Power supply reliability

— What kinds of solutions the Company take to improve the reliability of power supply to consumers and the overall efficiency of the grid complex?

— Ensuring reliable power supply is one of the priority tasks we set for our branches and subsidiaries. To this end, we implement annual measures of the production programme, which includes maintenance and repair, as well as renovation of main and auxiliary power grid equipment, buildings and structures, maintenance and repair of motor transport and special equipment, and other necessary measures. In addition, there are programmes aimed to improve the power supply reliability of struggling regions.

Personnel training, drills and exercises also go a long way. Sure enough, upgrade and renovation of infrastructure is very important. This work falls under the permit of the investment programme.

Moreover, the Rosseti Group is directly involved in developing the procedure for interaction between electric power entities in the event of outages in ownerless grids; in part, the situation will be brought under control by regulations on the creation of backbone territorial grid companies.

Yevegeny Lyapunov,
Deputy General Director — Chief Engineer

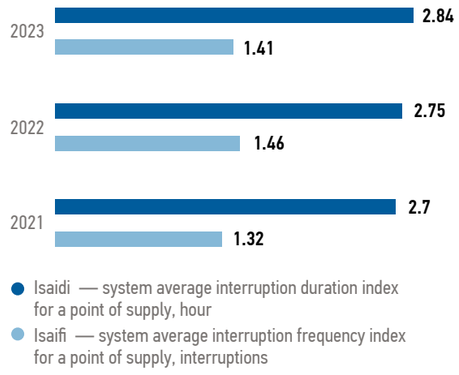
Timely and high-quality delivery of production programmes, particularly, with the application of a risk-based approach, makes it possible to annually improve the efficiency of measures taken and maintain the high reliability of power grid equipment, as evidenced by the absence of growth in the actual values of reliability indicators of the services rendered relative to the reliability level established by the tariff regulation authorities. Despite the actual increase compared to 2022, the system average interruption duration index (Id) improved against the target value set by FAS of Russia for 2023 (0.03192 hours) by 59%.

The year-on-year increase in the number of process faults across the Rosseti Group in 2023 can be explained by higher number of failures caused by the adverse impact of natural and climatic phenomena, as well as the interferences of unauthorised persons and organisations.

Indicator	2021	2022	2023 plan	2023 actual	Change 2023/2022, %
System average interruption duration in the transmission grid complex, Id, hour/interruptions[1]	0.0110	0.0100	0.03192	0.0132	–59[2]
Indicative indicator — volume of under-delivered electric power Iens, MWh	2,356	4,705	–	3,444	–27
Number of process faults (accidents) in the 110 kV grid, thsd faults	9.8	9.4	–	9.6[3]	2
Number of process faults related to erroneous actions of all categories of the Company's personnel, faults	30	29	–	36[4]	24

[1] Actual indicators of reliability of the services provided correspond to the reliability level established by the Federal Antimonopoly Service of the Russian Federation (planned values: 2022 — 0.03241; 2023 — 0.03192).
[2] Compared with the planned indicator for 2023. The indicator is improved by 59%.
[3] For correct calculation of dynamic pattern, the data do not include the branches established in 2023, as well as JSC RES, JSC Electromagistral, JSC Energetik.
[4] For correct calculation of dynamic pattern, the data do not include the branches established in 2023, as well as JSC RES, JSC Electromagistral, JSC Energetik.

Power supply reliability indicators



In 2023, the indicators of reliability of services rendered Isaidi (system average interruption duration index per point of supply, hour) and P_{ISAIFI} (system average interruption frequency index per point of supply, interruptions) are comparable to the values of 2022.

The Company has the Regulations on the Uniform Technical Policy in the Power Grid Sector[1] in place (hereinafter referred to as the Uniform Technical Policy). The purpose of the document is to define the main technical areas that ensure higher reliability and efficiency of the power grid complex in the short and medium term while guaranteeing the safety and reliability of power supply to consumers, as well as the transition to risk-oriented management coupled with digital technologies and big data analysis.

