TESS

Unmanned energy facilities

The project is included in the collection of the best AI solutions in the fuel and energy sector

Effective domestic practices of applying artificial intelligence technologies in the fuel and energy complex

ANO "Digital Economy" 2024

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Minister of Energy of the Russian Federation

Ever since the implementation of the state plan for the development of the electric power industry, when Soviet scientists, engineers, construction workers, and managers succeeded in laying the foundation for many of our country's economic successes, and up to the present day, Russia has remained one of the world leaders in the field of energy.

The observed global transformation of economic processes once again requires us to consolidate and focus our efforts on enhancing the competitiveness and efficiency of domestic fuel and energy complex (FEC) enterprises. Under such conditions, the adoption of trusted digital technologies becomes a key priority.

The President of the Russian Federation, V.V. Putin, has repeatedly emphasized the importance of introducing digital technologies and artificial intelligence into economic sectors. Consequently, we face a serious task: to test the developments of our advanced engineering and mathematical schools within the FEC in the shortest possible time.

To accomplish this task, the Russian Ministry of Energy is actively working on removing barriers to the implementation of artificial intelligence, shaping industry-specific demand, and standardization. It is important to note that the application of AI in the FEC has already yielded results. In the near future, this technology will be utilized by the majority of FEC organizations.

A software and hardware complex for managing the operating modes of local intelligent energy systems

Processes
Transmission and Distribution. Operational Dispatch Control. Generation.

Model practice
Selection of optimal technologies, formulations, operating modes, and equipment settings to enhance process efficiency

Stage
Final product

Technology type
Intelligent Decision Support Systems (IDSS)

Vendor
TESS JSC

Client
LLC "Siberian Generation"

Problem
High costs associated with connecting small-scale generation facilities to existing centralized power grids with parallel operation capability. High risks of equipment failures and emergency outages when exchanging power with the external grid

Solution
The solution is a software and hardware complex for Local Intelligent Electric Systems, which enables fully automated power redistribution and exchange with the external grid. It selects the most efficient and economical operating modes—including the choice of operational equipment configuration and islanded or parallel operation options—while accounting for consumer demands, potential equipment failures, and emergency situations.

Decision-making regarding mode selection is ensured by applying five patented intelligent methods for emergency and operational control of power systems, as well as an auto-operator. These methods are based on the use of expert-type artificial intelligence, which simulates the reasoning and knowledge of domain experts)

Effects
- Reduction of specific gas consumption for electricity generation by 10-15%
- Reduction of costs for grid connection to centralized power supply networks by 30-50%
- Increase in power supply reliability for consumers by 20-30%
- Reduction of emergency power plant outages during network short circuits by 50-70%

About the Company

TESS is a modern technology company specializing in the servicing of engineering systems

800+ successfully completed projects

20+ years, we have been powering people and companies

23 cities of operation across Russia

1000+ employees on staff

53% of employees have a relevant professional degree

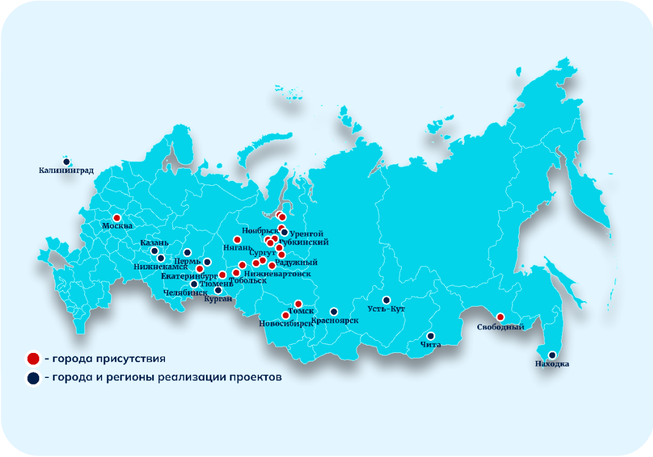
Our fleet is equipped with everything necessary to execute the most complex projects: specialized machinery, high-precision instruments, professional tooling, and cutting-edge technologies

About the Company

Why Choose us?

Extensive geographic reach

Our operations are supported by fully staffed and complementary divisions across four key regions of Russia: the Urals, Siberia, the Far East, and the Central Federal District



Technical Proficiency

We maintain partnerships with leading domestic companies in the energy sector and have extensive experience in successfully implementing projects of various scales

Safety

We operate on the principle that no objective can justify violating occupational health and safety requirements or disregarding human life and health

Mission and Values

Our Mission

Energy of

Life

> We contribute to global development by creating and implementing new energy solutions.

Mission and Values

Our Values

CREATIVITY

We create something new, drawing inspiration from the process of achieving goals.

- Any task is a joy.
- We are inspired by ambitious goals.
- We take pleasure in the creative process.

SAFETY

The safety of our employees and partners is our priority.

- We treat nature and resources with care.
- We care for ourselves and for those around us.
- Social safety and family are important to us.
- A healthy lifestyle is one of our priorities.

COLLABORATION

By uniting, we empower each other through respect, openness, honesty, and trust.

- Warmth, kindness, and respect are important to us.
- We listen, know how to find common ground, and believe in people.
- Fairness is the foundation of our interactions.

EFFICIENCY

We use resources rationally, measure results, and continuously improve processes and products.

- We avoid unnecessary actions, focusing on what is important and necessary.
- We achieve results in the most efficient way.
- We employ innovative approaches and technologies.

Reasons determining the relevance and necessity of decentralizing the management of power system operations in general, and of local power systems with small-scale generation in particular.

- The ever-increasing security threats to critical infrastructures, including energy infrastructure, associated with their modern information-network-based control systems, which have high cyber vulnerability.
- The preference of private investors for energy facilities with independent control systems and minimal organizational and technological constraints for their integration into existing electrical grids and power systems.
- Maximum freedom for owners of energy facilities to achieve their business goals while maintaining common power system operation modes during parallel operation within integrated power associations.
- The unpredictability of global socio-political development, which allows for the emergence of major military conflicts with large-scale negative consequences for energy infrastructure and, accordingly, increasing demands for its survivability. The foundation of this survivability lies in the decentralization of generation, operational management, and, above all, restoration capabilities.
- The aforementioned reasons compel a move away from the hegemony of the centralized development and operational management concept for electric power systems. This concept must be augmented with the capabilities and potential of decentralized development and management, especially in relation to Autonomous and Resilient Energy Systems (ARES).

