OPTIMIZATION OF ELECTRICITY DISTRIBUTION OF THE HYBRID LOCAL ENERGY SYSTEM

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In the process of introducing wind and solar energy, the problem of creating additional regulatory capacities to ensure stable energy supply in periods when energy does not come from renewable sources arises [1, 2].

A local energy system is an effective solution for individual consumers whose connection to remote areas or central power lines is not economically viable or difficult. The variable nature of solar and wind sources can be partially overcome by combining the two sources in an optimal combination. The excessive power of one power source can compensate for the insufficient power of another during a certain period of time, making the system more reliable [3, 4].

The hybrid energy system refers to a distributed generation source caused by the development of renewable energy sources, but its characteristics are the subject of traditional energy research [5, 6]. Taking into account the topology of the distribution network, in which a combined electromagnetic process occurs, characteristic of the mode of operation and consumption, it is defined as a set of consumer electrical equipment consisting of limited low-voltage power, converters and interconnected power. Thus, talking about the technical power system as an object in which the processes of production, transmission and consumption of electricity occur simultaneously in a synchronous mode.

The local electric power system refers to the power supply systems of individual companies or settlements, including complex power sources and electric and heat networks with power distribution of limited length, which have communication lines with central networks and can work both autonomously and together with centralized systems. The configuration of the local electric power system with controlled energy sources is shown in Figure 1.

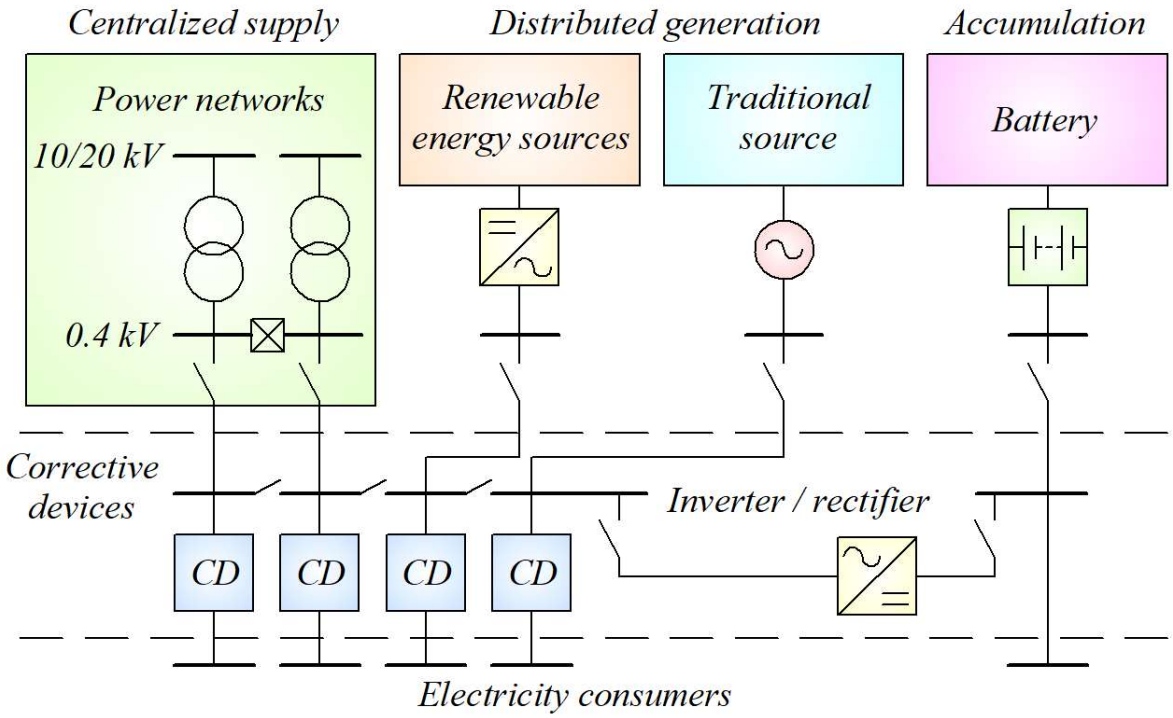

Figure 1 – Configuration of the local power system

A feature of the local power system is the need to optimize the composition and characteristics of generating capacities, the mode of joint operation. Such optimization requires consideration of details of energy consumption, reliability requirements, availability of renewable energy sources and cost indicators. Thus, when working with backup energy sources based on internal combustion engines, the requirement of maximum use of renewable energy sources is added to the reliability assessment to minimize fuel consumption and reduce electricity costs. Here, the criteria for the operation of the energy system are not only reliability indicators that can be achieved during normal electricity production, but also economic and environmental standards.

Optimization criteria based on the most common requirements for hybrid systems based on renewable energy sources have the following formulations:

– the total produced energy is approximately equal to the consumed energy, which means that the mathematical expectation of imbalance is reduced to a minimum;

– the power imbalance should be as small as possible, i.e. the dispersion of the imbalance is reduced to a minimum;

– limitation of the operating mode for the reserve source;

– limitation of excess or lack of energy;

– minimization of the cost of equipment expressed in deterministic values.

The following indicators can be used to assess the impact on the reliability of electricity supply to consumers:

– predicted load loss – the time when the power system load exceeds the current production capacity (h / year);

– predicted energy loss – expected amount of energy lost per year (MW·h / year);

– predicted frequency of load losses – the number of cases when power generation capacity is insufficient (cases / year);

– predicted unused energy for a certain period – excess energy that was not spent or accumulated (MW·h / year).

The value of the balance reliability indicator should be chosen based on the definition of the level of reliability that covers the power consumed by the consumer, and the additional costs of increasing it will be more than compensation for the possible level of losses.

Implementation of a set of measures along with special conditions for connecting renewable energy objects to energy systems can ensure high efficiency and use of a large amount of renewable energy in acceptable conditions and with high efficiency.

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