Modelling of Prognosis for Bioenergy Production in Ukraine

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ABSTRACT
Promoting renewables, in particular bioenergy, is vital to move Ukraine towards a low-carbon economy. Decision-makers might turn to bioenergy projections for developing their policies or investments. This paper presents statistical calculations and economic-mathematical modeling of the state of the bioenergy sector in Ukraine. Using Spearman’s rank correlation coefficient, correlations between different factors influencing biofuel production were investigated. Modeling of the forecast of biofuel production was done with the use of a multiple regression equation, which provides for the creation of a standard linear model. It enables predicting future development of renewable energy and bioenergy, highlighting and choosing the most appropriate factors to be stimulated by the government in order to achieve the goals of renewable energy development and energy security as a result.

Keywords: Bioenergy, Renewables, Energy Security, Energy Strategy
JEL Classifications: Q42, Q38, O13, P28

1. INTRODUCTION
Due to the limited fossil energy sources, the necessity of energy security for Ukraine, sustainable biomass production is an obvious solution to a number of issues. Leading countries are actively developing bioenergy and other renewable energy resources, according to the 7th Sustainable Development Goal (“Ensure access to affordable, reliable, sustainable and modern energy for all”), by 2030 it is planned to significantly increase the share of energy from renewable sources in the world energy balance (United Nations General Assembly, 2015). SDG 7 is a strategic reference point for the development of the energy sector in the world.

A lot of research attempts to seek ways for implementing this goal, as well as to predict future development of renewable energy and bioenergy in particular (Salerno et al., 2017; Panukhnyk et al., 2021; Pruntuševa et al., 2021; Was et al., 2020; Yakubiv et al., 2019; Yakymchuk et al., 2021). Xingang and Pingkuo (2014) noted the fact that bioenergy is one of the most effective ways of achieving a country’s energy security. Matsumoto and Shiraki (2018) evaluated energy security performance in Japan under alternative scenarios of future socioeconomic and energy conditions by using three energy security indicators.

In order to find out which factors play the most important role in the bioenergy sector in Ukraine and what exactly should be stimulated, we conducted statistical calculations and economic-mathematical modeling.

The research aims to analyze the correlations between the production of bioenergy and different factors and to construct a model for forecasting bioenergy future production. It will help to highlight the factors to be stimulated by government in order to achieve the goals of renewable energy development and energy security as a result. To determine correlations between bioenergy production and selected factors, the following hypothesis was formulated: The level of bioenergy production is dependent on the certain factors of economic, energy, ecological sphere. Stimulating these factors by the government will boost the growth of the sector.
2. METHODS

2.1. Bioenergy Production: Basic Dimensions for Research

In order to study the dynamics and further forecast the potential of bioenergy production, we performed a correlation analysis of the main indicators that affect the sector. We included the following factors: biofuel and waste production, total primary energy supply, coal and peat production, coal and peat import and export, crude oil production and import, oil products import, natural gas production and import, nuclear energy production, hydroelectric power generation, production of wind and solar energy, share of natural gas imports. Also we took into account the official hryvnia exchange rate against the dollar, “feed-in” tariffs, the price of electricity and natural gas for the population, the price of natural gas for businesses, the price of Brent oil, subsidies for liquefied gas, solid and liquid household fuel, base tax on profit and the base rate of the Single Contribution for Compulsory State Social Insurance. All the mentioned factors affecting bioenergy production were calculated for the last 12 years.

Statistical analysis was performed using the Python 3.7.7 software environment and open source libraries (modules) for scientific calculations: numpy 1.18.1, pandas 1.0.3, statsmodels 0.11.0 and graphical display of the results: matplotlib 3.1.3, seaborn 0.10.1.

At the initial stage of the study, a correlation analysis was made, where the dependent variable (Y) is “Biofuel and waste production”, all other 25 variables are independent (X1, …, X25).

Due to the fact that the data set includes only 12 observations (in all variables one observation for each of the 12 years), the distribution of such data in the variables may deviate from normal. Therefore, in order to identify the relationships between the dependent and independent variable, we calculated the Spearman correlation coefficients (ρ).

The next stage of the study was to create a model for the indicator “Biofuel and waste production,” which is a dependent variable (Y), while all the other 25 variables are independent (X). To create the model, the method of multiple linear regression was used, which involved deriving an equation of the type:

\[ Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \ldots + a_nX_n, \]

Where \( a_0, a_1, a_2, \ldots, a_n \) - parameters of the multiple regression equation; \( X_1, X_2, X_3, \ldots, X_n \) - factor features.

