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SUSTAINABLE GROWTH IN KAZAKHSTAN: GREEN ECONOMY, DECARBONIZATION AND ENERGY TRANSITION

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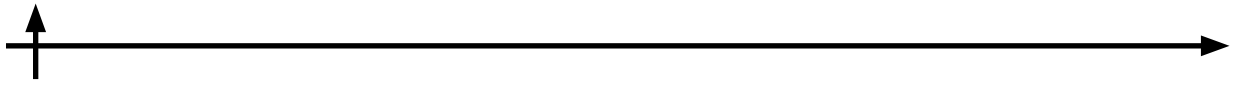
Abstract. This research paper is highly relevant in the context of global efforts towards sustainable development and climate change mitigation. It provides a comprehensive analysis of Kazakhstan's transition from a fossil fuel-dependent economy to a green economy, highlighting the country's unique challenges and opportunities in this transformative journey. The paper emphasizes the importance of legislative, strategic, and economic instruments in facilitating this shift, showcasing Kazakhstan's commitment to balancing economic growth with environmental sustainability. By examining Kazakhstan's approach to decarbonization, including investments in renewable energy and energy efficiency, the paper offers valuable insights for other resource-rich countries facing similar challenges. Overall, this research is significant for its contribution to understanding the complexities of transitioning to a sustainable energy future in the context of a heavily fossil fuel-reliant nation. The aim of this research is to explore and analyze the pathways through which Kazakhstan can achieve sustainable economic growth by integrating green economy principles, decarbonization strategies, and energy transition processes. This involves understanding the interplay between environmental sustainability, economic development, and energy sector transformation in the context of Kazakhstan's unique geographical, economic, and socio-political landscape.

Keywords: sustainable development, decarbonization, energy transition, environmental sustainability, energy sector

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УСТОЙЧИВОЕ РАЗВИТИЕ КАЗАХСТАНА: ЗЕЛЕНАЯ ЭКОНОМИКА, ЭНЕРГЕТИЧЕСКИЙ ПЕРЕХОД, ДЕКАРБОНИЗАЦИЯ

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Аннотация. Данное исследование посвящено всестороннему анализу перехода Казахстана от экономики, зависящей от ископаемого топлива, к "зеленой" экономике, а также уникальным проблемам и возможностям страны на пути преобразований в контексте глобальных усилий по обеспечению устойчивого развития и смягчению последствий изменения климата. В исследовании подчеркивается важность законодательных, стратегических и экономических инструментов для содействия этому переходу, демонстрируется стремление Казахстана сбалансировать экономический рост с экологической устойчивостью. Рассматривая подход Казахстана к декарбонизации, включая инвестиции в возобновляемые источники энергии и энергоэффективность, предлагаются идеи для других богатых ресурсами стран, сталкивающихся с аналогичными проблемами. В целом, данное исследование является важным вкладом в понимание сложностей перехода к устойчивому энергетическому будущему в условиях страны, в значительной степени зависящей от ископаемого топлива. Данная статья направлена на определение перспектив устойчивого экономического роста путем интеграции принципов "зеленой" экономики, стратегий декарбонизации и процессов энергетического перехода. При этом, особое внимание уделяется взаимосвязи между экологической устойчивостью, экономическим развитием и трансформацией энергетического сектора в контексте уникального географического, экономического и социально-политического ландшафта Казахстана.

Ключевые слова: устойчивое развитие, декарбонизация, энергетический переход, экологическая устойчивость, энергетический сектор

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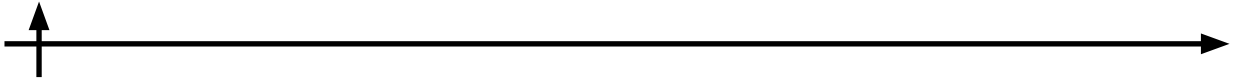
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Introduction

The transformation of energy systems, particularly through decarbonization, is a critical and multifaceted endeavour essential for the sustainable development of the global economy. As the world grapples with the escalating challenges of climate change, the shift from fossil fuels to renewable and cleaner energy sources becomes not just an environmental imperative but a cornerstone for future economic stability and social well-being.

