UDC: 338.242

Olim Astanakulov
D.Sc. (Economics), Associate Professor,
International Islamic Academy of Uzbekistan (IIAU)
11 Abdulla Kodiri Str., Tashkent, 100011, Uzbekistan
astanakulov@gmail.com
ORCID ID: https://orcid.org/0000-0002-0536-1214

Khurshid Asatullaev
PhD (Economics), Professor,
Tashkent Institute of Finance (TIF)
60-A Amir Temur Ave., Tashkent, 100000, Uzbekistan
asatullayev75@mail.ru
ORCID ID: https://orcid.org/0000-0001-7725-4197

Nodira Saidaxmedova
D.Sc. (Economics), Associate Professor,
Jizzakh Polytechnic Institute (JizPI)
4 Islam Karimov Str., Jizzakh, 105021, Uzbekistan
saidaxmedova74@gmail.com
ORCID ID: https://orcid.org/0000-0001-9422-3608

Nilufar Batirova
PhD Student (Economics),
International Islamic Academy of Uzbekistan (IIAU)
11 Abdulla Kodiri Str., Tashkent, 100011, Uzbekistan
n.batirova@iiau.uz
ORCID ID: https://orcid.org/0000-0001-7542-0825

The energy efficiency of the national economy assessment in terms of investment in green energy

Abstract
Introduction. The study of the development of CO_2-neutral economy shows that this concept was only examined from a theoretical point of view in the first phases and has become a priority development area of all countries of the world since 2019. Carbon neutrality means not only a massive conversion of traditional energy into renewable (alternative), but also a complete thermal modernization, a change in the production sector towards energy saving and energy efficiency, innovative changes in wastewater treatment systems and recycling, etc. In other words, an important engine for the development of a CO_2-neutral economy in the national economic system is a set of mechanisms and instruments to improve energy efficiency through sustainable innovative development.
Theoretical base. For a detailed analysis of the conditions for the development of the energy efficiency of the national economy (Charles, 2019), it is necessary to monitor the state of the energy system and the environmental situation in the country (Huang, 2019), since today almost all countries of the world have reconsidered their priority areas in the development of the energy sector and have actively started to implement reforms for modernization and conversion towards energy production (Khan, 2018). The most promising areas were alternative energy sources and the development of a carbon-neutral economy (Jiahai, 2019). Therefore, the countries of the European Union have agreed on an action plan for energy efficiency for the period 2007-2020 (Kraemer, 2020), which is a 20-20-20 plan - reducing CO_2 emissions by 20%, improving energy efficiency by 20% and increasing the share of renewable sources in the energy sector by 20% (Lakshman, 2019). In this phase, Russia plans to achieve 11% of renewable energy sources in the structure of final energy consumption and increase energy efficiency by 9%. At the same time, Russia, which has joined the Paris Climate Agreement (Rehbein, 2020), has set itself the goal of reducing CO_2 emissions by 40% by 2030 compared to 1990 (Shu, 2019).
The aim of the study is to develop theoretical and methodological tools for assessing the level of energy efficiency of the national economy and its main determinants.

Results. The forecast results showed that there is a significant discrepancy between the optimistic and realistic scenarios of the dynamics of changes in the economy's diverging sub-index of energy efficiency. According to the optimistic scenario, the balancing of the convergent and divergent sub-indices will take more than 10 years (in 2020, the value of the convergent sub-index of energy efficiency of the national economy was 0.84 and the projected value of the divergent sub-index in 2030 was 0.71).

Conclusions. The growth of the economy's integral energy efficiency index is possible if a stable balance is achieved between its convergent and divergent determinants. Calculations have confirmed that the implementation of state policies to ensure the energy efficiency of the economy should primarily focus on increasing divergent determinants of the energy efficiency of the economy. To target the diverging sub-index of the national economy's energy efficiency, the paper performs a scenario forecast of the vector of its change based on the Brown model, which takes into account the retrospective nature of the distribution of its time series and eliminates fluctuations in random variables.

