ACCELERATING RENEWABLE ENERGY TRANSFORMATION IN UZBEKISTAN THROUGH DIGITAL ECONOMY TOOLS

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Abstract. This article examines the digital transformation initiatives within Uzbekistan's renewable energy sector, emphasizing the adoption of digital economy tools. As the global transition towards renewable energy accelerates, Uzbekistan aims to increase the share of alternative energy sources to 25% by 2030, enhancing solar and wind capacity. The analysis highlights the role of digital innovations, including artificial intelligence, IoT devices, and online energy trading platforms, in facilitating the transition. Furthermore, the article discusses the government's "Digital Uzbekistan 2030" strategy and its investment climate, which promote technological integration and stakeholder engagement. The findings suggest that further digitalization could significantly accelerate renewable energy growth, benefiting the economy and promoting sustainability.

Keywords. Renewable Energy. Digital Economy. Internet of things.

INTRODUCTION

The global economy is currently witnessing a rapid expansion of alternative green renewable energy technologies, which are increasingly substituting traditional fossil fuel-based energy sources [1]. This trend is further reinforced by the integration of digital economy tools within the renewable energy sector. Not only is this trend prevalent in developed countries, but it is also gaining significant traction in developing markets. In these regions, where energy markets are less mature, there is a greater receptiveness to new technologies and investments.

This article seeks to investigate the digital transformation initiatives within Uzbekistan's renewable energy sector and assess the potential impacts of adopting digital economy tools, with a specific emphasis on smart grid technologies. The assessment will be carried out through an analysis of statistics and information sourced from credible references.

The Republic of Uzbekistan is experiencing a rapid movement in digitalization, coupled with a strong governmental focus on renewable energy sources. The country has established an ambitious goal of increasing the share of alternative energy to 25% by 2030. This target includes enhancing solar power generation capacity to 7,000 MW and wind energy capacity to 5,000 MW by the same year [2].

In 2020, the Government of Uzbekistan launched the "Digital Uzbekistan 2030" strategy, aimed at enhancing digital skills and doubling the contribution of digital services to the GDP. Approximately $25 billion was planned for investment in digital infrastructure. Concurrently, a tax-free regime was introduced for the IT sector, and an IT Park was established to provide government consulting services to its residents [3]. These governmental initiatives are expected to stimulate digital transformation not only in the traditional IT sector but also in the renewable energy sector, where the government is equally committed to accelerating the transition to renewable energy sources. Together, these two directions have the potential to create a synergistic effect.

The most effective and proven digital innovations in the field of renewable energy are as follows:

- Artificial Intelligence, Machine Learning Algorithms, and Data Science Techniques: These are utilized for regulatory and manufacturing monitoring, determining consumption patterns, tracing delivery failures, forecasting demand and supply, optimizing energy storage, and automating smart grid control [4], [5];

- Internet of Things (IoT) Devices: Employed as real-time data monitoring tools [6];

- Online Energy Trading Markets: This includes the use of blockchain technology and smart contracts for trading platforms, peer-to-peer (P2P) energy trading platforms, and certifying renewable energy credits [7];

- Applications for Tracking Energy Usage: These enable users to monitor their energy consumption and participate in demand response programs, as well as access marketplaces that offer discounts and bonus programs for energy-efficient products.

Some of the aforementioned elements of the digital economy are partially implemented in Uzbekistan's energy system, while others are awaiting integration, which will be discussed further in this article.

Prerequisites for Transformation. In the late 2010s, Uzbekistan's energy system was characterized by outdated infrastructure, a state monopoly on generation, transportation, and distribution, and a reliance on natural gas, with a minimal share of renewable energy sources. There was a significant demand-supply imbalance and a lack of green technologies [8].

The aging infrastructure, a remnant of the Soviet era, required modernization and the adoption of new technologies. Between 2017 and 2019, the government initiated comprehensive energy reforms to reduce dependence on fossil fuels, modernize the overloaded energy system, and diversify with an emphasis on renewable energy to mitigate environmental impact and promote sustainable development.

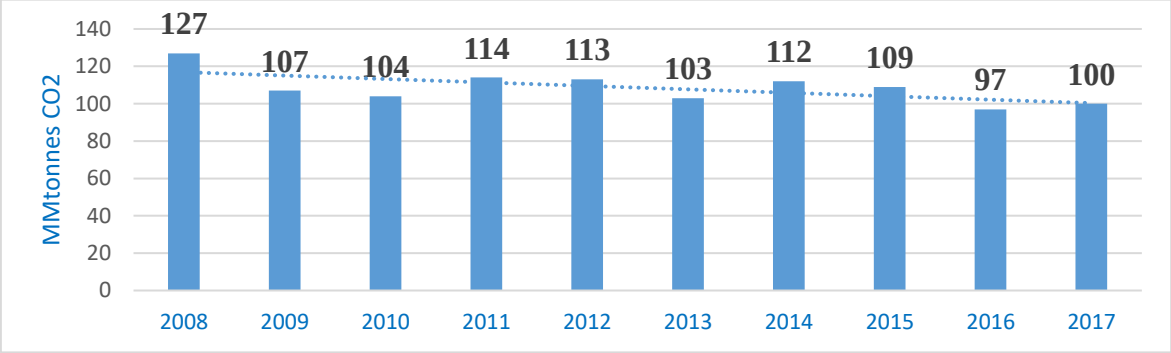

Fig 1. CO2 emissions in Uzbekistan in 2008 - 2017, MMtonnes CO2

Source: US Energy Information Administration country review [9]

