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Analysis of Energy Projects Financial Efficiency and Renewable Energy Generation in Russia

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ABSTRACT

The authors study the development of the oil and gas industry and assess the financial efficiency of the use of renewable energy sources, which determine the **relevance** of the research topic. **The purpose** of this work is to study the effectiveness of the development of the Russian energy sector and its contribution to the world economy. The main question to which this article should give an answer is that how the Russian power industry will develop in corresponding to the global trends in energy consumption. This paper **uses a method** for finding the parameters of the efficiency of renewable energy sources using exponential smoothing. The paper uses data from the analytical report of British Petroleum and the Bloomberg system for the period from January 2012 to December 2019. **The result** of the study shows an improvement in the accuracy of the predicted values, while previous models had higher standard error estimates. **The novelty** of the study is to achieve accurate results of the forecast of fossil-fuel consumption for 3 years ahead (the forecast accuracy is 80.5). The article **concludes** that while Russian oil and gas projects are very important for the Russian economy until now, renewable energy projects are more beneficial. In addition, Russia does not seem to support the global trend towards a renewable and sustainable economy. Although oil and gas prices remain acceptable, unforeseen changes in the behavior of real buyers can hinder the efficiency of the Russian economy and lead to a disruption of Russia's economic growth if Russia does not decisively steer towards renewable energy from now on. The growth of the Russian power industry corresponds to the global trends in fossil energy consumption (while fossil prices, thus incomes keep worsening), and thus innovative solutions for enhancing renewable energies must be adopted. The article proves that many pipeline projects (South Stream, Turkish Stream, Nord Stream 2) move the Russian energy sector back to the past because they just contradict existing trends.

Keywords: Power consumption; Energy resources; Natural gas; Hydropower; Electrical grids; Stock quotes movement

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ОРИГИНАЛЬНАЯ СТАТЬЯ

Анализ финансовой эффективности энергетических проектов и производства возобновляемой энергии в России

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АННОТАЦИЯ

Авторы изучают развитие нефтегазовой отрасли и оценивают финансовую эффективность использования возобновляемых источников энергии, что определяет **актуальность** темы исследования. **Целью** данной работы является изучение эффективности развития российского энергетического сектора и его вклада в мировую экономику. Главный вопрос, на который должна дать ответ эта статья, заключается в том, как будет развиваться российская энергетика в соответствии с мировыми тенденциями потребления энергии. Авторы применяют **метод** параметров эффективности возобновляемых источников энергии с использованием экспоненциального сглаживания. Исследование основано на данных аналитического отчета British Petroleum и системы Bloomberg за период с января 2012 по декабрь 2019 г. **В результате** показано улучшение точности прогнозируемых значений, в то время как предыдущие модели имели более высокие оценки стандартной ошибки. **Новизна** исследования заключается в достижении точных результатов прогноза потребления ископаемого топлива на 3 года вперед (точность прогноза составляет 80,5). Сделан **вывод** о том, что, хотя российские нефтегазовые проекты до сих пор очень важны для российской экономики, проекты в области возобновляемых источников энергии более выгодны. Кроме того, Россия, похоже, не поддерживает глобальную тенденцию к возобновляемой и устойчивой экономике. Хотя цены на нефть и газ остаются приемлемыми, непредвиденные изменения в поведении реальных покупателей могут помешать развитию российской экономики и привести к нарушению экономического роста России, если она не будет ориентироваться на возобновляемые источники энергии. Рост российской электроэнергетики соответствует мировым тенденциям (в то время как цены на ископаемые ресурсы, следовательно, и доходы продолжают падать), и поэтому необходимо принять инновационные решения по расширению использования возобновляемых источников энергии. В статье доказано, что многие проекты («Южный поток», «Турецкий поток», «Северный поток-2») направляют российский энергетический сектор в прошлое, противореча мировым тенденциям в энергетике.

Ключевые слова: энергопотребление; энергоресурсы; природный газ; гидроэнергетика; электрические сети; движение биржевых котировок

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INTRODUCTION

The development of the oil and gas industry financial efficiency determines the relevance of the research topic. The purpose of this article is to study the development of Russia's energy sector and its contribution to the global economy. The tasks included are the analysis of the biggest and most important projects of the Russian energy industry that have an impact on a global scale. Furthermore, the article analyzes activities of large market participants such as Gazprom, which is actively working in Europe, and giving the opportunity to reduce the consumption of coal. It allows to reduce emissions into the atmosphere. Secondly, the wide use of renewable energy sources (RES), like solar and wind energy, becomes possible.

The article novelty consists in the analysis of modern Russian Oil and Gas projects using a modified random forest ensemble model [1–3]. This research paper is the first to include these analytical methods.

The power industry in Russia is under state control. In other words, the government owns over 50% of stocks of Gazprom, RusHydro and the Federal Grid Company of Unified Energy System. This allows them to plan the work of the three monopolies exclusively in the interests of the state and of their own company interests. The investment activities of Gazprom particularly should be emphasized. Their large-scale plans will offer resources that are additionally needed by the Chinese economy, as many of their projects are located in the general area of these countries. Projects in Yamal and especially the Amur oil refinery are accompanied by multi-million-dollar credits from European and Asian banks [4, 5].

