

Additional information on innovation development and R&D

R&D project	Technical results in the reporting period	Significance of the project for the Company	Plans
«Development of an automatic control system for an unmanned aerial vehicle used to troubleshoot elements of overhead power lines, with a network of charging stations as an element of the control system»	<ul style="list-style-type: none"> – Test program of the charging system; – Test reports of elements of the charging system and the test report of the charging system as a whole; – Report on the completion of the multifunctional charging system; – Certificate for a multifunctional charging system; – Design and technological documentation for a multifunctional charging system; – Multifunctional charging system, a certificate for a multifunctional charging system; – Software for the system for analyzing information from the UAV diagnostic sensors with the output of the analysis according to the evaluation criteria; – Test report of the UAV control system based on the developed test program with positive opinions from the customer and at least one independent expert; – Software for the system of automated monitoring of overhead lines using the UAV group. 	The use of unmanned aerial vehicles simplifies and speeds up inspections of the Conductor, makes it possible to prevent technological disruptions in the work of the Conductor, provides an objective assessment of the condition of the Conductor elements through the use of several diagnostic sensors, eliminates the participation of special equipment for lifting people to inspection of elements of power line poles, eliminates the direct human involvement and the need to disconnect the Conductor.	<p>The project is underway. The term of the work is 2018-2020.</p> <p>Upon completion of the project the following will be developed:</p> <ul style="list-style-type: none"> – a multifunctional UAV charging system that combines the functions of a charging station, weather station, control command receiving station, and a device for transmitting data from an UAV to a data processing system; – a system for processing diagnostic information from a UAV group based on a neutron network using elements of artificial intelligence; – a UAV group management system; – a multifunctional UAV charging system.
«The study of the growth rate of the main types of forest-forming tree species depending on climatic zones and soil conditions in the places where routes are passing, operating overhead lines with the creation of regional frequency maps for clearing routes along overhead lines and issuing	<ul style="list-style-type: none"> – Research report «Conducting research aimed at development of geoinformation databases on forest vegetation to determine the rate of overgrowth clearing of overhead lines, develop recommendations on the frequency and methods of clearing them in the territories when IDGC of Centre operates». 	The results of the work are planned to be applied to the formation of work plans for clearing routes of overhead lines with high accuracy with the aim of eliminating disproportionate planning and eliminating the failure rate of overhead lines due to the impact of tree and shrub vegetation. The formation of geographic information bases will allow to form the required frequency of clearing and control of undergrowth of trees.	<p>The project is underway. The term of the work is 2019-2021.</p> <p>Upon completion of the project the following will be developed:</p> <ul style="list-style-type: none"> – regional geoinformation databases (digital layers) characterizing the required frequency of clearing routes of overhead lines from trees and shrubs in the territories of branches; – recommendations on the frequency and methods of clearing routes of overhead lines.

recommendations on how to perform the work»			
«Software package for Big Data analysis in order to identify non-metered volumes of electricity»	<ul style="list-style-type: none"> – Supply and installation of software on the Customer's equipment. – Development and training of a predictive model. – Development of a Technical Project (TP) consisting of: <ol style="list-style-type: none"> 1.1. Project certificate 1.2. Project plan 1.3. Project risks 1.4. Technical specifications 1.5. Solution architecture 1.6. Test plan 1.7. Acceptance test procedure 1.8. Software Package contents: <ul style="list-style-type: none"> – Release description. – User manual. – Administrator guide. 	<p>The creation of a software package based on methods of analyzing large data arrays with machine learning algorithms that predict the likelihood and extent of detecting non-metered electricity consumption at consumers' electricity delivery points will automate the planning of work for electricity metering crews and increase the efficiency of monitoring consumers' metering points and reduce non-technical losses.</p>	<p>The project is underway. The term of the work is 2019-2020.</p> <p>The software package, in order to identify non-metered volumes of electricity, provides functionality for each of the user roles (Distribution Zone, Executive branch of the branch, Executive office of the Company, system administrator), with the aim of interacting with the system in terms of the following main functions:</p> <ul style="list-style-type: none"> - tracking the loading of data into the software package (by structural units, periods, download formats); - obtaining registers of delivery points for a Distribution Zone with the possibility of preliminary grouping of data: for feeder 6(10) kV, TS 6 (10)/0.4 kV, settlements, probability and volume of potential non-metered consumption per month, key factors on the basis of which a probability level (optional) is assigned, an electrician; - control of targeted (at delivery points) performance of activities for previous periods at a Distribution Zone/branch (based on previously generated registries and downloaded reports from ERP SAP), indicating the planned probability and effect (previously predicted by the system) and the effect actually achieved (including per employee/crew), highlighting cases when inspections by personnel of a Distribution Zone/branch do not lead to identification or elimination of facts of non-metered consumption; - analytical information on operation of the algorithm (level of reliability/accuracy of the algorithm, specific weights of criteria, zones and areas of analysis, data sources, level and degree of reliability of binding of subscribers of ERP SAP to external data sources).

