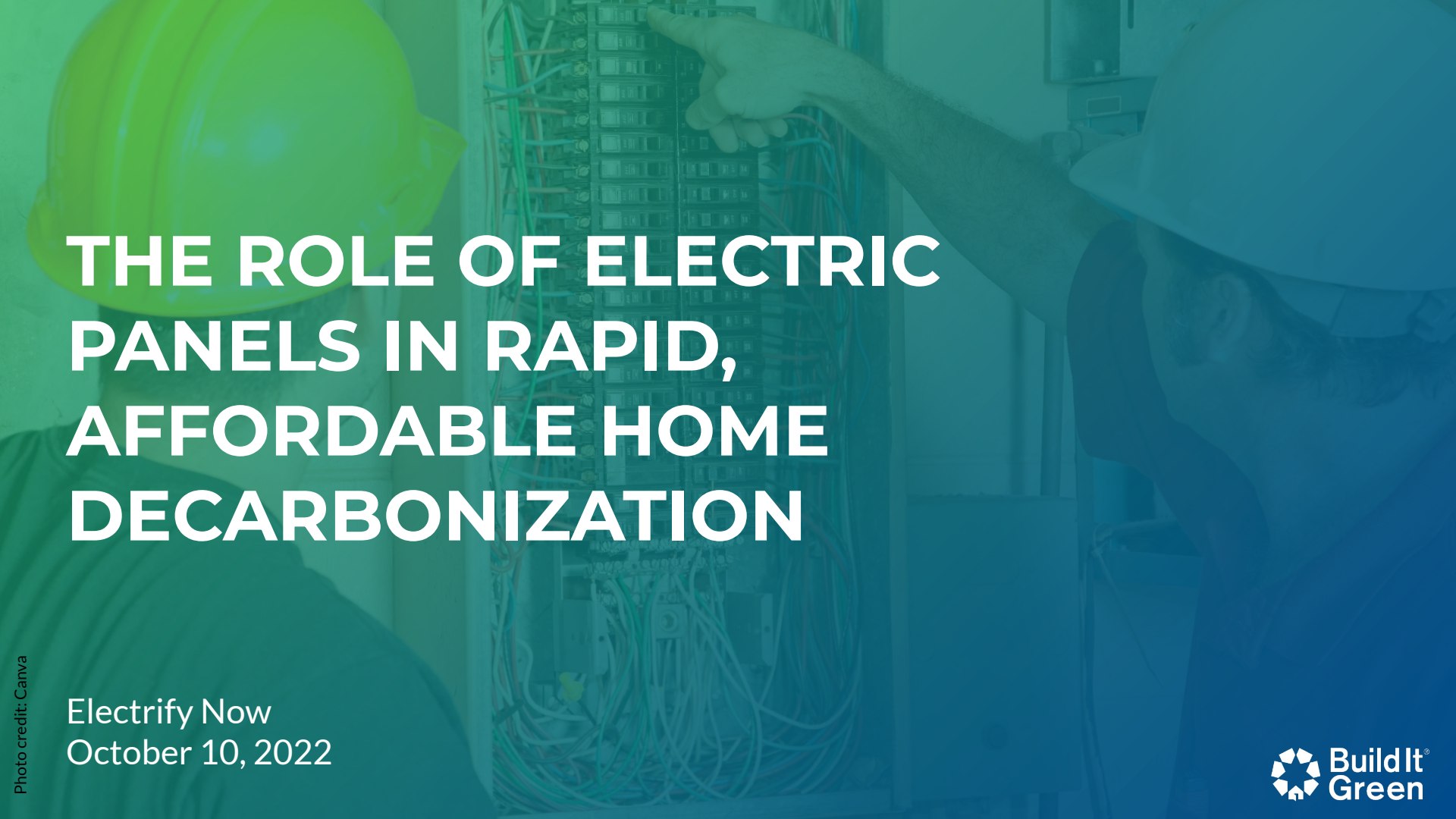


THE ROLE OF ELECTRIC PANELS IN RAPID, AFFORDABLE HOME DECARBONIZATION

Electrify Now
October 10, 2022

Photo credit: Canva

Build It Green

WHO WE ARE

Build It Green has been working to make California's homes more healthy and high performing since 2004.

We have convened a group of cutting edge, innovative leaders in electrification **to address the barriers and opportunities of electrical panels** to help reach our **building decarbonization goals as quickly, cost-effectively, and equitably as possible.**

Build It Green

What we'll cover

- Why home electrification matters
- What's the issue with electrical panels
- Strategies to avoid panel upsizing

NOTE: We're going to focus on existing single family homes in this conversation, because the rules and issues for multi-family are sufficiently different, but they're equally important!

Why home electrification matters

Benefits of all-electric homes

Buildings are responsible for **roughly 25%**[1] of climate change related emissions in California. More than many other states we use natural gas in our homes, to heat air, water and food for cooking. Converting all that gas use into electricity, while cleaning the grid, will **dramatically reduce emissions from homes**.

There's also **health and safety** — recent research found gas combustion inside homes, and leaks in and near homes releases toxic chemicals that can lead to cancer, as well as major safety risks[2] .