The main hypothesis is that recent trends, which are manifested as a slowdown in global economic growth and an excess of the aggregate supply of hydrocarbons over their demand, lead to a drop in energy prices and increased cross-country tensions, both for producing and recipient countries. This leads to toughening cross-country competition [6, 7]. This research result proves the main hypothesis.

The paper analyses the trends in the Russian electric power industry corresponding to the global trends in energy consumption. Its development is impossible without the adoption of innovative solutions. In general, the Russian energy sector is not stagnating, and new projects are accompanied by innovative solutions.

The main question to which this article should give an answer is that how the Russian power industry will develop in corresponding to the global trends in energy consumption.

The article proves that so many pipeline projects (South Stream, Turkish Stream, Nord Stream 2) move the Russian energy sector to the past. It will increase the share of fossil fuel energy in the next 10–20 years until oil sources will become weak.

The conclusion includes results of gas flows analysis from Russia. The choice of this method is most appropriate from the point of view of risk diversification in gas supplies to Europe.

LITERATURE REVIEW

The reduction of consumed fuels and energy resources through innovative technologies is a prominent task that needs solving. The increase of energy efficiency of the power supply system requires reduction of power loss during energy transfers [7–10].

In 2017 the environmental effects of Russian energy systems were already studied by the International Renewable Energy Agency (IRENA) and in last 5 years a revolution took place regarding the efficiency of many renewable energy sources around the world (in solar energy, for example) [11].

A review of studies in the field of logical assessment of energy projects in Russia allows us to identify four main areas of use of quantitative methods for analyzing information. Firstly, a formal analysis of the projects can be carried out to assess the energy policy of Russia and to compare energy projects with each other. The use of renewable energy sources promises to improve the situation according to international studies. Furthermore, it should be noted that the energy supply system can use not only solar and wind energy, but also the heat of the earth [12].

This makes the task of determining the cost-efficiency of heat supply systems using renewable energy sources difficult. The study aims to determine the impacts of oil price on the markets and the possibility of using renewable energy sources [13–15].

In connection with the novelty of the topic, this study prioritizes conducting research. The focus of the study was given to the development of new gas projects and the interaction between governments and national energy companies [16–19]. Unfortunately, the economic side of the development of the energy sector is also influenced by political aspects — such as sanctions from the USA. It is necessary to analyze methods of eliminating the sanctions in the best interests of European countries. Price movements of successfully developing companies should be confirmed by relevant trends.

METHODS

While looking for new methodological approaches and methods for mathematical modeling of complex systems, researchers are increasingly paying attention to the world around Random Forest model.

Random Forest models are currently one of the most well-known and effective tools for intelligent data analysis, which is being developed thanks to advances in the theory of artificial intelligence and computer science [19]. Since the rapid development of computer technology creates the prerequisites for the emergence of neurocomputers, which, according to experts, will process information according to the same principles as the human brain [2, 3], the interest in neural network technologies is gradually covering an increasingly wide range of users.

At the same time, despite the considerable scientific development, the tough market requirements and increased competition, as well as the dynamism of the geo-economic environment as a whole, provide an additional impetus for conducting both fundamental and applied research in the direction of development of such intelligent modeling technologies as fuzzy sets and identification of the features of their use in the economy. The fuzzy set concept depends on the assumption that the characteristic function of the set (the membership function for a fuzzy set) can take any values in the range [0, 1]. It is not just the values 0 or 1. It is a major concept of fuzzy logic [1, 2].

To determine the trend, technical analysis may be used, examining peaks and troughs. Also, the article considers a model of pricing energy, which is as follows:

$$Energy\ cost = \sum A + B + C + D, \quad (1)$$

where A is the costs incurred by the infrastructure dependent on the annuity factor and related CAPEX costs; B is the operational costs of plant technology; C is the supply chain costs, collection, and treatment; D is the transport cost.

The first step is the selection of the initial features in the data set. Then, it is constructed for each of the group. Furthermore, its performance and feature importance are calculated. In other words, there is a number of separate and interconnected models for the time period, to evaluate their accuracy and influence of their parameters on the metrics. The modified random forest ensemble model is appropriate for datasets with not so long a time period for fossil-fuel power plant efficiency from 2020 until 2022. Many researchers found that fossil-fuel power will not be a crucial share in the next 20–30 years [5, 11, 18]. The fundamental analysis shows that the renewable energy share in Russia is stable in 2003–2019. There is no trend to rise like in global energy generation (*Fig. 1, 2*).

The paper uses the data selection approaches for modified random forest ensemble model:

1. Total gas flow from Russia, GWh/d.
2. Electricity generation in Russia, TWh.
3. Line length and electricity output.

The base number of fossil-fuel power plant efficiency from 2020 until 2022: horizon for the forecasting model is n = 730 days. It was tested for other n = 365, 1095 and 1460 days in order to estimate the significance of chosen features and potential of forecast and time influence on the model accuracy.

