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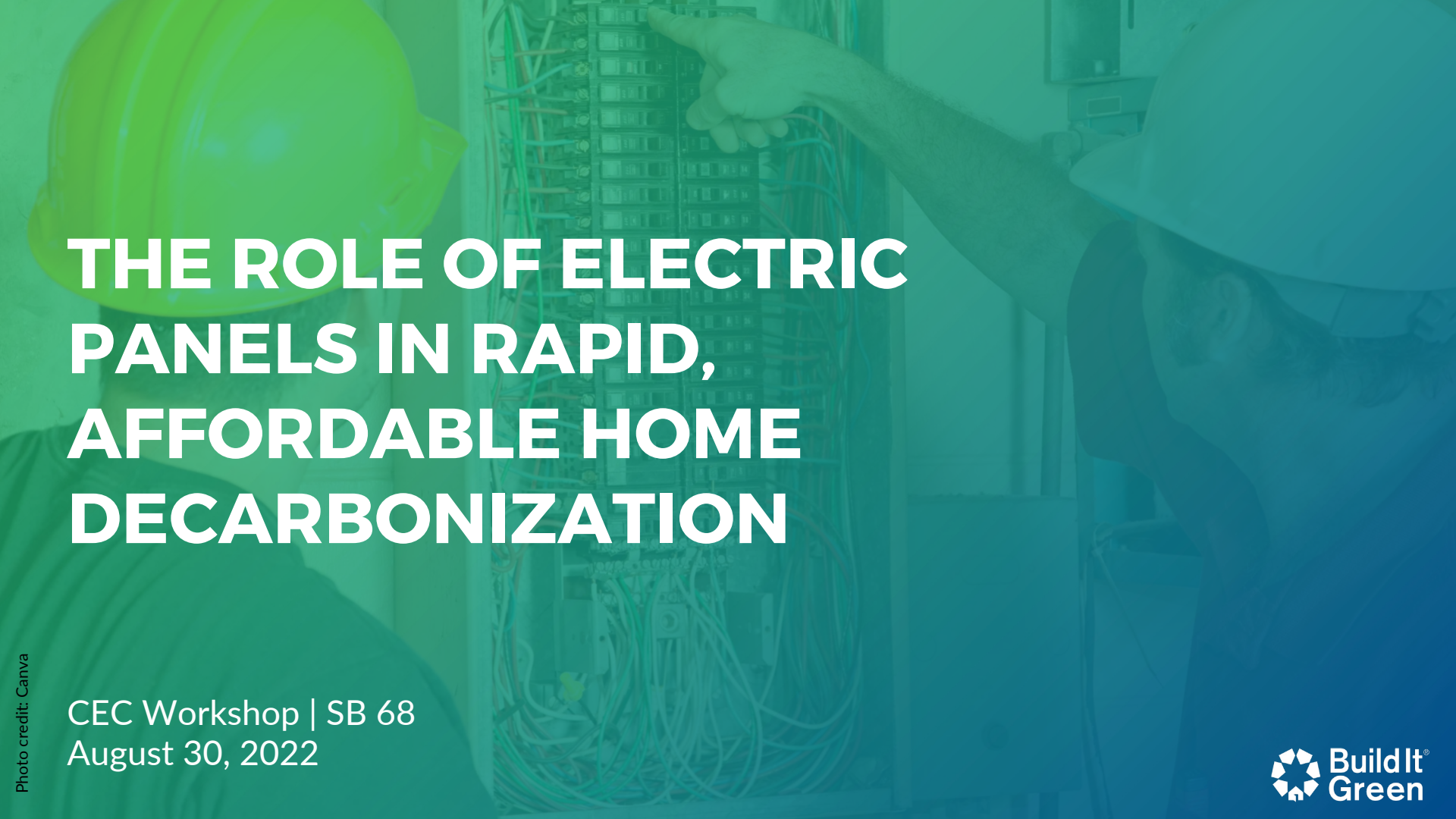

THE ROLE OF ELECTRIC PANELS IN RAPID, AFFORDABLE HOME DECARBONIZATION

CEC Workshop | SB 68
August 30, 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.**

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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

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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-californias-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

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 ~1965[2] — 200 amps is the minimum now).

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

6M Appx. number total homes in California built before ~1965[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, while hitting our state goals

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 upgrade because of damaged or unsafe equipment, 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, help plan for future solar installation, EV charging, and other electrification needs.

