INNOVATIONS

The Board of Directors adopted the OAO IDGC of Urals' 2020–2024 Innovation Development Program to be potentially extended till 2030[31]. The 2021–2025 mid-term implementation plan was revised and approved as a part of the 2020 Innovation Development Program progress report[32].

The following key directions of innovation-driven development were set to enhance efficiency of the program planning and implementation:

1. In terms of technological innovations:

- state-of-the-art technologies and solutions — activities related to the usage of new materials, isolations, equipment in primary business processes (current limiters, controlled devices, new-type wires with improved electrical conductivity and durability, new-type isolators, power electronics, etc.);
- digitization of management and technological processes — transition from analogue to digital principles of control over relay protection and emergency automation, automated process control systems, metering and telecommunications (digital measuring transformers, digital network equipment, shift to digital substations etc.); digitization of production asset management; launch of digital monitoring in the networks and at substations;
- enhancement of grids flexibility — development of network properties to enhance resilience to network disturbance and automated restoration of normal operations (adaptive relay protection and emergency automation, control systems, logic automation, digital on-line network model).

2. In terms of organizational and marketing innovations:

- designing new and systemic re-engineering of existing business processes through the lens of end-to-end performance (management of production assets, management systems, front-end services, management of life cycles of the system, lean production practices);
- HR management innovations (implementation of HR management technologies, relevant to this day);
- shaping innovative environment around the Company (collaboration with innovative companies, scientific and educational institutions dealing with scientific and technical issues by partnership in technological platforms, implementation of cooperation agreements with anchor higher education institutions).

The goal of the Company's Innovation Development Program for the mid-term and long-term (till 2030) periods is to shift to the new-generation innovative network with game-changing properties related to reliability, efficiency, availability, controllability and customer-centricity.

2021 Achievements:

1. Transition to 35–110(220) kV digital substations

The goal of the Digital Substations projects is to create grid facilities with intelligent control and management system by installing state-of-the-art equipment and systems as well as to use IEC 61850 data transfer protocols. Effect from the deployment of the "Digital Substation" technology: reduced exploitation costs due to extended repair intervals, usage of low-maintenance equipment, reduced time for restoration of normal network operation, reduced possibility of incidents and damages of equipment, usage of network fault location and remote switch control system.

The "Digital Substation" technology is planned to be deployed on the following pilot substations:

- 110 kV "Tekhnologicheskaya" substation (Permenergo)

  Innovative technologies implemented: i) digital relay protection and automation devices, supporting digital data exchange; ii) digital (electronic) current and voltage measuring devices (incl. transformers and various detectors, incl. fiber-optic) supporting digital data exchange.

  2021 achievements: the design specifies a digital decentralized substation, using MMS, GOOSE and Sampled Values protocols. During design process, application of analogue signal converters and electronic CT and VT shall be compared from the technical and economic point of view. In 2021, we performed design and survey works. Technical solutions are in the process of approval.

  2021 expenses totaled RUB 5.86 million (target), RUB 5.86 million (actual).

- 110 kV "Esaulka" substation (Chelyabenergo)

  Deployment of the project shall:

  - give an opportunity to connect new customers, increase net supply;
  - enhance reliability of electricity supply and voltage quality;
  - replace outdated and obsolete equipment;
  - achieve optimal load of the district;
  - enhance observability and manageability of the facility, test solutions using RPA and telematics devices supporting "digital substation" technology in line with IEC 61850.

  2021 expenses totaled RUB 1.91 million (target), RUB 1.91 million (actual).

· 110 kV "Asbest" substation (Sverdlovenergo)

Innovative technologies implemented: i) digital relay protection and automation devices, supporting digital data exchange; ii) digital (electronic) current and voltage measuring devices (incl. transformers and various detectors, incl. fiber-optic) supporting digital data exchange; iii) PMU devices integrated into DSP; iv) smart meters with possible integration into the unified management system, providing remote control and information on network parameters; v) intelligent (digital) monitoring systems and hardware troubleshooting.

