Good Stewardship of the Electric Panel

TECH CLEAN CALIFORNIA

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Esteemed Contributors and Subject Matter Experts:

TECH CLEAN CALIFORNIA

Pacific Gas and Electric Company

SDGE

Southern California Edison
Energy for What's Ahead℠

California Energy Commission

California Public Utilities Commission

Berkeley Lab

Build It Green

TRC

SPUR

Redwood Energy

Tom Kabat

Agenda

Introduction	9:00AM – 9:10AM
Session 1, Part 1: Utility Front of Meter Considerations	9:11AM – 9:40AM
Session 1, Part 2: Customer Considerations	9:41AM – 10:05AM
Intermission	10:06AM – 10:15AM
Session 2, Part 1: Power Efficiency	10:16AM – 10:55AM
Session 2, Part 2: Power Control	10:56AM – 11:35AM
Session 2, Part 3: Policy Impacts and Status	11:36AM – 12:20PM

Electrifying California

Current rebates encourage panel upgrade!
Rebates do not pay for low power or power efficient appliances/systems

1.1 million (8%)

CA homes that are all electric as of 2020

14 million

homes built in CA

6 million

built before 1968*

**when 100A became standard – it's now 200A*

$25–$40b

cost of upgrading 6 million homes

Good Stewardship Premise

There are two basic ways to approach electrification at the panel:

1. **Upsize the panel** to fit power-hungry electrification needs
2. **Optimize the panel** by selecting more power efficient, right sized or well controlled electrification

- New homes almost always have enough panel capacity –200A typical
- Existing homes may not have 200A
- Panel/wiring/service upgrades are costly (thousands of dollars)—this is a big barrier to electrification/decarbonization.
- Can we find the best path forward for the customer? One that:
  - Meets customer needs
    - Budget and ROI
    - Long term plans
    - Speed of deployment
  - Minimizes the cost, delays, and manages grid impact of electrifying for under 100A… and avoid panel replacement

What's at Stake in the Approach

*Early examples are showing that **with power efficiency:***

- Fewer **workforce hours** are needed
- More homes on a block can **electrify without overstressing the distribution transformer**
- Customers are likely to **save money** compared to upsizing

Upward Rate Pressure and Workforce & Supply Chain Issues

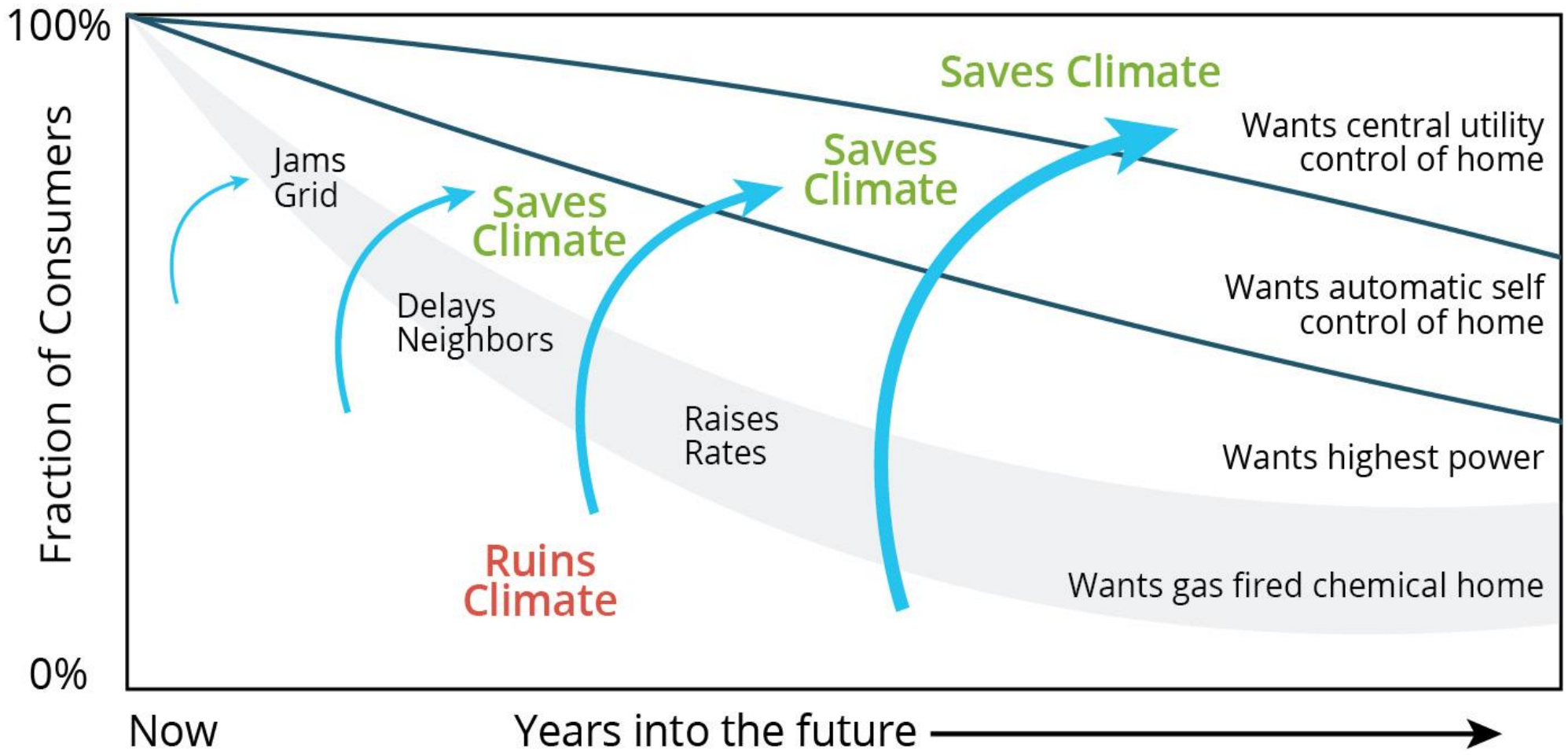
- For installing new service lines
- For performing load studies and scheduling utility tasks
- For upsizing distribution transformers and feeder wires

Owner Expenses

- For running branch circuits
- For installing new electric panels
- For installing new service risers through roofs

These factors show how power efficiency can help accelerate widespread electrification by making the best use of a talented workforce addressing these problems

Possible Market Shares of Home and Vehicle Electrification Types



State of the Grid

High Voltage Transmission Grid:

In decent shape and is keeping up with demand but will need several improvements over time to carry more power on the same paths and may need new paths from remote renewables and cross-linking larger areas for load and resource diversity. **This will require more workforce**

Distribution System:

May face constraints first at the end of the distribution line at the distribution transformer from "I Squared R" losses that quadruple the transformer temperature rise if the power flow is doubled. **This will require more workforce**

Luckily, there are several approaches to relieving this potential problem:

- Power-Efficient Electrification (PEEL) with the help of contractors, consumers, and well-designed programs that save money, keeping rates fair. **Frees up workforce hours per home**
- Distribution system upsizing done by the shrinking utility workforce in the face of transformer supply chain constraints. **Requires more workforce**
- Non-wire alternatives on utility system (control of customer loads, or customer solar or customer batteries or utility batteries etc.) **Requires more utility workforce**

Session 1, Part 1:
Utility Front of Meter Considerations

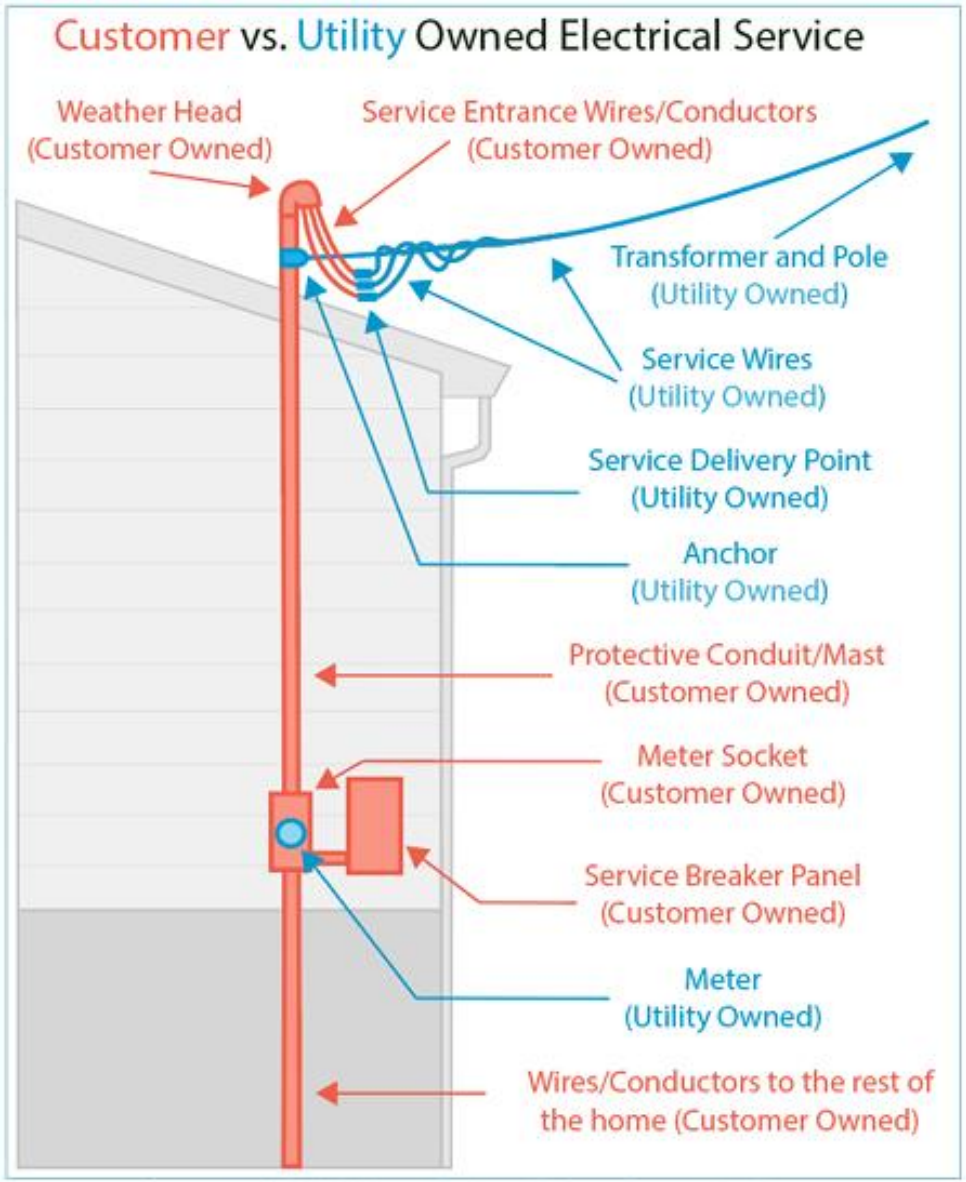
Moderator: Elizabeth Alvarez, SDG&E®

Session 1, Part 1:
Utility Front of Meter Considerations

Agenda:

- Why is this important
- Cost and wait time for panel upgrades
- Transformer cost sharing
- Protect your project and notify the utility
- Questions and answers

Speakers: Elizabeth Alvarez, SDG&E
Susanna Thompson, SCE
Chad Martin, PG&E



Courtesy of Emily Higbee, Redwood Energy Research Director

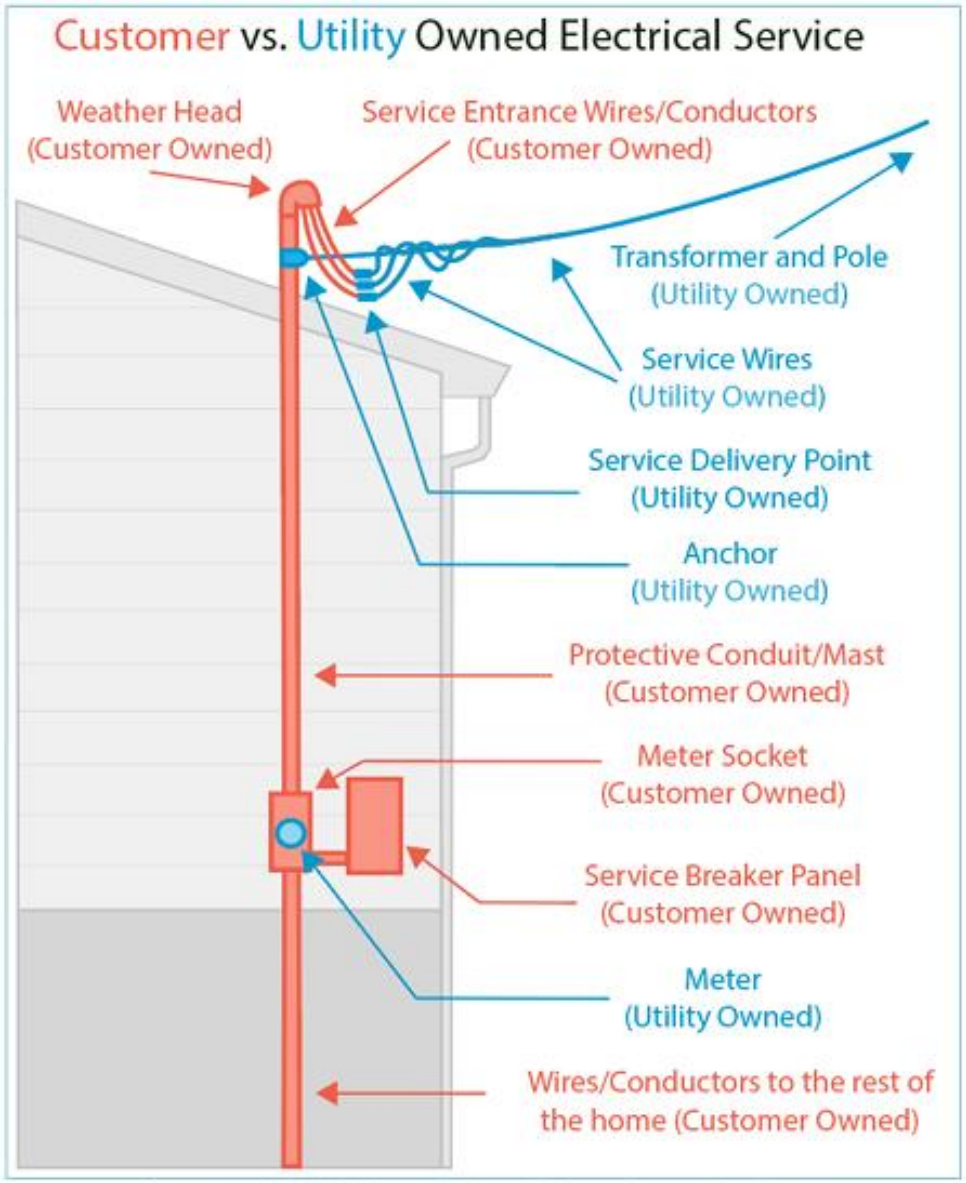
Front of the Meter vs. Behind the Meter

Utility Infrastructure – Front-of-the-Meter (FTM)

The utility owns and is responsible for constructing, maintaining, and upgrading electrical infrastructure to the meter panel

Customer Infrastructure – Behind-the-Meter (BTM)

Customer owns and is responsible for constructing, maintaining, and upgrading infrastructure from meter to the customer appliances



Courtesy of Emily Higbee, Redwood Energy Research Director

Cost and Wait Time of Panel Upgrade

Cost

- Cost ranges from a few thousand dollars up to $30,000 for a very complex project
- If a panel upgrade only requires disconnect/reconnect, there is no utility cost to customer
- Cost and timeline are very site-dependent and can vary greatly

Wait Time

- Three to six months wait time on average
  - *Can be about one month for a basic disconnect / reconnect*
  - *Up to 12 months for complex situations*
- Depending on existing facilities and loads being added, service wires and transformer may need to be upgraded
- Overhead vs underground considerations
- Utility must be able to support the maximum capacity of a panel

Cost and Wait Time of Panel Upgrade

2023 Energy Efficiency Potential and Goals Study

Table C-2. Summary of Upgrade Costs

Building Type	Cost		Source [84]	Comments (Reliability of the Source)
Single Family	**Total:**	**$1,900–$4,000**	1	Based on interview with seven water heater and 15 HVAC contractors for a specific home
Single Family	**Total:**	**$2,000–$4,500**	2	It appears that the cost does not include overhead
	Total (With Overhead to underground conversions or panel relocations):	**$3,000-$10,000**		
	Average:	$2,780		
Single Family	**Total:**	**$4,671**	3	The report was published in 2016. The cost estimates are based on RSMeans data and it does not include overhead
	HPWH Branch Circuit (15A to 30A):	*$640*		
	Panel:	*$3,181*		
	Service Connection (utility Fee):	*$850*		
Single Family	**Total Cost:**	**$8,188**	11	This is based on a recent upgrade in California (2021). The high labor cost is a result of panel relocation.
	Labor:	*$4,740*		
	Material – New Panel:	*$1,400*		
	Material – New Subpanel:	*$500*		
	Rough in and Outlet for EV:	*$600*		
	Breakers:	*$480*		
	City Permit:	*$600*		
	Overhead (15%):	*$1,068*		
Single Family	**Total:**	**$4,256**	13	Used available cost data from [3]
All Building Types	**Total cost (the national average):**	**$1,500–$4,000**	9	Cost data from a great variety of sources and does not reflect specific region or building type
	Average:	*$2,500*		
	Lowest (to upgrade to 100Amps):	*$800*		
	Highest (to upgrade to 400 Amps):	*$10,000*		
Residential Buildings	**Total:**	**$4,750-$10,000**	14	Used HomeAdvisor estimates for the period of study (Q4 2019) in California but
	Electrical wiring (depending on length of run and whether trenching is under landscaping or hardscaping):	*$4,000-$8,000*		

Transformer Replacement – Rule 15 and 16

What if everyone on the block upgraded their panel?

If existing facilities are overloaded or will be after the newly added load, transformers or secondary equipment may need to be upgraded, which could cause time delays

There are known material shortages that could cause additional delays

Allowances and Cost Allocation

Service Upgrade Allowances:

PGE: $3,255

SDG&E: $3,981

- If one customer is on a transformer, that customer will likely pay for the transformer
- If multiple customers are on the same transformer, will most likely be covered by utility

There are possible sharing scenarios, but they are unlikely

Notifying the Utility of an Upgrade

Protecting Yourself and the Customer

- Don’t notify **unless** you know the work is happening
- Notify **as soon as** you know the work is happening
  - If you do not notify, there may be delays to your project
  - If the load is added without warning or notifying the utility and equipment is damaged, the customer may incur those costs
  - If the project is completed first before notifying the utility, there may be costly rework

How to Apply for an Upgrade

Portal:
yourprojects-pge.com/login

Process:

Expectations:

Portal:
sce.com/partners/consulting-services/localplanning

Process:

Expectations:

Portal:
sdge.com/builder-services/track

Process:

Expectations:

Q&A

Session 1, Part 2:
Customer Considerations

Moderator: Tom Kabat

Session 1, Part 2: Customer Behind the Meter Considerations

Agenda:

- Who needs service upgrades?
- How long does a service upgrade take?
- What about knob and tube wiring?
- Customer future proofing and electrification roadmap
- Complimentary time-of-use rates and demand response programs
- Setting bill impact expectations
- Questions and answers

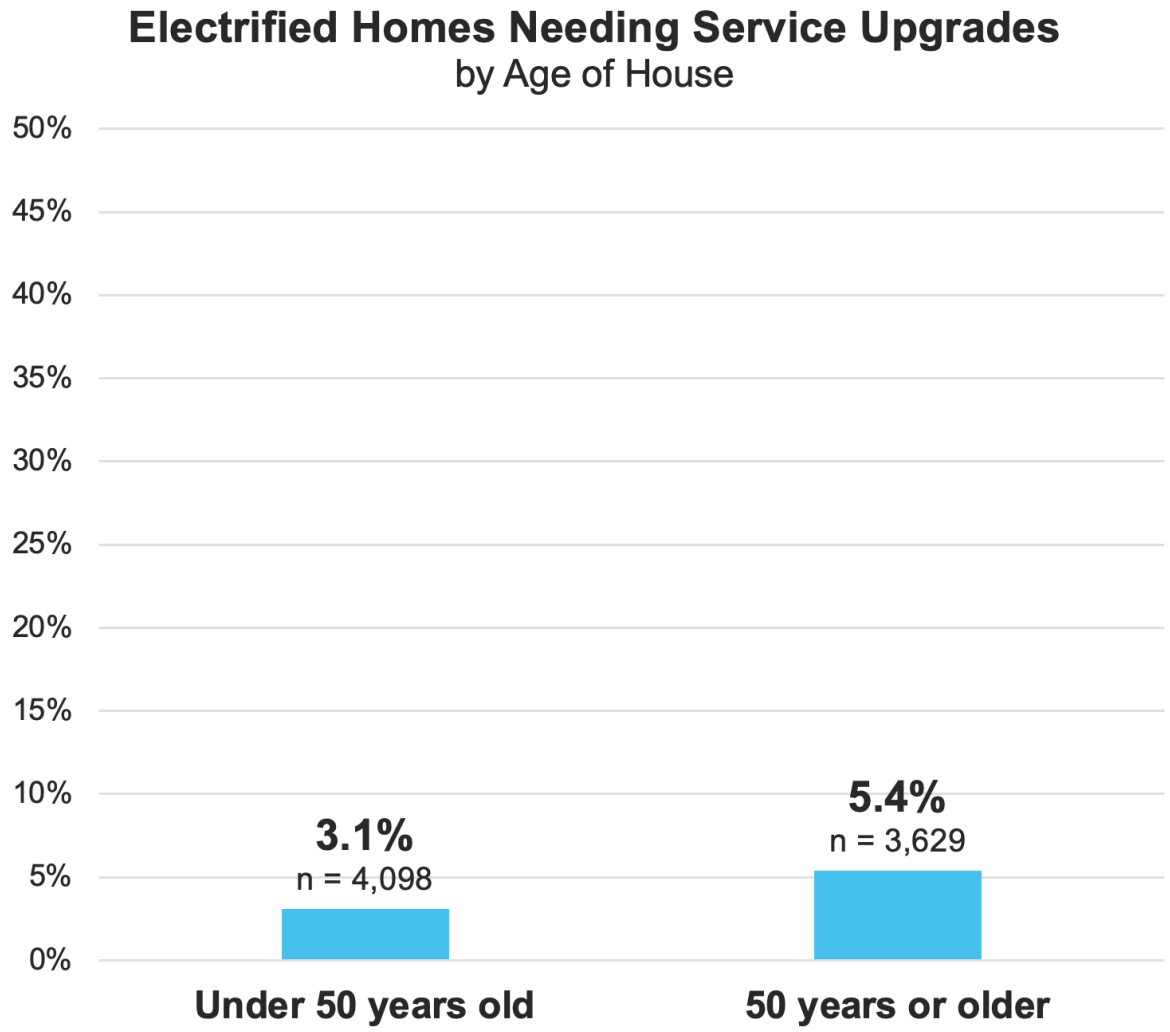
Speaker: Sean Armstrong, Redwood Energy

Service Updates

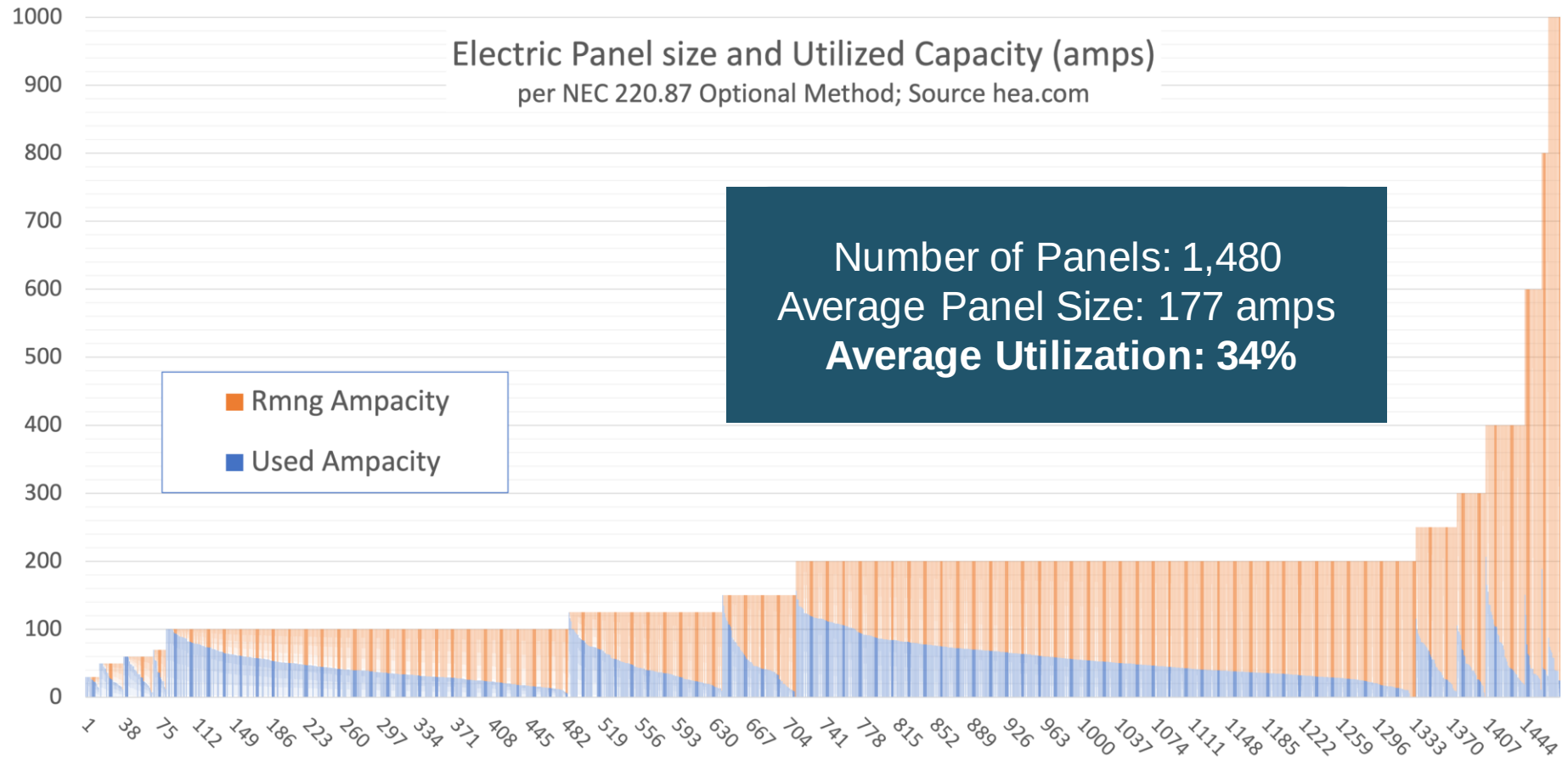
4.8% of electrified homes* needed service upgrades:

3.1% of homes built since 1970
5.4% of homes built before 1970

*based on homes electrified using TECH Clean California-enrolled contractors and rebates



HEA Study of 1,480 Home Panels in PG&E Territory



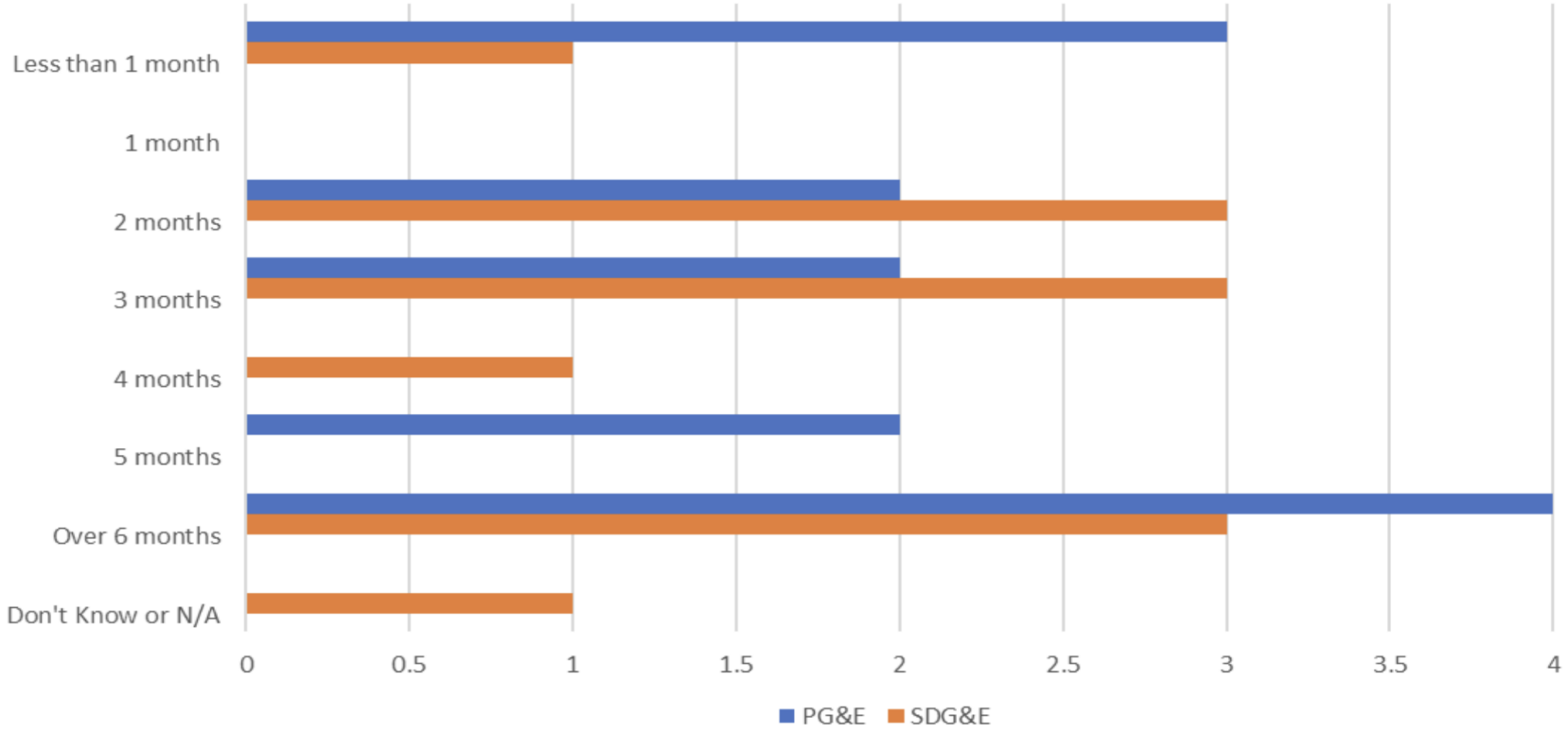
Out of **1,480** home panels in PG&E territory, about **5%** have less than 100A

Service Upgrades

Responses to Question 9:

Approximately how long did it take from when you or your contractor first contacted your utility to when you had the utility electrical service upgrade completed?

