

Article

Global Conditions and Changes in the Level of Renewable Energy Sources

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Abstract: The progressing globalization of the contemporary economy impacts its volatility and unpredictability. The directions of changes in the socioeconomic development of the contemporary global economy are determined by a number of interrelated diverse factors. Factors clearly influencing the development of the modern international economy include innovation, digitization processes, instability of the economy caused by armed conflicts or pandemic outbreaks, the concept of sustainable development, climate policy, as well as issues related to the depletion of energy resources and the necessity of ensuring global energy security. The purpose of the article is to identify the factors of the development of the contemporary economy along with the analysis and evaluation of their impacts on changes in the level of renewable energy sources (RESs) in the EU countries. The time scope of the analysis covers the years 2013 and 2022 (a 10-year perspective). The study used the methods of literature study, literature criticism, statistical data analysis (statistical databases: EUROSTAT and IRENA), and linear ordering methods (TOPSIS and EDAS). The study results indicate that the levels of the RESs have changed in response to the factors diagnosed in the study. In the years studied, the leaders in terms of levels of RES development were France, Spain, and Denmark.

Keywords: globalization/global conditions; European Union; renewable energy sources; TOPSIS method; EDAS method; synthetic measure; ranking



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1. Introduction

Along with the ongoing process of globalization, there is a growing interest in local, regional, and global issues, which should be treated as a problem of transformation towards a market economy on one hand and a deepening of disparities in development between individual countries and regions on the other [1]. Currently, globalization is understood as an increase in the freedom of movement of goods, services, capital (both productive and speculative), cultural goods, and technology, as well as labour. The indicated flows are closely related to the growing interdependence between the economies of individual countries and the internationalization of problems associated with rapid socioeconomic development [2].

Globalization is a multifaceted and multidimensional issue, which implies its impact on many sectors and spheres of the economic lives of countries and regions of the world. It affects such areas as economics, social development, ecology, and politics. As a result of this process, a global economy is created, encompassing the economies of all countries, resulting in one common, large market [3]. The factors widely recognized in the literature as influencing the shaping of the contemporary global economy include innovation, the development of the digital economy, economic crises caused by armed conflicts or pandemic outbreaks, the idea of sustainable development, and the phenomena of energy depletion and environmental issues. Some are gaining in importance, while others are becoming less significant.

Determinants that clearly influence the development of contemporary international economics are technological progress, understood as positive changes in the techniques and technologies applied, and innovation. Contemporary economic practice is characterized by increased intensification of innovative activities. Innovation, from the perspective of globalization, is increasingly recognized as one of the key factors shaping the competitiveness of enterprises, subregions, regions, and systems at the supranational level [4]. The future of countries in the global economy is strongly dependent on the development of their innovative potential. It largely influences the ability to maintain a high productivity of production factors, the standard of living of societies, and success in global competition [5]. Digitization, in turn, is a major driver of socioeconomic change and a carrier of value with growing importance. It has become widespread and global, and is currently the most effective tool for managing and implementing innovations [6]. Digitization processes become universal and global in character, affecting not only enterprises or selected sectors, but the entire society, economy, and the links between countries and societies worldwide. The contemporary global economy has been undergoing a digital transformation for several years. However, it should be emphasized that digitization brings both opportunities and threats associated with, among other things, the social consequences of automation and robotization processes in the economy and public administration, as well as uncertainty or risk related to security as it is broadly understood [7]. This security includes health and energy security. Both the COVID-19 pandemic and the armed conflict in Ukraine have significantly affected the balance of the global economy: the first crisis changed the way societies function worldwide, and the war in Ukraine caused geopolitical uncertainty, disrupting energy supplies [8] and exacerbating the already unfavourable global situation [9].

In recent decades, in addition to economic factors, greater attention has been paid to climate change, leading to more actions aimed at environmental conservation. The answer is, among other things, sustainable development, meaning “development that meets the needs of the present without jeopardizing the ability of future generations to meet their own needs” [10]. This concept articulates threats related to the depletion of natural resources, climate change, pollution of the natural environment, population growth, and environmental degradation of entire ecosystems. In terms of civilization, there is talk of “global rationality” and an “economy of moderation”, signifying human functioning that, in terms of environmental exploitation constraints, enables survival over the long term [11]. The current dominant problem concerning the global economy is associated with the depletion of energy resources due to the high level of energy consumption by societies. Energy production is of fundamental importance for contemporary lifestyles and standards of living. Increased energy demand brings numerous negative consequences, including climate change and global temperature rise due to increased carbon dioxide emissions into the atmosphere. To mitigate these problems, many countries monitor their energy consumption and implement instruments for improvement. Currently, RESs are the main alternative to fossil fuels, and are perceived as a significant factor in combating dangerous climate change. Their utilization in national energy balances is not only a manifestation of implementing guidelines arising from global agreements but is also a sensible and economically conditioned action. RESs have exceptional potential to meet the growing energy needs of the world’s population for electricity [12]. At the same time, energy is one of the key factors for the sustainable development of societies [13].

The aim of this study is to identify the factors of contemporary economic development along with providing an analysis and assessment of their impacts on changes in the level of RESs in EU countries. Achieving the research goal involved the following steps:

- Reviewing the literature on factors of contemporary global economic development;
- Collecting available statistical data on RESs for the years 2013 and 2022 for EU countries and conducting statistical verification;
- Determining the values of the synthetic measures and rankings of EU countries for 2013 and 2022, based on the TOPSIS and EDAS methods;

- Classifying EU countries into groups with similar levels of achievement of the studied phenomenon.

To achieve the research goal, the following research hypotheses were formulated:

Hypothesis 1 (H1). *In the majority of the EU countries examined, desirable changes occurred from the perspective of current policies and strategies in the area of renewable energy development in the years 2013 and 2022.*

Hypothesis 2 (H2). *The Scandinavian countries are the leaders in the utilization of renewable energy sources in the EU.*

Hypothesis 3 (H3). *There were minor changes in the composition of groups of EU countries with similar utilization of renewable energy in 2022 compared to 2013.*

The originality of the work lies in the wide range of diagnostic variables analysed. The literature on the subject presents works analysing a diverse spectrum of factors [14–21], different time references [22], and in most studies, the focus was limited to the territorial unit of a country, e.g., Pakistan [23], Taiwan [24], Japan [25], Crete [26], Spain [27], or metropolitan areas, e.g., Istanbul [28].

Based on the analysis of secondary research results, a research gap was identified, which became the motivation for conducting research related to assessing the level of development of RESs based on a wide spectrum of diagnostic features (forty variables reflecting factors influencing the shaping of the contemporary global economy). The subject of the study is the countries of the European Union. The time scope of the research covers the years 2013 (the effects of the 2008–2009 crisis, including the currency, banking, and debt crises) and 2022 (the time after the COVID-19 pandemic). The data sources were the IRENA [29] and EUROSTAT [30] databases.

