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POLITICAL AND ECONOMIC RATIONALE FOR THE DEVELOPMENT OF RENEWABLE ENERGY IN EUROPEAN UNION COUNTRIES

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Purpose: There are two factors related to the implementation of the Green Deal. The first relates to economic issues and depends on economic development. The second is related to political actions. The aim of this article is to analyze the impact of political and economic factors on the renewable energy sector. Assuming the idea of common priorities in the EU, it can be hypothesized that the action programs for renewable energy implemented by the EU should enable countries to accelerate their efforts to develop this sector of the economy.
Design/methodology/approach: Firstly, k-means analysis will be employed to cluster EU countries based on whether they would achieve the declared target of a 20% share of renewable energy in gross final energy consumption. Secondly, the application of k-means will facilitate the division of countries into groups based on their economic affluence, distinguishing them between richer and poorer nations. Next, the study will utilize the ANOVA, which help determine if the actions carried out by the EU are sufficient to achieve the increasing share of renewable energy. It will consider the diversity of countries in terms of economic and political factors.
Findings: The first hypothesis, regarding the significance of the political factor, was successfully confirmed. The analysis conducted revealed that EU countries vary in their implementation of the EU renewable energy objectives. The second hypothesis regarding the significance of the economic factor has been dismissed. It was not confirmed that the degree of economic development has an impact on the growth of the renewable energy sector.
Originality/value: It can be assumed that all EU countries would support the policy toward the growth of renewable energy. While various factors play a crucial role in shaping the renewable energy market, it is difficult to find an analysis that explains the lack of significant progress in this sector of the economy.
Keywords: renewable energy; economic factors; political factors; Green Deal; European Union; investments.
Category of the paper: Research paper.

1. Introduction

Development of the renewable energy sector requires investments that will yield a profit on the incurred expenditure and additional benefits in the long term. It is widely accepted that investments in this branch of the economy have a multifaceted impact on the environment, the economy, the development of technological innovations, energy independence, and public health (Krozer, 2013, pp. 68-73; Omer, 2012, pp. 561-576). It can be assumed that as long as technology advances and investments develop, the costs of implementation of renewable energy infrastructure will tend to decrease. In addition, these investments may further increase the attractiveness of the venture for both individual and organized consumers (Reuter et al., 2012, pp. 249-254).

Although investment in the renewable energy market seems to be economically valuable, should we consider political factors? According to Wüstenhagen and Menichetti "policy has not only created opportunities, but also posed risks for renewable energy investors" (Wüstenhagen, Menichetti, 2012, p. 1). They note that political factors can influence the renewable energy market. One has to agree with them because it is not a fully free market and there are no free competition rules, e.g. due to technological issues or monopolies.

It seems obvious that the EU member states have recognized the importance of the development of the renewable energy branch, driven by concerns about the scarcity of traditional energy sources as well as environmental challenges at the beginning of the 21th Century. That is why it can be assumed that all EU countries would support the policy toward the growth of renewable energy. While various factors play a crucial role in shaping the renewable energy market, it is difficult to find an analysis that explains the lack of significant progress in this sector of the economy, particularly in terms of achieving the EU goals in this field.

In the available literature, numerous papers address issues related to renewable energy, due to the importance of research in the area of sustainable development, as well as practical implications for the EU's Green Economy goals.

The primary literature on renewable energy covers technological issues (Turkenburg, Faaij, 2000, pp. 219-272), trends (Bull, 2001, pp. 1216-1226; Gross et al., 2003, pp. 105-122), analyses of renewable energy sources (Twidell, 2021), energy storage (Amrouche et al., 2016, pp. 20914-20927) and many others. Interesting considerations are pursued by Lund, who points out that the plans for the development of the renewable energy sector must encompass strategies for integrating renewable sources into coherent energy systems, with a focus on energy savings and energy efficiency. Using Denmark as an example, the author discusses the challenges and prospects of transforming traditional energy systems into ones that rely on 100% renewable energy sources. He demonstrates that there are no barriers that could prevent energy transformation (Lund, 2007, pp. 912-919).

Dincer stresses that the use of renewable energy sources is one of the most efficient and effective solutions for achieving sustainable goals (Dincer, 2000, pp. 157-175). He mentions that the development of this sector is determined by political factors. On the other hand, in his article "Renewable energy, non-renewable energy and sustainable development", Güney compares the impact of renewable and non-renewable sources on sustainable development. He observes that renewable energy positively affects both highly developed and developing countries (Güney, 2019, pp. 389-397). This perspective prompts a closer examination of the economic factors that can significantly influence the development of the renewable energy sector.

