We will be starting soon!

Thanks for joining us

Practical Guide to All-Electric Residential Buildings

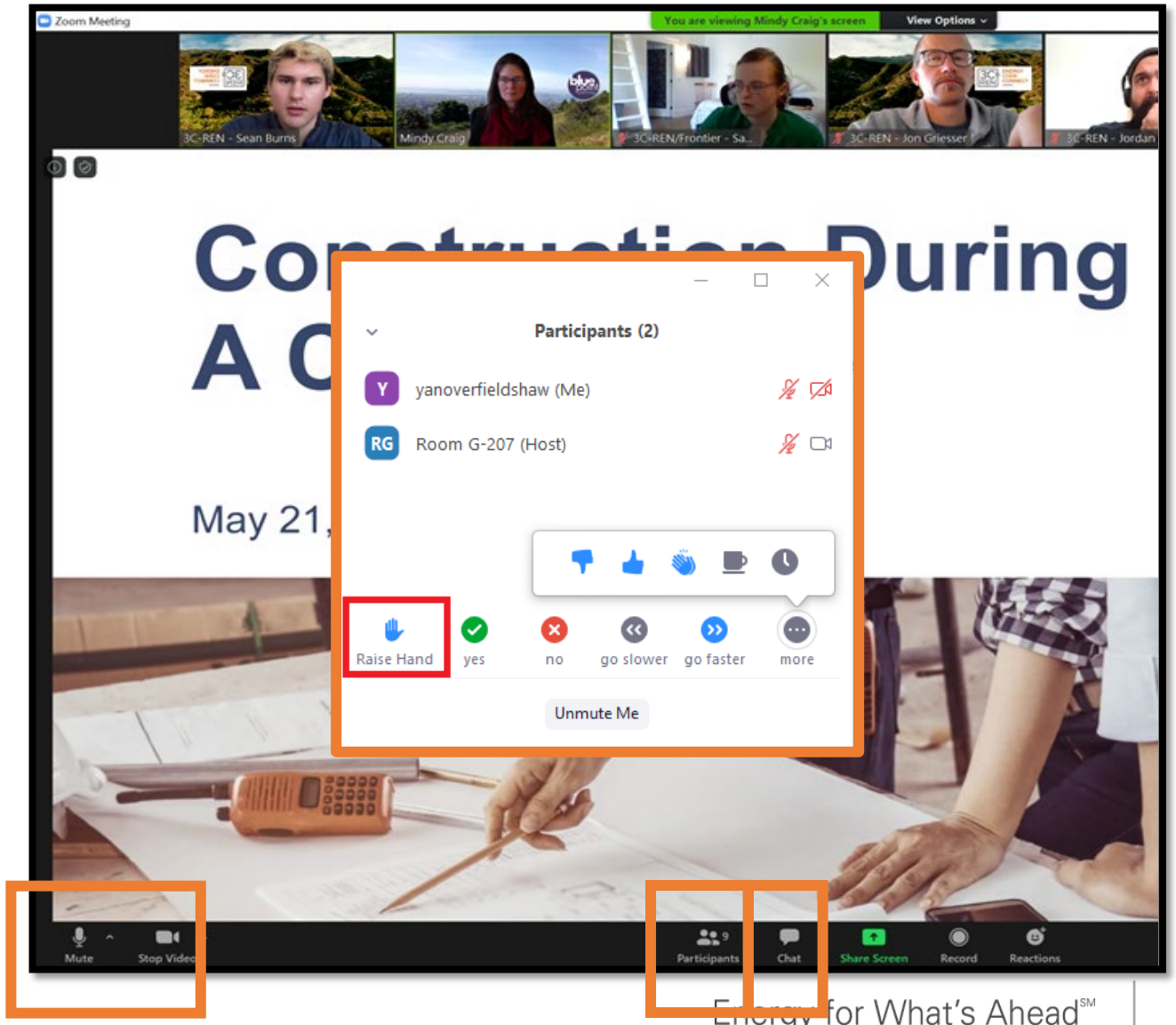
Nick Brown - Build Smart Group

Robert Fortunato, ForStrategy Consulting, Inc.

July 11th 8:30-12 PM

Zoom Orientation

- Please be sure your full name is displayed
- Please mute upon joining
- Use "Chat“ box to share questions or comments
- Under "Participant" select "Raise Hand" to share a question or comment verbally
- The session may be recorded and posted to 3C-REN's on-demand page. Feel free to ask questions via the chat and keep video off if you want to remain anonymous in the recording.



3C-REN: Tri-County Regional Energy Network

- Three counties working together to improve energy efficiency in the region
- Services for –
  - **Building Professionals:** industry events, training, and energy code compliance support
  - **Households:** free and discounted home upgrades
- Funded by ratepayer dollars that 3C-REN returns to the region

3C REN ENERGY CODE CONNECT

3C REN BUILDING PERFORMANCE TRAINING

3C REN HOME ENERGY SAVINGS

3C REN ENERGY CODE CONNECT

- Serves all building professionals
- Three services –
  - **Energy Code Coach**
  - **Training and Support**
  - **Regional Forums**
- Makes the Energy Code easy to follow

Energy Code Coach:
3c-ren.org/codes
805.781.1201

Event Registration:
3c-ren.org/events

BUILDING PERFORMANCE TRAINING

- Serves current and prospective building professionals
- Expert instruction:
  - **Technical skills**
  - **Soft skills**
- Helps workers to thrive in an evolving industry

Event Registration:
3c-ren.org/events

3C REN HOME ENERGY SAVINGS

Multifamily (5+ units)

- No cost technical assistance
- Rebates up to $750/apartment plus additional rebates for specialty measures like heat pumps

Single Family (up to 4 units)

- Sign up to participate!
- Get paid for the metered energy savings of your customers

Enrollment:
3C-REN.org/contractor-participation

The Practical Guide to All-Electric Residential Building Design

Nick Brown
Robert Fortunato

3C-REN

July 11, 2024

Goals - This course was built to:

- Make the benefits of clean energy, all-electric buildings clear in terms of time, money, lifestyle, health, and safety.
- Make the technical understanding and modeling of Net Zero Energy/ Zero Carbon all electric buildings more accessible to architects, developers, contractors, engineers, planning officials and the general public.
- Introduce the all-electric technologies and proper design and installation techniques that makes switching easier.

Structure of Class

:30	Why All-Electric?
:20	Technologies to Go Electric-PV & Batteries
:20	Energy Modeling for All-Electric
:25	Technologies to Go Electric-Cooking & Appliances
:10	Break
:30	Technologies to Go Electric-Water Heating
:30	Living with Induction & Heat Pump Water Heaters
:20	Technologies to Go Electric-HVAC Heat Pumps
:15	Energy Modeling All-Electric
:10	Avoiding Common Missteps
:10	Summary

Introductions

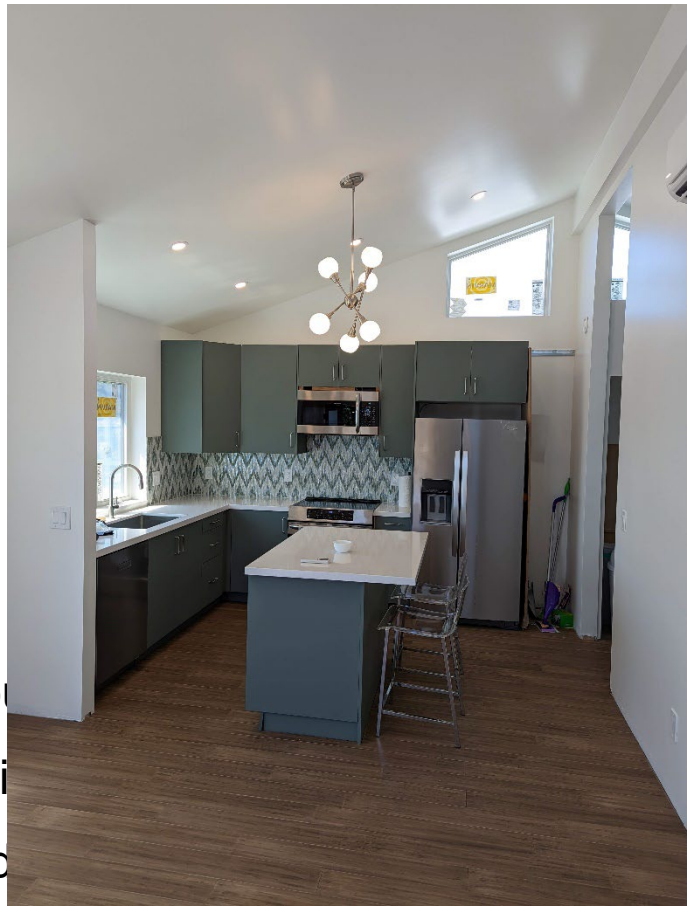
Nick Brown
Robert Fortunato

Nick Brown

Owner/Builder, Net Zero Nest
President, Build Smart Group

CABEC CERTIFIED CEA ENERGY ANALYST

Nick Brown
R22-15-40004



Net Zero Nest:

- Completed in 2016
- 1,950 sf, 3 BR & 3 Bath
- 4.4 kW PV array (16 panels)
- Now All Electric

All-Electric ADU:

- Completed in 2022
- 576 sf, 1 BR & 1 Bath
- 4.1 kW PV array (12 panels)
- Net Zero Carbon

Instructor for variou

- All-Electri
- Demyth-c
- Energy Standards for Residential Architects
- Net-zero Design

Details of your tracked charges

Your rate: DOMESTIC
Billing period: Feb 5 '16 to Mar 8 '16 (32 days)

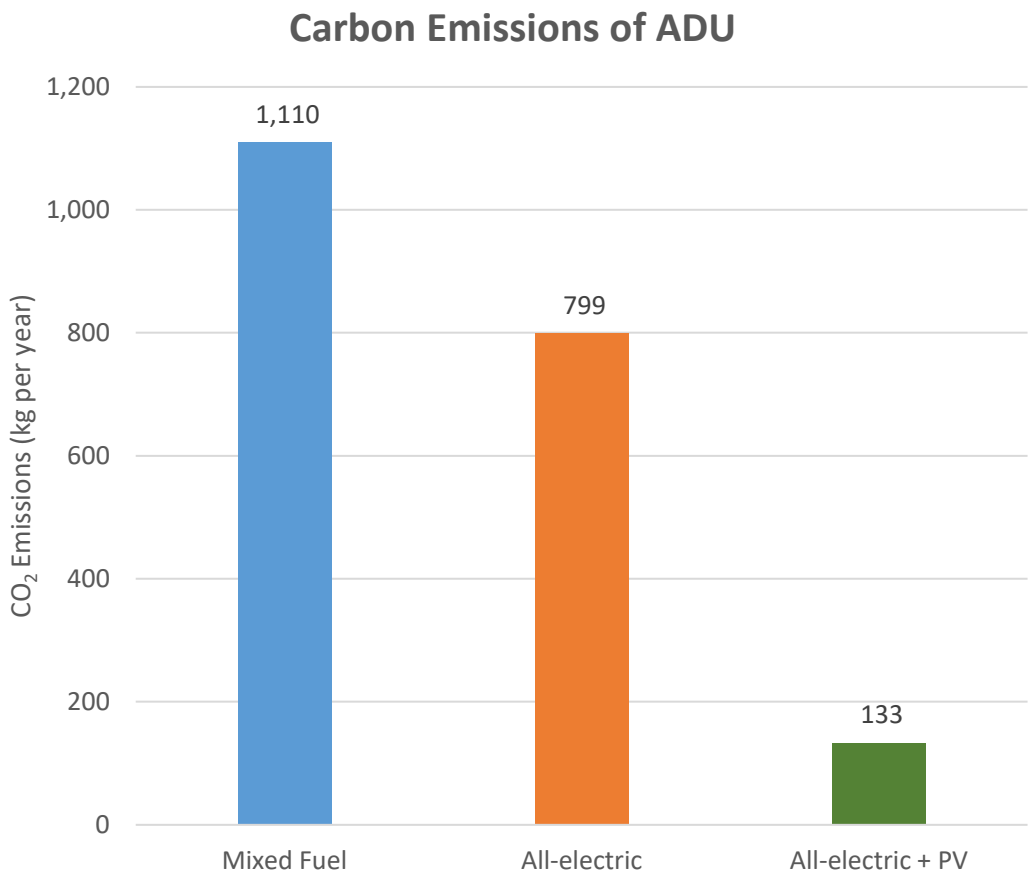
Delivery charges		
Energy-Winter		
Tier 1 (within baseline)	-124 kWh x $0.07682	-$9.53
DWR bond charge	-124 kWh x $0.00539	-$0.67
Generation charges		
DWR		
DWR energy credit	-124 kWh x -$0.00022	$0.03
SCE		
Energy-Winter		
Tier 1 (within baseline)	-124 kWh x $0.06909	-$8.57
Energy Charge Total		**-$18.74**

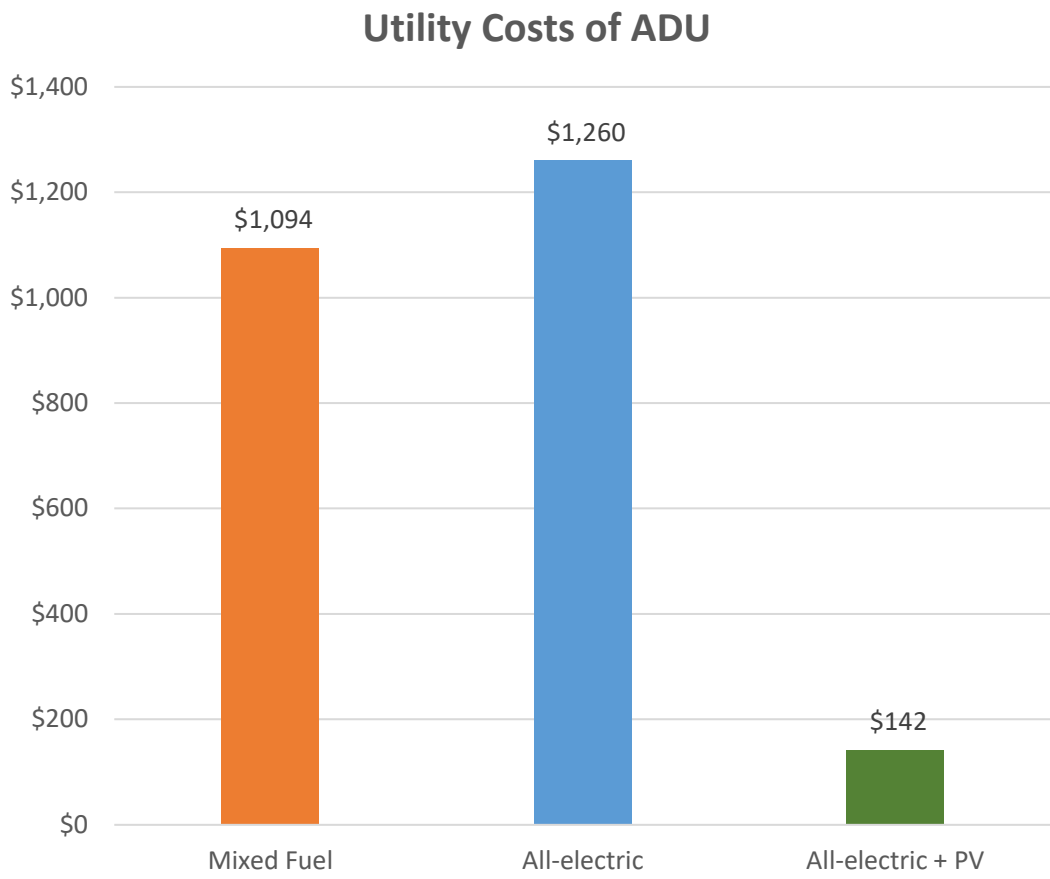
Additional information regarding your Net Consumption/Generation:

- *Your cumulative energy charge total as of previous month: -$214.88*
- *Your current month energy charge total: -$18.74*
- *Your cumulative energy charge Year-to-Date: -$233.62 **
- *Your cumulative kWh Year-to-Date: -1,162 kWh*

**If you earned a credit on your bill, the amount you receive may be less than your Cumulative Energy Charge which is based on SCE's rates. Your "Compensation Total" is based on the Cumulative kWh Year-to-Date shown above, which is then multiplied by a CPUC approved value per kWh.*

ADU Designed to be Close to Net Zero Carbon

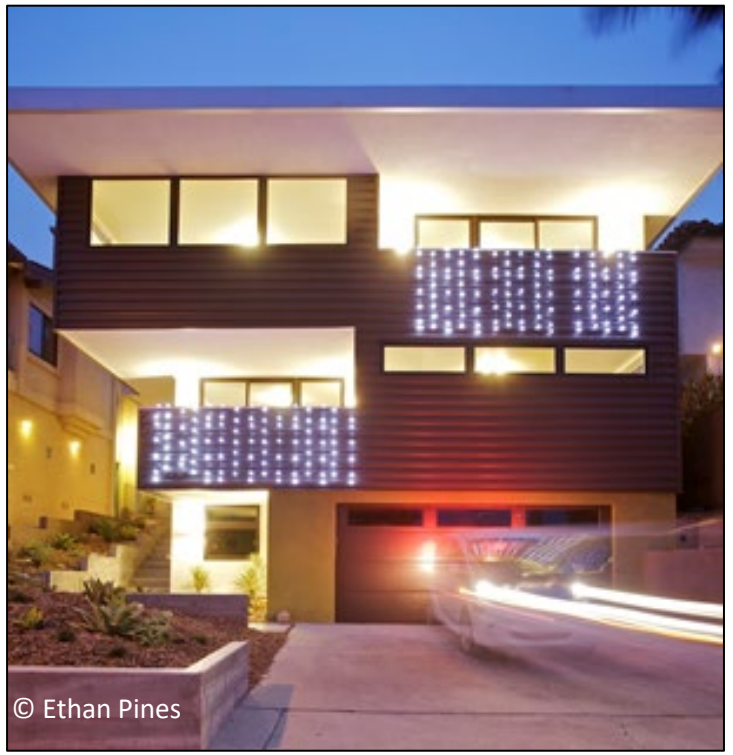




Charts based on design-stage energy modeling in CBECC-RES with hourly energy usage, SCE Time of Use electric rates, and Carbon emission factors as of late 2022.

Robert Fortunato

Owner/Builder, Green Idea House
President, ForStrategy Consulting, Inc.



Green Idea House:

Completed in 2012

2,150 sf, 3 BR & 2 Bath

6.5 kW PV array (26 panels)

Green Point Rated, Living Building Challenge NZE Petal

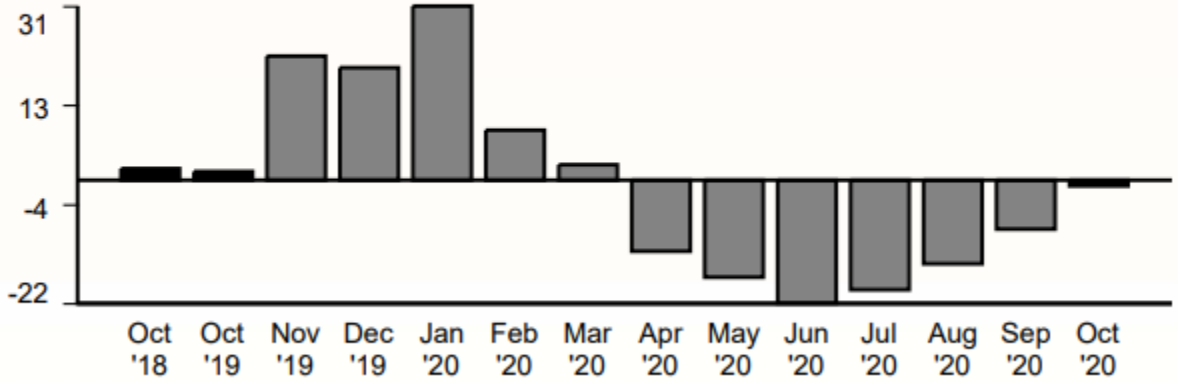
Robert Fortunato

Your past and current electricity usage

	Electricity (kWh)
Winter Season - Consumption	
On peak	62
Off peak	130
Super off peak	230
Winter Season – Net Generation	
On peak	-99
Off peak	-354
Super off peak	-1
Total electricity usage this month in kWh	**-32**

Your daily average electricity usage (kWh)

2 Years ago: 2.00 Last year: 1.53 This year: -1.03



Additional information regarding your Net Consumption/Generation:

- *Your year-to-date energy charges total as of previous month: -$1,215.44*
- *Your current month energy charge total: -$42.36*
- *Your year-to-date energy charges: -$1,257.80*
- *Your year-to-date kWh: -1,703 kWh*

- 2nd single family residence in California and 12th single family residence (anywhere!) to certify under The Living Building Challenge's Zero Energy program

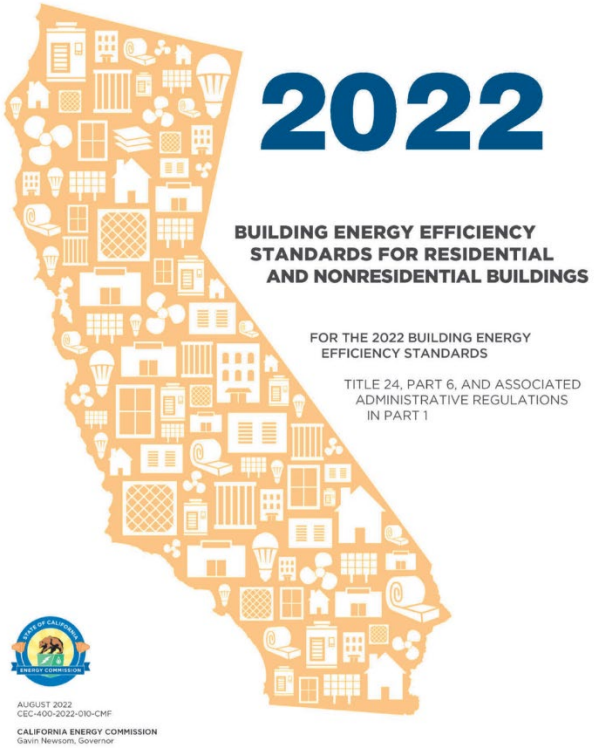
Definitions

- ZNE: Zero Net Energy
  - A building that produces as much onsite clean energy as it uses over the course of the year.
- Zero (Net) Carbon
  - A building that produces as much onsite clean energy as it uses of the course of the year, measured hourly according to the Carbon intensity of local energy production throughout the year.
- Greenhouse Gases
  - Emissions of gases proven to trap the Sun's energy in the Earth's atmosphere, leading to rising temperatures. These include CO_2, Methane, and others.

Why All Electric?

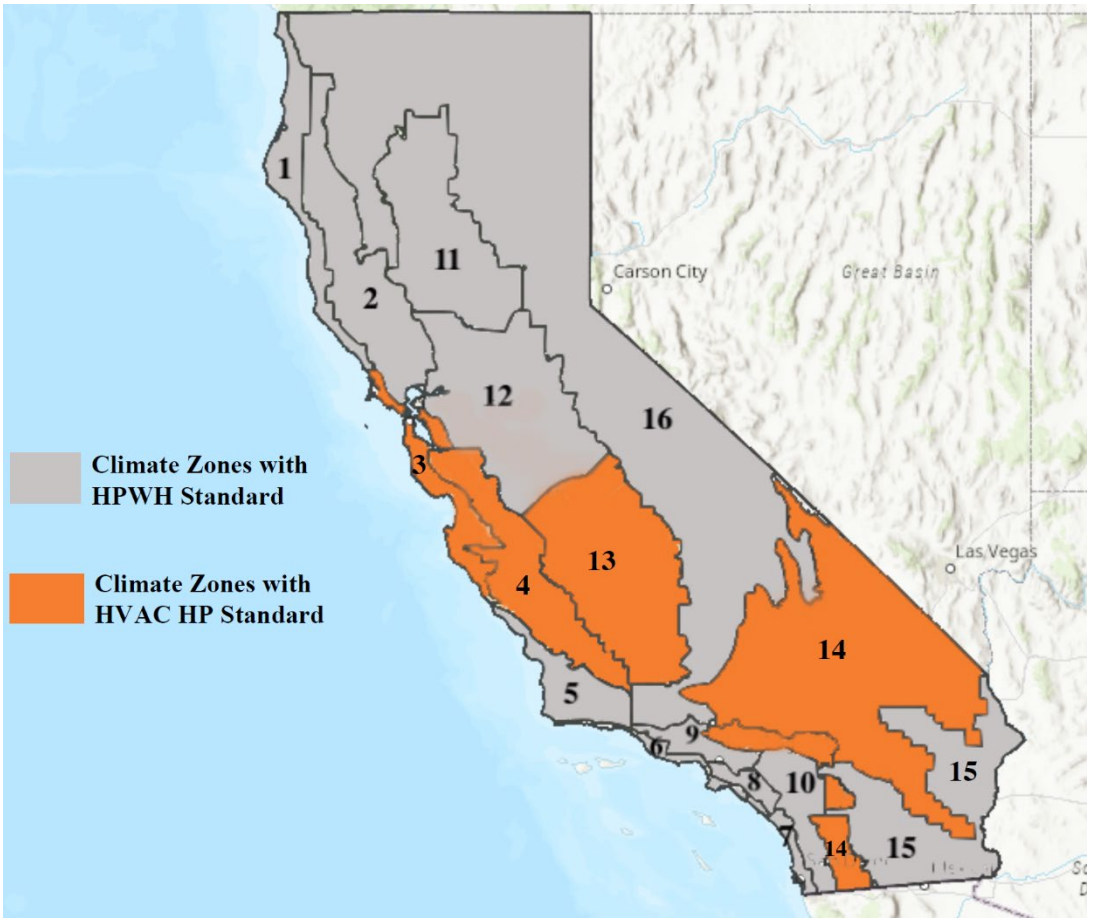
Reasons to Electrify Homes

- One less utility - Less expensive to build and operate
- AMA Study - Gas Stoves Increase Household Air Pollution (NO_x) and the Risk of Childhood Asthma
- Reduced dependence on foreign energy
- Reduced external pollution, GHG emissions
- Better backup power/water in an emergency
- Improved lifestyle
- Billions of dollars in incentives, training….
- Easier energy code compliance

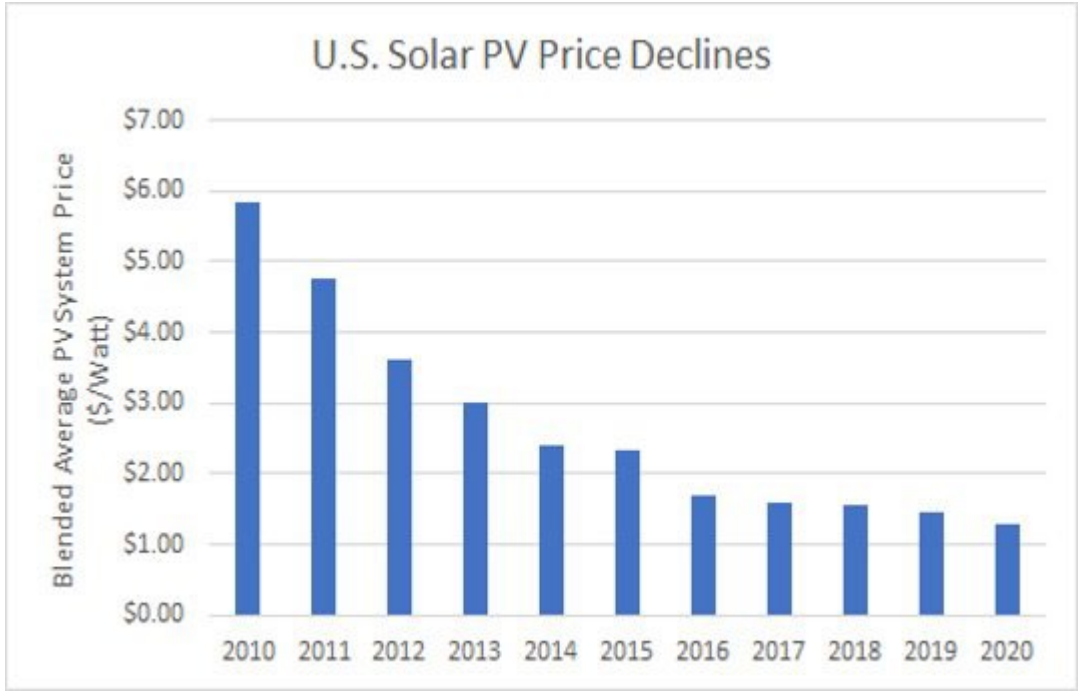


The 2022 California Energy Code: Compliance Easier with All-Electric Systems

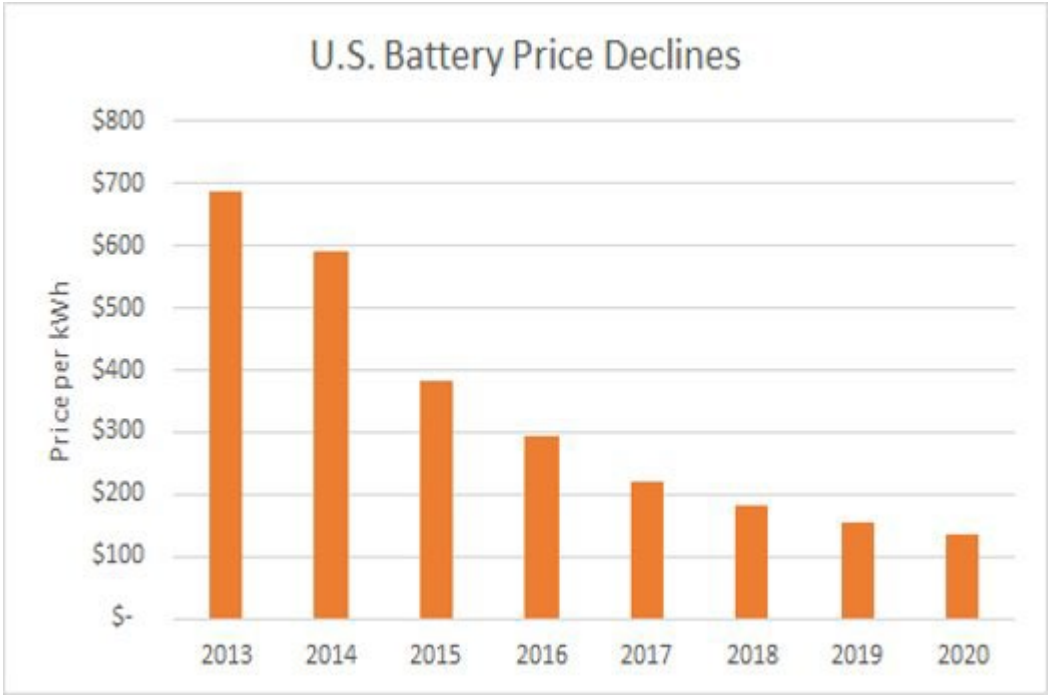
- Dedicated electrical circuits, plumbing etc. are required to backup every gas appliance installed
  - Except central HW in multifamily.
- New compliance metric measures GHG emissions
- Heat pumps prescriptive standard
- Gas cooktops require additional mechanical ventilation than electric



