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Prospects for the development of smart electric power industry in Uzbekistan

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ABSTRACT. The article discusses such issues as the energy situation for the development of smart electric power industry in Uzbekistan, the conditions and factors that contribute to the use of smart power systems, the main approaches to the implementation of smart power systems (SPS) and the stages of building an SPS. The development of the smart electric power industry in Uzbekistan has great prospects for the future. Now the government of the country is actively working on the modernization of electric power systems and the introduction of new technologies to improve the efficiency and environmental friendliness of the energy sector. The energy situation and measures to reform the electric power industry of the Republic of Uzbekistan are given. The main conditions facilitating the use of SPS are identified. The main approaches to the implementation of the objectives of the SPS concept are determined. The stages of construction of smart electric power systems are highlighted.

I. INTRODUCTION

Nowadays, in the context of a steady increase in energy consumption, the issue of attracting powerful energy sources and introducing new technologies aimed at improving the efficiency of resource use and reducing the negative impact on the environment is becoming increasingly important.

The main conceptual idea of smart power systems is to change the traditional approach to managing electricity consumption. Nowadays, it is no longer enough to simply provide consumers with energy, it is necessary to develop innovative solutions for managing energy systems that will not only reduce the cost of electricity production, but also make it more affordable and cheaper for end users. That is why smart power systems, which allow implementing innovative technologies for managing the production, distribution and consumption of electricity, have been so relevant lately. The main principle of such systems is customer orientation, automation and optimization of production processes, as well as the use of new environmentally friendly energy sources [1,2,3].

One of the key areas of development is the creation of smart power grids that will use modern technologies for energy management and electricity generation. This will optimize energy consumption, reduce production costs and improve the reliability of the power system. At the same time, the development of the electric power industry is a difficult task that sometimes requires complex solutions at various levels. In this context, Uzbekistan is actively developing in the field of electric power and is making significant efforts to achieve decent results in this area [4,5].

The development of smart electric power industry in Uzbekistan has great prospects in the future. Now the Government of the country is actively working on the modernization of electric power systems and the introduction of new technologies to improve the efficiency and environmental friendliness of the energy sector. In addition, projects on the introduction of renewable energy sources, such as solar and wind energy, are already being actively implemented in Uzbekistan. This will reduce dependence on fuel imports and reduce the negative environmental contribution of the energy sector.

The article discusses such issues as the energy situation for the development of smart electric power in Uzbekistan, the conditions and factors contributing to the use of smart power systems, the main approaches to the introduction of smart power systems (SPS) and the stages of building an SPS.

II. MATERIALS AND METHODS

The technological infrastructure of modern electric power systems is complex and includes many different spatially distributed, but interconnected technical elements that carry out the processes of production, transmission and distribution of electric energy in real time and realize a common strategic goal – to provide reliable power supply to energy consumers. Smart power systems make it possible to distribute the load on power systems more evenly, which reduces the likelihood of accidents and emergencies. They also have flexible capabilities for managing production capacity and energy consumption, which allows them to quickly adapt to changing market conditions and consumer requirements.

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Traditional technologies for managing huge flows of electrical energy in systems with modern, complex infrastructure have become unreliable, as evidenced by numerous system accidents in Uzbekistan in recent years. In this regard, it is proposed to develop a new concept for controlling electric energy flows, called "Smart Grids" or smart.

Currently, the available generating capacity of the Republic of Uzbekistan is 13.99 GW, of which:

- Thermal power plant (TPP) - 11.8 thousand. MW or 84.30 %;
- Hydroelectric power station (HPP) - 1.86 thousand. MW or 13.32 %;
- Photovoltaic power plant (PPP) – more than 200 MW or 1.43 %;
- Block stations and isolated stations - more than 133 MW or 0.95%.

Figure 1. shows the diagram distributing the generated capacities of the Republic of Uzbekistan [6,7].