Many authors also study the impact of renewable energy on sustainable development in individual countries. These papers encompass not only the European market, which is considered the most developed area in available literature (Jagerwaldau, 2007, pp. 1414-1437), but also other countries such as Tanzania (Bishoge et al., 2018, pp. 70-88), India (Naidu, 1996, pp. 575-581), Iran (Rezaei et al., 2013, pp. 320-329), Bangladesh (Ahmed et al., 2014, pp. 223-235), and many others. Besides this field of research, the analysis examines the impact of renewable energy on various economic sectors. For instance, Chel and Kaushik analyze the issues of renewable energy's impact on sustainable agriculture (Chel, Kaushik, 2011, pp. 91-118) and the construction industry (Chel, Kaushik, 2018, pp. 655-669). Meanwhile, Liczmańska-Kopcewicz and others examine the food market in terms of utilizing renewable energy (Liczmańska-Kopcewicz et al., 2020, pp. 1-20). Green brands play a significant role in this context. The effectiveness of green brands depends on the use of, among other things, renewable energy (Lyeonov et al., 2019; Us et al., 2023; Xin, Long, 2023, pp. 531-538).

The indicated literature demonstrates the multidimensionality of renewable energy management. As shown above, authors from various disciplines highlight different aspects or perspectives of renewable energy management. However, renewable energy studies often do not pay particular attention to the political and economic rationale that determines the effectiveness of its development. What factors determine the growth of the renewable energy sector in EU countries? The available literature does not provide a clear answer to this question.

The aim of this article is to analyze the impact of political and economic factors on the renewable energy sector. Assuming the idea of subsidiarity as one of the overriding priorities for the functioning of the EU, it can be hypothesized that the action programs for renewable energy, implemented by the EU, should contribute to the acceleration of efforts to develop this branch of the economy in the EU.

The article consists of three parts, which will successively analyze the influence of correlation between CO_2 emissions and the percentage of renewable energy in final consumption, and then the political and economic factors on the development of the renewable energy sector. Using the division into two groups of countries, the research will enable an analysis of the relationship between the dependent variable:

Y – share of renewable energy in gross final energy consumption by sector;
and the independent variables:

X_1 – declaration of achieving the renewable energy target in 2020;

X_2 – Gross Domestic Product per capita.

Firstly, k-means analysis will be employed to cluster EU countries based on whether they would achieve the declared target of a 20% share of renewable energy in gross final energy consumption. Secondly, the application of k-means will facilitate the division of countries into groups based on their economic affluence, distinguishing them between richer and poorer nations.

Two specific questions will be posed in the article:

1) Is there differentiation among individual groups of countries in terms of share of renewable energy in gross final energy consumption due to the declaration of meeting the EU's goals?
2) Is there differentiation among individual groups of EU countries in terms of the share of renewable energy in gross final energy consumption based on their level of affluence?

The study will utilize the ANOVA (Analysis of Variance) method, with the following null hypothesis (H0):

H0 - There is no differentiation in terms of share of renewable energy in gross final energy consumption among groups of countries due to political declaration and economic development.

Alternative hypothesis:

H1 - There is differentiation in terms of share of renewable energy in gross final energy consumption among groups of countries due to political declaration and economic development.

The analysis will help determine whether the actions carried out by the EU are sufficient to achieve the increasing share of renewable energy. It will consider the diversity of countries in terms of economic and political factors.

2. Factors shaping the renewable energy market in the EU

The European Union sets ambitious goals related to environmental protection and combating climate change through its strategy known as the Green Deal. In this strategy, the EU assumes that renewable energy is a key tool that will lead to the achievement of the "zero-emission economy" goal by 2050 and a reduction of up to 55% in CO_2 emissions into the atmosphere by 2030 (European Commission, 2019). Such EU policy is paramount because the EU's member states depend on energy supplies (Poiană et al., 2017, pp. 175-189). Therefore, the governments of the EU's member states should bear in mind that without their energy

resources, they will remain consistently dependent on imports. Russia's invasion of Ukraine has shown that the most strategic goal for European countries should be to increase their independence from Russia, both for humanitarian and economic reasons. It is related to avoiding collaboration with an unstable and irresponsible state, such as Russia has proven to be (Krzykowski, 2022, pp. 93-113; Kuczyńska-Zonik, Sierzputowska, 2023; Tokarski, 2022, pp. 10-16).

The relationship between renewable energy and CO_2 emissions is one of the central aspects of endeavours to mitigate climate change, which is why numerous studies have examined this dependency, pointing out the positive correlation between increasing renewable energy and decreasing CO_2 emissions (Apergis et al., 2010, pp. 2255-2260; Irandoust, 2016, pp. 118-125; Saidi, Mbarek, 2016, pp. 364-374). In the available literature, the results of research in which the authors show the negative impact on these variables can also be found (Jebli, Youssef, 2015, pp. 173-185). On the other hand, Menyah underlined that "renewable energy has not reached a level where it can make a significant contribution to emissions reduction" (Menyah, Wolde-Rufael, 2010, pp. 2911-2915).

In the context of "The Green Deal", renewable energy sources such as solar, wind, hydroelectric, and geothermal power have a pivotal impact on the EU's goals. Fig. 1 presents a comparison between CO_2 emissions and renewable energy usage between 2004 and 2021 in the EU (27).