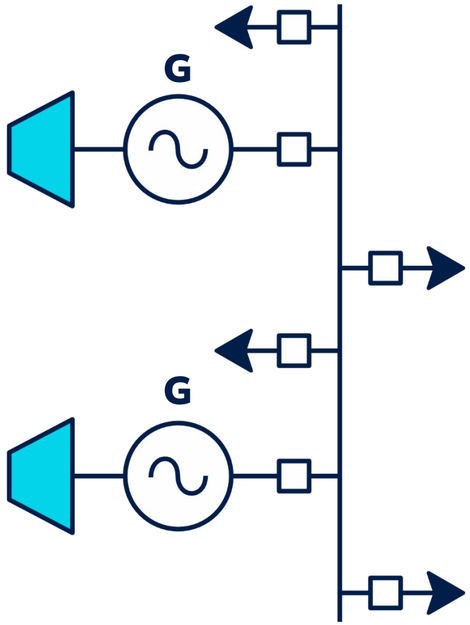
Minimum Glossary

- **Active Electrical Network with Distributed (Small-Scale) Generation (ARES)** — A distribution electrical network with multiple sources and facilities containing small-capacity electrical energy sources connected at various nodes of the network.
- **Agent (generalized)** — An entity (person, automation, etc.) acting on behalf of (in the interests and according to the rules of) a particular subject (consumer, enterprise, etc.).
- **Multi-Agent Management System (MAS)** — A management system that operates through the interaction of intelligent agents.
- **Decentralized Multi-Agent Management System (DMAS)** — A multi-agent management system that operates through the interaction of intelligent agents at the same level without exchanging information between them, using local information about the state of the controlled object.
- **Mono Multi-Agent Management System (MMAS)** — A management system that operates through the interaction of intelligent agents of a single subject, acting in its interests and according to its rules.
- **Poly Multi-Agent Management System (PMAS)** — A management system that operates through the interaction of intelligent agents of multiple subjects, acting in their interests but according to common rules.
- **LES (Local Energy Supply System)** — A local energy supply system with electrical energy sources having a total capacity of 1 - 25 MW, connected to a 6-110 kV centralized power supply distribution network with the capability of power exchange. It can operate under the control of automation independent of the external system, both autonomously and in parallel with the external grid, and can stably and safely transition from autonomous to parallel operation and vice versa without disrupting the power supply to consumers

Operation of a local power system with small-scale generation, both autonomously and as part of an ARES

Disadvantages of autonomous operation

- Low reliability
- Low quality of electricity (especially frequency stability)
- Low utilization of installed capacity
- Long payback periods



Effects of Integration with Centralized Power Supply Systems

For small-scale generation facilities:

- High reliability
- High quality of electricity (frequency stability)
- High capacity utilization
- Payback period of 5-7 years (with low connection costs)

For centralized power supply grids:

- Reduction of losses (due to network load relief)
- Ability to connect additional consumers (due to network load relief)
- Improvement of electricity quality (voltage stability) in the area where small-scale generation is connected

Technological barriers to the integration of local energy systems into the external electrical grid and with each other

- Poor electromechanical compatibility due to the low mechanical inertia of the rotors in small-scale generation units. Risk of dangerous asynchronous conditions occurring.
- Occurrence of unacceptable shock torques on the shafts of small-scale generation units during transient short circuits in the electrical network
- Increase in short-circuit currents
- The need to reconstruct the relay protection systems at the substation connecting the facility with small-scale generation
- The need to integrate the facility with small-scale generation into the dispatch management system.
- Increased requirements for the professional level of operational personnel at LES (Local Energy Systems) within ARES (Active Electrical Networks with Distributed Generation)

The development is protected by law. Patents for invention No. RU 2662728 C2, RU 2752248 C1, RU 2752693 C1, RU 2784610 C1.

Technology for Decentralized Multi-Agent Control of ARES Operating Modes

The focus of decentralization of management is on the main system tasks of managing the general operating mode of an electrical network with distributed generation and their decentralized solution:

- Maintaining active power balance (frequency regulation) in normal operating modes
- Maintaining reactive power balance (voltage regulation) in normal operating modes
- Emergency (anti-disturbance) control in response to large disturbances of the normal operating mode
- Maintaining the operational capability of the power supply system in post-emergency (restoration) modes
- Restoring the integrity and normal operating mode of the network after its emergency or protective (anti-disturbance) separation into isolated parts

The development is protected by law. Patents for invention No. RU 2662728 C2, RU 2752248 C1, RU 2752693 C1, RU 2784610 C1.

Axioms, Ideas, and Principles of Control

General, invariant to its organization

- Conformity between the variety of states of the controlled object and the control system (according to Ashby's Law of Requisite Variety).
- Observability: The ability of the control system to determine the states of the controlled object.
- Controllability: The ability of the control system to influence and change the states of the controlled object.
- Decision-making based on principles of open-loop control, feedback control, disturbance-based control, or their combination.
- Optimality and multi-criteria nature of control.
- Priority of emergency (anti-disturbance) control.

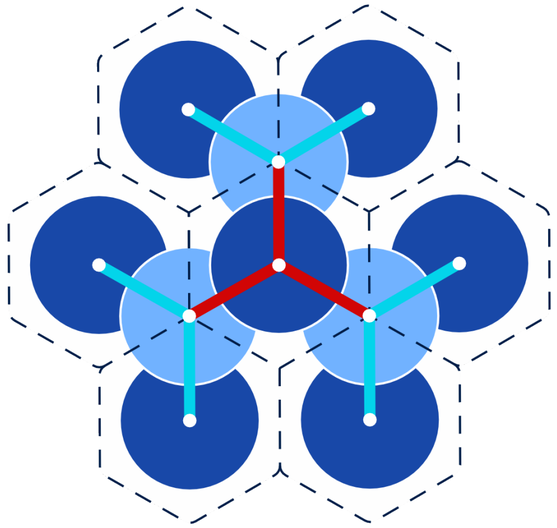
Principles adopted in the development of a DMAS for electrical network mode control.

