We will be starting soon!

Thanks for joining us

Overcoming Installation Challenges with Heat Pumps

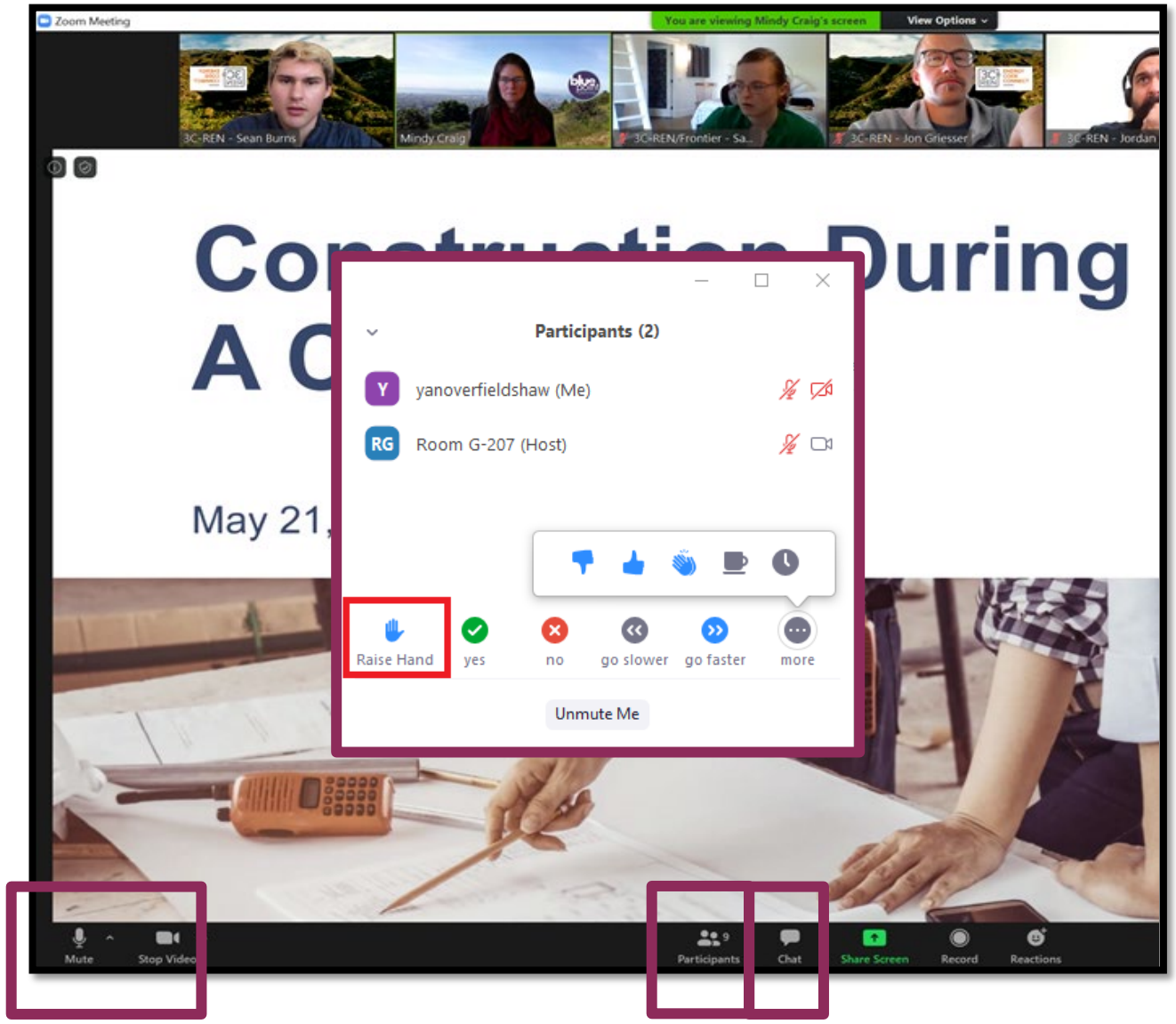
Nick Brown – Build Smart Group

Bobby Hahn – Pacific Systems Group

April 16, 2024

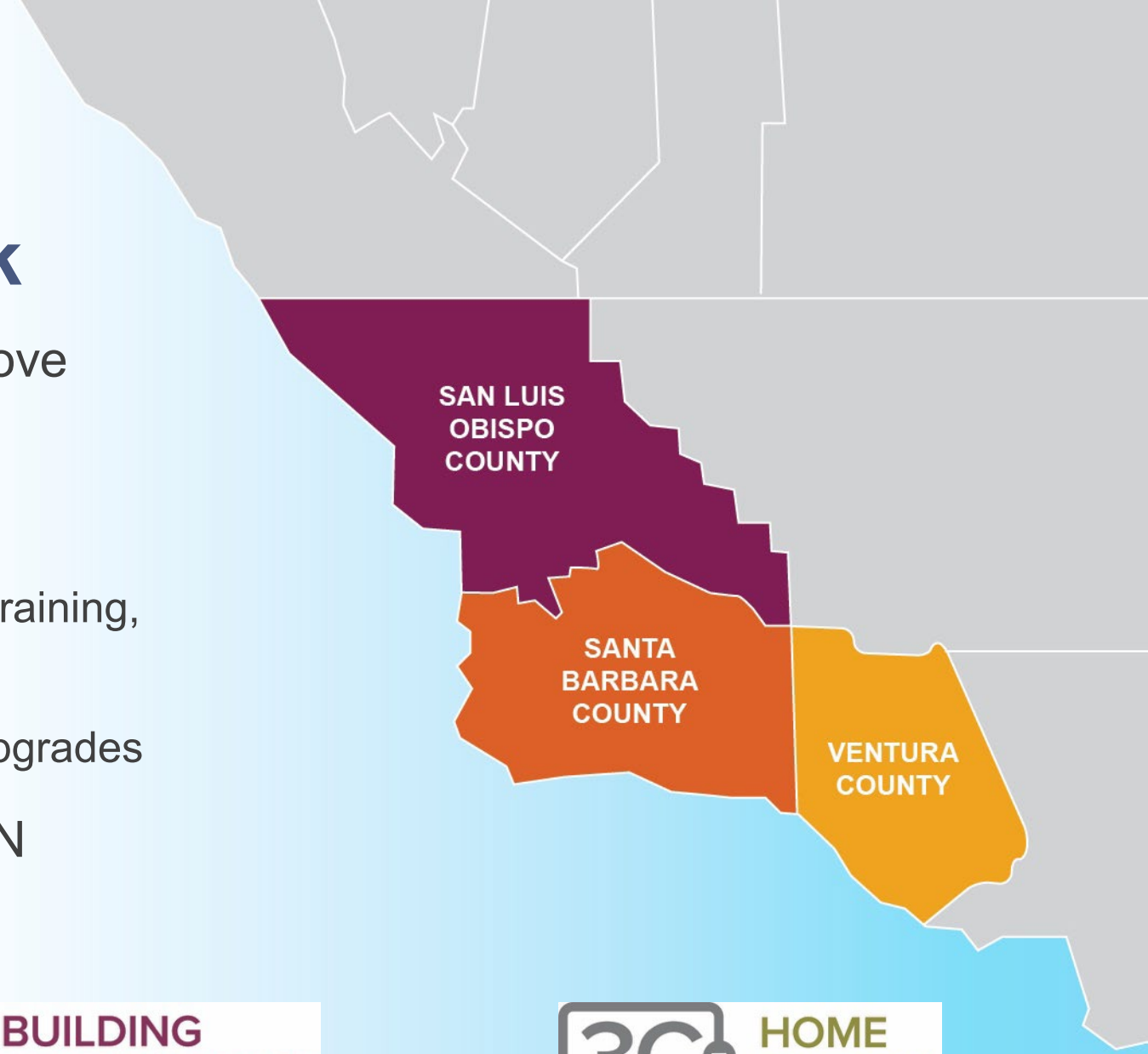
Zoom Orientation

- 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



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

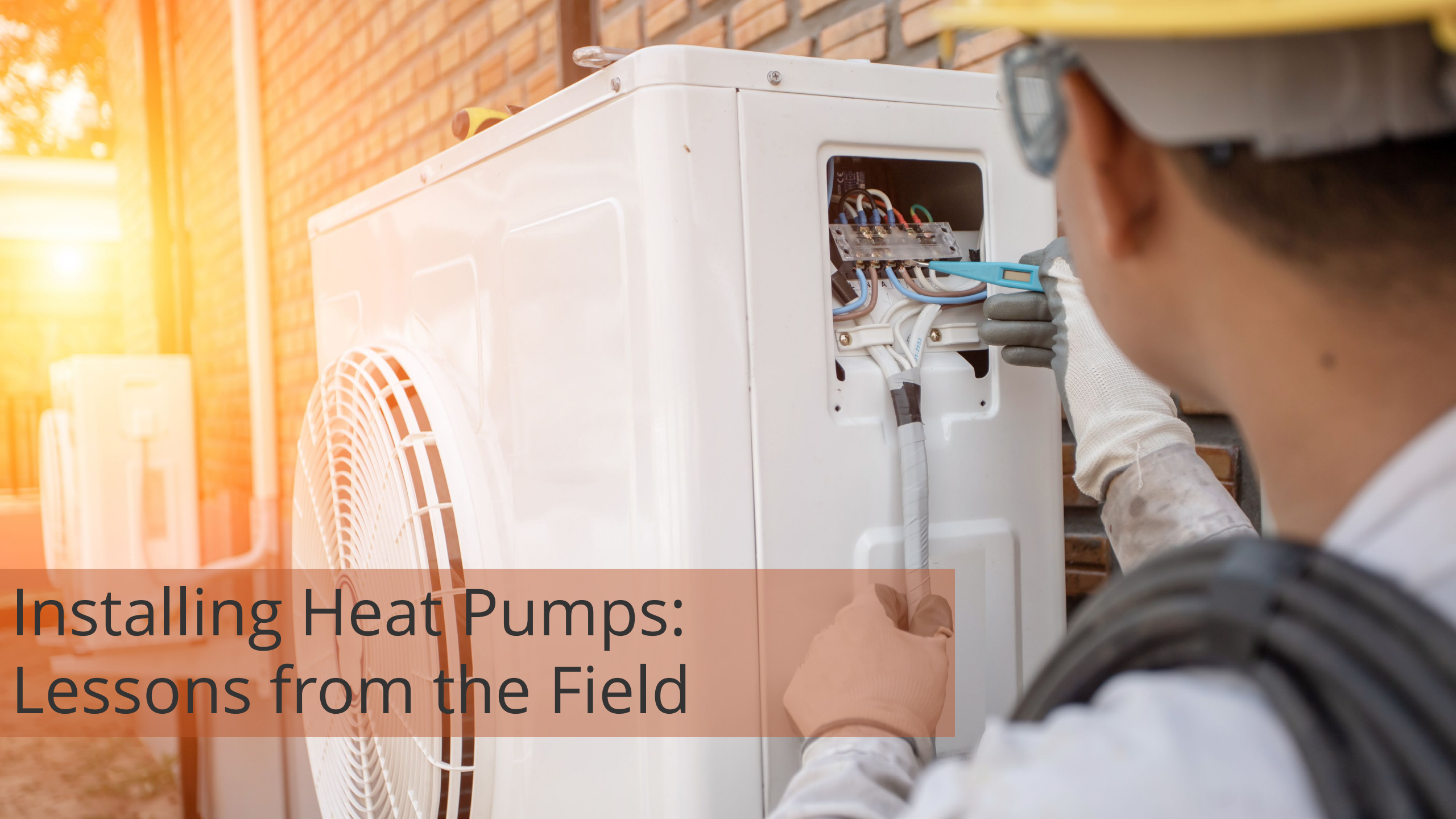
Multifamily (5+ units)

- 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



Installing Heat Pumps: Lessons from the Field

Meet your Trainers

Nick Brown

- President of Build Smart Group
- Certified Energy Analyst (CEA)
- CABEC Board Member & Member of the Year 2019
- Subject Matter Expert for Energy Code Ace, instructor for “Residential Energy Code Standards for Architects”
- CEC grant researching phase change material applications in HVAC systems
- ***nick@buildsmartgroup.com***

Bobby Hahn

- Principal at Pacific Systems Group
- 28 years in the HVACR Industry: VRF, Ductless, DX Systems, Chilled Water, Air Quality, Filtration, and Controls
- Member of CABEC, IHACI, ASHRAE, ACCA, MANA
- Past board member of Institute of Heating and Air Conditioning Industry
- ***bobby@psghvac.com***

