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Simplifying Home Electrification with Circuit Controls

CEC Workshop:
SB68

August 30, 2022

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WHAT IS SB68?

- Authored by State Senator, Josh Becker
- Directs CEC to publish best practices for building electrification:

"It is the intent of the Legislature to **reduce the barriers** that impede building owners from **electrifying** their buildings or adding EV charging equipment as a means of accelerating the reduction of emissions of greenhouse gases from the building and transportation sectors."

WHAT IS SB68?

"...the commission...shall gather or develop, and publish on the commission's internet website, guidance and best practices to help building owners, the construction industry, and local governments overcome barriers to electrification of buildings and installation of electric vehicle charging equipment that include any of the following topics:

(a) Availability of **electrical equipment**...that can **minimize electrical service capacity** requirements.

(b) Approaches for **energy budgeting** to fit electrical replacements and vehicle-charging equipment within the **existing electrical service** capacity of the building whenever possible...

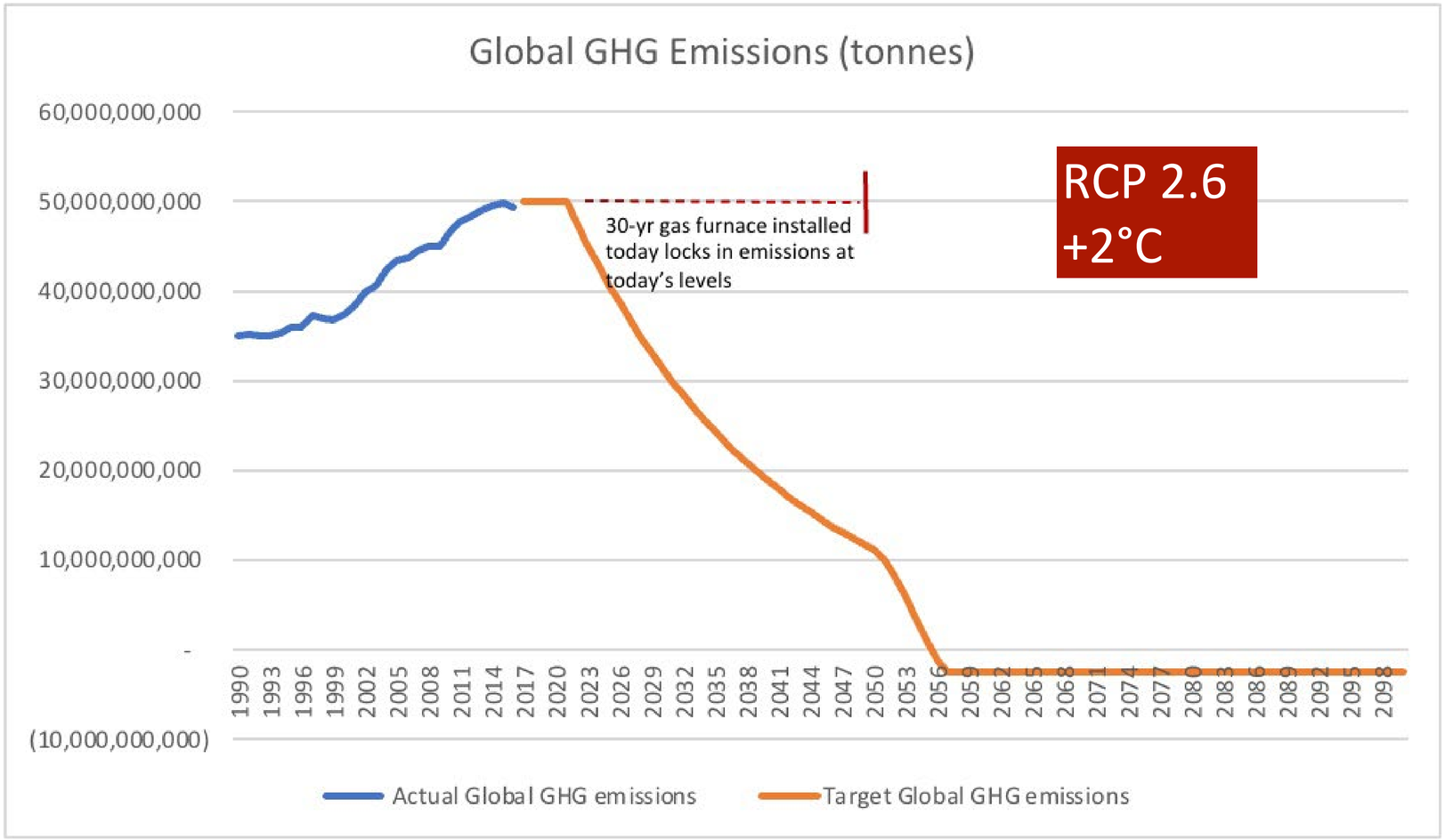
(c) Technologies that allow the non-coincidental **sharing of electrical circuits**.

