



ELECTRIC SERVICE OPTIMIZATION FOR CONTRACTORS

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

PURPOSE OF THIS GUIDE

A recent study¹ 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. Yet many residential retrofit projects default to upgrading the electrical service, a costly and time-consuming process that often slows project timelines and increasing costs to customers. While there are many situations that rightly call for electrical service upgrades, this document is designed to provide tools and recommendations for contractors to minimize unnecessary service upgrades.

Proper project planning and use of code-approved alternative load calculations when adding new electrical loads like heat pumps or air conditioning, can be a win for everyone. Customers avoid costly service upgrades; contractors can complete jobs in a timely fashion and spend money where customers benefit most, and building officials can expedite permit approvals with accurate load calculations and complete permit packages.

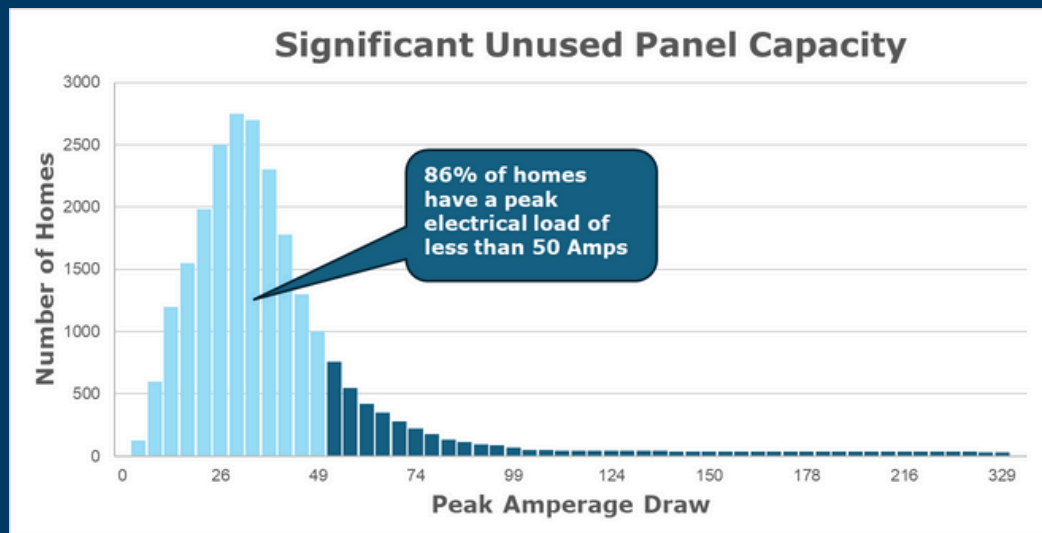


Figure 1: Peak Power Draw in CA Homes

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.



WHAT'S INCLUDED

Readers will find actionable information for permit application plan reviewers, practical solutions when submitting permit applications and insights into tactics that minimize 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 situation-specific electric load calculations more accurately determine actual available electrical capacity for new loads in existing buildings. Traditional load calculators used for new construction projects (CEC 220.82) don't do this.

» COMMON TECHNOLOGIES TO REDUCE PEAK ELECTRICAL LOADS

Selecting lower peak-power appliances is another technique. Included are insights into many of the most common technologies.

STRATEGIES TO MINIMIZE SERVICE UPGRADES

When designing a retrofit, some combination of the following strategies work together to minimize the need for service upgrades. Details are covered further in this document.

» 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 others 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 can vary, and local jurisdictions may have additional requirements or different interpretations of code when submitting permit applications. While contractors generally are the most knowledgeable about the requirements of the jurisdictions they work in, below are some recommendations from various building departments that have helped streamline the application process and reduce permit review times. Some of these are recommendations for building departments, others are relevant for contractors.

