

**Development and verification of new technologies to reduce auxiliary power consumption for the needs of 220-750 kV substations.**

**T. RYABIN, E. DAVYDOV**

**Research and Development Center of the Federal Grid Company of the Unified Energy System Joint-Stock Company**

**Russia**

**e-mail: [Davydov@ntc-power.ru](mailto:Davydov@ntc-power.ru)**

**A. MOLSKIY, A. YEPIFANOV**

**Federal Grid Company of Unified Energy System PJSC**

**Russia**

**Key words:** energy efficiency, energy efficiency potential, power transformers cooling, heat extraction and recovery, frequency control, optimization of auxiliary power consumption of substations.

**Abstract:**

FGC UES PJSC is the world's largest electric grid company (EGC) managing 933 substations (SS) covering 77 regions of Russia. The presented report, "Energy Efficient Substation", covers the issues of a significant reduction in the consumption of electric power (e.p.) for the own needs, or auxiliary power consumption, of the FGC UES PJSC substations, describes a number of new technologies that allow reducing the auxiliary power consumption, both at existing facilities and newly constructed ones.

Despite the relatively small share of auxiliary power consumption of substations in the process loss structure (4.56% of total electric power losses in 2014), they amount to about 1 billion rubles a year in monetary terms.

The research found that more than 60% of the auxiliary power consumption is the cost of cooling power transformers and heating the buildings of the substations (400 and 180 million kWh per year, respectively). At the same time, about 90% of the power transformers at the substations are equipped with outdated cooling systems (CS) which do not have a smooth regulation of the amount of heat that is removed depending on the load and temperature of the transformer oil, and, therefore, there is a significant over-expenditure of energy for cooling, which leads to the existing energy-saving potential. The conducted studies revealed that the potential for reducing the auxiliary power consumption of substations is from 30 to 50% of current consumption.

The innovative technologies developed by the Joint-Stock Company FGC UES R&D Center and implemented in the period from 2011 to 2016 at the FGC UES PJSC facilities allowed to achieve a significant reduction in auxiliary power consumption for some of the

large load using equipment of substations. For instance, the implementation of a heat recovery system for power transformers at the 500 kV Nizhegorodskaya substation allowed to reduce the consumption of electricity for heating the building with an area of 1,700 m<sup>2</sup> by 77% to 100 thousand kWh per year.

Frequency control of electric motors of the cooling system of auto-type transformers, introduced at the 750 kV Vladimirskaya substation for the first time in the world, allowed to save more than 80% of electric power.

The report describes a number of promising technologies (and their combinations), also tested at the FGC UES PJSC facilities; an assessment of the applicability of the above technologies in new construction is made. The obtained pilot operation results show the reliability and efficiency of the applied technical solutions.

FGC UES R&D Center JSC plans to continue work on the creation of an energy-efficient substation in the future; proposals for correcting the regulatory structure of calculating and estimating the auxiliary power consumption of the substations; areas of focus of further R & D works related to the development of a range of control systems for cooling transformers and of a standard range of energy-efficient substation control building and studies on the optimization of auxiliary power consumption of other load using equipment (lighting, heating equipment, etc.) are presented.

Based on the results of the pilot implementation and elaboration of a number of technologies that have shown their effectiveness, calculations of the cost of activities and the magnitude of the effects received have been conducted and presented, specific steps have been developed for FGC UES PJSC for the next 5 years, which will significantly reduce the cost of auxiliary power consumption at existing facilities as well as during the new construction.