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#hplessons

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Getting to Know You

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Goals for today

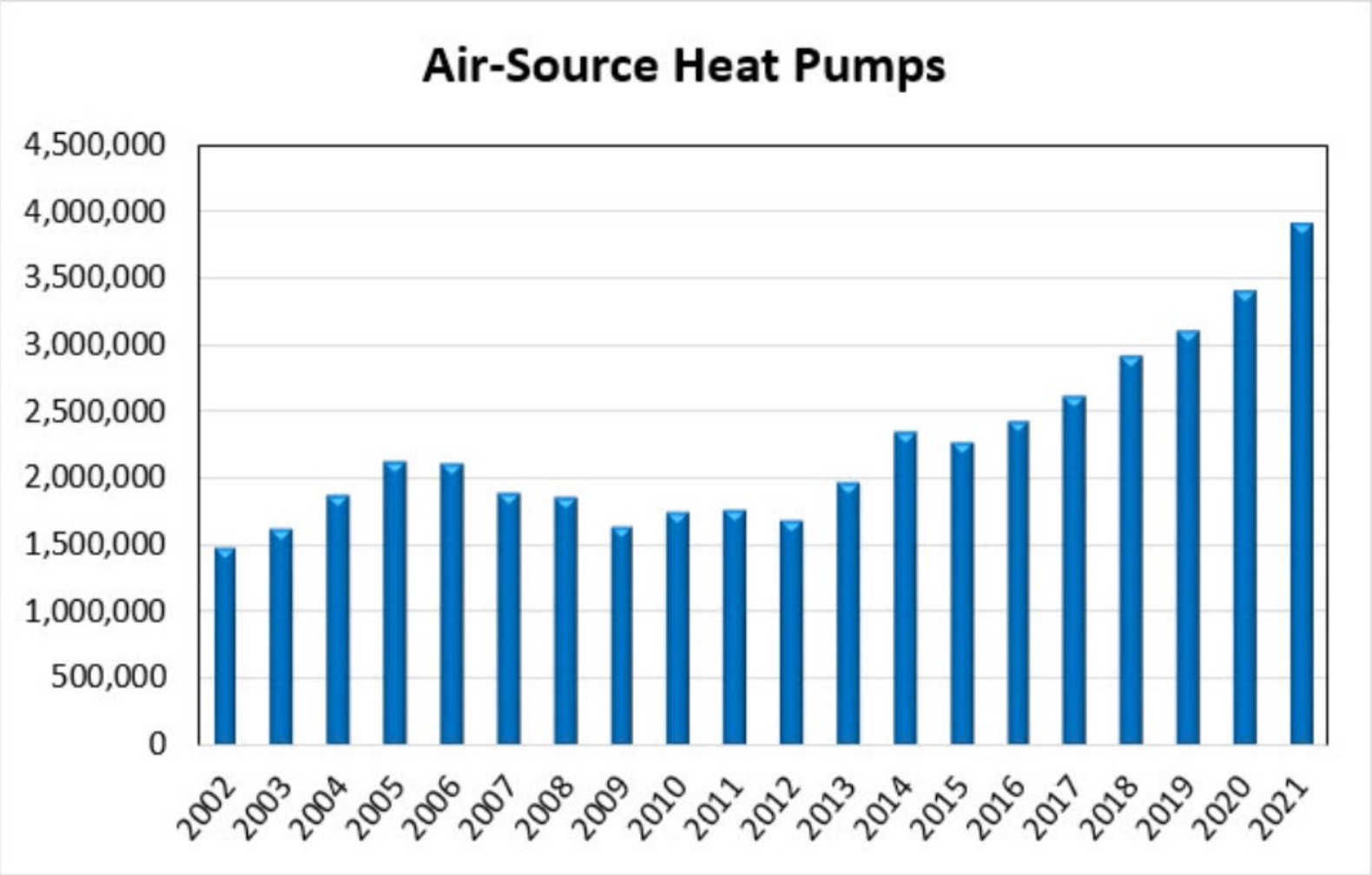
Establish the **value that heat pump HVAC systems can provide** to your business

Understand **heat pump function**, and the advantages heat pumps have over traditional gas/electric split systems

Delve into **key installation hurdles** in replacement situations, such as:

Dealing with existing ductwork	MERV-13 filtration requirements	Designing and pricing zoned system options	Ensuring cold weather performance	Sizing the heat pump system properly	Upgrading electrical panels

Goal #1: Establish the value that heat pump HVAC systems can provide to your business

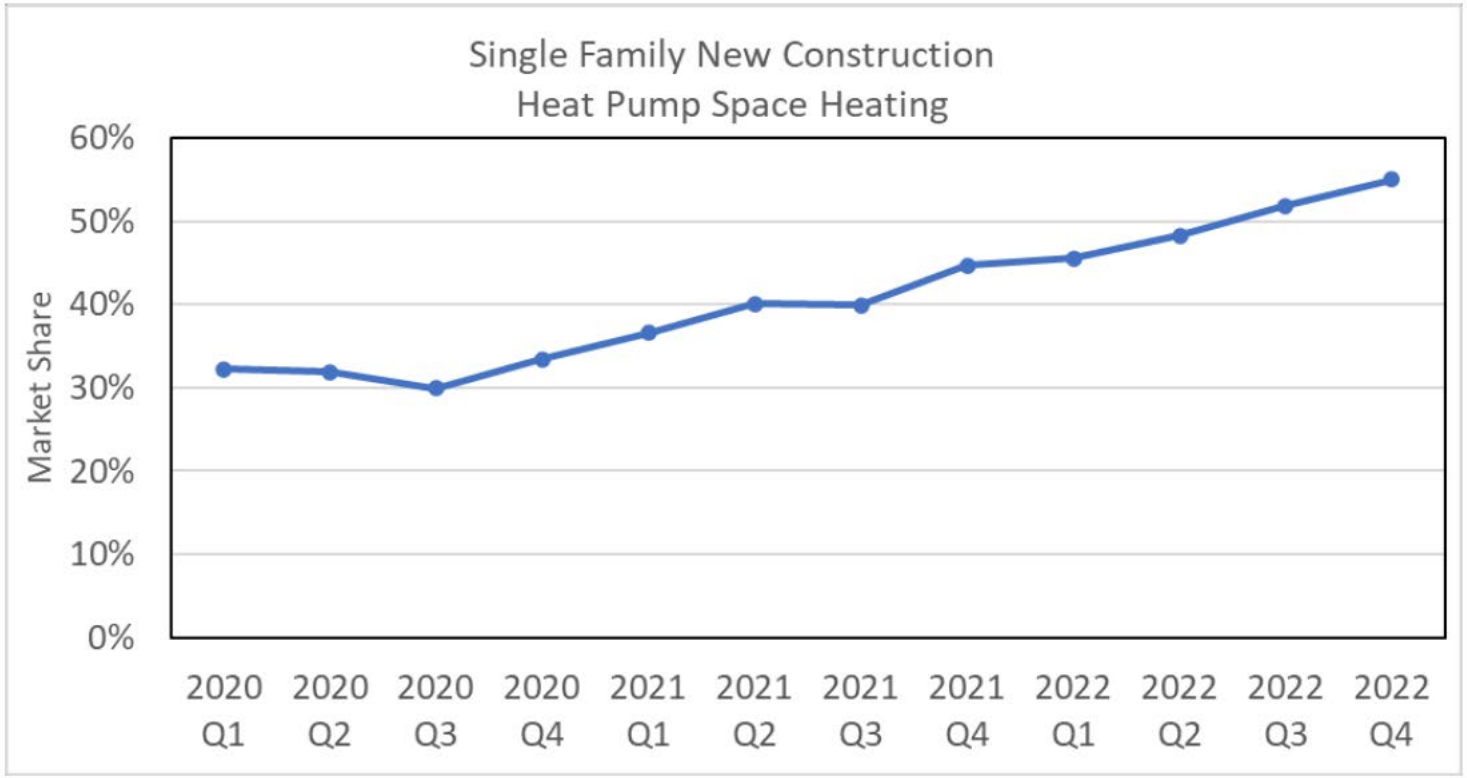


Heat Pumps as a Business Growth Opportunity

Source: http://www.ahrinet.org/resources/statistics/historical-data/central-air-conditioners-and-air-source-heat-pumps

