Econometric analysis of the influence of factors on the share of energy from renewable sources in the EU

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Abstract **-** The use of renewable energy is at the core of EU energy policy, reducing dependence on fossil fuels imported from non-EU countries, reducing greenhouse gas emissions and decoupling energy costs from oil prices. Currently, 22.5% of energy consumed in the EU comes from renewable sources. This increase over 2021 is due to strong growth in solar energy. This share is also increasing due to the consumption of non-renewable energy sources in 2022. According to expert forecasts, the share of renewable energy sources in Europe will continue to grow. Achieving the 42.5% target by 2030 will require a deep transformation of the European energy system.
The very strong climate and energy policies pursued in the EU for about a dozen years and aimed at limiting emissions of harmful substances into the environment have led to a gradual abandonment of traditional energy sources. Increasing demand for energy while reducing its supply from traditional sources means that in order not to make the economy too dependent on energy imports, the dynamic development of renewable energy is necessary. The EU is therefore taking very extensive operational and strategic actions to use other sources for production, such as wind, solar energy, mechanical water energy, biomass and geothermal energy, as well as tidal waves, ocean heat, wave energy and sea currents.
In this study, we assess the impact of energy, economic and environmental factors on the share of renewable energy in the EU. The aim of these studies was to identify the energy, economic and environmental indicators that have the greatest impact on the share of energy from renewable sources in the European Union. The study was conducted using the Statgraphics Centurion software package. The source data for the study was data from the official Eurostat website for the period from 2012 to 2022. The results of this study show that changes in gross domestic product in market prices per capita have a positive impact, as do changes in greenhouse gas emissions per capita negatively affect the share of energy from renewable sources in the EU in the period 2012-2022. This may most likely be due to the fact that EU countries are more likely to invest in renewable energy as they can afford to invest in the development of expensive renewable energy technologies and support subsidies for the promotion and regulation of renewable energy. The negative impact of per capita greenhouse gas emissions on renewable energy development is due to the high share of coal in the EU energy mix, meaning that coal not only has negative environmental impacts, but also negative environmental impacts. development of renewable energy.

Key-Words **-** European Union; renewable energy; greenhouse gas emissions; gross domestic product; correlation; regression

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1 Introduction

Currently, the European Union imports up to 60% of its energy, which costs more than 350 billion euros. To solve the problem of ensuring energy security and reducing the dependence of the European energy market on energy imports, especially from the Russian Federation, the EU Energy Union was created. In January 2015, priority areas of its activity were outlined: creation of an integrated energy market, decarbonization of the economy, security of energy supply, increasing energy efficiency, development of scientific research and innovation. And although in 2019, with a change in the leadership of the European Commission, the post of European Commissioner for the Energy Union ceased to exist, energy security problems were not removed from the agenda, but were combined with climate change problems.

It is predicted that by 2030, the generation of electricity from renewable sources will be 46 - 50%, which may aggravate the problem of uncontrolled production, since with the current level of technology development, the existence of a parallel traditional energy supply system is necessary. Currently, renewable energy receives government subsidies and priority access to the electrical grid, thereby crowding out other sources, which, due to insufficient load, reduces the efficiency of nuclear and fossil fuel power plants. Energy transmission systems also suffer from uneven generation and power surges. Thus, the most pressing issue is balancing generation, energy storage and rapidly changing demand. In addition to those mentioned above, the following disadvantages of renewable energy can be noted: high level of capital costs, low efficiency, dependence on climatic conditions, inability to recycle wind generator blades and photovoltaic panels. It is important that the production of components of generating plants requires a large amount of metals, the main producer of which is currently China, and in order to reduce dependence on China it is necessary to have alternative sources of raw materials.

In addition, not all EU member states have reached a consensus on what types of energy generation are considered “green”, what production methods they are willing to abandon, and cross-border regulatory schemes have not been worked out everywhere.

For example, Germany plans to completely abandon nuclear energy by 2023, Austria and Luxembourg are also against nuclear energy, and France, Finland and the Czech Republic are not ready to give it up.

In this regard, of great interest is the “Additional climate change law aimed at accelerating decarbonization” published by the European Commission on February 2, 2022, according to which, subject to certain conditions, projects in the field of gas and nuclear energy are recognized as environmentally friendly and included to the EU Taxonomy, which is a list of environmentally sustainable economic activities that need priority investment to achieve climate neutrality by 2050.

