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## GREEN ENTREPRENEURSHIP IN THE CONTEXT OF FINAL ENERGY CONSUMPTION DYNAMICS AND SUSTAINABLE DEVELOPMENT OF THE NATIONAL ECONOMY

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**Abstract.** The relevance of this study stems from the growth of final energy consumption and the increasing resource burden on the economy amid expanding economic activity. The traditional model of economic growth is accompanied by increasing energy intensity and environmental risks, necessitating a transition to sustainable development. In this regard, green entrepreneurship is viewed as a key mechanism for structural economic transformation, ensuring increased resource productivity and a reduction in environmental burden without restricting economic activity. The aim of the study is to analyze the dynamics of final energy consumption and assess the role of green entrepreneurship as a driver of sustainable national economic development. The authors applied statistical time series analysis, trend testing, economic and mathematical modeling, and forecasting based on a linear trend model. The results of the study revealed a stable upward trend in energy consumption with low time series volatility and the absence of anomalous observations. The constructed trend model demonstrated high explanatory power and allowed for the formation of point and interval forecasts for the medium term. The obtained estimates indicate a continued upward trend in final energy consumption, generating sustainable demand for energy-efficient and environmentally oriented solutions. The findings demonstrate that green entrepreneurship is a systemic factor in aligning economic growth with energy and environmental constraints. Scaling up green business models helps reduce specific energy consumption, improve resource efficiency, and create competitive advantages for the national economy. Therefore, developing the green sector should be considered a strategic direction for sustainable growth.

**Keywords:** green entrepreneurship, sustainable development, energy consumption, environmental friendliness, efficiency, strategy.

**Main provisions.** Green entrepreneurship is acquiring strategic significance as a mechanism for structural economic adaptation. Its role is to break the direct correlation between economic growth and rising resource consumption. International experience shows that countries actively implementing green innovations achieve higher resource productivity and the resilience of their economic systems. This applies similarly to national economies: expanding the green sector can transform rising energy consumption from a threat into a source of technological innovation. The obtained analytical results demonstrate a stable

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upward trend in final energy consumption, with no anomalous fluctuations and low time series volatility. This demonstrates the systemic nature of the increase in energy demand, driven by expanding economic activity, infrastructure modernization, and the growth of production processes. Growing final energy consumption creates a stable market for innovative solutions aimed at reducing specific energy consumption and carbon emissions. The projected increase in electricity demand reinforces the importance of developing the green sector as a factor in energy sustainability. Without the systematic implementation of energy-efficient solutions, rising energy consumption will be accompanied by higher production costs and increased environmental constraints. In this context, green entrepreneurship acts as a systemic driver of sustainable development, ensuring a balance between the energy needs of the economy and environmental constraints.

**Introduction.** Modern economic development is increasingly driven by the need to transition to sustainable growth models that combine increased competitiveness with the conservation of natural resources and reduced environmental impact. Increasing climate risks, rising energy consumption, depleting raw materials, and environmental constraints are creating a new economic reality in which traditional models of industrial growth are becoming ineffective. In this context, green entrepreneurship is a key mechanism for transforming the national economy, ensuring the simultaneous achievement of economic, environmental, and social goals.

This topic is relevant because economic growth is accompanied by increased final energy and resource consumption, increasing pressure on the environment and infrastructure. Analysis of energy consumption dynamics reveals a steady upward trend, necessitating the implementation of innovative solutions aimed at improving energy efficiency and resource conservation. Green entrepreneurship is shaping the market for such solutions, from energy service technologies and digital consumption management to circular business models and environmental innovations.

Globally, ESG approaches and green innovations are becoming the standard for corporate development, determining the investment attractiveness and long-term sustainability of companies. For the national economy, this means integrating green business models into the economic growth system. Otherwise, the risk of technological lag, rising costs, and reduced competitiveness in international markets increases. Therefore, research into green entrepreneurship is of strategic importance as a tool for structural economic modernization, reducing energy and material intensity in production, and developing new markets for sustainable technologies.

The practical significance of the study lies in the fact that the results obtained can be used in developing public policy in the areas of the green economy, SME support, and sustainable financing. An analysis of resource consumption dynamics allows us to justify the need to scale up energy service projects, implement green procurement, develop a circular economy, and stimulate environmental innovation.