» **Building Departments: 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)
- Cutsheets/specifications of new equipment

» **Contractors: Maintain a checklist for staff of information needed to complete load calculations. 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 electrical smart-meter 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 (accessible with permission from customer)
 - 125% of maximum demand is used
 - No renewable energy system on record or installed

CA APPROVED 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

California Electrical Code (CEC), Chapter 2, Article 220² 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 (smart-meter) utility data. Provides factor of safety and other provisions when calculating peak electrical load post retrofit. This data is available through the utility, or third-parties such as [Greenbuttondata.org](https://www.greenbuttondata.org) or [UtilityAPI.com](https://www.utilityapi.com)
- » **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 across California yet, some jurisdictions are adopting or allowing sections of the 2023 National Electric code that apply to Energy Management Systems (EMS). Details for the use of 220.70 is provided in [the extended document here](#). *Check with your local building department before recommending this to customers.*

» **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	Advanced Metering Infrascruct. 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 ELECTRICAL LOADS IN ENERGY RETROFITS

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.

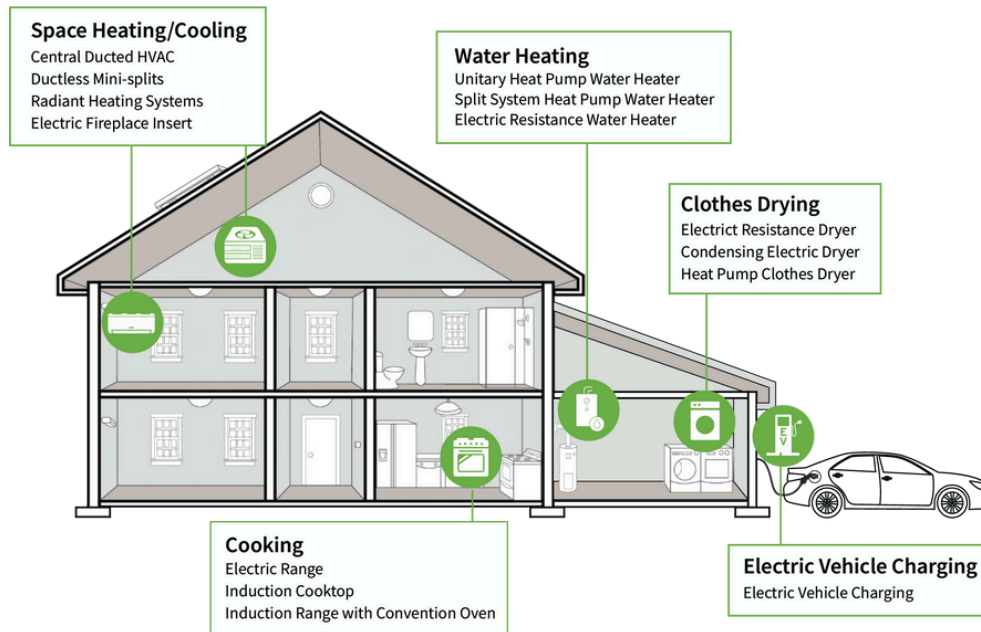


Figure 3: Key Load Reduction Technologies

- » **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 capacity where space is available can ensure adequate capacity for higher demand events. Many major manufacturers now offer these models.
- » **Induction cooking:** Eliminates combustion byproducts produced from gas burning cooktops and stoves. Improves indoor air quality and safety. More efficient than traditional electric resistance.
- » **Heat pump clothes dryers:** HP clothes dryers are about 30% more efficient than standard electric resistance dryers and are less damaging to clothing, although drying times are increased.
- » **Low-power level 2 EV chargers:** Reduce total peak demand and can often share circuits with other appliances in the home when additional circuits or capacity is not available (example: Dryer and EV charger)
- » **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.



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

Disclaimer: The information presented in this document serves as a general guide for building code compliance and the utilization of alternative methods for calculating electrical loads. Content herein does not constitute legal advice. Always consult licensed professionals regarding the details of any construction project. Richard Heath & Associates Inc. disclaims any implied warranty of the information provided herein including any warranties of merchantability and or fitness for a particular purpose of this content.

¹Adapted from HEA <https://corp.heac.com/home-electrification>