Optimal Management of Network Integrated EV Batteries by Individual EV Usage Forecasts: Vehicle to Home and Vehicle to Grid Case Studies

Summary

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The growing attention in sustainability and environmental problems is driven by deep changes in entire sectors. Among others, the transport and the power sectors will assist to the greater transformation in the next years. As a result, recent lines of research are studying the use of Electric Vehicles (EVs) as sources of grid flexibility as well as their effects on the energy balance of users equipped with charging station and Photovoltaic (PV) generators.

This dissertation presents a novel approach to exploit and control the EV batteries of network integrated vehicles using individual EV forecasts. The approach is based on a bilevel programming where the real-time management is integrated by a preliminary optimization phase. On the other hand, the EV forecasts rely on statistical elaborations of real EVs usages historical data. Moreover, the proposed approach has been declined in two different case studies with different purposes.

The first case study regards the integration of an EV in a PV powered household, thus aims to maximize the obtainable PV self-consumption and self-sufficiency. The second case study considers an entire fleet of 214 EVs connected into the power system and able to supply grid services such as Replacement Reserve and Secondary Regulation. The objective of this latest case is to maximize the economic benefit achievable from the bidirectional power exchanges of the EVs fleet from and toward the grid. In both case studies, the results are presented in comparison with specific logics assumed as reference in order to evaluate the effectiveness of the proposed methodology.