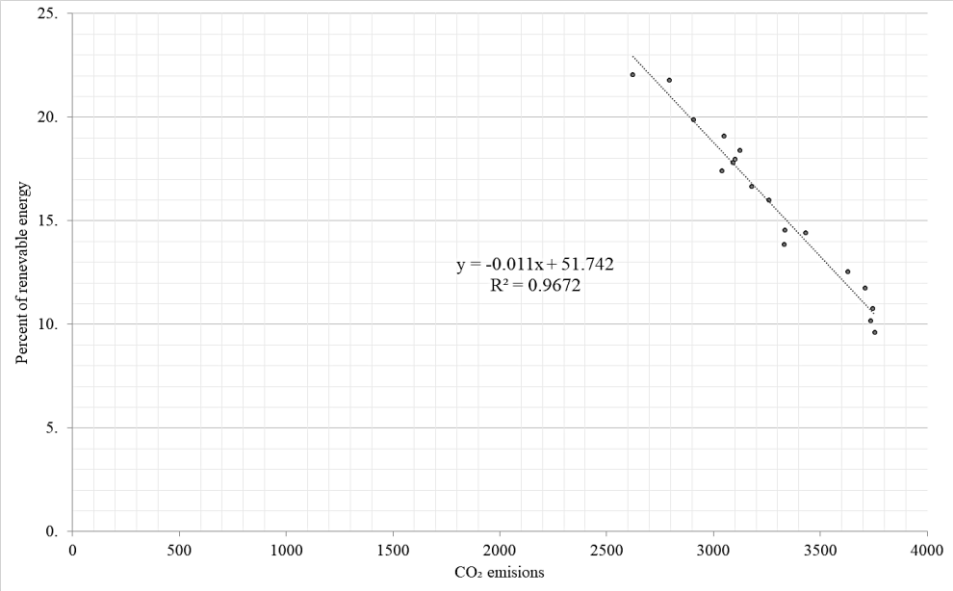

Figure 1. Correlation between CO_2 emissions and percentage of renewable energy in final consumption. Source: Share of renewable energy in gross final energy consumption by sector, https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en; CO_2 emissions, https://ourworldindata.org/co2-and-greenhouse-gas-emissions.

It is widely accepted that the EU has made significant efforts to reduce its carbon dioxide emissions and increase renewable energy sources worldwide. As shown in Fig. 1, the EU's commitment to renewable energy plays a critical role in reducing CO_2 emissions within the

region. The dependency between renewable energy and CO_2 emissions in the EU is evident in the progress made towards achieving its climate goals and transitioning to a low-carbon, sustainable energy system. The correlation between variables is significant, since it amounts to -0.98%. The EU has made progress in reducing CO_2 emissions from the highest amount of 3,755 Mt in 2004 to 2,793 Mt in 2021. The trend seems to have been steadily decreasing since then. At the same time, renewable energy in gross final consumption has increased from about 10% to more than 20%. The Union barely achieved its objectives, making it challenging to claim significant progress, especially given that it only aimed for a 10% increase between 2009 and 2020, and the goal has now risen to 45%. Additionally, the success of the EU as a whole organisation cannot be attributed to the success of individual member states belonging to the organisation. Fig. 2 illustrates CO_2 emissions gap by country between 2009 and 2020.

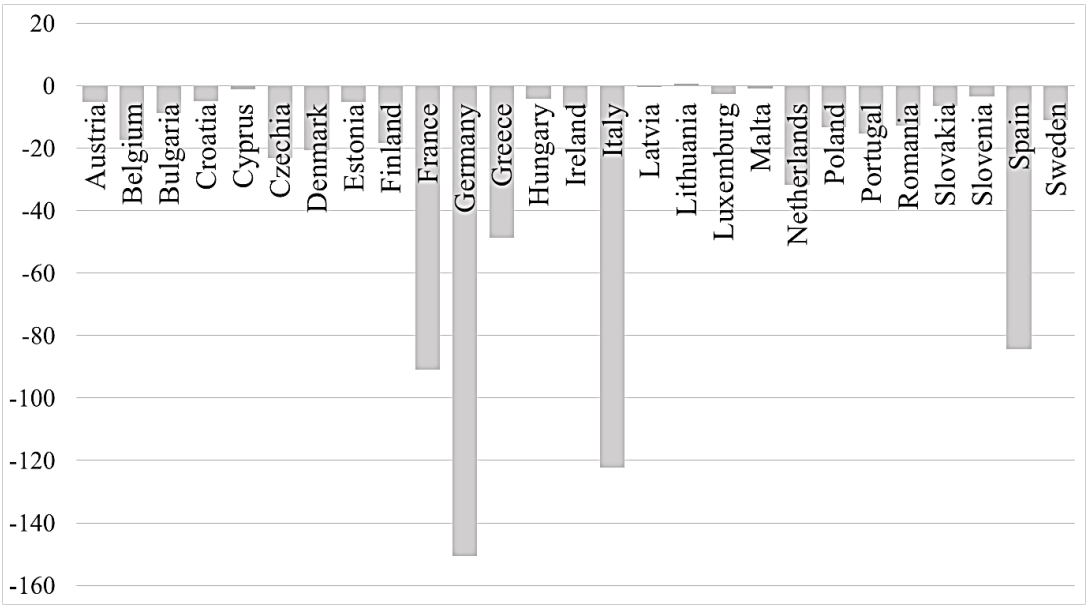

Figure 2. CO_2 emissions gap by country between 2009 and 2020.