Market Penetration of Heat Pumps in New Construction

- 2019 code
- Data based on 50,856 CF-1R records in CHEERS registry



Source: 2023 CEC Heat Pump Forum

Heat Pumps Promote Decarbonization in California

- California’s climate is ideal for heat pumps
- HVAC heat pumps eliminate the need for fossil fuel-based space heating
- Today's all-electric home has ~50% lower CO2 emissions than dual-fuel
- Heat pumps are the only way to comply with all-electric Reach Codes
  - San Luis Obispo
  - Santa Barbara
  - Los Angeles
  - … and more…
- Heat pumps are prescriptive standard in 4 Northern California climate zones in 2022 code for new homes (3, 4, 13, 14)

California Has Strong Climate Commitment

- 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)

- 26% GHG reduction by 2025
- 1.5 deg C goal

PARIS (2016)

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

AB 3232

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

SB 1477

- No Gas Furnace or Water Heater Sales by 2030

CA Air Resources Board (2022)

CARB

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

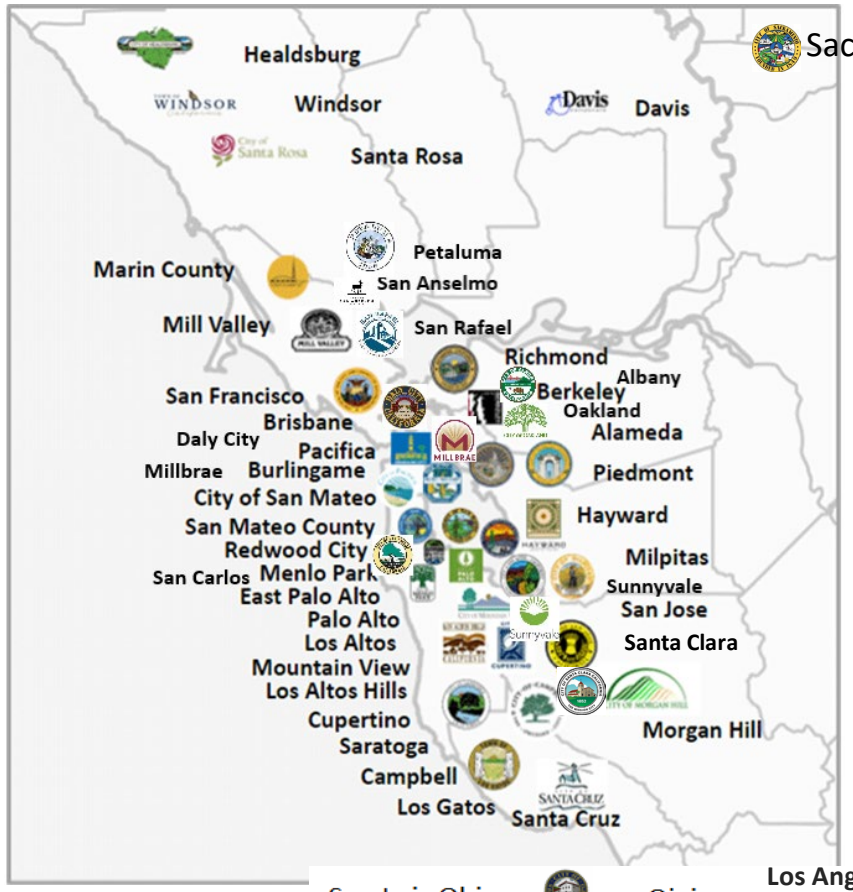
Reach Codes allow cities to **ask builders to go beyond state codes**

50+ of them are All-Electric

- Los Angeles, Santa Barbara, Encinitas, and Solana Beach are the latest

Heat Pumps & Heat Pump Water Heaters will be prescriptive standard in 2025 energy code

But, Berkeley's reach code was put on hold after legal challenges



Sacramento

San Luis Obispo

Santa Barbara

Ojai

Santa Monica

Los Angeles

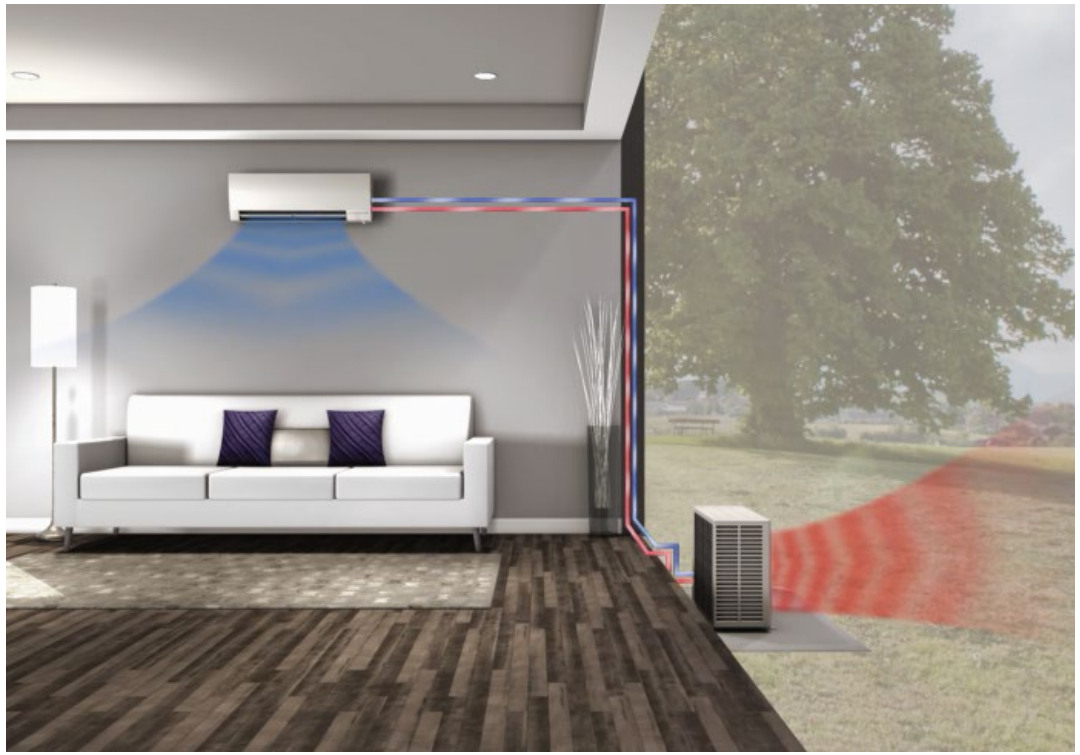
Encinitas

Solana Beach

Goal #2: Understand **heat pump function**, and the advantages heat pumps have over traditional gas/electric split systems

