Федеральная Сетевая Компания

Единой Энергетической Системы

МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ
ЦИФРОВАЯ ПОДСТАНЦИЯ СТАНДАРТ IEC 61850
МОСКВА, 3-5 ОКТЯБРЯ 2017 ГОДА

ПРОГРАММА РАБОТ ПО РАЗРАБОТКЕ И ВНЕДРЕНИЮ ТЕХНОЛОГИИ «ЦИФРОВАЯ ПОДСТАНЦИЯ» В ЕНЭС. РЕЗУЛЬТАТЫ. ПЕРСПЕКТИВЫ

PROGRAM OF WORK ON DEVELOPMENT AND INTRODUCTION OF TECHNOLOGY «DIGITAL SUBSTATION» IN UNEG. RESULTS. PROSPECTS

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CHARACTERISTICS OF THE ELECTRIC GRID COMPLEX OF JSC "FGC UES"

THE PRESENCE

The branches of JSC "FGC UES"

1. The branch of JSC "FGC UES" – MES Center
2. The branch of JSC "FGC UES" – MES North-West
3. The branch of JSC "FGC UES" – MES Western Siberia
4. The branch of JSC "FGC UES" – MES East
5. The branch of JSC "FGC UES" – MES Siberia
6. The branch of JSC "FGC UES" – MES Urals
7. The branch of JSC "FGC UES" – MES of Volga
8. The branch of JSC "FGC UES" – MES South

PRODUCTION ASSETS

	2014	2015	2016
Number of substations 35 kV and above, PCs.	857	861	870
Power of SS 35 kV and higher, thousand MVA	331,6	333,8	341,1
The number of transformer substations (distribution points) 6-35/0,4 kV, PCs.	266	209	277
The length of the transmission line (for road), thousand km	131,5	133,1	134

KEY PERFORMANCE INDICATORS

	2014	2015	2016
Supply from the grid, mln kWh	515250	525769	540540
Total losses, %	4,13	4,09*	4,11*
The volume of connected power by contracts of connection, MW. Including:	5 537	8 185	5 635
generation units	1 769	5 419	2 982
consumers and network organizations	3 768	2 766	2 653
The average duration of interruption of electric energy, hour	0,01992	0,01348	0,01171
The amount of MWh lost	1 562	1 093	1 156

** in comparable conditions*

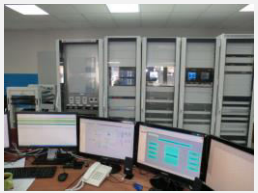
INNOVATIVE DEVELOPMENT OF JSC "FGC UES“
Basic directions

- Digital substation
- Digital design
- Energy efficiency and reduction of losses
- Remote management and security
- Power quality
- Reliability and asset management
- Composite materials and superconductivity

Expected effects

Economic:
- *reducing the cost of design and construction*
- *reduction of operating costs of SS.*

Technological:
- *reduction of time for design and adjustment;*
- *reduction of errors and increase the reliability of solutions;*
- *the introduction of new technological solutions.*



THE IMPACT OF TECHNOLOGY

Priority areas for technological and innovative development	KPIs								
	The reliability of power supply of consumers		Effective management				Infrastructure development		
	Reliability: the lack of growth of major accidents	Achieving the level of reliability of provided services	The reduction of operating costs (costs)	The reduction of investment costs	The level of electricity losses	The measure of labor productivity	Implementation of the schedule of input of objects in operation	Efficiency of innovation activities	The deadlines for technological connection
Digital substation		■	■	□		■		□	□
Digital design	□	□	□	■	□	■	■	■	■
Energy efficiency and reduction of losses	□		■	□	■	□		□	
Remote management and security	■	■	■			■		□	□
Power quality		■	□		□	□		□	
Reliability and asset management	□	■	■	□		■		□	□
Composite materials and superconductivity			■	■			□	□	□

■ – affects; □ – affects indirectly; "an empty cell" – actually a complete lack of influence of the corresponding priority directions of technological and innovative development for KPIs.