Photo: e-M Insurance

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

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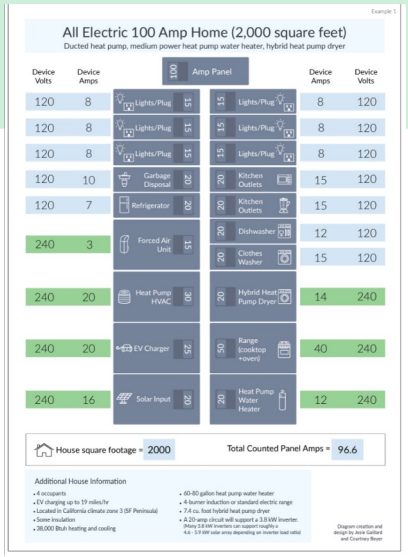
Strategies to electrify without upgrades

1 Panel optimization & planning



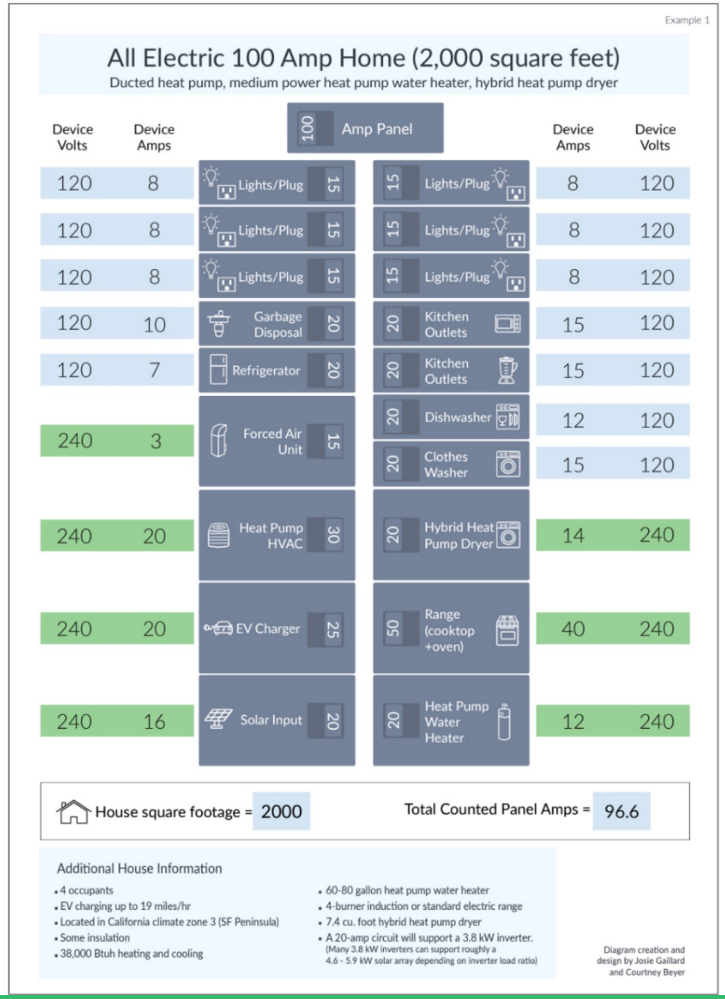
2 Technology & devices

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.



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.** Target less than 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.

