ET Summit 2024

Presented by

On Panel Sizes and Electrification

Where Engineering Logic Meets Behavioral Psychology

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Q: How Do We Decarbonize the Energy System?

(A: Electrify, pretty much, everything – as soon as possible…)

Q: Are there barriers to electrification?

(A: Yes, there are many, both in front of and behind the meter.)

CALIFORNIA AIR RESOURCES BOARD

Zero-emission Space and Water Heaters Standards

Motivation

Commercial and residential buildings are responsible for approximately 10 percent of GHG emissions in California. Zero-emission standards for new space and water heaters sold in California would decrease GHG emissions from buildings to help the state meet its climate goal of achieving carbon neutrality by 2045 or earlier and are part of California's climate strategy as laid out in the 2022 Scoping Plan. Buildings also emit about 66 tons per day (tpd) of NOx to the ambient air, about four times the emissions from electric utilities and nearly two-thirds the emissions from light-duty vehicles statewide. Therefore, a potential regulation would reduce NOx emissions as outlined in the 2022 State SIP Strategy to assist with meeting state and federal air quality standards and achieving public health benefits.

Concept for Regulation

The concept for the regulation would not be a ban on non-zero-emission space and water heaters. This potential regulation would not limit use or repair of existing non-zero-emission space or water heaters. Existing non-zero-emission space and water heaters would not need to be replaced before 2030. Instead, the concept for zero-emission standards for these would mean that any time a person or business purchases a new space or water heater (whether for new construction or to replace in existing buildings), they would only be able to purchase zero-emission units. Therefore, non-zero-emission space and water heaters could remain in operation after 2030.

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Quantifying the electric service panel capacities of California's residential buildings