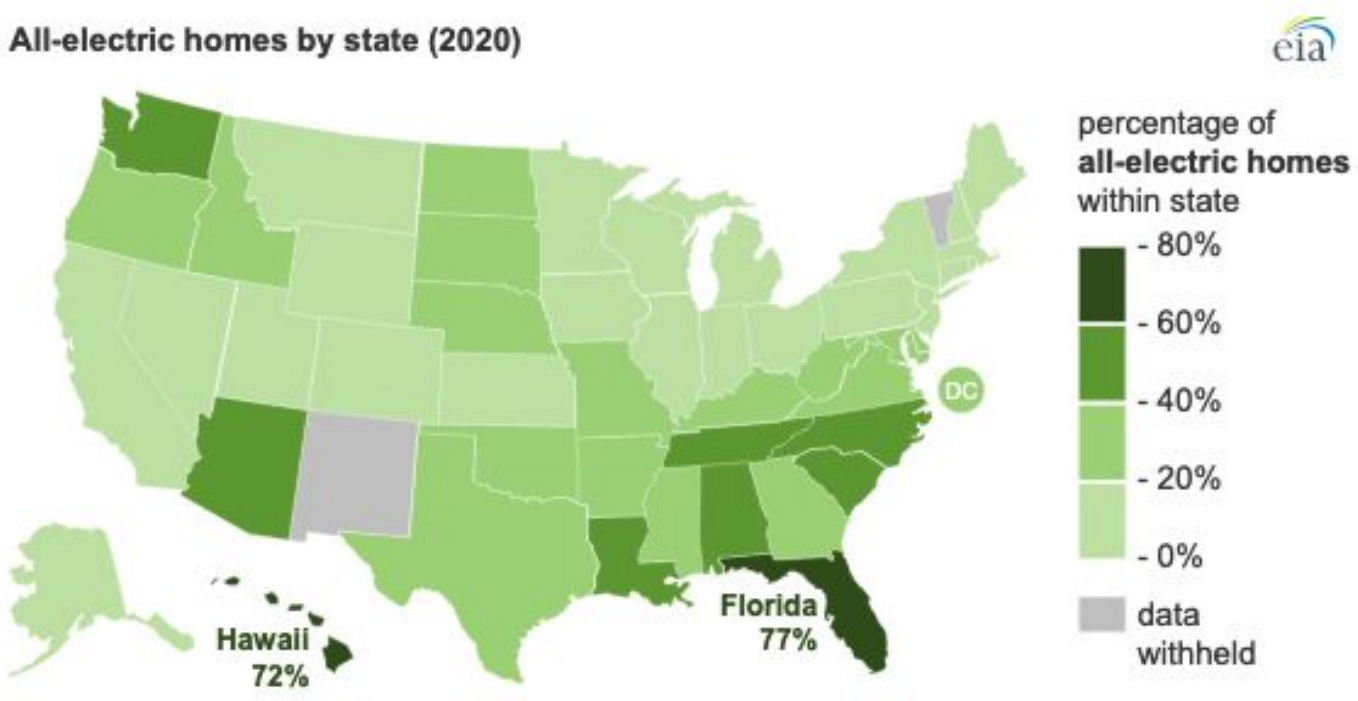
In order to hit our state climate goals and reduce human and environmental harms, we need to make this transition as **quickly**, **equitably** and as **cost-effectively** as possible.

8%
(1.1 Million)

Of California homes were all-electric as of 2020[3]

[1] National Resource Defense Council https://www.nrdc.org/experts/joe-vukovich/real-climate-impact-california's-buildings
[2] Harvard School of Public Health https://www.hsph.harvard.edu/c-change/news/natural-gas-used-in-homes/
3 Energy Information Administration. https://www.eia.gov/todayinenergy/detail.php?id=52999

All-electric homes by state



Parts of the west and northeast have the lowest rates of home electrification, and highest use of fossil fuels inside the home, especially for space and water heating.

Data source: U.S. Energy Information Administration, *Residential Energy Consumption Survey*

Panels: barrier or opportunity?

An important piece of equipment to a successful electrified home is the electrical panel. There are roughly 7.5 million single family homes in our state[1], with a median age of 45 years[2], meaning many homes' electrical systems are also aged.

That means upgrading or upsizing panels is required in some cases. However, **a faster, more affordable, safe option is available for most homes with a 100 ampere (amps) circuit breaker panel or greater** (standard for new buildings in CA after ~1968[2] — 200 amps is the minimum now).

14M Appx. number of homes in California[1]

6M Appx. number total homes in California built before ~1968[3]

[1] UC Terner Center for Innovation. https://ternercenter.berkeley.edu/wp-content/uploads/2021/07/SB-9-Brief-July-2021-Final.pdf
[2] National Association of Home Builders. https://www.nahb.org/blog/2021/04/median-age-of-housing-stock-by-state-varies-by-more-than-35-years/
[3] American Housing Survey, Census Bureau, 2019. https://www.census.gov/library/working-papers/2011/demo/SEHSD-WP2011-18.html.
[4] National Fire Protection Association, history of the NEC 'about the code'.

This could save billions

In a scenario where every house built before 1990 requires an electric panel [upsize], **an investment between $25 - $40 billion dollars would be required**…. Regardless of the exact amount, it's important to note that just one component of electrification, updating the main electrical panel of a home, will require a tremendous financial investment.

