Stationary Battery Design and Control for Renewable Integration in Local Energy Communities

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Local Energy Communities are coming up as new energy frameworks to push forward the transition towards a renewables-based energy system [1]. Indeed, local management of the matching between energy demand and production is key to deal with the technical and economic issues due to the high volatility of renewable energy sources. Further criticalities are rising for the increasing penetration of electric vehicles -EVs [2,3].

In this study we discuss on the mutual influence between the definition of load control strategy and optimal design when sizing a PV-powered Electric Vehicle charging station with a stationary battery energy storage system. In such a way EVs and the stationary system are flexibility sources, through the management of the charging process.

A bi-level optimization approach has been adopted. In particular, Genetic Algorithm has been used to optimally define the number of slow and medium charge type columns to be installed, while a MILP algorithm to obtain the optimal weekly control of the charging station. Typical PV and base load power profiles for a representative year have been defined performing a clustering analysis of historical database of the electricity load and solar irradiance. Uncertainties have been taken into account in the calculation of the daily expected energy demand at the Electric Vehicle charging station carrying out a statistical analysis.

Results demonstrate that reduction on grid power standard deviation and mean squared error with respect to the mean grid power value linearly increase with battery capacity, but with a higher slope in case of the optimal EV charging process. This result gives an insight into the potential benefits deriving from the interaction between stationary and mobile storages in peak shaving and valley filling grid services. The impact of thermal effects will also be discussed, with a particular insight on the role of new solutions and their impact on the energy efficiency of EVs.

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