The concept of the fourth energy transition in Kazakhstan, as discussed in a 2020 study, revolves around the shift to renewable energy sources. This transition is seen as a critical step for the country to emerge from socio-economic challenges and address the pressing issue of climate change. In this transformative phase, renewable energy and energy efficiency have a



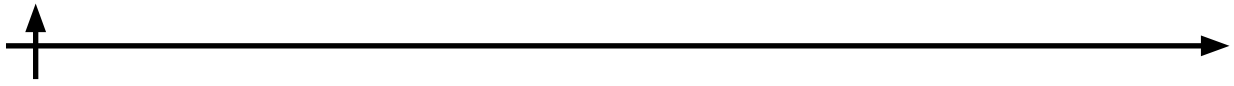
pivotal role (Assem, 2020). Decarbonization, the process of reducing carbon dioxide emissions, is central to this transformation. It involves a comprehensive shift in the energy sector, moving away from carbon-intensive sources like coal, oil, and natural gas to embrace renewable energies such as solar, wind, and hydropower. This transition is more than a technical shift; it encompasses socio-economic changes, policy innovation, and a reimagining of how energy is consumed and produced. The continuous worldwide shift towards a low-carbon economy has garnered significant attention in recent times (Zhakiyev, 2022).

This transformation is also deeply intertwined with economic considerations. The global economy, long dependent on fossil fuels, faces the challenge of transitioning to a system that not only sustains economic growth but also adapts to the realities of a finite planet. This shift presents both challenges and opportunities. On one hand, it requires massive investments and the phasing out of industries that have been economic staples for centuries. On the other, it opens up new avenues for innovation, job creation, and economic diversification in the burgeoning green economy. Technological innovation plays a pivotal role in this transition. Advances in renewable energy technologies, energy storage solutions, smart grid developments, and improvements in energy efficiency are not only crucial for reducing greenhouse gas emissions but also present significant economic opportunities. The growth of green industries is poised to drive job creation, foster new markets, and stimulate economic growth, aligning environmental objectives with economic development.

Research conducted in 2020 on decarbonization strategies for developing Asia, including Kazakhstan, aligns with the objectives of the Paris Agreement. The study suggests a drastic overhaul of the energy portfolio, advocating for a decrease in fossil fuel use and an increase in low-carbon energy sources. This shift is deemed essential for substantial reductions in CO₂ emissions and meeting global climate targets (Wenji, 2020).

Moreover, the global nature of climate change necessitates international cooperation. While agreements like the Paris represent a collective commitment to emission reduction, more robust and concerted global efforts are required. A study focusing on Kuwait, yet relevant to Kazakhstan, examines the role of energy transition and economic diversification in implementing climate agreements. It highlights the necessity for transitioning from fossil fuels to renewable energy sources. The research points out the critical need for policy reforms, energy pricing adjustments, and efficient energy consumption management for a successful transition (Hilmi, 2020). Effective policy frameworks are essential in facilitating this energy transition. Policies such as carbon pricing, renewable energy subsidies, energy efficiency regulations, and support for research and development are key components. The social implications of the energy transition are profound and wide-ranging. Ensuring equitable access to clean energy, addressing the needs of communities transitioning away from fossil fuels, and fostering public engagement are critical for a just transition. These social dimensions highlight the need for policies that are environmentally sound and socially equitable.

Kazakhstan, a country with a significant legacy in fossil fuel production, is now embarking on a transformative journey towards a greener and more sustainable future. This transition is not merely a response to the global call for environmental stewardship but also a strategic move towards ensuring long-term economic prosperity and stability. The nation's vast natural resources, including oil, coal, and gas, have historically been the backbone of its economy. However, the growing awareness of climate change impacts and the global shift towards renewable energy sources have prompted Kazakhstan to reevaluate and reshape its energy strategy. The concept of decarbonization, which involves reducing carbon dioxide emissions to minimize the effects of climate change, is central to this transformation. For Kazakhstan, this means diversifying its energy portfolio, investing in renewable energy sources like wind, solar, and hydroelectric



power, and enhancing energy efficiency across various sectors. This shift is not just environmentally significant but also economically strategic, opening up new avenues for growth and development in the green energy sector. Kazakhstan's energy transition is also closely tied to its broader economic ambitions. As the country seeks to position itself as a regional leader and a competitive player in the global market, transitioning to a more sustainable energy system is key. This involves not only harnessing renewable energy sources but also implementing policies and frameworks that encourage innovation, attract investments, and foster a conducive environment for the growth of new, sustainable industries.