The Commission's proposal also seeks to clarify metering and billing rules for consumers. Shadow negotiations began in February 2018 and led to a partial agreement between EU institutions on 19 June 2018. The final text was approved by the Parliament (13 November 2018) and the Council (4 December 2018). It was published in the Official Gazette on December 21, 2018 and came into force three days later. Although measurement and payment requirements can be implemented by 25 October 2020 [1, 2], Member States must comply with the revised guidelines by 25 June 2020.

Since the introduction of the 27% target in 2014, many changes have taken place in the energy sector. Key renewable energy technologies such as solar PV and offshore wind have achieved significant cost reductions beyond expectations given their speed and scale. As these technologies develop, so will low-cost renewable energy.

Technological development in end-use sectors has also increased rapidly; Electric vehicles, for example, are achieving rapid sales growth and could play a key role in providing a large proportion of renewable energy in the EU's driving and electricity categories by 2030. At the same time, new information and communication technologies are changing the way we create and consume energy. Due to this positive development, the 27% increase target agreed in 2014 can be considered as the EU target [3].

In 2015, the share of renewable energy in EU member states varied from 5% to 54%. Diversity will remain until 2030, reflecting many factors such as different starting points, current capacities, existing and planned policies and market conditions for renewable energy in each country; However, this gap may narrow by 2030 as member countries with lower shares can grow faster. By 2030 the total share of renewable energy likely to result from Member States' plans and estimates will not reach the EU's 27% target; Therefore, further commitments from Member States are required to meet or exceed the 2030 target. In 2050, renewable energy will be the main additional energy source, accounting for two-thirds of the energy mix. This would require an increase in renewable energy stocks of around 1.2% per year, a sevenfold increase over recent years. If the world increases its share of renewable energy by 2030, the European Union (EU) will account for 14% of the world's renewable energy and become the third largest consumer of renewable energy after China and the United States. [3]

2 Review of literature

Studies on the influence of certain factors of the development of renewable energy sources usually analyze the period since 1990 and consider different groups of countries. Marques et al. [4], Marques and Fuinhas [5], Cadoret and Padovano [6], Lucas et al. [7] and Papiez et al. [8] evaluated the impact of selected factors on the development of renewable energy in EU countries. Studies by Popp et al. [9]; Polzin et al. [10] and Biresselioglu et al. [11] analyzed European and non-European countries belonging to the OECD. Aguirre and Ibikunle [12] explore the EU and OCED countries along with five BRICS countries, while Kilinc-Ata's [13] study also includes 50 US states.

Most studies use panel data to conduct an econometric analysis of factors that influence the development of renewable energy sources. Their authors use the following methods for analyzing panel data, such as: fixed effects with vector decomposition estimator (FEVD) [4,12], the panel corrected standard error (PCSE) estimator (PCSE) [6,10,12,14], the Feasible Generalized Least Squares (FGLS) estimator [9] or the estimate of dummy variables with least squares (LSDV) [5, 6]. Marques and Fuinhas [5] apply panel dynamic evaluations such as GMM-dif and GMM-sys. In his work, Biresselioglu et al. [11] similarly uses the system for estimating the generalized method of moments (GMM). Marques et al. [15] apply the quantile method to study the factors contributing to the development of renewable energy in European countries, while Menz and Vachon [23] use the least squares method to study the development of wind power.

In most studies that analyze the influence of various factors on the development of renewable energy, the share of renewable energy in the total primary energy supply (TPES) is used as the dependent variable [4,5,7,12,14,15]. Dependent variables used by other authors include: the share of renewable electricity in the total supply of electricity from non-water renewable sources [13], the number of installed wind power generators [11] or the total newly introduced capacity indicating the country and year in a particular type of renewable energy sources (solar energy, wind, biomass) [10].