(d) The development of **whole building electrification plans** to help building owners prepare for future additions of electrical equipment...

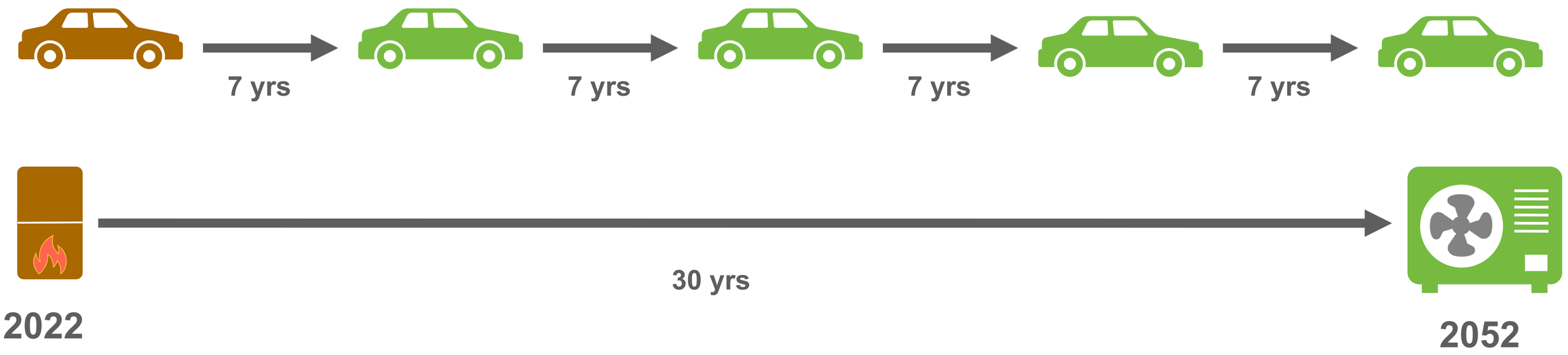
(e) Model permit applications...for the most common building electrification, energy storage, or vehicle charging installation projects...to **streamline and standardize permitting and inspections**."

