Making Homes Electric Ready – Ways to Avoid or Streamline Electric Panel Replacement

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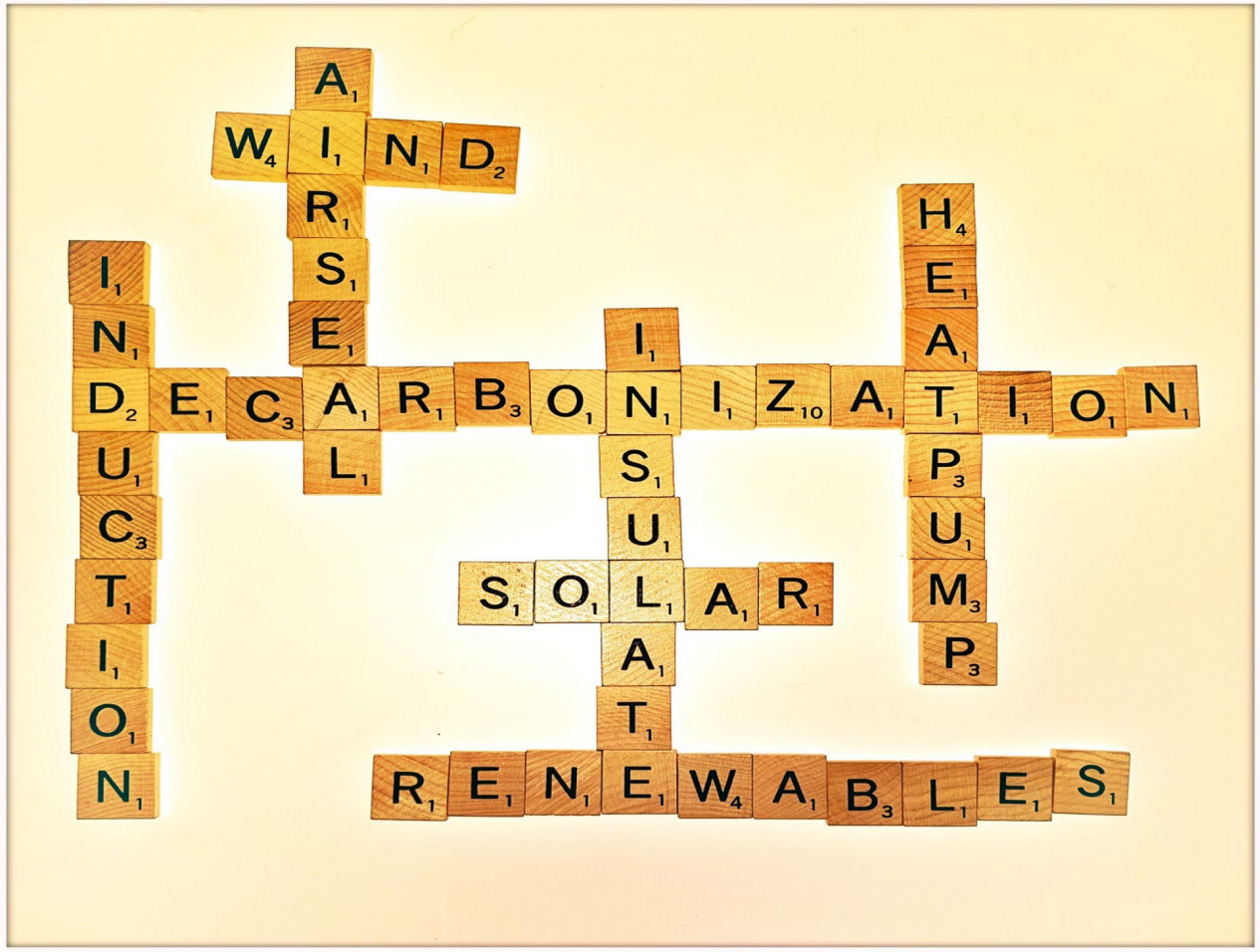
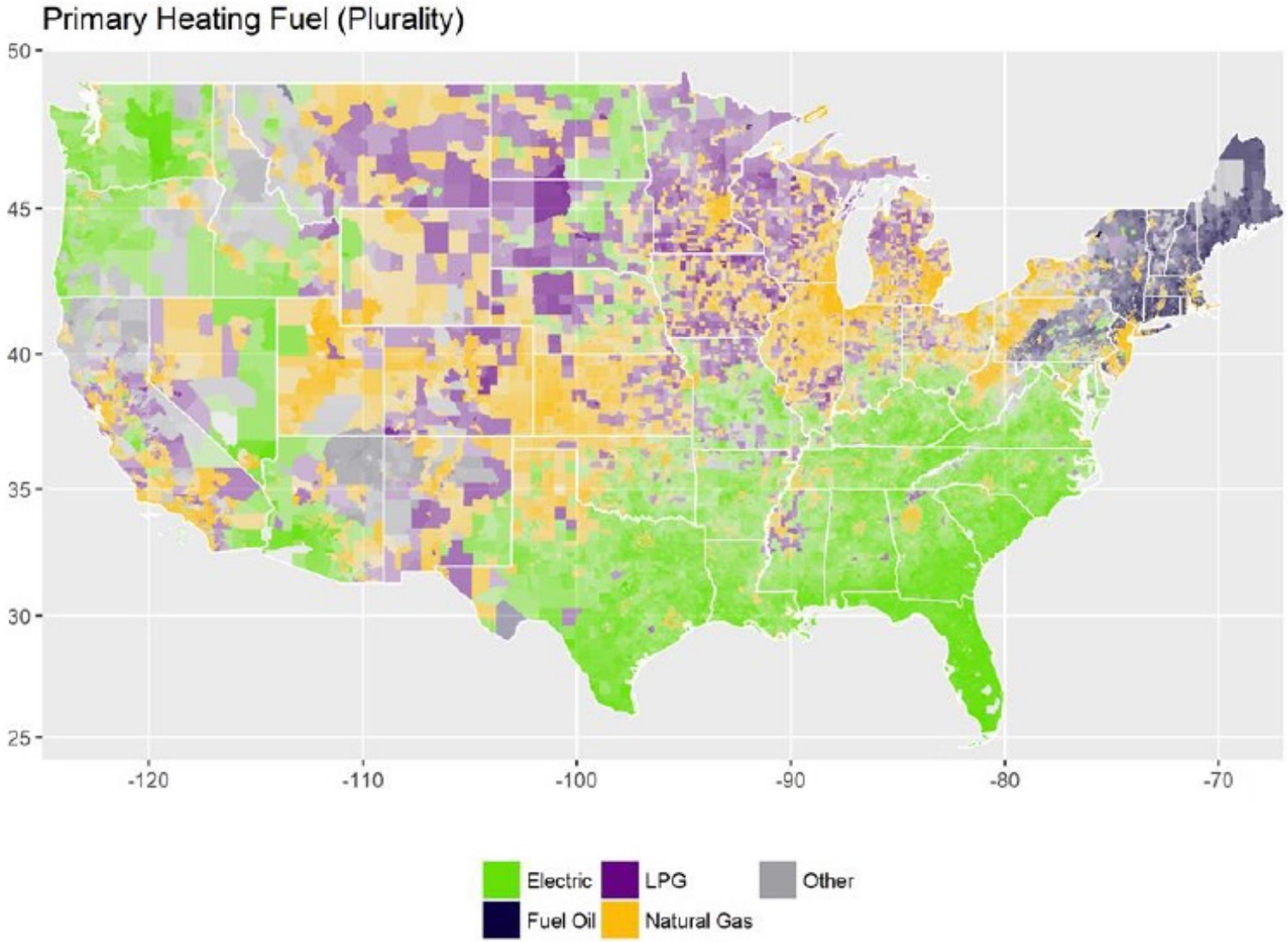


Problem Scope: How Many Homes?