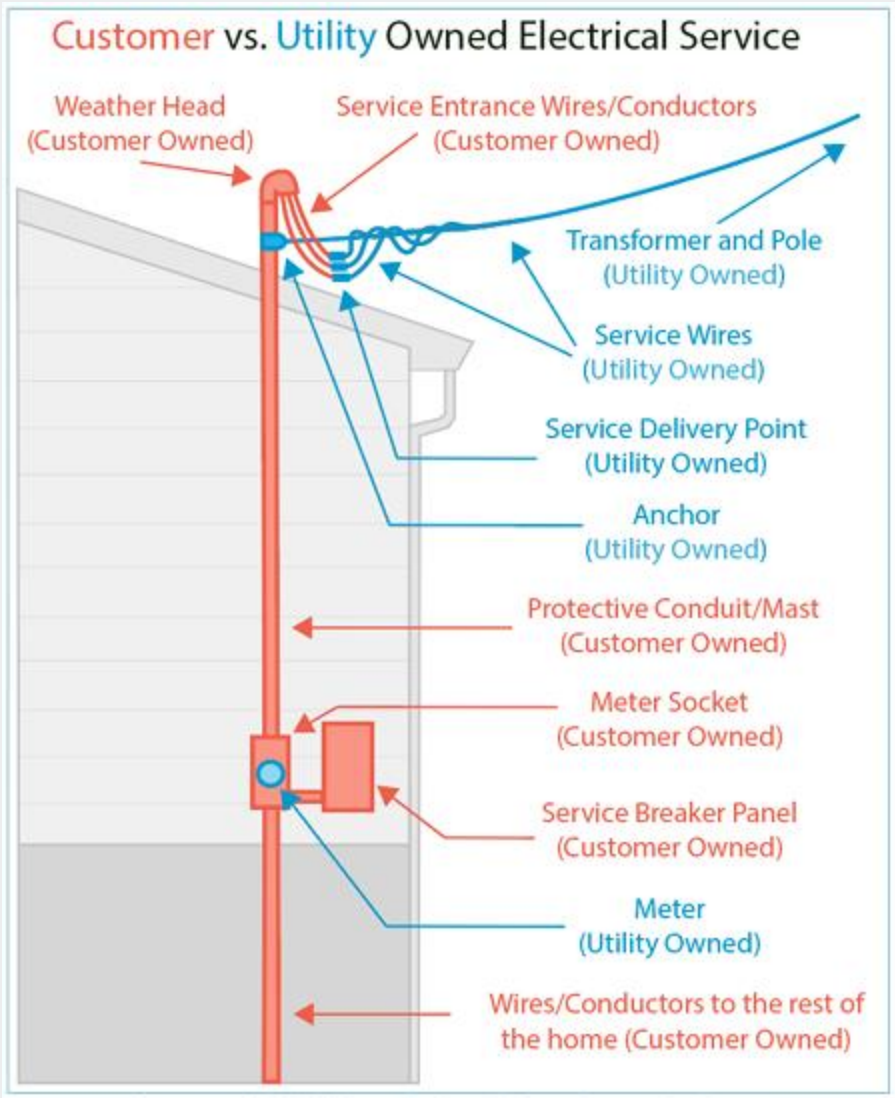
3/4ths of Service Upgrades took 2+ Months
1/4 took 6+ months



Circuit Breaker Panel Costs

Each new circuit that is wired costs $250–$750.
Upgrading the circuit breaker panel costs $1,300–$5,000.

Cost Description	Average Cost	Transaction
Homeowner Equipment Service Upgrade Fee	$1,300 – $5,000	Homeowner → Contractor
Breaker Panel Upgrade	$1,300 – $5,000	Homeowner → Contractor
Upgrade/New Branch Circuits	$250 – $700 per circuit	Homeowner → Contractor

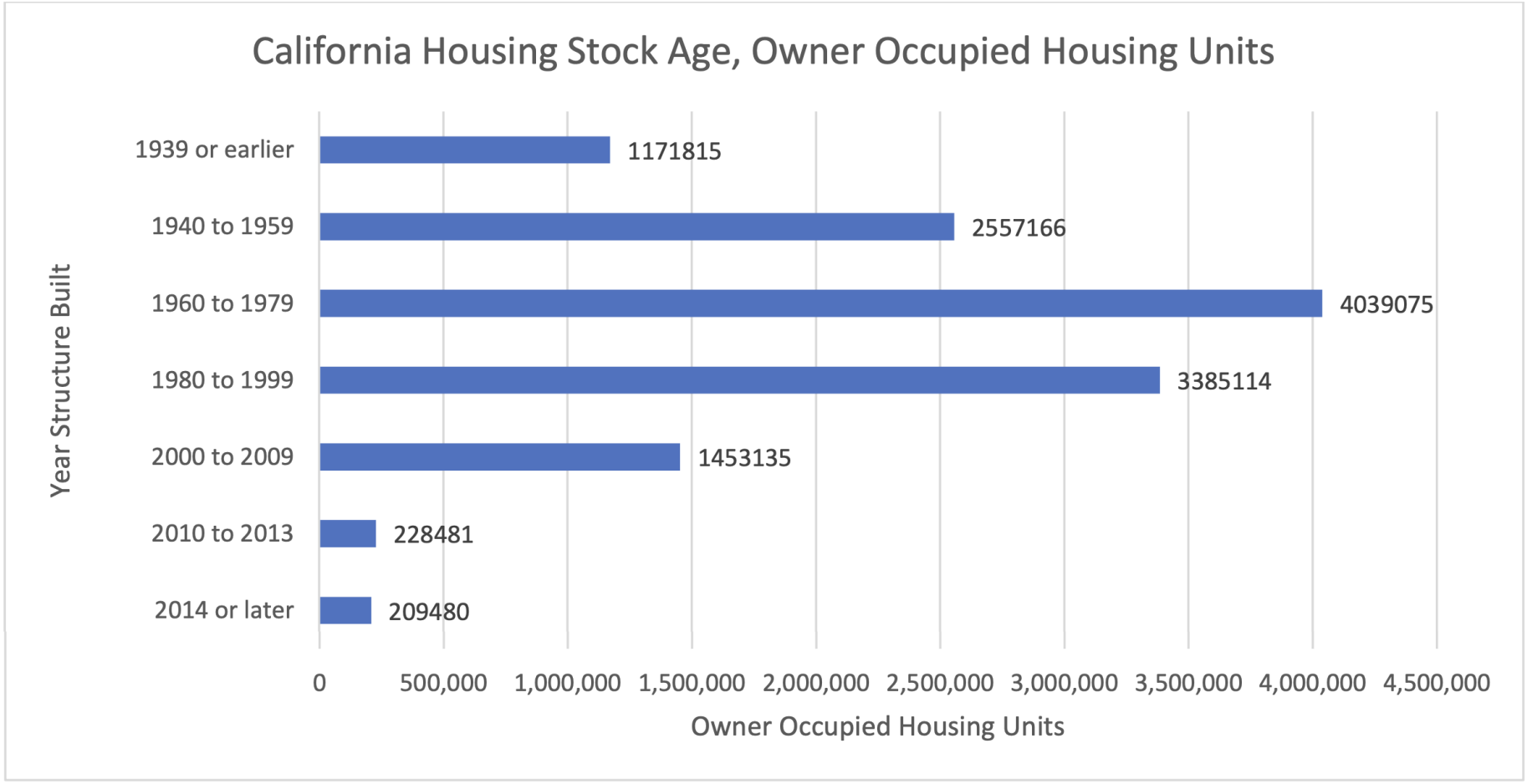


Courtesy of Emily Higbee, Redwood Energy Research Director

California Housing Code

Knob and Tube was used until the 1940s, comprising 9% of California housing

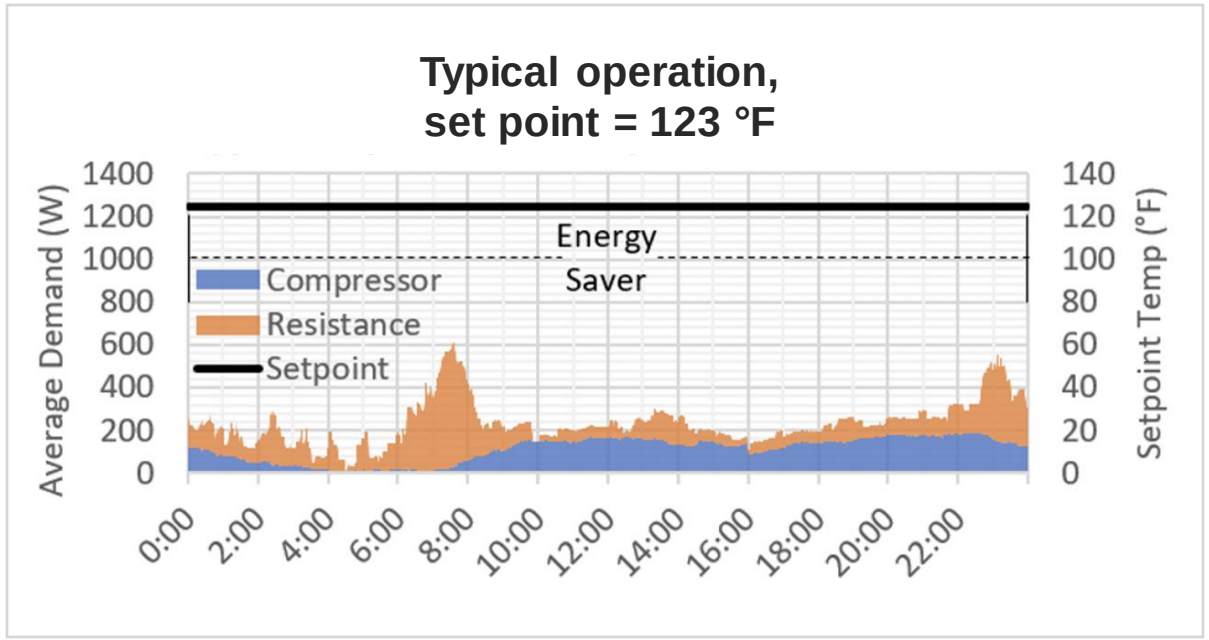
100A panels became Code in 1962

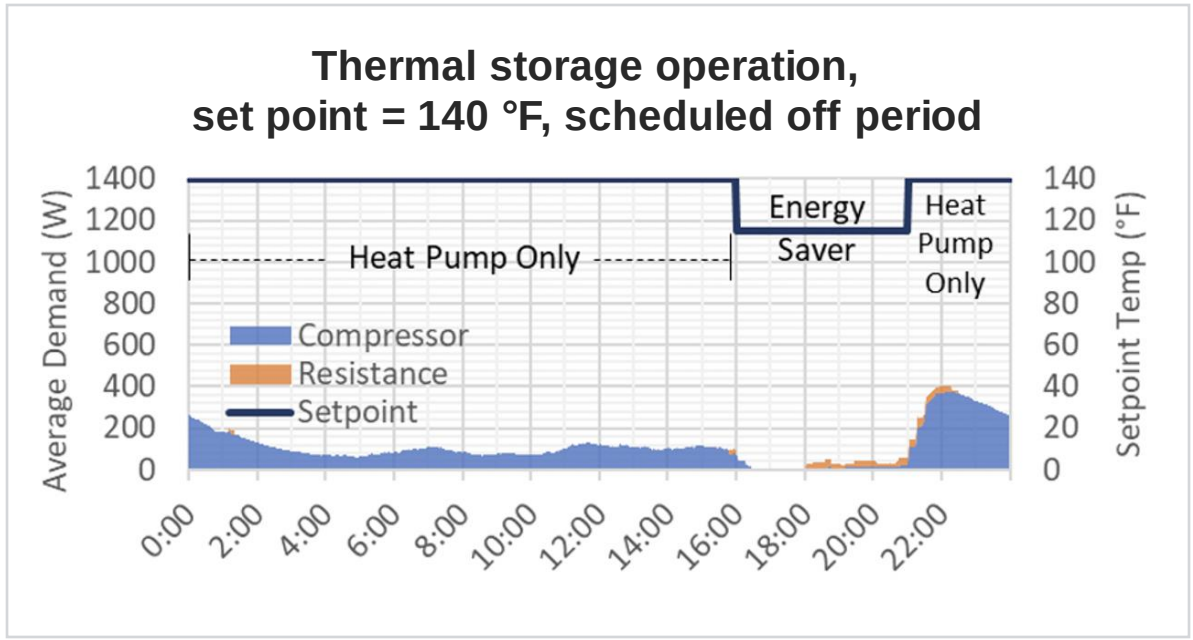


Knob and Tube Wiring

Knob and tube wiring is safe if **undamaged** and **uninsulated**—but those are both uncommon conditions after 80+ years

Heat Pump Only vs. Electric Resistance Backup



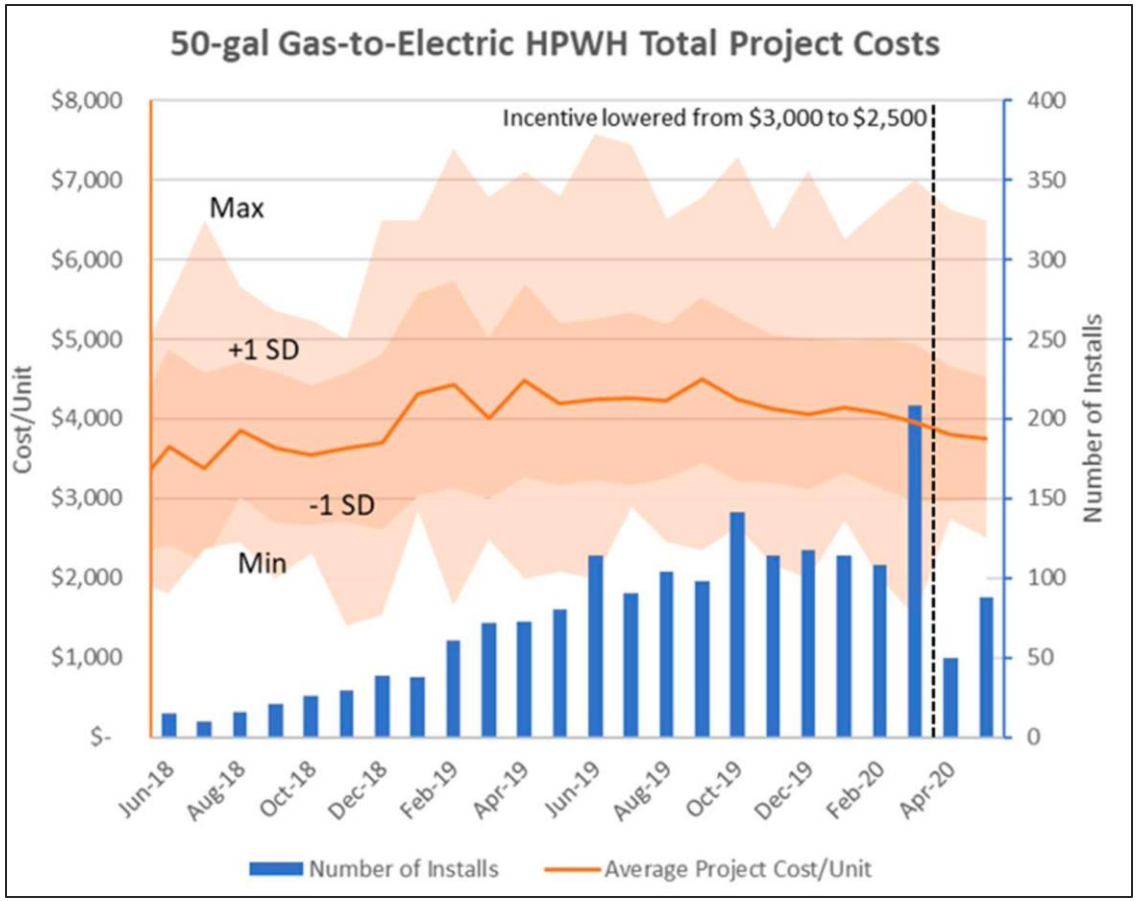


A heat pump water heater without resistance uses **30% less electricity**

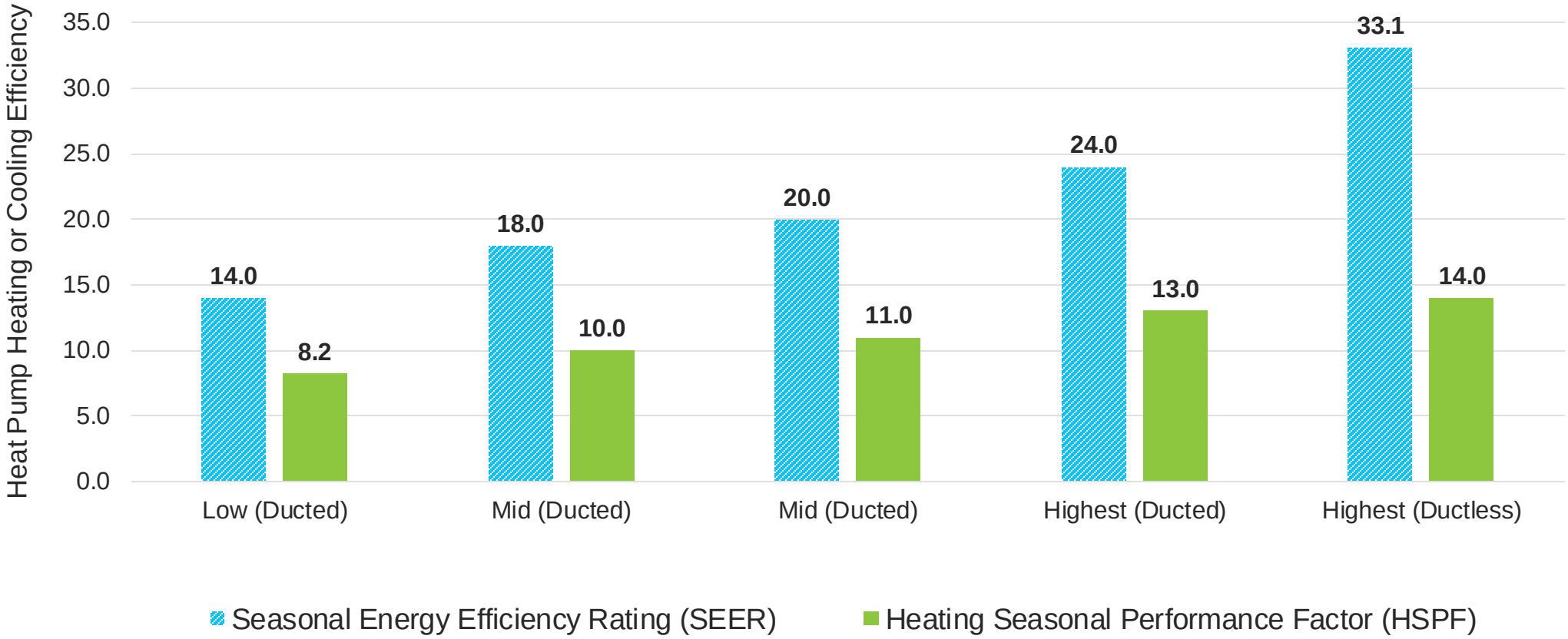
Range of Contractor Costs

Sacramento Market for 50-gallon Heat Pump Water Heaters

68%–95%–99.7%



The Wide Range of Efficiency in 1- to 3-Ton HVAC Heat Pumps



Heat Pump HVAC Retrofit Panel Upgrade Frequency

TECH Clean California – Voluntary Heat Pump HVAC Retrofits in Single Family Homes

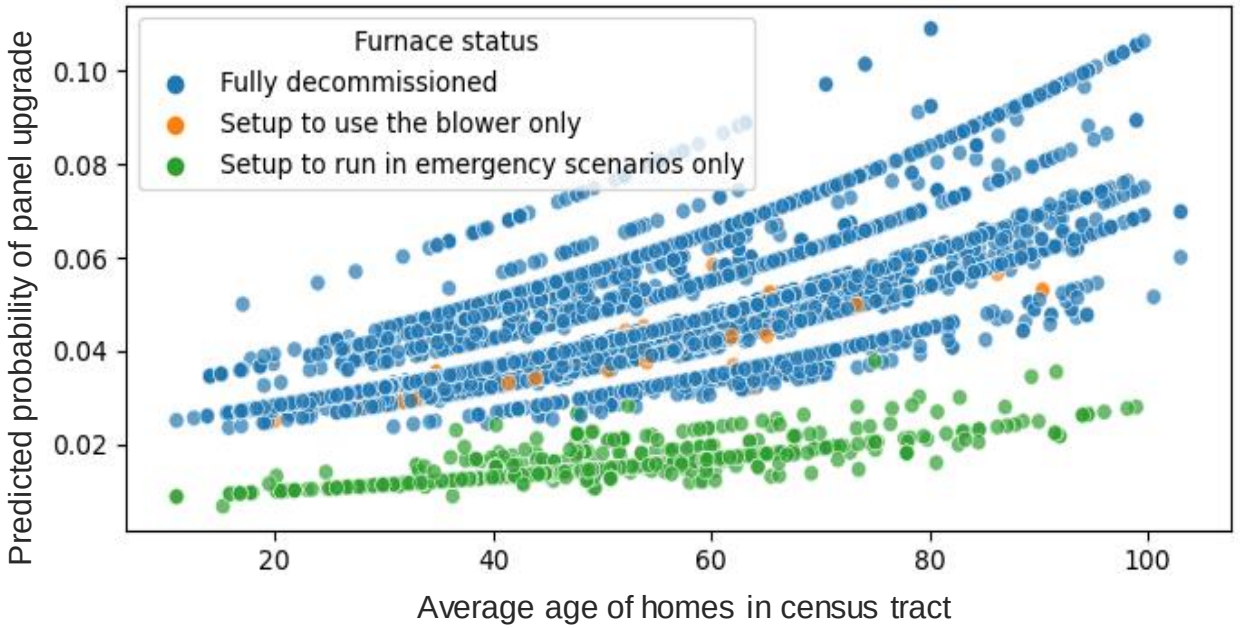
Electrical panel upgrades occurred in only 5% of TECH Clean California's general market heat pump HVAC retrofit projects

Likelihood of panel upgrade was not significantly associated with:

- Project location in disadvantaged community or hard-to-reach county
- HVAC system capacity
- Pre-installation panel capacity

Likelihood of panel upgrades was correlated with:

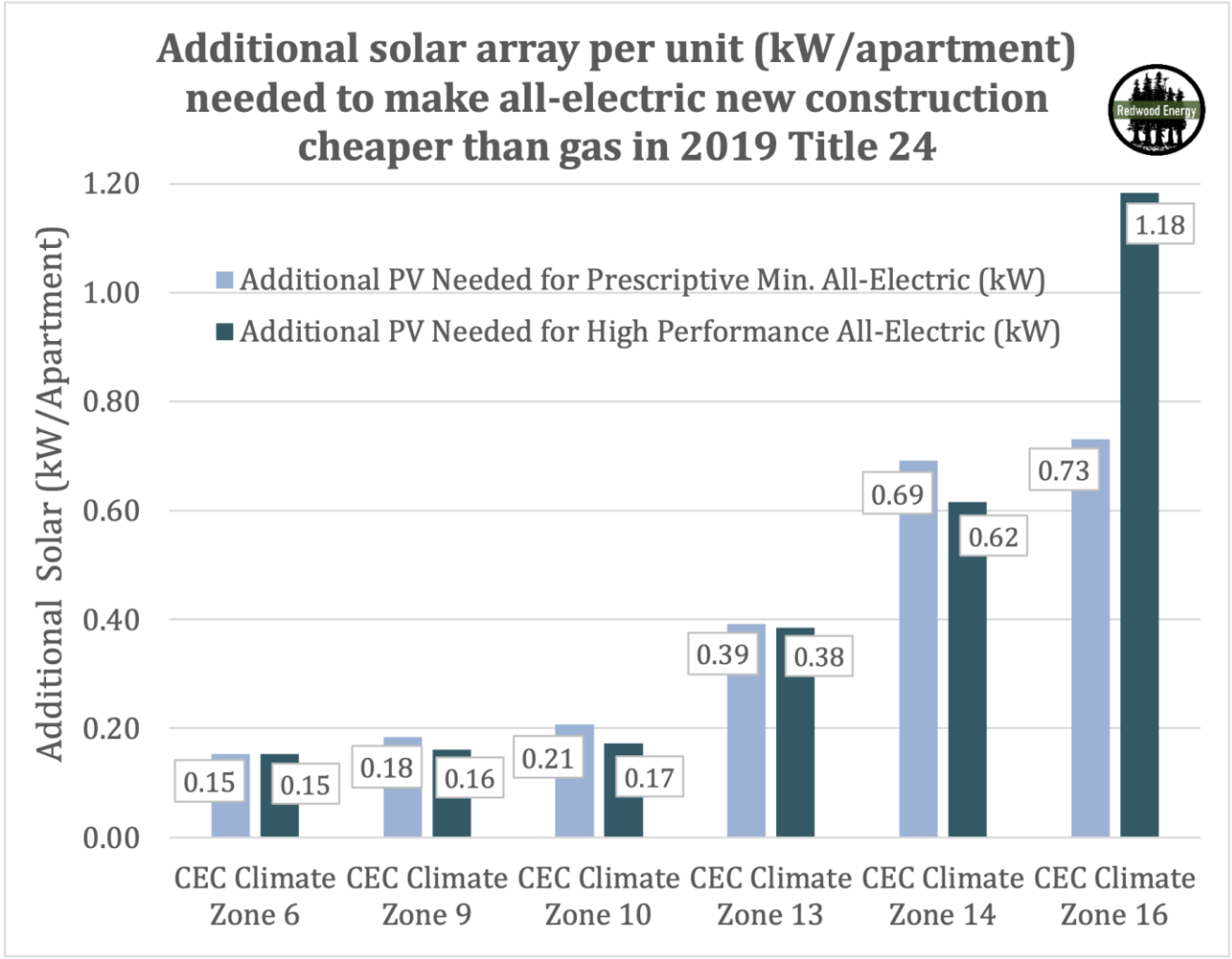
- The complete electrification of the HVAC system
- Home age (especially in census tracts where average home age is >50 years)



Program data available for download at techcleanca.com/public-data/

Setting Bill Expectations

Unlike in most of the U.S., electrification **raises bills** in California IOU territories unless rooftop solar is added



Q&A

Intermission

Back at 10:15 am

Session 2, Part 1:
Power Management

Moderator: Jenny Low, Build It Green

Session 2, Part 1: Power Management

Agenda:

Using the Watt Diet For Whole Home Electrification – Helping Contractors be Good Stewards of the Panel

- Shell measures and fixtures
- Energy efficient equipment (<kWh)
- Power efficient equipment (<kW)

Electrical Load Calculations

- Right size equipment and oversize wires
- Questions and answers

Speaker: Tom Kabat

Session 2, Part 1: Power Management

TOPIC

Using the Watt Diet For Whole Home Electrification

Helping Contractors Be Good Stewards of the Panel

Tom Kabat
Energy Engineer
tomgkabat@gmail.com

Slides courtesy of:
Josie Gaillard, Tom, HEA, and 3-C REN

Problem/Opportunity:

There's a chance to put a lot of new equipment onto the grid, but it depends on how we select it, size it, and install it

If we are bad stewards of the panel:

- We paint the customer into a corner
- They need a panel upsizing before they can finish full electrification
- Too many oversized (overly peaky) loads jam up the neighborhood transformers and wires
- Utility staff and supply chain are backlogged. Electricians backlogged too
- Projects take too long waiting for utility permission
- Utilities yank the program support and wait until they can upgrade each neighborhood
- All this is bad for everyone's business

Solution

- Contractors right-sizing and using high performance inverter heat pumps
- Avoid resistor strips in HVAC and minimize them in heat pump water heaters
- Consider stout wire and smaller nameplate machines on right-sized breakers
  - E.g., a 17-amp machine on a 40-amp capable wire connected to a 20-amp breaker; breakers list the range of wire sizes that fit breaker jaw
- **Contractors getting the job based on being good stewards and branching into heat pump water heaters and electrification plans for customers**

Use TECH Clean California incentives to cover business expansion

Our Choices:

Make a plan
(do it right and tell the customer)

1. Talk about it
2. Use good, inverter driven, high COP, right-sized equipment without resistor strips (get buy-in)

Do it right without a plan
(do it right and tell the customer)

Use good, inverter driven, high COP, right sized equipment without resistor strips (like there was a plan)

Do it wrong

Use cheaper single- or two-speed, lower COP, oversized equipment and maybe with resistor strips (contractor shifting risk & cost onto customer, soc.)

