ENERGY TRANSFORMATION IN CENTRAL ASIA AND THE CAUCASUS REGION AND MAIN DIRECTIONS OF REGIONAL COOPERATION OPPORTUNITIES

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Abstract
The main objective of the study is to analyze the opportunities, challenges, and regional cooperation potential of the green energy transition in Central Asia and the Caucasus region, with a particular focus on assessing the strategic importance of the "Trans-Caspian Green Energy Corridor" project.
The study employs descriptive and analytical methods, conducting comparative analysis based on reports from international organizations, official statistical data, and strategic documents. A qualitative approach is predominantly used in evaluating normative and institutional frameworks.
The establishment of effective cooperation mechanisms among regional countries in the energy sector, the realization of renewable energy potential, and the modernization of energy infrastructure in accordance with international standards may accelerate the energy transition. In this regard, the "Green Energy Corridor" is considered a strategic platform. Furthermore, the application of innovative technologies and the development of digital energy management systems may significantly contribute to increasing energy efficiency.
Political and economic asymmetry, technological inequality, institutional incompatibility, and limited access to financial resources among regional countries are the main factors complicating integration. At the same time, attracting international investments and expanding public-private sector cooperation may support the elimination of existing challenges.
The research presents a comprehensive approach by analyzing regional energy cooperation within the context of energy security and climate change through a unified framework. The article examines both the geo-economic and political aspects of green energy corridors in an integrated manner. This approach contributes to a relatively underexplored area in the existing literature. At the same time, strengthening regional cooperation may play an important role in ensuring long-term energy security. The findings of the study can serve as an analytical basis for the formation of sustainable energy policies, the planning of strategic energy projects, and the strengthening of international partnerships for Azerbaijan and other regional countries.
Keywords: *green energy, renewable energy, energy transition, Central Asia, Caucasus region, regional cooperation.*

MƏRKƏZİ ASİYA VƏ QAFQAZ REGİONUNDA ENERJİ TRANSFORMASİYASI VƏ REGİONAL ƏMƏKDAŞLIQ İMKANLARININ ƏSAS İSTİQAMƏTLƏRİ

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Xülasə

Mərkəzi Asiya və Qafqaz regionunda yaşıl enerji keçidinin imkanlarını, çağırışlarını və regional əməkdaşlıq potensialını təhlil etmək, xüsusilə "Transxəzər Yaşıl Enerji Dəhlizi" layihəsinin strateji əhəmiyyətini qiymətləndirməkdir.
Tədqiqatda deskriptiv və analitik metodlardan istifadə olunmuş, beynəlxalq təşkilatların hesabatları, rəsmi statistik məlumatlar və strateji sənədlər əsasında müqayisəli təhlil aparılmışdır. Normativ və institusional çərçivələrin qiymətləndirilməsində keyfiyyət əsaslı yanaşma üstünlük təşkil etmişdir. Region ölkələri arasında enerji sahəsində səmərəli əməkdaşlıq mexanizmlərinin yaradılması, bərpa olunan enerji potensialının reallaşdırılması və enerji infrastrukturunun beynəlxalq standartlara uyğun modernizasiyası enerji keçidini sürətləndirə bilər. “Yaşıl Enerji Dəhlizi” bu baxımdan strateji platforma kimi qiymətləndirilir. Bundan əlavə, innovativ texnologiyaların tətbiqi və rəqəmsal enerji idarəetmə sistemlərinin inkişafı enerji səmərəliliyinin artırılmasına mühüm töhfə verə bilər. Region ölkələri arasında siyasi-iqtisadi asimmetriya, texnoloji qeyri-bərabərlik, institusional uyğunsuzluq və maliyyə resurslarına çıxış imkanlarının məhdudluğu inteqrasiyanı çətinləşdirən əsas amillərdir. Bununla yanaşı, beynəlxalq investisiyaların cəlb olunması və dövlət-özəl sektor əməkdaşlığının genişləndirilməsi mövcud problemlərin aradan qaldırılmasına dəstək göstərə bilər. Tədqiqat, enerji təhlükəsizliyi və iqlim dəyişiklikləri kontekstində regional enerji əməkdaşlığını vahid yanaşma çərçivəsində analiz etməklə kompleks yanaşma təqdim edir. Məqalədə yaşıl enerji dəhlizlərinin həm geoiqtisadi, həm də siyasi aspektlərinin birgə təhlili aparılmışdır. Bu yanaşma mövcud ədəbiyyatda az işlənmiş bir sahəyə töhfə verir. Eyni zamanda, regional əməkdaşlığın gücləndirilməsi uzunmüddətli enerji təhlükəsizliyinin təmin edilməsində mühüm rol oynaya bilər. Tədqiqat nəticələri Azərbaycan və region ölkələri üçün dayanıqlı enerji siyasətinin formalaşdırılması, strateji enerji layihələrinin planlaşdırılması və beynəlxalq tərəfdaşlıqların gücləndirilməsi üçün analitik əsas kimi istifadə oluna bilər.

