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**ANALIZA WYBRANYCH PROBABILISTYCZNYCH
ELEMENTÓW PLANOWANIA ROZWOJU
SIECI PRZESYŁOWEJ**

PRACA DOKTORSKA

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ANALYSIS OF SELECTED PROBABILISTIC COMPONENTS OF TRANSMISSION NETWORK DEVELOPMENT PLANNING

Abstract

The purpose of the dissertation is to propose a new methodological formulation to transmission network development planning process, including probabilistic components, with taking into account calculation methods of the probabilistic power flow, in terms of the possibility of its implementation in domestic conditions. This objective was formulated on the basis of the critical review of transmission system development planning methodologies. The review covered the methodology implemented in Poland, methodologies used in selected European countries and the worldwide, as well as methodologies described in the CIGRE reports, ENTSO-E papers and developed within projects financed by the European Union. The countries covered by the detailed analysis were selected on the basis of criteria indicating the possibility of using probabilistic components in the transmission system development planning process. The above review was also the basis for the thesis creation which indicates that the increase of the non-deterministic conditions of the transmission system development planning process requires the use of complementary probabilistic models. These models are designed to allow to make rational investment decisions. In order to prove such thesis, an analysis and evaluation of the influence of selected conditions on the methodology was made. The analysis and evaluation has been carried out in the context of: the electricity market, the natural environment, power generation technology, power and electricity demand, the network infrastructure availability (including Monte Carlo and LHS simulation methods), methods of power flow calculation, as well as in context of making investment decision and software supporting the analytical process. In the range of power flow calculation methods, classic-deterministic methods were briefly characterized, while more broadly probabilistic methods were presented and evaluated, by means of simulation, analytical and approximation methods. In addition, a two-point estimation method (from the group of approximation methods) was proposed to include emergency transmission system states, single or multiple branch outage. Conducted analyzes of the conditions together with their evaluation allowed for a new methodological formulation of the transmission system development planning process in Poland, featuring non-deterministic elements. In this regard, a general model of the process was formulated, solutions and implementation procedures indicated, and software tool support issues were analyzed.

A computational example of the transmission system development planning process was carried out on a test network model of 39 nodes and 50 branches. In the planning process, the deterministic method was used and two probabilistic methods: simulation and approximation. In the simulation method random states of the network were determined using the LHS method, whilst the two-point estimation method takes into account the modification proposed for the emergency network states. In the summary, a comparison of the deterministic and probabilistic methods was made, implementation possibilities of the proposed approach were indicated with reference to the simulation methods of power flow calculation, and an area of the potential further research study was formulated.