Building Electrification & the Electric Grid Explained: San Mateo County Analysis

Electrification has become a key strategy in addressing climate change due to the availability of carbon free electricity. As California pursues economy-wide decarbonization, communities and decision makers are worried about the impacts of building electrification and electric vehicles on the reliability of the electric grid. These concerns are sparked by experiences with past power outages (e.g., those caused by the winter 2022 atmospheric river events), and a critical need for 24/7 electricity for San Mateo businesses and residents. These concerns have driven some community members to link electrification and potential power outages, raising the question: "will electrification policies break the grid?"

This explainer explores the root causes of power outages and the link between building electrification and electric grid reliability. It also illuminates how local government climate policies can aid in preparing the grid for a decarbonized future. This report covers key points relating to grid reliability and electrification to aid decision makers as they work to meet their climate goals. For a deeper dive, explore our accompanying long-form policy whitepaper: *Building Electrification & The Electric Grid: San Mateo County Analysis.*

Grid Reliability and Electrification at-a-Glance

1. **Will building and vehicle electrification cause more power outages?**
   - Grid expansion plans are already underway by State agencies and utilities to serve new loads from electric vehicles and buildings.
   - Local electrification efforts are not expected to overwhelm the grid.
   - New technologies like smart panels will make electrification easier and improve grid resilience.
2. **What causes power outages?**
   - Most power outages are caused by company-initiated safety shutoffs or physical disturbances to the grid such as tree limb impacts or animal disturbance.
   - Power outages caused by too much electricity demand are rare, occurring only once since 2001. The single occurrence caused rolling outages for customers ranging from 15 minutes to several hours. [1]
3. **What should local governments do to meet climate goals while keeping the grid resilient?**
   - Local governments that pass electrification policies make it easier for the State to plan for future electrical demand.
   - Local governments should prepare for lengthy timelines to upgrade parts of the distribution grid to connect new policy-driven local electrical loads. Planning for distribution system upgrades can make electrification projects easier by accounting for these lengthy lead times needed.

Heat pump technologies, shown here, provide a more efficient and cost-effective alternative to methane gas powered options. In many instances, heat pumps can provide cooling in homes where air conditioning didn't exist previously.

1. Will Building and Vehicle Electrification Cause More Power Outages?

Electrification describes the shift to using electricity instead of fossil fuels like methane gas and oil for heating, cooking, and transportation. When residents and businesses electrify, they introduce new electrical loads at the customer level. The timing of these loads is critical, because the grid was built to meet the demand at the peak hour (usually a hot summer day in California). If these loads increase the peak demand, it could create the need to upgrade portions of the grid to match new peak demand.[2] While most electric buildings will have a low impact on peak demand (mostly increasing electricity demand during winter heating loads), electric vehicles have the potential to increase demand during the current summer peak. Due to these new loads and their expected growth over time, multiple entities within the State have begun planning around electrification.

How Are Planners Preparing for New Electrical Loads?

The State of California has multiple plans and forecasts to supply carbon-free electricity by 2045 while keeping pace with future increased electrical demand.[3] By 2035, planners are assuming an approximate 27% increase in Statewide electrical demand from 2023 levels: this increase includes new electrical loads from economic and population growth[4] and shows that the assumptions for building and vehicle electrification which have been factored into the forecasts are ambitious, matching the pace of actual local decarbonization progress. New loads from building electrification and light duty vehicles are expected to have the biggest impacts on future electric demand, though there will also be significant savings from solar, battery storage, and energy efficiency. Energy efficiency and building electrification is linked. For example, heat pump HVAC systems can be used to reduce peak loads through higher efficiency cooling technologies compared to traditional window units.[5]

Table 1 How much building and transportation electrification is the State planning for? *[2023 California Energy Commission Integrated Energy Policy Report]*[6]

Decarbonization Topic	What's Included in Resource Planning Through 2040?
Building Electrification	New Construction: 100% all-electric space and water heating in new construction for residential buildings beginning in 2026; and 2029 for the commercial sector. Existing Buildings: 100% replace on burnout for space and water heaters in the Bay Area AQMD territory in 2027 and 2029; and 2030 for the rest of the State 'More ambitious' scenarios that also electrify cooking and clothes drying were modeled not selected for inclusion in the forecast due to high rates of uncertainty for building electrification. 2035 Electrification Load Impact: 5,378 MW.* * These increases to load could be significantly reduced through reductions in demand from solar, energy storage, and energy efficiency, cumulatively subtracting -4,785 MW from this total. This also applies to the projections for vehicle electrification.
Vehicle Electrification	Passenger Vehicles: 13.7 million ZEVS on road by 2035 Commercial Vehicles: 407,000 ZEVS on road by 2035 2035 Electrification Load Impact: 4,810 MW, with most (3,949 MW) coming from passenger vehicles
Projected 2035 Statewide Electrical Demand	Managed Peak by 2035: 56,937 MW, equal to a ~27% increase from the actual 2023 peak of 44,534 MW

