

**Power Outages: Implications for California's
Medically Vulnerable Population**

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Abbreviations:
DME: Durable Medical Equipment
PSPS: Public Safety Power Shutoffs

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Natural disasters in the United States have resulted in persistent morbidity and mortality due to disruptions in access to healthcare, loss of critical utilities, and displacement, disproportionately affecting disadvantaged communities. Among natural disasters, wildfires are frequently associated with unplanned power outages from infrastructure damage or planned outages aiming to de-energize powerlines in anticipation of wildfires. The planned outages – public safety power shutoffs (PSPS) – are deployed to protect life and property.¹ Power outages particularly impact the medically vulnerable, precluding the use of electricity-dependent equipment like nebulizer machines and wound vacs, affecting refrigeration of medications, or simply shutting down fans and air conditioning.²

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The 2019 fire season was devastating, and its largest fire, the Kincade Fire, was caused by electrical transmission lines despite the extended, deliberate outages across the state. We calculated county-level cumulative exposure to power outages in 2019. More customers experienced PSPS events in 2019 alone than in 2020 – 2023 combined, and power outages caused extended disruptions in nearly every California county ([Supplement A–C](#)). More than half the events in October 2019 lasted more than 24 hours. Many Medicare beneficiaries were Durable Medical Equipment (DME) users in counties where disruptions lasted longer than 24 hours. Counties at the highest risk for significant power disruptions were home to many at-risk populations, including DME users and those with limited healthcare access. ([Supplement D, E](#))

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Since 2019, governmental, nongovernmental, and healthcare organizations have significantly invested in decreasing necessary de-energizing events and mitigating their negative impacts.³ The California Department of Public Health and utility companies like PG&E have invested in microgridding efforts, portable battery programs, community resource centers, and increased public outreach and engagement – such as the Medical Baseline program for patients needing power to receive electricity services at lower rates. However, the results of a study of adults with access and functional needs in Mariposa County found significantly increased delays in medical care and health harms in those with more medical conditions or using more medical devices after the 2022 Oak Fire.⁴