3. RESULTS AND DISCUSSION

3.1. The Main Indicators of the Bioenergy Sector and Their Effects on the Bioenergy Production

3.1.1. Correlation analysis of indicators

Applying the Spearman rank correlation coefficient for the main indicators of the bioenergy sector of Ukraine, a positive correlation was found (\( \rho = 0.752, P = 0.005 \)) between the indicators of biofuel production and the rate of the “feed-in” tariff (Figure 1). The “feed-in” tariff is one of the most effective mechanisms to stimulate the development of the biofuel market and, accordingly, significantly impacts its production.

Meanwhile, the rate of the “feed-in” tariff for electricity from biogas and biomass (0.12 Euro/kWh) is among the lowest in European countries (Figure 2). Therefore, we think that it should be increased for this type of energy.

The detected correlation between the biofuel production and the electricity price for population (\( \rho = 0.910, p = 0.00004 \)) and the natural gas price for companies (\( \rho = 0.867, p = 0.0002 \)) shows the presence of positive relationships: the growth of biofuel production is observed at the growth of prices for electricity and natural gas (Figure 3). It is also worth mentioning that the natural gas production is significantly affected by the price of Brent oil.

**Figure 1:** Scatter plot of biofuel production indicators and the “feed-in” tariff

![Scatter plot of biofuel production indicators and the “feed-in” tariff](image)

**Figure 2:** The rate of the “feed-in” tariff for electricity from biogas (a) and biomass (b) in some countries and in Ukraine, 2019

![The rate of the “feed-in” tariff for electricity from biogas (a) and biomass (b) in some countries and in Ukraine, 2019](image)
Gas prices for enterprises are set according to the cost of alternative fuel in some European countries (like France, Italy, Belgium). In Ukraine, natural gas prices have been unreasonably understated for a long time. The tariffs were increased under the Memorandum on Economic and Financial Policy signed on 27 February 2015. In general, the gas tariffs increase for all categories of consumers amounted on average to 285% (Markevych and Omelchenko, 2016).

Meanwhile, the weighted average tariff for electricity for the population in Ukraine amounts to UAH 1.03 per 1 kWh, and the same average tariff in the EU countries is € 0.20, which is almost 6 times higher. It is obvious that the increase of electricity tariffs is inevitable and will make biofuel use more cost-efficient.

The detected reverse correlation analysis between natural gas import (\( \rho = -0.811, P = 0.001 \)), natural gas import share (\( \rho = -0.757, P = 0.004 \)) and biofuel production indicators shows the trend of growing biofuel and waste production and falling import of fuel resources (Figure 4). Energy security of Ukraine is among the strategic priorities of the country. Meanwhile, it substantially depends on the reliability of natural gas supply. Reduction of blue-dyed fuel import dependence is among the most important tasks faced by the bioenergy sector.

Substantial direct correlation (\( \rho = 0.879, P = 0.00016 \)) was detected between biofuel production and dollar rate (Figure 5). The dependence is explained by the fact that the hryvnya rate against foreign currency generates the country’s expenditures on imported energy products, which are not enough to meet the economy’s needs.

There is a statistically significant relationship between the indicators of biofuel production and wind and solar energy production (\( \rho = 0.909, P = 0.00004 \)) (Figure 6). In particular, Figure 6 shows that there is a similar dynamics of growth in renewable energy parameters with the trend towards biofuel production growth. It can be caused by the relevance of transition to sustainable energy resources, efficient stimulating measures, and the demand for them.
Figure 6: Scatter plot of the indicators of biofuel production, thous. toe and wind and solar energy production, thous. toe

Meanwhile, Figure 7 shows that the total capacity of RES facilities mainly consists of solar and wind energy that are rapidly evolving. Considering the available biofuel capacity, a similar development can be expected in the sector if the necessary stimulating mechanisms are elaborated and implemented.

All the results of calculations are given in Table 1. As $P > 0.05$ for coal and peat exports, natural gas production, nuclear energy production, Brent oil price and the base rate of the Single Contribution rate, the obtained correlations are not statistically significant and were not taken into account.