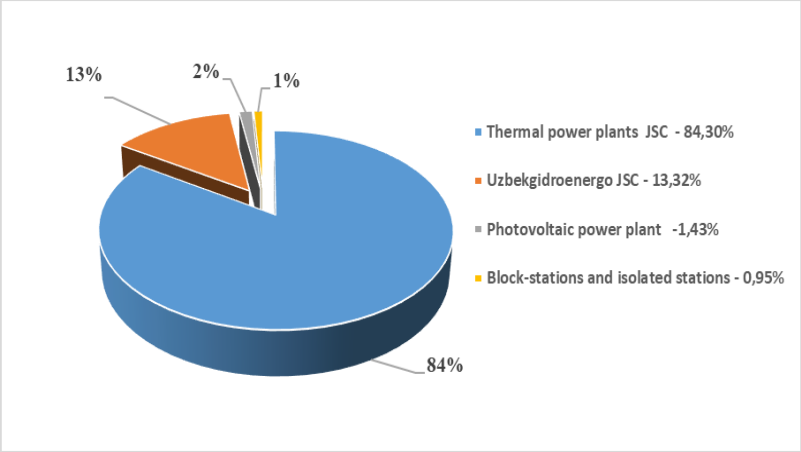

Figure 1. Diagram distributing generated capacities of the Republic of Uzbekistan.

The main source of generation is 11 thermal power plants, including 3 thermal power plants.

The capacity of modern energy-efficient power units is 3241 MW or 27.4% of the total capacity of thermal power plants. Hydropower includes 48 hydroelectric power plants, including 6 microelectric power plants with a total capacity of 1.3 MW. The utilization rate of the republic's hydropotential is 27.7%. Transportation of electric energy from generation sources is carried out via 35-500 kV backbone networks, including:

- Substations (hereinafter SS) - 85 units with a total capacity of 25389.9 MVA;
- Power transmission lines (hereinafter PTL) - 11458.9 km fact.

Distribution and supply of electric energy to consumers within the republic is carried out through distribution networks of 0.4-110 kV, including:

- SS 35-110 kV - 1626 units with total capacity - 20421 MVA;
- PTL 35-110 kV - 28642 km;
- Transformer substation (TSS) – 75534 units with total capacity - 13933 MVA;
- PTL 0.4-10 kV - 223987 km.

At the same time, a significant part of the facilities of the electric grid economy have an operational life of more than 30 years, these include 66% of main and 62% of distribution networks, 74% of substations and more than 50% of transformer stations. This is one of the factors contributing to the increase in the level of technological losses of electric energy during its transportation and distribution. The average level of technological losses of electric energy in the main networks is 2.72%, in distribution networks 12.47%.

Thermal energy continues to be the main source of electric energy generation in the Republic of Uzbekistan, and its development with the use of energy-efficient technologies will ensure the stability of the country's energy system as a whole. In order to increase the energy efficiency of thermal power plants during the construction of new power plants operating in the basic mode, combined-cycle gas plants (CCGTs) with an efficiency of units of at least 60% will be mainly used. The construction of regulating power plants to cover the peak loads of the power system, with a total capacity of about 1200 MW, will be carried out on the basis of low-power gas turbine units (GTU) and gas piston engines [8,9].

The development of coal generation is envisaged through the construction of new coal-fired power units with a capacity of 300 MW (2x300) at the Angren TPP, as well as the phased modernization of existing power units of the Novo-Angren TPP, providing for year-round coal burning, as well as reducing harmful emissions into the atmosphere.

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The development of cogeneration plants for heating and hot water supply in cities will be carried out mainly due to the introduction of GTU of medium capacity. In particular, in 2020, a GTU with a capacity of 17 MW was introduced at the Fergana TPP and in 2023 - two GTU with a total capacity of 64 MW at the Tashkent TPP.

As new generating capacities are commissioned, the decommissioning of morally and physically obsolete thermal power units will be phased out. The total output capacity of the equipment that has spent the park resource will reach 5,54 thousand MW by 2030.

According to the development of hydropower in the Republic of Uzbekistan, in the period 2021-2030, it is planned to carry out work on 62 projects, including the construction of 35 HPPs with a total capacity of 1,537 MW and the modernization of 27 existing HPPs with an increase in capacity by 186 MW. As a result, by 2030, the total capacity of the HPP will be 3785 MW, the volume of electricity generated will be 13.1 billion kWh.