California Energy Commission. California Building Decarbonization Assessment - Final Commission Report, August 13, 2021, pg 109

Much of this can be avoided!

What’s the issue with electric panels?

Why not just upsize?

It's expensive and time consuming! It can also trigger a service upsize (not just the panel hardware), costing additional thousands of dollars and months of time that are often unnecessary.

We can make many families safer, more comfortable, and help them save money and energy ***without* upsizing**. This is possible while being both completely safe and without any sacrifice of quality of life. In fact, health and safety outcomes are likely to improve.

$3,000-$25,000

Avg. cost range of panel upsizes in California[1]

3-6 months

Avg. time needed to perform an upsize[1]

[1] Redwood Energy & NV5, Service Upgrades for Electrification Retrofits study, 2022.

Why not just upsize (beyond the home)?

Not only is it expensive for homeowners, but also for utilities, to upgrade grid equipment and factor in managing for potentially larger loads. Service upgrade charges, in addition to electric panel upgrade expenses, further increase costs.

Better utilizing what power is already available is a **grid-friendly** and **neighborhood-friendly** approach to electrification, and allows more people to electrify more quickly and affordably.

$2,000-$30,000

Avg. cost of service upgrades in California[1]

[1] Redwood Energy & NV5, Service Upgrades for Electrification Retrofits study, 2022.

Sometimes upgrades and upsizes needed

Yes, sometimes homes need an upsize and upgraded equipment because of damaged or unsafe devices, or truly insufficient electrical infrastructure (like fuse boxes in un-retrofitted pre-1960's homes with 60 amp service or less).

In these cases, planning ahead for efficient home electrification and decarbonization can **still save money and time**.

Photo: e-M Insurance

But many times not!

When a service upgrade is required, it is most often a direct result of an electrical panel upgrade triggered by insufficient service capacity required to meet a customer's increasing electrical load.

Most customers and contractors are unaware of **available options** to mitigate the need for a panel upgrade, and also potentially trigger a service upgrade.

> *In one study in San Mateo County, out of 10 customers making their homes all-electric, only one actually needed to upsize their electrical panel and service to do so except when electrifying luxury amenities like pool heating*[1].

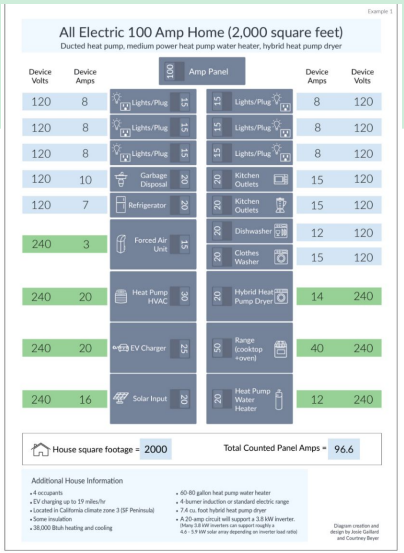
What are some options?

[1] Report forthcoming, San Mateo County Office of Sustainability All-Electric Homes Program

How to electrify a home without upsizing panels (or service)

Strategies to electrify without upsizing

1 Panel optimization & planning



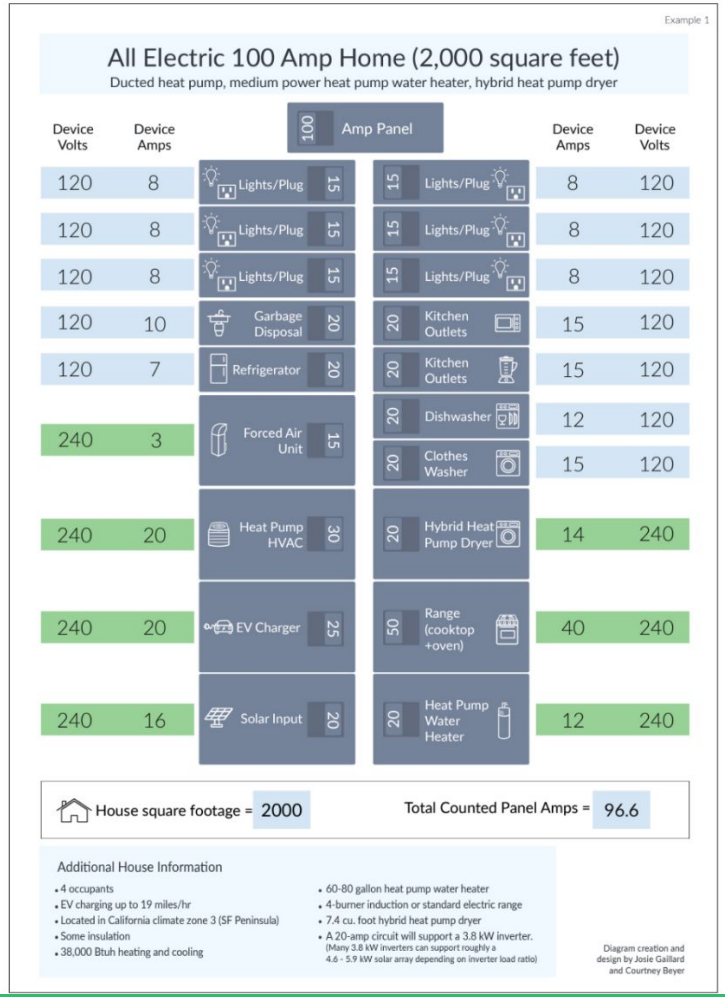
2 Technology & gadgets

Diagram:
Josie Gaillard & Courtney Geyer
Photo: Span.io

Strategy 1: Panel Optimization

For homes with 100 amp panels (or greater) it is possible to ‘optimize’ the panel through appliance choice and whole home electrification planning.