2. Materials and Methods

Multiple-criteria decision analysis (MCDA) and multiple-criteria decision making (MCDM) are sub-disciplines of operations research, within which computational tools are developed to support the subjective assessment of a finite number of decision alternatives within a finite number of performance criteria [31]. A wide range of integrated MCDM tools are used for analysing RES issues, including PROMETHEE [32,33], VIKOR [34], ELECTRE [35], and AHP [Analytic Hierarchy Process, [32]. The TOPSIS method (the Technique for Order of Preference by Similarity to Ideal Solution) is often employed in this research area [36,37]. For example, Ulewicz used the TOPSIS method to analyse the types of RESs preferred by Polish industry. In response, it was found that biofuels are the most preferred resource, while geothermal energy is the least preferred [38]. The EDAS method (Evaluation based on Distance from Average Solution) was utilized for comparison of the test results obtained with the TOPSIS method. Introduced in 2015 by Keshavarz Ghorabae [39], the EDAS method is a tool within the MCDA/MCDM framework. It is employed for RES analysis, among other applications [40–42].

Both the TOPSIS and EDAS methods incorporate normalization techniques. In MCDM models, the normalization process aligns all variables adopted in the study, ensuring their mutual comparability [43,44]. The methods of normalizing data in MCDA can be categorized into two main groups: profit-oriented methods and methods that consider cost criteria [44,45]. Numerous simulations [44,45] have demonstrated that the choice of normalization method significantly influences the final rankings generated through MCDM methods.

2.1. TOPSIS Method

The TOPSIS method is used to create comprehensive rankings of multi-criteria objects not only in the field of RESs but also in issues related to sustainable energy and develop-

ment [46–51]. Developed by Hwang and Yoon [52], this method allows the determination of the distances of the objects selected for the study (in the study, all EU member states were considered as objects) from the so-called positive ideal solution (pattern) and negative ideal solution (anti-pattern). The indicated tool belongs to one of the MCDA/MCDM methods used to solve real decision-making problems. Its results allow for the linear ordering of objects, considering the leader of the ranking as the unit with the smallest distance from the theoretically positive ideal solution and simultaneously the largest distance from the negative ideal solution. The potential object characterized by all the highest values for stimulant variables and the lowest values for destimulant variables is considered the positive ideal solution. Conversely, variables describing the negative ideal solution simultaneously take the lowest values for stimulants and the highest values for destimulants [31,44,53].

In the TOPSIS method, a k -element set of objects is considered with m variables. As a result, an $X [k \times m]$ data matrix is obtained with the values achieved by each object in all selected variables. The TOPSIS method additionally requires the arbitrary determination of a vector of weights in $[1 \times m]$ for subsequent features (the values of the weights (w_j) for each variable were determined using the Shannon Entropy method (Section 2.3)) [46]. This allows for the differentiation of the level of importance of individual variables in the shaping process of the aspect under study.

Only variables characterized by high variability and low correlation with other variables were included in this study. Features were reduced using coefficients of variation (V) and Pearson's linear correlation (r^*). The critical value of Pearson's linear correlation coefficient was arbitrarily set at 0.7 ($r^* = 0.7$), while the coefficient of variation was set at 0.1 ($V = 0.1$) [54].

The procedure for ranking objects according to the TOPSIS method consists of the following steps [44,46,53,55]:

- Normalization of $X [k \times m]$ matrix data using Formula (1) to ensure the comparability of indicators:

$$Z_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^k X_{ij}^2}} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (1)$$

- Taking into account the weights assigned to individual variables, according to Formula (2):

$$v_{ij} = w_j * Z_{ij} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (2)$$

- Determining the values of variables for the positive ideal solution a^+ and the negative ideal solution a^- :

$$a^+ = [v_1^+, v_2^+, \dots, v_m^+] \quad (3)$$

$$a^- = [v_1^-, v_2^-, \dots, v_m^-] \quad (4)$$

where

$$v_j^+ = \begin{cases} \max(v_{ij}) & \text{— when characteristic } j \text{ belongs to the stimulants collection} \\ \min(v_{ij}) & \text{— when characteristic } j \text{ belongs to the destimulants collection} \end{cases}$$

$$v_j^- = \begin{cases} \min(v_{ij}) & \text{— when characteristic } j \text{ belongs to the stimulants collection,} \\ \max(v_{ij}) & \text{— when characteristic } j \text{ belongs to the destimulants collection.} \end{cases}$$

- Determining the Euclidean distances of individual objects from the positive ideal solution a^+ and negative ideal solution a^- , using Formulas (5) and (6):

$$d_i^+ = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^+)^2} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (5)$$

$$d_i^- = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^-)^2} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (6)$$

- Calculating the synthetic ranking measure, determining the similarity of a given object to the ideal solution, using Formula (7):

$$q_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad \text{for } i = 1, 2, \dots, k \quad (7)$$

The coefficient q_i can take values in the range $[0, 1]$, with its highest value indicating the best solution (object) in a given set, and its lowest value indicating the worst [44]. The closer the value of the coefficient q_i is to 1, the more similar the object is to the theoretical positive ideal solution.

Calculating the synthetic measure allows for the hierarchical arrangement of objects and the creation of their typology. The typology of objects is usually created using the arithmetic mean and the standard deviation of the measure q_i , distinguishing the following groups [46,53,56]:

I—objects with the highest level of the measure ($q_i \geq \bar{q} + S_q$),

II—objects with a high level of the measure ($\bar{q} \leq q_i < \bar{q} + S_q$),

III—objects with a low level of the measure ($|\bar{q} - S_q| \leq q_i < \bar{q}$),

IV—objects with the lowest level of the measure ($q_i < |\bar{q} - S_q|$),

where

$\bar{q}$ —the arithmetic mean of the synthetic measure,

S_q —the standard deviation of the synthetic measure.

In this study, the individual groups reflect the ranges of values of the level of RES development in EU countries. Regarding the objective of the manuscript, which was to show the evolution of RESs, the researchers assumed that the indicated ranking (division into four groups) would most effectively differentiate between leaders and countries with very low levels of RES development. The authors' intention was to determine the changes over the examined years in each typological group as well. This division is commonly used in the literature [46,53,57–60].

2.2. EDAS Method

In contrast to the TOPSIS method, the reference variant in the EDAS method is the so-called averaged solution (AV), which assumes average values for all criteria included in the study [61]. To determine the distance from the averaged solution, it is essential to determine two basic measures: positive distance from average (PDA) and negative distance from average (NDA) [62]. Based on these measures, the best alternative is determined [63].

Like the TOPSIS method, the EDAS method considers a k -element set of objects given m variables, resulting in an $X [k \times m]$ data matrix. Similarities between the methodologies of both methods include the need to determine the type (stimulant or destimulant) and weight of each variable. In both cases, it is also necessary to normalize the data [61].