The paper uses the Random Forest model which is a class of artificial neural networks in which connections between nodes form a directed graph along a time sequence. For example, the renewable energy efficiency can be calculated:

$$Ts = k * I / E * C * V\ , \quad (2)$$

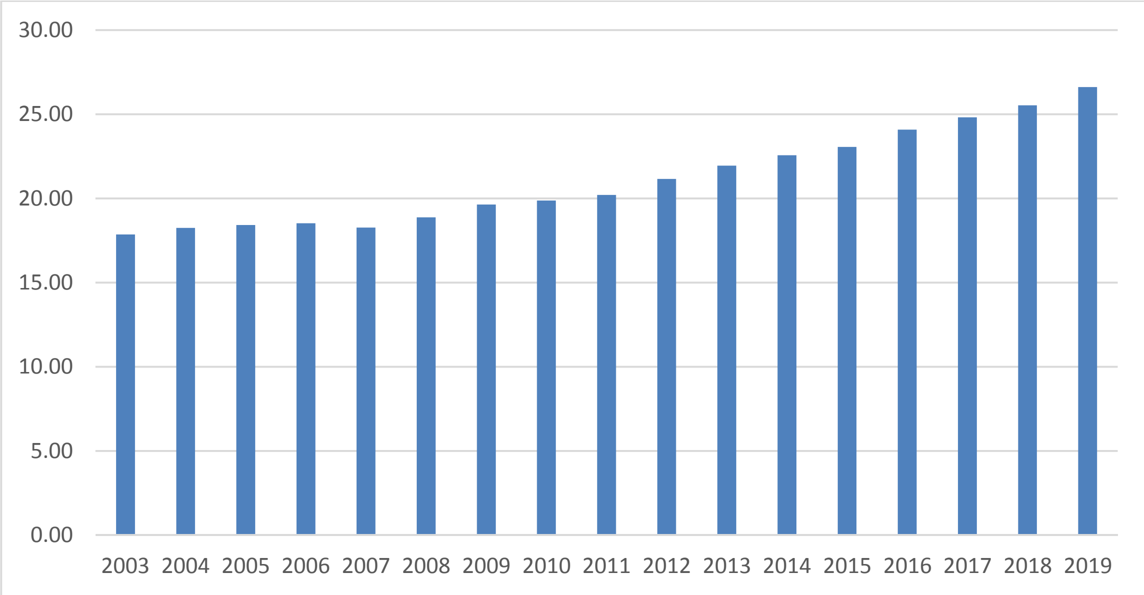

Fig. 1. **Renewable energy share in global generation, %**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

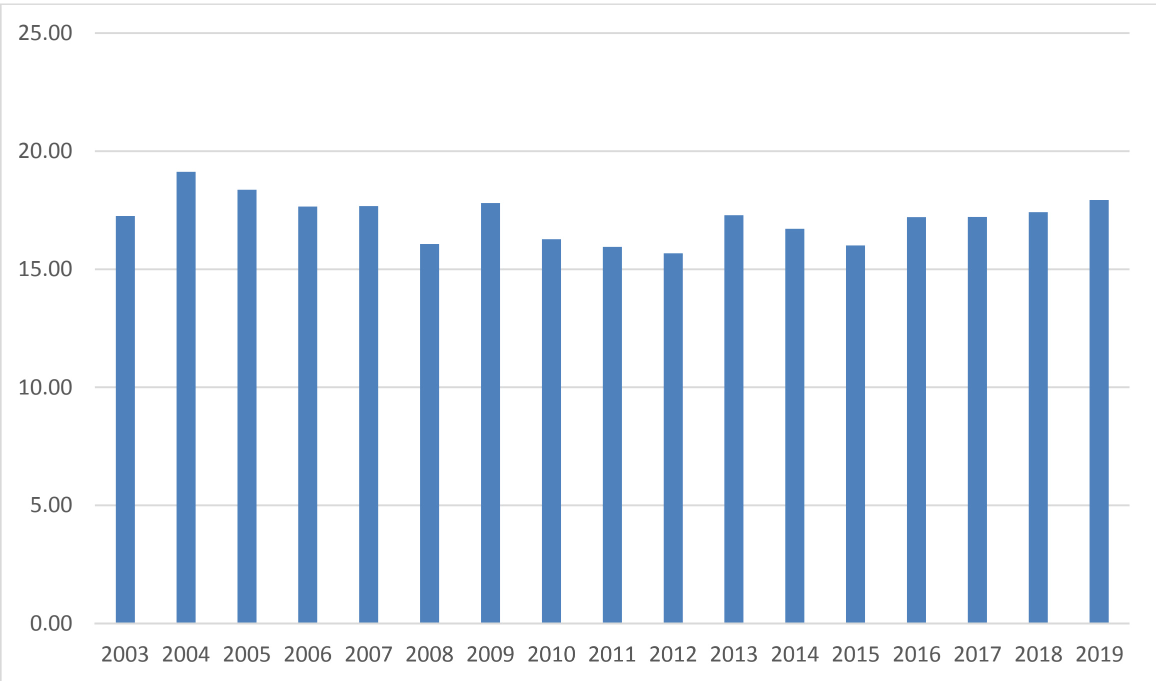

Fig. 2. **Renewable energy share in Russia, %**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

where I is the share of investments in solar panels in the total of investments in installations; k is the coefficient of investments, that depends on the type of installation; E is the specific annual amount of solar energy that installations receive, GJ/(m^2*year); C is the renewable energy efficiency of the solar establishment; V is the cost of the replaced heat energy, rub/GJ.

It can be used such formula too:

$$Tw = ki / U * T * P, \quad (3)$$

where ki is the average capital cost in renewable energy; U is the coefficient of renewable power consumption; T is the annual operating time of installments, hours per year; P is the cost of the replaced energy, USD/(kW·hour). The following universal formula can determine the payback period of power plants:

$$Tb = kb \,/\, Vb\,, \quad (4)$$

where kb is the average capital expenditures; Vb is the volume of the reactor, м[3].

