Distribution Feeder Microgrids

OVERVIEW

To meet energy and environmental goals and challenging reliability and resiliency targets, the electric grid is transitioning from solely central generation to the inclusion of distributed energy resources (DERs). With a high penetration of DERs on primary circuits (feeders), utility substation communication, automation, and control must adopt to this new paradigm. In principle, utility substations can transition to and operate the feeder circuits in an islanded mode, effectively as Distribution Feeder Microgrids. This creates the need for research to address the challenges associated with integrating and managing significant deployment of DERs on circuits served by distribution substations. In response, this study addresses substation control to manage circuits emanating from utility substations as a microgrid. To this end, a model for substation automatic control using a Generic Microgrid Controller compliant with the IEEE 2030.7 standard was developed, and the role and impact of substation control to improve energy management, increase renewable penetration, and reduce greenhouse gas emissions were evaluated.

GOALS

- Develop a model for substation control
- Evaluate the role and impact of automation at utility substations with increased PV and energy storage
- Determine emission reduction and reliability improvements

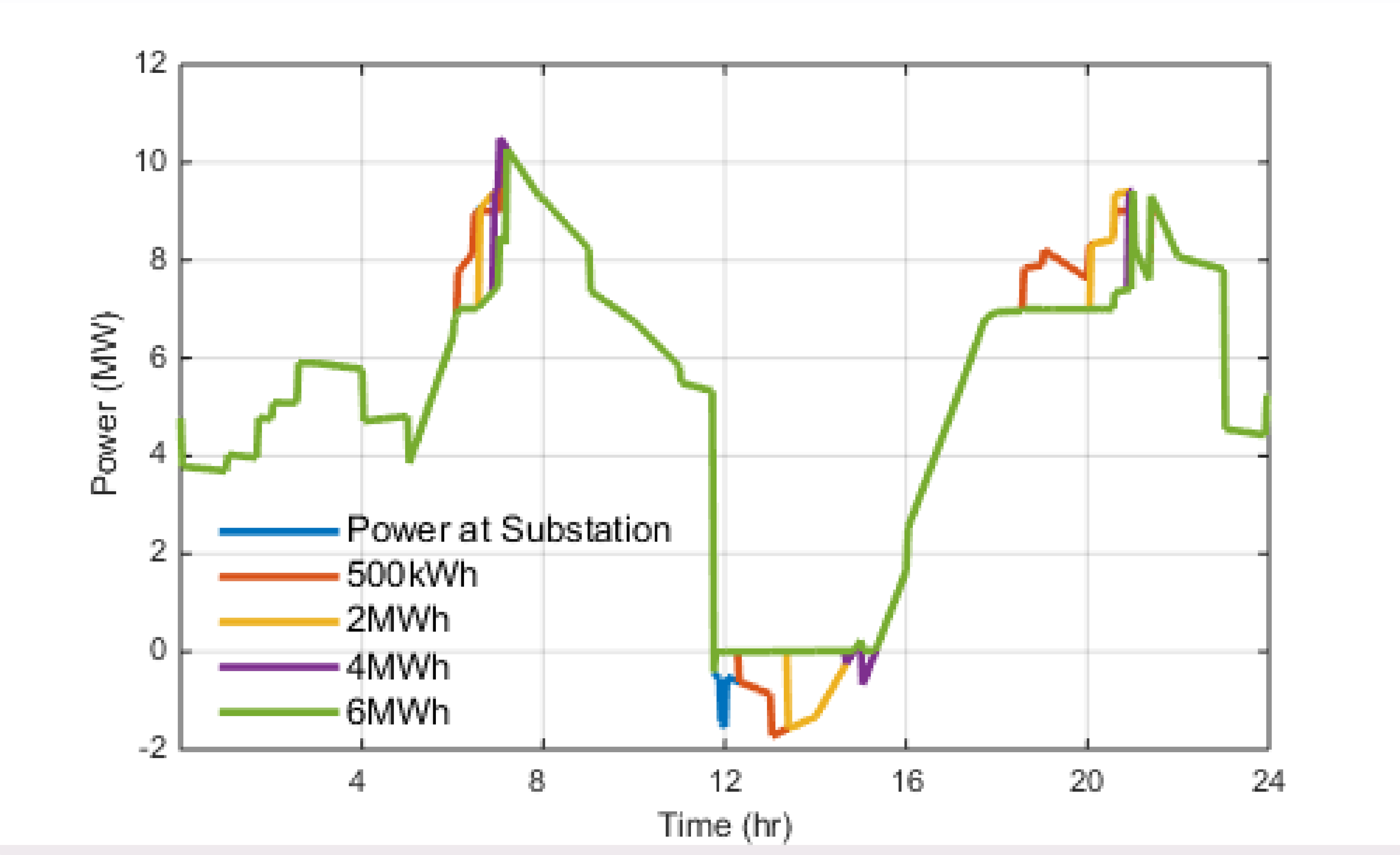
RESULTS

With increased penetration of DERs, especially distributed generation and smart grid technologies enabling communication, control, and automation, distribution feeders have the potential to become microgrids. The study results show that treating these circuits as a feeder microgrid and thus control them as a single entity through a controller, improves operation efficiency, benefits the customers, and provides benefits to the grid such as reduced GHG emissions and deferred investment in transmission and distribution infrastructure.

