Assessing the Peak Shaving Ability of Energy Storage across the United States

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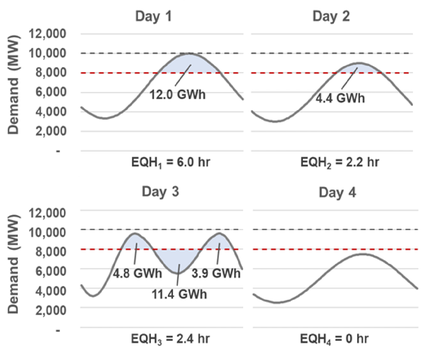
Introduction

- Lithium-ion batteries have rapidly declining costs and are increasingly considered for peak shaving.
- To effectively meet resource adequacy needs, system operators and planners must properly consider variable generators, such as solar photovoltaics and wind, along with energy-limited resources (e.g., storage).
- We present a streamlined calculation to determine the required "equivalent hours of energy storage" at the balancing authority level.
- Our approach quantifies the energy storage durations required to meet peak demand, subject to regional load profiles and renewable generation patterns.

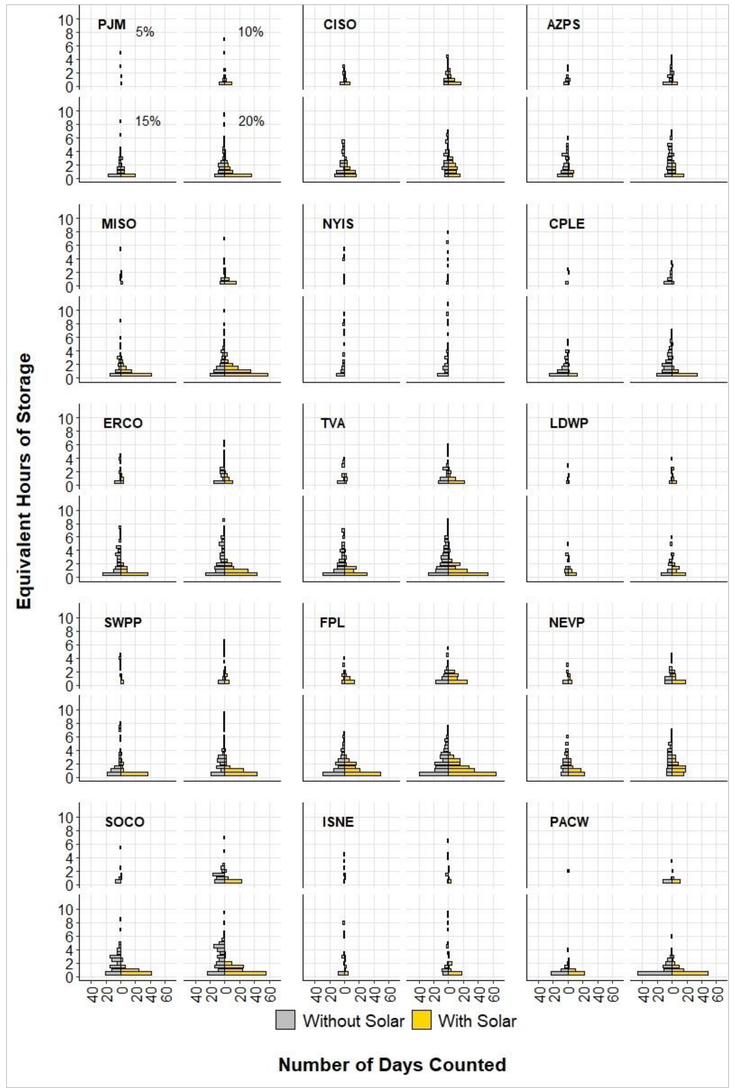
Methods

- The objective is to determine the duration of energy storage necessary to meet peak load across a range of load shapes and levels of peak reduction (5% - 20%).
- Data: Four years (2016-19) of screened and imputed hourly demand data from Ruggles et al. (2020) and one year (2019) of concurrent solar and wind generation data from EIA 930 database.
- We develop a computationally efficient method to capture the potential of energy storage through mixed-integer linear programming.
- We define "equivalent hours of storage" as the duration needed for resource adequacy at the balancing authority level.
- We examine a base case and increasing penetrations of solar and wind generation.