Our Choices:

Good power efficient solutions implemented

Make a plan
(do it right and tell the customer)

1. Talk about it
2. Use good, inverter driven, high COP, right-sized equipment without resistor strips (get buy-in)

Right:
- Making an all-electric plan
- Being good stewards of the panel
- Planning power efficient solutions in all end uses

Do it right without a plan
(do it right and tell the customer)

Use good, inverter driven, high COP, right sized equipment without resistor strips (like there was a plan)

Right:
- Being good stewards of the panel
- Picking power efficient solutions in our trade

Do it wrong

Use cheaper single- or two-speed, lower COP, oversized equipment and maybe with resistor strips (contractor shifting risk & cost onto customer, soc.)

Wrong:
- Not thinking ahead
- Installing high power equipment

Problems of Electrifying without a Plan or without Being Good Stewards

- Homeowner's first electrification projects use up too many panel amps
- Contractor maybe not thinking about whole-home electrification
- Typical Problems:
  - 50-amp car chargers
  - 50-amp HVAC systems
  - 30-amp heat pump water heaters

Problems of Electrifying without a Plan

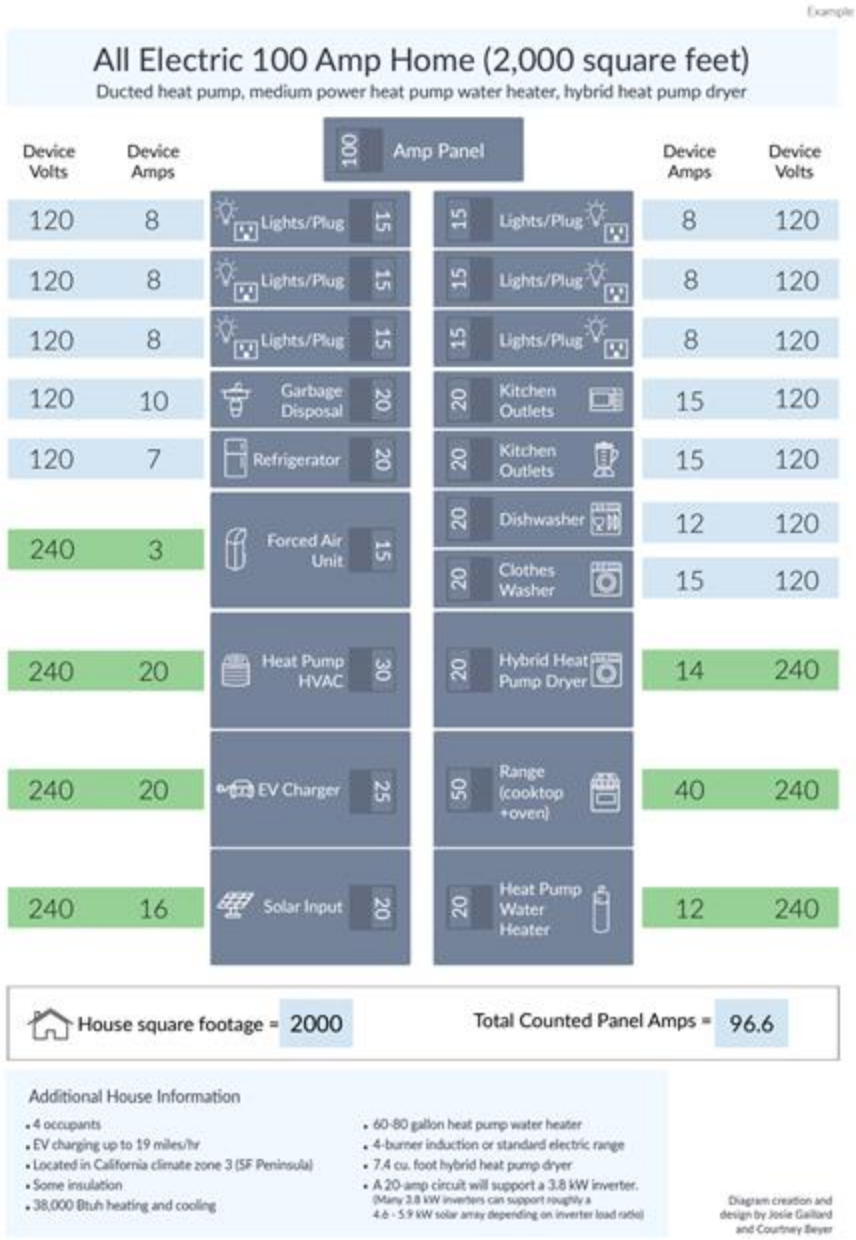
- Electric panel is poorly filled
- Panel and service line need to be upsized
- Utility gets involved
- Long wait times (several months)
- Could cost $5,000 (overhead service line) or $20,000 (underground)

Benefits of Electrifying with a Plan

- Helps avoid an unexpected $5,000 electric panel upgrade
- Provides roadmap for homeowner
- Helps guide tradespeople
- Helps avoid unnecessary work and costly mistakes
- Facilitates right sizing equipment (vs. oversizing)
- Home more likely to be power efficient and grid-friendly

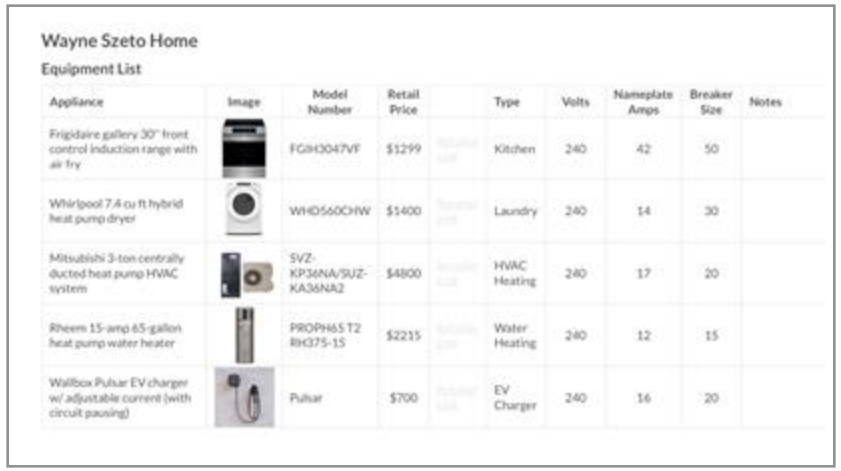
Panel optimization works: If house is < 3000 sq ft and located in a mild climate, a 100-amp panel is usually sufficient

Homes with 60-amp panels or smaller should consider upsizing panel



Components of an Electrification Plan

1. Recommended equipment list
2. Electrical load calculations per NEC 220.83(B) or 220.87
3. Wiring plan (optional but helpful)
4. Project list for contractors with photos of existing equipment and locations



Wayne Szeto Home

Equipment List

Appliance	Image	Model Number	Retail Price		Type	Volts	Nameplate Amps	Breaker Size	Notes
Frigidaire gallery 30" front control induction range with air fry		FGIH3047VF	$1299		Kitchen	240	42	50	
Whirlpool 7.4 cu ft hybrid heat pump dryer		WHD560CHW	$1400		Laundry	240	14	30	
Mitsubishi 3-ton centrally ducted heat pump HVAC system		SVZ-KP36NA/SUZ-KA36NA2	$4800		HVAC Heating	240	17	20	
Rheem 15-amp 65-gallon heat pump water heater		PROPH65 T2 RH375-15	$2215		Water Heating	240	12	15	
Wallbox Pulsar EV charger w/ adjustable current (with circuit pausing)		Pulsar	$700		EV Charger	240	16	20	

Electrical Service Load Calculation

performed according to NEC Optional Method 220.83(B)

General Information:

Permit Applicant: _____ Phone Number: _____

Project Address: _____

Contractor: _____ License #: _____

Certification:

I certify that the information in the calculations below is accurate and complete.

Signature: _____ Date: _____

Printed Name: _____

Phone Number: _____ Email Address: _____

General Light and Plug Loads				Volt-Amps
Dwelling	2,000 sq. ft.	×	3 VA/sf	= 7,000
Kitchen Small Appliance Circuits	2 min. 2)	×	1,500 VA each	= 3,000
Laundry (Washing Machine) Circuit	1 min. 1)	×	1,500 VA each	= 1,500
Appliance Loads (nameplate value)	**Volts**		**Amps**	**Volt-Amps**
Built-in Microwave (not countertop model)	120	×	10	= 1,200
Dishwasher	120	×	15	= 1,800
Garbage Disposal	120	×	9.5	= 1,140
Refrigerator (on dedicated circuit)	120	×	5	= 600
Stove hood	120	×	1	= 120
NEW: Frigidaire gallery 30" front control induction range with air fry	240	×	42	= 10,080
NEW: Whirlpool 7.4 cu ft hybrid heat pump dryer	240	×	14	= 3,360
NEW: Rheem 15-amp 65-gallon heat pump water heater	240	×	12	= 2,880

Project List for Wayne Szeto Home

Contractor Type	Description
Electrician	1. Use existing 100A service line. 2. Modify main electrical panel as specified in Electrical Panels Table. Main 100A electrical panel 3. Install 1 new subpanel as specified in Electrical Panels Table.

Note:

- Homeowners can do their own plan or get help from an expert
- A plan takes an expert ~30 minutes and may take a homeowner ~3 hours

Actions

Regardless of whether you make a whole all-electric house plan, you can still make your project compatible with future electrification

Basic Watt Diet Approaches

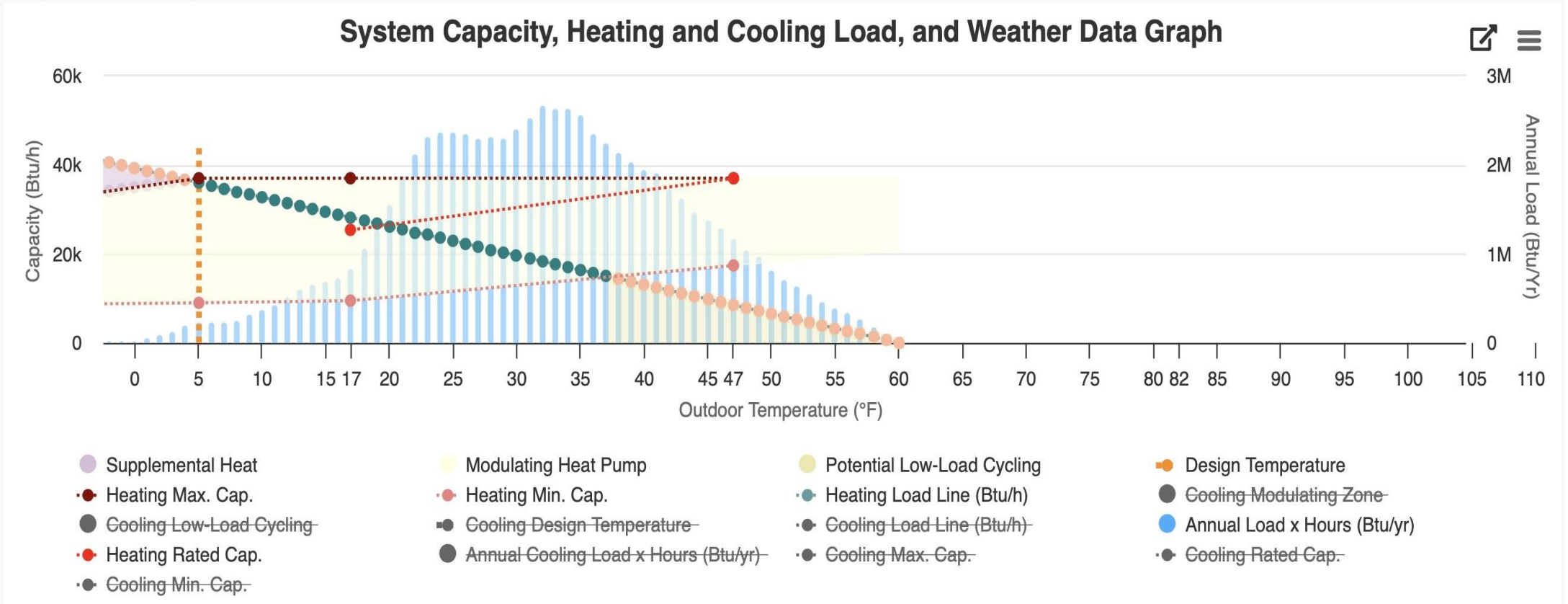
- Choose Multifunction and/or power-efficient devices
- Choose HVAC that can avoid resistor strips
  - COPs 2-3+ vs. 1 for resistance
- Make a thermal plan* that can include air sealing and attic insulation
  - The shell fixes can occur after the electrification
  - Every “prerequisite” is another stumbling block preventing action. We lose too many clients by making hurdles for them to jump over

**not a prerequisite*

Denver in the NEEA Equipment Performance Site

Run System Sizing

Graph Information



NEEA Equipment Performance Table

Information Tables

Brand	AMERICAN STANDARD / MITSUBISHI ELECTRIC
Series	Nv-Series
Ducting Configuration	Singlezone Ducted, Compact Ducted
AHRI Certificate #	206374558
Outdoor Unit Model #	NAXSKH30A112AA
Indoor Model #	TPEADA0301AA70A
Indoor Unit Type	Mini-Splits
Furnace Model #	
EER	12.5
SEER	15
HSPF (Region IV)	9
EER2	
SEER2	
HSPF2 (Region IV)	

Performance Specs

Heating / Cooling	Outdoor Dry Bulb	Indoor Dry Bulb	Unit	Min	Rated	Max
Cooling	95°F	80°F	Btu/h	15,600	33,000	33,000
			kW	1.12	2.49	2.49
			COP	4.08	3.88	3.88
Cooling	82°F	80°F	Btu/h	17,500	-	35,600
			kW	0.94	-	2.13
			COP	5.46	-	4.9
Heating	47°F	70°F	Btu/h	17,400	37,000	37,000
			kW	1.05	2.94	3.26
			COP	4.86	3.69	3.33
Heating	17°F	70°F	Btu/h	9,500	25,400	37,000
			kW	1.18	2.96	4.99
			COP	2.36	2.51	2.17
Heating	5°F	70°F	Btu/h	9,000	-	37,000
			kW	1.44	-	5.67
			COP	1.83	-	1.91
Heating	-13°F	70°F	Btu/h	8,500	-	29,600
			kW	1.34	-	5.79
			COP	1.86	-	1.5

Session 2, Part 1: Power Management

TOPIC

Electrical Load Calculations

Tom Kabat
Energy Engineer
tomgkabat@gmail.com

Electricity Basics (Ohm's law) P = IV

Watts = Amps x Volts
(Power = Current [flow rate] x Pressure)

P=IV **Power = Current X Voltage**
V= I squared R Volts = Current^2 X Resistance
V= I squared R Volts = Current X Current X Resistance
I = P/V

Example:
How many amps does it take to provide **1,000 watts** from a **240V** line?

P = I V I = P / V

Amps = Watts / Volts = 1,000 W

1,000 W / 240 V = **4.2 amps**

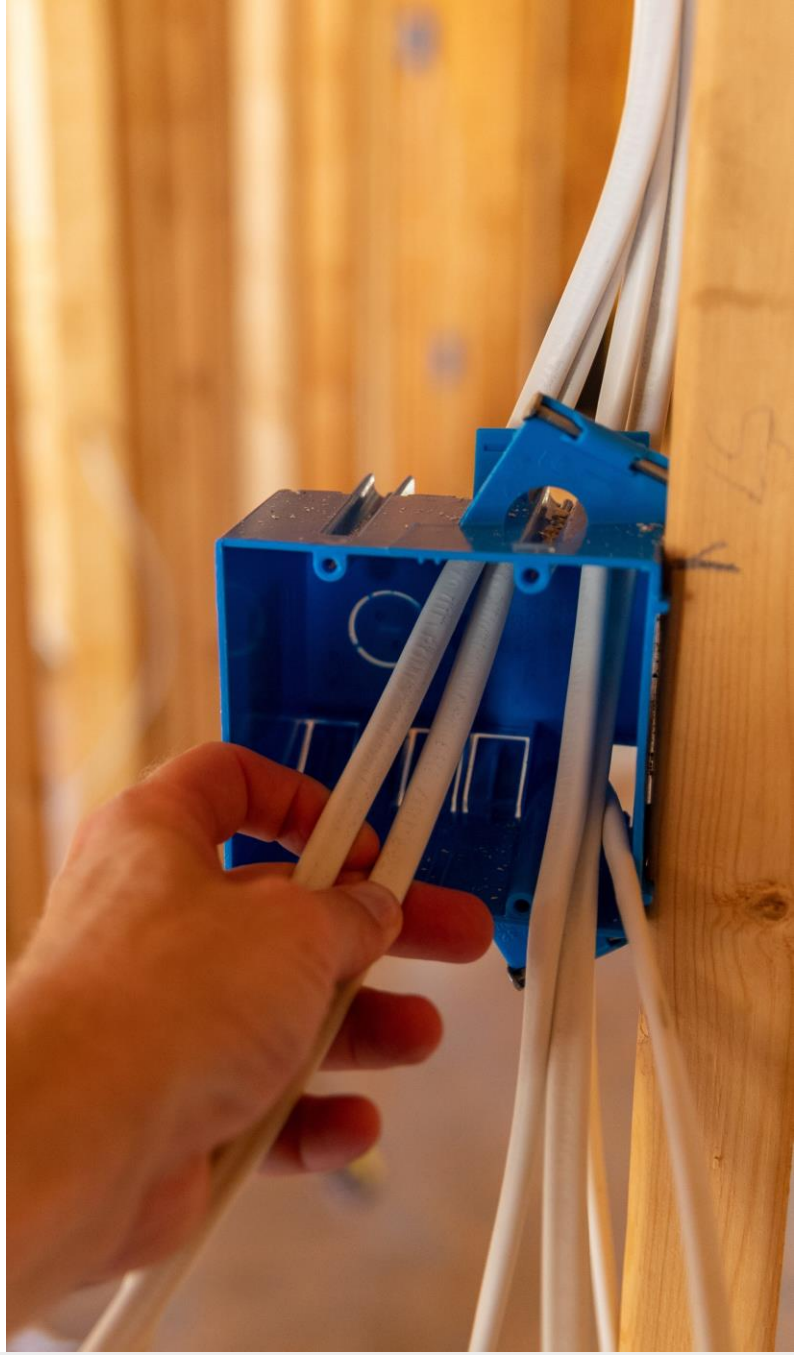
Electric Current Overheat Safety

- Wires have resistance (ohms)
  - Larger diameter wires have more conductance (less resistance)
  - Smaller diameter wires have more resistance (ohms)

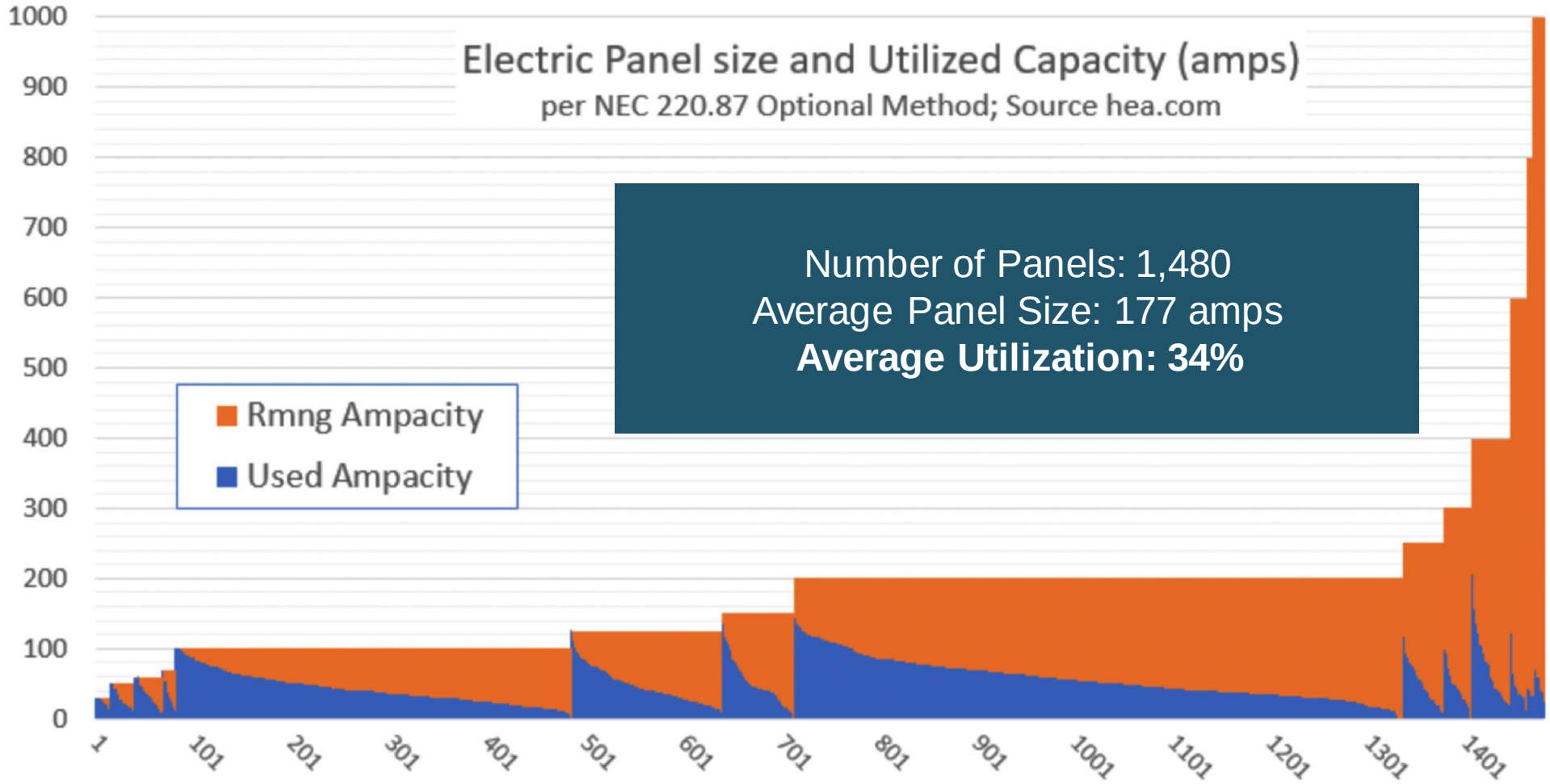
- Current flow (amps) through wires causes wire heating

- Wires have thermal limits on how much heat they can dissipate (per foot) while maintaining a safe temperature, therefore, wires have maximum safe current ratings

- Breakers selected are small enough to protect the wire from current that would overheat it