Many studies show different factors influencing the development of RES. Marquez and his friends. [4,15], Marques and Fuenhas [5,9], and Aguirre and Ebikunli [12] consider three important aspects of this development. The first group includes political factors such as a complete reform to identify EU countries, unusual ways of ratifying the Kyoto agreement, government policies that help improve energy efficiency, research and development programs, financial incentives and taxes. The second group includes social and economic factors such as oil, gas and coal prices, carbon dioxide (CO2) emissions (carbon footprints per capita), coal, oil, natural gas and nuclear energy. Production, energy expenditure, income (GDP or GDP growth), energy consumption and primary energy. The third group dealing with renewable energy potential includes national factors such as renewable energy contribution, electricity market regulation and renewable energy potential (calculation of biomass, as well as solar/wind/hydropower). Lucas et al. [7] distinguish three indicators and groups according to their relevance to each aspect of energy policy: environmental sustainability (signing the Kyoto Protocol, energy intensity, emission levels), supply dependence (total dependence on energy supply, degree of diversity for energy sources and various type of electricity generation) and competition (coal, gas and oil prices, GDP per capita). Polzin et al. [10], Bircelioglu et al. [11] and Kilink-Ata [13] consider economic, energy security, environmental and energy market data as dynamic factors and investigate their effects on energy efficiency. Cadoret and Padovano [6] analyze the political aspects of the development of renewable energy sources. It divides variables into three categories: political economy, economy, energy and environment. Political units are also used by Marques and Fuenhas [5], Polzin et al. [10], Aguirre and Ibikunle [12], Nesta et al. [17] and Zhao et al. [18]. Pope and others. [9] and Johnston et al. [19] estimate technological progress as measured by the number of patents per technology in investment in renewable energy. Their variables are the share of energy exports from total electricity and per capita production of coal, natural gas, and oil.

Marquez and his friends [4, 15], Marques and Fuenhas [5, 9] and Lucas et al. [7] argue that as CO_2 emissions increase, renewable energy consumption decreases, and therefore environmental pollution does not play a large enough role in encouraging renewable energy development. In contrast to previous work, Cadoret and Padovano [6], together with Aguirre and Ebikunli [12] confirm a positive relationship between CO_2 emissions and energy production.

Marquez and his friends. [4, 15], Marques and Fuenhas [5, 9] and Lucas et al. [7] found that per capita energy consumption has a significant effect on energy production from renewable energy sources at home. Aguirre and Ebikunli [12] show that energy consumption is negatively correlated with renewable energy contribution, meaning that countries use more renewables and more fossil fuels because these are cheaper.

Marquez and his friends. [4, 15], Marques and Fuenhas [5, 9] also believe that increasing fuel efficiency will reduce renewable energy consumption. As observed by Sovakul [20], the effect inhibits RES development.

The impact of GDP on renewable energy generation is not perfect. Articles examining the relationship between RES use and economic growth (for European countries: [8, 20–23], for OECD countries: [24–27]) consider different perspectives (conservation, feedback, growth and moderation). By analyzing the impact of different factors on renewable energy development in all EU countries, Marques et al. [4] Income growth appears to support renewable energy investment, but find a different relationship with non-EU countries in the 2000s.

Similarly, Marques et al. [15], Cadoret and Padovano [6] and Lucas et al. [7] argue that per capita income has a negative effect on RES development.

Marquez and his friends. [4, 15], and Cadoret and Padovano [6] prove that external energy dependence has a positive effect on renewable energy development, but Marques and Fuenhas [5, 14] and Lucas et al. [7] show that excessive dependence on energy imports inhibits the installation of renewable energy sources. This dependence is mainly associated with traditional energy sources, and the production processes in the analyzed countries show that they depend on petroleum resources, which is a major obstacle to the development of renewable energy.

Finally, many authors [4-7, 14, 15, 20, 28, 29] confirm that growth decreases with the increasing contribution of natural energy sources (coal, oil, natural gas and nuclear power) to electricity generation. . From renewable energy. In their opinion, this is the presence of the industrial influence that prevents the development of renewable energy sources.

3 Material and methods

In this study, we assess the impact of energy, economic and environmental factors on the share of renewable energy in the EU.

Energy consumption has traditionally been used as an indicator of development. It is also used to identify the country's energy needs. Large consumption needs put strong pressure on energy consumption. Energy consumption can be met by traditional energy sources, clean sources, and using a combination of traditional and clean sources. In this case, the factor of influence on renewable energy is the energy consumption per capita.