Heat Pumps: Reversible Air Conditioners

https://vimeo.com/438351346



How Heat Pumps Work

Heat Pump Advantages vs. Standard Gas/Electric Split Systems:

- No system fossil fuel usage
- Can be powered with roof-top solar
- Eliminate risk of gas leaks
- Operational cost savings, especially as gas is phased out in numerous municipalities
- Powered from condenser, resulting in easier installation
- Achieve both heating and air conditioning with one system
- Easier to install than ultra-low NOX furnaces
- No exhaust to deal with
- Help California meet its climate goals

Variable Capacity Heat Pump (VCHP)

- Modulate heating & cooling to match load
  - Maintains comfort continuously
- Both indoor and outdoor units are quiet
- Equipment has long lifespan
- Can be 60% or more efficient (SEER rating)
- The 2022 CA Energy Code (Title 24, Part 6) offers compliance credit for VCHPs (~10%)
- The CEC soon will extend VCHP credit to ducted units

Goal #3: Delve into Key Installation Hurdles

- Dealing with existing ductwork
- MERV-13 filtration
- Ductless vs. Ducted
- Cold weather performance
- Sizing correctly
- Electrical upgrades

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What challenges do you encounter when retrofitting to heat pumps?

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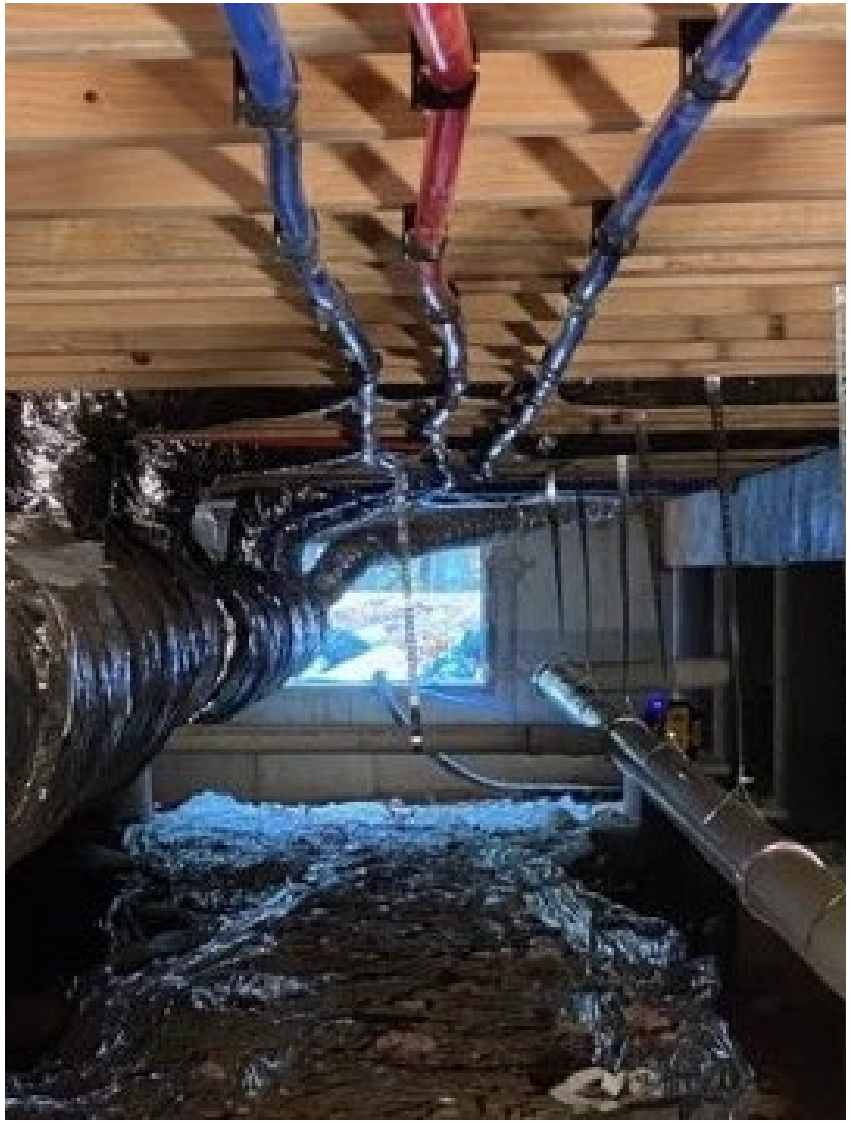

Existing Ductwork

- Air leakage accounts for 25 – 40% of the energy used for heating and cooling in a typical home
- Worst case: ducts located in unconditioned spaces such as attics or crawlspaces

Source: energystar.gov

Dealing with Existing Ductwork

Negatives associated with 10+% leakage and loss:

- Inefficiency
- High energy costs
- Equipment wear & tear
- Impossible to size system correctly

Title 24 Code: Duct Sealing

Single Family and Multifamily duct leakage allowance:

- Leakage ≤ 10% of total air handler airflow; or
- Leakage ≤ 7% to outside; or
- If unable to meet leakage requirements, a smoke test to verify all accessible leaks are sealed

Beyond 10%, ductwork should be replaced

– OR – replaced with ductless system

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What percent of the time do you reuse existing ductwork?

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Why would you retain existing ductwork?

