Digital and automated technologies in the Russian energy industry

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Abstract. The article emphasizes the need for implementing digital and automated technologies and describes their potential. The article distinguishes between the directions of digital transformation of the energy industry using key implementation criteria that allow companies to adapt to new tasks and goals, improve the availability of the power grid infrastructure, and increase the operation effect. The article specifies the targets of digitalization and explores existing and promising digital technology projects.

1. Introduction
The existing energy industry of the Russian Federation has significant potential due to the use of modern technical solutions and changes in organizational models [28].

The implementation of digital technologies can reduce the time of response to the actual challenges of electricity consumers [13]. The tasks can be implemented in an evolutionary way using innovative, automated breakthrough technologies and solutions, including through the use of digital networks, digital substations and digital company management methods [9]. In addition, the solution of these problems will open up opportunities for the provision of new services, such as a tariff menu, small distributed generation, and energy infrastructure [11].

2. Materials and methods
The directions of digitalization of the energy industry were distinguished based on the implementation criteria and goals. The directions can solve the following tasks [7]:

- Adaptability of the company to new tasks and challenges (SAIDI, SAIFI, reduction in the number of technological violations, reduction in the time of elimination of technological violations) [5].
- Increasing the availability of the power grid infrastructure for consumers (reduction in the period of technological connection for consumers up to 150 kW to 120 days, reduction in the cost of connection and the number of steps to connect to the network).
- Improving the efficiency of the company [26-27].
- Increasing the shareholder value of capital [3].
- Bringing to a new level of response to market challenges [23] (adaptability to new market conditions, implementation of new digital technologies, development of human resources and new competencies, business diversification, use of new services for the consumer) [1].
The key factor in the implementation of the digital network is the platform nature of solutions, the unified digital environment, and the information security technologies [2].

3. Results
Based on the goal, objectives, sources and analytical reports of energy companies and the concept of "Digital Transformation 2030", the targets of Russian power grids (PJSC Rosseti) in the field of digitalization were identified (figure 1) [4].

![Digitalization targets](image)

**Figure 1.** Digitalization targets (compiled by the author).

The above guidelines will improve the quality and availability of transmission and technological connection services. Through the digitalization, there will be an effect for energy consumers. The effects will improve the quality.

4. Discussion
Currently, there are digital technologies in electrical networks (table 1), and digitalization projects are being developed. They can solve the following tasks [6;8;10]:

- Business process management.
- Transmission of electricity through telecommunications equipment.
- Prevention of accidents [17].
Table 1. Existing and promising digital technologies of the Russian energy industry.

| Solutions                        | Existing (2019-2024)                                                                 | Promising (2025-2030)                                                                 |
|----------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Information Systems management   | ADMS systems with functionality support (SCADA, DMS, EMS, OMS, GIS, AMI, WFM) based on a network model with a topology processor. | Network-centric two-loop online and offline decision support systems (including digital design) of a digital network company based on the ontology of business processes and the mathematical model of the network as a single data bus with elements of artificial intelligence (including predictive risk-based analytics). |
| Digital substations              | Architectures for building secondary circuits of protection and automation (centralized, distributed, combined) using the IEC 61850 protocol. Mainly with the traditional architecture of secondary circuits. Based on existing technical solutions in terms of switching, measuring and distribution equipment, protection and automation terminals. | Compact Plug - and - Play power centers that use digital communication channels. Different architecture for primary circuits, which do not require special long-term adjustment during commissioning, made according to digital projects. Incorporating intelligent switching equipment, digital measurement systems and connection controllers (integrated functions of protection and automation, accounting and data transmission), probably not requiring individual configuration of the predictive diagnostics system. |
| Automation systems for the elimination of accidents in air (cable) networks | Predominantly distributed automation of air networks using automatic sectioning points, controlled disconnectors and short circuit indicators. Centralized (using indicators of emergency events) automation of cable networks integrated into ADMS systems. | Adaptive autocluster (consisting of elementary automated cells) networks of optimal topology, calculated using digital network models, with intelligent automatic devices (not requiring individual settings), non-automatic, unattended network dividers integrated into online and offline decision support systems. |
| Intelligent metering and energy monitoring systems | AIIS KUE (AMI) systems and intelligent electricity meters. Systems for energy monitoring of load nodes at the boundaries of balance sheet ownership and load nodes of networks. Integrated into the ADMS systems. | Intelligent energy monitoring and energy management systems. Measuring controllers at the level of end users that support industrial Internet of things technologies (in terms of data transmission) integrated into online and offline decision support systems, distributed registry technologies for the implementation of smart contracts. Measuring controllers for energy monitoring |

Digital technology programs will have a significant impact on the power grid system of the Russian Federation [15].

As part of the digital transformation of electrical networks, it will be necessary to create communication channels with objects of all voltage classes using a wide range of telecommunication technologies [19]. The implementation of software and hardware systems for technological management and corporate information systems for enterprise management involves the use of significant computing power, requiring special server rooms [21;25].

Taking into account the development of communication services, data storage and processing (cloud solutions), within the digital transformation it is planned to involve the existing communication
operators that meet the quality criteria for these systems [29-30]. The decision to develop own information infrastructure will be made taking into account all development and maintenance costs (if it is economically feasible) [31].

5. Conclusion
Digital transformation will improve the reliability, quality, and availability of services for the transmission of electricity to consumers, create a new infrastructure for the most efficient process of electricity transmission between energy supply companies, and develop competitive markets for related services.

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