ELECTRIC SERVICE OPTIMIZATION FOR BUILDING OFFICIALS

Minimizing electrical service upgrades while ensuring public safety and code compliance in retrofit projects

PURPOSE OF THIS GUIDE

A recent study[1] of smart meter data (AMI data) in over 22,000 homes in California, 86% of homes had a peak electrical load of less than 50 Amps, and nearly half of homes had a peak of less than 30 Amps, see Figure 1. Yet many contractors default to costly and time-consuming electrical service upgrades, often slowing project timelines and increasing costs to consumers unnecessarily.

Proper planning and proper use of alternative load calculations when adding new electrical loads like heat pumps or air conditioning, is a "win-win-win." Customers avoid costly service upgrades; contractors can complete jobs in a timely fashion and building officials can expedite permit approvals with well crafted load calculations and permit packages.

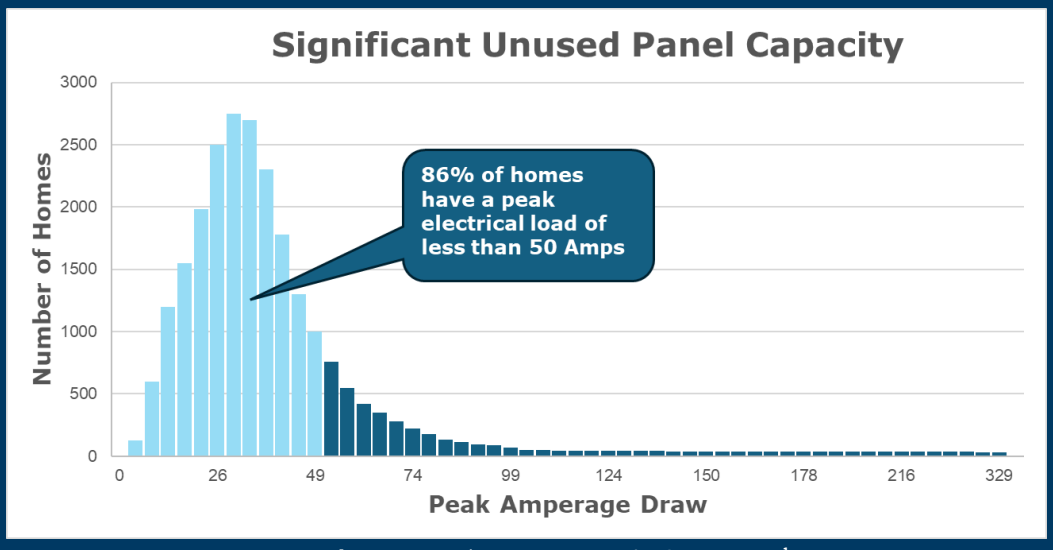

Figure 1: Peak Power Draw in CA Homes[1]

Scan the QR code or click to access details about alternative load calculations, low power appliances and energy management devices in the: "Electric Service Optimization for Building Officials" extended document.

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WHAT'S INCLUDED

Readers will find actionable information for permit application plan reviewers, practical solutions to aid contractors submitting permit applications and insights into the tactics that minimize the need for costly electric service upgrades while ensuring public safety and compliance with current building codes.

» STRATEGIES FOR OPTIMIZING ELECTRICAL SERVICE:

Homes with electrical panels under 200A can often avoid service upgrades through one or more strategies: Alternative Load Calculations, Low-Power Appliances, and/or Energy Management Systems.

» BUILDING CODES AND LOAD CALCULATIONS

Appropriate use of CA code approved application-specific electric load calculations accurately determine available electrical capacity for new loads.

» COMMON TECHNOLOGIES TO REDUCE PEAK ELECTRICAL LOADS

Optimizing existing electrical service capacity may include careful selection of new equipment and appliances. Included are insights into over a dozen of the most common technologies.

STRATEGIES TO MINIMIZE SERVICE UPGRADES

Remaining electrical capacity can be efficiently used when adding new loads using a combination of these strategies:

» ALTERNATIVE LOAD CALCULATIONS:

CA Electrical Code Section 220 offers several methods for calculating existing and new electrical loads, appropriate for different situations.

» LOW-POWER APPLIANCES:

There are numerous options for energy efficient, lower peak power appliances that can reduce demand on electrical panels and lower utility bills.

» ENERGY MANAGEMENT SYSTEMS (EMS):

Smart Panels, circuit level management devices and other devices can manage total power demand while ensuring all home energy needs are met.

PERMIT APPLICATION AND REVIEW

Local adoption of California's building and energy codes vary, and local jurisdictions may have unique requirements when submitting permit applications. Included below are recommendations from various building departments that have helped streamline the application process and reduce permit review times.

