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Classification of European countries according to indicators related to electricity generation

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ABSTRACT

On the way to complying with the 2015 Paris agreements regarding climate change, there are notable differences between the positions of the countries. Even considering the same geographical area such as Europe, the existence of a supranational environmental policy, assumed by the 27 European Union (EU) countries, generates evident differences with neighboring countries that do not belong to this organization. In this paper, 17 indicators related to electricity generation are proposed and, based on the information from the year 2020 of these indicators for 45 European countries, two multivariate techniques are applied with the aim of verifying whether or not such a policy generates similarities and differences between those countries affected by such supranational policy and those who are not obligated to apply it. The initial hypothesis seems to have been fulfilled in part: the non-EU countries have mainly been grouped together, while the members of the EU have separated from them. This result would be in line with the fact that the supranational policy of the EU seems to have the expected effect of homogenizing the countries in terms of the energy variables considered in this analysis.

1. Introduction

The growing urgency to reduce carbon emissions and their increasingly irreversible effects on global warming has made the transition to renewable energies even more necessary. The 2015 Paris agreements (the outcome of the United Nations Climate Change Conference held 7–8 December -COP21-) promoted carbon neutrality as one of the key items on the global agenda, with the aim of limiting global warming to below 2 °C, preferably below 1.5 °C, compared to pre-industrial levels. For this transition, many efforts have focused on shifting energy generation from fossil fuels to renewable energies [1], among other reasons because the expected effects of decarbonisation are not only limited to the environmental field, with a reduction in greenhouse gas emissions, but also extend to the social and economic spheres [2]. And it is that these effects must be assumed with efforts by citizens, the business community and responsible organizations [3] regardless of a country's level of wealth or development [4,5]. In this regard, Zeng et al. [5] point out that, although bank financing, institutional loans and international cooperation funds are some of the main forms of financing, the lack of stable channels, the scarcity of credit to small and medium-sized enterprises, and imperfect government policies are major barriers to successful renewable energy deployment. Seetharaman et al. [6] add that while economic barriers are only indirect complications, institutional, technical and socio-cultural complications are also of great importance. Reddy and Painuly [7] and Verbruggen et al. [8] encourage that, given the differences between the various barriers, they should be addressed separately to achieve the full potential of renewable energies [9]. In fact, any analysis that considers the necessary change that an economy must make to generate sustainability must incorporate all these considerations (social, economic and, of course, environmental).

In recent years, some countries have achieved important goals in the substitution of fossil resources by renewable sources and in the rational and efficient use of the energy produced [10,11]: once each country makes this individual effort, it is necessary for the rest to do the same. The planet is unique, and any negative or positive environmental action affects us all. Hence, for example in Europe, supranational environmental policies have been established, complementary to those implemented nationally, with the aim of forming a common front in the transition to renewable energies and their widespread use. However, and with regard to electricity generation in particular, its production

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from renewable sources does not yet exceed its production by non-renewable means, and countries, even those with a high level of development, show significant differences in the structure, production and consumption and import of their electricity production.

In this context, it is particularly interesting, therefore, to establish a basis for comparison between countries that will also make it possible to subsequently outline common objectives. This is the line followed in the research that we are developing and from which this paper is derived. Thus, its aim is to analyse the differences and similarities between European countries in terms of electricity generation. The countries chosen are the 45 that geographically and politically belong to the European continent, 27 of which belong to the EU and abide by the same environmental policy. The hypothesis put forward by the paper is that the EU countries will show more similarities than those that do not follow a common environmental policy.

The examination is based on the information provided by 17 variables, most of which are directly and indirectly related to the generation of electricity with renewable and non-renewable sources, but others are added that help to contextualize the development of the country (Gross Domestic Product, hereinafter GDP, Human Development Index, hereinafter HDI, and population index). Then, two multivariate techniques are used: cluster analysis in order to classify the forty-five countries, with the aim of observing the differences between the resulting groups, given by the inherent characteristics of each nation, and factorial analysis in order to extract the possible factors that would explain the groups obtained by the cluster analysis. Understanding these groupings of countries according to their electricity energy production and consumption and their determining factors makes it possible to discover more appropriate strategies and policies in the construction of common paths for sustainable energy production.

The structure of this paper is as follows. First, is provided review of the existing literature, which allows us to highlight the importance and timeliness of the issue addressed. This is followed by a brief presentation of the multivariate analysis techniques used, detailing the sources of the information analysed for each country. Finally, and before addressing the conclusions and policies derived from the analysis, the results obtained regarding the study are shown and interpreted.

2. Electricity generation: national indicators to be considered for its analysis

It is not easy to find consensus in the specialized literature on which indicators (or variables) to use if one wants to establish comparisons between countries in terms of electricity generation. One of the main problems facing the development of indicators and their assessment is the comparability between indicators, as most of them use different definitions and units of measurement [12], or differences in geographical and territorial conditions in each region [13]. Liu et al. [14] point to the need to establish a multi-criteria evaluation indicator, which would facilitate investment decisions in new electricity generation systems from renewable sources. Along these lines, some works, such as those of Lassio et al. [15] and Cîrstea et al. [16] have proposed indices that can analyse the sets of parameters used in the literature.

Despite there being no consensus, there are some indicators that are repeated in studies that address electricity generation with renewable and non-renewable sources. So, the effects of the use of renewable energies on electricity production have been widely discussed in the literature, especially regarding their relationship with GDP. In fact, Formánek [17] indicates that the consumption of renewable energies and GDP growth have a positive and significant relationship, a conclusion also reached, among others, by the works of Al-Mulali et al. [18], Azam et al. [19] and Chien and Hu [20]. However, the latter stress that the effect on GDP is not so much due to an improvement in the trade balance, but rather to an increase in gross capital formation. Amri [21] and Saad and Taleb [22] agree that there is a two-way relationship between renewable energy consumption and long-term economic growth. Others point out that the relationships are unidirectional, especially in the short term [23,24], or that the relationship between GDP per capita and increased use of renewable energy is not as strong as is often argued, concluding that it is not a simple causal relationship, but rather a sum of conditioning factors [25]. Analyses such as those of Belaïd and Zrelli [26] draw attention to the contrasting relationship between economic growth (GDP) and non-renewable electricity consumption and carbon dioxide emissions, which renewable sources reduce. In this same line, Caraballo and García [27] analyse the relationship between the use of renewable and non-renewable energies and economic development, using GDP, in addition to the HDI and CO_2 emissions as decision variables in their study. They conclude that greater energy consumption means greater economic growth and that the differential effect of non-renewables is greater. This means that, on occasions, it is preferable to grow less, but in a more sustainable way. Vasylieva et al. [28] approach their analysis by differentiating different dimensions (social, economic, environmental, etc.) and making use of GDP or the emissions generated by each energy source. Finally, and in line with the previous ones, Gromada et al. [29] carry out their analysis based on the percentage of the energy mix that is due to renewable energies or the HDI of each region.

The approval in September 2015 of the Sustainable Development Goals (hereinafter SDGs) by the United Nations (hereinafter UN) opened up a range of options to improve assessments of renewable energy's impact on a country's development, both from the perspective of the indicators that can be used, as well as for international comparisons that can clarify the factors of success and failure. Of the 17 global development goals to be achieved by 2030, number 7 is dedicated to affordable and clean energy, including five targets: universal access to modern energy, increasing renewable energy production, improving energy efficiency, promoting investment in this field and improvements in developing countries, and six indicators, including percentages of population with access to electricity and energy services and renewable energy production. According to the United Nations SDGs Report 2022, there has been considerable improvement in terms of energy efficiency and access to electricity. Nevertheless, much remains to be done to achieve the 2030 sustainable energy goals, as millions of people still lack basic electricity services and progress in clean energy has stalled in many areas, as well as extending renewable energy in the electricity sector to other sectors [30].