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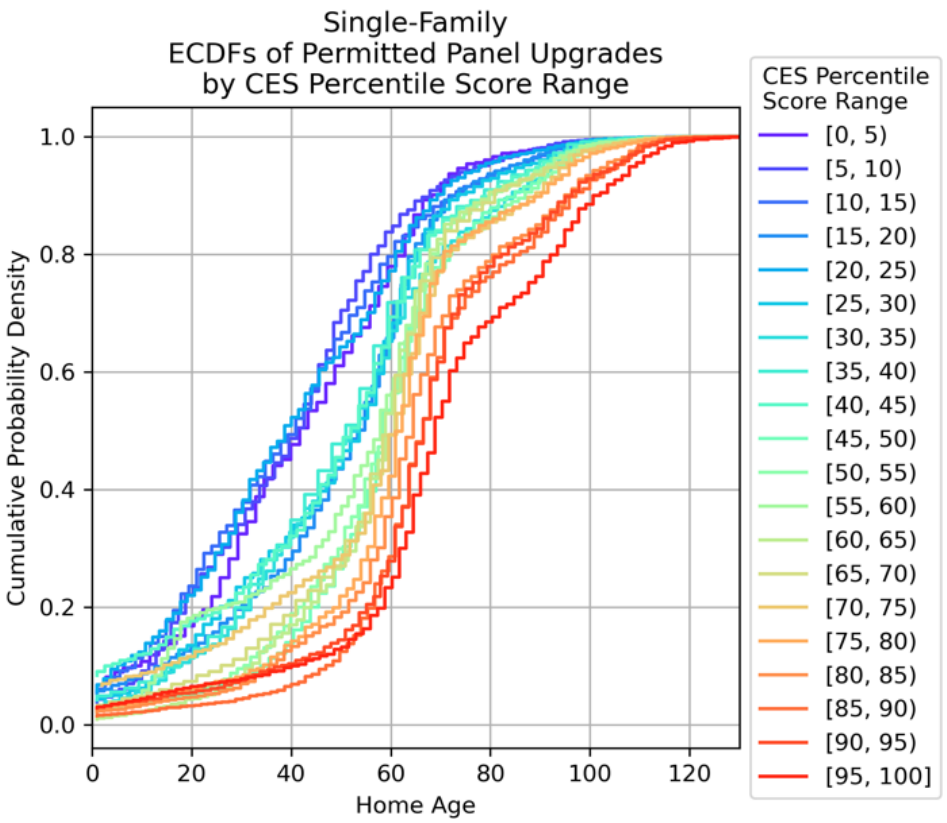
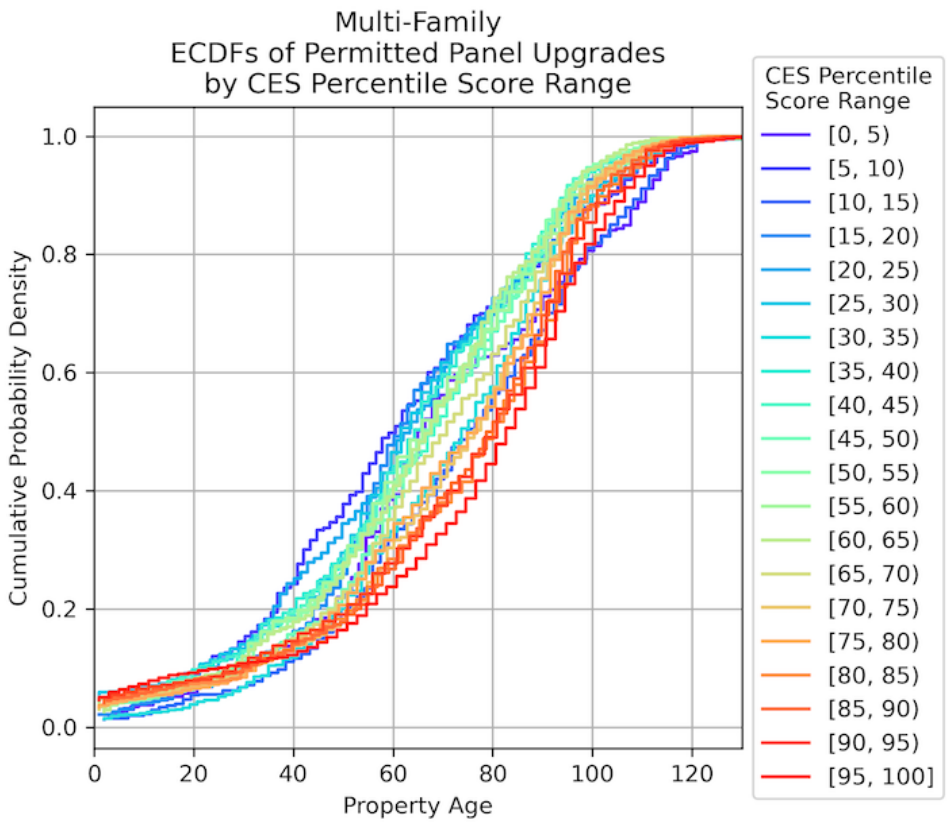
A B S T R A C T

This study seeks to quantify the size distribution of existing installed electrical service panels within California's residential buildings, a potentially significant barrier to future decarbonization efforts. A large sample of historical building permit data was collected for municipalities throughout the state, from which permitted panel upgrades were extracted and analyzed. These data were used to develop a method for estimating panel capacities that incorporates information about historical code requirements for panel sizing in new construction with a statewide database of parcel-level building attributes. Overall, we find that 3% of single-family (SF) and 10% of multi-family (MF) properties in California have panels in the smallest size range, which will most likely require upgrades. However, 32% of SF and 59% of MF properties have panels of intermediate size, which will likely require the addition of load management systems to support comprehensive electrification. Future panel upgrade needs are expected to be more acute within disadvantaged communities, where the proportion of SF homes with the smallest-sized panels is 4x that in more affluent neighborhoods. We discuss the implications of these and other results within the context of existing and planned future state policies related to residential electrification.

We developed a novel methodology for simulating the likelihood of panel upgrades having occurred at residential properties since the time of their original construction.