The study's results are of interest because they allow us to identify priority investment areas and tools for supporting green business models. From a practical perspective, they can be used in formulating sustainable development programs, ESG transformation strategies for enterprises, and regional initiatives to improve resource efficiency. Consequently, the development of green entrepreneurship should be viewed not as an auxiliary activity, but as a systemic factor in the long-term sustainability of the national economy.

**Literature Review.** The implementation of modern digital solutions and the development of information technologies in the green economy can ensure significant progress in achieving environmental, economic, and managerial objectives [1]. Currently,



countries around the world are adopting environmental policies in accordance with their national conditions to support the achievement of carbon neutrality goals. Sustainable development has become the center of global attention (Arisanti et al., 2024) [2], (Jasmi & Hassan, 2024) [3], (Khasawneh, 2024) [4].

Today, entrepreneurs are faced with the challenge of finding a balance between operating in a competitive market environment and promoting sustainable development. This balance should bring both economic and environmental benefits to enterprises. Green innovations can achieve this balance by reducing harmful environmental impacts, while simultaneously increasing the economic efficiency of enterprises and contributing to corporate environmental and financial performance (Ahmed et al., 2023) [5], (Passaro et al., 2023) [6]. Green innovation differs from traditional manufacturing innovation by focusing on financial benefits while emphasizing the creation of environmental benefits, aiming to achieve sustainable development through corporate green innovation (Zhang et al., 2024) [7].

At the same time, despite the growing body of research on green innovation, ESG transformation, green finance, circular economy, and sustainable entrepreneurship, the existing literature remains fragmented. Earlier studies and review papers show that this field has largely been developed through conceptual, venture-level, financing-related, and case-based approaches (Belz F.M., Binder J.K., 2017) [8], (Muñoz P., Cohen B., 2018) [9], (Muo I., Azeez A.A., 2019) [10], while multilevel linkages between entrepreneurship and broader sustainability outcomes are only partially reflected in existing analytical frameworks (Johnson M.P., Schaltegger S, 2020) [11]. As a result, most studies focus either on firm-level environmental practices, financing mechanisms, or sector-specific cases, whereas insufficient attention is paid to the macroeconomic relationship between final energy consumption dynamics and the development of green entrepreneurship as a driver of sustainable growth.

In the Kazakhstani context, this problem is particularly acute. Research shows that green finance is in its infancy, accompanied by institutional barriers and limited access of SMEs to financial instruments (R.D. Doszhan, 2022) [12]. The concept of a green economy is recognized as a strategic direction for the country's development; however, energy modernization and resource conservation require significant investment and technological transformation. L.A. Kuanova and A. Temirbek consider the green economy as a new type of development for Kazakhstan, emphasizing energy modernization and reducing the negative impact of energy on the environment [13]. In the waste management and circular economy sector, systemic problems with infrastructure, regulation and scaling of green business models remain. Ausharipova D.E., Kulumbetova L.B., Tankova E. propose to eliminate these problems and obstacles by using innovative business models for recycling waste into secondary raw materials in order to create conditions for activating "green business" based on the principles of a circular economy. The study concluded that the municipal solid waste (MSW) sector in Kazakhstan is a promising niche for the development of eco-entrepreneurship [14]. D.Turekulova analyzes the sustainable development of SMEs and the factors influencing their development, in particular, the impact on the development of ecotourism in Kazakhstan [15]. B. Keneshbayev provides a rationale for the importance of green entrepreneurship for the structural sustainability of territories, focusing in his research on diversification, SME development, and the reduction of environmental risks [16]. However, it should be noted that green entrepreneurship has not yet become a mass economic phenomenon capable of radically changing the structure of the national economy.

Thus, the main problem is that green innovations are recognized as strategically important, but their implementation remains fragmented and insufficiently integrated into



market mechanisms. The lack of scalable support ecosystems, the insufficient maturity of green financial instruments, and the limited involvement of SMEs hinder the transformation of green entrepreneurship into a fully-fledged driver of sustainable growth. Therefore, the scientific contribution of this article lies in combining the analysis and forecasting of final energy consumption with the conceptual substantiation of green entrepreneurship as a systemic mechanism for increasing resource efficiency, reducing environmental pressure, and supporting the sustainable development of the national economy.

