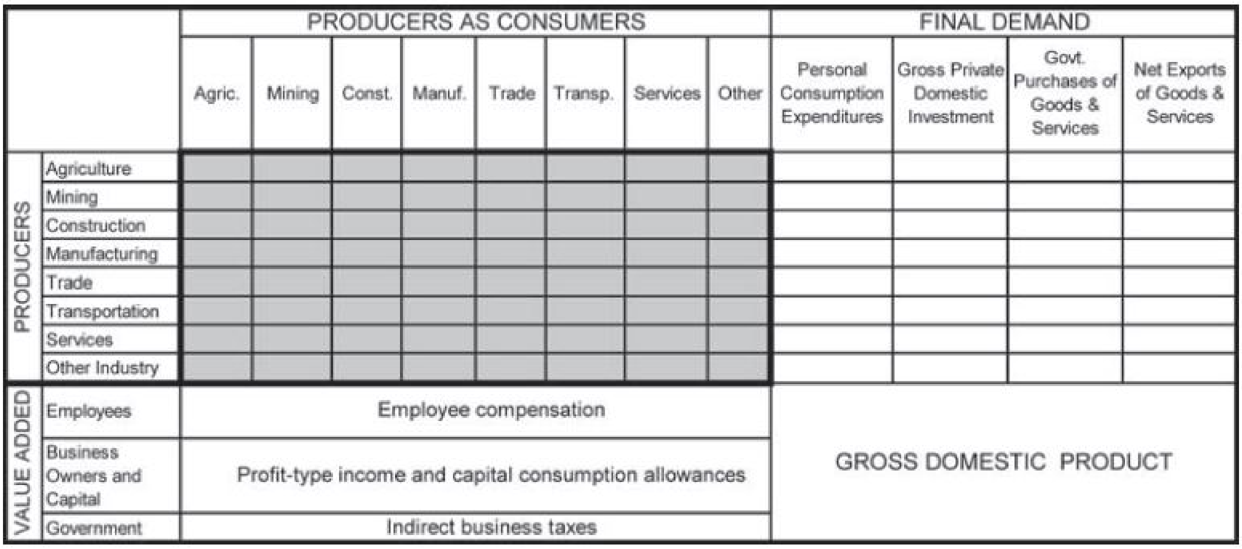
Following [23], the basic Input/Output model demand can be represented by the next matrix formula:

$$X = (I - A)^{-1}Y \tag{1}$$

where, X is the vector of final production of the economy; I is the identity matrix; A is an n × n matrix of technical coefficients a_{ij} that is defined as amount of production of sector i that sector j needs to produce one unit of output. With these coefficients we are able to compute the direct impacts from a final demand shock for a particular good on the multiple economic sectors.

[3]Wassily Leontief received the Nobel Prize in Economic Science in 1973 for the development of the input-output method and for its application to important economic problems.

Figure 1: Input-Output transaction table



The $(I-A)^{-1}$ is the n × n matrix called the Leontief inverse or, the input/output multipliers. We can interpret this matrix as the "Keynesian multiplier of the multi-sectorial and multi-regional output, given that it allows to calculate to what extent it has to increase the output of the entire economy, quantifying both direct and indirect effects, to serve a certain increase in final demand". [1] The internal elements of the matrix, b_{ij} can be interpreted as the "total required increase in the production of sector i to meet an increase of one unit in the final demand of sector j"[37]. Moreover, the sum of the j elements, allocated in the columns, gives the output multiplier of the sector j, that can be interpreted as the total change in gross output of the entire economy by an initial shock in the final demand of \$1 in sector j.

3.2 Creating the investment vector to model renewable energy

The method we are going to use to asses the employment generated through a policy of 1 million of Euro invested in renewable energy is by the way of including the investment cost of each technology in the model.

WIOD (World Input–Output Database) tables do not consider into their industries anyone related to the renewable energy.[4] Thus, technologies such as wind onshore or solar photovoltaic are not included as a category in this type of table. Nevertheless, the activities related to these technologies are captured implicitly in the WIOD table. The principle research work is to find

[4]WIOD table contains data from 56 sector that are classified according to the International Standard Industrial Classification revision 4 (ISIC Rev. 4)

Table 2: Composition of Renewable energy industries using alternative cost structures

	Wind (Tegen et al.,2013)	Wind (IRENA, 2012)	Wind (B&V, 2012)	Solar (B&V,2012)	Solar (IRENA,2012)
Construction	0.2	0.276	0.255	0.095	0.125
Nonmetalic mineral products	0.03	0.16		0.12	0.05
Fabricated metal products	0.16	0.16	0.34	0.41	0.21
Machinery	0.37				0.385
Computer and electronic products, electrical equipment appliances and components	0.15	0.314	0.34	0.33	0.122
Truck transportation	0.03				
Insurance carries and related activities	0.03				
Miscellaneous professional, scientific and technical services	0.02	0.09	0.04	0.02	0.109
Management of companies and enterprises	0.01		0.025	0.025	
Sum of weights	1	1	1	1	1

Source: Own elaboration

which components for the creation and start-up of renewable energy technologies and, in what percentage are distributed through the tables. For example, we can find in WIOD tables the means of transport or the electrical component which are necessary parts for the good running of the renewable energy. Thus, if we can then identify the several components and their weights, we can study the impacts of increased demand for the renewable energy. We can see this approach in [23] as one of the two methods to asses the impact of a new industry.

The trend of the most countries in the world to use "green" investment in order to die down the economic consequences of the Covid-19 pandemic allow us to asses that there is going to be a exogenous demand of clean energy as a result of the public spending, in the first place, or private investment by business or households.

In order to simulate the number of employment that this increase of demand will produce, firstly, we build a demand level, that is a weighted average of various industries that exist within the I-O tables. This information could be estimated by survey data, expert interviews, financial reports from energy industries, or other type of sources. However, in this master thesis, we are going to use the vectors of demand used by [16]. All the information was selected from "extensive surveys or databases of projects (such as the database of thousands of ESCO projects maintained by the Lawrence Berkeley National Laboratory), and in other cases the data result from a combination of sources, such as business journals, industry associations, and tenders e.g. [18] and [19]". The costs and components identified by these various agencies and organizations after are assigned to I-O industry categories to the components which are presented in the Table 2.

Once we have estimated the cost structures of the renewable energies, we must allocate each element of the Table 2 to a sector of the model. Indeed, we have to create, from our initial input/output table, a vector of international trade distribution by sectors.

We are going to call $InstCost_i$ the installation cost vector with dimension 56×1 and $IntTrade_{ic}$ with the same dimension that the other. This vector express the shares that each region sets aside to the Spanish final demand by sectors. By definition, the sums of share for each sectors sum 1. Then, the investment vector is calculated as follows:

$$Inv_i = InstCost_i IntTrade_{ic} \tag{2}$$

The result of the equation (2) is a vector with a dimension of 168×1. We need this dimension in order to multiply it with the Employment Multiplier, which will be explained next, that has a dimension of 168×168.

To conclude this part of the methodology, we must remark that the investment vector has been constructed from the use of the installation cost vector and the shares of international trade. We can identify, because of the characteristics of the model, the quantity of money invested in each sector and region, under the assumption that the investment is distributed as in the baseline (current sectoral and trade structure).