This means **thoughtfully choosing appliances that have great performance and are not only energy, but also power, efficient.** It also considers the use of load-sharing devices. This Watt Diet approach is technically feasible now with available technologies and appliances on the market.

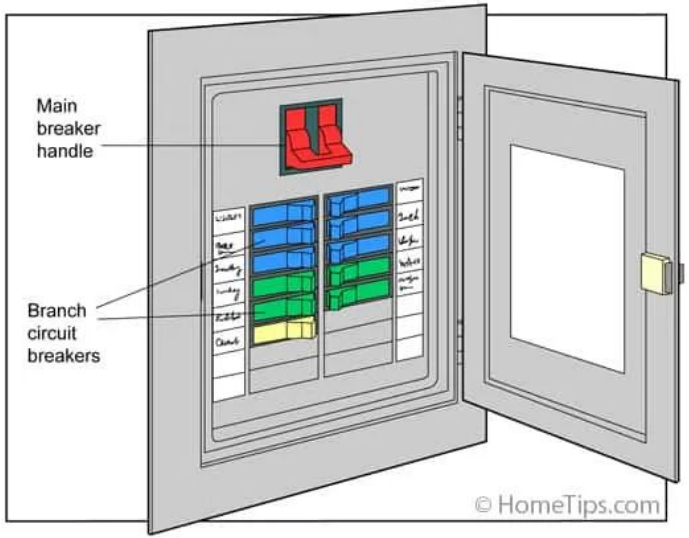


How many amps of service do I have to my panel?

There's no one way to tell, but here are a few things to try:

1. Inspect the outside of the power meter box. There may be an amperage rating listed on a label affixed to the power meter.
2. Inspect your main electrical panel to determine if it has a label on it indicating its amperage rating. If this is the case, the label will usually be affixed inside the panel door.
3. Check the size of the main breaker on the panel →

Also note, the size of your panel and the amount of electricity designed to service that panel might be different — for example, a 200 amp panel could be wired to only receive 125 amps of service from the utility.



Source: Don Vandervort, HomeTips

Strategies to optimize panel capacity

+ **Select power efficient versions of the appliances.** Choose the 15-amp version of a heat pump water heater instead of the 30-amp nearly identical version. Selecting high performance, power sipping versions of heat pumps instead of lower performance versions.
+ **Reduce heat and cooling loss by insulating and air sealing.** Goal to get below 3 ton HP.
+ **Avoid oversized EV chargers.** Choose a Level 2 (20-amp or 30-amp) charger for your EV charging and avoid 50-amp chargers at home.
+ **Use EV charger pausing circuits.** These briefly pause EV charging if many devices are on at once and the main breaker is at risk of popping.
+ **Use prioritized circuit sharing devices.** These handy devices can allow major appliances to share a single 240V circuit, taking turns automatically without homeowner action, like pause EV charging while other appliances, like the dryer, finish.
+ **Select appliances that combine two functions into one machine.** For example, the kitchen range (combining an oven and cooktop in one slide-in appliance), which lets us avoid a separate high power circuit for wall ovens.

Courtesy Redwood Energy

What's a power-efficient appliance?

+ **Doesn't sacrifice comfort** — for many appliances you don't notice the difference in performance at all — water is hot when you need it, everything works as expected.
+ **Not necessarily more expensive** than alternative appliance options

Comparing two electric appliances

Instantaneous (Tankless) Hot Water Heater

Heats water almost instantly as it moves through the system, only requiring energy while in use.