Information is Power

OUR ONLY PATH REMAINING TO 2°C

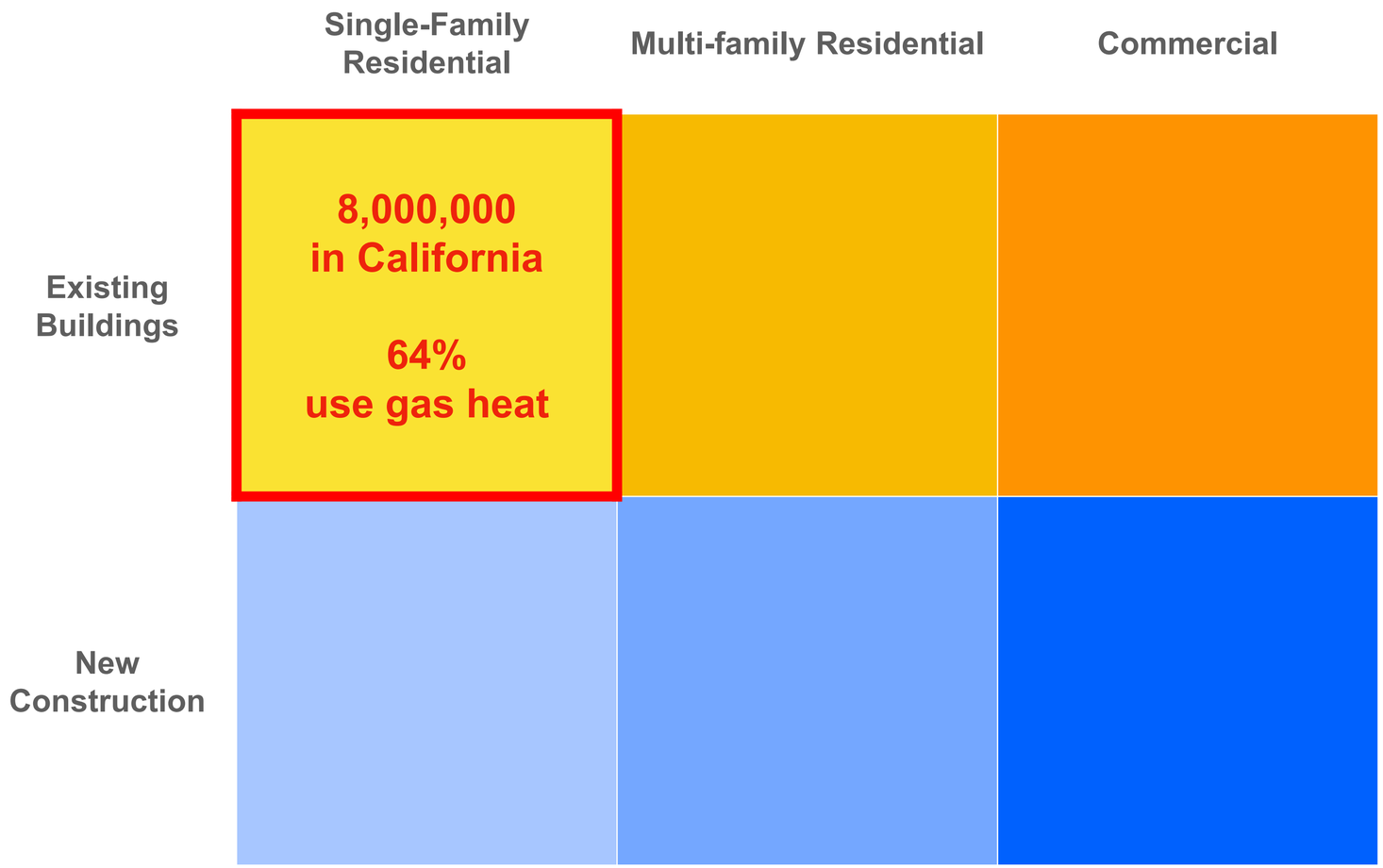


EQUIPMENT TURNOVER RATES



- ~167,000 gas furnaces will be replaced this year in **California** alone
- **Every furnace we fail to convert this year locks in emissions until 2052**, absent govt intervention

