Bidirectional Charging Impact Analysis of Electric Vehicle Battery Cycle Aging Evaluation in Real World, Under Electric Utility Grid Operation

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Abstract : This scientific article examines the integration of electric vehicles (EVs) into electricity grids using Vehicle-to-Grid (V2G) technology. The study compares the economic implications of two EV charging approaches: firm EV charging and managed EV charging. Interestingly, the research finds that the firm EV load is associated with a higher Net Present Cost (NPC) compared to the managed charging load, highlighting the economic benefits of the latter approach. The facility being studied consumes 26,498 kWh of electricity daily and has a peak demand of 2,022 kW. To meet its electricity needs, the proposed system incorporates several generation sources, notably a Canadian Solar PV system with a nominal capacity of 4,000 kW and a Tesla storage system with a nominal capacity of 10,079 kWh. These sources produce an annual total of 6,918,968 kWh. Additionally, the study evaluates two tariff plans, with a focus on the 'EV' tariff. The analysis reveals that adopting the 'EV' tariff can result in significant cost savings for the hospital. However, it emphasizes that the hospital must individually meter its EV charging station to qualify for this advantageous tariff. Furthermore, the research addresses the issue of EV battery degradation, particularly concerning its implications for V2G technology integration. Despite widespread concerns, empirical evidence in various grid service contexts is limited. To address this gap, the paper introduces a comprehensive method to quantify EV battery degradation. A unique aspect of this approach is its multiyear perspective, enabling a robust comparison of scenarios involving driving alone and those incorporating multiple vehicle-grid services. This innovative methodology provides valuable insights into the complex relationship between EV battery degradation and the evolving energy landscape.

Keywords : Firm EV, Managed EV, Tesla storage, Multi-year planning, degradation, PV