The government outlined necessary reforms through legislative measures aimed at establishing a framework for future changes and improvements, including the "Concept Note for Ensuring Electricity Supply in Uzbekistan 2020-2030," [10], "On the Use of Renewable Energy Sources," and "Concepts for the Development of Renewable Energy Sources in the Country for the Period 2019-2023."

Investment boom

A highly favorable investment climate, combined with support and consultancy from world financial institutions, has resulted in a significant increase in investor interest in Uzbekistan's green energy projects. This new investment era can be traced back to the late 2010s, when more than ten international investment agreements were signed between the government and various international financial institutions and investors. Given that the market is still developing, entry barriers are relatively low, and demand is bolstered by government support.

Fig 3. Project financial aid to Uzbekistan from European Investment Bank and European Bank for reconstruction and development by 2024

Financial institution	Amount, €, mln	Number of projects
European Investment Bank	120,7	4
European Bank for reconstruction and development	4 979	164*

**70% of the projects and finance are focused on sustainable development*

Source: European Investment Bank [11]

and European Bank for reconstruction and development [12]

These initiatives have led to an investment boom primarily structured as public-private partnerships. Currently, over 20 projects are operational in Uzbekistan, mainly developed by companies from the UAE, Saudi Arabia, China, and France, with more additional projects in the design and construction phases [13].

The localization of equipment production could enhance project efficiency. Current wind power plant projects in Uzbekistan rely on imported wind turbines, which increases the cost of electricity and consequently hinders the expansion of renewable wind energy in the country. This situation underscores the necessity for the domestic production of turbines, which would help optimize costs for wind farms and attract additional investment by leveraging the country’s natural resources.

Digital Economy in the Renewable Energy Sector of Uzbekistan

To date, several elements of digital economy tools have been implemented in both the renewable and traditional energy systems of Uzbekistan:

IoT devices. Uzbekistan has made considerable progress in the deployment of smart grid technologies, including advanced metering infrastructure, to modernize its energy sector. The country has also invested in digital control systems and automation technologies to optimize processes related to energy generation, transmission, and distribution [6].

Online energy trading markets: The establishment of a digital energy platform, as part of ongoing market liberalization efforts, has facilitated trading activities and enhanced the efficiency and reliability of the energy system [6].

Applications for tracking energy usage: Although applications for monitoring renewable energy usage are not yet widespread, their adoption is increasing in the traditional energy sector. In 2024, Hududgazta'minot JSC and "Hududiy Elektr Tarmoqlari" launched mobile applications designed to monitor natural gas consumption and expenses, as well as manage electricity bills online.

To further enhance the development of solar and wind renewable energy, while contributing to the national goal of doubling the share of digital services, several measures can be considered. These measures would involve integrating new financial, trading, and Internet of things (IoT) technologies, as well as engaging the nation's population in the process:

Improving online trading programs. The existing online trading platform can be significantly enhanced by reducing transaction costs through the adoption of block chain and smart contract technologies, as evidenced by international experience. Additionally, the platform could be integrated with a marketplace for energy consumers, allowing participants to purchase energy-efficient products at discounted rates, which could be funded by bonuses generated from energy savings systems. These bonuses could also be incorporated into state programs that currently subsidize the acquisition of private solar installations.

Involvement of IT Parks. Residents of Uzbekistan's IT parks can contribute to the development of mobile applications for renewable energy consumption, which would be integrated with the online trading platform, marketplace, and bonus system.

Utilization of advanced technologies. Machine learning, artificial intelligence, and data science can be further employed for regulatory compliance, manufacturing forecasts, real-time monitoring, and post-performance analysis.

CONCLUSIOINS

Government efforts to increase the share of renewable energy sources, primarily based on wind and solar power, combined with a significant shift towards digitalization, have resulted in an increase in the renewable energy share in Uzbekistan by 2023. The core elements of digital economy tools introduced to the renewable sector in Uzbekistan include deployment of IoT devices and smart grid technologies, the establishment of online energy trading markets, and the

development of mobile applications for tracking energy usage. Additionally, there are several effective avenues for further digital implementation, including

Furthermore, the growth potential of the renewable sector, reinforced by digital advancements, is bolstered by an investment boom characterized by significant interest from foreign investors, supported by governmental initiatives aimed at enhancing the investment climate.

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