Data from the American Community Survey (2016).

>25% of homes are already all-electric
- highly regional

75% of homes have central AC

Electric Heating

- 51% of MF units
- 27% of SF units

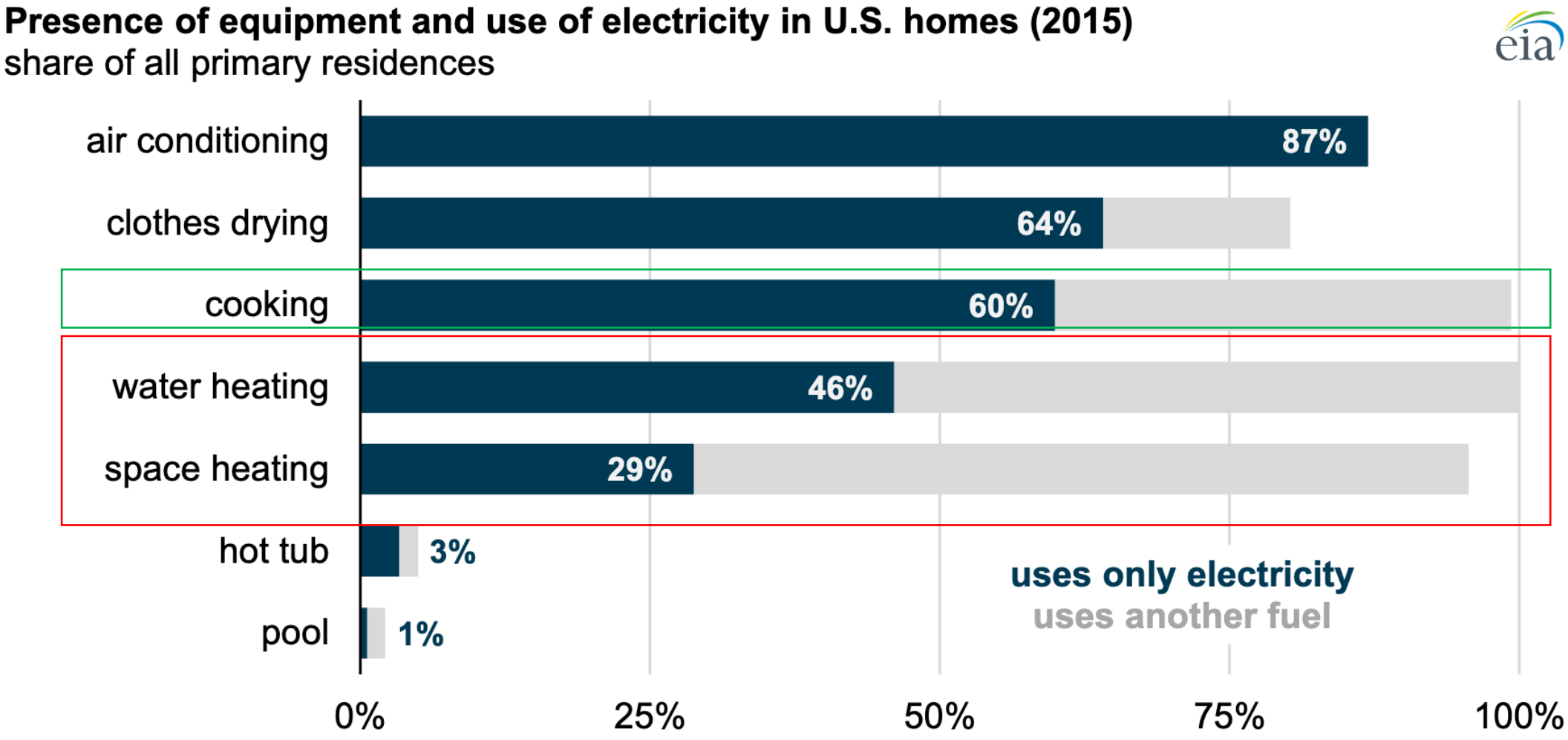
Electric DHW

- 55% of MF units
- 41% of SF units

Electric Cookers

- 67% of MF units
- 56% of SF units

Problem Scope: Electric End-uses

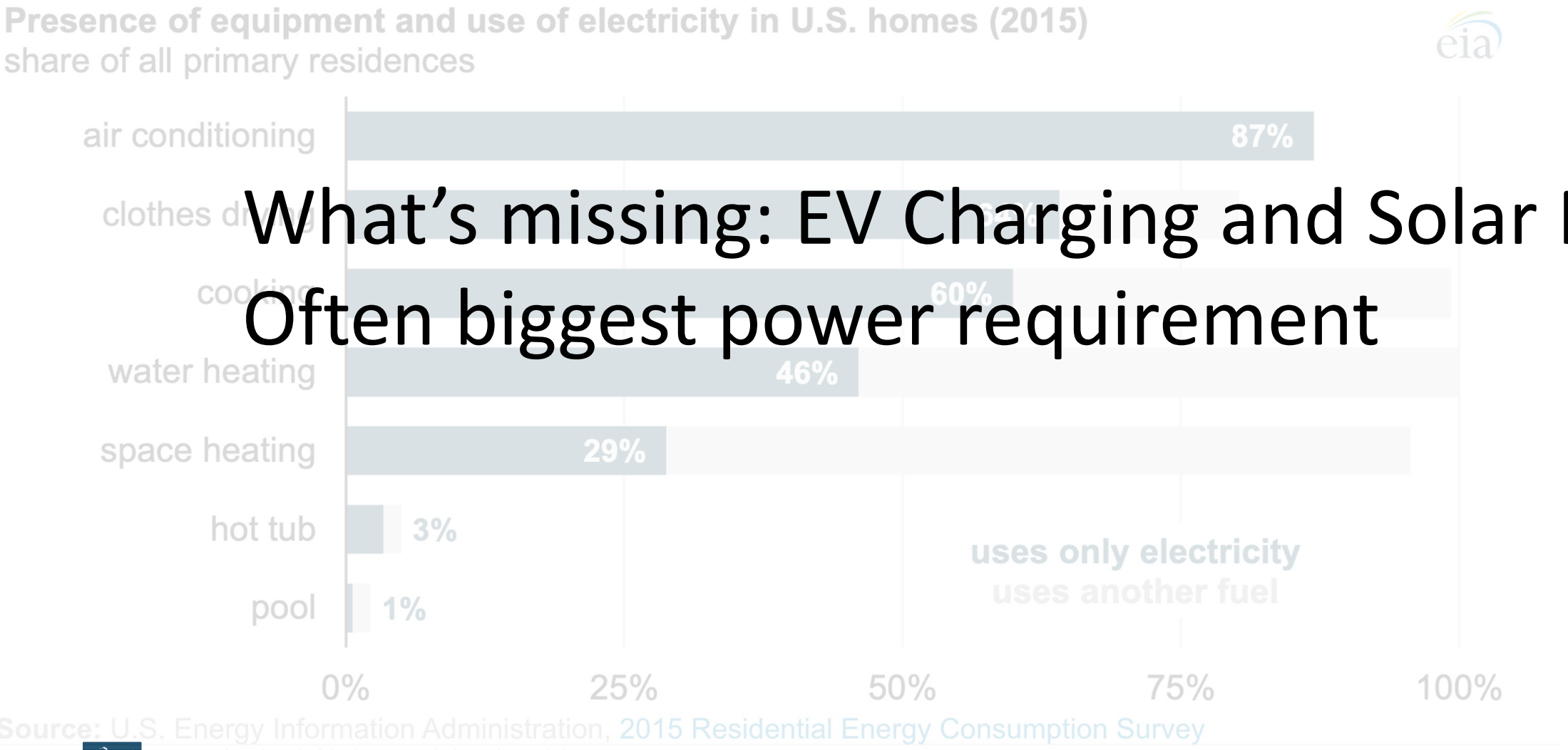


Highest Power Requirement?

Biggest energy users

Source: U.S. Energy Information Administration, 2015 Residential Energy Consumption Survey

Problem Scope: Electric End-uses



