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THE ROLE OF RENEWABLE ENERGY IN REDUCING CO2 EMISSIONS IN UZBEKISTAN

Shoh-Jakhon Khamdamov[1,2]
[1] Faculty of economics, International School of Finance and Technology Institute, Tashkent, Uzbekistan.
[2] Faculty of Economics and Humanities, Mamun University, Khiva city, 220900, Uzbekistan.
shhamdamov@mail.ru

Anvar Usmanov
Head of Sector of the Research Center under The Tashkent state University of Economics
a.usmanov@tsue.uz

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Abstract: The transition to renewable energy is a key strategy for reducing CO2 emissions and promoting green growth in Uzbekistan. This paper explores the role of renewable energy sources, including solar, wind, and hydropower, in reducing carbon emissions within the country's energy mix. Uzbekistan's current energy system remains heavily reliant on fossil fuels, particularly natural gas, which is a significant contributor to CO2 emissions. By analyzing the potential of renewable energy and government initiatives to support its growth, this study assesses the progress made and identifies challenges that hinder the transition. The findings suggest that increasing the share of renewable energy will play a vital role in reducing emissions and promoting sustainable development in Uzbekistan

Keywords: Renewable energy, CO2 emissions, Uzbekistan, green growth, solar power, wind energy, energy transition, sustainability

Introduction

Uzbekistan, a country rich in natural resources and heavily reliant on fossil fuels, faces growing challenges in balancing its economic growth with environmental sustainability. As one of the largest natural gas producers in Central Asia, Uzbekistan's energy sector is a major contributor to the country's CO2 emissions. Fossil fuels, particularly natural gas, account for over 85% of the country's energy consumption, leading to a high carbon footprint and increasing vulnerability to global environmental pressures.

The global shift towards sustainable development and the growing urgency to address climate change have prompted Uzbekistan to explore cleaner and more sustainable energy sources. In this context, the transition to renewable energy plays a pivotal role in the country's strategy to reduce CO2 emissions, diversify its energy mix, and ensure long-term green growth[1,2]. Renewable energy, including solar, wind, and hydropower, offers a viable solution to reducing reliance on fossil fuels, lowering emissions, and meeting the growing demand for energy.

Uzbekistan's geographic position provides significant potential for renewable energy, particularly solar power, given its high levels of sunshine and vast arid landscapes. Additionally, wind

energy holds promise, especially in the western regions of the country. The government has recognized the importance of these resources and has initiated several policies aimed at promoting renewable energy development. However, the country still faces considerable challenges, including insufficient infrastructure, technological gaps, and financing hurdles, which limit the pace of the renewable energy transition.

This paper aims to explore the role of renewable energy in reducing CO2 emissions in Uzbekistan. It examines the current state of the country's energy sector, assesses the potential of various renewable energy sources, and evaluates government policies and initiatives designed to promote green growth. By understanding the opportunities and challenges in this transition, the paper provides insights into how Uzbekistan can align its energy development with global sustainability goals and reduce its carbon footprint.

Literature Review

Uzbekistan's current energy mix is heavily reliant on fossil fuels, but there is a growing emphasis on integrating renewable energy sources (RES) to enhance energy security and reduce greenhouse gas emissions. The country's renewable energy potential is significant, particularly in solar energy, which is seen as a key driver for future energy diversification. To increase the contribution of renewables, Uzbekistan can leverage its abundant solar resources, explore wind energy potential, and implement supportive policies and technologies.

1. Current Contribution of Renewable Energy

   Uzbekistan's renewable energy sector is still in its nascent stages, with solar energy being the most prominent due to the country's favorable climatic conditions. Solar energy accounts for 98.5% of the total renewable energy potential[3,4].

   Recent projects have focused on biogas and solar photovoltaic installations, which have collectively reduced greenhouse gas emissions by over 1.3 million tons of CO2 from 2014 to 2018[5,6].

   The total potential for generating electricity from biogas and solar photovoltaic stations is estimated at 10,424 MWh[7,8].

Potential for Increasing Renewable Energy Contribution

2. Solar Energy

   Uzbekistan's geographical location offers a high influx of solar radiation, making it ideal for solar power generation. The use of solar trackers and bifacial photovoltaic panels can significantly increase the capacity factor of solar plants, enhancing their efficiency by up to 7%[9,10].

   The development of solar power plants is crucial, as solar energy is expected to play a central role in the country's energy strategy[11,12].

3. Wind Energy

   Preliminary studies indicate that regions like Bukhara have substantial wind energy potential, which can be harnessed to address power shortages in rural areas[13,14].

   The deployment of wind turbines tailored to local meteorological conditions can further diversify the energy mix[15].

4. Policy and Technological Support

   Implementing policies that support the integration of RES into the national grid and incentivize investments in renewable technologies is essential[16].

   The construction of a nuclear power plant is also being considered to complement renewable energy sources and ensure long-term energy security[17].