Source: *Data on CO2 and Greenhouse Gas Emissions by Our World in Data,* https://github.com/owid/co2-data.

Only four countries visibly reduced their CO_2 emissions over the period, while Poland and Lithuania slightly increased them. Among the countries making relevant progress were Germany, France, Italy and Spain. The graph shows significant differences between countries in terms of CO_2 reductions. This means that, despite a common target, there are features that determine the effectiveness of measures in the area under consideration.

Two factors can be distinguished: political and economic, which are related to the implementation of the Green Deal. Czarny indicated that it is difficult to determine whether decisions made by specific countries are of an exclusively political or economic nature (Czarny, 2018). The first one is directly related to political actions. Here, the response of the countries to the challenge of increasing the share of renewable energy in the energy mix is a major step towards the EU's environmental goals. The lack of appropriate policies could undermine the European concept and reduce the countries' energy security. The second factor relates to

economic issues and depends on economic development. From this perspective, investments in renewable energy can play a crucial role in building a sustainable future for the EU's population. However, they require financial outlays and appropriate policy decisions by Member States to respond to the challenges of the Green Deal. These are dependent on many factors, such as the type of renewable energy, scale of the projects, locations, technology, investment, and operating costs, as well as the country's energy policy.

3. Political factors

In United Europe is a community of values, shared history, culture, and principles. Based on this, countries chart their common path of development. Thus, it is worth examining whether the political factors influence the shaping of the renewable energy growth in the EU countries. Gross perceives that "governments around the world are placing considerable faith in renewable energy as important technologies for reducing energy related environmental problems, particularly CO_2 emissions" (Gross et al., 2003, p. 105). Encouraging the development of the renewable energy market requires a combination of instruments and policies in every EU country, which can play a crucial role in promoting renewable energy adoption. Lu describes three important sustainable energy policies, i.e., Energy-Efficiency Standard (EES), Feed-In-Tariff (FiT), and Building Energy Performance Certification (BEPC) Schemes (Lu et al., 2020). For instance, governments could guarantee feed-in-tariffs above market rates for renewable energy producers, providing a stable income stream and incentives investment in renewable energy projects. Additionally, renewable portfolio standards or tax incentives encourage investors to engage in these types of projects.

These policies vary from one country to another and depend on political regimes, political conditions, and the benefits of political parties, making them subject to change over time. Several empirical studies conclude that governments need to increase the adoption rate of renewable energy and promote effective policy incentives and policy controls to reduce prevalent CO_2 emissions in their countries and regions (Qudrat-Ullah, 2013).

Also, at the EU level, common actions towards the development of renewable energy usage should be promoted. In 2009, EU leaders set a target that 20% of energy consumption in the EU countries should come from renewable energy sources by 2020 (The European Parliament and the Council of the European Union, 2009). Although it had not been achieved by many countries, a new, higher target was set in 2018. At that time, EU countries agreed that 32% of energy consumption would need to come from renewable sources by 2030 (The European Parliament and the Council of the European Union, 2018). The European Parliament directive aimed to maintain global leadership in emissions reductions resulting from the Paris Agreement (UNFCCC, 2016). Three years later, the target was revised again, and in July 2021, in view of

the EU's new climate ambitions, the goal was proposed to be changed to 40% (The European Parliament and the Council of the European Union, 2021). These were not the final solutions that were decided in the EU renewable energy forum. The energy crisis, which was the result of Russia's invasion of Ukraine, contributed to negotiating an initial agreement in March 2023. The document on the binding EU renewable energy target for 2030 sets a new goal of at least 42.5% of renewable energy in gross final energy consumption, with a view to reaching 45%. The target has more than doubled compared to 2020 (European Commission, 2022).

It should be noted that in 2009, when the European Union set the 20% renewable energy goal, each EU country declared how it intended to achieve its individual targets and developed a renewable energy action plan. Not all countries declared their intention to achieve a 20% share of renewable energy in gross final energy consumption. The table below shows the breakdown of countries into two groups based on the EU's target of achieving a 20% share of renewable energy in gross final energy consumption.

Table 1.
Division of countries in terms of meeting the 20% target for the share of renewable energy in final energy consumption

First group – countries that declared achieving 20% renewable energy in gross final consumption	Second group – countries that did not declare achieving 20% renewable energy in gross final consumption
Sweden	Germany
Finland	Slovakia
Latvia	Czechia
Austria	Cyprus
Portugal	Ireland
Denmark	Poland
Croatia	Netherlands
Estonia	Hungary
Lithuania	Belgium
Slovenia	Luxemburg
Romania	Malta
Bulgaria	
Greece	
Spain	
Italy	
France	

Source: Eurostat, EU overachieves 2020 renewable energy target, 19.01.2022, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220119-1.