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- **Publish or display a checklist for applicants that clearly states the items required for permit submittal. This may reduce the number of incomplete or non-compliant applications requiring revisions. Checklist items may include:**
  - Scope of work for all proposed additions and improvements
  - Breaker schedule showing amperage of all new circuits, with conductor and conduit sizing information
  - Site plan if equipment will be installed in new locations, including property line setbacks for exterior equipment
  - Electrical load calculations
  - Photograph showing main service panel and main circuit breaker ratings
  - List of key relevant code references (especially important for load calculations or non-standard scope items)
  - Cutsheets/specifications of new equipment
- **Maintain a checklist of necessary fields for applicable load calculation methodologies and provide load calculation examples. Checklist items may include:**
  - 220.83
    - Square footage matches records
    - "Small branch circuits" included
    - VA of various appliances match the nameplate rating or industry standard if not available
    - 220.83(a) or 220.83(b) differentiates if either air conditioning and/or electric space heating is to be installed when not present previously
  - 220.87
    - 1 year of data at hourly intervals, with the exception of 15-minute data for a minimum of 30 days if 1 year of data is not available
    - 125% of maximum demand is used
    - No renewable energy system on record or installed

CA ELECTRICAL CODE ALTERNATIVE LOAD CALCULATIONS

National and State electrical codes offer several methods for calculating the existing and planned electrical loads. The calculated electrical loads aid in determining if the existing electrical infrastructure (in front of and behind the meter) will be adequate for the planned improvements. Every project is unique and requires accurate assessments and calculations to identify needed electrical improvements. References here are provided for informational purposes only. A qualified electrical professional must evaluate each project individually.

Figure 2: Upgrading Utility Service Capacity is Expensive and Time Consuming

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California Electrical Code (CEC) , Chapter 2, Article 220 provides methodology for calculating the total existing and proposed electrical loads for:

- **Noncoincident Loads (220.60):** Provisions for the additional of circuit level controls, including circuit splitting, sharing, or circuit pausing equipment
- **Dwelling Units (220.82):** Provides a standard load calculation methodology intended for new construction and is the most common method referenced by Authorities Having Jurisdiction (AHJ's)
- **Existing Dwelling Units (220.83):** Provides methodology appropriate for existing residential retrofits adding new electric loads, especially when Advanced Meter Infrastructure (AMI) data is not available
- **Multifamily Dwelling Units – 3 or more (220.84):** Provides methodology used when calculating electric loads for three or more dwelling units sharing a feeder/service for multiple dwelling units
- **Two Dwelling Units Supplied by a Single Feeder (220.85):** Provides methodology used for calculating electric loads when two dwelling units are supplied by a single service drop from the utility (feeder) to both dwelling units
- **Determining Existing Loads (220.87):** Utilizes existing maximum peak incident electrical load, as determined by AMI utility data. Provides factor of safety and other provisions when calculating peak electrical load post retrofit
- **Energy Management Systems (220.70):** This section determines the rules for establishing an EMS "setpoint," or the maximum load an EMS will allow to be drawn from the control system. While not adopted in California, yet, several jurisdictions are adopting sections of the 2023 National Electric code that apply to EMSs. Details for the use of 220.70 is provided in the extended document.

- **Data requirements for calculating electrical loads:** The required data and information needed to carry out load calculations using the four methodologies include:
  - Existing panel size
  - House square footage
  - Name plate rating for AC or electric space-heating equipment
  - Per circuit load
  - Name plate rating for appliances
  - Number of small appliance branch circuits
  - AMI data

Table 1 summarizes which data points are required for the various load calculation methods. Subsequent sections list the data used for each methodology:

Load Calculation	Existing Panel Size	House Square Footage	Name Plate Rating for AC or Electric Space-Heating	Name Plate Rating for Appliances	Number of Small Appliance Branch Circuits	AMI Data	Per Circuit Load
CEC 220.83	●	●	●	●	●		
CEC 220.87	●		●	●		●	
CEC 220.60	●			●			●
CEC 220.70	●						●

Table 1: Data Needed to Compute Load Calculations by Methodology

COMMON NEW ELECTRIFICATION LOADS

Residential electrification efforts are focused on space heating and cooling, water heating, cooking, clothes drying, electric vehicle (EV) charging and energy management systems (EMS). Figure 3 provides a visual summary of many of the appliance options available to customers when replacing gas burning models.