Açar sözlər: *yaşıl enerji, bərpa olunan enerji, enerji keçidi, Mərkəzi Asiya, Qafqaz regionu, regional əməkdaşlıq*

ЭНЕРГЕТИЧЕСКАЯ ТРАНСФОРМАЦИЯ В ЦЕНТРАЛЬНОЙ АЗИИ И КАВКАЗСКОМ РЕГИОНЕ И ОСНОВНЫЕ НАПРАВЛЕНИЯ РЕГИОНАЛЬНОГО СОТРУДНИЧЕСТВА

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Резюме
Основная цель исследования заключается в анализе возможностей, вызовов и потенциала регионального сотрудничества в процессе перехода к зеленой энергетике в Центральной Азии и Кавказском регионе, с особым акцентом на оценку стратегической значимости проекта «Транскаспийский зеленый энергетический коридор».
В исследовании использованы описательные и аналитические методы, проведен сравнительный анализ на основе отчетов международных организаций, официальных статистических данных и стратегических документов. При оценке нормативных и институциональных рамок преобладал качественный подход.
Создание эффективных механизмов сотрудничества между странами региона в энергетической сфере, реализация потенциала возобновляемой энергетики и модернизация энергетической инфраструктуры в соответствии с международными стандартами могут ускорить энергетический переход. В этом контексте «Зелёный энергетический коридор» рассматривается как стратегическая платформа. Кроме того, внедрение инновационных технологий и развитие цифровых систем управления энергетикой могут существенно повысить энергоэффективность.
Политико-экономическая асимметрия, технологическое неравенство, институциональная несогласованность и ограниченный доступ к финансовым ресурсам между странами региона являются основными факторами, затрудняющими интеграцию. Вместе с тем привлечение международных инвестиций и расширение сотрудничества между государственным и частным секторами могут способствовать преодолению существующих проблем.
Исследование представляет комплексный подход к анализу регионального энергетического сотрудничества в контексте энергетической безопасности и изменения климата. В статье совместно анализируются как геоэкономические, так и политические аспекты зелёных энергетических коридоров. Данный подход вносит вклад в сравнительно малоизученную область существующей литературы. В то же время укрепление регионального сотрудничества может сыграть важную роль в обеспечении долгосрочной энергетической безопасности.
Результаты исследования могут быть использованы в качестве аналитической основы для формирования устойчивой энергетической политики, планирования стратегических энергетических проектов и укрепления международного партнёрства для Азербайджана и стран региона.
Ключевые слова: *зеленая энергетика, возобновляемая энергетика, энергетический переход, Центральная Азия, Кавказский регион, региональное сотрудничество.*

INTRODUCTION

In the modern world, the transition to green energy is of strategic importance not only in terms of environmental protection but also in terms of socio-economic stability and energy security. This transition process, based on sustainability principles, stands at the center of global efforts to combat climate change. The use of renewable energy sources—especially solar, wind, hydro, and geothermal energy—contributes to maintaining ecological balance by significantly reducing carbon emissions released into the atmosphere.

In recent years, the increase in investments directed toward green energy projects by both the public and private sectors has further strengthened the innovation potential in this field. As a result of technological advancement, innovations such as high-efficiency photovoltaic solar panels, next-generation wind turbines, and energy storage systems are being developed. These technologies not only enhance efficiency in energy production and consumption but also lead to cost reductions and create opportunities for large-scale implementation.

In addition, the transition to green energy sources plays an important role in ensuring the energy independence of countries. Reducing dependence on fossil fuels, minimizing the need for imported energy carriers, and strengthening domestic energy production have become priority issues in national security strategies. This approach also serves to increase economic resilience and reduce risks arising from price volatility in energy markets.

Smart energy grids facilitate the integration of renewable energy sources into the system, enabling more efficient management of energy supply and demand. Through these technologies, the flexibility of energy production increases, losses decrease, and it becomes possible to adapt to real-time energy demand. At the same time, the expansion of green energy applications is observed in sectors such as transportation, industry, and agriculture, and this process ultimately paves the way for alternative energy solutions to replace fossil fuels.

Within the framework of combating climate change, the importance of international cooperation is steadily increasing. Countries seek more effective and mutually beneficial solutions by sharing their green energy policies and practices. This creates significant advantages not only environmentally but also economically and geopolitically. The development of green energy offers great opportunities for creating a cleaner and healthier world.