Астанакулов О. Т.
доктор економічних наук, доцент,
Міжнародна Ісламська академія Узбекистану, Ташкент, Узбекистан

Асатуллаєв Х.
кандидат економічних наук, професор,
Ташкентський фінансовий інститут, Ташкент, Узбекистан

Саїдахмедова Н.
доктор економічних наук, доцент,
Джизакський політехнічний інститут, Джизак, Узбекистан

Батірова Н.
аспірантка (економіка),
Міжнародна Ісламська академія Узбекистану, Ташкент, Узбекистан

**Оцінка енергоефективності національної економіки
з точки зору інвестицій у зелену енергетику**

Анотація

Вступ. Вивчення еволюції вуглецево-нейтральної економіки показує, що на перших етапах ця концепція розглядалася тільки з теоретичної точки зору, а з 2019 року вона стала пріоритетним напрямком розвитку для багатьох країн світу. Вуглецева нейтральність означає не тільки масовий перехід від традиційної енергетики до відновлюваної (альтернативної), але й повну теплову модернізацію, модифікацію виробничого сектора в напрямку енергозбереження та енергоефективності, інноваційні зміни в системах очищення стічних вод й утилізації відходів. Іншими словами, важливим двигуном розвитку вуглецево-нейтральної економіки в системі національної економіки є сукупність механізмів й інструментів підвищення рівня енергоефективності за рахунок сталого інноваційного розвитку

Теоретична база статті. Для детального аналізу передумов розвитку енергоефективності національної економіки необхідно стежити за станом енергетичної системи та екологічною ситуацією в країні (Чарльз, 2019; Хуан, 2019), оскільки сьогодні практично всі країни світу переосмислили свої пріоритетні напрямки в розвитку енергетичного сектора й активно почали проводити реформи з модернізації та перепрофілювання виробництва енергії (Хан, 2018), розвитку вуглецево-нейтральної економіки й альтернативної енергетики (Цзяхай, 2019). Так, країни Європейського Союзу погодили План дій з підвищення енергоефективності на 2007–2020 роки (Крамер, 2020), який передбачає скорочення викидів CO_2 на 20%, підвищення енергоефективності на 20% і збільшення частки відновлюваних джерел в енергетичному секторі на 20% (Лакшман, 2019). У планах Росії на даному етапі – досягнення частки відновлюваних джерел енергії в структурі кінцевого енергоспоживання на рівні 11% і підвищення рівня енергоефективності на 9%. У той же час Росія, яка приєдналася до Паризької угоди з клімату (Ребейн, 2020), поставила за мету скоротити викиди CO_2 на 40% до 2030 року порівняно з 1990 роком (Шу, 2019).

Мета дослідження – розробка теоретико-методологічного інструментарію оцінки рівня енерго-ефективності національної економіки та його основних детермінант.

Результати. Результати нашого прогнозу показали, що існує істотна розбіжність між оптимістичним і реалістичним сценаріями динаміки змін дивергентного субіндексу енергоефективності національної економіки. Згідно з оптимістичним сценарієм, балансування конвергентних і дивергентних субіндексів займе більше 10 років (у 2020 році значення конвергентного субіндексу енергоефективності національної економіки склало 0,84, а прогнозне значення дивергентного субіндексу в 2030 році – 0,71).

Висновки. Зростання інтегрального показника енергоефективності національної економіки можливе за умови досягнення стійкого балансу між його конвергентними й дивергентними детермінантами.

Розрахунки підтвердили, що реалізація державної політики забезпечення енергоефективності національної економіки повинна бути спрямована перш за все на підвищення рівня дивергентних детермінант енергоефективності національної економіки. Для таргетування дивергентного підіндексу енергоефективності національної економіки в роботі виконано сценарне прогнозування вектора його зміни на основі моделі Брауна, що враховує ретроспективний характер розподілу його часових рядів і виключає флуктуації випадкових величин.

Ключові слова: зелена енергетика; інвестиції; економіка; оцінка.

Астанакулов О. Т.
доктор экономических наук, доцент,
Международная Исламская академия Узбекистана, Ташкент, Узбекистан
Асатуллаев Х.
кандидат экономических наук, профессор,
Ташкентский финансовый институт, Ташкент, Узбекистан
Саидахмедова Н.
доктор экономических наук, доцент,
Джизакский политехнический институт, Джизак, Узбекистан
Батирова Н.
аспирантка (экономика),
Международная Исламская академия Узбекистана, Ташкент, Узбекистан

Оценка энергоэффективности национальной экономики с точки зрения инвестиций в зеленую энергетику