### 3.1.2. Bioenergy production model

For the application of the second research method, the data for analysis were taken for the 2005-2018 period. It included 14 observations. Yet, considering the fact that the rate of produced bioenergy has been growing considerably since 2006, we assume that the rate of the parameter in 2005-2006 could have been caused by the trends of emerging sector or inefficient statistical data collection in the 1st years of the rates recording by the state. Therefore, the rates for 2005-2006 could have been caused by different trends than in the following period, so they can affect the accuracy of the prognosis in the model constructed based on more recent data. Hence, observations for 2005-2006 were excluded from the analysis.

Therefore, the statistical data for analysis was taken for the 2007-2018 period, so the model includes 12 observations. The absent statistics (NaN) in certain variables were replaced by average rates of the respective variable.

It is obvious that there are interdependent parameters among 25 factors impacting the industry development. Due to the multicollinearity problem, the regression models can turn out to be unsuitable for quality economic and reliable prognosis. Therefore, we calculated the univariate (simple) regression models for each variable with subsequent inclusion of other models with the largest $R^2$ until $R^2$ grows in the multiple model and predictor variables have the statistically significant $p$-value. First, the $R^2$ coefficients were calculated for a simple linear regression alternatively for all predictor variables (Table 2). The received $R^2$ were ranged in ascending order and the model with the highest $R^2$ was selected.

| Parameters | Spearman coefficient ($\rho$) | Sig. (2-tailed) $P$ |
|------------|-------------------------------|---------------------|
| Biofuel and waste production | 1.000 | - |
| Total primary energy supply | $-0.755^{**}$ | 0.005 |
| Total production | $-0.643^*$ | 0.024 |
| Coal and peat production | $-0.643^*$ | 0.024 |
| Coal and peat import | 0.916** | 0.00002 |
| Coal and peat export | $-0.545$ | 0.067 |
| Crude oil production | $-0.874^{**}$ | 0.0002 |
| Crude oil import | $-0.741^{**}$ | 0.006 |
| Oil products import | 0.846** | 0.001 |
| Natural gas production | $-0.161$ | 0.618 |
| Natural gas import | $-0.811^{**}$ | 0.001 |
| Nuclear energy production | $-0.420$ | 0.175 |
| Hydroelectricity production | $-0.594^*$ | 0.042 |
| Wind and solar energy production | 0.909** | 0.00004 |
| Share of natural gas import | $-0.757^{**}$ | 0.004 |
| Official hryvnya rate against dollar “Feed-in” tariff | 0.879** | 0.00016 |
| Electricity price for the population | 0.752** | 0.005 |
| Natural gas price for the population | 0.910** | 0.00004 |
| Electricity price for enterprises | 0.809** | 0.001 |
| Brent oil price (annual average) | 0.867** | 0.0002 |
| Subsidies, number of households | $-0.3986$ | 0.1993 |
| Subsidies, mln UAH | 0.594* | 0.042 |
| Basic income tax rate | 0.811** | 0.0013 |
| Basic single contribution rate | $-0.894^{**}$ | 0.00008 |

Source: The authors’ calculations

| Variables | Factors influencing the development of the bioenergy sector | Coefficient of determination $R^2$ |
|-----------|--------------------------------------------------------|-------------------------------|
| $X_1$ | Natural gas production | 0.00987 |
| $X_2$ | Hydroelectricity production | 0.295975 |
| $X_3$ | Nuclear energy production | 0.314746 |
| $X_4$ | Brent oil price (annual average) | 0.323167 |
| $X_5$ | Crude oil import | 0.46566 |
| $X_6$ | Coal and peat export | 0.598383 |
| $X_7$ | Basic single contribution rate, % | 0.608156 |
| $X_8$ | Share of natural gas import, % | 0.658817 |
| $X_9$ | Basic income tax rate, % | 0.669047 |
| $X_{10}$ | “Feed-in” tariff, € | 0.673243 |
| $X_{11}$ | Import of oil products | 0.702043 |
| $X_{12}$ | Subsidies (number of households) | 0.708585 |
| $X_{13}$ | Coal and peat import | 0.734971 |
| $X_{14}$ | Natural gas import | 0.779457 |
| $X_{15}$ | “Feed-in” tariff, UAH | 0.779602 |
| $X_{16}$ | Total primary energy supply | 0.781226 |
| $X_{17}$ | Crude oil production | 0.781627 |
| $X_{18}$ | Total production | 0.81273 |
| $X_{19}$ | Production of coal and peat | 0.817794 |
| $X_{20}$ | Production of wind and solar energy | 0.821504 |
| $X_{21}$ | Natural gas price for the population | 0.838954 |
| $X_{22}$ | Subsidies (total) | 0.839493 |
| $X_{23}$ | Electricity price for the population | 0.924996 |
| $X_{24}$ | Official hryvnya rate against dollar | 0.936332 |
| $X_{25}$ | Natural gas price for enterprises | 0.940015 |

Source: The authors’ calculations
In this case, the model looks like:

\[ Y = a_0 + a_1 X_1, \]

Where \( X_1 \) - predicative changes from Table 2.