According to the author, green entrepreneurship should not be viewed as a separate economic sector, but as a systemic mechanism for modernizing the entire production structure. Its role lies not only in reducing environmental risks but also in enhancing the long-term competitiveness of the economy through increased resource productivity, technological modernization, and the development of new markets. A key objective of public policy and corporate strategy is the transition from isolated environmental projects to the institutionalization of green innovation:

- implementation of ESG standards;
- development of green financing;
- stimulation of energy service and circular business models;
- integration of digital solutions into resource management.

Only if green solutions become economically viable and scalable will it be possible to achieve a balance between market competition and sustainable development.

Thus, the future of the national economy is determined not by the choice between growth and the environment, but by the ability to combine them into a unified green growth model, where entrepreneurship is the key driver of technological and institutional change.

**Materials and methods.** The study's methodological framework is based on a combination of quantitative statistical methods, economic and mathematical modeling, and systems analysis, enabling a comprehensive assessment of resource consumption dynamics and the role of green entrepreneurship in ensuring the sustainable development of the national economy.

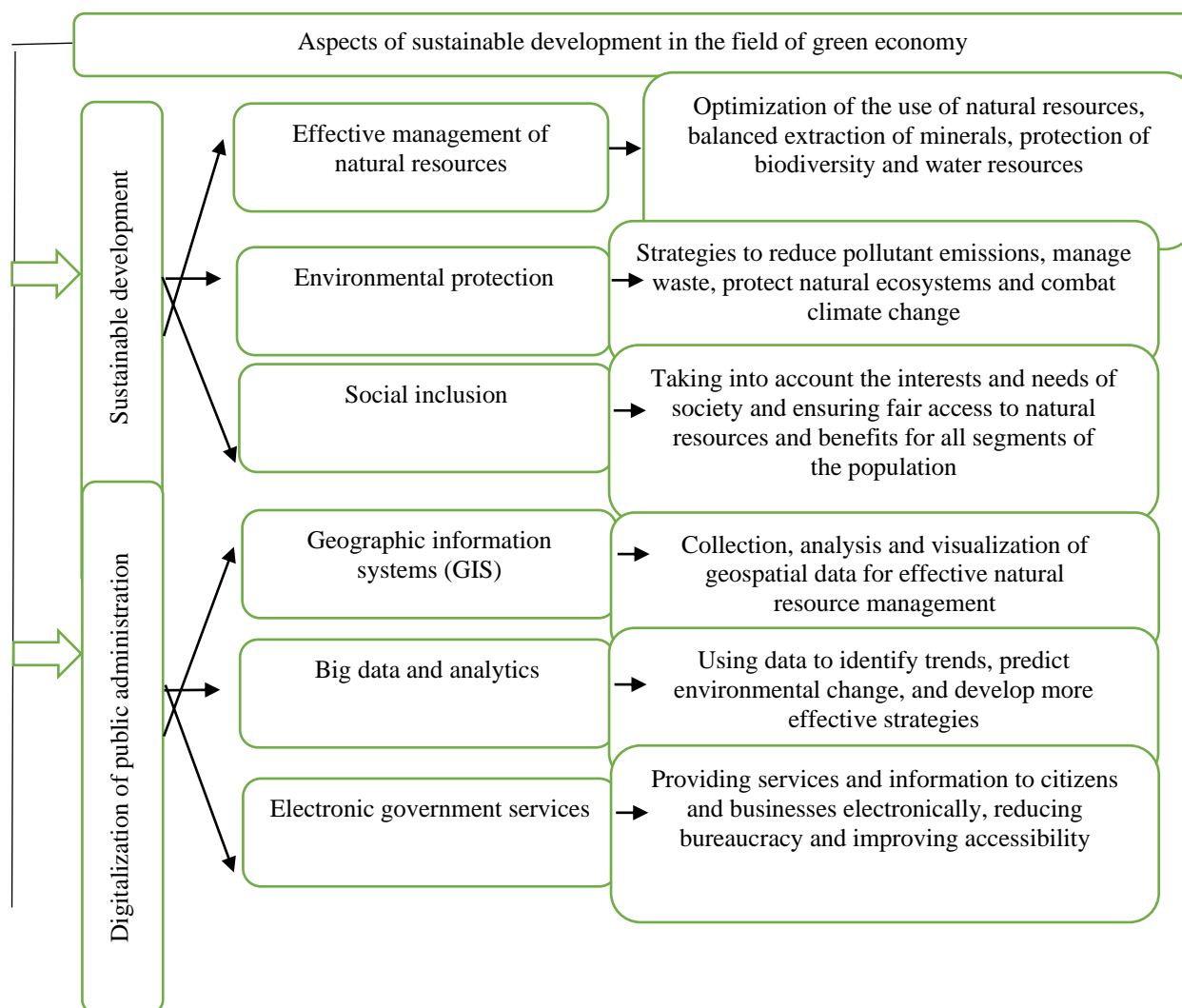
Official statistical data on final energy consumption, resource efficiency indicators, and environmental indicators were used as the empirical base. To analyze time series dynamics, statistical data processing methods were used, including calculating growth rates and increments, the coefficient of variation, and checking for outliers using the Irvine test. This allowed to assess the stability of the time series and eliminate the influence of random fluctuations on the analysis results.