Аннотация

Введение. Изучение эволюции углеродно-нейтральной экономики показывает, что на первых этапах эта концепция изучалась только с теоретической точки зрения, а с 2019 года она стала приоритетным направлением развития среди всех стран мира. Углеродная нейтральность подразумевает не только массовый переход от традиционной энергетики к возобновляемой (альтернативной), но и полную тепловую модернизацию, модификацию производственного сектора в направлении энергосбережения и энергоэффективности, инновационные изменения в системах очистки сточных вод и утилизации отходов и т.д. Иными словами, важным двигателем развития углеродно-нейтральной экономики в системе национальной экономики является совокупность механизмов и инструментов повышения уровня энергоэффективности за счет устойчивого инновационного развития

Теоретическая база статьи. Для детального анализа предпосылок развития энергоэффективности национальной экономики необходимо следить за состоянием энергетической системы и экологической ситуацией в стране (Чарльз, 2019; Хуан, 2019), поскольку сегодня практически все страны мира переосмыслили свои приоритетные направления в развитии энергетического сектора и активно начали проводить реформы по модернизации и перепрофилированию в направлении производства энергии (Хан, 2018). Наиболее перспективными направлениями были альтернативные источники энергии и развитие углеродно-нейтральной экономики (Цзяхай, 2019). Так, страны Европейского союза согласовали План действий по повышению энергоэффективности на 2007–2020 годы (Крамер, 2020), который представляет собой план на 20-20-20 лет – сокращение выбросов CO_2 на 20%, повышение энергоэффективности на 20% и увеличение доли возобновляемых источников в энергетическом секторе на 20% (Лакшман, 2019). В планах России на данном этапе – достижение 11% доли возобновляемых источников энергии в структуре конечного энергопотребления и повышение уровня энергоэффективности на 9%. В то же время Россия, присоединившаяся к Парижскому соглашению по климату (Ребейн, 2020), поставила цель сократить выбросы CO_2 на 40% к 2030 году по сравнению с 1990 годом (Шу, 2019).

Цель исследования – разработка теоретико-методологического инструментария оценки уровня энергоэффективности национальной экономики и его основных детерминант.

Результаты. Результаты нашего прогноза показали, что имеется существенное расхождение между оптимистическим и реалистичным сценариями динамики изменений дивергентного субиндекса энергоэффективности национальной экономики. Согласно оптимистическому сценарию, балансирование конвергентных и дивергентных субиндексов займет более 10 лет (в 2020 году значение конвергентного субиндекса энергоэффективности национальной экономики составило 0,84, а прогнозное значение дивергентного субиндекса в 2030 году – 0,71).

Выводы. Рост интегрального показателя энергоэффективности национальной экономики возможен при условии достижения устойчивого баланса между его конвергентными и дивергентными детерминантами. Расчеты подтвердили, что реализация государственной политики обеспечения энергоэффективности национальной экономики должна быть направлена в первую очередь на повышение уровня дивергентных детерминант энергоэффективности национальной экономики. Для таргетирования дивергентного подиндекса энергоэффективности национальной экономики в работе выполнено сценарное прогнозирование вектора его изменения на основе модели Брауна, учитывающей ретроспективный характер распределения его временных рядов и исключающей флуктуации случайных величин.

Ключевые слова: зеленая энергетика; инвестиции; экономика; оценка.

1. Introduction

The study of the development of CO_2-neutral economy shows that this concept was only examined from a theoretical point of view in the first phases and has become a priority development area of all countries of the world since 2019. Carbon neutrality means not only a massive conversion of traditional energy into renewable (alternative), but also a complete thermal modernization, a change in the production sector towards energy saving and energy efficiency, innovative changes in wastewater treatment systems and recycling, etc. In other words, an important engine for the development of a CO_2-neutral economy in the national economic system is a set of mechanisms and instruments to improve energy efficiency through sustainable innovative development.

2. Brief Literature Review

The level of energy efficiency and monitoring of the dynamics of the development of this indicator have become key areas in shaping the energy strategy of many countries of the world, including Russia. In view of the instability of the price policy for fossil fuels (oil, gas) and the intensification of climate change-related environmental problem, and the negative (irreversible) effects on the environment had to be recognized that the effective (rational) use of energy resources is an alternative way to increase the economic, environmental and social safety level of the country (Akber, 2017).

For a detailed analysis of the conditions for the development of the energy efficiency of the national economy (Charles, 2019), it is necessary to monitor the state of the energy system and the environmental situation in the country (Huang, 2019), since today almost all countries of the world have reconsidered their priority areas in the development of the energy sector and have actively started to implement reforms for modernization and conversion towards energy production (Khan, 2018). The most promising areas were alternative energy sources and the development of a carbon-neutral economy (Jiahai, 2019).