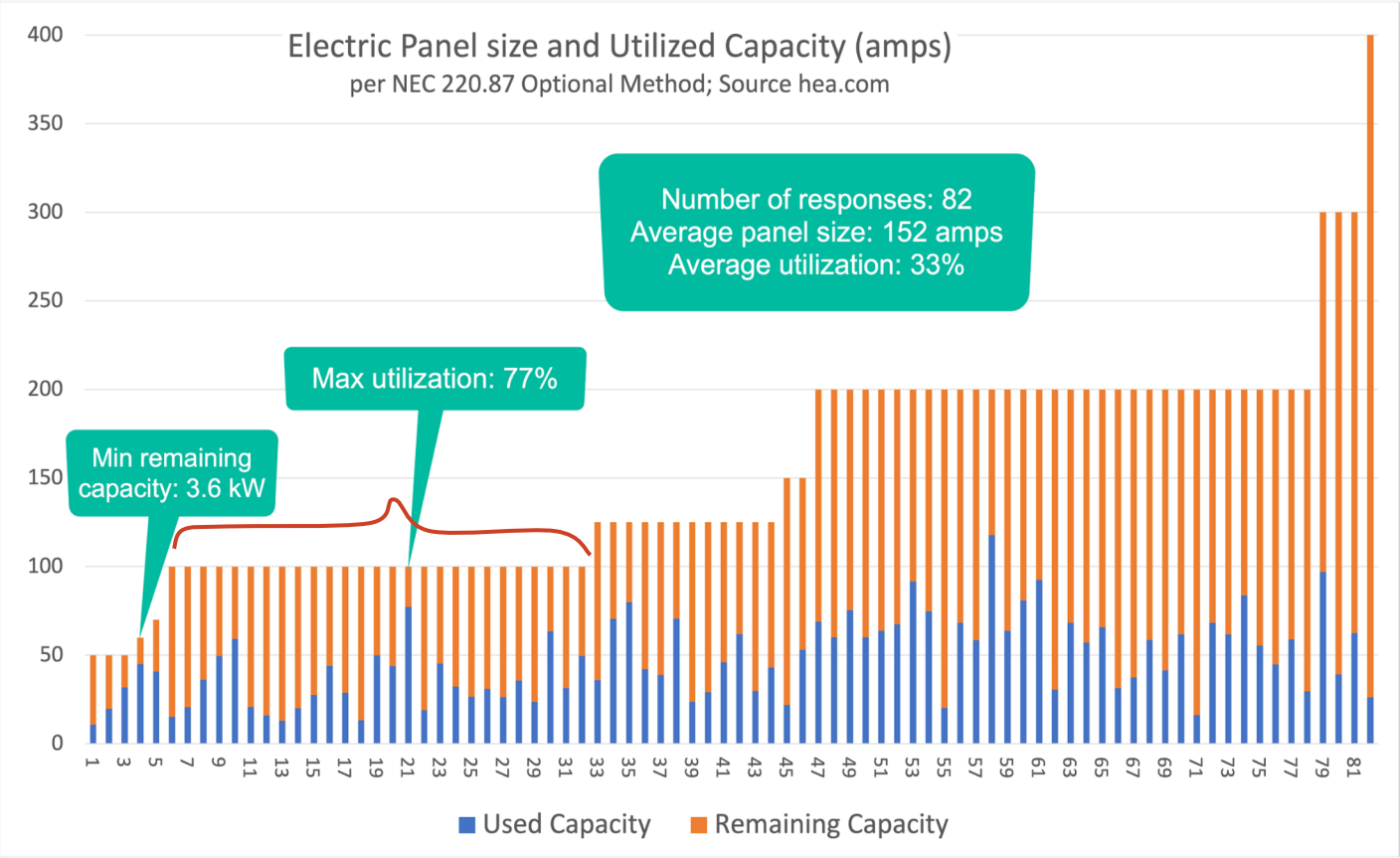
- **Energy-efficient?** *Yes.* This device requires a lot of power, but only for a short time. Its overall energy use is low.
- **Power-efficient?** *No.* This device demands a lot of power at once, requiring most, if not all, of a standard electric panel's capacity.

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



Each line is a single home and represents a sampling of homes from across PG&E’s service territory

Source: HEA, HomeIntel

Panel load calculations options

Two parts of NEC most relevant for electrifying existing buildings:

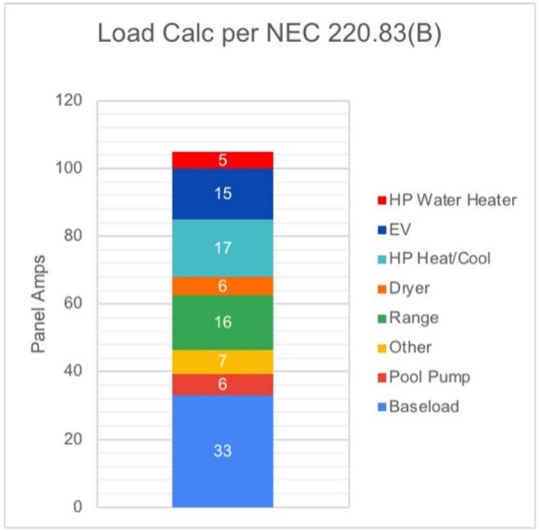
+ **220.83(B)** — Uses nameplate ratings on existing electrical equipment
+ **220.87** — Uses historical peak power use data