The first group of countries includes those that declared reaching the 20% target by 2020. The second group includes those that declared a smaller target than a 20% share of renewable energy in final energy consumption. Among EU Member States, only France failed to meet its target and did not achieve the 20% share of renewable energy required by the EU. Eleven countries did not declare the level of renewable energy indicated by the EU. The EU as a whole succeeded in meeting its goals. This was possible because many countries had declared and invested in the development of the renewable energy sector much more than the required 20%. Notable among these is Sweden, which has a share of over 60% of renewable

energy in gross final energy consumption. Finland and Latvia also achieved very good outcomes (over 40%). The statistical analysis results across the groups of countries surveyed are presented in tab. 2.

Table 2.
Division of countries in terms of meeting the 20% target for the share of renewable energy in final energy consumption

Group	n	Mean	Sd	Median	Min	Max	skew	kurtosis
First - yes	11	35.19	11.87	34.72	19.34	62.57	0.78	0.03
Second - no	16	17.18	4.95	17.21	11.73	31.33	1.25	1.52

Sources: Eurostat, Share of renewable energy in gross final energy consumption by sector, https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en; Eurostat, EU overachieves 2020 renewable energy target, 19.01.2022, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220119-1

The averages within the groups differ significantly. In the first group, declaring a desire to achieve a minimum of 20% renewable energy in final energy consumption, the average was 35.19%, while in the group declaring lower targets, the average was only 17.18%. The difference between them is double. When analysing the basic statistics, a very high standard deviation (Sd) is shown in the first group, which may indicate a lack of intergroup variation. Kurtosis (kurtosis) and skewness (skew) are not questionable. It is therefore worth analysing the box plots for the presence of outliers that affect the quality of the ANOVA analysis. Below is a box plot showing the percentage share of renewable energy in gross final energy consumption due to the policy pledge.

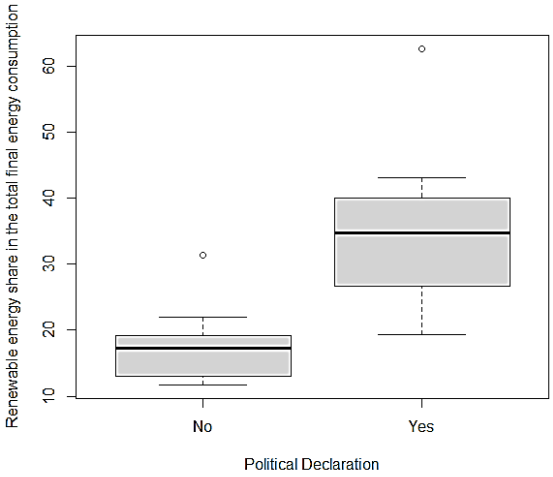

Figure 3. Box plot of percent of renewable energy in gross final consumption due to the policy pledge.

Source: Eurostat, Share of renewable energy in gross final energy consumption by sector, https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en; Eurostat, EU overachieves 2020 renewable energy target, 19.01.2022, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220119-1.

The first outlier is noticeable in the graph, pertaining to Lithuania. Although Lithuania did not declare a minimum 20% share of renewable energy in gross final energy consumption in 2009, it succeeded in meeting its targets and even exceeded the EU's indications by 10%.

Interestingly, it is the only country that has achieved such good results despite the lack of a political declaration. It is worth noting that Lithuania is one of the three Baltic states that declare a common Baltic identity with Latvia and Estonia, and one of the communities of the Baltic Sea Region prioritising sustainable development goals. Sweden, Denmark, and Finland are also part of the Baltic Sea Region (Tomala, 2020). The Nordics were mentioned in the first group, as they declared their commitment to meet the EU's renewable energy targets. The second outlier relates to Sweden, which has achieved the best result (62.6%). Sweden is one of the leaders in the EU when it comes to environmental goals, which is why it has achieved the high value of renewable energy in gross final consumption. Other countries within the Baltic Sea Region, such as Poland and Germany, did not achieve results similar to Lithuania.

The assumptions for the ANOVA test in the evaluated example were not confirmed. The results for tests of normality of distribution and homogeneity of variance are shown below.

Table 3.
The assumption for the ANOVA test

Normality test p-value > 0.05	**Shapiro-Wilk**	**Lilliefors (Kolmogorov-Smirnov)**	**Anderson-Darling**
First group - yes	0.367	0.5819	0.4381
Second group - no	0.02151	0.3682	0.09199
Homogeneity of variance	Bartlett test for homogeneity of variances	Levene's Test for Homogeneity of Variance (centre = median: median)	Levene's Test for Homogeneity of Variance (centre = median: mean)
p-value>0.05	0.003083	0.0395	0.0395

Source: Eurostat, Share of renewable energy in gross final energy consumption by sector, https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en; Eurostat, EU overachieves 2020 renewable energy target, 19.01.2022, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220119-1

Tests of normal distribution have been performed using three methods. Two of them have confirmed the presence of a normal distribution in both groups. Only the Shapiro-Wilk test in the first group has not confirmed the normality of the distribution (p-value < 0.05). However, none of the three tests for the homogeneity of variance have positively verified the condition for ANOVA (p-value < 0.05). Therefore, a non-parametric Kruskal-Wallis test has been applied to verify whether there is variation regarding the share of renewable energy in gross final energy consumption between groups of countries in terms of political declaration.