Cost of Solar PV and Batteries

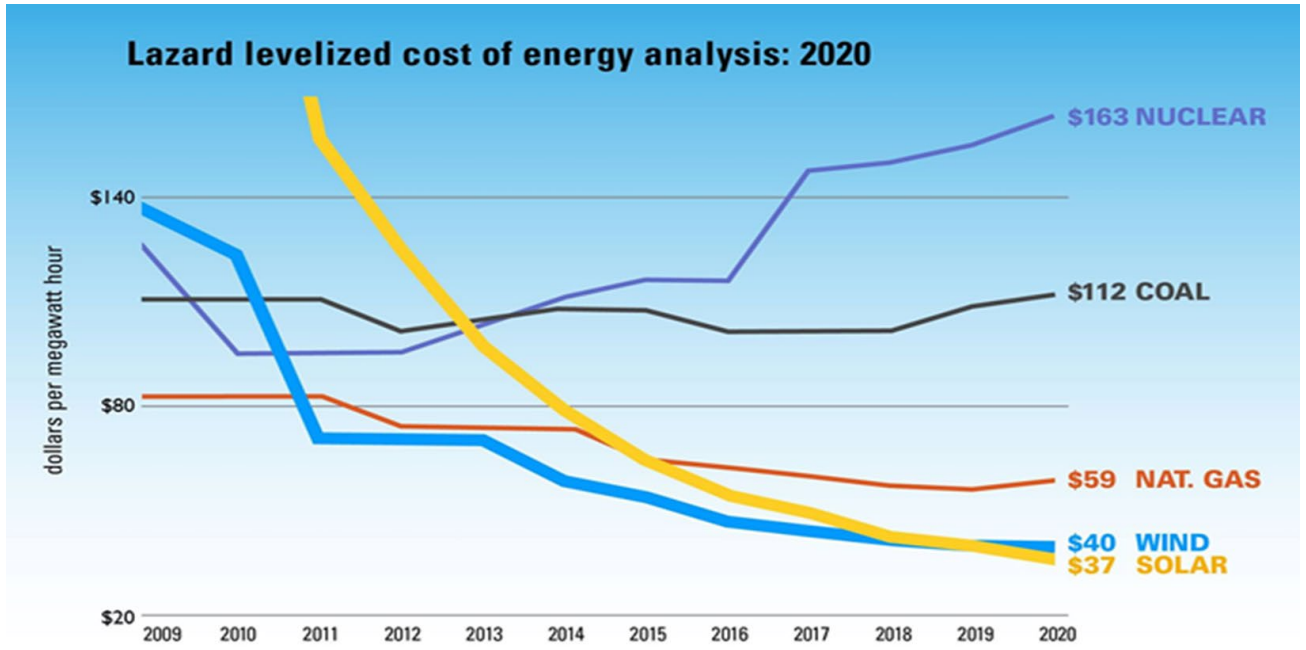


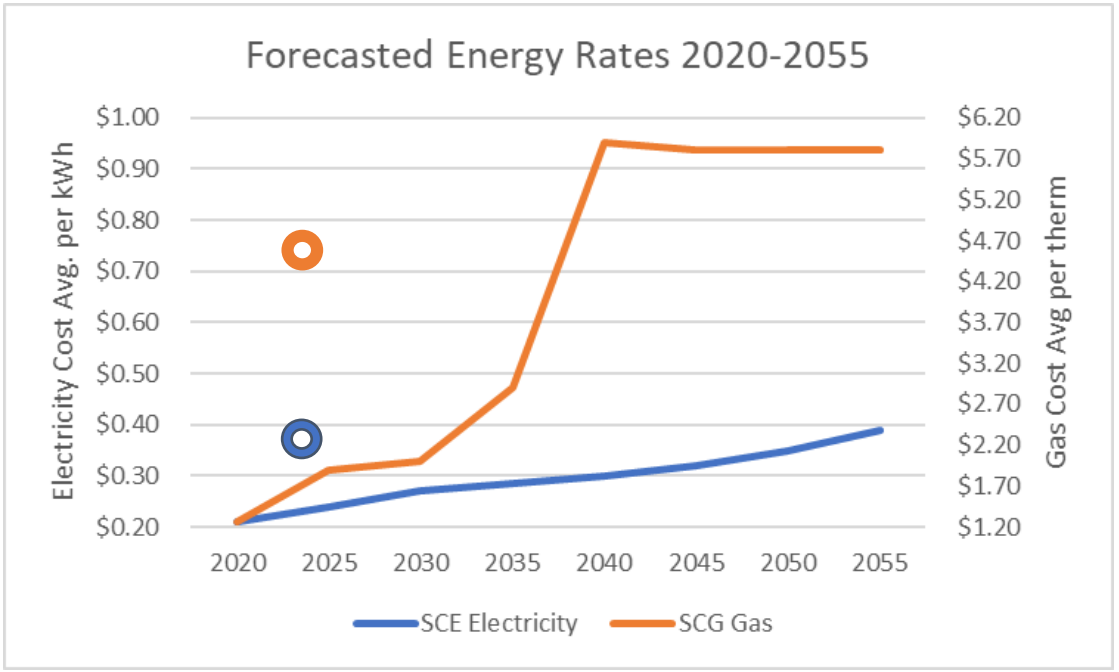
Source: SEIA



Source: BloombergNEF

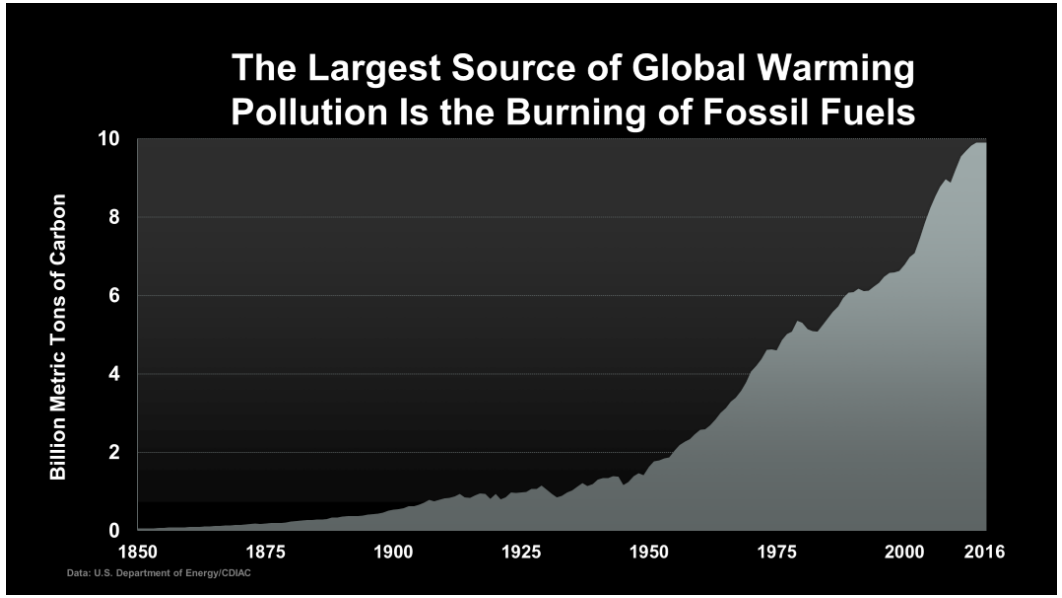
Energy Costs Now and in the Future

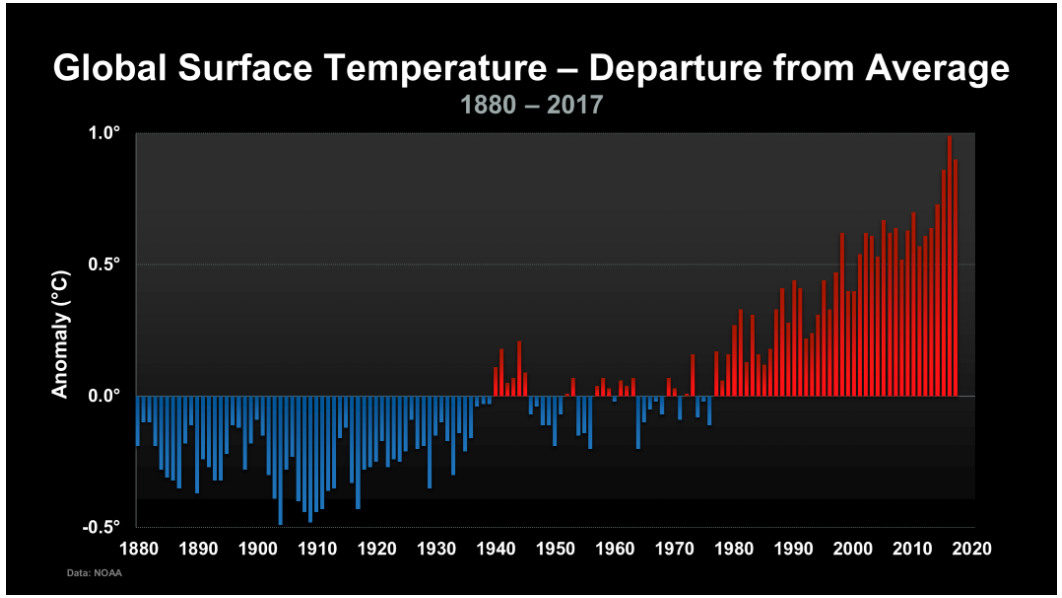




Source: 2021 IEPR & E3 2025 Energy Accounting presentation

Gas no longer the transition fuel -- other technologies have superseded gas.





Heat Pumps for Peace and Freedom

Joe Biden Could Damage Putin Badly--and He Doesn't Have to Ask Joe Manchin

Bill McKibben
Feb 27

118 132

California is Driving All-Electric

- 40% GHG reduction by 2030

SB 32 (2016)

Electric sector:
- 60% renewables by 2030
- 100% carbon-free by 2045

SB 100 (2018)

- Carbon neutrality by 2045

Gov. Exec Order (2018)

- Expected: No gas furnace or gas water heater sales by 2030

Air Resources Board (CARB)

- 40% GHG reductions <u>in buildings</u> by 2030

AB 3232

- $200M/4yrs incentives for building decarb
- TECH/BUILD

SB 1477

- No ICE Car Sales by 2035

Gov. Exec Order (2020)

Defense Production Act
- Accelerate Clean Energy technologies

Executive Order (2022)

$369b Inflation Reduction Act
- 40% GHG reductions by 2030

U.S. Congress (2022)

All-Electric or Electric-Favored Reach Codes

Reach Codes allow cities to **ask builders to go beyond state codes**

~45 of them are All-Electric

- Santa Monica, SLO, Santa Barbara, Encinitas, and Solana Beach

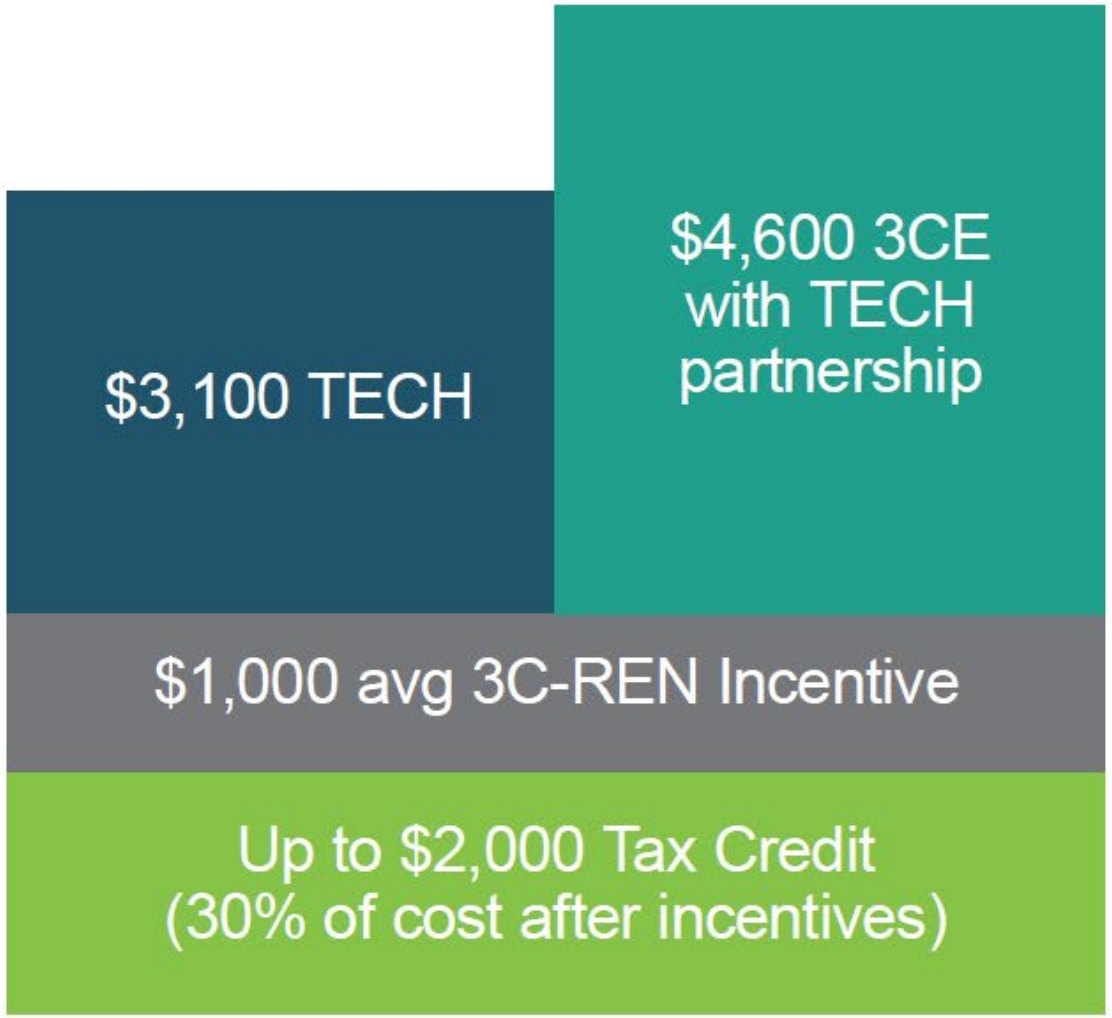
50+ in 2019 Cycle

- These codes are being updated for 2022 code
- Many are using health & safety ordinances

Los Angeles City Zero Carbon Building Reach Code took effect April, 2023

Example Project:
Heat Pump Water Heater <55 Gallons

$7,600



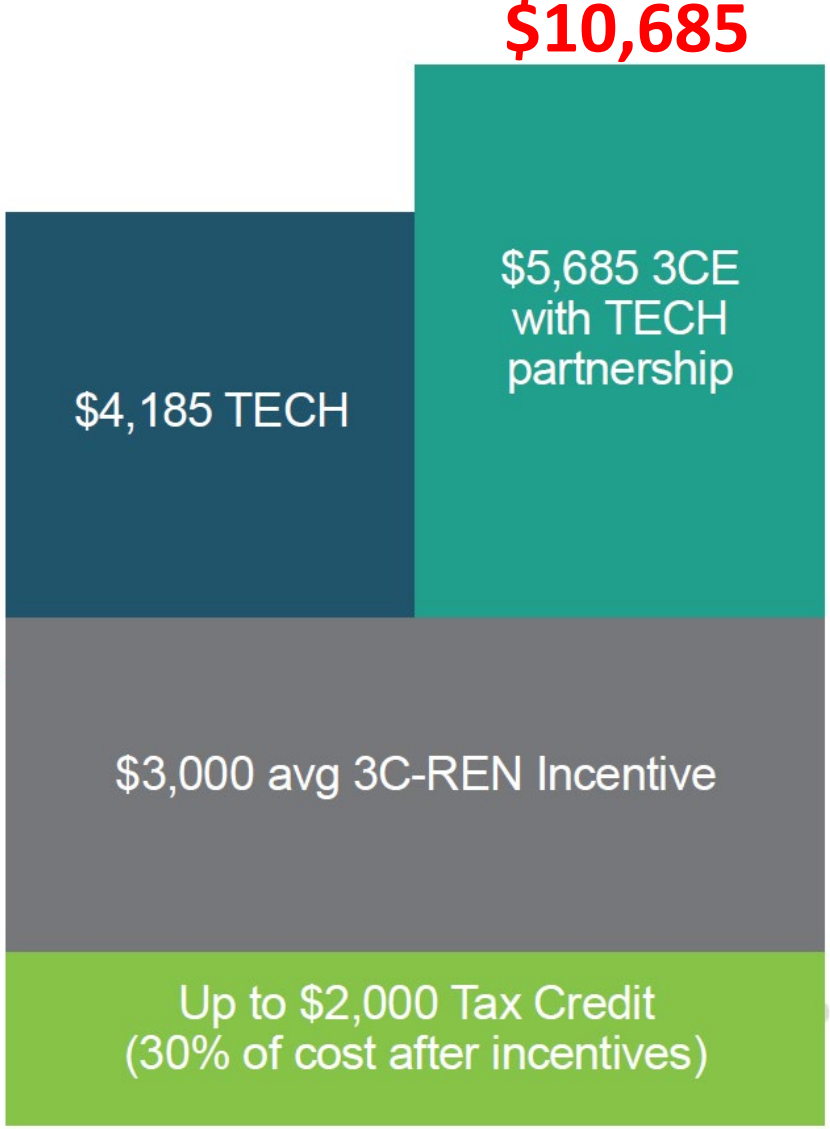
Central Coast Community Energy

TECH CLEAN CALIFORNIA

3C-REN HOME ENERGY SAVINGS

Inflation Reduction Act (IRA)

Same Project, but with Equity & Hard to Reach



Central Coast Community Energy

TECH CLEAN CALIFORNIA

3C-REN HOME ENERGY SAVINGS

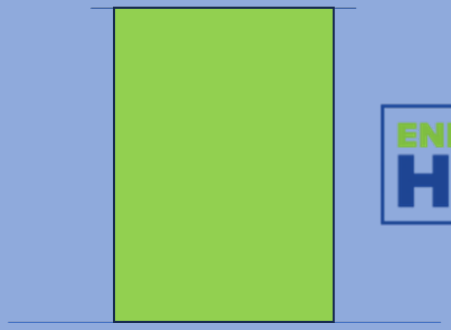
Inflation Reduction Act (IRA)

Single Family Retrofit Incentives Really Add Up

- CA Energy Smart Homes
  - $4,250 to remodel all-electric
  - $1,000 for electrical panel upgrades
  - $600 Advanced heat pump bonus
  - $250 heat pump dryer

Up to $6,100

$4,250 Whole House base incentive
+$250 HP dryer
+$1,000 Elec panel
+$600 Advanced HP bonus



CALIFORNIA ENERGY-SMART HOMES

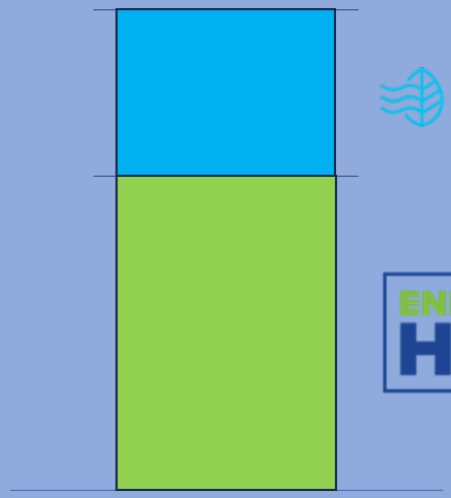
Single Family Retrofit Incentives Really Add Up

- TECH Clean California
  - Relaunching statewide mid-August
  - Rebates to installing contractors
  - PG&E
    - $1,100-$1,800 HPWH
    - $1,000-$1,500 Heat Pump
    - $2,000 Electrical
  - SCE & SDG&E & Munis
    - $3,100-3,800 HPWH
    - $1,000-$1,500 Heat Pump
    - $2,000 Electrical

$10,200 - $13,400

$1,000-$1,500 Heat Pump
$1,100-$3,800 HPWH
$2,000 Electrical

$4,250 Whole House base incentive
+$250 HP dryer
+$1,000 Elec panel
+$600 Advanced HP bonus



TECH CLEAN CALIFORNIA

CALIFORNIA ENERGY-SMART HOMES

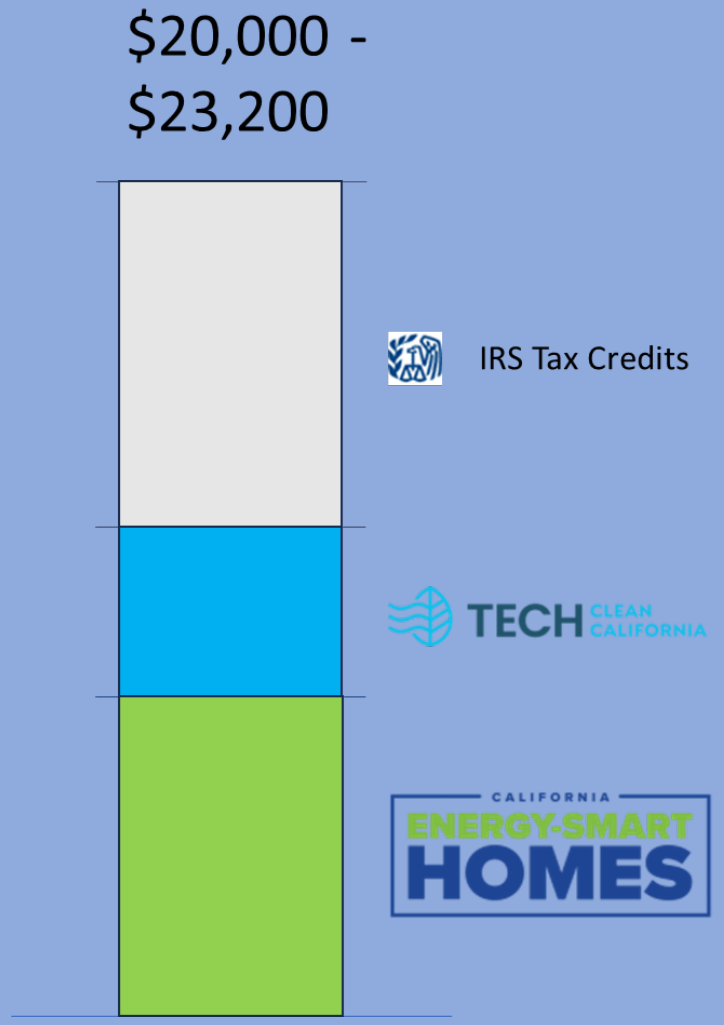
Single Family Retrofit Incentives Really Add Up

- Federal Tax Credits (part of Inflation Reduction Act)
  - Available now for 10 years
  - Can take tax credits each year
  - 30% tax credit available on:
    - PV panels
    - Batteries
    - Heat Pumps
    - HPWHs
    - Other Energy Efficiency upgrades
    - Electrical Panel

$4,000 PV panels
$2,000 Heat Pump
$2,000 HPWH
$1,200 Efficiency
$600 Elec panel

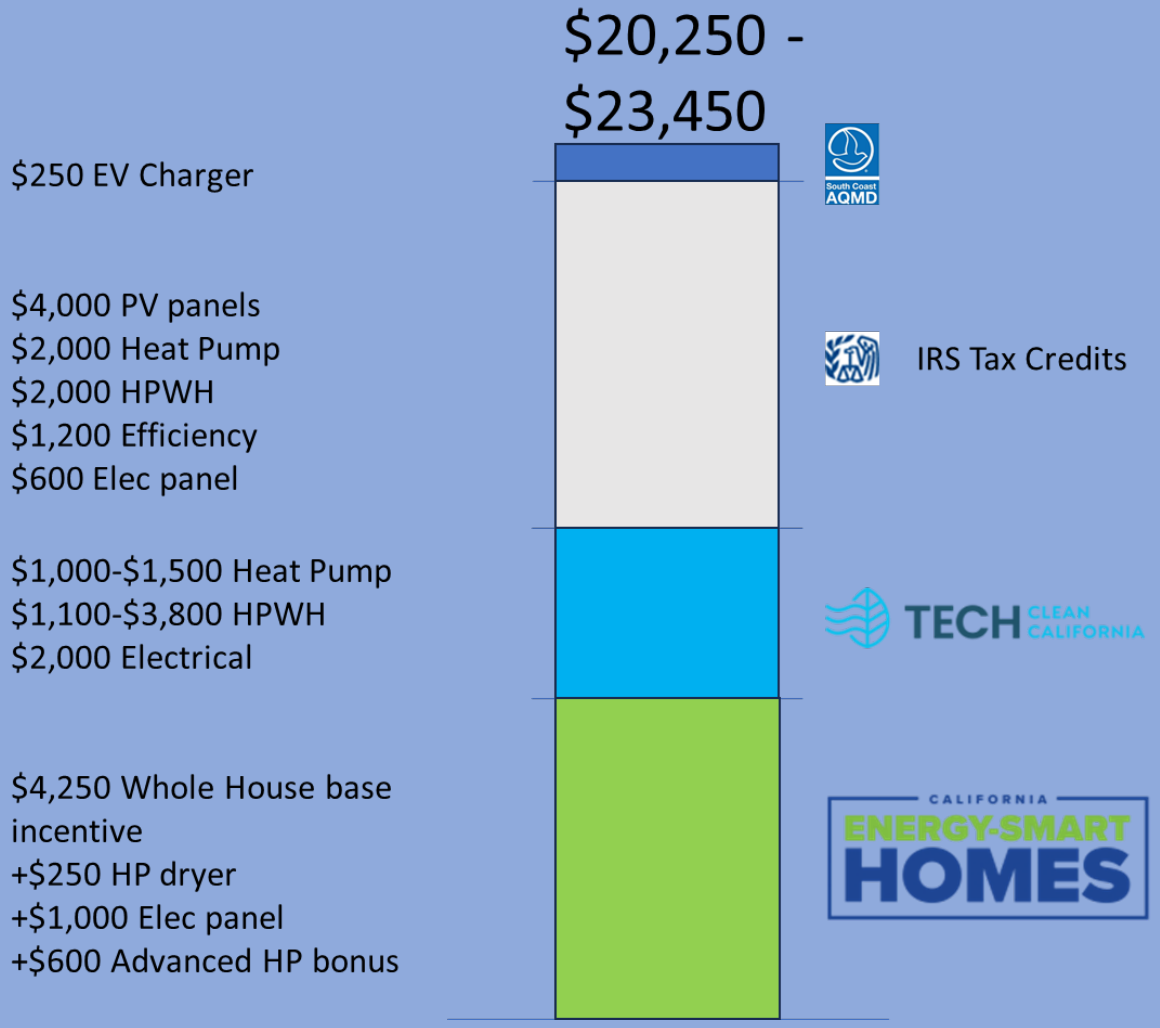
$1,000-$1,500 Heat Pump
$1,100-$3,800 HPWH
$2,000 Electrical

$4,250 Whole House base incentive
+$250 HP dryer
+$1,000 Elec panel
+$600 Advanced HP bonus



Single Family Retrofit Incentives Really Add Up

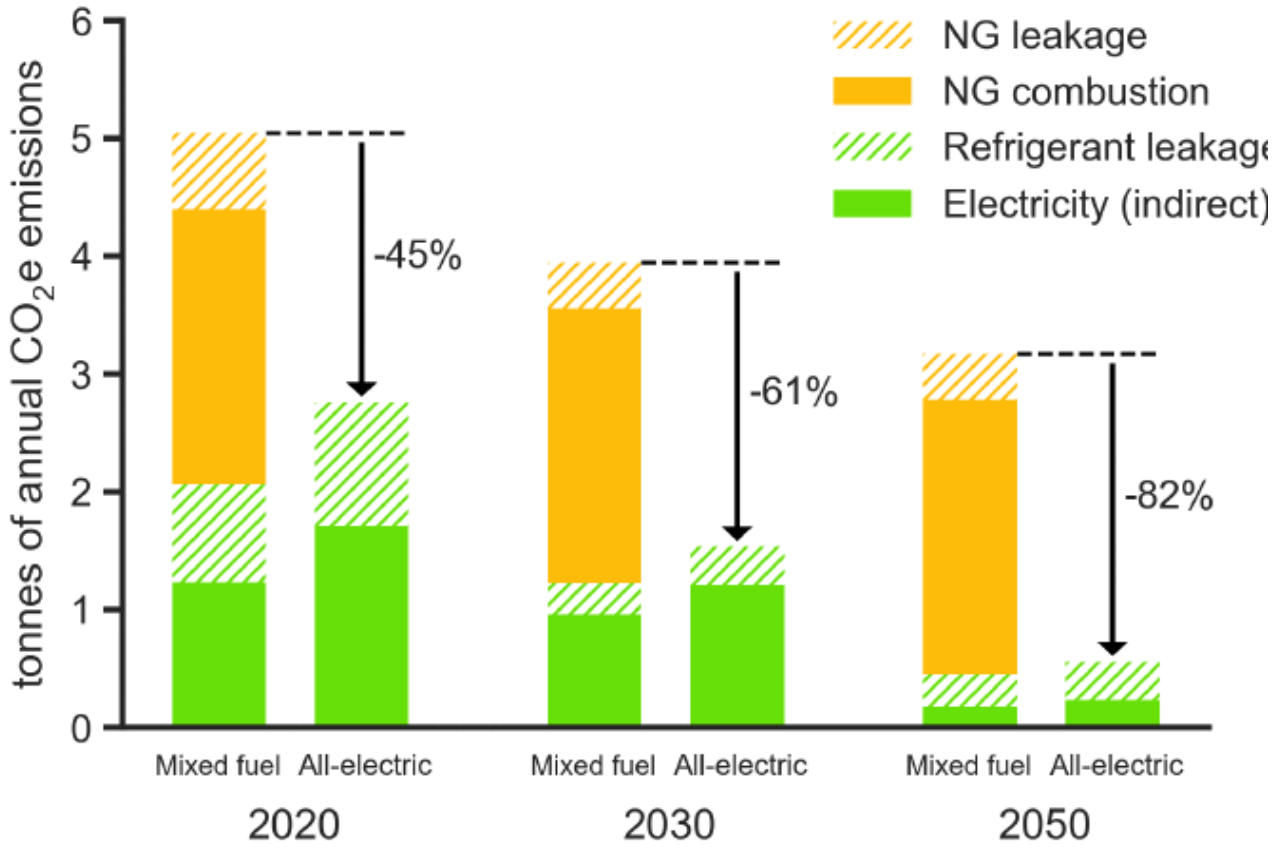
- Electric Vehicles qualify for rebates
  - $7,500 federal rebate
  - $250 South Coast AQMD EV charger incentive



Recent Research Shows Why All-Electric is the Way Forward

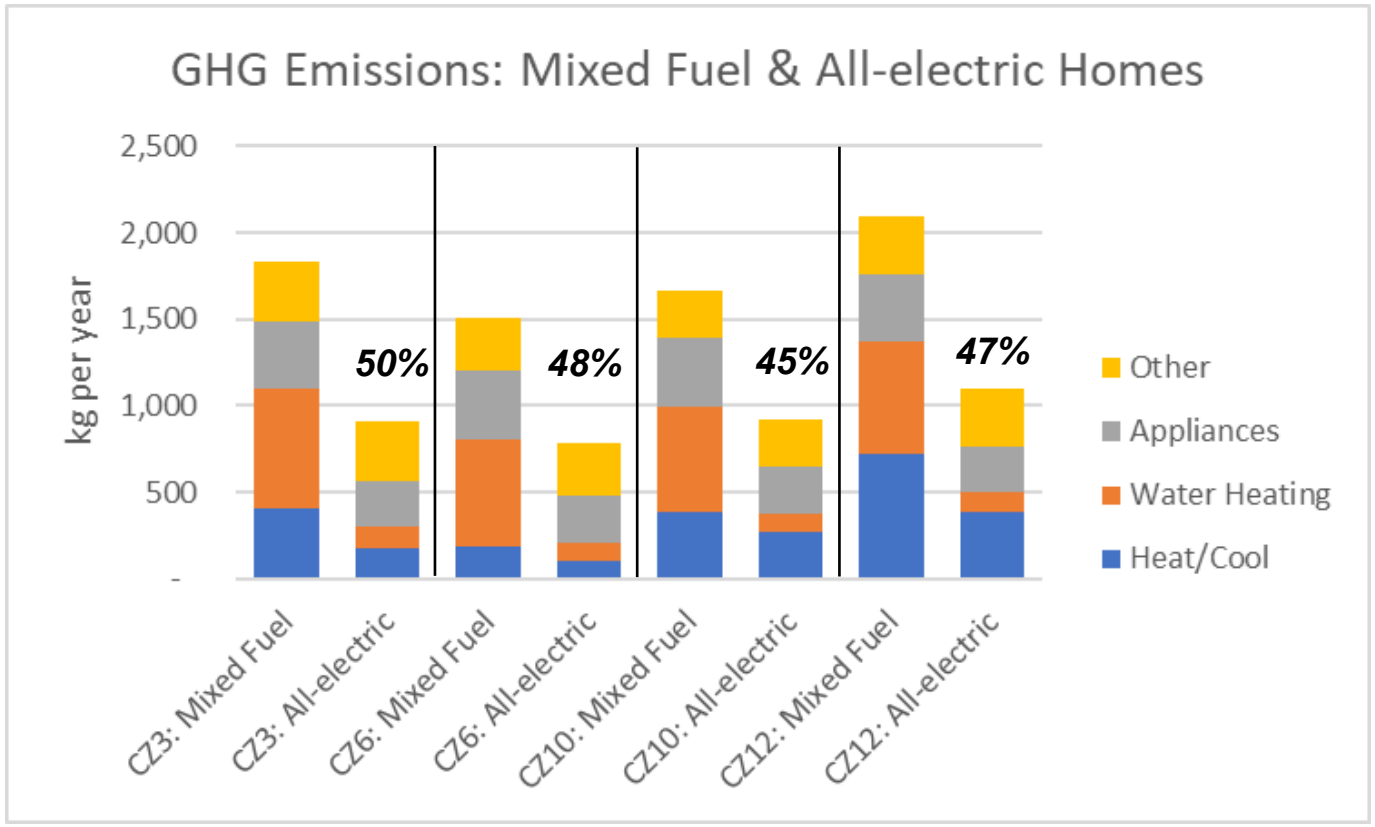
Electric Homes Have 45% Lower GHG Emissions

Figure 3-1: Annual GHG emissions from a 1990s vintage single family home for Sacramento



"Residential Building Electrification in California", E3, April 2019

All-Electric Designs Reduce GHG Emissions ~50%



Source: CBECC-RES 2022 modeling of new 1751 sqft home with standard efficiency gas furnace/heat pump; gas tankless/heat pump water heater; gas & electric appliances

- **TIP: Use your compliance models to design for lower GHG emissions and Zero Net Carbon**

100% Renewable Electricity Looks Like This

- Foundation of All-electric homes is Greening of Electric Grid
- Multiple studies show how 100% renewable grid will be achieved
  - Intermittency included
  - Uncertainty included
  - California & the entire U.S.
  - Without higher utility costs
  - While creating jobs

100% Renewable Electricity Looks Like This Nationwide!