To achieve the indicators of renewable energy development, the target parameters of the annually commissioned capacities of renewable energy facilities in 2020-2030 have been determined, providing for the construction of 3 GW of wind and 5 GW of solar power plants.

In wind energy, the main direction will be the creation of large wind farms with a single capacity of 100-500 MW, most of which will be concentrated in the North-Western region (the Republic of Karakalpakstan and Navoi region).

Solar power plants with a capacity of 100-500 MW will be concentrated mainly in the Central and Southern regions (Jizzakh, Samarkand, Bukhara, Kashkadarya and Surkhandarya regions). However, solar power plants with a capacity of 50-200 MW will be built in other regions of the republic. At the same time, large solar power plants (totaling more than 300 MW) will gradually be equipped with industrial-scale energy storage systems to ensure stabilization of variable generation and regulation of peak loads.

Nowadays, measures are being implemented to reform the electric power industry of the Republic of Uzbekistan, pursuing the following goals (Figure 2.):

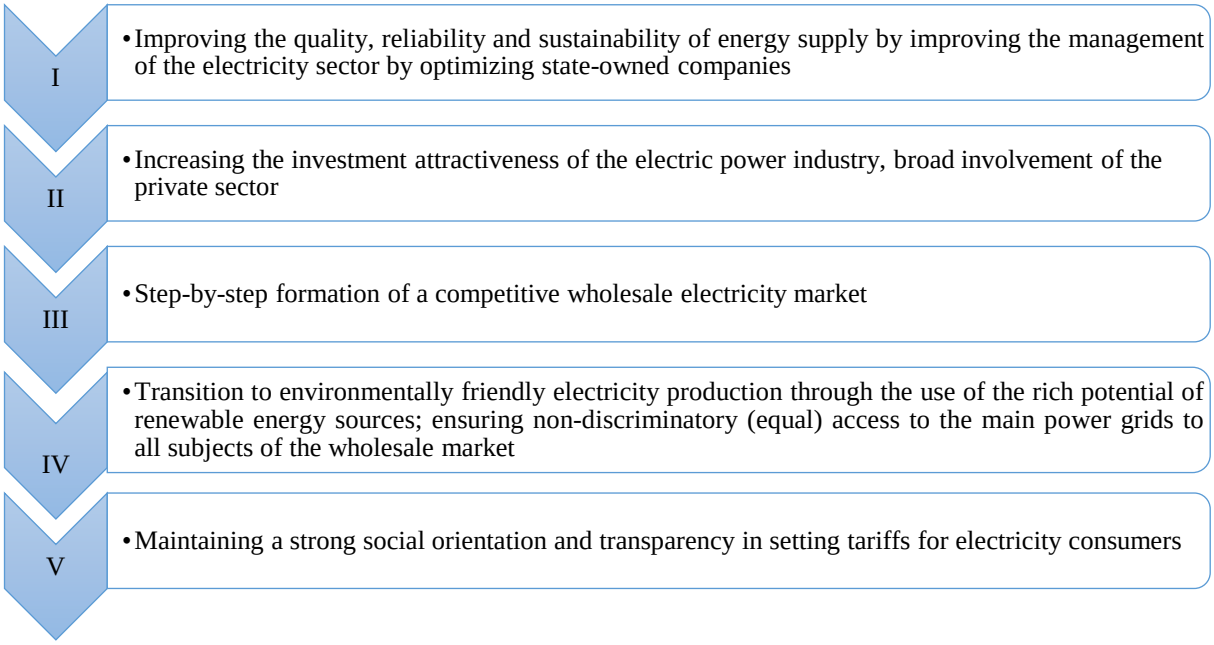

Figure 2. Measures to reform the electric power industry of the Republic of Uzbekistan

The reform of the electric power sector of Uzbekistan on the way to the introduction of a competitive wholesale electricity market is being carried out in stages.

