Thesis Proposal Master Energy

Academic year 2023-2024 **Nr.:**

Title NL: Evaluatie van de EV-FV-onthaalcapaciteit via spatiaal-temporeel machinaal leren

Title EN: Spatial-Temporal Machine Learning Approach to Evaluate the Combined EV-PV Hosting Capacity

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Description:

Introduction: Nowadays, the power distribution system is experiencing a transformation as it adapts to accommodate many photovoltaics (PVs) and electric vehicles (EVs) into the grid. Although they are becoming popular due to their clean and sustainable nature, they pose new challenges, such as voltage violations and equipment overloading to system operators, that compromise system security. Therefore, the hosting capacity (HC) of combined EV-PV has been a topic of significant interest in recent years. The HC of combined EV-PV in the distribution system refers to the maximum amount of EVs and PVs that can be integrated into the low-voltage grid without exceeding the system security indices.

Literature: The current HC analysis methods are classified into three main categories: deterministic (worst-case), stochastic, and time series [1]. Unlike time series approaches, deterministic and stochastic methods consider specific scenario(s) to evaluate the HC. In contrast, time series methods consider the relation between the system variables over time by exploiting time-dependent power flow algorithms such as quasi-static time series (QSTS) [2]. Moreover, some articles emphasize the spatial effects of EV-PV placement on evaluating the HC of low-voltage distribution systems. However, these approaches suffer from computational burden since they are established based on different power flow algorithms. Additionally, finding a unified evaluation of PVs and EVs HC, especially in residential distribution systems, can be very complex due to their different effects on the grid. Nevertheless, there is a bright correlation between them in order to calculate the combined HC.

Research Question: The use of smart meters has the potential to revolutionize the distribution system by enabling real-time monitoring of system variables and providing a large amount of data to system operators. This abundance of data can be used to overcome the shortcomings of current HC analysis methods by investigating data-driven approaches that can map power flow data to the combined hosting capacity of EVs and PVs. By leveraging historical data, it is possible to estimate the combined hosting capacity without having to calculate power flow [3]. The proposed machine learning approach should consider the spatial-temporal effects of EV-PV and capture the correlation between them in determining the combined hosting capacity. A strong background in machine learning, particularly deep learning, and distribution power system analysis is necessary for this research.

References

[1] Qamar, N, Arshad, A, Mahmoud, K, Lehtonen, M. Hosting capacity in distribution grids: a review of definitions, performance indices, determination methodologies, and enhancement techniques. *Energy Sci Eng. 2023*; 1- 24. doi:10.1002/ese3.1389

[2] M. J. Reno, J. Deboever and B. Mather, "Motivation and requirements for quasi-static time series (QSTS) for distribution system analysis," *2017 IEEE Power & Energy Society General Meeting*, Chicago, IL, USA, 2017, pp. 1-5, doi: 10.1109/PESGM.2017.8274703.

[3] J. Wu, J. Yuan, Y. Weng and R. Ayyanar, "Spatial-Temporal Deep Learning for Hosting Capacity Analysis in Distribution Grids," in *IEEE Transactions on Smart Grid*, vol. 14, no. 1, pp. 354-364, Jan. 2023, doi: 10.1109/TSG.2022.3196943.

Number of students: 1☒ 2☐ 1 or 2☐

This Master Thesis is suitable for EIT-KIC student: *yes/no (EIT-KIC Master Thesis represents 30 ECTS (compared to 24 ECTS for Master Energie/Energy), so some extra business/entrepreneurship aspects may be added for EIT-KIC)*

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