- Simulated hourly operation of the U.S. power system over 60,000 hours (7 weather years) in each of the 134 regional zones

"Given the plummeting costs of clean energy technologies, the U.S. could reach 90 percent zero-carbon electricity by 2035, maintain reliability, while lowering customer electricity bills from today's levels, on the path to 100 percent zero-carbon by 2045"

- Supporting 530,000 NET new jobs/yr
- Avoiding $1 trillion in health/environmental damages
- Source: U.C. Berkeley Goldman School of Public Policy, "2035: The Report", June 2020

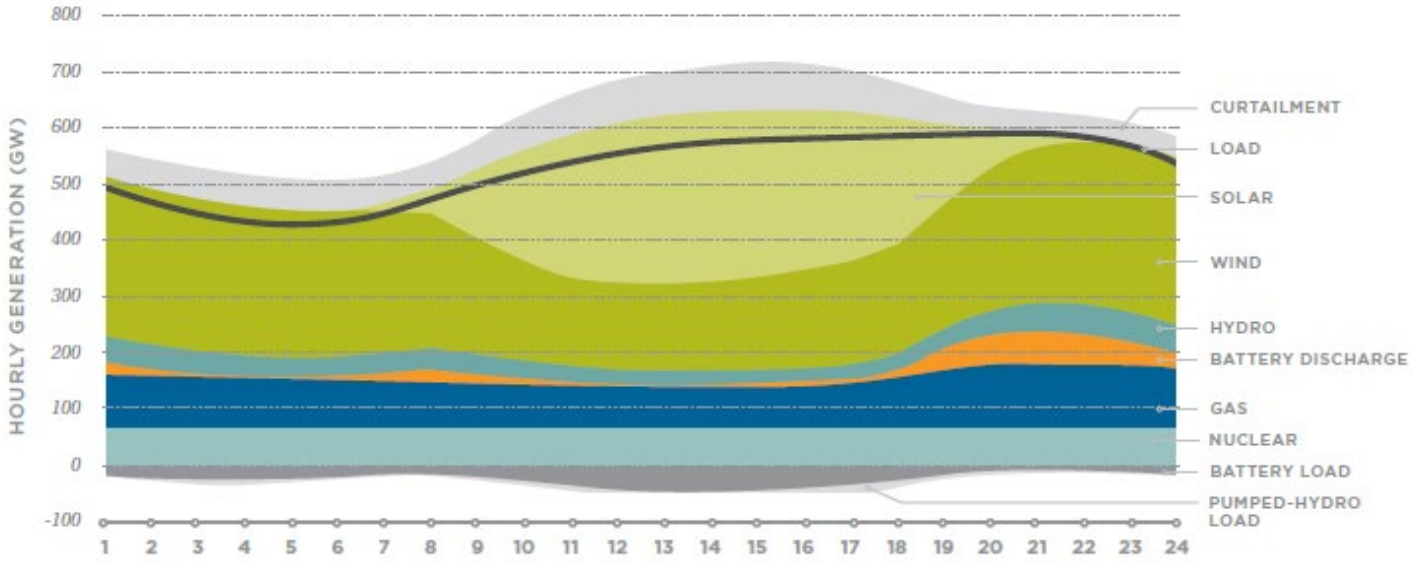
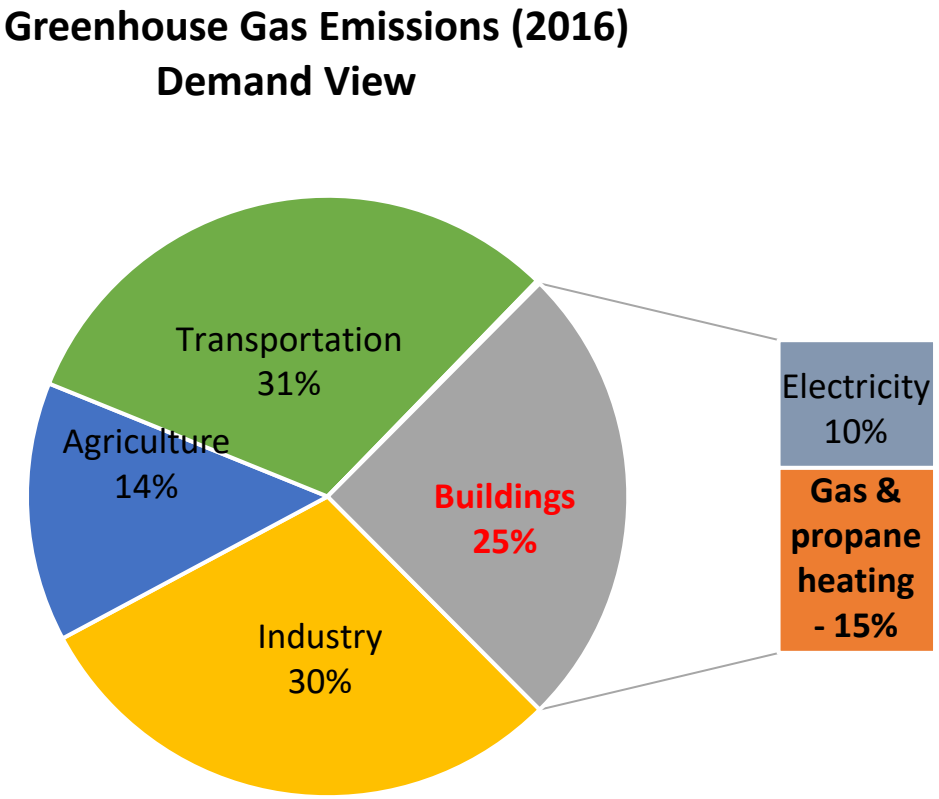


FIGURE 6.

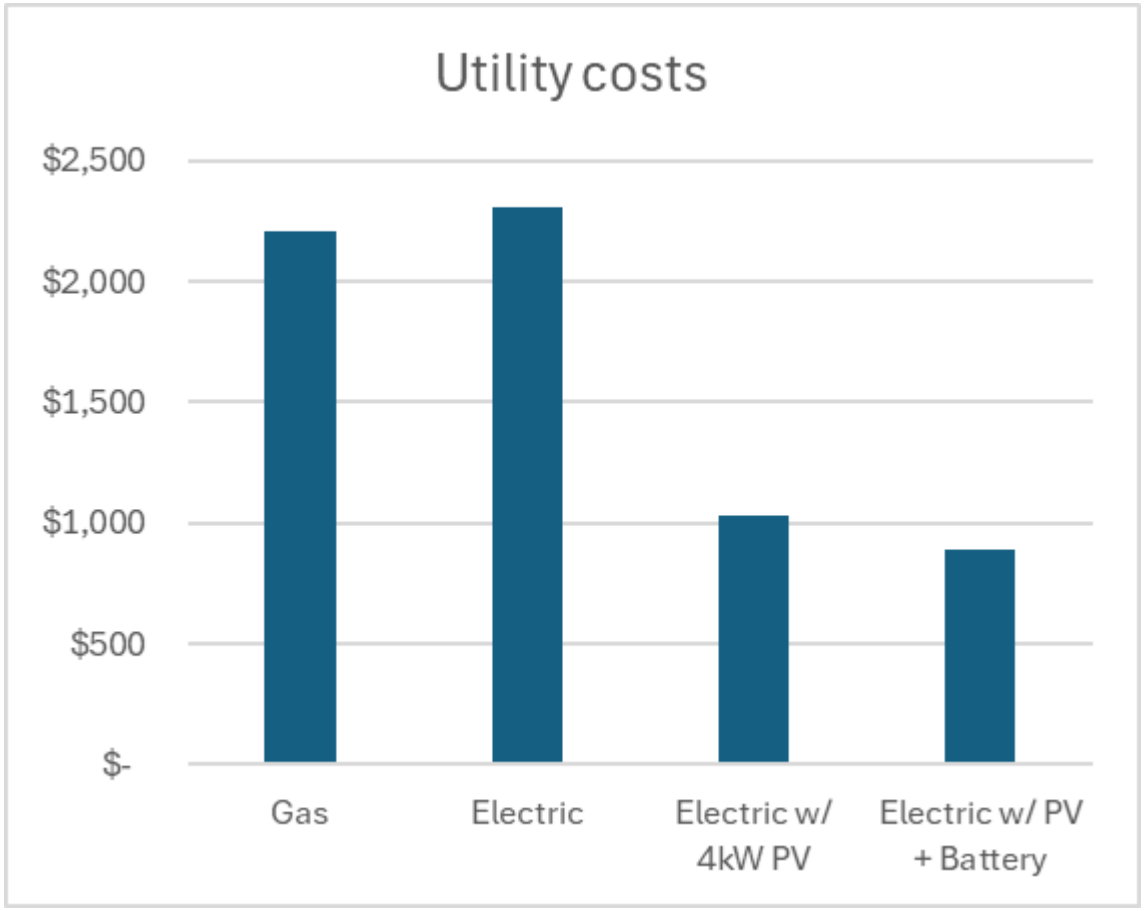
Hourly U.S. Power-System Dispatch for an Average Weather Day in the 90% Clean Case in 2035

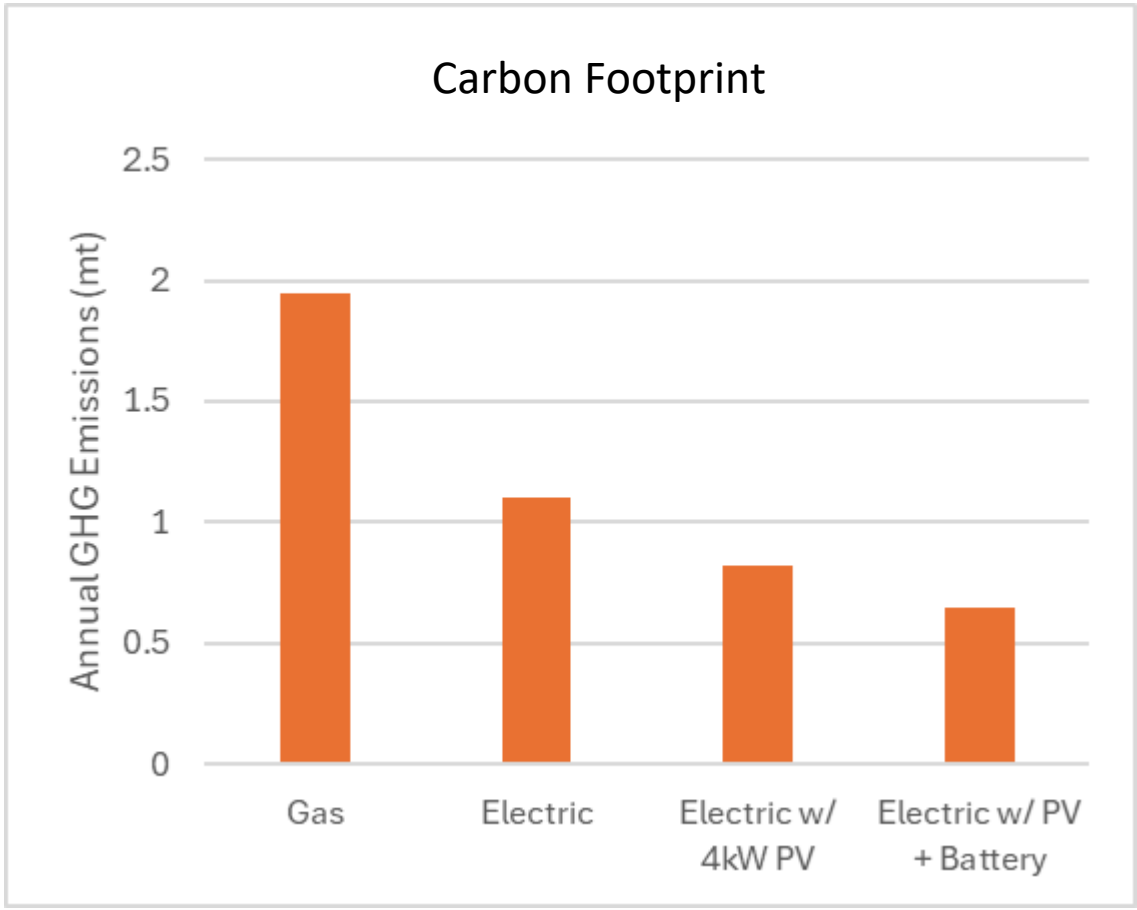
Buildings ≈ a Quarter of CA GHG Emissions



Source: NRDC analysis based on Air Resource Board 2016 GHG inventory, including fugitive methane emissions

Electric Homes with Solar Save People Money





Project Spotlight: Jefferson 17-unit in Los Angeles

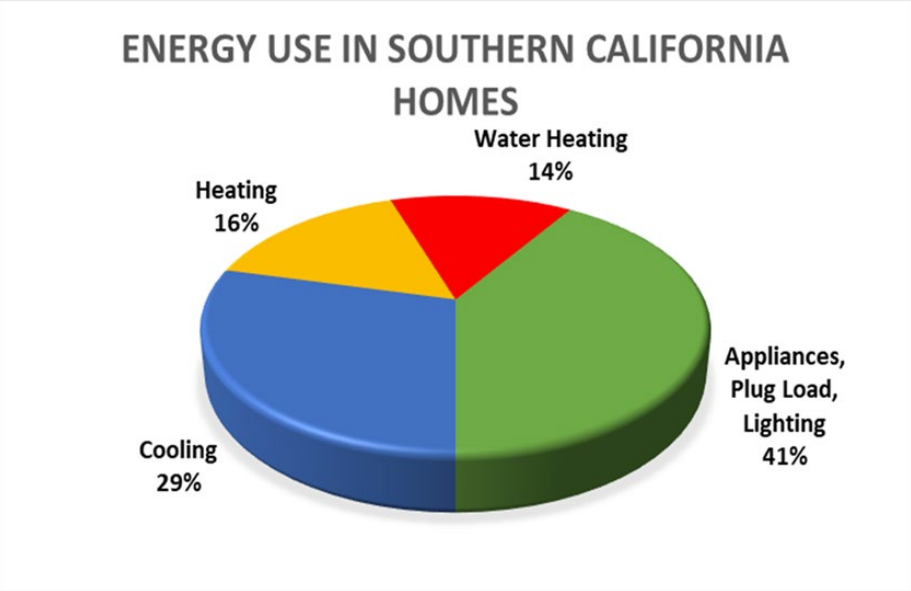
"**It just doesn't make any sense to me to run all those gas lines through my building… just from a financial perspective.** We hope to save money and permitting by having one less trade."

- Steve Kraemer, Rock Development

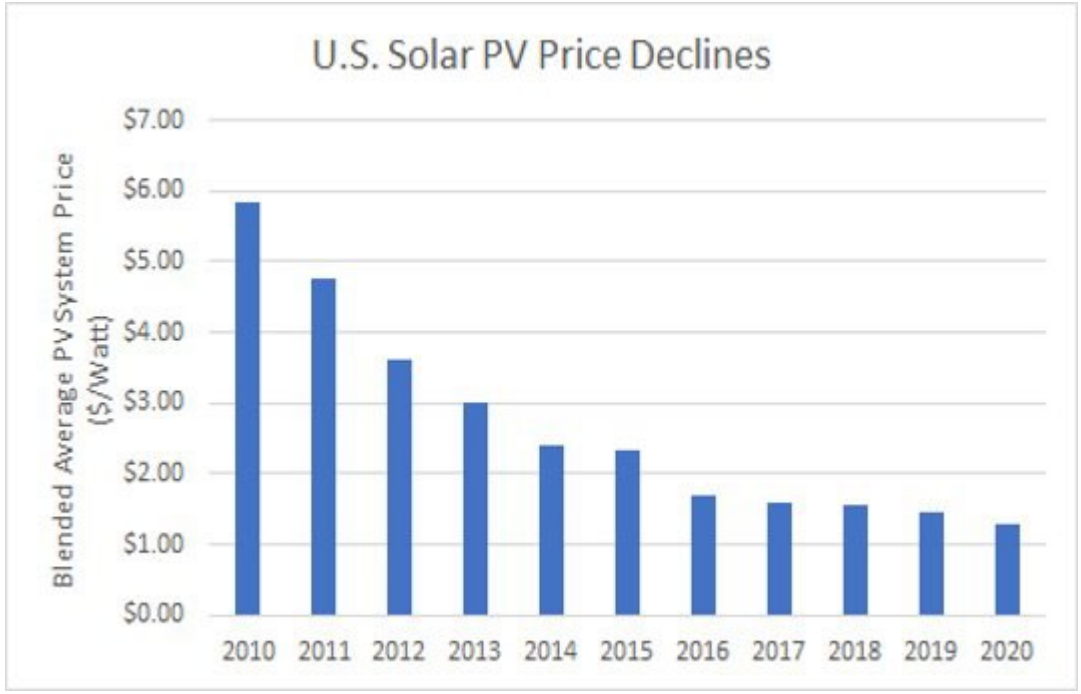
- All-Electric
- HPWH in each unit/hallway
- Ductless mini in each unit; condensers on the roof
- Required electrical upgrades through LADWP
- Complied with Non-residential energy code

Technologies to Go Electric

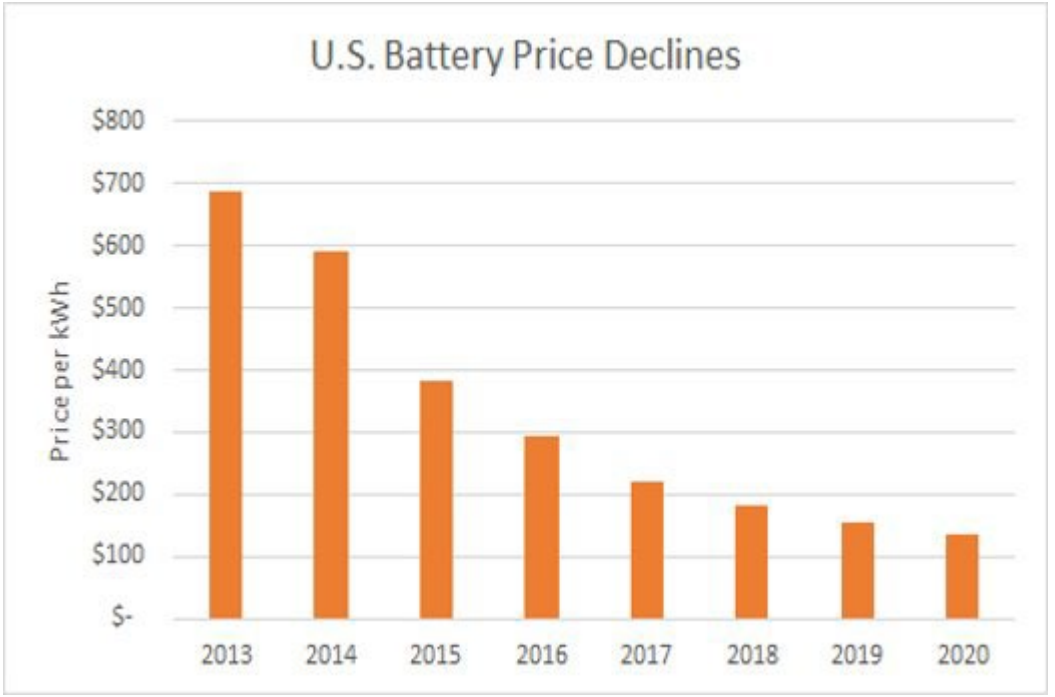
- **Electrical Infrastructure**
- **Solar & Batteries**
- Heat Pumps
- Heat Pump Water Heaters
- Electric & Heat Pump Clothes Dryers
- Induction Cooktops



Cost of Solar PV and Batteries



Source: SEIA



Source: BloombergNEF

Electrical Infrastructure

- Many Single Family projects will need Panel upgrades
- Many Multifamily projects will need Transformer upgrades
- Calculate loads & do site planning EARLY
- Utility typically pays for transformers, not customer
  - Need a 10’x10’ footprint for typical MF building
- All-electric peaks typically slightly higher than mixed fuel
- Plan for 2X transformer size for future EV charging loads

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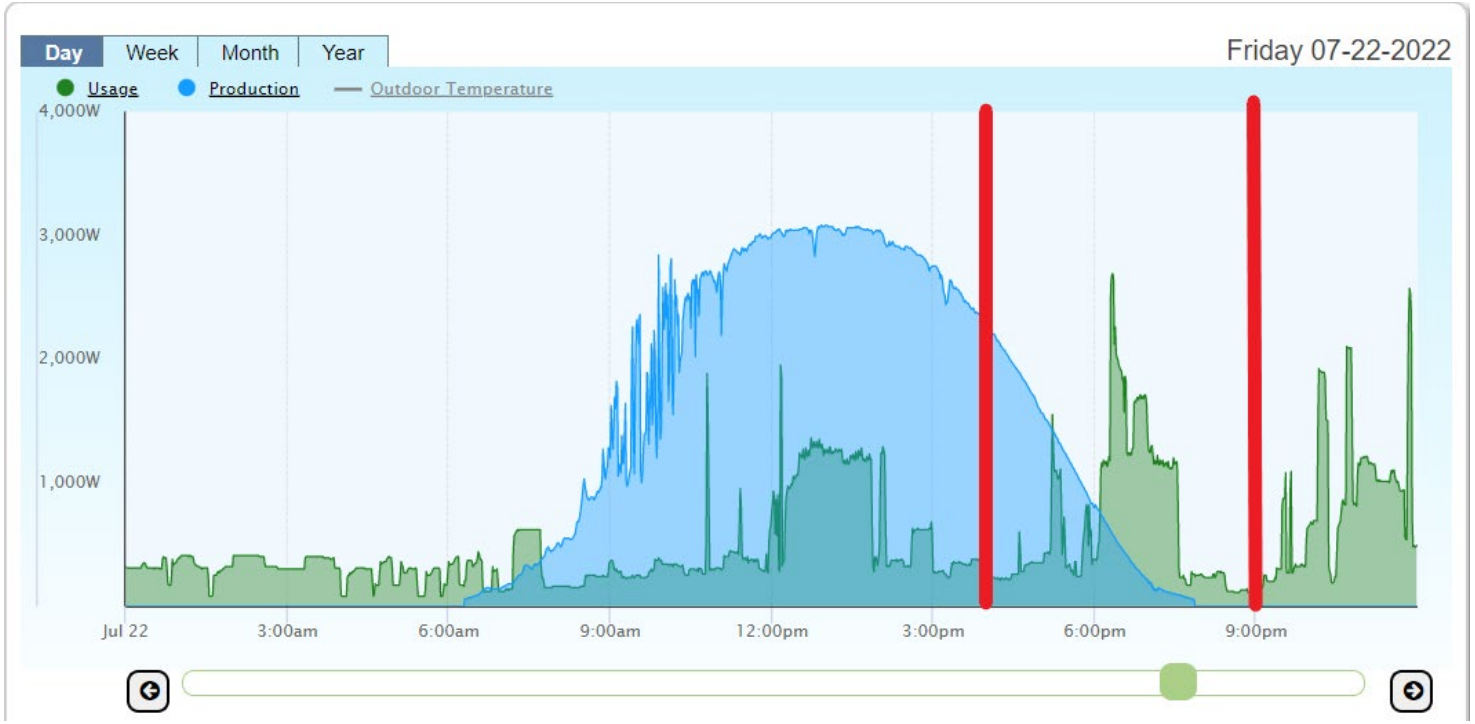
Solar PV Panels Produce Energy Onsite

- PV required on all new homes as of 2020
- Interaction of PV & electric systems
  - PV offsets electric load of house
  - No distribution loss on power lines
- Makes intuitive sense to run more systems on electricity
- Builders & homeowners make the connection
  - Electricity on the roof
  - Electric systems in the house
- Managing load is important
  - Building shell
  - Shifting load to off-peak times
  - Utilizing PV production on-site



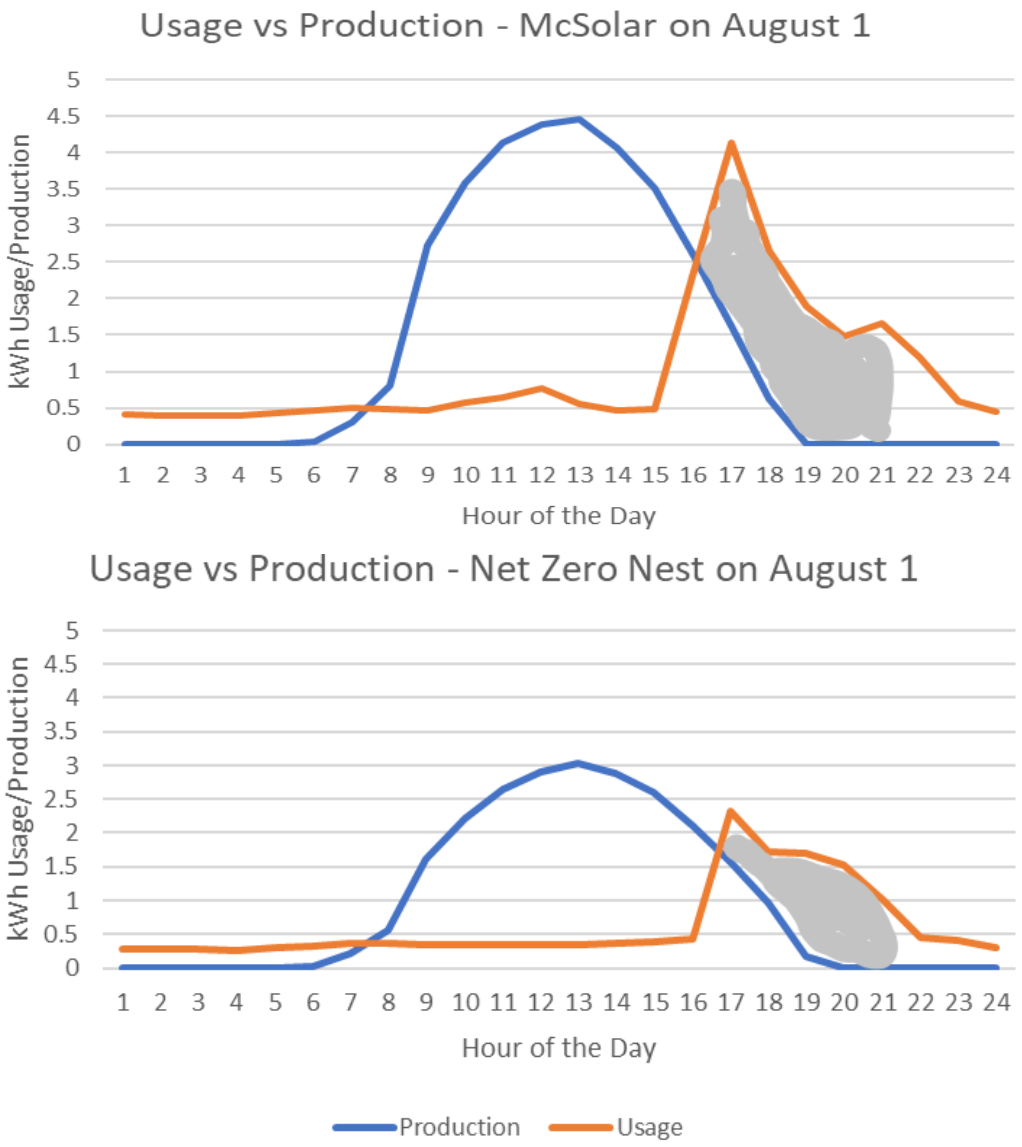
Typical Friday in the ADU: Usage 13 kWh, Production 23 kWh:
Daytime PV to Home: 8 kWh (35% of production)
Non-PV Hours: 4.5 kWh
Peak Hours 4-9pm: -0.1 kWh, 2.2 kWh after sunset

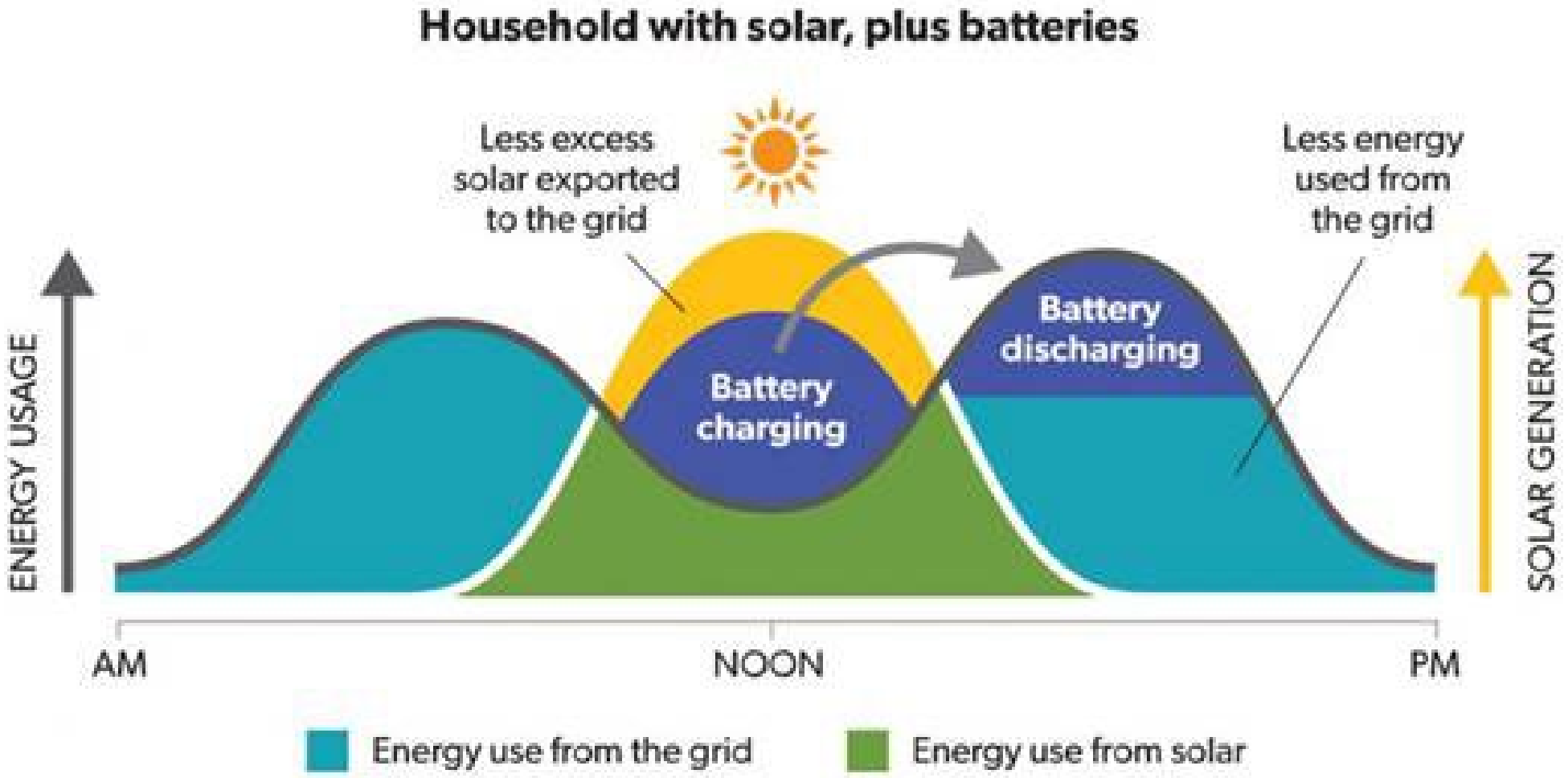
Efficiency + Solar is the Key

- Electricity used “under the mountain” is virtually free
- Advanced homes will move more of usage under the mountain and have less usage “on the plains”

<u>Grid Burden 4-9 pm</u>:

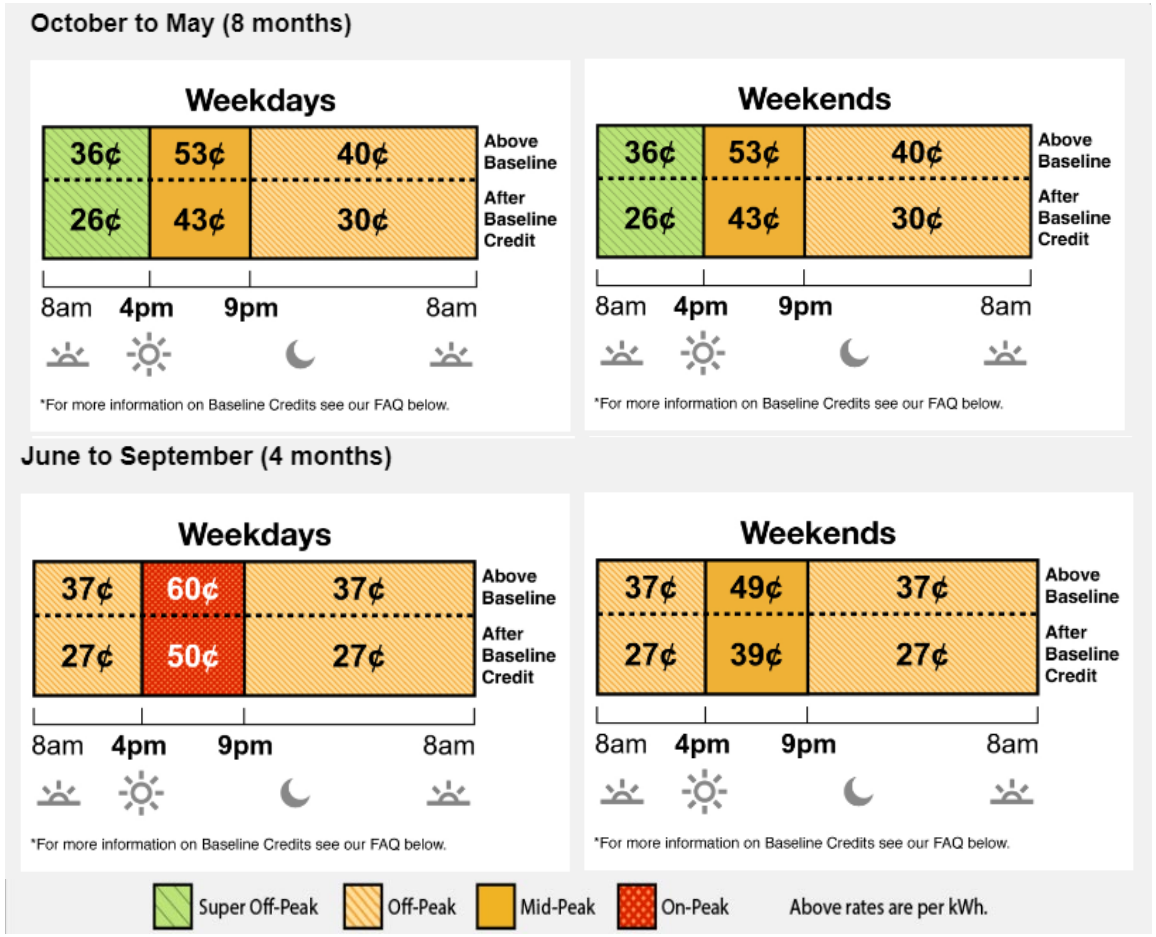
- McSolar ZNE: 2.5 kW, 8.5 kWh
- Performance ZNE: 1.5 kW, 4.2 kWh




