

All-Electric Accessory Dwelling Units (ADUs)



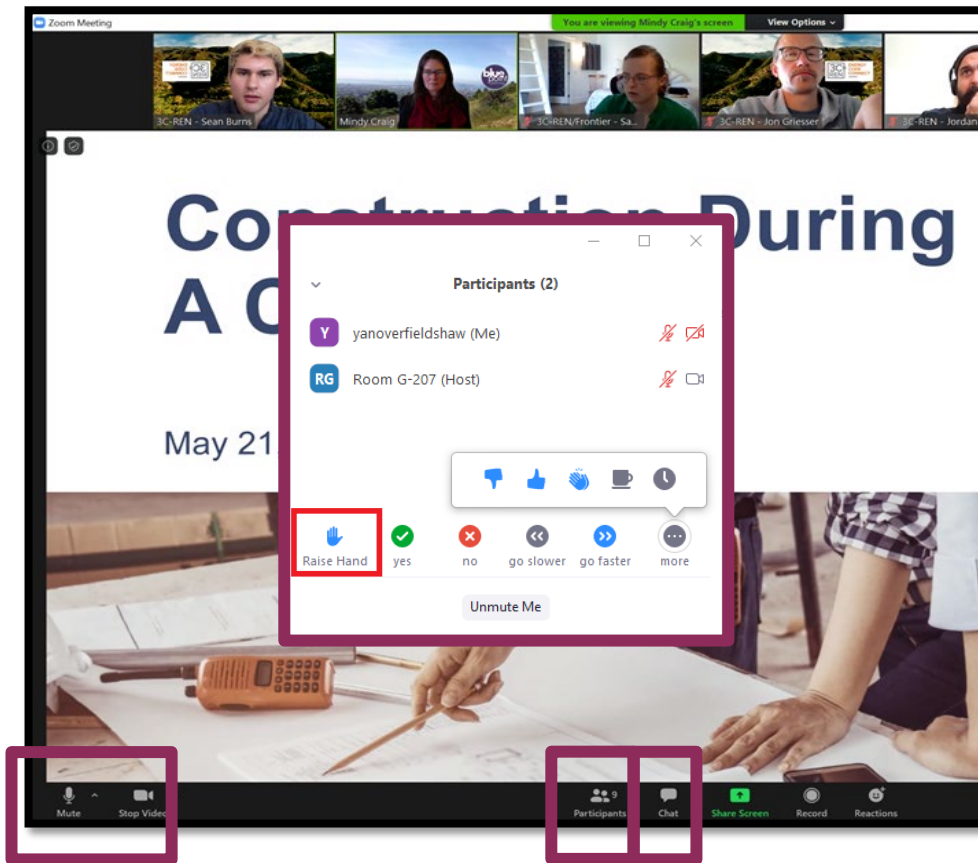
Nick Brown - Build Smart Group

September 12th, 2024



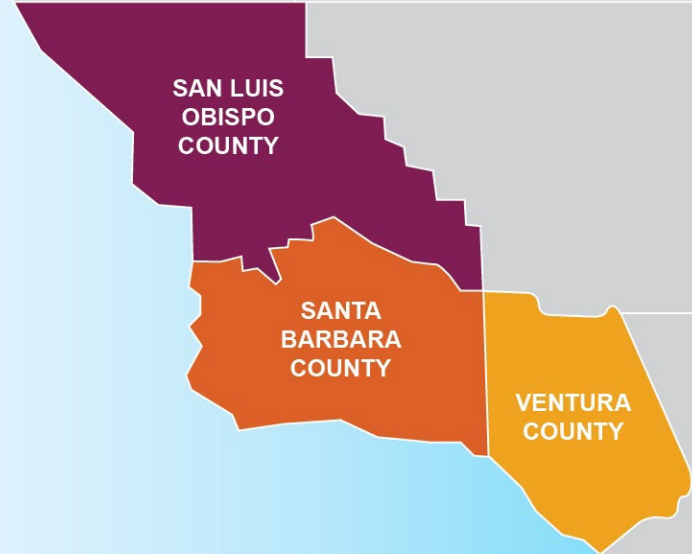
Zoom Orientation

- 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





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





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





All-Electric Accessory Dwelling Units (ADUs)

Nick Brown - Build Smart Group

September 12th, 2024



Nick Brown

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



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 various

All-Electric

Demyth-o

Energy Standards for Residential Architects

Net-zero Design Energy for What's AheadSM

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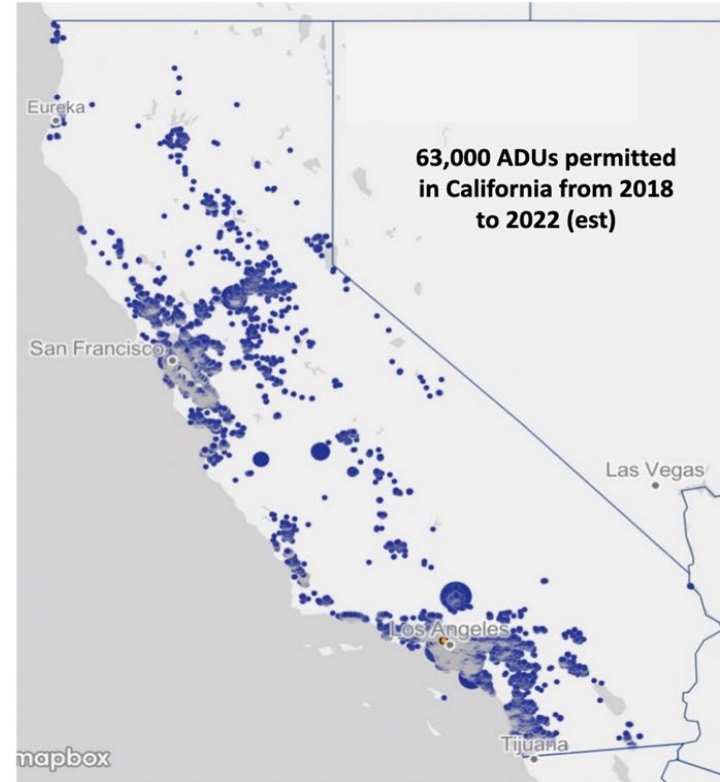
**What do you first think of
regarding ADUs?**

ⓘ Start presenting to display the poll results on this slide.

ADUs are 20% of California Housing Production

ADUs: A California Success Story

- 63,000 ADUs permitted statewide 2018 - 2022 (approx 20% of all housing types permitted)
- A new \$6 Billion industry, providing jobs & economic growth
- ADUs incentives/programs now a required part of housing planning
- Statewide leader Los Angeles—5,000 ADU permits 2021
- 73% approve of ADUs in their neighborhood (Zillow survey of 26 metros 2022)



Small housing can...



WORK QUICKLY,
EVERYWHERE
Naturally affordable,
statewide, at low-cost, with
no subsidy.