What's missing: EV Charging and Solar PV

Often biggest power requirement

Why not just replace all the panels?

What does it cost?

- Circuits: **$250-$750 each**
- Panel: **$1,000-$5,000**
- Service: **$1,000-$25,000** to homeowner + similar amount for utility

Time delays

- **3-6 months** project delays
- >1-year lead time on transformers
- Utility might reject your interconnection

Additional ratepayer costs for:

- Utility distribution system capacity increases
- New generation/storage

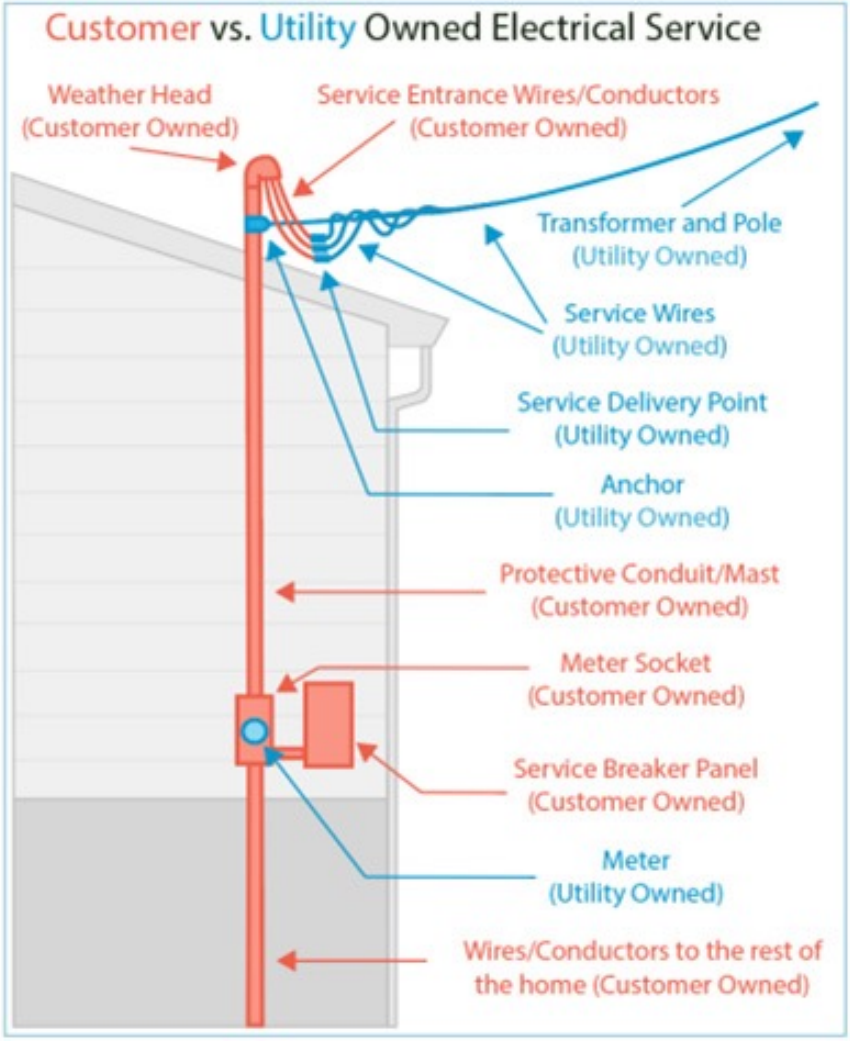


Image courtesy of Redwood Energy

Why not just replace all the panels?