3.3 Quantification of the employment effect

In order to quantify the employment effect of the investment in renewable energy, we are going to use a Multi-Regional Input-Output methodology (MRIO). Following [16], to make this study we have to convert the Leontief inverse matrix into an Employment Requirements (ER) matrix. In order to estimate it, previously, we have to calculate the ratio between the total employment and total output of each sector i, called l_i. Thus, the vector express the intensity of employment needed to deliver one unit of output. Once we have diagonalized this vector we have, we multiply the matrix $n \times n$ with the inverse of Leontief in order to obtain the Employment Requirements matrix. Analytically, $ER = L(I - A)^{-1}$, where L is a matrix resulting of diagonalized the vector of employment intensity and $(I - A)^{-1}$ is the Leontief inverse. This new matrix contains the direct and indirect employment that the economy can create from an additional investment (indeed, from any change in final demand). For example, if we invest 1 dollar million in the onshore wind industry, we can intermediately see the jobs created through this investment (direct jobs), as well as the number of jobs supported in other industries such as provision for civil constructions and trucking.

Concentrating on getting the employments created through green investments, the basic equation is:

$$\Delta X = ER\Delta Inv$$

This static model allow us to identify the total jobs generated with an increase in the final demand, in this case the component we are going to modify is the investment. Nevertheless, we can see the direct jobs in the diagonal of the ER matrix. To complete the analysis the indirect effects for a given industry can be shown as the sum of all the values in the column, j, of the ER matrix, minus the value of each industry in the diagonal. Mathematically, for the calculation of the total and direct employment we have to compute the following equations:

$$Emp_{ic} = ER_{ic}Inv \tag{3}$$

$$DEmpl_i = L_{ij}Inv \tag{4}$$

where the subscripts i and j refers to the sectors and c is the country or region. The variable *Emp* expresses the number of employment created, *ER* refers to the employment multipliers and the diagonalized Employment Requirements vector. Lastly, the variable *Inv* is the investment vector.

3.4 The database

The multi-regional input-output table we are using in this master thesis has been constructed from the World Input-Output Database (WIOD) that covers 43 countries and an additional region for the rest of the world [36]. The data included in the table is organized into 56 sectors according to the International Standard Industrial Classification revision 4 (ISIC Rev. 4).[5] The quantities are expressed in millions of US dollars and the Table 4 expresses the relationship between the code and description of each sector.

[5] For further information see [13]

Table 3: Relationship between code and sector in WIOD tables.

Code	Sector	Code	Sector
r1	Crop and animal production, hunting and related service activities	r29	Wholesale trade, except of motor vehicles and motorcycles
r2	Forestry and logging	r30	Retail trade, except of motor vehicles and motorcycles
r3	Fishing and aquaculture	r31	Land transport and transport via pipelines
r4	Mining and quarrying	r32	Water transport
r5	Manufacture of food products, beverages and tobacco products	r33	Air transport
r6	Manufacture of textiles, wearing apparel and leather products	r34	Warehousing and support activities for transportation
r7	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	r35	Postal and courier activities
r8	Manufacture of paper and paper products	r36	Accommodation and food service activities
r9	Printing and reproduction of recorded media	r37	Publishing activities
r10	Manufacture of coke and refined petroleum products	r38	Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities
r11	Manufacture of chemicals and chemical products	r39	Telecommunications
r12	Manufacture of basic pharmaceutical products and pharmaceutical preparations	r40	Computer programming, consultancy and related activities; information service activities
r13	Manufacture of rubber and plastic products	r41	Financial service activities, except insurance and pension funding
r14	Manufacture of other non-metallic mineral products	r42	Insurance, reinsurance and pension funding, except compulsory social security
r15	Manufacture of basic metals	r43	Activities auxiliary to financial services and insurance activities
r16	Manufacture of fabricated metal products, except machinery and equipment	r44	Real estate activities
r17	Manufacture of computer, electronic and optical products	r45	Legal and accounting activities; activities of head offices; management consultancy activities
r18	Manufacture of electrical equipment	r46	Architectural and engineering activities; technical testing and analysis
r19	Manufacture of machinery and equipment n.e.c.	r47	Scientific research and development
r20	Manufacture of motor vehicles, trailers and semi-trailers	r48	Advertising and market research
r21	Manufacture of other transport equipment	r49	Other professional, scientific and technical activities; veterinary activities
r22	Manufacture of furniture; other manufacturing	r50	Administrative and support service activities
r23	Repair and installation of machinery and equipment	r51	Public administration and defence; compulsory social security
r24	Electricity, gas, steam and air conditioning supply	r52	Education
r25	Water collection, treatment and supply	r53	Human health and social work activities
r26	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	r54	Other service activities
r27	Construction	r55	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
r28	Wholesale and retail trade and repair of motor vehicles and motorcycles	r56	Activities of extraterritorial organizations and bodies

Source: Own elaboration from WIOD tables

4 Results and discussion

Through this section[6] we are going to develop the results we obtain using the methodology and data explained before[7]. Firstly, we are going to present the baseline result and therefore the different scenario contemplated in the research will be exposed.

Table 4 summarizes the structure of our analyses. First, we present the baseline results, according to the initial data that adjusts better to actual values (see Section 4.1). Then, we establish additional scenarios changing the two components of the investment cost (i.e. the distribution of international trade and the cost structure of installation), in order to prove the consistency of the results (see Section 4.2). On the one hand, we modify the shares of international trade for the sectors r17 and r19, *Manufacture of computer, electronic and optical products* and *Manufacture of machinery and equipment*, respectively. On the other hand, we modify the cost structures for the two technologies analyzed: wind onshore and solar photovoltaic. In this sense, two additional cost structures for wind onshore and, one more for solar

[6]The total results disaggregated by regions, sectors and scenarios are found in Annex A.

[7]The results we have obtained do not represent operations and maintenance employment in renewable energy and thus should not be used for comparisons of clean energy employment in the long run.

photovoltaic are considered.

Table 4: Structure of the Results

	Framework	Explanation
Baseline	Default	According to the initial data that fits reality better
Scenarios	Change in the distribution of international trade	Sectors r17 and r19 Hypothesis 1: All is produced in Spain. Hypothesis 2: All is produced in the Rest of the World. Hypothesis 3 : All is produced in Europe.
	Changes in the cost structure of installation	Wind onshore: 1. IRENA, 2012 [19] 2. B&V, 2012 [4] Solar Photovoltaic: 1. B&V, 2012 [4]