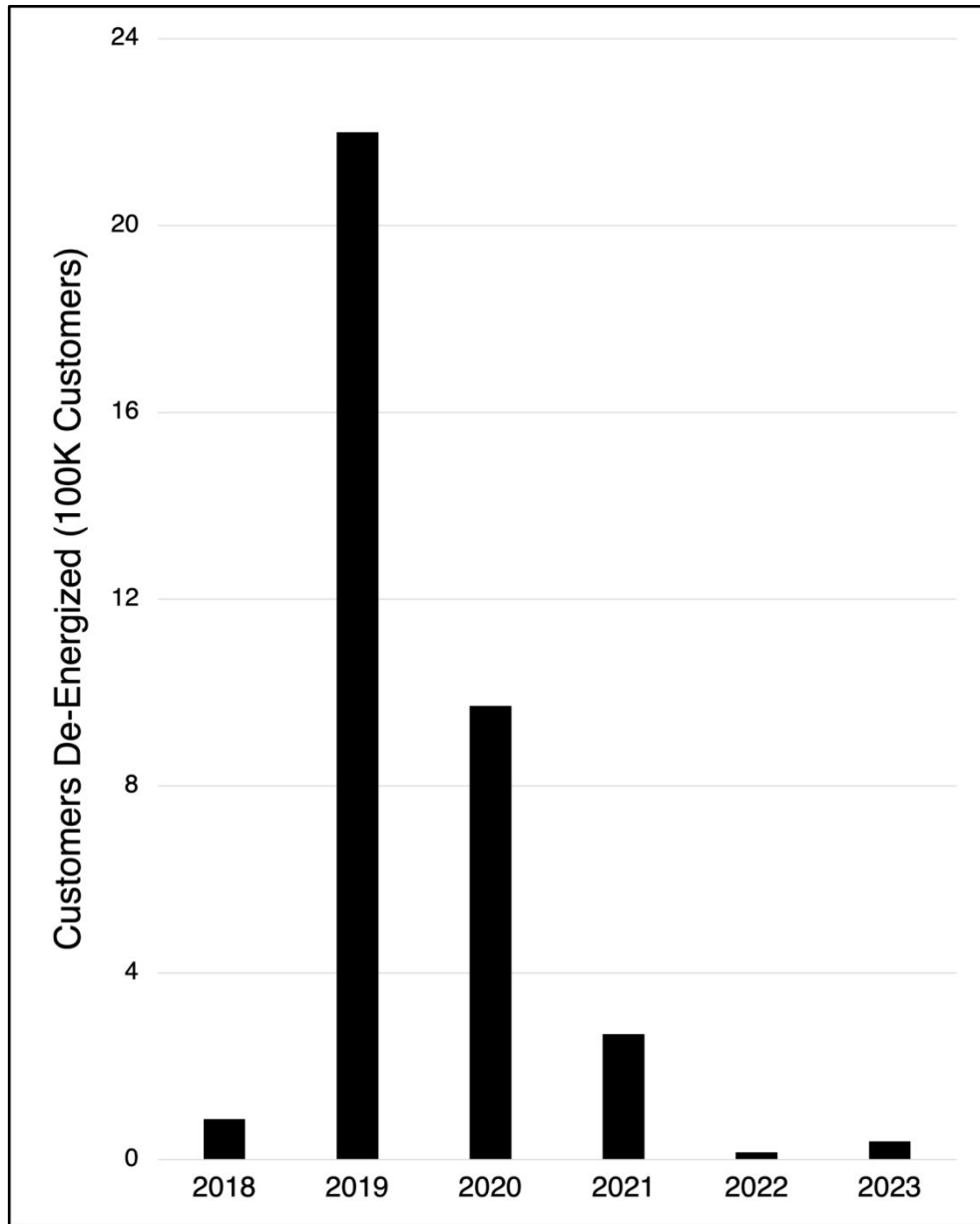
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We continue to prepare for disasters in the United States by mostly preparing for mass casualty events. Our analysis underscores the need to integrate *in situ* medical vulnerability (to power disruptions or other interruptions in healthcare access) into disaster planning and response. The United States sees more frequent, cascading crises – such as the compound climate disaster resulting in severe power outages during Hurricane Beryl and extreme heat in Texas, in the summer of 2024. Pre-emptive planning should require mapping and maintaining rosters of medically vulnerable populations that can be reached in anticipation of disasters, in the context of local hazards. Effective alternative pathways to healthcare access must be integrated into disaster response planning. Local capacity to access and use such data in decision-making is limited and requires local or federal investment expansion. Integrating high-resolution socioeconomic and medical vulnerability data – especially regarding those critically dependent on electricity and other care services – in disaster planning and response is a prudent and essential step in caring more equitably for communities impacted by disasters.⁵

References

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Supplement A: Number of customers in California de-energized through public safety power shutoffs by utility companies in California. Data from California Public Utilities Commission Public PSPS Dashboard:

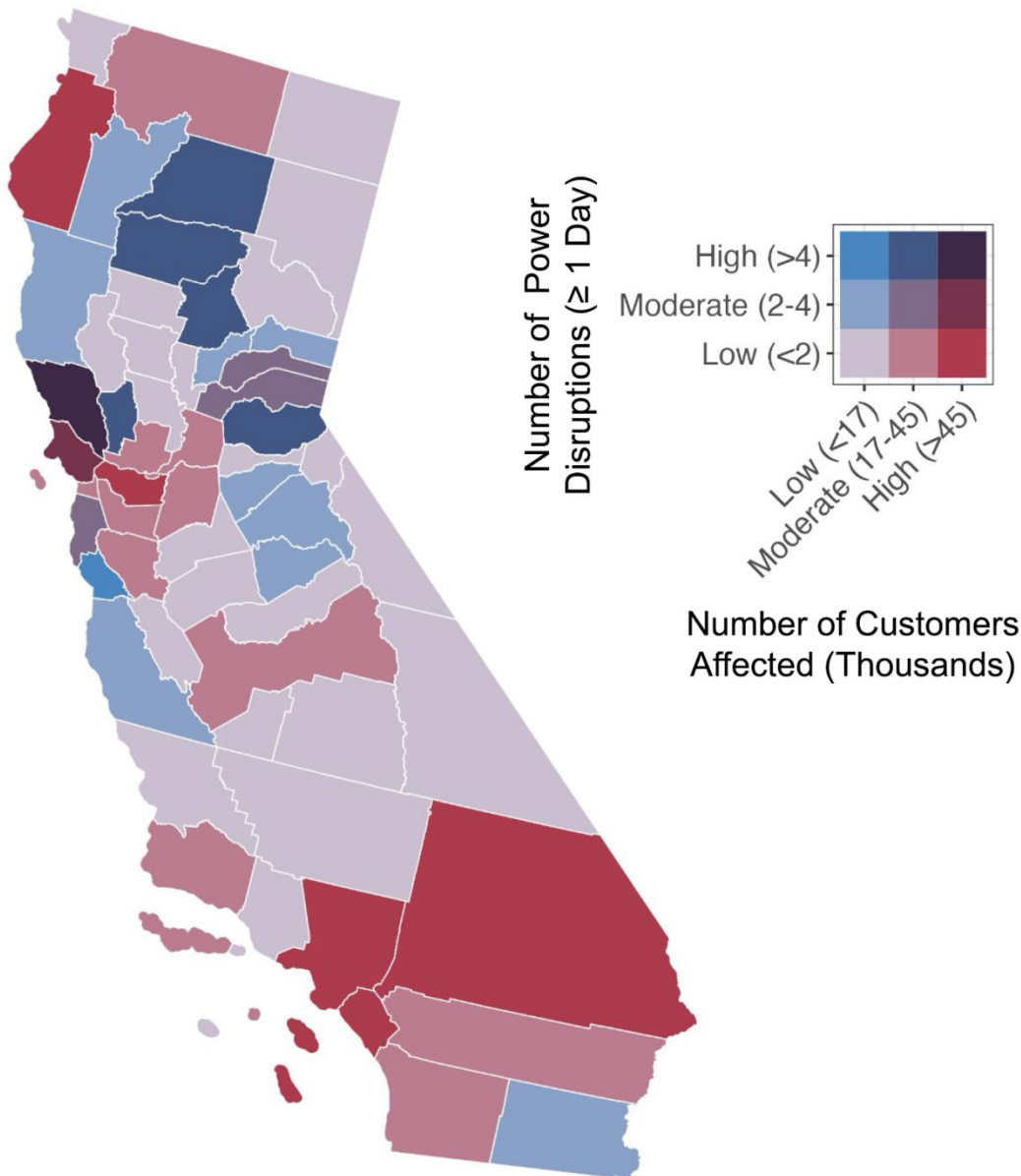
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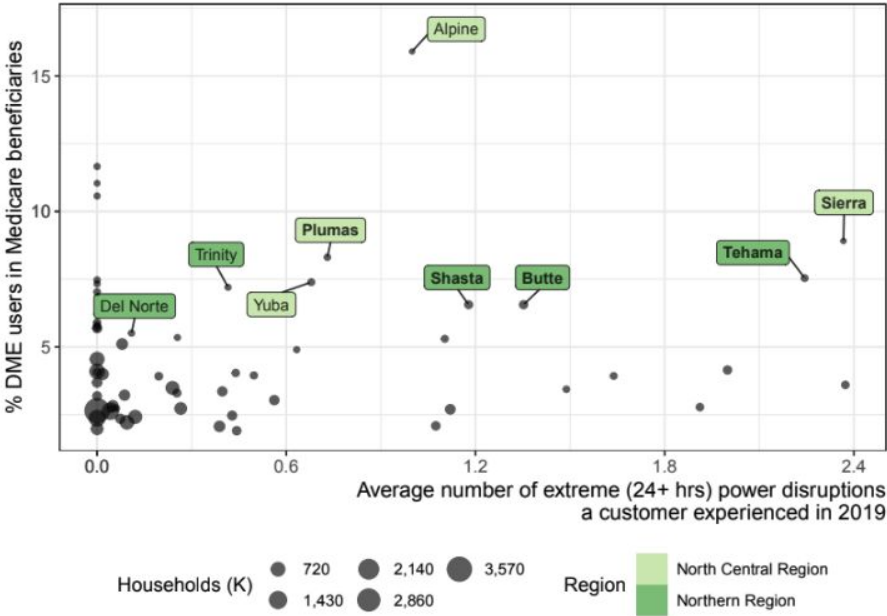
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Supplement B: Power outage data were sourced from poweroutages.com, which aggregates data from 16 (61.5%) of California’s utility companies, servicing 80% of the population. We used county-level housing unit data from the American Community Survey to approximate the number of customers per county. We defined a county as experiencing a power outage if the number of customers without power was greater than 0.5% of housing units within the county and if the outage lasted at least one hour. We then used tertiles to separate occurrences of power disruptions and customers affected into low, medium, and high categories. We calculated the number of monthly power disruptions in 8-hour windows, to accommodate varying daily power needs for devices like nightly BiPAP machines or mobility devices. Using data from the ASPR emPOWER database, we determined the number of electricity-dependent durable medical equipment (DME) users and the total number of Medicare beneficiaries per county. Using data from the Health Resources and Services Administration (HRSA), we calculated the number of uninsured residents served by Federal (Section 330) Health Center Programs (HCP), look-alikes (organizations that meet Federally Qualified Health Center eligibility requirements), and the percent of low-income residents (below 200% of the Federal Poverty Level) in each county. The ASPR, HRSA, and poverty-level data collectively are a reasonable proxy for the burden of medically vulnerable people and the subset dependent on electricity for their medical needs.