2021 achievements: due to a long period of preparation of design and estimate documentation and System Operator's endless comments after re-examination of the design and estimate documentation, revised in the course of design (in 2019–2021) in unison with changes of regulatory and administrative documents (incl., DM levels and scope of telematics), the design and estimate documentation has not been yet approved. In light of Sverdlovenergo's financial economic situation, the project shall be implemented beyond the terms stipulated by the investment program.

2021 expenses totaled RUB 0.5 million (target), RUB 0.0 million.

2. Transition to digital smart grids with distributed intelligent automation and control system.

We completed projects related to the roll-out and development of smart metering (0.4–110 kV) in Permenergo, Sverdlovenergo and Chelyabenergo branches. The goal of the project is to create a customer-centered automated metering system with smart metering functions (remote reading of metering parameters, incl. billing and load limitation/disconnection; remote collection of consumption data; multi-tariff function; monitoring of meter status; data exchange).

Innovative technologies implemented:

· smart metering system is based on the usage of smart meters united into one system of automated control and recording. To get the system working, a new-generation meter is mounted on a power line tower. The meter transfers consumption metrics to the dispatcher and customer's display. Two-way GSM/GPRS communications enable to monitor the system in real time, control electricity supply and rapidly detect losses and attempted electricity thefts. Alongside with the installation of the automated metering system, cable entrance points are reconstructed: old-generation wires are replaced with self-supporting insulated wires, which provides higher quality of energy supply and reduces unauthorized connections to zero. Implementation of state-of-the-art automated systems of control and recording of electricity consumption makes it possible to arrange remote metering on any facilities and perform remote switching off/on;

· customer services and CRM (management of electricity supply and demand).

Effects from implementation: i) reliable metering at points of delivery at responsibility boundaries of multi-family and single-family houses; ii) reliable metering at points of delivery for consumers connected to networks with peak losses and consumption; iii) location of electricity loss centers through upgraded metering systems on 6(10)/0.4 kV substations making it possible to prepare balances of main substations with problematic feeders; iv) minimization of expenses on metering automation (per metering point).

2021 achievements: i) exclusion of in-house losses (in multi-family houses) from electricity purchased to compensate losses; ii) reduction of losses on selected network sections (by enhanced accuracy of metering and reduced unmetered consumption); iii) growth of net supply (same as previous, plus monthly billing using metered values as of the end of each calculation period); iv) reduction of operating expenses related to meter maintenance (manual data collection, manual data input, instrumental inspections).

2021 expenses in Permenergo: RUB 434.12 million (target), RUB 400.37 million (actual); 2021 expenses in Chelyabenergo: RUB 72.39 million (target), RUB 58.57 million (actual); 2021 expenses in Sverdlovenergo: RUB 10.30 million (target), RUB 144.24 million (actual). Varience from target figures is due to revision of investment program during 2021 (transfer and increase of expenses in 2021 in Sverdlovenergo) and due to long-term procurement procedures and cancelled tenders (in Permenergo, Chelyabenergo).

3. Transition to end-to-end performance of business processes and automation of control systems.

Build-up of Production Assets Management System (PAMS).

Goals of the project: i) build-up of the system for regular centralized management of core production assets in line with the Company's strategic goals; ii) enhancement of the quality of planning for repair, maintenance, upgrade and reconstruction programs; iii) provision of Company's management with a tool to generate objective data on production assets' health and exploitation costs; iv) creation of a mechanism for provision of maximum possible reliability level within set funding.

Innovative technologies implemented: i) deployment of ERP systems; ii) creation of a network model, compliant with the single data standards; iii) SCADA; iv) mapping systems — geographic information systems linked to geolocation and geopositioning systems; v) electronic catalogues and databases of standard technical solutions.

Effects from implementation: i) build-up of the system for planning and recording of production programs execution (repair program, maintenance program, upgrade and reconstruction program and other programs included into the exploitation decree), compliant with uniform requirements set by external regulatory documents and Company's bylaws; ii) integration of the system covering financial and management accounting, control of logistics, transport and human resources; iii) integration of the system with external systems to arrange data exchange, required for planning of production programs, integration with Rosseti's GIS systems, business analysis systems of the Company; iv) establishment of the KPI system related to production asset management on all levels that help evaluate and compare production departments, branches in terms of processes, technical and economic properties for further solutions.