New loads from building and transportation electrification are being actively accounted for and continually updated by grid planners. For example, the 2023 IEPR forecast has changed significantly from 2021 to account for new building electrification policies (e.g. Inflation Reduction Act, Bay Area Air Quality Management District), and new models for electric vehicle adoption. New loads from building and vehicle electrification are not expected to overwhelm existing capacity or lead to power outages based on increased electrical loads from electrification in the short term, although the grid will have to undergo planned expansions and/or retrofits to keep up with future demand. Upgrading the grid to meet but not drastically exceed new demand is key to cost effectiveness for ratepayers. This phase in of grid upgrades also allows for leveraging new technologies like reconductoring and bi-directional charging for EVs.[7]

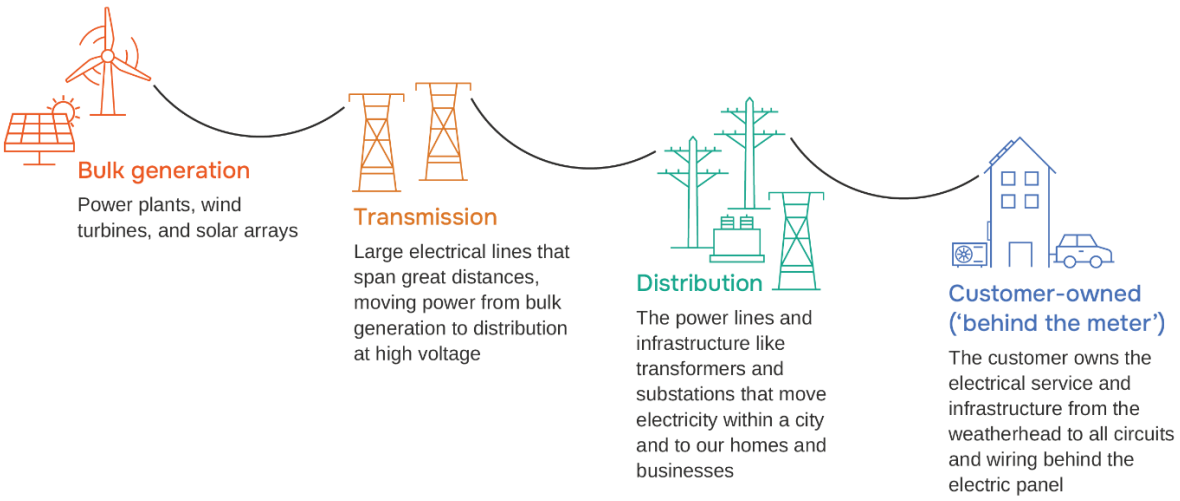
High voltage transmission lines move power from bulk generation to distribution power lines.

2. What Causes Grid Failures (Power Outages)?

Grid failures can be caused by issues at any of the three grid components (bulk generation, transmission, or distribution). Most power outages are caused by local distribution system level impacts caused by physical issues with equipment like trees, animals, and component failures. These outages are not related to electricity consumption. The following sections detail the types of power outages a customer may experience, what causes them, and how they relate to electrification.

How Does the Electric Grid Work?

There are three parts to what we cumulatively call the "grid" or the infrastructure that brings electricity to our homes and businesses.[1] These components are the bulk generation (power plants), transmission lines (long range movement of electricity), and local distribution system (the wires in your neighborhood).



Source: PG&E, as adapted by the County of San Mateo

Bulk System Failures, Explained

Bulk system outages almost never happen, occurring only once since 2001 (the California Energy Crisis), during the August 2020 rolling blackouts. Residents may remember in September of 2022 California sent texts to millions of people to reduce electricity use during a several hour span. This campaign to reduce consumer electric consumption was successful in avoiding a systemwide blackout and was one of the few bulk power related events in recent years. Most bulk power failures have been related to energy consumption changes in response to extreme heat events.