HELP FAMILIES
Weather hardships like
COVID-19 and wildfires, own
and share a home, age in
place



BOOST EQUITY,
ECONOMY, &
ENVIRONMENT
Inclusive neighborhoods,
creation of generational
wealth, homes and jobs with
small carbon footprint

ADUs adapt to changing family needs



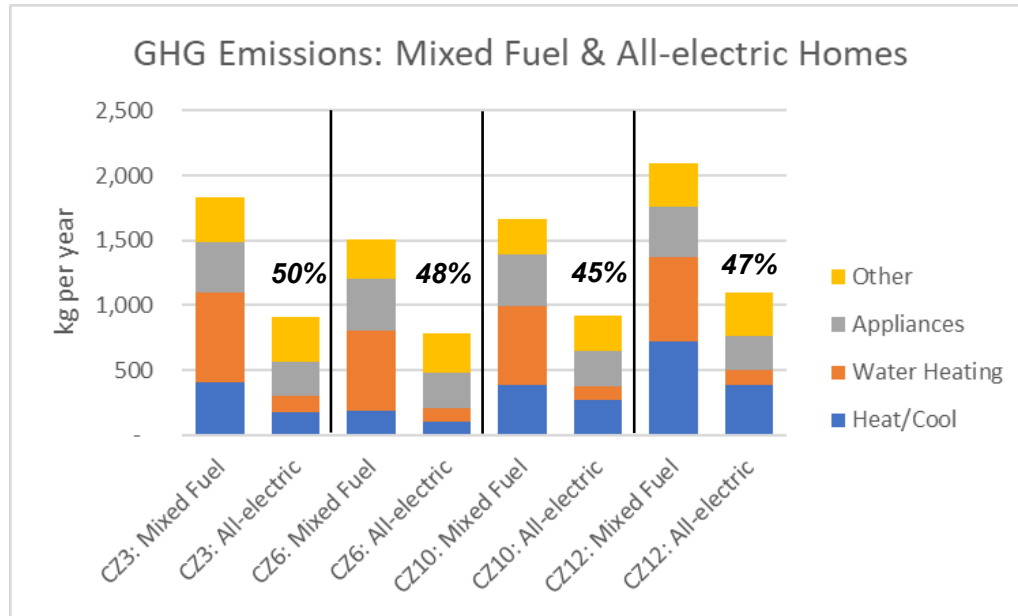
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**What do you first think of with
"all-electric homes"**

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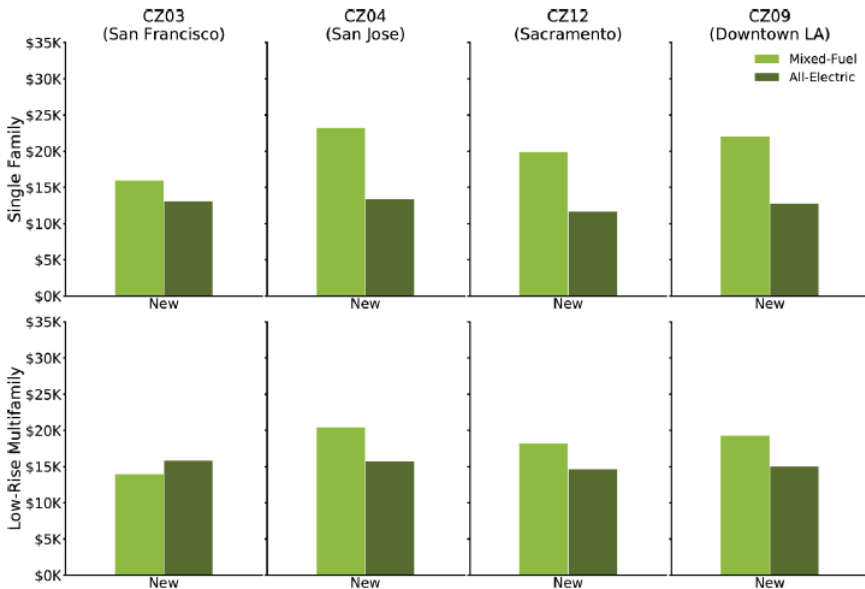
Electric Homes Have ~50% Lower GHG Emissions



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

All-Electric Homes Can be Lower First Cost

Figure 3-8 Capital costs per unit of all appliances (HVAC, water heater, stove, and clothes dryer) and infrastructure (including gas connection costs) for new construction



*“Residential Building Electrification in California”,
E3, April 2019*

ADU Cost Comparison-Gas vs Electric

End Use	Cost Gas	Cost Electric
Heating & Cooling	Central Gas furnace + A/C \$10,000	Ductless Minisplit Heat Pump \$10,000
Water Heating	Gas Tankless \$2,600	Heat Pump WH \$2,900
Cooking	Frigidaire Gallery Gas Range w/ Air Fry 30” \$2,000	Frigidaire Gallery Induction Range w/ Air Fry 30” \$2,100
Clothes Drying	Gas Dryer \$800	Heat Pump Dryer \$1,300
Total	\$15,400	\$16,300

Why We Chose Net Zero Energy in 2015

2015

- All solar was helpful to the grid
- We treated gas and electric interchangeably
- Energy modeling software had old hourly factors and gas baselines

TODAY

- PV exported to the grid has less value
- We understand all-electric has GHG advantages over mixed fuel
- Energy modeling software has updated hourly factors that better reflect today's grid and reward heat pumps

Why We Chose Net Zero Carbon for ADU

- Buildings are 25%+ of California emissions
- To fight climate change, we need to (1) reduce building energy use and (2) power with renewables
- Net Zero Energy ignores important aspects:
 - GHG emission differences between gas and electric
 - Time of Use

This ADU:

- All-electric yields 28% GHG reduction (before PV)
- 12 PV panels produce up to 4 kW that grid doesn't have to supply
- Fully offsets its grid usage with onsite PV production (over the course of the year) in terms of Carbon emissions
- Utility bills of \$142 per year

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What is the difference between Zero Net Energy (ZNE) and Zero Net Carbon (ZNC)?

ⓘ Start presenting to display the poll results on this slide.

ADU-related Energy Code Changes in 2022

EXCEPTIONS

- No PV required in new ADUs if PV size < 1.8 kW
- Electric tankless water heater OK if < 500 sqft
- No whole house fan required if < 500 sqft

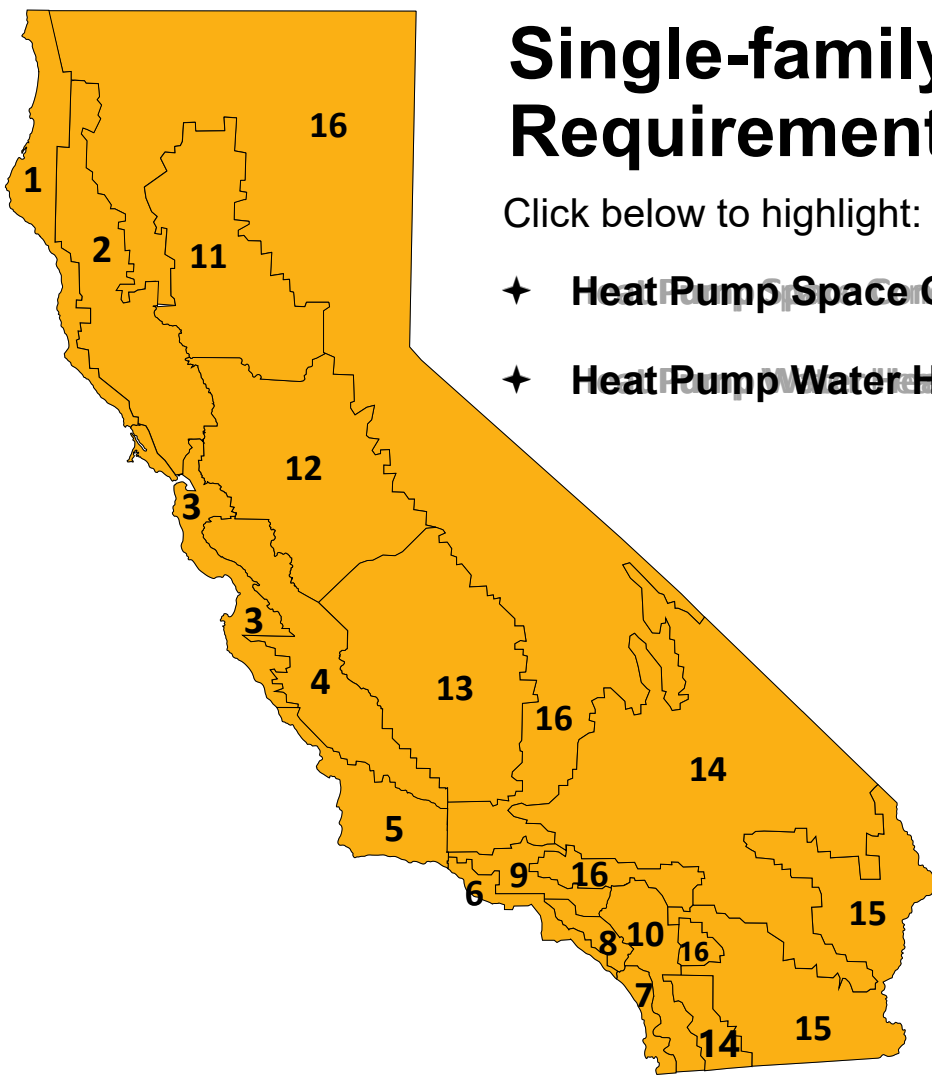
HIGHLIGHTS

- Heat pump water heaters standard in all CZs
 - Gas tankless OK in 3,4,13,14 if paired with HVAC heat pump
- Gas systems required to be electric-ready
- All new homes must be battery-ready
- Minisplit compliance credit