Based on the SDGs and their indicators, the first step of our search was the definition of conceptual framework builts on the necessary complementarity between official statistics and the indicators proposed by the SDGs to make a comparison between countries. Such a comparison can be useful to know what the most advanced countries are doing and the path to be followed by the least advanced, thus accepting the relationship between these indicators and the socioeconomic level of a country. One of the main limitations in the definition of this framework is the possibility that there may be no data to construct indicators that are considered important, which forces the search for equivalences and the establishment of the boundary between what is to be measured and what can be effectively achieved, at least for the time being.

To start building this conceptual framework, we considered the five targets associated with SDG 7, which seeks to ensure access to affordable, reliable, sustainable and modern energy for all, as previously discussed. To complete this starting point, the socioeconomic part was added, which is represented in SDG 8, on the promotion of sustained, inclusive and sustainable economic growth. Among the targets associated with this goal that can serve as a reference is to maintain adequate economic growth and a progressive improvement of efficient production and consumption.

Once the measurement framework was established, the second stage consisted of selecting the indicators that could potentially form part of the measurement system. The selected indicators had to meet the following criteria.

- They should be available for the entire region under analysis: this makes it possible to overcome one of the most common difficulties in this type of analysis, namely missing values, which tend to appear in comparisons between countries.
- They should be available for at least the last five years, which is a sign of their stability and may allow for further research in the future.
- They should come from internationally recognized sources, which supports the reliability of the data and the results obtained.

So, due to the above requirements, the third step was the search for information focused on sources at the international level, which would not only provide data recognized by potential users, but would also be reliable and periodically updated, to allow subsequent comparisons in time and space. Finally, the four sources of information selected were: International Energy Agency (IEA), the World Bank (WB), Our World In Data (OWID) and United Nations (UN).

The fourth stage consisted of establishing the categories into which the indicators could be classified. There were four categories of indicators, considering the SDGs as a basis, the sources selected, and the selection criteria established.

- Availability of energy resources: loss of mineral and energy resources.
- Energy dependence: exports and imports of resources with which to generate energy or national electricity consumption.
- Electricity generation: this involves differentiating by production sources, both renewable and non-renewable resources to establish the energy mix for subsequent comparisons.
- Socioeconomic conditions of the country: GDP per capita, Population, HDI, and Official Developments Aid (hereinafter ODA) received to ensure and improve economic and social welfare levels) are considered.

Based on these four categories of indicators, seventeen explanatory variables[1] have been used in this investigation, all of them corresponding to 2020, the last year for which information could be obtained, from IEA, WB, OWID and UN, as discussed above.

The context of analysis is limited to Europe. The countries chosen are the 45 that geographically and politically belong to the European continent. Specifically, the 45 countries, members (27) and no members (18) of the EU are: Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Malta, Moldova, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and United Kingdom.[2]

On this continent, as in the rest of the world, the goals and policies designed to achieve sustainable development differ from area to area. One of the peculiarities in this region of the world is that the EU has been a pioneer in setting targets by adopting legally binding rules to address the problem of climate change, something that was subsequently imitated by many countries globally. As part of this process, EU member countries have established a comprehensive plan outlining how each country intends to meet the dynamic targets in the next 10 years from 2021, the so-called National Energy and Climate Plans (hereafter NECP) [31]. However, aggregate data may hide important differences between member states, with countries with very ambitious targets versus others with trajectories below their potential [32].

The major objective of this paper is the formation/classification in groups of the 45 countries considered, in such a way that those that appear in the same group will be the most similar countries in terms of the variables considered. The observation of the formed groups can help to verify, on the one hand, if EU countries will be classified in groups different from those containing non-EU countries, and, on the other hand, which EU countries are placed in similar positions and which differ more from the rest.

3. Sources and methods

With the objective pursued, the two most appropriate multivariate analysis techniques were used. The cluster analysis will allow us to obtain the aforementioned classification of the countries into internally homogeneous groups and with clear differences with respect to the rest of the groups. Factorial analysis, for its part, helps to determine the generic factors that are hidden behind the formation of the groups carried out.

Specifically, the purpose of cluster analysis is to group objects - in this case, countries - into homogeneous groups according to the similarities between them. To do this, it is necessary to standardise the original variables beforehand so that the different units in which they are expressed do not affect the result. There are several results that can be obtained from a cluster analysis, including the classification of objects into groups, so that each one belongs to one, and only one, of the groups, and the construction of hierarchies of objects according to their similarities.

Once the set of objects, countries in this case, to be classified has been determined, defined through the most appropriate variables from the point of view of classification, there are three basic steps: 1) choice of the measure that defines the proximity or distance between the objects, 2) selection of the classification method, and 3) interpretation of the resulting clusters (in Section 4).

Regarding the choice of the proximity measure, from the data matrix M, of order Nxp, where N is the number of entities, or countries in this case, to be classified and p the number of observed variables of the entities, the matrix S, of order NxN, where each s_{ij} indicates the value of the proximity or similarity between entities i and j. Also, the matrix D, of order NxN, where each d_{ij} indicates the value of the non-proximity or distance between entities i and j, is constructed.

The most widespread definition is that of a measure of dissimilarity called metric distance, which represents objects as points in a coordinate space so that the observed proximities correspond to the metric distances between them: the smaller the distance, the closer the proximity between entities, and the greater the distance, the greater the difference between entities. Numerous measures of distance have been defined as appropriate for the proximity between variables or between objects, and in each of these contexts, they have been defined according to the type of variable (quantitative or qualitative). If the variables that characterise the objects are quantitative, the most commonly used distance is the Euclidean distance, defined as:

$$D(i,j) = \sqrt{\sum_{k=1}^{p} \left|x_{ik} - x_{jk}\right|^2} \tag{1}$$

where x_{ik} is the value of the i-th country for the k-th variable, with k = 1, …,p, i = 1, …,N,

x_{jk} is the value of the j-th country for the k-th variable, with k = 1, …, p, j = 1, …,N, j≠i.

Classification methods can be divided into hierarchical or optimisation methods, depending on whether a hierarchy is established in the groupings or whether a single classification is carried out. In this paper, the chosen method is a hierarchical one. Hierarchical methods are those that impose a hierarchical order in the classification of objects, based on the information of the corresponding distance matrix, with the following characteristics.

[1] The complete list of variables, as well as their definition, source and unit of measurement, is available in table A1 in the Appendix.

[2] Data of the 17 variables for the 45 countries considered is available in table A2 in the Appendix.

(a) The group of entities is classified by merging them, in successive stages, from N clusters each consisting of a single entity to a single cluster consisting of all entities (agglomerative hierarchical method), or by dividing, in successive stages, a single cluster consisting of the N entities to obtain N clusters each consisting of a single entity (divisive hierarchical method).
(b) The hierarchical classifications can be represented in a two-dimensional diagram, called a dendrogram, which illustrates the successive mergers or divisions achieved at each stage of the analysis.
(c) Once the dendrogram has been obtained, the researchers must subjectively choose, according to their knowledge of the subject in question, the cut-off point of the dendrogram to obtain the final classification of the objects. In any case, the number of clusters must be set according to the nature of the set of objects to be grouped, as a small value could mean an excessive agglomeration, and a value that is too large would lose the synthesis capacity provided by the application of this type of analysis.