- Autonomy of Decision-Making: Each agent makes decisions independently within the scope of its authority and the common rules of behavior.
- Unity and Mandatory Adherence to Common Rules: All agents must uniformly and obligatorily follow the common rules for decision-making and actions.
- Maximized Use of Local Information: Each agent primarily utilizes local information about the state of the controlled system (the operating mode of the LES, its network area) to assess its own state and the state of the system as a whole, and to make decisions.
- Use of Expert-Type Artificial Intelligence: Expert-type artificial intelligence is employed for identifying state classes and making decisions

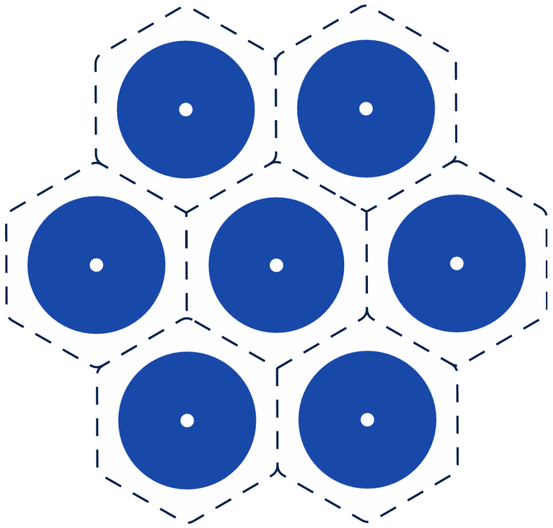
Comparison of Centralized and Decentralized Control Structures

Vision of the General Control Structure — Two-Loop Control

Structure of a Centralized (Hierarchical, Three-Level) Control System



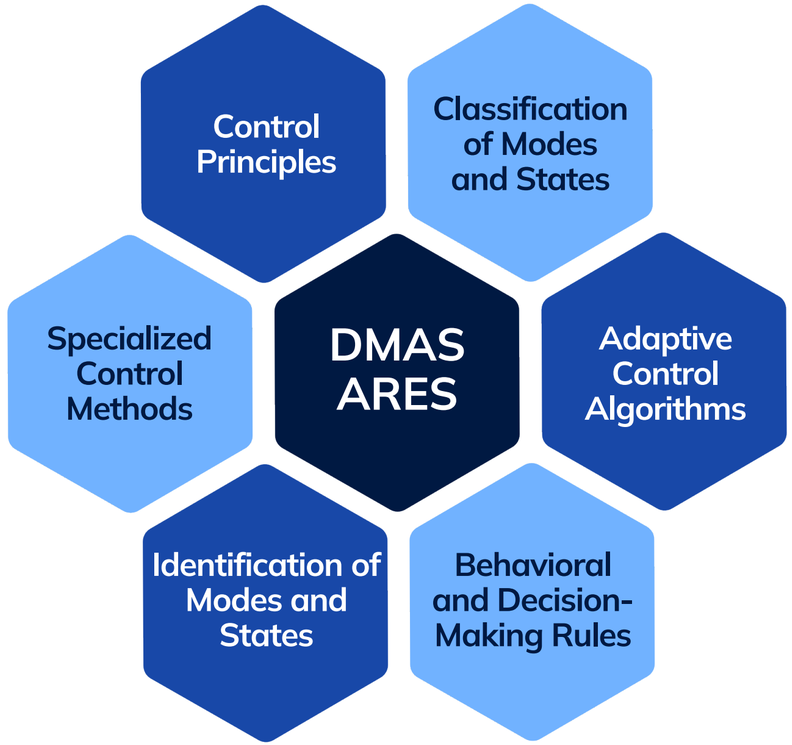
Structure of a Decentralized Control System



DMAS ARES is a distributed expert-type artificial intelligence system. It utilizes knowledge about operating modes, control methods, as well as decision-making and implementation processes to perform comprehensive decentralized online control of an ARES

Composition of DMAS Agents

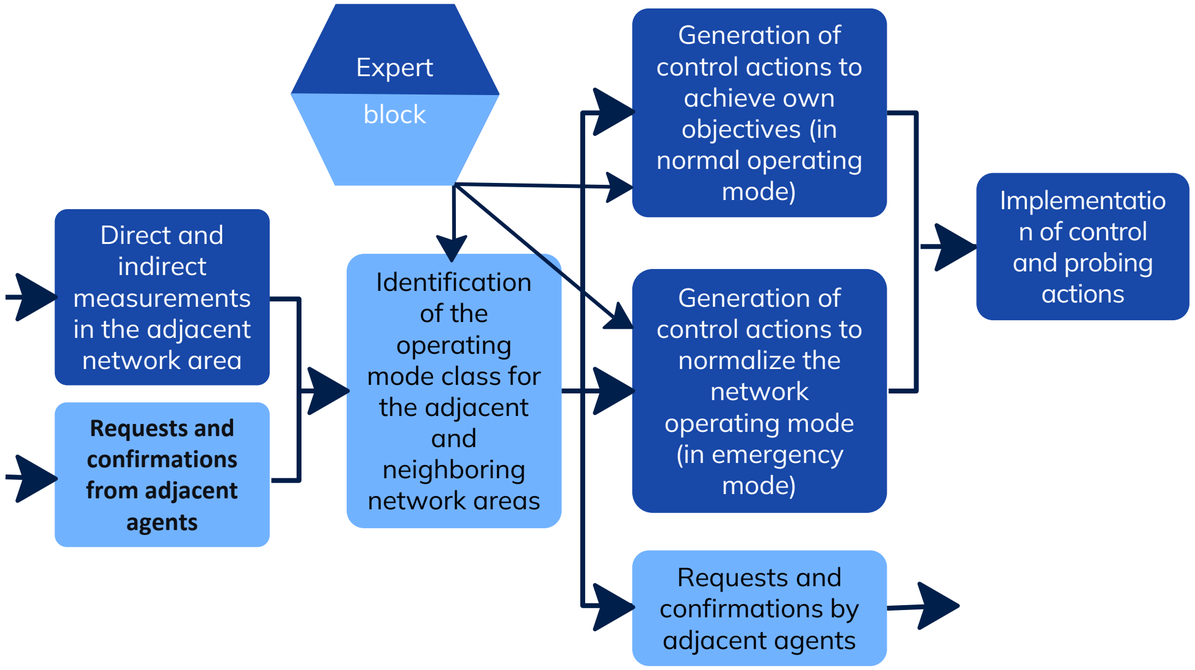
- Agent for Comprehensive Control of ILES
- Agent for Frequency and Power Regulation of a Power Station
- Agent for Voltage Regulation at a Network Node
- Agent for Network Switch
- Agent for Rapid (Express) Separation of LES from the External Grid
- Agent for Synchronization of a Power Station with the External Grid
- Agent for Rapid (Express) Frequency-Based Load Shedding in an LES
- Agent for MAS Administration
- Agent for Monitoring Successful Induction Motor Starting