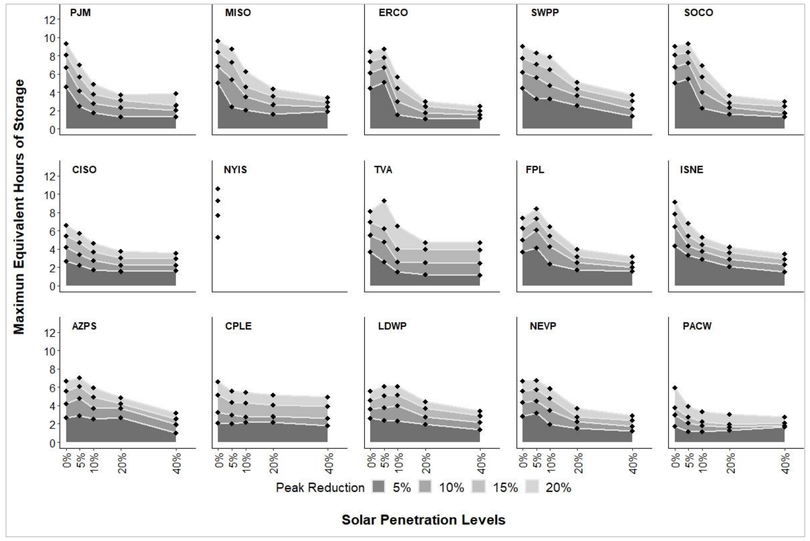


Results and Conclusions

Deeper peak reduction requires larger energy storage duration.

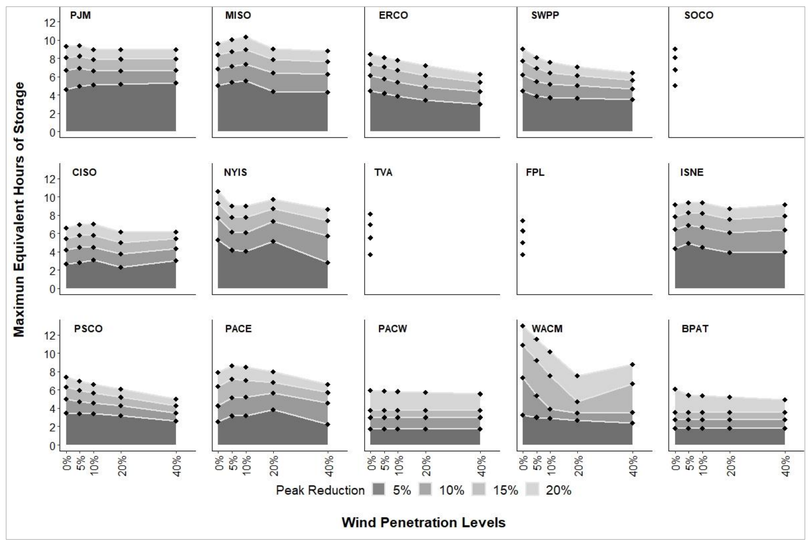


Deploying 4-6 hours of storage is sufficient for peak shaving up to 5% of the annual peak.



In most cases, solar generation narrows net peak loads, reducing the equivalent hours of storage needed to meet peak.

Higher penetrations of solar yield diminishing returns in narrowing the net peak loads.



Wind generation yields less of peak shaving benefit than solar, as wind is generally less correlated with peak demand.

- Ruggles, T. H., Farnham, D. J., Tong, D., & Caldeira, K. (2020). Developing reliable hourly electricity demand data through screening and imputation. *Scientific Data*, 7(1), 155. https://doi.org/10.1038/s41597-020-0483-x
- EIA. *Hourly Electric Grid Monitor*. https://www.eia.gov/beta/electricity/gridmonitor/dashboard/electric_overview/US48/US48