Triggers rewiring: knob and tube replacement

Another **$10,000-$30,000**

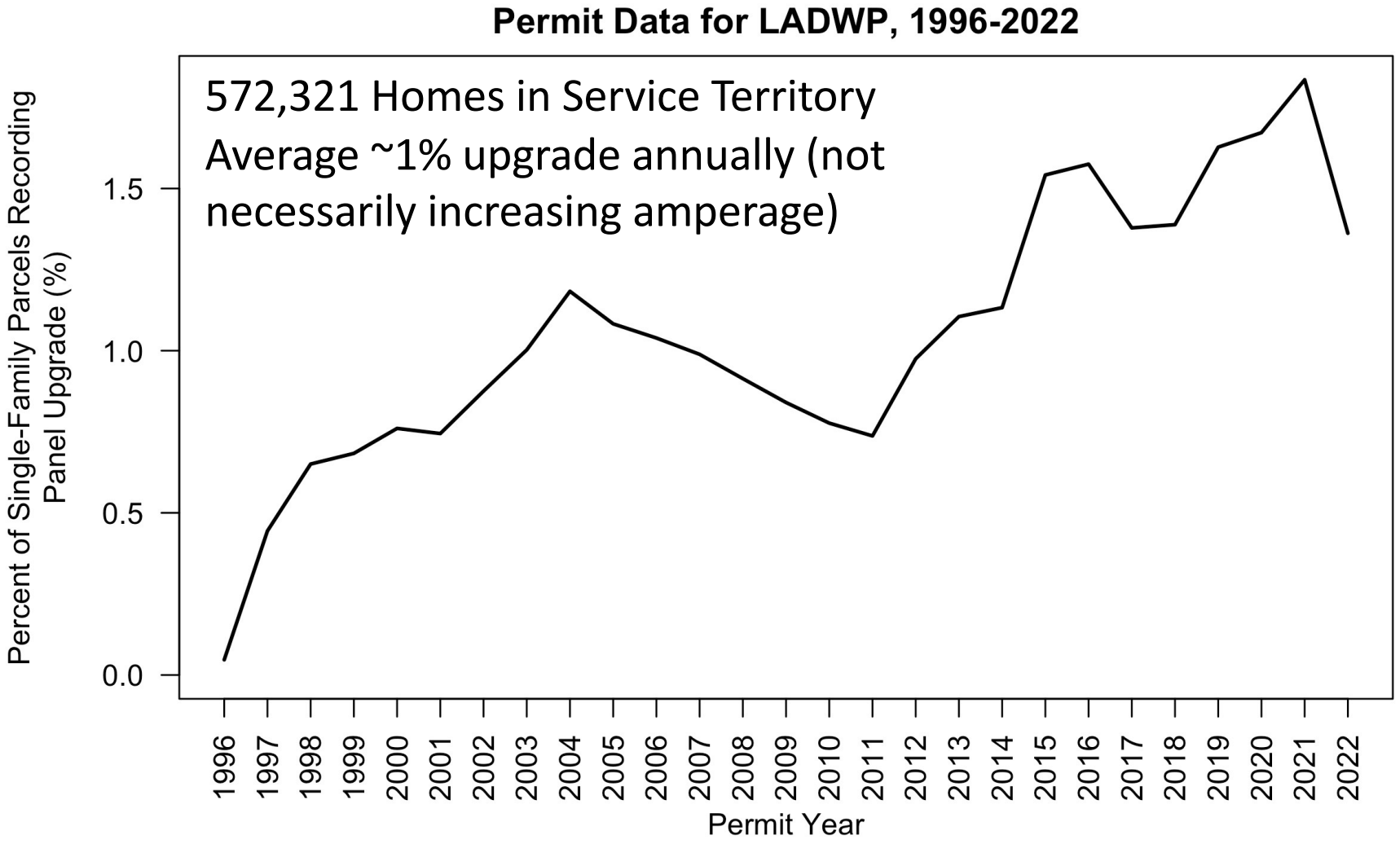
Sometimes an update is needed

Old, unsafe or damaged panels

Fuse Boxes

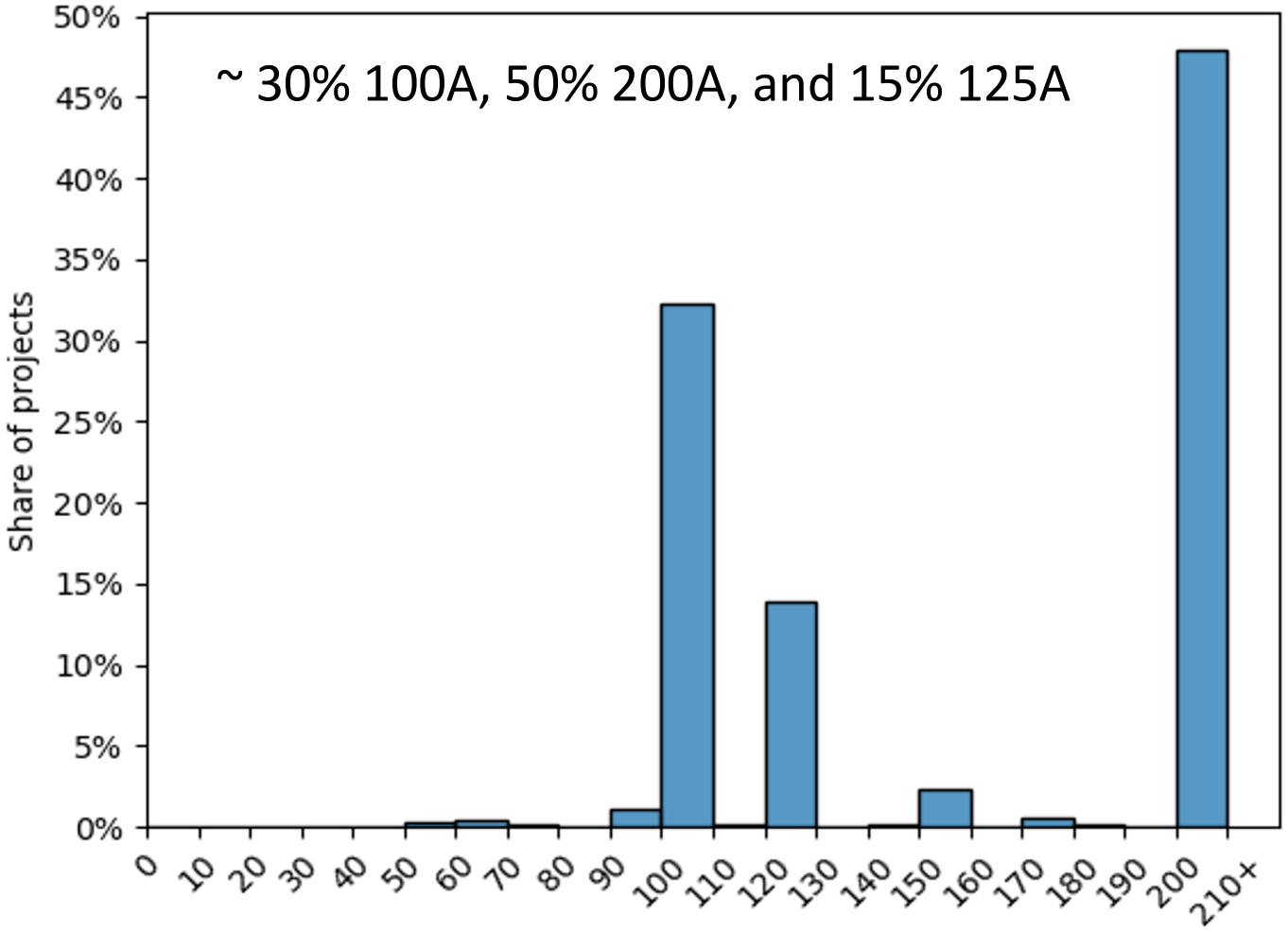
Zinsco/GTE Sylvania and Federal Pacific panels are dangerous

What are current replacement Rates?