<p>«Investigation of existing systems for compensation of 6-35 kV capacitive earth fault currents of a branch of IDGC of Centre, PJSC - Smolenskenergo»</p>	<ul style="list-style-type: none"> – Scientific and technical report on the current state of compensation systems in Smolenskenergo and technological violations associated with the consequences of single-phase earth faults. – Scientific and technical report on scientific and technical studies of the physical principles of various types of arc-suppressing devices used in Smolenskenergo and existing on the market, with a comparative analysis and description of the advantages/disadvantages, based on the physical principles of work. – Scientific and technical report with the definition of optimal combinations of arc-suppressing devices + automation, taking into account the specifics of the operation of some of arc-suppressing devices/automatic regulators. – Scientific and technical studies on electrical safety (including taking into account the possible removal of potential on the CL shields) at 033 on overhead lines and CL with various systems for compensating capacitive currents at 033. 	<p>Recommendations resulting from the implementation of the research “Study of existing compensation systems for capacitive earth fault currents of 6-10 kV of a branch of IDGC of Centre, PJSC - Smolenskenergo”, it is planned to be used to develop measures to reduce the damage level of 6-10 kV cables due to overvoltages arising from single-phase earth circuits.</p>	<p>The project is underway. The work completion term is 2018-2020.</p>
<p>«Development of a mobile laboratory for monitoring the quality indicators of transformer oil»</p>	<ul style="list-style-type: none"> – Report on patent research in the field of the use of mobile instrumentation and analytical support for monitoring the physicochemical parameters of transformer oil; – Report on the implementation of research; – Conclusion with an assessment of project feasibility and risk assessment. 	<p>The results will provide increased efficiency in obtaining results of measurements and tests, as well as their automated transfer to the mobile control system of IDGC of Centre, increase the number and volume of equipment diagnostics.</p> <p>The results of the work can be used in updating the scientific and technical documentation governing the implementation and application of results of chromatographic analysis of gases dissolved in transformer oil.</p> <p>The positive experience in operating the digital mobile physicochemical laboratory to assess the technical condition of high-voltage equipment can be used to optimize the production chemical laboratories of IDGC of Centre.</p>	<p>The project is underway. The term of the work is 2019-2021.</p>

«Alarm and blocking from reverse transformation at 10/0.4 kV transformer substations»	<ul style="list-style-type: none"> – A search was made for patent studies in the field of devices for signalling and blocking (opening the input switch on the low side of a 10/0.4 kV transformer substation) in case of voltage supply from the low side of a transformer substation, including from sources connected to power lines of 0.4 kV. – An algorithm of operation and device circuits for signalling and blocking (turning off the input switch on the low side of a 10/0.4 kV transformer substation) was developed in case of voltage supply from the low side of a transformer substation, including from sources connected to power lines of 0.4 kV 	Ensuring the safe operation of electric grids of 10 kV and 0.4 kV by detecting facts of unauthorized supply of voltage to the 0.4 kV network, signalling these facts and blocking the interruption of the input switch or another switching device on the low side of a 10/0.4 kV transformer substation in case of voltage supply from the low side of a transformer substation, including from sources connected to power lines of 0.4 kV.	The project is underway. The term of the work is 2019-2020.
---------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------

Key projects, during the implementation of which innovative, advanced, progressive technical solutions, technologies, materials and equipment compliant with the Technical Policy (including the Innovative Development Program) were used:

Ite m #	Branch of IDGC of Centre	Facility name	Key technical parameters
1.	Tverenergo, Belgorodenergo, Kostromaenergo, Bryanskenergo, Voronezhenergo, Yarenergo, Smolenskenergo, Tambovenergo, Orelenergo	<ul style="list-style-type: none"> – Modernization of Conductor 0.4 kV №1 PTS-962 Pominovo SS 35/10 kV Turginovo with replacement of bare wire with self-supporting insulated wire and poles within the framework of automation SS 35/10 kV Turginovo – Construction of Conductor 0.4 kV №1 from the designed PMTS 10/0.4 kV SS 35/10 kV Turginovo as part of the automation SS 35/10 kV Turginovo – Construction of Conductor 0.4 kV №2 PTS-962 Pominovo SS 35/10 kV Turginovo as part of the automation SS 35/10 kV Turginovo – Reconstruction of Conductor 0.4 kV №2 TS-25-49 f.25 SS 110/35/10 kV Novy Oskol with replacement of bare wire with self-supporting insulated wire of a larger cross section and installation of poles in Novy Oskol – Reconstruction of Conductor 0.4 kV №2 CTS 10/0.4 kV №31-02 f.34 SS 110/35/10 kV Novy Oskol with replacement of bare wire with self-supporting insulated of a larger cross section and installation of poles in Novy Oskol – Construction of Conductor 0.4 kV №1 from the designed PTS 10/0.4/160 kVA f.34 SS 110/35/10 kV Novy Oskol for load splitting of the electric grid section of Novooskolsky district, Novy Oskol, etc. – Retrofitting of Conductor 0.4 kV №1 TS-193 Goloperovo village f.6 SS 35/10 kV Glebovo, SS 35/10 kV Burmakino, SS 35/10 Sarayevo, SS 35/10 kV Skomorokhovo with wire replacement – Reconstruction of Conductor 0.4 kV SS 35/10 kV Sarayevo 	<p>Steel multi-faceted pole (pole UMz04-7-90), according to patent of IDGC of Centre, PJSC for a utility model № 138695 of 20.02.2014.</p> <p>Voltage class - 0.4 kV</p> <p>Design - 8-facet steel galvanized conical pole</p> <p>Pole height -7 m, pipe foundation height – 3 m</p> <p>Slewing capacity - 90 degrees</p> <p>Pole weight with foundation - 348 kg</p> <p>Calculated bending moment - 11,128 tfm</p> <p>Life cycle - 50 years</p> <p>Quantity – 740 pcs</p>

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
		<ul style="list-style-type: none"> – Retrofitting of Conductor 0.4 kV №2 TS 148 f.06 SS 110/10 kV Tufanovo with replacement of wire and poles, etc. 	
2.	Tverenergo, Kostromaenergo, Lipetskenergo, Bryanskenergo, Voronezhenergo, Yarenergo, Smolenskenergo, Tambovenergo, Orelenergo	<ul style="list-style-type: none"> – Grid connection of power installations of consumers with maximum power up to 15 kVt (OHL 10 kV SS “Komsomolskaya”, OHL 10 kV SS “Puchezh”, SS “Ples”) – Construction of TS 10/0.4 kV TS 841, 842 f.4 Pishchalino SS 35/10 Burmakino, TS 1328 f.4 SS 110/35/10 kV Nila Krasnogor village of Pereslavl'sky district, TS-451 SS 35/10 kV Sarayevo Kudrino village of Pereslavl'sky district, TS 465 f.6 Vasilevo SS 35/10 kV Glebovo – Reconstruction with replacement PTS 10/0.4 kV (30 for 63 kVA) TS-30 Tokarevo f.131 SS 35/10 kV New village Tokarevo village of Bolsheselsky district – Retrofitting of Conductor 0.4 kV №1, 2 TS 560 Bukontievo f.07 SS 110/10 kV Utkino with replacement of wire and poles and etc. 	<p>Pole-mounted transformer substations PMTS a mounted power transformer (without additional supports) on a single-legged pole according to patent of IDGC of Centre, PJSC № 133982 of 27.10.2013 and № 146463 of 10.09.2014</p> <p>Voltage class: 10/0.4 kV Cooling system – oil Insulated bushings 10 kV HV voltage regulation - $\pm 2 \times 2,5\%$ (Rail NLTC) Capacity of power transformer: 25-100 kVA. HV protection – fuses PKT 101-10-8-12,5 PD/ PRVT-10 U1 LV protection – LV switches (VA57-35 25-100A/ PVR-3-0,38 40A/ VA88-35) Type of power transformer: TMG Winding circuit: Y/Zn-11 (Δ/Y_n-11)</p> <p>Quantity – 300 pcs</p>
3.	Tverenergo Kurskenergo Belgorodenergo Kostromaenergo Bryanskenergo Voronezhenergo Yarenergo Smolenskenergo Tambovenergo Orelenergo	<ul style="list-style-type: none"> – Conductor 10 kV from SS 35/10 kV Turginovo – Construction of a sectioning point with a disconnector SS 110/35/10 kV Zubtsov – Construction of a sectioning point on Conductor 10 kV SS 35/10 kV Olkhovatka, SS 35/10 kV Molotychi, SS 35/10 kV “V. Lyubazh”, SS 35/10 kV Sergievka, SS 35/10 kV Olgovka, SS 35 / 10 kV Vanino, SS 35/10 kV Zozuli, SS 110/35/10 kV Borisovka, SS 35/10 kV Kryukovo, SS 110/35/10 kV Kosmynino, SS 110/35/10/6 kV Nerekhta 1, SS 110 / 35/6 kV Bryanskaya (FGC) with installation of sectioning points using a recloser. – Modernization of Conductor 6 kV SS 110/6 kV Vodozabor, SS 110/6 kV Michurinskaya, SS 110/6 kV Sovetskaya, SS 110/10 kV 	<p>Recloser 10 kV including SCADA integration with the operator's control room of Distribution Zone</p> <p>Rated voltage - 10 kV Current rating – 630 A Current interrupting rating – 12,5 kA commutation life at current rating, cycles «CO» - 30000 Commutation life: · at current rating, cycles «CO» - 30000 · at current interrupting rating, cycles «CO» - 50 Opening time OSM - max 15 ms Closing time OSM - max 50 ms, Communication, data transfer: Direct connection (USB or Bluetooth)</p>