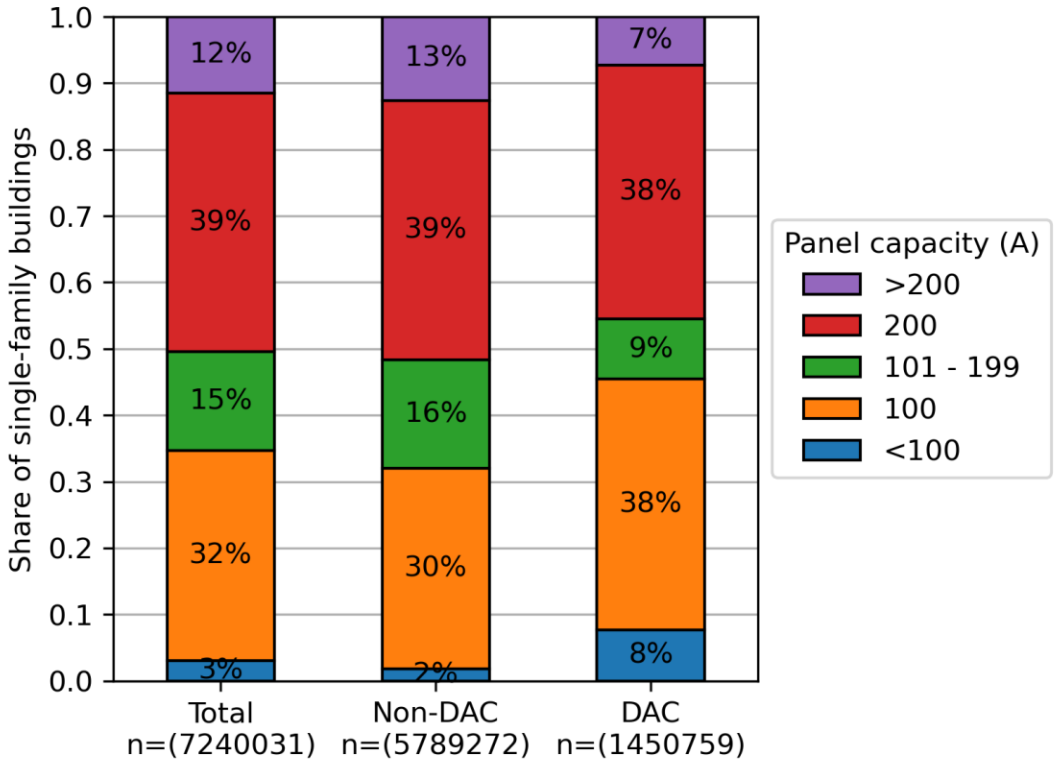
We used a large sample of municipal building permit records, which include <100k permitted panel upgrades, as the basis of this approach.