Among the hierarchical methods, the most widely used are the agglomerative ones, and among these, the most popular, used in this study, is Ward's method, whereby at each stage, mergers are generated that optimise an objective function, namely the minimisation of the total sum of squared errors within cluster c, defined as:

$$E_c = \sum_{k=1}^{p} \sum_{i=1}^{N} (x_{kic} - \bar{x}_{kc})^2 \tag{2}$$

where x_{kic} is the value of the k-th variable, with k = 1, …,p, in the i-th country, with i = 1, …,N in the cluster c.

$\bar{x}_{kc}$ is the average of the k-th variable in the cluster c

Applying this hierarchical classification method, we obtain as a result the groups of countries presented and analysed in Section 4 of this paper. To describe each of the groups, one can resort to the mean values of all the variables per group, or apply a factor analysis and determine which factors explain most of the variability of the original information matrix. In this latter sense, the objective of Factor Analysis (FA) is to reduce the information contained in the data matrix using a smaller number of dimensions called factors, analysing and explaining the structure of the interrelationships between the original variables, and defining these as a linear combination of unobservable variables, or common factors, and an error term, or single factor. Nonetheless, it is the common factors (Fj) that are of interest and are susceptible to interpretation. As a preliminary step, the application of this analysis requires the selection of variables, usually continuous quantitative variables, that adequately define the objects; and, as the results are not invariant to changes in origin and scale, standardising the original data before running the analysis.

Factor analysis is applied to a set of observable random variables of size p $(X_1, X_2, \ldots, X_{p-1}, X_p)$, which are defined for a single population. The aim is then to obtain a new set, of size m, of common factors $(F_1, F_2, \ldots, F_{m-1}, F_m)$ and unique factors $(U_1, U_2, \ldots, U_{p-1}, U_p)$. Given the objective of this technique, the new set will be smaller than the original set $(m < p)$. Once the factors are established, they are related to the variables through a linear factorial model of the form:

$$X_i = a_{i1}F_{i1} + \ldots + a_{im}F_{im} + d_iU_i, \forall i = 1, \ldots, p \tag{3}$$

where a_{ij} represents the saturation of variable X_i and factor F_j (j = 1, …, m). It is important to note that, as in any dimension reduction process, the application of factor analysis implies the loss of a certain amount of available information.

One of the simplest ways to extract the factors, which is the one used in this article, is Principal Component Analysis (PCA), in which single factors are not considered. With this method, the first principal component is the linear combination of variables that captures the largest variability in the sample; the second will be that linear combination of variables that captures most of the remaining variability, and so on.

Having defined the data matrix X, the first step is to examine the sample correlation matrix $R_p = (r_{ij})$, where rij is the observed sample correlation between variables X_i and X_j. In relation to the correlation matrix, the basic assumptions that, if fulfilled, justify the application of a FA are two: 1) high correlations between variables; 2) pairs of variables that have high correlations with each other must have high correlations with the same factor.

There are several indicators of the degree of association between variables, which justify or not the application of factor analysis, and which must be checked before its application. Among them, Barlett's test of sphericity and the Kaiser, Meyer and Olkin measure of sampling adequacy (KMO) stand out.

Under the hypothesis of normality, Bartlett's test of sphericity tests the null hypothesis of null intercorrelations between variables. If this hypothesis is rejected, the application of factor analysis is justified. As for the sample adequacy measure, for the application of factor analysis, the Kaiser, Meyer and Olkin (KMO) coefficient is given by:

$$KMO = \frac{\sum_{i \neq j}\sum_{i \neq j} r_{ij}^2}{\sum_{i \neq j}\sum_{i \neq j} r_{ij}^2 + \sum_{i \neq j}\sum_{i \neq j} b_{ij}^2} \tag{4}$$

where r_{ij} and b_{ij} represent, respectively, the observed correlation coefficients and the magnitudes of the partial correlation coefficients between variables X_i and X_j. The KMO coefficient should tend to unity, exceeding in any case the value of 0.5, when the assumptions made for the application of factor analysis are met.

Finally, for an adequate interpretation of the factors extracted, by one of the available methods, among which the principal components method is the one applied in this paper, the factors are usually rotated. One type of rotation is orthogonal, whereby the axes are rotated in such a way that non-correlation between factors is preserved. The most widely applied orthogonal method is the varimax method, whereby the number of variables with high loadings on a factor is minimised.

4. Results and analysis

The results of the two multivariate techniques applied on the information matrix (17 variables for 45 countries described in Section 2) have been extracted using statistical software IBM SPSS Statistics version 22.

The presentation of results will be done in reverse order to the presentation of the multivariate analysis techniques, made in Section 3. That is, first we will address the results obtained after the application of the Factor Analysis and later, the groups extracted by applying the Cluster Analysis, to close this section with a more detailed description of each of the groups based on the mean values of all the variables by group, and the extracted factors.

As mentioned, the first step to know if the Factor analysis is appropriate is to examine the sample correlation matrix to verify that there are high correlations between variables that justify the reduction in the number of variables (see Table A2 of the Appendix). However, the most useful way to check the suitability of the Factor Analysis, especially if the number of variables is high, is to know the value of the KMO coefficient and the Barlett's test of sphericity. In this case, the KMO coefficient was 0.678, exceeding the minimum required value of 0.5, and the significance of Bartlett's test of sphericity was null, rejecting the hypothesis of null intercorrelations between variables (see Table 1). Therefore, the application of Factor Analysis is justified.

To extract the factors, the SPSS software is based on the value of the respective eigenvalues of each of the possible factors that can be extracted (maximum number of variables). The eigenvalue expresses numerically the number of variables that could be substituted. If the

Table 1
Factor analysis. KMO and Bartlett's test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.678
Bartlett's Test of Sphericity	Approx. Chi-Square	602.255
	Df	136
	Sig.	.000

Source: Results from SPSS Statistics version 22.

eigenvalue is equal to 1, nothing is gained with the factor, since weighs as much as an original variable. An eigenvalue less than 1 implies a loss and if it is greater than 1 there is a gain if the factor is used. Therefore, the scree plot between the factors and their eigenvalues shown as Fig. 1 indicates that the number of factors to extract in this case is 5, extracted factors must have an eigenvalue greater than 1.0.

After applying the factor analysis, the total variance explained by the five extracted factors, through the principal components' method, was 77.265 %, an acceptable level for a reduction of 17 original variables (see Table 2) into only five factors.

The rotated component matrix was extracted by applying the orthogonal varimax method (see Table 3). Thus, by reviewing the scores of each variable in each of the five factors in the rotated component matrix, the factors can be identified, finding the highest values, either positive or negative, which indicate a greater relationship, positive or negative, between variable and factor.

It is convenient that all the variables are assigned to one of the factors, although this is not mandatory. In this case, following this recommendation, all the variables were associated with one of the 5 factors using a higher weight, in absolute value, than 0.65.

Table 4 can be interpreted as follows. Since there is a high positive correlation in Factor 1 with the variables of "population", "natural gas electricity generation", "nuclear electricity generation", "coal electricity generation", "oil electricity generation" and "hydroelectric electricity generation", an explanation of the cluster formations below could be *Population and non-renewable sources and hydroelectric electricity generation.*

Likewise, Factor 2, which shows a high positive correlation with the variables "solar electricity generation", "wind electricity generation", "other renewable sources electricity generation (biofuels, waste and geothermal)", indicates that the union of certain countries in the same group may be due to this factor called *Renewable electricity generation except hydroelectric*.