Single-family Prescriptive Requirements for Heat Pumps

Click below to highlight:

- ✦ Heat Pump Space Conditioning
- ✦ Heat Pump Water Heater



Existing Exceptions for ADUs

- Conversions of existing unconditioned space comply as Additions, not New
 - No PV required for ADUs complying as Additions
- Existing walls becoming part of ADU need only have cavity insulation
- R-22 roofs allowed in Alterations and Additions < 700 sqft

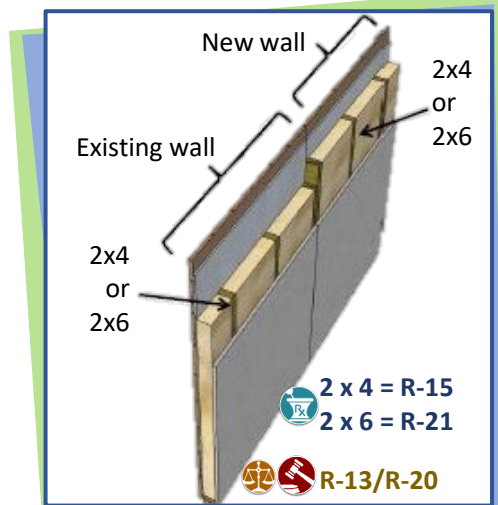
Courtesy of [Energy Code Ace](#)

Public



Extended or Converted Wall

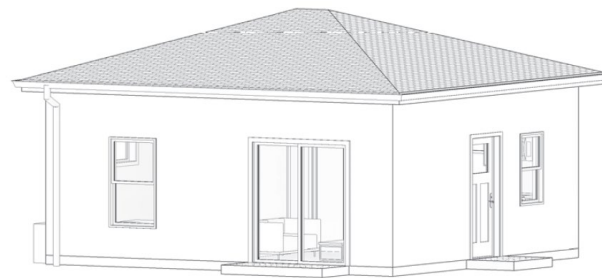
- Existing wall with existing siding not removed or replaced
- New wall extended from existing wall



Typical All-electric ADU Designs for 2022 Code



*Images
Courtesy of
ADU Homes*



1,100 sqft ADU in Climate Zone 12

- Ducted minisplit heat pump
- Heat pump water heater in garage
- Electric appliances
- Minimum 2.2 kW PV array
- 2x6 R-21 walls
- 2x12 R-38 cool roof
- Windows vinyl U=0.30/SHGC=0.23

440 sqft ADU in Climate Zone 3

- Ductless minisplit heat pump
- Electric tankless water heater
- Electric appliances
- No PV array required (< 1.8 kW exception)
- 2x6 R-21 walls
- R-38 attic or vaulted ceiling
- Windows vinyl high-gain U=0.30/SHGC=0.50

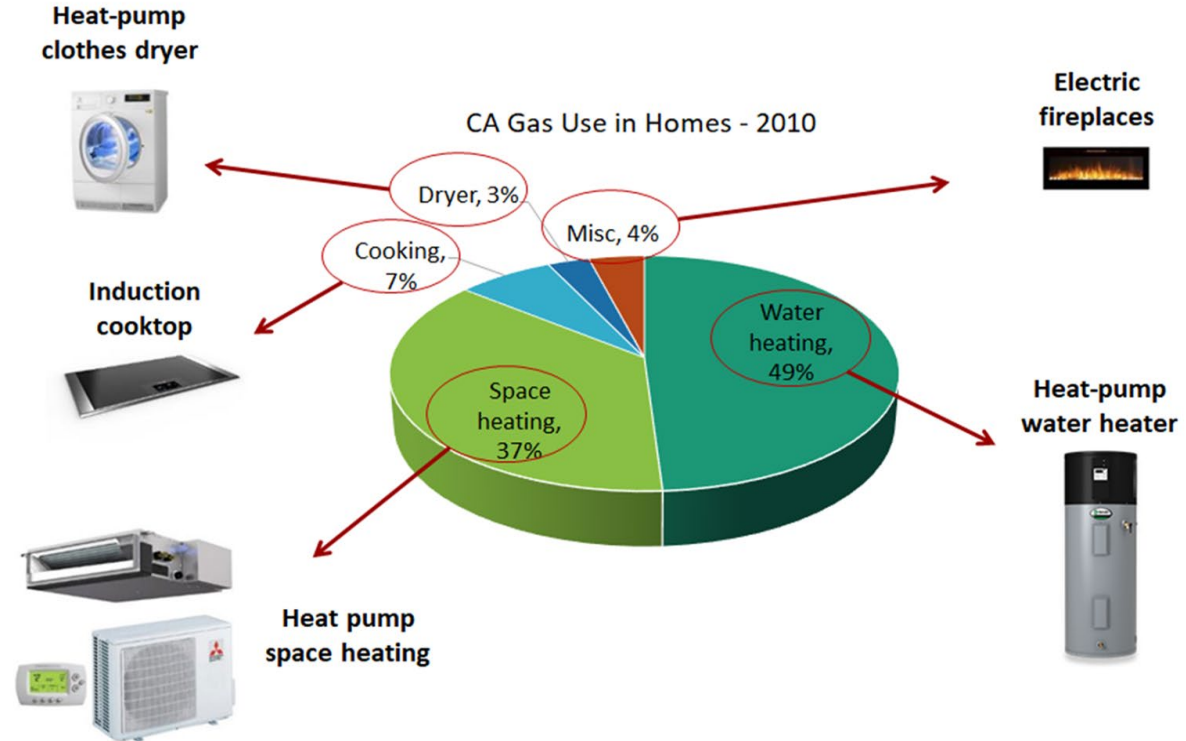
High-Performance ADU Design for 2022 Code

- Ductless minisplit (or ducted)
- Heat pump water heater
- Induction range
- Heat pump dryer
- High-performance envelope plus air sealing
- Larger PV system
- Heat recovery ventilator
- EV charger
- Battery storage system



Systems to Build All-Electric

- Heat pump water heaters
- Heat pump HVAC
- Induction cooking
- Heat pump Dryers
- Transformers/Electrical panel