Household with solar, plus batteries
Less excess solar exported to the grid
Less energy used from the grid
Battery charging
Battery discharging
ENERGY USAGE
SOLAR GENERATION
AM
NOON
PM
Energy use from the grid
Energy use from solar

Heat Pump Water Heaters And EVs Can Soak Up Low-Carbon, Low-Cost Electricity, Without Adding Load On-Peak

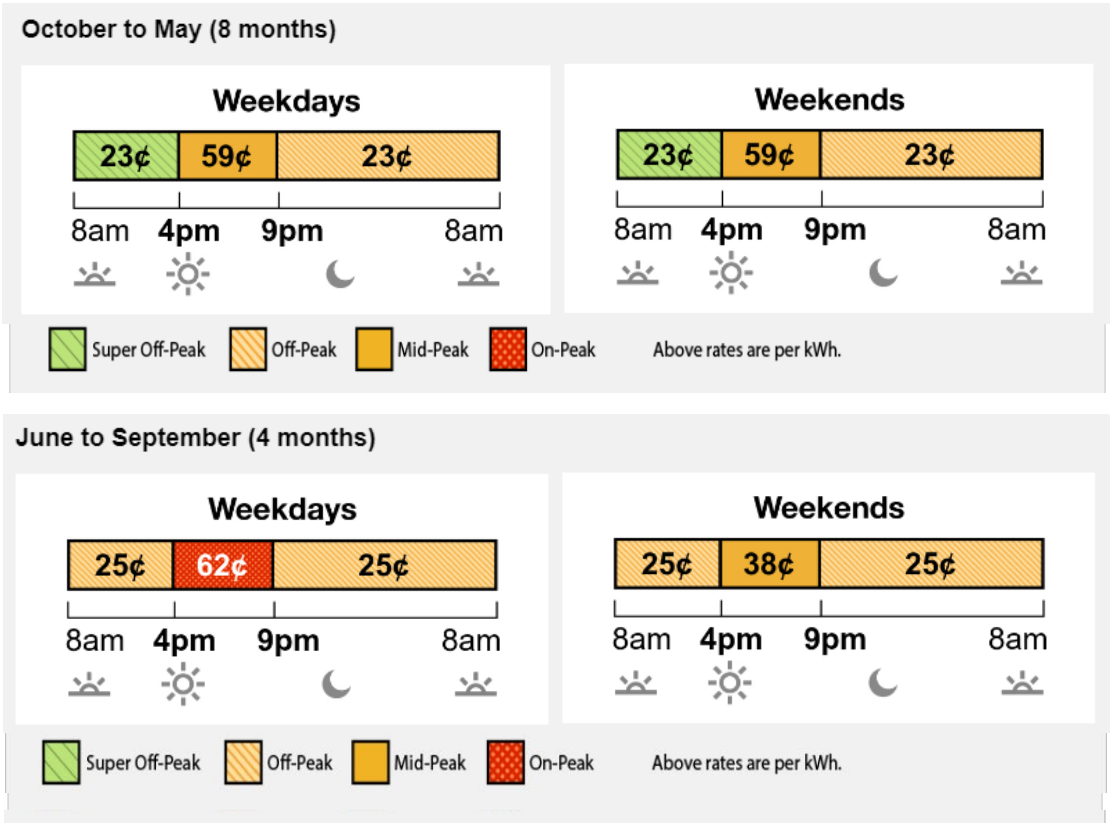
Residential Time of Use Rates – SoCal Edison



TOU-D-4-9 PM (rate plan as of 2/1/2024)

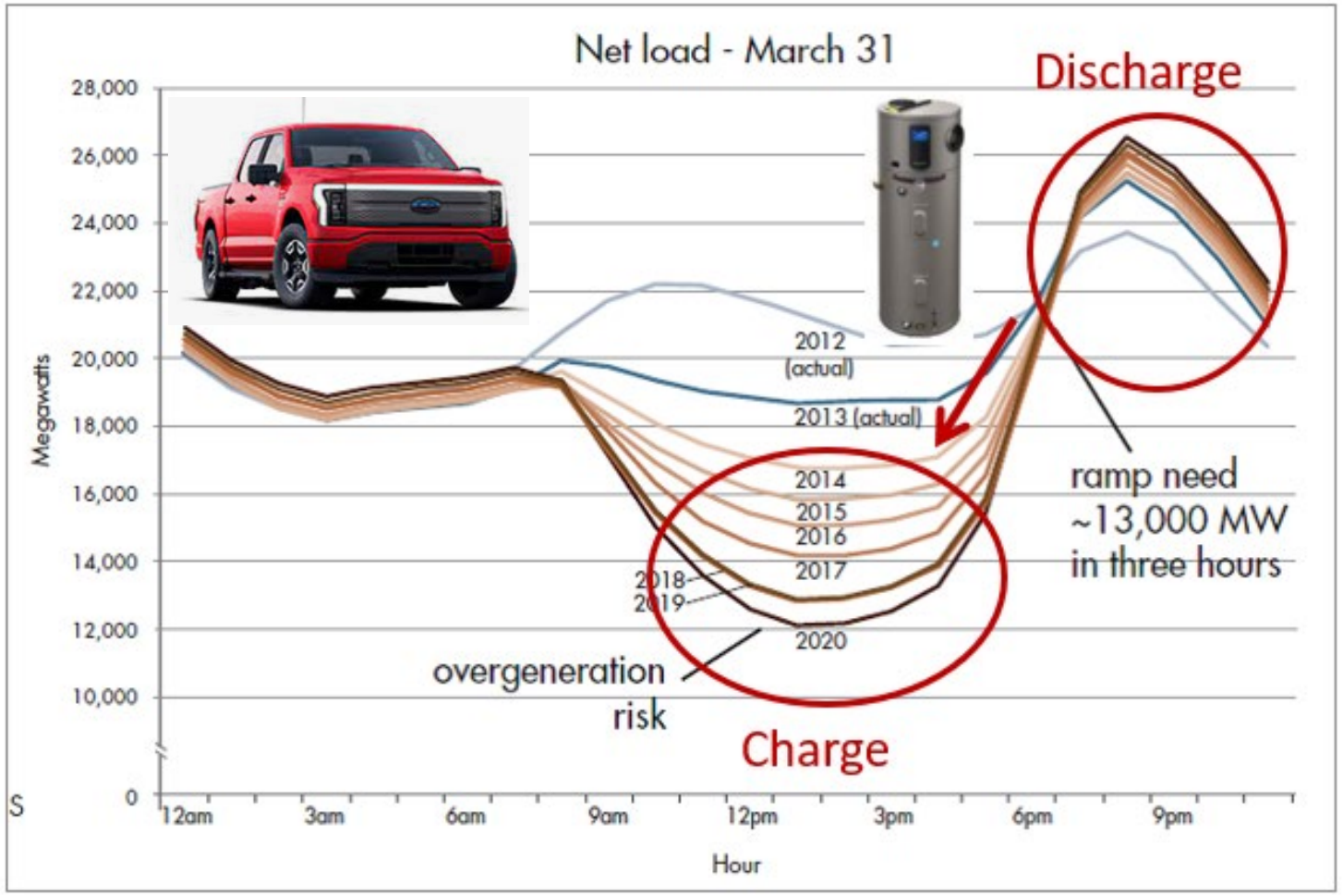
Heat Pump Water Heaters And EVs Can Soak Up Low-Carbon, Low-Cost Electricity Off-Peak, Without Adding Load On-Peak

Residential Time of Use Rates: SCE TOU-PRIME

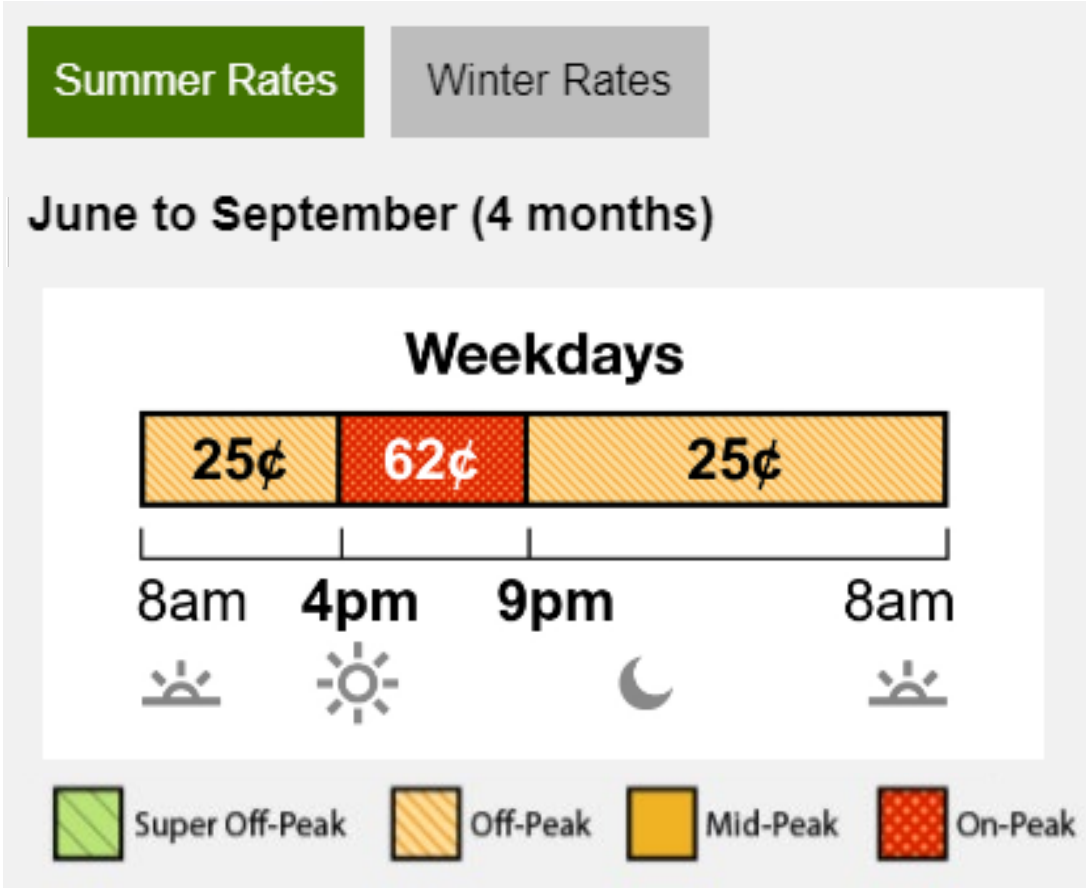


TOU-PRIME (HPs, EVs eligible)

Heat Pump Water Heaters And EVs Can Soak Up Low-Carbon, Low-Cost Electricity Off-Peak, Without Adding Load On-Peak



SCE TOU-D-PRIME Rates Have 4-9 pm Peak



Electric Vehicles & Bi-Directional Charging

- HUGE future potential synergies:
  - EV to home
  - EV to grid
  - Home to EV to home
- EV charging can use excess solar power
  - $0.01 per mile

Battery Storage

- A good answer to the usage-production mismatch of solar homes
- Concept: Store surplus solar in the day & release in evening peak
  - Reduces excess on grid for utility to manage
  - Reduces ramp-up required by grid in summer evening peak periods
- Title 24 compliance credit for new homes with batteries
- Enhanced financial payback under Net Billing rates for Solar with Storage
- Complex analysis makes investment decision difficult
- All-electric Homes + Battery + EV = compatible

Natural Disasters, Resiliency, and ZNE Homes

Typically, PV panels not producing power after a grid outage

- Utility has responsibility to protect electric customers in case of emergency
- SCE, PG&E, and SDG&E are increasingly shutting down the grid in windy fire-prone areas

If Grid goes down, PV continues to power critical loads

- Run PV to Islanding Inverter, then to Battery
- Run Battery to Critical Load Panel (Fridge, phone chargers, key lighting)

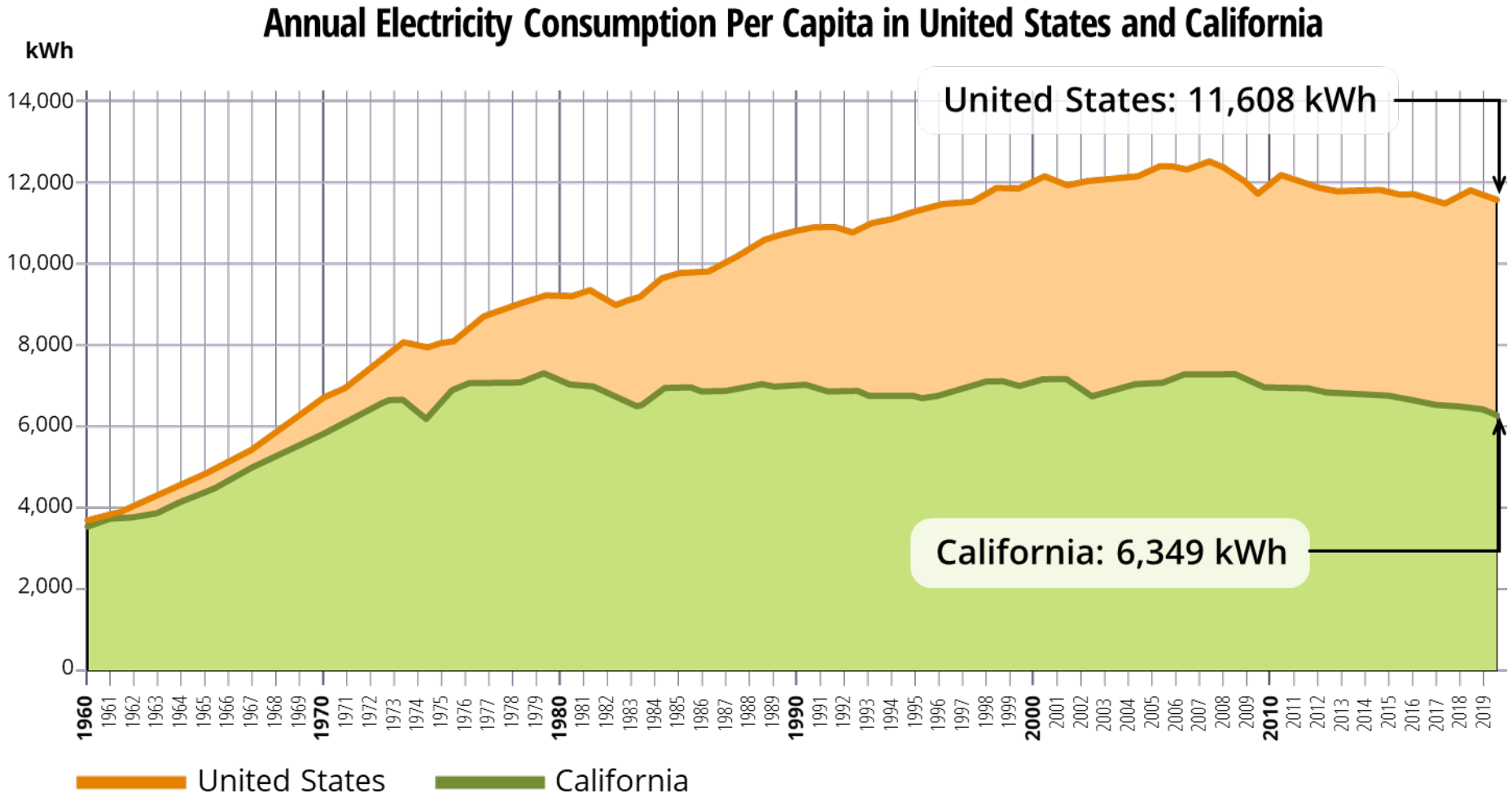
Recent Battery Project Example

Energy Modeling for All-Electric Homes

- Introduction to Modeling
- Solar PV
- Batteries

SOUTHERN CALIFORNIA EDISON®

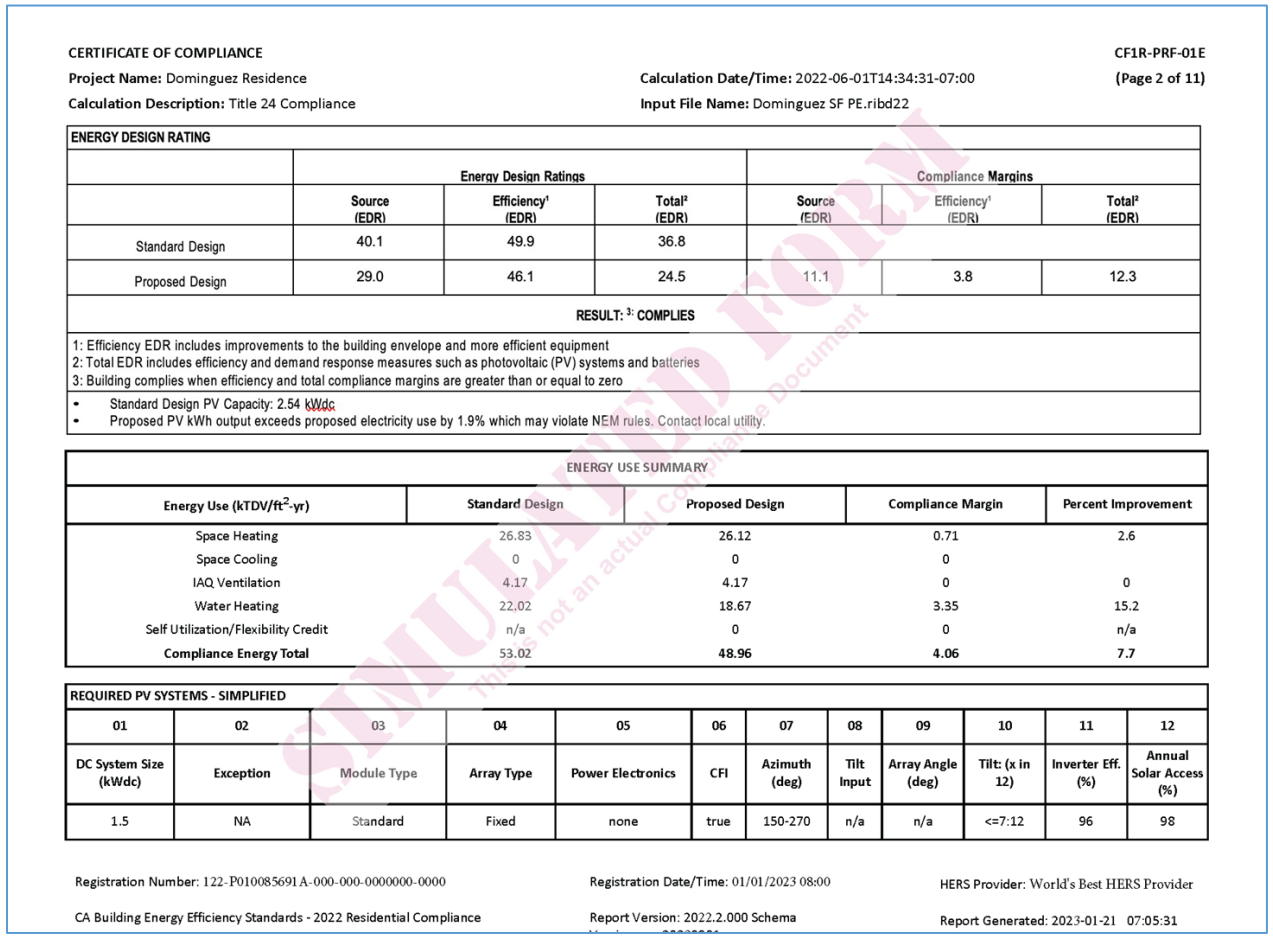
California: Energy Policy Leading the Nation



Why Understand Modeling?

- Impacts cost
- Can delay a project
- Identifies energy saving options
- Required for permits
- Sizes solar system to the house
- Know what questions to ask your consultant

Title 24 Built Around Performance Modeling



CERTIFICATE OF COMPLIANCE — CF1R-PRF-01E

Project Name: Dominguez Residence — **Calculation Date/Time:** 2022-06-01T14:34:31-07:00 — (Page 2 of 11)

Calculation Description: Title 24 Compliance — **Input File Name:** Dominguez SF PE.ribd22

ENERGY DESIGN RATING

	Energy Design Ratings			Compliance Margins		
	Source (EDR)	Efficiency[1] (EDR)	Total[2] (EDR)	Source (EDR)	Efficiency[1] (EDR)	Total[2] (EDR)
Standard Design	40.1	49.9	36.8			
Proposed Design	29.0	46.1	24.5	11.1	3.8	12.3
RESULT: [3] COMPLIES						

1: Efficiency EDR includes improvements to the building envelope and more efficient equipment
2: Total EDR includes efficiency and demand response measures such as photovoltaic (PV) systems and batteries
3: Building complies when efficiency and total compliance margins are greater than or equal to zero

- Standard Design PV Capacity: 2.54 kWdc
- Proposed PV kWh output exceeds proposed electricity use by 1.9% which may violate NEM rules. Contact local utility.

ENERGY USE SUMMARY

Energy Use (kTDV/ft²-yr)	Standard Design	Proposed Design	Compliance Margin	Percent Improvement
Space Heating	26.83	26.12	0.71	2.6
Space Cooling	0	0	0	
IAQ Ventilation	4.17	4.17	0	0
Water Heating	22.02	18.67	3.35	15.2
Self Utilization/Flexibility Credit	n/a	0	0	n/a
Compliance Energy Total	53.02	**48.96**	**4.06**	**7.7**

REQUIRED PV SYSTEMS - SIMPLIFIED

01	02	03	04	05	06	07	08	09	10	11	12
DC System Size (kWdc)	Exception	Module Type	Array Type	Power Electronics	CFI	Azimuth (deg)	Tilt Input	Array Angle (deg)	Tilt: (x in 12)	Inverter Eff. (%)	Annual Solar Access (%)
1.5	NA	Standard	Fixed	none	true	150-270	n/a	n/a	<=7:12	96	98

Registration Number: 122-P010085691A-000-000-0000000-0000 — Registration Date/Time: 01/01/2023 08:00 — HERS Provider: World's Best HERS Provider

CA Building Energy Efficiency Standards - 2022 Residential Compliance — Report Version: 2022.2.000 Schema — Report Generated: 2023-01-21 07:05:31

SIMULATED FORM
This is not an actual compliance Document

- Gives designers flexibility to meet energy budget their way
- Most value-added features will get selected
- Allows for what-if analysis
- Prescriptive Method also
  - Used for small projects, ADUs
  - Must meet every requirement

CF1R Form

Evolving Building Energy Efficiency Ratings

For Residential Construction

Energy Code	New Construction	Additions	Alterations
2016	TDV	TDV	TDV
2019	EDRe, EDRt	TDV	TDV
2022	**EDRs**, EDRe, EDRt	TDV	TDV

New for 2022
s = "source"
EDR metric

Enables measure of emissions in some form

Time Dependent Valuation (TDV):
"TDV Energy" is the time varying energy used by the building to provide space conditioning, water heating and specified building lighting. It accounts for the energy used at the building site and consumed in producing and delivering energy to a site, including, but not limited to, power generation, transmission and distribution losses.

Energy Design Rating (EDR):
An alternate way to express the energy performance of a home using a scoring system where 100 represents the energy performance of a reference design building meeting the envelope requirements of the 2006 International Energy Conservation Code (IECC). A score of 0 represents the energy consumption of a building that has zero net energy consumption. The lower the score, the better.

Source Energy Design Rating (EDRs):
A separate EDR metric based on "hourly source energy," which establishes a "carbon-proxy" analysis of the building in kBTU/sf-yr units to support decarbonization and electrification policy goals.

EDR as a Compliance Metric (2022)

Source EDR

a score repr
building ene
expressed in ter
source
based

Includes energ
- Envelope
- IAQ
- HVAC
- DHW
- Unregulate
- PV
- Battery

Efficiency EDR

Total EDR

g the
TDV
g in

by:
es

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Energy Design Ratings: Source (EDR1)	Efficiency[1] (EDR2)	Total[2] (EDR2)	Compliance Margins: Source (EDR1)	Efficiency[1] (EDR2)	Total[2] (EDR2)
Standard Design	53.2	53.4	36.2			
Proposed Design	48.9	51.8	33.7	4.3	1.6	2.5

All three ratings show better (lower) rating for Proposed than Standard

All three compliance margins (deltas) show zero or positive values

Result[3]: COMPLIES

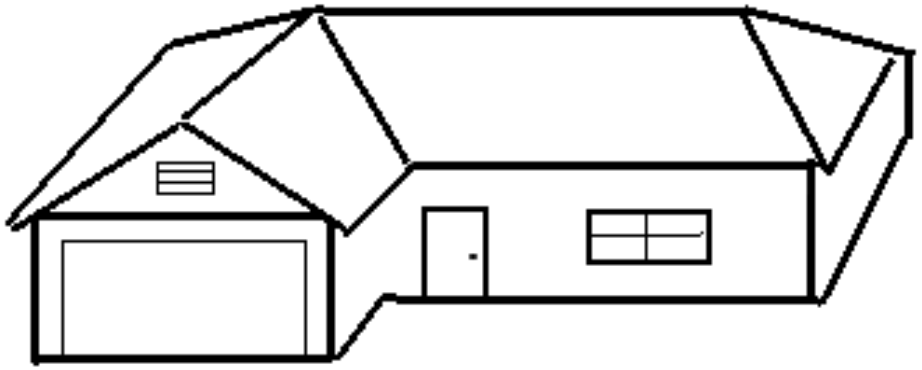
(not current)

[1] Efficiency measures include improvements like a better building envelope and more efficient equipment
[2] Total EDR includes efficiency, photovoltaics and batteries
[3] Building complies when all source, efficiency and total margins are greater than or equal to zero

Standard Design PV Capacity: 2.70 kWdc

A building complies ONLY if **all three** compliance scores are met (each Proposed Design score is lower or equal to Standard Design score)

Title 24 Modeling in 2 Slides

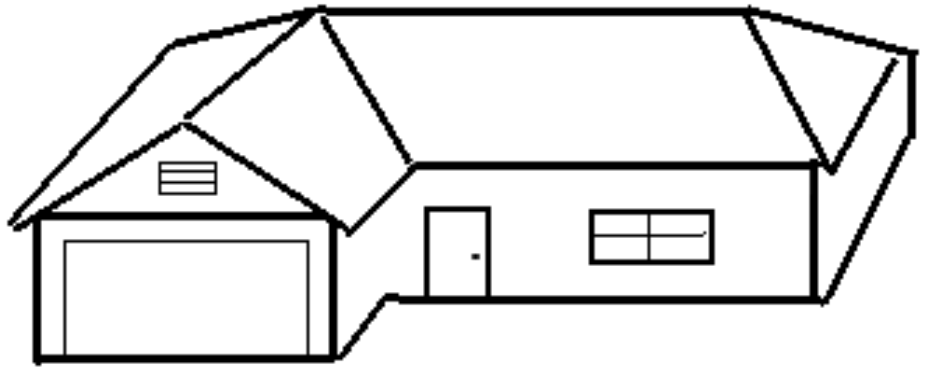


Proposed House

Climate Zone 10 (Riverside)

Actual Features

- 2x6 R-21 walls
- R-38+R-13 attic
- QII & Refrigerant Charge HERS
- Ducted Heat Pump 14 SEER, 8.2 HSPF
- Heat Pump Water Heater Rheem 50 gal 3.5 UEF
- Windows .32/.29, 28% glazing
- No Whole House Fan
- 3.6 kW PV array



Standard House

Climate Zone 10

Prescriptive Package Features

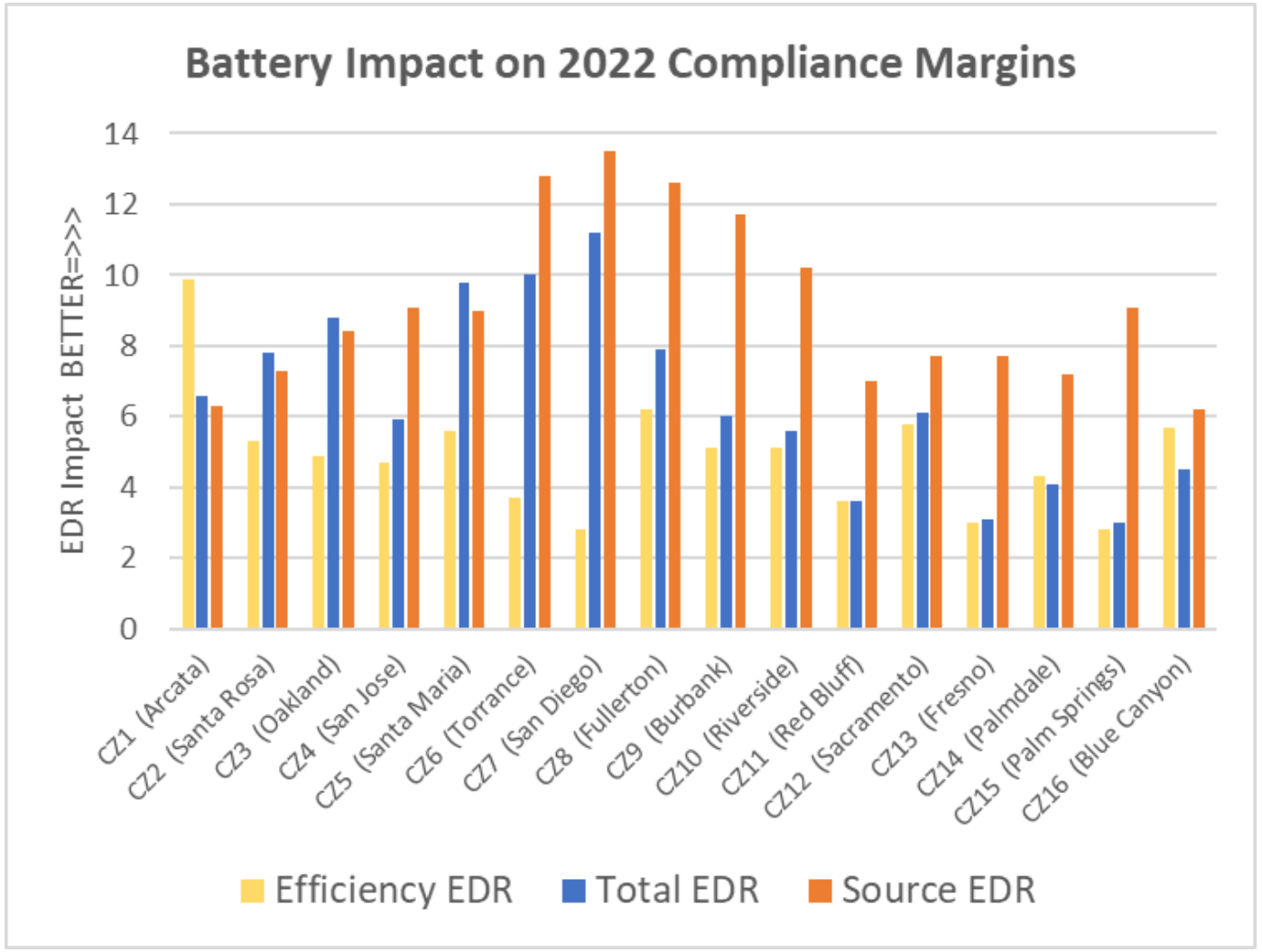
- 2x6 R-21+R-5 walls
- R-38+R-19 attic, cool roof tile
- QII & Refrigerant Charge HERS
- 13.4 SEER2, 80 AFUE gas furnace split system
- Heat Pump Water Heater 2.0 UEF
- Windows .30/.23, 20% glazing
- Whole House fan
- Prescriptive Standard PV array

How Modeling Software Works

1,962 kWh net of PV 0 therms 39.1 EDR Efficiency (EDR2) 25.7 EDR Total with PV 29.5 EDR Source (EDR1)	992 kWh net of PV 112 therms 39.8 EDR Efficiency (EDR2) 26.9 EDR Total with PV 36.1 EDR Source (EDR1)
Proposed House Actual design features	Standard House Prescriptive Package features