Factor 3, or *Country development*, owes its name to the positive correlation it shows with "GDP" and "Human Development Index" and negative correlation with "mineral depletion" and "net ODA received".

The high positive correlation between "energy depletion" and "fuel exports" means that Factor 4 can be called *Use and availability of non-renewables energy resource*. Finally, Factor 5 or *Electricity consumption and energy imports dependence*, with a high positive correlation with "fuel imports" and "per capita electricity consumption", is indicative that European countries with significant (high or low) electricity consumption and fuel dependence can be classified in the same group.

On most occasions when there are many objects characterised by a considerable number of variables, as is the case here, the "variable reduction" factor analysis is usually accompanied by cluster analysis. This leads to the extraction of a number of internally homogeneous but heterogeneous groups, which can be explained by the factors extracted with the factor analysis or by obtaining minimum and maximum values for each variable in each group.

Once the main factors that explain the variability of the original information matrix are known, we can proceed to determine the groups of countries by applying Ward's hierarchical classification method, one of the most referenced with the objective of creating groups of countries with similar characteristics regarding the variables considered.

Fig. 2 shows the dendrogram obtained by applying Ward's method to the previously standardised variables. The dendrogram shows how the groups of countries would be formed from the left, where each of the countries would represent an individual group, to the right, where they would all form part of a single group. For reasons of group explanations, it has been decided to "cut" the dendrogram vertically by the level of distance that generates several groups that is neither too high (leftmost cut) nor too low (rightmost cut). Specifically, the cut-off level (vertical dashed line on dendrogram) has generated the extraction of 7 groups, whose explanation is given, as indicated above, by the minimum and maximum values of each variable in each group, shown in Table A4 of the Appendix.

From the groups described above, and from the information provided by the factor and cluster analyses, specific comments can be extracted for each of the groups, addressing the nature of the similarities between the countries included, as far as the situation of the countries considered in electricity generation through renewable and non-renewable sources is concerned (see Table 5).

Azerbaijan and Norway, two of non-EU countries form the Group 2. This group have the highest values of energy depletion and fuel exports. These are two of the world's leading producers and exporters of non-renewable resources. Despite the environmental policies that have been proposed in these countries, in both cases, they are committed to mitigating the effects of the low production in other European countries, by increasing their exports of natural gas to them, which could jeopardise the objectives associated with these policies.

In Group 3 two EU countries (Cyprus and Greece) join with two other non-EU countries (Belarus and Serbia). This group is characterised by the highest per capita electricity consumption and the highest external energy dependence, with the highest percentage of fuel imports, more than double the average of the 45 countries (8.3 %). One of the future approaches for this group of countries could be the progressive reduction of per capita electricity consumption to converge towards more sustainable values.

Group 4 is composed of eight non-EU countries with the lowest levels of development, the highest net ODA received and the lowest GDP per capita and Human Development Index values (Albania, Armenia, Bosnia & Herzegovina, Georgia, Moldova, Montenegro, North Macedonia and Ukraine). It also has the lowest average electricity generation with oil, natural gas, wind and other renewable sources and a high percentage of fuel imports, the second highest, above the overall average (8.3 %).

Four EU countries (Spain, Italy, United Kingdom[3] and France) form the Group 5, mainly characterised by the lowest per capita electricity consumption and the lowest mineral depletion. Consequently, starting from these low levels of per capita electricity consumption, one of the clear objectives for these countries is to continue modifying the electricity matrix towards greater generation with renewable sources. Spain, Italy and United Kingdom have very similar electricity generation from renewable sources, at around 45 % of total electricity. While France is a country highly dependent on nuclear energy for electricity generation, accounting for 88.6 % of non-renewable sources and 66.6 % of total electricity generation. Its use of other non-renewable sources (coal, oil and natural gas) accounts for only 8.5 % of the electricity produced.

The country with the highest level of development, highest GDP per capita and Human Development Index values, Germany (EU country), individually forms Group 6. It has the highest values for electricity generation from renewable sources, except hydroelectric power, and the lowest percentage of energy depletion and fuel exports. Even so, it has high dependence on non-renewable resources, mainly coal and natural gas, which account for about 55 % of electricity generation. This situation has been clearly highlighted by the ongoing conflict in Ukraine, which has put German energy supply at risk and has led the authorities to look for alternative sources to natural gas from Russia.

[3] United Kingdom left the EU in January 2020. Since the data in this study is precisely from the year 2020, it can still be considered a country under the criteria established in the EU in terms of environmental policy.

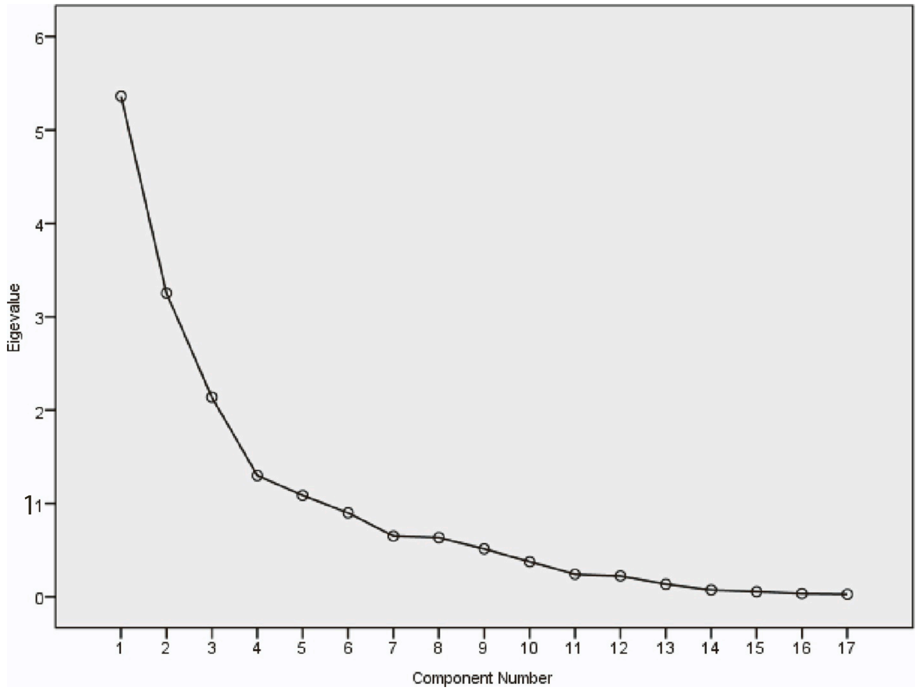

Fig. 1. Factor Analysis. Scree plot.
Source: Results from SPSS Statistics version 22.

Table 2
Factor analysis. Total variance explained.

Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	3.908	22.990	22.990
2	3.117	18.334	41.324
3	2.664	15.668	56.992
4	2.194	12.908	69.900
5	1.252	7.365	77.265

Extraction Method: Principal Component Analysis.
Source: Results from SPSS Statistics version 22.

Table 3
Factor analysis. Rotated component matrix.

