Business & Technology Advisory
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Summary of Lawrence Berkeley National Laboratory Report:

Evaluating the Capabilities of Behind-the-Meter Solar-plus-Storage for Providing Backup Power During Long-Duration Power Interruptions

Highlights

- Extreme weather events are becoming more common and destructive, affecting the reliability of the power grid.
- This report summarizes a Lawrence Berkeley National Laboratory (LBNL) study which estimated the performance of behind-the-meter (BTM) solar PV-plus-energy-storage-systems (PVESS) in providing critical-load or whole-building backup across a wide range of geographies, building types, and power interruption conditions.
- Results for single-family detached homes show that if heating and cooling loads are excluded from backup, a small PVESS with just 10 kWh of storage can fully meet basic backup power needs over a 3-day outage in virtually all U.S. counties and in any month of the year.
- Results for commercial buildings show that roof area constraints on PV system sizing are a major determinant to PVESS backup performance and can vary considerably based on building type (based partly on the number of stories). Also, providing full-building backup for a multi-day outage would require significantly larger systems than what is typically observed in the market today.

Background

In 2021, there were 20 weather/climate disaster events with losses totaling $145 billion in the United States. Winter Storm Uri, which brought record cold temperatures across the lower 48, was a major driver behind these costs. The storm caused power grids to fail across the U.S., most notably in Texas, where 5.2 million homes and businesses lost power. So far, in 2022, there have been 15 events with losses exceeding $1 billion each, resulting in the deaths of 342 people and significant economic effects on the impacted areas[1].

With increasing extreme weather events, it has become imperative to understand the backup power capabilities of BTM PVESS across a broad range of conditions and contexts. In September 2022, the U.S. Department of Energy's Lawrence Berkeley National Laboratory released a report entitled *Evaluating the*

[1] NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2022). https://www.ncei.noaa.gov/access/billions/, DOI: 10.25921/stkw-7w73

Capabilities of Behind-the-Meter Solar-plus-Storage for Providing Backup Power during Long-Duration Power Interruptions[2] which looks at this topic. This advisory offers a summary of that report.

Overview

The study estimates the performance of behind-the-meter solar PV-plus-energy-storage-systems (PVESS) in providing critical-load or whole-building backup across a wide range of geographies, building types, and power interruption conditions. The study also considers a set of 10 historical long-duration power outage events and evaluates how PVESS could have performed in providing backup power during those specific events. The goal was to establish a baseline set of performance estimates and identify key performance drivers.

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Data & Methods

The authors used data from NREL's ResStock and ComStock models to generate building end-use load profiles, and NREL's System Advisor Model was used to generate solar profiles. PVESS sizing for residential systems assumed PV sized to generate 100% of annual energy consumption for single-family and mobile homes, and storage systems of 10 kWh and 30 kWh, which is reflective of options currently available in the market today. For commercial buildings, the base case for PV sizing was the lesser of 100% of annual energy consumption or available roof area, while storage sizing was done at 30% of average daily PV generation, equal to median commercial sizing in the market today. The battery storage dispatch was simulated using a script written in R programming language.

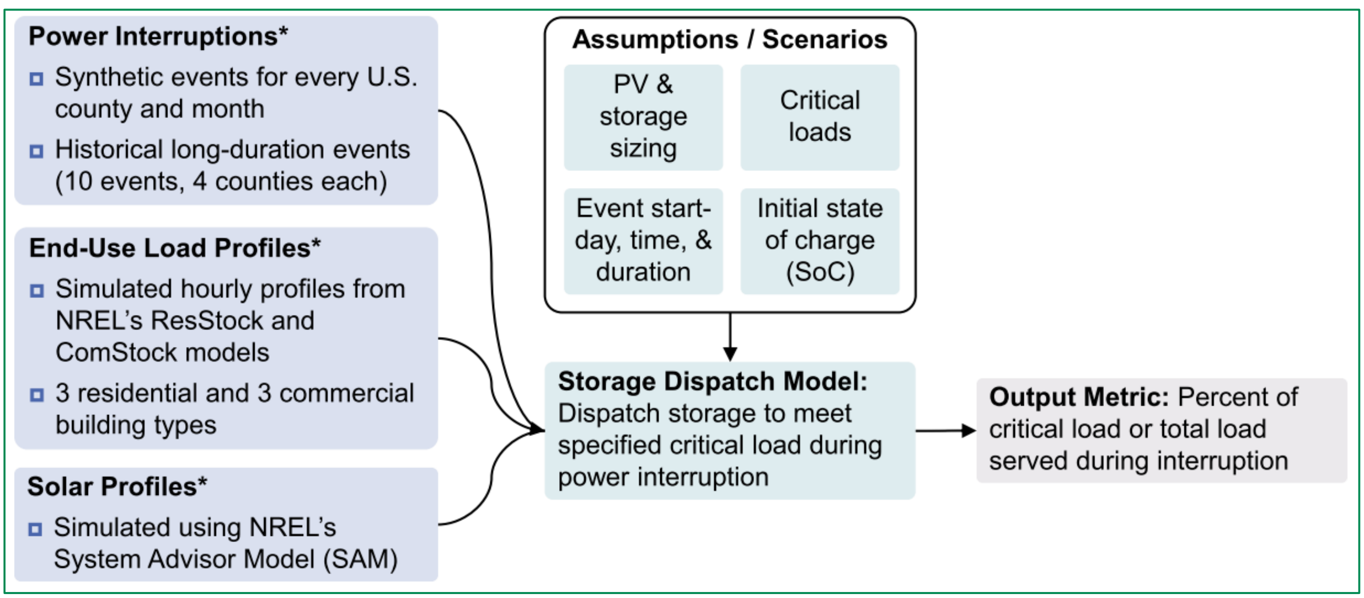

Figure 1: Overview of Analysis Structure. Graphic courtesy LBNL

[2] Gorman, Will, Galen L Barbose, Juan Pablo Carvallo, Sunhee Baik, Chandler Miller, Philip White, and Marlena Prapost. ***Evaluating the Capabilities of Behind-the-Meter Solar-plus-Storage for Providing Backup Power during Long-Duration Power Interruptions***. 2022.

