RENEWABLE ENERGY AND ECONOMIC DEVELOPMENT: OPPORTUNITIES AND CHALLENGES FOR UZBEKISTAN

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Abstract

Renewable energy has become an increasingly important component of economic development as countries seek to meet growing energy demand while reducing environmental risks and dependence on fossil fuels. For developing economies, renewable energy can contribute not only to environmental sustainability but also to energy security, investment, employment, technological development and regional economic growth. This article examines the relationship between renewable energy and economic development, with particular attention to Uzbekistan. The study uses a qualitative research approach based on secondary data, government policy documents and reports from international organisations. The findings indicate that renewable-energy development can support Uzbekistan's economy through increased electricity generation, foreign and domestic investment, job creation, improved energy security, reduced pressure on natural-gas resources

and the development of new industries. Recent investments in solar, wind and hydropower demonstrate that renewable energy is becoming an increasingly important part of Uzbekistan's economic strategy. However, several challenges remain, including high initial investment costs, ageing electricity infrastructure, financing constraints, limited technical skills and the need for energy-storage systems. The article argues that renewable energy should be integrated into a broader economic-development strategy that combines infrastructure modernisation, human-capital development, private investment and energy-market reform. If these conditions are met, renewable energy can become not only an environmental solution but also a significant driver of Uzbekistan's long-term economic development.

Keywords: renewable energy, economic development, economic growth, energy security, investment, employment, sustainable development, Uzbekistan

1. Introduction

Energy is one of the fundamental foundations of economic development. Almost every economic activity depends on reliable access to electricity and other forms of energy. Factories require electricity to operate machinery, businesses need energy for communication and digital systems, agricultural producers depend on energy for irrigation and processing, and households use electricity for lighting, heating, cooling and other essential activities.

As economies develop, their demand for energy generally increases. Population growth, industrialisation, urbanisation and digitalisation can significantly increase electricity consumption. At the same time, countries are facing growing pressure to reduce greenhouse-gas emissions and limit environmental damage caused by fossil-fuel consumption. This creates a difficult policy challenge: governments must increase energy supply while making that supply cleaner and more sustainable.

Renewable energy provides one possible solution to this challenge. Solar, wind, hydropower and other renewable sources can generate electricity without relying entirely on finite fossil fuels. However, their importance goes beyond environmental protection. Renewable-energy projects can attract investment, create employment, stimulate technological innovation and improve energy security.

For developing countries, this economic dimension is particularly important. Renewable-energy development can create new industries and reduce dependence on imported energy or volatile international fuel prices. At the same time, renewable-energy projects can support regional development by bringing infrastructure and employment to areas that have historically had limited access to reliable electricity.

Uzbekistan is an important example of this process. The country is experiencing increasing electricity demand as its population grows and its economy expands. According to the World Bank, Uzbekistan's electricity demand is projected to **double by 2030 and exceed 120 billion kilowatt-hours**. Despite increases in electricity production, around 10% of demand has remained unmet because of transmission and distribution constraints, particularly in underserved regions.

This situation makes energy development a major economic priority. Uzbekistan has therefore accelerated investment in solar, wind and hydropower. In 2026, the Ministry of Energy reported that solar and wind power plants had a combined installed capacity of approximately **5.6 GW**, while the government has set a target of increasing solar and wind capacity to 21 GW by 2030 and producing 60 billion kWh of green electricity annually.

The development of renewable energy is also increasingly connected to Uzbekistan's strategy for technological and economic transformation. The government has highlighted the importance of reliable and sustainable electricity for new sectors such as digital technologies and artificial intelligence.

Therefore, the relationship between renewable energy and economic development deserves detailed examination.

The main objective of this article is to analyse **how renewable energy can contribute to economic development in Uzbekistan**, while also identifying the main challenges that could limit its economic impact.

The article focuses on five key areas:

1. renewable energy and energy security;
2. renewable-energy investment and economic growth;
3. employment and human capital;
4. regional economic development;
5. infrastructure and financing challenges.

2. Literature Review

The relationship between energy and economic development has been widely discussed in economic literature. Energy is considered an important input into production because it supports industrial activity, transportation, agriculture and services.

Traditional economic development has relied heavily on fossil fuels. Coal, oil and natural gas have historically provided relatively stable and energy-dense sources of power. However, dependence on fossil fuels creates several economic risks, including price volatility, import dependence, environmental costs and resource depletion.

Renewable energy provides an alternative pathway.

The International Energy Agency identifies renewable energy as an important component of countries' efforts to meet growing energy demand and reduce greenhouse-gas emissions. Uzbekistan has also established renewable-energy objectives and policies to increase the role of renewable sources in its electricity system.