Econometric modeling methods were used to identify trends and perform forecasting. A linear trend model based on the ordinary least squares method was constructed to determine the long-term dynamics of final energy consumption and obtain forecast values for the subsequent period. Model reliability was verified through residual series analysis and the construction of confidence intervals at a significance level of 0,05. Additionally, comparative analysis and a logical framework method were used to interpret the results in the context of green entrepreneurship, the ESG agenda, and the transition to a sustainable development model. A systems approach allowed us to consider energy consumption, resource productivity, and enterprise innovation as interconnected elements of a unified economic and ecological system.

Thus, the combination of methods applied ensured the scientific validity of the findings, allowed us to identify patterns in resource consumption dynamics, and assess the potential of green entrepreneurship as a driver of sustainable economic growth.



**Results and discussion.** In the context of the green economy and public administration in the Republic of Kazakhstan, sustainable development encompasses key aspects such as the rational use of natural resources, carbon footprint reduction, development of renewable energy sources, environmental safety, and institutional strengthening of environmental regulation mechanisms. These areas require effective management decisions, the integration of digital tools, interdepartmental collaboration, and the attraction of private investment in environmentally oriented projects (Figure 1).



**Figure 1** – Aspects of sustainable development in the field of green economy

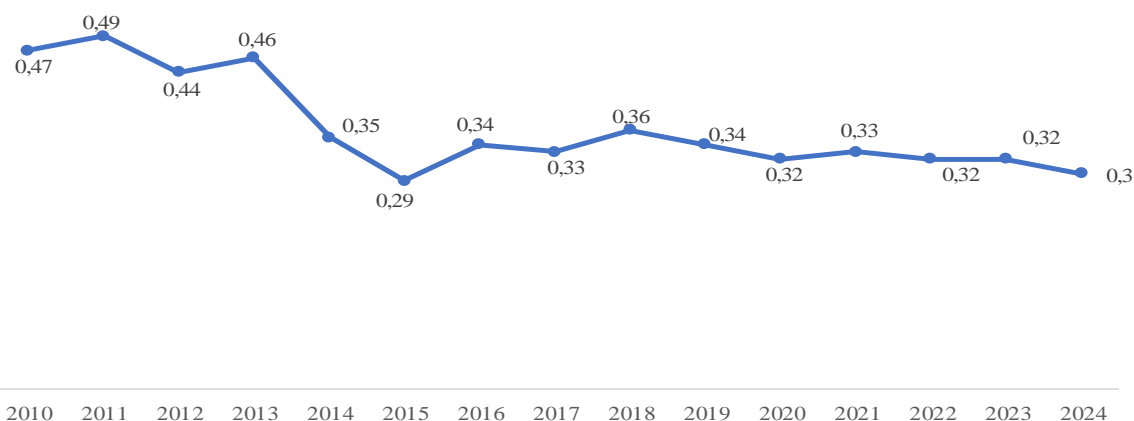
Note: compiled by the authors

The initiatives presented by the government and international partners for 2022-2026 are shaping a green entrepreneurship ecosystem:

- institutional reforms and advocacy mechanisms reduce regulatory risks;
- grant and project-based instruments provide start-up capital and expertise;
- the climate agenda creates sustainable market demand for environmental solutions.

