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Best-case-aware planning of photovoltaic-battery systems for multi-mode charging stations

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Abstract-

The proliferation of charging stations entails multiple challenges for power systems. In this regard, the installation of photovoltaic-battery systems may help to mitigate the negative effects of charging points. However, such assets should be carefully planned, paying attention to economic aspects, principally. Most of existing works optimize the photovoltaic-battery system in charging infrastructures taking a representative-space of the involved variables (e.g. photovoltaic potential, charging demand or energy prices). However, this approach tends to ignore low-probable scenarios. Thus, the best-case scenario for charging demand (i.e. that for which the highest charging profit is accessible) may not be included in the analysis and therefore such demand could be not attended properly, thus losing this monetary opportunity. This paper focuses on this issue and questions if considering the best-case scenario into planning photovoltaic-battery systems for charging stations is worthwhile or not. To this end, a novel best-case-aware planning tool is developed, including the best-case scenario through a novel chance-constrained formulation. The overall problem is then decomposed into a master-slave structure by which the economy of the system is optimized together with the number of scenarios for which the best-case profile can be attended. A case study serves to validate the developed tool and shed light on the questions arisen in this work. In particular, it is checked that considering the best-case scenario into planning tools is questionable from a monetary point of view. Nevertheless, its inclusion unlocks some collateral advantages such as incrementing the users’ satisfaction or reducing the grid-dependency.

Index Terms- Battery energy storage; Chance-constrained programming; Electric vehicle; Photovoltaic energy; Renewable energy

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