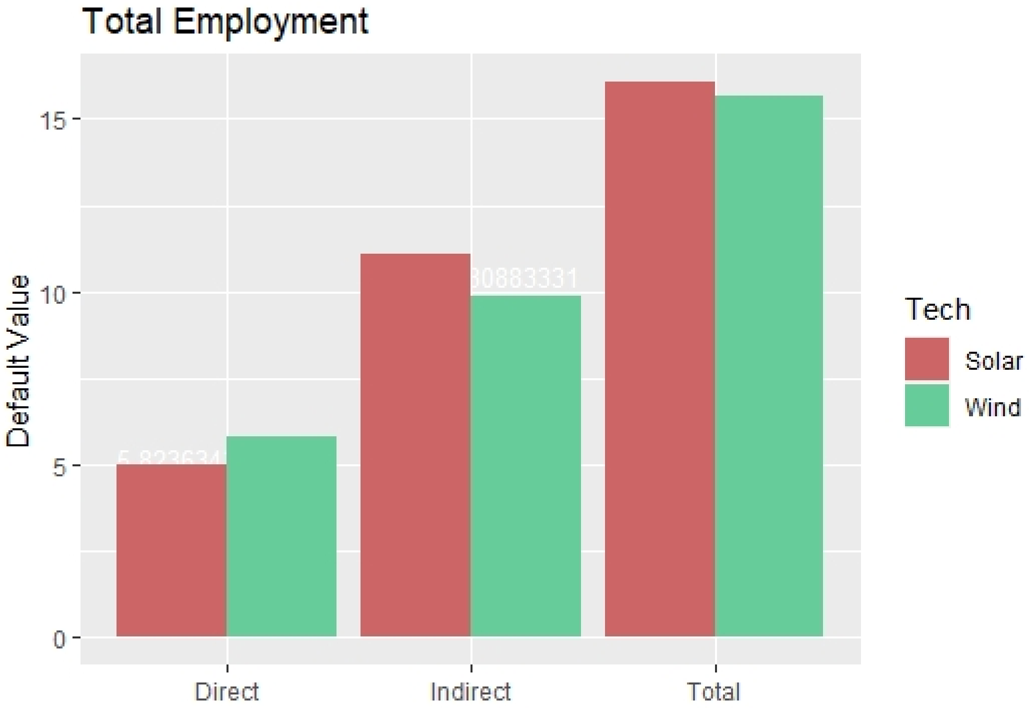
Source: Own elaboration

4.1 Baseline results

We can identify the results we obtained in the research as employment multipliers because we are showing the employments generated per million invested. The application of the methodology input-output allows us to disaggregate the results of the employment footprint in total, direct and indirect. In this sense, the Figures 2 and 3 shows the distribution of the employment generated both for the entire World and Spain.

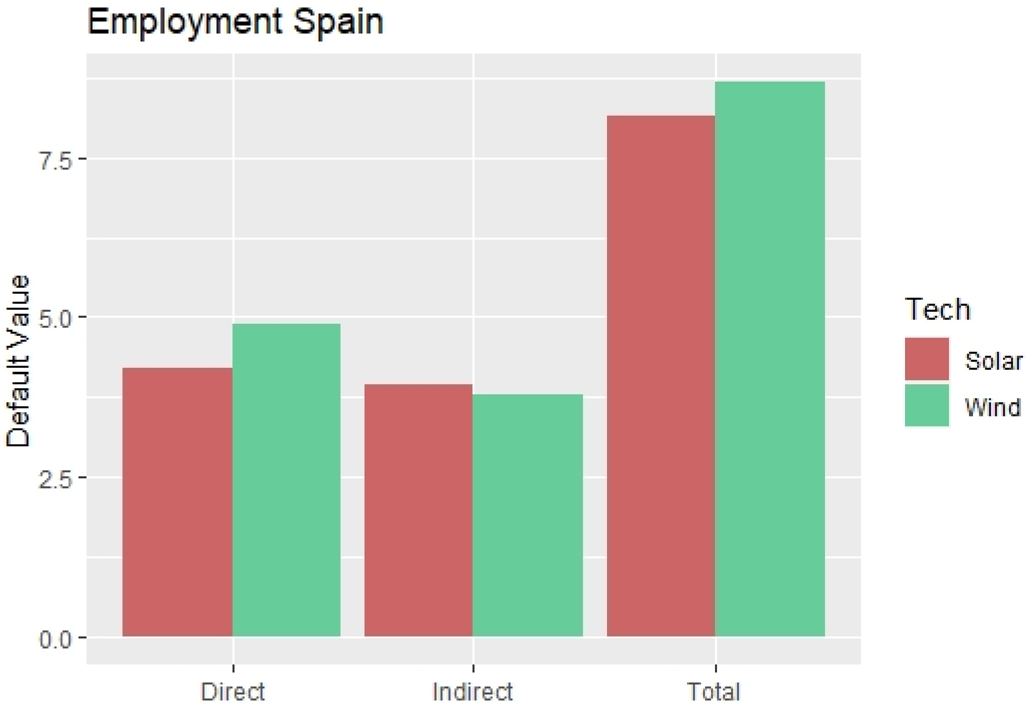
More than 15 employments could be generated in the World with an investment of $1 million in Spain, for the wind onshore and solar photovoltaic energy. We find that the 62.87 percent of the employment is indirect for the wind energy, which means that around 10 jobs are involve with activities no related with the installation of wind plants. On the other hand, the direct employment represents 30.94 % of the total job generation for the solar energy.

Figure 2: Total Employment generated with investments in clean energy



Attending the Spanish case, we find that the wind energy generates more total and direct employment footprint, while the solar has a slightly more indirect jobs generated. If we compare the values of direct employment and the Spanish and Total cases, we discover that the 83.89 % of the directs ones are generated in Spain. It is on the grounds that the investment is done in that country. By sectors, *Repair and installation of machinery and equipment* (sector 23) accumulates the 27 percent of the total employment of wind energy generating 2.35 jobs. For the solar source, half of the direct employment is distributed among the sector related to the acquisition of component for that energy, that are sectors from 14 to 19.

Figure 3: Employment generated in Spain with investments in clean energy



Roundabout jobs is more disseminated far and wide, where Spain just produces 3.79 and 3.94 positions and they are moving in segments with high force in human capital such as architectural and engineering activities, legal and accounting activities or administrative services.

If we compare the results we obtained with others of the literature we show that our results are in line with those who obtanied Garrett-Peltier in [16], in Pollin *et al.* in [30] or in [15]. While our calculations are greater than the ones of [16] (7.52 new employments for wind energy and 7.24 in solar), in Spain the renrewables energy generates less employment per million invested rather than in [30](13.3 jobs for wind and 13.7 for solar energy). Nevertheless, finding that the studies shown in the literature are similar to ours means, firstly, that our results are reliable and secondly that the generation of jobs in renewable energies in Spain resembles those of others countries.

Lastly, in general terms more solar employment is generated in Rest of Regions[8] as we can see in Figure 6. However, at least one direct employment more is created in wind onshore rather than in solar. The direct employment in this area is residual as it is not greater than 1 job in no technology.

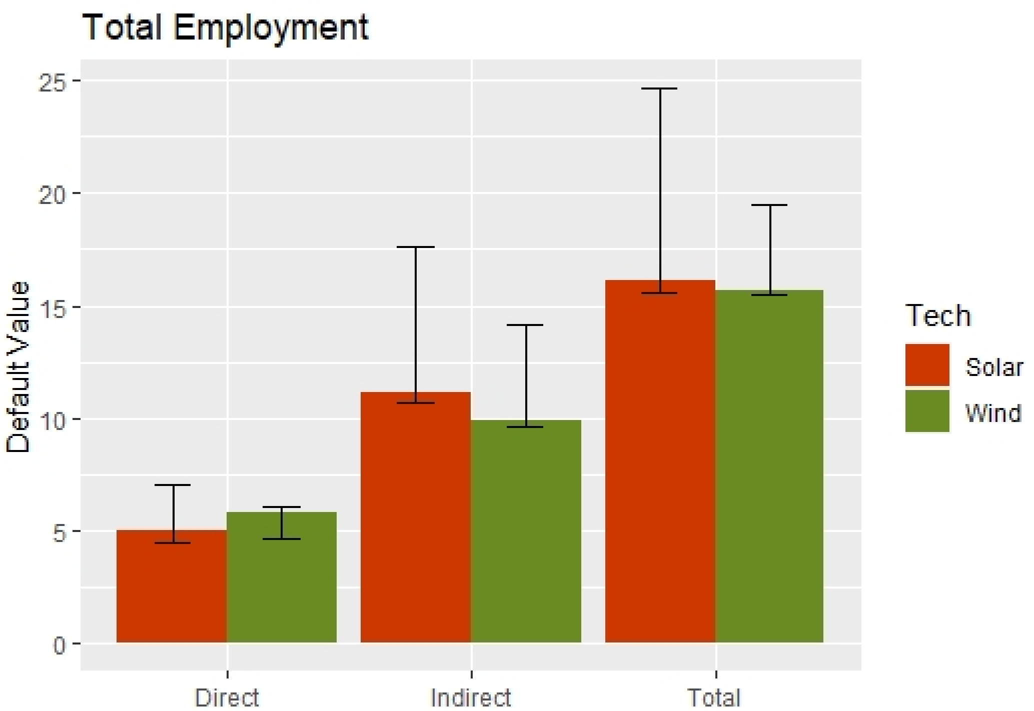
[8]The Rest of Regions is a new area resulting from grouping Europe and the Rest of the World

4.2 Scenarios

A significant segment of all researches is the one that demonstrate the consistency of the outcomes. For that reason, in this section we analyze changes in the distribution of international trade and in the installation cost structure. We consider the hypotheses presented in the Table 3 and we focus on the variability of the outcomes under these different hypotheses.