Variable	Component				
	1	2	3	4	5
V1	.302	−.144	−.627	.105	−.004
V2	.150	−.063	−.112	.955	−.056
V3	−.197	−.092	−.735	−.140	−.112
V4	.140	−.079	−.067	.936	.114
V5	−.190	−.056	−.296	−.345	.706
V6	−.007	.017	.848	−.059	−.222
V7	.842	.451	−.054	.089	−.110
V8	−.107	−.108	.028	.232	.684
V9	.045	.167	.889	−.183	−.075
V10	.660	.383	−.128	.116	−.137
V11	.670	.376	.080	−.042	.329
V12	.871	.160	−.064	.199	−.086
V13	.730	.078	.041	−.066	−.101
V14	.817	−.080	.127	.291	−.149
V15	.261	.914	.111	−.091	.027
V16	.187	.917	.168	−.057	−.070
V17	.166	.911	.167	−.047	−.135

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Source: Results from SPSS Statistics version 22.

Table 4
Factorial Analysis. Extracted factors from information of rotation matrix.

Factor	Identification	Correlated Variables
1	*Population and non-renewable sources and hydroelectric electricity generation*	High positive correlation with “population”, “natural gas electricity generation”, “nuclear electricity generation”, “coal electricity generation”, “oil electricity generation” and “hydroelectric electricity generation”
2	*Renewable electricity generation except hydroelectric*	High positive correlation with “solar electricity generation”, “wind electricity generation”, “other renewable sources electricity generation (biofuels, waste and geothermal)”
3	*Country development*	High positive correlation with “GDP” and “Human Development Index”. Negative with “mineral depletion” and “net ODA received”
4	*Use and availability of non-renewables energy resource*	High positive correlation with “energy depletion” and “fuel exports”
5	*Electricity consumption and energy imports dependence*	High positive correlation with “fuel imports” and “per capita electricity consumption”

Source: Elaboration by authors.

Group 7 is made up exclusively of the Russian Federation (non-EU country). The Russian Federation is one of the world’s leading producers and exporters of oil and natural gas and relies heavily on revenues from these two natural resources, which in 2021 accounted for about 45 % of the country’s federal budget. It is one of the world’s top three crude oil producers, along with Saudi Arabia and the United States, and is the world’s second largest producer of natural gas, after the United States, as well as being the world’s largest exporter and having the largest reserves of natural gas [33]. 80 % of its electricity generation is from non-renewable sources (coal, oil, natural gas and nuclear). It is the group with the highest non-renewable electricity generation, coal (22.6 % of the total generated in the 45 countries), oil (13.5 %), natural gas (34.5

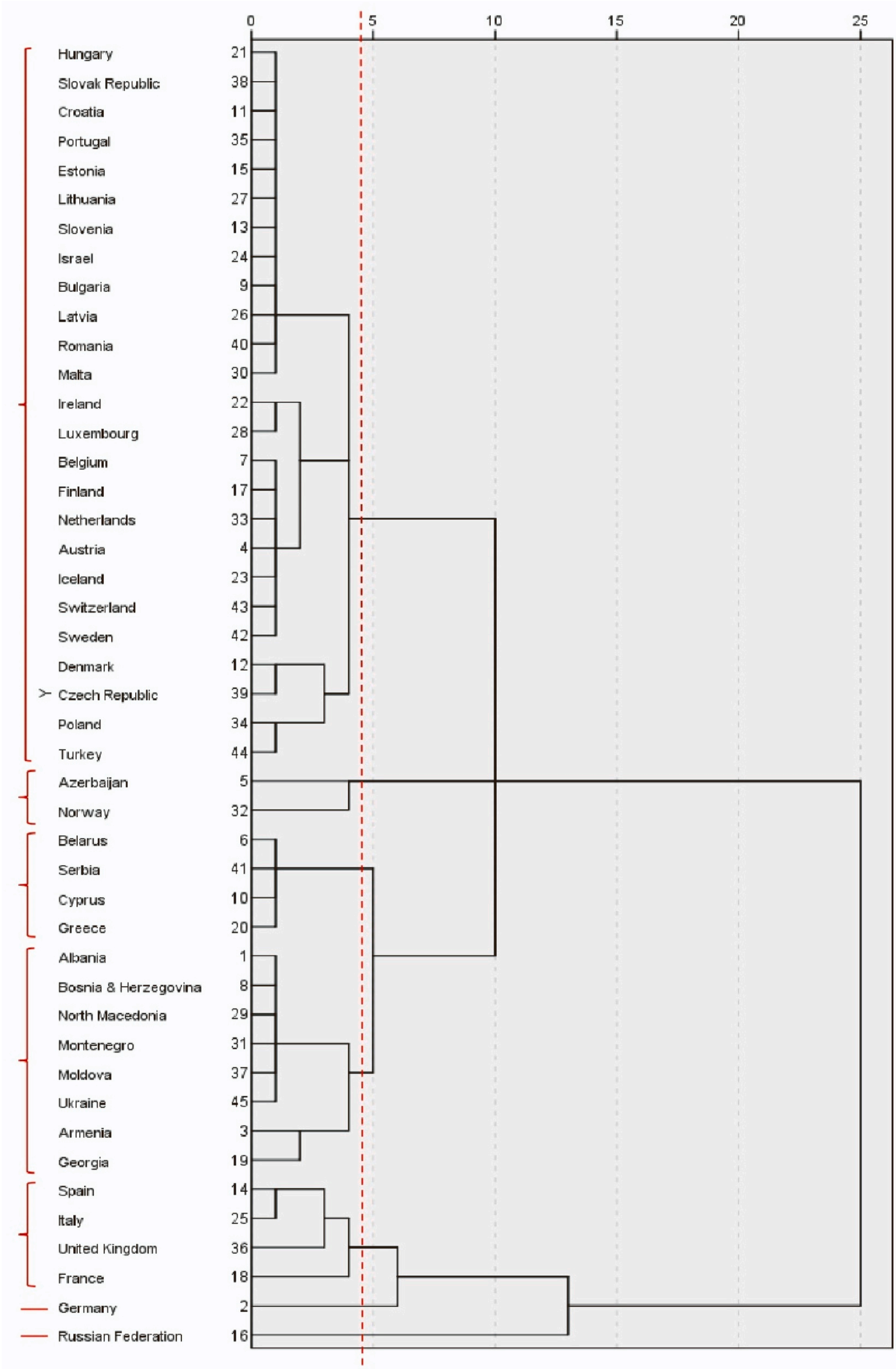

Fig. 2. Cluster analysis. Dendrogram.
Source: Elaboration by authors.

Table 5
Cluster Analysis. Classification of the 45 countries in 7 groups, explained by the highest and lowest variable averages.

Group	Countries	Causes in the formation of the Group
1	Hungary, Slovak Republic, Croatia, Portugal, Estonia, Lithuania, Slovenia, Israel, Bulgaria, Latvia, Romania, Malta, Ireland, Luxembourg, Belgium, Finland, Netherlands, Austria, Iceland, Switzerland, Sweden, Denmark, Czech Republic, Poland, Turkey	No extreme values in variables Almost null net ODA received High GDP
2	Azerbaijan, Norway	Highest energy depletion Highest fuel exports Lowest coal electricity generation No nuclear electricity generation Lowest solar electricity generation
3	Belarus, Serbia, Cyprus, Greece	Highest fuel imports Lowest population Highest per capita electricity consumption No nuclear electricity generation Lowest hydroelectric electricity generation
4	Albania, Bosnia & Herzegovina, North Macedonia, Montenegro, Moldova, Ukraine, Armenia, Georgia	Highest net ODA received Lowest GDP Lowest human development index Lowest oil electricity generation Lowest natural gas electricity generation Lowest wind electricity generation Lowest other RS electricity generation
5	Spain, Italy, United Kingdom, France	Lowest mineral depletion No net ODA received Lowest per capita electricity consumption
6	Germany	Lowest energy depletion No net ODA received Lowest fuel exports Highest GDP Highest human development index Highest solar electricity generation Highest wind electricity generation Highest other RS electricity generation
7	Russian Federation	Highest mineral depletion No net ODA received Lowest fuel imports Highest population Highest coal electricity generation Highest oil electricity generation Highest natural gas electricity generation Highest nuclear electricity generation Highest hydroelectric electricity generation

Source: Elaboration by authors.