The result (p-value = 5.201e-05) is less than 0.05, indicating that the hypothesis H0 should be rejected. There is an inter-group variation between the first and the second group, which measures the share of renewable energy in gross final energy consumption due to the political declaration. Additionally, a post-hoc Dunn test shows that there is a statistically significant difference between the group declaring a 20% or higher share of renewable energy and the group declaring a lower share of renewable energy with 95% confidence.

It can be inferred that a country's appropriate policies affect the efficiency of implemented measures, which leads to the progress of the renewable energy market in countries striving to achieve EU targets. The energy policies of the Nordic countries offer best solutions to this phenomenon. As frontrunners, they employ multiple sustainable energy and climate-related approaches. This signifies that other entities operating in the European market can adopt their management tools and benefit from their experience. It is important to recognize the significance of scientific studies and reports, such as *Towards Enhanced Climate Change Adaptation in the Nordic Region*, in developing recommendations for appropriate actions (Gram-Hanssen et al., 2023). These include synchronising actions at different levels, implementing well-chosen strategies and priorities, aligning climate action, and more.

4. Economic factors

The According to Solaymani "The close and high relationship between production growth and energy consumption growth in the economy refers to the dependence of the economy on energy. Thus, the economy is not only sensitive to energy supply and price shocks, but any initiative to conserve energy can have an impact on the performance of the economy" (Solaymani, 2021).

In 2019, the European Union prioritised achieving climate neutrality by 2050 through the establishment of a renewable energy sector and enhancing energy efficiency (European Commission, 2019). Implementing the Green Deal requires reducing dependence on other countries' energy resources and meeting sustainable development goals. As emphasized by Bórawski et al., renewable energy sources play a significant role in reducing carbon dioxide emissions and pollution (Bórawski et al., 2022, p. 1; Solaun, Cerdá, 2019, p. 1). These socio-political benefits are crucial, but they have required financial investments, which could be a barrier to developing the renewable energy sector for poorer countries. The European Commission recognizes this problem; hence the Fund for Just Transition was established in the EU regulation from 24 June 2021. "It provides support to all Member States. The allocation criteria were based on industrial emissions in carbon-intensive regions, on industrial employment and the extraction of coal and lignite, peat and oil shale production, and on the level of economic development" (The European Parliament and the Council of the European Union, 2021). Is it possible to differentiate countries according to their level of economic development in order to achieve green energy goals? The answer to this question is not straightforward. On the one hand, it can be hypothesized that due to the uneven economic development of European Union countries, richer countries are more effective in implementing investments in the renewable energy sector. On the other hand, taking into account the EU's

aid, European countries should have similar conditions for implementing the green energy strategy.

The first step in the analysis was the grouping of countries by their level of economic development. The diagram below shows a box plot of the GDP per capita for EU countries in 2021.

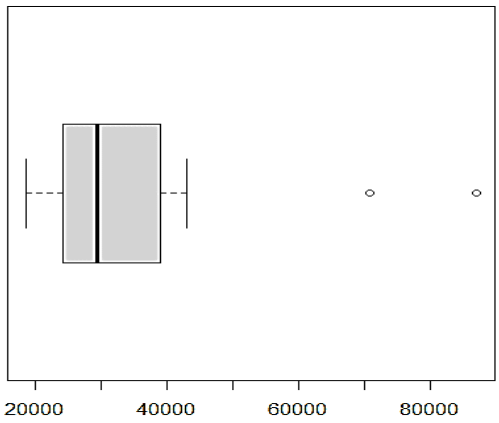

Figure 4. Boxplot of GDP per capita in the EU countries in 2021.

Source: Eurostat, Purchasing power adjusted GDP per capita, https://ec.europa.eu/eurostat/databrowser/view/SDG_10_10/default/table?lang=en&category=sdg.sdg_10.

Two anomalies are noticeable in Fig. 4 concerning Luxembourg and Ireland, whose GDP per capita varies significantly from the rest of the European countries. Since the ANOVA method is sensitive to outliers and based on its assumptions, these countries have been excluded from further analysis.

In the subsequent stage, the EU countries were categorized into two clusters by using the k-means analytical technique. The findings of the analysis are presented below. This method allows for grouping countries into two clusters, with the data in one cluster having a maximum level of similarity and data between clusters having a minimum similarity (Bishop, 1995; Duda, Hart, 1973).

Table 4.
Groups of countries according to GDP per capita

Group	Country	X1	Y
First group Reacher countries	Belgium	39000	13.014
	Denmark	43000	34.715
	Germany	39000	19.168
	France	33800	19.342
	Malta	32400	12.154
	Netherlands	42100	13.003
	Austria	39800	36.445
	Finland	36400	43.096
	Sweden	39800	62.573

Cont. table 4.