Next, \( R^2 \) was calculated for models with two variables, one of which is “Natural gas price for enterprises,” as this variable received the best indicator in the calculation of single models (Table 3). The model looks like:

\[ Y = a_0 + a_1 X_1 + a_2 X_2 \]

Where \( X_1 \) - variable “Natural gas price for enterprises”
\( X_2 \) - predicative variables from Table 3.

Next, a variable was selected and included in the model, which when included in the multiple regression model together with the above selected variables, determines the largest \( R^2 \).

The model looked like:

\[ Y = a_0 + a_1 X_1 + a_2 X_2 + a_3 X_3 \]

Where \( X_3 \) - variable “Natural gas price for enterprises”
\( X_1 \) - variable “Basic single contribution rate”
\( X_2 \) - predicative variables from Table 4.

Next, a variable was selected and included in the model, which stipulates the largest \( R^2 \) if included in multiple regression along with the abovementioned variables, etc. The final model is the following:

**Table 3: Coefficients of determination of models with two predictor variables**

| Variables | Factors influencing the development of bioenergy sector | Coefficient of determination R² |
|-----------|--------------------------------------------------------|-------------------------------|
| \( X_1 \) | Share of natural gas import, % | 0.940017 |
| \( X_2 \) | Wind and solar energy production | 0.940021 |
| \( X_3 \) | Oil products import | 0.940023 |
| \( X_4 \) | Total primary energy supply | 0.940832 |
| \( X_5 \) | Basic income tax rate, % | 0.940939 |
| \( X_6 \) | Natural gas import | 0.941098 |
| \( X_7 \) | Hydroelectricity production | 0.941547 |
| \( X_8 \) | Total production | 0.94185 |
| \( X_9 \) | Crude oil production | 0.942668 |
| \( X_{10} \) | Coal and peat production | 0.942323 |
| \( X_{11} \) | Crude oil import | 0.944278 |
| \( X_{12} \) | Coal and peat import | 0.944827 |
| \( X_{13} \) | Natural gas price for the population | 0.945397 |
| \( X_{14} \) | Nuclear energy production | 0.946278 |
| \( X_{15} \) | Natural gas production | 0.946433 |
| \( X_{16} \) | Brent oil price (annual average) | 0.948767 |
| \( X_{17} \) | Coal and peat export | 0.952458 |
| \( X_{18} \) | Official hryvnya rate against dollar | 0.955312 |
| \( X_{19} \) | “Feed-in” tariff, € | 0.958967 |
| \( X_{20} \) | “Feed-in” tariff, UAH | 0.969871 |
| \( X_{21} \) | Subsidies (number of households) | 0.973078 |
| \( X_{22} \) | Subsidies (total) | 0.973791 |
| \( X_{23} \) | Electricity price for the population | 0.976241 |

Source: The authors’ calculations

**Table 4: Coefficients of determination of models with three predictor variables**

| Variables | Factors influencing the development of bioenergy sector | Coefficient of determination R² |
|-----------|--------------------------------------------------------|-------------------------------|
| \( X_1 \) | Brent oil price (annual average) | 0.976253 |
| \( X_2 \) | Coal and peat export | 0.976327 |
| \( X_3 \) | Oil products import | 0.976337 |
| \( X_4 \) | Official hryvnya rate against dollar | 0.976341 |
| \( X_5 \) | Share of natural gas import, % | 0.976356 |
| \( X_6 \) | Natural gas production | 0.976473 |
| \( X_7 \) | Natural gas price for the population | 0.976502 |
| \( X_8 \) | Coal and peat production | 0.976526 |
| \( X_9 \) | Total production | 0.97667 |
| \( X_{10} \) | Natural gas import | 0.976696 |
| \( X_{11} \) | Crude oil production | 0.976713 |
| \( X_{12} \) | Nuclear energy production | 0.976817 |
| \( X_{13} \) | Hydroelectricity production | 0.976864 |
| \( X_{14} \) | Electricity price for the population | 0.976927 |
| \( X_{15} \) | Total primary energy supply | 0.97713 |
| \( X_{16} \) | Subsidies (total) | 0.978418 |
| \( X_{17} \) | Coal and peat export | 0.978588 |
| \( X_{18} \) | “Feed-in” tariff, € | 0.97864 |
| \( X_{19} \) | “Feed-in” tariff, UAH | 0.979704 |
| \( X_{20} \) | Subsidies (number of households) | 0.979807 |
| \( X_{21} \) | Crude oil import | 0.981432 |
| \( X_{22} \) | Wind and solar energy production | 0.98661 |
| \( X_{23} \) | Basic income tax rate, % | 0.988974 |