4. Application of the latest technologies and materials.

Goals of the project: implementation of a pilot project related to use of innovative wires for aerial power lines. We plan to use innovative wires on the following facilities:

- reconstruction of 110 kV "Gornaya - Metanol" (circuit II), "Kizelovskaya GRES-3 - Gornaya" (circuit I) power lines (Stage 1) (10.534 km);
- reconstruction of 110 kV "Gornaya - Metanol" (circuit I), "Kizelovskaya GRES-3 - Gornaya" (circuit II) power lines (Stage 2) (9.873 km);
- reconstruction of 110 kV "Kizelovskaya GRES-3 - Gornaya" (circuits I,II and branch lines) (Stage 3) (3.9 km).

Effects from implementation: i) reduction of incidents, unscheduled repairs and repeated tension; ii) extension of power line faultless lifetime; iii) enhancement of reliability of electricity supply.

2021 achievements: we completed design and survey works, comparing innovative wires, purchased equipment (incl. innovative wires and line fittings) and started construction and assembly works. In 2022, we plan to complete C&A works and acquire innovative conductors. 2021 expenses totaled RUB 34.40 million (target), RUB 34.40 million (actual).

Target and actual expenses in 2021, RUB million net of VAT

Expenses	Expense target value	Expense actual value
Transition to digital substations	8.27	7.77
Transition to digital smart grids with distributed intelligent automation and control system	549.57	608.45
Transition to end-to-end performance of business processes and automation of control systems	10.00	15.21
Application of the latest technologies and materials	34.40	34.40
Total	**602.24**	**665.83**

RUB 665 million

EXPENSES ON INNOVATIONS IN 2021

There were 3 research and development works during 2021, according to the mid-term plan on the implementation of the Innovative Development Program:

1) Research project "Development of an automated system for handling of keys to electric equipment and control of access to facilities, integrated with PAMS, with application of electronic keys and signature" (in progress, project time: 16.08.2021–30.11.2022).

Key 2021 achievements:

- design and engineering documentation to the automated system for handling of keys (services, devices, software, software components, components, required for system operations) prepared;
- drafts of administrative and regulatory documents regarding accommodation of equipment in DPC prepared;
- a draft of the Standard (Requirements to the technology-facilitated arrangement of recording, storage and delivery of keys) prepared;
- a draft of the Standard (Functional and Technical Requirements to equipment used for grid facility monitoring systems) prepared;
- technological documentation dealing with system application prepared.

2) Research project "Mobile system for recording results of computer-vision inspections of power lines and equipment with identification of defects and integration into the PAMS defects register" (completed).

Key 2021 achievements:

- project solution on creation of software and interface prepared;
- software and methodologies for testing procedures and algorithms of the system and interface prepared;
- algorithms and procedures of functioning, required for creation of system software, incl. integration components, developed;
- interface for system's and infosphere's interaction developed;
- interface for users' and system's interaction developed.

3) Research project "Study of compliance of MPLS, WDM by ECI Telecom (Apollo, Neptune), installed in Permenergo and Chelyabenergo branches, with PAO Rosseti's STO 34.01-9.2-004-2019 and IEC 61850" (completed).

Key 2021 achievements:

- communications test schemes installed, signal routing with simulated incidents studied (Apollo and Neptune equipment);
- recommendations on the arrangement of telecom channels for RPA signals passage via PSN;
- passage of signals via digital networks, based on various technologies, compared.

Innovations expenses 2019–2021, RUB million

Parameter	2019	2020	2021	2021/2020, %
Expenses on innovations	492.71	520.71	665.83	127.87%
R&D expenses	31.75	22.69	31.51	138.87%

PROGRESS OF THE DIGITAL TRANSFORMATION PROGRAM

Actual funding of the activities under the 2020–2030 Digital Transformation Program totaled RUB 2,113.6 million, incl. RUB 1,789.6 million spent on smart metering, RUB 315.7 million on corporate information control systems and RUB 8.254 million spent on integrated system of information security.

Funding of the Digital Transformation Program's activities, RUB million

2019	2020	2021	2021/2020, %
1,006.1	1,583.1	2,113.6	133.5%