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APPROACH TO THE SELECTION OF DISTRIBUTION NETWORKS DESIGN SOLUTIONS

Slipchenko S.

An important stage in the design of the distribution network is the choice of the most optimal variant of the design solution. Since designing, construction and operation of distribution networks are associated with significant material costs, it is important that the projected network in the future provide the necessary reliability of power supply to consumers. It should be taken into account that the correctness of decisions on the development of energy systems adopted at a certain moment is visible after a sufficiently long period when it is impossible or very difficult to correct the admitted omissions. At the same time, the initial information at the time the decision is to be made, is often not sufficiently reliable. And usually you have to deal with a multi-criteria problem, because an indicator of the effectiveness of decisions is not one but several criteria. Thus, there is an obvious need to apply the mathematical theory of problem solving under conditions of uncertainty and multi-criteria.

The distribution network is a dynamically developing object in time. Its development is determined mainly by two factors: a change in the load of already connected consumers over the years and the need for new consumers to join the network [1]. Specific ways to develop the network can be: the construction of new sections of power lines or additional circuits to existing lines; the introduction of new TSs or an increase in the number of transformers on existing TSs; transfer of power lines to overvoltage; the introduction of new compensating and partitioning devices, etc. At the same time at the given moment the network will be in a certain state, characterizing it by the corresponding scheme, the parameters of the elements (active and reactive resistance, etc.), capacity, the capital expenditures on its development over this period of time. The development of the network can be represented in the form of a connected graph. The choice of the best variant of network development is conveniently made according to the discounted cost criterion in the form:

$$D = \sum_{t=1}^{T} (E\,\Delta C_t + \Delta A_t)(1+E)^{t-t},$$

where T is the estimated period; $\Delta C_t = C_t - C_{t-1}$, $\Delta A_t = A_t - A_{t-1}$ - change of capital costs and annual costs during the transition from stage t-1 to stage t, t - year of cost reduction.

This function is separable, which is a necessary condition for the application of the dynamic programming method [2].

Nondeterministic initial information for networks designing is divided into a stochastic (probabilistic-definite) one, in which random variables are known in the

form of probabilistic characteristics, and uncertain information, in which it is known that some parameters exist, but their deterministic or probabilistic characteristics are unknown and only the domain of their existence can be defined. Stochastic one can include, for example, information on the specific transmission lines' damage, and the uncertain information include possible prospective technical characteristics of the electric network elements. With stochastic information each variant of the network development corresponds not to one value of the optimality criterion but to a set of values. A certain probability of occurrence corresponds to each of these values. In such cases the decision to choose the optimal option is always associated with the risk of obtaining the wrong result on which are guided at decision-making [3].

The alternate way of decisions making, when distribution networks projecting, is to formulate the problem in the form of a multi-criteria, when a number of local criteria, appearing on equal terms with each other, are formulated. A number of requirements are imposed on a set of local criteria in multi-criteria problems. So, the set of criteria must be complete, i.e. reflect all the most important factors. In this case, it must be non-redundant, i.e. which does not contain duplicate estimates of various factors, and also, if possible, minimal to reduce the size of the problem. In addition it should maximally facilitate the adoption of an unambiguous decision. When solving a specific problem, a corresponding set of local criteria must be determined and each local criterion formulated in a form that allows it to be quantified.

Proceeding from the peculiarities of the variety of problems in the design of distribution electrical networks, the following approach is recommended for selecting the most optimal variant of the design solution:

1) Application of such a perspective mathematical method as a method of dynamic programming, considering a distribution network as a dynamically developing object in time.
2) Accounting for the uncertainty of the source information by applying a number of relevant criteria.
3) Application of the multi-criteria approach in the design process, using a group of local criteria of equal importance.

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