In this context, it is worth noting that countries such as Azerbaijan, Kazakhstan, and Uzbekistan—leading states of the Central Asia and Caucasus region with rich fossil fuel resources—are also among those successfully implementing the green energy transition. The steps taken by these countries toward sustainability and environmental protection can also be assessed as sound strategies aimed at strengthening energy security.

In particular, Azerbaijan’s hosting of COP29 last year marked an important turning point. Within the framework of this international event, “green energy corridor” projects were presented, aimed at promoting the development of renewable energy and enhancing energy integration among regional countries. These initiatives are considered significant progress in terms of coordinating energy systems and strengthening regional cooperation.

This study analyzes the opportunities, challenges, and regional cooperation potential of the green energy transition in Central Asia and the Caucasus region, examining the role of renewable energy sources in the region’s energy transformation and exploring the prospects for ensuring “green development.”

MAIN PERSPECTIVES OF ENERGY TRANSFORMATION IN CENTRAL ASIA AND THE CAUCASUS REGION

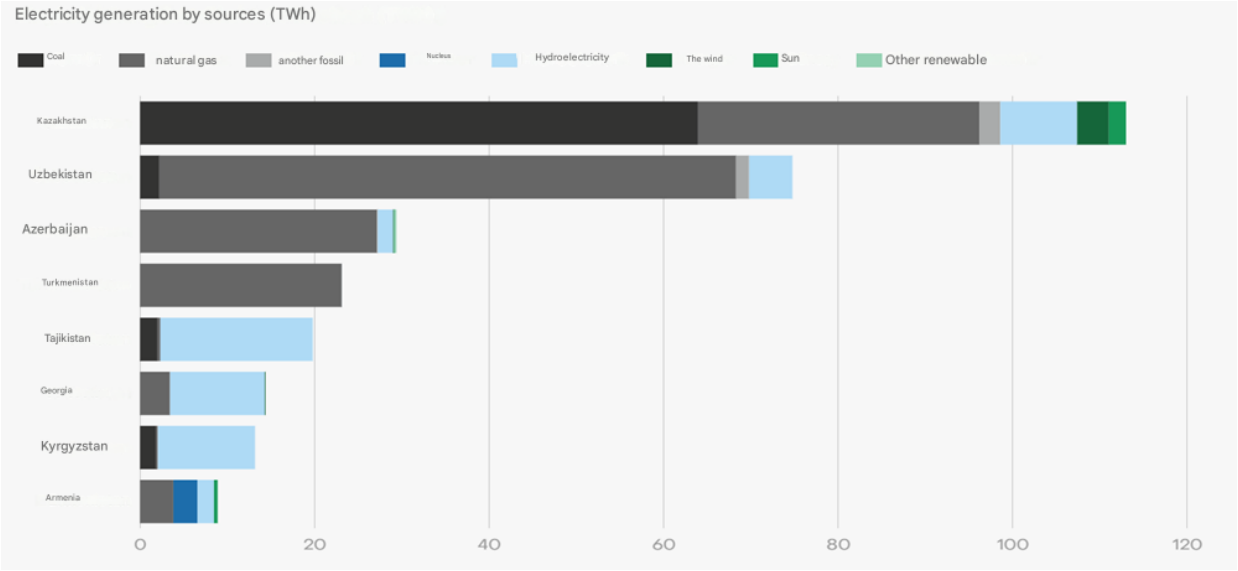
While large-scale research in the field of renewable energy has been conducted in developed countries, relatively limited attention has been given to the decarbonization of energy systems in less developed regions. However, these regions are not only more vulnerable to the negative impacts of climate change, but also possess rapidly growing domestic energy demand and are rich in natural resources that are vital for the energy transition. In this regard, the Central Asia and Caucasus region represents a particularly interesting subject of study due to both its strategic geographical location and its resource potential.

Following the collapse of the Soviet Union in 1991, the countries of Central Asia and the Caucasus have played a significant role in the global economic system primarily as suppliers of fossil energy resources, particularly oil and natural gas, which has been widely reflected in existing academic literature. Nevertheless, in recent years, against the backdrop of increasing global demand for clean energy and strategic materials contributing to the energy transition, the potential and role of Central Asia and Caucasus countries in this field have increasingly become the focus of academic research (Sulaimanova et al., 2023).

The Central Asian region has already demonstrated its potential for cooperation among neighboring countries through large-scale hydroelectric projects. This cooperation can be further expanded by utilizing the windy northern and sunny southern parts of the region. Thus, green energy is becoming not only a climate objective but also a strategic tool for regional stability, energy security, and sustainable economic development.