Source: The authors’ calculations

**Figure 7:** Capacity of the renewable energy sources in Ukraine in 2010-2019

Source: based on the information from (State Agency on Energy Efficiency and Energy Saving of Ukraine, 2021)
Y = a₀ + a₁X₁ + a₂X₂ + a₃X₃ + a₄X₄

Where X₁ – variable “Natural gas price for enterprises”
X₂ – variable “Basic single contribution rate”
X₃ – variable “Basic income tax rate”
X₄ – predictor variables from Table 5.

Predictor variables have the statistically insignificant P-value (P > 0.05) in the model with five and more of them. So they were not included in the analysis. Therefore, the model with R² close to 1 and with 4 predictor variables was calculated.

The key statistical parameters of multiple regression are in Table 6.

### Table 5: Coefficients of determination of the models with four predictor variables

| Variables | Factors influencing the development of bioenergy sector | Coefficient of determination R² |
|-----------|-------------------------------------------------------|---------------------------------|
| X₁        | Total primary energy supply                            | 0.98978                         |
| X₂        | Natural gas production                                 | 0.98992                         |
| X₃        | Official hryvnya rate against dollar                   | 0.989066                        |
| X₄        | Electricity price for the population                   | 0.989074                        |
| X₅        | Brent oil price (annual average)                       | 0.989365                        |
| X₆        | Coal and peat import                                  | 0.9894                         |
| X₇        | Oil products import                                   | 0.989432                        |
| X₈        | Natural gas price for the population                   | 0.98964                         |
| X₉        | Nuclear energy production                             | 0.98969                         |
| X₁₀       | Wind and solar energy production                       | 0.989775                        |
| X₁₁       | Total production                                       | 0.989974                        |
| X₁₂       | Hydroelectricity production                            | 0.990134                        |
| X₁₃       | Subsidies (total)                                     | 0.9903                          |
| X₁₄       | Subsidies (number of households)                      | 0.990833                        |
| X₁₅       | Crude oil import                                      | 0.991118                        |
| X₁₆       | Coal and peat production                              | 0.991148                        |
| X₁₇       | Crude oil production                                  | 0.991649                        |
| X₁₈       | Coal and peat export                                  | 0.991726                        |
| X₁₉       | Share of natural gas import, %                        | 0.991827                        |
| X₂₀       | Natural gas price for enterprises                      | 0.992108                        |
| X₂¹       | “Feed-in” tariff, €                                    | 0.992976                        |
| X₂²       | “Feed-in” tariff, UAH                                  | 0.994954                        |

Source: The authors’ calculations

### Table 6: Statistical parameters of multiple regression

| Parameter | Value |
|-----------|-------|
| Coefficient of determination (R²) | 0.995 |
| Adjusted R² | 0.992 |
| F-test | 345.1 |
| P-value | 4.09e-08 |
| Omnibus | 10.338 |
| Kurtosis | 4.467 |
| Durbin-Watson | 2.391 |
| Cond. No. | 1.14e+03 |

Source: The authors’ calculations

### Table 7: Results of the regression analysis of the factors’ impact

| Factor | Equation coefficient | Standard deviation | t | P-value | CI, lower 95% | CI, upper 95% |
|--------|----------------------|--------------------|---|---------|---------------|---------------|
| Y-intercept, a₀ | 4359.0797 | 654.658 | 6.659 | 0.000 | 2811.059 | 5907.101 |
| Natural gas price for enterprises | 78.4946 | 19.807 | 3.963 | 0.005 | 31.658 | 125.331 |
| Basic single contribution rate | −36.4406 | 7.913 | −4.605 | 0.002 | −55.153 | −17.728 |
| Basic income tax rate | −84.7952 | 18.436 | −4.600 | 0.002 | −128.388 | −41.202 |
| “Feed-in” tariff, UAH | 185.0419 | 64.244 | 2.880 | 0.024 | 33.128 | 336.955 |