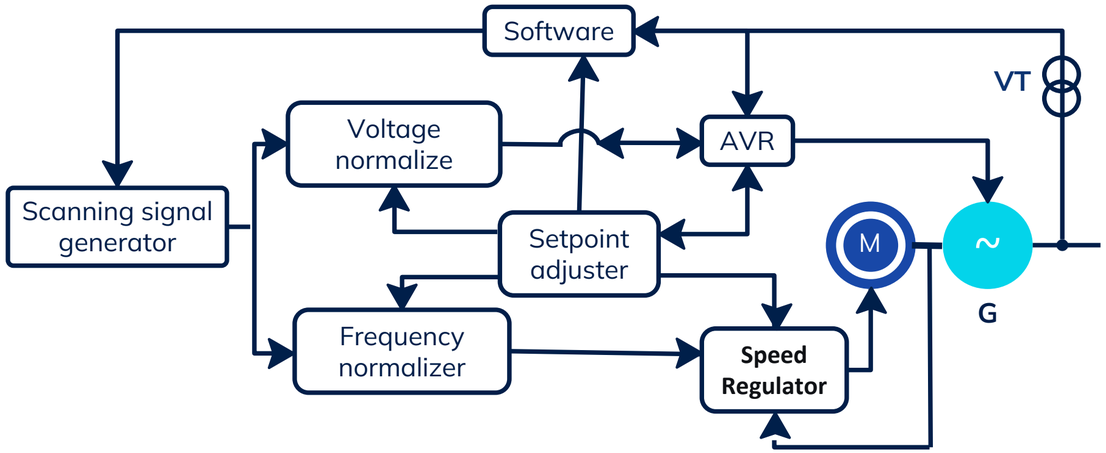
The development is protected by law. Patents for invention No. RU 2662728 C2, RU 2752248 C1, RU 2752693 C1, RU 2784610 C1.

Examples of Integrating "Intelligent" Agents with Existing Monitoring and Control Devices

System for voltage control in a network area



System for monitoring voltage and power of a power plant unit with a grid synchronization control agent



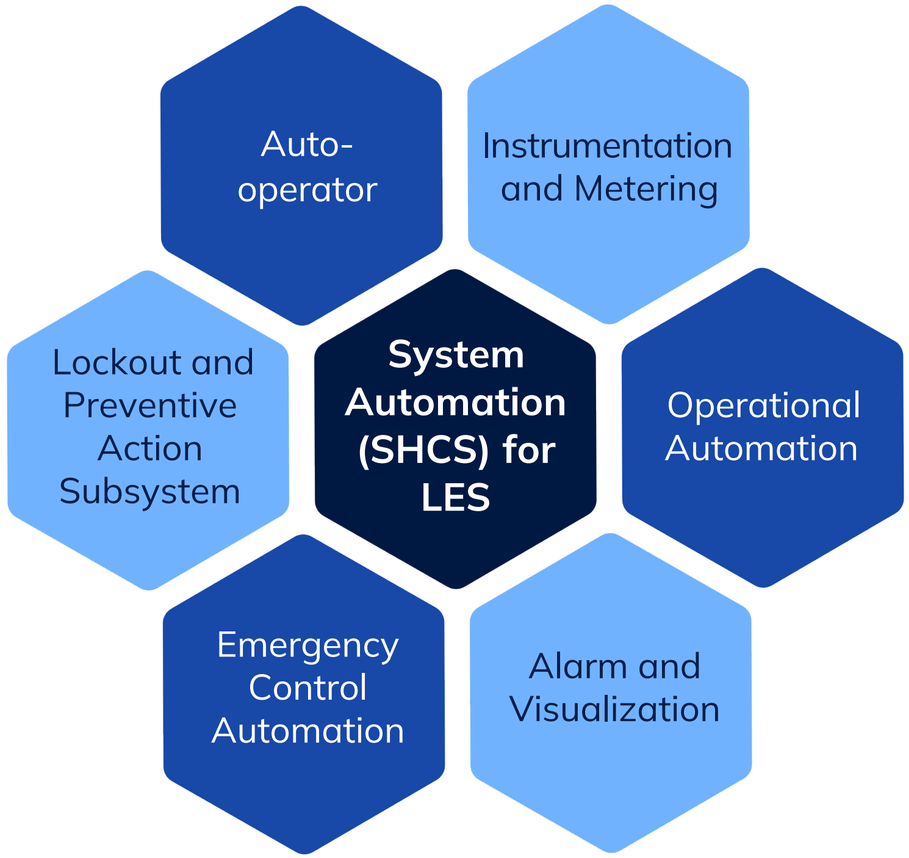
The development is protected by law. Patents for invention No. RU 2662728 C2, RU 2752248 C1, RU 2752693 C1, RU 2784610 C1.

Local Energy System Software - **Agent of the ARES Multi-Agent Control System**

System Automation Hardware (SHCS) **for Local Energy System Mode Control** Based on a Small-Scale Generation Facility. It integrates into a single device an auto-operator, operational automation, emergency automation, telemetry, remote control, and remote measurements.