The root cause of these bulk system outages are failures of grid planners to match supply with demand during peak hours, which are changing rapidly as consumers react to new extreme weather events through increased electrical demand to heat and cool buildings, rather than the physical limit of the grid itself.[8] Luckily, agencies responsible for maintaining the grid are including ambitious projections for electrification (to meet legislated State goals for carbon neutrality) in their planning as shown in Table 1. While electrification could potentially cause a bulk system failure without proper planning, multiple Statewide planning initiatives are working to match forecasted demand with appropriate generation resources as shown in Table 1.

Transmission System Failures, Explained

Grid failure at the transmission level is rare but can cause widespread damage when it occurs as transmission systems span large geographic areas. Core issues of failure at the transmission level are both physical issues such as vegetation contact (e.g. vegetation contact with high voltage lines) and capacity based. Each transmission wire can move a set amount of electricity at one time. As more bulk generation is required to meet demand, new transmission systems will also be needed to move additional electricity across the State, especially if demand occurs during peak hours. While transmission lines can have additional capacity and/or can have redundance (transmission from multiple sources to one area) a lack of sufficient transmission capacity can cause increased costs and longer power outages. If new transmission lines are built too slowly, they can also hinder the deployment of new sources of bulk renewable power.[9]

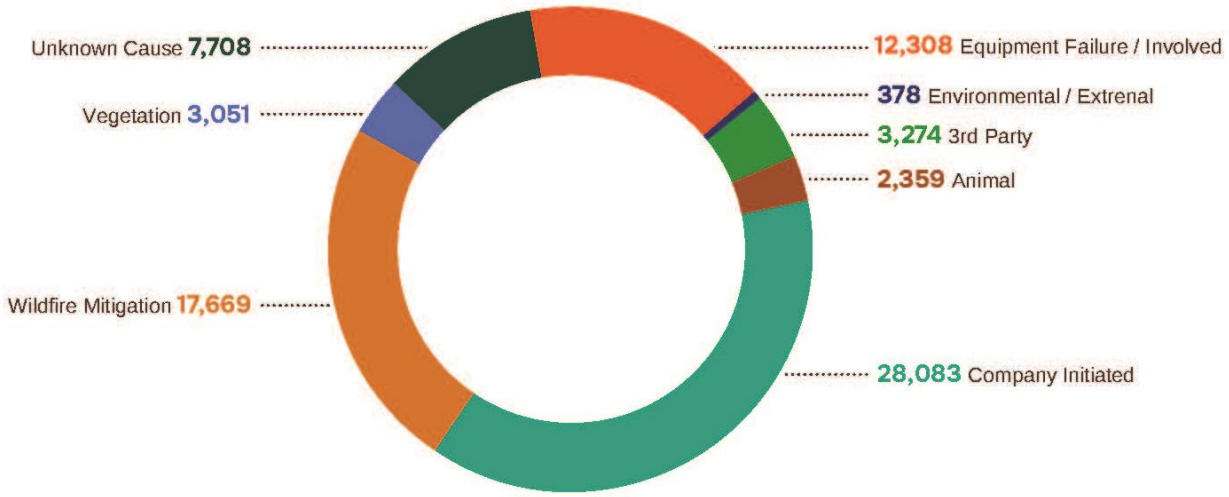
The State is tackling these two core transmission reliability issues through legislation to increase power line undergrounding and accelerate the deployment of new transmission projects. Assembly Bill 367 which was signed by Governor Newsom in 2023 aims to expedite the transmission process by streamlining evaluation and project approval.[10] 2023 Senate Bill 884 established a program for expediting undergrounding of distribution infrastructure as well.[11] PG&E has stated that they plan to bury 10,000 miles of powerline in areas with high wildfire risk. This undergrounding not only will reduce risk of wildfire caused by vegetation contact with power lines, but also PG&E interruptions to service through PSPS events.[12] New technologies like reconductoring and smart sensors may also provide additional capacity for transmission lines to avoid new infrastructure in favor of retrofitting existing lines.

Distribution System Failures, Explained

Distribution system outages are the most common type of power outages. While there has only been one bulk system outage since the CA energy crisis, there were thousands of smaller distribution-system outages during this time period. Outages are primarily driven by local factors like weather and maintenance (ex. power safety power shutoff due to fire risk, planned maintenance projects, animal disturbance, trees falling on power lines, etc.) as shown in Figure 1. However, as described above, the frequency of EPSS and PSPS events are a real and concerning trend in grid reliability impacting PG&E customers throughout San Mateo County. Policymakers should continue to monitor this fast-evolving intersection between wildfire resiliency efforts and local electric reliability.