Therefore, the countries of the European Union have agreed on an action plan for energy efficiency for the period 2007-2020 (Kraemer, 2020), which is a 20-20-20 plan - reducing CO_2 emissions by 20%, improving energy efficiency by 20% and increasing the share of renewable sources in the energy sector by 20% (Lakshman, 2019).

In this phase, Russia plans to achieve 11% of renewable energy sources in the structure of final energy consumption and increase energy efficiency by 9%. At the same time, Russia, which has joined the Paris Climate Agreement (Rehbein, 2020), has set itself the goal of reducing CO_2 emissions by 40% by 2030 compared to 1990 (Shu, 2019).

The study of the development of a CO_2-neutral economy shows that this concept was only examined from a theoretical point of view in the first phases and has become a priority development area of all countries of the world since 2019. Carbon neutrality means not only a massive conversion of traditional energy into renewable (alternative), but also a complete thermal modernization, a change in the production sector towards energy saving and energy efficiency, innovative changes in wastewater treatment systems and recycling, etc.

An important engine for the development of a CO_2-neutral economy in the national economic system is a set of mechanisms and instruments for improving energy efficiency through sustainable innovative development (Tian, 2018).

It should be noted that the transition to a carbon-neutral economy depends primarily on the efficiency of the energy sector, which is of strategic importance for the country (Chen, 2019).

The problem of improving energy efficiency in Russia is one of the most important problems for ensuring sustainable innovative development and energy independence of the country (Ghosh, 2016).

In particular, the scientific community today focuses on evolutionary theories for the development of the energy efficiency of the economy in the context of sustainable and climate-neutral development using bibliometric analyses.

For example, in the scientific publication (Blondeel, 2016), the authors carried out a detailed analysis using the Scientometric databases Scopus and Web of Science Software in relation to the significant contribution of international communities, universities and scientific societies to highlighting problems and solutions in the field of sustainable development and energy efficiency in connection with the formation of an energy-saving infrastructure (Al-Yahyaee, 2019).

Accordingly, a large number of scientific papers are devoted to the study of the energy efficiency of the national economy (Iñigo, 2014), the study of indicators and determinants that

influence them, as well as methods of improvement related to energy saving and energy security of the country.

3. Purpose
To develop theoretical and methodological tools for assessing the level of energy efficiency of the national economy and its main determinants.

4. Materials and Methods
The methodological basis of the work consists of fundamental provisions of economic theory, management theory, state regulation of the economy, macroeconomic forecasting, economic mathematical modelling and scientific work to improve the energy efficiency of the economy.

According to certain tasks, the following research methods were used: trend and bibliometric analysis - to identify patterns in the development of theory to ensure the energy efficiency of the economy; methods of logical generalization, comparison and benchmarking - in the formation of conceptual foundations for the implementation of state policies to improve the energy efficiency of the economy, etymologizing approaches to assess the energy efficiency of the economy.

5. Results and Discussion

5.1. Determinants of the impact of green energy on the country's economy
The scientific publication (Kraemer, 2020) investigated seven determinants of the impact (GDP per capita (in constant prices), the real price of energy is equivalent to the price of oil, the real price of energy in terms of gas prices, the added value of the industrial sector (in constant prices), carbon dioxide emissions per capita (metric tons), the number of technological exports, gross formation of fixed capital (in constant prices)) on the level of energy efficiency using a stochastic approach and comparative analysis:

$$EE_t = E\ (GDP_t,\ PE_t,\ PG_t,\ VI_t,\ CO_t,\ T_t,\ F_t,\ GR_t,\ EU_{EPt},\ t_t)\,, \tag{1}$$

where:
EE_t is energy efficiency (GDP per 1 kilogram of oil); GDP_t is GDP per capita (in constant prices);
PE_t - the real price of energy in equivalent to oil prices;
PG_t - real energy price in terms of gas prices;
VI_t - added value of the industrial sector (in constant prices);
CO_t - CO_2 emissions per capita (metric tons);
T_t - amount of technological export;
F_t - gross fixed capital formation (in constant prices);
GR_t - institutional adjustment indicator (fluctuates against the standards of the industrialized economic market from 1 to 4);
EU_{EPt} - institutional adjustment indicator (1 for countries subject to European energy policy, 0 - otherwise);
t_t - temporary adjustment factor (1996-2013).