Innovative activities

Innovative development is one of the Rosseti Group's strategic priorities with a focus on improving the efficiency of power grid management and enhancing the reliability, quality and efficiency of consumer power supply. Cutting-edge technologies help to reduce operating costs and significantly improve the safety of operations.

The Company has in place the Innovative Development Programme for the period of 2021–2025 with an outlook until 2030[2].

Main tasks of innovative development

- Developing, testing and enabling the commercial use (distribution) of innovative equipment and practices, with due account for the factors of comprehensive efficiency and based on the life cycle management of objects and systems
- Switching to being an 'adaptor' of available innovative solutions and technologies market to tackle current problems, including through the development of the 'open innovations' tool
- Improving the innovation management system, in particular, through the effective use of intellectual property management systems and regulatory and technical documentation
- Laying the groundwork for the development of advanced scientific research, process operations and advanced production in the Russian Federation
- Developing human resources with promising competences to meet the objectives of innovative development
- Better gearing with the subjects of the sectoral innovation ecosystem — small and medium enterprises, Russian innovation development institutions, technology platforms, higher education bodies, research and design organisations, equipment manufacturers, etc.
- Laying the groundwork for the transition to the use of intelligent devices based on electronic components of Russian make

[1] Resolution of the Board of Directors of PJSC Rosseti dated 17 October 2022 (Minutes No. 592 dated 20 October 2022).
[2] Approved by the decision of the Company's Board of Directors (Minutes No. 577 dated 9 June 2022).

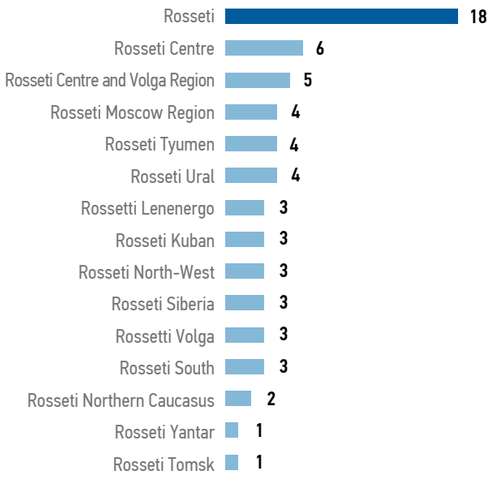
Key areas of innovative development for the period of 2021 to 2025 with an outlook until 2030

1	2	3	4	5
Transition to smart substations of 220–1,150 kV	Transition to active-adaptive grids with a distributed smart automation and control system	Transition to integrated efficiency of business processes and automation of management systems (life cycle management of innovative projects)	Utilisation of new technology solutions and materials in power engineering	Introduction of organisational innovations

Results of 2023

Investments in R&D, *RUB bln*

Number of R&D performed in 2023

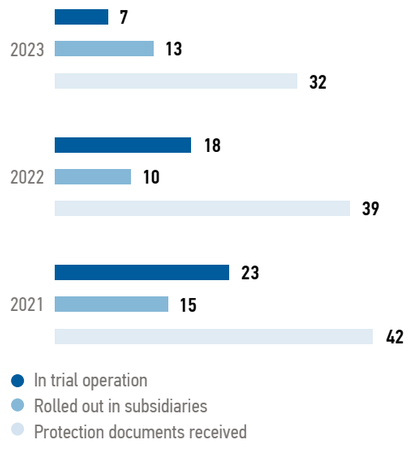


The R&D in 2023 is represented by 63 works (45 works of subsidiaries and 18 works of PJSC Rosseti)[1].

Actual volume of R&D programme fulfilment in 2023 was

1.13 RUB BLN (VAT EXCLUDED)

R&D results



[1] The R&D list is given in Appendix 5 to the Report.

— What is the Company's approach to development of innovative equipment?

— Innovation is an integral part of production programmes aimed to improve the reliability and efficiency of the grid complex, particularly in preparation for peak load seasons. The Rosseti Group includes scientific and technical centres that are responsible for in-house development. For example, in partnership with manufacturers, new types of compacted wires were designed which make it possible to transmit more power using existing PTLs. A high-temperature superconducting cable line is under construction in St. Petersburg, which is unrivaled throughout the world in terms of length.