Initially, the performance of each model is calculated using metrics provided by NumPy and Scikit-learn. Out of which the paper uses Root Mean Squared Error, Mean Absolute Percent Error (MAPE), Accuracy (provided by Scikit-learn), Pearson Correlation Coefficient (PCC) and Mean Squared Error (MSE). RMSE is a standard deviation of the difference between actual data and the forecasted result.

Models are evaluated as a whole with a particular focus on Accuracy:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}, \quad (5)$$

where TP is true positives, TN is true negatives, FP is false positives and FN is false negatives;

$$RMSE = \sqrt{\frac{\sum_{t=1}^{n}(g_t - f_t)^2}{n}}, \quad (6)$$

where g_t = actual value, f_t = forecasted value, n = = number of data points;

MAE measures the difference between two continuous variables.

$$MAE = \frac{\sum_{t=1}^{n}|g_t - f_t|}{n}; \quad (7)$$

$MAPE$ is a measurement of accuracy based on the percentage error.

$$MAPE = \left[\frac{1}{n}\sum\frac{|g_t - f_t|}{g_t}\right]*100; \quad (8)$$

PCC is a measurement of relationship strength between to variables.

$$PCC = \frac{n\sum g_t f_t - (\sum g_t)(\sum f_t)}{\sqrt{\left[n\sum g_t^2 - (\sum g_t)^2\right]\left[n\sum f_t^2 - (\sum f_t)^2\right]}}. \quad (9)$$

Table 1

Design and power of main Oil and Gas projects

	Billions of cubic meters	
	Number of threads	Power
Nord Stream-2	2	55
The power of Siberia	1	38
Turkish stream	2	31.5

Source: BP Statistical Review 2020.

Table 2

Energy consumption share by Fuel in Russia and China

Energy consumption share by Fuel	Russia, %	China, %
Gas	55	4
Oil	21	18
Nuclear power	6	1
Hydroelectricity	2	7
Coal	15	70

Source: Bloomberg.

In order to estimate the impact of each group on the prediction by the Scikit-learn tools for future importance calculation. For each decision tree, the Scikit-learn computes a node`s importance using Gini with two child nodes.

RESULTS

Traditional energy generation projects of Russia

The research paper explores some achievements and successes of several Russian energy companies and compares them with a foreign corporation (Gazprom, RusHydro, Federal Grid Company of Unified Energy System and transnational oil and gas and petrochemical company British Petroleum).

Let us examine the activities of these companies in further detail. The number of threads is a relevant parameter for decision-making and choosing between energy strategies because a number of threads of more than 1 shows that the delivery of resources can be long in the case of problems with the main tube. Recent projects in development or operation are presented below in *Table 1*.

The volume and sizes of deliveries are also presented, confirming the company's activity, price

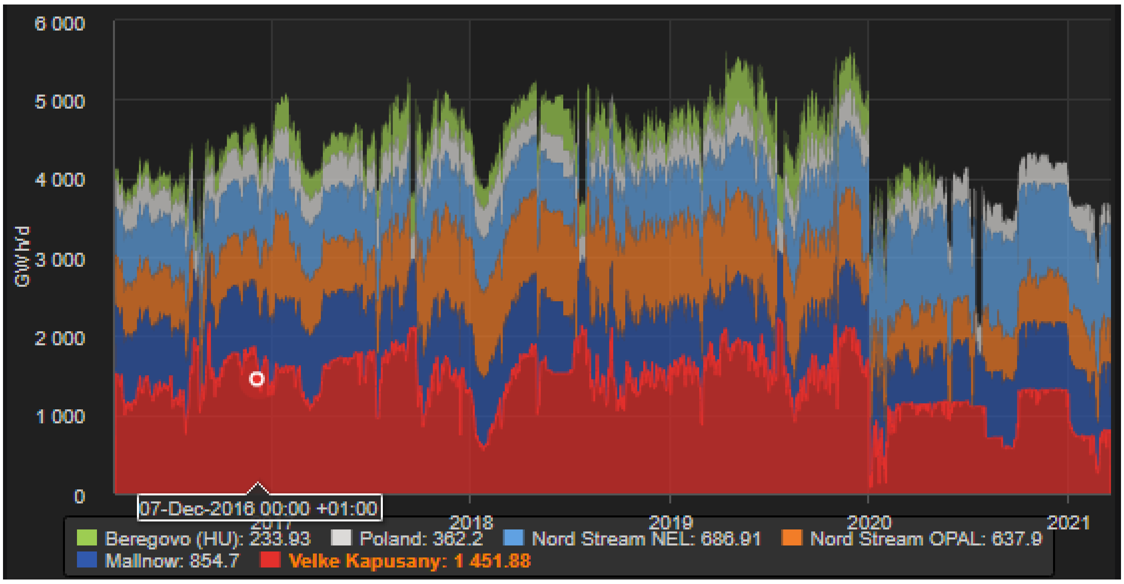

Fig. 3. **Total gas flow from Russia, GWh/d**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