Moreover, this transition has profound social implications. Ensuring equitable access to energy, creating new job opportunities in the green sector, and addressing the socio-economic impacts of moving away from fossil fuels are critical considerations. Kazakhstan's approach to this energy transition can serve as a model for balancing economic growth with environmental sustainability and social equity.

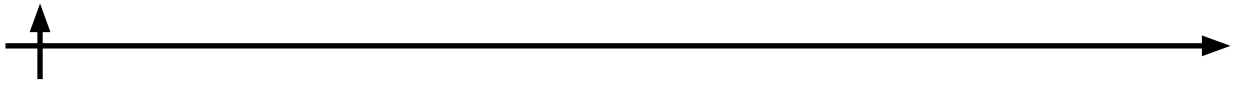
In summary, the shift towards decarbonized energy systems is a crucial and complex process, pivotal for achieving a sustainable and resilient global economy. This transformation transcends mere technological change, encompassing comprehensive socio-economic restructuring, innovative policy-making, and inclusive social strategies (Li, 2023). It represents not just a challenge but a significant opportunity to harmonize environmental sustainability with economic growth and social equity. As we navigate this path, the collective efforts in technology, policy, and societal engagement will shape a future that is not only environmentally sound but also prosperous and equitable for all. This process, while daunting, is a vital step towards a more sustainable and promising future for generations to come.

Materials and Methods

The research adopts a mixed-methods approach, blending qualitative and quantitative data to comprehensively analyze Kazakhstan's shift towards a green economy. Central to the study is an extensive literature review, encompassing academic papers, government reports, and industry analyses, to understand the historical and current dynamics of Kazakhstan's energy sector. Quantitative data collection focuses on key statistics related to energy production, consumption, carbon emissions, and the growth of renewable energy in Kazakhstan. Complementing this, qualitative data is derived from policy documents, strategic plans, and expert interviews, offering insights into the motivations and strategies behind the country's energy transition.

A descriptive analysis method is employed to present a clear picture of Kazakhstan's current energy landscape, highlighting its reliance on fossil fuels and the strides made in renewable energy adoption. This is paired with a comparative analysis, where Kazakhstan's energy policies and transition strategies are juxtaposed with those of countries in similar economic and geographical situations. Additionally, policy analysis is conducted to assess the effectiveness of Kazakhstan's legislative and economic measures in promoting sustainable energy practices (Muslimov, 2022).

The study also incorporates case studies of successful renewable energy projects and green economy initiatives within Kazakhstan, providing practical examples of theoretical strategies in action. Interviews with industry experts and policymakers are conducted to gain direct insights into the challenges and future directions of Kazakhstan's energy transition. The methodology, while comprehensive, acknowledges its limitations and maintains strict adherence to ethical research standards, ensuring a balanced and thorough exploration of Kazakhstan's journey to-



wards a sustainable energy future.

Results and Discussion

Kazakhstan's energy landscape is characterized by a heavy reliance on fossil fuels, a legacy of its vast natural resources and historical development patterns. As the world's 9th largest country in terms of land area and blessed with substantial reserves of oil, coal, and natural gas, Kazakhstan has long been a significant player in the global energy market. This section of the article would explore various aspects of Kazakhstan's current energy landscape (Brodach, 2021).

Kazakhstan ranks among the top countries in terms of oil and coal reserves. It is a major oil producer, with the petroleum sector playing a dominant role in its economy. The country also has substantial coal reserves, making it one of the top coal producers globally. Natural gas, although less prominent than oil and coal, is also a significant part of the energy mix.