Taken together, this transforms green entrepreneurship into a practical driver of sustainable national economic development through increased employment, innovation, and resource efficiency. The creation of a unified national digital platform for ecology and the





**Figure 3** – Energy intensity of Kazakhstan’s GDP, toe/thousand US dollars

Note: compiled by the authors based on the source [18]

**Table 1** – Indicators of total final electricity consumption, 1000 toe.

Year	Total final energy consumption, of which:	Industry	Transportation	Households	Commercial and government services	Agriculture	Other activities	Non-energy use of energy
2017	40 042,7	16 619,3	5 539,4	10 934,0	4 971,8	861,8	1 045,5	70,9
2018	41 313,5	15 015,6	6 294,4	11 276,8	5 249,2	1 651,7	1 504,7	321,1
2019	38 327,6	13 137,1	5 914,7	11 856,4	4 606,7	871,9	1 671,9	268,9
2020	40 331,9	12 558,8	7 443,5	13 490,2	3 972,2	832,9	1 671,9	362,4
2021	43 261,7	13 107,4	8 045,7	14 713,3	5 529,9	982,4	73,7	809,3
2022	41 156,5	11 852,1	8 308,0	13 686,8	5 314,7	1 074,8	86,4	833,6
2023	43 382,4	11 566,4	10 239,2	14 701,6	4 945,9	795,3	-	1 134,0
2024	44 647,3	9 898,6	11 129,2	16 305,4	4 991,1	799,4	-	1 523,6

Final energy consumption increased from 40,042.7 (2017) to 44,647.3 thousand toe (2024), i.e., by 4,604.6 thousand toe (+11,5%). The compound annual growth rate for 2017-2024 is +1,57% per year. In recent years, the growth in total consumption has been driven primarily by the transport sector and households, rather than by industry, indicating a shift of the energy burden from the productive sector to final consumption. This reflects changes in both the economic development model and consumption patterns. Under these conditions, the main potential for reducing energy intensity and the environmental burden lies in the residential sector, urban infrastructure, and the transport system. Therefore, these areas constitute the key priority field for the development of green entrepreneurship focused on energy-efficient technologies, digital demand-side management, and sustainable service solutions capable of delivering economic growth without a proportional increase in energy consumption.

Final energy consumption is increasing at moderate rates (~1,8% per year), with low volatility and a stable structure, confirming the systemic nature of this growth and reinforcing



the need to deploy energy-efficient and digital solutions within the framework of green entrepreneurship (Table 2).

**Table 2** – Growth rates and increase in final energy consumption

Year	Total final energy consumption	Growth rate, %	Increase rate, %
2017	40 042,7	103,47	3,47
2018	41 313,5	103,17	3,17
2019	38 327,6	92,77	-7,23
2020	40 331,9	105,23	5,23
2021	43 261,7	107,27	7,27
2022	41 156,5	95,13	-4,87
2023	43 382,4	105,40	5,40
2024	44 647,3	102,92	2,92

Note: compiled by the authors based on calculations made

$$\text{CAGR} = \left( \frac{X_{2024}}{X_{2016}} \right)^{\frac{1}{8}} - 1, \quad (1)$$

$\text{CAGR} = (44647,3/38699,5)^{\frac{1}{8}} - 1 \approx 1,8\%$  per year. The growth in final energy consumption can be attributed to:

- sector growth;
- production expansion;
- structural changes in the economy.

Sustained growth in final energy consumption reflects an objective expansion of economic activity. At the same time, it creates demand for green entrepreneurial solutions aimed at improving energy efficiency, digitally managing consumption, and conserving resources, thereby enabling economic growth while reducing energy use per unit of output and the environmental burden, making green entrepreneurship a practical driver of sustainable development in the national economy.

The constructed linear trend model, estimated using the least squares method, makes it possible not only to describe the indicator's dynamics in the retrospective period but also to use the model to forecast future values. Initially, the Irwin criterion indicated that, with 95% probability, the original time series contains no anomalous observations (Table 3).

**Table 3** – Checking for anomalous observations in the time series

Year	Final energy consumption, 1000 toe	Observed value of the Irwin criterion	Calculation formulas
2017	40 042,7	0,5000	<p>Observed value of Irwin's criterion <math>\lambda_t = \frac{ y_t - y_{t-1} }{\sigma_y}, t = \overline{2, 11}</math></p> <p>Critical value of Irwin's criterion <math>\lambda_{0,05} = 1,3</math></p>
2018	41 313,5	0,3932	
2019	38 327,6	0,5713	
2020	40 331,9	0,6217	
2021	43 261,7	0,0136	
2022	41 156,5	0,5396	
2023	43 382,4	0,1936	
2024	44 647,3	0,6810	

Note: compiled by the authors based on calculations made



The time series contains a pronounced trend component: despite fluctuations, the overall level of final energy consumption for 2016-2024 increased (from 38,699.5 to 44,647.3 thousand toe).