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Fan Watt Draw

4.3.3.2 Air Handler Fan Efficacy and System Airflow

It is mandatory that central forced-air systems operate at fan efficacy values less than or equal to:

- 0.58 watts/CFM for air handlers that are not gas furnaces
- 0.45 watts/CFM for gas furnaces

Ducted Fan Coils - Residential

Title 24 2022 Building Energy Efficiency Standards

Central forced-air systems must also operate at airflow rates of at least 350 CFM per nominal cooling ton, or 250 CFM/ton for small duct, high velocity systems

MERV-13 Filtration

- Mandatory for all ducted system installations and returns, including retrofit
- Requires HVAC be designed for higher resistance
- Potentially requires modifications to ductwork, including return grilles
- Applies to all ducted HVAC systems
- Ductless system avoid this requirement
  - Simplifies HERS inspections

MERV-13 Can Be a Selling Point

A new ducted heat pump system can deliver cleaner air to the customer:

- Improves the health and productivity of the occupants
- 1 in 7 Californians experience asthma – which is tied to particulates
- Filters out smoke & smog (PM2.5)
- Also filters out airborne bacteria & viruses
- May require a completely new duct system

System Nominal Cooling Capacity (Ton)	Minimum Return Duct Diameter (Inch)		Minimum Total Return Filter Grill Gross Area (Inch^2)
1.5	16		500 *(3.5 ft^2)*
2.0	18		600 *(4.2 ft^2)*
2.5	20		800 *(5.6 ft^2)*
System Nominal Cooling Capacity (Ton)	**Return Duct #1**	**Return Duct #2**	**Minimum Total Return Filter Grill Gross Area (Inch^2)**
3.0	16	14	900 *(6.3 ft^2)*
4.0	18	18	1200 *(8.3 ft^2)*
5.0	20	20	1500 *(10.4 ft^2)*

2022 Residential Standards, Table 150.0-B/C

MERV-13 Design Considerations

- HVAC system must be designed with MERV-13 return filters in mind
- May require 2 return grilles: Table recommends this for systems 3 tons or more
- May require air handling unit with higher static pressure rating
- Requires 2” deep filter grille(s)

Ducted vs. Ductless

Rick Chitwood's Top 10 Advantages of Ducted Mini Split Systems

- High AHRI equipment performance ratings
- Ducts and air handler located in conditioned space
- High comfort levels
- Exceptional air filtration and small particle removal
- Conventional appearance
- Low installation costs
- Low operating costs
- Low maintenance costs & built-in fault detection

Advantages to Ductless Systems

- No MERV-13 or fan watt draw requirement
- Title 24 VCHP credit
- Compartmentalization for indoor air quality
- Zone control for comfort, setpoints, and efficiency
- Easier to have equipment in conditioned space
- Easier installation
- No mold growth
- No capacity loss
- Maximum energy savings

New HVAC Ratings

Beginning January 1, 2023, the DOE increased the minimum efficiencies for central air conditioners and heat pumps. The testing procedures for determining those efficiencies changed as well.

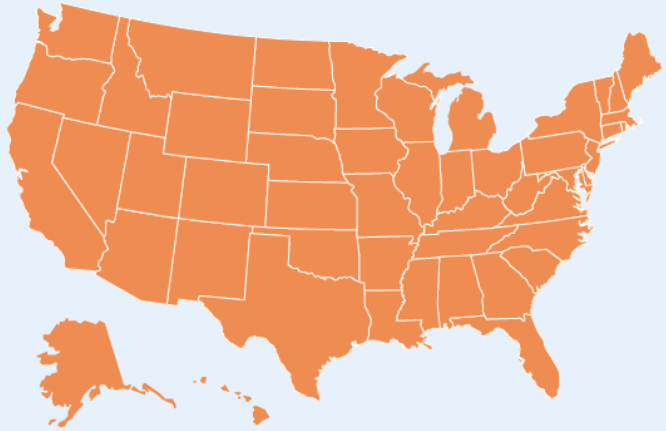
– For heat pumps and air conditioners in the Southwest, the minimum efficiency increased from 14.0 to 15.0 SEER under today's test procedure.

– The Ratings changed 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

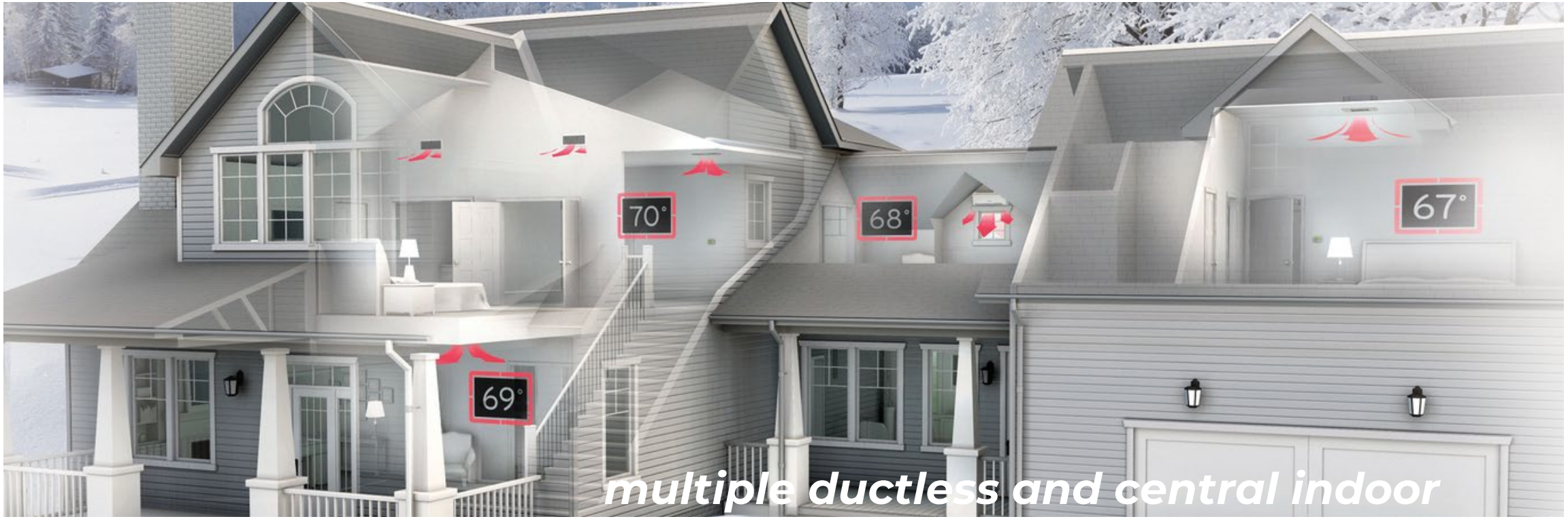
Real World Example

Santa Maria:
3 bed 2 bath, 2100 sf

- Current split system at end of useful life
- You quote like-for-like gas furnace and A/C PLUS ducted & ductless mini-split

System Technical Considerations

Like-for-like replacement: 14.3 SEER2, 80 AFUE	Single stage, central heat pump : 14.3 SEER2, 8.2 HSPF2	Ducted mini split: 17 SEER2, 10 HSPF2	Ductless multi split: 22 SEER2, 10 HSPF2
• Duct loss, estimated 30% capacity loss • Ultra-low NOX furnace requirement add $350 to initial costs • MERV-13 filter requirement • HERS rating • Potential mold build up in ductwork	• Duct loss, estimated 30% capacity loss • MERV-13 filter requirement • HERS rating • Potential mold build up in ductwork • Comparable cost to gas split system • 15-24% GHG reduction	• Duct loss, estimated 30% capacity loss • MERV-13 filter requirement • HERS rating • Potential mold build up in ductwork • Excellent efficiency • Great overall savings • 34-37% GHG reduction	• No duct loss • No MERV-13 filter requirement • No HERS rating • No mold build up in ductwork • Best efficiency and savings • 34-37% GHG reduction



Ducted + Ductless: They Can Work Together!