From an economic perspective, renewable energy can influence development through several mechanisms.

First, it can increase **energy security**. A country that generates more electricity domestically from solar, wind and hydropower can reduce its dependence on a limited number of energy sources.

Second, renewable energy can stimulate **investment**. Large renewable-energy projects require capital for construction, equipment, engineering, transportation and maintenance.

Third, renewable energy can create **employment**. New industries require engineers, technicians, construction workers, financial specialists and managers.

Fourth, renewable energy can support **regional development**. Solar and wind projects can be located in regions where land and natural conditions are favourable, creating economic activity outside major cities.

Finally, renewable energy can improve **long-term competitiveness**. As global markets increasingly place importance on environmental standards and carbon emissions, countries with cleaner energy systems may become more attractive to international investors.

However, renewable-energy development also creates challenges.

Solar and wind power are variable sources of electricity. Their output depends on weather and time of day. This means that electricity systems need storage, flexible generation, improved transmission networks and effective demand management.

In addition, renewable-energy projects often require high initial capital investment. Developing countries may therefore need international financing, public-private partnerships and appropriate investment policies.

The literature consequently suggests that renewable energy should not be treated as an isolated technological issue. It is part of a broader economic transformation involving infrastructure, finance, labour markets and institutions.

3. Methodology

This study applies a **qualitative research methodology** based on secondary data and documentary analysis.

The research uses information from official sources, including the Government of Uzbekistan and the Ministry of Energy, as well as international institutions such as the World Bank and the International Energy Agency.

The analysis focuses specifically on Uzbekistan and examines renewable energy through five economic dimensions:

- energy security;
- investment;
- employment;
- regional development;
- infrastructure and productivity.

Recent renewable-energy projects and government targets are used as case evidence.

The research does not attempt to estimate a statistical causal relationship between renewable-energy consumption and GDP growth. Instead, it analyses the mechanisms through which renewable energy can influence economic development.

This approach is appropriate because Uzbekistan's renewable-energy transition is currently developing rapidly, meaning that recent policy changes and investment projects are particularly important for understanding its economic potential.

4. Results

4.1. Renewable Energy and Energy Security

One of the most important economic benefits of renewable energy is improved energy security.

Energy security refers to the ability of a country to provide reliable, affordable and sufficient energy to households and businesses.

For Uzbekistan, this issue is becoming increasingly important because electricity demand is expected to grow significantly.

According to the World Bank, electricity demand is projected to exceed **120 billion kWh by 2030**, approximately twice the current level. At the same time, existing transmission and distribution constraints have contributed to unmet demand and power outages in some areas.

Renewable energy can help address this challenge by increasing electricity-generation capacity.

Solar and wind resources are particularly valuable because they can be developed relatively quickly and at different scales.

Large solar and wind farms can provide electricity to the national grid, while smaller renewable-energy installations can support rural and remote communities.

Hydropower can provide another important source of renewable electricity.

In June 2025, the World Bank approved **$150 million** in concessional financing to support small hydropower development in Uzbekistan. The project is expected to support up to 150 MW of small hydropower capacity and generate more than 520 GWh of green electricity annually by 2030.

Importantly, many of the proposed small hydropower plants can use existing irrigation canals.

This creates an economic advantage because existing infrastructure can reduce some construction requirements.

4.2. Renewable Energy and Investment

Renewable energy is becoming an increasingly important destination for investment in Uzbekistan.

The transition requires large amounts of capital for:

- solar power plants;
- wind farms;
- hydropower facilities;

- battery storage;
- transmission networks;
- distribution systems;
- energy-efficient technologies.

This creates opportunities for both domestic and international investors.

Uzbekistan has increasingly used public-private partnerships and international financial support to attract investment into renewable energy.

In 2025, the World Bank approved a $150 million programme for small hydropower, while private developers and banks are expected to participate in the implementation of the programme. The project is expected to mobilise approximately **$38 million in commercial financing**.

The development of renewable-energy infrastructure can also create a multiplier effect.

For example, the construction of a solar plant creates demand for construction workers, engineers, transportation services and equipment suppliers. Once the plant becomes operational, additional jobs are needed for maintenance, management and technical support.

Therefore, renewable-energy investment can stimulate economic activity beyond the energy sector itself.

Uzbekistan's investment environment is also becoming increasingly attractive for renewable-energy projects.

The country's investment authorities identify renewable-energy generation, battery storage, electricity transmission and grid modernisation as important investment opportunities.

This demonstrates that renewable energy is increasingly being viewed as an economic sector rather than simply an environmental policy.

4.3. Renewable Energy and Employment

The renewable-energy transition can have a significant impact on employment.