Electricity generation in Central Asia and the Caucasus largely depends on fossil fuels. The weak interconnection of electricity grids across the region and the lack of diversity in energy sources create difficulties in meeting the growing demand for electricity, thereby creating significant opportunities for the development of green energy corridors. The following graph illustrates electricity generation by different sources in the Central Asia and Caucasus region (Graph 1).

Graph 1. *Electricity generation by different sources, kWh*



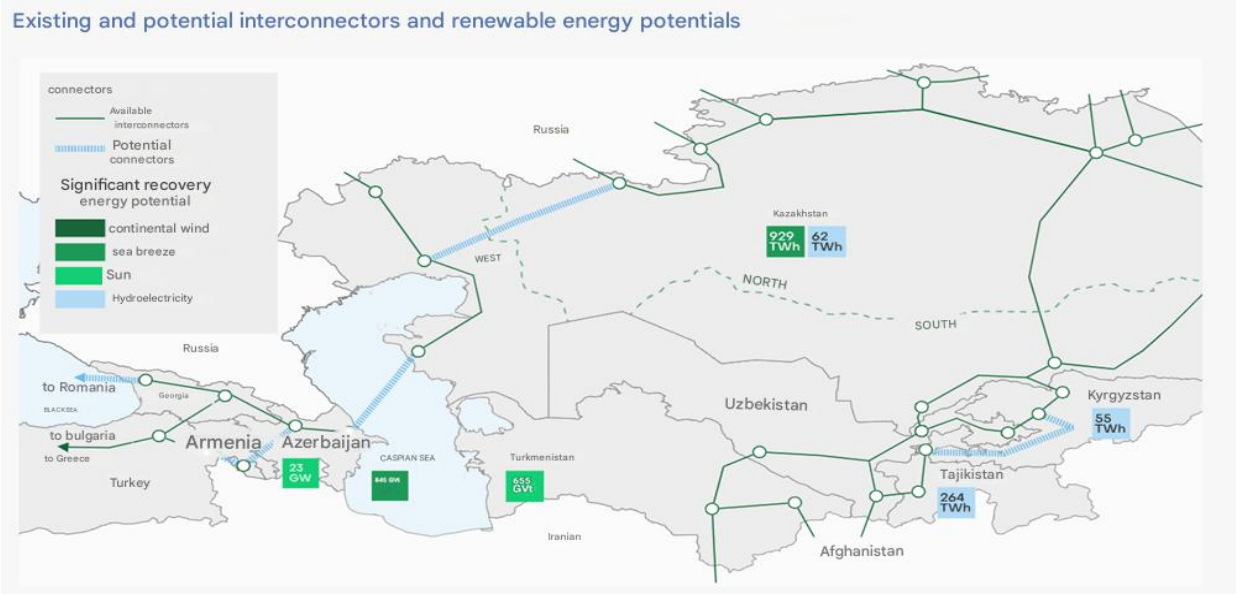
Source: *Ember Energy, 2025.*

Dependence on fossil fuels in the region varies from country to country. Turkmenistan (99%), Uzbekistan (94%), and Azerbaijan (89%) generate the majority of their electricity from natural gas. Overall, natural gas accounts for more than half of electricity generation in the region. On the other hand, in Kazakhstan, coal serves as the main energy source, meeting 57% of electricity demand, while natural gas holds a 29% share. Hydropower remains the only significant renewable energy source in the region, accounting for between 76% and 88% of electricity generation in Tajikistan, Kyrgyzstan, and Georgia.

As a result of this situation, electricity generation in Central Asia and the Caucasus produces higher carbon emissions compared to Turkey—a G20 country dependent on coal—despite Turkey's electricity demand being 8% higher. The region generates 239 million tons of CO_2 emissions annually, which is 62% more than Turkey's emissions (Ember Energy, 2025).

The Central Asia and Caucasus region possesses geographical diversity that offers a complementary renewable energy profile, with high wind potential in the north, strong solar energy potential in the south, and hydropower opportunities around the region's two major rivers in the east. The distribution of renewable electricity across the region through interconnectors can help balance supply and demand under different conditions and times, enabling the provision of affordable and reliable electricity. The following graph presents the renewable energy potential of the Central Asia and Caucasus region (Figure 1).

***Figure 1**. Existing and potential interconnectors and renewable energy potentials*



***Source:** Ember Energy, 2025.*

When discussing energy transformation in the Central Asia and Caucasus region, Azerbaijan, Georgia, Kazakhstan, and Uzbekistan should be particularly emphasized. The unifying factor among these four countries is their accession to the Paris Climate Agreement. They have committed to significantly reducing greenhouse gas emissions by 2030. Uzbekistan, Azerbaijan, and Georgia aim to reduce emissions by 35%, while Kazakhstan targets a reduction in the range of 15–25% (IRENA, 2022). Each has declared its "Nationally Determined Contributions" (NDCs) and, to varying degrees, relies on the expanded use of renewable energy sources such as solar, wind, hydro, and bioenergy to achieve these goals. Uzbekistan and Kazakhstan have also long expressed interest in incorporating

nuclear energy into their energy mix. Below, the renewable energy potential of the countries in the Central Asia and Caucasus region is assessed individually.