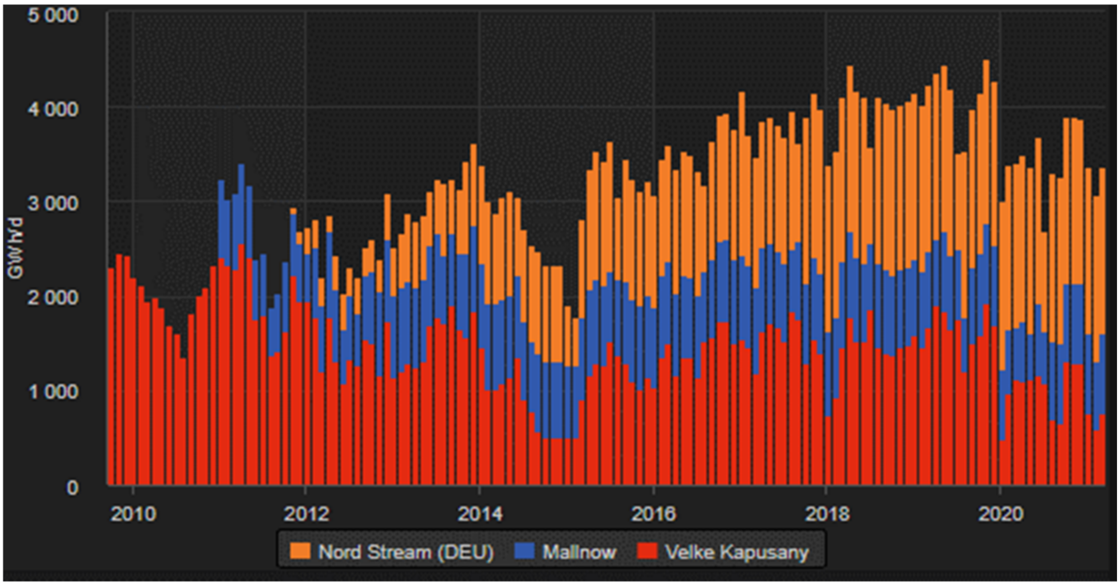

Fig. 4. **Main Gas flow from Russia, GWh/d**

Source: Bloomberg, BP Statistical Review (2020). URL: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html (accessed on 10.08.2021).

charts of growing stocks over the past year, along with some other formulas indicators of technical analysis. Successful projects of the company and the dividend policy that Gazprom can afford significantly affect its price quotes.

1. The Nord Stream-2 is a gas pipeline that exits the Russian Ust-Luga and is over 1200 km long. At the end of December 2019, all participants removed its pipe layers from the site of the construction of Nord Stream-2 and, due to U.S. sanctions, the project was completely abandoned. But at the end of 2020, the Nord Stream-2 was reopened again. Many authors proved that this pipeline is not needed because it only distracts gas from existing pipelines but adds no new or additional gas to the market. Moreover, in an increasingly carbon-free global economy, this gas is just not needed any more [18–22].

2. The Power of Siberia. In May 2014, Gazprom and the China National Petroleum Corporation (CNPC) signed an agreement on the supply of Russian gas via an eastern route. It was finished after 30 years and assumes an annual supply of 38 billion cubic

meters of gas after reaching its design capacity. In September 2016, Gazprom and CNPC signed a contract for the construction of an underwater crossing over the Amur River.

On December 2, 2019, Russian gas supplies to China were launched through the Power of Siberia gas pipeline. This project will allow the Russian party to reduce the risks accompanied with European gas supplies, and will reduce coal consumption in China, which will have a significant impact on the environment and energy market, *Table 2*.

3. Turkish stream. The offshore section of the gas pipeline running along the bottom of the Black Sea was built in 2019 and consists of two threads. The first line is intended for Turkish consumers, the second — for gas supply to the countries of Southern and Southeast Europe. In November, both lines were filled with gas, and in early January 2020, Northern Macedonia and Greece received the first volumes of Russian gas. Main current gas flow from Russia are illustrated below. The initiation of reverse-flow natural gas scheduling at Slovakian-Ukrainian interconnection Veľké Kapušany, has provided Russian gas supply via transport system of Ukraine. The Mallnow station was constructed for Gazprom gas transporting in November 2012. Mallnow compressor station near Frankfurt an der Oder in the vicinity of the German-Polish border. The extension of the Mallnow station improved a capacity for receiving up to 600,000 m3/h (*Fig. 3, 4*).

Electronic trading platform "Gazprom export" (ETP) with delivery a month in advance. Now customers can buy gas with one day delivery in advance, on weekends, until the end of the month. Most of the sales through ETP in 2019 were accounted for by Germany — 8.5 billion cubic meters, Slovakia — 2.3 billion cubic meters, Austria — 1.5 billion cubic meters. *Table 3* shows the breakdown of trading by month.

4. The prospects of building a giant gas chemical complex on the Yamal Peninsula and raising funds for project financing for the construction of the Amur Gas Processing Plant (GPP). This chemical complex allows to produce ethylene and propylene from dry gas with a design capacity of 3 million tons as part of the consortium. The cost of this project is about 1 trillion rubles. The connection Amur GPP project with the rest of the article is that Russian gas needs a market for conversion into other goods because gas demand is too low on the back of renewable energy transition around the world. The main client for this ethylene and propylene can be Europe and China like it was mentioned in the previous research [4, 5].