The two next figures show with the bars in black the range of variability of the results under the different hypotheses for the Total and Spanish cases, respectively. We find that the solar photovoltaic energy experiments high volatility in its results due to the important change from 16.072 total employment created in the *Baseline* to 24.661 we obtained in the scenario where all is produced in the Rest of the World (Hypothesis 2). Same wide range of variable experiments the indirect employment for the solar energy source. In this case, the most extreme hypothetical value is 41% higher than the initial greatest worth which is 4,973. Once again, this value corresponds to the scenario express before where all is produced in the Rest of the World. Nevertheless, we find that any scenario affect negatively to the initial results, being the greatest decrease the one experienced in the direct employment of wind energy, which is 2%.

Figure 4: Total Employment generated including Scenarios

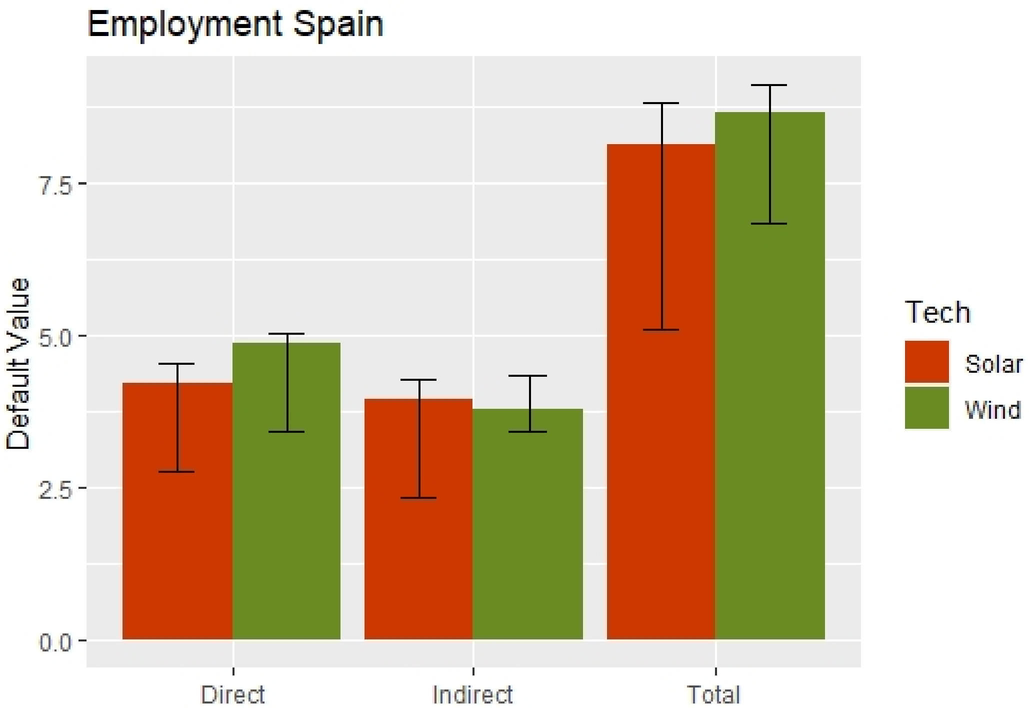


Similar results can be shown for the wind onshore technology. However, the variability of the results is slightly weaker being the direct employment practically constant for the different scenarios considered. A greater range has the Total and Indirect employment where the maximum is arranged in 24.661 and 17.615 jobs, both values are included in the Hypothesis 2. That is a gain of more than 50% from the *Baseline* value.

Spain has a figure quite different from the Figure 5 or the Figure 6. We find that the results of the different scenarios tend to be biased toward the minimum. In this sense, the solar photovoltaic energy is the one that could lose the more quantity of employment. More precisely, the range encompasses from 8.839 in the best situation (Hypothesis 1) to 5.112 in the worst (Hypothesis 2), being 8.150 the initial total employment.

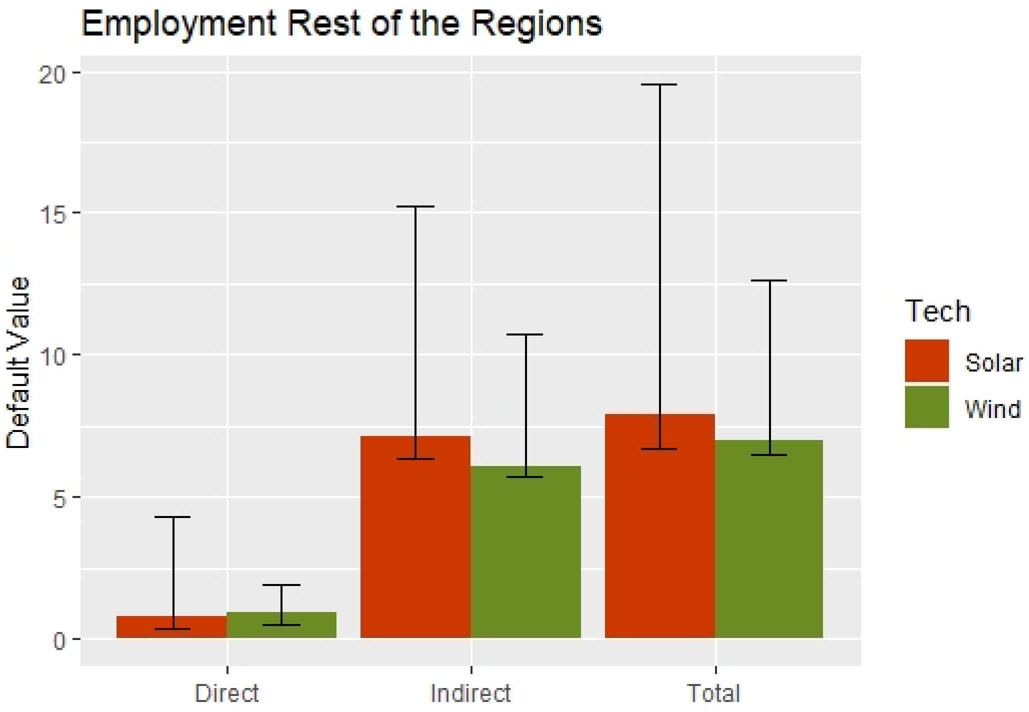
Contrary, the results of the wind onshore energy are more stable being the minimum direct job created 4.588 (Hypothesis 2) and the maximum 5.036 (Hypothesis 1). This little variability of the wind energy could be related with the fact that Spain is a country with an important industry dedicated to the manufacture of components for wind energy.