BUILDING COMPLIES

Batteries Provide Solid Compliance Credit

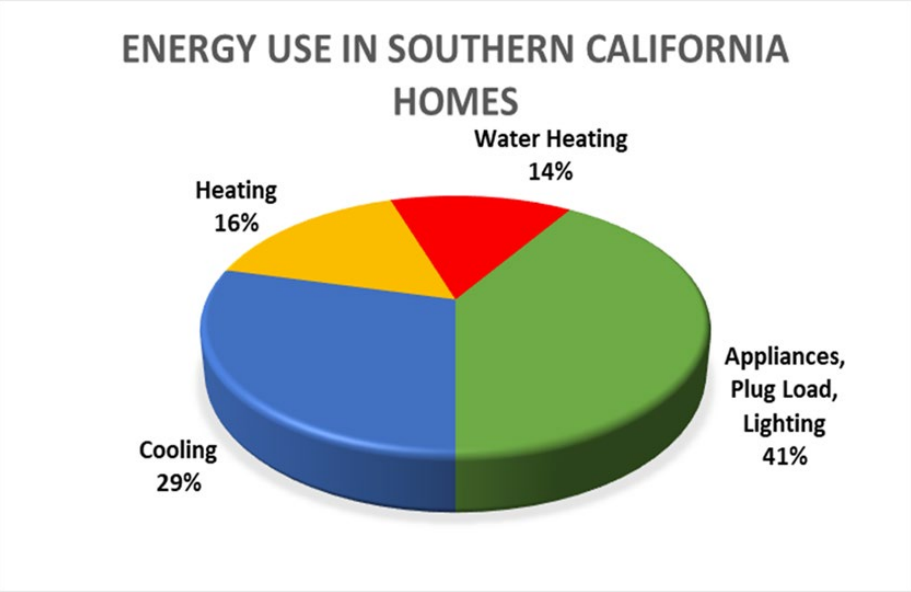


Average Compliance Impact:

- 4.9 Efficiency EDR (11%)
- 6.5 Total EDR (21%)
- 9.1 Source EDR (24%)

Technologies to Go Electric

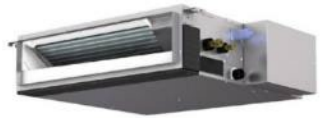
- Solar & Batteries
- **Induction Cooking**
- **Heat Pump Water Heaters**
- **Electric & Heat Pump Clothes Dryers**
- Heat Pumps



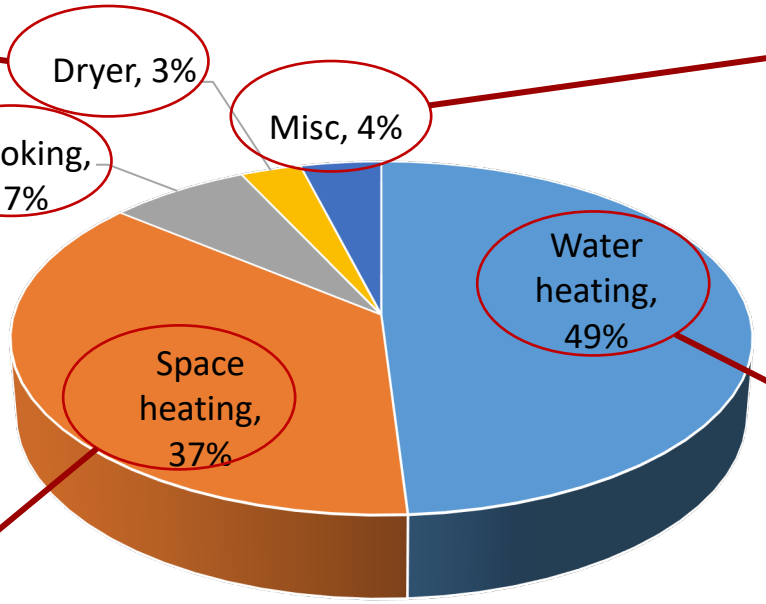
High-efficiency Electric Alternatives to Gas Use in Residential Buildings

Heat-pump clothes drver

Induction cooktop



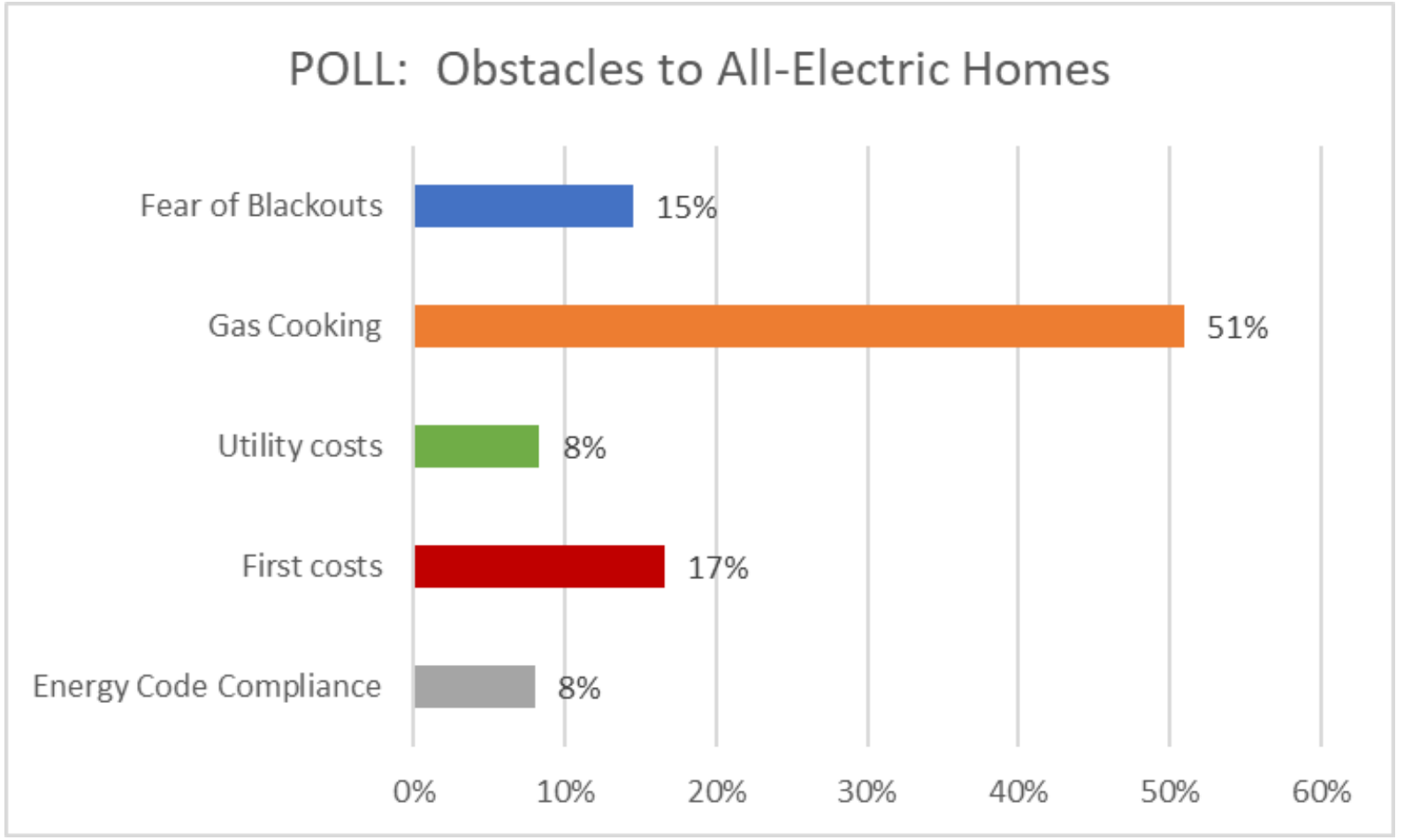
Heat pump space heating



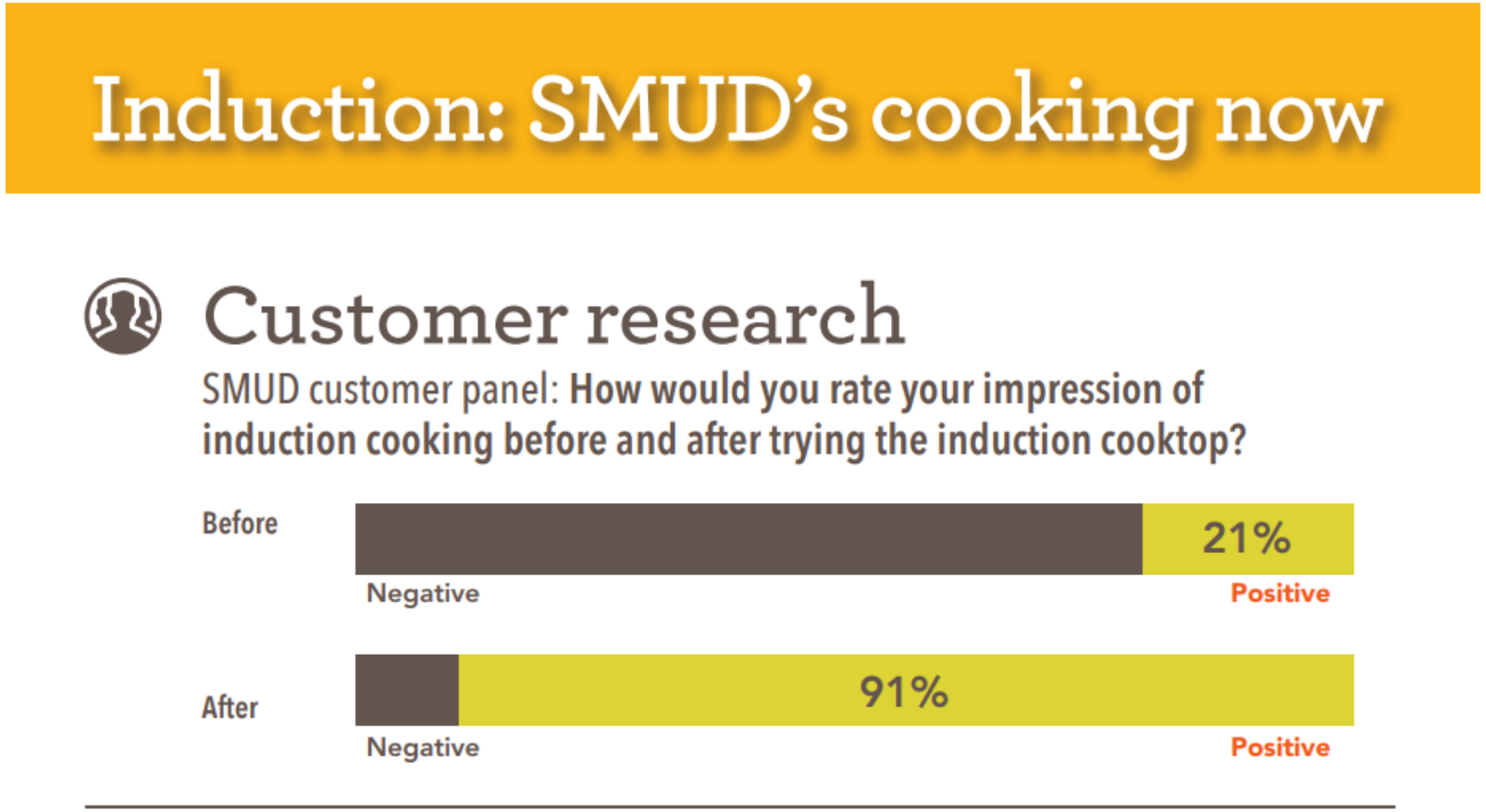
Electric fireplaces

Heat-pump water heater

CABEC Poll Taken September 2020



Preference for Gas Cooking – Real or Not?



http://2019.utilityforum.org/Data/Sites/5/media/posters/smud-induction-infographic-poster2.pdf

Induction Cooktops

- Work by heating up cookware
- No gas combustion byproducts
- Safer for kids to touch
- Auto-off

- Boil water in half the time
- Digital controls
- Biggest barrier is inertia

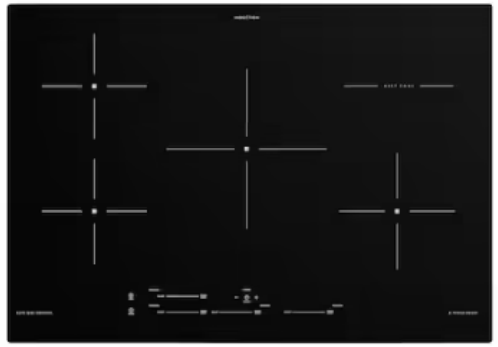
Chefs & Consumer Reports Prefer Induction

- 6 of Top 8 Ranges for 2020 were electric
- Top 2 were Induction

Fuel	Model	Rating	Cost
Induction	GE Profile PHS930SLSS	86	$2,432
Induction	Kenmore Elite 95073	84	$1,525
Gas	LG Signature LUTD4919SN	84	$3,000
Induction	LG LSE4617ST	82	$2,500
Induction	LG LSE4616ST	82	$1,700
Smoothtop	Whirlpool WGE745c0FS	82	$1,000
Gas	Samsung NY58J9850WS	81	$2,725
Induction	Frigidaire Gallery FGIF3036TF	81	$1,035

Embrace Better Technologies:

Induction Cooking



SÄRKLASSIG
Induction cooktop, 30 "
$829.00

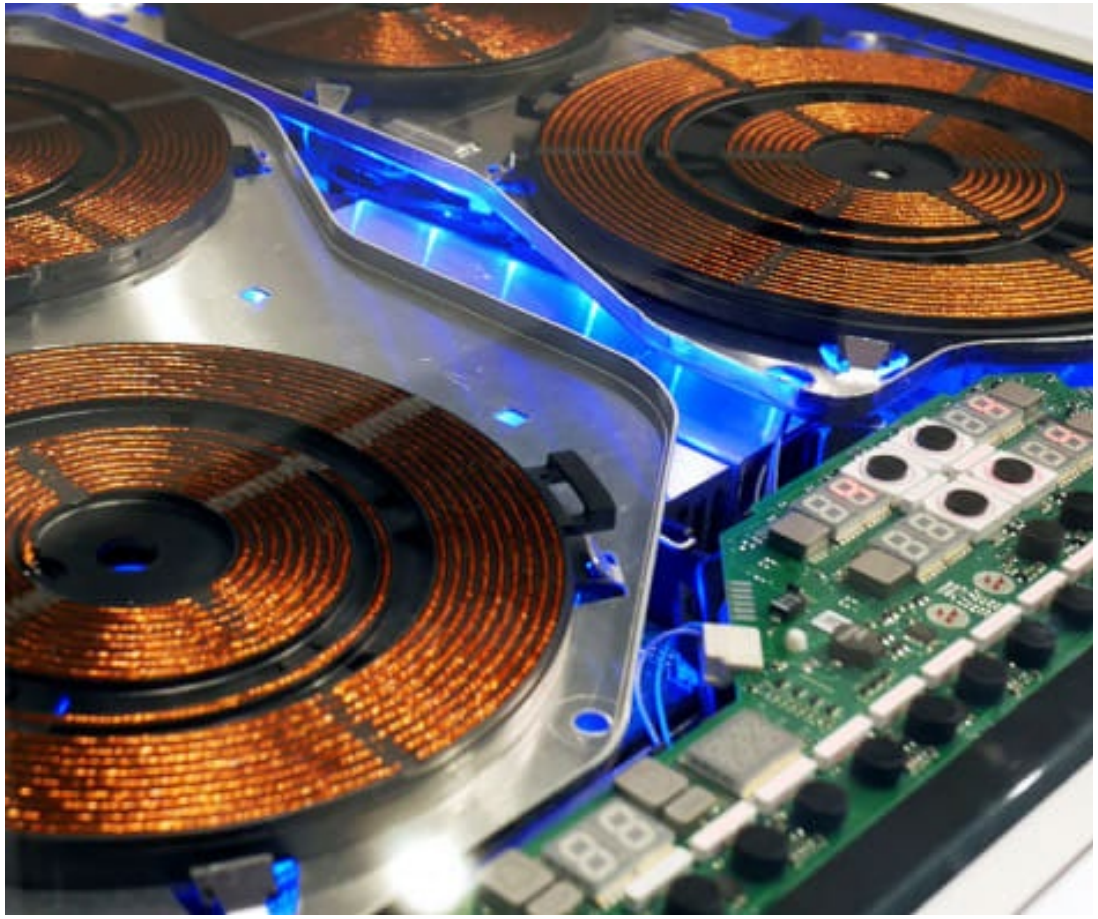
TILLREDA
Portable induction cooktop
$59.99

Top seller

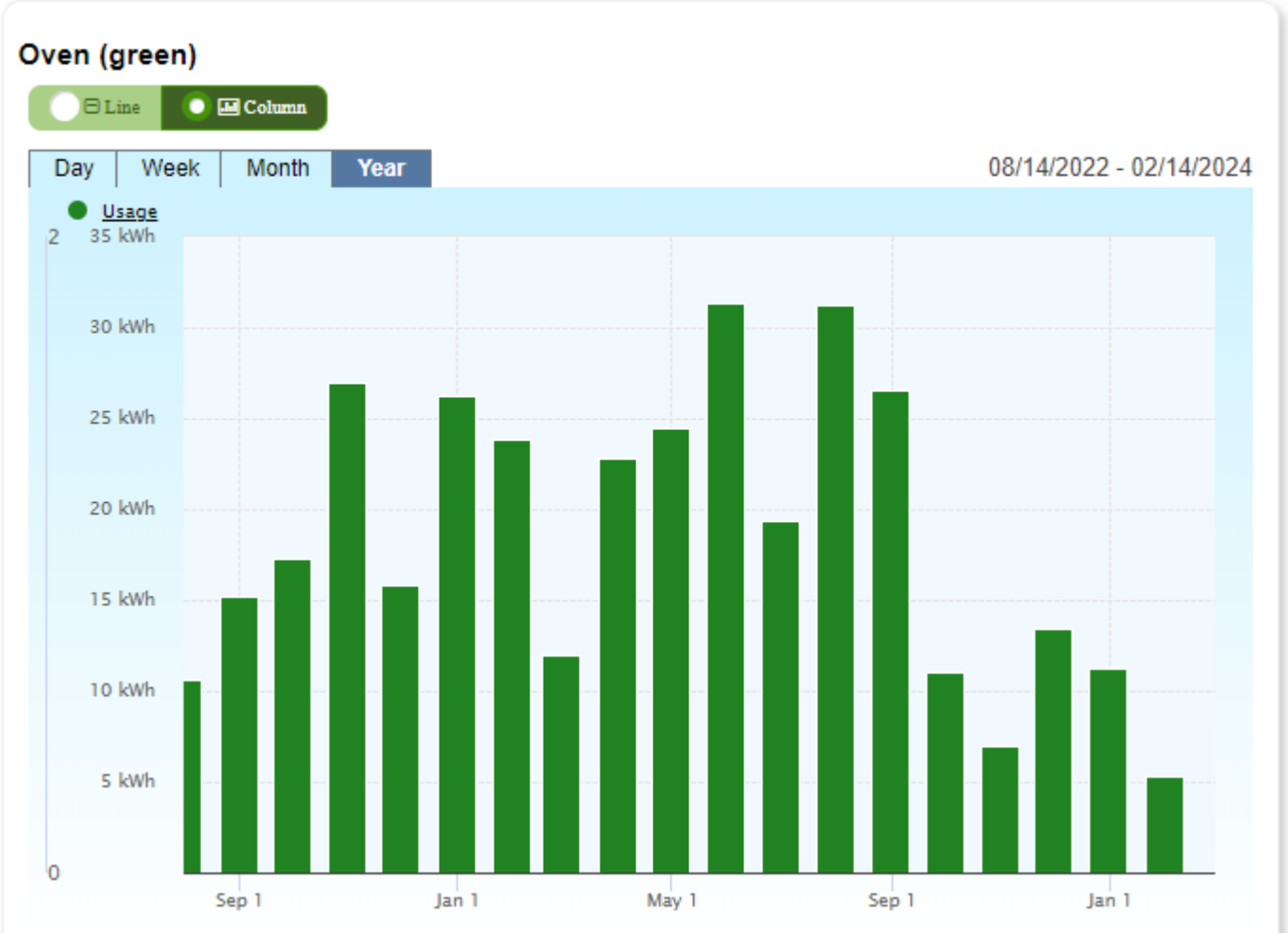
TVÄRSÄKER
Range with induction
$1,399.00
★★★★★ (11)

FRUITEAM 13-Piece Cookware Set Non-stick Ceramic Coating Cooking Set, Induction Pots Pans Set with Lids, Heavy Du...
★★★★½ 636
$119.99 ~~$159.99~~
Save $10.00 with coupon
prime Get it as soon as **Thu, Apr 22**
FREE Shipping by Amazon

Induction Advancements

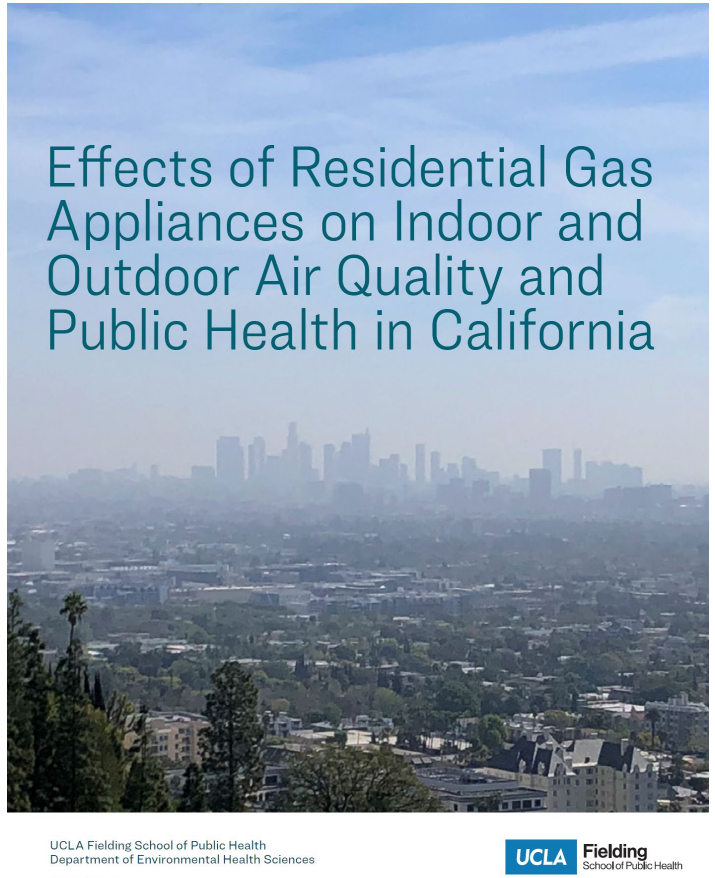


Induction Oven Averages 20 kWh per month for Family of 4



Embrace Better Technologies: Induction Cooking

IAQ Better Without Natural Gas in the Home



- AMA Study – Gas appliances increase risk of childhood asthma.
- UCLA study found that 90% of homes exceed NOx limits after one hour of cooking
- 4 out of 9 natural gas cooktops exceeded NOx concentrations of 100 ppb
- RMI Study - 20% of childhood asthma in CA due to gas cooking
  - Children living in homes with gas cooking are 34% more likely to have asthma

Gas Cooktops Require High-end Range Hoods for 2022

- Compliance requires EITHER:
  - Capture Efficiency & prescriptive duct sizing; OR
  - Airflow cfm HERS testing
- 60% higher airflow/CE required for Gas Ranges
- Higher airflow/CE required for smaller spaces

Table 150.0-G Kitchen Range Hood Airflow Rates (cfm) and ASTM E3087 Capture Efficiency (CE) Ratings According to Dwelling Unit Floor Area and Kitchen Range Fuel Type

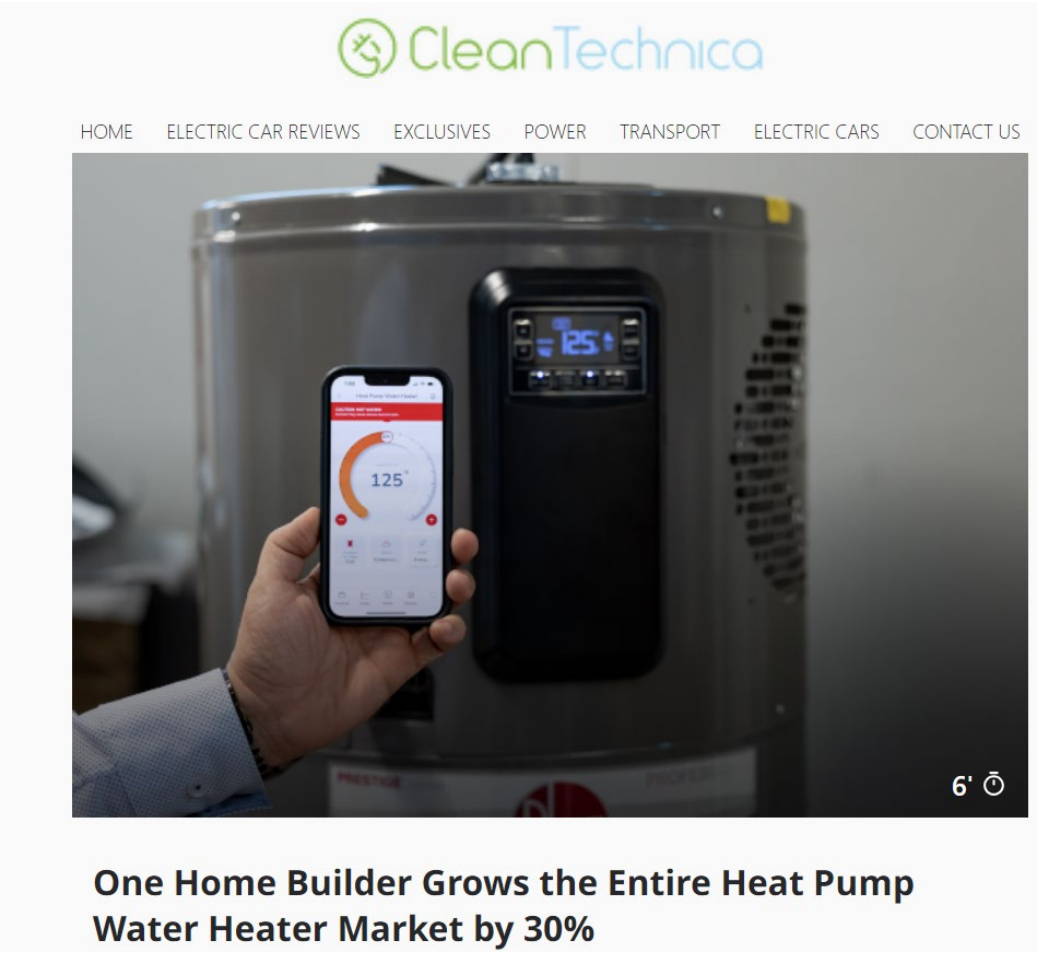
Dwelling Unit Floor Area (ft^2)	Hood Over Electric Range	Hood Over Natural Gas Range
>1500	50% CE or 110 cfm	70% CE or 180 cfm
>1000 - 1500	50% CE or 110 cfm	80% CE or 250 cfm
750 - 1000	55% CE or 130 cfm	85% CE or 280 cfm
<750	65% CE or 160 cfm	85% CE or 280 cfm


Let's All Go To The
Lobby

Electric Heat Pump Water Heaters

- Less expensive to install, operate and maintain
- 3x more efficient than tankless
- Demand response/ Timer capacity acts as a thermal battery
- 240V units & now 120V retrofit units available
- Stores 50 gal. fresh drinking water
- Dehumidifies & cools garages and surrounding spaces
- Requires careful placement for air volume and sound

Clayton Homes Installed 24,000 HPWHs in under 1 year!

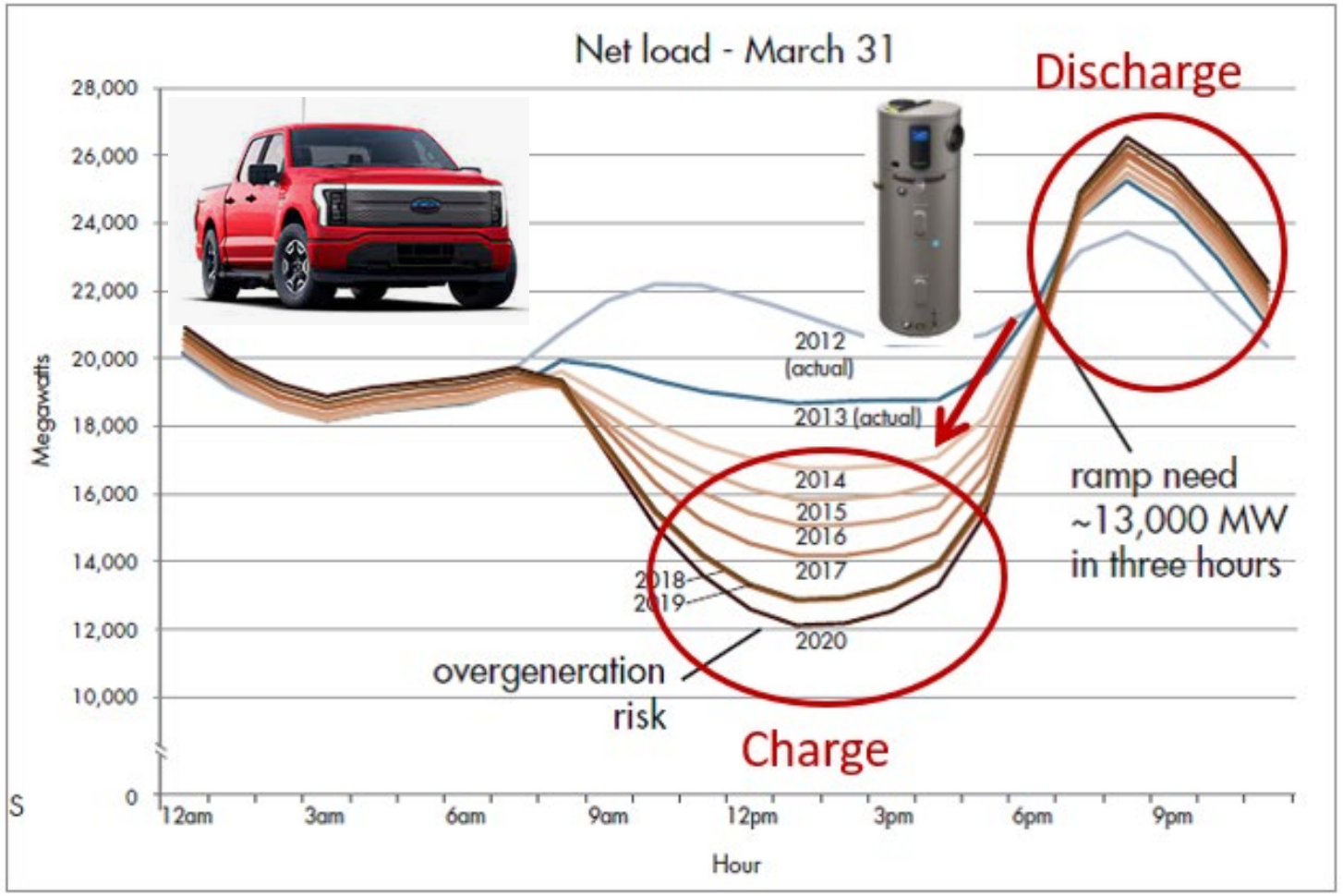


- Clayton Homes committed to HPWHs in all their new homes
- HPWHs made ZNE homes and $5,000 rebates possible
- Clayton homeowner reported their energy bill went from $250→$75 in January after switching to Clayton eBuilt home