The procedure for constructing a ranking using the EDAS method includes the following steps [39,61–63]:

- Determination of the averaged solution (AV) for all criteria:

$$AV = [AV_j]_{1 \times m} \quad \text{for } j = 1, 2, \dots, m \quad (8)$$

where

$$AV_j = \frac{\sum_{i=1}^k X_{ij}}{k} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (9)$$

- Determination of positive distance from average (*PDA*) and negative distance from average (*NDA*), taking the type of variables into account:

$$PDA = [PDA_{ij}]_{k \times m} \quad (10)$$

$$NDA = [NDA_{ij}]_{k \times m} \quad (11)$$

where

if j is a stimulant,

$$PDA_{ij} = \frac{\max(0, (X_{ij} - AV_j))}{AV_j} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (12)$$

$$NDA_{ij} = \frac{\max(0, (AV_j - X_{ij}))}{AV_j} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (13)$$

if j is a destimulant,

$$PDA_{ij} = \frac{\max(0, (AV_j - X_{ij}))}{AV_j} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (14)$$

$$NDA_{ij} = \frac{\max(0, (X_{ij} - AV_j))}{AV_j} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (15)$$

- Calculation of the sum of the values of the *PDA* and *NDA* indicators for all objects, after taking into account the weights w_j :

$$SP_i = \sum_{j=1}^m w_j PDA_{ij} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (16)$$

$$SN_i = \sum_{j=1}^m w_j NDA_{ij} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (17)$$

where w_j is the weight assigned to the j th variable.

- Normalization of the values of *SP* and *SN* indicators:

$$NSP_i = \frac{SP_i}{\max_i(SP_i)} \quad \text{for } i = 1, 2, \dots, k \quad (18)$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)} \quad \text{for } i = 1, 2, \dots, k \quad (19)$$

- Calculation of the final values of the AS_i indicator, on the basis of which the ranking of objects is constructed:

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \quad \text{for } i = 1, 2, \dots, k \quad (20)$$

Similarly, the q_i indicator and the AS_i indicator can take values in the range of $[0, 1]$. The leader of the ranking created using the EDAS method is the object with the highest AS_i value. In a manner analogous to the TOPSIS method, for the EDAS method, countries were assigned to one of four groups, reflecting a specific level of RES development. The arithmetic mean and standard deviation of the AS_i indicator values were utilized here.

To determine the compatibility of rankings developed by different linear ordering methods (TOPSIS and EDAS), this study uses Spearman's rank correlation coefficient, which can be represented by the following formula [64–66]:

$$r_s = 1 - \frac{6 \sum_{i=1}^k c_i^2}{k(k^2 - 1)} \quad \text{for } i = 1, 2, \dots, k \quad (21)$$

where

c_i —differences between object ranks,
 k —the number of objects.

Spearman's rank correlation coefficient values range from -1 to 1 . The closer the value of the coefficient is to unity, the greater the compatibility of the rankings.

2.3. Shannon Entropy Method

Shannon Entropy was employed to determine the values of the weights of each variable in the TOPSIS and EDAS methods. It constitutes an MCDM model that uses an initial decision matrix, $X [k \times m]$, to determine the weights of each criterion [42]. Stimulant variables are characterized by invariability, while destimulants are transformed by inverse proportionality, according to Formula (22) [67]:

$$y_{ij} = \begin{cases} x_{ij} & \text{for stimulant} \\ \frac{1}{x_{ij}} & \text{for destimulant} \end{cases} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (22)$$

The further procedure for determining the values of variable weights using Shannon Entropy includes the following steps [41,42]:

- Normalization of the transformed decision matrix [68]:

$$r_{ij} = \frac{y_{ij}}{\sum_{i=1}^k y_{ij}} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (23)$$

- Determination of the entropy vector [68]:

$$e_j = -\frac{1}{\log_k} \sum_{i=1}^k r_{ij} \log r_{ij} \quad \text{for } i = 1, 2, \dots, k \text{ and } j = 1, 2, \dots, m \quad (24)$$

where, if $r_{ij} = 0$, then $\log r_{ij} = 0$.

- Final determination of the values of the weights of each variable [41,42]:

$$w_j = \frac{1 - e_j}{\sum_{j=1}^m (1 - e_j)} \quad \text{for } i = 1, 2, \dots, m \quad (25)$$

2.4. Variables Adopted for the Studies

When determining the variables influencing the levels of RES development in individual EU countries, the analysis of the subject literature and the authors' previous research experience were taken into account. To ensure comparability of variables across countries, features described by absolute values were recalculated using appropriate indicators (e.g., presenting the value of a given variable per 100,000 inhabitants). The analysis covered the extreme years of the 2013 to 2022 period, allowing for the observation of changes in the level of RES development in EU countries. The study excluded the UK, which was no longer a member state in 2022. Additionally, it was noted that many variables lacked values in the EUROSTAT database for this country.

In the first stage of the study, a set of 40 diagnostic features, acting as stimulants and destimulants, was proposed as a result of a substantive formal analysis of the variables. The potential set of variables, before taking into account the statistical criteria, is as follows (the data are presented in megawatts (MW) rounded to the nearest 1 megawatt, with values from 0 to 0.5 MW presented as 0. The data were obtained from [29,30]):

- X1— Total renewable energy, MW per 100,000 inhabitants;
- X2— Hydropower, MW per 100,000 inhabitants (complete lack of data for Cyprus and Malta);