These distribution outages are generally not driven by customer load, like the increases in electric vehicle charging and building electrification. Adding new loads to an individual building or facility may require distribution system upgrades (such as service lines and transformers), leading to costs borne by either the customer, PG&E, or both. Due to the electrical codes in place, increased electrical loads are generally not associated with distribution reliability. As demand increases, new infrastructure is continually installed to meet this demand before the new loads are allowed, ensuring electrification does not decrease the safety or reliability of the grid.[13]

Figure 1 Most PG&E Distribution Outages Were Company Initiated[14]



Source: PG&E via E3, as adapted by the County of San Mateo

Public Safety Power Shutoffs (PSPS) and Enhanced Power Line Safety Settings (EPSS), Explained

In addition to physical issues with the grid itself, a newer type of electricity disruption has emerged due to the impacts of climate change and several grid-caused wildfires in California. Public Safety Power Shutoffs (PSPS) allow investor-owned utilities to temporarily shut off electrical power during high-risk conditions. PSPS events are one of the most widely experienced types of interruptions in electrical service. PSPS events decreased in both duration and frequency between 2019-2021. However, PG&E's recent switch to Enhanced Power Line Safety Settings (EPSS) where circuit breakers automatically cut power to a block of customers when there is a physical disturbance to

the local grid has led to an uptick in duration and frequency of outages since 2021. PG&E is currently working to reduce PSPS duration and prevalence by undergrounding or burying 10,000 miles of powerlines in the highest wildfire risk areas. PG&E is also working to install more resilient poles and trimming/removing vegetation around powerlines. The company states that these efforts will help reduce wildfire risk and improve reliability of the system overall.[15]

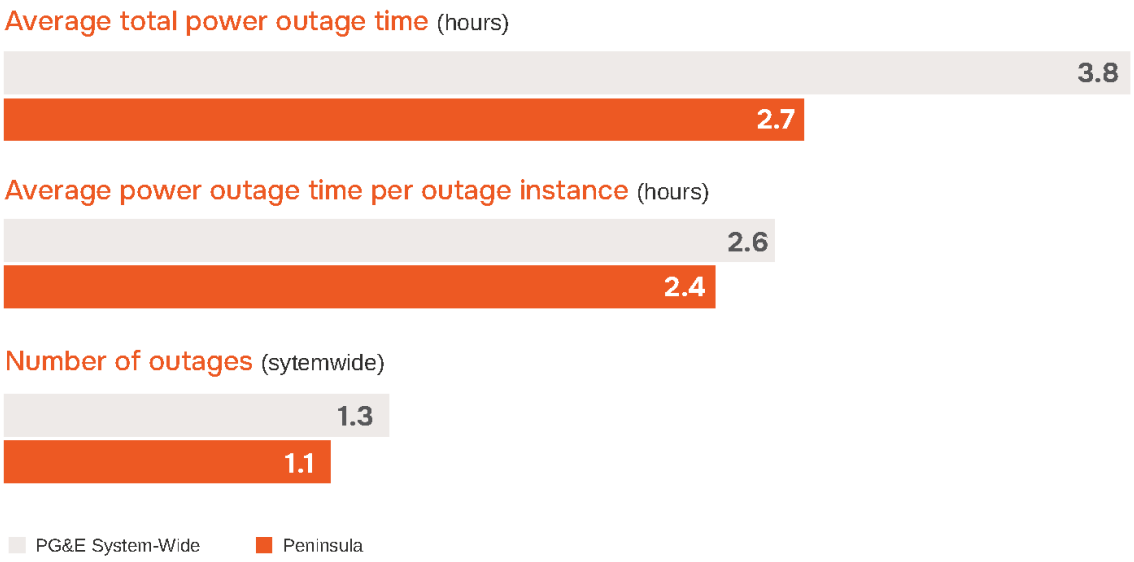
How Common are Grid Failures (Power Outages)?

Self-initiated outages by PG&E have been on the rise, though rates of wildfire ignition have improved. In 2022, the rate of annual outage minutes was 71% higher than the previous 5-year average, while the number of outages was 44% higher than the previous 5-year average. The self-initiated outages caused by PSPS and EPSS also indicate a resiliency success story- with EPSS successfully cutting the number of grid-induced fire ignition instances by 68%. However, this wildfire reduction strategy has come at the cost of longer, and more frequent power outages experienced by customers since 2021.