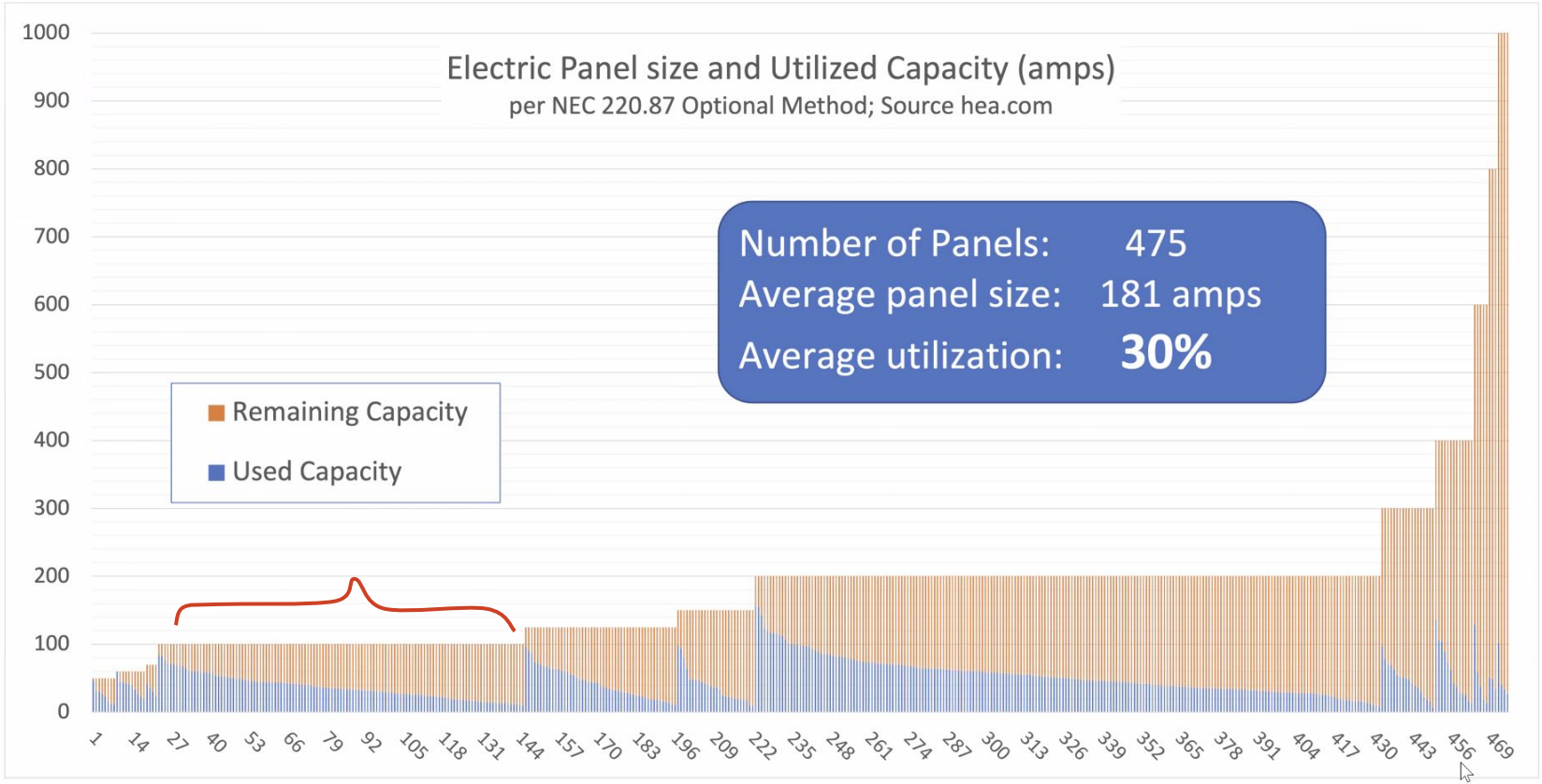
- **Energy-efficient?** *Yes.* This device requires a lot of power, but only for a short time. Its overall energy use is low.
- **Power-efficient?** *No.* This device demands a lot of power at once, requiring most, if not all, of a standard electric panel's capacity.

Heat Pump Hot Water Heater

Uses electricity to extract heat from the air and heat water in a storage tank.

- **Energy-efficient?** *Yes.* This device may operate for a long time, but its rate of energy consumption (power) is low.
- **Power-efficient?** *Yes.* This device uses much less power, both because it is 3x more efficient and because it deploys its power more gradually.

