Forecasting and Modelling the Uncertainty of Low Voltage Network Demand and the Effect of Renewable Energy Sources

More and more households are using renewable energy sources, and this will continue as the world moves towards a clean energy future and new patterns in demands for electricity. This creates significant novel challenges for Distribution Network Operators (DNOs) such as volatile net demand behavior and predicting Low Voltage (LV) demand. There is a lack of understanding of modern LV networks' demand and renewable energy sources behavior. This article starts with an investigation into the unique characteristics of householder demand behavior in Jordan, connected to Photovoltaics (PV) systems. Previous studies have focused mostly on forecasting LV level demand without considering renewable energy sources, disaggregation demand and the weather conditions at the LV level. In this study, we provide detailed LV demand analysis and a variety of forecasting methods in terms of a probabilistic, new optimization learning algorithm called the Golden Ratio Optimization Method (GROM) for an Artificial Neural Network (ANN) model for rolling and point forecasting. Short-term forecasting models have been designed and developed to generate future scenarios for different disaggregation demand levels from households, small cities, net demands and PV system output. The results show that the volatile behavior of LV networks connected to the PV system creates substantial forecasting challenges. The mean absolute percentage error (MAPE) for the ANN-GROM model improved by 41.2% for household demand forecast compared to the traditional ANN model.

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