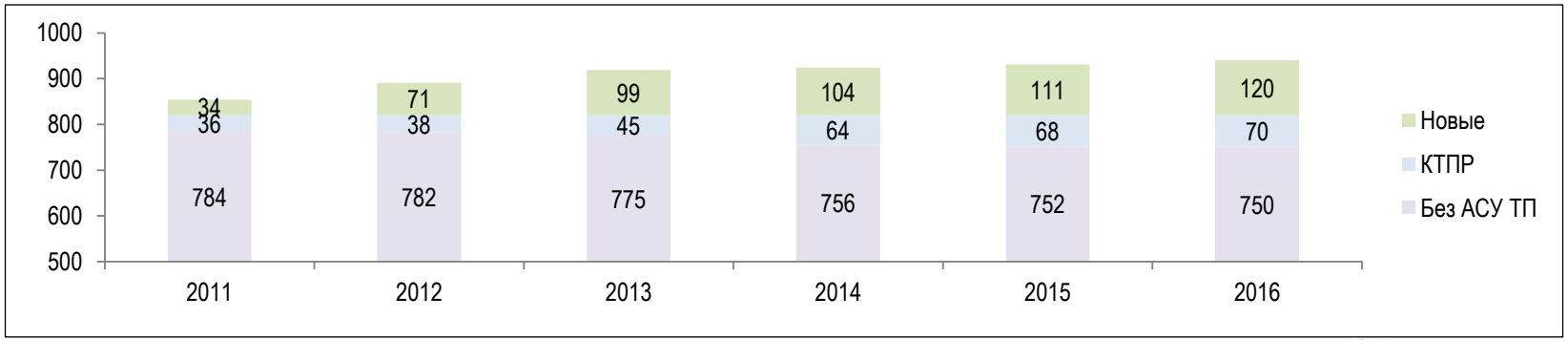
TESTING AND IMPLEMENTATION OF TECHNOLOGY

- ✓ Technical policy of the company aims to maximize the implementation of standards in IEC 61850 with the aim of improving the reliability and optimizing of the processes accompanying the use of equipment.

- ✓ The first experience of application of this technology took place in the end of 2005 at the SS 500 kV Aluminievaya.
- ✓ In 2006-2007:

  - SS 750 kV Belyy Rast
  - SS 500 kV Voronezhskaya
  - SS 330 kV Knyazhegubskaya
  - SS 750 kV Leningradskaya

- ✓ Equipping substations with automated process control systems with support of the IEC 61850 8.1:



THE FIRST STEPS IN THE DEVELOPMENT OF TECHNOLOGY

Currently 120 substations of JSC "FGC UES", put into operation, transmission signals from the relay into the SCADA system via 61850 – 8.1 (MMS) and implement operational locks by using GOOSE messages.
37 substations are in the process of setting up.
The first experience of application of this technology took place in the end of 2005 at the substation 500 kV Aluminievaya.
Since 2010 this technology is implemented on the equipment all the manufacturers of APCS used in the JSC "FGC UES", what is reflected in the standards of the organization.

Support of MMS for devices of relay protection and automation and SCADA allowed to refuse application of devices of central alarm, expensive sets of RTU (man-machine devices), the interface converters for various protocols (ModBus, Porofibus, 60780-1(3),4) and significantly expand the list of recordable signals while reducing capital costs for implementation.

So, for substations equipped with SCADA and MMS is currently prepared a standard draft for reconsideration of service rules in the direction of a significant reduction of preventive complexes.