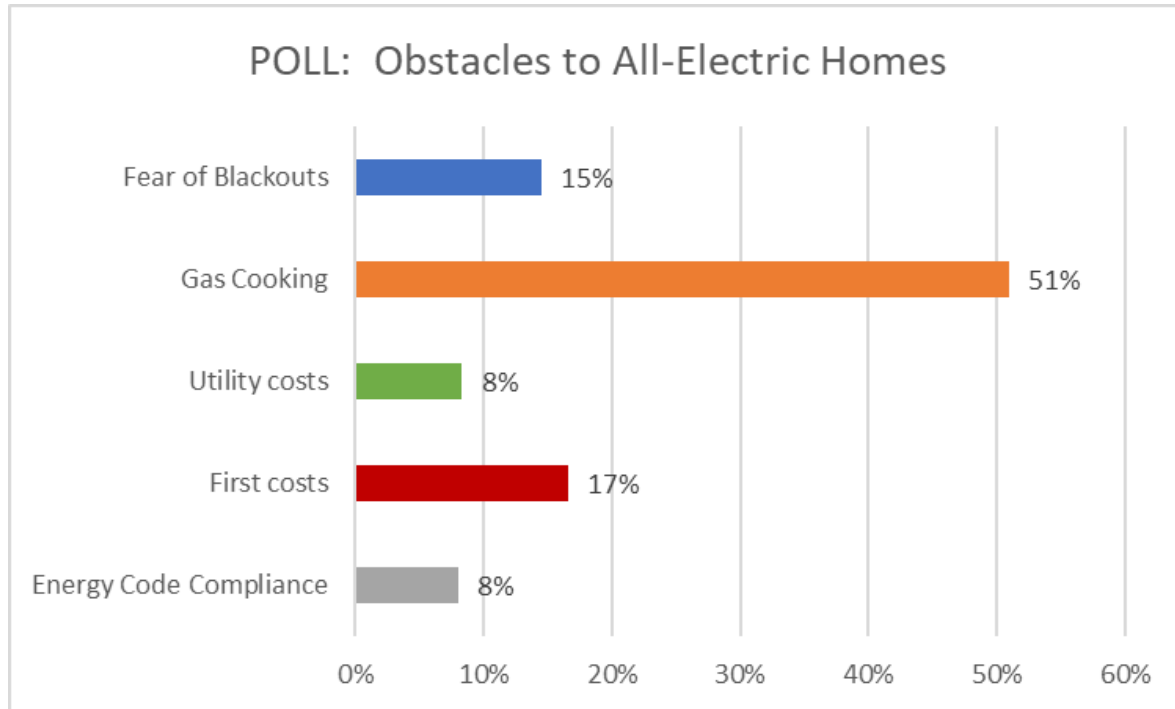


Induction Cooktops

- 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



CABEC Poll Taken September 2020



N=44 respondents

Public

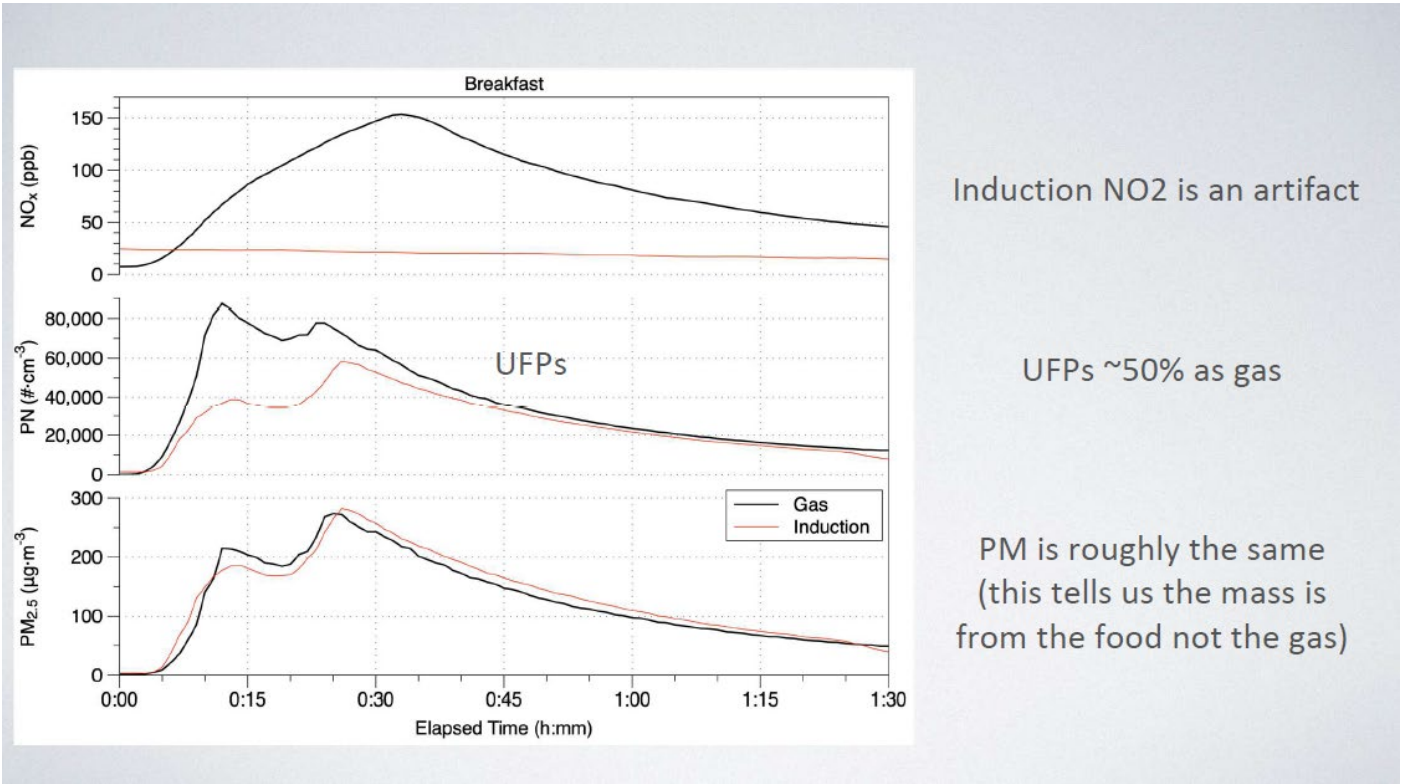
IAQ Better Without Gas in the Home

Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California

- American Medical Association: Gas Appliances Increase risk of childhood Asthma
- Prior study found 4 out of 9 natural gas cooktops exceeded NOx concentrations of 100 ppb
- UCLA study found 90% of homes exceed NOx limits after one hour of cooking
- Gas clothes dryers also create by-products
 - Venting at 150 cfm increases heating/cooling load



Cooking with Gas Means Higher NO₂ and Ultra-fine Particles



Induction NO₂ is an artifact

UFPs ~50% as gas

PM is roughly the same
(this tells us the mass is from the food not the gas)

Source: Woody Delp, LBNL Study Teaser, Dry Climate Forum 2023

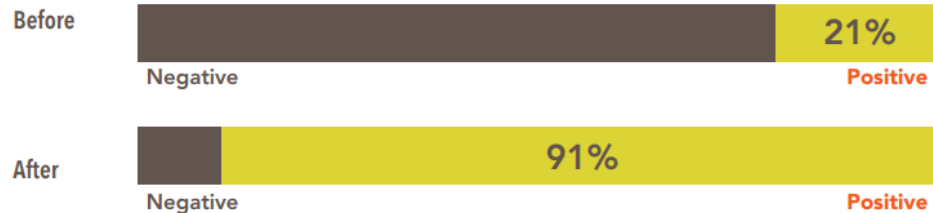
Preference for Gas Cooking – Real?

Induction: SMUD's cooking now



Customer research

SMUD customer panel: How would you rate your impression of induction cooking before and after trying the induction cooktop?



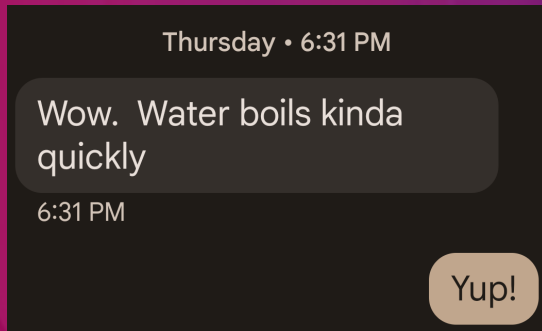
<http://2019.utilityforum.org/Data/Sites/5/media/posters/smud-induction-infographic-poster2.pdf>

Great Looking and New Products Coming



Public

One Friend Discovers Induction



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After this section on Induction cooking, what are your impressions of Induction compared to gas cooking? Pros and cons?