Kazakhstan, with its vast territory, possesses the highest onshore wind energy potential in the region. Its annual wind energy potential is estimated at approximately 929 TWh, which is equivalent to three times the region's total electricity demand. Plans by Chinese companies to manufacture wind turbines in Kazakhstan could help overcome logistical challenges related to transporting large turbine components and contribute to job creation within the country.

The region also has significant potential for offshore wind energy development. According to World Bank estimates, the Caspian Sea has an offshore wind energy potential of 845 GW. Of this, 509 GW is located in shallow waters, making it relatively more cost-effective to develop. Azerbaijan's Offshore Wind Energy Roadmap indicates that, within decarbonization scenarios that consider energy connections with neighboring markets such as Turkey and the EU, a 7.2 GW offshore wind capacity by 2040 is a realistic target.

In terms of solar energy, the southern part of the region is particularly noteworthy. Turkmenistan and Uzbekistan possess solar energy potential comparable to the sun-rich southern regions of Turkey. Turkmenistan's solar energy potential is estimated at 655 GW, which is eight times the region's current total installed capacity. Even Azerbaijan, with its relatively smaller territory, has an economically viable solar energy potential of 23 GW, according to estimates by the Ministry of Energy.

Hydropower potential in the region also remains largely underutilized. Even Tajikistan and Kyrgyzstan, where hydropower is the primary energy source, are unable to fully exploit this potential. Studies estimate that Tajikistan's economically viable hydropower potential is 264 TWh, while Kyrgyzstan's is 55 TWh. Kazakhstan also has a technical hydropower potential of 62 TWh. Although the construction of hydropower plants may take longer compared to solar and wind projects, the region can benefit from hydropower resources while minimizing social and environmental risks.

The region is not only rich in renewable energy resources but also characterized by the concentration of diverse clean energy sources across different geographical areas. The interconnection and modernization of electricity grids can enable efficient utilization of this diverse renewable energy potential. In this regard, the planned green energy corridors between Azerbaijan–Georgia–Romania, Uzbekistan–Kazakhstan–Azerbaijan, and Azerbaijan–Turkey will play an important role in accelerating the energy transition in the region (Ember Energy, 2025).

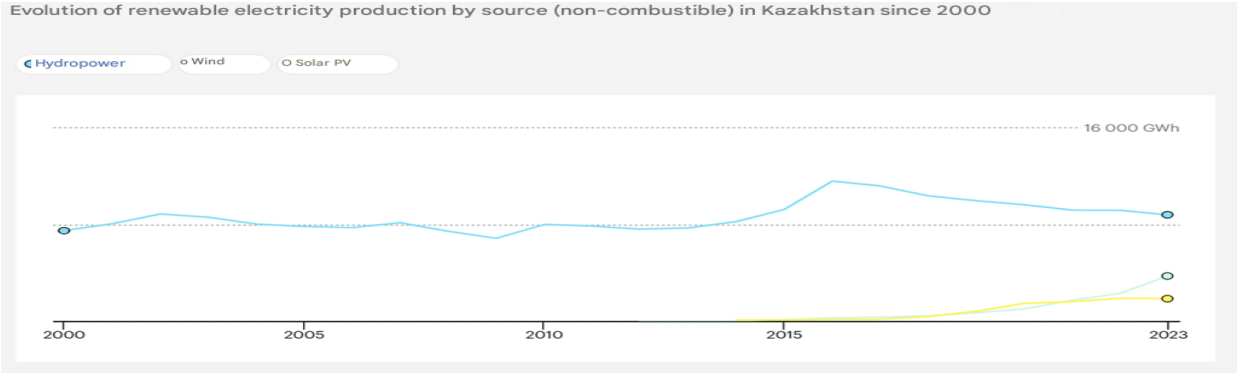
On the other hand, political will and practical steps related to the energy transition vary from country to country. Despite its high dependence on coal, Kazakhstan is the first country in the region to legislate a net-zero emissions target and establish an emissions trading system. As a result of recent projects, the share of wind and solar energy in electricity generation in Kazakhstan reached approximately 5% in 2023. The Kazakh government aims to increase this figure (excluding large hydropower plants) to 15% by 2030 (IEA,2025a). The following graph shows Kazakhstan's electricity generation by renewable energy sources in 2023 (Graph 2).