OUR FOCUS

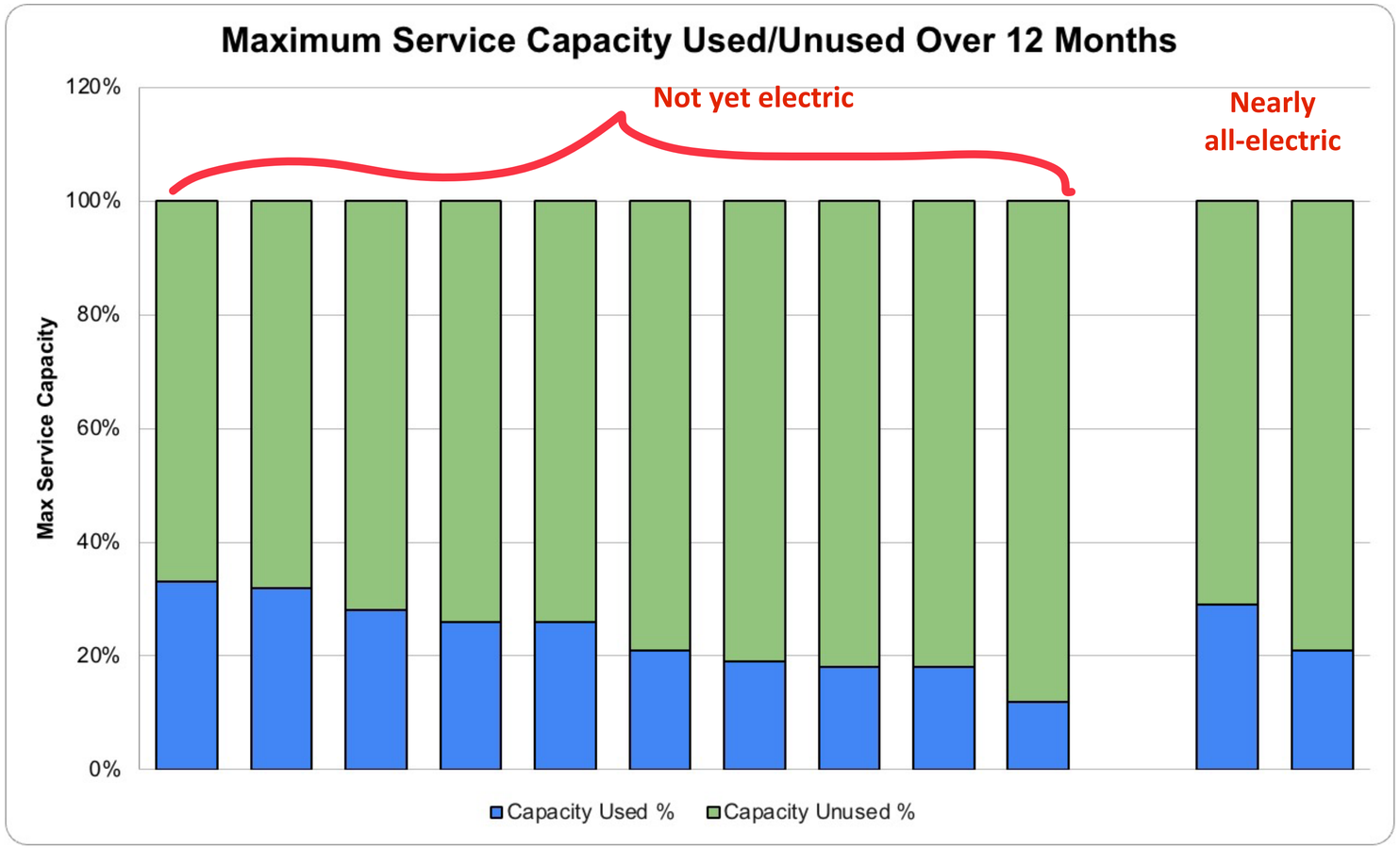

Single-Family Residential
Multi-family Residential
Commercial
Existing Buildings
New Construction
8,000,000 in California
64% use gas heat

THE CHALLENGE

- Status quo annual HVAC replacements in CA: 167,000 furnaces
- Accelerated replacements (10 vs. 30 yrs): 500,000 furnaces
- Therefore, we need 3x the HVAC workforce: who will do this work?
- Cost to upsize all 8 million service lines and main panels: $24 billion
- That's $24 billion not spent on appliance replacement
- Need ?x the electrician workforce: who will do this work?

THE GOOD NEWS

- We don't need to increase service lines to homes, in the vast majority of cases
- In our experience, 90% of homes with 100A panels or greater can be fully electrified (including EV charger) without a service line increase



WHOLE HOME ELECTRIFICATION

Electrification Plans w/ NEC Load Calcs

Example 1

All Electric 100 Amp Home (2,000 square feet)