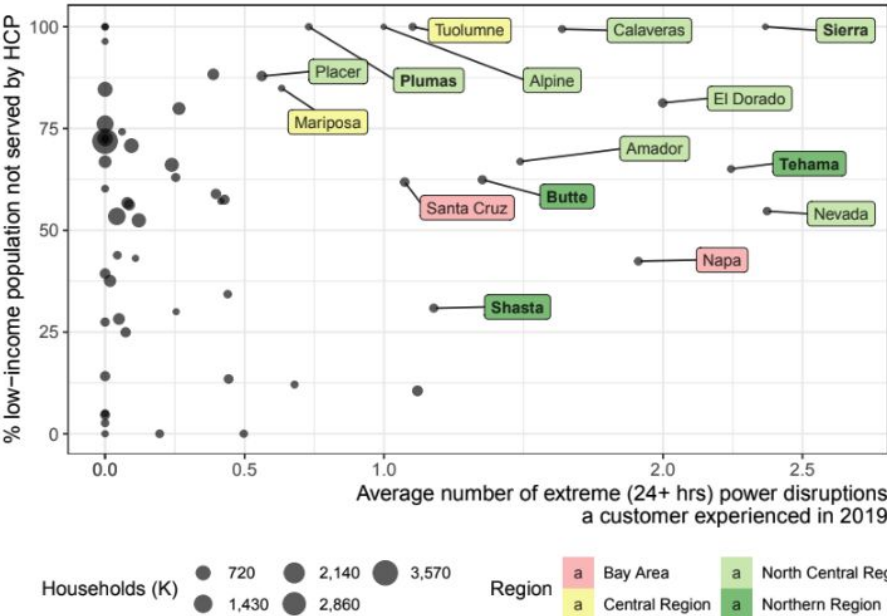
Supplement C: County-wise frequency of power disruption events lasting ≥ 1 day and the total number of customers affected by county, in 2019. The Southern counties of Orange, San Bernadino, and Los Angeles had high numbers of customers affected, as did the Northern counties of Humboldt. The Northern counties of Shasta, Tehama, Butte, El Dorado, Napa, and Sonoma experienced higher numbers of disruptions, with a moderate number of customers affected.



Supplement D: Average number of extreme (24+ hours) power disruptions experienced by customers at the county level in 2019 and the percent of durable medical equipment (DME) users out of Medicare beneficiaries living in each county. Counties with bold names have a high level of vulnerability.



Supplement E: Average number of extreme (24+ hours) power disruptions experienced by customers at the county level in 2019 and the percent of low-income population (below 200% federal poverty line) not served by Health Center Program (HCP) in each county.



Supplement Note: The underlying code and key data files are available in a GitHub repository linked here (<https://github.com/jiashenyue/ca-poweroutage-medical-vulnerable-pop?tab=readme-ov-file>) with a Zenodo data link on the README page.