The implementation of the initial stage of the reforms of the transition to market relations led to the unbundling of the vertically integrated state company Uzbekenergo JSC on the principle of functionality into enterprises directly engaged in the following activities (Figure 3):

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Figure 3. The scheme of unbundling of the state company JSC "Uzbekenergo"

Taking into account the current international trends in the development of the electric power industry, it can be concluded that the development and use of an smart energy system is appropriate for conducting an energy-saving policy in the Republic of Uzbekistan. The introduction of the SPS will increase the sustainability, energy security and energy efficiency of the Republic. Given the high density of electrical loads, we can also talk about the prospects and appropriateness of the development of small-scale energy facilities integrated into a common energy system. Smart technologies can contribute to the effective management of such a modernized energy system in Uzbekistan.

III. RESULTS

The development of smart electric power industry provides for new approaches and technologies for managing and optimizing power systems using modern information and communication technologies, data analysis, artificial intelligence and other innovative solutions. This system reflects new trends and prospects for the development of the electric power industry, increases its efficiency, reliability and environmental safety.

Conditions and factors contributing to the use of smart power systems in the Republic of Uzbekistan. The main conditions contributing to the use of SPS are:

1. Insufficient energy efficiency of the Republic of Uzbekistan, the factors of which include:

- large dispersion of consumers;
- uneven daily energy consumption, presence of peak loads;
- losses during transmission and distribution of energy;
- incomplete use of installed generating capacities;
- consumers' use of outdated equipment and technologies.

2. Insufficient energy security, the factors of which include:

- Low concentration and territorial distribution of generating capacities
- Complex geographical location of generating enterprises and transformer substations
- Large length of power lines between various elements of the network
- Inefficient supply of energy to consumers in the event of an accident

3. Insufficient environmental safety.

The main approaches to the implementation of the objectives of the SPS concept are:

1. Automation of power supply network management processes, includes the creation of control systems that can control electricity consumption and dynamically regulate energy consumption in real time.
2. Centralized network management is associated with the creation of a centralized management that can perform tasks to optimize the use of energy resources and calculate the most efficient energy transmission routes.
3. The use of distributed energy sources involves the use of various types of renewable energy sources, such as solar and wind energy, to create distributed energy sources that can provide a more stable and sustainable energy supply.
4. The use of innovative technologies, includes the use of modern technologies, such as artificial intelligence, blockchain, Internet of Things (IoT) and others, to improve the efficiency of all processes of managing power supply networks.

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5. Increasing energy efficiency is associated with the creation of management mechanisms that can help consumers manage their energy consumption in order to avoid unnecessary costs and reduce the load on the energy supply system as a whole.

The construction of smart electric power systems usually includes the following stages:

1. Project analysis - involves defining the goals and objectives of the project, analyzing the needs and requirements of users, as well as assessing technical capabilities and financial risks.

2. Design - includes the definition of system requirements, the development of architecture and the design of each of its components (hardware and software components).

3. Development - at this stage, all components of the system are created, tested and debugged. Including the development of hardware devices, software, control and communication systems.

4. Implementation - is associated with the installation and configuration of hardware and software components, as well as with the training of users of the system.

5. Maintenance and maintenance. After the implementation of the system, regular maintenance and maintenance of all its components, as well as software and hardware updates are required.

6. Evaluation of results. At this stage, the effectiveness of the system is evaluated, where users and developers can analyze the results of the system, as well as identify opportunities for its improvement.

Each stage must be thought out and carefully implemented for the successful construction of the SPS.

As a result, a system-integrated system with a single network infrastructure has been created, technologically (PTL) and informationally connecting all generating energy sources and all the multitude of consumers within the entire country or a separate region (Figure 4).