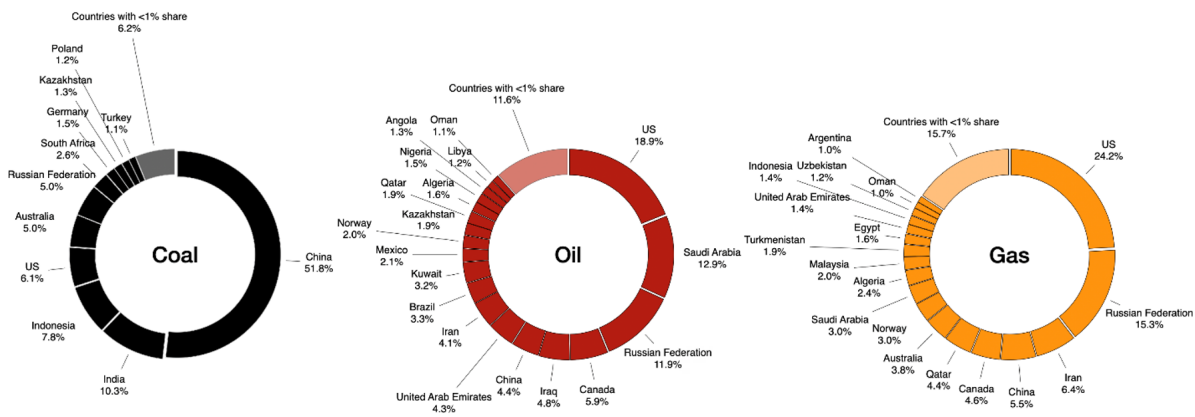
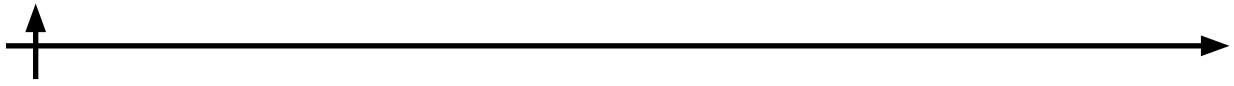


Fig. 1. Stages of RPA technology implementation at an industrial enterprise

Coal production reached a record high, oil production was 99% of the record level set in 2019, and gas production was 99.8% of the record level set in 2021 (Gulf Studies, 2023). Only nine countries produced a 5% or greater share of a fossil fuel in 2022: China, India, Indonesia, the US, Australia, Russia, Saudi Arabia, Canada, and Iran (Statistical Review, 2023). Kazakhstan is among the top 10 countries in terms of proven coal reserves of 1.3% of world reserves (chart 1), where 2/3 is brown coal, 1/3 is hard coal. The largest coal basins are located in the central and northern parts of the country: Ekibastuz (10 billion tons), Karaganda (6.9 billion tons) and Turgai (5.9 billion tons) (77.5% of proven coal reserves) (World Fossil Fuel Production & Primary Energy, 2023).

Humanity consumed oil at a rate equivalent to 622 million litres per hour continuously (157 million US gallons per hour). This is an increase of 27 million litres per hour over the rate in 2021 of 595 million litres per hour [5]. The oil and gas complex of Kazakhstan plays a significant role in the development of the country, provides a significant part of tax revenues to the country's budget and forms about a quarter of GDP. Since gaining independence, the volume of oil and gas condensate production in the republic has increased by more than three and a half times: from 25 million tons. up to 90.5 million tons per year in 2019. Kazakhstan ranks 17th among countries in the world in oil production. The main hydrocarbon production in Kazakhstan is concentrated in three largest fields: Tengiz, Karachaganak and Kashagan, the development of which is carried out by established consortia with the participation of transnational vertically integrated companies (Altukhova, 2023). To maintain and increase production at large fields, projects to expand and extend the achieved production level are being imple-



mented. The achievements of the oil and gas sector of Kazakhstan include the discovery of the Kashagan field, which is one of the 10 largest fields in the world. The achieved production level at Kashagan is 400,000 barrels per day.

Decarbonization in Kazakhstan is a significant process, given the country's status as a major energy producer and its reliance on fossil fuels. Kazakhstan, the largest landlocked country in the world, is rich in natural resources, including substantial fossil fuel reserves, minerals, and metals. It is also one of the largest emitters of greenhouse gases (GHGs) per capita in Central Asia. The decarbonization process in Kazakhstan involves transitioning from this heavy reliance on fossil fuels to more sustainable energy sources, in line with global efforts to combat climate change (Allahhah, 2023; Fadeev, 2023). Kazakhstan's energy sector is heavily reliant on coal, oil, and natural gas. Coal, particularly, has been a dominant source of energy, used extensively for electricity generation and heating. This reliance has contributed to high levels of carbon dioxide (CO₂) emissions. In recent years, Kazakhstan has been among the top 30 CO₂ emitters globally, with the energy sector accounting for a significant portion of these emissions. Focusing on marketing strategies for decarbonization within Kazakhstan's energy sector is crucial. Such strategies should aim to advance the concepts of decarbonization, a green economy, and ecological awareness in the energy market, highlighting the significance of servitization and motivational shifts to embrace green technologies (Economic Research Institute, 2023; Aizhana, 2022).