%) and nuclear (26.7 %). It is also the group with the highest rate of mineral depletion (0.494), well above the average for the 45 countries (0.07 %), and the least dependent on external sources, with fuel imports of just 0.733 %, well below the overall average (8.3 %). Russia has one of the highest volumes of CO_2 emissions in the world, which, together with all the above, makes it the country analysed that should make the greatest effort to modify its energy policy.

Finally, there are 25 countries (most of them EU countries) that do not present a differentiated behaviour in the variables considered, but rather tend to present average values and, because of the techniques applied, end up forming a single group (Group 1). Even so, it should be noted that this is a group of countries with low values of mineral and energy depletion, almost no net ODA received and a high average per capita GDP.

As can be seen, our initial hypothesis seems to have been fulfilled in part: the non-EU countries have mainly been grouped together in Groups 2, 4 and 7, while the members of the EU have separated from them. This result would be in line with the fact that the supranational policy of the EU seems to have the expected effect of homogenizing the countries in terms of the energy variables considered in this analysis.

5. Conclusions

The adoption of the Sustainable Development Goals (SDGs) by the United Nations has provided an opportunity to improve assessments of the impact of renewable energies on a country's development. These can be based on indicators and international comparisons that can show the factors that will contribute to their better implementation. Although considerable progress has been made, there is still a long way to go to achieve the 2030 sustainable energy use targets, and there are large inequalities between regions of the world.

In Europe, there are large differences between countries in the design and implementation of energy strategies, even in the European Union, which has supranational policies to address climate change. In this sense, is particularly interesting to verify if such a supranational policy is evidenced in that those countries belonging to this organization can really be considered similar in terms of certain variables related to electricity generation, and therefore different from non-EU countries.

The aim of this investigation work has been to analyse the differences and similarities that, in terms of electricity generation, exist among 45 European countries. The statistical analysis is based on the information by country about 17 variables, directly and indirectly related to electricity production for the year 2020, referring to the availability of energy resources, energy dependence, the proportions of electricity generated by renewable and non-renewable sources, and its socioeconomic conditions. Multivariate analysis techniques (cluster analysis and factor analysis) were applied to this information to identify internally homogeneous groups of countries and explanatory factors for the total variability of the information matrix. The results showed seven groups of countries with similar characteristics in the use of renewable energy resources and electricity generation and consumption.

From these groups and from the information provided by the multivariate analysis techniques employed, specific aspects have been extracted for each of the groups that illustrate the importance of paying attention to developing energy policies that improve the substitution of non-renewable resources with renewable ones and contribute to achieving sustainable development objectives.

Among the 45 European countries considered, groups characterised by an intensive use of non-renewable energy resources and their high production and export (Russian Federation, and Azerbaijan-Norway) have been identified. These three non-EU countries need to pay particular attention to changing their energy policies. The recent Russia-Ukraine conflict has meant that two of these countries (Azerbaijan and Norway) have had to increase their production and exports to compensate for the cut in Russian exports to other European countries, compromising their environmental objectives. This war has also revealed one country's great weaknesses, Germany. This country is in a group with clearly positive indicators in terms of environmental policy objectives but is heavily dependent on non-renewable resources for electricity generation.

Belarus, Cyprus, Greece and Serbia form a group that needs to pay particular attention to reducing their electricity consumption levels and external energy dependence in order to achieve more sustainable targets. By contrast, Spain, Italy, United Kingdom and France make up the group with the lowest levels of electricity consumption per capita and, consequently, their clear objective is to further increase the share of electricity generation from renewable sources, especially France, which is highly dependent on nuclear energy. Albania, Armenia, Bosnia & Herzegovina, Georgia, Moldova, Montenegro, North Macedonia and Ukraine are eight non-EU countries that form the group with the lowest development indices, where international assistance seems very important to make their environmental development strategies bear fruit. Finally, the specific characteristics of the techniques used in this study mean that those countries that did not present a differentiated behaviour in the variables considered end up forming a group, without particularly noteworthy homogeneous aspects.

In addition to the configuration of each of the groups, it is worth noting the formation of groups exclusively made up of non-EU countries and others made up of EU member countries.

This investigation has only just begun. Even so, the objectives of defining indicators that allow the comparison between countries in terms of electricity generation and the classification of countries covered by a supranational environmental policy (EU countries) and others not covered by such a policy (non-EU countries), have been achieved.

However, we are aware of the limitations of this research. Firstly, the analysis only referred to the most recent year available for all the variables in the 45 countries. The selected year was 2020. We have to take care about the conclusions due to the possible impact of Covid-19. Therefore, it is interesting to extend this study to a greater number of years when the availability of information allows it. Secondly, we have proposed the use of 17 variables referring to 4 categories of indicators, but others indicators or variables could be defined to improve the analysis. Finally, we have used the multivariate analysis techniques that we consider most appropriate to obtain the main goal of this investigation. However, the hierarchical cluster analysis forces all countries to be classified in one group, so a very heterogeneous group can be generated. With the deepening of the research, another classification method could be applied, along the lines of the k-means method, in which the researcher directly proposes the number of groups to extract.

Declaration of competing interest

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The authors declare no known interests related to their submitted manuscript.

Data availability

Data will be made available on request.

Appendix

Table A.1
Description of variables used in cluster and factorial analysis (*)

Variable(1)	Name	Data Source(2)	Definition
V1	Mineral depletion	WB	Ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. Percentage of Gross National Income (GNI).
V2	Energy depletion	WB	Ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. Percentage of GNI.
V3	Net ODA received	WB	Net official development assistance (ODA) consists of disbursements of loans made on concessional terms (net of repayments of principal) and grants by official agencies of the members of the Development Assistance Committee (DAC), by multilateral institutions, and by non-DAC countries to promote economic development and welfare in countries and territories in the DAC list of ODA recipients. It includes loans with a grant element of at least 25% (calculated at a rate of discount of 10%). Percentage of GNI.
V4	Fuel exports	WB	Fuel exports (% of merchandise exports). Fuels comprise the commodities in SITC (Standard International Trade Classification) section 3 (mineral fuels, lubricants and related materials).
V5	Fuel imports	WB	Fuel imports (% of merchandise imports). Fuels comprise the commodities in SITC (Standard International Trade Classification) section 3 (mineral fuels, lubricants and related materials).
V6	GDP	WB	GDP per capita, PPP (constant 2017 international $).
V7	Population	WB	Total population.
V8	Per capita electricity consumption	OWID	It is measured in kilowatt/hour (kWh) per capita.
V9	Human Development Index	UN	Summary measure of average achievement in key dimensions of human development: Life expected at birth, years of schooling and GNI per capita.
V10	Coal electricity generation	IEA	It is measured in Gigawatt/hour (GWh).
V11	Oil electricity generation	IEA	It is measured in GWh.
V12	Natural gas electricity generation	IEA	It is measured in GWh.
V13	Nuclear electricity generation	IEA	It is measured in GWh.
V14	Hydroelectric electricity generation	IEA	It is measured in GWh.