- X3— Marine energy, MW per 100,000 inhabitants;
- X4— Wind energy, MW per 100,000 inhabitants;
- X5— Pure pumped storage, MW per 100,000 inhabitants (no data available for Sweden for 2022);
- X6— Onshore wind energy, MW per 100,000 inhabitants;
- X7— Offshore wind energy, MW per 100,000 inhabitants;
- X8— Solar energy, MW per 100,000 inhabitants;
- X9— Solar photovoltaic, MW per 100,000 inhabitants;
- X10— Concentrated solar power, MW per 100,000 inhabitants;
- X11— Bioenergy, MW per 100,000 inhabitants;
- X12— Solid biofuels and renewable waste, MW per 100,000 inhabitants (no data for Cyprus and Malta for 2013 and 2022. No data available for Greece for 2013);
- X13— Other solid biofuels, MW per 100,000 inhabitants (no data for Cyprus and Malta for 2013 and 2022. No data available for Greece for 2013);
- X14— Biogas, MW per 100,000 inhabitants;
- X15— Renewable energy share of electricity capacity, %;
- X16— Overall share of energy from renewable sources, %;
- X17— Share of energy from renewable sources in gross electricity consumption, %;
- X18— Share of energy from renewable sources for heating and cooling, %;
- X19— Share of energy from renewable sources in transportation, %;
- X20— Final energy consumption, million tons of oil equivalent;
- X21— Final energy consumption, index, 2005 = 100;
- X22— Energy taxes, percentage of gross domestic product (GDP);
- X23— Energy taxes, million EUR per 100,000 inhabitants;
- X24— Total environmental taxes, percentage of gross domestic product (GDP);
- X25— Total environmental taxes, million EUR per 100,000 inhabitants;
- X26— Income situation in relation to the risk of poverty threshold, %;
- X27— The real gross disposable income of households per capita, current prices, million units of national currency (in 2022, 2017 data were used for Bulgaria, while 2020 data were used for Romania);
- X28— Material import dependency, %;
- X29— Greenhouse gases emissions from production activities, kilograms per capita;
- X30— Consumption footprint, Planetary Boundary (in 2022, 2021 data were adopted for all countries);
- X31— Patents related to recycling and secondary raw materials, per million inhabitants (in 2022, 2020 data were adopted for all countries);
- X32— Circular material use rate, %;
- X33— Human resources in science and technology (HRST), percentage of population in the labour force;
- X34— High-tech exports, %;
- X35— Research and development expenditure, by sectors of performance, percentage of gross domestic product (GDP);
- X36— Implicit tax rate on energy, EUR per tonne of oil equivalent (TOE);
- X37— Environmental tax revenues, percentage of total revenues from taxes and social contributions (excluding imputed social contributions);
- X38— Energy productivity (purchasing power standard (PPS) per kilogram of oil equivalent);
- X39— Price per kilogram of oil equivalent (KGOE), EUR;
- X40— Electricity price for medium-sized non-households, EUR per kilowatt hour.

The diagnostic features adopted for the study, which indicate the levels of RES development in EU countries, include the following:

- RES capacities, representing the maximum net generating capacity of power plants and other installations utilizing RESs to produce electricity (features X1 to X14). For most countries and technologies, the data reflect installed and connected capacity at the end of the calendar year;

- The manner of use of RES electricity (features X15 to X21);
- Energy taxation as a budgetary instrument that is also used as a tool to encourage opting for RES (features X22 to X25 and X36);
- Human resources quality. For the development of countries, including the level of RES development; those human resources that, by virtue of their education, are engaged in creative work, development, dissemination, and application of scientific and technical knowledge, and consequently are a prerequisite for generating technological progress and innovation, and are of paramount importance (features X31–X35);
- The financial well-being of households, which is determined by their income (features X26–X27);
- Income, the source of which is environmental taxes. It can be a tool to stimulate RES development (feature X37);
- The quality of exogenous conditions (feature X28);
- Environmental pollution (feature X29);
- A significant consumption footprint (the term “consumption footprint” refers to the environmental and climate impacts of the consumption of goods and services by EU citizens, regardless of whether these are produced within or outside the EU. This indicator enables the estimation of the extent to which the planet is occupied by human activities to satisfy our daily needs, such as transport, food, and energy consumption) reduction in the EU (feature X30);
- Energy productivity (feature X38);
- Energy costs (features X39–X40).

The above set of potential diagnostic variables was subsequently subjected to statistical verification with respect to their variability and degree of correlation. The value of the coefficient of variation at $V \leq 10\%$ and Pearson’s correlation coefficient with a threshold arbitrarily set at $r^* = 0.7$ resulted in the elimination of the following seventeen features from the set of variables: X1, X4, X5, X8, X11, X12, X13, X15, X16, X20, X22, X23, X24, X25, X26, X30, and X38. Finally, 23 diagnostic variables were adopted for the purpose of the study, among which 20 are stimulants, while the remaining three, X21, X28, X29, are destimulants.

3. Results and Discussion

The value of the synthetic indicator, calculated on the basis of the TOPSIS and EDAS methods, allowed the countries to be classified into four groups: those with the highest, high, low, and very low levels of RES development. The results obtained confirm the clearly varying levels of RES development (Tables 1–4, Figures 1 and 2).

The results of the TOPSIS method calculations indicate that, in 2013 and 2022, the group of countries with the highest level of RES development included the same three countries: France, Spain, and Denmark (Table 1). In the decade analysed, hydropower accounted for the largest percentage of the RES mix in France: 44.4% in 2013, and 23.8% in 2022. Meanwhile, the decline in energy production from marine energy and pure pumped storage was 3.21% and 4.43%, respectively. At the same time, a 190.8% total increase in energy production from RESs was recorded. In 2013, wind energy accounted for the largest percentage of the RES mix in Denmark. This country also saw a 47.1% increase in energy production from this source in the decade under review. At the same time, with a 78.2% increase in the amount of energy obtained from RESs, the largest increase was in the production of energy obtained from solar energy, up 336.1%. In contrast, a 44.4% decrease was recorded for hydropower production. The difference between the maximum and minimum values of the synthetic index in the group of countries with the highest level of development during the analysed decade clearly decreased, i.e., from 0.063 to 0.047. This shows a narrowing of the gap between the countries in the first group.

Table 1. Synthetic indicators of the RES development levels of EU countries in 2013 and 2022 based on the TOPSIS method.

2013			2022		
Ranking Position	Country	Indicator Value	Ranking Position	Country	Indicator Value
Group of countries with the highest level of RES development					
$q_i \geq 0.2035$			$q_i \geq 0.2064$		
1	France	0.4542	1	France	0.4770
2	Spain	0.4526	2	Spain	0.4707
3	Denmark	0.3111	3	Denmark	0.2403
Group of countries with a high level of RES development					
$0.0844 \leq q_i < 0.2035$			$0.0852 \leq q_i < 0.2064$		
4	Luxembourg	0.1188	4	Belgium	0.1358
5	Belgium	0.1160	5	Netherlands	0.1322
6	Germany	0.0897	6	Luxembourg	0.1237
			7	Germany	0.0869
			8	Finland	0.0866
Group of countries with a low level of RES development					
$0.0346 \leq q_i < 0.0844$			$0.0360 \leq q_i < 0.0852$		
7	Sweden	0.0759	9	Sweden	0.0698
8	Austria	0.0618	10	Austria	0.0599
9	Finland	0.0545	11	Ireland	0.0438
10	Italy	0.0541			
11	Latvia	0.0486			
12	Czechia	0.0444			
13	Netherlands	0.0408			
14	Greece	0.0398			
15	Portugal	0.0368			
Group of countries with a very low level of RES development					
$q_i < 0.0346$			$q_i < 0.0360$		
16	Slovenia	0.0345	12	Portugal	0.0350
17	Ireland	0.0336	13	Latvia	0.0335
18	Bulgaria	0.0294	14	Czech Republic	0.0307
19	Slovakia	0.0243	15	Slovenia	0.0287
20	Croatia	0.02290	16	Italy	0.0285
21	Poland	0.02288	17	Greece	0.0249
22	Estonia	0.0217	18	Croatia	0.0237
23	Romania	0.0216	19	Estonia	0.0216
24	Cyprus	0.0194	20	Malta	0.0211
25	Malta	0.0181	21	Poland	0.0204
26	Lithuania	0.0179	22	Bulgaria	0.0203
27	Hungary	0.0148	23	Slovakia	0.0190
			24	Lithuania	0.01832
			25	Romania	0.01827
			26	Cyprus	0.0168
			27	Hungary	0.0134

Source: own study based on data from [29,30].