The presence of a pronounced trend component and the confirmed adequacy of the model indicate that the identified pattern of indicator change is stable and can be extrapolated to the short-term forecast period.

Forecasting is carried out by substituting time factor values corresponding to future periods into the trend equation:

$$\hat{y}^{t+k} = a + b(t + k), \quad (2)$$

where:

$\hat{y}^t$  – final energy consumption forecast;

$t$  – year number

$\hat{y}^t = 38455,03 + 571,09 \cdot t$ . On average, final energy consumption grows by approximately 571 thousand toe per year.

To verify the adequacy of the model, a number of residuals were examined for the following properties: equality of mathematical expectation to zero, randomness of residuals, and compliance with their normal distribution law (Table 4).

**Table 4** – Model adequacy check

Property being tested	Statistics used		Border	Conclusion
	Name, calculation formula	Resulting value		
Randomness	Turning points (“peaks”) test $p > \left[ \frac{2}{3}(n-2) - 1,96 \sqrt{\frac{16n-29}{90}} \right]$	8	>3	Adequate
Normality	RS criterion $RS = \frac{e_{\max} - e_{\min}}{S}$	3,29	2,80-3,91	Adequate
Equality of mathematical expectation of residual series levels to zero	Student's t-statistic $t_{\text{набл.}} = \frac{\bar{e}}{S} \sqrt{n}$	0,00	$\leq 2,14$	Adequate

Note: compiled by the authors based on calculations made

To assess the model's accuracy, the following was calculated:

– average relative approximation error, the value of which indicates an acceptable level of model accuracy:

$$E = \frac{1}{n} \sum_{i=1}^n \frac{|e_t|}{y_t} \cdot 100\% = 10,841\%, \quad (3)$$

Thus, the model is of sufficient quality and can be used for forecasting. To calculate a point forecast, the corresponding values of the factor  $t=n+k$  were substituted into the



constructed model. To construct an interval forecast, a confidence interval was determined at a significance level of  $\alpha=0,05$ . The width of the confidence interval was calculated using the formula:

$$U(k) = S_e t_\alpha \sqrt{1 + \frac{1}{n} + \frac{(n+k-\bar{t})^2}{\sum_{t=1}^n (t-\bar{t})^2}}, \quad (4)$$

The results of constructing point and interval forecasts for 2025-2027 are presented in Table 5.

**Table 5** – Point and interval forecasts of the final energy consumption indicator

Year	Point forecast, thousand toe	Interval forecast	
		Upper bound	Lower bound
2025	44524,9	41995,5	47054,3
2026	45096,0	42124,7	48067,3
2027	45667,1	42178,0	49156,2

Note: compiled by the authors based on calculations made

**Table 6** – Future directions in the field of final energy consumption

No.	Direction	Justification
1	Portfolio of priority areas for green entrepreneurship by sector	Energy efficiency and energy services (ESCO) for SMEs, housing and utilities, and social facilities
		Circular economy – recycling, repair, reuse, eco-design
		Green solutions for agriculture – water conservation, precision farming, biogas/biofertilizers
		Clean transport/logistics – route optimization, electric charging, urban services
2	Integrate green SMEs into demand through public procurement and the quasi-public sector	Minimum green criteria (energy efficiency, life cycle, maintainability)
		Green procurement pilots in 2-3 major categories (lighting, heating units, recycling)
3	Develop infrastructure and standards for the circular economy	Separate collection, sorting, "secondary raw materials" as a commodity
		Quality standards for secondary raw materials, logistics, incentives for recyclers
4	Establish a KPI system for green entrepreneurship at the national and regional levels	Number of green SMEs/startups
		Volume of green investments/loans/grants
		Jobs created (women/youth)
		Energy savings and reduced energy intensity
		CO <sub>2</sub> reduction
		Waste reduction and increased recycling rate
		Share of green procurement
Revenue/export of green goods and services		

Note: compiled by the authors

A point forecast can be used in strategic planning as a baseline scenario for developing sustainable socioeconomic development programs, reflecting the most likely dynamics of economic activity and enabling the development of benchmarks for investment policy, infrastructure modernization, and the implementation of resource-saving technologies.