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
		Molotinskaya, SS 35/10 kV Zhiryatinskaya, SS 35/10 kV Domashovo, SS 110 / 10 kV Teplichnaya and etc. – Modernization of Conductor 10 kV SS 110/35/10 kV Lom, SS 110/35/10 kV Zalesye, SS 35/10 kV Tutaev, SS 110/35/6 kV, SS 35/6 kV Chebakovo, SS 35/10 kV Vatolino, SS 110 kV Malotalinskaya, SS 35 kV Stolovskaya, SS 35 kV P.Prigorodnaya, SS 35 kV Bokinskaya, etc.	RS485-RS232 converter GSM modem Integration into SCADA through the adapter EDIMAX EU-4208 - 3G router/3G modem iRZ RUH2b - GSM antenna (in the control room) - iRZ RUH2b (in the control room), IEC data transfer protocol 60870-5-104 Quantity-182 pcs
4.	Tverenergo	– Reconstruction of Conductor 10 kV f.12 SS 35/10 kV Turginovo as part of reconstruction of SS 35/10 kV Turginovo	High-strength wire ASVP-81/9 Tensile strength not less than 29,077 kN Operating temperature – 90 °C Admissible continuous current – 350 A Specific weight – 299 kg/km. Cable length 10,35 km (by wire)
5.		- Retrofitting SS 110/35/6 kV Redkino with replacement of current transformers, RF arresters and relay protection and automation devices	Current transformer with nitrogen insulation TOGF-110III UHL1 200-400-800/5 0,5S Rated voltage, kV – 110 Rated primary current, A – 200-400-800 Rated secondary current, A – 5 Quantity of secondary windings, pcs – 6 Accuracy class of secondary windings - 0,2S/0,5S/10P/10P/10P Gas filling - low nitrogen Gas leakage rate per year, % of gas weight, not more than – 0,5 Quantity - 3 three phase sets (9 pcs)
6.		- Reconstruction of Conductor 10 kV, feeder №13 SS №15 as part of grid connection in the village of Yakovlevo, Mikhailovsky village settlement, Kalininsky district	Universal 10 kV cable for various installation conditions in the air and in the ground Cable AHXAMK-WM 3x50+62I 10kV Voltage – 10 kV; Weight – 1880 kg/km; Core material – aluminum; Insulation – peroxydated polyethylene; Twisting – three single-core cables are twisted into a bundle around an insulated, galvanized, steel conductor; Maximum operating temperature – 90 °C; Permissible current loads: - in the ground – 155 A; - in the air – 160 A. Cable length 1,202 km