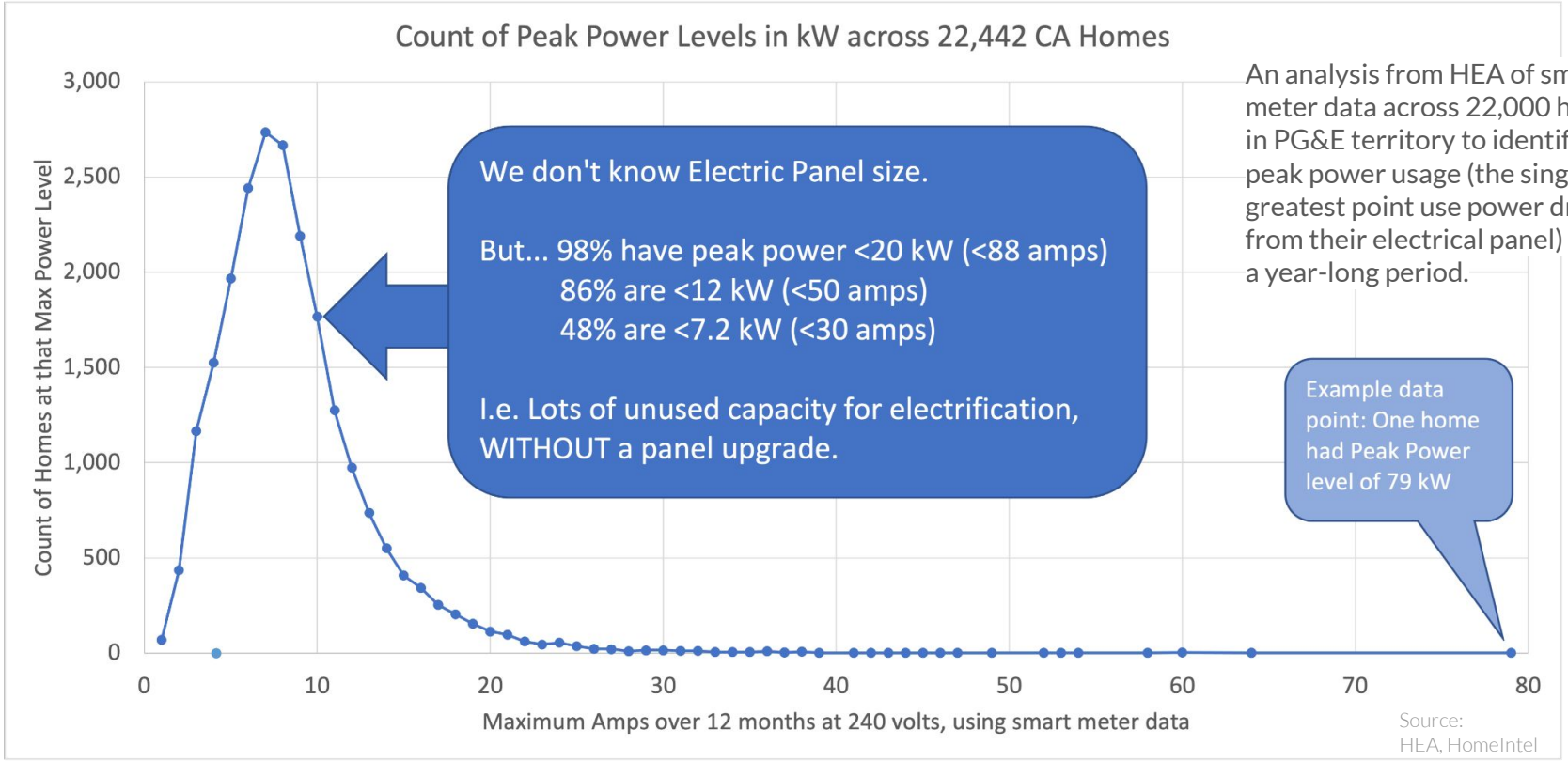
Available capacity to electrify on ‘optimized’ panels



*Not a representative sample of all CA homes, and mix of all electric and electric + gas.

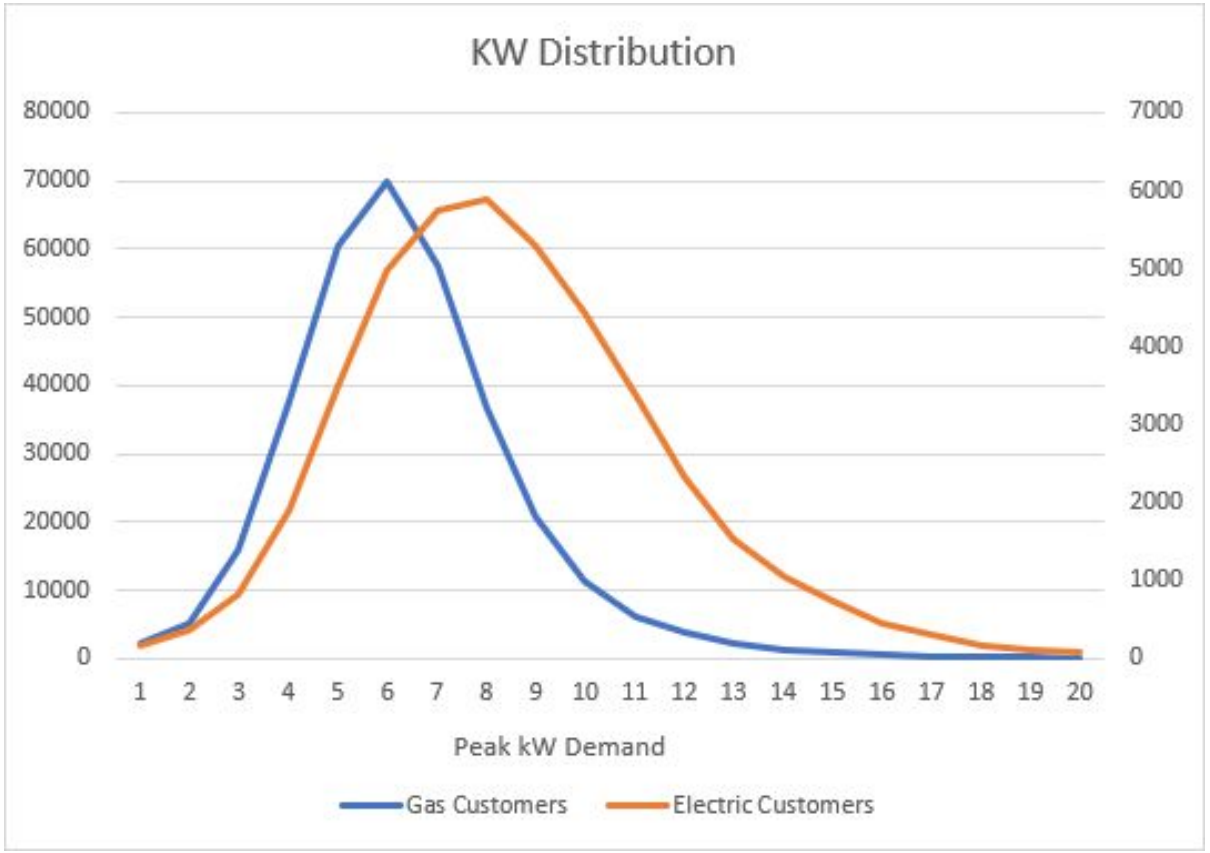
Source:
HEA, HomeIntel

Available capacity to electrify on ‘optimized’ panels



An analysis from HEA of smart meter data across 22,000 homes in PG&E territory to identify peak power usage (the single greatest point use power draw from their electrical panel) over a year-long period.