The foundation of **emergency control** for parallel operation with the external grid is a method of operational and emergency management that uses pre-emptive (under 80 ms) separation of a balanced LES from the external network at a pre-determined fixed section prepared in advance by the auto-operator

At present, the **SHCS represents a novel and the only low-cost method that solves the task of connecting an LES to the electrical grid**. It ensures coordinated operation of operational and emergency automation, which constitutes a new type of automation system



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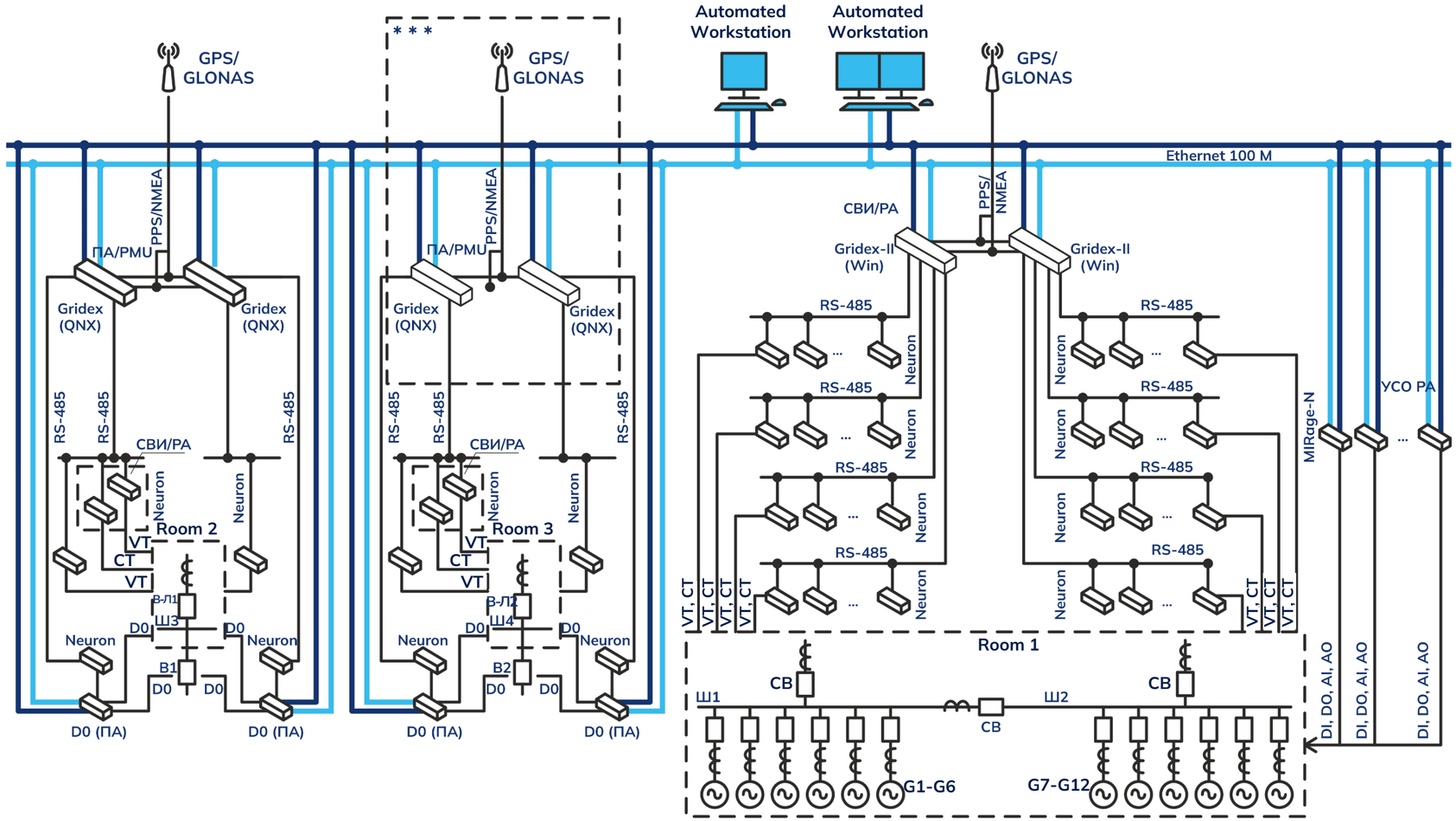
The SHCS controls switching devices in the power output scheme, the composition and loading of the LES power plant generators in terms of active and reactive power, and synchronizes the generators with each other and with the external electrical grid. It ensures the safety of parallel operation of the LES with the UPS for the power plant equipment, the reliability of power supply to consumers, the ability to feed excess generating capacity into the ARES (Active Distribution Network with Distributed Generation), and automatic transitions to island mode and parallel operation with the ARES

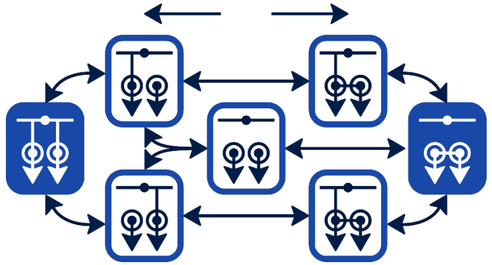


The SHCS and Auto-operator of the Local Energy System provide:

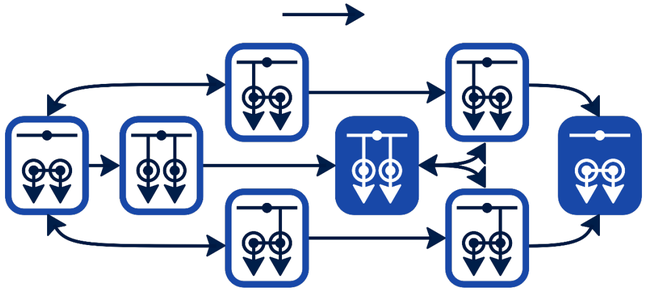
- Pre-emptive, balanced emergency separation of the LES from the grid.
- Control over the composition, loading, and operating mode of generating equipment (fulfilling commercial obligations for power and energy supply, as well as system services).
- Maintaining readiness for sporadic, balanced separation.
- Restoration of normal operating mode after a disturbance.
- Execution of operational transitions from parallel operation to islanded mode and vice versa.

The development is protected by law. Patents for invention No. RU 2662728 C2, RU 2752248 C1, RU 2752693 C1, RU 2784610 C1.