THE USE OF TECHNOLOGIES 61850

Protocol	Application	Implementation
61850 – 8.1 (MMS)	transmission of non-priority signals (discrete and analog), not participating in the cycle management in soft real time. Data collection is done by survey, or in the form of reports on events (sporadically).	100%
61850 – 8.1 (GOOSE)	transmission of digital signals with high priority for implementation of control commands.	60%
61850 – (PPS)	Protocol of time synchronization via a dedicated coaxial cable or optical fiber	80%
61850 – 1588(NTP)	Protocol of time synchronization via the working path Ethernet	20%
61850 37118 (WAMS)	Protocol of transfer counts of vector measurements to the highest levels of management (dispatching centers)	30%
61850 9.2	Protocol of transfer of samples of instantaneous values (voltages and currents) for the purposes of management, measurement and accounting.	5%

TECHNOLOGY 61850 IN THE PROGRAM OF INNOVATIVE DEVELOPMENT

Technologies, equipment for digital substations with the support of Protocol of IEC 61850:	• optical transformers for current and voltage supporting Protocol IEC 61850-9.2 • converters of the analog values of current and voltage (Merging Unit (AMU) into a digital stream of IEC 61850-9.2; • digital relay protection with the organization of horizontal communication according to the Protocol IEC 61850-8.1; • the connection controllers with the operational functions of the distributed lock with support of the Protocol IEC 61850-8.1.

	Number of SS with the technology of "digital substation"	Number of SS with the technical service for measuring systems
2016	3	-
2017	5	1
2018	10	3
2019	15	4
2020	25	5

Problems

Problems discovered through the experience of using IEC 61850 (8.1):

- different manufacturers apply their own profiles that are not compatible without adaptation works, however, they do not contradict the basic standard of IEC 61850 8.1.
- a significant part of the signals on the diagnostic parameters in the standard is underdetermined and left to the farming of producers and integrators.

Language is a part of our organism and no less complicated than it.
Язык — это часть нашего организма и не менее сложная, чем сам этот организм.
Ludwig Wittgenstein
Людвиг Витгенштейн

SCIENTIFIC AND TECHNICAL SUPPORT OF THE TEHNOLOGY

2005

Experience analysis and conceptual design

2010

On the basis of JSC “STC FGC UES“ experimental testing ground "Digital substation"

The purpose of creating of experimental testing ground:
working out optimal technical solutions to build systems of relay protection and automation, the functional testing of relay protection and control equipment, including supporting the IEC 61850 Protocol.

2014

Development of prototypes

- *Complex evaluation of the dynamic characteristics of digital substation*
- *Simulator IED*
- *Software and technical complex for synchronous vector measurements (PMU)*
- *Optical voltage transformer 220 kV*

2016-2020

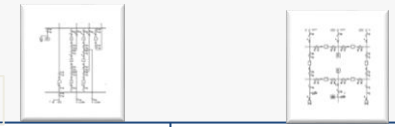
Current and future scientific researches (NIOKR)

- *Typical design decisions for relay protection and APCS*
  - *-Corporate profile IEC 61850*
  - *-Generic architecture*
  - *-Standard cabinets*
- *Information security of digital substations on the basis of IEC 61850*
- *Operation diagnosis systems*
- *Wave fault locator with support of IEC 61850*
- *The complex for testing of technical solutions and operational acceptance*

DIGITAL DESIGN AND DIGITAL SUBSTATION

The draft of industry standard "Schematic electrical switchgear substations 35-750 kV. Typical solutions. Recommendations for use"

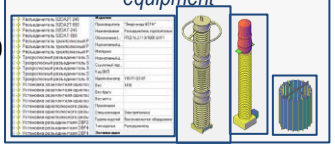
2016



Catalogue of the generalized models of the main equipment

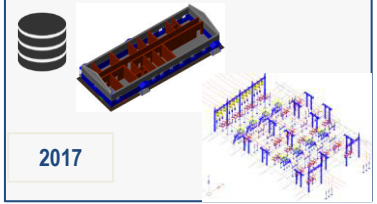
2017

Table of applicability of the certified equipment



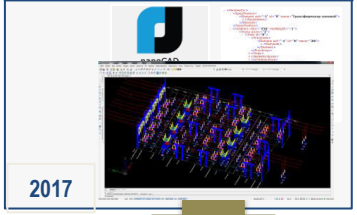
The catalogue of technical solutions for repeated use

2017



Application to CAD

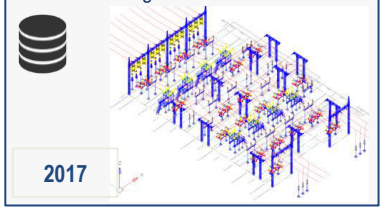
2017



Open format and API

The standard catalogue of outdoor switchgears 110-500kV.