Figure 5: Employment generated in Spain including Scenarios



To conclude, the figure showing the results for the Rest of Regions is included in the Figure 6. It is astounding how low the initial values are compared to the high values obtained in the most favourable scenario for all the employment footprint classification. Indeed, in this region we also find that the variability, as in the Figure 4, is biased toward the maximum.

Figure 6: Employment generated in Rest of the World including Scenarios



In this section we have developed the employment footprint and spillovers that can be generated with an investment of $1 million in Spain. We find that in general, the solar photovoltaic energy creates more employment and has more variability rather than wind onshore source. Indeed, the Hypothesis 2, in which all is produced in the Rest of the World, is the one that generates more employment and therefore, is the maximum of the most error bars. On the other hand, great sensitivity to change in the installation cost structure is not appreciated. Thus, the variability of employment generation mainly depends on international trade structures. In this sense, the great variability of solar energy is explained. The dependence that Spain has for the imports of solar components means that any change in the international trade structure modifies the baseline results greatly.

5 Limitations and Future Work

This research presents the typical limitation of input-output studies: not accounting for time lags, homogeneity of outputs, sectoral aggregation, absence of economies of scale, invariance of technological coefficients, linearity of technological coefficients and missing interactions between prices and quantities [26].

In addition this study does not take into consideration the prices of the components and the most recent data for both, the multi-regional input-output tables and the cost of installation shares for each technology. On the other hand, we have to take into account that the cost structures and prices depends on each enterprise and may vary according to the project. Besides, data availability has restricted the exercise to the year 2014. The World Input–Output Database contains information for that year as the latest. Further analysis may use data more recent as soon as the data are available.

6 Conclusions

The results presented in this research fill a gap in the literature, since there are not recent studies for the employment footprint and spillover effects of policies related to investments in clean energy sources. The use of a multi-regional input-output model allows us to capture, not only the total employment created in Spain, but also the jobs breakdown between direct and indirect, and the spillover effects in Europe and in the Rest of the World. Moreover, the use of this methodology allows us to identify, together with the utilization of the cost vector of each technology, the real quantity that the policymakers should invest in each sector.

The analysis shows that Spain could generate a minimum of 8.6 and 8.1 jobs for every million dollar invested in wind onshore and solar photovoltaic technologies, respectively. The effect could be even greater in the case of wind power, given that most of the components of that technology are produced there. Those result are in line with the ones obtained by Garret-Peltier in [16] in which they estimate 7,52 jobs on average for wind and 7,24 for Solar.

Regarding to the rest of regions, we find that producing all the components in the Rest of the World gets more impact in the employment footprint and also in the spillovers. Moreover, by technology, the solar photovoltaic experiments more variability depending on the assumptions made.

Given these results, we claim that Spain faces a great challenge in the *European Green Deal* context. It is the moment to transform the economy into one without emissions, low carbon and to start using renewable energies as the main source of supply in the Spanish electricity system. In this sense, if Spain wants to be an aid beneficiary from the European Union, it must go with specific projects. This study provides conclusive data that Spain should rely on renewable energy now, given that job creation is high per million invested. In addition, the climatic conditions necessary for the correct development of an emission-free electrical system are met.

Finally and in conclusion, our results can be used by the policymakers in order to decide the policies that fit more with the objectives of recovery and the ones imposed by the European Union in the plan *Next Generation EU*. De-carbonization, digitalization and the search of new economic growth paths based on the ideas of climate neutrality are fundamental pillars of the program. Therfore, Spain has a implicit advantage because of the presence of favourable elements for the development of renewable energies.

7 Annex

7.1 Annex A

Through this annex we are going to include the gross results we obtained after the calculations. In this sense, we include only the total employment generated in three tables. Firstly, we present the baseline and the scenario resulting of changing the cost structure of installation, by sector and region. Then, we display the scenario under the different hypothesis and finally, the Table 7 we group the results.

Table 5: Detailed results for the baseline and the different installation cost vectors

Region	Sector	Wind	Solar PV	Wind	Wind	Solar PV
		Default Wind	Default	IRENA	B&V, 2012	B&V, 2012
R	r1	0.555	0.658	0.651	0.680	0.744
R	r2	0.132	0.157	0.161	0.166	0.186
R	r3	0.031	0.036	0.036	0.038	0.042
R	r4	0.323	0.420	0.402	0.438	0.543
R	r5	0.047	0.056	0.056	0.059	0.066
R	r6	0.140	0.181	0.164	0.174	0.188
R	r7	0.066	0.081	0.081	0.084	0.095
R	r8	0.041	0.048	0.052	0.051	0.058
R	r9	0.018	0.018	0.019	0.020	0.022
R	r10	0.042	0.049	0.047	0.050	0.059
R	r11	0.115	0.139	0.142	0.153	0.172
R	r12	0.008	0.009	0.009	0.010	0.010
R	r13	0.093	0.106	0.113	0.118	0.127
R	r14	0.110	0.153	0.356	0.079	0.292
R	r15	0.302	0.438	0.319	0.475	0.544
R	r16	0.133	0.182	0.142	0.208	0.241
R	r17	0.280	0.246	0.465	0.498	0.491
R	r18	0.118	0.123	0.156	0.167	0.165

Region	Sector	Wind	Solar PV	Wind	Wind	Solar PV
		Default Wind	Default	IRENA	B&V, 2012	B&V, 2012
R	r19	0.100	0.308	0.100	0.109	0.125
R	r20	0.026	0.030	0.024	0.026	0.029
R	r21	0.043	0.014	0.012	0.013	0.014
R	r22	0.073	0.080	0.078	0.088	0.096
R	r23	0.135	0.005	0.005	0.005	0.006
R	r24	0.058	0.075	0.073	0.078	0.095
R	r25	0.003	0.004	0.004	0.004	0.005
R	r26	0.011	0.015	0.012	0.016	0.018
R	r27	0.085	0.089	0.104	0.106	0.105
R	r28	0.043	0.049	0.048	0.051	0.058
R	r29	0.518	0.618	0.628	0.677	0.759
R	r30	0.182	0.217	0.221	0.237	0.267
R	r31	0.202	0.236	0.232	0.242	0.289
R	r32	0.022	0.028	0.027	0.029	0.034
R	r33	0.010	0.009	0.009	0.010	0.011
R	r34	0.047	0.055	0.054	0.057	0.066
R	r35	0.029	0.029	0.029	0.031	0.035
R	r36	0.095	0.104	0.104	0.108	0.120
R	r37	0.005	0.006	0.006	0.006	0.006
R	r38	0.003	0.004	0.004	0.004	0.004
R	r39	0.019	0.020	0.020	0.021	0.024
R	r40	0.038	0.037	0.036	0.038	0.042
R	r41	0.102	0.111	0.112	0.120	0.136
R	r42	0.071	0.011	0.011	0.012	0.013
R	r43	0.018	0.005	0.005	0.005	0.006
R	r44	0.020	0.019	0.020	0.021	0.024
R	r45	0.061	0.064	0.063	0.079	0.088
R	r46	0.017	0.019	0.018	0.019	0.020
R	r47	0.012	0.019	0.019	0.016	0.016
R	r48	0.005	0.007	0.007	0.006	0.006
R	r49	0.026	0.031	0.031	0.032	0.036