The justification of a consistent multi-level system of energy efficiency indicators and their impact on the economy will be examined in a scientific publication (Lakshman, 2019). In general, the author (Henderson, 2019) identifies two main types of indicators:

energy efficiency, namely: economic and thermodynamic energy efficiency indicators using real GDP as the denominator, and physical and thermodynamic energy efficiency indicators based on the production volume index.

When investigating a linear programming model for measuring general economic Energy Efficiency Indicators (Global Environment Institute, 2019), the authors use the Data volume analysis (DEA) method, which is very popular in energy efficiency analysis. Scientists use the environmental concept of data volume analysis (DEA) to identify three alternative energy efficiency indicators (2-3) at the level of the 21st century:

$$EE_1\ (x_0,\ z_0,\ y_0,\ e_0) = min\,\theta\,, \tag{2}$$

where:
x_0 is the vector of non-energy inputs;
z_0 - energy consumption vector;
y_0 - vector of desired outputs;
e_0 - vector of unwanted outputs.

$$EE_2 (x_0, z_0, y_0, e_0) = min \, L \sum_l^1 L = \theta l,$$ (3)

where:
L are energy inputs consisting of different energy sources.

The systematization of scientific research to determine the energy efficiency level of the economy has shown that there is a lack of a theoretical and methodological approach to its assessment, generally accepted by the international community, due to the discrepancy and inconsistency of indicators for the energy efficiency of the economy and its assessment instruments.

The paper identifies three main approaches for determining the energy efficiency level of the economy in relation to the main evaluation criteria, which describe the conditions for the functioning of the energy sector of the economy and the targeted importance of its development:

1) dynamic comparative approach the assessment of the national economy's energy efficiency is based on the comparison of the actual and retrospective values of individual energy indicators (energy intensity of the country's GDP, energy consumption, energy productivity, etc.). This approach only takes into account the dynamics of fluctuations in one indicator and ignores changes in other target indicators;

2) statistical / methodological approach-the determination of the energy efficiency of the economy is based on estimates of the energy components of the world reviews and indices (Environmental Performance Index (Global Environment Institute, 2019), Global Sustainable competitiveness Index (Jiahai, 2019), SDGs Index energy efficiency index ODEX, etc.) within a certain interval. As part of this approach, most indices assess the energy determinant based on the technical stability and stability of the country's energy system;

3) integral-additive approach - the determination of the energy efficiency of the national economy is based on an additive assessment model that integrally combines social, economic, energy and environmental normalized parameters of the functioning of the country's energy system.

According to the recommendations of the World Energy Council, for example, the Energy Trilemma Index considers three aspects of the development of the energy sector of the economy: energy security, access to energy and environmental sustainability.

5.2. Integrated investment tool for energy efficiency of the economy

Scientists in their scientific research (Tian, 2018) calculate the projected impact of sectoral economic development on the energy efficiency and CO_2 emissions of road freight transport, so this publication presents a new method for analyzing the relationships between economic activity, transport demand, energy efficiency and carbon dioxide emissions with a high level of detail in various sectors of the Finnish economy.

In the study (Subhojit, 2019), taking into account the growth of the regional economy, the authors ask an urgent question about ways to improve energy efficiency. Scientists use the stochastic frontier model to estimate the function of the energy demand and to analyze the impact of determinants on energy efficiency.

The analysis is based on economic data from the regions of Japan. The authors have drawn the following conclusions in the course of the study:

• energy efficiency indicator (4) is effective, since its assessment is strongly correlated with the energy intensity rating;

• increasing population density effectively contributes to improving energy efficiency;

• the development of highways and infrastructures contributes to improving energy efficiency in Japan.

