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Influence of the type of receivers on electricity losses in power grids

Summary. *This article will discuss the impact of the type of electricity receivers on the operation of the power grid, with particular emphasis on the issue of electricity losses. To determine the impact of receivers, simulation studies were performed based on the mathematical model of the low-voltage power network developed by the authors using the electric multi-pole method and the Newton method.*

Keywords: electricity losses, constant impedance load, constant power load, mathematical modelling, low voltage power grid, distributed generation

Introduction

The problem of electricity losses in power grids has existed since the beginning of electricity and results from physical phenomena occurring in devices and elements that make up the power system. There are two basic types of receivers: constant impedance and constant power. Currently, energy losses are also significantly influenced by the increase in the share of electricity production from renewable energy sources and the location of generation units in the grid. In the era of energy transformation, research was undertaken to examine the impact of the type of electricity receivers on electricity losses in the power grid at the voltages supplying these receivers.

Materials and methods

The research focused on a simulation experiment. For this purpose, simulation models of low-voltage power grid fragments with constant impedance, constant power, as well as mixed receivers for different values of supply voltages were developed. The models were developed using the electric multi-pole method and Newton's method. In the first experiment, determining energy losses in low-voltage lines depending on the type of receiver and supply voltage, a fragment of a low-voltage power network supplying one household was taken into account. Then, a mathematical model of a fragment of a low-voltage power grid in a rural area was developed. It was used to determine energy losses in transmission lines for various types of receivers and supply voltage. An analysis of energy losses was also carried out, taking into account distributed generation (prosumer photovoltaic installations) connected to such a grid. The analysis of the results allowed to propose a solution to the voltage problems and the lack of impact of connecting the PV installation on energy losses in low voltage lines.

Conclusions

From the analysis of the obtained results, it can be seen that

- depending on the type of receiver connected to the low-voltage power grid and depending on the supply voltage, one may cause an increase in energy losses in the lines or this impact may be negligible
- placing the distributed generation units in the depth of the grid has an impact on electricity losses, because if the power generation from photovoltaic installations is higher than the temporary local needs, part of the power is returned to the grid (change of power transmission direction), which causes an increase in voltage, an increase in the current flowing through the lines, and this causes a significant increase in active and reactive power losses in the lines, and consequently also electricity losses.
- energy losses in low voltage transmission lines can be reduced by placing distributed generation units at MV/LV transformer stations. This can be achieved because the energy produced by the source is sent via lines to consumers and the surplus energy is transformed into the medium voltage grid. In addition, the proposed location of the sources improves the operation of the power system by maintaining the voltage values in the range of the PN-EN 50160 standard on the entire supplied section.

Literature

1. Cieślik, S. Analiza symulacyjna strat mocy czynnej w elektroenergetycznej sieci niskiego napięcia z mikroinstalacjami z podobciążeniową regulacją napięcia, Poznań University of Technology Academic Journals. Electrical Engineering, 2015, 82: 101-111.
2. Mazur, Ł.; Kłosowski, Z. A New Approach to the Use of Energy from Renewable Sources in Low-Voltage Power Distribution Networks. Energies 2023, 16, 727. https://doi.org/10.3390/en16020727

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