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
7.	Tverenergo, Belgorodenergo, Kostroma Bryanskenergo, Voronezhenergo, Yarenergo, Tambovenergo, Orelenenergo	<ul style="list-style-type: none"> Automation of Conductor 10 kV SS 35/10kV Turginovo Modernization of Conductor 10 kV of the distribution network of the Yasnogorsky Distribution Zone with installation of sectioning points using disconnectors with a motor actuator Modernization of Conductor 10 kV SS 35/10 kV Zozuli, SS 110/35/10 kV Borisovka, SS 35/10 kV Kryukovo, SS 35/10 kV Zozuli, SS 35/10 kV Gruzskoye, SS 110/35/10/6 kV Nerekhta 1, SS 110/10/6 kV Nerekhta 2, SS 110/35/10 kV Kosmynino, SS 35/10 kV Tatarskoye, SS 35/10 kV Vladychnoe, SS 110/10 kV Teplichnaya, SS 35/10 kV Novozhivotinoe, SS 35/10 kV Beryozovka, SS 35/10 kV Tutaev, SS 35/10 kV Vatolino, SS 35/10 kV Velikoye Selo, SS 35 kV P.Prigorodnaya, SS 35 kV Bokinskaya, SS 35 kV Timiryazevskaya 	<p>Line-isolating switch 6-20 kV for outdoor installation with a motor actuator including SCADA integration with the operator's control room of Distribution Zone</p> <p><u>RMNSA-10/630-T-St-UHL1</u>, actuator PA-N-1-UHL1</p> <p>Rated voltage – 10 kV Rated current – 630 A Switching on/off time – 4 second Conventional thermal current – 12,5 kA Electrodynamic current – 31,5 kA Power supply – NOL-10 III/UKHL1 Interfaces - GSM, GPRS</p> <p><u>RLK-10/400-T-St-UHL1</u>, actuator PDD-1UHL1</p> <p>Rated voltage – 10 kV Rated current – 400 A Switching on/off time – 4 second Conventional thermal current – 10 kA Electrodynamic current – 25 kA Power supply – OL-1,25/10UHL1 Interfaces - GSM, GPRS</p> <p><u>RLKS-10.IV/400UHL1 operated disconnectors</u> with an actuator PDD-1 UHL1</p> <p>Rated voltage: 6 (20) kV; Rated current: 400 A; Main technical data of the PDD-1 UHL1 actuator: - maximum torque of 400 Nm; - angle of rotation of the shaft 90 degrees; - time of electromotive operation of no more than 5 s; - weight 80 kg. Interfaces - GSM, GPRS</p> <p><u>RIC-RE V1.2 01-11</u> actuator PDD-1UHL1</p> <p>Rated voltage – 10 kV Rated current – 630 A Switching on/off time – 3 second Conventional thermal current – 10 kA Electrodynamic current – 25 kA Power supply – OL 230 V, battery Interfaces - GSM, GPRS</p> <p>Quantity – 117 pcs</p>

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
8.	Tverenergo, Lipetskenergo	<ul style="list-style-type: none"> – Modernization of Conductor 10 kV f.03 SS 35/10 kV Turginovo with replacement of bare wire with self-supporting insulated wire and poles within the framework of automation of SS 35/10 kV Turginovo – Construction of Conductor 10 kV f.03 SS 35/10 kV Turginovo to the designed PMTS 10/0.4 kV as part of automation of SS 35/10 kV Turginovo – Retrofitting of Conductor 110 kV Dvurechki levaya, pravaya with wire replacement and installation of poles made of polymeric materials 	<p>Composite poles 10 kV Design - a conical stand. Total height of the pole (including the foundation): 10,5 m. Maximum permissible bending moment of the stand: at least -7 TCxM Height from ground level to lower traverse: 8,93 m. Assigned service life, at least years – 50; Weight: PKO-10-1-3-U – 195 kg, 2AKO-10-1-3 – 380 kg Poles PKO-10-1-3-8,5-U-2 Poles 2AKO-10-1-3-8,5-T-2 Poles 2AKOu-10-1-3-8,5-T-2 Poles 2AKO-10-1-3-9,5-T-2 Quantity: 18 pcs</p> <p>Composite poles 110 kV Design of the stand consists of 4 composite modules in the form of truncated conical pipes of various sizes, connected to each other by a telescopic method. Modules for a pole rack consist of a basic fiberglass composition that accepts the main mechanical load. The foundation installation of the poles is the fastening of the rack into the ground in a drilled foundation pit. For racks PK 110-2, the recess is 4m in the pit with a diameter of 1100 mm. Rated voltage: 110 kV; Total height of the pole (including the foundation): PKf110-2+4-30,2 m; PKf110-2+6 – 32,2 m; Height from ground level to lower traverse: PKf110-2+4 – 15,4 m; PKf110-2+6 – 17,4 m; Maximum permissible bending moment of the stand at the ground level: PKf110-2+4 - PKf110-2+6 from 800 to 1200 kNm; Weight (max): PKf110-2+4 -3024 kg PKf110-2+5 - 3224 kg; PKf110-2+6 - 3454 kg; For wire suspension, composite poles are equipped with insulating traverses with the following characteristics: Voltage class: 110 kV; Withstand voltage of a full lightning impulse: 600 kV; Withstand alternating short-term voltage in the dry state - 340 kV, in the rain – 260 kV. The foundation installation of poles is the fastening of the rack into the ground in a drilled foundation pit with a diameter of 1100 mm. Quantity: 8 pcs</p>