We are currently working on a new Innovative Development Programme until 2029, the main goal of which will be to strengthen the technological sovereignty of the industry. Moreover, we are cooperating with the Engineering and Innovation Support Centre to implement a mechanism for 'maturing' import-substituting products of domestic technology companies.

Yevegeny Lyapunov,
Deputy General Director — Chief Engineer

External view of the panel installed at the Sputnik 110 kV substation.

Research and development in 2023

Research and development in 2023 covered all key areas of the Innovative Development programme of PJSC Rosseti for 2021–2025 with an outlook until 2030.

Key R&D results as at year-end 2023

R&D focus area: **transition to digital substations of various voltage classes**. Below are the completed R&D projects:

- Development of a software and hardware complex (SW&HW) for accepting into operation the RPA and automated process control systems (APCS) of substations compliant with IEC 61850. As a result, two prototypes of the "Acceptance" SW&HW complex were built, one of which was put into pilot operation at the facilities of the MPG Centre, a branch of PJSC Rosseti, and the other at JSC STC FGC UES. For SW&HW complex, procedures were developed for comprehensive tests of bay protection using analysis of MMS reports published by RPA terminals when a test action is applied to them and when signals are exchanged between terminals via electrical connections or in the form of GOOSE messages. This approach allows evaluating the correctness of parameterisation of terminals and inter-cabinet connections, errors in checking of which cause a significant share of failures during operation. This SW&HW complex will be used for quality control (certification) of RPA and APCS cabinets to assess the possibility of application at the Rosseti Group's facilities.
- Development of a digital RPA complex with a 'substitute' digital panel for typical cabinets of the 3rd and 4th digital substation designs. During the R&D project, a prototype of a 'substitute' digital panel used as part of the digital RPA complex of highly-automated substations (HASS), universal type for typical cabinets of the 3rd and 4th designs was developed and built. Regulatory documents were developed, such as technical requirements to the systems and methodical recommendations on designing, debugging and operation of digital RPA and APCS complexes on the basis of typical cabinets of the 3rd and 4th design for 110–750 kV HASS with the use of a 'substitute' panel. The R&D prototype was put into operation at Voronezhenergo, a branch of PJSC Rosseti Centre, at the Sputnik 110 kV substation.

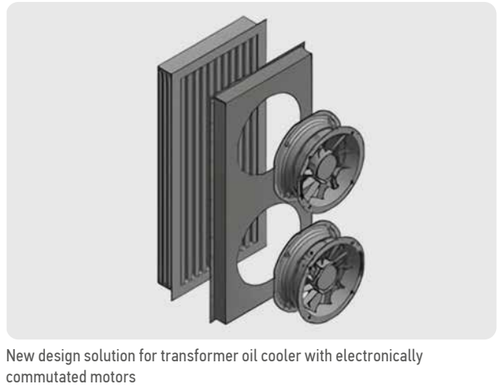
External view of the RPA panel with the substitution function.

R&D focus area: **transition to smart (active-adaptive) grids with a distributed intelligent automation and control system.** In 2023, PJSC Rosseti Centre and Volga Region completed R&D work to develop an automatic control system for a power storage system for parallel operation with the 0.4 kV distribution grids. As a result, the functional capabilities and technical requirements (parameters) of the automatic control system (ACS) of the mobile energy storage system (MECS) were determined for application in the power grid complex, with the view to address the problem of power supply to consumers in technologically isolated and hard-to-reach areas. The knoware and software of MECS ACS IC, as well as technical and functional requirements for the prototype are developed.

Energy Storage System

R&D focus area: **transition to integrated efficiency of business processes and automation of management systems (lifecycle management of innovative projects)**. PJSC Rosseti Kuban has the R&D pertaining to automated machine learning-based classification of incidents completed. The system is designed to automate and analyse information security events by configuring and implementing algorithms for automatic classification of LAN node behaviour and user actions based on machine learning methods. The product reduces the amount of labour input of the information security administrator.