Table 3

Average ETP trading volumes in 2017–2020

Month	Billion m3 sales
Nov.	0.64
Oct.	1.3
Sept.	1.39
Aug.	1.54
July	2.79
June	1.27
May	1.37
Apr.	1.1
March	0.89

Source: Bloomberg.

Amur GPP would be the second largest in the world. On December 23, 2019, the company entered a package of transactions for a total of 11.4 billion euros. Funds were provided by European, Chinese, Japanese and Russian credit organizations. The total cost of the project is estimated to be about 20 billion euros.

In relation to the projects discussed above, it is appropriate to compare the movement of stock prices for Gazprom with respect to the stock price of British Petroleum (BP) — one of the leading oil, gas and petrochemical Transnational companies. Moreover, BP is a major shareholder (~19.5% of the authorized capital) of Rosneft.

BP has released its annual statistical data, concerning the study of the global energy market. Natural gas has a share of about 24% in the world energy market now. This share will decrease not so quickly as the oil share as a result of efficiency growth in renewable energy generation around the world.

Oil retains its position in the total energy sum compared to last year. Coal, which is second in the fuel mix, is at 27% and this is the lowest result since 2015. The share of natural gas has increased. The contribution of hydroelectricity and nuclear energy has not changed significantly in recent years. Strong growth is observed in RES (renewable energy sources). The energy picture of Russia is as follows. Oil consumption has increased (+2.1%). Gas remains to be the primary source of fuel — 55% of energy consumption. Coal consumption fell by 5.5% due to an increase in electricity generation (+9.5%). RES at the moment is in its infancy and occupies an insignificant place.

Table 4

Electricity generation in Russia, TWh

Year	2011	2012	2013	2014	2015	2016	2017	2018
Production	77	81.2	124.1	113.6	114.3	124.8	127	130.6

Source: URL: https://www.fsk-ees.ru/about (accessed on 10.08.2021).

The Federal Grid Company is the largest hydro-energy-generating company in Russia and the third largest in the world. It has electricity generation growth in Russia (*Table 4*).

The Federal Grid Company (FGC) is a Russian energy company whose main activity is the transmission of electricity through the Russian electrical grid. Moreover, this is one of the largest companies in the world in terms of thread length. The main production indicators can prove the idea of electricity generation growth in 2014–2018 on the back of stable export volumes from Russia to Europe (*Table 5–7*).

The cost of gas production in Norway is more than twice as high as in Russia and is about $ 1.04 per million British thermal units (MMBtu). Norway can provide all oil and gas demand in Europe in the future. In this case, Russia's oil and gas export can become insufficient for European countries.

Norway provides about 25 percent of Europe's consumption (115 billion cubic meters) and is Russia's main competitor. The movement of Norwegian and Russian gas flows reflects that Gazprom's export became dependent on the export facilities of Norway (*Fig. 5*).

Efficiency of renewable energy generation in Russia

The study was able to achieve results with a prediction of fuel consumption for 3 years ahead (RMSE 5 to 25 MAPE, average MAPE = 16.52) because of using the Random Forest model. The paper exactly computed the fossil-fuel power generation forecast (by plant) from 2021 until 2023. The relevance of such computation is important for the future study. But there are a few caveats. The neural network must be trained on the data for each fossil-fuel power plant throughout its work separately each time, i. e. only after the formation of a new image of this model can predict the indicators of this particular power plants, otherwise predicted values differ too greatly from the actual.

To increase the accuracy in future studies, you can use a vector model, but it is a little more complex and requires more time to train. You can also take a lot of power plants for all years, or one power plant, but with all the other indicators (vacation, expenditure by category, cost). Unfortunately, Random Forest models do not support the same flexibility in time series sets as simpler algorithms. Fossil-fuel power generation forecast (by plant) from 2021 until 2023 shows that most energy plants in Russia will have the same efficiency in the next 3 years (*Fig. 6*).

Also, this model does not support multivariability, which means that it only takes fuel consumption as the basis for predictions. The accuracy of previous models is about 0.5 but the modified random forest model has an accuracy of more than 0.8. MAPE, MSE, MAE and PCC are at the high-level tuning of hyperparameters (*Table 8, 9*).

It can be concluded that for the indicator of power generation of renewable plants, thousand kWh, the model gives a more accurate result than in the earlier works (MSE is about 272 MWh) [1–3].

A comprehensive assessment of the efficiency of power plants using renewable energy sources in Russia allows us to make the following conclusions.

DISCUSSION

This is due to states' high activity levels in the energy industry. Furthermore, it is important to analyze alternatives in management techniques, and possible use for by-products in order to sustain effective production and consumption. This is the reason for a detailed study on the environmental aspects of Russian projects and the supply chain that it provides, as well as the evaluation of potential sources [2, 20–22].

The reason for researching the environmental aspects of Russian projects and evaluating its potential resources is to determine a sustainable and efficient chain of life in production [23, 24].

These results can be achieved only under the conditions of certain actions, including changes in social behavior, vehicle technologies and the introduction of biofuel innovations. Infrastructure projects have been hampered by market uncertainty and other fuel supply problems in the last few years [25, 26].

Table 5

Line length and electricity output

Year	2014	2015	2016	2017	2018
Length of power lines, thousand km	138.8	139.1	140.3	142.4	146
Electricity supply to consumers, kWh	515.3	525.8	540.5	547.4	557.7

Source: URL: https://www.fsk-ees.ru/about (accessed on 10.08.2021).