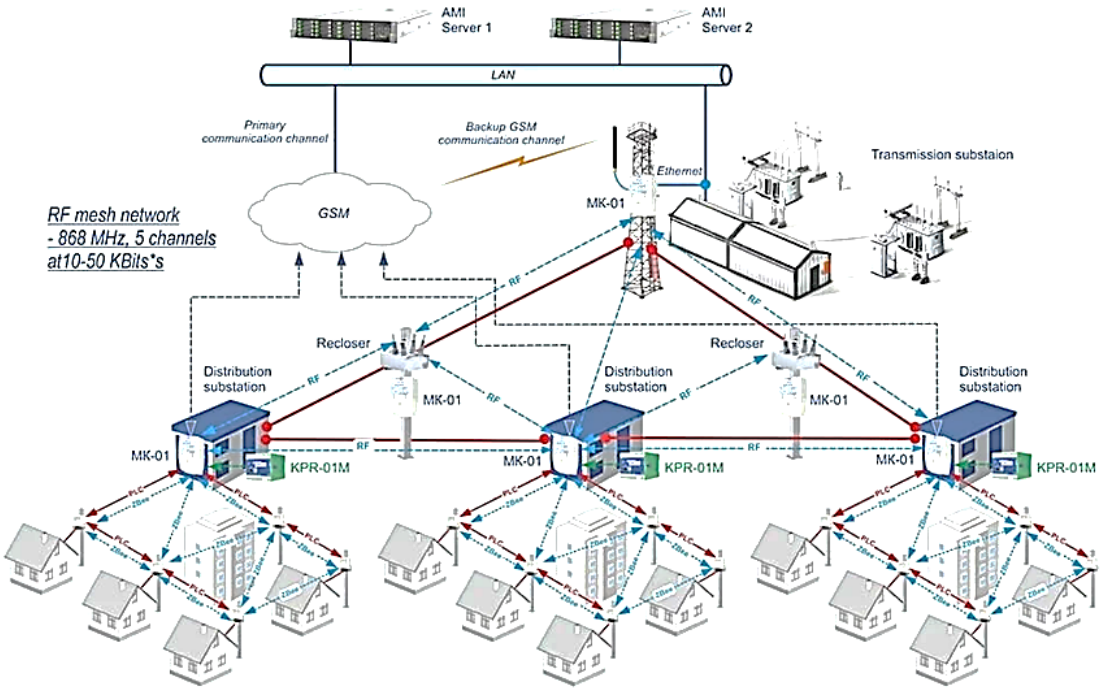

Figure 4 of a system-integrated system with a single network infrastructure.

Thus, the prospects for the development of smart power systems are associated with the use of new technologies and energy-efficient solutions that will allow achieving maximum efficiency and saving energy resources at minimal cost.

IV. DISCUSSION

The economic strategic goal of the creation of the SPS is the possibility of establishing the most reliable, safe and energy-efficient mode of operation of the systems at any real time under any changing conditions of their external and internal environment.

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The main technological and social prerequisites for the creation of the SPS, as well as any other innovative solutions of the XXI century of the development of civilization, are the following [10,11,12]:

- the ongoing integration of the production activities of energy companies, which are gradually turning into regional or global integrated companies, which requires new technologies for managing their modes;
- the ever-increasing gap between objectively occurring changes in the world due to the generation of new knowledge and proposed technologies and the ability of the relevant companies to fully comply with them, which determines the need for their constant improvement;
- excessive growth in the aggregate of consumed energy resources, which requires the use of more "smart", efficient and environmentally friendly strategies for their use;
- customer-oriented strategy of energy companies as a means of achieving their high competitiveness and developing new markets, which implies the need to constantly monitor the behavior of energy consumers and take into account their requirements for electricity supply;
- the growing technical capabilities and affordability of smart and networked information technologies, gradually turning managed objects and their environment into a "digital reality" regulated by intelligence.

V. CONCLUSION

As a result of the implementation of smart power systems, there is a reduction in energy consumption costs, an increase in production efficiency and a reduction in harmful emissions into the atmosphere. The economic strategic goal of creating smart power systems is the possibility of providing the most reliable, safe and energy-efficient mode of operation of the system at any real time under any changing conditions of their external and internal environment. In future smart power systems (SPS) there will be an active flow of electricity and information. One of the main tasks of this system is to collect, store and process a large amount of information about energy consumption in real time. To do this, special sensors and technologies will be installed at energy facilities (for example, at power stations) that transmit data to the SPS network. This data will be analyzed and used to manage energy flows and improve the quality of energy supply.

In addition, with the help of the SPS, users will be able to track their electricity costs and control their energy budget. For this purpose, applications running on mobile devices, as well as Internet portals and energy management services will be developed.

Thus, it can be concluded that the smart electric power industry is an important area of development of the energy sector of Uzbekistan. This will increase the efficiency of electricity production, reduce costs, reduce the negative environmental contribution and ensure more reliable operation of the power system as a whole.

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