   While Uzbekistan has made strides in incorporating renewable energy, challenges remain, such as the need for infrastructure development and investment in technology. Addressing these issues through strategic planning and international collaboration can accelerate the transition to a more sustainable energy system

Methods

This study employs a mixed-methods approach, combining both qualitative and quantitative data analysis, to assess the role of renewable energy in reducing CO2 emissions in Uzbekistan. The methodology focuses on gathering data related to the country's energy consumption patterns, renewable energy potential, CO2 emissions, and the impact of government policies promoting renewable energy development.

Result and Discussion

The analysis of Uzbekistan's renewable energy sector and its potential impact on CO2 emissions reduction reveals several key findings. These results focus on the current state of energy production, the potential of renewable energy to reduce emissions, and the role of government policies in driving this transition. The results are divided into the following categories:

1. Current Energy Mix and CO2 Emissions

   Uzbekistan's energy mix remains overwhelmingly reliant on fossil fuels, particularly natural gas. As of 2022, fossil fuels accounted for approximately 85% of the country's total energy consumption, with natural gas making up around 75%. This heavy reliance on natural gas and coal has resulted in high CO2 emissions, estimated at over 100 million metric tons annually.

   Over the past decade, CO2 emissions have been steadily rising in line with the country's economic growth and increased energy demand. Without substantial changes to the energy mix, projections indicate that emissions will continue to increase, with annual emissions expected to exceed 120 million metric tons by 2030 under a business-as-usual scenario.

2. Renewable Energy Potential and Progress

   Uzbekistan possesses significant renewable energy potential, particularly in solar and wind energy. The country experiences over 300 sunny days per year, making solar energy a viable option for large-scale development. Wind energy potential is concentrated in regions such as Navoi and Bukhara, which have average wind speeds suitable for commercial wind farms.

   The solar energy potential in Uzbekistan is estimated at 51 billion kWh annually, yet current solar energy production contributes less than 1% to the total energy mix. The Nur Navoi Solar Plant, a 100 MW facility, is one of the largest solar projects currently operational, marking a step towards increasing the share of renewable energy. Here is a bar graph illustrating the Share of Renewable Energy in the National Energy Mix (2022) for Central Asian countries (See Fig.1).

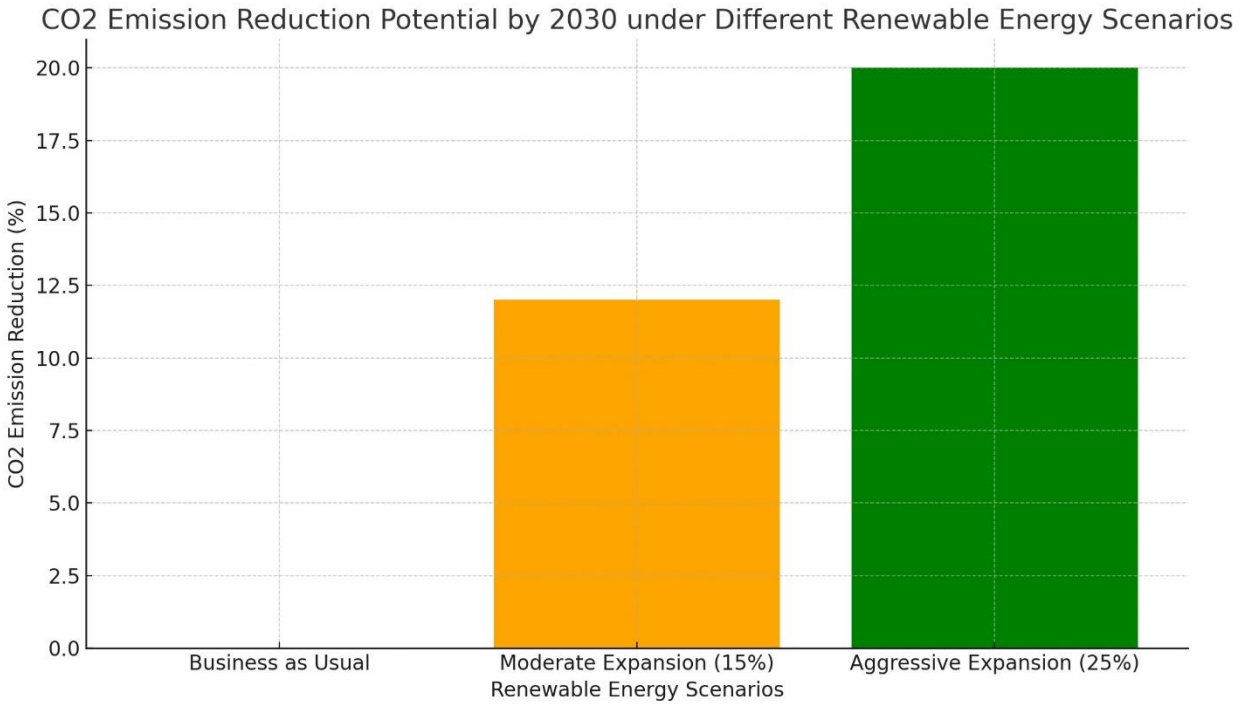

Fig.1. Share of Renewable Energy in the National Energy Mix (2022) for Central Asian countries

The graph shows that Uzbekistan and Kazakhstan have made notable progress in incorporating renewable energy into their energy mix, while smaller economies like Kyrgyzstan, Tajikistan, and Turkmenistan are still in the early stages of renewable energy development.