***Graph 2**. Electricity generation by renewable energy sources*

***Source:** International Energy Agency (IEA),2025a*

In general, the development trend of electricity generation from renewable energy sources in Kazakhstan since 2000 can be shown in the graph below (Graph 3):

***Graph 3.** Evolution of electricity generation from renewable energy sources*



***Source:** International Energy Agency (IEA), 2025a*

Although Uzbekistan remains dependent on residual fuels, it plans rapid growth in renewable energy and energy storage. The country possesses significant renewable energy potential, most of which comes from solar energy. The total solar energy potential is estimated at 2,134 × 10^3 PJ, while the technical potential is assessed at 7,411 PJ, approximately four times the country's current primary energy consumption. Uzbekistan benefits from high solar irradiation. Global Horizontal Irradiance (GHI), which measures the density of solar resources incident on a horizontal surface including both direct and diffuse radiation, serves as an indicator for assessing the potential of solar photovoltaics (PV) that convert both types of radiation into electricity. Uzbekistan's average GHI is estimated at 4.52 kWh/m²/day (with a range of 4.0–5.0 kWh/m²/day), which is higher than that of several European countries with favorable solar conditions, such as Spain (4.64 kWh/m²/day) and Italy (4.07 kWh/m²/day) (IEA,2025b). The table below shows the distribution of renewable energy potential in Uzbekistan by source (Table 1):

Table 1. *Renewable energy potential in Uzbekistan*

Renewable energy potential in Uzbekistan

Renewable energy source	Total potential	Technical potential
Hydropower	385 PJ	84 PJ
Wind power	92 PJ	17 PJ
Solar energy	2 134 x 10^3 PJ	7 411 PJ
Geothermal energy	2 805 x 10^3 PJ	13 PJ
Total	**4 940 x 10^3 PJ**	**7 507 PJ**

Source: Uzbekistan Energy Profile, based on IEA (2020a).

Source: *International Energy Agency (IEA),2025b*

18 GW, with the majority supplied by residual fuels. That year, more than 90% of the country's electricity was generated from residual fuels, while wind and solar contributions were minimal. Since then, new wind and solar power plants with a combined capacity of 2.5 GW have been commissioned. Additionally, at the beginning of 2024, the Uzbek government increased the share of renewables in electricity generation from 25% to 40% by 2030. In parallel, the capacity targets for wind and solar energy were updated, doubling from 12 GW to 27 GW. Uzbekistan also maintains a leading regional position in energy storage by financing grid-scale solar power plants as well as battery projects with capacities of 63 MW, 500 MWh, and 668 MW.

The Presidential Decree No. 1209 dated May 29, 2019, "On Accelerating Reforms in the Energy Sector of the Republic of Azerbaijan," established the legal framework for market liberalization, increased competition, and transition to green energy. The Law of the Republic of Azerbaijan No. 339-VIQ dated May 31, 2021, "On the Use of Renewable Energy Sources in Electricity Generation," provides the legal, economic, and organizational framework and support mechanisms to promote green energy. Furthermore, the Social-Economic Development Strategy of the Republic of Azerbaijan for 2022–2026 highlights the transition to green energy, improvement of energy efficiency, and development of a low-carbon economy as key national priorities.

The technical potential of the country's onshore renewable energy sources is 135 GW, and offshore potential is 157 GW. The economic potential of renewables is estimated at approximately 27 GW, including 3,000 MW of wind energy, 23,000 MW of solar energy, 380 MW of bioenergy potential, and 520 MW of small hydropower potential.

The total installed capacity of the energy system is 9,732.5 MW, distributed across 107 plants. These include 65 hydropower plants with a total capacity of 1,443.5 MW, 5 wind power plants with 63.5 MW, 9 solar power plants with 278.2 MW, 1 bioenergy plant with 37 MW, and 3 hybrid plants with 7.3 MW. The capacity of renewable energy sources accounts for approximately 18.8% of the total capacity, i.e., 1,829.6 MW.

In 2024, total electricity production in Azerbaijan reached 28.4 billion kWh. Hydropower plants generated 3 billion kWh, while other sources produced 839.7 million kWh. Of this, wind power plants generated 50.9 million kWh, solar power plants 556.3 million kWh, and bioenergy plants 232.5 million kWh of green electricity.

Azerbaijan is determined to become a leader in renewable energy by leveraging its abundant wind and solar potential. This initiative is a key part of the country's plan to reduce greenhouse gas

emissions by 40% by 2050. By 2030, Azerbaijan aims to increase the share of renewables in installed electricity capacity to 30% and diversify its energy system to strengthen its leadership in green energy (Ministry of Energy of the Republic of Azerbaijan, 2025).