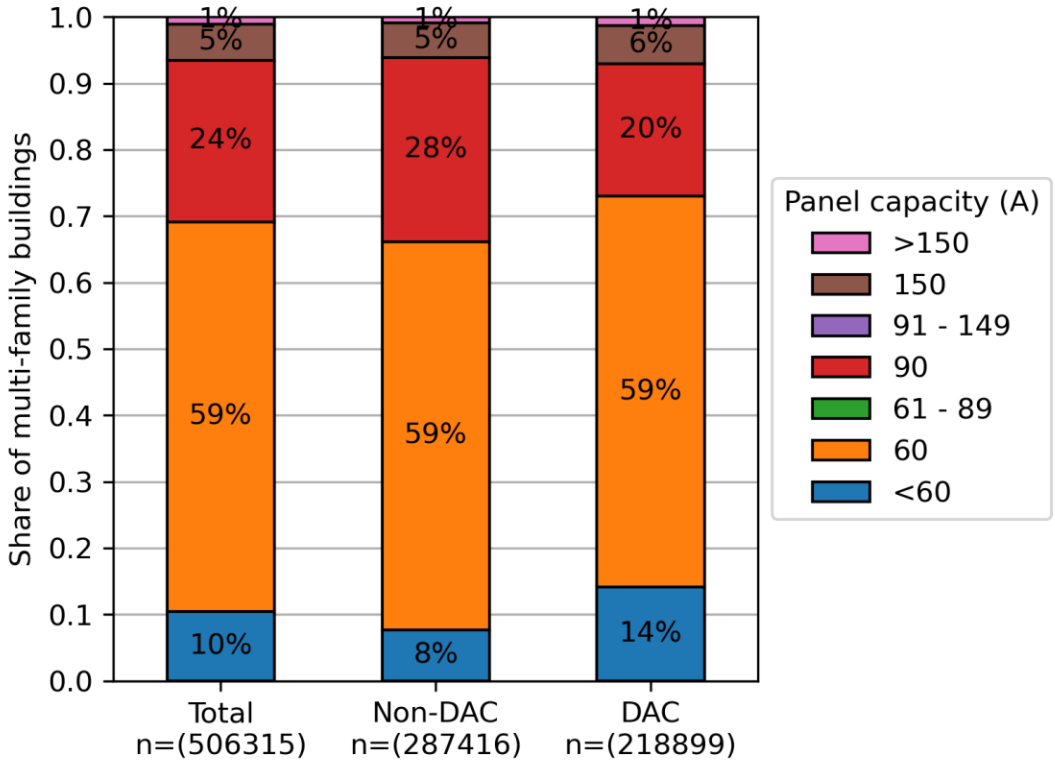




These plots show our best estimates for the currently existing panel sizes of all the single-family and multi-family properties throughout the state of California for which requisite building attribute information were available.

Aggregate results are shown for each building sector as well as differentiated by the DAC status of the Census Tracts in which the properties are located.





* Multi-Family panel sizes are given per dwelling unit

Some Take Home Messages

Good news:

The number of single-family homes with extremely small sized panels (<100 Amps) is small (~3%).

Due to antecedent upgrades and evolving code requirements, most homes now have 200 Amp panels.

This should be sufficient for these households to fully electrify without the need for additional capacity.

Bad news:

The occurrence of smaller sized panels is far more prevalent (4x so) in disadvantaged communities.

These households are likely the most constrained in terms of the financial resources needed to upgrade panels.

Panel upgrade decisions are generally made on the margin, leading to a lack of integrated capacity planning.

Q: How Many People are Going to Need Upsized Panels to Fully Electrify?

(A: It's complicated…)

There is a point where engineering logic stops, and behavioral psychology takes over

There is a big difference between the minimum panel size that you could possibly use to electrify your home given the suite of low-power technologies and optimization strategies currently available.

Versus

The panel size that you think (or have been convinced) that you need to future proof your home and enjoy the energy end use performance capabilities that you desire.

Remember that in America bigger is (usually) considered better

We tend to have a penchant for energy end-use solutions that provide an excess of capacity/capability (when we can afford it).





* HVAC contractors are notorious of over-sizing systems to avoid customer disappointment.

Panel upsizing is expensive, except for people who have a lot of money

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- If you are a person of means, you probably already live in a bigger, newer vintage home, that was built with a larger capacity panel (or at least has been upgraded recently). Thus, panel capacity is likely not to be an issue in terms of electrifying your home.
- But even if you are forced to upsize the panel for some reason, at $3-$5k on average, cost is not likely to be a major barrier.*

* This scenario does of course exclude some potentially VERY expensive ancillary work that could be required in some instances like full wiring upgrades or the need to either pay for new or relocate existing utility service distribution infrastructure

Now consider an alternative scenario

Now consider an alternative scenario

- A statewide regulation is created which prohibits the sale of new air and water heating appliances that operate using gas.
- The aging gas furnace that you use to heat your home suddenly breaks down and you are now forced to find a replacement solution.
- You contact an HVAC contractor to give you a quote and they indicate that your existing electrical service panel lacks sufficient capacity to support an appropriately sized heat-pump system.
- You are now faced with the cost of upgrading your home's electrical service panel and one of its major appliances – at the same time.

Here are some options for you, none of which are ideal

- Try to repair the existing gas appliance and avoid the need for both the panel upgrade and heat-pump install (at least temporarily). ⟷ Low Cost Short-Term
- Choose a lower power rated heat-pump and install some new load management hardware to avoid the need for a panel upgrade. ⟷ Mid Cost Long-Term + Tradeoffs
- Determine whether you qualify for state and federal rebates to defray some of the costs of the panel upgrade and heat-pump install. ⟷ Mid-High Cost Long-Term

This scenario begs some questions about the implementation of potential regulations

- Should there be different compliance pathways/timelines for low-income households?
- Should there be a longer-term deadline upon which existing gas equipment will no longer be able to be used/repaired – and thus, must be replaced?
- Why only regulate space and water heating? Why not all domestic end-use gas appliances?

Thank You!

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