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ANALYSIS OF HYDROPOWER RESOURCES OF UZBEKISTAN

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Abstract
The increasing global demand for electricity has significantly raised the consumption of hydrocarbon fuels in energy production. This article explores Uzbekistan's energy sector, emphasizing the need for diversifying energy sources and utilizing renewable energy, especially hydropower. It provides insights into Uzbekistan's current energy challenges, its hydropower potential, and strategic state policies aimed at promoting sustainable energy production.
Keywords: Hydropower potential, diversification, energy capacity, HPP (hydropower plants).

Global Energy Demand and Uzbekistan's Situation

Today, the worldwide demand for electricity is growing rapidly, leading to massive use of hydrocarbon fuels in power generation. Uzbekistan is facing similar challenges. The country's energy sector remains heavily reliant on hydrocarbons, which poses both environmental concerns and issues of energy security. Addressing these challenges requires a shift towards renewable energy sources, including hydropower, solar, and wind energy [1].

Uzbekistan's Growing Energy Needs

The country's energy consumption continues to increase. Estimates suggest that electricity demand may grow by 11–12% annually. To meet this rising demand, Uzbekistan must maximize the utilization of all types of renewable energy sources. As part of a national strategy, it aims to install wind farms with a total capacity of 5,000 MW and solar plants with a capacity of 7,000 MW by 2030 [2].

Uzbekistan's Hydropower Potential

Focusing on hydropower, Uzbekistan boasts a significant hydropower capacity, primarily from its rivers and basins. The country's total hydropower potential is estimated at over 1,000 billion kWh, with a technical potential of 274 billion kWh and a usable capacity of 166 billion kWh [3].

Major hydropower resources are concentrated in the Chirchiq-Angren basin (33%), the Fergana Valley (24%), the southwestern part of the country (34%), and the lower reaches of the Amudarya River (78%). However, to date, only 23% of this potential has been utilized.

Table 1. Distribution of hydropower potential by region

Region	Energy Points	Capacity (MW)	Energy (billion kWh)
Jizzakh	542	1,354	8.12
Qashqadaryo	613	16,409	98.45

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Tashkent	1,424	130,958	785.75
Fergana	42	15,265	86.94
Total	4,255	233,542	1,396.61

Development of Small Hydropower Plants (HPPs)

Despite the vast potential, Uzbekistan has not fully capitalized on its hydropower resources. Only 11% of available potential is currently used, mainly due to insufficient development of small and micro HPPs. There are plans to address this by constructing new small HPPs in various regions of the country, including:

- **Piskom HPP** (400 MW, Tashkent)
- **Quyi Chotqol HPP** (90 MW, Tashkent)
- **Shaudar HPP** (7,2 MW, Samarkand)

These projects are expected to boost electricity generation while minimizing environmental impact, in line with government policies focused on increasing the share of renewable energy in the country's energy mix.

Environmental Impact and Sustainability of Hydropower

One of the key advantages of hydropower is its minimal environmental footprint compared to fossil fuel-based energy production. Hydropower plants (HPPs) produce zero direct emissions, making them a vital component in the fight against climate change. For Uzbekistan, which faces challenges related to air pollution and greenhouse gas emissions from its energy sector, expanding hydropower offers a clear path to a more sustainable and greener energy portfolio [4].

Furthermore, hydropower projects can contribute to water management by regulating river flows, reducing flood risks, and providing reliable water supplies for irrigation, which is crucial for Uzbekistan's agriculture-dominated economy. The Chirchiq-Angren basin and Fergana Valley are regions where water management and hydropower development could align to deliver mutual benefits [5].

However, the environmental benefits of hydropower must be balanced against potential risks, such as the disruption of aquatic ecosystems and the displacement of local communities. Uzbekistan's future hydropower projects should incorporate modern environmental assessments and sustainable development practices to mitigate these risks.

The Role of Hydropower in Energy Security

Uzbekistan's reliance on imported energy sources, particularly natural gas, makes the country vulnerable to external market fluctuations. By boosting its hydropower capacity, Uzbekistan can reduce its dependence on fossil fuels and strengthen its energy security. Hydropower is not only renewable but also stable, providing a consistent source of electricity unlike the intermittent nature of solar and wind energy.

Investing in small and medium-sized hydropower plants across different regions will also diversify the country's energy grid, making it more resilient to disruptions. This regional distribution ensures that even remote areas, such as parts of the Fergana Valley or the southwestern regions, can access reliable and locally generated electricity.

Integration with Other Renewable Energy Sources

Hydropower is part of a broader renewable energy strategy for Uzbekistan. By combining hydropower with solar and wind energy, Uzbekistan can create a more flexible and reliable energy grid. Hydropower plants can serve as a balancing power source, compensating

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for periods when solar and wind outputs fluctuate. This type of energy mix—where hydropower supports other renewables—can be a game changer in achieving a stable and sustainable energy future for the country.

For example, during the daytime, solar energy can be the dominant source, while hydropower plants can take over at night or during periods of lower sunlight. Similarly, wind energy, which is more variable, can be complemented by the constant energy generation from hydropower plants, ensuring a steady electricity supply throughout the year.

Technological Innovations and Investments

One of the critical barriers to developing Uzbekistan's hydropower sector has been the lack of modern infrastructure and technological innovations. To address this, Uzbekistan has been exploring partnerships with foreign investors and international development organizations. These partnerships aim to bring in cutting-edge hydropower technologies that are more efficient and environmentally friendly.Smart grid systems, for instance, can be integrated with hydropower plants to optimize energy distribution and ensure that energy supply matches demand in real-time. Additionally, advances in turbine design allow for smaller, low-impact hydropower plants to be constructed in locations that were previously deemed unsuitable for large-scale projects.

Attracting international investment is also key to financing these hydropower projects. Uzbekistan has made strides in improving its investment climate and is offering incentives to foreign companies willing to invest in its renewable energy sector. Long-term public-private partnerships (PPPs) will be critical in securing the necessary capital and expertise to realize Uzbekistan's hydropower potential.

Conclusion:

Uzbekistan is at a pivotal moment in its energy transition. The expansion of hydropower, coupled with other renewable energy sources, provides a roadmap for energy independence, economic growth, and environmental sustainability. The government's clear commitment to renewable energy, as outlined in its ambitious 2030 and 2050 energy strategies, ensures that Uzbekistan is moving toward a future where energy is both secure and clean.

Hydropower, with its vast potential, will undoubtedly play a central role in this transformation. However, success will depend on continued investment, innovation, and the implementation of environmentally responsible practices. By overcoming these challenges, Uzbekistan can emerge as a regional leader in renewable energy and a model for other nations striving for a greener energy future.

These additions offer a more comprehensive view of hydropower's role in Uzbekistan's energy landscape, incorporating environmental, technological, and economic perspectives, which strengthen the article's overall scope. Uzbekistan faces significant energy challenges, primarily due to its reliance on hydrocarbons. The government has set ambitious goals to diversify its energy sources, and hydropower will play a key role in this transition. The development of small and micro HPPs will help tap into the country's substantial hydropower potential, supporting sustainable energy production. However, the success of these initiatives depends on overcoming technical and infrastructural barriers.Government efforts to integrate renewable energy, including wind, solar, and hydropower, will not only diversify the energy mix but also address global environmental concerns, ensuring energy security for the future.This article summarizes the hydropower potential and development strategies of Uzbekistan, presenting a roadmap for sustainable energy growth in the country.

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To further enhance the article on Uzbekistan's hydropower resources and energy strategy, here are some additional insights and sections that could be incorporated:

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