(continued on next page)

Table A.1 (*continued*)

Variable(1)	Name	Data Source(2)	Definition
V15	Solar electricity generation	IEA	Solar PV and thermal electricity generation. GWh.
V16	Wind electricity generation	IEA	It is measured in GWh.
V17	Other RS electricity generation	IEA	Other renewable sources electrictiy generation. Includes biofuels, waste and geothermal. GWh.

Source: Elaboration by authors.
(*) Other variables were included in the initial approach of this paper but were eventually excluded from the multivariate analysis for various reasons. For example, access to electricity, one of the SDGs, is not relevant in this context, given that almost all the countries analysed have an access rate of 100 % or close to it. While the volume of CO_2 emissions and the consumption of renewable energy, fundamental in this type of study, had to be discarded due to their perfect correlation with other variables incorporated, which prevented the application of the factor analysis.
(1) Data refer to 2020 or the most recent year available.
(2) Data sources: WB (World Bank, https://cutt.ly/QMQykPK), OWID (Our World in Data, https://cutt.ly/aMQprT4), IEA (International Energy Agency, https://cutt.ly/1MQt8ks), UN (United Nations, https://cutt.ly/yMQtI5D).

Table A.2
Data used in the statistical analysis for the 17 variables and 45 European countries

Country	V1	V2	V3	V4	V5	V6	V7	V8
Albania	0.014	0.832	2.083	0.906	6.892	13253.733	2837743	17965775772301200
Armenia	0.877	0.000	0.849	3.015	15.763	12619.892	2963234	24531676808654400
Austria	0.000	0.025	0.000	1.941	5.725	51857.692	8917205	7715880793213700
Azerbaijan	0.202	10.528	0.286	87.247	2.612	13726.770	10110116	25424123100087800
Belarus	0.000	0.419	1.422	12.613	20.400	19186.776	9398861	38029716632549500
Belgium	0.000	0.000	0.000	5.025	8.038	48752.502	11555997	7413731188160150
Bosnia & Herzegov.	0.021	0.024	2.211	6.744	9.676	14520.906	3280815	4841671901464480
Bulgaria	0.227	0.037	0.000	4.638	8.478	22379.094	6927288	5803721218632340
Croatia	0.000	0.195	0.000	9.043	8.498	27076.979	4047200	3099368774706030
Cyprus	0.004	0.000	0.000	20.042	13.995	39007.715	1207361	40937895237698000
Czech Republic	0.000	0.032	0.000	1.200	3.545	38511.269	10698896	79912840607166200
Denmark	0.000	0.148	0.000	2.074	4.167	55819.910	5831404	51580361846846800
Estonia	0.000	0.143	0.000	4.851	11.169	35257.162	1331057	4814532115527690
Finland	0.047	0.000	0.000	7.011	9.746	47397.418	5530719	12174819476284400
France	0.000	0.003	0.000	1.882	6.891	42320.524	67391582	8096878797451540
Georgia	0.550	0.015	6.891	0.380	11.862	13966.326	3714000	29043182386790000
Germany	0.030	0.013	0.000	1.818	6.220	51423.235	83240525	6770986971310550
Greece	0.014	0.014	0.000	21.871	19.906	27072.619	10715549	47748078618351700
Hungary	0.000	0.135	0.000	2.194	5.560	31167.711	9749763	3499510720833080
Iceland	0.000	0.000	0.000	0.719	6.672	52375.681	366,425	5682788495575220
Ireland	0.010	0.000	0.000	0.427	3.920	90789.221	4994724	6407482458570520
Israel	0.000	0.059	0.000	2.054	8.066	39056.419	9216900	7909024768165270
Italy	0.000	0.051	0.000	2.142	8.443	39071.023	59554023	4553863860632840
Latvia	0.000	0.000	0.000	3.572	6.220	30053.263	1901548	30905895784226600
Lithuania	0.000	0.009	0.000	7.043	11.225	37107.057	2794700	15401440154634400
Luxembourg	0.000	0.000	0.000	0.083	5.127	112557.310	632,275	15287055733766100
Malta	0.000	0.000	0.000	3.259	17.316	40696.738	525,285	4443709389204550
Moldova	0.000	0.000	4.240	0.066	7.740	12269.923	2617820	13294212218649400
Montenegro	0.045	0.000	4.198	16.648	7.928	18258.950	621,718	6341295116772810
Netherlands	0.000	0.131	0.000	7.458	9.527	54324.384	17441139	7264058303262530
North Macedonia	0.203	0.052	2.423	1.412	7.875	15779.691	2083380	2817939510321650
Norway	0.000	4.586	0.000	49.318	4.392	63548.001	5379475	26492140492294700
Poland	0.092	0.071	0.000	1.580	5.291	32398.705	37950802	4158589545693700
Portugal	0.068	0.000	0.000	4.604	8.639	31961.775	10305564	5100324725031310
Romania	0.007	0.340	0.000	2.417	5.219	28925.789	19286123	30703367327136500
Russian Federation	0.494	4.655	0.000	42.099	0.733	26578.461	144104080	7025919649135640
Serbia	0.059	0.256	0.929	2.621	17.218	18255.054	6908224	39590112479100000
Slovak Republic	0.006	0.006	0.000	2.400	6.243	30509.769	5458827	5241057182804790
Slovenia	0.000	0.002	0.000	3.056	5.634	37050.548	2100126	8159979663596450
Spain	0.009	0.000	0.000	4.049	9.407	36210.875	47351567	5640806824191630
Sweden	0.001	0.000	0.000	4.541	7.793	50925.181	10353442	1647799377044080
Switzerland	0.000	0.000	0.000	0.610	2.076	68755.437	8636896	7934792032557160
Turkey	0.097	0.067	0.076	2.692	4.964	28393.466	84339067	34642419066362200
Ukraine	0.036	0.390	1.459	1.128	11.346	12407.790	44134693	305248769034466
United Kingdom	0.000	0.354	0.000	7.064	5.310	42820.565	67215293	4499844625263240

Country	V9	V10	V11	V12	V13	V14	V15	V16	V17
Albania	0.794	0	0	0	0	5281	32	0	0
Armenia	0.757	0	0	3166	2756	1778	21	2	0
Austria	0.913	2356	726	9955	0	45,344	2043	6792	5331
Azerbaijan	0.730	0	49	24,377	0	1067	47	96	201
Belarus	0.807	31	2130	34,574	0	398	175	194	430
Belgium	0.928	1834	88	26,521	34,435	1319	4972	12,871	6553
Bosnia & Herzegov.	0.781	11,446	42	20	0	4493	46	262	10
Bulgaria	0.802	13,530	304	2284	16,626	3320	1473	1477	1702

(continued on next page)

Table A.2 (*continued*)