Panels Have Lots of Available Capacity

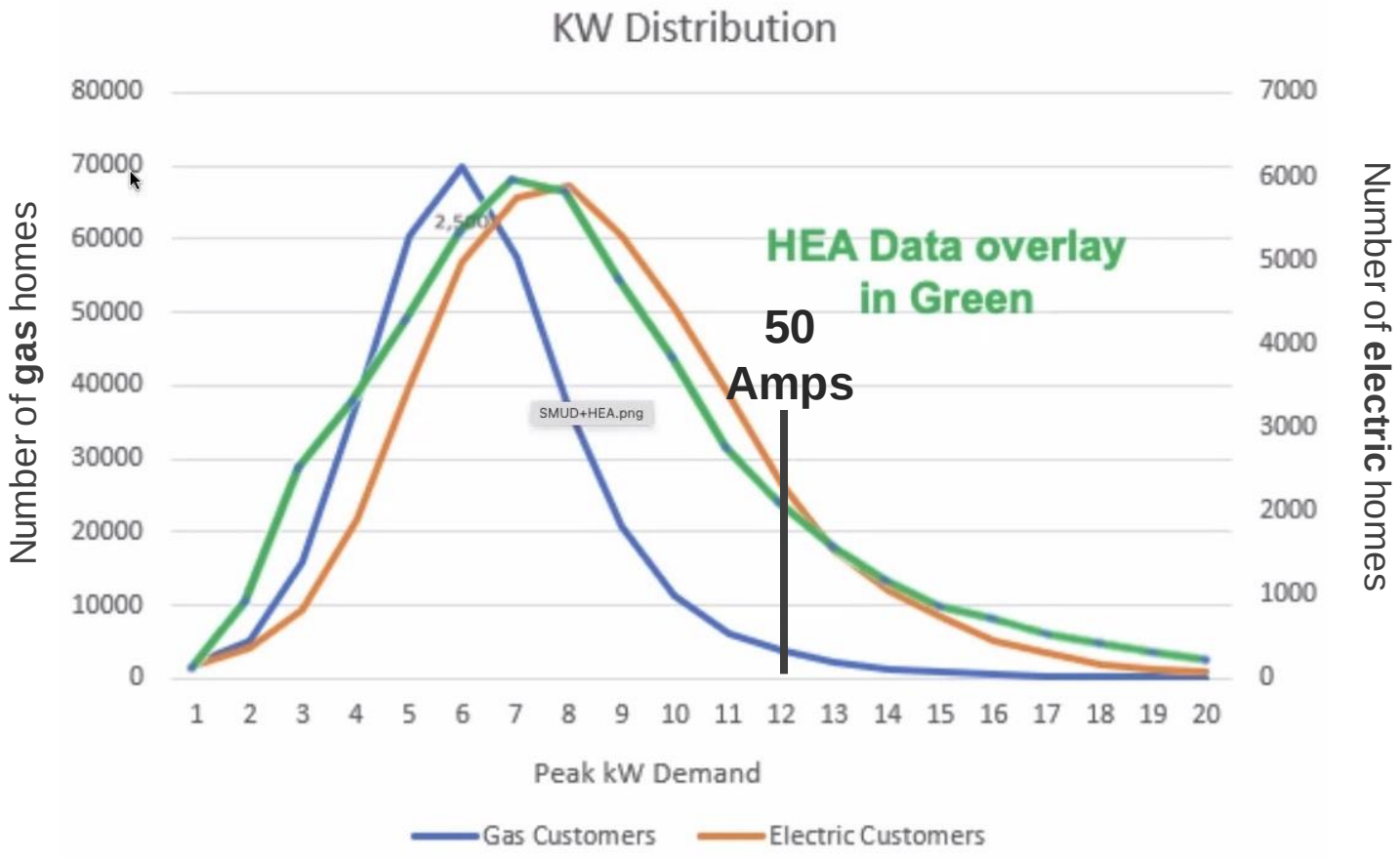


Slide Courtesy of HEA

Whole Home Electrification Does Not Add Much to the Home Peak

- Orange minus blue shows that **electrification adds about 2 – 4 kW of peak load** to most gas houses
- Very few houses peak at 100 Amps 24 kW
- This graph goes from 1 to 20 kW (up to 83 amps)

I recommend 100A panels since 15% of customers need 50A or more



Two Ways of Getting Permission to Add Load to the Panel

1. **Top-Down History Method (NEC 220.87):**
   Use metered or billing historic peak multiplied by 1.25 (spikey factor) plus full nameplate load of new equipment (as though it's fully coincident with the old peak)

2. **Bottom-Up Method (NEC 220.83 B):**
   Calculating the panel loads from nameplate loads X demand factors:
   - Where: demand factor should be called coincidence factor.
   - It's an assumption about how fractionally coincident the device peak is with the building annual peak

Load Calculation with 220.87

Using a Top-down History Approach

(good for adding one to two items at a time):

- Starts with power capacity of the smaller of **main disconnect** or **panel rating** (= amperage rating X 240 volts = **wattage rating**)

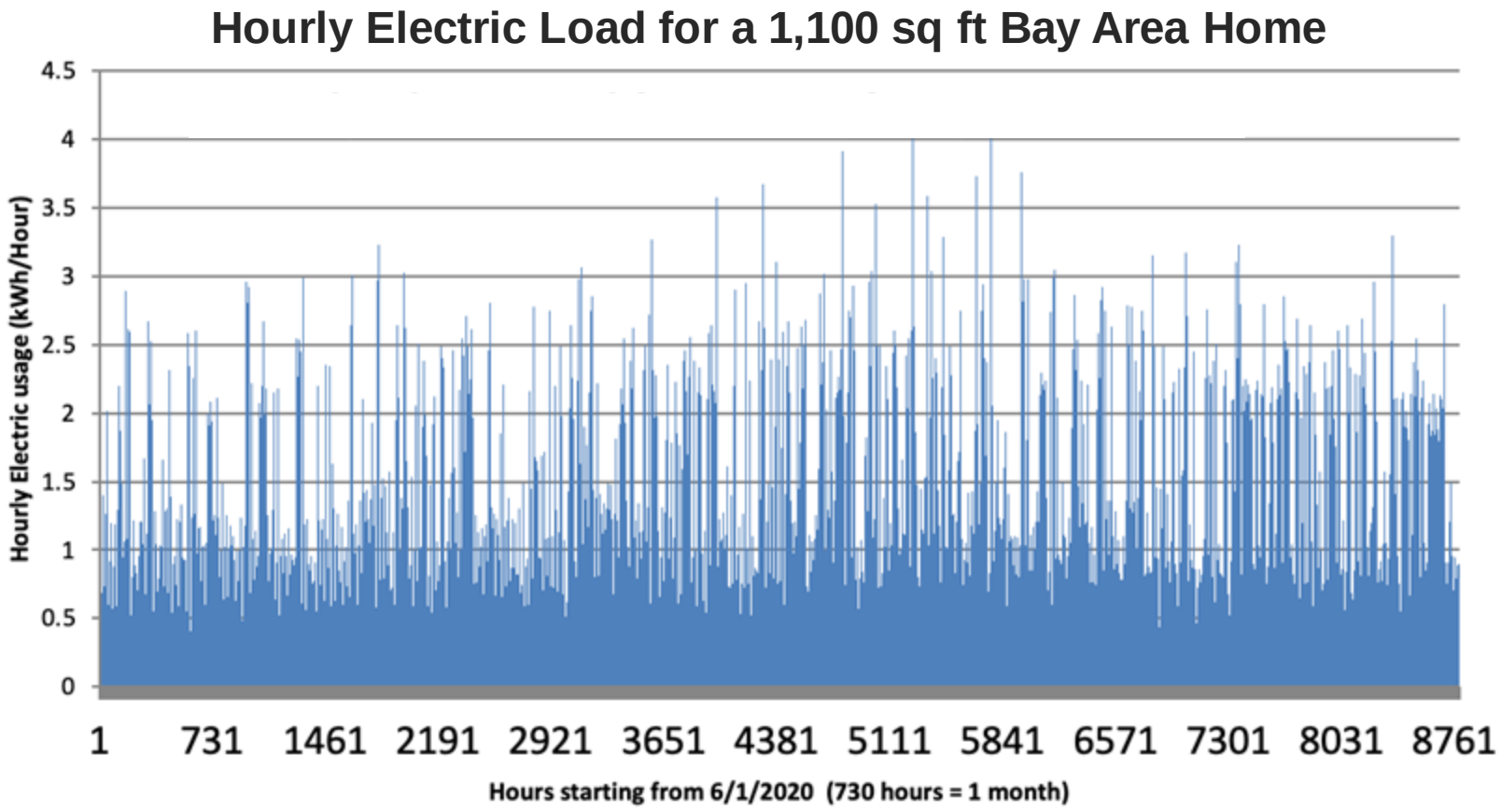
- Then calculate occupied peak load wattage on main disconnect or feeder
  = peak usage interval last year (highest 1-hour usage) in peak watts in recent year
  OR
  = peak usage 15-minute interval in recent 30 days in peak watts
  — Peak load * 1.25 = **wattage already occupied**

- **Remaining wattage space** =
  wattage rating minus **wattage already occupied**

- New devices are allowed if their full nameplate wattage fits within **remaining wattage space**

- Good for adding new devices per year

Determining How Much Electrification a Panel Can Accommodate

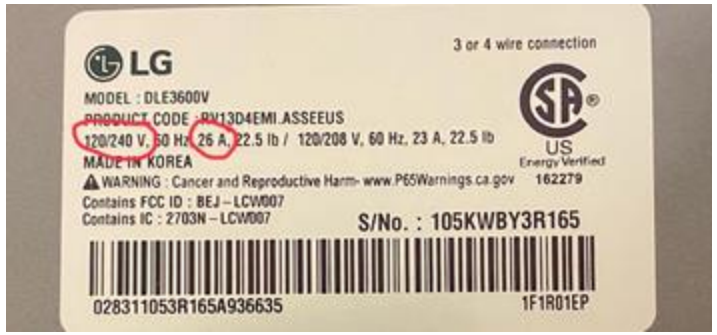


Load Calculation with 220.87

Using a Top-down History Approach ***(good for adding one to two items at a time):***

History not allowed if modified by solar or batteries or by load control devices.

100 A 24 kW → 100 amps X 240 V = **24,000 W Rating**

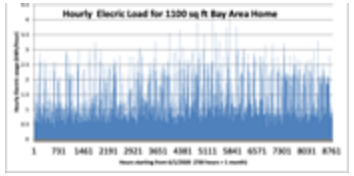


Remaining space available for full nameplates of new equipment:

19,000 Nameplate Watts

24,000 W – 5,000 W → 19 kW

4,000 W peak usage measured → 4,000 W peak usage X 1.25 = **5,000 W occupied**



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Bottom-Up Method: NEC 220.83 (B)

- Good for when you lack history data
- Or when you want to add cooking, drying and water heating, or EV all at once, along with HVAC
- Or if you’re not allowed to use 220.87

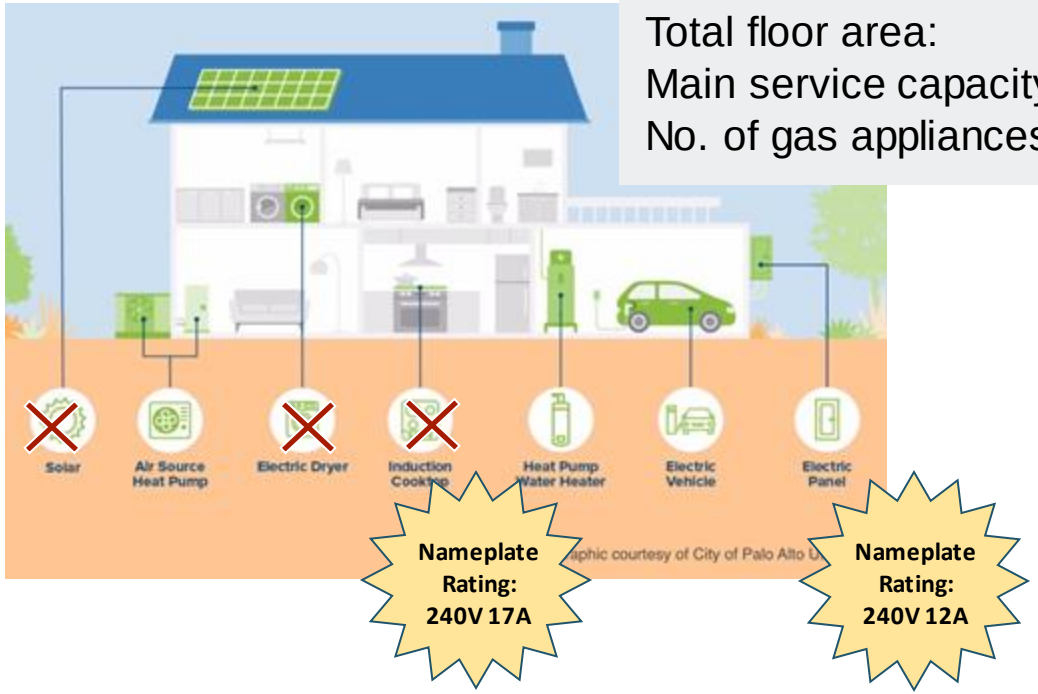
Load Calculation

Adding Electric HVAC, Heat Pump Water Heaters

In this example, we use NEC code sections **220.83 (B) + 625.40**

Home B

Total floor area:	2,000 sq ft
Main service capacity:	100 amps
No. of gas appliances:	2



Load Type	Amps	Volts	Watts
Kitchen Circuit	12.5	x 120	= 1500
Kitchen Circuit	12.5	x 120	= 1500
Laundry Circuit	12.5	x 120	= 1500
Refrigerator	5	x 120	= 600
Dishwasher	10	x 120	= 1200
Garbage Disposal	5	x 120	= 600
Lights + Plugs	(3 watts / sq foot)		= 6000
		Subtotal	**= 12,900**

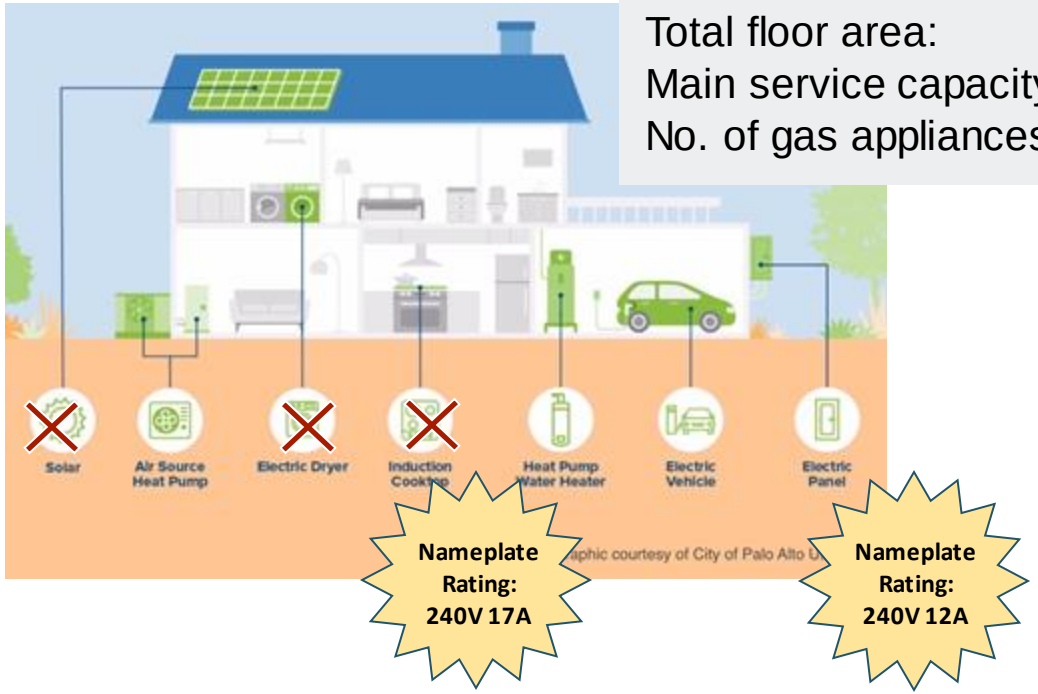
Load Calculation

Adding Electric HVAC, Heat Pump Water Heaters

In this example, we use NEC code sections **220.83 (B)**

Home B

Total floor area: 2,000 sq ft
Main service capacity: 100 amps
No. of gas appliances: 2



Load Type	Amps	Volts	Watts
Kitchen Circuit	12.5	x 120	= 1500
Kitchen Circuit	12.5	x 120	= 1500
Laundry Circuit	12.5	x 120	= 1500
Refrigerator	10	x 120	= 1200
Dishwasher	10	x 120	= 1200
Garbage Disposal	5	x 120	= 600
Lights + Plugs	(3 watts / sq foot)		= 6000
First 8,000 watts @ 1.0 coincidence factor			= 8,000
Remaining 5,500 watts @ 0.4 coinc. Factor			= 2,200
HVAC 4,080 watts @ 1.0 coincidence factor			= 4,080
HPWH 2,880 watts @ 0.4 coincidence factor			= 1,152
		Total	**= 15,432**

Amperage = 15,432 with 240V = 65 amps

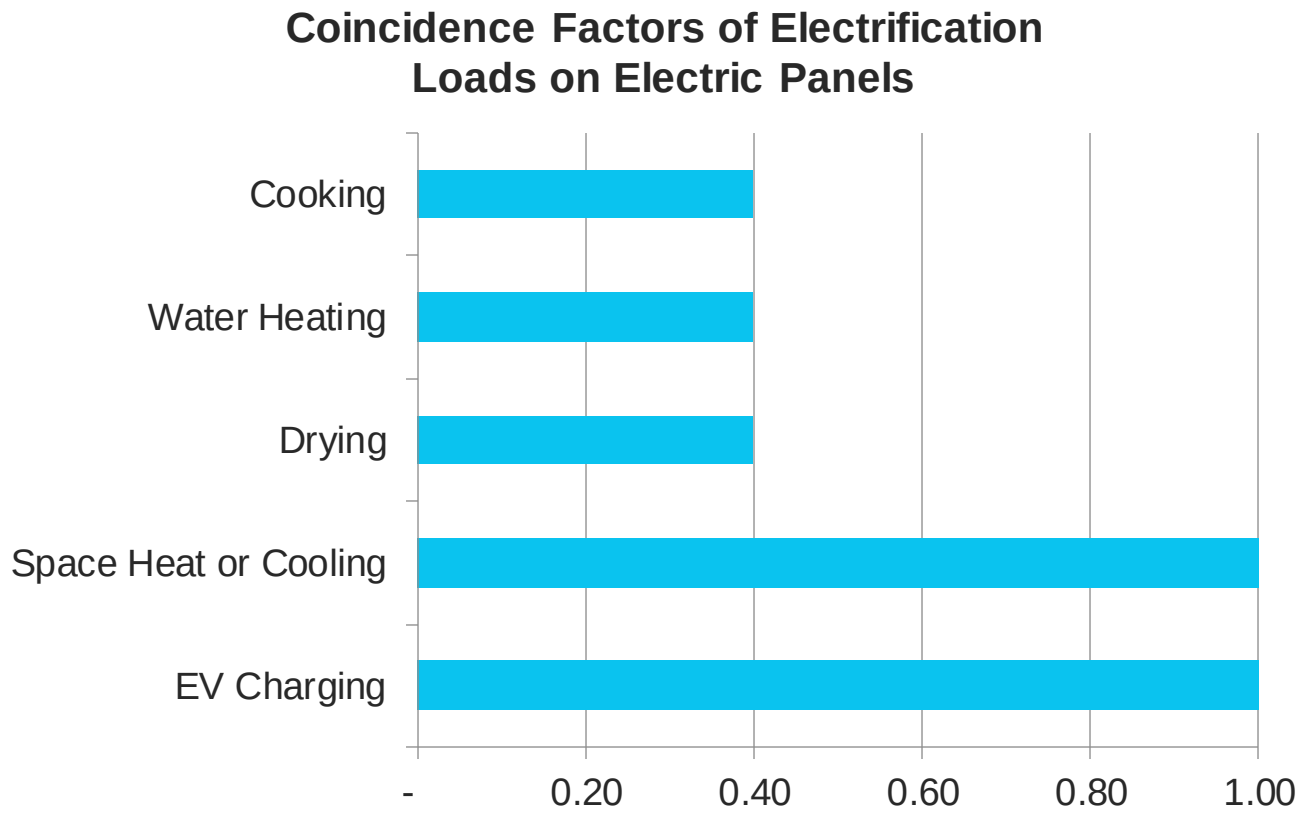
Electrical Load Calculations

General Light and Plug Loads					Volt-Amps
Dwelling	2,350 sq. ft.	×	3 VA/sf	=	7,050
Kitchen Small Appliance Circuits	2 (min. 2)	×	1,500 VA each	=	3,000
Laundry (Washing Machine) Circuit	1 (min. 1)	×	1,500 VA each	=	1,500
Appliance Loads (nameplate value)	**Volts**		**Amps**		**Volt-Amps**
Built-in Microwave (not countertop model)	120	×	10	=	1,200
Dishwasher	120	×	15	=	1,800
Garbage Disposal	120	×	9.5	=	1,140
Refrigerator (on dedicated circuit)	120	×	5	=	600
Stove hood	120	×	1	=	120
NEW: Frigidaire gallery 30'' front control induction range with air fry	240	×	42	=	10,080
NEW: Whirlpool 7.4 cu ft hybrid heat pump dryer	240	×	14	=	3,360
NEW: Rheem 15-amp 65-gallon heat pump water heater	240	×	12	=	2,880
General Loads Subtotal					32,730
First 8,000 VA @ 100%					8,000
Remaining VA @ 40%					9,892
General Loads Total					17,892
Other Loads (nameplate value)	**Volts**		**Amps**		**Volt-Amps**
NEW: Electric Vehicle Charging Load @ 125% (with circuit pausing)	240	×	0	=	0
Bathroom Heater #1 @ 100%	120	×	11	=	1,320
NEW: Mitsubishi 3-ton centrally ducted heat pump HVAC system @ 100%	240	×	17	=	4,080
Other Loads Total					5,400
Total Load (General + Other)					23,292 VA
Divide Load by 240 Volts					97 A
Rating of Existing Electrical Service					100 A
Panel Upgrade Required?					No

NEC Article 220.83(B) Coincidence Factors

When using NEC 220.**83(B),** these are the electrification coincidence factors for adding equipment

But, when using NEC 220.**87**, the factors are 100% for adding equipment



NEC Code Sections Relevant to Electrification

- 220.82 (B) New Homes 10 kW @ 1.0
- 220.82 (C) New Homes HVAC @ 1.0 with some diversity for strip heat and 4+ separate zones
- 220.83 (A) Existing Homes 8 kW @ 1.0
- 220.83 (B) Existing Homes adding HVAC @ 1.0 coincidence factor
  First 8 kW of other loads also counts at 1.0 coincidence factor
- 220.54 For multifamily and laundromat dryer fleets, not single-family homes
- 220.87 To use historic hourly usage to find the remaining panel capability
- 625.40 For applying the 1.25 combination long duration factor and coincidence factor for EVSE loads on their branch, how far up?

Session 2, Part 1: Power Management

TOPIC

Optimizing the Panel: Fitting Everything on It

Electrically (amps) and Physically (space)

Tom Kabat
Energy Engineer
tomgkabat@gmail.com

7 Ways To Lower Your Panel Amps

1. Pick high efficiency equipment (Heat Pump HSPF > 10)
2. Pick power efficient versions of heat, water heater, dryer, cooking
   E.g., heat pumps without backup resistance, low amp heat pump water heaters with big tanks
3. Avoid oversizing (heat pump 2- to 3-tons for most homes, EVSE 20 amps = 39k miles)
4. Pick multifunction devices (e.g., combo washer/dryer, range)
5. Consider circuit sharing devices (e.g., alternate dryer & EV charger)
6. Consider circuit pausing devices (e.g., pauses charger or heat pump water heater)
7. Decrease your loads (e.g., add air sealing, insulation and duct sealing, or go ductless)

Power Counting in Each Usage Category

Clothes Drying
Difference 8 A

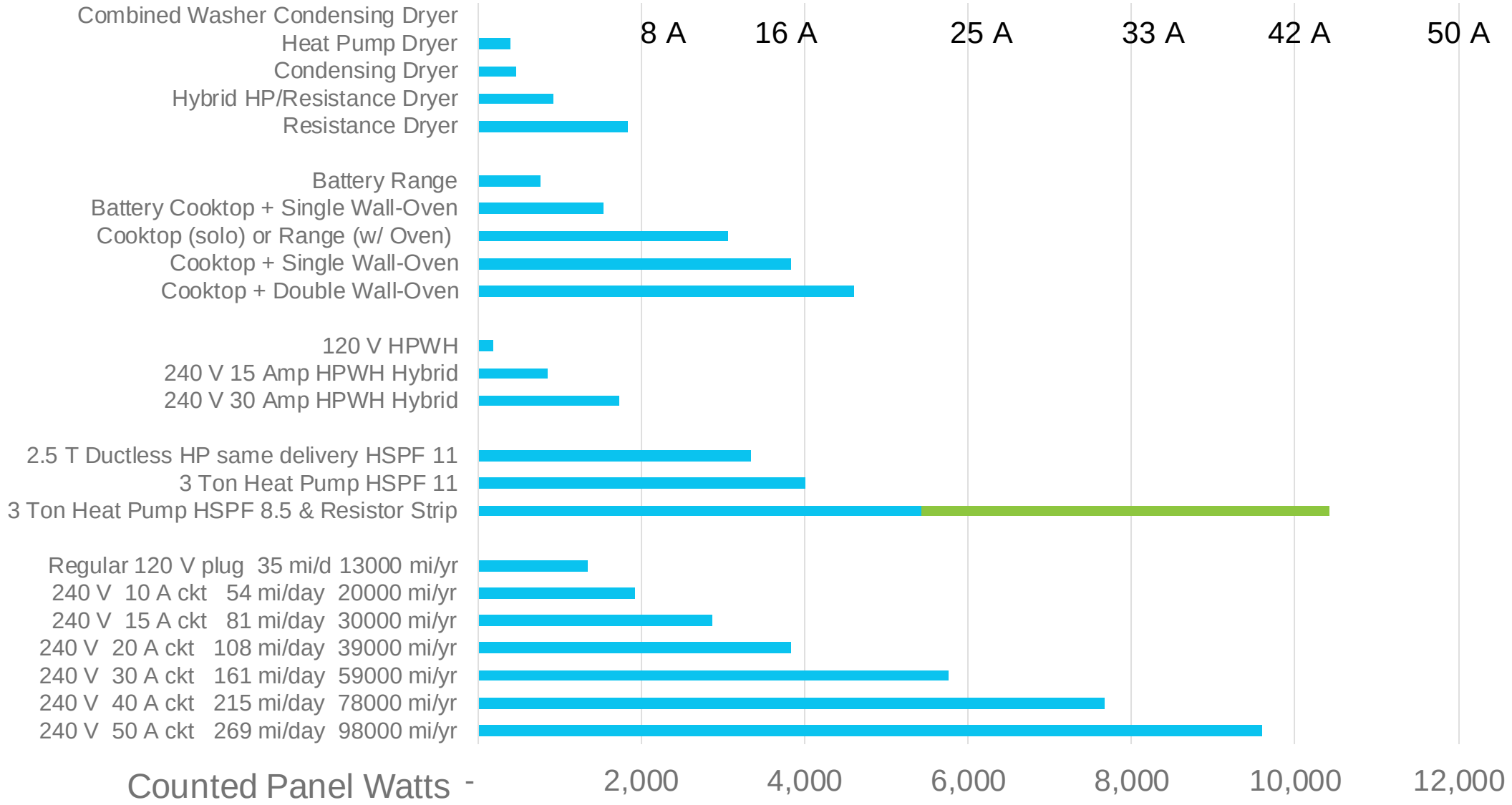
Cooking
Difference 16A

Water Heating
Difference 6 A

HVAC
Difference 25A

EV Charging
Difference 34A

Total Diff 89 A



Super Watt Diet With 120V Cooking

Replace:	Old Wattage	With:	Voltage	Wattage	Amps nameplate	Amps Counted	Amps removed	Net Amps Added		
Gas Dryer	800	Combo W/D machine	120	1200	10	2	1.33	0.7		
Gas Cooktop	200	Battery Cooktop	120	1200	10	2	0.33	1.7		
Gas WH	0	120V HPWH	120	900	7	1.5	0	1.5		
Gas Furnace/AC	4500	3 Ton 240V Inverter HP	240	4500	18.75	18.75	18.75	-		
Gasoline Car	0	120 V EVSE	120	1200	10	0	0	-	12,000	miles/year
Pre Elec. Total	5,500	Electrification Total		9,000	56	24.3	20.4	**3.8**	**Amps Added**	
								920	**Watts Added**	