Reconfiguration of the LES structure under normal operating conditions



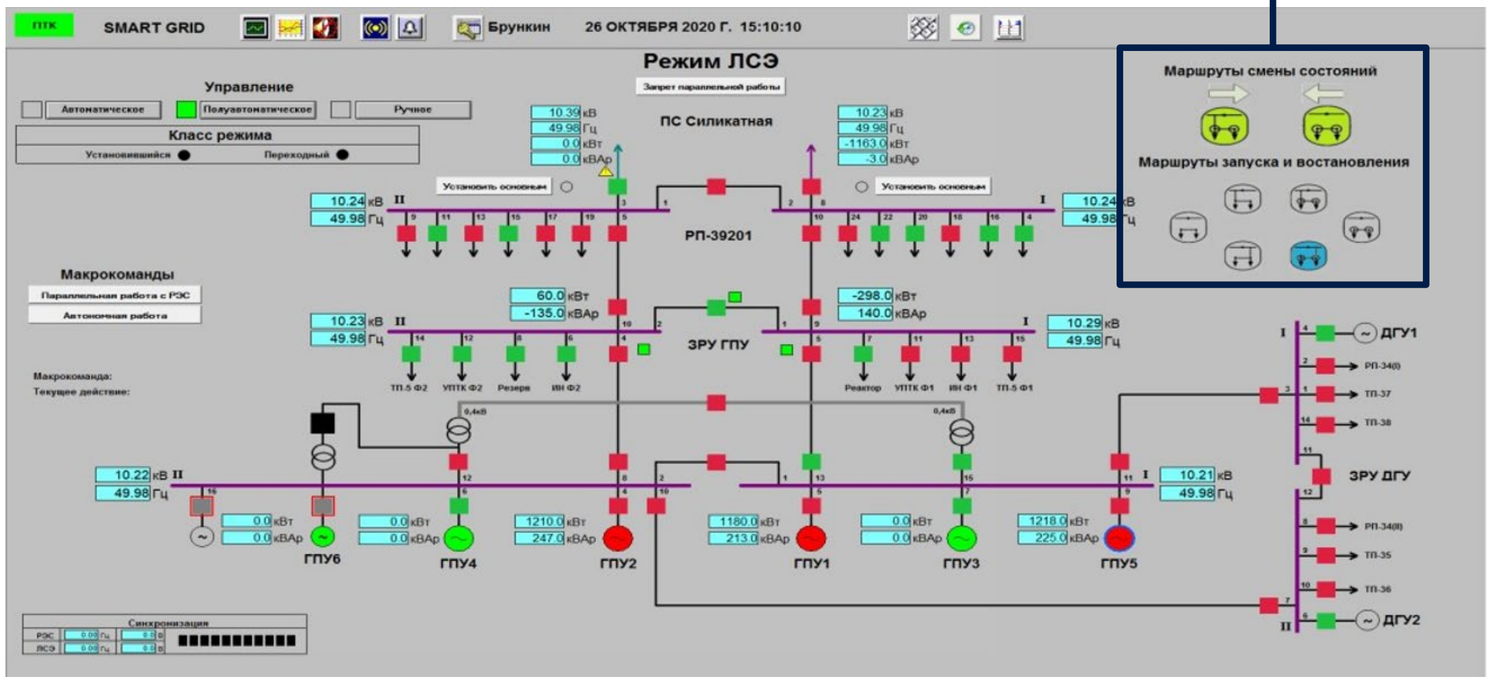
Restoration of the normal parallel operation mode after its disruption



Auto-operator
Operational Scripts

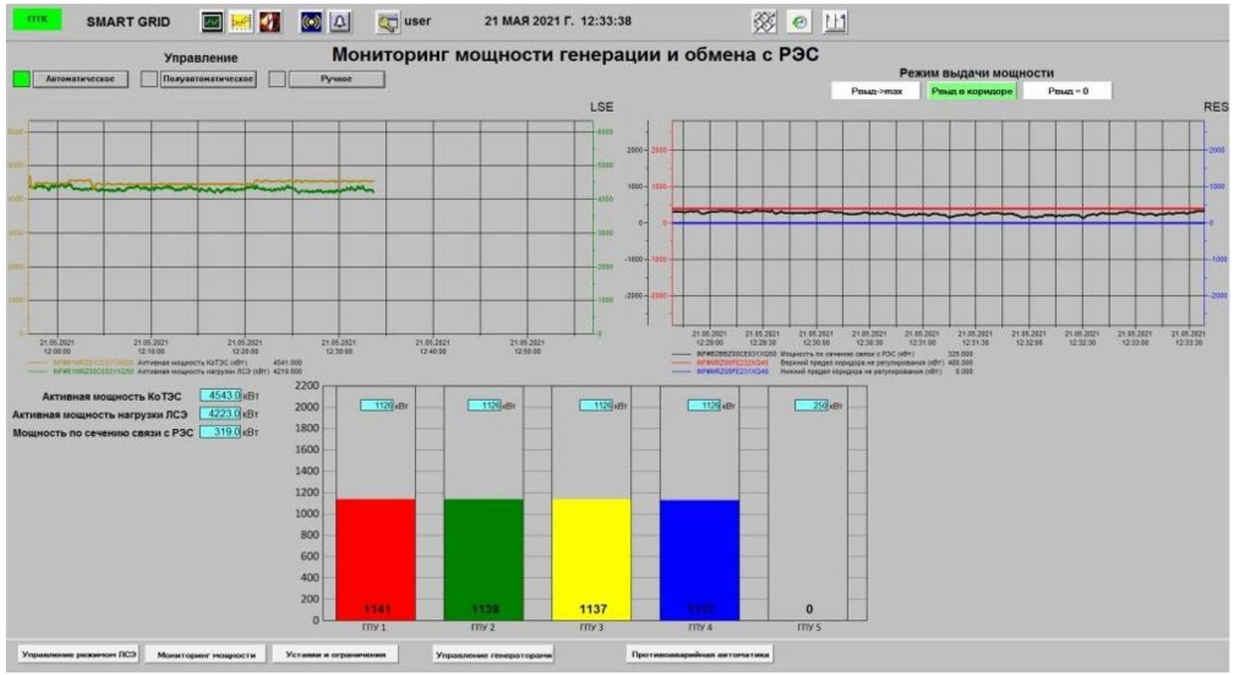
Status and Pictogram

LES Operating State Class	
LES Normal Operating State Class	
Separated buses of the external electrical grid at the LES connection points	
Synchronous electrical connection	
Load	
Generator under load	
Switchgear Bus Section of a Power Center with Co-located Generation and Loads	