Table 2. Positions of EU countries and the distances between them in terms of RES development level (based on the synthetic indicator of TOPSIS method).

Country	Position in the Ranking in 2013	Position in the Ranking in 2022	Change of Position 2022/2013 (Number of Positions)	Distance from the Leader of the Ranking (in Points)	
				2013 (The Leader: France)	2022 (The Leader: France)
Austria	8	10	↓ (2)	0.3924	0.4170
Belgium	5	4	↑ (1)	0.3382	0.3412
Bulgaria	18	22	↓ (4)	0.4248	0.4567
Croatia	20	18	↑ (2)	0.4313	0.4533
Cyprus	24	26	↓ (2)	0.4348	0.4602
Czechia	12	14	↓ (2)	0.4098	0.4463
Denmark	3	3	=	0.1431	0.2367
Estonia	22	19	↑ (3)	0.4324	0.4554
Finland	9	8	↑ (1)	0.3997	0.3903
France	1	1	=	X	X
Germany	6	7	↓ (1)	0.3644	0.3901
Greece	14	17	↓ (3)	0.4144	0.4521
Hungary	27	27	=	0.4394	0.4636
Ireland	17	11	↑ (6)	0.4206	0.4332
Italy	10	16	↓ (6)	0.4001	0.4485
Latvia	11	13	↓ (2)	0.4056	0.4435
Lithuania	26	24	↑ (2)	0.4363	0.4587
Luxembourg	4	6	↓ (2)	0.3353	0.3533
Malta	25	20	↑ (5)	0.4361	0.4559
Netherlands	13	5	↑ (8)	0.4134	0.3448
Poland	21	21	=	0.4313	0.4566
Portugal	15	12	↑ (3)	0.4174	0.4420
Romania	23	25	↓ (2)	0.4325	0.4587
Slovakia	19	23	↓ (4)	0.4299	0.4579
Slovenia	16	15	↑ (1)	0.4197	0.4483
Spain	2	2	=	0.0016	0.0063
Sweden	7	9	↓ (2)	0.3783	0.4072

==No changes; X—leader; ↑—increase; ↓—decrease. Source: own study based on data from Table 1.

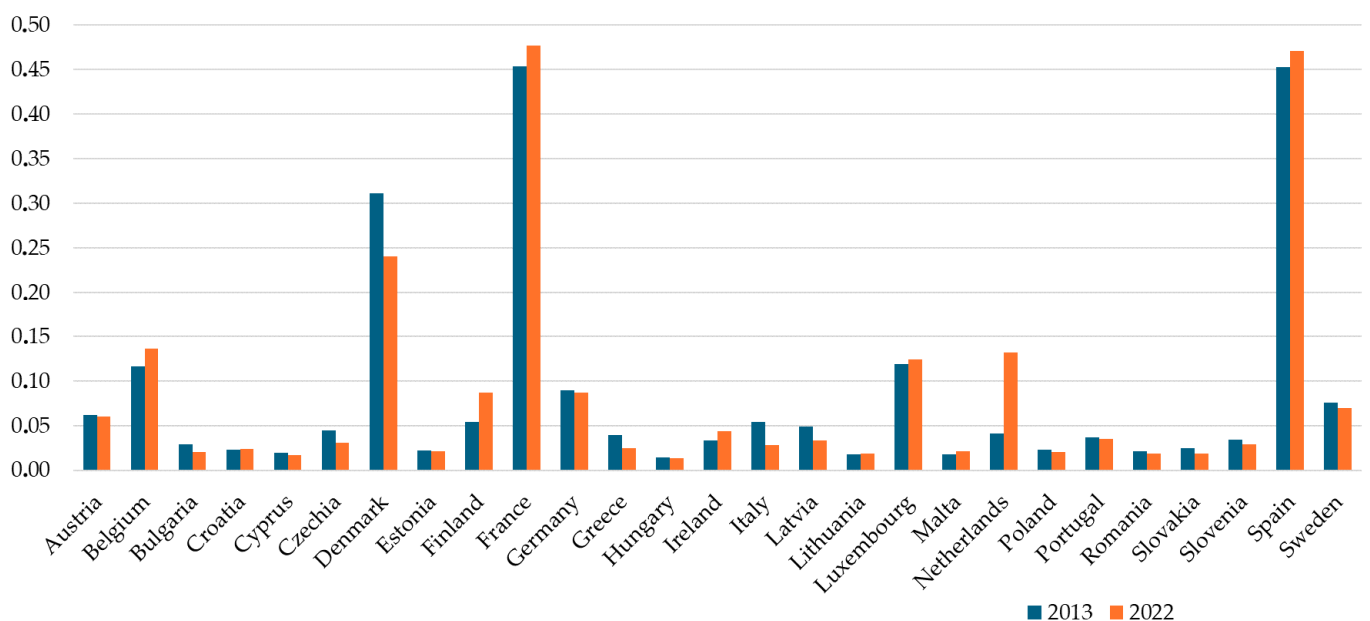
**Figure 1.** Distances of EU countries from the synthetic indicator according to results of the TOPSIS method in 2013 and 2022. Source: own study based on data from Table 1.