Watt Diet With 240V Cooking

Replace:	Old Wattage	With:	Voltage	Wattage	Amps nameplate	Amps Counted	Amps removed	Net Amps Added		
Gas Dryer	800	Combo W/D machine	120	1200	10	2	1.33	0.7		
Gas Cooktop	200	240V Range	240	9600	40	16	0.33	15.7		
Gas WH	0	120V HPWH	120	900	7	1.5	0	1.5		
Gas Furnace/AC	4500	3 Ton 240V Inverter HP	240	4500	18.75	18.75	18.75	-		
Gasoline Car	0	240V 40A Smart charger	240	7680	32	0	0	-	78,000	miles/year
Pre Elec. Total	5,500	Electrification Total		23,880	108	38.3	20.4	**17.8**	**Amps Added**	
								4,280	**Watts Added**	

Regular Jumbo Electrification

Replace:	Old Wattage	With:	Voltage	Wattage	Amps nameplate	Amps Counted	Amps removed	Net Amps Added		
Gas Dryer	800	30 Amp Dryer	240	4500	18.75	7.5	-	7.5		
Gas Cooktop	200	240V Range	240	9600	40	16	0.33	15.7		
Gas WH	0	30 Amp HPWH	240	4500	18.75	7.5	0	7.5		
Gas Furnace/AC	4500	3 ton 240V HP + 5 kW res	240	9500	39.58	39.583	18.75	20.8		
Gasoline Car	0	240V 40A dumb charger	240	7680	32	32	0	32.0	78,000	miles/year
Pre Elec. Total	5,500	Electrification Total		35,780	149	102.6	19.1	**83.5**	**Amps Added**	
								20,040	**Watts Added**	

A Tale of two Bookends (on design methods)

Very Watt Diet vs. Old Jumbo

	Poles	Nameplate W	Panel W	A	Ckt	Poles	Nameplate W	Panel W.	A	Ckt
HVAC	1 1 Ton	1,400	1,400	6	1	2 5 tons 60A 2 Strip Resist	7,000 + 5,000 Res	7,000 5,000	29 21	1 1
Water Heat	0 120V Share	400	160	1		2 240V 30A	4,600	1,840	8	1
EV Charging	0 120V	0	0			2 240V 50A	9,600	9,600	40	1
Cooking	0 120V Batt	1,600	640	3		2 240V 40A	9,600	3,840	16	1
Drying	0 120 Combo	0	0			2 240V 30A	4,600	1,840	8	1
Tot w/o HVAC	0	2,000	800	3	0	8 150A	28,400	17,120.	71	4
Total w/ HVAC	1	3,400	2,200	9	1	12 210A	40,400	29,120	121	6

11 Ways to Free up Physical Panel Space

1. Pick multifunction appliances
2. Free up furnace circuit
3. Choose shared circuit version 120V heat pump water heater
4. Use tandem or slim breakers
5. Automatic circuit sharing devices (two appliances share one circuit)
6. Junction box (join two low-load circuits)
7. Square D breakers can hold two circuits
8. Pig Tail breaker can hold two circuits
9. Add subpanel for about 9 circuits
10. Line tap solar
11. Use a meter collar (bypasses the main panel and connects to the meter)

Examples of Multifunction Devices

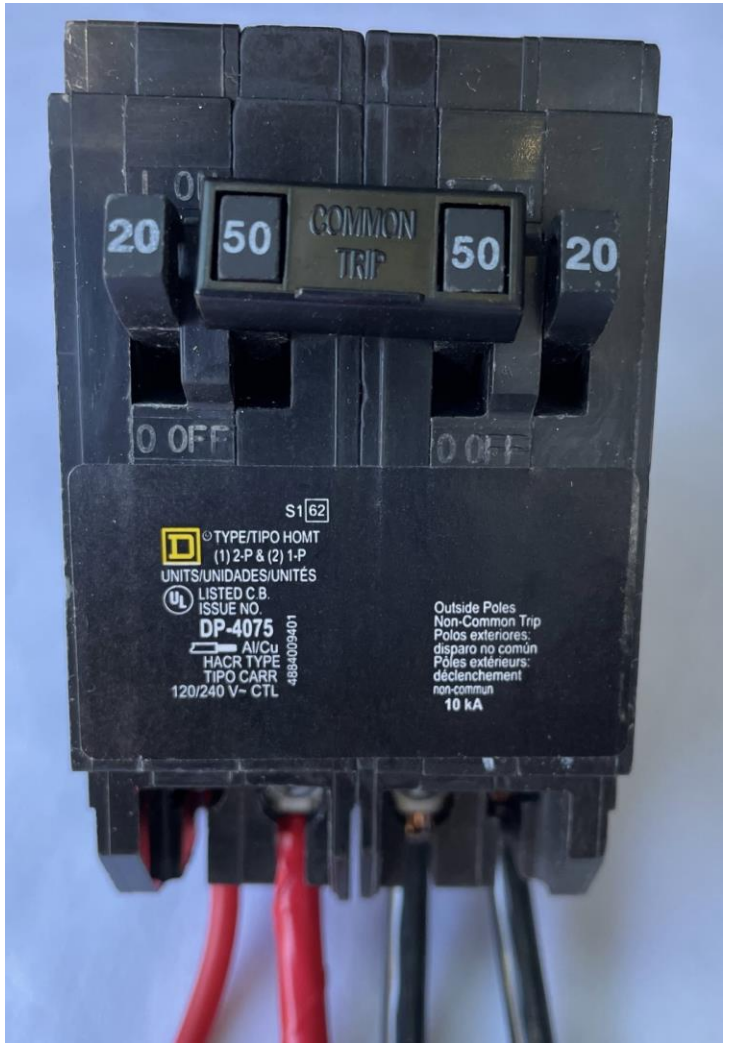
- Combined slide-in range has oven and cooktop on one circuit
- Combined (all in one) washer/dryer has both washing and drying performed by the same machine
- Combined space heat pump and water heat pump provide both space heating and cooling on the same circuit
- Umbilical fed mini splits and ductless mini splits power both the outdoor machine and the indoor machine from the same circuit

Cooktop and Baking

Wash and Dry

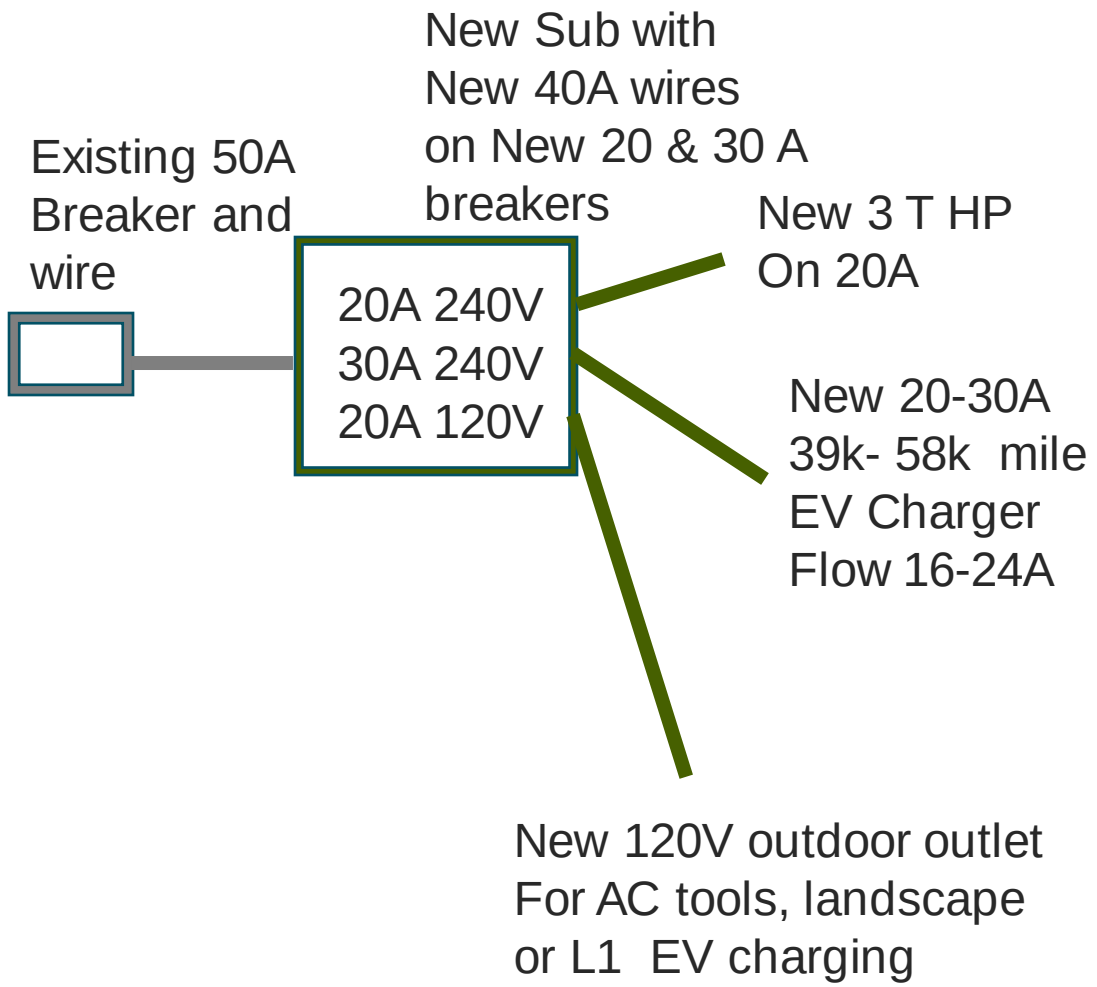
Example One: Electrification Plan from HVAC Contractor

- You started with **100-amp panel** and **no AC**
- We put in power efficient 3-ton heat pump using 17A on 20-amp quad breaker freeing up space to move two of your other 20-amp, 120V circuits to the quad in the same space
- We freed up your old 15-amp, 120V furnace circuit for a 120V heat pump water heater near heat pump air handler. So, you are prewired and ready for dedicated or shared 120V
- You can power a combo washer/dryer on your existing washer circuit freeing up the dryer breaker double space for quad
- Your future projects can use a quad breaker to feed a 50-amp range and a 20-amp EV circuit for 39,000 miles per year



Example Two: Electrification Plan from HVAC Contractor

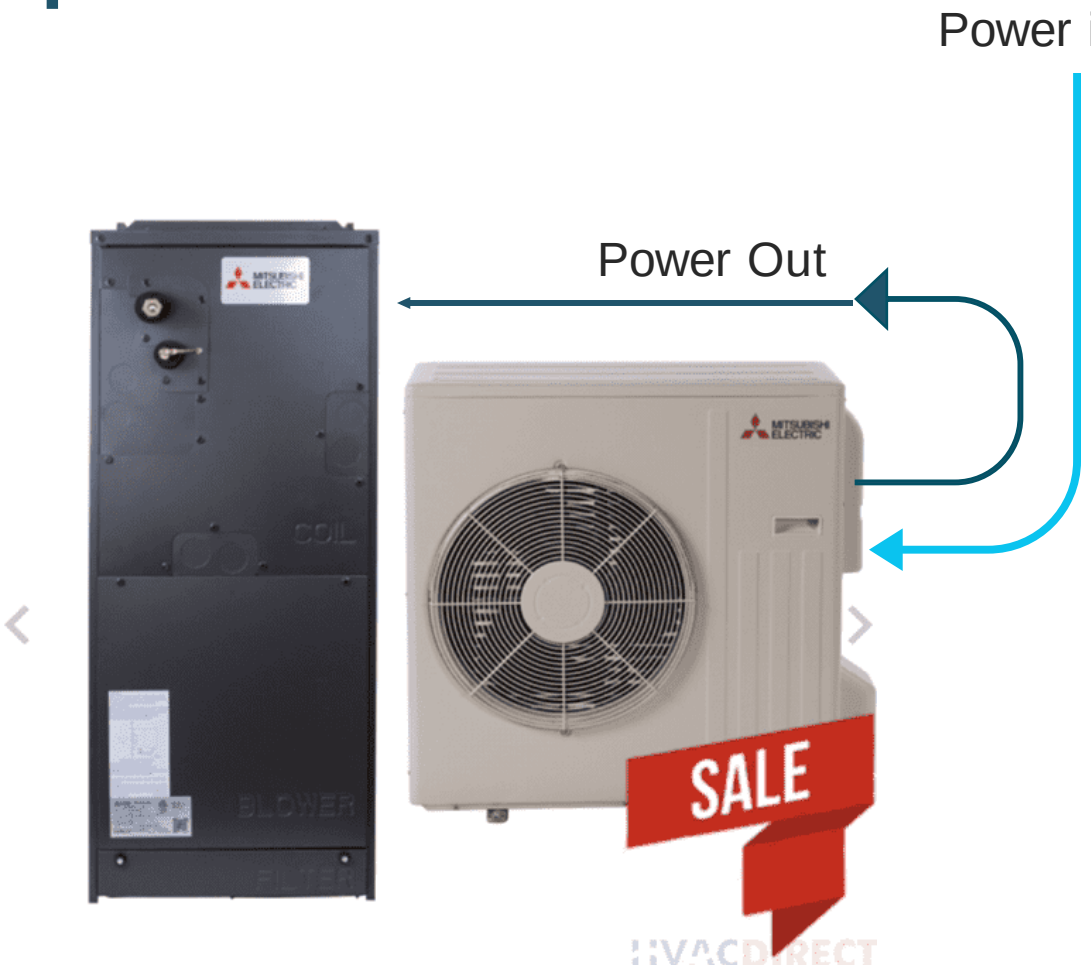
- You started with **100-amp panel** and **50-amp AC** circuit
- We used your 50A circuit to feed a new sub panel to power an efficient 3-ton heat pump using 17A on 20-amp breaker in the sub. This left eight more spaces for future projects (if you have a neutral line)
- You can power up to a 30-amp EV circuit for 58,000 miles per year from the sub
- We freed up your old 15-amp, 120V furnace circuit for a 120V heat pump water heater near heat pump air handler
- And use a quad breaker to feed a 50-amp range from the main without adding spaces
- You can power a combo washer/dryer on your existing W circuit freeing up the dryer breaker



Free Up the Furnace Circuit with Umbilical-Fed Central Heat Pump or Ductless Heat Pump

- Umbilical fed mini splits and ductless mini splits power both the outdoor machine and the indoor machine from the same circuit.
  - Central Examples: Mitsubishi, Fujitsu, Others?
  - Any ductless heat pump

- This frees up the typical 120V 15-amp furnace circuit to be used as a 120V heat pump water heater circuit, or for other use



Using a Few ‘Tandem’ or ‘Slim’ Breakers

Top left breaker is normal 1” 1 pole breaker

Top two breakers on right are 2 tandem breakers filling the same sized space

Middle right 2” wide breaker has two-pole middle section for a 240V circuit and two more slim single-pole breakers on the outside

Bottom right shows 2” wide 2-pole breaker for comparison

Examples of Combining Old Under-Loaded Circuits

- Junction box
  - —(combines two 15-amp circuits into one 15-amp wire to a 15A breaker)
  - —(combines two 20-amp circuits into one 20-amp wire to a 20A breaker)
- Square D brand has breakers allowing two wires held in double jaw
- Can use a “pig tail” in the panel combining two wires into one wire fed by the same amperage breaker
- Can use a sub panel fed by one big breaker and a feeder wire
  - —The sub panel can feed up to ~10 circuits
  - —Can use old AC wire as new sub panel feeder near compressor
  - —Useful for replacing knob and tube wiring or for shortening the branch wire paths

New Products That Free up Panel Spaces and Amps

120V Washer/Dryer:
GE & LG 4.8-5.0 cu ft combo unit w/ heat pump dryer
11 amps / 120 volts Zero added.

120V HP Water Heater:
AO Smith Voltex 120V Plug-in Hybrid Electric Heat Pump
10 amps / 120 volts

120V HP Water Heater:
Rheem Proterra 120V Plug-in Hybrid Electric Heat Pump
4 amps / 120 volts

6 Contractor Practices to be Good Stewards

- Avoid strip heat resistors
- Pick highest efficiency equipment at small power size for long run hours (get buy in)
- Pick Heat Pumps with umbilical-fed air handlers
- Pick 120V plug-in heat pump water heaters (convert old furnace circuit to receptacle)
- Pick combined devices that meet two needs e.g. heat and cool, space and water, oven and cooktop, washing and drying
- Use Quad Breakers for 240V devices you add. Whether you need them… or the next trade. Show the client: “In our bid, because we’re careful, you still have room for more”
  - Maybe you can install the circuit for the next trade. E.g. HPWH, for emergency ready
  - Maybe you put your quad breaker where solar is and move the solar onto it. Or put your quad where 20-amp (20%) solar will be (opposite from utility feed end)

Resources

- SwitchIsOn.org rebate finder
- Ashp.neep.org (Air source product guide to performance)
- PG&E Electrification Staying on the Panel Class:
- Retrofit Guide for Homes
- Watt Diet Site
- Josie's Plan Making App: ZeroCarbon-Home.com
- PCE Electrification Guide

Q&A

Session 2 Part 2:
Panel Load Management/ Power Control Strategy

Moderator: Abhijeet Pande, TRC

Session 2 Part 2: Power Control Strategy

Agenda:

- Owner selected controls
  - Circuit sharers and pausers
  - Smart panels and smart breakers
- Considerations
  - Code
  - AHJ
  - Current rebate and demand response program availability
- Questions and answers

Speaker: Larry Waters
Electrify My Home

BSA Electronics[xli]
Dryer Buddy

Neo Charge[xlii]
Smart Splitter

Eaton[xxxix]
Energy Management Circuit Breaker (EMCB)

EV-PowerShare[xliii]
EV-PS Smart

SimpleSwitch[xliv]
240V / EV Circuit Switch

Load Sharing and Circuit Splitting

Smart Circuit Breakers

Smart Circuit Breakers and Relays are accessory devices that can transform all or part of an electrical panel into a smart panel, allowing household to make more use of their limited electrical capacity. These devices will allow for control, monitoring, and management of circuits. Load management functionality allows residential electric consumption to stay below installed electrical capacity limits, avoiding the need for an electric service upgrade. The number of circuits controlled can be tailored to the needs of the home, potentially saving money.

Smart Electric Panels

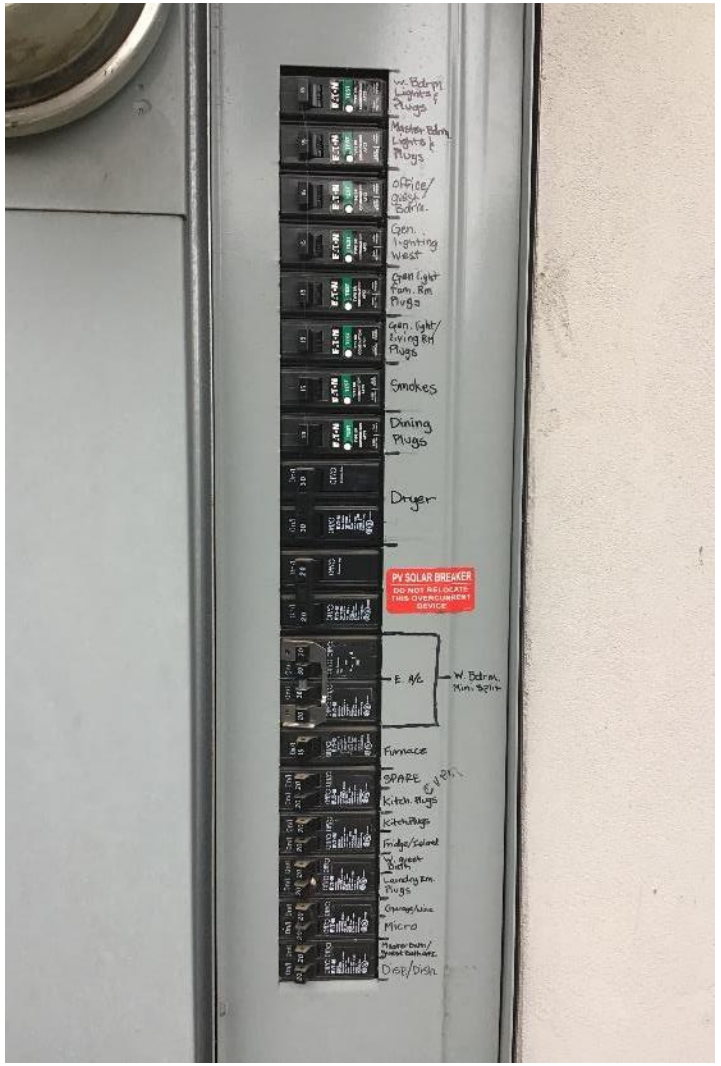
A smart electrical panel is an integrated device that fully replaces a traditional electrical panel but can allocate power based on need, allowing households to make more use of their limited electrical capacity. A typical smart electrical panel will allow for control, monitoring, and management of circuits. Load management functionality allows residential electric consumption to stay below installed electrical capacity limits, avoiding the need for an electric service upgrade.

Outlet Splitters

Outlet Splitters allows for two 240 Volt loads, such as an electric car charger and dryer to share the same outlet, eliminating the need to upgrade electric service when installing a new load. Outlet Splitters are ideal for situations where loads are located near each other and are not likely to be used at the same time.

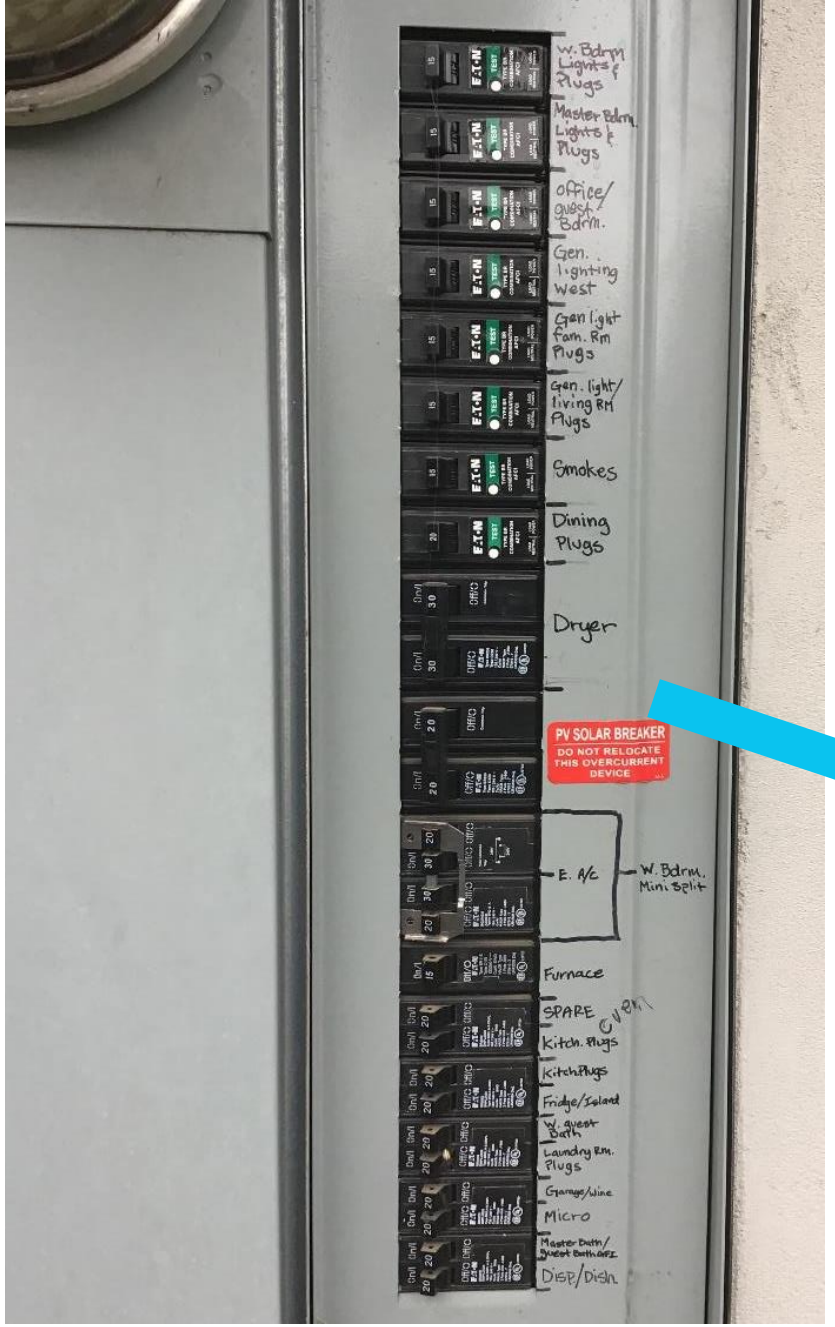
Circuit Control Units

A circuit control unit is an accessory device that can help manage power on one or more circuits, allowing household to make more use of their limited electrical capacity. A typical circuit control unit can manage a single load however multi load models are available. These units are ideal for situations where only one or two new electrical loads are being installed at a home.



Are These Panels Full?

Solutions to “Full” Panels



Task: Add a HPWH Circuit

- Option 2: Circuit Splitter!

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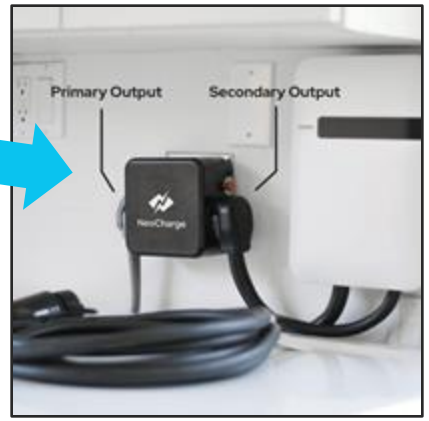
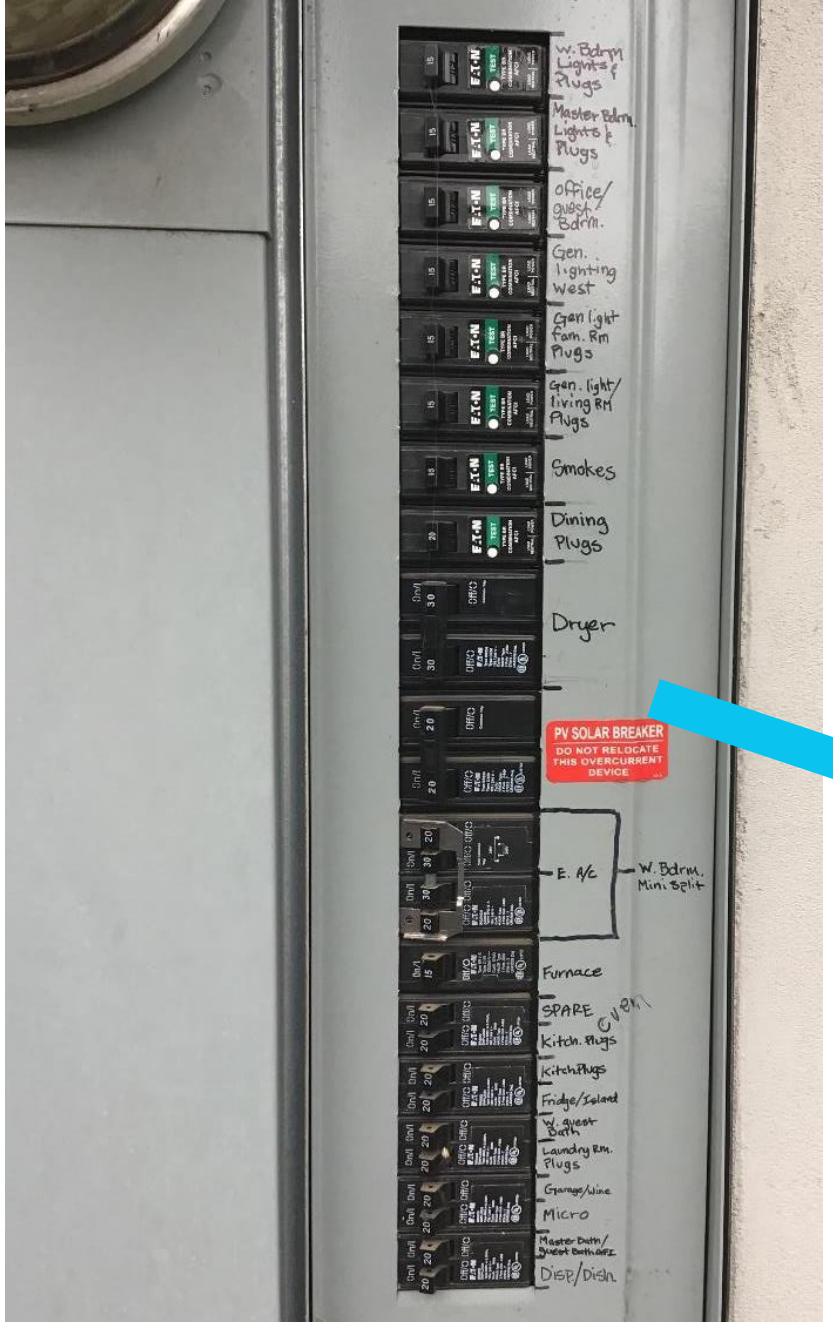


ELECTRIFY MY HOME

Solutions to “Full” Panels



Task: Add a HPWH Circuit

- Option 3: Circuit Pausing!