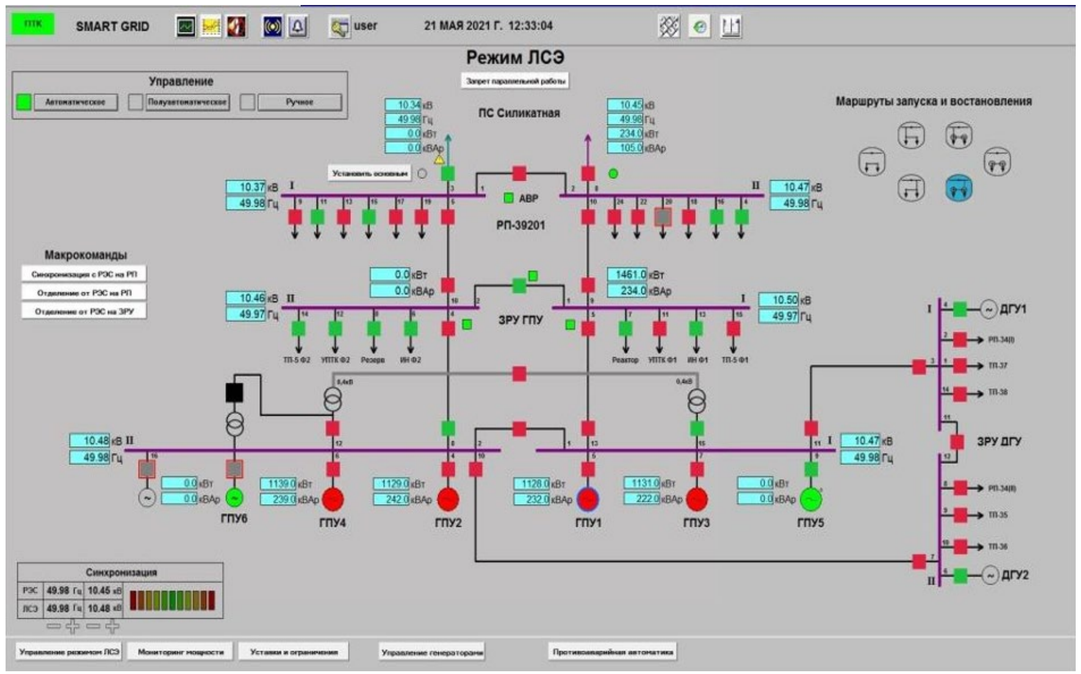


Key Interface Views of the System Automation Dispatch

Monitoring of Generation Power and Power Exchange with the Receiving Power System



LES Main Electrical Diagram



Benefits and Outcomes of Deploying an Active Grid (ARES) with Decentralized Control Technology for LES

For a Distribution Network Company

- Enhanced Power Quality and Supply Reliability Enabled by the LES
- Reduction of peak loads by performing the aggregator function in demand-side management. Extension of equipment service life
- Connecting new consumers without grid reinforcement investments by utilizing guaranteed generation located in grid-congested zones
- The ability to purchase electricity from small-scale generation to cover losses and own needs at prices below market rates

For the Transmission System Operator

- The ability to level the load curve and perform emergency (anti-disturbance) balancing of the system's operating mode
- Operational and Emergency Control

For owners of small-scale generation within a LES

- Increased reliability and quality of power supply for own consumers
- Localization of disturbances during accidents and automatic restoration of the normal operating mode
- Increased interval between generator overhauls due to the stability of the electricity generation mode during parallel operation with the grid
- Reduction of stress on circuit breakers during short-circuit current interruption in parallel operation by means of pre-emptive disconnection of backfeed from the external electrical grid
- Generating profit from the sale of surplus power and energy to the external grid, including through the execution of direct contracts on the retail market
- Reduction of costs for own generation reserves and production regulation for frequency maintenance

Overall Effect

- Enabling information integration of the LES with the Integrated Power System to improve grid observability by deploying synchronized phasor measurement units

The development is protected by law. Patents for invention No. RU 2662728 C2, RU 2752248 C1, RU 2752693 C1, RU 2784610 C1.

Developers and Utilities: **Benefits for You**

Reliability and independence of power supply

- A high degree of independence from centralized grids, reducing the risk of outages.
- The ability to gradually increase capacity to accommodate future expansion and modernization

Economic Benefits:

- Reduced electricity costs through self-generation.
- Lower consumption of purchased fuel.
- Increased market attractiveness of properties due to modern and efficient energy infrastructure.
- Eligibility for state support in the form of subsidies and tax incentives as developers implementing energy efficiency projects.

Reputation

- Reduction of emissions, strengthening the image of an environmentally responsible developer.
- Compliance with modern state policy requirements in the fields of energy conservation and ecology.
- Implementation of advanced energy resource management technologies highlights the developer's innovative approach

Industrial Enterprises (Mining, Petrochemicals, Metallurgy): **Benefits for You**

Reliability and independence of power supply

- Reduced dependence on external suppliers and price volatility for energy resources through the implementation of own generation sources.
- Minimization of risks associated with external outages and disruptions in the public power grid.

Economic Benefits:

- Optimization of energy consumption through the ability to distribute loads based on production process requirements and energy resource availability.
- Utilization of production by-products as fuel for power generation, enabling additional reductions in waste disposal and energy procurement costs.
- Enhanced efficiency and competitiveness through the implementation of advanced energy solutions.
- Access to state subsidies, tax incentives, and other support mechanisms when investing in energy-efficient technologies and renewable energy sources

Reputation

- Reduction in the volume of harmful emissions into the atmosphere through the integration of systems based on more efficient small-scale generation technologies.
- Implementation of advanced energy resource management technologies highlights the innovative approach, positively impacting the company's reputation.