R&D focus area: **application of new technologies and materials in the electric** power industry. The generic solutions of energy-efficient transformer cooling control system were designed using electronically commutated motors adapted to direct winding temperature measurement. The R&D process covered the development of technical documentation for a software and hardware complex for a transformer cooling system using electronically commutated motors, the construction of a prototype and pilot operation at the Trubino 500 kV substation of the MPG Centre, a branch of PJSC Rosseti.



New design solution for transformer oil cooler with electronically commutated motors

Digital transformation

The goal of digital transformation is to improve the efficiency of operations and reliability of existing services, change the logic of processes, and create new business services as a result of the introduction of digital technologies.

The Company approved the Digital Transformation Strategy of the Rosseti Group until 2030, which stipulates further development and implementation of digital technologies in the Company's operations. The document is currently being updated to accommodate new requirements of the Ministry for Digital Technology, Communication and Mass Media of the Russian Federation.

Current challenges for the Rosseti Group in digital enablement

- Need to carry out a large-scale replacement of imported software in use and achieve the required level of technological sovereignty
- Growing level of cyberthreats, especially with regard to critical infrastructure facilities
- Shortage of free production capacities of domestic manufacturers/developers and qualified human resources

Target values of the Rosseti Group's Digital Transformation Strategy, *%*

Indicator	2023 (actual)	2024	2027
Estimated reduction in operating costs due to digital transformation[1]	0.24	0.82	1.10
Observability of the power grid	30	31	34
Share of end-user metering points included in the smart electricity metering system	22.5	31	41

— What are the tasks and projects in the area of digital process transformation that you could highlight?

— One of the important tasks is the design of integrated corporate information systems for enterprise management and production asset management. This work is based on domestic software, including cutting-edge unrivaled solutions.

In general, the Rosseti Group is introducing a new mechanism for accumulating experience from current IT projects and reusing best practices by modelling the architecture in a single automated system. In the longer term, this will make it possible to reduce implementation costs and timelines.

PJSC Rosseti, assisted by the Minenergo of Russia, made it possible to use its IT infrastructure to connect external LGOs to the Unified Portal of State and Municipal Services. In 2023, we also expanded the functionality of Rosseti Group's Power Grid Services Portal and mobile application in terms of grid connections and additional services, as well as provision of smart metering services.

Furthermore, we completed the transition of the Group's companies to a domestic electronic document management system, while adding additional options relating to digital signatures and work via a mobile application.

Preparations were made to automate the collection and processing of counterparty bankruptcy data. There are pant to integrate Sberbank's solution into the legal process management system of the Rosseti Group, which will significantly reduce labour costs and increase the efficiency of work with debtors.

The Company took part in the pilot project of the Federal Tax Service of Russia on the creation of the automated subsystem on Tax Monitoring. The first stage of the project was finalised, marking the transition to electronic interaction with the Nalog-3 automated information system (AIS) under 10 main scenarios.

Konstantin Kravchenko,
Deputy General Director for Digital Transformation

[1] Based on the approved individual digital transformation programmes of S&As of the Rosseti Group.

— What are the tasks and projects in the area of digital process transformation that you could highlight?

— Making a register of equipment authorised for use in PJSC Rosseti was of great significance. The register is publicly available on the website ezak.rosseti.ru. With the QR-code verification, one can obtain up-to-date data on certified equipment and review the materials of the commission. Moreover, our employees can quickly add and edit information concerning the conclusions made.

Quality control (certification) of equipment, materials and systems is a part of incoming inspection of purchased products, which involves checking for compliance with the requirements of PJSC Rosseti's Technical Policy, the by-laws and industry-specific regulations. In addition, were run the analysis of supply chains for imported components and possible service risks.

Yevegeny Lyapunov,
Deputy General Director — Chief Engineer

— Tell us what is so special about the RS-20 technology management platform and its implementation.

— RS-20 is a backbone project of the Elektroenergetika Industrial Competence Centre established by the Government of the Russian Federation, which can help to eliminate problems related to data inconsistency, as well as automate and unify data exchange on the basis of a unified model of the power grid complex. As of today, the software modules with necessary features were developed and put into pilot operation at PJSC Rosseti and some of its subsidiaries.