The construction and operation of renewable-energy projects require different categories of workers.

These include:

- engineers;
- electricians;
- construction workers;
- project managers;
- financial specialists;
- environmental specialists;
- technicians;
- maintenance workers.

As the industry develops, demand for specialised skills is likely to increase.

This creates an opportunity for Uzbekistan's large young population.

Universities and vocational institutions can develop programmes in:

- renewable-energy engineering;
- electrical systems;
- environmental management;
- energy economics;
- sustainable finance;
- energy efficiency;
- data analysis.

The green-energy transition can therefore contribute to human-capital development.

However, this requires educational institutions to respond to changing labour-market demand.

If the number of renewable-energy projects grows faster than the supply of qualified specialists, companies may face skills shortages.

Therefore, renewable-energy policy should be closely connected with education and employment policy.

4.4. Regional Economic Development

Renewable energy can also support regional development.

Large solar and wind projects are often constructed outside major urban centres because they require large areas of land and favourable natural conditions.

This can create economic opportunities in rural areas.

For example, the World Bank's small-hydropower programme is specifically designed to improve electricity supply in underserved and rural regions. The project is expected to support local economic activity and stimulate production in small and medium-sized enterprises.

Reliable electricity can also support local businesses.

A small manufacturing company cannot operate efficiently if electricity is frequently interrupted. Shops, restaurants, farms and service providers also depend on reliable energy.

Therefore, improving electricity supply can indirectly increase local productivity and employment.

Renewable energy can consequently contribute to **decentralised economic development**.

Instead of economic activity being concentrated only in major cities, improved energy infrastructure can allow businesses to develop in smaller towns and rural areas.

4.5. Renewable Energy and Natural-Gas Resources

Another economic benefit of renewable energy is the possibility of reducing the amount of natural gas required for electricity generation.

Uzbekistan has historically depended heavily on natural gas in its energy system.

When renewable sources generate electricity, natural gas can potentially be redirected towards other uses or saved for periods of high demand.

Government estimates have suggested that the development of planned solar and wind projects could save billions of cubic metres of natural gas annually.

This has an important economic implication.

Natural gas is not only an energy input. It is also a valuable economic resource that can be used by households, industries and chemical producers.

Therefore, reducing gas consumption in electricity generation can potentially increase the flexibility of the energy system.

However, the economic value depends on the cost of renewable electricity, grid integration and the opportunity cost of alternative uses of natural gas.

4.6. Renewable Energy and Technological Development

The renewable-energy transition can also stimulate technological development.

Modern renewable-energy systems increasingly depend on:

- smart grids;
- battery storage;
- digital monitoring;
- artificial intelligence;
- energy forecasting;
- automated control systems.

This creates opportunities for Uzbekistan to develop capabilities in advanced technologies.

The connection between renewable energy and digitalisation is becoming increasingly important.

In 2026, the Uzbek government highlighted that the rapid expansion of artificial intelligence and digital technologies is increasing demand for electricity and that countries' competitiveness will increasingly depend on affordable, reliable and environmentally sustainable energy.

This means renewable energy can support not only traditional industries but also the emerging digital economy.

Data centres, telecommunications systems and technology companies require reliable electricity.

Consequently, a strong renewable-energy system can become part of the infrastructure needed for future economic transformation.

5. Challenges

5.1. High Initial Costs

One of the biggest challenges associated with renewable energy is the high initial investment requirement.

Although solar and wind technologies have become increasingly competitive, building large-scale projects still requires substantial capital.

Developing countries may face difficulties financing these investments because of high interest rates, currency risks and limited domestic capital markets.

International development institutions and private investors can therefore play an important role.

5.2. Ageing Electricity Infrastructure

Renewable-energy generation cannot deliver its full economic value if electricity networks are inefficient.

The World Bank estimated that technical distribution losses in Uzbekistan were approximately **13% in 2024**, while more than half of distribution facilities had been operating for over 30 years.

This means that grid modernisation is essential.

In May 2025, the World Bank approved $100 million in concessional financing for modernising electricity distribution networks, with an additional $50 million in co-financing from Uzbekistan's Regional Electric Power Networks.

The investment is expected to improve renewable-energy integration and electricity reliability.

5.3. Intermittency and Energy Storage

Solar and wind energy are not constant sources of electricity.

Solar generation falls at night and changes according to weather conditions. Wind generation also varies.

Therefore, countries with high renewable-energy shares require:

- battery storage;
- flexible power plants;
- improved forecasting;
- stronger transmission networks;
- demand-management systems.

Uzbekistan has already begun developing energy-storage infrastructure.