These results show that decentralization is one of the directions for improving the energy efficiency of the national economy.

$$EE_{jt} = F\,(GRP_{jt},\, RP_{jt},\, PP_{jt},\, AN_{jt},\, CDD_{jt},\, HDD_{jt},\, ISH_{jt},\, SSH_{jt},\, EF_{jt})\,, \qquad (4)$$

where:

j - represents the j-th region;

t - represents the time interval, respectively;

GRP_{jt} - real gross regional product;

RP_{jt} - the real price of energy;

PP_{jt} - population;

AN_{jt} - residential and non - residential area;

CDD and HDD are the number of days without heating and the number of days with heating, respectively (climatic factors);

ISH and SSH represent the share of the industrial sector and the share of the commercial sector in gross regional product, respectively;

EF is the level of unused energy.

$$lnEE_{jt} = \alpha + \alpha_{GRP}lnGRP_{jt} + \alpha_{RP}RP_t + \alpha_{PP}PP_{jt} + \alpha_{AN}AN_{jt} + \alpha_{CDD}CDD_{jt} + \alpha_{HDD}HDD_{jt} + \alpha_{ISH}ISH_{jt} + \alpha_{SSH}SSH_{jt} + \beta_{jt} + jt, \qquad (5)$$

where:

α is the calculated parameter;

$\beta_{jt} + jt$ is the error coefficient.

The growth of the economy's integral energy efficiency index is possible if a stable balance is achieved between its convergent and divergent determinants. Calculations have confirmed that the implementation of state policies to ensure the energy efficiency of the economy should primarily focus on increasing divergent determinants of the energy efficiency of the economy.

Economic, social, environmental and political fluctuations, including negative effects on the efficiency of the functioning of the energy sector of the national economy. This in turn updates the appropriateness of assessing the impact of institutional determinants to ensure energy efficiency.

As the results of the scenario forecast confirmed that the growth of the Integral Energy Efficiency Index is possible by balancing the convergent and divergent components. This is only possible by increasing the energy efficiency sub-index of the economy.

To date, there is not a single generalized tool for improving the energy efficiency of the national economy that would approach each state and its development model in general.

Many scientific papers are devoted to investigating the influence of institutional, innovative and investment determinants on the energy efficiency of the national economy.

Taking into account the identified trend, the search for determinants of growth of the diverging sub-index of energy efficiency of the national economy becomes relevant, which in various combinations can significantly increase its current level and accelerate the speed of synchronization with the European average.

It should be noted that scientists will traditionally identify such main indicators and factors that affect the level of energy efficiency - the structure of GDP, the energy intensity of GDP, the primary and final energy consumption, the energy saving of buildings, the share of renewable energy sources in the country's energy balance and so on. It should be noted that the transition to a carbon-neutral economy depends primarily on the efficiency of the energy sector, which is of strategic importance for the country (Khan, 2018).

The results of the study showed that the efficiency of the functioning of the energy sector of the national economy, and thus the possibility of improving its energy efficiency, depends directly on the effectiveness of the state administration in ensuring economic and political stability in the country, improving the investment climate and the dissemination of innovative energy-efficient technologies. It should be noted that government measures to improve the energy efficiency of the national economy should be formed taking into account the following aspects:

- Development of an effective program to subsidize all of the population, which focuses on the energy-saving use of housing and municipal services-this will increase the interest of the population to use their energy resources sparingly.
- Popularization and support of households of associations in condominiums, for further control, thermal modification and possibility of energy saving of their buildings.

- Government incentives through green investments by companies that introduce renewable energy sources, energy savings and innovative technologies into production, thereby reducing the energy intensity of the country's GDP and strengthening its competitive position in the international market.
- Replace traditional energy sources (fossil fuels, gas) with renewables (solar, wind, hydro and bioenergy) and this process will allow us to become an energy independent state in the future.
- Government support for companies that process secondary raw materials and introduce closed production cycles.
- Mass introduction of municipal electric cars in the passenger transport sector and transition to ecological cargo turnover (river, air, sea).

The analysis of the experiences of the countries of the European Union has shown that effective government control contributes to improving the energy efficiency of the national economy.

The use of correlation and regression analysis tools for Russia for the period 2000-2020 enabled us to empirically demonstrate the statistically significant impact of such indicators on the diverging sub-index of the national economy's energy efficiency: the rule of law, the government's ability to openly implement policies and regulatory measures, and corruption control (Table 1).

A logical continuation of the study is to determine the impact of green investments and innovations in the energy sector on the diverging sub-index of the national economy's energy efficiency, taking into account the efficiency level of public administration. To this end, a two-stage approach has been developed:

1) in the first phase, a first data array is formed (sources: analytical databases of the World Bank, Eurostat and Bloomberg), which consists of statistical analysis tools that we have checked for multicollinearity (Pearson correlation coefficient) and normality of distribution (graphical quantile method for comparing two probability distributions);
2) in the second phase, a quantile regression OLS model is created that allows us to consider the heterogeneity of the factors studied.

