294

Aligning consumer storage incentives with distribution grid reinforcement deferral: a case study in northern California

Sammit Vartak[1], Eli Brock[2], Duncan Callaway[3,4], Russell McKenna[1,5]

[1]Chair of Energy Systems Analysis, ETH Zurich, Zurich, Switzerland. [2]Laboratory for Control, Optimization, and Power, University of California, Berkeley, Berkeley, United States. [3]Energy and Resources Group, University of California, Berkeley, Berkeley, United States. [4]Electrical Engineering and Computer Sciences, University of California, Berkeley, Berkeley, United States. [5]Laboratory for Energy Systems Analysis, Paul Scherrer Institute, Villigen, Switzerland

Extended Abstract

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Abstract Summary

The electrification of residential heating and electric vehicles is projected to increase peak demand on electricity distribution networks, requiring costly feeder and transformer reinforcements due to limited load integration capacity. Battery energy storage is identified as a non-wire alternative that can reduce peak demand at constrained grid locations and defer or partially substitute conventional grid reinforcement. At the same time, consumer response to retail tariff signals can also help reduce network stress. This study investigates alternative tariff structures to incentivise consumer battery storage deployment in locations and capacities that are most valuable for utility reinforcement deferral under a projected electrification-driven load-growth scenario. A feeder-level mixed-integer linear programming model is developed to minimise the annualised system cost of supplying projected load in 2050 in a portion of the Pacific Gas and Electric distribution area, while accounting for load integration capacity limits. From the utility perspective, the analysis determines the least-cost combination of reinforcement and storage, whereas from the consumer perspective, it evaluates storage deployment under time-of-use and grid-integration capacity-based tariffs. Results show that about 80% of the analysed feeders require reinforcement, with battery storage able to defer reinforcement for 5% of feeders and partially substitute reinforcement for 70% of feeders. From the consumer perspective, the existing tariff schemes do not lead to storage adoption, while a larger peak-to-off-peak price spread under a capacity-based tariff yields 2.5 times more storage deployment than a time-of-use tariff and improves alignment on about half of the feeders requiring reinforcement. These findings show that alternative tariff structures can improve, but do not fully align, consumer battery storage adoption with utility reinforcement-deferral

needs, indicating that further analysis is required to identify appropriate tariff signals and the feeder characteristics associated with better alignment.

Presenting Author Biography

Sammit Vartak is a doctoral student at the Chair of Energy Systems Analysis, ETH Zurich. His research focuses on decentralised energy systems and modelling of electricity distribution grids. He holds a master's degree in Electrical Power Engineering from RWTH Aachen University in Germany and a bachelor's degree in Electrical Engineering from the University of Pune in India. He has previously worked in renewable energy consulting.