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Electric Heat Pump Water Heaters

- Less expensive to install, operate and maintain
- 3x more efficient than gas tankless and electric
- New 120V “plug-in” models on market for retrofits
- Can perform grid support function as a thermal battery
- Stores 50 gal. fresh drinking water
- Dehumidifies & cools garages and surrounding spaces
- Requires careful placement for air volume and sound
- ADU’s 50gal using 20-35 kWh per month



Location, Location, Location



Basement or Garage
(min 700 cubic feet)



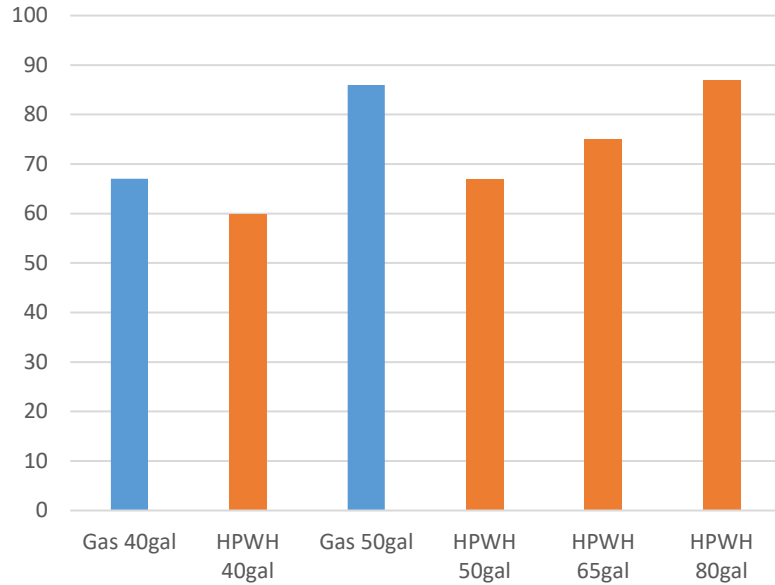
Outdoor closet
(needs fully louvered door)
Public



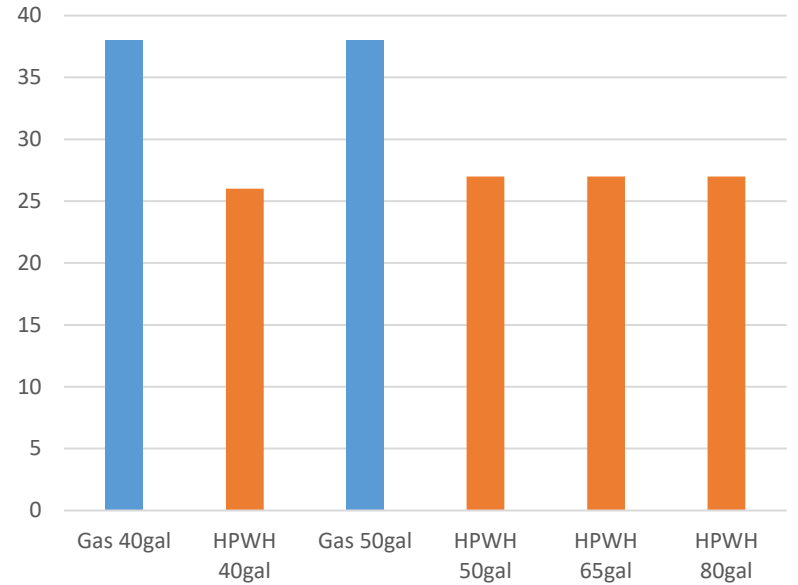
Indoor closet
(needs fully louvered door)

HPWHs are Energy Sippers

Water Heater First Hour Rating, gph



Water Heater Recovery Rate gph



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What are some of the important installation challenges for Heat Pump Water Heaters in ADUs? (check all that apply)

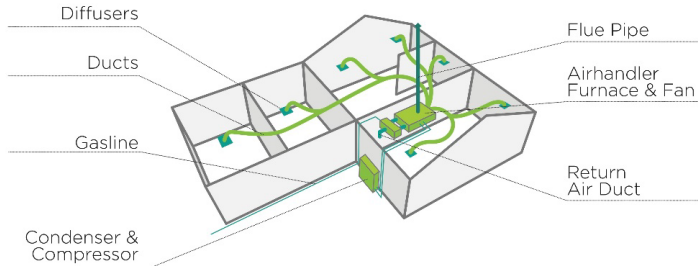
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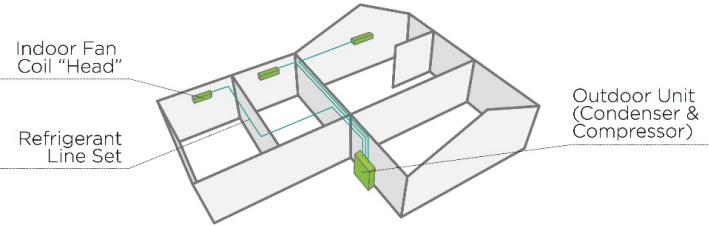
Heat Pumps are Reversible Air Conditioners

Mini-Splits Ideal for ADUs

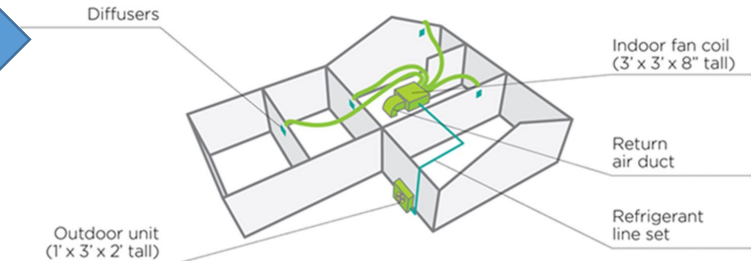
No. 1: Conventional Gas/Electric Split System



No. 3: Ductless Mini-Split



No. 4: Ducted Mini Split System



Ductless Minisplit Heat Pumps

- Move heat with refrigerant
- No energy loss from ductwork
- Can link multiple indoor units to one outdoor (multisplit)
- Maximum use of modulating technology
- Solid compliance credit available through VCHP



ADU has Ductless Minisplit Heat Pump



Public

Ceiling Cassettes: Alternative to High Wall Indoor Units



Ducted Minisplit Heat Pumps

- Traditional aesthetics
- Limited duct losses
- Modulating technology
- New compliance credit coming for ducted minisplits in 2023 (Detailed VCHP)



Ducted Minisplit Heat Pumps



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Packaged Unit Heat Pumps



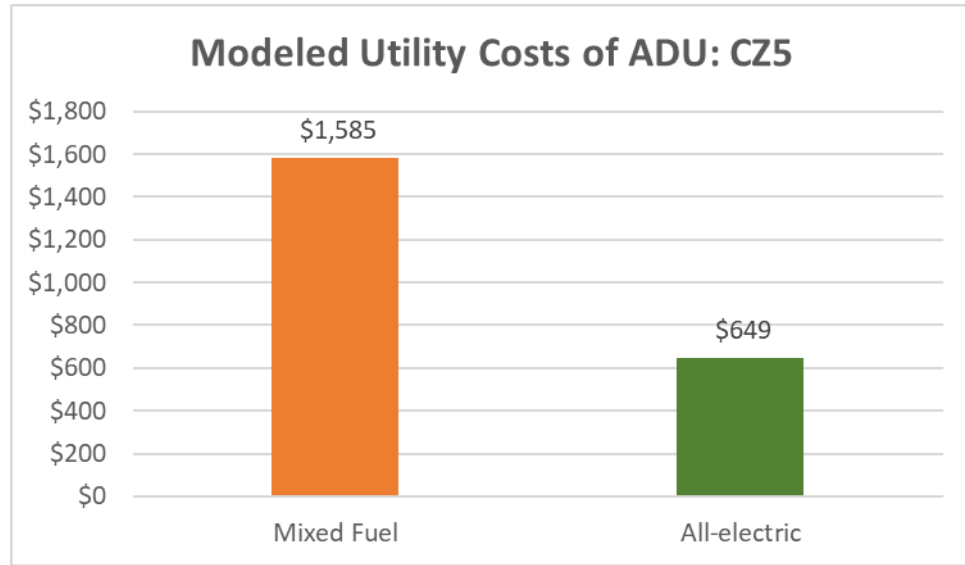
Heat Pump Clothes Dryers

- 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 (10-15 kWh/month)