Kazakhstan has recognized the need for decarbonization and has taken steps towards this goal:

1. **Renewable Energy Development:** The country has been gradually increasing its investment in renewable energy sources, such as wind, solar, and hydroelectric power. As of recent data, renewable energy sources (excluding hydroelectric) account for a small but growing percentage of Kazakhstan's total energy mix.

2. **Policy Initiatives:** Kazakhstan has implemented various policies aimed at reducing GHG emissions. This includes the introduction of an emissions trading system (ETS) in 2013, which was one of the first of its kind in Asia.

3. **International Commitments:** Kazakhstan is a party to the Paris Agreement and has committed to reducing its GHG emissions. The country has set targets to decrease its GHG emissions to a certain percentage below 1990 levels by 2030.

The decarbonization process in Kazakhstan faces several challenges:

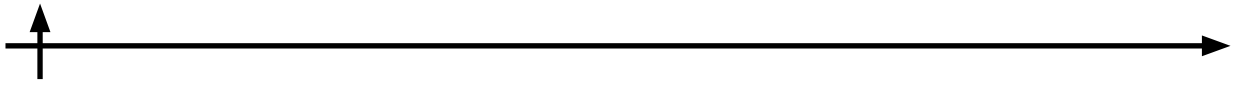
1. **Economic Dependency:** The economy is heavily reliant on the export of fossil fuels, making the transition to a low-carbon economy challenging.

2. **Infrastructure and Investment:** There is a need for significant investment in renewable energy infrastructure and technology.

3. **Policy and Regulatory Framework:** Effective implementation of policies and regulations supporting renewable energy and energy efficiency is crucial.

Some studies examined the economic and ecological challenges and advantages in the development of various energy sources in Kazakhstan. One study analysed the cost-effectiveness of conventional and unconventional hydrocarbon, non-hydrocarbon, and renewable energy sources, highlighting the environmental benefits of non-traditional energy sources like biometane (Poljanskihh, 2018).

There was a study that examined the environmental impact of energy production, focusing on the potential and obstacles of wind energy in Kazakhstan. It evaluated wind power production possibilities in 42 different areas across the nation, pinpointing regions with significant potential for economic feasibility and reduction in emissions, underscoring the need for policy measures to promote wind energy adoption (Ivakhnenko, 2020; Jianzhong, 2018).



However, there are also opportunities:

1. **Abundant Renewable Resources:** Kazakhstan has significant potential for solar and wind energy development, given its vast territory and favourable climatic conditions.
2. **Diversification of Economy:** Transitioning to a green economy presents an opportunity for economic diversification and sustainable development (Makarov, 2021).
3. **International Cooperation:** Kazakhstan can leverage international partnerships and investments to accelerate its decarbonization process.

Decarbonization in Kazakhstan is a complex but essential process, requiring concerted efforts from the government, private sector, and international community. While challenges exist, the potential benefits of a transition to a low-carbon economy are significant, including improved environmental quality, sustainable economic development, and enhanced energy security. Continued monitoring and adaptation of strategies will be key to achieving Kazakhstan's decarbonization goals (Zharov, 2021).

Institutional instruments and economic mechanisms represent key elements in the green economy development strategy in Kazakhstan. These instruments and mechanisms, covering a wide range of policy and financial initiatives, form the basis for the transition to sustainable economic development (Dlimbetova, 2016). To review existing measures and their effectiveness, the tools and mechanisms of the green economy in Kazakhstan are systematized, including examples of their practical application (table 1).

The development of a green economy in Kazakhstan is supported by a number of institutional instruments:

1. **Legislation:** The basis of legislative support is the “Ecological Code of the Republic of Kazakhstan”, “Law on Supporting the Use of Renewable Energy Sources” and other regulations aimed at environmental protection and sustainable use of natural resources.
2. **Strategic planning:** An important step was the development and implementation of the national strategy “Kazakhstan 2050”, which provides comprehensive measures for the transition to a green economy.
3. **Government programs:** Programs are being implemented to improve air quality, and energy efficiency, develop alternative energy sources and preserve biodiversity.