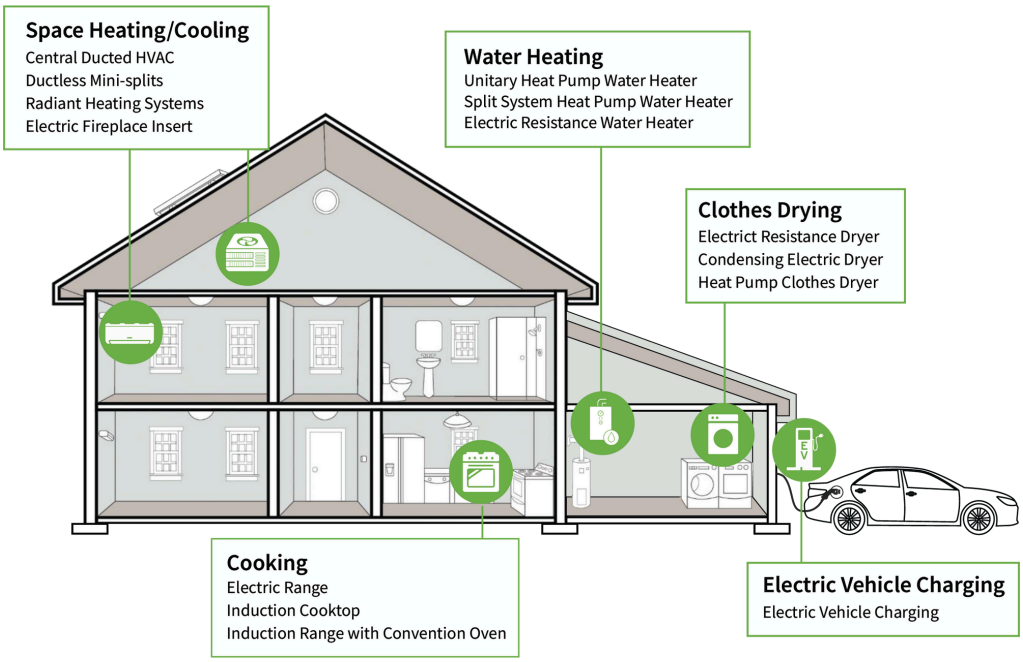

Figure 3: Key Load Reduction Technologies

- **Heat pumps:** Properly sized heat pump HVAC systems with inverter driven condensers can reduce peak electrical loads and improve indoor air quality.
- **Heat pump water heaters:** 120V powered heat pump water heaters are appropriate for homes with lower water heating demand. Upsizing the tank size can ensure adequate capacity for higher demand events.
- **Induction cooking:** Eliminates combustion byproducts produced from gas burning cooktops and stoves. Improves indoor air quality and safety.
- **Low power level 2 EV chargers:** Reduce total peak demand and can often share circuits with other appliances in the home.
- **Energy management systems:** EMS and load-sharing devices are not new loads but are effective tools to reduce service upgrades. Load-sharing devices allow two or more devices to share the same circuit but do not allow more than one connected device to operate at a time. EV charger connected to electric dryer circuit is a common example.

ALTERNATIVE LOAD CALCULATION TEMPLATES

An essential part of any electrification permit application is the load calculations. A sample template that may be used to submit along with building applications has been made publicly available for download may be downloaded from here or by scanning the QR code.

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SUCCESSFUL CASE STUDIES

Meet the Davis, Martinez, and Kim families. Each family was able to successfully electrify their home with existing electrical service capacity by using a combination of methods.

- Calculating loads under CEC 220.87 in conjunction with a circuit control unit, the Davis family fully electrified their home, including installing an electric vehicle charging station.
- Using CEC 220.83, the Martinez family electrified their home, eliminating their reliance on expensive propane for water and home heating.
- Using NEC 220.70, the Kim family electrified their home, utilizing a smart electric panel with digital energy management to avoid costly service upgrades. The pre-and-post-upgrade stories are included in the extended document.

DAVIS RESIDENCE



Davis Residence with Upgraded Circuit Splitter and HPWH

Davis Load Calculations

Calc. Type	Max. (VA)	Peak Load (VA)	Room (VA)	Pass /Fail
CEC 220.82	24,000	24,213	(-213)	FAIL
CEC 220.83	24,000	23,301	987	PASS
CEC 220.87	17,865	16,885	980	PASS

MARTINEZ RESIDENCE



Martinez Residence with Induction Cooktop and HPWH

Martinez Load Calculations

Calc. Type	Max. (VA)	Peak Load (VA)	Room (VA)	Pass /Fail
CEC 220.82	24,000	24,501	(-501)	FAIL
CEC 220.83	24,000	23,301	699	PASS
CEC 220.87	10,778	10,145	643	PASS

KIM RESIDENCE



Kim Residence with Upgraded Induction Range and Ductless Mini Split

Kim Load Calculations

Calc. Type	Max. (VA)	Peak Load (VA)	Room (VA)	Pass /Fail
CEC 220.82	24,000	25,864	(-1,864)	FAIL
CEC 220.83	24,000	24,664	(-664)	FAIL
CEC 220.70	24,000	19,200	4,800	PASS

[1]Adapted from HEA https://corp.hea.com/home-electrification

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