Expected Utility Costs – TOU rates

- This ADU with typical gas systems would cost \$1,103 electric and \$482 gas to operate
- Built All-electric with 12 PV panels and other upgrades and it will cost only \$649 to operate
- Similar results in CZ 3 & CZ12 (San Francisco & Contra Costa)
- ROI of \$936 savings/\$9,000 cost = 10% (plus no gas meter, protection from gas rates, IAQ, comfort, rebates)



Mixed fuel design: Gas tankless DHW, Gas furnace & 16 SEER A/C, typical envelope, No PV

All-electric design: Heat Pump DHW, Ductless Minisplit, HRV, SIPS, 4.0 kW PV

Calculations using PG&E E-TOU-D rates (mixed fuel) and E-ELEC rates (all-electric) and NEM3 as of September 2024

Shell before E(lectrics), except after 'C'

- Money spent on building shell produces savings for 100+ years
 - Money spent on PV and mechanical systems requires maintenance and has 10-20 year lifespan
- Even in an All-electric NZC home, specify an insulated and tight envelope!
- High-performance walls (even factory panels like SIPS)
- High-performance attics and roofs
- Air sealing, caulking, and sealing penetrations
- Today's fantastic windows and doors with attention to the South & West

Lessons Learned from this Project

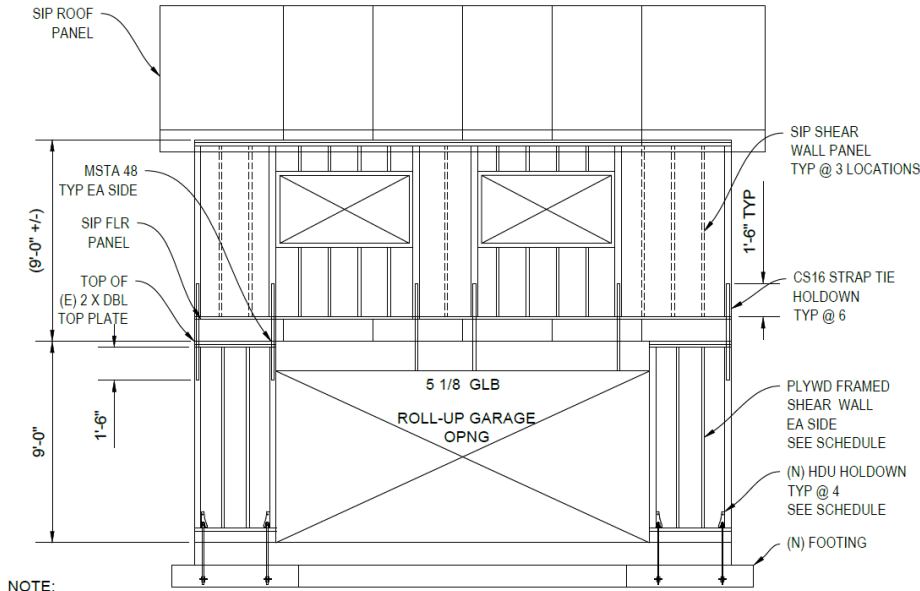
- All-electric systems are performing well
- Checking on systems (commissioning) pays off
- SIPS go up fast, but require planning & coordination
- IAQ: Simple HRVs are a great upgrade for healthy spaces
- Vaulting possible with SIPS, HRV, ductless minisplit combination
- Building above an old garage requires lots of foundation work
~\$12,000
- Net Zero Carbon upgrades cost ~\$15,000
- \$500/square foot cost of construction

SIPS Panels: Comparable Cost After 2 Projects

- SIPS factory turns architectural plans into shop drawings of panels
- Structural engineer needs to use SIPS factors in calculations
- After approval, they produce the panels and ship to the jobsite with numbered guide for assembly
- Panels joined with splines



Architectural & Shop Drawings



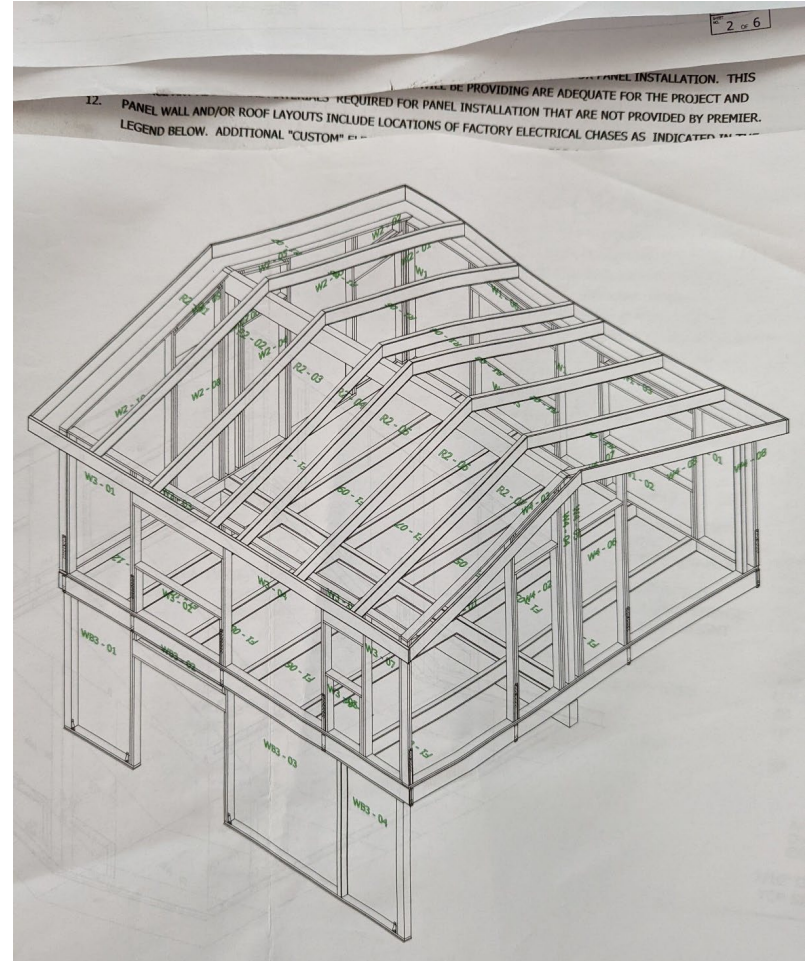
NOTE:

1. INFORMATION SHOWN IS NEW (N) CONSTRUCTION UNLESS NOTED OTHERWISE AS EXISTING (E).

3A

SOUTH WALL ELEVATION

SCALE: 1/4" = 1'-0"



