Chapter 4
Optimization of Sectionalization Parameters of Distributive Electric Networks

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ABSTRACT

The reliability of electrical consumers depends on the presence of sectioning devices in electrical network distribution. Determining the number and installation sites of sectioning machines is an important optimization problem, based on a comparison of the cost of installing devices and reducing the damage to consumers from an undersupply of electricity. A mathematical model is proposed to determine the cost-effectiveness of installing partitioning switching devices for networks with a means of increasing reliability. This allows for the choice when installing switching devices not only meets an economic criterion (in the form of reducing damage to the power supply system as a whole), but also takes into account the change in the duration of downtime of local consumers.

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INTRODUCTION

According to the concepts of optimization (Leshchinskaya, 2003; Ishizaka, & Nemery, 2013; Brown, 2009) and the implementation of measures to improve the operation of the systems providing electric energy to the consumer, the research should be based on a comprehensive study of the object and its characteristic processes, i.e. on a systems approach. The following postulates are the basis of the systems approach: 1) the system should be considered as a whole, and not as a simple set of its components; 2) the optimization goals should be based on clearly defined decision objectives; 3) the optimization model must take into account all the defining properties of the system, which are necessary for drawing up a fairly complete picture of the system behavior.

From the point of view of the system approach, according to the above postulates, it is necessary to decompose the system for providing electrical energy to the consumer into its components in order to carry out optimal planning and management of its further development.

BACKGROUND

The system for providing electrical energy to the consumer consists of the following subsystems: power supply subsystems, representing a set of electrical installations designed to provide consumers with electrical energy (power lines, transformer substations, installed capacities of consumers' electrical installations); locations of electrical installations, which determines the nature of weather conditions and the landscape of the territory; measures aimed at improving the reliability of power supply to consumers. One of the main tasks of the system for providing electrical energy to the consumer is to supply the consumer with the goods in the required volume and of a given quality, which is done by increasing the reliability of the power supply.

A large number of scientific papers (Prakhovnik, Popov, & Nakhodov, 2010; Zorin, Tislenko, Kleppel', & Adler, 1984; Begovic, & Lambert, 2002; Tislenko, 1991; Pruss, & Tislenko, 1989) are devoted to the analysis of the effectiveness of using one or another method of improving reliability. In modern scientific research (Buynyy, Podolnyi, & Zorin, 2004; Javadian, & Massaeli, 2011), it has been shown that one of the most effective methods for increasing the reliability of power supply for an agricultural consumer is network partitioning using circuit breakers, in particular reclosers, with simultaneous organization of localized and selective operation of relay protection.

We will use the methodology of the systems approach to describe the object of study and identify factors that have a significant impact on the efficiency of partitioning.

According to the principle of operation of the distribution network, the following factors will affect the total annual outage: network design, power line length, which, due to its length, causes about 80% of damage to the distribution network 10 kV (Tislenko, Kholmskiy, & Gurbich, 1975); the number of transformer substations (the second object in terms of the number of damage to distribution networks); weather conditions characteristic of a given territory (there are a number of studies (Makoklyuyev, Pavlikov, Vladimirov, & Fefelova, 2003; Vaccaro, Popov, Villacci, & Terzija, 2011) showing the existence of a dependence of the amount and time of damage on weather conditions characteristic of a given territory — temperature, precipitation, humidity, thunderstorm intensity); landscape characteristics that affect the speed of restoration of power supply (Pruss, & Tislenko, 1989) due to the varying degree of