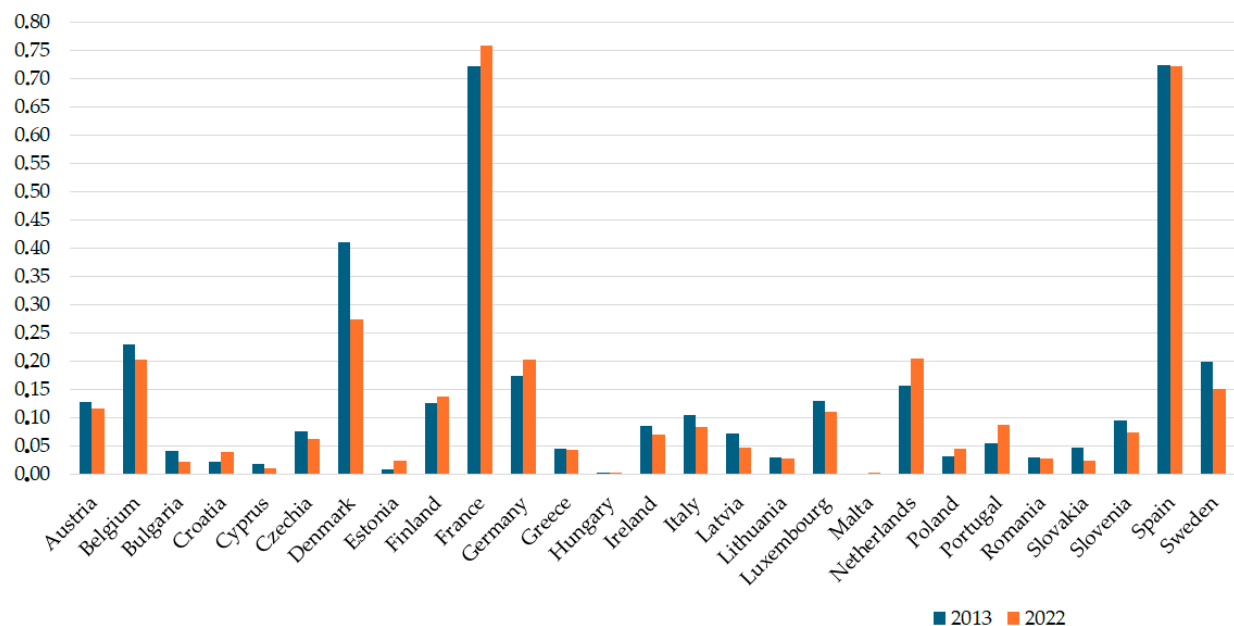
Table 3. Positions of EU countries and the distances between them in terms of RES development level (based on the synthetic indicator of the EDAS method).

2013			2022		
Ranking Position	Country	Indicator Value	Ranking Position	Country	Indicator Value
Group of countries with the highest level of RES development					
$AS_i \geq 0.3254$			$AS_i \geq 0.3181$		
1	Spain	0.7226	1	France	0.7585
2	France	0.7209	2	Spain	0.7219
3	Denmark	0.4109			
Group of countries with a high level of RES development					
$0.1395 \leq AS_i < 0.3254$			$0.1325 \leq AS_i < 0.3181$		
4	Belgium	0.2296	3	Denmark	0.2743
5	Sweden	0.1990	4	Netherlands	0.2046
6	Germany	0.1745	5	Belgium	0.2032
7	Netherlands	0.1562	6	Germany	0.2027
			7	Sweden	0.1516
			8	Finland	0.1381
Group of countries with a low level of RES development					
$0.0464 \leq AS_i < 0.1395$			$0.0530 \leq AS_i < 0.1325$		
8	Luxembourg	0.1291	9	Austria	0.1169
9	Austria	0.1283	10	Luxembourg	0.1109
10	Finland	0.1252	11	Portugal	0.0882
11	Italy	0.1057	12	Italy	0.0841
12	Slovenia	0.0945	13	Slovenia	0.0733
13	Ireland	0.0857	14	Ireland	0.0698
14	Czechia	0.0770	15	Czechia	0.0623
15	Latvia	0.0730			
16	Portugal	0.0552			
17	Slovakia	0.0472			
Group of countries with a very low level of RES development					
$AS_i < 0.0464$			$AS_i < 0.0530$		
18	Greece	0.0457	16	Latvia	0.0472
19	Bulgaria	0.0407	17	Poland	0.0447
20	Poland	0.0315	18	Greece	0.0435
21	Lithuania	0.0302	19	Croatia	0.0387
22	Romania	0.0298	20	Lithuania	0.0290
23	Croatia	0.0226	21	Romania	0.0277
24	Cyprus	0.0186	22	Slovakia	0.0251
25	Estonia	0.0081	23	Estonia	0.0238
26	Hungary	0.0030	24	Bulgaria	0.0219
27	Malta	0.0017	25	Cyprus	0.0101
			26	Malta	0.0032
			27	Hungary	0.0028

Table 4. Positions of EU countries and the distances between them in terms of RES development level (based on the synthetic indicator of the EDAS method).

Country	Position in the Ranking in 2013	Position in the Ranking in 2022	Change of Position 2022/2013 (Number of Positions)	Distance from the Leader of the Ranking (in Points)	
				2013 (The Leader: Spain)	2022 (The Leader: France)
Austria	9	9	=	0.5942	0.6416
Belgium	4	5	↓ (1)	0.4930	0.5553
Bulgaria	19	24	↓ (5)	0.6818	0.7366
Croatia	23	19	↑ (4)	0.7000	0.7197
Cyprus	24	25	↓ (1)	0.7040	0.7484
Czechia	14	15	↓ (1)	0.6456	0.6962
Denmark	3	3	=	0.3117	0.4841
Estonia	25	23	↑ (2)	0.7145	0.7347
Finland	10	8	↑ (2)	0.5974	0.6203
France	2	1	↑ (1)	0.0016	X
Germany	6	6	=	0.5481	0.5557
Greece	18	18	=	0.6769	0.7149
Hungary	26	27	↓ (1)	0.7196	0.7557
Ireland	13	14	↓ (1)	0.6368	0.6887
Italy	11	12	↓ (1)	0.6168	0.6744
Latvia	15	16	↓ (1)	0.6496	0.7113
Lithuania	21	20	↑ (1)	0.6923	0.7295
Luxembourg	8	10	↓ (2)	0.5934	0.6475
Malta	27	26	↑ (1)	0.7209	0.7552
Netherlands	7	4	↑ (3)	0.5664	0.5538
Poland	20	17	↑ (3)	0.6911	0.7137
Portugal	16	11	↑ (5)	0.6674	0.6702
Romania	22	21	↑ (1)	0.6928	0.7307
Slovakia	17	22	↓ (5)	0.6754	0.7333
Slovenia	12	13	↓ (1)	0.6280	0.6852
Spain	1	2	↓ (1)	X	0.0365
Sweden	5	7	↓ (2)	0.5235	0.6068

==No changes; X—leader; ↑—increase; ↓—decrease. Source: own study based on data from Table 3.

**Figure 2.** Distances of EU countries from the synthetic indicator according to results of the EDAS method in 2013 and 2022. Source: own study based on data from Table 3.

In 2013, countries with a high level of RES development were Luxembourg, Belgium, and Germany. After a ten-year period, the group of countries with high levels of development expanded to include the Netherlands and Finland. The group leader in 2013 was Luxembourg, which fell to third place in 2022. Hydropower and pure pumped storage dominated in Luxembourg, with 43.8% and 42.5% in 2013 and 35.5% and 34.7% in 2022. A notable increase of 1500.2% was recorded for offshore wind energy's share in Germany during the analysed period. At the same time, its share in the RES mix increased by 11.9%. In 2022, Finland rose from the group of countries with low RES development to the group of high-RES-development countries. Finland ranked fifth, with an increase in the synthetic indicator value from 0.0545 to 0.0866. During this time, there was a shift in the structure of Finnish RESs. Hydropower accounted for 32.1% in the first year analysed, and despite a 2% increase in its share, wind energy was the dominant RES in 2022. There was an increase of 1155.9% in the share of wind energy; at the same time, the share of onshore wind energy increased by 1216.2%, and offshore wind energy increased by 180.2%.

