

Optimal planning and operation of energy community DERs considering local energy trading and uncertainties

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Abstract-

Local energy trading between customers in energy communities (ECs) received significant interest from academia and industry as a promising approach for managing a large number of distributed energy resources (DERs) and empowering end users to take an active role in energy systems. Most of the existing literature focuses on the operation of ECs, often with an implicit assumption about the capacities (i.e., ratings) and penetration levels of the DERs. However, there is a noticeable lack of emphasis on optimizing the planning and integration of DERs within these ECs. Considering the high cost of DERs, there is a need to optimally size DERs of ECs' participants that maximize the benefits, minimize the expenses of DER owners, and reduce the payback period. In this paper, a linear programming model is proposed for the optimal planning and operation of DERs installed in a residential EC in Spain, which includes photovoltaic (PV), battery energy storage (BES), and electric vehicles (EV). The objective is to minimize the EC's total annual costs, including investment, maintenance and operation (O&M), and operation costs (i.e., energy and contracted power costs). Furthermore, the proposed approach considers load demand, PV generation, electricity prices, and EVs arrival and departure uncertainties. The simulation results demonstrate that optimal planning reduces the annual costs by 10.95 % compared to the scenario without optimal PV and BES planning. Sensitivity analysis shows that, by decreasing the investment costs of BES by 30 %, increasing the electricity prices by 40 %, or decreasing the electricity selling price by 40 %, it could be feasible to install BES at part of the EC houses. There are no violations of the distribution network limits in all studied scenarios.

Index Terms- Local electricity market; Peer-to-peer energy trading; Energy community; Transactive energy; Optimal planning; Optimal sizing

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