An interval forecast must be considered:

– the upper bound can be considered as a benchmark for an optimistic scenario, assuming accelerated innovation and the expansion of green production;



– the lower bound can be considered a conservative scenario, minimizing economic and environmental risks and ensuring the sustainability of regional programs.

In the context of the identified trends in growth and structural restructuring of final energy consumption, green entrepreneurship development should be focused on sectors with the greatest resource-saving potential: primarily households, transportation, and urban infrastructure. In the course of the study, the author proposed recommendations and future directions in the area of final energy consumption (Table 6).

Scaling up energy-efficient technologies, digital consumption management systems, circular business models, and distributed generation allows for the transformation of rising energy demand into a driver of technological modernization. In this context, green entrepreneurship serves as a mechanism for aligning economic growth with environmental constraints, ensuring increased resource productivity, reducing carbon emissions, and creating new competitive markets. Consequently, strategic development of the green sector should be considered a key area of sustainable national economic development, capable of ensuring long-term economic resilience while simultaneously improving environmental and social performance.

**Conclusion.** The study has shown that final energy consumption in Kazakhstan demonstrates a stable upward trend, reflecting the growing resource burden associated with economic activity, infrastructure development, and changes in the structure of final demand. The analysis revealed that the increase in total final energy consumption is largely driven by households and the transport sector, which indicates that the main potential for reducing energy intensity and environmental pressure lies beyond the industrial sector. The constructed linear trend model confirmed the persistence of this upward dynamic and made it possible to generate point and interval forecasts for the medium term, which may be used in strategic planning and in the development of sustainable socioeconomic policy measures.

In this context, the results support the conclusion that green entrepreneurship should be considered an important mechanism for adapting the national economy to rising energy and environmental constraints. The projected growth of final energy consumption creates a stable demand for energy-efficient technologies, digital consumption management, circular business models, and environmentally oriented service solutions. Therefore, the development of green entrepreneurship can be viewed as a strategic direction for increasing resource efficiency, reducing environmental pressure, and improving the long-term competitiveness of the national economy. At the same time, the practical significance of the study lies in identifying priority areas where green business solutions may have the greatest effect, primarily in households, transport, urban infrastructure, and circular economy initiatives. The findings may be useful for improving public support instruments for green SMEs, expanding green procurement practices, developing ESG-oriented approaches, and introducing KPI systems for evaluating the contribution of green entrepreneurship to sustainable development.

At the same time, the obtained results should be interpreted with due regard to the study's limitations. The empirical analysis is based on aggregate data on final energy consumption and its sectoral structure rather than on direct indicators of green entrepreneurship, such as the number of green enterprises, green investment volumes, sales of green products and services, or the sector's contribution to employment and value added. Therefore, the study does not measure the direct quantitative effect of green entrepreneurship on energy consumption dynamics, but rather substantiates its strategic relevance in the context of the identified energy trends. In addition, the forecasting results are based on a linear trend model applied to a relatively short time series, which limits the possibility of capturing structural breaks, non-linear effects, and the influence of external shocks. Moreover,



the use of national-level aggregate indicators does not fully reflect regional differences or sector-specific institutional conditions affecting the development of green business. These limitations determine the direction for further research, which may include the use of direct green entrepreneurship indicators, expanded econometric models, and more disaggregated data at the sectoral and regional levels.

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## ТҮПКІЛІКТІ ЭНЕРГИЯ ТҰТЫНУ ДИНАМИКАСЫ ЖӘНЕ ҰЛТТЫҚ ЭКОНОМИКАНЫҢ ТҰРАҚТЫ ДАМУЫ ТҮРҒЫСЫНАН ЖАСЫЛ КӘСІПкерлік