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What advantages of ductless systems most appeal to you?

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

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What advantages of ducted systems most appeal to you?

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Cold Weather Performance

- Evolution of the technology
- Cold Climate Air Source Heat Pump Product List (NEEA/NEEP)

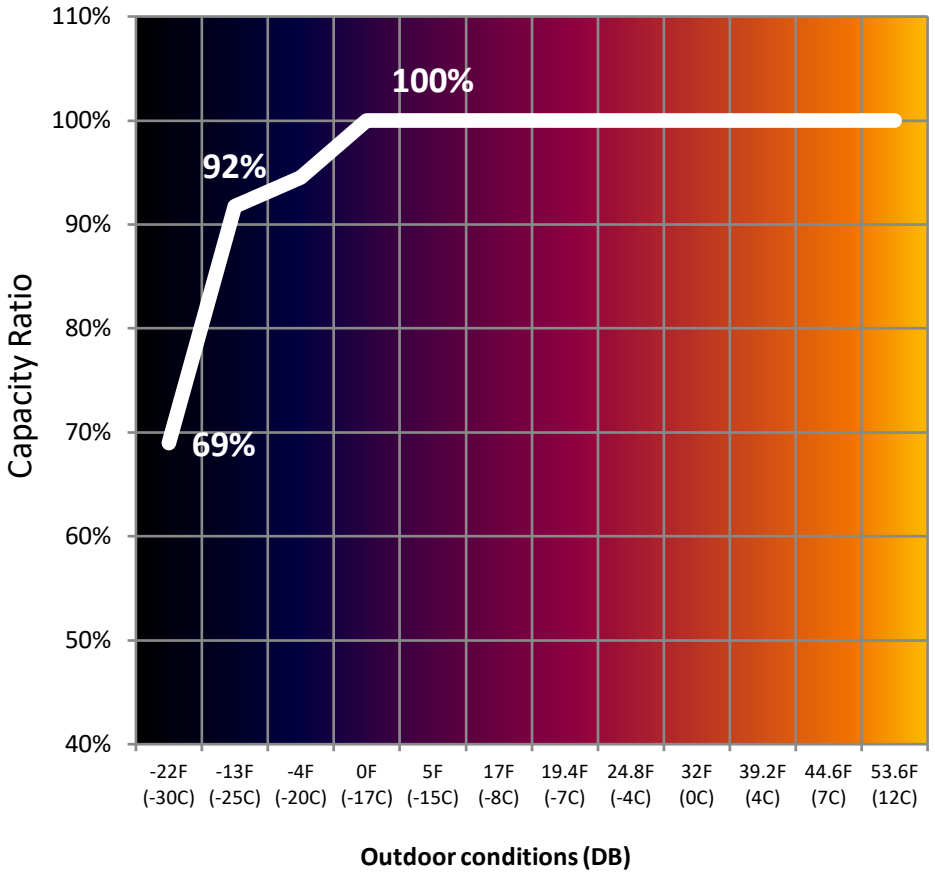
neea

Cold Climate Ductless Heat Pump Specification and Recommendations

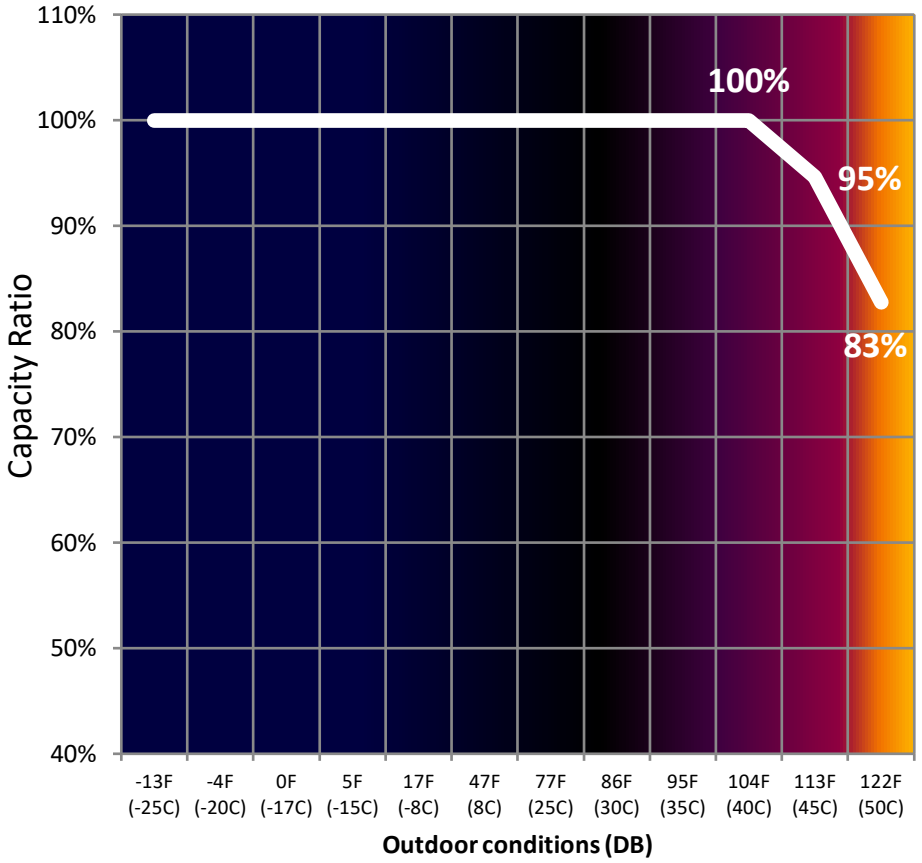
Guidance for Northwest IECC Climates Zones 5 and 6 (RTF Heating Zones 2 and 3)
Version 2.0 – September 2020