Available capacity to electrify on ‘optimized’ panels



In California, the vast majority of homes in California have peak power use well below **20 kW (88 amps at standard 240 volt input)**, with about **half** below 30 amps, indicating they should all have plenty of remaining panel capacity for electrification.

Source:
Scott Bluck, Sacramento Municipal Utility District (SMUD)

Panel load calculations options

Two parts of NEC most relevant for electrifying existing buildings:

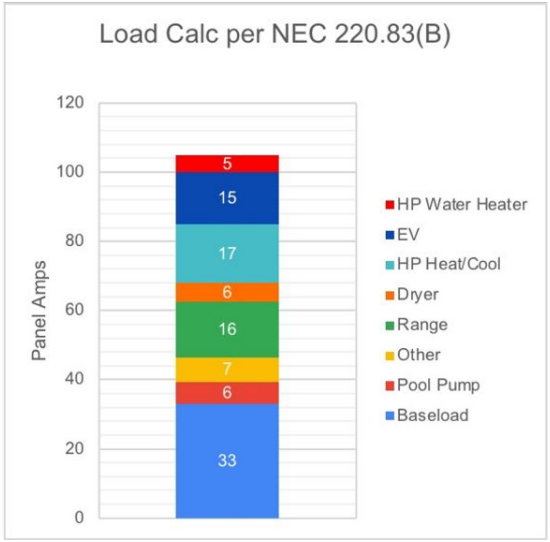
+ **220.83(B)** — Uses nameplate ratings on existing electrical equipment
+ **220.87** — Uses historical peak power use data

These are considered optional methods that give more flexibility for calculating loads for existing buildings.

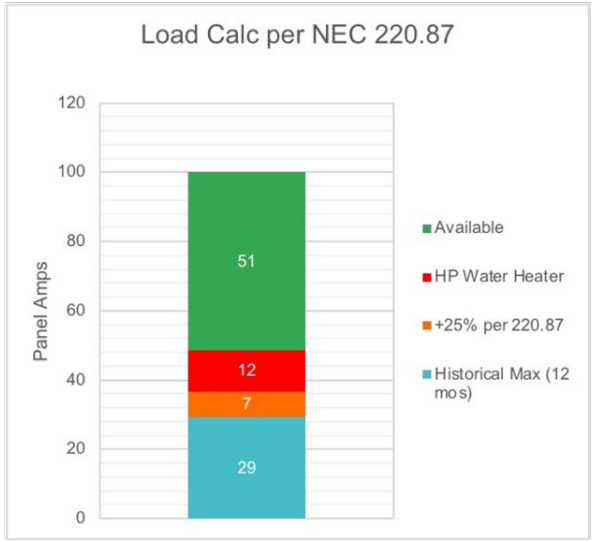
Tools to support simplify electrical load calculations and help homeowners and tradespeople develop whole-home electrification plans are being developed, for example:
www.zerocarbon-home.com

Comparison of load calculation options

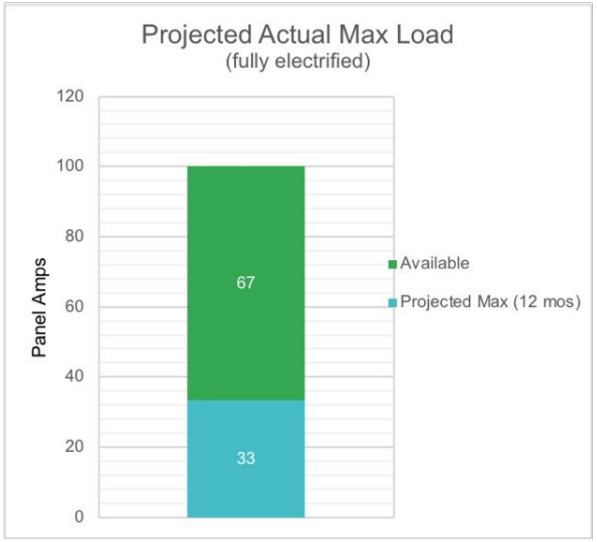
Same house: Calculations using both 220.83(B) and 220.87, and projected max load



Per NEC 220.83(B):
no room left for HPWH



Per NEC 220.87:
plenty of room for HPWH



In practice:
Fully electrified w/ room to spare

Summary Strategy 1: Panel Optimization

In summary, home-owners and utilities can save thousands of dollars and become more climate resilient by avoiding upsizing panels and related grid infrastructure.

Purchasing new, power and energy efficient appliances is not without cost. Incentives exist, with more on the way, to help support and subsidize these appliance purchases.