Country	V9	V10	V11	V12	V13	V14	V15	V16	V17
Croatia	0.855	1222	35	3424	0	5810	96	1721	1082
Cyprus	0.894	0	4253	0	0	0	326	240	61
Czech Republic	0.892	32,686	84	6834	30,043	3437	2235	699	5307
Denmark	0.947	3062	263	1184	0	16	1181	16,353	6691
Estonia	0.892	2984	22	27	0	31	119	844	1605
Finland	0.938	5489	266	3702	23,291	15,856	256	7938	11,888
France	0.898	5067	5266	35,203	353,833	66,708	13,579	40,704	11,085
Georgia	0.802	0	0	2821	0	8248	0	91	0
Germany	0.944	148,164	4907	99,564	64,382	24,877	50,600	130,965	57,362
Greece	0.886	5978	4606	18,041	0	3445	4358	9321	561
Hungary	0.849	3841	42	9077	16,055	244	2450	655	2409
Iceland	0.957	0	3	0	0	13,160	0	7	5961
Ireland	0.943	1630	393	16,244	0	1224	64	11,549	1194
Israel	0.917	20,444	278	47,577	0	0	4066	227	0
Italy	0.889	13,064	9771	137,649	0	48,558	24,942	18,702	28,197
Latvia	0.871	0	0	2075	0	2603	5	177	865
Lithuania	0.879	0	123	1698	0	1080	129	1552	729
Luxembourg	0.924	0	0	175	0	1094	178	338	445
Malta	0.911	0	60	1841	0	0	233	0	6
Moldova	0.766	0	1	5820	0	276	4	51	28
Montenegro	0.826	1504	0	0	0	1634	0	293	0
Netherlands	0.939	10,057	1346	72,413	4087	46	7989	15,339	10,688
North Macedonia	0.774	2635	92	1145	0	1277	24	117	57
Norway	0.959	181	219	1312	0	141,593	27	9911	434
Poland	0.876	109,423	1894	16,791	0	2936	1990	15,800	8771
Portugal	0.863	2392	1162	18,034	0	13,988	1682	12,263	4255
Romania	0.824	9581	174	10,046	11,466	15,701	1733	6945	444
Russian Federation	0.830	175,803	8179	464,917	215,914	214,240	1862	1138	3365
Serbia	0.804	26,538	17	584	0	9735	14	1030	183
Slovak Republic	0.857	2121	426	3618	15,417	4739	656	4	1547
Slovenia	0.913	4363	12	579	6353	5224	368	6	287
Spain	0.899	5980	11,136	69,388	58,279	33,888	20,544	56,273	6674
Sweden	0.942	1783	337	108	48,916	71,806	1035	27,526	11,107
Switzerland	0.956	1	32	616	24,025	41,022	2520	145	3186
Turkey	0.833	106,269	323	69,331	0	78,119	11,265	24,703	14,349
Ukraine	0.775	42,852	441	11,257	76,203	7487	1635	1932	384
United Kingdom	0.924	6201	887	114,128	50,278	7894	12,801	75,610	44,949

Source: Elaboration by authors with data from WB (World Bank, https://cutt.ly/QMQykPK), OWID (Our World in Data, https://cutt.ly/aMQprT4), IEA (International Energy Agency, https://cutt.ly/1MQt8ks) and UN (United Nations, https://cutt.ly/yMQtI5D).

Table A.3
Factor Analysis. Correlation Matrix

Variable	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17
V1	1.000	.214	.340	.171	.113	−.360	.175	.057	−.487	.223	.031	.291	.101	.205	−.118	−.137	−.130
V2	.214	1.000	−.069	.942	−.308	−.130	.182	.087	−.277	.149	.050	.310	.104	.376	−.105	−.093	−.103
V3	.340	−.069	1.000	−.081	.196	−.467	−.196	.025	−.539	−.138	−.196	−.149	−.135	−.171	−.188	−.202	−.218
V4	.171	.942	−.081	1.000	−.147	−.136	.130	.148	−.213	.097	.111	.286	.066	.370	−.124	−.103	−.128
V5	.113	−.308	.196	−.147	1.000	−.351	−.299	.175	−.227	−.274	.048	−.266	−.207	−.363	−.100	−.146	−.194
V6	−.360	−.130	−.467	−.136	−.351	1.000	−.043	−.088	.805	−.074	.001	−.033	.013	.111	.129	.195	.194
V7	.175	.182	−.196	.130	−.299	−.043	1.000	−.145	.022	.803	.640	.846	.641	.666	.585	.547	.564
V8	.057	.087	.025	.148	.175	−.088	−.145	1.000	−.083	−.033	−.080	−.142	−.164	−.078	−.151	−.161	−.168
V9	−.487	−.277	−.539	−.213	−.227	.805	.022	−.083	1.000	−.032	.125	.001	.063	.142	.266	.345	.357
V10	.223	.149	−.138	.097	−.274	−.074	.803	−.033	−.032	1.000	.365	.693	.343	.526	.462	.413	.424
V11	.031	.050	−.196	.111	.048	.001	.640	−.080	.125	.365	1.000	.609	.456	.428	.598	.431	.353
V12	.291	.310	−.149	.286	−.266	−.033	.846	−.142	.001	.693	.609	1.000	.497	.713	.318	.245	.318
V13	.101	.104	−.135	.066	−.207	.013	.641	−.164	.063	.343	.456	.497	1.000	.527	.274	.314	.205
V14	.205	.376	−.171	.370	−.363	.111	.666	−.078	.142	.526	.428	.713	.527	1.000	.138	.127	.115
V15	−.118	−.105	−.188	−.124	−.100	.129	.585	−.151	.266	.462	.598	.318	.274	.138	1.000	.889	.851
V16	−.137	−.093	−.202	−.103	−.146	.195	.547	−.161	.345	.413	.431	.245	.314	.127	.889	1.000	.895
V17	−.130	−.103	−.218	−.128	−.194	.194	.564	−.168	.357	.424	.353	.318	.205	.115	.851	.895	1.000

Source: Results from SPSS Statistics version 22.

Table A.4
Cluster Analysis. Variable averages and minimum and maximum for the 7 groups

Group	V1	V2	V3	V4	V5	V6	V7	V8	V9
1	0.022	0.056	0.003	3.380	7.154	44964.019	1.124E+07	1.468E+16	0.897
2	0.101	7.557	0.143	68.282	3.502	38637.385	7.745E+06	2.596E+16	0.845
3	0.019	0.172	0.588	14.287	17.880	25880.541	7.057E+06	4.158E+16	0.848
4	0.218	0.164	3.044	3.787	9.885	14134.651	7.782E+06	1.239E+16	0.784
5	0.002	0.102	0.000	3.784	7.513	40105.747	6.038E+07	5.698E+15	0.903

(*continued on next page*)

Table A.4 (*continued*)

6	0.030	0.013	0.000	1.818	6.220	51423.235	8.324E+07	6.771E+15	0.944
7	0.494	4.655	0.000	42.099	0.733	26578.461	1.441E+08	7.026E+15	0.830
Minimum	0.002	0.013	0.000	1.818	0.733	14134.651	7.057E+06	5.698E+15	0.784
Maximum	0.494	7.557	3.044	68.282	17.880	51423.235	1.441E+08	4.158E+16	0.944

Group	V10	V11	V12	V13	V14	V15	V16	V17
1	13402.72	335.72	12966.16	9228.56	13124.76	1949.52	6637.24	4256.08
2	90.50	134.00	12844.50	0.00	71330.00	37.00	5003.50	317.50
3	8136.75	2751.50	13299.75	0.00	3394.50	1218.25	2696.25	308.75
4	7304.63	72.00	3028.63	9869.88	3809.25	220.25	343.50	59.88
5	7578.000	6765.000	89092.000	115597.50	39262.00	17966.500	47822.250	22726.250
6	148164.00	4907.00	99564.00	64382.00	24877.00	50600.00	130965.00	57362.00
7	175803.00	8179.00	464917.00	215914.00	214240.00	1862.00	1138.00	3365.00
Minimum	90.50	72.00	3028.63	0.00	3394.50	37.00	343.50	59.88
Maximum	175803.00	8179.00	464917.00	215914.00	214240.00	50600.00	130965.00	57362.00

Source: Elaboration by authors.

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