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
9.	Tverenergo, Belgorodenergo, Kostromaenergo, Bryanskenergo, Voronezhenergo, Yarenergo, Smolensk Tambovenergo	<ul style="list-style-type: none"> Automation of Conductor 10 kV f.03 SS 35/10 kV Turginovo Modernization of Conductor 10 kV f.8 SS 35/10 kV Zozuli, SS 110/35/10 kV Borisovka, SS 35/10 kV Kryukovo, SS 35/10 kV Gruzskoye, SS 110/35/10/6 kV Nerekhta 1, SS 110/10/6 kV Nerekhta 2, SS 110/10 kV Grigortsevo, SS 35/10 kV Novozhivotinoe, SS 35/10 kV Berezovka, SS 35/10 kV Ramon-1, SS 35/10 kV Vereyka, SS 110/10 kV Novousmanskaya, SS 110/35/10 kV Volya, SS 35/10 kV R.Khava, SS 110/10 kV Raduga, SS 35/10 kV Parusnoye, SS 110/35/10 kV No. 32 Nikolskoye, SS 110/35/6 kV Vostochnaya, SS 35/6 Pechersk, SS 110 kV Malotalinskaya, SS 35 kV Stolovskaya, SS 35 kV P.Prigorodnaya, etc. 	<p>Fault detector on a power line including SCADA integration with the operator's control room of Distribution Zone / Grid Control Centre</p> <p><u>Fault detector-B33-MP3:</u></p> <ul style="list-style-type: none"> duration of the emergency process required for detecting multi-phase-to-ground fault protection - 0,04 s; setting range of the current threshold of multi-phase-to-ground fault protection – 10-1000 A; range of currents in the line at which single phase-to-ground fault protection is detected – 10-150 A SCADA integration according to IEC-104 <p><u>Fault detector-B34-MP3:</u></p> <ul style="list-style-type: none"> setting range of the current threshold of multi-phase-to-ground fault protection: 20÷1000 A minimum current of zero-phase-sequence for detecting single phase-to-ground fault protection – 0,5 A event registration time – 0,5÷200 s SCADA integration according to IEC-104 <p><u>FLA3.1V:</u></p> <p>Tripping current:</p> <ul style="list-style-type: none"> a) Standard mode: a value is selected from the range of 4-1500A in steps of 20A b) Automatic mode: the response level is selected depending on the actual line current (150% - 500%) <p>Delay time: Selectable from 40-300ms in 20ms steps</p> <p>Indication:</p> <ul style="list-style-type: none"> 6 LEDs (360° view, with brightness over 3000 mcd each) Blinker (360° view, red colour) Different indication depending on the type of fault <p>Visibility: At least 100 m during the day, 500 m at night</p> <p>Overall dimensions: Diameter: 80 mm</p> <p>Height: 184 mm</p> <p>Moisture protection class: IP67</p> <p>Weight: 0,610 kg</p> <p>Operating temperature range: From -40°C to +70°C</p> <p>Accuracy: ± 10%</p> <p>Indication time: 800 hours</p> <p>Indication frequency: 1 time per second</p> <p>Data transfer (two-way): 433,75 MHz</p> <p><u>FI-3A2F/W:</u></p> <p>Types of logged events:</p> <ul style="list-style-type: none"> short circuit, single-phase earth fault.