POTENTIAL CHALLENGES

+ Low number of electricians who understand the nuances in the code, how to calculate panel load, and how to support property owners in navigating panel avoidance.
+ Potential pushback from local building and health and safety (fire) officials who also have low familiarity or high risk avoidance

COMING 2024

Two national research labs and the Department of Energy are doing research right now to help address code challenges!

If you do need to upsize...

Sometimes a panel or service upsize is needed, and some areas do provide financial support to property owners to do this. Nationwide, new High-Efficiency Electric Home Rebate Act (HEEHRA) as part of the Inflation Reduction Act offers rebates up to $4,000 for electrical panel / breaker box improvements and $2,500 for needed additional wiring.

Note they also provide rebates for **weatherization**!

HEEHRA Rebate Levels

For Qualified Electrification Projects

Income Eligibility and % Costs Covered	
Low-income: <80% Area Median Income (AMI) % costs covered (including installation)	**100%**
Moderate-income: 80-150% AMI % costs covered (including installation)	**50%**
Overall Incentives	
Max consumer rebate	**$14,000**
Max contractor rebate	**$500**
Rebates for Qualified Electrification Projects	
Heat pump HVAC	**$8,000**
Heat pump water heater	**$1,750**
Electric stove/cooktop	**$840**
Heat pump clothes dryer	**$840**
Breaker box	**$4,000**
Electric wiring	**$2,500**
Weatherization insulation, air sealing, ventilation	**$1,600**

Source:
Rewiring America

Strategy 2: Technology

Another tool for electrification, deployed in conjunction with power-efficient appliance choices and panel optimization, is to utilize the growing number of devices and technologies to manage coincident (peak) demand inside a home to prevent maxing out available power. Examples include:

+ Load sharing devices
+ Meter collars
+ Smart circuit breakers
+ Smart panels & sub-panels

Photos:
Lumin, Eaton, Schneider Electric, SimpleSwitch

Load sharing/ circuit splitting

Smart circuit splitters allow two devices (typically high power) to share a single circuit, which can help avoid an electrical panel upgrade (most commonly sharing between an EV charger and an electric clothes dryer).

	Neo Charge[116] Smart Splitter	**BSA Electronics**[117] Dryer Buddy	**SimpleSwitch**[118] 240V Circuit Switch	**Splitvolt**[119] Splitter Switch	**Thermolec**[120] DCC	**Evduty**[121] Smart Current Sensor
						
Cost ($)	$500 (Appliance) $550 (Dual Car)	$200 – 365 (several outlet versions)	$550 (240V) $650 (EV) $550 (120V)	$319	$1,050 (DCC-9), $945 (DCC-10)	$500
Switch On/Off Between Two Devices	Yes	Yes	Yes	Yes	NA	NA
Continuous Power to Two Devices	Yes	Yes	No	No	NA	Yes, *shares power between appliance circuit and EV circuit*
Monitors Whole House Loads	No	No	No	No	Yes, *if total panel exceeds 80% rated load, turns off EV charging. Reconnects automatically*	Yes, *monitors a unit/home's current draw, left over current will be used to charge EV*

Source: Redwood Energy & Menlo Spark

Load sharing/ circuit splitting challenges

REGULATORY ENVIRONMENT

Technology innovation moves quickly, and codes, standards, safety approvals and rules move slowly. In some jurisdictions, there is no guidance for how to use these devices or they are not allowed by the local building codes or health and safety authorities.

EXISTING INFRASTRUCTURE

If you have a particularly fossil gas intensive home, you may not have any 240 volt plugs, for example if you have a gas dryer, to be easily shared with EV charging equipment or similar.

Recommendations to save time, money and resources

Avoid panel upsizing if at all possible

- Do whole house panel optimization planning
- Choose power efficient appliances

If an upsize is required, make them as small as possible and consider smart panel or circuit technology

- Jurisdictions should consider only subsidizing the minimum panel required, when supporting panel upgrades, for whole home electrification, to lessen impacts on the overall grid and increase overall community access and ability to affordably electrify.

And an added benefit: reduce grid stress as we all electrify!

Other Resources

All-electric retrofit guides and the **Watt Diet calculator** from Redwood Energy: https://redwoodenergy.net/all-electric-retrofits/

Smart grid technologies — Rewiring America

Load sharing & related devices — Canary Media

PG&E class on How to electrify without upgrading your panel

Building Electrification Institute

Electrification Retrofit Consultants & Contractors in California

There are many, but here are a few to get you started:

- All-Electric California
- Electrify My Home
- QuitCarbon
- and many others at the **Switch Is On Contractor Directory**: https://switchison.cleanenergyconnection.org/

Thank you

This presentation is developed with support, knowledge and resources from the **Panel Optimization with Electrification Reassessments (POWER) working group**.

Learn more here: www.builditgreen.org/blog/panel-optimization-group/

This presentation has been given by Build It Green, an Oakland based organization that believes every Californian deserves to live in a safe, affordable home in a resilient and thriving neighborhood. Our mission to help accomplish that by providing credible and accessible resources to develop regenerative communities. We envision, and are committed to creating, a healthy housing ecosystem that fosters the well-being of individuals, communities, and the natural world. We exist to support all those who share this commitment.

Reach out to learn more at www.builditgreen.org or hello@builditgreen.org

Photo credit: Canva

Build It Green