Table 1:
Results of the study of the impact of Public Administration efficiency in Russia on the divergent subindex of energy efficiency of the national economy based on data for 2000-2020

Indicator	Coefficient		SE	t-stat	P value	R2	Corel	Communication power	Adequacy of the model	Direction of impact
RUL	α_0	-1.834	0.421	-4.569	0.000	0.48	0.72	Noticeable	Adequate	Positive
	β_j	1.886	0.733	2.703	0.032					
GEF	α_0	-0.911	0.085	-11.277	0.000	0.34	0.60	Noticeable	Adequate	Positive
	β_j	0.343	0.177	2.036	0.095					
VA	α_0	-0.740	0.020	-38.252	0.000	0.16	0.42	Moderate	Inadequate	Positive
	β_j	0.015	0.012	1.261	0.273					
PS	α_0	-0.748	0.019	-41.024	0.000	0.14	-0.40	Moderate	Inadequate	Negative
	β_j	-0.013	0.012	-1.167	0.305					
REQ	α_0	-0.947	0.057	-17.556	0.000	0.65	0.84	High	Adequate	Positive
	β_j	0.482	0.135	3.744	0.011					
CC	α_0	-1.401	0.088	-16.769	0.000	0.93	1.00	Very high	Adequate	Positive
	β_j	0.958	0.128	7.816	0.000					

Note: $R2$ - coefficient of determination; Corel - correlation coefficient; P-value - statistical significance of the coefficient; SE - standard error of regression; t-stat - statistics.

Source: Calculated by the authors

6. Conclusion

The growth of the economy's integral energy efficiency index is possible if a stable balance is achieved between its convergent and divergent determinants. Calculations have confirmed that the implementation of state policies to ensure the energy efficiency of the economy should primarily focus on increasing divergent determinants of the energy efficiency of the economy. To target the diverging sub-index of the national economy's energy efficiency, the paper performs a scenario forecast of the vector of its change based on the Brown model, which takes into account the retrospective nature of the distribution of its time series and eliminates fluctuations in random variables.

The forecast results showed that there is a significant discrepancy between the optimistic and realistic scenarios of the dynamics of changes in the economy's diverging sub-index of energy efficiency. According to the optimistic scenario, the balancing of the convergent and divergent sub-indices will take more than 10 years (in 2020, the value of the convergent sub-index of energy efficiency of the national economy was 0.84 and the projected value of the divergent sub-index in 2030 was 0.71).