High energy dependence on energy imports has an impact on the development of RES, but also high energy dependence on imports impedes the introduction of RES. This dependence is mainly associated with traditional energy sources, which is a sign that the production infrastructure in the EU countries depends on fossil energy sources, which is a significant obstacle to the development of renewable energy sources.

In this case, the factors influencing the development of renewable energy are import dependence on traditional energy sources (coal, oil, natural gas).

The economic factors selected in this study is the prices of conventional forms of energy, such as natural gas, oil, coal, and GDP per capita.

Climate change is associated with emissions of large amounts of greenhouse gases such as carbon dioxide (hereinafter CO_2), chlorofluorocarbons, methane, nitric acid and ozone. This phenomenon is called the greenhouse effect, which is caused by these gases. When this effect is not controlled, it leads to a significant and continuous increase in the average temperature of the planet. The most common factor responsible for these climate changes is CO_2. We suggest that environmental concerns are an incentive for the widespread use of RES instead of traditional energy sources. We chose per capita CO_2 emissions as a factor, expecting more CO_2 to mean a greater incentive to develop RES.

The purpose of these studies was to identify the factors that have the greatest impact on the share of renewable energy in the European Union. The study was conducted using the Statgraphics Centurion software package. The initial data for the study were data from the official Eurostat website for the period from 2012 to 2022 [30].

As a method of econometric modeling, we chose correlation and regression analysis, which allows you to choose from the whole set of factors considered the most significant.

This study examined the influence of factors on the share of renewable energy in the European Union from 2012 to 2022. When analyzing the influence of independent variables on the dependent variable (the share of energy from renewable sources), multivariate regression analysis was used.

Share of energy from renewable sources (%) was taken as the dependent indicator (Y).

The independent variable factors (X) were as follows:

X_1 - Gross inland energy consumption per capita, toe per capita;
X_2 - Import dependency of Solid fossil fuels, %;
X_3 - Import dependency of Natural gas, %;
X_4 - Import dependency of Crude oil, %;
X_5 - Greenhouse gas emissions per capita, tonnes of CO_2 equivalent per capita;
X_6 - Crude oil prices, US dollars per barrel;
X_7 - Natural Gas Prices, US dollars per million Btu;
X_8 - Coal Prices, US dollars per tonne;
X_9 - Gross domestic product at market prices, Current prices, euro per capita.

Table 1 summarizes the statistics for each of the selected variables. It also includes summary statistics for descriptive variables, including sample mean, standard deviation, skewness, and kurtosis.

Of particular interest here are the standard deviation and the normal kurtosis, which can be used to determine whether a sample comes from a normal distribution.

Values of this statistic from −2 to +2 typically indicate large deviations, which can interfere with most statistical methods applied to these data.
In this study the X_8 curve shows the standard deviation and the average kurtosis lies outside this.
Table 1 presents a summary statistics for each of the selected data variables. It includes a summary of descriptive statistics of the variables, which include sample mean, standard deviation, skewness and kurtosis.
Of particular interest here are the standardized skewness and standardized kurtosis, which can be used to determine whether the sample comes from a normal distribution.
Values of these statistics outside the range of -2 to +2 indicate significant departures from normality, which would tend to invalidate many of the statistical procedures normally applied to this data.
In this study X_8 variable show the standardized skewness and standardized kurtosis are out of this range.

4 Results and discussion

Multicollinearity is a statistical term for the existence of a high order linear correlation amongst two or more explanatory variables in a regression model. In any practical context, the regression model.

Table 1. Summary Statistics

	Y	X_1	X_2	X_3	X_4	X_5	X_6
Average	13,27	3,44	42,65	64,15	85,82	9,66	85,15
Standard deviation	3,08	0,20	2,31	5,52	2,62	0,85	27,80
Coeff. of variation	23,22%	5,73%	5,41%	8,61%	3,06%	8,82%	32,65%
Minimum	8,53	3,18	38,92	53,64	80,87	8,6	45,76
Maximum	17,52	3,72	46,90	74,32	88,79	10,9	124,2
Range	8,99	0,54	7,98	20,68	7,92	2,3	78,44
Stnd. skewness	-0,21	0,31	0,26	-0,17	-0,64	0,41	0,09
Stnd. kurtosis	-1,06	-1,15	-0,38	-0,08	-0,81	-1,12	-1,14