We are also working to fulfil the requirements of the order of the Minenergo of Russia on the approval the Rules for Providing Information Required for Operational and Process Management in the Electric Power Industry. The requirements apply to power engineering entities and consumers with installed generating capacity equal to 5 MW or more, as well as grid facilities with a voltage of 110 kV and above. Going further, the experience obtained can be extended to lower voltage classes.

Konstantin Kravchenko,
Deputy General Director for Digital Transformation

Key results of the transmission power grid complex in 2023

RS-20 platform	To improve grid observability, a digital enterprise model is being designed based on the in-house development of the RS-20 integration platform[1]
Projects on automation	Automation projects are underway to optimise operating costs by: • Increasing the availability of information (single data entry) • Reducing the time and labour intensity of operations (reduction of paperwork) • Improving the quality of decision-making (decision-making based on data in information systems, forgoing manual reconciliation)
Remote control of substations	Rollout of substation remote control system is ongoing, which makes it possible to make the control of electric power regimes better and more reliable: • Reducing the time of operational switching operations • Reducing the risk of erroneous actions of personnel • Reducing the time required to eliminate process faults
Development of RPA-class tools[2]	The work is underway to study optimal scenarios for the application of RPA-class tools to robotise routine processes and operations, which will ensure the rise in labor productivity
Solutions for data collection and processing, data exchange	Solutions are being engineered to collect and process diagnostic information and analyse the technical condition and growth flaws of substation main equipment, create a cloud infrastructure and standardise data exchange process

[1] Included in the priority areas for phasing out foreign industry solutions and is a key element of Elektroenergetika Industrial Competence Centre.
[2] Robotic process automation (RPA) is a business process automation technology based on the metaphorical software of robots (bots) or artificial intelligence workers.

Development of IT architecture and IT services

Creation of a unified IT architecture for the united Company

The Rosseti Group faces the top-priority task of creating a unified IT architecture for all subsidiaries, unifying and standardising business processes and IT solutions, and ensuring optimal cost of ownership of IT assets across the Group. Import substitution and information security are mandatory elements of this process. In this regard, import substitution is a good opportunity to move from disparate and diverse imported solutions to a single domestic IT architecture.

As part of this task, work began in 2023 to create an automated information system for modelling the unified IT architecture of PJSC Rosseti to introduce a mechanism for effectively reusing best practices for automating business processes and creating IT systems within the perimeter of the Rosseti Group, as well as to improve the digital maturity of processes in general.

This work is accompanied by the development of a unified methodology for process modelling, description of data and IT infrastructure, which will make it possible to reduce the time and labour intensity of IT system implementation in the future. In the reporting year, PJSC Rosseti approved an organisational standard defining uniform requirements and notations for modelling architectures as part of the business process survey and the design of corporate information systems at Rosseti Group's companies.

Development of the Power Grid Communications Network (PGCN)

Digital transformation of the power grid sector, construction of highly automated power grids, implementation of highly automated substations, and innovative development are impossible without the use of advanced telecommunications and information technologies.

The PGCN is a complex of interacting communication networks of transmission and distribution power grid companies. The telecommunications infrastructure of power grid companies is built in accordance with the approved Roadmaps for the Development of Telecommunications Networks.

The key objective defined by the Concept of the Power Grid Complex Communications Network and the Unified Technical Policy is to provide and expand the range of communications services with specified quality indicators at optimal development and operation costs.

One of the main indicators of the PGCN development is the level of provision of power grid facilities with digital communication channels, which enable the implementation of the dispatch control system (ADCS), process management (APMS) and corporate governance system. This approach helps to improve the observability of the power grid complex and upgrade the quality of management of power grid facilities.