In 2013, nine countries (Sweden, Austria, Finland, Italy, Latvia, Czechia, The Netherlands, Greece, Portugal) had a low level of RES development, while in 2022 there were three such countries (Sweden, Austria, Ireland). This was due to unfavourable changes in Italy, Latvia, Czechia, Greece, Cyprus, and Portugal, as these countries joined the group of countries with a very low level of RES development. At the same time, there was a favourable change in the Netherlands as this country moved from the low development group to the group characterized by a synthetic index within the range of $0.0346 \leq q_i < 0.0844$. In 2013, RES energy production from hydropower dominated in Sweden (46.2%). Hydropower dominated also the structure of Austria's RESs, accounting for 60.8% in 2013 and 45.9% in 2022. At the same time, its share in the RES mix increased by 11.9%. Significant changes in the RES structure occurred in Portugal, where there was an increase of 1150.0% in offshore wind energy.

In 2013, the group of countries with the lowest level of RES development was the most numerous. It included twelve countries: Slovenia, Ireland, Bulgaria, Slovakia, Croatia, Poland, Estonia, Romania, Cyprus, Malta, Lithuania, and Hungary. After a decade, only Ireland left this group and joined the group of low-RES-development countries. Over the decade, Ireland saw an increase in the share of energy from solid biofuels and renewable waste, wind energy, and onshore wind energy, by 369.2%, 240.2%, and 242.0%, respectively. Despite the increase in the share of solar energy in Poland (by 558,250.0%) and Cyprus (by 1225.7%), these countries have not left the group of countries with the lowest level of development. Within this group of countries, the largest decrease was observed in Slovakia for the share of wind energy (i.e., by 20.0%).

The data presented in Table 2 and Figure 1 reveal a positive trend in the level of RES development in most EU countries over the course of the years examined. Ten countries ranked higher (with the Netherlands, Ireland, Malta, Estonia, and Portugal moving up eight places, six places, five places, and three places, respectively), twelve countries ranked lower, and five countries held their ranking over the course of the years analysed. There is also a clear difference regarding the distance to the leader—in both years, it was France (in 2013, Hungary's distance to France was 0.4394, and in 2022 the distance increased to 0.4636). A distance in the range of 0.0016–0.3924 characterized eight countries in 2013, and 19 countries were characterized by a distance in the range of 0.4001–0.4394. In 2022, a distance in the range of 0.0063–0.3903 was recorded for seven countries, and of 0.4072–0.4602 for twenty countries. Noteworthy is the fact that 2013 saw six countries ranked above the EU average in terms of the synthetic indicator, and in the second year analysed, this number increased to eight. All of these countries belonged to the I and II typological groups.

Based on the value of the synthetic indicator calculated using the EDAS method, the group of EU countries with the highest level of development, in both years analysed, included France and Spain, with Denmark also included in this group in the first year studied (Table 3, Figure 2). The leader of the level of RES development ranking in 2013 was Spain with an indicator value of 0.7226, and in 2022 this position was taken by France with

an indicator value of 0.7585. The synthetic indicator for France increased by 0.038 points compared to the first year examined, moving it up to the top position in 2022. France was the only country to have offshore energy, at just under 218 MW in 2013 (211 MW in 2022), and the value of wind energy increased by 159% during the period under review. The core of the group with a high level of RES development in both years analysed consisted of the following countries: Belgium, Sweden, Germany, and the Netherlands, for which the synthetic indicators were in the range of 0.2296–0.1562 in 2013. In 2022, the group also included Denmark (0.2743) and Finland (0.1381). Denmark's RES structure saw a 336% increase in solar energy and solar photovoltaic -. It should be noted that Finland recorded an increase in solar energy and solar photovoltaic by 6467%, and wind energy by 1155%. The largest group was made up of countries with low and very low levels of RES development, which included 20 countries in 2013 and 19 in 2022. The lowest-ranking countries in both analysed years were Hungary and Malta, with 2013 indicator values of 0.030 and 0.0017, respectively (in 2022 it was Malta—0.032 and Hungary—0.0028). It should be noted that despite its inhabiting the penultimate position, the value of the indicator for Malta improved by 0.0015 points. Particularly noteworthy among the EU countries analysed are Poland, Estonia, Ireland, and Hungary, which in 2013 and 2022 saw increases in both solar energy and solar photovoltaic of 558,350%, 26,650%, 13,400%, and 8437%, respectively, although they were ranked in Typological Groups III and IV on based on the synthetic indicators. Meanwhile, only countries in the group with the highest level of RES development achieved a synthetic indicator higher than the EU average in this aspect.

Table 4 and Figure 2 present the changes in ranking position and the distances between EU countries in terms of the level of RES development (based on the EDAS method). In the years under analysis, 10 countries ranked higher than they had, while 4 countries remained in the same position and 13 countries experienced a decline. The distance separating the ranking leader in 2013 (Spain from Malta) was 0.7209, and in 2022 (France from Hungary) was recorded at 0.7557. The most favourable changes were recorded for Portugal, which improved its ranking by five positions, Croatia, which advanced by four positions, the Netherlands and Poland, which both improved by three positions, and Estonia and Finland, which both advanced by two positions. The least favourable changes were observed for Bulgaria and Slovakia, which declined in the ranking by five positions. Sweden, which had previously ranked fifth, fell to seventh place. The smallest distances from the leader of the ranking (Spain) in 2013 were achieved by France—0.0016, Denmark—0.0317, and Belgium—0.4930. In 2022, the smallest gaps from the leader (France) were achieved by Spain—0.0365, Denmark—0.4841, Belgium—0.5553, and Germany—0.5557.

Table 5 presents each country's position in the 2013 and 2022 rankings, based on two separate linear ordering methods: TOPSIS and EDAS. Spearman's rank correlation coefficient for them was 0.94 in 2013, and 0.95 in 2022. These values indicate a very strong positive correlation between the rankings. Thus, they lead to the conclusion that in a synthetic analysis of RES development in the EU countries, both methods can be used, providing a reliable source of information on the phenomenon under study.

The positions in the 2013 ranking are consistent for the following three countries: Cyprus, Denmark, and Germany. The leader of the 2013 ranking according to the TOPSIS method was France (second place—EDAS), while according to the EDAS method, it was Spain (second place—TOPSIS). Hungary obtained the lowest value of the q_i index in 2013 (26th place—EDAS). In the case of the EDAS method, the ranking was closed by Malta (25th place—TOPSIS). In contrast, the results of the linear ordering of countries for 2022 are fully consistent for 5 of the 27 countries (Denmark, Finland, France, Hungary, and Spain). France ranked first in both rankings in 2022. Hungary, which once again came last in the TOPSIS ranking, also achieved the lowest value of the AS_i indicator. The differences in the positions of each country in the two rankings result from the change in the reference variant from the ideal and negative ideal solutions in the TOPSIS method to the average solution (EDAS method). However, the 2013 and 2022 rankings (constructed using the

TOPSIS and EDAS methods) were dominated by France, Spain, and Denmark. Therefore, they can be considered the countries with the highest level of RES development in the EU.