2017

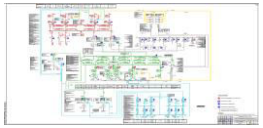


Norms of technological designing of substations of alternating current with higher voltage 35-750 kV (NTD SS) – 2017

Requirements for digital models

Digital model schemes of the layout of SS

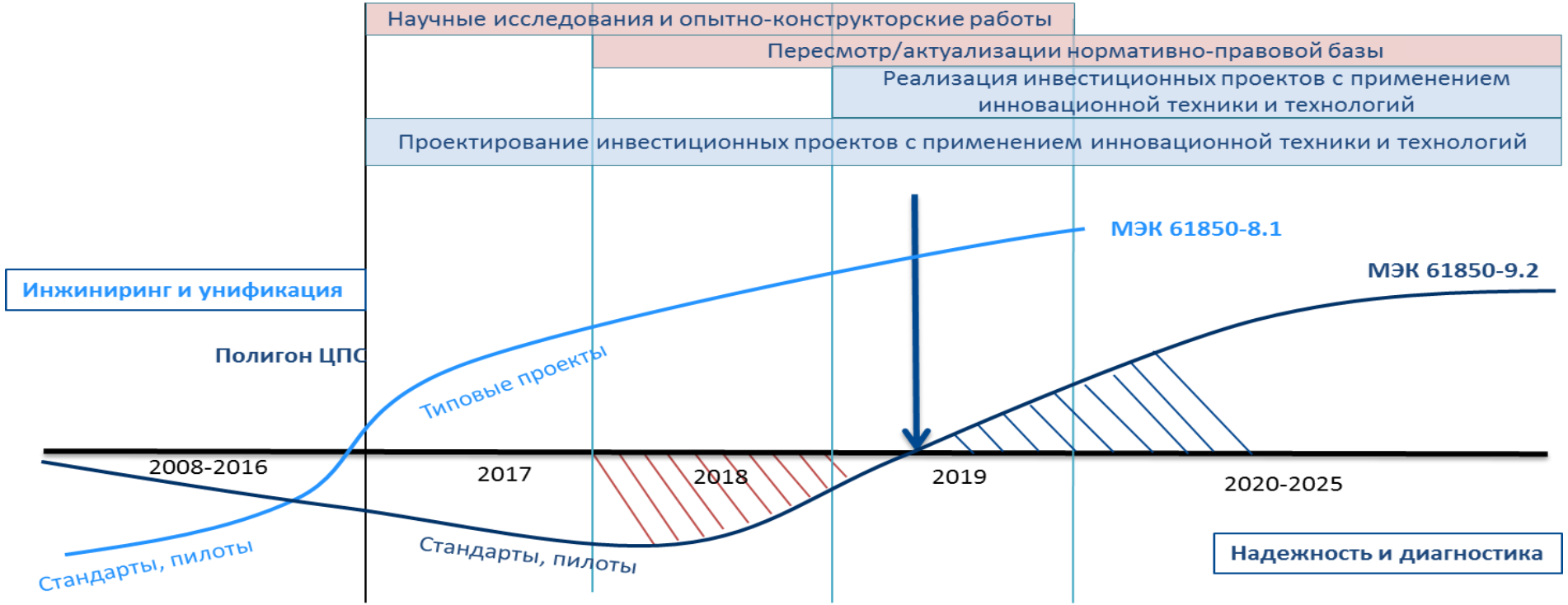
Automated creation of the personal data based on the database of standard solutions