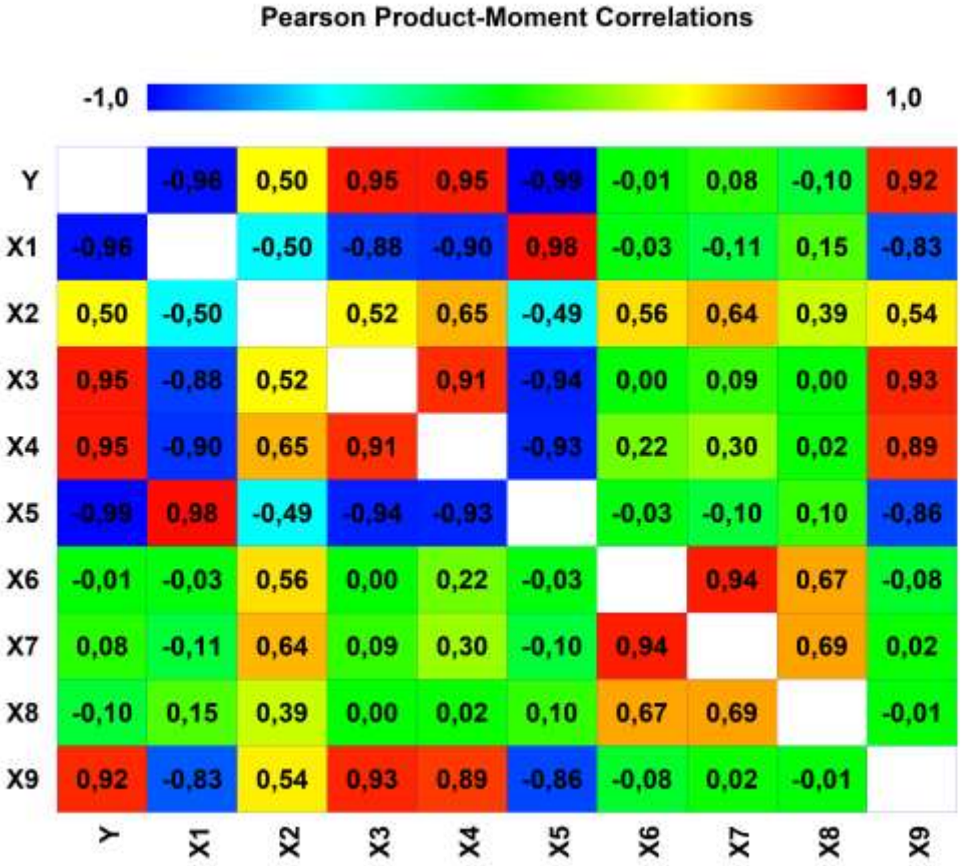
	X_7	X_8	X_9
Average	8,05	83,48	26314,3
Standard deviation	2,35	25,25	2177,1
Coeff. of variation	29,20%	30,25%	8,27%
Minimum	4,3	56,64	22500
Maximum	11,6	147,67	30000
Range	7,3	91,03	7500
Stnd. skewness	-0,07	2,26	0,10
Stnd. kurtosis	-0,88	1,75	-0,36

In any practical context, the correlation between explanatory variables will be non-zero, although this will generally be relatively benign in the sense that a small degree of association between explanatory variables will almost always occur but will not cause too much loss of precision.
The presence of multicollinearity usually results in an overstatement of the standard error, i.e. the standard error tends to be large, leading to small “t” value and a high coefficient of determination. The usual procedure when multicollinearity exists is to drop the offending variable or alternatively to drop the variable that provides lesser contribution towards model improvements. A simple procedure to determine which variable to drop is to calculate the correlation matrix. The correlation matrix on Fig. 1 represents the correlation coefficients for the variables used in this study.

This correlation matrix shows Pearson product moment correlations between each pair of variables. These correlation coefficients range between -1 and +1 and measure the strength of the linear relationship between the variables. P-values above 0,05 indicate statistically insignificant non-zero correlations at the 95,0% confidence level.

Factors X_2, X_6, X_7 and X_8 are insignificant because they have a low correlation with the dependent variable Y and have P-values above 0,05 indicate statistically insignificant non-zero correlations at the 95,0% confidence level.