By 2027, more than 2 GW of new green energy projects are planned, including major wind and solar power plants executed in partnership with domestic and international stakeholders:

- **Garadagh Solar Power Plant** – On October 26, 2023, the pilot 230 MW Гарадаг Solar Power Plant was commissioned in collaboration with the UAE's Masdar company. Built with $262 million in foreign investment, it will produce 500 million kWh annually, save 110 million m³ of natural gas, and reduce CO_2 emissions by 200,000 tons per year.
- **Khizi-Absheron Wind Power Plant** – Planned in cooperation with Saudi Arabia's ACWA Power, this 240 MW plant will generate 1 billion kWh annually, saving 220 million m³ of natural gas and avoiding over 400,000 tons of CO_2 emissions.
- **Shafag Solar Power Plant** – A 240 MW project implemented with bp in Jabrayil district using a virtual power transmission model. Annual generation of about 500 million kWh will save 120–150 million m³ of natural gas and reduce CO_2 emissions by 260–330 thousand tons.
- **Mega Project** – Masdar is constructing 445 MW in Bilasuvar, 315 MW in Neftchala solar plants, and 240 MW wind plants in Absheron and Garadagh. The first panel at Bilasuvar Solar Power Plant was installed on October 2, 2025.
- **Gobustan Solar Power Plant** – A 100 MW plant by China's Universal International Holdings Limited, producing approximately 260 million kWh annually, saving 57 million m³ of natural gas and reducing 124,000 tons of CO_2.
- **Ufug and Shams Solar Plants** – Each 50 MW, planned in Jabrayil district as part of green energy development in liberated areas, contracts signed on June 2, 2025, during Baku Energy Week with Nobel Energy.
- **Floating Solar Panels Project** – On July 29, 2024, a 100kW pilot photovoltaic system was inaugurated on Lake Boyukshor with ADB support, the first floating solar plant in Azerbaijan. It aims to strengthen national capacity and explore large-scale projects on water reservoirs.
- **Hydrogen Energy** – A market study on low-carbon hydrogen, prepared with EBRD support, assessed the production, domestic use, export potential, and economic viability of green and blue hydrogen in Azerbaijan. The study concluded that green hydrogen production is economically feasible, with potential for regional export and domestic consumption. A National Strategic Review on low-carbon hydrogen was presented at COP29.

Georgia – In 2019, Georgia's total primary energy supply was 5.1 million tons of oil equivalent, primarily from natural gas (45%) and oil (27%), with renewables at 20.4%. Electricity demand is mostly met by hydropower (66%), supplemented by imports (11%) and thermal generation (22%), with the remaining 1% from other renewables such as wind and solar. Heavy reliance on hydropower means production depends on rainfall (REN21, 2021).

Georgia ranks among the world's leaders in per capita water resources. Of roughly 26,060 rivers, 300 are excellent for hydropower, but currently only 20–22% of total hydro potential is utilized. The country also has significant solar and wind energy potential, summarized in the table below (Table 2).

Table 2. *Renewable energy potential of Georgia*

Technology	Capacity (2019)	Potential Capacity	Production potential
Hydropower	3,600 MW	15,000 MW	50 TWh/year
PV	1 MW	1500 MW	1250-1800 kW/m²/year
The wind	20.7 MW	1450 MW	4.16 TWh/year

Source: *REN 21, 2021.*

New interconnectors have the potential to link Europe's power grid with Central Asia, but this will require substantial investment. For example, strengthening connections between the northern and southern regions of Kazakhstan's electricity grid and integrating the western region with the rest of the country is essential. A direct link between Kazakhstan and Azerbaijan would require an undersea cable across the Caspian Sea, while another undersea cable is planned to connect Romania and Georgia across the Black Sea. Alternatively, Turkey, already integrated into the European grid, could provide a land link between Europe and the Caucasus, though strengthening Azerbaijan's connection with Turkey is necessary.

In any scenario, Azerbaijan will play a central role in bridging Central Asia and Europe. By raising its renewable energy targets, the country can position itself as a regional green energy hub, serve as a bridge between Central Asia and Europe, and foster stronger cooperation among neighboring countries in the clean energy transition.

There are strong reasons for the region to pursue this goal. Accessing regions with renewable energy resources can ensure a more stable energy supply, diversify energy sources, and leverage the complementary nature of different renewable energy types. According to the International Energy Agency (IEA), achieving global net-zero targets without international cooperation could be delayed by decades, highlighting that collaboration can accelerate the transition.

Today, wind and solar energy are the cheapest sources of electricity globally. The cost of onshore wind installations has decreased by 70% since 2010, and solar energy costs have dropped by 90% over the same period. Further reductions in clean energy costs are expected, with the IEA projecting faster decreases if collective action is taken. Cross-border cooperation can stimulate innovation, provide stronger investment incentives, create economies of scale, and ensure a fair competitive environment to support the transition.