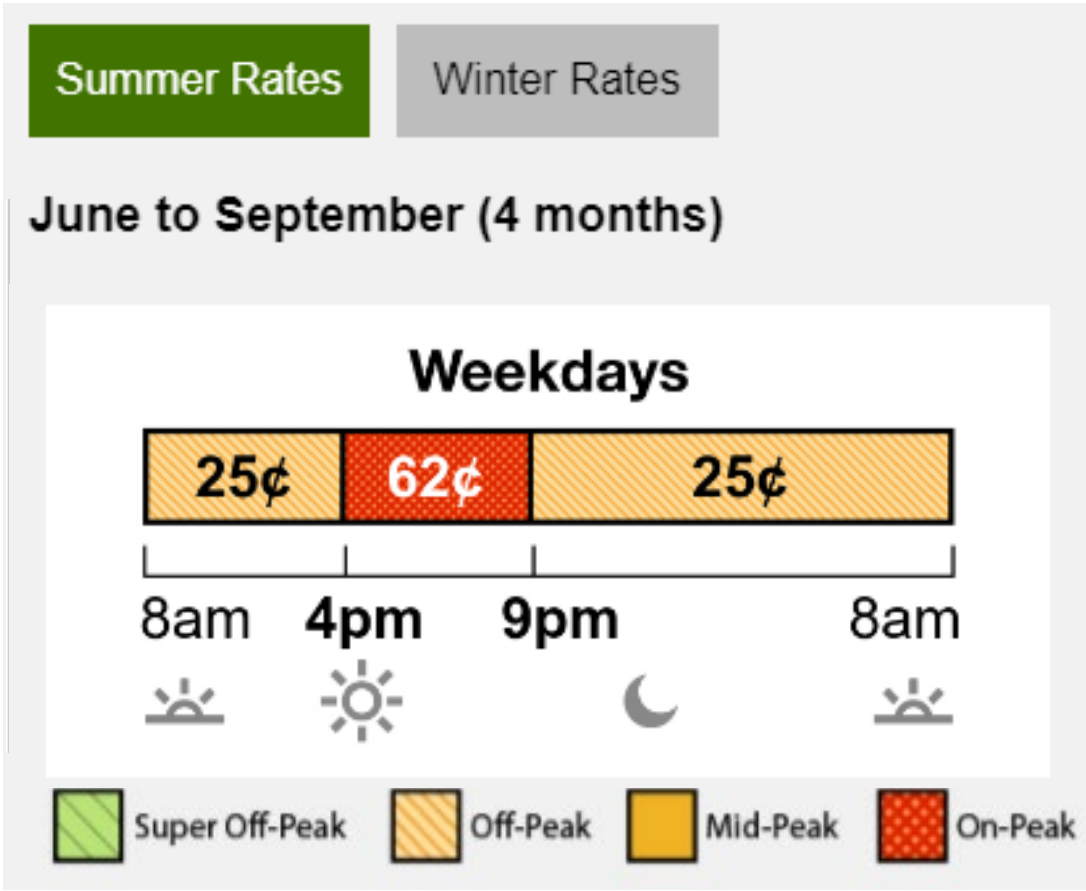
Click on Image
for YouTube video

Location, Location, Location

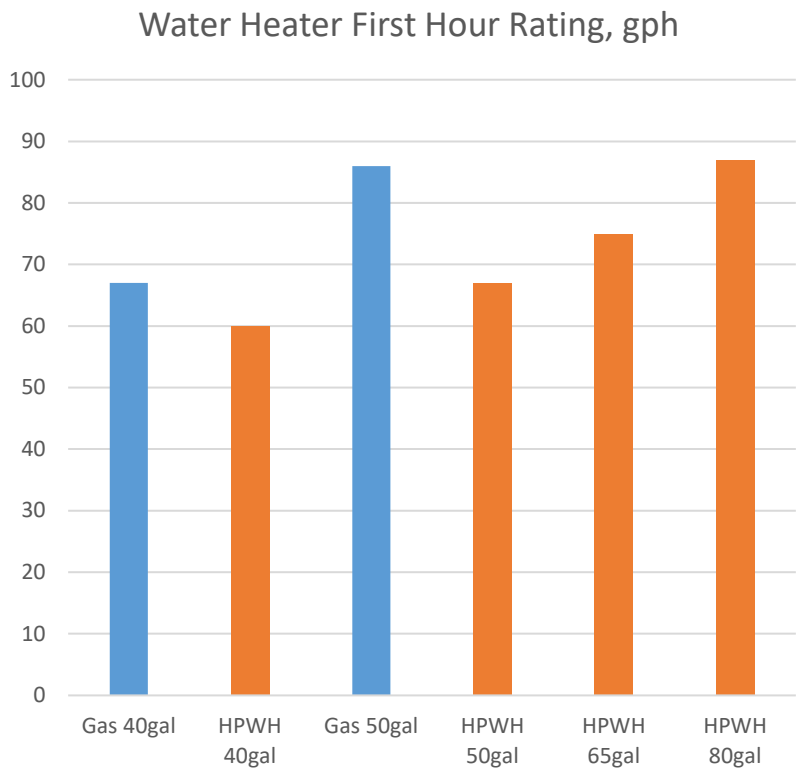
Heat Pump Water Heaters And EVs Can Soak Up Low-Carbon, Low-Cost Electricity Off-Peak, Without Adding Load On-Peak

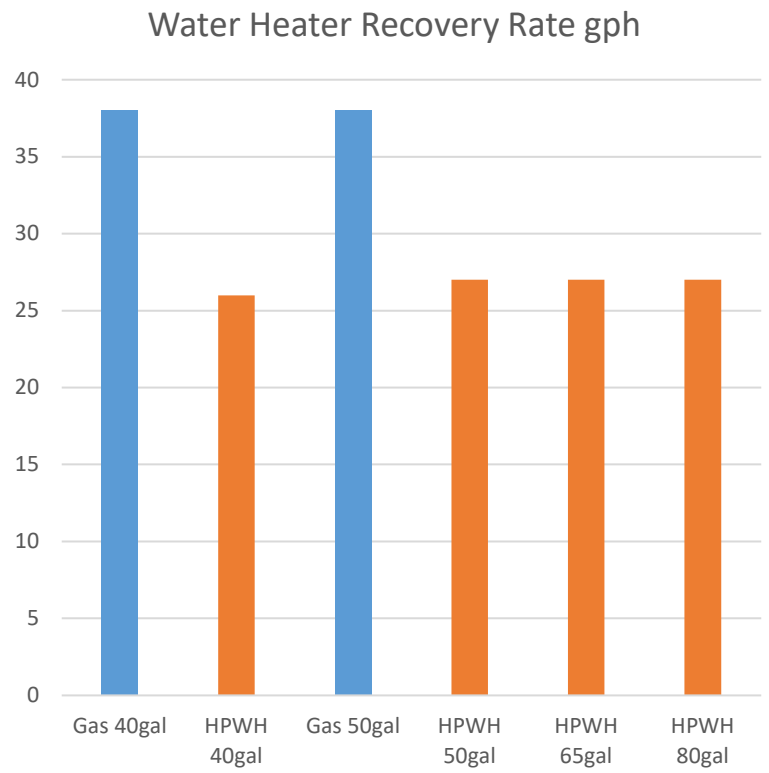


SCE TOU-D-PRIME Rates Have 4-9 pm Peak

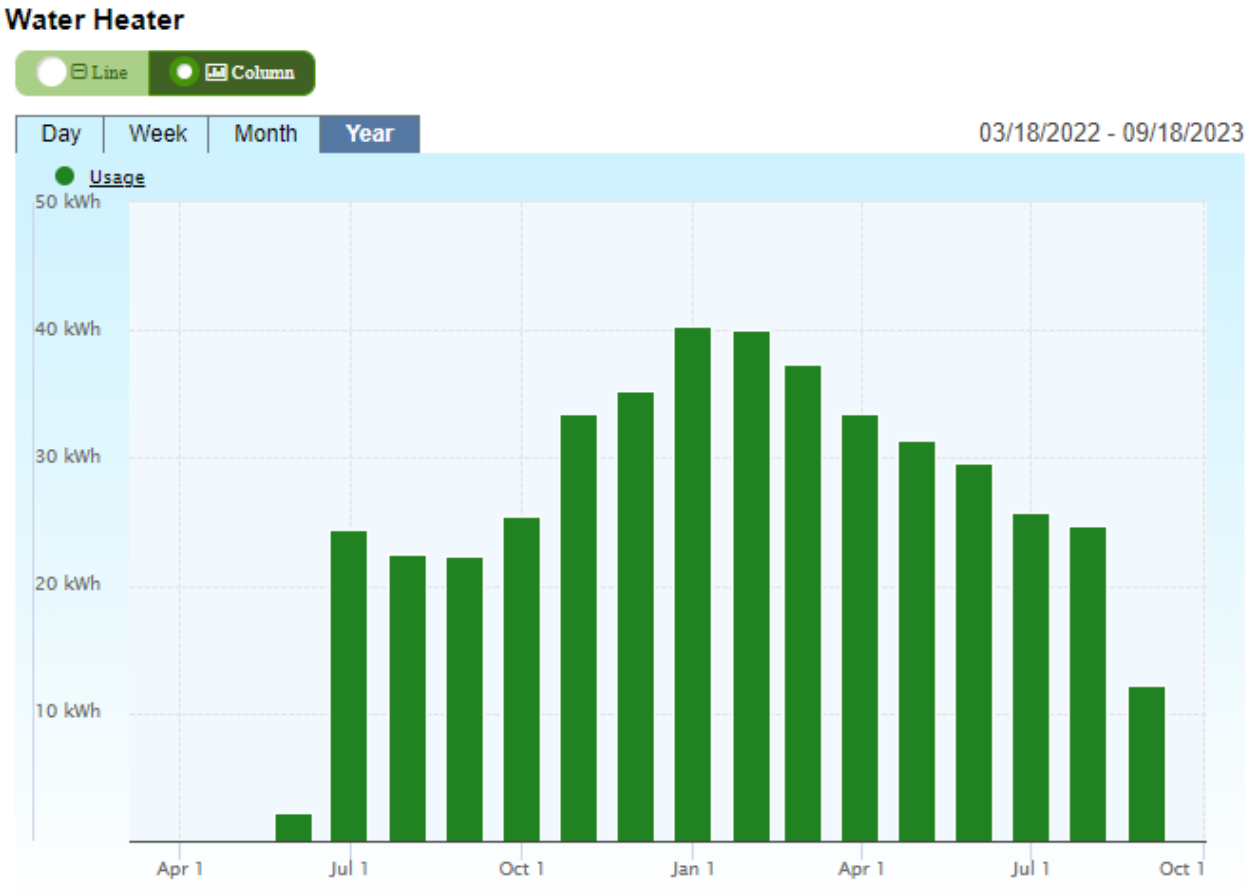


HPWHs are Energy Sippers



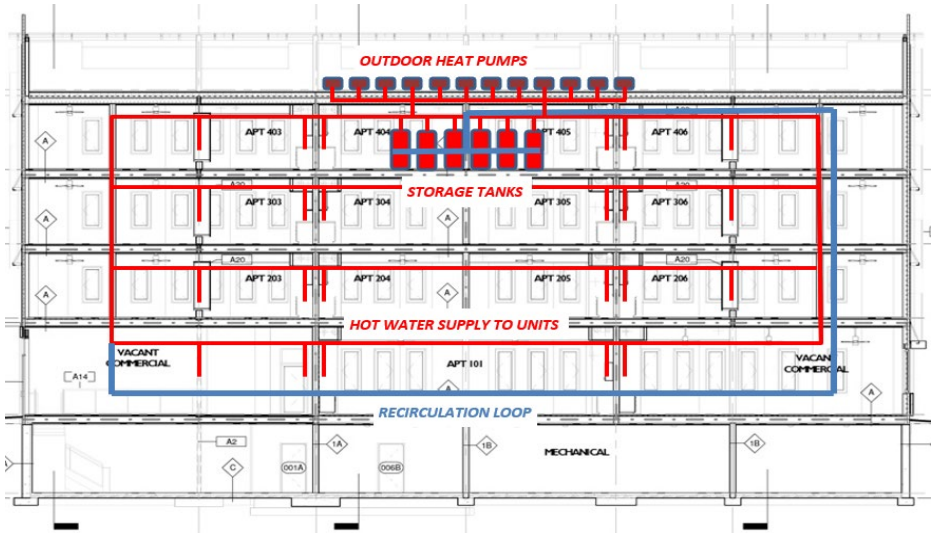


HPWH Averages 1 kWh per day in an ADU with 2 people

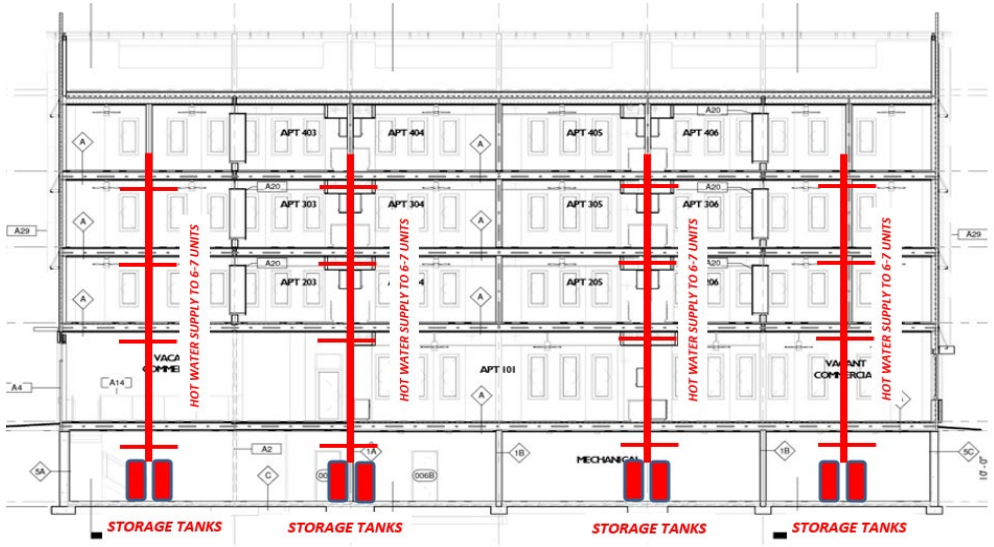


Embrace Better Technologies for Multifamily: HPWH – Centralized, Shared, or Individual

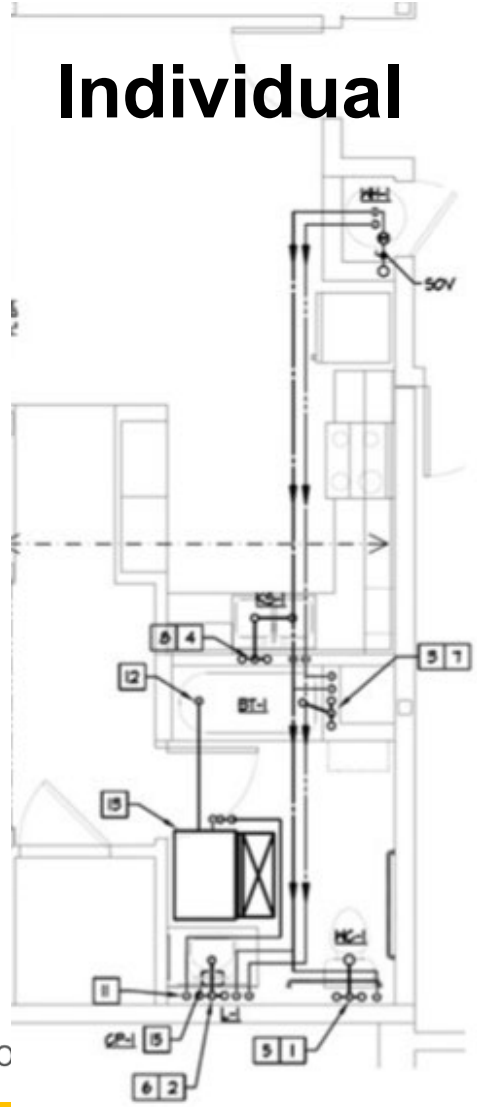
Centralized



Shared



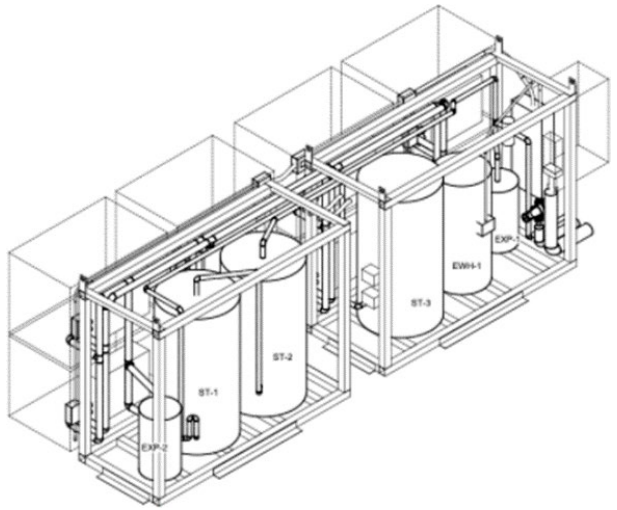
Individual

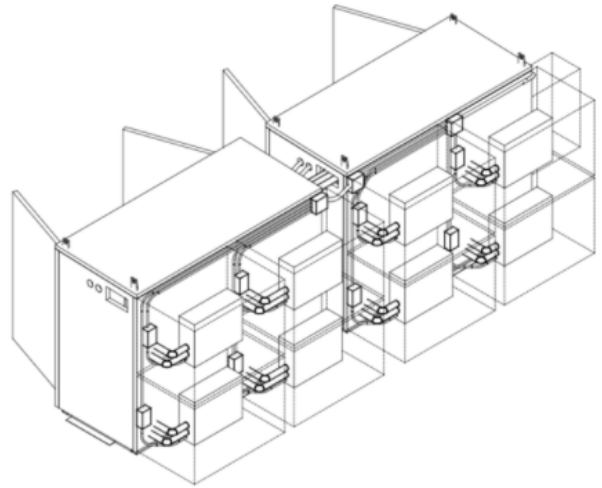


Energy fo

Embrace Better Technologies for Multifamily:
Centralized HPHW

Pros:
- **Doesn't take up rentable floor space**
- **Can be centrally monitored and serviced**
- Sizing assistance with ECOSIZER
- Water Drop Palletized Units coming





Cons:
- **Owner is responsible for all water heating**
- **One year warranty**
- **If it fails, the whole building goes down**
- Service contract required
- Dual plumbing
- **Significant recirculation line loss**
- Separate tanks
- Roof area
- Structural implications
- Crane required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Embrace Better Technologies for Multifamily:
Shared HPHW

Pros:
- **Warranty 3 years**
- **When it fails, that segment of the building goes down**
- Less dual plumbing
- **Less recirculation line loss**
- No Separate Tanks
- **Doesn’t use roof area**
- No structural implications
- No crane required
- May not need service contract

Cons:
- **May take up rentable floor space**
- **Owner is responsible for all water heating**
- Requires careful venting
- Requires primed floor drains

2 – 80 gallon HPWH for 6-7 Apartments

Embrace Better Technologies for Multifamily:

Individual HPHWs

Pros:

- **Warranty 10 years**
- **When it fails, only one unit goes down**
- **Tenant is responsible for water heating bill**
- No dual plumbing
- No recirculation line loss
- No Separate Tanks
- **Doesn’t use roof area**
- No structural implications
- No crane required
- No service contract needed

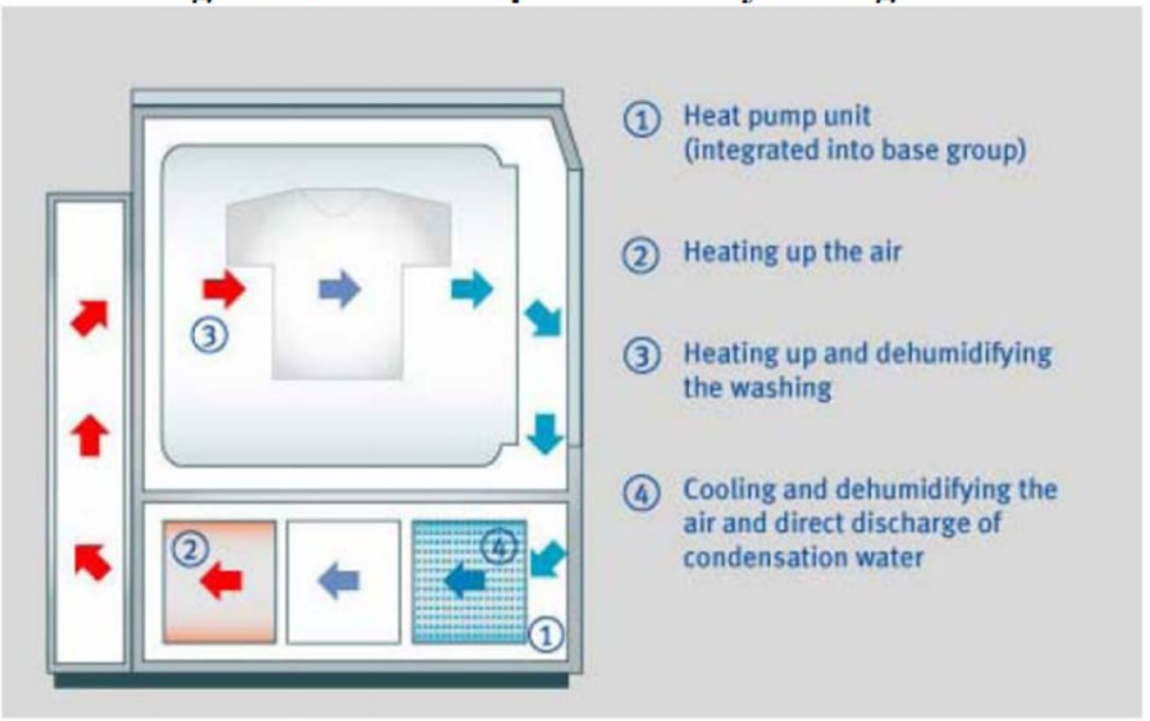
Cons:

- **Takes up rentable floor space**
- Requires careful venting
- Requires primed floor drains

Heat Pump Clothes Dryers

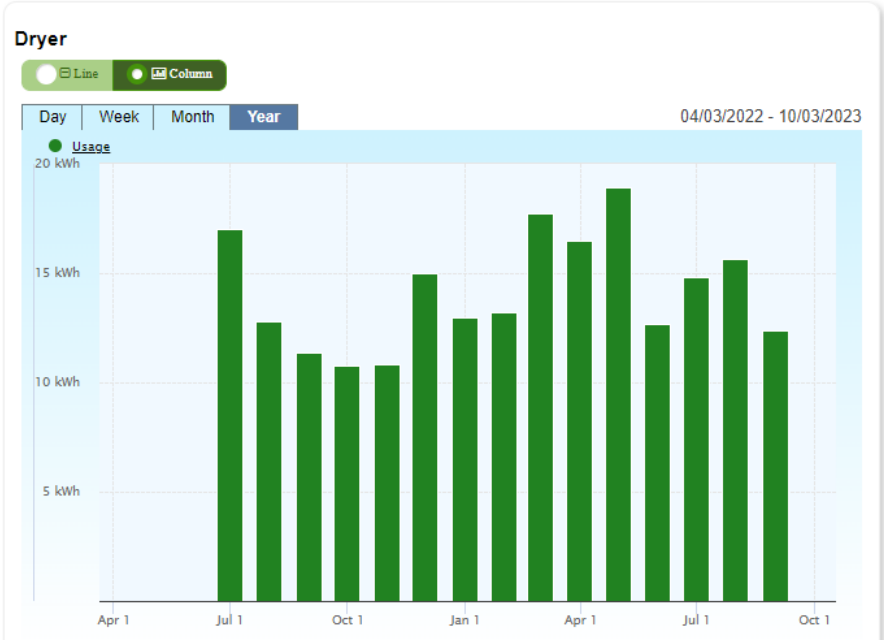
- Closed loop heat pump
- Removes moisture from air in drum
- Heats air going back to drum
- No penetrations of building envelope to vent hot air
- Water goes down the drain
- Gentler on clothes
- 33-60% lower energy use than gas dryer

Figure 1. Heat Pump Clothes Dryer Diagram[3]



Heat Pump Dryer Actual Energy Use

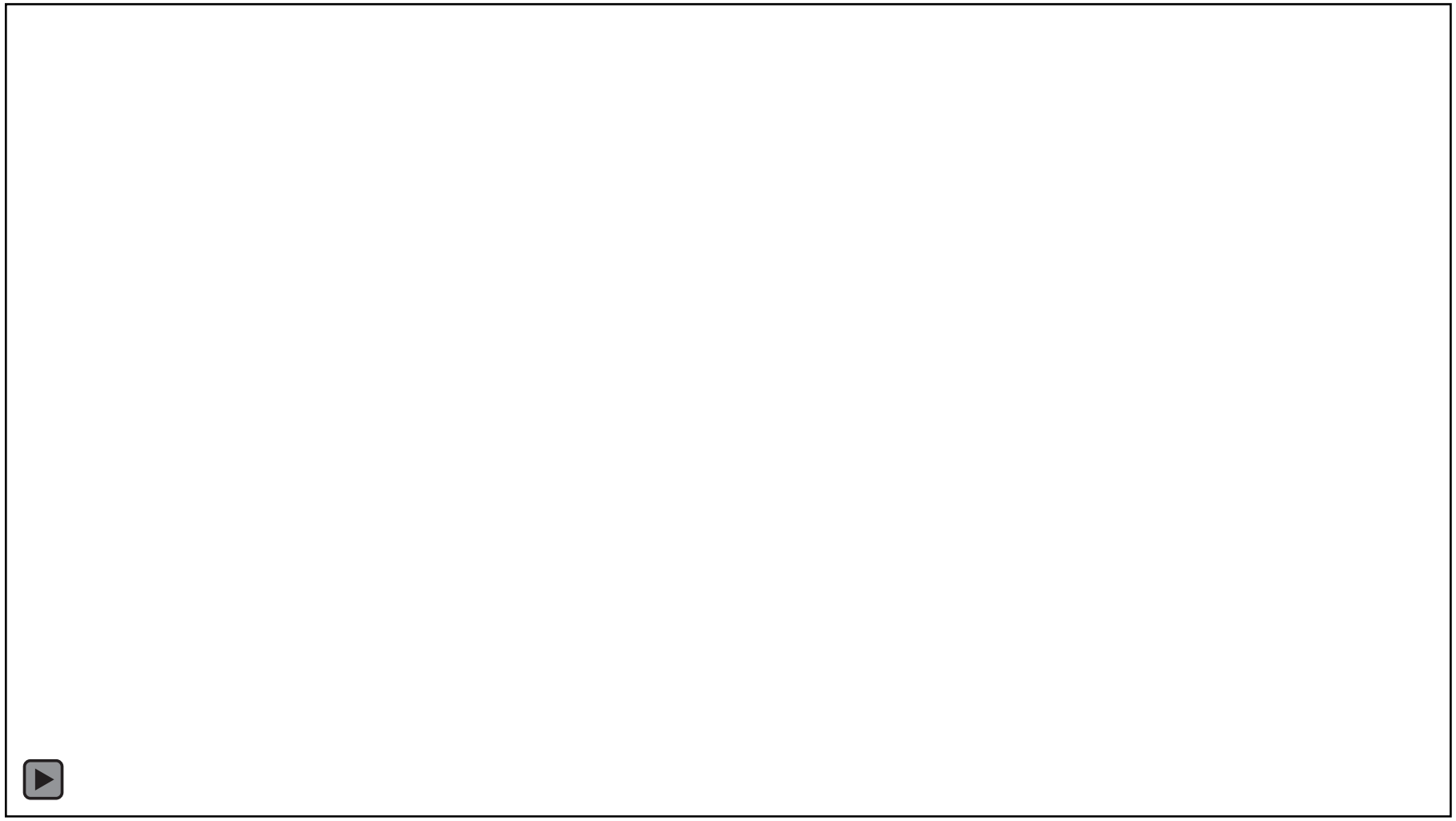
- Uses 1.5 kWh per load & 15 kWh per month for Family of 2
- 65 minutes per load
- $3 per month
- 900 Watts peak is less than a hair dryer



Pool Heating

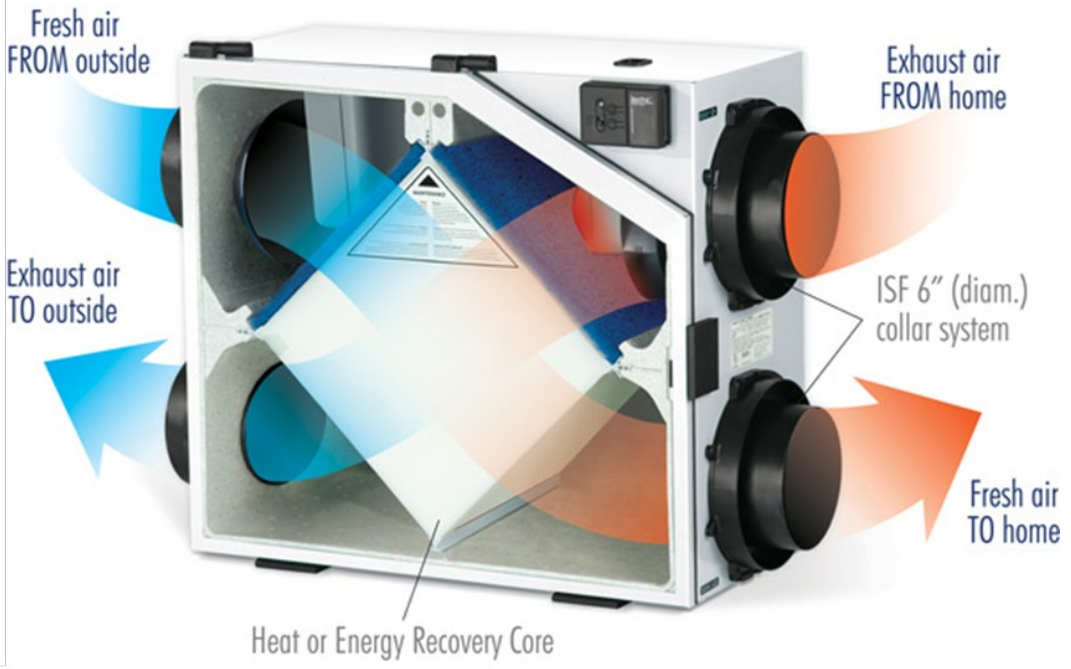
- Heat pump pool heaters are capable
- This 120,000 btu model costs $4,000
- Comparable gas models are between $1000 - $2,000
- Run year round, ***this unit is estimated to save $5,000 in the first year*** or 64% in L.A. climate
- It would run 9 hours on the coldest day of the year
- Receive payback in 1 year

Fireplaces



Recovery Ventilators a Great Upgrade for Indoor Air Quality

- HRVs & ERVs temper incoming air to reduce space conditioning energy required
- Provide enhanced circulation of fresh air throughout home
- Significant compliance credit



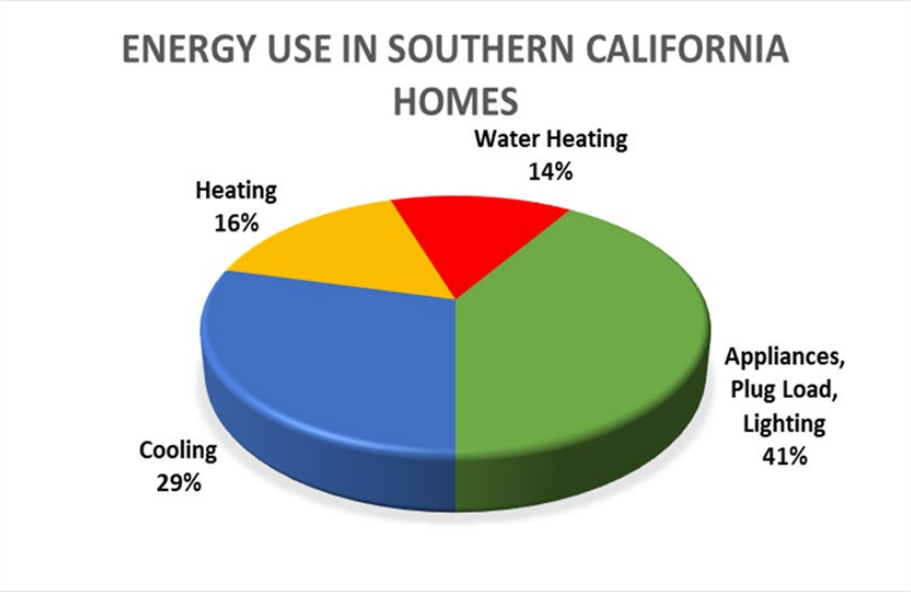
Living with Induction Cooking & Heat Pump Water Heaters