Region	Sector	Wind	Solar PV	Wind	Wind	Solar PV
		Default Wind	Default	IRENA	B&V, 2012	B&V, 2012
R	r50	0.114	0.111	0.120	0.122	0.127
R	r51	0.035	0.039	0.037	0.041	0.047
R	r52	0.030	0.033	0.033	0.034	0.038
R	r53	0.007	0.008	0.008	0.009	0.010
R	r54	0.118	0.135	0.134	0.142	0.162
R	r55	0.040	0.047	0.046	0.050	0.057
R	r56	0.000	0.000	0.000	0.000	0.000
E	r1	0.028	0.032	0.030	0.032	0.034
E	r2	0.005	0.006	0.006	0.006	0.006
E	r3	0.000	0.000	0.000	0.000	0.000
E	r4	0.011	0.015	0.013	0.014	0.017
E	r5	0.009	0.011	0.010	0.011	0.011
E	r6	0.019	0.025	0.021	0.023	0.024
E	r7	0.015	0.016	0.017	0.017	0.017
E	r8	0.011	0.013	0.013	0.013	0.014
E	r9	0.007	0.008	0.007	0.008	0.008
E	r10	0.002	0.002	0.002	0.002	0.002
E	r11	0.027	0.033	0.031	0.035	0.039
E	r12	0.002	0.003	0.002	0.003	0.003
E	r13	0.045	0.050	0.048	0.051	0.053
E	r14	0.037	0.047	0.105	0.028	0.081
E	r15	0.086	0.131	0.083	0.125	0.141
E	r16	0.136	0.188	0.116	0.169	0.189
E	r17	0.112	0.092	0.211	0.226	0.220
E	r18	0.089	0.083	0.123	0.131	0.124
E	r19	0.051	0.269	0.039	0.042	0.046
E	r20	0.018	0.019	0.013	0.014	0.014
E	r21	0.016	0.004	0.003	0.003	0.004
E	r22	0.013	0.014	0.014	0.015	0.014
E	r23	0.340	0.020	0.015	0.017	0.018
E	r24	0.012	0.015	0.013	0.014	0.017

Region	Sector	Wind	Solar PV	Wind	Wind	Solar PV
		Default Wind	Default	IRENA	B&V, 2012	B&V, 2012
E	r25	0.004	0.005	0.004	0.005	0.006
E	r26	0.041	0.057	0.042	0.062	0.071
E	r27	0.043	0.043	0.045	0.047	0.044
E	r28	0.024	0.028	0.023	0.025	0.027
E	r29	0.121	0.137	0.126	0.137	0.148
E	r30	0.067	0.076	0.071	0.077	0.082
E	r31	0.065	0.070	0.064	0.066	0.075
E	r32	0.001	0.001	0.001	0.001	0.002
E	r33	0.002	0.002	0.002	0.002	0.002
E	r34	0.026	0.029	0.026	0.028	0.031
E	r35	0.015	0.017	0.015	0.017	0.018
E	r36	0.021	0.022	0.020	0.022	0.023
E	r37	0.004	0.005	0.005	0.005	0.005
E	r38	0.003	0.004	0.004	0.004	0.004
E	r39	0.006	0.007	0.006	0.007	0.007
E	r40	0.020	0.022	0.021	0.023	0.024
E	r41	0.022	0.024	0.022	0.024	0.026
E	r42	0.004	0.003	0.003	0.003	0.004
E	r43	0.015	0.010	0.009	0.009	0.010
E	r44	0.006	0.006	0.006	0.006	0.007
E	r45	0.094	0.081	0.071	0.136	0.141
E	r46	0.039	0.045	0.042	0.041	0.039
E	r47	0.006	0.021	0.017	0.009	0.006
E	r48	0.017	0.029	0.026	0.021	0.019
E	r49	0.012	0.016	0.015	0.015	0.015
E	r50	0.193	0.202	0.193	0.199	0.208
E	r51	0.027	0.034	0.029	0.037	0.041
E	r52	0.013	0.016	0.014	0.015	0.015
E	r53	0.005	0.005	0.005	0.005	0.005
E	r54	0.021	0.022	0.020	0.023	0.024
E	r55	0.000	0.000	0.000	0.000	0.000

Region	Sector	Wind	Solar PV	Wind	Wind	Solar PV
		Default Wind	Default	IRENA	B&V, 2012	B&V, 2012
E	r56	0.000	0.000	0.000	0.000	0.000
S	r1	0.034	0.037	0.040	0.037	0.034
S	r2	0.004	0.004	0.005	0.004	0.004
S	r3	0.001	0.001	0.001	0.001	0.001
S	r4	0.002	0.002	0.002	0.002	0.002
S	r5	0.027	0.030	0.031	0.029	0.028
S	r6	0.013	0.015	0.015	0.015	0.014
S	r7	0.030	0.032	0.039	0.037	0.034
S	r8	0.011	0.014	0.015	0.013	0.015
S	r9	0.032	0.041	0.042	0.034	0.032
S	r10	0.001	0.001	0.001	0.001	0.002
S	r11	0.028	0.035	0.034	0.037	0.041
S	r12	0.004	0.005	0.005	0.005	0.005
S	r13	0.037	0.040	0.043	0.045	0.045
S	r14	0.193	0.272	0.775	0.082	0.571
S	r15	0.203	0.309	0.207	0.376	0.440
S	r16	0.627	0.864	0.618	1.161	1.365
S	r17	0.318	0.256	0.642	0.694	0.673
S	r18	0.162	0.134	0.288	0.310	0.298
S	r19	0.065	1.250	0.036	0.038	0.040
S	r20	0.009	0.011	0.009	0.010	0.010
S	r21	0.025	0.008	0.008	0.008	0.008
S	r22	0.032	0.035	0.038	0.038	0.033
S	r23	2.358	0.053	0.055	0.058	0.060
S	r24	0.033	0.039	0.041	0.036	0.045
S	r25	0.014	0.015	0.017	0.018	0.017
S	r26	0.073	0.102	0.078	0.122	0.142
S	r27	1.437	0.925	1.969	1.814	0.714
S	r28	0.038	0.032	0.036	0.034	0.032
S	r29	0.383	0.416	0.407	0.410	0.395
S	r30	0.214	0.183	0.225	0.216	0.169

Region	Sector	Wind	Solar PV	Wind	Wind	Solar PV
		Default Wind	Default	IRENA	B&V, 2012	B&V, 2012
S	r31	0.319	0.223	0.239	0.191	0.244
S	r32	0.003	0.003	0.002	0.002	0.002
S	r33	0.032	0.005	0.005	0.004	0.004
S	r34	0.088	0.088	0.079	0.084	0.092
S	r35	0.035	0.044	0.044	0.039	0.035
S	r36	0.058	0.074	0.075	0.064	0.056
S	r37	0.014	0.020	0.019	0.015	0.014
S	r38	0.009	0.013	0.013	0.010	0.009
S	r39	0.016	0.018	0.019	0.018	0.017
S	r40	0.036	0.036	0.030	0.027	0.027
S	r41	0.095	0.088	0.091	0.089	0.081
S	r42	0.035	0.008	0.009	0.009	0.007
S	r43	0.080	0.009	0.010	0.009	0.008
S	r44	0.023	0.026	0.027	0.026	0.022
S	r45	0.246	0.218	0.213	0.384	0.376
S	r46	0.168	0.400	0.357	0.211	0.134
S	r47	0.037	0.201	0.166	0.074	0.037
S	r48	0.061	0.163	0.140	0.079	0.056
S	r49	0.098	0.301	0.259	0.148	0.097
S	r50	0.541	0.762	0.761	0.602	0.553
S	r51	0.109	0.107	0.121	0.117	0.102
S	r52	0.050	0.058	0.055	0.053	0.052
S	r53	0.026	0.023	0.022	0.021	0.021
S	r54	0.095	0.098	0.092	0.085	0.085
S	r55	0.000	0.000	0.000	0.000	0.000
S	r56	0.000	0.000	0.000	0.000	0.000

