

**DIGITAL TRANSFORMATION, TECHNOLOGICAL AND
ECONOMIC SOVEREIGNTY ON THE EXAMPLE
OF THE ENERGY SECTOR OF UZBEKISTAN**

S. X. XAKIMDJANOVA¹

¹Assistant teacher of the «Department of economics
and management of industry»
Tashkent state technical university,
Tashkent, Republic of Uzbekistan

Annotation. In recent years, within the framework of global trends of digitalization and innovative development, the energy sector of Uzbekistan has also experienced significant changes. One of the most important factors for Uzbekistan in this process is not only increasing the efficiency and sustainability of energy supply, but also strengthening technological and economic sovereignty. The industry, the development of innovative solutions and the creation of its own capacities for the production of power equipment are becoming an integral part of the country's strategy aimed at ensuring independence and sustainability.

Key words: energy, digitalization, transformation, automation.

The digital transformation of Uzbekistan's energy industry involves the introduction of the latest information and communication technologies (ICT) to optimize the processes of energy production, distribution and consumption. The purpose of this process is not only to increase the operational efficiency and reliability of energy supply, but also to ensure the energy security and independence of the country. One of the most important elements of the digital transformation in the energy sector of Uzbekistan is smart energy systems, or Smart Grid. These systems allow the integration of various energy sources, including conventional and renewable, into a single grid, as well as increase the flexibility and sustainability of the entire energy infrastructure. The use of Smart Grid contributes to more accurate monitoring of the state of power grids, prompt response to emergency situations and optimization of energy consumption. In Uzbekistan, in particular, smart meters are being introduced, which allow not only to record energy consumption, but also to transmit data in real time, which helps not only to ensure transparency in settlements with

consumers, but also to optimize the distribution of electricity depending on the needs in different regions.

Big Data analytics in this area is used to improve the forecast of energy consumption, as well as to analyze the operation of individual nodes of power grids and electricity generation. In Uzbekistan, projects are actively developing to create platforms for data collection and analysis, which makes it possible to predict consumption peaks and regulate the load in real time. The use of such solutions helps to significantly reduce operating costs, increase the reliability of the energy infrastructure and minimize energy losses. An example of the successful implementation of such technologies is the development of a platform for analyzing and managing electricity distribution, which is already used in some regions of the country. Automation of processes in the energy sector of Uzbekistan is being actively implemented both in the generation and distribution of energy. The installation of automated control systems makes it possible to increase the efficiency of energy facilities, reduce the human factor and quickly manage production processes. Particular attention is paid to the automation of work at thermal and hydroelectric power plants, as well as the introduction of intelligent solutions for network management. This includes the use of a SCADA (Supervisory Control and Data Acquisition) system, which helps to monitor the performance parameters of objects, such as pressure, temperature and voltage, in real time and make timely decisions to maintain optimal operation.

With the development of renewable energy sources such as solar and wind farms, there is a need for more complex and flexible digital solutions. Projects are being implemented in Uzbekistan to create digital platforms for renewable energy management, which help integrate these energy sources into the overall energy system. The introduction of green technologies plays an important role in the energy sector in terms of fuel economy, and also plays a major role in reducing emissions into the atmosphere. Uzbekistan has set targets for renewable energy generation and capacity. The country plans to produce 25% of its electricity from its own renewable sources by 2030 and intends to increase its energy capacity by adding 7 GW of solar energy and 5 GW of wind energy (Table 1, 2).

Table 1 – Targets for the construction of solar power plants until 2030

Solar stations	17
Total capacity of projects	7000 MW
Total cost of projects	\$4.8 billion
Annual Output	15.3 billion kW.
Annual Natural Gas Savings	4.5 billion cubic meters.

Table 2 – Targets for the construction of wind farms until 2030

Number of projects	11
Total capacity of projects	5000 MW
Total cost of projects	\$6.0 billion
Annual Output	17.5 billion kW.
Annual Natural Gas Savings	5.2 billion cubic meters.
Reduction of annual harmful emissions	6.7 million tons.

The key priorities for Uzbekistan in the field of green energy are: improving infrastructure, supporting private investment, as well as integrating renewable sources into the national energy system. Numerous large projects for the construction of solar and wind power plants, as well as legislative initiatives aimed at creating a more favorable environment for investors, indicate the seriousness of the country's intentions in implementing its environmental and energy policies. However, additional efforts are needed to achieve the Sustainable Development Goals and increase the share of renewable energy in the national energy mix. Challenges related to infrastructure modernization, high capital costs, and the need for technical integration of variable energy remain challenges that require an integrated approach. In general, the development of green energy in Uzbekistan opens up new opportunities for economic growth, improving the environmental situation and increasing the country's energy security. This area has prospects for creating new jobs, attracting foreign investment and integrating the country into global energy and environmental trends.

The use of digital technologies in such facilities allows you to optimize energy production depending on weather conditions, as well as monitor the efficiency of equipment operation, prevent breakdowns and plan

maintenance in a timely manner. Technological sovereignty in the energy sector of Uzbekistan is manifested in the country's desire to develop and produce its own equipment and technologies for energy facilities, as well as to strengthen independence in the development and implementation of new solutions. In the context of global economic instability and sanctions risks, the development of domestic production is becoming an important part of the strategy to ensure energy security.

One of the most important steps towards technological sovereignty is the creation and development of our own production facilities for the production of power equipment. Uzbekistan is actively working on the creation of domestic factories for the production of turbines, generators, transformers and other equipment for energy facilities. This reduces dependence on imports and reduces vulnerability in the event of external economic sanctions. An important aspect is the development of both traditional and renewable energy sources, as well as the improvement of the production of power equipment.