	Bulgaria	18600	17.015
	Czechia	29700	17.667
	Estonia	28800	38.010
	Greece	20700	21.928
	Spain	27000	20.729
	Croatia	22600	31.329
	Italy	30900	19.034
Second group Poorer countries	Cyprus	29400	18.419
	Latvia	23300	42.107
	Lithuania	29000	28.230
	Hungary	24300	14.115
	Poland	25000	15.624
	Portugal	24300	33.982
	Romania	23900	23.596
	Slovenia	29200	25.000
	Slovakia	22500	17.412
Outliers	Luxemburg	87100	11.735
	Ireland	70900	12.546

Sources: Eurostat, Share of renewable energy in gross final energy consumption by sector, https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en; Eurostat, Purchasing power adjusted GDP per capita, https://ec.europa.eu/eurostat/databrowser/view/SDG_10_10/default/table?lang=en&category=sdg.sdg_10

The group of wealthier nations comprises 9 countries that are highly developed. Conversely, the group of less affluent countries comprises 16 nations. Simple statistics were examined for each distinct group regarding the share of renewable energy in gross final energy consumption. The findings of the study are outlined below.

Table 5

Share of renewable energy in gross final energy consumption by sector by groups of countries

Group	n	Mean	Sd	Median	Min	Max	skew	kurtosis
First	9	28.17	17.29	19.34	12.15	62.57	0.7	-0.96
Second	16	24.01	8.44	21.33	14.12	42.11	0.76	-0.77

Sources: Eurostat, Share of renewable energy in gross final energy consumption by sector, https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en; Eurostat, Purchasing power adjusted GDP per capita, https://ec.europa.eu/eurostat/databrowser/view/SDG_10_10/default/table?lang=en&category=sdg.sdg_10

The averages between the groups exhibit differences, with the group of wealthier countries presenting a comparatively higher share of renewable energy by 4%. However, the averages across both groups are substantially low and do not suffice the target of 45% renewable energy proportion in gross final energy consumption by 2030 and 55% by 2050. Kurtosis and skewness present no objections, whilst the standard deviation value of the wealthier group is twice that of the poorer group and may hint at the lack of intergroup differentiation. It is worth noting that in the first group of more affluent countries, a smaller minimum of renewable energy within their gross final energy consumption can be observed. Luxembourg, Malta, Belgium, Netherlands, and Ireland possess the lowest percentage of renewable energy besides their high level of GDP per capita. However, Sweden is the undisputed EU leader with a remarkable 62.57% renewable energy share. Poorer nations, such as Estonia, Latvia, and Portugal, also exhibit positive outcomes.

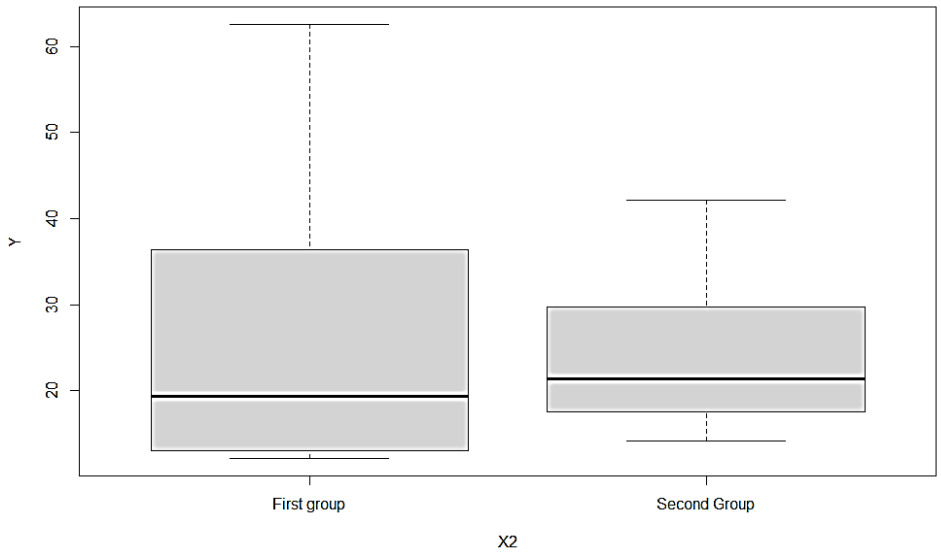

Figure 5. Renewable energy share in the total final energy consumption by group of countries.

Source: Eurostat, Purchasing power adjusted GDP per capita, https://ec.europa.eu/eurostat/databrowser/view/SDG_10_10/default/table?lang=en&category=sdg.sdg_10

In order to perform an ANOVA test, it is necessary to check the assumptions of normal distribution and homogeneity of variance. Tab 6 shows the results of conditions for ANOVA analysis.