Source: Own elaboration

Table 6: Detailed results for the different hypotheses

Region	Sector	Wind Hypothesis 1	Solar PV Hypothesis 1	Wind Hypothesis 2	Solar PV Hypothesis 2	Wind Hypothesis 3	Solar PV Hypothesis 3
R	r1	0.534	0.616	0.683	1.361	0.557	0.633
R	r2	0.126	0.142	0.170	0.403	0.132	0.154
R	r3	0.029	0.032	0.041	0.092	0.032	0.038
R	r4	0.321	0.419	0.345	0.578	0.319	0.361
R	r5	0.045	0.051	0.063	0.138	0.048	0.055
R	r6	0.137	0.176	0.162	0.320	0.138	0.155
R	r7	0.063	0.073	0.083	0.234	0.067	0.077
R	r8	0.038	0.042	0.060	0.132	0.041	0.049
R	r9	0.016	0.016	0.025	0.052	0.018	0.020
R	r10	0.041	0.047	0.048	0.090	0.042	0.045
R	r11	0.111	0.133	0.145	0.253	0.113	0.129
R	r12	0.007	0.009	0.009	0.017	0.008	0.009
R	r13	0.086	0.091	0.142	0.340	0.091	0.107
R	r14	0.106	0.145	0.141	0.265	0.110	0.151
R	r15	0.294	0.410	0.353	1.045	0.300	0.405
R	r16	0.128	0.165	0.166	0.494	0.133	0.178
R	r17	0.154	0.127	1.133	1.162	0.251	0.267
R	r18	0.109	0.104	0.175	0.397	0.118	0.128
R	r19	0.095	0.137	0.124	4.218	0.101	0.207
R	r20	0.025	0.024	0.031	0.120	0.026	0.036
R	r21	0.043	0.012	0.045	0.040	0.043	0.015
R	r22	0.068	0.070	0.096	0.229	0.077	0.085
R	r23	0.135	0.004	0.137	0.020	0.135	0.005
R	r24	0.055	0.068	0.076	0.190	0.058	0.070
R	r25	0.003	0.003	0.004	0.010	0.003	0.004
R	r26	0.011	0.014	0.012	0.021	0.011	0.015
R	r27	0.082	0.082	0.108	0.209	0.086	0.086

Region	Sector	Wind	Solar PV	Wind	Solar PV	Wind	Solar PV
		Hypothesis 1	Hypothesis 1	Hypothesis 2	Hypothesis 2	Hypothesis 3	Hypothesis 3
R	r28	0.040	0.043	0.058	0.146	0.044	0.052
R	r29	0.473	0.531	0.776	1.901	0.530	0.633
R	r30	0.165	0.183	0.285	0.728	0.184	0.216
R	r31	0.193	0.215	0.257	0.610	0.203	0.229
R	r32	0.021	0.025	0.030	0.082	0.022	0.029
R	r33	0.009	0.007	0.014	0.024	0.011	0.012
R	r34	0.045	0.049	0.061	0.139	0.049	0.061
R	r35	0.027	0.025	0.038	0.077	0.031	0.034
R	r36	0.089	0.089	0.130	0.313	0.098	0.113
R	r37	0.005	0.005	0.006	0.011	0.005	0.007
R	r38	0.003	0.003	0.004	0.009	0.003	0.004
R	r39	0.018	0.017	0.027	0.057	0.020	0.022
R	r40	0.035	0.033	0.049	0.090	0.040	0.044
R	r41	0.095	0.098	0.142	0.313	0.103	0.109
R	r42	0.070	0.010	0.073	0.027	0.071	0.012
R	r43	0.018	0.004	0.019	0.010	0.018	0.007
R	r44	0.019	0.017	0.028	0.057	0.021	0.021
R	r45	0.057	0.055	0.082	0.174	0.063	0.073
R	r46	0.016	0.016	0.021	0.042	0.018	0.023
R	r47	0.010	0.016	0.020	0.048	0.012	0.020
R	r48	0.005	0.007	0.006	0.013	0.005	0.008
R	r49	0.023	0.026	0.040	0.100	0.026	0.034
R	r50	0.105	0.099	0.124	0.198	0.135	0.135
R	r51	0.033	0.035	0.045	0.095	0.036	0.041
R	r52	0.028	0.029	0.040	0.092	0.031	0.035
R	r53	0.007	0.007	0.010	0.024	0.008	0.009
R	r54	0.110	0.117	0.164	0.414	0.120	0.137
R	r55	0.037	0.039	0.062	0.180	0.040	0.046
R	r56	0.000	0.000	0.000	0.000	0.000	0.000
E	r1	0.028	0.030	0.026	0.020	0.031	0.048

Region	Sector	Wind Hypothesis 1	Solar PV Hypothesis 1	Wind Hypothesis 2	Solar PV Hypothesis 2	Wind Hypothesis 3	Solar PV Hypothesis 3
E	r2	0.005	0.006	0.005	0.004	0.006	0.009
E	r3	0.000	0.000	0.000	0.000	0.000	0.000
E	r4	0.011	0.014	0.011	0.010	0.012	0.020
E	r5	0.009	0.010	0.008	0.007	0.011	0.017
E	r6	0.019	0.025	0.018	0.015	0.020	0.026
E	r7	0.015	0.015	0.014	0.011	0.016	0.025
E	r8	0.011	0.013	0.010	0.009	0.012	0.017
E	r9	0.006	0.007	0.006	0.005	0.008	0.016
E	r10	0.001	0.002	0.001	0.001	0.002	0.002
E	r11	0.028	0.033	0.025	0.022	0.028	0.037
E	r12	0.002	0.003	0.002	0.002	0.002	0.003
E	r13	0.045	0.046	0.040	0.027	0.049	0.082
E	r14	0.037	0.045	0.036	0.040	0.040	0.059
E	r15	0.086	0.131	0.081	0.075	0.087	0.153
E	r16	0.134	0.164	0.129	0.106	0.145	0.384
E	r17	0.037	0.030	0.021	0.014	0.367	0.309
E	r18	0.089	0.081	0.080	0.053	0.091	0.108
E	r19	0.050	0.086	0.048	0.046	0.053	1.693
E	r20	0.018	0.016	0.017	0.011	0.019	0.044
E	r21	0.016	0.003	0.016	0.003	0.016	0.006
E	r22	0.013	0.012	0.012	0.009	0.016	0.024
E	r23	0.339	0.016	0.338	0.010	0.343	0.051
E	r24	0.012	0.014	0.011	0.009	0.014	0.028
E	r25	0.004	0.005	0.004	0.003	0.004	0.007
E	r26	0.041	0.057	0.039	0.037	0.041	0.059
E	r27	0.041	0.038	0.039	0.027	0.048	0.083
E	r28	0.023	0.023	0.021	0.015	0.028	0.064
E	r29	0.115	0.120	0.105	0.076	0.145	0.266
E	r30	0.062	0.064	0.057	0.042	0.086	0.158
E	r31	0.062	0.061	0.058	0.041	0.074	0.134