Digitalisation of communication channels, *%*

Level of digitalisation of communication channels of power grid facilities as to dispatch centres of JSC SO UPS

Power transmission grid complex

Power distribution grid complex

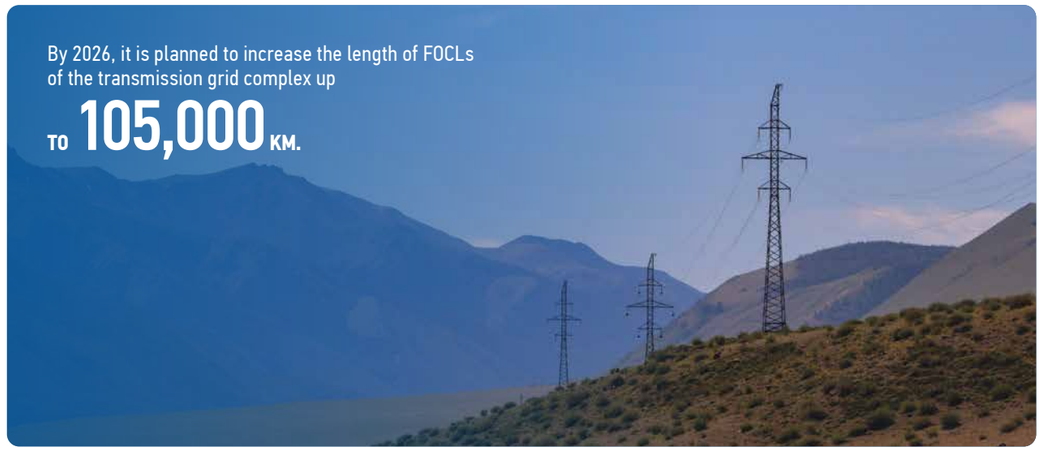
Level of digitalisation of communication channels of power grid facilities as to the Grid Control Centre

Power transmission grid complex

Power distribution grid complex

The main development directions of the PGCN are its digitalisation and intellectualisation, achieved through the widespread introduction of modern equipment and new generation communication network technologies at power grid facilities.

To ensure exchange of 'big data' of intelligent control systems on the basis of digital technologies, the Company implements fiber-optic communication lines (FOCL), which are built by fitting fibre-optic cables on overhead transmission lines (OTL). Along with this, the resources of leading telecoms operators are being widely deployed on the basis of long-term counter lease relations.

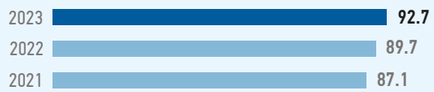


Power transmission grid complex

92,700 KM
of FOCLs in 2023, including:

- **57,400 km** — in-house construction
- **35,300 km** — lease and 'right of way' on OTLs

FOCL length, *thsd km*



Share of domestic equipment utilisation:

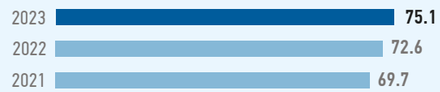
- **76.5%** — optical cable
- **22.0%** — digital information transmission systems

Power distribution grid complex

75,100 KM
of FOCLs in 2023, including:

- **39,800 km** — in-house construction
- **25,300 km** — lease and 'right of way' on OTLs

FOCL length, *thsd km*



Share of domestic equipment utilisation:

- **96.3%** — optical cable
- **41.1%** — digital information transmission systems

Automatic Process Management Systems

Automatic Process Management System (APMS) is a unified distributed hierarchical system, which allows upgrading the Unified Energy System (UES) regime management due to high level of observability, as well as preventing emergency shutdowns of consumers, reducing decision-making time and probability of erroneous actions of emergency response personnel in emergency modes. When implementing APMS development projects, preference is given to the use of equipment and software from domestic manufacturers at all levels of the process control hierarchy.

In 2023, work was carried out to create, expand and upgrade data acquisition and transmission systems (DATS) at all branches and subsidiaries of PJSC Rosseti in accordance with the approved programmes for upgrading and expanding the DATS and organising operational telephone communications between dispatch and operational personnel of PJSC Rosseti within the operational service area.