Table 6

Main Gas flows from Russia, GWh/d

Name	2020, 1	2020, 2	2020, 3	2020, 4	2020, 5	2020, 6	2020, 7	2020, 8	2020, 9	2020, 10	2020, 11	2020, 12
Greifswald (OPAL)	559	567	582	583	631	638	533	529	552	560	541	562
Greifswald (NEL)	1195	1213	1190	1142	1123	1195	1226	1202	1199	1210	1192	1192
Mallnow	860	859	858	859	859	859	868	773	772	827	870	868
Velke Kapusany	777	646	787	810	810	811	811	625	578	736	803	803
Polish Offtake	261	261	261	261	261	262	253	253	252	252	252	251
Net VIP Bereg (HU)	105	97	98	100	95	101	101	108	103	80	281	272
Romania	29	29	29	29	29	29	29	29	29	29	29	29
Total	3786	3672	3805	3784	3808	3895	3821	3519	3485	3694	3968	3977

Source: Bloomberg, author calculations.

Table 7

Analysis Summary

	Greifswald (OPAL)	Greifswald (NEL)	Mallnow	Velke Kapusany
Average	567.6471	1192.88	851.18	760.688
Standard error	7.297734	6.08148	7.5767	18.8328
Median	562	1198	860	801.5
Standard deviation	30.08933	25.0746	31.239	75.331
Sample variance	905.3676	628.735	975.9	5674.76
Excess	1.399464	3.74782	3.7712	1.44661
Asymmetry	1.238365	−1.865	−2.199	−1.6474
Interval	109	103	98	233
Minimum	529	1123	772	578
Maximum	638	1226	870	811
Amount	9650	20279	14470	12171
Greatest (1)	638	1226	870	811
Smallest (1)	529	1123	772	578
Reliability level (95.0%)	15.4705	12.8922	16.062	40.1411

Source: Bloomberg, authors' calculations.

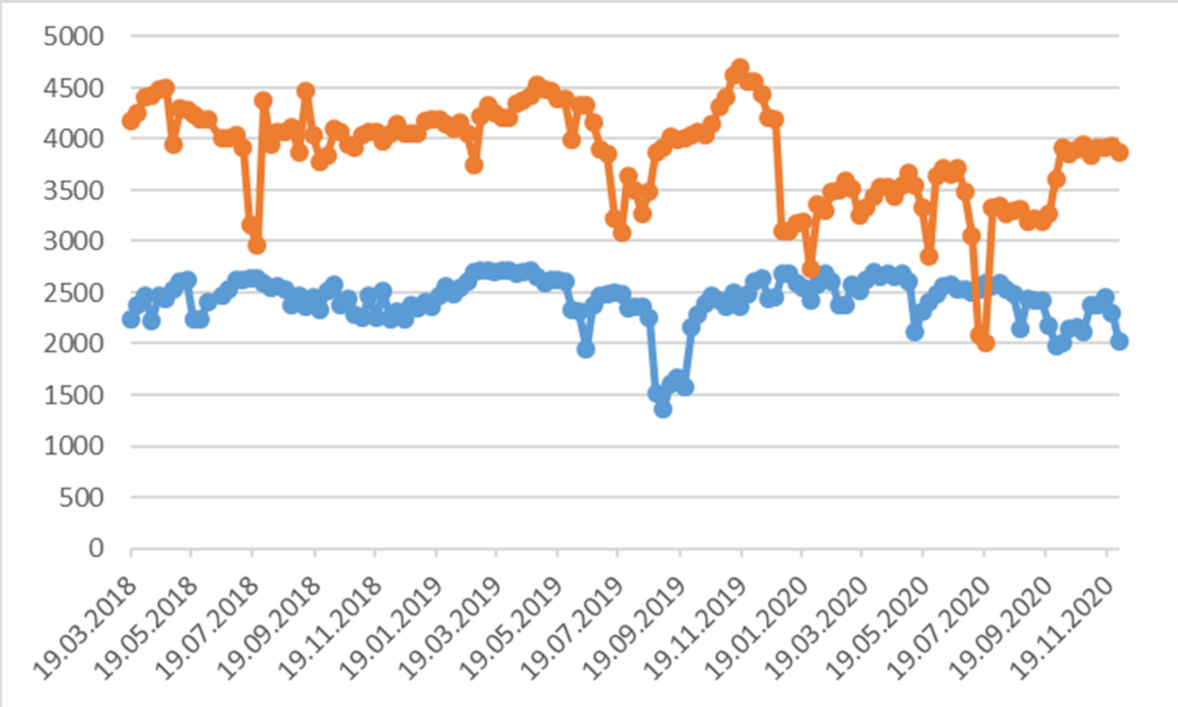

Fig. 5. **Gas flows from Norway (blue) and Russia (orange), GWh/d**
Source: Bloomberg.