Forklift set 66 Panels in 7 Days



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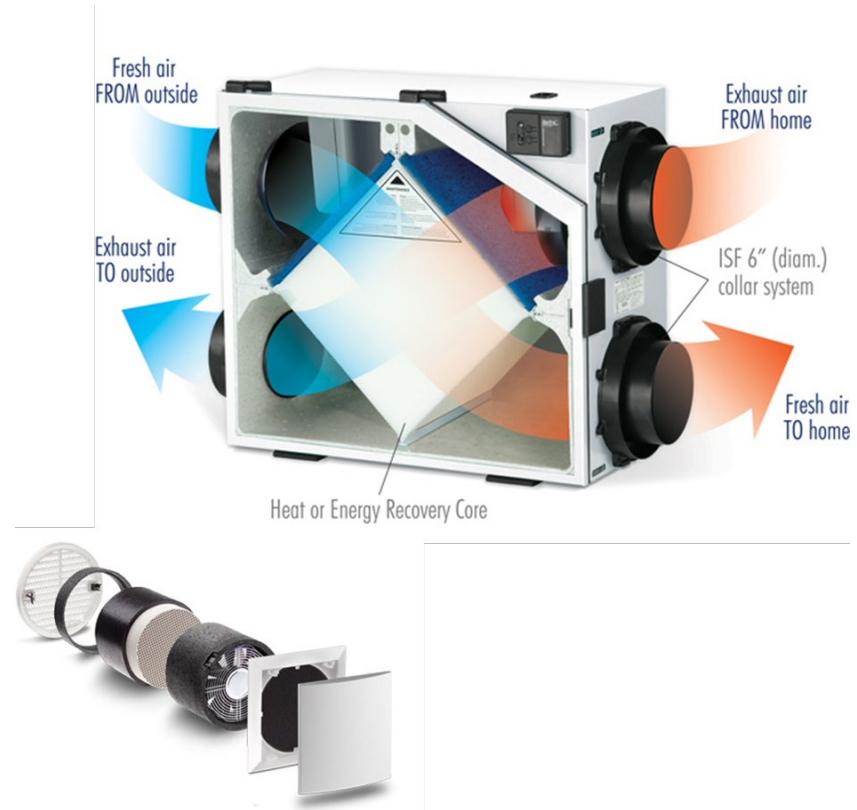
Continuous Insulation Building Shell

- Walls: 2x6 R-23
 - Equal to 2x6 R-21+R-5
- Floors: 2x12 R-45
 - Equal to 2x12 R-38+R-4
- Roofs: 2x10 R-37
 - Equal to 2x10 R-30+R-10 cathedral



Recovery Ventilators (HRVs) Are 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
- Using ~60 kWh per month



SIPS, HRV, & Ductless Mini Allows for Vaulting

- HRV replaces bathroom exhaust fan
 - Code only requires 20 cfm in bathroom if continuous
- Ductless minisplit doesn't need an attic or closet location
- SIPS are roof and insulation in one step



Cost of Net Zero Carbon Upgrades

- PV Panels: 4 kW @ \$12,000 (+\$9,000 after tax credit)
- SIPS: \$51,000 installed: cost neutral
- Ductless minisplit: \$10,000 neutral
- Heat pump WH: \$3,000 neutral
- Heat pump dryer: \$1,300 (+\$500)
- Induction range: \$1,800 (+\$500)
- HRV: \$2,000 (+\$1,800)
- 100 amp subpanel & new main \$5,600 change order neutral



Incentive Programs Can Make All-Electric Pay

- [CA Energy Smart Homes](#) \$1,600 base incentive all-electric
- [TECH](#): \$1,500-\$3,500 HPWH rebate for qualified contractors when program relaunches Fall 2025. Also \$2,000 for electrical upgrades and \$1,500 for low GWP HPWHs
- [BayREN](#): \$250 HP Dryer, \$250 induction
- Inflation Reduction Act: 30% tax credits for Heat Pumps, HPWHs, PV, and Batteries
 - Rebates ***income qualified*** up to \$8,000 Heat Pump, \$1,750 HPWH, \$840 Induction/HP Dryer, \$4,000 electrical panel Coming Soon through TECH
- [PG&E](#) Golden State Rebates: \$500-\$900 HPWH replacing gas or electric

ADU Economics

- $\$500/\text{sf} \times 576 \text{ sf} = \280K cost of construction
- Annual interest expense on $\$280\text{K}$ @ 5% = $\$10,000$ after taxes
- Other expenses (property taxes, maintenance, etc) $\$5,000$
- Total expenses $\$15,000$
- Rental & utility income $\$31,000$ in Year 1
- Net income $\$16,000$ in Year 1
- Return on investment = 6% in Year 1
- Value at completion is 100% recovered at time of sale
- Larger home value to appreciate

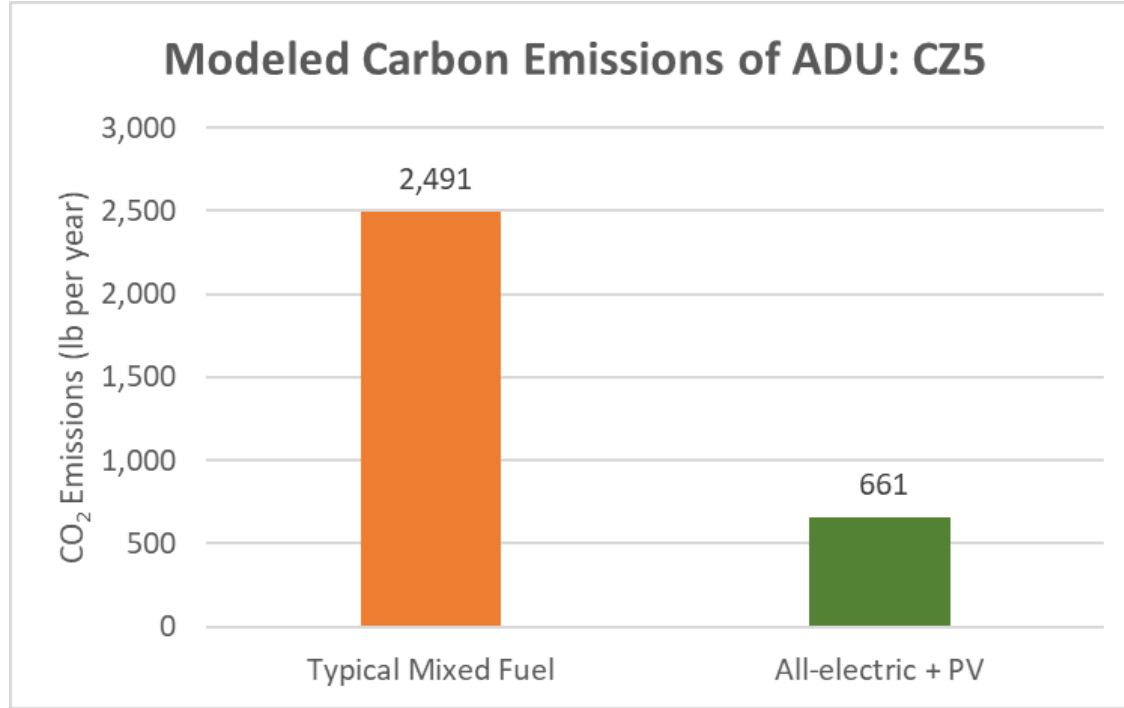
Modular ADU Economics

- 1 bed, 1 bath, 500 sf factory-built unit (Abodu)
- Cost is \$268,800 for unit + \$40,000 for site and permit costs = \$309,000 total or ~\$618 per sqft
- ROI is ~4%
- Value of property at completion is 100% recovered at time of sale
- Larger home value to appreciate
- Less work by property owner than site-built project

Source: <https://www.businessinsider.com/abodu-homes-cost-adu-california-tiny-house-photos-2023-2>