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

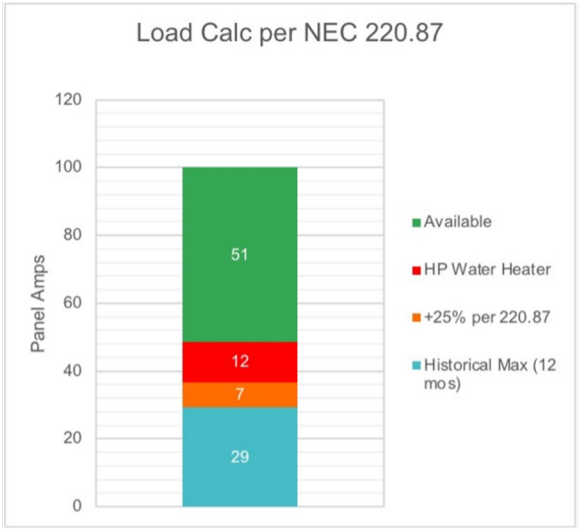
Tools to support simplify electrical load calculations and help homeowners and tradespeople develop whole-home electrification plans are being developed, for example:
www.zerocarbon-home.com

Comparison of load calculation options

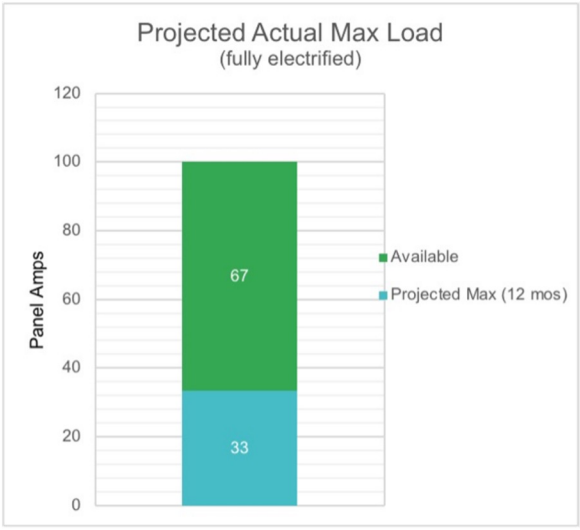
Same house: Calculations using both 220.83(B) and 220.87, and projected max load



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

Source: Josie Gaillard

Summary Strategy 1: Panel Optimization

In summary, home-owners and utilities can save thousands of dollars 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.

WHAT'S NEEDED

More direct support for whole home electrification planning and incentives to support particularly low income homeowners plan, purchase appliances and pay for contractor work is needed to help accelerate this effort.

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

Other considerations

Improve non-mechanical home systems - insulation, air sealing, etc.

Energy efficiency, and home envelope, should come as soon as possible and are cost-effective at improving comfort and performance of new appliances.

Grid optimization / demand response capabilities

Tools and approaches to manage peak load and high demand curves, through smart equipment choice and efficient electrification, will extend the life of current equipment and improve overall resilience.

Workforce

We need to maximize the use of available talent to make as much decarbonization progress now, while also training new, skilled workers who can safely and knowledgeably perform this critical work.

Recommendations to save time, money and resources

Avoid panel upsizing if at all possible

- Do whole house panel optimization planning
- Incentivize 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!

Ongoing research

LBNL and NREL have been jointly funded by the US DOE to investigate the role of electrical panel and infrastructure upgrades in home electrification projects in existing US homes. The overarching goal is to highlight the least-cost pathways to electrify the existing housing stock, in part by avoiding electric service and panel upgrades. *As funded, the work involves multiple elements, including:*

- Characterization of electrical panels in homes, plus the frequency and cost of upgrades. Analysis will leverage both real-world data sets and residential building stock modeling using NREL's ResStock.
- Evaluation of current low-power and load control solutions on the market, including technology reviews, estimation of load control needs, and potential field evaluation of select technologies.
- Development of a novel standard for whole-dwelling load control technologies.
- Market transformation efforts, including proposing amendments to the National Electric Code that are supportive of low-power and low-cost home electrification, and developing resources for contractors and code officials to support panel upgrade alternatives.

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

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

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