When considering this matrix in order to identify multicollinear factors, they are guided by the following rule: if the correlation matrix of factor variables contains pair correlation coefficients in magnitude greater than 0.8, then it is concluded that in this model of multiple regression there is multicollinearity.



	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9
Y		-0,96	0,50	0,95	0,95	-0,99	-0,01	0,08	-0,10	0,92
X1	-0,96		-0,50	-0,88	-0,90	0,98	-0,03	-0,11	0,15	-0,83
X2	0,50	-0,50		0,52	0,65	-0,49	0,56	0,64	0,39	0,54
X3	0,95	-0,88	0,52		0,91	-0,94	0,00	0,09	0,00	0,93
X4	0,95	-0,90	0,65	0,91		-0,93	0,22	0,30	0,02	0,89
X5	-0,99	0,98	-0,49	-0,94	-0,93		-0,03	-0,10	0,10	-0,86
X6	-0,01	-0,03	0,56	0,00	0,22	-0,03		0,94	0,67	-0,08
X7	0,08	-0,11	0,64	0,09	0,30	-0,10	0,94		0,69	0,02
X8	-0,10	0,15	0,39	0,00	0,02	0,10	0,67	0,69		-0,01
X9	0,92	-0,83	0,54	0,93	0,89	-0,86	-0,08	0,02	-0,01	

Fig 1. Correlation matrix

When considering this matrix in order to identify multicollinear factors, they are guided by the following rule: if the correlation matrix of factor variables contains pair correlation coefficients in magnitude greater than 0.8, then it is concluded that in this model of multiple regression there is multicollinearity.

If there is multicollinearity for its elimination or reduction, there are a number of methods, in particular step-by-step procedures for selecting the most informative variables.

The most important task in the construction of multiple linear regression is the correct selection of factors included in this equation. In solving this problem, the following schemes have gained the most widespread use: the method of Forward Stepwise Selection and the method of Backward Stepwise Selection i.e. the elimination of factors from its full set.

Forward Stepwise Selection is performs a forward stepwise regression. Beginning with a model that includes only a constant, the procedure brings in variables one at a time provided that they will be statistically significant once added. Variables may also be removed at later steps if they are no longer statistically significant.

Backward Stepwise Selection is performs a backward stepwise regression. Beginning with a model that includes all variables, the procedure removes variables one at a time if they are not statistically significant. Removed variables may also be added to the model at later steps if they become statistically significant.

Fitting the model using the original data showed 3 insignificant variables. To remove them from the model, the analysis parameters can be used to perform the backward stepwise selection.

Backward selection begins with a model involving all the variables specified on the data input dialog box and removes one variable at a time based on its statistical significance in the current model. At each step, the algorithm removes from the model the variable that is the least statistically significant. Removal of variables is based on either a P-to-enter test. In the former case, if the least significant variable has an P-value large than 0,05, it will be removed from the model. When all remaining variables have less P-value, the procedure stops.

In first step the highest P-value on the independent variables is 0,26, belonging to X_4. Since the P-value is greater to 0,05, that term is not statistically significant at the 95,0% or higher confidence level. Consequently, X_4 must be removing from the model.

In the second step the highest P-value on the independent variables is 0,107, belonging to X_1. Since the P-value is greater to 0,05, that term is not statistically significant at the 95,0% or higher confidence level. Consequently, X_1 must be removing from the model.

In the third step the highest P-value on the independent variables is 0,084, belonging to X_3. Since the P-value is greater to 0,05, that term is not statistically significant at the 95,0% or higher confidence level. Consequently, X_3 must be removing from the model.

The algorithm then stops, as the highest P-value on the independent variables is 0,0002, belonging to X_9. Since the P-value is less than 0,05, that term is statistically significant at the 95,0% confidence level. Consequently, it is a final model.

Table 2 shows the results of fitting a multiple linear regression model to describe the relationship between Y and 7 independent variables.

Table 2. Estimation results of the dependent variable: Share of energy from renewable sources

Parameter	Estimate	Standard Error	T-Statistic	P-Value
CONSTANT	30,2887	3,3062	9,16112	0,0000
X_5	-2,76445	0,171756	-16,0952	0,0000
X_9	0,000367866	0,0000672072	5,47361	0,0002

Table 3 shows the statistical significance of each variable as it was added to the model. Since the P-value in the ANOVA table is less than 0,05, there is a statistically significant relationship between the variables at the 95,0% confidence level. The estimation result of the independent variables independent variables to the dependent variable is shown in Table 4.