Live Broadcasts

SOUTHERN CALIFORNIA EDISON®

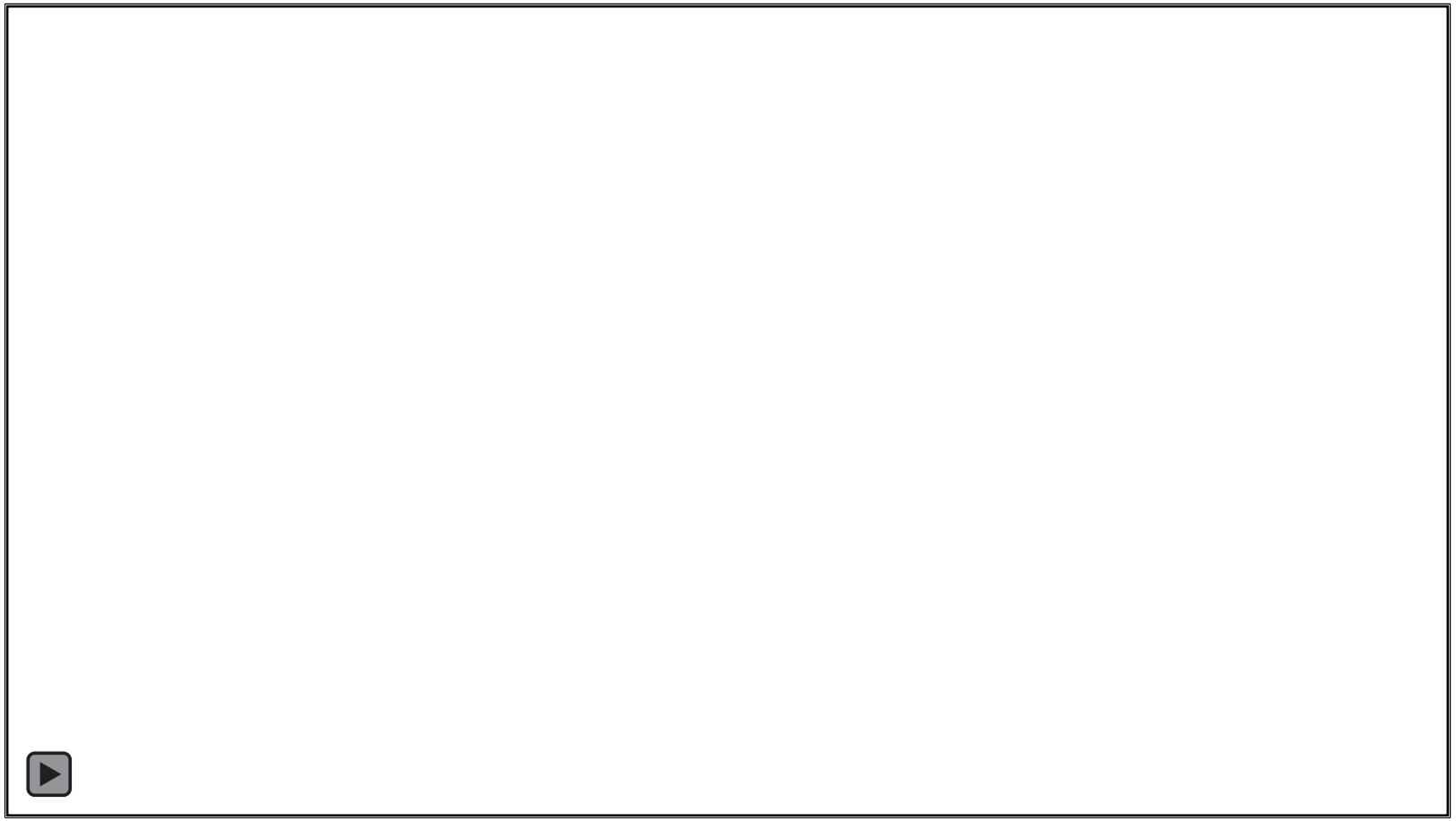
Technologies to Go Electric

- Solar & Batteries
- Heat Pump Water Heaters
- Electric & Heat Pump Clothes Dryers
- Induction Cooktops
- **Heat Pumps**



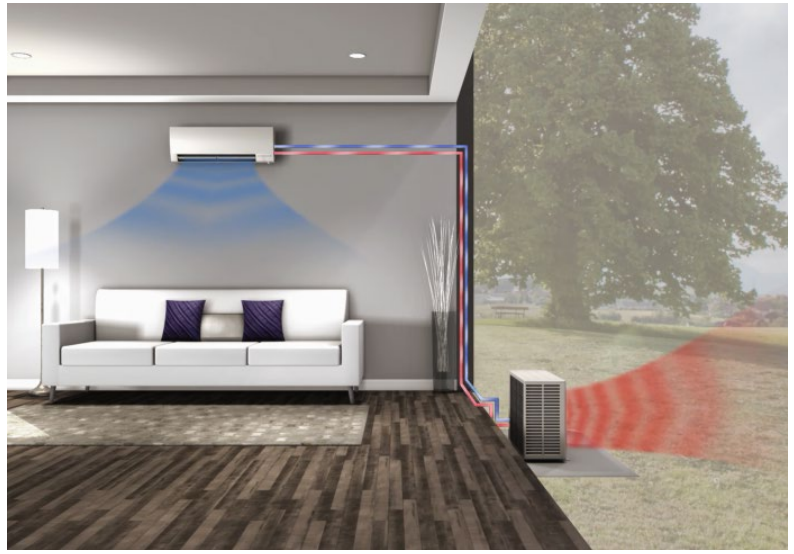
Heat Pumps: Reversible Air Conditioners

https://vimeo.com/438351346



Heat Pumps: Reversible Air Conditioners

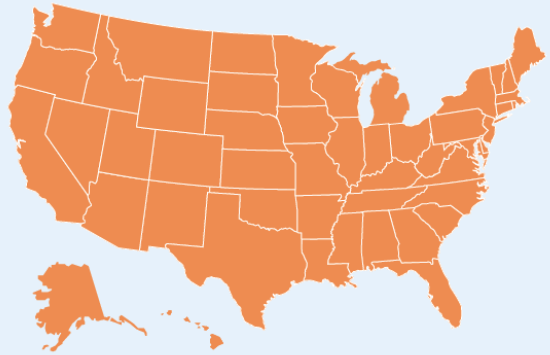
- Efficient All-Electric Heating & Cooling in One System
- Heat pumps are often simpler/less expensive to install
- Wide variety of configurations possible (ductless, ducted, ceiling cassettes)
- Often no ducting and no HERS inspections



New HVAC Equipment Standards Effective Jan 1, 2023

- Beginning January 1, 2023, the DOE is increasing the minimum efficiencies for central air conditioners and heat pumps. The testing procedures for determining those efficiencies are changing as well.
- For heat pumps and air conditioners in the Southwest, the minimum efficiency will increase from 14.0 to 15.0 SEER under today's test procedure.
- The Ratings will change to SEER2, EER2, and HSPF2 on Jan 1, 2023
  - Minimum 14.3 SEER2 & 7.5 HSPF2 (heat pumps)
  - Minimum 14.3 SEER2 & 11.7 EER2 (AC systems)*
    - Split systems >45kbtu: Min 13.8 SEER2 & 11.2 EER2
    - Packaged AC units 13.4 SEER2 & 10.6 EER2
    - Packaged heat pumps 13.4 SEER2 & 6.7 HSPF2

National



2023 Minimum Efficiencies			
System Type	Current Minimum	New Minimum with M Ratings	New Minimum with M1 Ratings
Split System HP	14.0 SEER	15.0 SEER	14.3 SEER2
	8.2 HSPF	8.8 HSPF	7.5 HSPF2
SPP AC and Gas Electric (EER applies to SW only)	14.0 SEER	14.0 SEER	13.4 SEER2
	11.0 EER	11.0 EER	10.6 EER2
SPP HP and Dual-Fuel HP	14.0 SEER	14.0 SEER	13.4 SEER2
	8.0 HSPF	8.0 HSPF	6.7 HSPF2

HVAC Heat Pump Advantages

- No separate furnace
- No gas lines
- No flue vent pipes
- No combustion gases inside building
- Quieter
- Space-saving
- Utility bill savings

Ducted Minisplit HPs provide high efficiency in space-saving cost-effective configurations

Heat Pumps Cost less

We surveyed Southern California HVAC Contractors: 600 square foot addition scenario

What would you bid for a gas furnace 80 AFUE Ultra Low-NOx and 14 SEER condensing unit with new R-6 ductwork and smart thermostat? Assume a 2-ton unit. Include all plumbing, electrical, and HVAC costs.

Range of Estimates Provided by Contractors – Gas Split System

$6,000	$15,000

What would you bid for a heat pump 8.2 HSPF and 14 SEER? Assume a 2-ton unit and include all plumbing, electrical, and HVAC costs.

Range of Estimates Provided by Contractors – Heat Pump

$6,000	$13,000

100% of contractors gave an equal or lower bid for heat pumps than gas split systems in this scenario.

Packaged Unit Heat Pumps

Window Heat Pumps Going in At Scale in New York City

HVAC RESIDENTIAL MARKET | AIR-SOURCE HEAT PUMPS | HVAC BREAKING NEWS

Window Heat-Pump Units Planned for NYC Public Housing

A Gradient Comfort window-mounted heat pump. The startup has a contract to provide 10,000 window-mounted heat pumps to be installed at public housing units in New York City.

Photo courtesy of Gradient Comfort

- Gradient will provide 10,000 window–mounted Heat Pumps to NYC Housing Authority (NYCHA)!
- Reduces cost (no electrical system upgrade, lengthy refrigerant piping, or drilling through walls)
- Residents expressed increase in comfort, air quality, easy cleaning/maintenance, control of indoor temperature
- 120 Volt plug-in has 9,000 btu heating & cooling and 10.8 CEER

Ductless Minisplit Heat Pumps

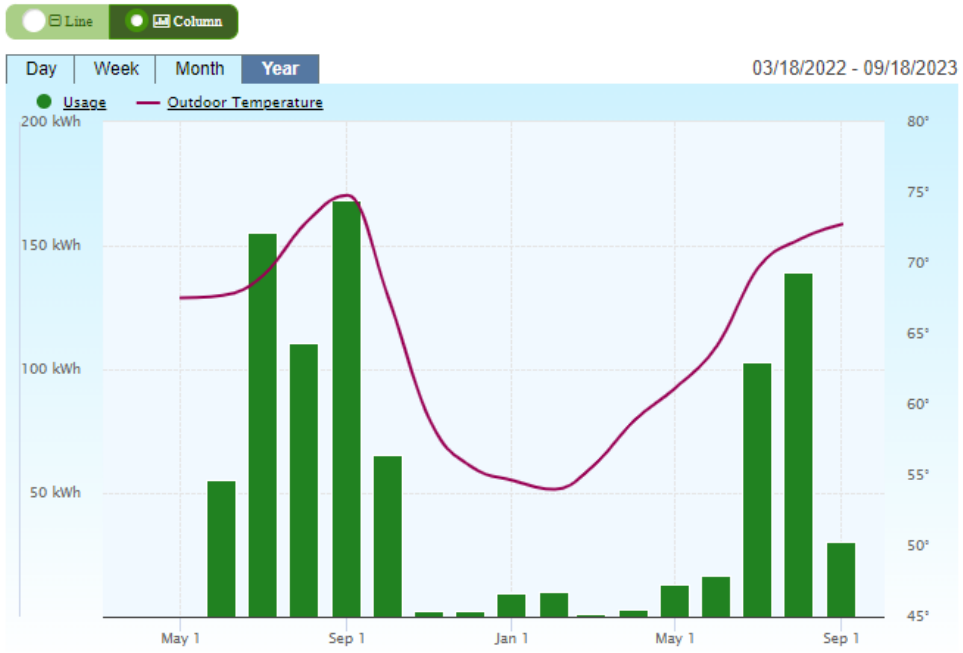
- Move heat with refrigerant
- No energy loss from ductwork
- Can link multiple indoor units to one outdoor (multiplit)
- Maximum use of modulating technology

Ceiling Cassettes: Alternative to High Wall Indoor Units

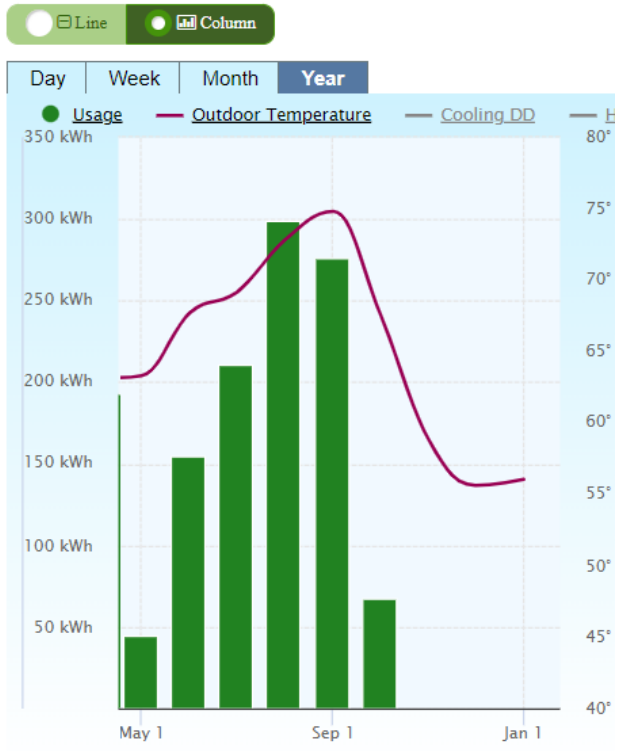
Ducted Minisplit Heat Pumps

Ductless Minisplit Heat Pumps Very Efficient

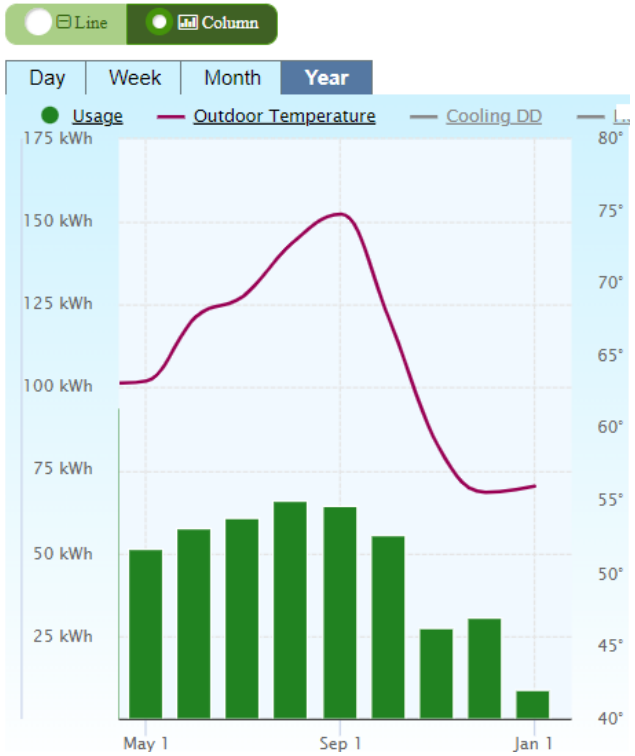
Heat Pump



AC



Forced Air Unit



ADU's Ductless minisplit used 570 kWh in Summer '22

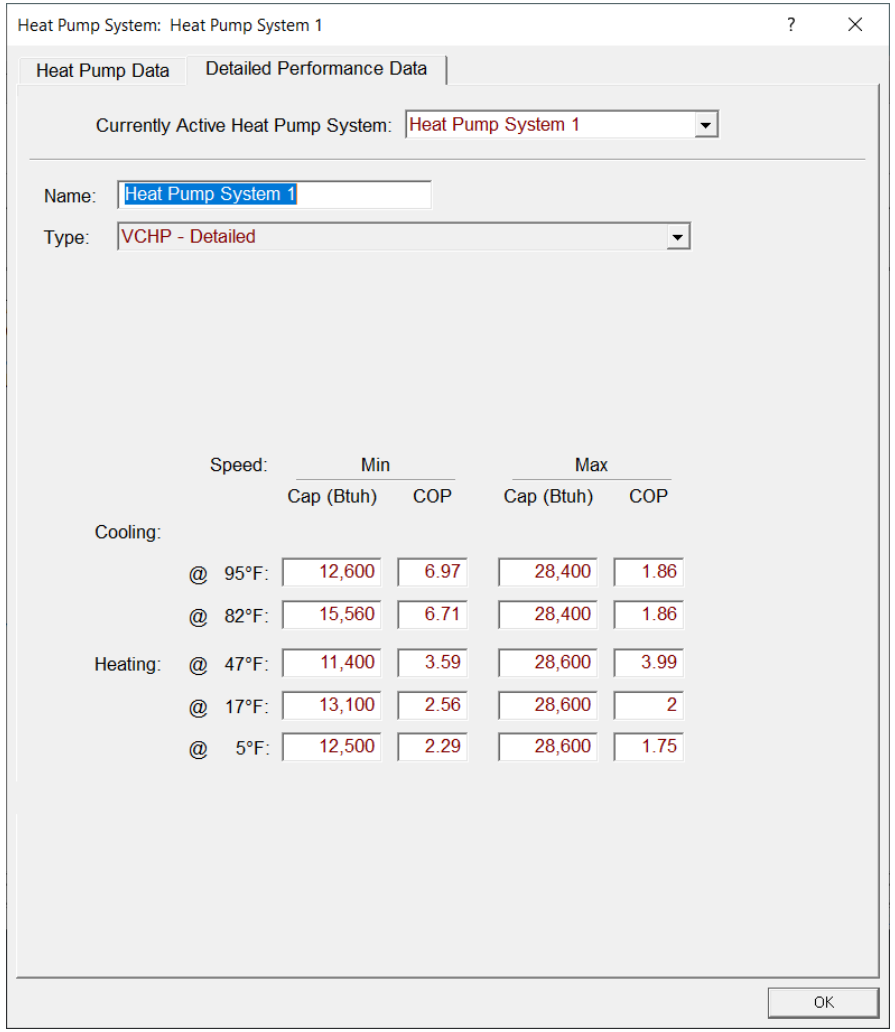
Main house AC & FAU used 1,460 kWh plus gas for heating

Energy Modeling for All-Electric Homes

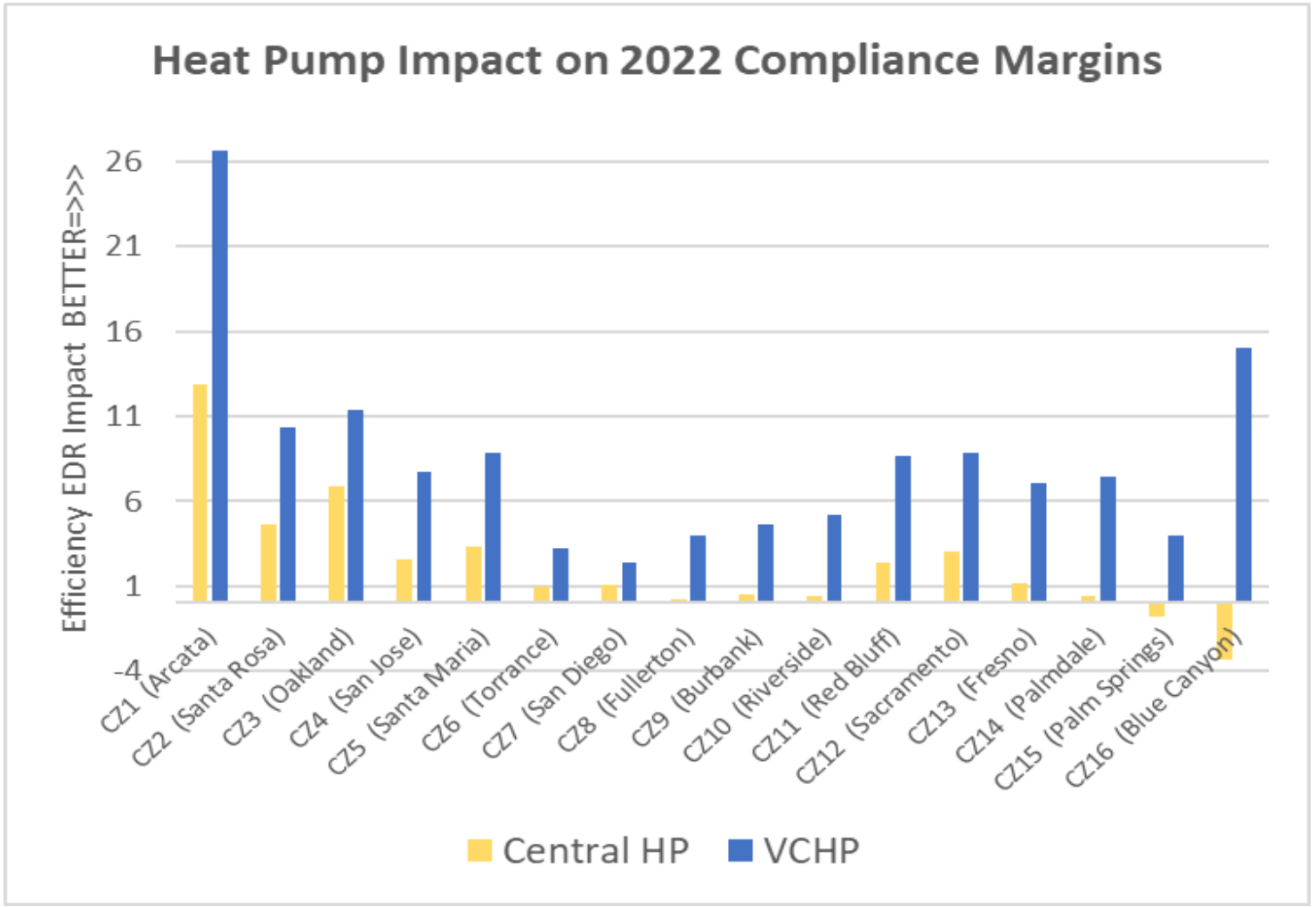
- Heat Pump Water Heaters
- Heat Pumps
- Electric Cooking
- Electric Clothes Drying

Energy Code Encourages All-Electric More than Ever

- Heat pumps prescriptive standard
- Source EDR metric favors electric systems
- Gas systems require electric-retrofit-ready circuits
- Compliance credit possible with advanced heat pumps (VCHP credit)



HVAC Heat Pumps Perform Well for Compliance



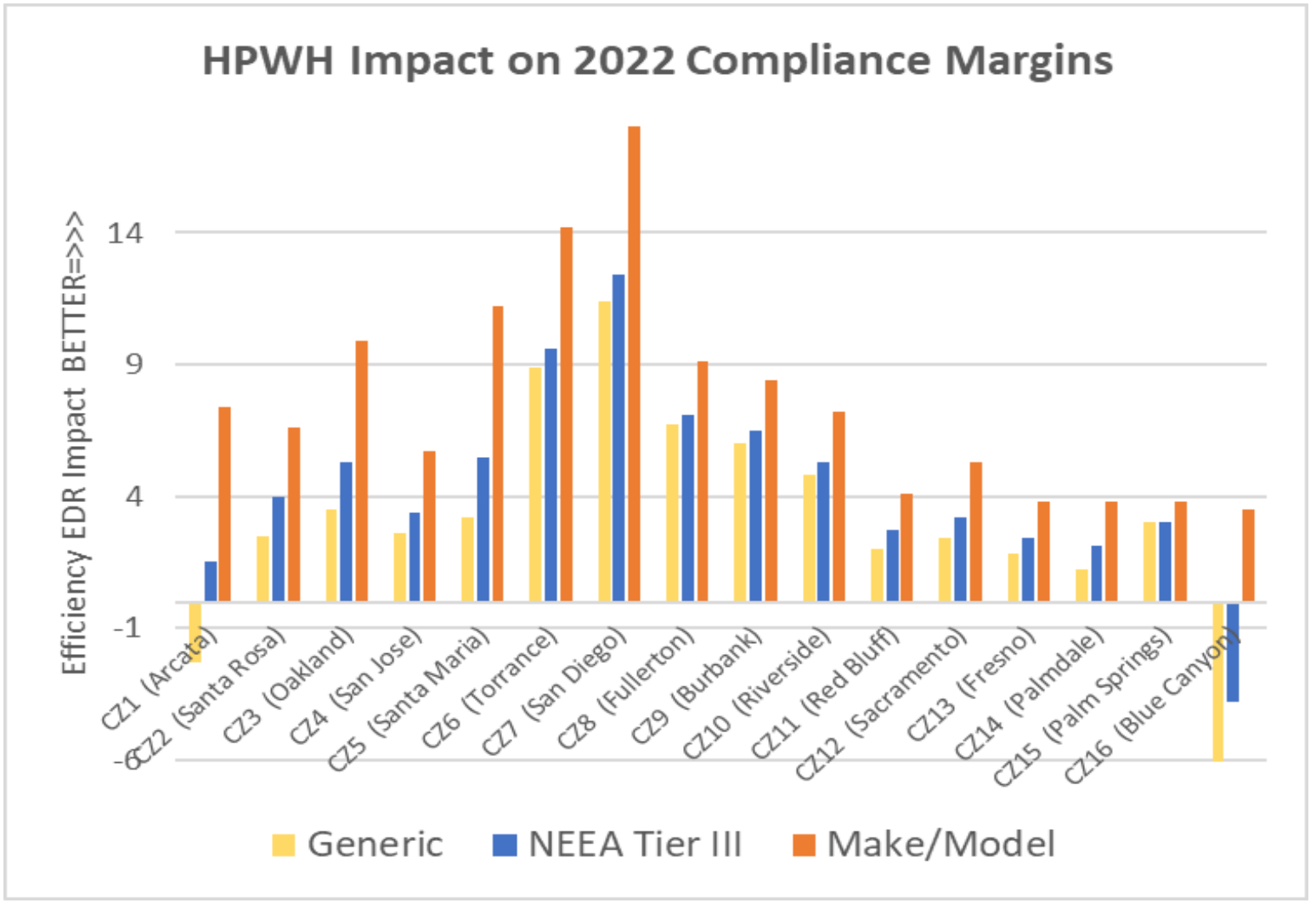
Average Compliance Impact:

- Efficiency EDR:
  - Central HP 2.3 (5%)
  - VCHP 8.5 (17%)
- Source EDR:
  - Central HP 8.2 (18%)
  - VCHP 10.5 (24%)

Talking to People About Heat Pumps

- Comfort
- Heat strips: can erase energy savings if used carelessly
  - Not necessary in large parts of California, especially with high-performance envelope
- Heat pump clothes dryers:
  - Trade off higher first costs for energy savings and gentle treatment of clothes
- Heat pump water heaters:
  - Careful with heat strips – run in Heat Pump Only mode
  - Use tank one size larger than typical gas tank
  - Ideal for peak shifting 4-9 pm = added value
  - Overcoming objections: space required & recovery rate

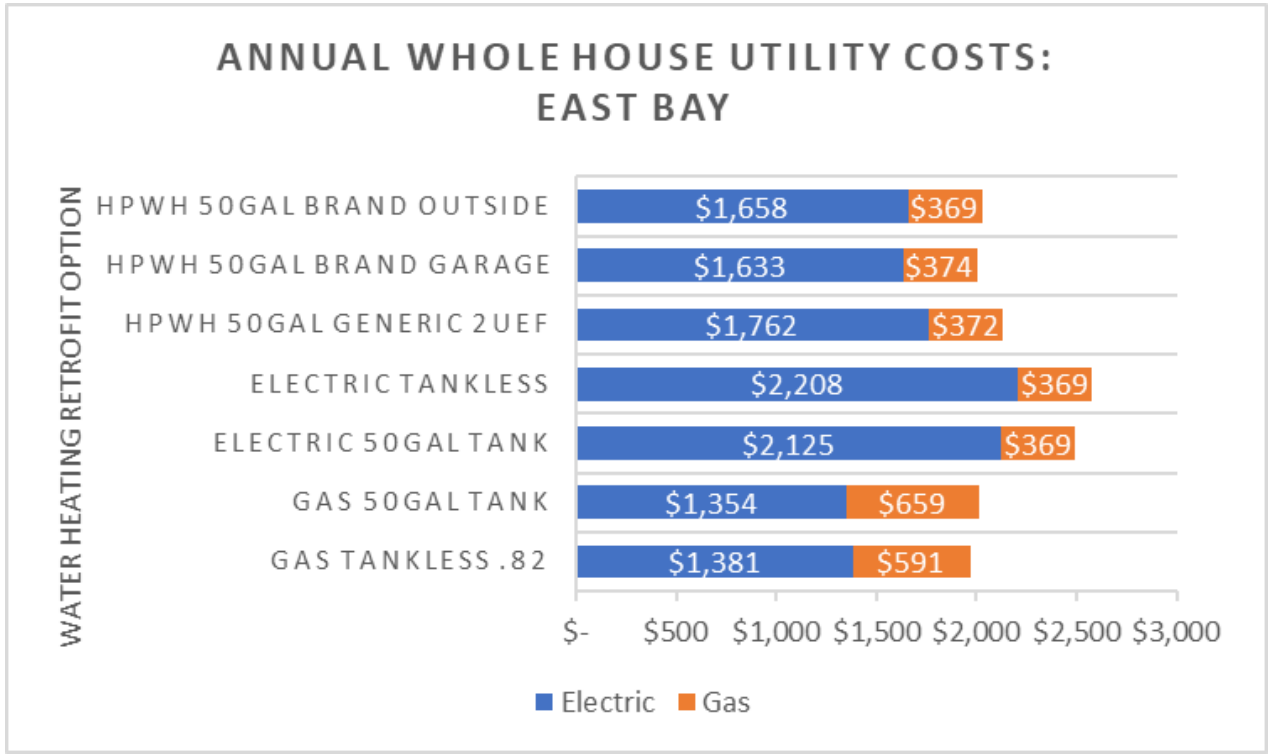
NEEA HPWHs Model Better than Gas



Average Compliance Impact:

- Efficiency EDR:
  - Generic 3.2 (8%)
  - NEEA Tier III 4.4 (10%)
  - Make/Model Specific 7.7 (17%)
- Source EDR:
  - Generic 10.0 (8%)
  - NEEA Tier III 10.6 (10%)
  - Make/Model Specific 11.6 (30%)

Heat Pump Water Heaters Have Comparable Operating Costs to Gas

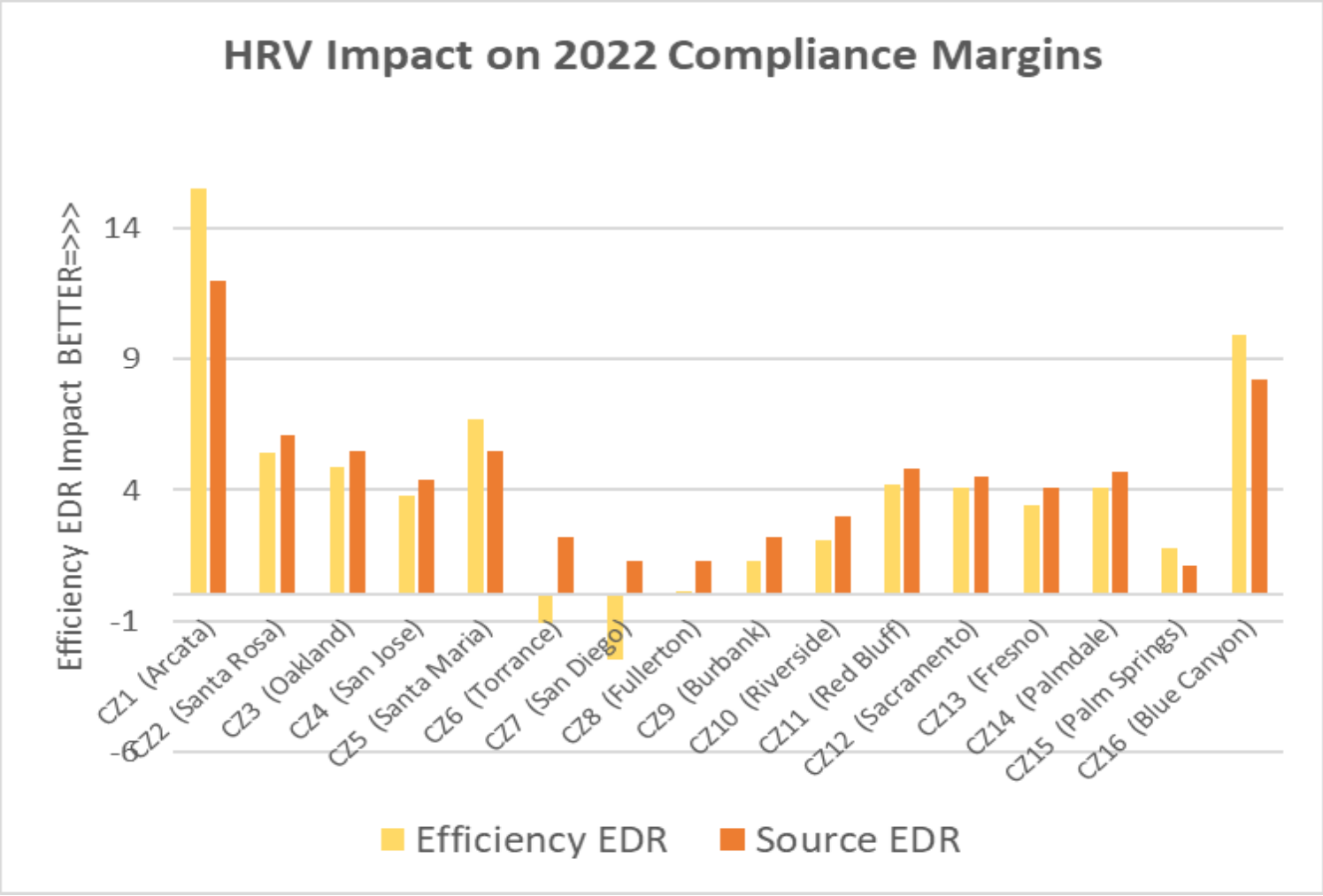


Total Home Utility Costs

Climate Zone	Gas Tankless WH	50 gal HPWH	Difference	% Difference
1- Eureka	$ 2,090	$ 2,188	$ 98	**5%**
2- Novato & San Rafael	$ 1,636	$ 1,689	$ 53	**3%**
3- San Francisco	$ 1,565	$ 1,622	$ 57	**4%**
4- San Jose	$ 1,550	$ 1,590	$ 40	**3%**
5- San Luis Obispo	$ 1,553	$ 1,615	$ 62	**4%**
11- Chico	$ 2,391	$ 2,421	$ 30	**1%**
12- East Bay	$ 1,973	$ 2,007	$ 35	**2%**
13- Fresno	$ 2,407	$ 2,428	$ 21	**1%**
16- Truckee	$ 2,297	$ 2,486	$ 189	**8%**
AVERAGE	$ 1,940	$ 2,005	$ 65	**3%**

NOTE: Ignores Solar panels and HPWH controls to minimize peak usage and run in economy mode

Compliance Credit for Recovery Ventilators



Average Compliance Impact:

- Efficiency EDR:
  - Typical HRV 4.0 (8%)
- Source EDR:
  - Typical HRV 4.4 (11%)

Gas vs Electric Comparison 2022 Code: CZ 10 (Corona)

SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead®

Dual Fuel

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Energy Design Ratings:			Compliance Margins:		
	Source (EDR1)	Efficiency¹ (EDR2)	Total² (EDR2)	Source (EDR1)	Efficiency¹ (EDR2)	Total² (EDR2)
Standard Design	36.1	39.8	26.9			
Proposed Design	47.0	43.6	29.4	-10.9	-3.8	-2.5

Result³: DOES NOT COMPLY

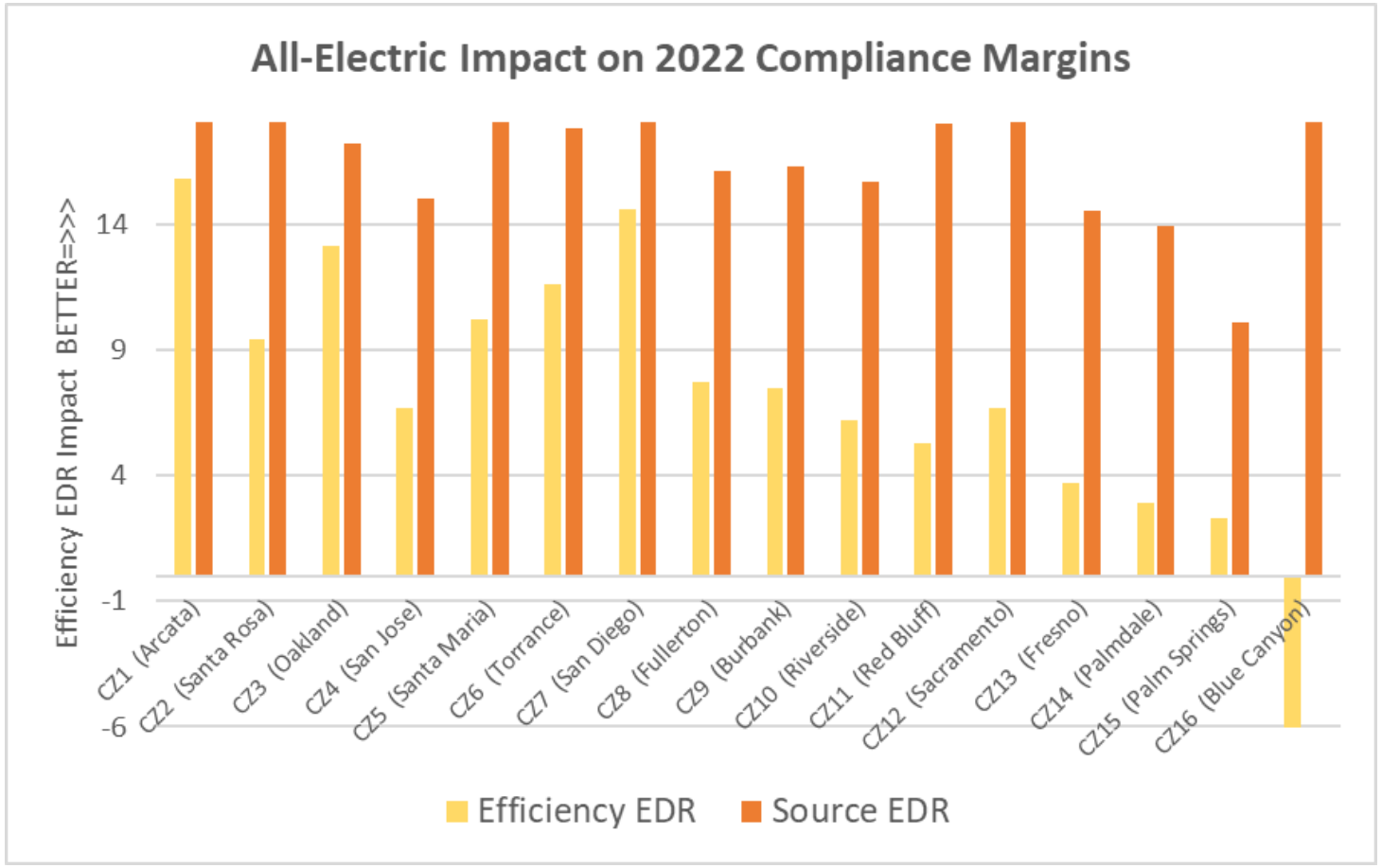
All Electric

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Energy Design Ratings:			Compliance Margins:		
	Source (EDR1)	Efficiency¹ (EDR2)	Total² (EDR2)	Source (EDR1)	Efficiency¹ (EDR2)	Total² (EDR2)
Standard Design	33.3	39.8	28.9			
Proposed Design	28.5	37.4	27.5	4.8	2.4	1.4

Result³: COMPLIES

All-Electric Makes Compliance Easier Everywhere



Average Compliance Impact:

- Efficiency EDR: 7.3 (16%)
- Source EDR: 19.1 (50%)

Key Questions to Ask Your Energy Consultant

- Are you using current 2022 software?
- Is all-electric now roughly equal to or better than gas?
- Are you taking the Variable Capacity Heat Pump credit?
- Did you model a specific NEEA rated Heat Pump Water heater?
- How far away from compliance are we?
  - What part of the building has a compliance deficit?
    - Heating
    - Cooling
    - Water Heating
    - Other
  - What could we do to close the compliance gap?

Homebuilders Already Building All-Electric in SoCal

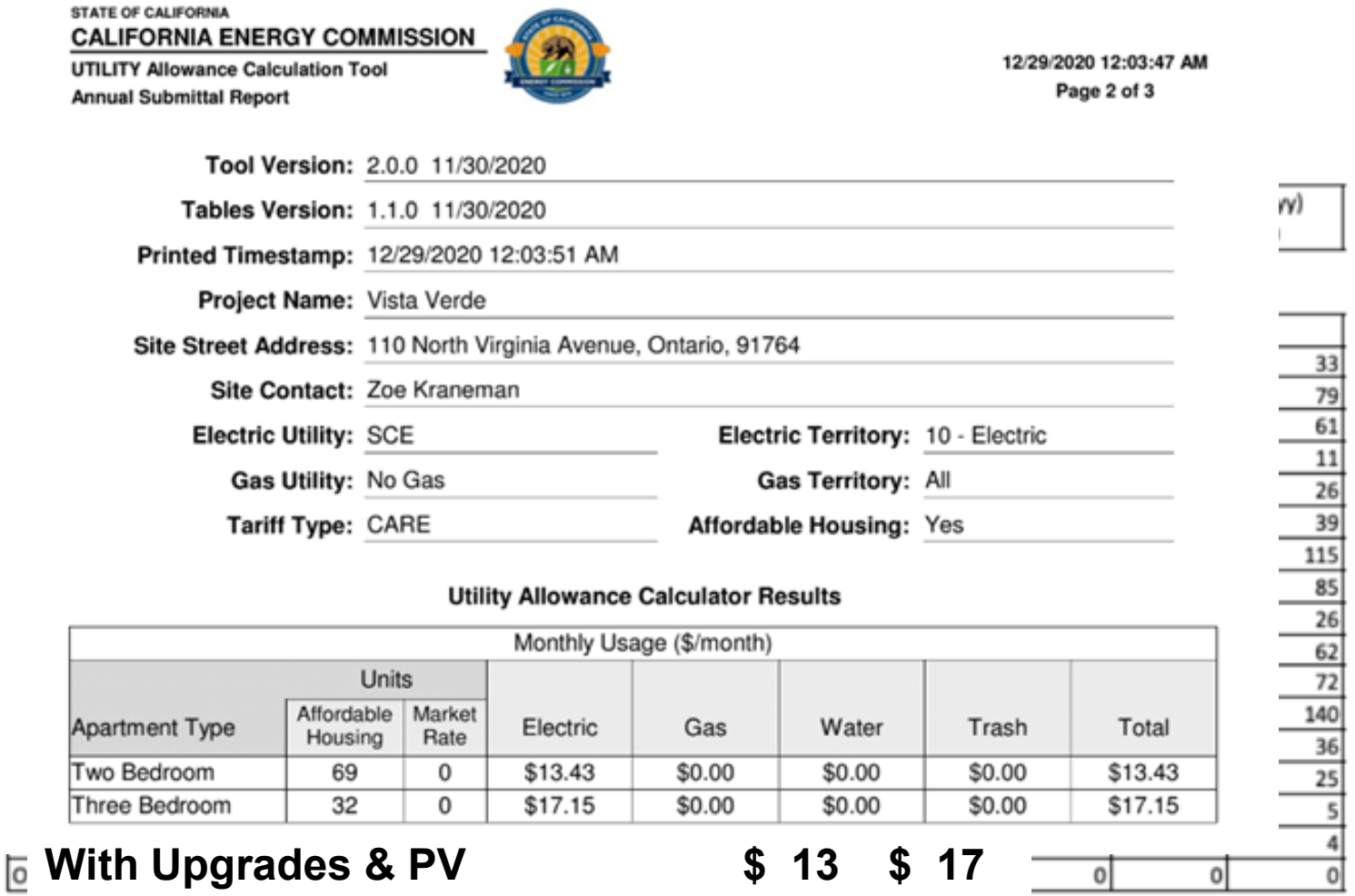
All-Electric Affordable 101-unit in Ontario, CA:

Built for $127 per square foot

- Individual unit HPWHs
- Individual unit heating and cooling minisplit HPs
- Builder makes use of incentives:
  - SOMAH
  - TECH
  - CALIFORNIA ENERGY SMART HOMES
  - BUILD
  - LIWEAP
  - MAHEP

More Marketable Buildings:
Can Charge Higher Rent With Lower Utility Bills

- 101-unit affordable multifamily building in Southern California
- Typical utility bills: $134 - $175 per month
- With upgrades & PV: $13 - $17 per month
- **Savings applied to rent add up to $160,000 per year in added revenue to building owner**



STATE OF CALIFORNIA
CALIFORNIA ENERGY COMMISSION
UTILITY Allowance Calculation Tool
Annual Submittal Report

12/29/2020 12:03:47 AM
Page 2 of 3

Tool Version: 2.0.0 11/30/2020
Tables Version: 1.1.0 11/30/2020
Printed Timestamp: 12/29/2020 12:03:51 AM
Project Name: Vista Verde
Site Street Address: 110 North Virginia Avenue, Ontario, 91764
Site Contact: Zoe Kraneman
Electric Utility: SCE **Electric Territory:** 10 - Electric
Gas Utility: No Gas **Gas Territory:** All
Tariff Type: CARE **Affordable Housing:** Yes

Utility Allowance Calculator Results

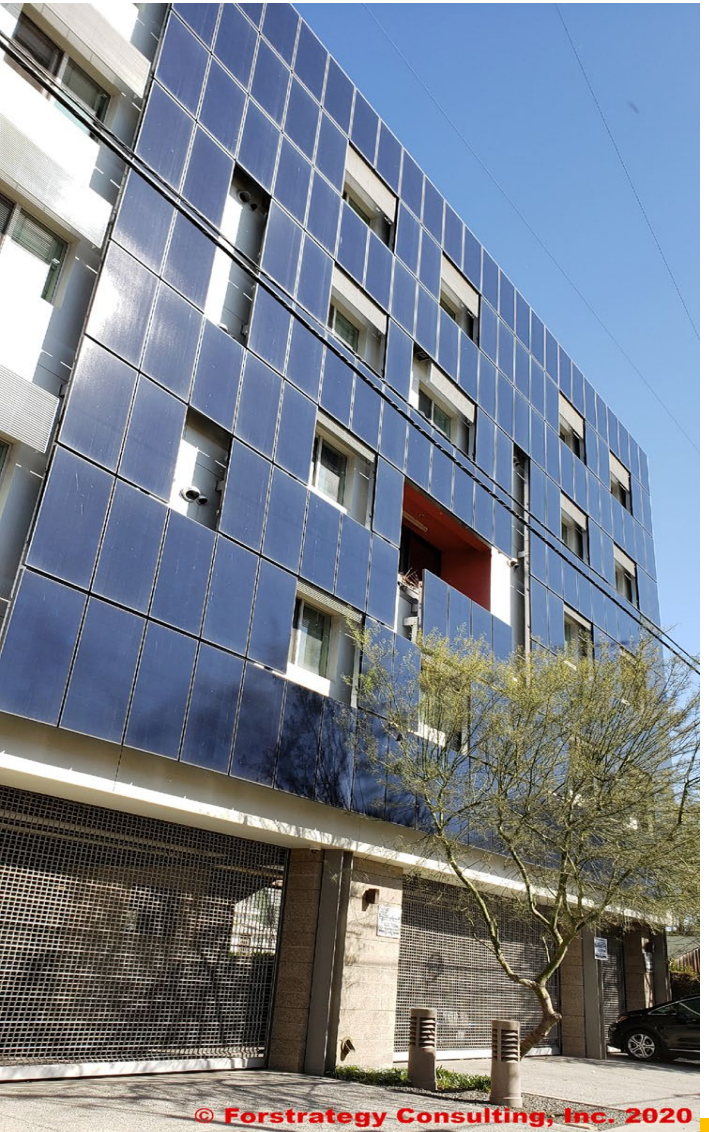
Apartment Type	Units: Affordable Housing	Units: Market Rate	Monthly Usage ($/month): Electric	Gas	Water	Trash	Total
Two Bedroom	69	0	$13.43	$0.00	$0.00	$0.00	$13.43
Three Bedroom	32	0	$17.15	$0.00	$0.00	$0.00	$17.15

With Upgrades & PV	**$ 13**	**$ 17**
Without Upgrades & PV	**$134**	**$175**

Proper Solar And HVAC Placement Optimizes

The Roof As The Engine Of The Building

Avoid Common Missteps



- Continuous commissioning
- Occupant behavior

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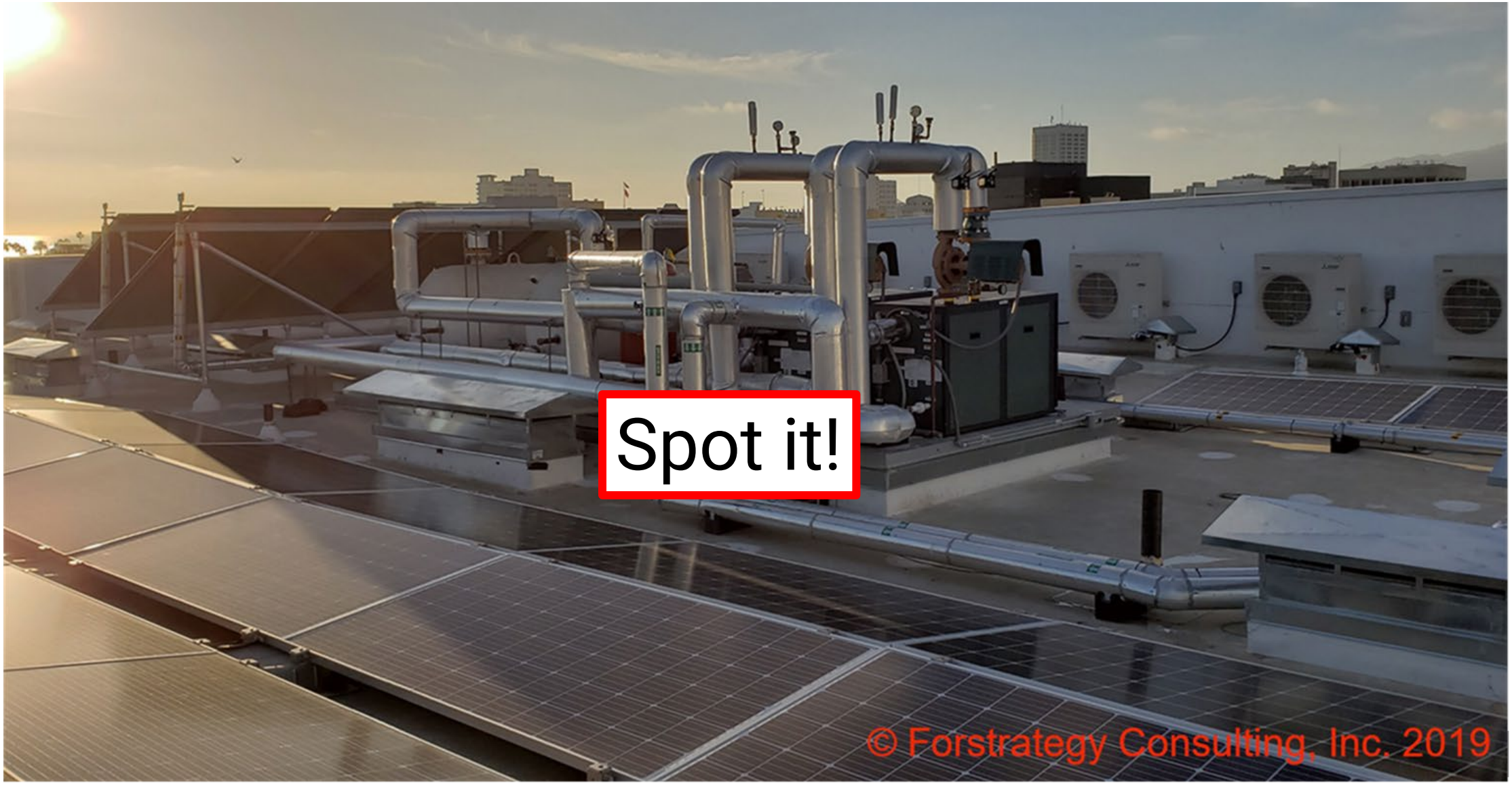
Avoid Common Missteps

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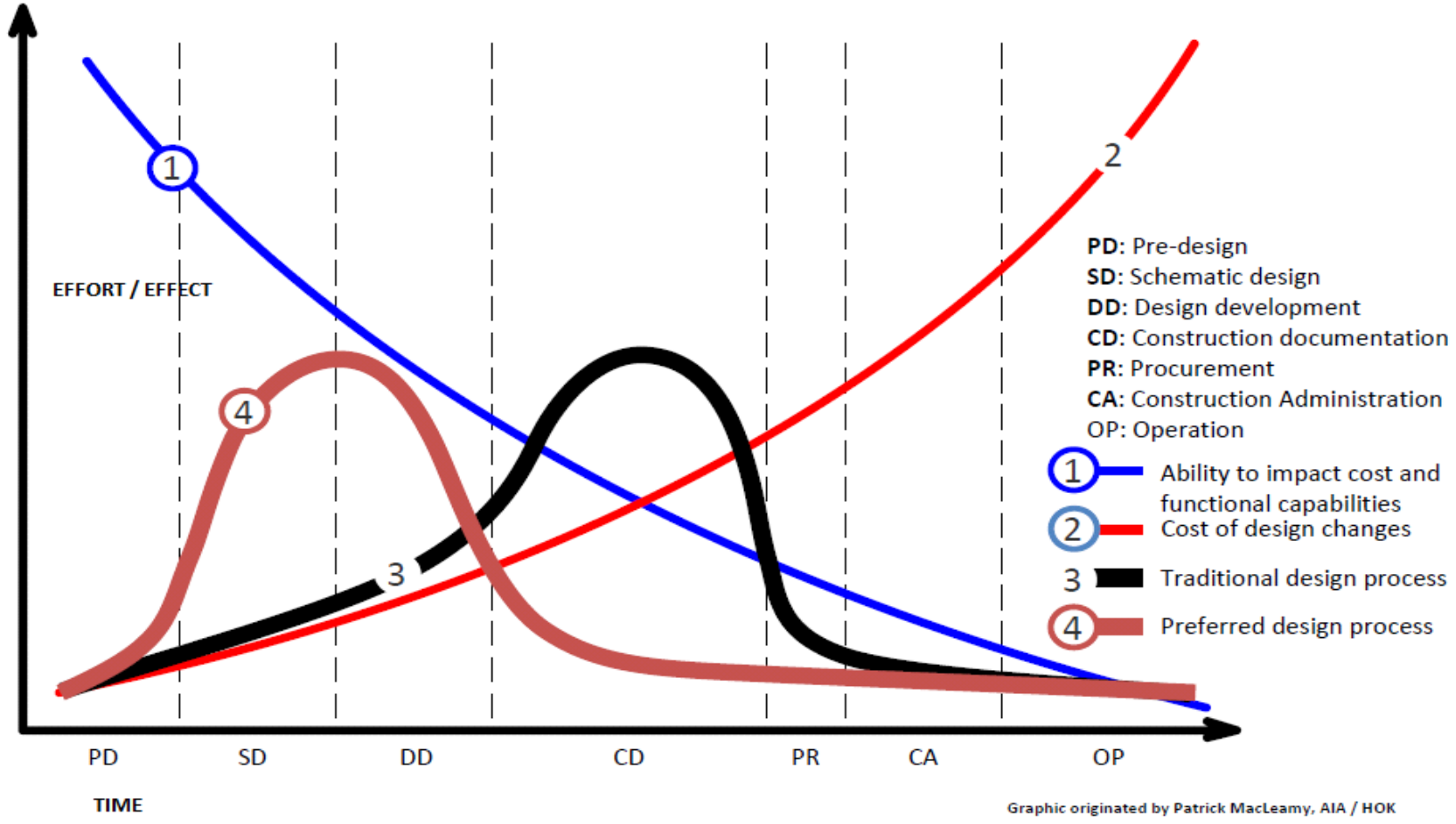
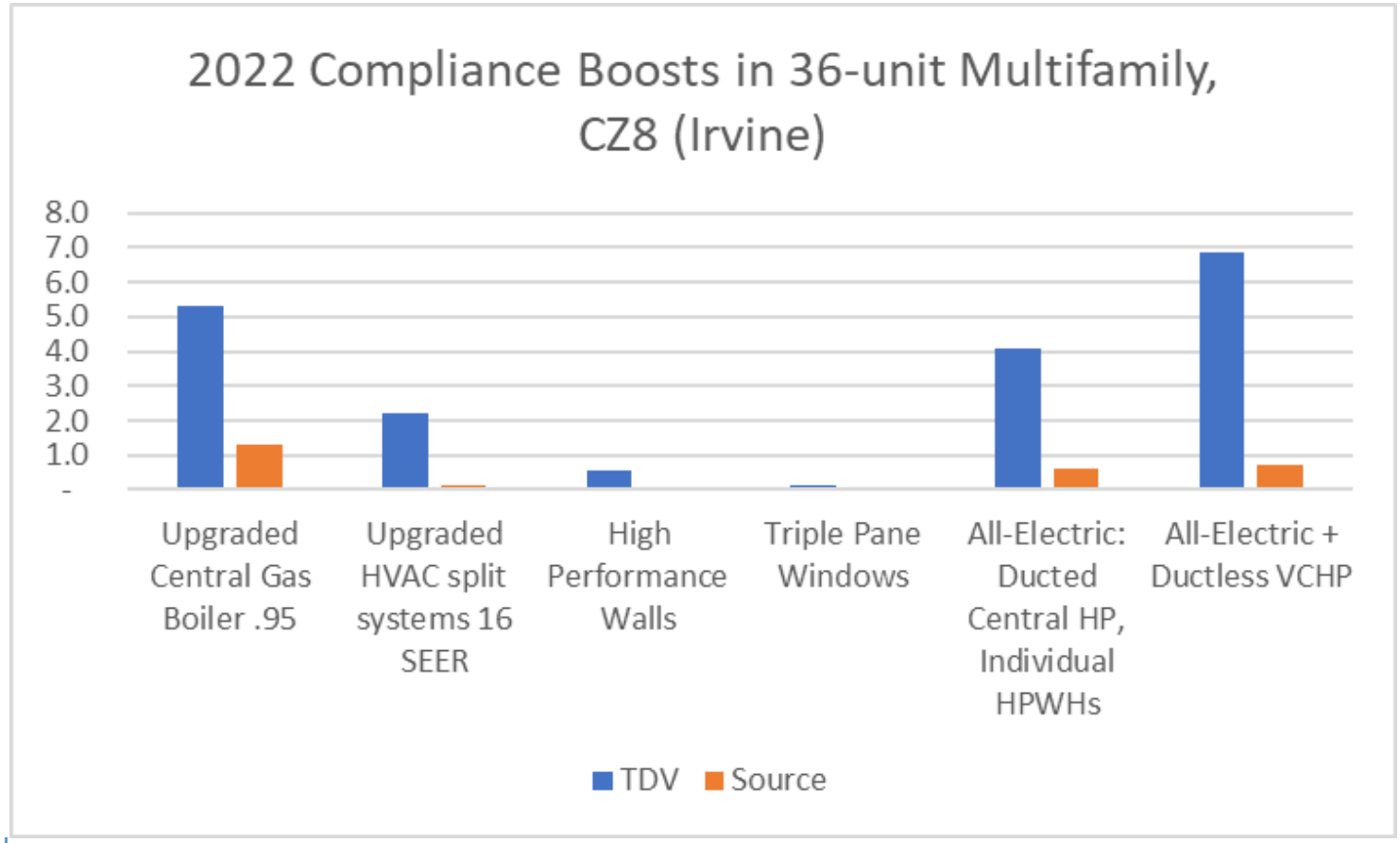
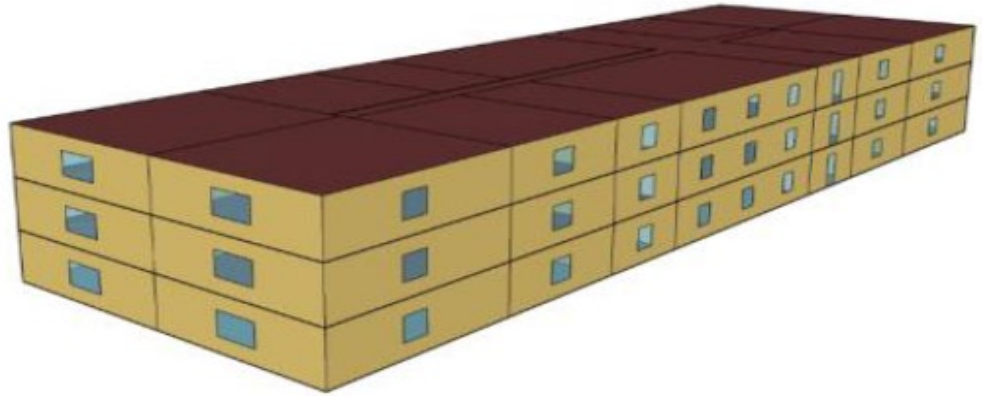
How/When Do We Fix it?



Easier Code Compliance



- In a 36-unit Multifamily building in Climate Zone 8 (Irvine):
  - All-electric with VCHP helps energy code compliance most
  - Only upgraded central boiler with solar thermal system provides bigger boost



Summary and Resources

Ideal All-Electric Home Design

- High-performance envelope
  - Well-sealed
  - High performance walls & attics with continuous insulation
- Passive Solar Orientation & Shading
- High-efficiency Ductless Minisplit Heat Pump
- NEEA-rated Heat Pump Water Heater
- Heat Pump clothes dryer
- Induction cooktop and electric oven
- Recovery Ventilator for fresh air
- LED lighting
- Size PV to cover electricity use & EV charging

All-Electric Summary

- Technologies are ready
- Systems are lower cost
- 45% GHG emissions reduction vs dual fuel
- Healthier indoor air
- Title 24 compliance boost of 7 Efficiency EDR points & 19 Source EDR Points on average
- Compatible with PV panels
- Safe from natural gas hazards

Resources

- AMA: Informing Physicians, Health Care Providers, and the Public That Cooking with a Gas Stove Increases Household Air Pollution and the Risk of Childhood Asthma
- Building Decarbonization Coalition www.buildingdecarb.org
- Rocky Mountain Institute www.rmi.org
- Net Zero Nest www.netzeronest.com
- Green Idea House www.greenideahouse.com
- Energy Vanguard www.energyvanguard.com
- Green Building Advisor www.greenbuildingadvisor.com
- Architecture 2030 www.architecture2030.org
- “Residential Building Electrification in California”, E-3, www.ethree.com
- “Induction Cooking-Here’s Why You should Make the Switch”, reviewed.com
- Tony Seba Rethinking the Future: https://www.youtube.com/watch?v=duWFnukFJhQ

Additional Tools & Resources

SCE – Building All-Electric
Building Decarbonization Coalition
"Selling Clean Energy Homes"
Redwood Energy Watt Diet Calculator
SCE Rebate Savings
Electric Vehicle Charging Association
New Buildings Institute
National Core
Indoor Air Pollution
Los Angeles Better buildings Challenge
Gas Stove Pollution
Onion Flats Projects
A Zero Emissions All-Electric Multifamily
Construction Guide Redwood Energy 2019
Ecotope HW Sizing tool

Building Electrification Action Plan for Climate Leaders
Building Electrification
A Roadmap to Decarbonize California's Buildings
Lazard Cost of Energy Analysis
SCE Rate Plan Comparison Tool

For Additional Learning Opportunities:
https://www.sce.com/business/consulting-services/energy-education-centers

Thank You!

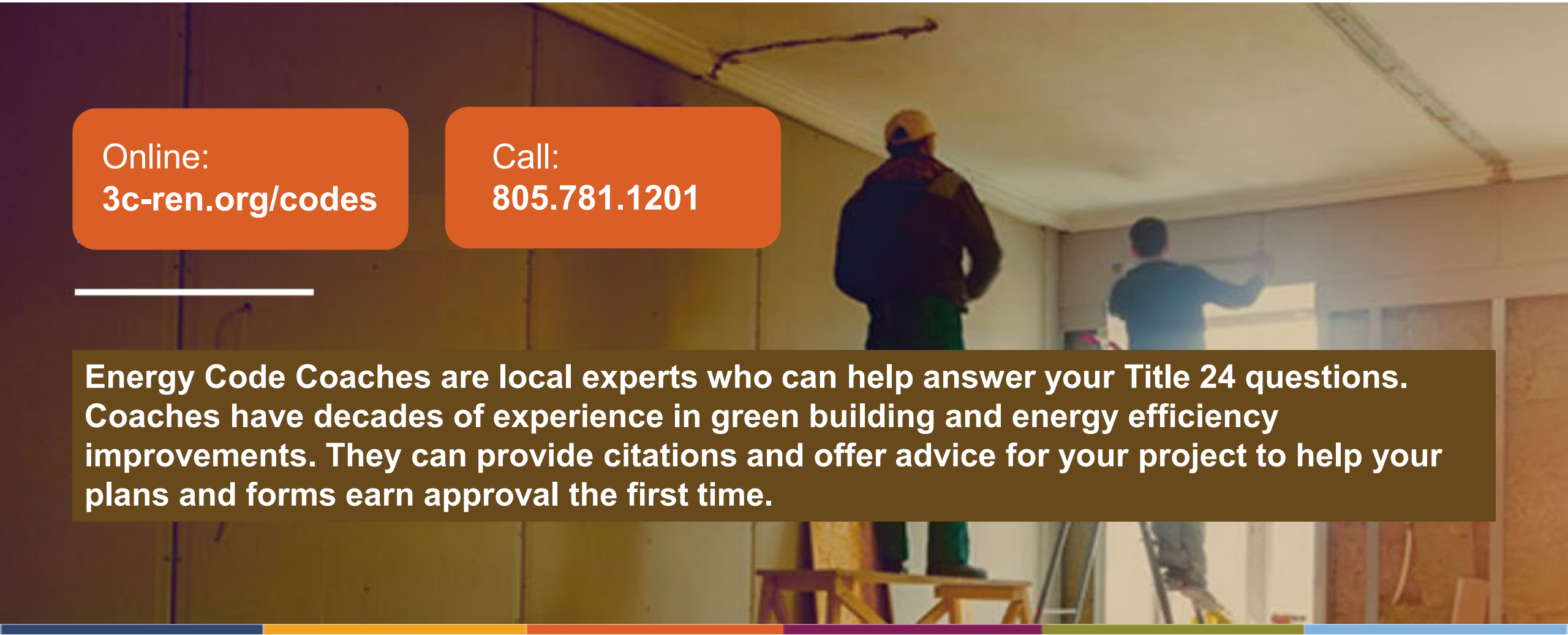
Questions??

Nick Brown - *nick@buildsmartgroup.com*

Robert Fortunato - *Fortunato@ForStrategy.com*

Questions about Title 24?

3C-REN offers a *free* Code Coach Service



Online:
3c-ren.org/codes

Call:
805.781.1201

Energy Code Coaches are local experts who can help answer your Title 24 questions. Coaches have decades of experience in green building and energy efficiency improvements. They can provide citations and offer advice for your project to help your plans and forms earn approval the first time.

Closing

- Continuing Education Units Available
  - Contact nnewman@countyofsb.org for AIA LUs
- Coming to Your Inbox Soon!
  - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
  - July 15th - Increasing Referrals for REALTORS
  - July 18th - Carbon Reduction through Building Electrification- Part 1: All Electric Design and Construction Series
  - July 19th - Zoning for Heat Pumps- Strategies for Best Outcomes
  - July 24th - Introduction to Passive House Retrofits
  - August 8th - Heat Pumps for Heating and Cooling- Part 2: All-Electric Design and Construction Series
- Visit www.3c-ren.org/events for our full catalog of trainings.

Thank you!

For more info:
3c-ren.org

For questions:
info@3c-ren.org

3C REN

TRI-COUNTY REGIONAL ENERGY NETWORK

SAN LUIS OBISPO • SANTA BARBARA • VENTURA