** Data courtesy of Eric Fournier, UCLA

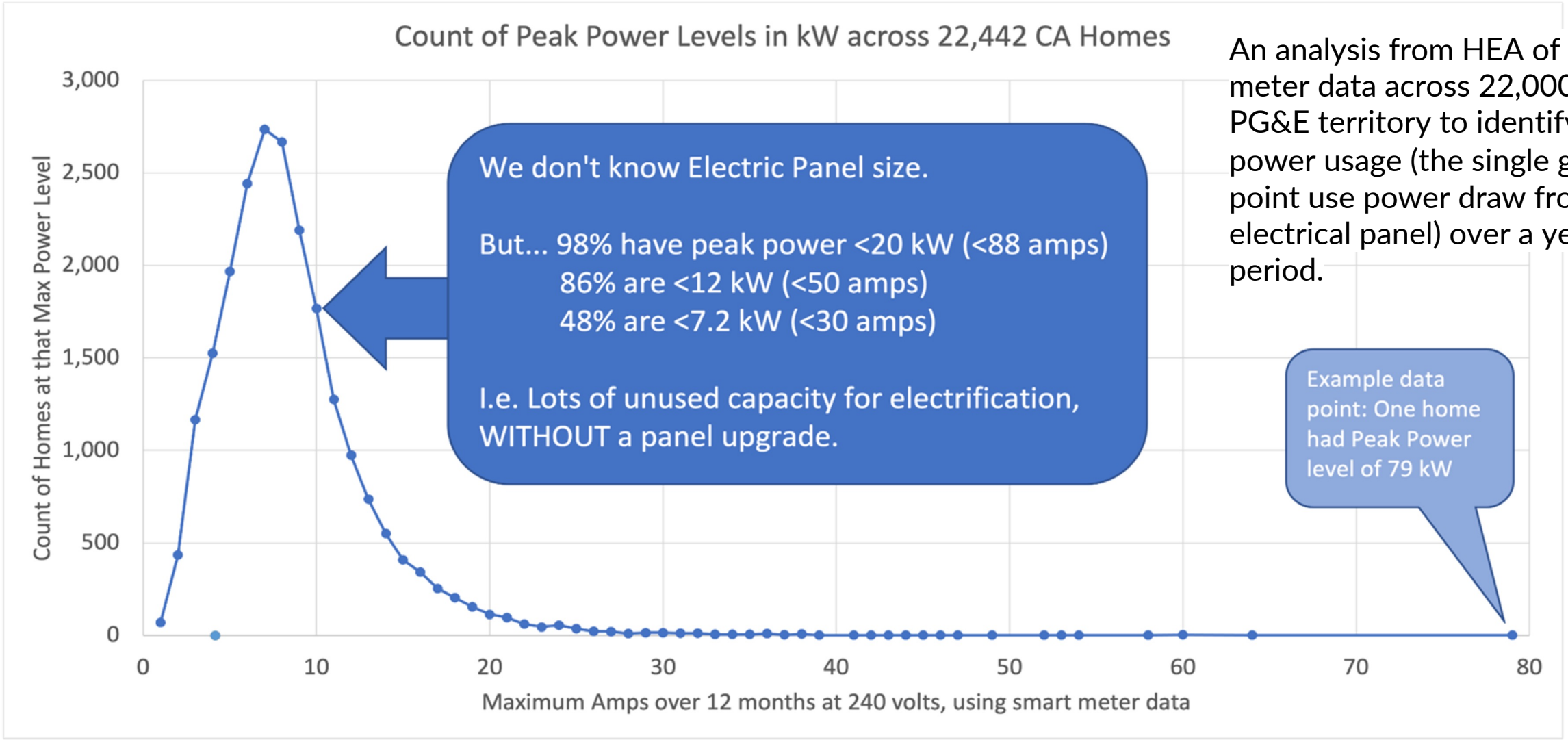
What capacity is installed?



From ~18,000 Home Electrification Projects

- Most data sets represent homes engaging in EE programs (not random)
- Bias to California housing stock
  - California a very gassy state – so may bias these values low
- Mostly single-family data

Can we add new loads?



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.

Beyond Amps – Space for breakers?

- BayRen Home Electrification Checklist
  - 100A: 31% have free space
  - 200A: 48% have free space

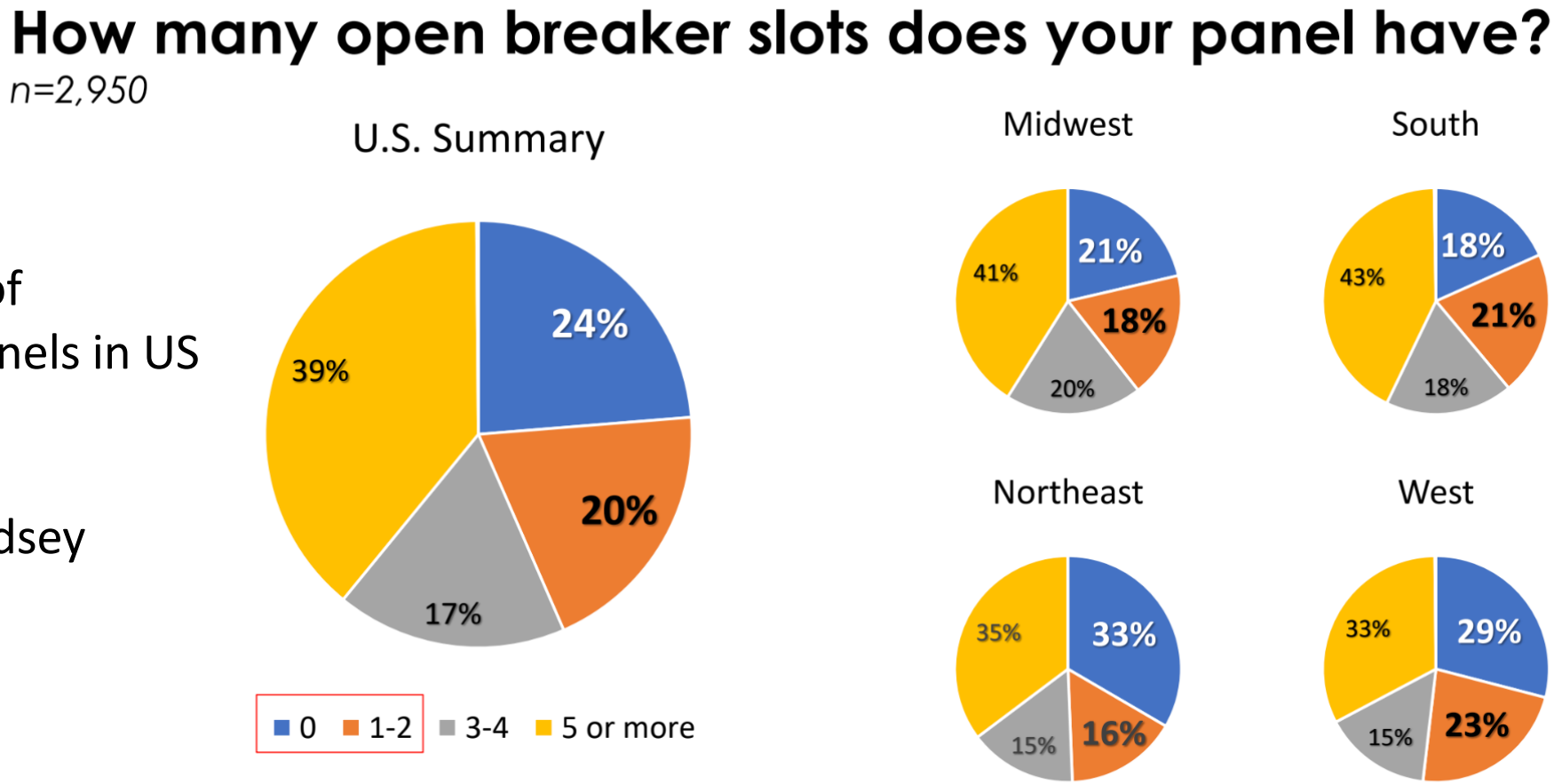
NO SPACE

LOTS OF SPACE

Beyond Amps – Space for breakers?