Economic mechanisms for a green economy in Kazakhstan include:

1. **Tax policy:** Introduction of tax incentives for enterprises using environmentally friendly technologies and taxation of environmental polluters.
2. **Funding:** Government funding for research and development in the field of green technologies, as well as support for private investment in sustainable projects.
3. **Market instruments:** Development of a system of “green” public procurement and stimulation of the production of environmentally friendly goods.

Examples of green economy implementation in Kazakhstan include:

1. **Renewable energy:** Projects for the construction of wind and solar power plants aimed at increasing the share of renewable sources in the country's energy balance.
2. **Energy efficiency:** Programs to improve energy efficiency in industry and the residential sector, including modernization of infrastructure and the use of energy-saving technologies.
3. **Environmental education:** Implementation of educational programs and campaigns on sustainable development and ecology aimed at increasing the environmental awareness of the population.

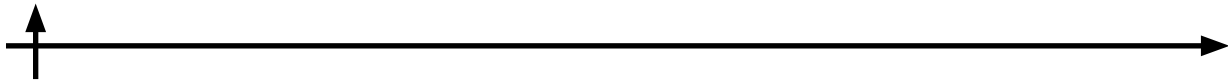
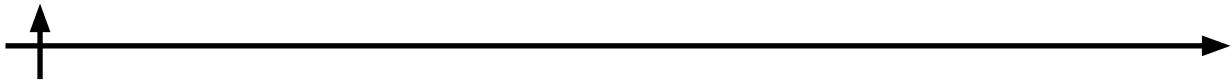


Table 1. Tools and mechanisms of green economy in Kazakhstan: overview and examples

Tools and mechanisms	Description	Examples of implementation of tools and mechanisms for the development of a green economy in Kazakhstan
Legislation and regulation	Development and implementation of laws and regulations aimed at environmental protection, energy efficiency and sustainable use of resources.	<p>Environmental Code of the Republic of Kazakhstan; Concept of the transition of the Republic of Kazakhstan to a green economy; Renewable Energy Support Act; Water Code of the Republic of Kazakhstan; Programs to improve urban air quality, including strict emissions standards for industrial plants; Kazakhstan 2050 Strategy; Action plan for environmental education and training in organizations of preschool, secondary, technical and vocational education for 2023-2029; Law on the protection of wildlife of the Republic of Kazakhstan; National project “Strong Regions – Driver of the Country’s Development”; Regulation of the use of land resources to prevent their degradation and ensure sustainable land use, etc (Yesekina, 2021).</p>
Economic incentives	Introduce carbon taxes, incentives and subsidies to support environmentally sustainable practices and technologies.	<p>Tax incentives and subsidies to stimulate the use of renewable energy sources, including the development of solar and wind energy; Development of green finance through grants and loans for environmentally sustainable projects; Tax incentives for projects to improve the energy efficiency of buildings and structures; Development of a program to support energy-saving technologies in housing and communal services; Introduction of a “green” public procurement system that stimulates the production and consumption of environmentally friendly goods and services, etc.</p>
Investments in green technologies	Funding research, development and deployment of clean technologies, including renewable energy.	<p>Projects for the construction of wind and solar power plants, as well as initiatives to improve energy efficiency in urban infrastructure; Development and implementation of technologies for wastewater treatment and waste disposal; Projects to create “green” cities, including integrated waste and water management systems. Creation of the National Fund for Sustainable Development, the purpose of which is to finance projects in the field of renewable energy and ecology; Development of projects for the implementation of “smart cities”, including technologies for smart management of energy resources and infrastructure; Development of projects for the disposal and processing of solid household waste, including the construction of waste treatment plants, etc.</p>
Education and awareness	Development of educational programs and information campaigns to raise awareness of the importance of sustainable development.	<p>Development of educational programs and courses on sustainable development and ecology in schools and universities, as well as information campaigns to increase environmental awareness among the population; Cooperation with international organizations to exchange knowledge and best practices in the field of environmental education; Organization and holding of national and regional environmental forums and conferences to discuss issues of sustainable development, etc.</p>
International cooperation	Participation in international environmental programs and agreements, cooperation with other countries in the field of sustainable development.	<p>Kazakhstan's participation in international environmental agreements, such as the Paris Climate Agreement, and cooperation with other countries and international organizations in the field of environmental sustainability, etc.</p>