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**Түйін.** Зерттеудің өзектілігі шаруашылық қызметтің кеңеюі жағдайында электр энергиясын түпкілікті тұтынудың өсуімен және экономикаға түсетін ресурстық жүктеменің артуымен айқындалады. Экономикалық өсудің дәстүрлі моделі энергия сыйымдылығының ұлғаюымен және экологиялық тәуекелдердің күшеюімен қатар жүреді, бұл тұрақты даму нысандарына көшуді талап етеді. Осыған байланысты жасыл кәсіпкерлік экономиканың құрылымдық трансформациясының негізгі тетігі ретінде қарастырылады, ол экономикалық белсенділікті шектемей, ресурстар өнімділігін арттыруды және экологиялық жүктемені төмендетуді қамтамасыз етеді. Зерттеудің мақсаты – электр энергиясын түпкілікті тұтыну динамикасын талдау және жасыл кәсіпкерліктің ұлттық экономиканың тұрақты дамуының драйвері ретіндегі рөлін бағалау. Авторлар уақыт қатарларын статистикалық талдау әдістерін, трендтің болуын тексеруді, экономикалық-математикалық модельдеуді және сызықтық тренд моделі негізінде болжауды қолданды. Зерттеу нәтижелері уақыт қатарының волатильділігі төмен болған жағдайда энергия тұтынудың тұрақты өсу үрдісін және аномальді бақылаулардың жоқтығын көрсетті. Құрылған трендтік модель жоғары түсіндіру қабілетін көрсетті және орта мерзімді кезеңге нүктелік әрі интервалдық болжам жасауға мүмкіндік берді. Алынған бағалаулар электр энергиясын түпкілікті тұтынудың өсу динамикасының сақталатынын көрсетіп, энергия тиімді және экологиялық бағдарланған шешімдерге тұрақты сұраныс қалыптастыратынын айғақтайды. Қорытындыларда жасыл кәсіпкерліктің экономикалық өсуді энергетикалық және экологиялық шектеулермен үйлестірудің жүйелі факторы екені негізделді. Жасыл бизнес-модельдерді ауқымдау энергияның үлестік тұтынылуын төмендетуге, ресурстық тиімділікті арттыруға және ұлттық экономиканың бәсекелік артықшылықтарын қалыптастыруға ықпал етеді. Сондықтан жасыл секторды дамыту тұрақты өсудің стратегиялық бағыты ретінде қарастырылуы тиіс.

**Түйінді сөздер:** жасыл кәсіпкерлік, тұрақты даму, энергия тұтыну, экологиялық тұрақтылық, тиімділік, стратегия.

## ЗЕЛЕНЕ ПРЕДПРИНИМАТЕЛЬСТВО В КОНТЕКСТЕ ДИНАМИКИ КОНЕЧНОГО ПОТРЕБЛЕНИЯ ЭНЕРГИИ И УСТОЙЧИВОГО РАЗВИТИЯ НАЦИОНАЛЬНОЙ ЭКОНОМИКИ

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**Резюме.** Актуальность исследования обусловлена ростом конечного потребления электроэнергии и усилением ресурсной нагрузки на экономику в условиях расширения хозяйственной деятельности. Традиционная модель экономического роста сопровождается увеличением энергоёмкости и экологических рисков, требуя перехода к устойчивым формам развития. В этой связи зелёное предпринимательство рассматривается как ключевой механизм структурной трансформации экономики, обеспечивающий повышение производительности ресурсов и снижение экологической нагрузки без ограничения экономической активности. Цель исследования заключается в анализе динамики конечного потребления электроэнергии и оценке роли зелёного предпринимательства как драйвера устойчивого развития национальной экономики. Авторами применены методы статистического анализа временных рядов, проверка наличия тренда, экономико-математическое моделирование и прогнозирование на основе линейной трендовой модели. Результаты исследования показали устойчивую тенденцию роста энергопотребления при низкой волатильности временного ряда и отсутствии аномальных наблюдений. Построенная трендовая модель продемонстрировала высокую объясняющую способность и позволила сформировать точечный и интервальный прогноз на



среднесрочный период. Полученные оценки указывают на сохранение восходящей динамики конечного потребления электроэнергии, формируя устойчивый спрос на энергоэффективные и экологически ориентированные решения. В выводах обосновано, что зелёное предпринимательство выступает системным фактором согласования экономического роста с энергетическими и экологическими ограничениями. Масштабирование зелёных бизнес-моделей способствует снижению удельного потребления энергии, повышению ресурсной эффективности и формированию конкурентных преимуществ национальной экономики. Поэтому развитие зелёного сектора следует рассматривать как стратегическое направление устойчивого роста.

**Ключевые слова:** зеленое предпринимательство, устойчивое развитие, энергопотребление, экологичность, эффективность, стратегия

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