EPRI Study of Electrical Panels in US Homes

By Doug Lindsey



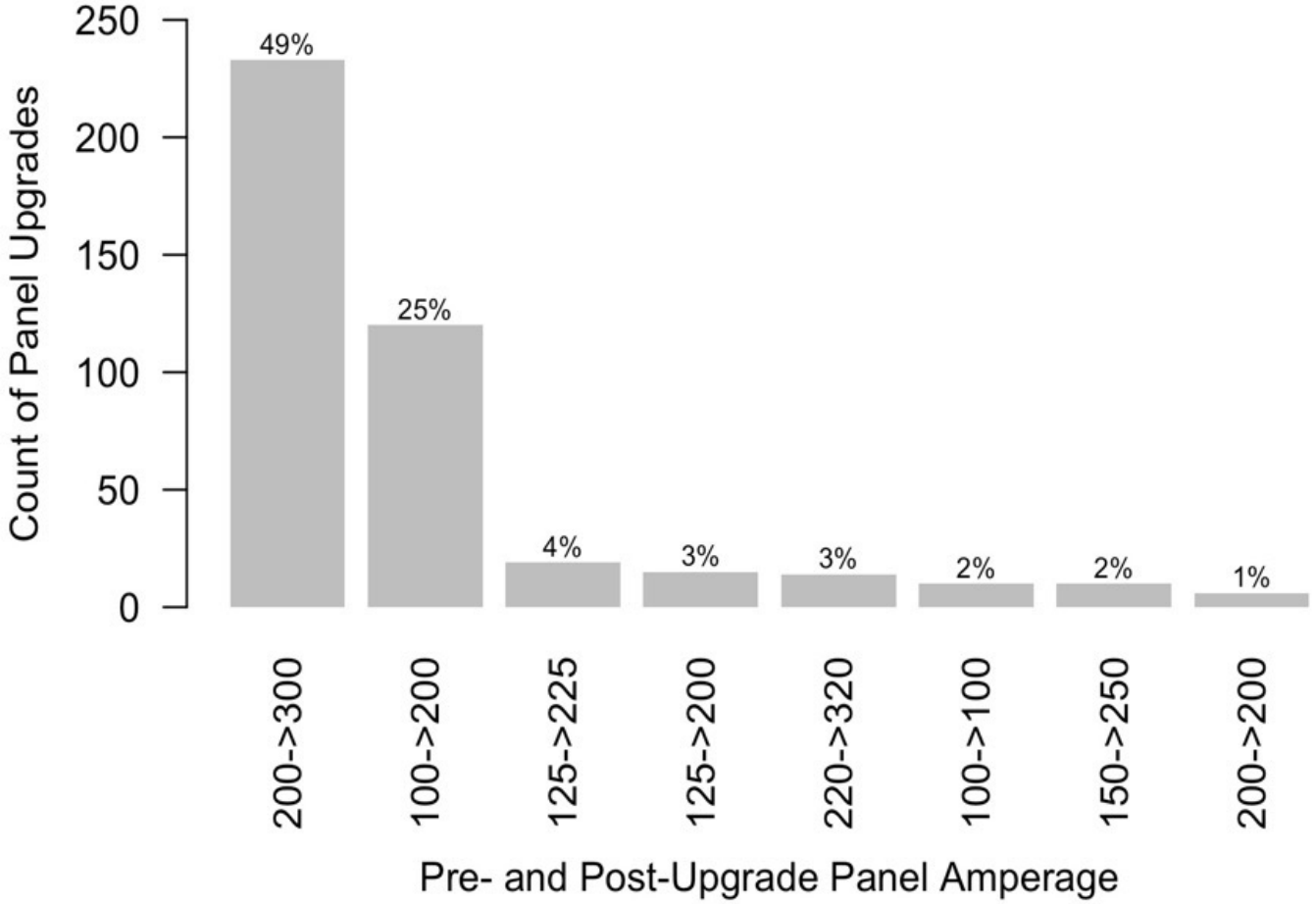
44 % of households have two or less open breaker slots

What's driving panel replacement?

Adding heat pumps not a big factor?

TECH Clean California

- 480 panel replacements out of 10,446 heat pump upgrades (**4.6%**)
  - **Most panel replacements were from 200A to 300A**
  - Smaller set from 100A to 200A



What's driving panel replacement?

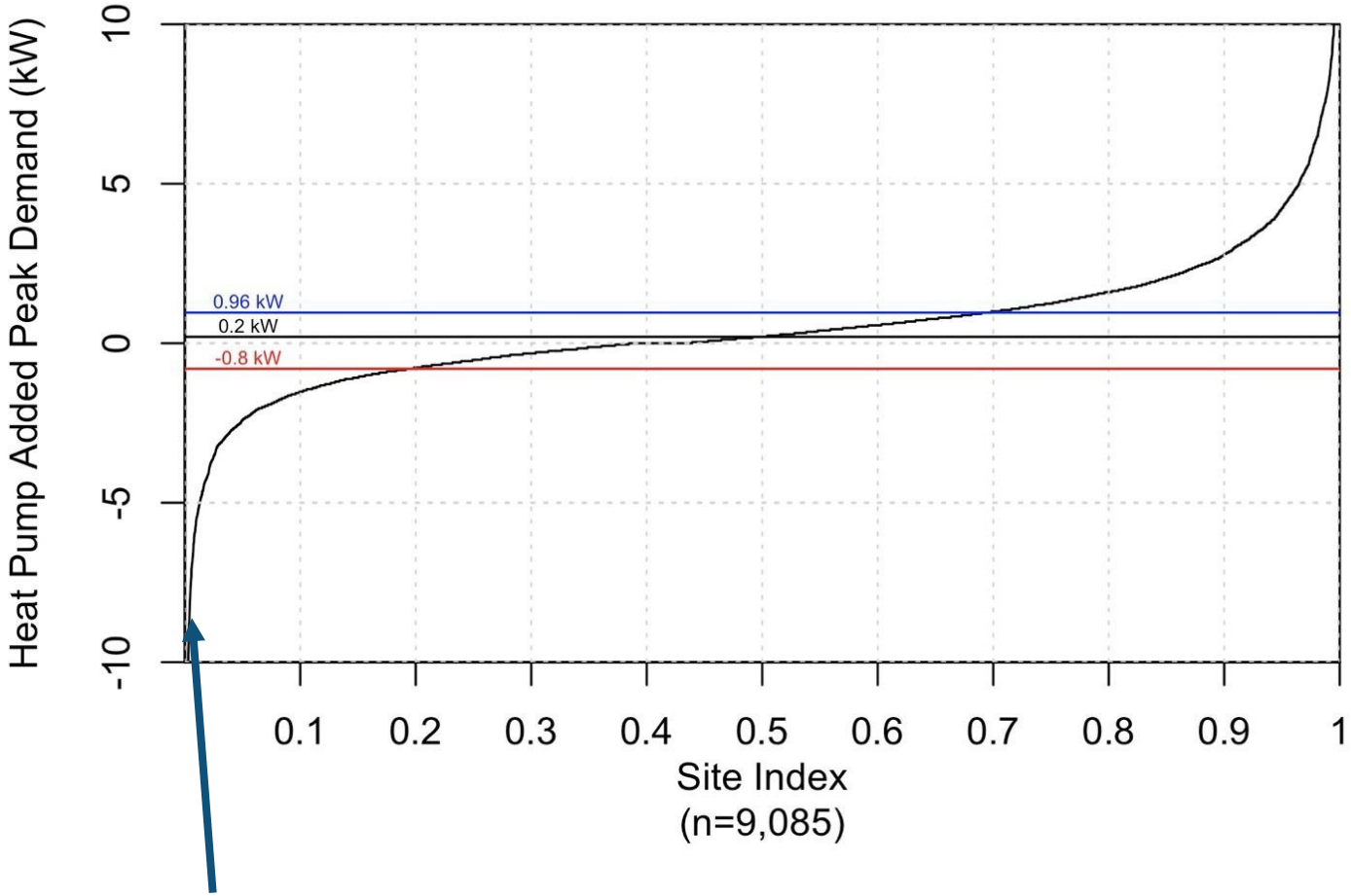
Adding heat pumps not a big factor?