In this context, developing green energy corridors in Central Asia, the Caucasus, and Europe presents significant opportunities to unlock renewable energy potential, enhance energy security, and reduce dependence on residual fuels at minimal cost. COP29 highlighted that regional collaboration and connectivity are key to creating a cleaner, better-connected, and more cost-effective energy future.

In recent years, Azerbaijan has made major advances in green energy, emerging as a significant player in the regional energy market. A key initiative is the **Central Asia–Azerbaijan Trans-Caspian Green Energy Corridor**, launched jointly by Azerbaijan, Kazakhstan, and Uzbekistan. Its primary goal is to establish an energy corridor from Central Asia across the Caspian Sea to Azerbaijan and onward to Europe, enabling the transmission of renewable energy. The project was first presented to the international community in November 2024 at COP29, when the presidents of Azerbaijan, Kazakhstan, and Uzbekistan signed a strategic agreement establishing a framework for intergovernmental cooperation in green energy development and transmission.

In April 2025, the project entered its practical implementation phase. The energy ministries of Azerbaijan, Kazakhstan, and Uzbekistan, together with the Asian Development Bank (ADB) and Asian Infrastructure Investment Bank (AIIB), signed a Memorandum of Understanding to support

the technical and economic feasibility (TEF) of the **Caspian Sea Green Energy Corridor**. The memorandum aimed to create the legal and institutional framework for integrating the three countries' energy systems and enabling the transmission and trade of renewable energy. It also strengthened strategic engagement by encouraging deeper participation from multilateral partners.

In July 2025, an international tender was announced to prepare the TEF for the project's first phase. The tender budget was set at $1 million, with an implementation period of 11 months. ADB coordinated the procurement process, while AIIB will sign a direct contract with the consulting firm selected through the tender. Work on the TEF was scheduled to begin on November 3, 2025, with the commercial phase of the project planned to start in 2027.

To manage the project, an institutional mechanism was established in 2025 in Baku: **Green Corridor Union LLC**, a joint venture formed by Azerbaijan's "Azərenerji" JSC, Kazakhstan Electricity Grid Operating Company, and Uzbekistan National Electric Grids JSC. This entity will oversee project execution, coordinate activities between partner countries, and manage the preparation of technical documentation.

International cooperation is also central to Azerbaijan's green energy agenda. Memoranda of Understanding on renewable energy transmission and trade have been signed between Azerbaijan, Georgia, Turkey, and Bulgaria. This approach not only expands Azerbaijan's energy export markets but also strengthens its position as a regional energy transit hub.

Under President Ilham Aliyev's strategic energy policy, Azerbaijan has attracted over $144 billion in foreign investment and established energy corridors across the Caspian Sea to the Mediterranean, Black, and Adriatic seas. Through the Baku–Tbilisi–Ceyhan oil pipeline, 540 million tons of Azerbaijani oil and 53 million tons of Central Asian oil have been delivered to global markets. This successful experience now provides a foundation for advancing in green energy (Azerbaijan State News Agency, 2024).

The **Trans-Caspian Green Energy Corridor** is a natural continuation of Azerbaijan's green energy transition strategy, strengthening regional integration and acting as a sustainable energy bridge between Europe and Asia. Its implementation promises substantial economic, environmental, and social benefits. Azerbaijan's leadership and coordination role further consolidate its position as a regional leader in green energy.

CONCLUSION

The study demonstrates that accelerating the green energy transition in Central Asia and the Caucasus depends not only on existing renewable energy potential but also on developing regional cooperation and integration mechanisms. The complementary natural and geographic conditions of the countries create favorable energy profiles. The geographic distribution of wind, solar, and hydro resources provides a strong basis for establishing integrated energy markets.

Multifaceted, multilateral projects like the **Trans-Caspian Green Energy Corridor** increase the region's strategic importance for energy security, export potential, and transit. Successful implementation requires not only robust technical and economic assessments but also effective institutional coordination, supportive regulatory frameworks, and strengthened international partnerships.

Political and economic asymmetry, technological disparities, limited access to financial resources, and weak institutional coordination remain key barriers to integration. Nevertheless, strategic planning and increased investment attractiveness by countries such as Azerbaijan, Kazakhstan, and Uzbekistan are major drivers of energy transformation in the region.

Deepening international cooperation, transferring innovative technologies, and coordinating energy markets will play a decisive role in achieving a sustainable and efficient green energy transition. In

this context, Azerbaijan, given its geostrategic position and proactive role, has the potential to act as a locomotive for green energy integration in the region.

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