In 2020, a gas turbine plant was opened in Uzbekistan in Tashkent, a joint project with foreign partners. This plant allows the production of turbines for gas and thermal power plants. First of all, this equipment is used to modernize existing and build new facilities, which is essential to meet the growing demand for electricity in the country. Also in 2021, a plant for the production of solar panels was launched in Uzbekistan in the Navoi region. This project is part of a national program to expand the use of renewable energy sources, especially solar, in the country. Uzbekistan has great potential for the development of solar energy, and the launch of such a plant allows the country not only to develop its solar energy, but also to create its own production of solar panels. To ensure the reliability and stability of electricity supply, Uzbekistan has also opened a transformer plant in Tashkent. This company produces transformers of various capacities, which are used for the distribution and transmission of electricity, as well as for the modernization of the country's networks and energy systems. Another important facility in the energy industry is a plant for the production of generators and power generator sets, which has been opened in recent years. This plant specializes in the production of generators for the needs of the energy sector, as well as for industrial enterprises and residential facilities. The production capacity of the plant allows us to provide the domestic market with high-quality and reliable generators, as well as to start exporting to neighboring countries.

The opening of new factories and production facilities in the energy sector plays a key role in ensuring the energy security and technological sovereignty of Uzbekistan. The country is actively developing its own production of high-tech equipment for energy facilities, which allows not only to increase domestic energy efficiency, but also to reduce dependence on imports. At the same time, Uzbekistan seeks to use its natural resources, develop renewable energy sources and stimulate job creation in high-tech industries. These steps are part of a long-term strategy to strengthen economic and technological sovereignty, ensure sustainable development and improve the quality of life of citizens.

With the increasing adoption of digital technologies in the energy infrastructure, the threat of cyberattacks is also growing. Uzbekistan is actively developing national cyber defense systems to protect its energy industry from possible external and internal threats. In this context, the development of domestic data protection systems and the creation of infrastructure for monitoring and protecting critical facilities is becoming an important part of ensuring technological sovereignty. In recent years, Uzbekistan has been actively developing its cyber defense system, including in the field of energy. Among the key steps to ensure security are the following:

1. In recent years, Uzbekistan has significantly increased attention to cybersecurity at the state level. In 2020, the Cybersecurity Strategy of the Republic of Uzbekistan was approved, which covers not only the public and private sectors, but also strategic areas such as energy, transport and healthcare. The strategy is aimed at creating a legal, organizational and technical framework for protection against cyber threats.

2. One of the most important steps in ensuring cyber defense of the energy sector is the creation of Cybersecurity Monitoring and Management Centers, which monitor the state of infrastructure in real time. This includes continuous monitoring of SCADA systems, anomaly detection, timely response to threats, and prevention of attacks.

3. To protect energy infrastructure management systems, Uzbekistan is implementing security protocols for SCADA systems and other critical applications. This includes the use of data encryption, multi-level authentication, as well as special man-in-the-middle (MITM) defenses that can be used to take control of objects.

4. One important step is to train cybersecurity professionals. Educational programs and courses are being created in Uzbekistan aimed at

training specialists who are able to effectively protect energy facilities from modern cyber threats. Important aspects of the training are practical skills in the field of SCADA system protection, threat analysis and incident investigation.

5. To improve the effectiveness of cyber defense, Uzbekistan actively cooperates with international organizations and companies working in the field of cybersecurity. This includes the exchange of experience, as well as joint training and exercises aimed at increasing the resilience of the energy sector to cyberattacks.

6. In particular, Uzbekistan participates in international initiatives aimed at strengthening the protection of critical infrastructure, such as the Global Forum on Cybersecurity, as well as within the framework of bilateral agreements with technology companies.

Digitalization of the energy sector is the most important stage on the way to modernizing the economy and improving the quality of life in Uzbekistan. In recent years, the country has been actively introducing new technologies aimed at improving the efficiency, reliability and sustainability of the energy infrastructure. safety, reduce costs and improve environmental sustainability. The creation of high-tech energy infrastructure, including smart grids and energy supply management platforms, is becoming attractive to foreign and local investors. It also creates new jobs and stimulates the development of new sectors of the economy, such as cybersecurity, information technology and research and development. technologies and the development of national production capacities helps Uzbekistan reduce dependence on external supplies of equipment and technologies. The development of its own database, grid management system and analytical platforms allows the country to manage its energy resources more efficiently and minimize vulnerability in the event of external economic or political shocks.

Conclusion. The digital transformation of Uzbekistan's energy sector is a key element of the country's strategy to ensure the country's technological and economic sovereignty. The introduction of smart energy systems, big data analytics and process automation not only increases the efficiency and reliability of the energy infrastructure, but also contributes to the sustainable development of the industry in the face of global challenges. The use of digital technologies makes it possible to integrate various energy sources, including renewable ones, providing more flexible and secure energy supply management. An important aspect of

digitalization is the development of our own production facilities, which significantly reduces dependence on imports and contributes to strengthening national energy security. The construction of factories for the production of high-tech equipment for the energy industry and the development of domestic technologies for the production of solar panels, gas turbines and other infrastructure elements are important steps towards strengthening technological sovereignty. No less important is the development of a cyber-defense system for energy facilities, which is becoming an integral part of ensuring security in the face of growing threats of cyberattacks. Creating effective protection systems and improving the skills of cybersecurity specialists are important measures to protect critical infrastructure. The digitalization of Uzbekistan's energy sector not only helps to improve the quality of energy supply, but also opens up new opportunities to attract investment, create jobs and strengthen the country's position in the international arena. A strategic approach to digital and technological innovation makes Uzbekistan's energy sector more resilient and independent, contributing to economic development and improving the quality of life of citizens. Going forward, by continuing to strengthen the domestic production base, develop digital platforms and improve governance systems, Uzbekistan will be able to make significant progress in the field of energy sovereignty and sustainable development.

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