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
			Short-circuit current sensitivity: 20 A; Current sensitivity I ₀ (single phase-to-ground fault protection): 0,5 A; Conductor voltage class: 6-35 kV Grid frequency: 50 Hz; Power supply: lithium batteries; Total indication time: > 1000 h Quantity – 146 pcs
10.	Kurskenergo, Voronezhenergo	– Installation of high-voltage electricity metering points on 6-10 kV power lines of the Kursky Distribution Zone – Installation of high-voltage electricity metering points on 6-10 kV power lines of Voronezhenergo	Metering and measurement point SMT Maximum voltage U _m , – 12 kV Average failure time - 500000 h Service life - 25 years Temperature - -40 ÷ +60 C <i>Sensor specifications SMT–75A TS-SNSS03-0002</i> Principle of operation - Active capacitive divider Rated primary voltage - 6/√3 - 10/√3 kV; Nominal voltage factor – 2; Nominal transformation ratio, V/V - 10000 : 1 Accuracy class according to GOST R IEC 60044-7-2010 - 0.5; Frequency range – 48-52 Hz; <i>Data transfer</i> Transmission device – 3G modem; Amount of data – information from the meter, network parameters. Quantity – 44 pcs
11.	Belgorodenergo	– Modernization of Conductor 0.4 kV №2 TS-980 SS 110/10 kV Zapadnaya with installation of an electric energy storage device, the city of Belgorod	Energy storage system Specifications of rechargeable lithium-ion batteries: Producer: Ener Zet LLC Factory type (brand): ENERTECH INT. Structure: – 144s4p Nominal stored energy, kWh – 53,28 Rated voltage, V – 532,8 Overall dimensions (H x W x D), mm – 1800x600x820 Weight, kg – 460 Converter specifications: Power, kVA – 10 Grid type – three-phase four-wire Rated voltage, V – 380 Voltage deviation from nominal no more than, % – +/- 10 Rated current, A – 25 Rated frequency, Hz – 50 Quantity – 1 pc

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
12.		– Reconstruction of the 2-circuit section of Conductor 110 kV Frunzenskaya-Zapadnaya №2, Conductor 110 kV Zapadnaya-Avtorezmavod with a device for crossing the river with changing the borders of the right of way and protection zone, the city of Belgorod	Non-standard anchor pole Conductor 110 kV in the form of a stylized coat of arms of the city Conventional name of the pole in the project – NTSO 110-2 Width of the pole in the axles – 2 m Dimension of the pole perpendicular to the power line – 17,43 m Height from the bottom of the base plate – 26,37 m Architectural lighting. Foundation: pile, made of drilling- drilled-in caissons with a diameter of 500 mm, length of 6 m, combined with a monolithic concrete grillage with volume reinforcement by A500C rod reinforcement. Insulation: strings of insulators of multi-chamber arresters – GIRMK-110-8xIRMK-10-U120AD(BA)-II-UHL1
13.		– Reconstruction of SS 35/10 kV Nikolskoye with replacement of a power transformer 2.5 by 2x4 MVA, installation of new equipment for the substation control building, direct current systems, telemechanics and communications, relay protection and automation devices	SS 35/10 kV Nikolskoye with implementation of the “digital substation” technology Outdoor switchgear 35 kV - circuit №35-5AN: - power transformers TMN-4000/35/10 with regulation under voltage; - 35 kV vacuum reclosers of the Rec35 Smart1 Sub7 type; - 35 kV disconnectors of the type RG-2-35.II/1000 UHL1; Closed switchgear 10 kV: - bays of the type KSO-207 “Novation” relay protection and automation devices: - a cabinet of primary, backup protection, AUV-35kV and ARKTN transformer 1T - IEC61850 8-1, 9-2; - a cabinet of primary, backup protection, AUV-35kV and ARKTN transformer 2T - IEC61850 8-1, 9-2; - a control automation cabinet SV-35kV - IEC61850 8-1; - a cabinet of step-by-step protections, automation controls Conductor-35kV Cheremoshnoye, N. Derevnaya, with voltage control TN-35kV 1 and 2 bus sections - IEC61850 8-1, 9-2; - a cabinet of devices for interfacing with outdoor installations (AMU, DMU connections Outdoor switchgear-35kV) - IEC61850 8-1, 9-2.
14.	Smolenskenergo	– Modernization of Conductor 10 kV f.1019 SS 110/35/10 kV Novodugino, SS 35/10 kV Katyn, SS 35/6 Pechersk, etc.	Line vertical-break (tilting-type) disconnecting switch 6-20 kV for outdoor installation RLR Tesla, RLK.1b-10.IV/400 Rated voltage – 10 kV, Maximum operating voltage – 12 kV, Rated current – 400 A, Conventional thermal current – 10 kA, Electrodynamic current – 25 kA, Conventional thermal current duration – 5 s, Inductive tripping current – 1 A, Capacitive breaking current – 1 A, Quantity – 160 pcs