The analysis focused on long-duration power interruptions, defined as lasting at least one day, using two different approaches – synthetic and historical interruption events. The analysis covers three residential building types (single family, mobile homes, and multi-family) and three non-residential building types (hospitals, secondary schools, and big-box retail stores).

Results & Conclusions

For synthetic events, results for single-family detached homes show that if heating and cooling loads are excluded from backup, a small PVESS with just 10 kWh of storage can fully meet basic backup power needs over a 3-day outage in virtually all U.S. counties and in any month of the year. If, instead, critical loads include heating and cooling, a PVESS of that size would meet 86% of critical load, averaged across all counties and months, while a larger PVESS with 30 kWh of storage (at the upper end of sizes currently observed in the market) would meet an average of 96% of critical load.

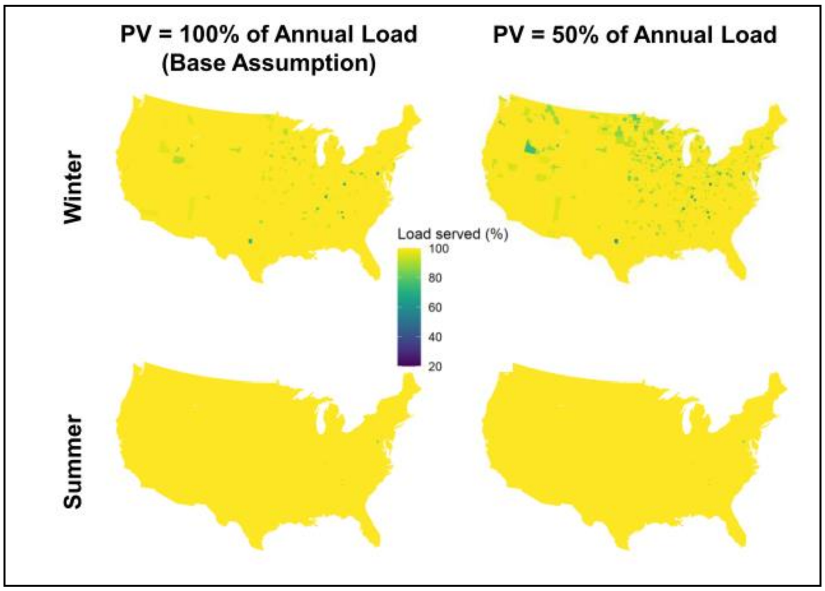

Figure 2:
Backup of limited critical loads with no heating/cooling

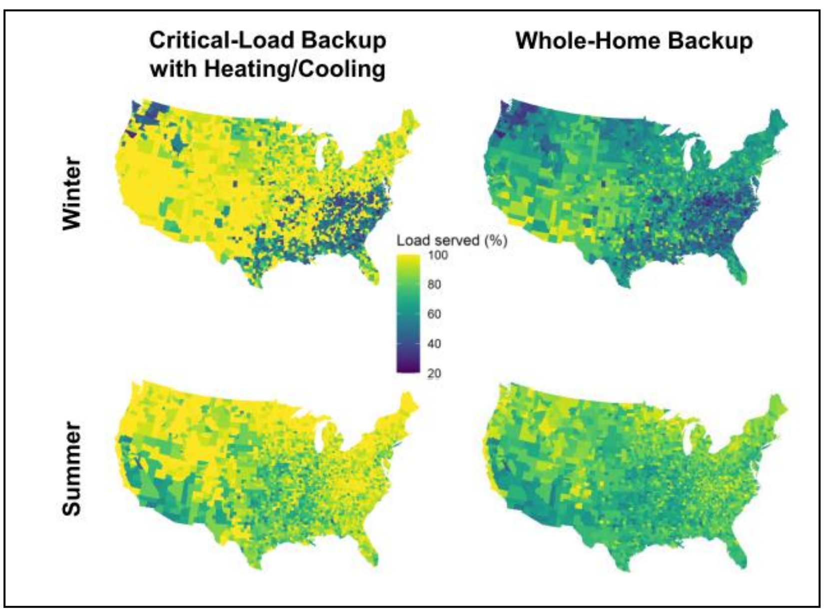

Figure 3:
Backup of critical loads with heating/cooling & whole home

For historical long-duration events, events were selected from the years 2017-2020 and include five hurricanes – Harvey (2017), Irma (2017), Florence (2018), Michael (2018), and Isaias (2020) – a Public Safety Power Shutoff (PSPS) wildfire event in California (2019), winter storms in Washington state (2019) and Oklahoma (2020), and thunderstorms in Iowa (2020) and Texas (2020). Results show that in 7 of the 10 events, most homes would have been able to maintain critical loads, using a PVESS with 30 kWh of storage.

Future Work & Other Resources

The authors identified four areas of planned future work. These include explicitly capturing temperature set-point adjustments during interruptions; modeling efficiency and electrification measures across a broader set of geographies (e.g., heat pumps in cold-weather climates); stochastic analysis of short-duration power interruptions; and modeling impacts of other battery uses (e.g., bill management) on initial State of Charge (SoC) at onset of power interruption.

Other Resources

- Full Report
- Narrative Summary
- Other Lawrence Berkeley National Laboratory Publications

Contact for Questions

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