NEW CAPABILITIES OF TECHNOLOGY 61850

New opportunities	Promising services and systems
Diagnosis of secondary equipment, transformers and their circuits	"Smart" recorders of emergency events, fault locators
Diagnostics of key parameters of the power equipment	Diagnostic systems of power equipment
Improvement of metrological characteristics	Means of on-line control (calibration) of the metrological characteristics of measuring channels Appraisal system for condition of facility level
The use of models for the management	System of options adaptation of regulators/protection.
Improving of data reliability of discrete signals for the purpose of operating and emergency control	Virtualization of functionality of transformer latch-off fixation and line latch-off fixation
Transient evaluation	Systems for controllable commutation Means of identification of accidents (disturbances) in the network

SCIENTIFIC AND TECHNICAL SUPPORT OF TEHNOLOGY



PILOT PROJECTS

Switchgear	MES, PMES, Name of SS	Years of implementation
500	SS 500 kV Tobol	2017
220/110	SS 220 kV Tempy	
110	SS 220 kV Radishchevo	2020
220	SS 220 kV Yuktali	2020 - 2023г.
10	SS 220 kV Varvarovka	2019 - 2021г.
220	SS 500 kV Trachukovskaya	2014 – 2020
220	SS 500 kV Somkinskaya	2015 – 2022
220/110	SS 220 kV Nadym	2015 – 2020
220	SS 220 kV Kargalinskaya	2015 - 2017
220	SS 500 kV Kurgan	2018 - 2021
220	SS 500 kV Gazovaya	2018 - 2021
500	SS 500 kV Itatskaya	2018-2020
220	SS 220 kV Novobryanskaya	2018-2024
220	SS 220 kV Naytopovichy	2018-2024
110	SS 220 kV Syktyvkar	2018-2024
220/110	SS 220 kV Sortavalskaya	2018-2024
220	SS 220 kV Oka	2017 - 2020
500	SS 500 kV Nizhegorodskaya	2018
500	SS 500 kV Nizhegorodskaya	2019 - 2020

NORMATIVE – TECHNICAL DOCUMENTS

Normative-technical support of application of IEC 61850:

- Industry standard 56947007-25.040.40.226-2016 "General technical requirements for APCS SS UNEG. The main requirements to software and hardware tools and complexes"
- Industry standard 56947007-25.040.40.227-2016 "Typical technical requirements to the functional structure of the automated process control systems of substations of the Unified national electric grid (APCS SS UNEG)"
- Industry standard 56947007-29.200.80.210-2015 “The controllers of grid connection. Typical specifications”
- Industry standard 56947007-29.240.10.028-2009. “Norms of technological designing of substations of alternating current with higher voltage 35-750 kV (NTD SS)”

The development of the 2017-2018:

- Network and communication systems at substations (based on the standards IEC 61850).
- Accurate time synchronization of network protocol for measurement and control systems. IEC 61588 edition 2.0.
- Guidelines for the design of digital substation.
- Technical requirements to hardware and software tools and electrical equipment of digital substation.
- Standard methods of tests of the digital substation components for compliance with the standard IEC 61850 of the first and second edition.
- Guidelines for the operation of digital substation equipment.
- Electronic measuring transformers of current and voltage with digital output according to IEC 61850. Test methods.
- Analog-to-digital interface device. Test methods.
- The electric power meters with digital inputs and digital outputs according to IEC 61850.Test methods and verification.

«Для извлечения максимальной пользы из этой новой технологии менеджерам объектов нужно обучаться и участвовать в разработке соответствующих решений для своих предприятий, а не занимать выжидательную позицию и не перепоручать свои задачи другим».

Special report 2016 SC B3 «Substations»

«However, to fully benefit from this new technology, asset managers need to educate themselves and participate in developing the appropriate solutions for their own utilities and not “sit on the fence” or outsource the challenge to others».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ЕЭС
THANK YOU!
PRODUCTIVE WORK AT THE CONFERENCE!