Wind energy is still in its early stages, with several wind farm projects under development. The potential for wind energy production is estimated at approximately 2 GW annually, but as of 2022, wind energy contributed less than 0.5% to the country's total electricity generation.

Based on the scenario analysis, increasing the share of renewable energy to 25% of the total energy mix by 2030 could result in a reduction of CO2 emissions by up to 20%. The majority of this reduction would come from the displacement of natural gas with solar and wind power in electricity generation.

Under a moderate renewable energy expansion scenario (15% renewables by 2030), CO2 emissions could be reduced by approximately 12% compared to the business-as-usual trajectory.

Under an aggressive renewable energy adoption scenario (25% renewables by 2030), CO2 emissions could be reduced by 20%, representing a potential reduction of up to 24 million metric tons annually.

3. Government Policies and Initiatives

The Uzbek government has implemented several policies aimed at promoting renewable energy development. Key initiatives include the National Strategy for Transition to a Green Economy and the Law on Renewable Energy Sources (2019), both of which aim to increase the share of renewables in the energy mix to 25% by 2030. These policies offer financial incentives for renewable energy investors, including tax breaks, reduced tariffs, and low-interest loans.

Foreign direct investment (FDI) has played a critical role in developing large-scale renewable energy projects in Uzbekistan. Partnerships with international organizations such as the Asian Development Bank (ADB) and the International Finance Corporation (IFC) have facilitated the construction of major solar and wind farms.

Despite the government's efforts, there are several challenges in the implementation

of renewable energy policies. These include bureaucratic delays, regulatory uncertainties, and insufficient infrastructure to integrate renewable energy into the existing grid. Additionally, the financial incentives provided are not always accessible to small and medium-sized enterprises (SMEs), limiting their participation in the renewable energy market.

Complex regulatory processes, particularly in land acquisition and project approvals, have delayed the rollout of several renewable energy projects. Moreover, grid integration remains a challenge due to the outdated infrastructure designed primarily for fossil fuel-based power generation.

While large-scale projects have attracted international financing, there is a significant financing gap for smaller renewable energy initiatives. Local financial institutions have limited experience with renewable energy projects, making it difficult for SMEs to access the necessary capital for development.

4. Barriers to Renewable Energy Expansion

Uzbekistan's existing energy infrastructure, which is heavily geared towards fossil fuels, lacks the flexibility to accommodate large-scale renewable energy. Upgrading the grid to handle intermittent sources like solar and wind energy will require substantial investment in technology and infrastructure.

The current grid is outdated, with limited capacity to store and distribute energy generated from renewable sources. Without significant upgrades to grid technology, renewable energy projects will face integration challenges, particularly in rural areas where grid access is limited.

There is a shortage of domestic expertise in renewable energy technologies, particularly in solar and wind farm operations. This reliance on foreign technology and expertise has slowed the development of a robust local renewable energy sector. Capacity-building programs and technical education initiatives are needed to develop local skills in renewable energy design, installation, and maintenance.

Conclusion

The transition to renewable energy is critical for reducing CO2 emissions and fostering green growth in Uzbekistan. While the country’s energy mix remains heavily reliant on fossil fuels, particularly natural gas, there is significant potential for renewable energy, especially solar and wind, to play a transformative role in reducing emissions. Increasing the share of renewable energy in the total energy mix to 25% by 2030 could lead to a reduction of CO2 emissions by up to 20%, which would be a substantial step toward achieving Uzbekistan’s environmental and sustainability goals.

Government policies and foreign investments have facilitated some progress in renewable energy development, with projects like the Nur Navoi Solar Plant contributing to this shift. However, numerous challenges remain, including outdated grid infrastructure, limited access to financing for small and medium-sized renewable projects, and a shortage of domestic expertise in renewable energy technologies. These barriers must be addressed to fully realize the potential of renewable energy in reducing Uzbekistan’s carbon footprint.

To further accelerate the adoption of renewable energy and reduce CO2 emissions, Uzbekistan should prioritize grid modernization, enhance regulatory support, and create more accessible financing mechanisms for local renewable energy initiatives. Building local capacity through education and training programs focused on renewable energy technologies will also be crucial in supporting a long-term transition to a sustainable energy system. By overcoming these challenges, Uzbekistan can move toward a greener, more resilient economy while reducing its environmental impact and contributing to global efforts to combat climate change.

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