Table 6
The assumption for the ANOVA test

Normality test p-value>0.05	**Shapiro-Wilk**	**Lilliefors (Kolmogorov-Smirnov)**	**Anderson-Darling**
First group	0.1155	0.1057	0.1387
Second group	0.07746	0.334	0.007888
Homogeneity of variance	Bartlett test for homogeneity of variances	Levene's Test for Homogeneity of Variance (centre = median: median)	Levene's Test for Homogeneity of Variance (centre = median: mean)
p-value>0.05	0.01943	0.1283	0.1283

Source: Eurostat, Share of renewable energy in gross final energy consumption by sector, https://ec.europa.eu/eurostat/databrowser/view/SDG_07_40/default/table?lang=en; Eurostat, Purchasing power adjusted GDP per capita, https://ec.europa.eu/eurostat/databrowser/view/SDG_10_10/default/table?lang=en&category=sdg.sdg_10

The analysed data are normally distributed both in the first group (p-value > 0.05) and the second one (p-value > 0.05). Bartlett's test negatively indicated the lack of homogeneity of variance (p-value = 0.01943), while two other tests: the Leven test for the median (p-value = 0.0959) and the Leven test for the mean (p-value = 0.0959) responded positively to the conditions of the ANOVA analysis. Hypothesis H0 of ANOVA was confirmed (p-value = 0.424). This means that there is no variation in the share of renewable energy in gross final energy consumption due to GDP per capita. The above analysis shows that the economic factor does not play a significant role in the development of the renewable energy industry.

5. Conclusions

The development of the renewable energy market in EU countries is driven by a commitment to combat climate change, reduce greenhouse gas emissions, and create a more sustainable energy system. The article has demonstrated that renewable energy capacity has been increasing over the years. Member states have invested in renewable energy infrastructure, resulting in a diversified energy mix. Thanks to the development of the renewable energy market, it has been possible to reduce greenhouse gas emission. Renewable energy sources have played a crucial role in reducing greenhouse gas emissions in the EU. Consequently, by relying less on imported fossil fuels, the EU could improve its energy security and reduced exposure to price volatility in global energy markets.

The effectiveness of developing renewable energy in the EU has been a subject of significant attention and debate. This article aimed to verify two hypotheses concerning the factors that influence the renewable energy market's development.

The first hypothesis, regarding the significance of the political factor, was successfully confirmed. The analysis conducted revealed that EU countries vary in their implementation of the EU renewable energy objectives. Therefore, their political targets diverge from those set at the EU level. It is noteworthy that the 2009 political declaration did not specify the same level of effort required from countries, as compared to the 2022 targets. Nations that were part of the first group and accepted the EU's renewable energy market challenge have an easier task at hand as compared to those who failed to achieve the 20% level by 2020. With the exception of France, most of the countries were able to meet the declared targets, but they were below the EU target. However, the current target has been set much higher, making it challenging for political opportunists to meet the EU's targets in the years ahead. Supplementary policy measures are necessary to facilitate the shift from conventional systems to sustainable energy sources.

The second hypothesis regarding the significance of the economic factor has been dismissed. Unless marked as such, subjective evaluations must be excluded. It was not confirmed that the degree of economic development has an impact on the growth of the renewable energy sector. Therefore, even countries with a lower level of development can benefit from investing in renewable energy. The Baltic States serve as a fascinating illustration in this regard. Lithuania, Latvia, and Estonia are considered to be among the poorer countries, but they have successfully reformed their energy markets based on renewable resources. It is essential to note that not only the economic aspect is crucial in this case. Their security in becoming independent of Russia appears to be more significant. Therefore, by investing in renewable energy sources, they can attain energy security.

The suggestion to enhance political measures supporting renewable energy in nations without a 20% renewable energy target is crucial. Economic factors should not serve as a rationale for authorities shirking their responsibility towards an eco-friendly transition. Therefore, it is vital for the general public to comprehend that political leaders lack justifications to impede progress in this domain.

Despite the successes achieved so far in developing the renewable energy market, it is important to bear in mind the challenges facing the EU in this area, such as:

1. Intermittency and Grid Integration: The intermittent nature of some renewable sources, such as solar and wind, poses challenges for grid stability and reliability. Energy storage and grid upgrades are necessary to manage this intermittency effectively. Advances in renewable energy technologies, including improved energy storage solutions and grid management, could address some of the challenges associated with intermittency.
2. Investment Barriers: Despite progress, some EU countries still face barriers to investment in renewable energy, such as regulatory hurdles, financing challenges, and uncertain policy frameworks. Increased investment from public and private sectors, as well as access to funding mechanisms like the European Green Deal's Just Transition Fund, can accelerate renewable energy development.
3. Technological Advancements: Maintaining a competitive edge in renewable technology development requires continuous innovation and research, which can be resource-intensive.
4. Political and Economic Variances: EU member states vary in their commitment to renewable energy, often influenced by political and economic factors. This can hinder harmonized efforts toward sustainable energy goals.
5. Policy Harmonization: Closer policy alignment among member states, particularly in areas such as energy subsidies and market regulations, could facilitate the transition to renewables. Collaboration with neighbouring regions and international partners can facilitate the import/export of renewable energy, further increasing energy security and supporting the growth of renewables.

In conclusion, the effectiveness of developing renewable energy in the EU has shown significant progress in reducing emissions, creating jobs, and increasing energy security. However, challenges related to intermittency, investment barriers, and policy differences among member states persist. The EU’s commitment to the European Green Deal and ongoing technological advancements offers promising avenues for furthering the development of renewable energy in the region.

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