Corporate Social Responsibility	Encouraging companies to adopt sustainable development practices and minimize the environmental impact of their activities.	Introduction of sustainable development standards in the activities of large oil and gas companies; Programs to reduce the carbon footprint and transition to green energy in industry, etc.
Support for local initiatives	Involving local communities in the development and implementation of sustainable practices and projects.	Development of sustainable agriculture, including organic farming and the use of renewable energy sources in the agricultural sector; Projects to introduce environmentally friendly public transport in large cities, etc.
Note: compiled by the authors		

The development of a green economy in Kazakhstan is a complex process that includes legislative, strategic and economic instruments. These measures aim to achieve a balance between economic growth, environmental sustainability and social well-being, which is key to the country's sustainable development in the long term.

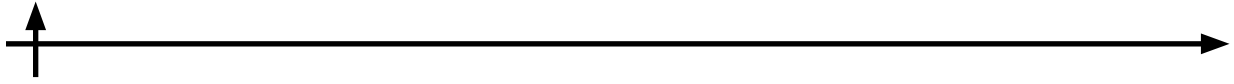
Conclusion

The process of Kazakhstan towards a green economy, as detailed in this paper, is a testament to the country's commitment to sustainable development amidst its heavy reliance on fossil fuels. The analysis of Kazakhstan's current energy landscape, institutional instruments, and economic mechanisms reveals a nation at a pivotal point of transformation, balancing its rich natural resource endowment with the global imperative for environmental stewardship and sustainable economic practices.

Kazakhstan's status as a significant global player in the fossil fuel market, with vast reserves of oil, coal, and natural gas, has historically shaped its economy. However, the global shift towards renewable energy and the urgent need to address climate change have prompted a strategic reorientation towards decarbonization. This transition, while challenging due to the country's economic dependency on fossil fuels, is seen as essential for future economic stability, environmental sustainability, and social well-being. The country's approach to decarbonization, which involves a comprehensive shift from carbon-intensive energy sources to renewables like solar, wind, and hydro power, is a bold step towards aligning with global climate goals. This transition is supported by a robust framework of institutional instruments and economic mechanisms. Legislative measures, strategic planning, and government programs form the backbone of this framework, guiding the nation towards its 2050 green economy goals.

Economic mechanisms, including tax incentives, government funding, and market instruments, play a crucial role in facilitating this transition. These measures not only encourage the adoption of environmentally friendly technologies but also aim to foster a conducive environment for sustainable economic growth. The practical applications of these policies, evident in renewable energy projects, energy efficiency programs, and environmental education initiatives, demonstrate Kazakhstan's proactive steps towards a sustainable future. Development of a green economy in Kazakhstan is a complex yet vital endeavor. It requires balancing economic growth with environmental sustainability and social equity. The nation's efforts to diversify its energy portfolio, invest in renewable energy, and enhance energy efficiency are commendable steps towards reducing its carbon footprint and contributing to global climate change mitigation efforts.

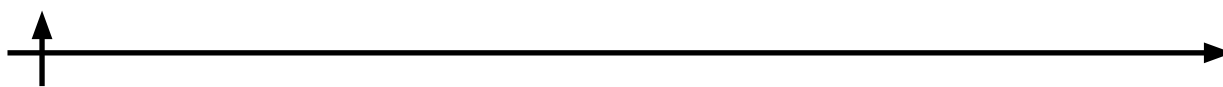
In conclusion, Kazakhstan's process towards a green economy and sustainable development



is a multifaceted process that encompasses legislative, strategic, and economic dimensions. It reflects a deep understanding of the need to harmonize economic development with environmental sustainability. As Kazakhstan continues to navigate this green transition, its experiences and strategies offer valuable insights for other resource-rich countries embarking on similar paths. The nation's commitment to a sustainable and resilient energy future not only positions it as a regional leader in green economy practices but also as a key player in the global effort to combat climate change.

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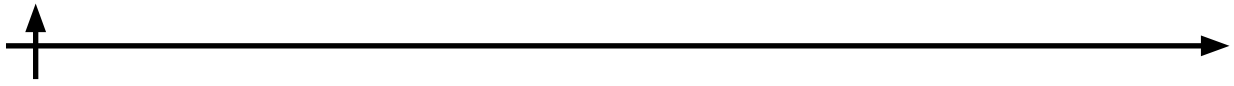
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