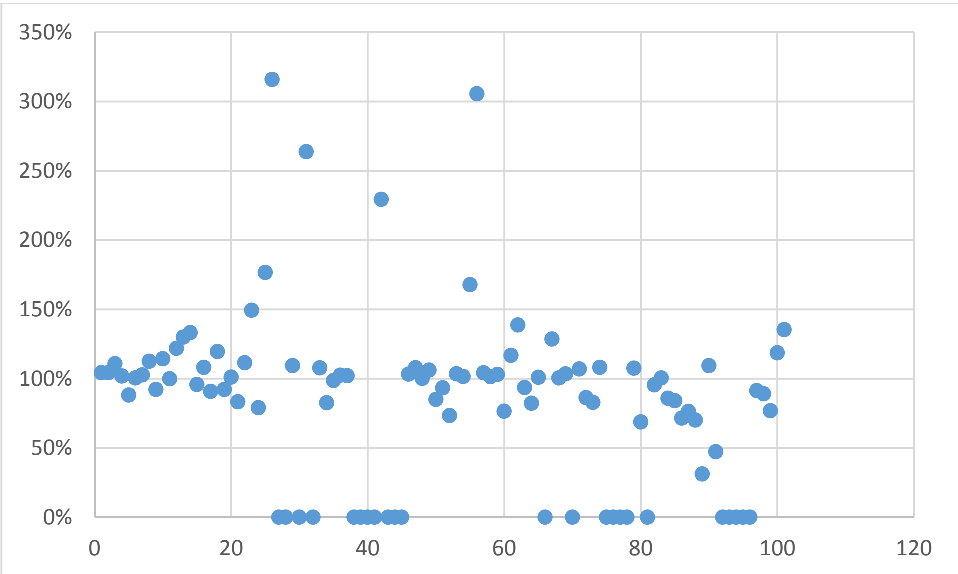

Fig. 6. **Fossil-fuel power generation forecast (by plant) from 2021 until 2023, MWh/t**
Source: Bloomberg.

Projects are concentrated in a wide variety of areas. It is important to be attentive regarding accessibility and the usage of raw material in such projects. This is the reason for this study to include proof of sustainable energy production from Russian companies [27–29].

In the realization of projects, there is a large number of components that are divided into two classes: 1) those that come from foreign companies' operations, 2) those that are produced in the domestic industry from the process of production.

Unlike other industries, the oil and gas sector has the advantage of a significant and useful place, which can be applied during different stages of the production of goods [19–21]. The study was able to achieve accurate results with a prediction of fuel consumption for 3 years ahead (RMSE 5 to 25 MAPE, average MAPE = 16.52), but there are a few caveats.

Table 8

Analysis Summary

RMSE	MAPE	MSE	MAE	PCC	Accuracy (%)	Horizon
16.52	1.945	272	157	0.49	80.11	3 years

Source: authors' calculation.

Table 9

Analysis Summary

Models	LSTM	RNN	ARIMA	Modified random forest model
Accuracy	0.528	0.502	0.512	0.811

Source: authors' calculation.

CONCLUSIONS

The study includes the development of Russia's energy sector and its contribution to the global economy. The tasks and goals of the biggest and most important projects of the Russian energy industry that have an impact on a global scale are researched in this paper as well. The article's novelty is renewable energy analysis by modification of random forest ensemble model for fossil-fuel power plant efficiency from 2020 until 2022.

This is the first research paper to consider this method. The article reviewed major projects of Gazprom, which contribute to the economic development of Russia, as well as Europe and Asia (the most important partners among which are Germany and China). The presence of the latter is most appropriate from the point of view of risk diversification in gas supplies to Europe. The creation and completion of the Turkish Stream gas pipeline aids in assessing this problem.

The diversification of the activities of Gazprom in Russia should also be noted. This refers to the development of the market of power engineering. In general, Russian energy is not stagnant and is accompanied by innovative solutions. It is worth noting that the creation of a new electronic trading platform, Gazprom export and the development of renewable energy sources of RusHydro contribute significantly to economic growth of the national economy. Currently, the last paragraph illustrates a backlog in comparison with advanced countries of the world, which must be reduced in the next few years.

To increase the accuracy in future studies, a vector model can be used, but it is more complex and requires more time to be developed. A lot of renewable power plants for all years, or one renewable power plant, but with all the other indicators (vacation, expenditure by category, cost). Unfortunately, Random Forest models do not support the same flexibility in time series sets as simpler algorithms.

The physically existing pipelines will not help the Russian gas industry if worldwide trust in Russian institutions and respectful democratic institutions keeps crumbling and its reliable democratic functioning and de-escalating policy-making are not perceived by Russia's economic and business partners. Therefore, any calculation of gas volume flows in various geographic directions is using a far too short horizon because such analysis does not touch on the essence of any business, which is mutual trust. Europe now tries to become independent of a Russia slipping more and more into authoritarian rule; in the same way as Europe became independent from Middle East gas governed by authoritarian regimes and It is described by a "gas flows analysis". Global demand will decrease anyhow because of efficiency improvements and the greening of economies.

The main conclusions are that: (1) The random forest model proves the financial efficiency of renewable energy production and (2) the accuracy of this model is very higher (0.81) and (3) it is highly relevant, since Russia does not seem to support the global trend towards a renewable and sustainable economy.

Although oil and gas prices remain acceptable, unforeseen changes in the behavior of real buyers can hinder the efficiency of the Russian economy and lead to disruption of Russia's economic growth. The growth of the Russian electric power industry corresponds to the global trends in energy consumption, and its development is impossible without the adoption of innovative solutions. In general, the Russian energy sector is not stagnating, and new projects should therefore drastically increase renewables by using sustainable technologies which represent innovative solutions.

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