The projects used:
- Domestic software included in the Unified Register of Russian Software for Electronic Computing Machines and Databases
- Products included in the Unified Register of Russian Radioelectronic Products

Number of power grid facilities equipped with modern telemetry and telecommand systems (DATS)

Type of facilities	commissioned in 2021	commissioned in 2022	commissioned in 2023	Total
MPG substation	6	12	40	474

Number of power grid facilities equipped with modern telemetry and telecommand systems (DATS)

Type of facilities	commissioned in 2021	commissioned in 2022	commissioned in 2023	Total
220 and above kV substation	3	1	1	61
110–150 kV substation	219	104	102	3,918
35 kV substation	367	49	65	2,741
6(10)–20 kV transformer substation, power distribution substation	5,446	2,111	2,272	32,740

Development of corporate information systems

In 2023, as part of the development of corporate information systems, 19 projects aimed to increase the level of digitalisation of the Company's business processes were underway. Some of them is described below:
- A project was implemented to introduce a new domestic electronic document management system.
- Work began on designing a comprehensive corporate information system for managing the enterprise of PJSC Rosseti and a production asset management system based on domestic software[1]. The projects will make it possible to create a unified corporate IT architecture based on a domestic solution stack.
- As part of the creation of an automated investment management system, a unified data model was formed and the functional and component architecture of the solution was developed.
- A project is underway to develop a digital model of the power grid[2], which will make it possible to form calculation models, provide a unified reference data for calculating grid performance indicators within the Rosseti Group, and reduce the cost of modelling adjacent power grids for each subsidiary.
- As part of the development of a unified portal for power grid services and a mobile personal customer account, electronic services were improved and functionality was expanded in terms of grid connections and additional services, as well as smart metering services.
- Work was organised to create a digital investment planning environment aimed at automating the processes of collection, verification and forecasting of technical and quantitative characteristics of investment projects with subsequent data transfer to related systems.
- The first stage of implementation of the module of integration with the automated information system of the Federal Tax Service of Russia (Nalog-3 AIS) was completed, which ensures compliance with the current requirements of the concept of development and functioning of the tax monitoring system in the Russian Federation in accordance with the current legislation.
- As part of automating the process of interacting with the Rosseti Group's customers, a unified CRM system is being designed to introduce predictive analytics tools to form tailored offers and proactively provide services.
- As part of the development of the automated information system for centralisation and automation of the treasury and finance function (treasury management AIS), a universal integration mechanism between PJSC Rosseti and insurance companies is being created to ensure transparency of the interaction process with insurance companies.

[1] In accordance with the requirements of the directives of the Government of the Russian Federation No. 10068p-P13 dated 6 December 2018.
[2] In accordance with the Order of the Ministry of Energy of the Russian Federation No. 1340 dated 20 December 2022 "On Approval of the Rules for Provision of Information Required for Operational and Process Management in Power Engineering".

Plans for implementing key projects in 2024–2025

Work will continue on laying the groundwork for the digital transformation of the Rosseti Group: transferring all key production information from paper to digital form, and creating systems for transferring information to all levels of the Company's management to ensure that all subsequent digital initiatives can be implemented.

The following key activities are in the works:
- Import substitution of system software
- Measures stipulated by Government Directive No. 10068p-P13[1] dated 6 December 2018 and Decree of the President of the Russian Federation No. 166 dated 30 March 2022 "On Measures to Ensure Technological Self-Sufficiency and Security of the Critical Information Infrastructure of the Russian Federation"
- Development of the Mobile Application and the Unified Power Grid Services Portal
- Creation of the Unified Platform for sales of services and fiscal electricity metering
- Creation of an integration platform based on RS-20 products to reduce the time and labour intensity of operations and keep data up-to-date through the use of single data entry
- Creation of an automated system for mobile team management (Digital Electrician) to reduce the time and labour intensity of operations

The Company is also initiating the launch of projects with the application of artificial intelligence[2] technologies , the purpose of which is to ensure whole new level of efficiency in the Company's operations.

[1] Decision of the Board of Directors on 24 April 2019 (Minutes No. 445 dated 26 April 2019).
[2] In accordance with the instruction of the President of the Russian Federation No. Pr-1770 para.1 b dated 6 September 2023).