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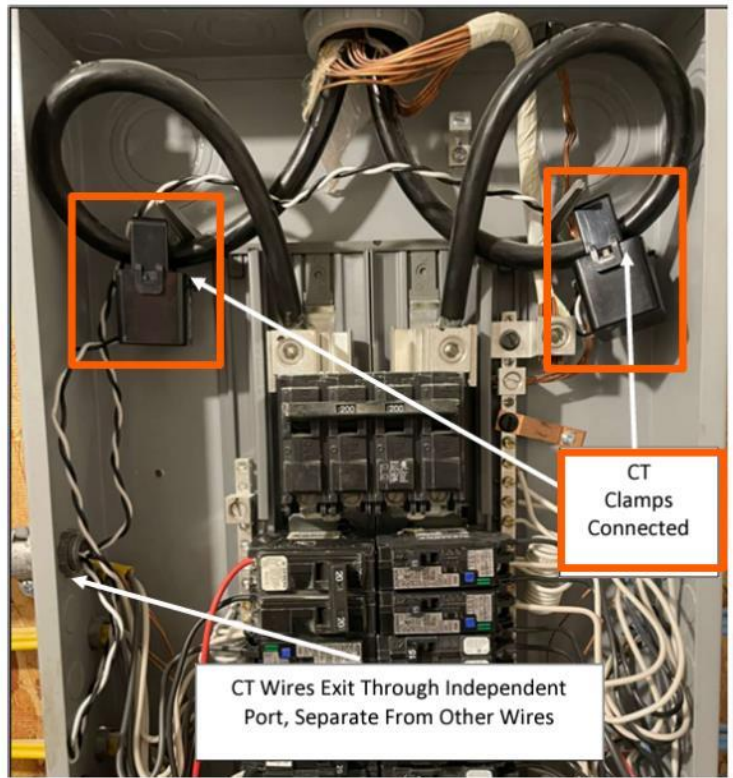
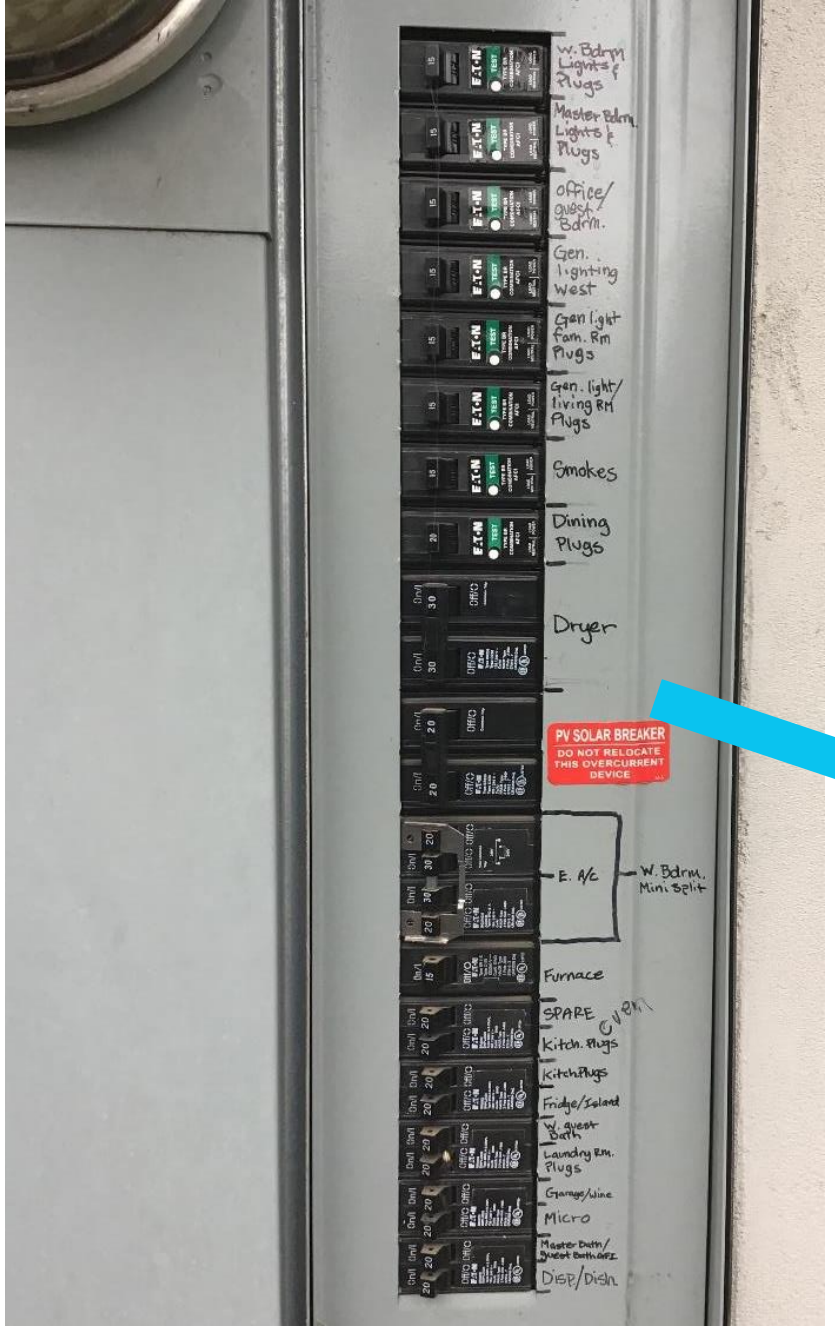


ELECTRIFY MY HOME



Solutions to “Full” Panels

Task: Add an EV CHARGING Circuit

- Option 3: Circuit Pausing w/ SMART CHARGER

+

ELECTRIFY MY HOME

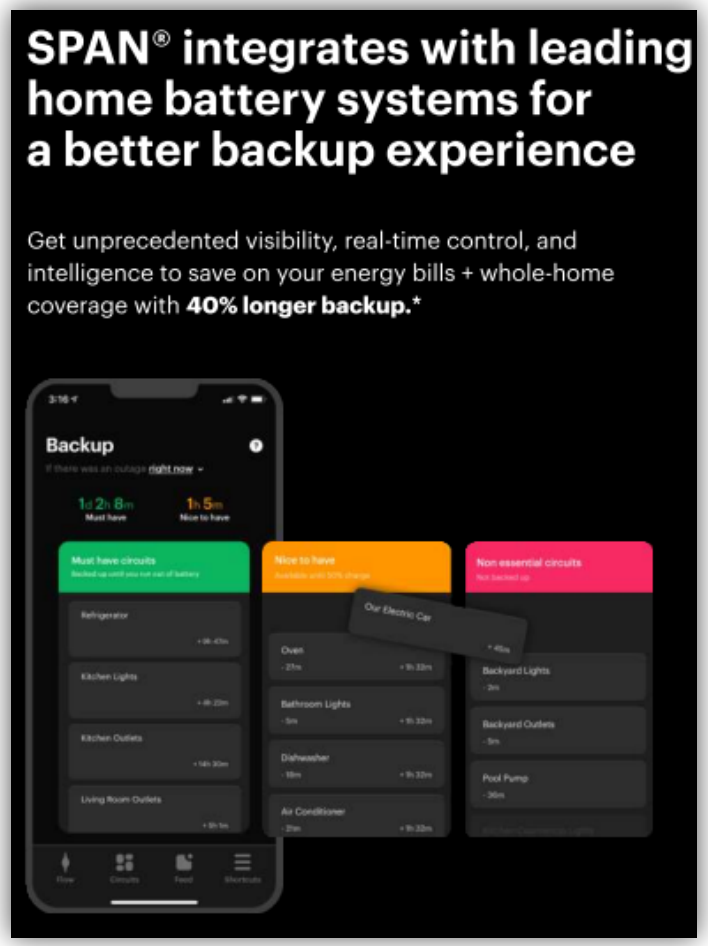
Solutions to "Full" Panels

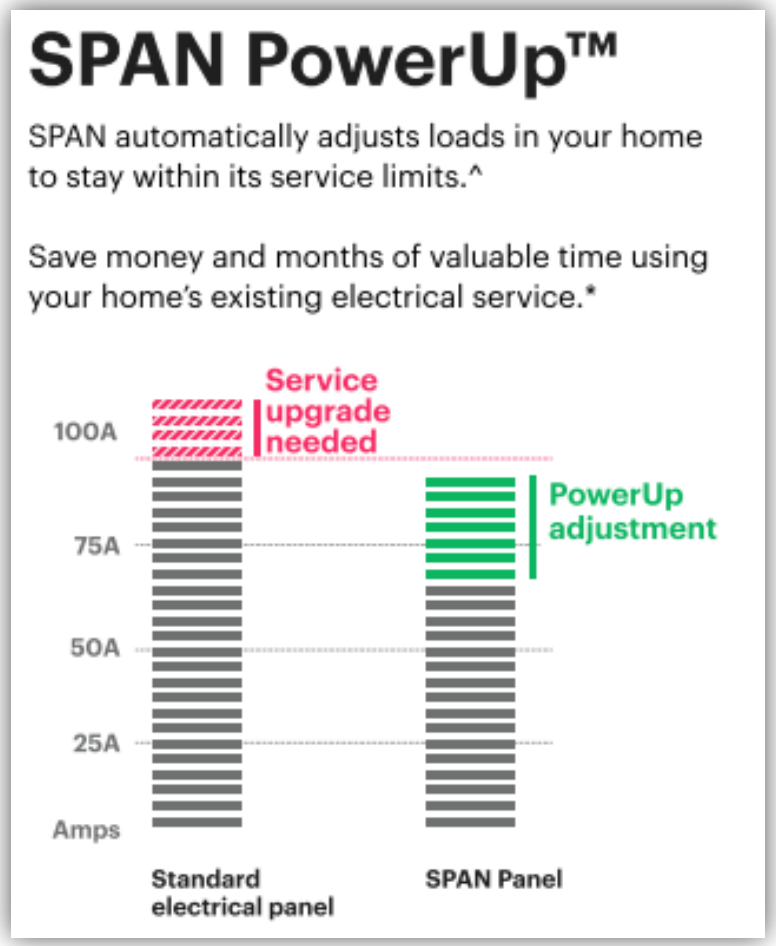
Task: Add a HPWH Circuit

(and much more)

- Option 5: Smart Panel

SPAN – Best Option for Limited 100A Panels





Example 3 (PRE) – Davis, CA

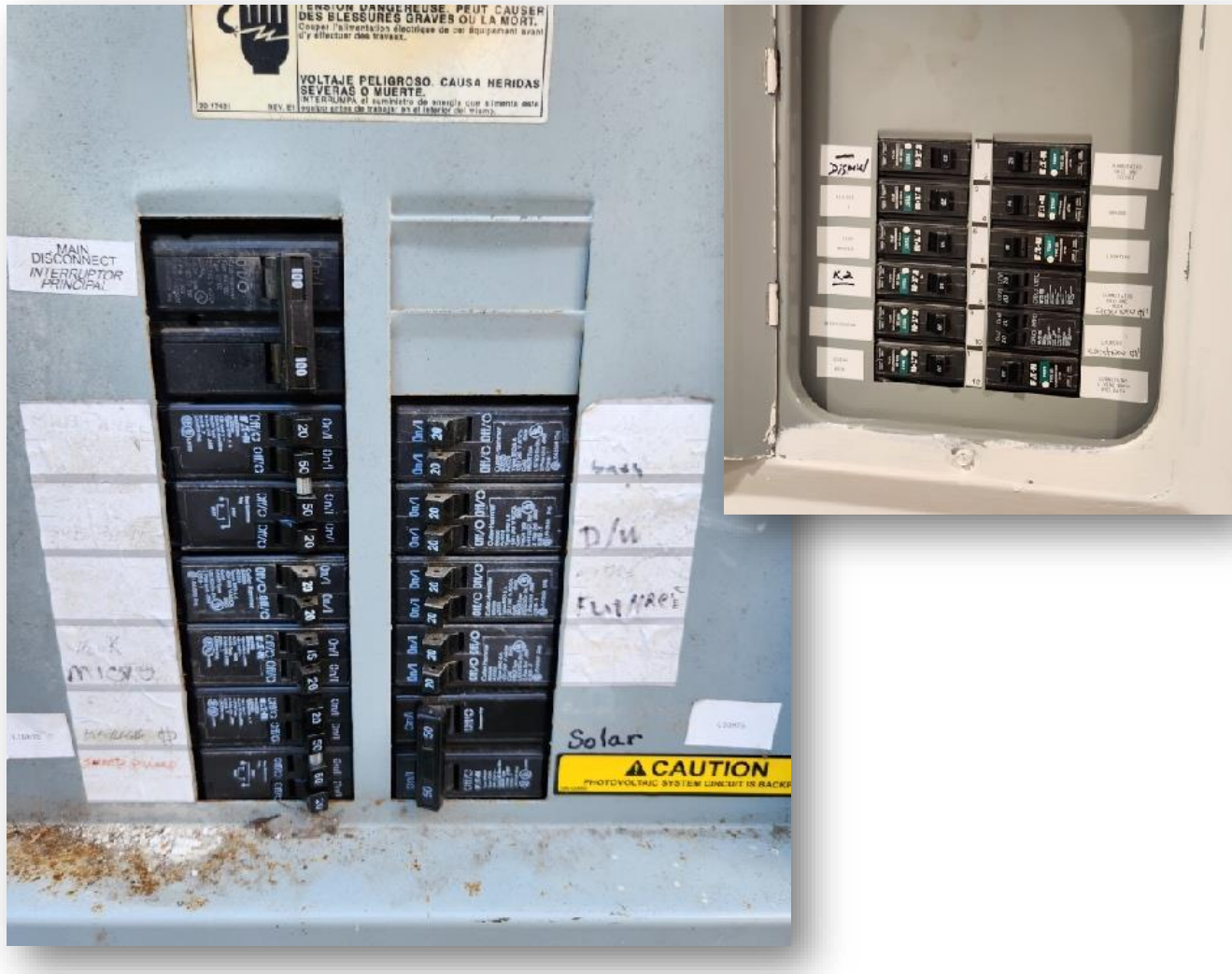
- **Existing Panel:** 100 Amps, Recessed, Feed Wire Capable of 125A
- **Staring Point:** All gas except dryer, small kiln
- **Goals:** Full electrification + insulation
- **The Challenge:** Near gas meter, limited physical breaker space, additional capacity needed to meet electrical load calc, customer wants fast charging for future EV

Example 3 (POST) – Davis, CA

- **New Panel:** 125 Amp SPAN Smart Panel, Feeding from Main
- **Scope:** 20A Mitsubishi, 120v RUUD HPWH, induction range
- **Thinking Ahead:** Customer wants fast charging for future EV

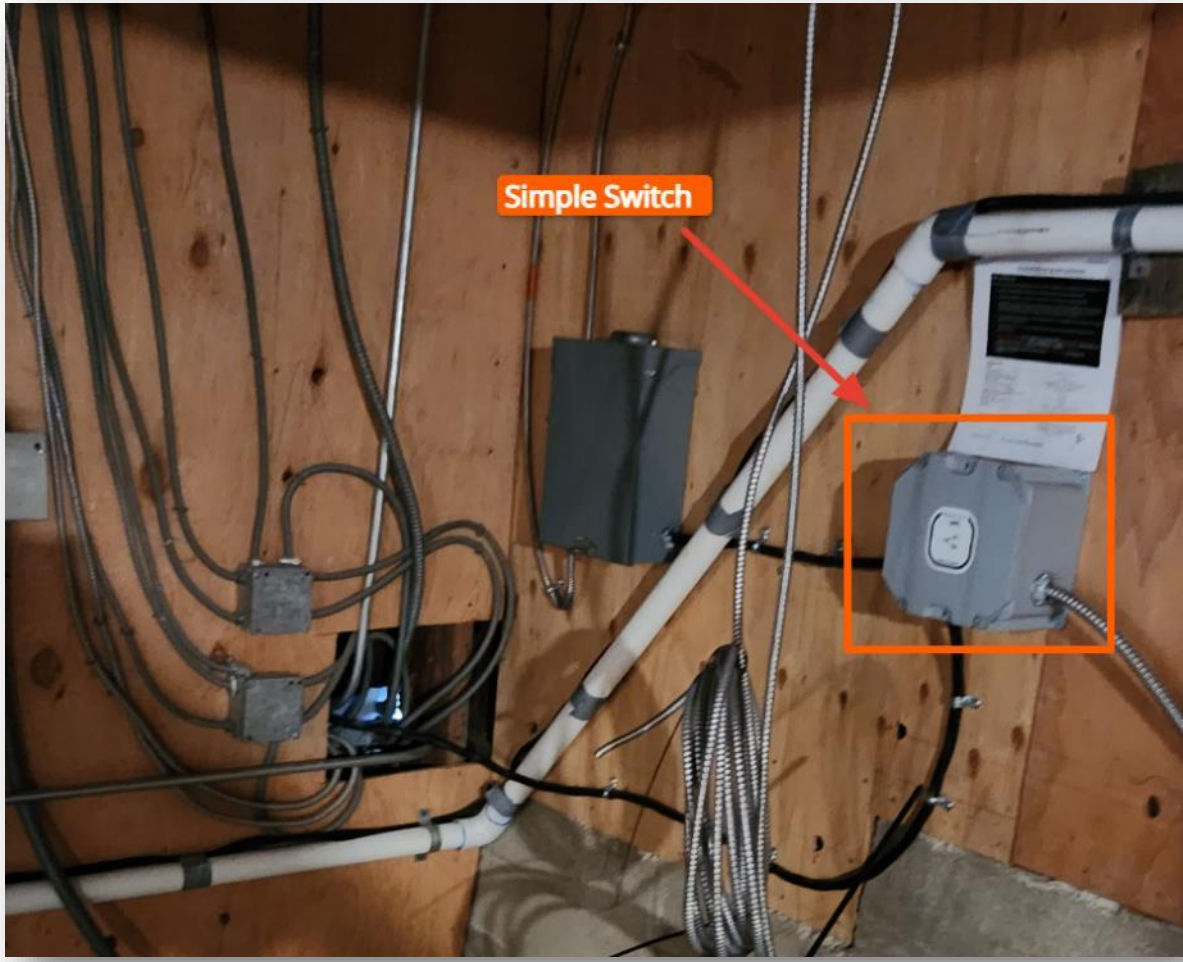
Example 1 (PRE) – Oakland, CA

- **Existing Panel:** 100 Amp
- **Staring Point:** All gas
- **Goals:** Remodel, full electrification
- The Challenge: 100A panel over gas meter, breakers mislabeled, multiple remodels resulted in unexpected loads



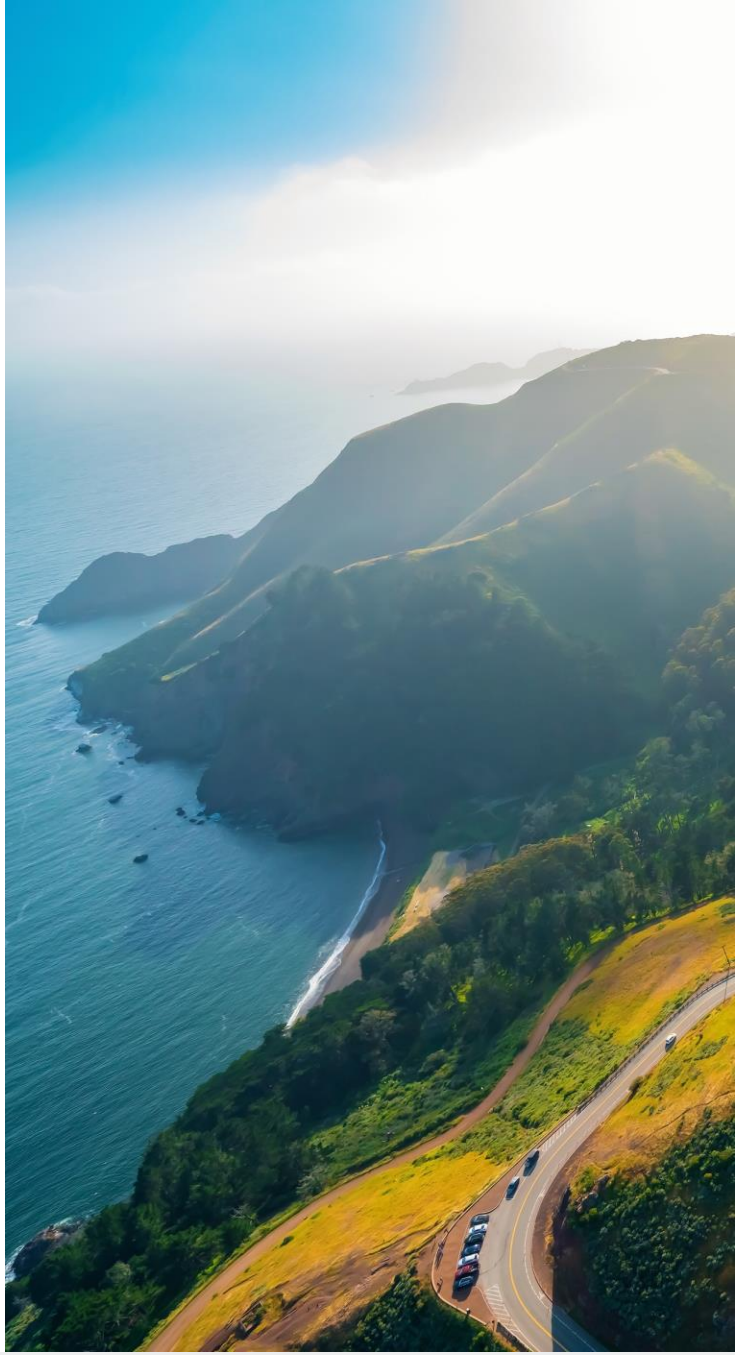
Example 1 (POST) – Oakland, CA

- **Post Panel:** No change! Customer may plan an upgrade when it's time for the EV
- **Solution:** Simple Switch b/w Range & Heat Pump Subpanel
- **Scope:** 25A Heat Pump, 30A Heat Pump Water Heater, Induction Range



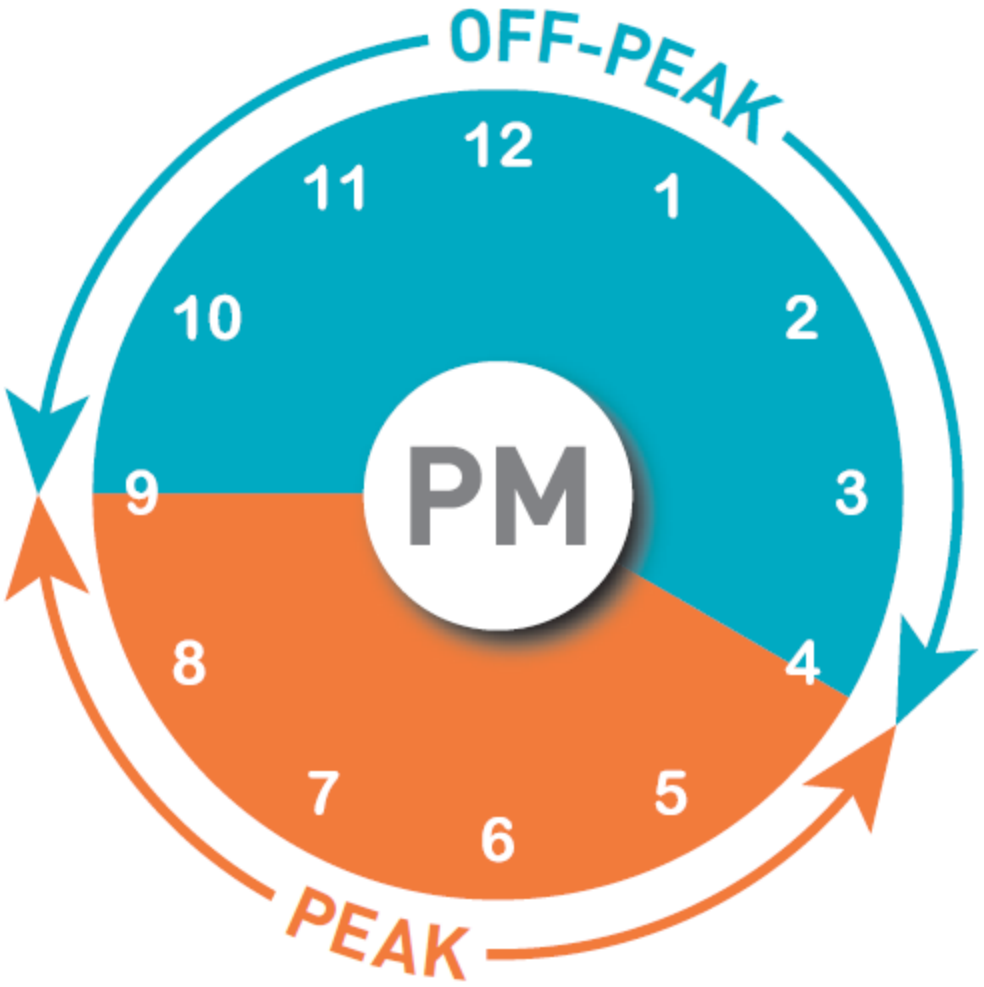
Considering Budget or Future Expansion

- Device costs vary and are often a consideration
- Consider lowest cost when designing for the wait time
- Amperages and loads will often dictate what type



Other Load Management Strategies

Time of Use / Load Shifting



Time-of-Use (TOU) :

