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Flexible distributed control and protection system for industrial objects – Consumers of electric power

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Abstract

Problems of efficient use of electric power and energy saving remain to be outstanding in our country. Implementation of smart systems for accounting and control of energy resources becomes the efficient solution of these problems. The problem of control and forecasting consumption of energy by the facility to cover internal needs represents an independent task. In general, systems are suggested which pertain to the control and accounting of energy resources supplied to the consumer of electric power. Approach to the development of system on the basis of concept of smart grids using dedicated complex of technical and software products allowing optimizing electric power expenditures, re-distributing electric power and promptly adjusting electric power grid characteristics is addressed in the present paper. Electric power supply control and monitoring devices receiving and transferring information to the server are installed in the places of connection of consumers to electric power supply grids. Server collects, accumulates and stores the information and is equipped with dedicated software allowing optimizing the load, preventing overloading and development of emergency situations within the electric power supply system. Such systems are suggested to be implemented by the facilities of nuclear industry.

Keywords: Nuclear power plant; Auxiliary electric power consumption; Power consumption; Distribution; Consumer; Equipment; Control and safety system; Software.

Introduction

Current day development of the national economy necessitates the need to ensure high-quality and reliable energy supply and energy consumption. Domestically manufactured and imported systems using diverse methods of control of electric power supply quality and systems for diagnostics of separate parameters of objects of the energy system are offered on the market. Achieving resolution of the problem of energy saving is further complicated by pronounced ageing of energy equipment, high costs of repairs of such equipment and severe conditions existing on the energy market of the country. According to the data presented in the "Energy strategy of Russia for the period until 2030" [1], not yet realized managerial and technological potential of energy saving reaches up to 40% of the overall volume of internal energy consumption. Efficient use of energy resources implies, first of all, strict control of consumption using advanced accounting systems. One of the directions is the reduction of losses of electric power due to the implementation of smart accounting systems providing the possibility of accounting the quality of electric power supplied and limiting the load.

As an example let us examine nuclear power plant (NPP) [2]. One of the outstanding tasks is to forecast electric power consumption for coverage of internal needs of the NPP for the given period of time. Consumption of electric power to cover auxiliary needs is explained by the large number of consumers of electric power ensuring functioning of NPP equipment and administrative buildings. NPP procures electric power to cover internal consumption from the united electric power supply system based on the forecasted energy consumption. Whether the NPP will consume the whole pre-ordered electric

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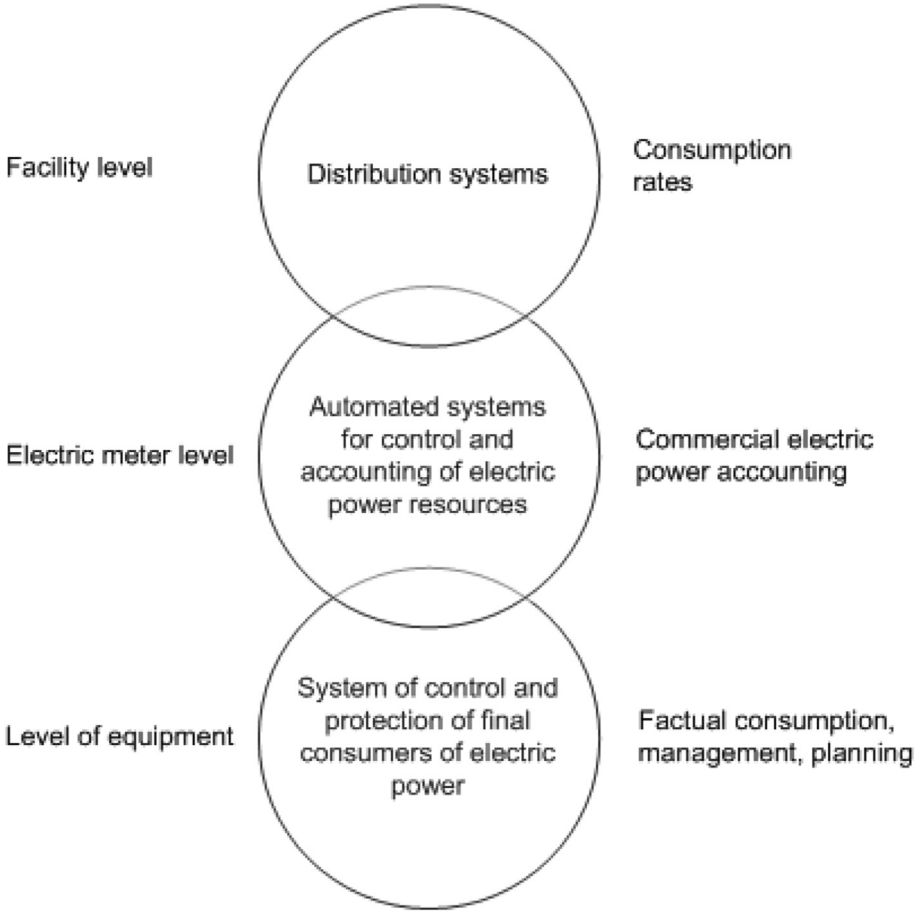

Fig. 1. Role and place of the system for control and safety of final users of electric power.

power or will exceed (or will fall short of) the allocated limits depends on the accuracy of the forecast. In case of inaccurate forecasting and deviation from the allocated limits of electric power supply the NPP will be forced to pay a penalty.

At present no mathematical models have yet been developed allowing evaluating with high enough precision the need in electric power to cover internal consumption for the forecasted period of time. Enhancement of accuracy of forecasting is achievable due to the accumulation of detailed information about each of the consumers of electric power (piece of equipment, workshop and/or subdivision) and generation of database of the consumers. Such systems are built on the basis of the concept of the so-called smart grids. The smart grid technology represents the system optimizing energy expenditures and allowing re-distributing electric power and promptly changing characteristics of the electrical grid. At the level of technological process bundling of electrical grids, consumers and producers of electricity within the united automated system takes place using dedicated complex of technical means.

Role and place of the proposed system

General layout of systems for distribution, accounting and control of electric power is provided in Fig. 1. Electric power distribution systems covering the whole chain from production (generation) of electric power to the final consumer at the level of facility (company) occupy the upper level. The task for this level is to supply high-quality electric power to the facility without disruptions in the supplies, to reduce the probability of theft of electric power. Rates of electric power consumption are developed for the facility at this level. Automated systems for control and accounting of electric power resources (electric power) referring to the distribution of electric power within the facility are attributed to the second level. The task for this level is to automatically collect the data for commercial accounting of electric power at the level of consumer (facility) using installed accounting devices.

The proposed system refers to the third level. The task for the third level is to perform complex assessment of functioning of electric power supply grids at the level of electric power consumer allowing ensuring safe maintenance of cable power lines, electrical equipment, generating recommendations pertaining to the optimization of connection of load, storage and analysis of the data on the consumed electric power for each element of the grids.

Architecture and arrangement of the system

Small innovation enterprise affiliated to the Obninsk Institute for Nuclear Power Engineering of the NRNU MEPhI pursues the developmqnt of flexible distributed system for