# On the use of methods for predicting the operating conditions of low-voltage networks with distributed generation in the face of the development of the prosumer energy sector


## Abstract

The growing number of distributed energy resources connected to power networks is the cause of significant changes currently observed in the way grids operate. These changes also affect low-voltage (LV) networks, where distributed generation occurs almost exclusively in the form of photovoltaic (PV) prosumer installations. Although the pace of development of prosumer energy sector in Poland has been impressive for several years, it is already known that the hosting capacity of national grids is running out, and the main barrier to further development of PV microinstallations is the phenomenon of excessive voltage increase. This dissertation describes the problem of preventing overvoltages, comparing selected voltage reduction strategies in simulation studies and proposing an original method based on the use of artificial neural networks.

The first part of the dissertation describes the process of development of distributed generation and the prosumer energy sector, presenting the most important legal acts, basic concepts, figures and forecasts. The theoretical basis of the phenomenon of voltage increase and the literature review of methods and strategies for voltage control in the LV network are presented.

In the further part of the dissertation, simulation models made in *PowerFactory* for various methods of voltage reduction in the network with a large share of PV sources were presented. These methods include modernization of grid infrastructure, the use of overvoltage relays, reactive and active power control modes in inverters of PV installations and the use of a transformer with an on-load tap changer (OLTC). The author's implementation was proposed as the last method. It uses the OLTC current compensation function, the settings of which are the result of artificial neural network algorithms. All methods were compared by performing simulations for the test LV network, with three scenarios differing in the level of PV penetration. The obtained results showed high efficiency of the proposed method and the best results in relation to other tested methods for the majority of selected comparison criteria. In addition, practical aspects were indicated – e.g. simplicity of implementation and the ability to use easily available data to train the neural network.



**Keywords:** distributed generation, prosumer energy, voltage increase, artificial neural networks