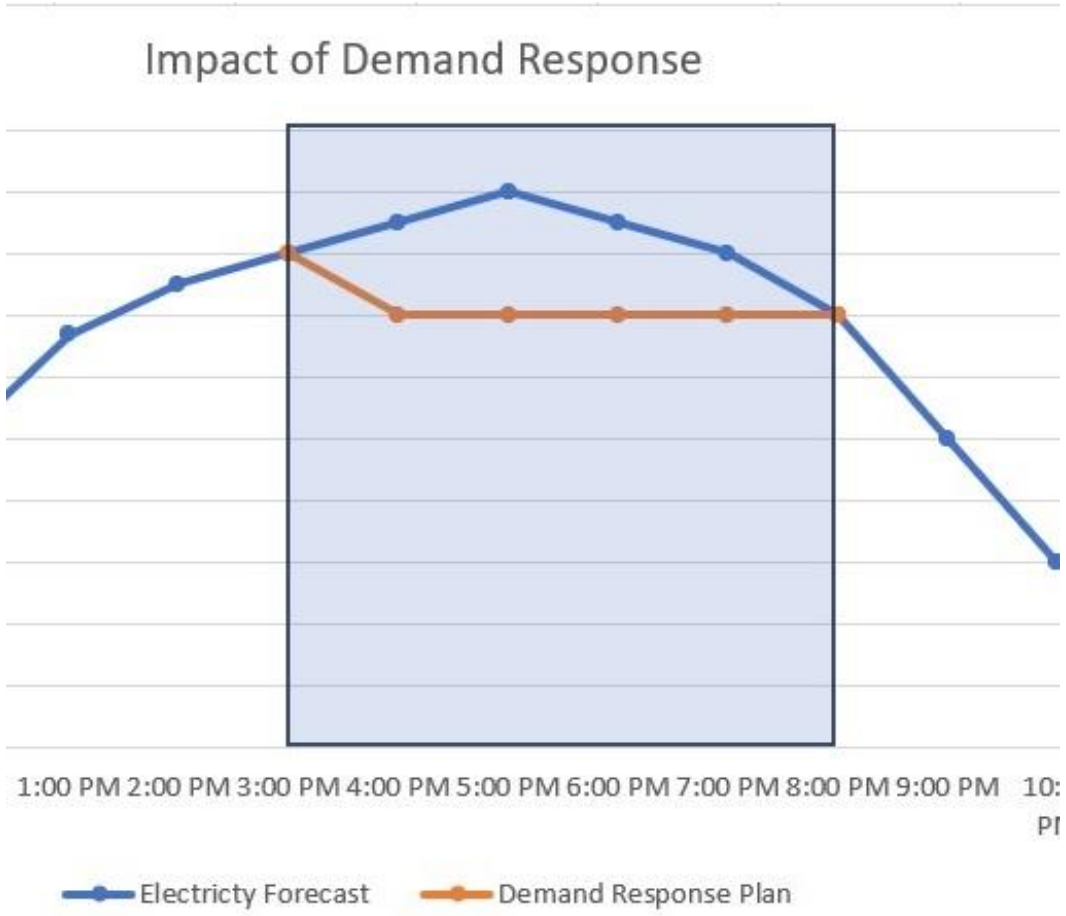
The time at which customers use electricity has a dramatic impact on their bill. It costs more to generate electricity during **peak** and those costs are passed on end users

Programing appliances like dishwashers and water heating impacts the overall load management strategy for your customer. Shifting loads to when electric costs are lowest is another tactic to keep in your electrification tool kit

Demand Response

When the grid is experiencing high demand, **demand response programs** are another way your customers can manage load by participating in programs designed to reduce demand

These programs are found across California under the names Summer Discount Program, SmartAC, Power Saver Rewards, OhmConnect, Leap, and Enel X



Rebates and Other Incentives

Rebates

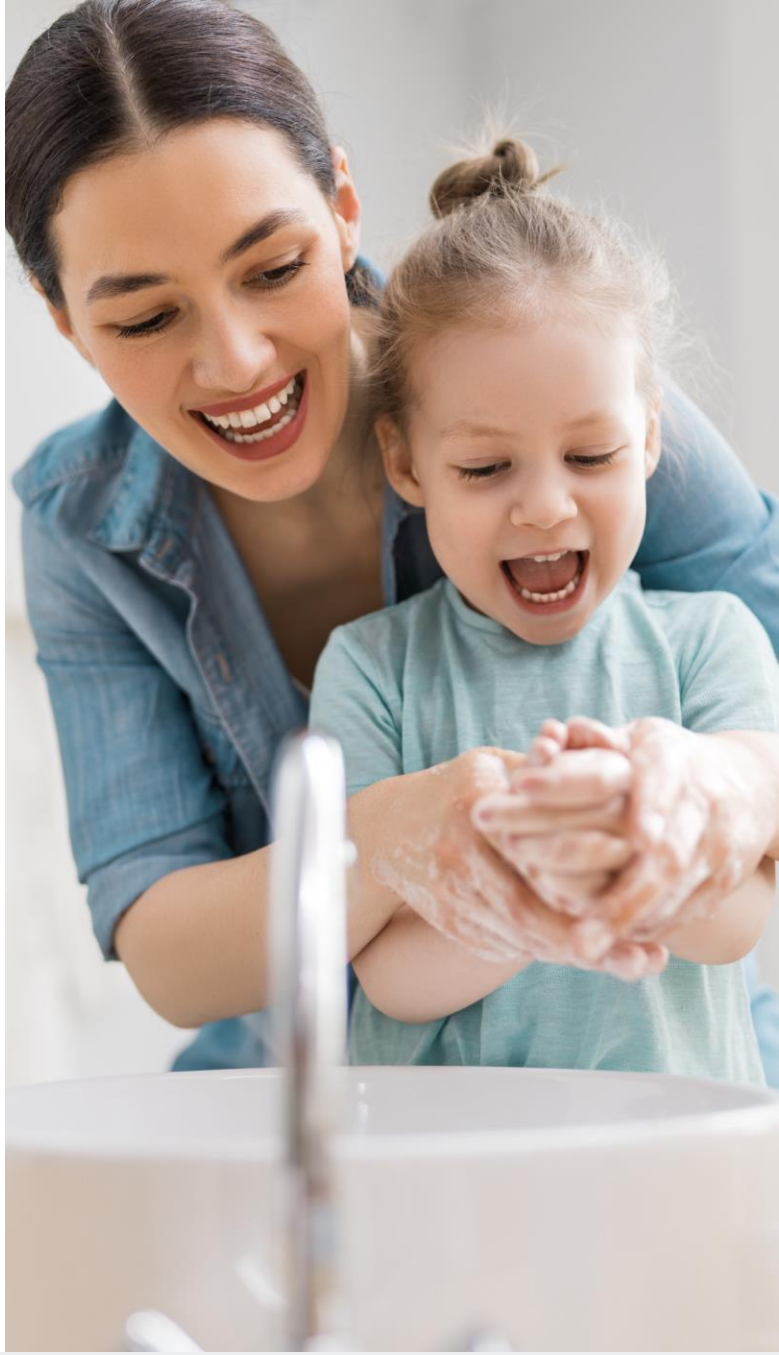
TECH Clean California:

$2,000 (capped at 50%) for the following electrical upgrades associate with a heat pump water heater installation:

- Replace, upgrade, or relocate main service panel
- Install smart load center/circuit breaker
- Install subpanel
- Upgrade feeder and/or secondary disconnect/dwelling unit main disconnect

For equity (low-income, hard to reach) customers

- Relocate $4,000 (capped at 100%) for the above plus:
- heat pump water heater
- Additional plumbing/wiring upgrades
- Venting
- Replace/repair/seal flooring, walls, or ceiling due to leakage or improper venting



Rebates

California Energy Smart Homes

- $1,000 (capped at project cost)

- Program-Approved Projects: (which result in a capped gas line and must be in either PG&E®, or SCE®, or SDG&E® electric service territory)
  - Upgrade to a new electric panel to meet added load demands of the home for new program measure installs
  - Adding/updating circuit breakers in existing electrical panels for program measure installs
  - New electrical wiring to the installed measures
  - Running 208-, 220/240-volt outlets/circuits for measure appliance installations

Rebates

IRA High-Efficiency Electric Home Rebate Act (HEEHRA)

- $4,000 for breaker box upgrades
- $2,500 for electrical wiring upgrades
- Must be associated with the installation of new electric appliances (heating, water heating, cooking, clothes drying)

- Income of less than 80% of the area median income (AMI)
  - Total cost of an electrical panel upgrade up to $4,000
  - Electrical wiring upgrade up to $2,500

- Income of between 80% and 150% of the aera median income,
  - 50% of an electrical panel costs up to $4,000
  - 50% of your electrical wiring costs up to $2,500

Tax Credits

IRA Tax Credits

- 30% of project cost, up to $600
- Any improvement to, or replacement of, a panelboard, sub-panelboard, branch circuits, or feeders which:
  - Are installed in a manner consistent with the National Electric Code
  - Has a load capacity of not less than 200 amps,
  - Is installed in conjunction with, and enables the installation and use of:
    - Any qualified energy efficiency improvements, or
    - Any qualified energy property (heat pump water heater, heat pump, central air conditioner, water heater, furnace or hot water boiler, biomass stove or boiler)

Q&A

Session 2, Part 3:
Policy Considerations

Moderator: Owen Howlett, CEC

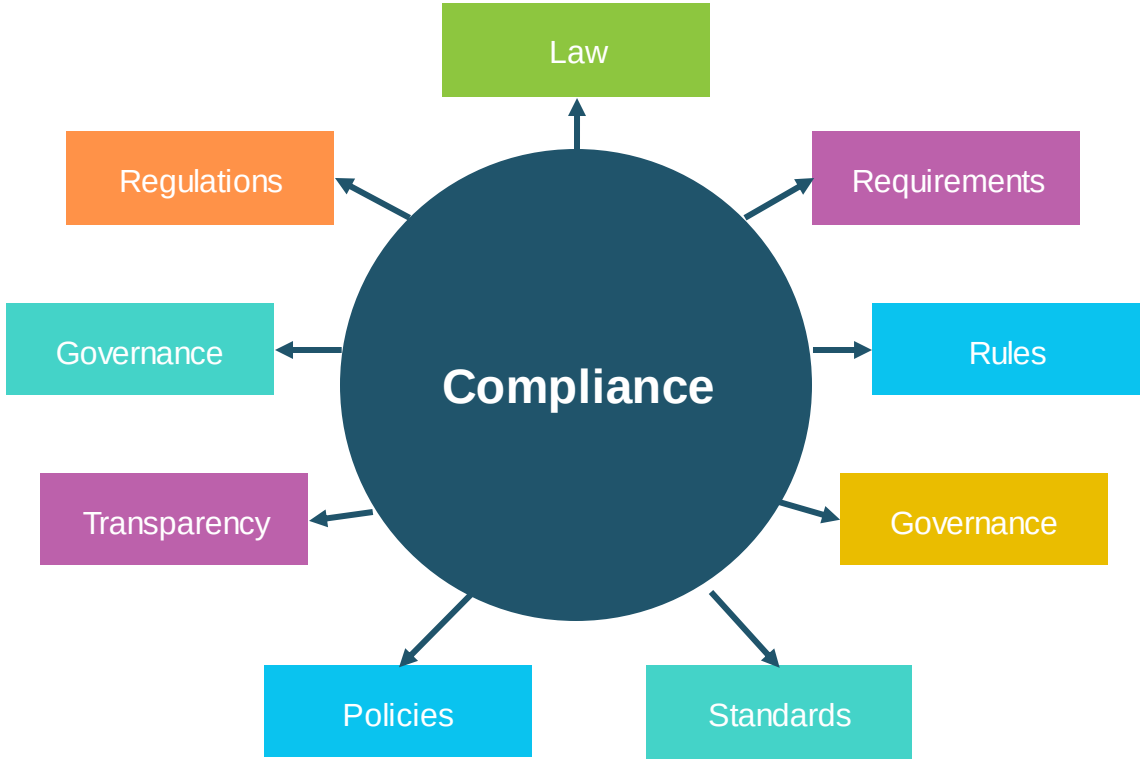
Session 2, Part 3:
Policy Considerations and California Update

Agenda:

- State efforts to reduce panel timelines
  - SB410
  - License ambiguity and permit streamlining
  - Future looking concepts and rebates
- State of current code
  - Amending the National Electric Code
  - VEA updates and data highlights?
- Questions and answers

Speakers:

Laura Feinstein, SPUR
Brennan Less, LBL
Travis Holtby, CPUC



Session 2, Part 3: Policy Considerations

TOPIC

Streamlining Electric Service Connections to Accelerate California's Clean Air & Climate Goals

Laura Feinstein
SPUR
January 23, 2024

SPUR

Why Streamlining Electrical Service Upgrades Is Critical

Current codes, programs, and permitting processes encourage panel upsizing

Smart policies and programs can make it easier for people to optimize their panels, and to make electric service upgrades less painful when they're necessary

Time Is of the Essence

- Bay Area Air District rules requiring homeowners to switch to heat pumps upon burnout begin in 2027
- CARB considering rules for 2030
- $100+ billion from Inflation Reduction Act and nearly $1B from California in building decarb subsidies

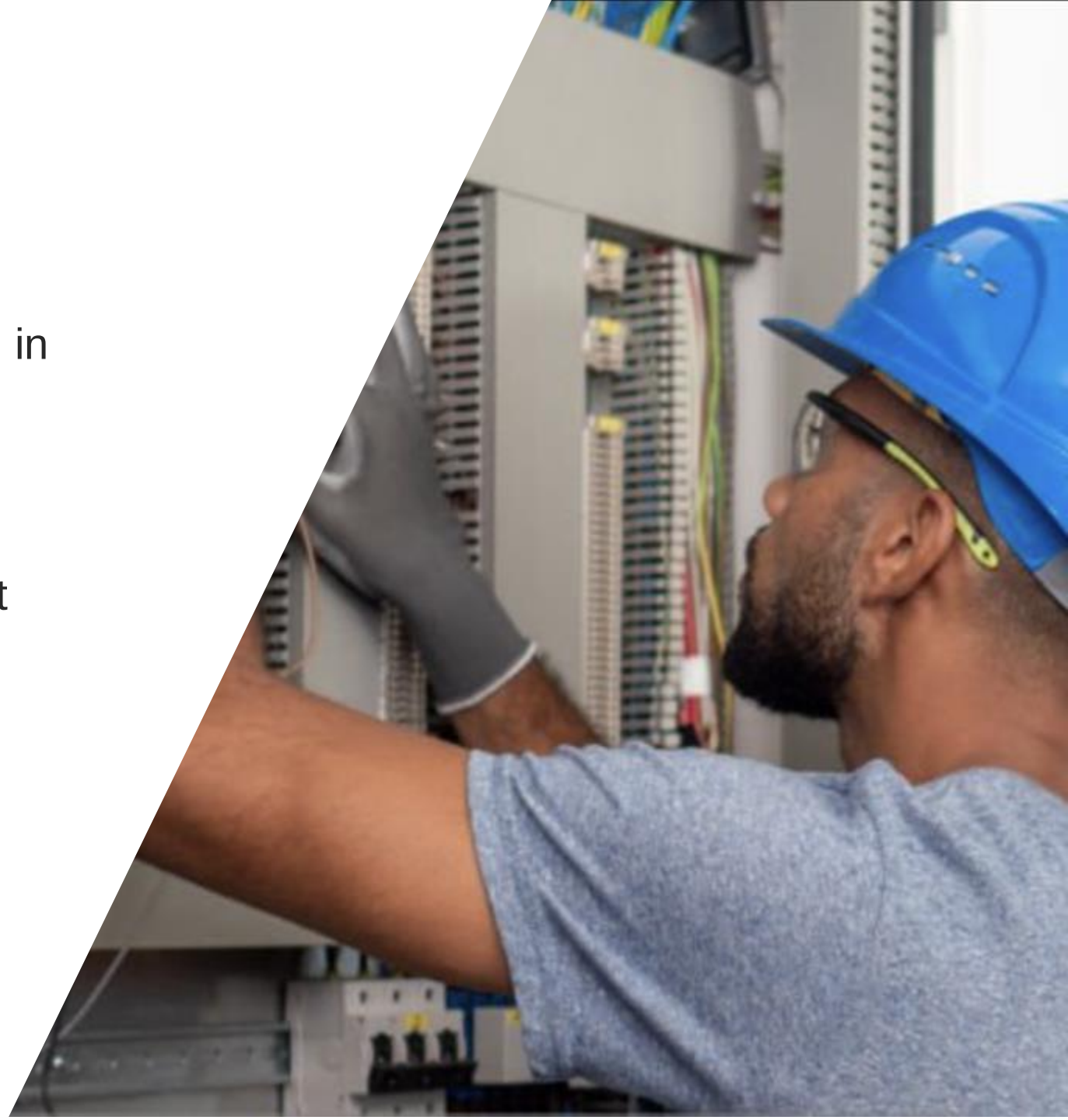
Strategies for Policymakers

Avoid	Streamline
Electrify buildings **without touching the electrical panel or service** • Removes one of the most expensive and time-consuming steps in home electrification • Avoids expensive upgrades to distribution infrastructure	**Make needed service upgrades as quick and affordable as possible** • Long timelines for energization are a major barrier to emergency replacements, which will become more common with zero-pollution appliance standards

Avoid: Upsize Less Often

- Remove baked-in bias to overestimate load in National Electrical Code
  Who: National Fire Protection Association

- Issue guidance for AHJs on how the current Electrical Code should be interpreted
  Who: Building Standards Commission



Avoid: Upsize Less Often

Utilities provide customers and their contractors with their peak demand from the previous twelve months (or as long as they've held the account, if less than a year)

- Secondary option: provide 15-minute interval data for all customers

Who: CPUC & Utilities

Avoid: Upsize Less Often

- Offer incentives that cover the cost to install load management devices
- Offer higher incentives for power-efficient equipment
- Don't cover new panels over 200 amps

Who: Energy Commission, Public Utilities Commission, and other incentive providers

SimpleSwitch Allows 2 appliances to share one circuit

DCC9
Sheds load for one circuit

Span.io
Sheds load for 0-32 circuits in the panel

ConnectDER Meter Collar

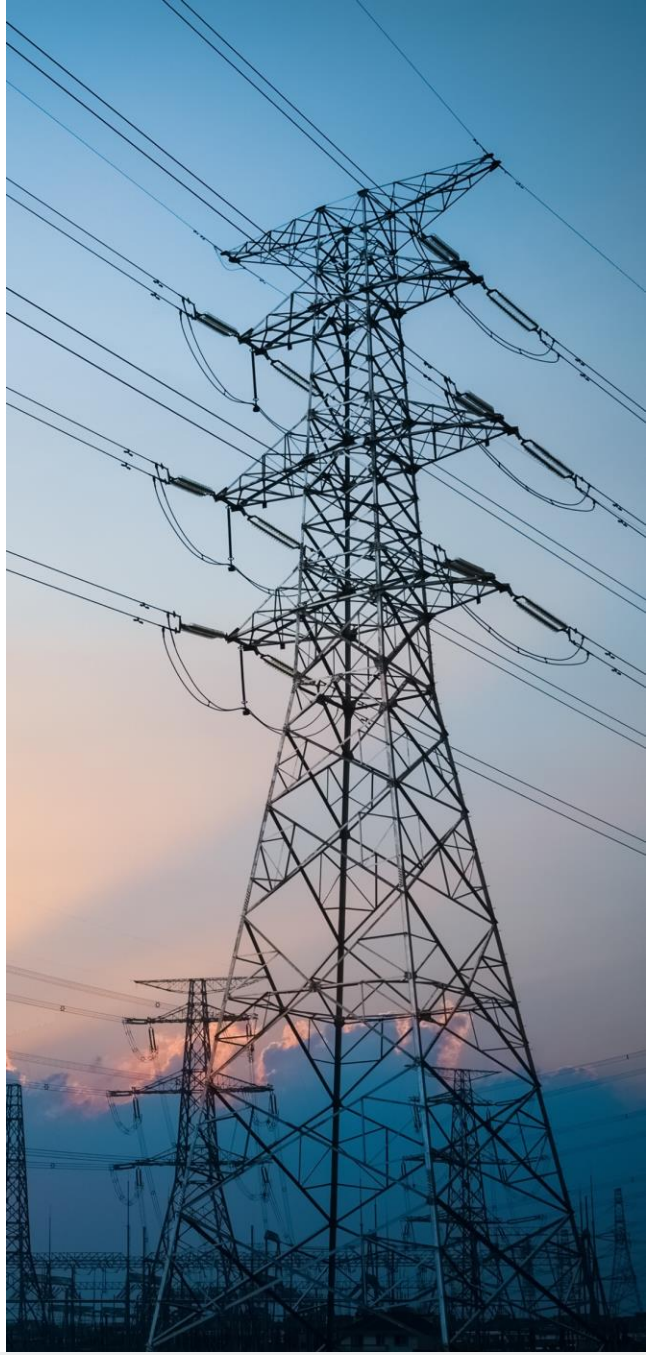
EARU Smart Circuit Breaker

Streamline

- Public utilities commission proceeding on energization timelines in response to legislation, SB 410 and AB 50.
  Kickoff workshop is February 2nd

- Goal is to set maximum and target timelines by September 2024

Your comments are important! If you have experience with applying for service upgrades, please reach out to lfeinstein@spur.org



California State Licensing Board Guidance

Stand-alone work on heat pump water heaters and thermostatic mixing valves

C20-Warm Air Heating, Ventilating and Air-Conditioning or C36-Plumbing

B-General Building contractors can self-perform installation/replacement of a heat pump water heater if the project includes work in two unrelated trades, or if they also hold the appropriate additional classification on their license

Incidental Electrical Work (i.e. install dedicated circuit for the heat pump water heater)

C20 and C36 contractors can self-perform, or subcontract out the work

Upgrading or replacing the electrical service panel

Should be performed by a C10-Electrical contractor under a separate contract, or a B-General Building contractor if the work is part of a heat pump water heater project

Source: California State Licensing Board letter to P. Hunziger dated Feb 10, 2022

Streamline

- Contractor State Licensing Board could allow specialty licenses (like plumbers and HVAC) to subcontract to electricians for panel upgrades needed for electrification
  Who: California State Licensing Board

Thank You

For more information, contact:

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@SPUR_Urbanist

TECH CLEAN CALIFORNIA

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Session 2, Part 3: Policy Considerations

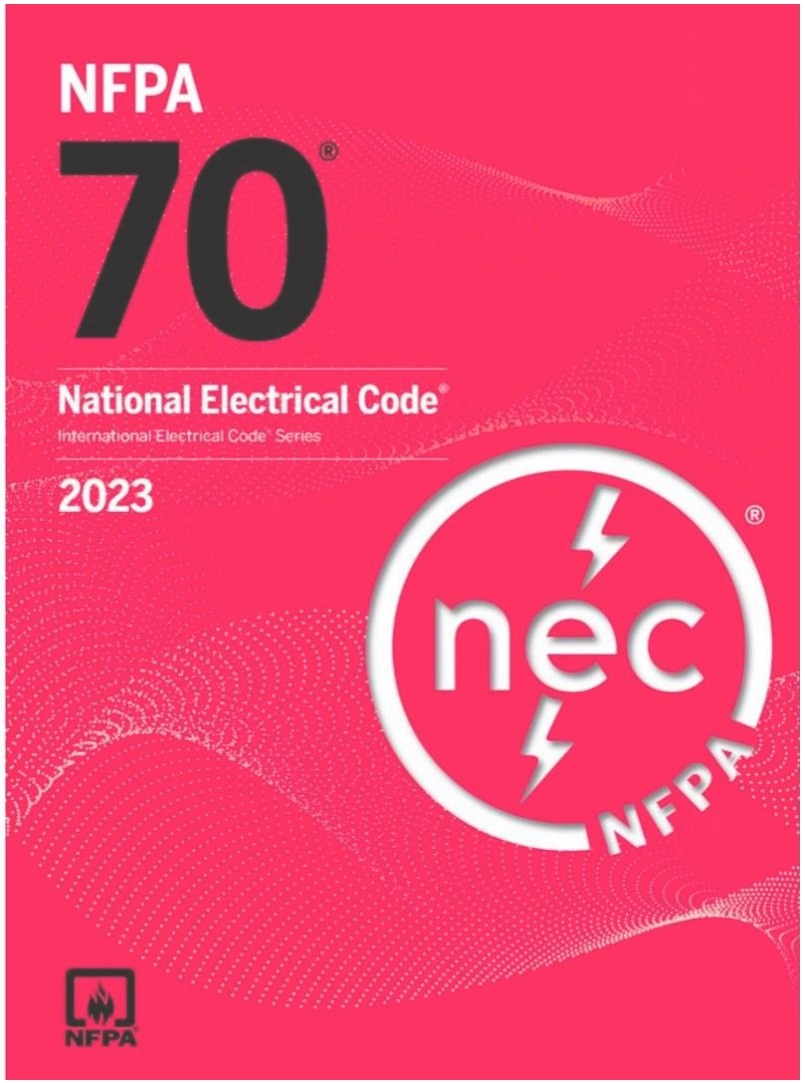
TOPIC

Updates to the NEC code

Brennan Less
Lawrence Berkeley National Labs
January 23, 2024

National Electrical Code (NEC)

- Standard managed by the NFPA
- Primarily aimed at mitigating fire and shock hazards
- Used to calculate electrical loads and stipulate requirements for electrical installations
- Adopted as part of Title 24 by CBSC, State Fire Marshal, Housing and Community Development
- Updated on a three-year cycle via ANSI standards process
  - **2020 NEC** (Currently in-force in California)
  - **2023 NEC** (Most recent version from NFPA)
  - **2026 NEC** (Under first draft development)
    - anticipated in-force in California in 2029



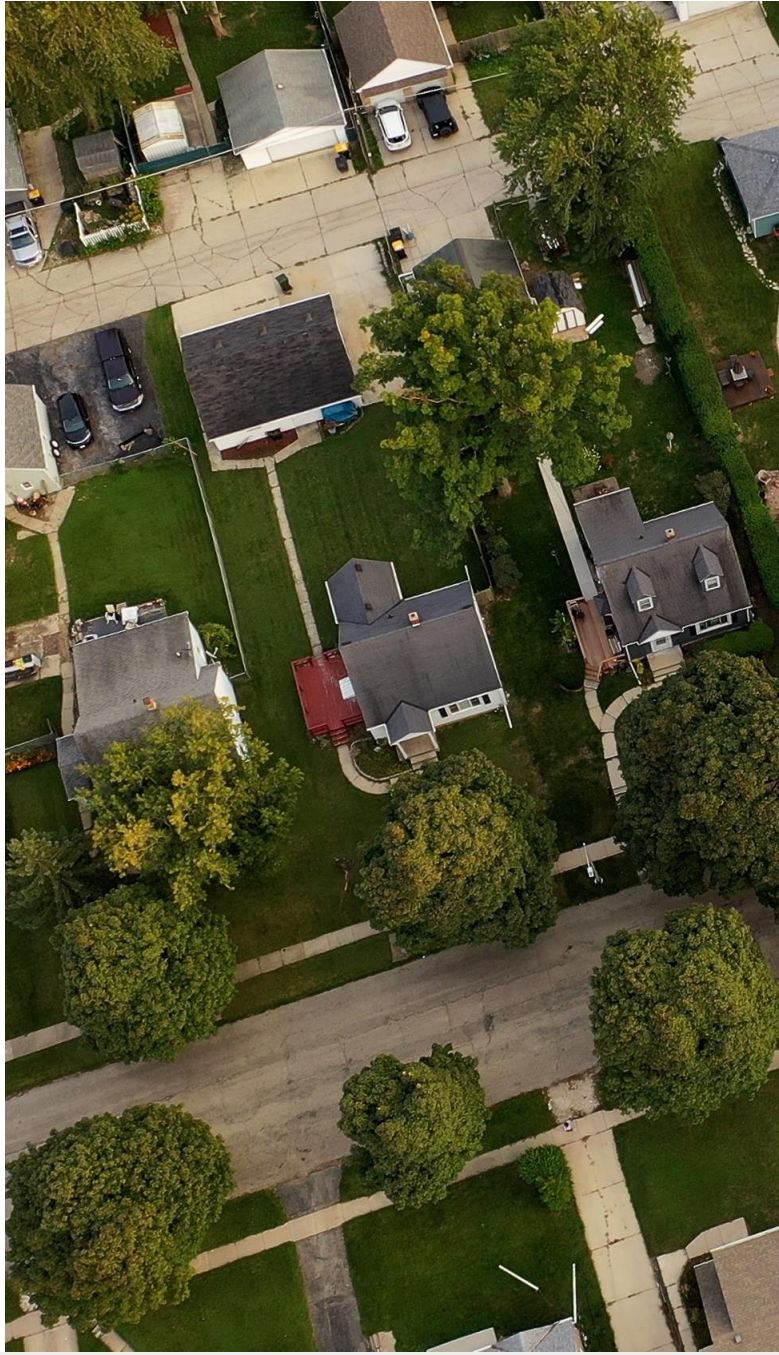
Potential Updates in the 2026 NEC

LBNL team submitted 17 Public Inputs addressing load calculations:

- Existing dwelling loads (220.83 and 220.87)
- New dwelling loads (reduce demand factors for select appliances where applicable)
- Lights and plug assumptions (from 3 to 2 VA/ft2)
- Energy Management Systems (new name (PCS)? Flexible requirements for different configurations. New Annex D examples)
- Noncoincident loads (clarify allowance to use listed controls to ensure noncoincidence)
- Electric vehicles (proposal to allow use of nameplate rating in place of 7.2 kW minimum has failed at task group)

Timeline for 2026 NEC:

- January, 2024: In-person code-making panel meetings
- July 10, 2024: First Draft report on 2026 NEC posted online
- August 28, 2024: End of Public Comment period for first draft (PLEASE SUBMIT YOUR PUBLIC INPUT IF YOU HAVE A PERSPECTIVE)
- March 21, 2025: Second (and final) report on 2026 NEC posted online

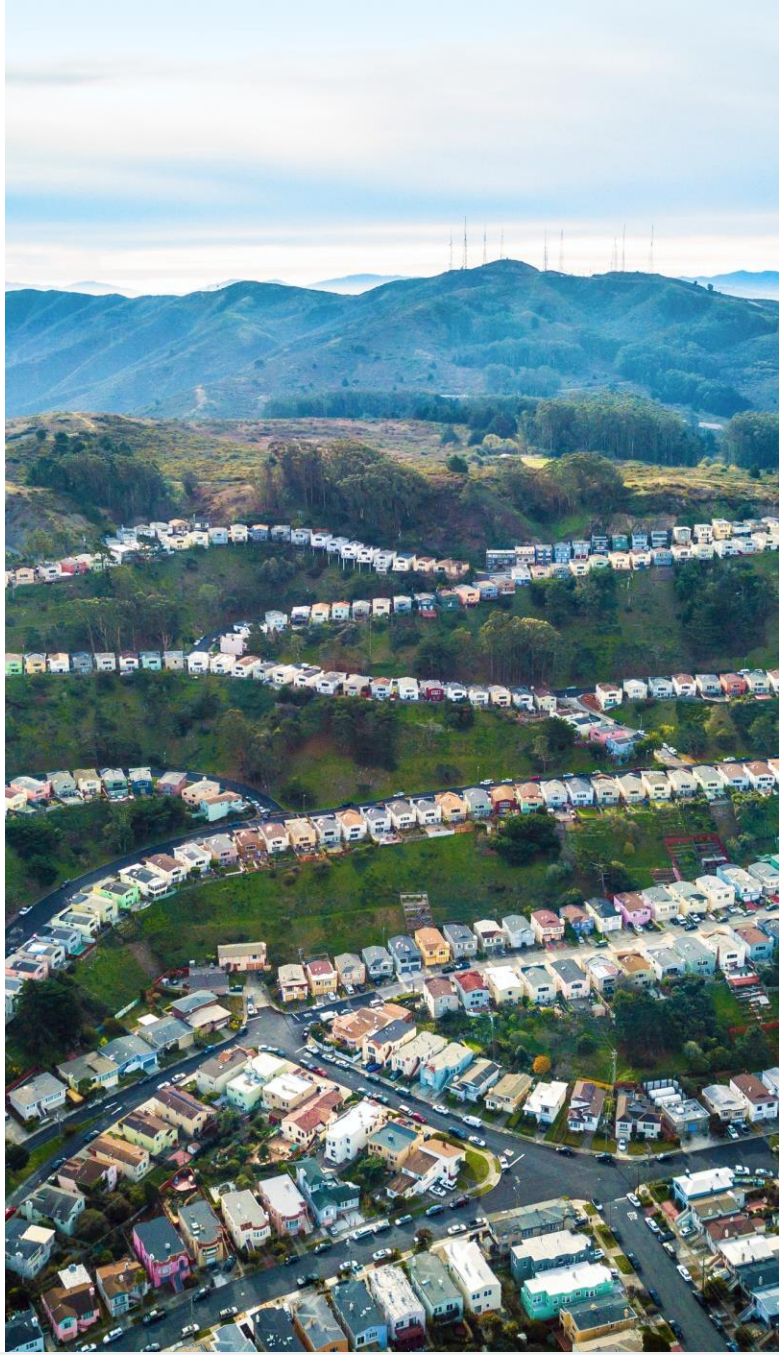


Can the State Move Faster?

- Potential for state adoption of more power-efficient provisions on an accelerated timeline?
  - Informational bulletins clarifying state interpretation of current code (CBPSC? State Fire Marshal?)
  - Local reach codes
  - Early adoption at state level of provisions in the approved 2026 NEC

- Local authority training on interpretation of the current code

- Create statewide tool(s) for load calculations and the like that ensures consistent approaches. Some local AHJs have their own spreadsheets along these lines currently



Thank You

For more information, contact:

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lbl.gov

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Session 2, Part 3: Power Management

TOPIC

CPUC EE's Viable Electric Alternative (VEA) Policy

Travis Holtby
California Public Utilities Commission
January 23, 2024

What is VEA?

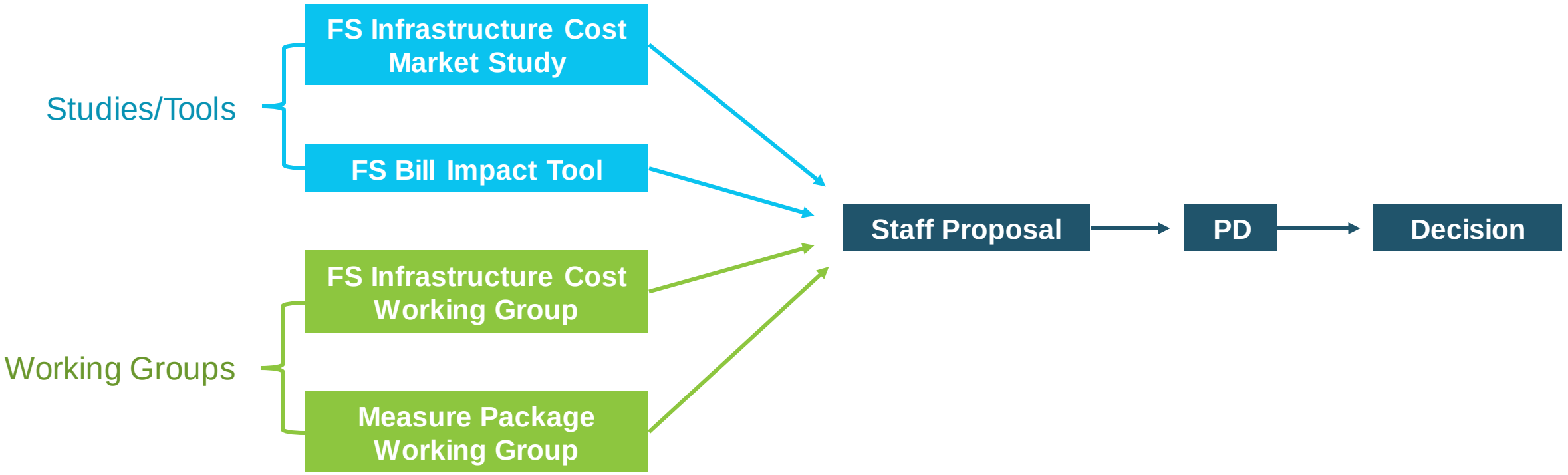
Phasing out natural gas ratepayer-funded energy-efficient incentives where possible

- Only phase out natural gas energy-efficient measures where we have a viable electric alternative, that means:
  - Commercial availability
  - Same level of service
  - Customer benefit/cost
    - —Measure cost
    - —Installation and infrastructure cost
    - —Non-significant customer bill impact
- Empirical, multi-phase approach to avoid unintended consequences
  - GHG emissions
  - Indoor air pollution
  - Environmental racism

D.23-04-035 – EE Natural Gas Incentives – 2024 Policy

- No energy-efficient incentives for non-cost-effective new construction gas appliances starting in 2024
  - For the residential and commercial sectors in the resource acquisition and market support portfolio segments
- Defines “exempt” – measures that save therms but don’t burn gas (insulation, building envelope, etc.)
  - Update EUL for exempt measures up to 30 years, if justified
  - Develop new exempt Measure Packages (doors, windows, etc.)
- Lays groundwork for VEA Phase 2

The 4 Tracks for Developing VEA Phase 2

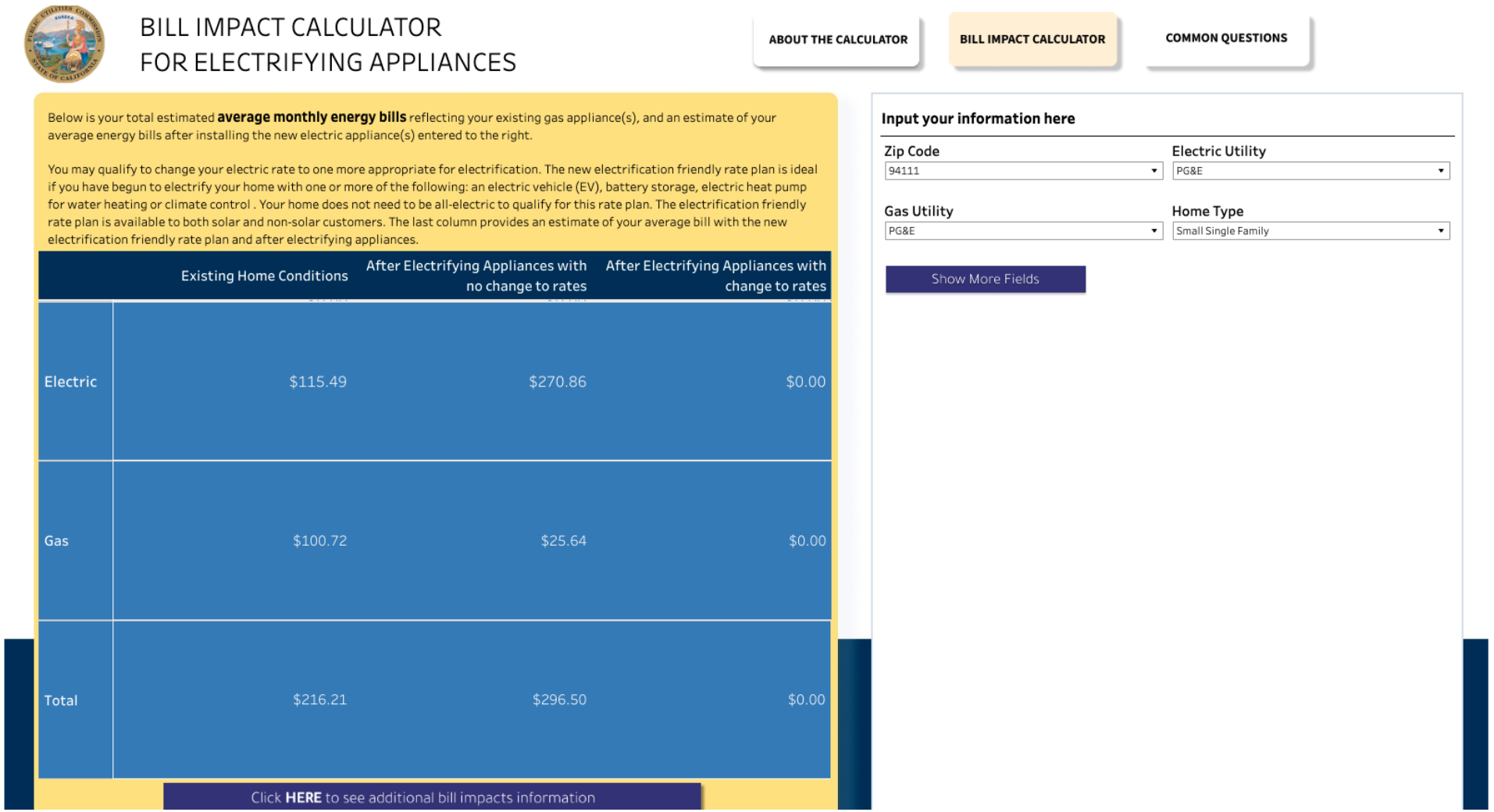


Fuel Sub Infrastructure Costs

- **Optimize** = anything less than panel upgrade (smart circuit, sub panel, etc.)
- **Upgrade** = Panel + anything else

- Market Study Results:
  - **Physical space in panel is much bigger constraint than amperage**
    - Ex: Residential - gas heat to ASHP for SF
      - 8% need more amps
      - 37% need more physical space
  - Avg. cost of infrastructure upgrades:
    - Residential: ~$5,500
    - Commmercial: ~$13,000

Fuel Sub Bill Impact Tool



Viable Electric Alternatives: Future Goals

Create factual foundation for expanding phase-out of natural gas energy-efficient measures where justified

- Retrofit measures
- Equity segment
- Custom projects

Create incentives for fuel sub infrastructure costs

Increase marketing and awareness of fuel sub

Thank You

For more information, contact:

Travis Holtby

California Public Utilities Commission

Travis.Holtby@cpuc.ca.gov

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CALIFORNIA Public Utilities Commission

Q&A

Thank You

For more information, contact:

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Sandy Laube, Fellow - Energy Efficiency

slaube@energy-solution.com

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energy-solution.com/tech

Questions

- What's one rule in a program you think is counterproductive?
- How would you alter it?
- Given limited funds, how many electrification installs should each contractor be permitted to harvest.
- How might power-efficient electrification let you increase the number of homes you electrify?
- What would be a good program design to encourage power efficient electrification?
- What type of advice letters (topics and advice) do you hope the CSLB would send the AHJs?
- Would your firm be interested in participating in a community organized bulk sale of electrification like HPWHs, or well controlled L2 EVSE or Ductless minisplits? (cuts your customer acquisition costs (sales costs)

Panel Optimization = Power Efficient Design

Making equipment choices to fit panel & lifestyle

Societal Benefits:

- Preserves workforce for more rapid electrification
  - Electricians, utility line crews, utility project planners, distribution engineers
- Leaves more neighborhood space for electrification on distribution wires
- Keeps electric rates low by reducing and delaying transformer upsizing etc.
- Starts a virtuous cycle of rate reduction and electrification
- Long steady inverter duty cycles help support solar power usage (all day)
- Reduces use of fossil peaking plants (spreads loads outside of peaks)

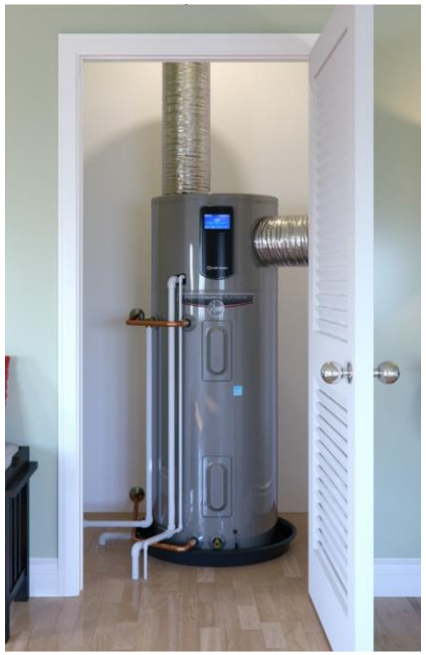
First Step: Gather Data

Utility Interval Data Showing Home's Current Energy Needs

Fixed equipment name plates

Homeowner Preferences

Electrification locations



Home Visit Observations, Measurements, and Photos

Electric Panels

Home Visit Data: Main Panel and Subpanels

- Main shut-off breaker capacity of main panel
- Number of available breaker spaces in main panel and subpanels
- Busbar capacity of main panel and subpanels
- Feeder breaker capacity to subpanels

Energy Basics

Energy is the ability to do work

e.g., lifting 778 lbs. one foot high = 1 Btu
e.g., 1 kWh can lift 778 lbs. 3,412 feet high

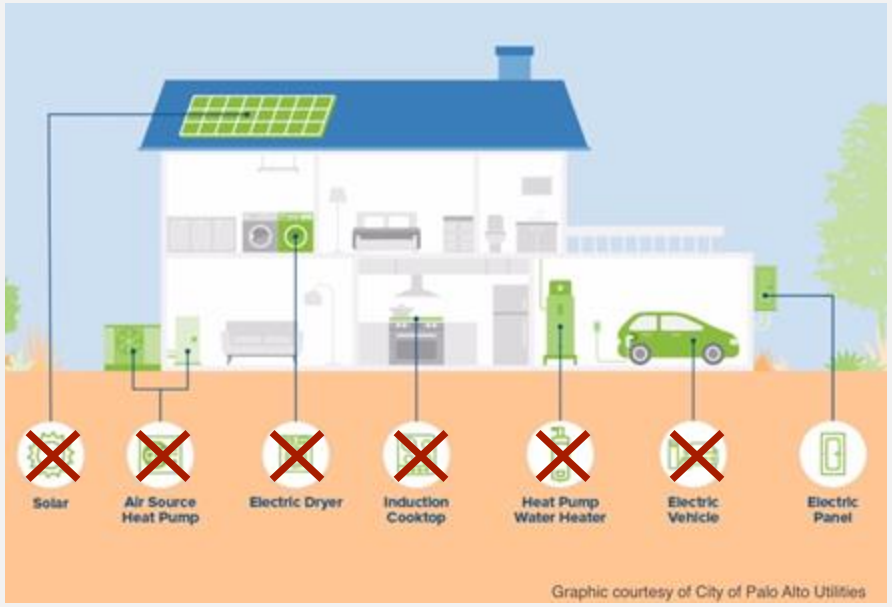
Power is the flow rate of energy

e.g., delivering 1 kWh of energy in ½ hour
takes 2 kW of power for 30 minutes

Load Calculation

Step One: Sum of Existing Electric Loads

Home A



Total Floor Area: 1,500 sq ft
Main Service Capacity: 100 amps
Number of Gas Appliances: 4

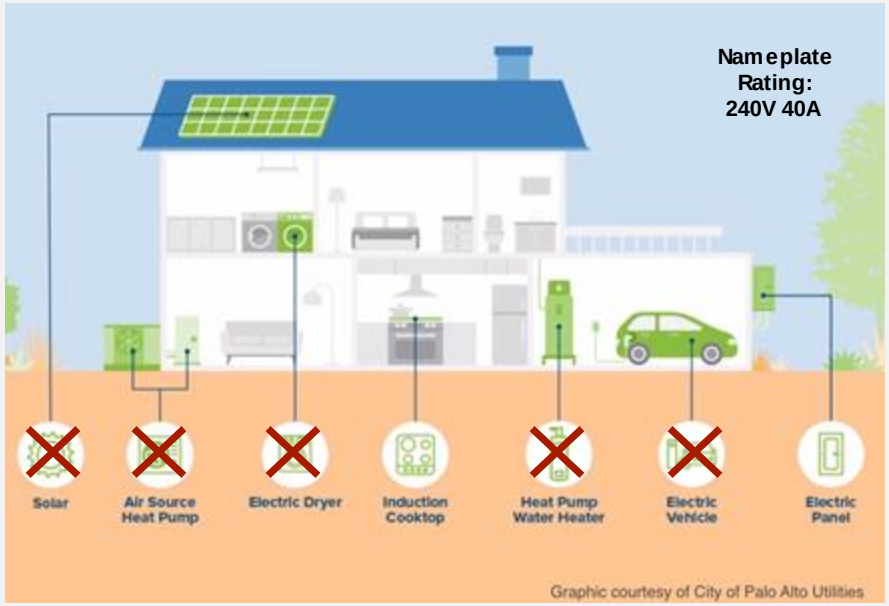
Load Type	Amps	Volts	Watts
Kitchen Circuit	12.5	x 120	= 1500
Kitchen Circuit	12.5	x 120	= 1500
Laundry Circuit	12.5	x 120	= 1500
Refrigerator	5	x 120	= 600
Dishwasher	10	x 120	= 1200
Garbage Disposal	5	x 120	= 600
Lights + Plugs	(3 watts / sq foot)		= 4500
			Subtotal = 11,600

Here we are using NEC code section: 220.83 (B)

Load Calculation

Step Two: Add New Electric Load, an Induction Range

Home A



Total Floor Area: 1,500 sq ft
Main Service Capacity: 100 amps
Number of Gas Appliances: 3

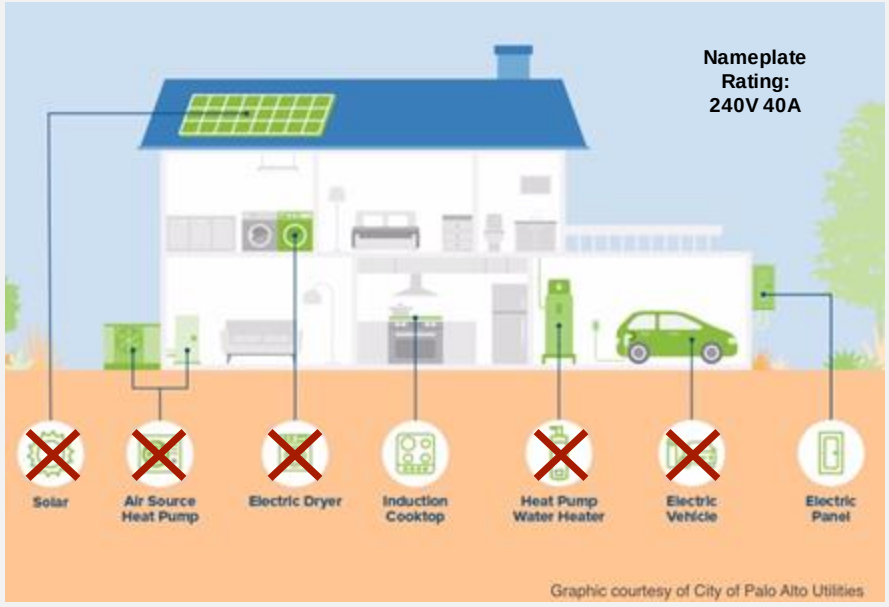
Load Type	Amps	Volts	Watts
Kitchen Circuit	12.5	x 120	= 1500
Kitchen Circuit	12.5	x 120	= 1500
Laundry Circuit	12.5	x 120	= 1500
Refrigerator	5	x 120	= 600
Dishwasher	10	x 120	= 1200
Garbage Disposal	5	x 120	= 600
Lights + Plugs	(3 watts / sq foot)		= 4500
Induct. Range	40	x 240	= 9600
			Subtotal = 21,000

Here we are using NEC code section: 220.83 (B)

Load Calculation

Step Three: Apply Coincidence Factors

Home A



Total Floor Area: 1,500 sq ft
Main Service Capacity: 100 amps
Number of Gas Appliances: 3

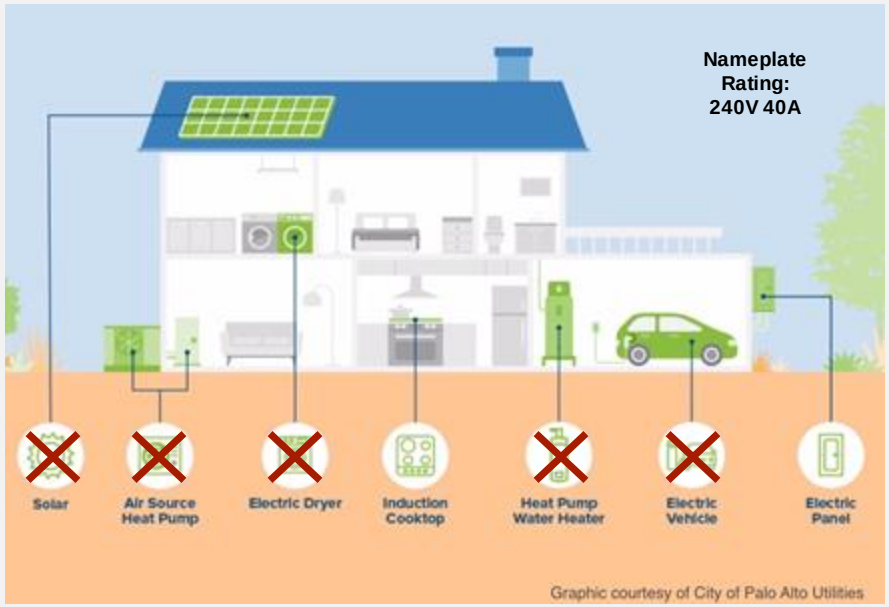
Here we are using NEC code section: 220.83 (B)

Load Type	Amps	Volts	Watts
Kitchen Circuit	12.5	x 120	= 1500
Kitchen Circuit	12.5	x 120	= 1500
Laundry Circuit	12.5	x 120	= 1500
Refrigerator	5	x 120	= 600
Dishwasher	10	x 120	= 1200
Garbage Disposal	5	x 120	= 600
Lights + Plugs	(3 watts / sq foot)		= 4500
Induct. Range	40	x 240	= 9600
			Subtotal = 21,000
First 8,000 watts @ 1.0 coincidence factor Remaining 13,000 watts @ 0.4 coincidence factor			= 8,000 = 5,200
			Total = 13,200

Load Calculation

Step Four: Calculate Load in Amps and Compare to Service Capacity

Home A



Total Floor Area: 1,500 sq ft
Main Service Capacity: 100 amps
Number of Gas Appliances: 3

13,200 watts / 240V = 55 amps

Here we are using NEC code section: 220.83 (B)

Circuit Sharing Devices

- Examples:
  - NeoCharge, Dryer Buddy and SplitVolt let your dryer and EV charger share the existing dryer outlet and circuit
  - SimpleSwitch 240 is a hardwired circuit sharing device to let two 240V items share the same circuit and take turns

- General:
  - They let two devices share, giving priority to one, and letting the other start when the priority device finishes

- Code Counting: Allows you not count the smaller of the two loads

- Bonus: Saves two poles in the electric panel by sharing one circuit

Circuit Pausing Devices

- Examples:
  - Thermelec DCC9 and SimpleSwitch 240M pause the car charger if the load on the electric panel goes over the 80% full level
  - Emporia smart charger with Emporia Vu also pauses the car charger if the load on the electric panel goes over the 80% full level
  - Lumin smart panel and Lumin smart breakers will do the same
- General: Circuit Pausing devices pause the controlled load when needed to keep panel load below a target level.
- Code Counting: Lets you not count the controlled load

7 Ways to convert from Tankless Gas Water Heater

- Electric resistance tankless (uses too much power)
- Heat pump water heater where tankless is
    - Outdoors put in an equipment locker, metal, wood, or small greenhouse
    - Or put in and outdoor Australian model
    - Indoors where the old tank had been
    - Can free up floorspace with a combo washer/dryer single machine
    - Can feed water heater from washer taps
- Split system with outdoor unit connected by water pipe
- Solar thermosyphon tank on roof with resistor in tank. (2/3 solar 1/3 resistor)
- Resistance tank and water conservation

Equipment Silver Bullets

1. 120-volt heat pump water heaters or 240-volt 15-amp hybrid water heaters
2. Upsizing water heater and adding a mixing valve to accommodate slower recovery time
3. 17-amp inverter-driven heat pump HVAC systems that are not just power efficient and energy efficient but also extremely quiet
4. Centrally ducted heat pumps with air handlers on same circuit, or multizone ductless
5. Split heat pump water heaters for tight spaces (consider combo washer/dryer to make space)
6. Heat pump dryers or combo washer/dryers (single 120-volt machine that washes and dries)
7. Wallbox Pulsar EV charger with adjustable current (6 to 32 amps) or Emporia smart charger
8. Circuit-sharing devices like NeoCharge (plug-in) and SimpleSwitch (hard wire)
9. Circuit pausers like DCC9, SimpleSwitch 240M and EV duty, Emporia Smart EV charger
10. Smart electric panels like Span.io & Lumin smart panel