Source: The authors’ calculations

The statistical analysis shows that the coefficient of determination is very high (0.995), i.e. the model describes 99.5% of the variation of the dependent variable. The significance of the multiple regression equation, in general, is estimated based on F-test, which confirms the significance level. The obtained multiple regression parameters show both the relationship between the variables under research and the fact that they are quite accurately described by the final equation.

Table 7 shows that P < 0.05 in all the equation coefficients, which confirms their statistical significance.

Therefore, the final equation of the relationship between biofuel production and other factors is the following:

\[ y = 4359.0797 + 78.4946x_1 - 36.4406x_2 - 84.7952x_3 + 185.0419x_4 \]

Where \( x_1 \) – Natural gas price for enterprises;
\( x_2 \) – Basic single contribution rate;
\( x_3 \) – Basic income tax rate;
\( x_4 \) – “Feed-in” tariff.

The correlation/regression analysis of the data in the energy industry shows the relationship between the parameters and contributes to predicting the value of the dependent variable \( y \) (“Biofuel production”). The results testify to the statistical significance of the developed model.

Meanwhile, it is worth mentioning that the regression equation has a rather significant (against other variables) y-intercept. In our opinion, it can indicate that additional factors were not taken into account. Their research can require additional examinations.

#### 3.1.3. Bioenergy production forecast

Prognosis is the next research stage. The 2035 Energy Strategy of Ukraine outlines the national goals regarding the share of biomass, biofuel, and waste in TPES. In 2035, the share should amount to 11 mln. toe or 11.5% of TPES. In our calculations, we focus on “production”, while the Strategy concentrates on “supply.” Export outside Ukraine constitutes the gap between these parameters. Arguably, these resources should be attracted to be used on the domestic market of Ukraine in full on condition of creating favorable conditions.

The constructed models help to predict the development of bioenergy in the future taking into account the change of main components and monitor whether the Strategy goals will be achieved. Predicting the growth in natural gas prices for enterprises, which can objectively be predicted considering the
industry’s import dependency and market preconditions, and the decline in the size of the “feed-in” tariff, we get the result of 4,500,000 toe in 2035 (Scenario I). According to the scenario, the tax rates remain unchanged (Figure 8). The rate we get is twice lower than the one provided by the Strategy.

The second scenario stipulates the gradual tax reduction for agricultural enterprises-biofuel producers. The factor’s impact is related in the first place to the fact that social contributions constitute a significant proportion in the structure of the biofuel cost, so the single contribution rate reduced to optimal level will stimulate the biofuel production. It also impacts the reduction of the corporate income tax base. Having tried various options, we settled upon the single social contribution rate of 8% and income tax rate of 7%, which are reasonable to recommend as amendments to the Tax Code of Ukraine. The Strategy also provides the gradual growth of prices for natural gas for enterprises with an achievement of 30 UAH per cubic meter in 2035. The “feed-in” tariff is established only till 2030. At these rates, the largest biofuel production growth was achieved. The results of prognosis under Scenario II (Figure 9) show that the biofuel production in 2035 will be at the level of 6,200,000 toe, which is also substantially lower than the expected rate.

4. CONCLUSION

Based on statistical methods, the condition of bioenergy sector is analyzed. The Spearman rank correlation coefficient is the ground for examining the correlation relationship between various factors impacting the biofuel production. The modeling of biofuel production prognosis is carried out using the multiple regression equation, which stipulates the development of the standard linear model. In the model, $R^2$ is close to 1, which confirms the statistical reliability of received results. The obtained multiple regression parameters show both the relationship between the variables under research and the fact that they are quite accurately described by the final equation. Meanwhile, it is worth mentioning that the regression equation has a rather significant y-intercept, which can indicate that additional factors were not taken into account.
The developed model helps to define the priority directions to increase biofuel production. According to the multiple correlation/regression model, biofuel production grows at the growing gas price for enterprises and “feed-in” tariff rate. Meanwhile, a lower tax burden positively impacts the development of priority industry for national security.

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