Ducted heat pump, medium power heat pump water heater, hybrid heat pump dryer

100 Amp Panel

Device Volts	Device Amps				Device Amps	Device Volts
120	8	Lights/Plug	15	15 Lights/Plug	8	120
120	8	Lights/Plug	15	15 Lights/Plug	8	120
120	8	Lights/Plug	15	15 Lights/Plug	8	120
120	10	Garbage Disposal	20	20 Kitchen Outlets	15	120
120	7	Refrigerator	20	20 Kitchen Outlets	15	120
240	3	Forced Air Unit	15	20 Dishwasher	12	120
				20 Clothes Washer	15	120
240	20	Heat Pump HVAC	30	20 Hybrid Heat Pump Dryer	14	240
240	20	EV Charger	25	50 Range (cooktop +oven)	40	240
240	16	Solar Input	20	20 Heat Pump Water Heater	12	240

House square footage = 2000

Total Counted Panel Amps = 96.6

Additional House Information

- 4 occupants
- EV charging up to 19 miles/hr
- Located in California climate zone 3 (SF Peninsula)
- Some insulation
- 38,000 Btuh heating and cooling
- 60-80 gallon heat pump water heater
- 4-burner induction or standard electric range
- 7.4 cu. foot hybrid heat pump dryer
- A 20-amp circuit will support a 3.8 kW inverter. (Many 3.8 kW inverters can support roughly a 4.6 - 5.9 kW solar array depending on inverter load ratio)

Diagram creation and design by Josie Gaillard and Courtney Beyer

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Power-Efficient Equipment Choices

[redacted] Home

Equipment List

Appliance	Image	Model Number	Retail Price
Frigidaire gallery 30" freestanding induction range		GCRI3058AF	$1098
Mitsubishi 3-ton centrally ducted heat pump HVAC system		SVZ-KP36NA/SUZ-KA36NA2	$4800
Rheem 15-amp 65-gallon heat pump water heater		PROPH65 T2 RH375-15	$2215
Wallbox Pulsar EV charger w/ adjustable current		Pulsar	$700

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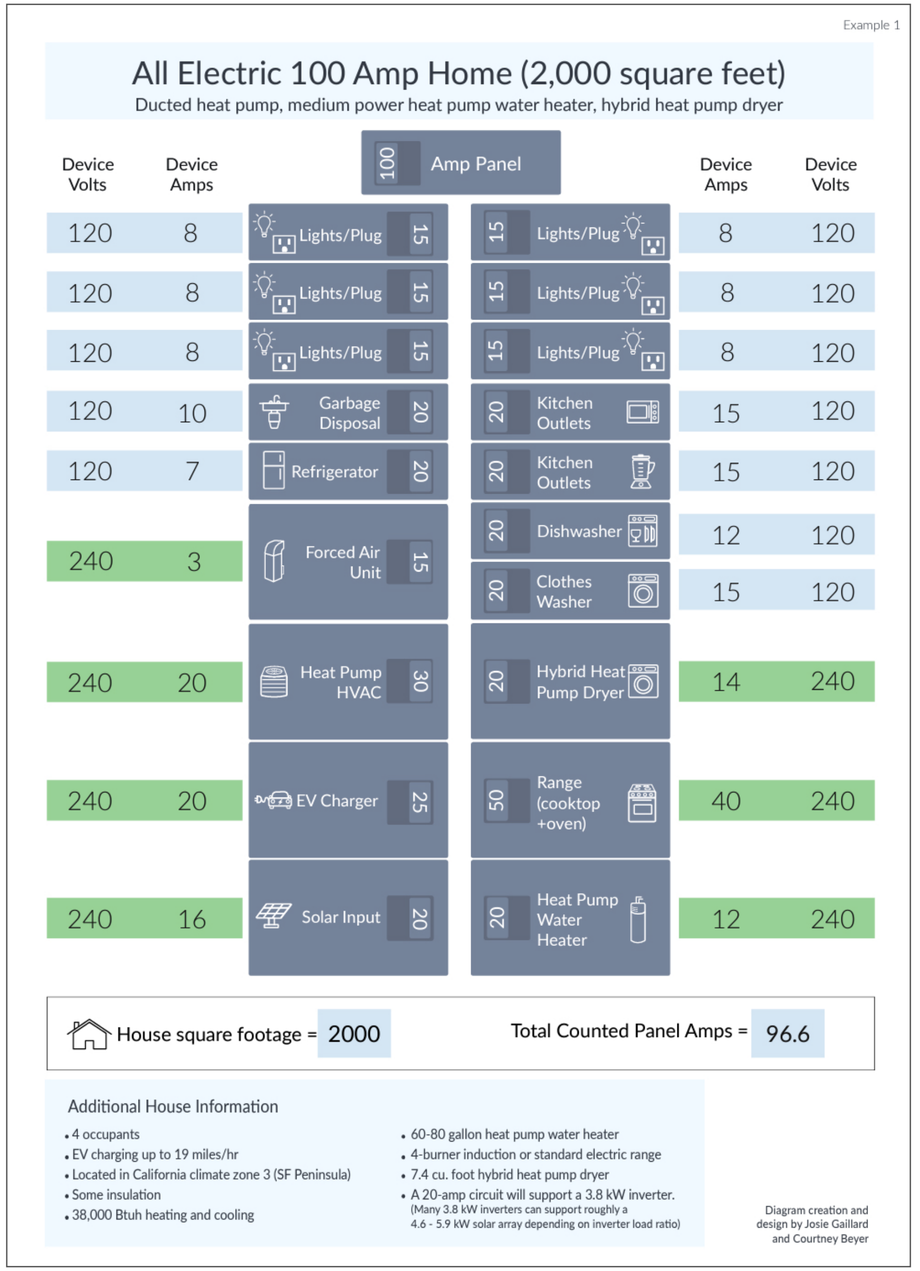
Circuit controls