According to government information, energy-storage capacity reached 1,245 MW in 2025, with plans to increase storage capacity to 4.5 GW by 2030.

This indicates that policymakers recognise storage as an important part of renewable-energy development.

5.4. Shortage of Skilled Workers

The renewable-energy sector requires specialised human capital.

If universities and vocational institutions fail to produce enough engineers and technicians, companies may depend heavily on foreign specialists.

This could increase project costs and reduce opportunities for domestic employment.

Therefore, renewable-energy expansion should be accompanied by investment in education.

5.5. Financing and Investment Risks

Renewable-energy projects often involve long payback periods.

Investors therefore need confidence that electricity markets, regulations and contracts will remain stable.

Uncertainty about electricity tariffs, taxation or regulation can discourage investment.

Uzbekistan's ongoing electricity-market reforms and increasing private-sector participation are therefore important for renewable-energy development.

6. Discussion

The results indicate that renewable energy can influence economic development through several interconnected channels.

The first channel is **energy security**.

By increasing domestic electricity generation, renewable energy can reduce supply shortages and improve reliability.

The second channel is **investment**.

Large-scale renewable-energy projects can attract foreign capital and stimulate domestic business activity.

The third channel is **employment**.

Renewable-energy development creates demand for technical and professional skills.

The fourth channel is **regional development**.

Renewable-energy infrastructure can improve electricity supply in rural areas and support local businesses.

The fifth channel is **technological development**.

Renewable energy increasingly depends on digital systems, storage technologies and smart-grid infrastructure.

These channels demonstrate that renewable energy should not be treated as an isolated environmental policy.

It is becoming part of a broader economic-development strategy.

However, the results also demonstrate that renewable-energy investment alone is insufficient.

A country can build large solar and wind plants but still experience electricity shortages if transmission and distribution systems remain inefficient.

Similarly, renewable-energy projects may create fewer domestic jobs than expected if the local workforce does not have the necessary skills.

Therefore, renewable-energy development needs to be integrated with:

- infrastructure policy;
- education policy;
- investment policy;
- industrial policy;
- financial-sector development;
- labour-market policy.

This integrated approach is particularly important for Uzbekistan.

The country is simultaneously experiencing economic expansion, population growth, digitalisation and increasing electricity demand.

Consequently, energy policy will influence the country's future economic competitiveness.

7. Policy Recommendations

Based on the findings, several policy recommendations can be proposed.

First, Uzbekistan should continue expanding renewable-energy capacity.

Solar, wind and hydropower should remain important components of the country's long-term electricity strategy.

Second, grid modernisation should occur alongside renewable-energy expansion.

Investment in transmission, distribution and storage is necessary to ensure that new renewable capacity can be used efficiently.

Third, education should be aligned with the renewable-energy labour market.

Universities should introduce or strengthen programmes related to renewable energy, energy economics, environmental management and sustainable finance.

Fourth, private investment should be encouraged.

Transparent procurement, predictable regulation and appropriate risk-sharing mechanisms can attract more domestic and international capital.

Fifth, local businesses should participate in renewable-energy supply chains.

Small and medium-sized enterprises can provide construction, maintenance, transportation and technical services.

Sixth, energy efficiency should receive equal attention.

Increasing electricity supply is important, but reducing unnecessary energy consumption can also improve economic efficiency.

Seventh, energy-storage systems should continue to develop.

Storage will become increasingly important as the share of solar and wind power increases.

Conclusion

Renewable energy has the potential to become an important driver of economic development in Uzbekistan.

The analysis shows that renewable energy can contribute to economic growth through several mechanisms, including improved energy security, increased investment, employment creation, regional development, technological innovation and more efficient use of natural resources.

Uzbekistan has already made significant progress in expanding solar, wind and hydropower capacity. The country's renewable-energy generation is growing rapidly, while government plans aim to substantially increase renewable capacity and electricity production by 2030.

Nevertheless, important challenges remain.

High investment requirements, ageing electricity infrastructure, intermittency, limited storage and skills shortages could restrict the economic benefits of renewable energy.

Therefore, the transition should not focus only on constructing renewable-energy facilities.

A successful renewable-energy strategy requires a complete ecosystem consisting of **modern electricity networks, energy storage, skilled workers, private investment, supportive regulation and efficient markets**.

For Uzbekistan, renewable energy can represent much more than an environmental policy.

It can become an important component of a modern economic-development model.

If renewable-energy expansion is combined with infrastructure modernisation, human-capital development and private-sector participation, Uzbekistan can improve energy security while creating new investment opportunities, jobs and technologies.

In this sense, renewable energy should be viewed not as a cost of economic development, but as a potential **investment in the country's long-term economic competitiveness and sustainable growth**.

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