While this overall uptick in longer and more frequent outages also applies to PG&E service on the Peninsula, it is important to understand the frequency and duration of these events. As shown in Figure 2, according to PG&E's 2022 Annual Electric Reliability Report to CPUC the average Peninsula customer experiences a little over one outage during the year, which lasts for an average duration of 2.4 hours. Outages of less than 5 minutes, which are not pictured below, happened 1.4 times/ year on average across PG&E's peninsula system. [16] In addition, the performance of the Peninsula's distribution grid is more resilient on average than the system overall.

Most PSPS events in San Mateo County have historically been concentrated in Unincorporated, or coast side communities. Local news media have also documented multi-day power outages experienced post-extreme weather events by the community, such as the February 2024 multi-day power outages experienced in Montara and Half Moon Bay following an atmospheric river event.[17] PG&E has also started to plan for and implement undergrounding and other system 'hardening' upgrades. The projects include undergrounding and removing lines in South San Francisco, Unincorporated County near Half Moon Bay, and south of Pescadero.[18] It is important to note that the averages shown in Figure 2 below, may not accurately reflect coastal communities' experience, which may experience outages far more frequent and longer in duration and, therefore complicate this topic for these residents.

Figure 2 Peninsula PG&E Reliability Outperforms PG&E Systemwide Average (2022)



Source: 2022 CPUC Annual Electric Reliability Report; Tables 1 & 5, as adapted by the County of San Mateo

Heat pump water heaters, as shown here, provide a more efficient and cost-effective alternative to methane gas powered options. Providing incentives and easing permitting processing to install this technology are within the scope of local government.

3. What Can Local Governments Do to Electrify While Increasing Grid Resiliency?

Local Policies Help the State Plan for New Loads & Can Reduce Strain on Utility-Scale Investments

By putting climate action targets into practice through building electrification policies, local governments can help the State plan for building electrification by providing them with a clear policy signal to prepare for new local electric loads. The California Energy Commission (CEC)'s forecasting report referenced in this explainer already tracks local building electrification policies as a metric of progress towards decarbonization.[19] The CEC considers the future of building electrification at the local level to be uncertain (particularly post-Berkely vs. CRA lawsuit), and selects the inclusion of different scenarios for electrification into their forecasts based on likelihood of implementation.[20] As local government planners take action to transition from incentive or voluntary programs to concrete building electrification policies, they can advance electrification within the policy realm, and increase the likelihood that the policy will be effectively integrated into the State's forecasts.[21]

Local policy can also help reduce strain on the grid. For example, if high-efficiency electric heat pump technologies are installed at scale instead of new loads from less efficient window mounted air conditioning units, overall peak electricity demand during the summer could be reduced. In turn, this would reduce the need for upstream installation of new sources of electricity and associated grid infrastructure. Cities can also adopt load-flexible decarbonization policies to promote/allow load management through smart panels and flexible demand through grid tied EVs and batteries as an additional effort to bring forward electrification efforts while boosting grid reliability. [22] Ultimately, electrification allows customers to participate in demand response programs which can improve grid resiliency.

Plan Ahead for Distribution System Upgrades

Cities bringing forward building electrification requirements should start planning with PG&E to invest in distribution capacity due to potentially long timelines to complete work. For example, while rarely needed, a new substation build-out can take 5-10 years.[23] The PG&E distribution system planning process occurs annually to address issues with distribution infrastructure. The State has also taken action to speed up timelines for connecting local building and transportation projects to the grid and has recognized that lag times for distribution grid upgrades can be a major bottleneck for electrification. The 2023 Powering Up Californians Act (SB 410) has set a deadline for CPUC to establish target timelines for utilities to connect new electric loads to the distribution grid, while reporting non compliances (e.g. failure to energize in time). It also requires utilities to factor new loads from local decarbonization goals into investments in grid planning, and train and hire the workforce necessary to electrify transportation and buildings.

While the State has started to lay the policy foundation to speed up grid upgrades, local climate action planners can use local policy targets for electrification as a catalyst to kick off the distribution grid upgrade process. These local polices also send an important signal to utilities to incorporate an all-electric future into their future forecasting and grid upgrade plans.[24]

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            1. Figure 13- Additional Achievable Fuel Substitution. AAFS= Building Electrification; AAEE= Efficiency – this was used to calculate total increased load from AAFS and combined reductions from efficiency; solar, storage
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