“PANEL OPTIMIZATION” for 2,000 sq ft home

- For homes with 100 amp electrical panels
- Helps avoid ~$5,000 electric panel upgrade
- Favors efficient devices w/ low rated amps
- Provides roadmap for building owner
- Helps guide tradespeople



DO TRADES KNOW THIS?

- No, each trade thinks about their appliance, not whole home
- Must either train all trades: plumbers, HVAC, electricians or...
- Train electrification experts who understand how all of home's electric systems work together
- Building code could accelerate this learning by requiring whole-home electrification plans

CIRCUIT CONTROLS

- EV charger installers most knowledgable about circuit controls today...
  - Circuit pausers
  - Smart breakers
  - Circuit sharing devices
  - Smart panels

MISPERCEPTIONS

- Circuit controls are not a panacea...they alone will not solve electrification of existing buildings

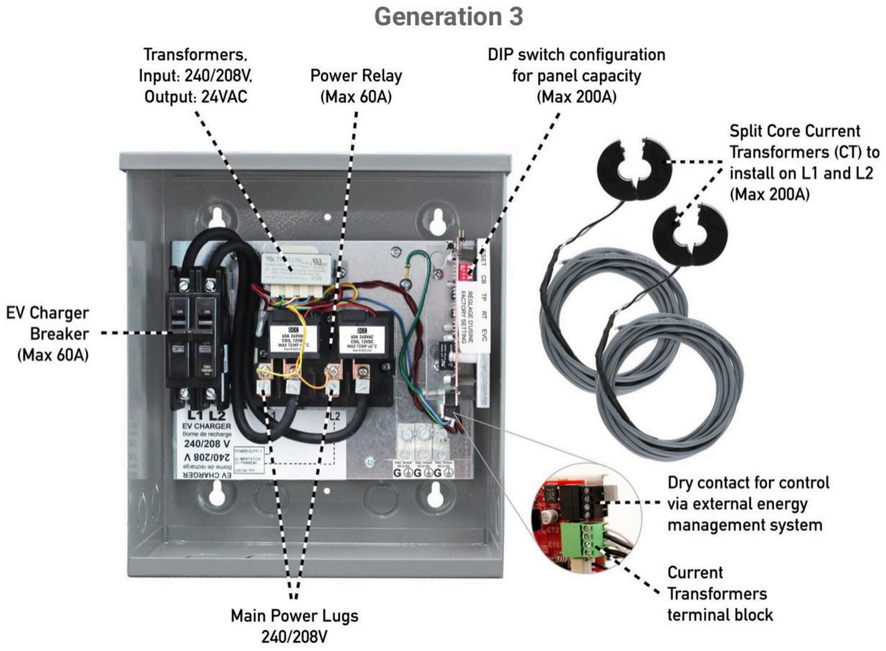
- Circuit controls are a valuable tool in the toolkit to close a final gap, if needed
  - First: make a plan
  - Second: choose power-efficient equipment
  - Third: deploy circuit controls