Mining Centers: **Benefits for You**

Reliability and independence of power supply

- Parallel operation of own generation with the centralized grid under SHCS control eliminates the risks of mining operation stoppages.
- The SHCS provides automatic and precise regulation of energy consumption, which is particularly critical for miners with high requirements for power supply stability.
- Independence from price volatility and resource availability enhances operational resilience.
- Stable power supply extends the service life of costly mining equipment, reducing repair and replacement costs.

Economic Benefits:

- Significant reduction in electricity costs through the use of own generation.
- Optimization of fuel consumption.
- Increased investment attractiveness of the mining center due to its modern energy infrastructure.

Reputation

- The high reliability of the power supply demonstrates the mining center's ability to ensure stable operation of the equipment, which is critically important for miners.
- The use of PTK confirms the use of modern energy management technologies in mining

Agro-Industrial Complexes: **Benefits for You**

Reliability and independence of power supply

- Independence from external suppliers of electricity and heat.
- Protection against external power outages and price volatility for energy resources.
- Increased autonomy of the agro-industrial complex enables stable and predictable energy supply regardless of external factors.

Economic Benefits:

- Reduction in electricity and heat costs through own generation and fully autonomous management provided by our SHCS's auto-operator.
- Carbon dioxide produced by the gas piston unit (GPU) operation can be utilized to stimulate plant growth in greenhouses.
- Ability to sell surplus electricity and heat on external markets through direct contracts.
- Extension of equipment service life by reducing peak loads and optimizing operating modes when connecting generating equipment for parallel operation with the external grid.

Reputation

- Eco-friendly utilization of emitted CO_2 highlights a responsible approach to the environment.
- Attracting partners and clients focused on sustainable and advanced technologies by demonstrating high standards of reliability and efficiency.
- Strengthening market positions through energy independence and eco-friendly solutions, which helps to stand out among competitors.

Data Centers and Telecom Hubs: **Benefits for You**

Reliability and independence of power supply

- Parallel operation of small-scale generation with the centralized grid under SHCS control eliminates the risk of downtime.
- The SHCS provides unmanned and precise generation regulation, which is especially critical for ensuring the reliability of infrastructure with high demands on response time.
- Independence from price volatility and resource availability enhances the operational resilience of the systems.

Economic Benefits:

- The SHCS enables flexible load distribution between local sources and the external grid, reducing peak costs and energy losses.
- Surplus energy generated by local sources can be sold on the market, creating an additional revenue stream.
- Stable operation of the energy system extends equipment service life, minimizing repair and replacement costs.

Reputation

- High power supply reliability demonstrates the ability to provide stable services, which is important to customers.
- The use of the SHCS for energy supply management confirms a commitment to modern solutions and advanced technologies.

Service: Creation and Organization of Management for a Intelligent Local Energy System (ILES) based on small-scale generation integrated with the external electrical grid.

Service Components:

- Pre-project survey
- Technical specification development
- Engineering
- ILES SHCS manufacturing
- Construction
- Commissioning and startup
- Technical support and maintenance
- Parameter adjustment (if required)

Our Advantages

01
Experience

20+ years of experience in servicing 110-500 kV energy facilities

02
Operational Footprint

Territorial diversification and the capability to provide comprehensive service support at any location across the Russian Federation.

03
SO UES Support

Interaction with JSC "System Operator of the Unified Energy System"

04
Technological Advancement

Presence of production facilities, comprehensive equipment and instrumentation fleet, and a certified electrical testing laboratory.

05
Individual Approach

Exclusive capabilities from manufacturers
Certification by major vendors
Import substitution solutions

06
Responsiveness

24/7 dispatch service availability

07
Innovativeness

Cooperation with scientific centers (including Novosibirsk State Technical University).
The company employs 3 Candidates of Sciences (Ph.D. holders).

08
Warranty of up to 5 years

Diagnostics and repair depending on the type and model of equipment.

Permits, Licenses, and Patents

Membership in self-regulatory organizations in the field of:

- Construction, reconstruction (including hazardous production facilities);
- Engineering surveys;
- Project documentation.

Licenses:

- Installation, maintenance and repair of fire safety equipment.
- Passenger transportation services.

Certified electrical testing laboratories Patents:

- RU 2662728 C2 — "Method for emergency control of the parallel operation mode of synchronous generators in electrical networks"
- RU 2752248 C1 — "Method for controlling the parallel operation mode of synchronous generators in electrical networks"
- RU 2752693 C1 — "Method for remote synchronization and restoration of the normal mode of an emergency-separated electrical network with generators"
- RU 2784610 C1 — "Method for decentralized synchronization and restoration of the normal mode of an emergency-separated electrical network with generators"

Integrated Management System

The company TESS adheres to the adopted policies of the Integrated Management System in accordance with ISO 9001, ISO 14001, and ISO 45001

We maintain a high level of quality in the services provided and continuously seek new opportunities to enhance operational efficiency.

Our Partners

НГТУ НЭТИ

ГИАЭС

СИБУР

RENAISSANCE HEAVY INDUSTRIES

ВОСТОКГАЗПРОМ

КАЗАНЬОРГСИНТЕЗ

НИПИГАЗ

ТРАНСНЕФТЬ

КОМПАНИЯ КРУС-ЗАПАД

МАГНИТ

точка
банк для предпринимателей

BENNING

НТЗ
HOSSER TELECOM SOLUTIONS

Компания ВЕСПЕР

ЭНЕРГОЗАЩИТА

Systême electric
Энергия. Технологии. Надежность.

завод Импульс
надёжные инженерные решения

VYBOS

ГАЗПРОМ НЕФТЬ

РОСНЕФТЬ

НОВАТЭК

Danfoss

ТАВРИДА ЭЛЕКТРИК
Совершенство технических решений

ЭЛЕКТРОЩИТ САМАРА
Энергия вашего будущего

ИРКУТСКАЯ НЕФТЯНАЯ КОМПАНИЯ

МЕХАНОТРОНИКА
Интеллектуальные устройства релейной защиты

СПЕЦИАЛЬНЫЕ СИСТЕМЫ И ТЕХНОЛОГИИ

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