Carbon Scoreboard



Actual 1st Year Carbon Emissions

July 22 - Sep. 23 Actual Carbon Emissions

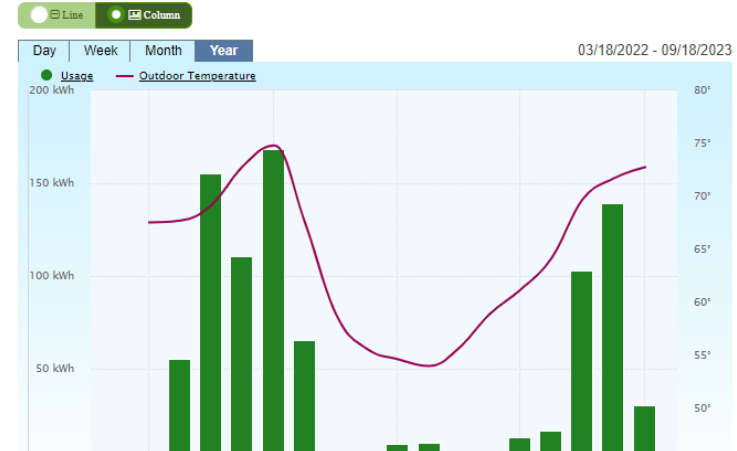


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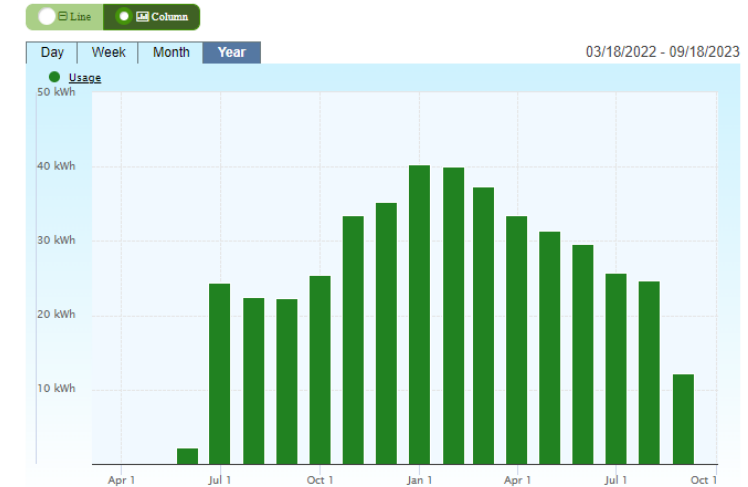
First Year Actuals

- 9.1 kWh per day Usage
 - Heat Pump: 1.9 kWh per day
 - HRV: 1.5 kWh
 - HPWH: 1.0 kWh
 - Other: 4.6 kWh
- Actual usage 28% lower than modeled
- 18.7 kWh per day Production
- First Year Was ZNC
 - 3,330 kWh annual usage
 - Typical CA household uses 6,800 kWh & 400 therms
 - This ADU uses 1/5 as much, even before PV (on btu basis)

Heat Pump



Water Heater



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How many kWh is the Electric ADU using per day? How does that compare to a typical single family home in California?

ⓘ Start presenting to display the poll results on this slide.

Small Home Utility Bills are Smaller

Winter 2022

- ADU heat pump ran 48 hours and used 5 kWh in Nov&Dec
- Main house gas furnace ran 750 hours and used 68 kWh in Nov&Dec (plus 60 therms of gas)

Summer 2022

- ADU heat pump ran 1,452 hours in July-Oct and used 386 kWh
- Main house A/C unit ran 1,347 hours in July-Oct and used 770 kWh

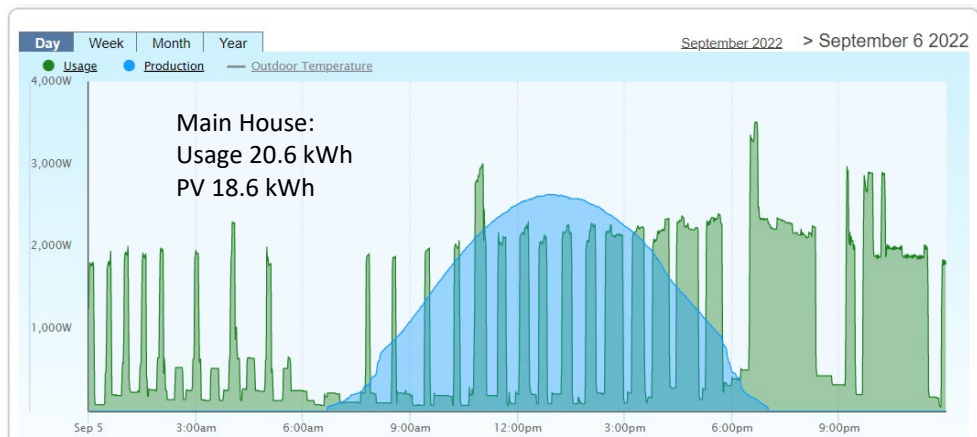
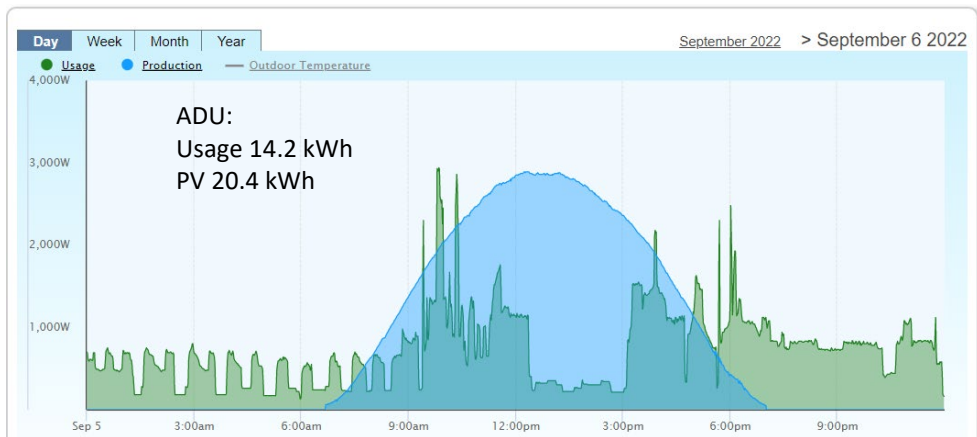
Self-consumption of PV much better in ADU

Exposure to peak electric rates much worse in main house

2022 ADU electric bills totaled \$66

2023 electric bill shows 2,000 kWh over-production through 7 months

Record Day Comparison: Sept 6, 2022



For More Information

- [PG&E Energy Education Center](#)
- [SCE Energy Education Center](#)
 - The Practical Guide to All-Electric Residential Buildings, May 2, 2023
- [Casita Coalition](#)
- [ADU California](#) by UC Berkeley
- Your City or County ([Fresno](#), [Santa Cruz](#), [Marin](#), [Napa Sonoma](#), [San Jose](#), and many more)
- [Energy Code Ace](#)
- Build Smart: nick@buildsmartgroup.com

Project Credits

- Architect: Koch+Andres
- Beginning Floorplan: ADU Homes, Inc.
- Structural Engineer: John Posadas
- General Contractor: RVM Construction & Nick Brown
- HVAC: Mitsubishi
- Water Heating: Rheem
- Appliances: Frigidaire, Miele, Asko, Whirlpool
- HRV: Lifebreath
- SIPS Panels: Premier SIPS
- SIPS Installers: Greenwalls-US

Keep in Touch



nick@buildsmartgroup.com

If you are interested in future classes, click on the link below to sign up for updates:

<https://forms.gle/LybMxbbKJMXnHvu19>

Follow us on Build Smart Group LinkedIn

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 shuskey@co.slo.ca.us for AIA and ICC LUs
- Coming to Your Inbox Soon!
 - Slides, Recording, & Survey – Please Take It and Help Us Out!
- Upcoming Courses:
 - September 24th - [Building Electrification, Passive House PER & California](#)
 - September 30th – October 4th - [Passive Design/Build Boot Camp with Emu Passive – Hands On Training and Exam \(FREE!\)](#)
 - October 3rd - [Building Tour of Four All-electric Buildings to Reduce the Carbon Footprint – 2024 Central Coast Bioneers](#)
 - October 9th - [All-Electric Retrofits with Electrical Panel Constraints](#)
 - October 10th - [Certified Passive House Designer/Consultant \(CPHD\) Pacific Fall Hybrid Cohort](#)
- 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



TRI-COUNTY REGIONAL ENERGY NETWORK
SAN LUIS OBISPO • SANTA BARBARA • VENTURA