STATE OF TECHNOLOGY

- Rapid innovation happening in circuit controls...driven primarily by EV charging
- Many start-ups... based in Europe & California
- Hard to stay on top of new offerings
- Many (not all) seek UL listing
- Easy to fully electrify a 100A home with controls available today
- Emerging solutions in this space will only make our jobs easier

CIRCUIT PAUSERS

- Pauses circuit when load on panel exceeds 80% of capacity
- Uses CT clamps to sense power
- Can be installed on main panel or subpanel
- EV charger companies starting to integrate them into chargers
- Our most frequently used type of circuit control

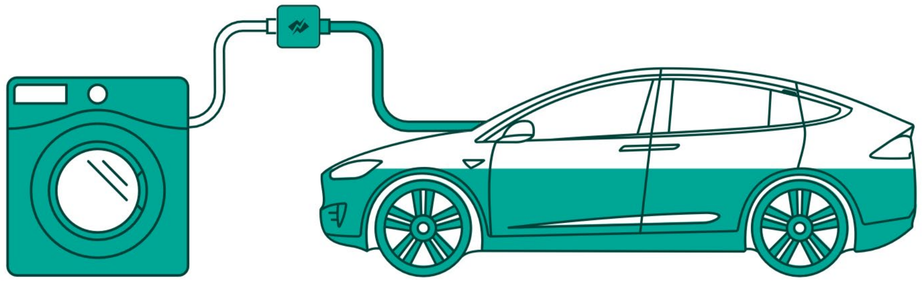


SMART BREAKERS

- Often compatible with conventional electrical panels
- Measure current going through themselves and can report via wifi to apps
- When paired with software, can control circuits, dynamically throttling current as needed
- First used in commercial construction applications
- Sometimes used in residential solar/battery applications
- Not currently seeing widespread use in existing homes purely for electrification

CIRCUIT SHARING DEVICES

- Can be hardwired or plug-in
- Plug-in versions can be easy, temporary fix for sharing dryer and EV charger



SMART PANELS

- Shed any of the circuits in the panel if load exceeds 80% of panel capacity
- Priority of circuit shedding set by homeowner
- 100A - 200A capacity
- Rated for indoor and outdoor use

TYPICAL USE OF CIRCUIT CONTROLS

- 100A home in Burlingame, CA
- Converting 4 gas appliances + car to electric
- 1st selected elected power-efficient equipment
- Added one circuit control: SimpleSwitch 240M circuit pauser to EV circuit
- NEC 220.83(B) load calcs
- That's it!

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" freestanding induction range	240	×	40	=	9,600
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					32,250
First 8,000 VA @ 100%					8,000
Remaining VA @ 40%					9,700
General Loads Total					17,700
Other Loads (nameplate value)	**Volts**		**Amps**		**Volt-Amps**
NEW: Electric Vehicle Charging Load @ 125% (with circuit pausing)	240	×	0	=	0
Bathroom Heater @ 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)					23,100 VA
Divide Load by 240 Volts					96.2 A
Rating of Existing Electrical Service					100 A
Panel Upgrade Required?					No

GREATER CHALLENGES WE FACE

- Range anxiety causes new EV buyers to oversize home EV chargers...leaving no room on panel for more electrification
- People installing new gas tankless water heaters - BIG problem and growing
- Electric resistance dryers - need better heat pump alternatives w/ 7.4 cu ft
- Permitting authorities lack basic knowledge about heat pumps, circuit control tech and in some cases NEC load calc methods > leads to permitting problems
- Trades other than electricians (plumbers, HVAC) need easy way to do NEC load calcs so they can switch from installing fossil fuel to electric appliances