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MODERN APPROACHES TO THE DEVELOPMENT OF POWER NETWORKS AND SYSTEMS

Modern energy systems are undergoing a significant transformation due to the development of technologies, decentralization of energy supply, integration of renewable energy sources, and increasing demands for the reliability and flexibility of power grids.

Trends in the development of power networks:

- Digitalization of networks: the use of smart meters, control systems (SCADA), sensors, and IoT technologies;
- Decentralization: the transition from centralized generation to microgrids and local energy sources;
- Integration of RES (renewable energy sources): solar, wind, and bioenergy installations require grid adaptation to unstable generation;
- Energy storage: the use of battery systems to balance the load;
- Flexible demand-side management (DSM).

Smart Grid

Smart Grid is an "intelligent network" that includes:

- two-way communication between consumers and suppliers;
- integration of distributed energy sources;
- increased efficiency, reliability, security, and resilience.

Microgrids

Microgrids are local energy systems that can operate autonomously or as part of a general network. They enhance energy security, especially in critical infrastructure.

The role of artificial intelligence and big data:

- demand and generation forecasting;
- optimization of load and network management;
- real-time detection of faults and malfunctions.

With the advancement of digitalization, the probability of cyberattacks increases, making data protection, secure information transmission, and system backup crucial.

Challenges and prospects:

- modernization of outdated infrastructure;
- integration of new technologies with minimal costs;
- increased resilience to climate change and emergency situations.

Modern power networks are complex and dynamic systems that require innovation, flexibility, and high reliability. The transition to Smart Grid and the development of microgrids are key steps toward the energy systems of the future.