~10,000 homes in Vermont

15 minute electric power before and after adding heat pumps

Mean nameplate rating 3.6 kW
Average addition 200 W

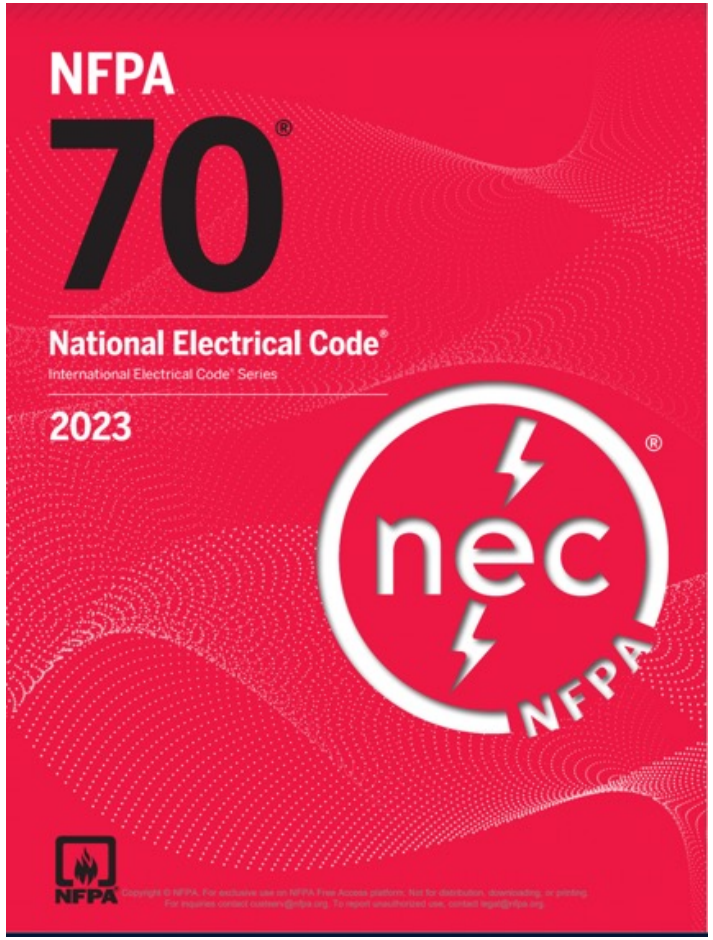
Avoid "backup" resistance heat
Change thermostat behavior: less (or no) setbacks



Electric Resistance Heated Homes

What IS driving panel replacement and service changes?

1. Reports from utilities: Current main drivers are adding Solar PV and EV Charging
2. Simplified approaches by electricians
    - Not using existing paths in the National Electric Code, e.g., using metered data
    - Profitable upsell?
    - Habit/comfort
3. NEC unclear and not developed with home electrification in mind
4. Local code authorities unprepared
    - Some will not allow circuit sharing or smart panel controls



Solutions for Avoiding Panel and Service Upgrades

Smart Electrical Panels

$3-5k + install

Most complicated and flexible

Circuit Sharing

$300-600 + install when hard-wired

Least complicated, sometimes DIY

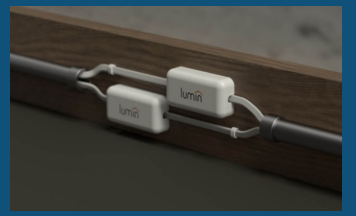
Others

NEC Load Calculations

Low Power Appliances

Meter collar solutions

Smart circuit breakers



Circuit Pausing

$400-900 + install

Medium complicated, requires CTs

Use existing methods in NEC

NEC 220.87 – metered data

- Existing loads based on metering data (15 minute)
- Total load = (Metered Load) x 1.25 + New Load

We are working on improvements: based on measured load coincidence + adding a 60 to 15 minute converter so we can use smart meter data

NEC 220.83 – sum connected loads

- Existing loads = sum of connected loads with different treatment when adding HVAC
- **No New HVAC**: 100% of first 8,000 watts + 40% of remaining loads (including heating and cooling)
- **New HVAC**: 100% of first 8,000 watts + 40% of remaining loads + max(heating, cooling)

Understanding the National Electrical Code (NEC): Watt Diet Calculator

https://www.redwoodenergy.net/watt-diet-calculator

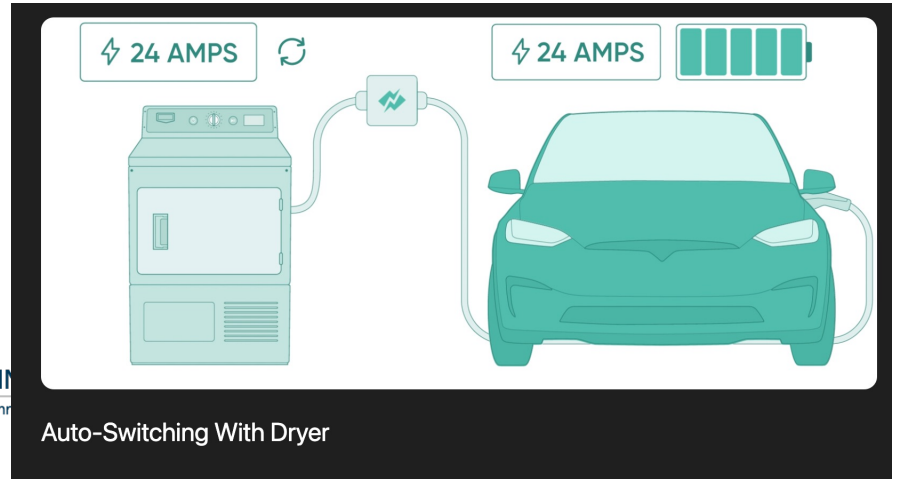
Circuit Sharing

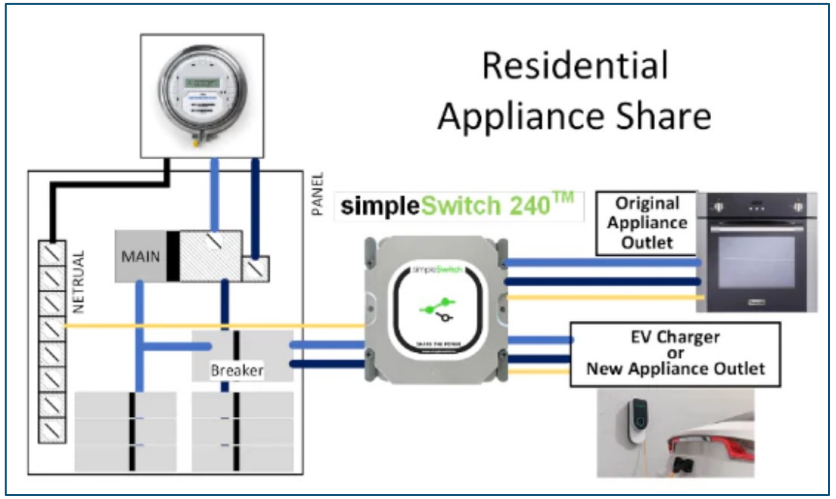
Plug Sharing (sometimes DIY)