References

1. Akber, M. Z., Thaheem, M. J., & Arshad, H. (2017). Life Cycle Sustainability Assessment of Electricity Generation in Pakistan: Policy Regime for a Sustainable Energy Mix. *Energy Policy, 111,* 111-126. https://doi.org/10.1016/j.enpol.2017.09.022
2. Al-Yahyaee, K. H., Rehman, M. U., Mensi, W., & Al-Jarrah, I. M. W. (2019). Can uncertainty indices predict Bitcoin prices? A revisited analysis using partial and multivariate wavelet approaches. *The North American Journal of Economics and Finance, 49,* 47-56. https://doi.org/10.1016/j.najef.2019.03.019
3. Astanakulov, O. (2019). Real options as a financial instrument to evaluate a project with a high degree of uncertainty: the specifics of application. *Economic Annals-XXI, 179*(9-10), 105-114. https://doi.org/10.21003/ea.V179-09
4. Blondeel, M., & Van de Graaf, T. (2018). Toward a global coal mining moratorium? A comparative analysis of coal mining policies in the USA, China, India and Australia. *Climatic Change, 150*(1-2), 89-101. https://doi.org/10.1007/s10584-017-2135-5
5. Dawn, S., Tiwari, P. K., Goswami, A. K., Singh, A. K., & Panda R. (2019). Wind power: Existing status, achievements and government's initiative towards renewable power dominating India. *Energy Strategy Reviews, 23,* 178-199. https://doi.org/10.1016/j.esr.2019.01.002
6. Ghosh, S., & Kanjilal, K. (2016). Co-movement of international crude oil price and Indian stock market: evidences from nonlinear cointegration tests. *Energy Economics, 53,* 111-117. https://doi.org/10.1016/j.eneco.2014.11.002
7. Global environment institute. (2019). *GEI Perspective: Analysis of the Potential of Renewable Energy Development and Energy Transition in the «Belt and Road» Countries.*
8. Harrison, T., & Kostka, G. (2014). Balancing priorities, aligning interests: developing mitigation capacity in China and India. *Comparative Political Studies, 47*(3), 450-480. https://doi.org/10.1177%2F0010414013509577
9. Henderson, I., & Mancini, M. (2019). *Sustainable finance progress report. Inquiry: Design of a Sustainable Financial System.* United Nations Environment Programme. Geneva, Switzerland. http://unepinquiry.org/wp-content/uploads/2019/03/Sustainable_Finance_Progress_Report_2018.pdf
10. Huang, Y. (2019). Environmental Risks and Opportunities for Countries along the Belt and Road: Location Choice of China's Investment. *Journal of Cleaner Production, 211,* 14-26. https://doi.org/10.1016/j.jclepro.2018.11.093
11. Iñigo del Guayo (2014). Promotion of Renewable Energy Sources by Regions: The Case of the Spanish Autonomous Communities. In M. Peeters, Th. Schomerus (Eds.), *Renewable Energy Law in the EU: Legal Perspectives on Bottom-Up Approaches* (pp. 53-74). Cheltenham: Edward Elgar Publishing. https://doi.org/10.4337/9781783473199.00011
12. Khan, I. M. (2018). Comparative Well-to-Tank Energy Use and Greenhouse Gas Assessment of Natural Gas as a Transportation Fuel in Pakistan. *Energy for Sustainable Development, 43,* 38-59. https://doi.org/10.1016/j.esd.2017.12.004
13. Kraemer, N. W., Kesh, S. K., Gurwitz, Z. R., & Mccabe, K. R. (2020). *Credit trends: global financing conditions: bond issuance is expected to grow 3.8% in 2020.* S&P Global Rating. https://www.spglobal.com/ratings/en/research/articles/200130-credit-trends-global-financing-conditions-bond-issuance-is-expected-to-grow-3-8-in-2020-11327333
14. Kumar, Ch. R., Kumar, V., & Majid, M. A. (2019). Wind energy programme in India: emerging energy alternatives for sustainable growth. *Energy & Environment, 30*(7), 1135-1189. https://doi.org/10.1177/0958305X19841297
15. Lakshman, S. (2019) *PM Modi vows to more than double India's non-fossil fuel target to 450 GW by 2022.* The Hindu. https://www.thehindu.com/sci-tech/energy-and-environment/prime-minister-narendra-modi-addresses-the-un-climate-summit-in-new-york/article29492091.ece
16. Rehbein, J. A., Watson, J. E. M., Lane, J. L., Sonter, L. J., Venter, O., Atkinson, S. C., & Allan, J, R. (2020). Renewable energy development threatens many globally important biodiversity areas. *Global Change Biology, 26*(5), 3040-3051. https://doi.org/10.1111/gcb.15067
17. Shi, Ch., Xi, L., Miao Y., Deng, Y., Nielsen, C. P., Noah, E., Wang, Yu., Logan, K. G., McElroy, M. B., & Hao, J. (2019). The Potential of Photovoltaics to Power the Belt and Road Initiative. *Joule, 3*(8), 1895-1912. https://doi.org/10.1016/j.joule.2019.06.006
18. Tian, X., Geng, Y., Sarkis, J., & Zhong, S. (2018). Trends and Features of Embodied Flows Associated with International Trade Based on Bibliometric Analysis. *Resources, Conservation & Recycling, 131,* 148-157. https://doi.org/10.1016/j.resconrec.2018.01.002
19. Wang, W., Zhang, M., & Li, P. (2014). Exploring temporal and spatial evolution of global energy production and consumption. *Renewable and Sustainable Energy Reviews, 30,* 943-949. https://doi.org/10.1016/j.rser.2013.11.027
20. Yu, Sh., Qian, X., & Liu, T. (2019). Belt and Road Initiative and Chinese Firms' Outward Foreign Direct Investment. *Emerging Markets Review, 41,* 1-22. https://doi.org/10.1016/j.ememar.2019.100629
21. Yuan, J., Li, X., Xu, Ch., Zhao, Ch., & Liu, Yu. (2019). Investment Risk Assessment of Coal-fired Power Plants in Countries along the Belt and Road Initiative Based on ANP-Entropy-TODIM Method. *Energy, 176,* 623-640. https://doi.org/10.1016/j.energy.2019.04.038