Region	Sector	Wind Hypothesis 1	Solar PV Hypothesis 1	Wind Hypothesis 2	Solar PV Hypothesis 2	Wind Hypothesis 3	Solar PV Hypothesis 3
E	r32	0.001	0.001	0.001	0.002	0.001	0.002
E	r33	0.002	0.002	0.002	0.002	0.003	0.005
E	r34	0.024	0.024	0.023	0.018	0.031	0.063
E	r35	0.014	0.013	0.013	0.009	0.020	0.046
E	r36	0.020	0.018	0.019	0.013	0.026	0.050
E	r37	0.004	0.004	0.003	0.003	0.005	0.010
E	r38	0.003	0.004	0.003	0.003	0.004	0.008
E	r39	0.006	0.006	0.005	0.004	0.007	0.013
E	r40	0.018	0.018	0.018	0.015	0.026	0.049
E	r41	0.021	0.020	0.020	0.016	0.027	0.053
E	r42	0.004	0.003	0.004	0.002	0.005	0.007
E	r43	0.015	0.008	0.014	0.006	0.017	0.022
E	r44	0.005	0.005	0.005	0.004	0.007	0.015
E	r45	0.090	0.068	0.086	0.047	0.108	0.177
E	r46	0.037	0.041	0.035	0.029	0.045	0.082
E	r47	0.005	0.020	0.005	0.019	0.007	0.025
E	r48	0.016	0.027	0.015	0.022	0.020	0.043
E	r49	0.012	0.014	0.011	0.011	0.016	0.035
E	r50	0.187	0.182	0.170	0.115	0.220	0.361
E	r51	0.027	0.032	0.025	0.022	0.031	0.052
E	r52	0.012	0.013	0.011	0.010	0.018	0.036
E	r53	0.004	0.005	0.004	0.004	0.006	0.010
E	r54	0.019	0.018	0.018	0.012	0.026	0.047
E	r55	0.000	0.000	0.000	0.000	0.000	0.000
E	r56	0.000	0.000	0.000	0.000	0.000	0.000
S	r1	0.035	0.040	0.032	0.023	0.032	0.023
S	r2	0.004	0.005	0.003	0.003	0.003	0.003
S	r3	0.001	0.001	0.001	0.001	0.001	0.001
S	r4	0.002	0.002	0.002	0.001	0.002	0.002
S	r5	0.028	0.032	0.025	0.018	0.025	0.018

Region	Sector	Wind Hypothesis 1	Solar PV Hypothesis 1	Wind Hypothesis 2	Solar PV Hypothesis 2	Wind Hypothesis 3	Solar PV Hypothesis 3
S	r6	0.013	0.017	0.012	0.009	0.012	0.009
S	r7	0.031	0.035	0.029	0.021	0.029	0.021
S	r8	0.012	0.016	0.010	0.009	0.010	0.010
S	r9	0.033	0.044	0.028	0.030	0.028	0.030
S	r10	0.001	0.002	0.001	0.001	0.001	0.001
S	r11	0.029	0.038	0.026	0.021	0.026	0.022
S	r12	0.004	0.005	0.004	0.003	0.004	0.003
S	r13	0.039	0.045	0.033	0.020	0.033	0.021
S	r14	0.194	0.275	0.191	0.259	0.191	0.259
S	r15	0.206	0.326	0.198	0.220	0.198	0.222
S	r16	0.631	0.896	0.618	0.700	0.618	0.704
S	r17	0.471	0.381	0.016	0.006	0.016	0.006
S	r18	0.164	0.140	0.156	0.111	0.156	0.112
S	r19	0.066	1.475	0.062	0.021	0.062	0.023
S	r20	0.010	0.012	0.009	0.005	0.009	0.006
S	r21	0.025	0.009	0.024	0.005	0.024	0.005
S	r22	0.034	0.038	0.029	0.020	0.029	0.021
S	r23	2.360	0.058	2.355	0.032	2.355	0.033
S	r24	0.033	0.042	0.031	0.024	0.031	0.024
S	r25	0.014	0.016	0.013	0.010	0.013	0.010
S	r26	0.074	0.108	0.071	0.073	0.071	0.073
S	r27	1.439	0.931	1.434	0.899	1.434	0.899
S	r28	0.038	0.034	0.036	0.021	0.036	0.021
S	r29	0.398	0.458	0.355	0.225	0.355	0.228
S	r30	0.220	0.196	0.202	0.123	0.202	0.124
S	r31	0.323	0.242	0.311	0.131	0.311	0.132
S	r32	0.003	0.003	0.002	0.002	0.002	0.002
S	r33	0.032	0.005	0.032	0.003	0.032	0.003
S	r34	0.090	0.097	0.083	0.048	0.083	0.048
S	r35	0.035	0.047	0.033	0.028	0.033	0.028

Region	Sector	Wind Hypothesis 1	Solar PV Hypothesis 1	Wind Hypothesis 2	Solar PV Hypothesis 2	Wind Hypothesis 3	Solar PV Hypothesis 3
S	r36	0.060	0.079	0.054	0.051	0.054	0.051
S	r37	0.015	0.021	0.013	0.015	0.013	0.015
S	r38	0.010	0.014	0.009	0.009	0.009	0.009
S	r39	0.017	0.020	0.015	0.011	0.015	0.011
S	r40	0.038	0.040	0.034	0.018	0.034	0.018
S	r41	0.098	0.096	0.091	0.051	0.091	0.052
S	r42	0.035	0.008	0.035	0.005	0.035	0.005
S	r43	0.080	0.010	0.079	0.006	0.080	0.006
S	r44	0.024	0.028	0.022	0.016	0.022	0.016
S	r45	0.252	0.240	0.234	0.114	0.234	0.116
S	r46	0.170	0.409	0.164	0.357	0.164	0.358
S	r47	0.037	0.201	0.037	0.201	0.037	0.201
S	r48	0.062	0.166	0.059	0.145	0.059	0.145
S	r49	0.099	0.307	0.095	0.271	0.095	0.271
S	r50	0.569	0.817	0.484	0.538	0.484	0.541
S	r51	0.112	0.116	0.104	0.068	0.104	0.068
S	r52	0.052	0.063	0.046	0.037	0.046	0.038
S	r53	0.026	0.025	0.024	0.014	0.024	0.014
S	r54	0.099	0.107	0.088	0.060	0.089	0.060
S	r55	0.000	0.000	0.000	0.000	0.000	0.000
S	r56	0.000	0.000	0.000	0.000	0.000	0.000

Source Own elaboration

Table 7: Result aggregated by regions

	Wind Default Wind	Solar PV Default	Wind IRENA	Wind B&V, 2012	Solar PV B&V, 2012	
Total Employment	15.686	16.072	16.320	16.244	16.658	
Total Employment Rest of the World	4.979	5.787	5.863	6.128	7.036	
Total Employment Europe	2.028	2.135	1.887	2.069	2.225	
Total Employment Spain	8.679	8.150	8.570	8.046	7.397	
	Wind Hypothesis 1	**Solar PV** Hypothesis 1	**Wind** Hypothesis 2	**Solar PV** Hypothesis 2	**Wind** Hypothesis 3	**Solar PV** Hypothesis 3
Total Employment	15.469	15.563	17.129	24.661	15.651	15.939
Total Employment Rest of the World	4.618	5.009	7.189	18.410	5.008	5.652
Total Employment Europe	1.905	1.715	1.790	1.139	2.489	5.145
Total Employment Spain	8.945	8.839	8.150	5.112	8.154	5.142

Source: Own elaboration

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