- Existing 240V receptacle near new load
- Example: *Existing dryer outlet in garage + new EV in garage*

Circuit Sharing (not DIY)

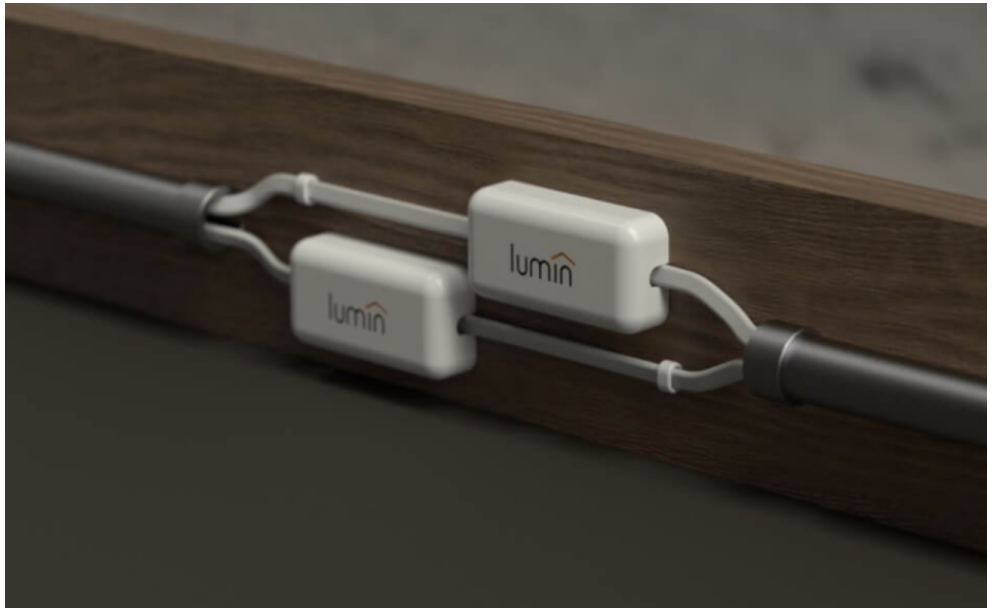
- Hardwired or plug 240v loads
- Not necessarily co-located
- Like a "smart junction box"
- Example: *Existing DHW in basement + new EV charger in garage*





Circuit Pausing

- **Control relay for circuit communicates with metering placed on the mains or feeder, turns load off at 80% of rated capacity.**
- Load maybe treated as zero in NEC electrical load calculations
- **$400-900 + installation**
- Installation is more complex due to installing CTs and necessary communication hardware
- Saves panel load, does NOT save physical space



Other solutions

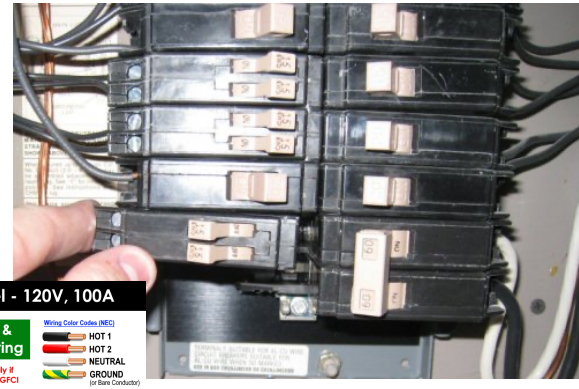
Meter collars for PV and EVs

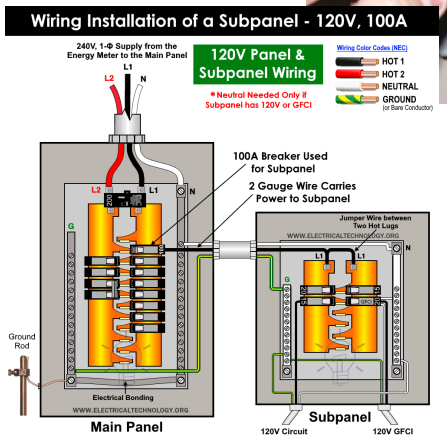
Smart circuit breakers

120V Battery-integrated appliances

120V plug-in appliances

Tandem breakers and subpanels if space is an issue





120V Condensing and HP dryers

Integrating transportation

- Current poor public charging infrastructure:
  - Need to be able to charge at home
  - Challenges for multifamily
- EV could easily be the biggest home load
  - Restrict power to 7.2kW – overnight charge completely recharges most EVs
  - Encourage low-power charging – good for most households
  - Use timers/smart circuit sharing/meter collars

DOE developing solutions for hard to electrify homes

https://www.herox.com/EASEPrize

More general Upgrades also help

Rethinking rebates?

Currently $2500 for a panel upsize (IRA up to $4000 + $2500 for additional wiring)

- Allows high power devices and higher peak load from home to utility
- New distribution and transformer upsizing - these costs passed on to ratepayers

Future rebates should be for ***avoiding*** panel replacement: reduces grid stress in the future as we electrify

- Low power, high performance heat pumps (no backup resistance heat)
- 120 V HPWH (no backup resistance heat)
- 120 V induction cooking
- 120 V Condensing and heat pump clothes dryers
- Circuit sharing and pausing
- Limit EV's to level 2 and use controllers
- Meter collars for Solar PV and EVs
- Support load metering NEC compliance path – make peak data readily available

Summary

1. Its not as bad as we think
   - Not an issue for already electric homes
   - A lot of homes have plenty of power available – depends on metering?
     - Utilities should make this data readily available
   - The big energy users and CO_2 emitters (heating and hot water) are **not** driving panel and service replacements
   - Big drivers are EV charging and Solar PV
2. There are technical solutions now and more coming for **Low Power Electrification**
   - Limit EV's to 7.2 kW
   - Low power 120V appliances (some with battery/thermal storage)
   - Meter collars, circuit sharers, circuit pausers, smart panels
   - The NEC has approaches we need to popularize (e.g., "Watt Diet") and is (hopefully) going to get better
   - Need to support electricians and code inspectors in this transition
   - Coming soon: battery integrated appliances: low input power + high output power when needed