Table 5. Comparison of the synthetic indexes calculated using the TOPSIS and EDAS methods for 2013 and 2022.

Country	2013				2022			
	TOPSIS		EDAS		TOPSIS		EDAS	
	Position	Value	Position	Value	Position	Value	Position	Value
Austria	8	0.0618	9	0.1283	10	0.0599	9	0.1169
Belgium	5	0.1160	4	0.2296	4	0.1358	5	0.2032
Bulgaria	18	0.0294	19	0.0407	22	0.0203	24	0.0219
Croatia	20	0.0229	23	0.0226	18	0.0237	19	0.0387
Cyprus	24	0.0194	24	0.0186	26	0.0168	25	0.0101
Czechia	12	0.0444	14	0.0770	14	0.0307	15	0.0623
Denmark	3	0.3111	3	0.4109	3	0.2403	3	0.2743
Estonia	22	0.0217	25	0.0081	19	0.0216	23	0.0238
Finland	9	0.0545	10	0.1252	8	0.0866	8	0.1381
France	1	0.4542	2	0.7209	1	0.4770	1	0.7585
Germany	6	0.0897	6	0.1745	7	0.0869	6	0.2027
Greece	14	0.0398	18	0.0457	17	0.0249	18	0.0435
Hungary	27	0.0148	26	0.0030	27	0.0134	27	0.0028
Ireland	17	0.0336	13	0.0857	11	0.0438	14	0.0698
Italy	10	0.0541	11	0.1057	16	0.0285	12	0.0841
Latvia	11	0.0486	15	0.0730	13	0.0335	16	0.0472
Lithuania	26	0.0179	21	0.0302	24	0.0183	20	0.0290
Luxembourg	4	0.1188	8	0.1291	6	0.1237	10	0.1109
Malta	25	0.0181	27	0.0017	20	0.0211	26	0.0032
Netherlands	13	0.0408	7	0.1562	5	0.1322	4	0.2046
Poland	21	0.0229	20	0.0315	21	0.0204	17	0.0447
Portugal	15	0.0368	16	0.0552	12	0.0350	11	0.0882
Romania	23	0.0216	22	0.0298	25	0.0183	21	0.0277
Slovakia	19	0.0243	17	0.0472	23	0.0190	22	0.0251
Slovenia	16	0.0345	12	0.0945	15	0.0287	13	0.0733
Spain	2	0.4526	1	0.7226	2	0.4707	2	0.7219
Sweden	7	0.0759	5	0.1990	9	0.0698	7	0.1516

Ligus et al. (2018), using the fuzzy TOPSIS method, analysed low-emission energy technologies (onshore wind, offshore wind, biomass and biogas, photovoltaic, nuclear) in the Polish context. The authors considered three groups of criteria: economic (GDP, trade balance, competitiveness and innovativeness of economy, unemployment rate, energy security of enterprise and public sector, balanced development of regions, land requirement), social (eliminating social inequality, shaping new energy culture, energy security of households) and environmental (carbon emissions; Sox, NOx, PM10, PM2.5; amount of waste generation; resource efficiency of the economy; interference in the landscape; risk of failure/accident) [69]. These criteria were determined by a different purpose from that of this article.

Milek et al. (2022) conducted an analysis of the level of RES development in the European Union countries, using a linear ordering method—Hellwig’s method. The evaluation in question was carried out based on nine diagnostic variables downloaded from the EUROSTAT and IRENA databases [70]. Despite the difference in the number of features used in the study and the different method, comparable results were obtained, i.e., in the group of countries with the highest level of RES development, in both analysed years, Denmark was the leader. Meanwhile, Poland was in the group of countries with the lowest level of RES development in both studies.

Similar research results to those obtained in this study are also evident in the analysis of RES development levels conducted by Stec and Grzebyk, 2020 [71]. In this case, despite

the use of a different linear ordering method (Hellwig's) and seven diagnostic variables (two concerning the share of RES energy in total and in transport, and the rest concerning renewable energy production), Denmark was in the group of countries with the highest level of RES development, and Poland was in the last group.

Publication [42] presents an MCDM model for assessing RES (photovoltaic, solar, wind, geothermal, and biomass) resources from economic, technical, social, and environmental perspectives. The assessment is based on the results of a study conducted with the EDAS method, which is analysed in this article. Moreover, ref. [72] also proposed MCDM, using an integrated Entropy–EDAS model to identify the best RES from the pool of solar, wind, biomass, biogas, and solar–wind hybrid energy. Another study also used MCDM to select the best type of RES, and the analysis included solar, wind, and hydropower [41].

4. Conclusions

The conducted research examined the level of RES development in EU countries in 2013 and 2022. The study used two linear ordering methods: TOPSIS and EDAS. The results of the analyses led to the following conclusions:

- Based on the TOPSIS method, the numbers of countries in the groups with high, low, and very low levels of RES development changed during the analysed years. In contrast, the number of countries classified to the group with the highest RES development did not change. The composition of the group is the same: France, Spain Denmark. There was a noticeable change in the distance between the leaders and other EU countries, which increased from 0.4394 in 2013 to 0.4636 in 2022. Noteworthy is the fact that the Netherlands and Ireland rose in the ranking by eight and six positions, respectively.
- The EDAS method revealed a change in the number of countries in all typological groups in 2013 and 2022. The groups with a low and very low level of RES development were the most numerous. The distance between the leader and the lowest-ranking country increased from 0.7209 to 0.7557. Notably, both Portugal and Croatia improved their ranking, by five and four positions, respectively.
- Based on the determined Spearman's rank correlation coefficient, it was concluded that the synthetic indicators calculated using the TOPSIS and EDAS methods can serve as a basis for assessing the level of RES development in EU countries.
- In both rankings, Denmark was the sole representative of the Scandinavian countries in the group with the highest level of RES development. Denmark ranks second among EU countries in terms of total RES production. It dominates the market for wind power generation, both onshore and offshore.
- The research results can be a valuable source of information for decision makers, as they confirm that RES development is susceptible to global economic, political, ecological, and social conditions. This is evidenced by the results of the conducted research based on diagnostic features related to the specified factors of global economic development.
- In the near future, the authors of the manuscript plan to conduct research that includes analysis and assessment of the impact of feed-in tariffs on RES development. Therefore, the following research questions can be formulated: Do the feed-in tariffs used in EU countries result in the expected RES development? To what extent does the diversity of feed-in tariff solutions in EU countries lead to an improved level of RES development?

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