https://doi.org/10.7250/CONECT.2025.030

MODELLING AND EVALUATION OF PHOTOVOLTAIC SYSTEMS COMBINED WITH CHARGING STATIONS FOR ELECTRIC VEHICLES

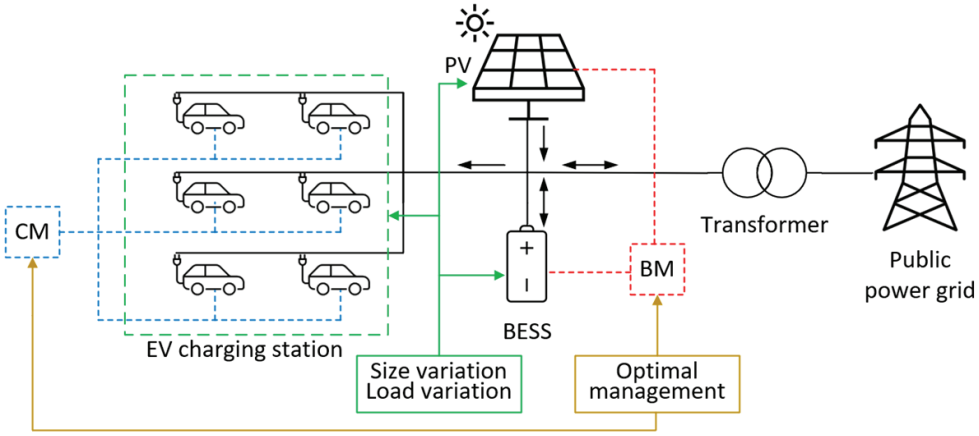
Gerald STEINMAURER[1], Christian WAGNER[2*]

[1,2] *University of Applied Sciences Upper Austria, Research group ASIC, Stelzhamerstraße 23, Wels, Austria*

[*] ***Corresponding author.*** Email address: *christian.wagner@fh-wels.at*

Abstract – The expansion of charging infrastructure for electric vehicles (EV) in Europe is progressing steadily. However, available charging capacities are rapidly approaching their limits, particularly at highly frequented public charging points, such as those along highways. One reason for this limitation is the restriction in electrical grid capacity. A solution to this problem could be the combination of large ground-mounted photovoltaic (PV) systems and public EV charging stations. The onsite usage of the energy provided by the PV system, offers a substantial advantage, as it leads to a significant reduction in the load on the electrical grid. In order to ensure sufficient power, even during periods of darkness or bad weather, the integration of battery energy storage systems (BESS) may be an additional option. This approach not only effectively mitigates the risk of overloading the electrical grid and ensures the reliability of energy supply, it also supports demand-oriented, decentral and flexible renewable integration. The present work therefore analyses the interaction of PV-BESS systems and EV charging stations and their impact on the power grid. The study is conducted using a mathematical model in MATLAB Simulink®. The model includes a ground-mounted PV system, a BESS including battery management (BM), EV charging stations and a transformer connected to the public power grid, see Figure. The EV charging stations are additionally equipped with a variety of controls, for instance, charging management (CM) can be executed in static, dynamic or sequential modes. The function of the CM is based on the economic model predictive controller (eMPC). By varying the individual components, such as the connected load of the ground-mounted PV system, the storage capacity of the external BESS and different charging profiles of EVs, questions regarding the optimum BESS size, BESS operation or optimum CM can be answered. Based on the simulation results, statements concerning the effects on the public power grid can be made. The influence of the PV-system, the BESS and the EV charging station on the quality parameters of the public power grid, including electrical voltage and frequency, can thus be investigated.

Keywords – Battery energy storage system (BESS); Battery Management (BM); Charging Management (CM); parameter study; power grid



Schematic model structure and components considered

ACKNOWLEDGEMENT

This work has been supported by the government of Upper Austria in the projects "COMPESTO – comprehensive energy storage", Research Grant Wi-2022-600132/7-Au and "Restore – Investigation of different energy storage technologies on the resilience of sector-coupled energy systems"