Deploying a large battery at the distribution substation helps alleviate the duck curve and can prevent PV curtailment. This case, among cases studied, resulted in no-export to the larger grid. This prevents PV curtailment if the feeder microgrid has a non-export agreement with the larger grid. Second, the ability of the battery to preclude export during high-PV generation intervals helps mitigate the duck curve.

Community Energy Storage (CES) is a more economic approach than residential storage for achieving high PV penetration and GHG reduction.

RESU (Residential Energy Storage unit) and CES cases assessed in this study, did not result in significant difference in terms of net demand profiles nor PV penetration (37.5% and 35.4% respectively).

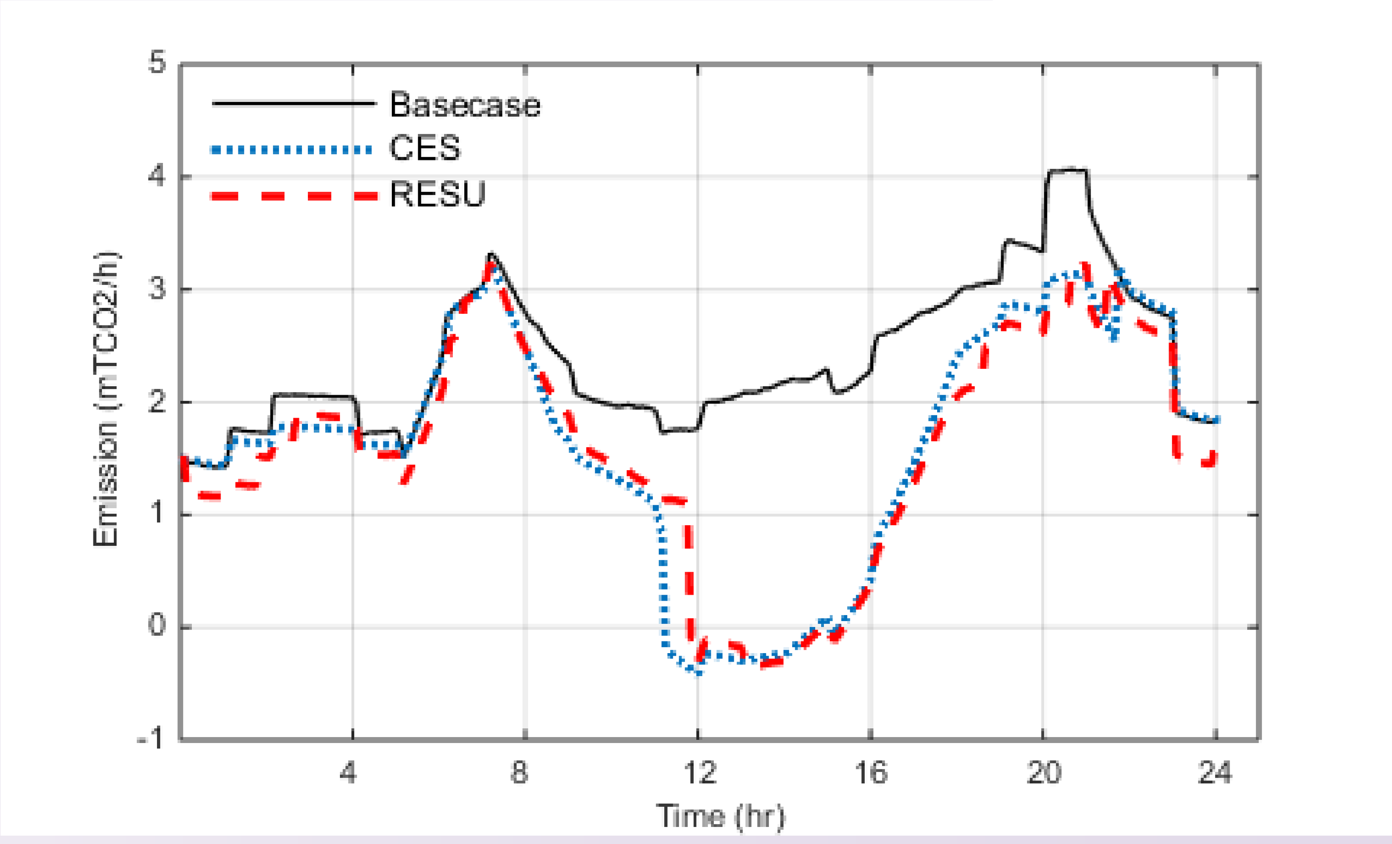


Circuit Battery Impact on Substation – 2MW Battery

RESULTS (continued)

However, using CES units, an increase in PV penetration was achieved with less battery energy storage deployed both in terms of power and energy capacity, representing a more economic approach. RESU cases result in 355 $mTCO_{2eq}$ reduction per MWh of installed energy storage, while the CES cases result in 660 $mTCO_{2eq}$ reduction per MWh of installed energy storage demonstrating that CES approach is a superior approach in terms of GHG reduction (and cost).

This is mainly due to the fact that RESUs are located behind the meter and owned by the customers, and thus operated primarily to benefit the customer rather than the grid.



24-Hours Emissions Profile

RECENT PUBLICATIONS/PAPERS

J.J. Lee, J. Bérard, G. Razeghi, S. Samuelsen(2019). Maximizing PV Hosting Capacity of Distribution Feeder Microgrid. Applied Energy. (Under Review)

G. Razeghi, J.J. Lee, S. Samuelsen (2019). Station Automation and Optimization of Distribution Circuit Operations. Final Report to CEC

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