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
15.		– Construction of PTS 10/0.4 Conductor 10 kV №1019 SS 110/35/10 kV Novodugino (transformer power 0.16 MVA), etc.	<p>Energy efficient power transformers with reduced No-load losses and Short-circuit losses (min class C according to EN 50464-1) Voltage class: 10(6)/0.4 kV; Power transformer type: TMGe; Winding circuit: D/Yn, Y/Zn; Power rating: 25-2500 kVA, including: - 160 kVA – 4 pcs. No-load losses: 320 W, short-circuit losses: 2350 W; - 250 kVA – 2 pcs. No-load losses: 425 W, short-circuit losses: 3250 W; - 400 kVA – 4 pcs. No-load losses: 610 W, short-circuit losses: 4600 W.</p> <p>Quantity – 22 pcs</p>
16.	Orelenergo	– Grid Control Centre of Orelenergo (ARIS SCADA of Orlovsky Distribution Zone)	<p>Central receiving and transmitting station “CSSS ENTEK – 1000” (CSSS) CSSS is built on the basis of a domestic industrial computer for installation in a 19-inch rack. CSSS passed all the necessary control tests and trials in industrial applications. The product is manufactured in accordance with AFLS.421455.201 TU The product has a certificate of conformity;</p> <p>Performance characteristics: - Power supply from a single-phase grid 220 (+22 -33) V DC with a frequency of (50+ 5) Hz - Overall dimensions – 430 x 457 x 88 mm - Weight (excluding removable elements) – 9,5 kg - Climatic version – from +5 to +400C - Relative humidity – no more than 80% at 25 0C - Design – a 19-inch rack mount - Communication interfaces – RS 485, IEC 60870-5-104, IEC 61850-90-2, NBIOT, RTU968, LPWAN, DNP.V3 - Rack size – 2U</p> <p>Quantity – 1 pc</p>
17.	Voronezhenergo	– Construction of Cable Line 110 kV SS 220 kV Buturlinovka - SS 110 kV Buturlinovka-2 circuit 1, 2 (length of 0,97 km).	<p>Cable 110 kV with cross-linked polyethylene insulation Voltage - 110 kV Shield cross section – 95 mm² Core cross section – 630 mm² Rated current – 935 A Length: – Cable Line 110 kV Buturlinovka-2–Buturlinovka circuit 1 – 542 m – Cable Line 110 kV Buturlinovka-2–Buturlinovka circuit 2 – 432 m</p>

Item #	Branch of IDGC of Centre	Facility name	Key technical parameters
18.	Lipetskenergo, Bryanskenergo, Tambovenergo	– Creation/modernization of ACS at TS 6-10 kV from 6-10 kV power lines of Lipetskenergo, Bryanskenergo, SS 110-35 kV of Tambovenergo	<p>Intelligent controller SM160-02</p> <p><u>Main technical specifications:</u> input of remote alarm signals (station-wide signals: failure, fire and security alarm); input of telemetry measurements (voltage, current, frequency, etc.) from multifunctional electric meters, digital meters, relay protection and automation devices via RS-485 interface; data collection from energy metering devices: readings and value profiles for tariffs, events, etc.; built-in GSM/GPRS module, support for installing two SIM-cards (primary and backup); external interfaces: 1(2) × LAN Ethernet 100Base-T, TCP/IP; 1 × USB host; 4 × RS-485; 2 remote alarm channels (dry contact); data transfer to the upper level of the system in several directions; exchange protocols: Modbus/TCP, Modbus/RTU; Discreteness of time representation by program indicator, 1 ms; Power consumption, max, 15 VA; Rated operating conditions: DC voltage, 24 V; Temperature 20±5 degrees; Operating conditions: DC voltage, from 10 to 30 V; Temperature from -40 to +70 degrees; Overall dimensions 40x85x97 mm Average service life of at least 30 years Mean time between errors 120000 h</p> <p>Quantity - 1135 pcs</p>