Table 3. ANOVA for Variables in the Order Fitted

Source	Sum of quares	Df	Mean Square	F-Ratio	P-Value
X_5	120,456	1	120,456	1665,02	0,0000
X_9	2,16747	1	2,16747	29,96	0,0002
Model	122,623	2			

Table 4. Analysis of Variance

Source	*Sum of Squares*	*Df*	*Mean Square*	*F-Ratio*	*P-Value*
Model	122,623	2	61,3115	847,49	0,0000
Residual	0,795792	11	0,0723447		
Total (Corr.)	123,412	13			
R-squared = 99,3552 percent					
R-squared (adjusted for d.f.) = 99,238 percent					
Standard Error of Est. = 0,26897					
Mean absolute error = 0,177641					
Durbin-Watson statistic = 2,85997 (P=0,8943)					
Lag 1 residual autocorrelation = -0,436458					

Based on the estimation results presented in Table 1, the following equation was obtained:

$$Y = 30{,}2887 - 2{,}76445 \cdot X_5 + 0{,}000367866 \cdot X_9$$

The R-Squared statistic indicates that the model as fitted explains 99,355% of the variability in Y. The adjusted R-squared statistic, which is more suitable for comparing models with different numbers of independent variables, is 99,238%. The standard error of the estimate shows the standard deviation of the residuals to be 0,26897. The mean absolute error (MAE) of 0,177641 is the average value of the residuals. The Durbin-Watson (DW) statistic tests the residuals to determine if there is any significant correlation based on the order in which they occur in your data file.

Since the P-value is greater than 0,05, there is no indication of serial autocorrelation in the residuals at the 95,0% confidence level.

The result of the regression estimation showed that if greenhouse gas emissions per capita, increases by 1 tonne of CO_2 equivalent per capita, share of renewable energy sources will decrease by 2,76445 percent and if gross domestic product at market prices increases by 1 euro per capita, share of renewable energy sources will rise by 0,000367866 percent.

The direct correlation between the influence of gross domestic product at market prices per capita on the share of energy from renewable sources means that EU countries are more likely to invest in renewable energy sources, since they can afford to invest in the development of expensive renewable energy technologies and support subsidies for the promotion and regulation of renewable energy sources. The positive effect of gross domestic product at market prices per capita on the promotion of renewable energy has also been found by Marques et al. [4].

The greenhouse gas emissions per capita negatively affect the development of renewable energy. This is due to the high share of coal in the EU energy balance, which means that coal not only has a negative impact on the environment, but also has a negative impact on the development of renewable energy. This is a rather unexpected effect, as one would expect that an increase in greenhouse gas emissions per capita would be a powerful incentive for renewable energy investments. These results are consistent with those from studies conducted by Marques et al. [4], Marques and Fuinhas [5], Lucas et al. [7], Marques and Fuinhas [14] and Marques et al. [15].

5 Conclusions

The main objective of this study was to assess the impact of energy, economic and environmental factors on the share of renewable energy in the EU. The results of this study show that changes in gross domestic product in market prices per capita have a positive impact, as do changes in greenhouse gas emissions per capita negatively affect the share of energy from renewable sources in the EU in the period 2012-2022. This may most likely be due to the fact that EU countries are more likely to invest in renewable energy as they can afford to invest in the development of expensive renewable energy technologies and support subsidies for the promotion and regulation of renewable energy. The negative impact of per capita greenhouse gas emissions on renewable energy development is due to the high share of coal in the EU energy mix, meaning that coal not only has negative environmental impacts, but also negative environmental impacts development of renewable energy.

Large gross domestic product at market prices per capita allows EU countries to cover the costs of developing renewable energy technologies. The effect of greenhouse gas emissions per capita correlate with the decrease of share of renewable energy sources. The effect of greenhouse gas emissions per capita on renewable energy is statistically significant and negative.

This result suggests that current greenhouse gas emissions per capita levels are not enough to switch to renewable energy sources. On the contrary, these levels remain incentives for continued burning of fossil fuels. It turns out that social pressure in the EU was not enough to stimulate renewable energy.

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