Extreme Weather Performance: Single Zone

VCHP High HEATING Capacity at Extremely Low Temperatures

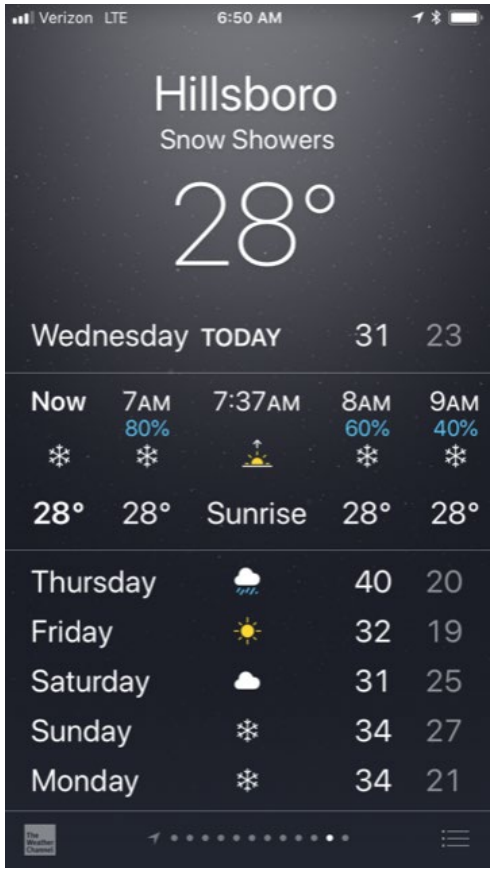


VCHP High COOLING Capacity at Extremely High Temperatures



Leaving Air Temperature

Inverter Compressor



Sizing: Bigger does NOT equal Better

Negative impacts of oversizing:

- Short cycling
- Higher humidity levels
- Equipment wear
- Diminished comfort
- Noise

Throw out your “rules of thumb”

Furnace sizing does not determine heat pump sizing

- Furnaces most often oversized

Reduce load and increase efficiency

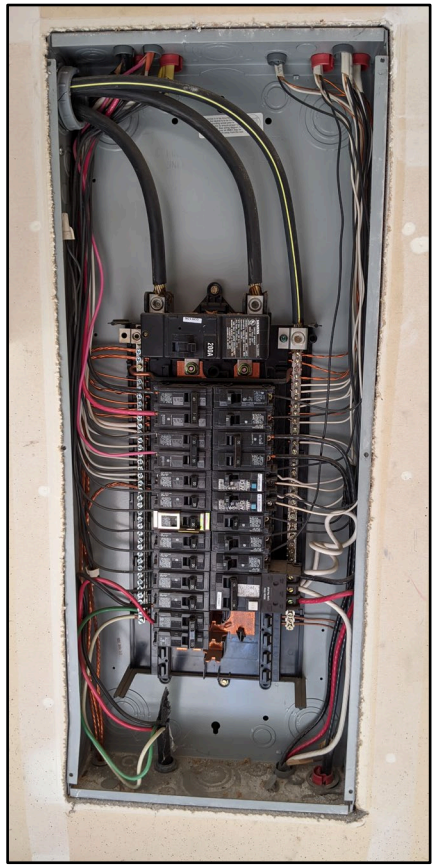
- Conduct a blower door test, fix duct leakage, add insulation

Perform load calculations

- Wrightsoft, Cool Calc preferred; CBECC and EnergyPro for block load calculations

Best Practices for Sizing

Electrical Panel Upgrades



- If homeowner has an AC system, capacity exists for heat pump
- VCHP: power indoor units from outdoor units
- Anticipated upgrades for future appliances: EVs, HPWHs, solar
- Circuit-sharing devices

Panel Rating (amps)	Average cost
100	$1500 -$2500
125	$1700-$2700
150	$2000 - $3000
200	$3500 - $4500

Source: Fixr.com

Watt Diet

- Establish your base load (e.g., lighting and plugs often on)
- Enter your other loads and power requirements from tech sheets
- Watt Diet calculates the panel you need
- Allows for circuit sharing
- *Watt Diet Calculator*

3. Determine "Watt Diet" and Panel Size

Use the drop down menu for the type of products and volts, amps and the circuit size will autofill. Many product will use less than their rated circuit amperage, refer to the "Product Data" tab to see specification sheets for products show in the drop down menu. If you do not want to select a device, choose the ""Select Device"" option in the dropdown.

Panel Baseline Assumtions	
Utility Service Volts (120, 240, 240 is most common)	240
Base Energy Use (defined by electrical code) (Watts)	5,573

3a. Device Selection: Use the drop down menu to determine each device, the voltage, rated amps and circuit size will autfill with your selection. If you want to remove the selection, choose "Select Device"

	Device	Select with Dropdown Menu	Volts	Rated Amps	Circuit Size (Amps)	Calculated Power (Watts)
Baseline Loads (specified by NEC)	Lighting+Plugs 3W/square					5,850
	Kitchen Countertop Circuits					3,000
	Laundry Circuit *(note: laundry circuit must be 1500*					1,500
Laundry *(note: if specified power is under the baseline, the baseline value is used.)*	Washer (or combined)	Washing Machine: LG	120	-	10	1,200
	Dryer	Heat Pump Dryer: Miele (120V)	120	-	15	1,800
Kitchen	Fridge	Fridge: Frigidaire 20.4 cuft	120	6	-	720
	Optional: Garbage Disposal	Garbage Disposal: GE	120	4	-	480
	Optional: Dishwasher	Dishwasher: Frigidaire	120	-	10	1,200
	Optional: Kitchen Hood	Kitchen Hood: Broan	120	1.4	-	168
	Optional: Microwave	Microwave: Frigidaire (built-in)	120	9.2	-	1,104
	Range (oven and cooktop)	Range: Frigidaire Induction	240	41.6	-	9,984
	Oven	No Device	-	-	-	-
	Cooktop	No Device	-	-	-	-
Water Heating	Water Heater	Heat Pump Water Heater: Rheem 30 Amp	240	21	-	5,040
Heating, Cooling and Ventilation	User Defined Heat Pump (Selected On Tab 2)		-	-	-	1,810
	Air Handler Fan (for central ducted system)	Air Handler Fan: General	120	4.6	-	552
Electric Vehicle Charging	EV Charger	EVSE Level 2 (high)	240	32	40	7,680

3b. Power Management Selection: use the drop down menu to choose what strategy of power management you would like to use. The selections are representative of real products. An example of how it works: when selecting "car to dryer" the EV charging will pause when the dryer runs, therefore the lesser power draw of the two will be subtracted from the Watt Diet.

Power Sharing	Circuit Sharing Device	No Device	-	-	*Watts Saved*	-
		"Device" Watts:	Total Watts (before coincidence calculation)			40,588

"Panel" Watts:

	Coincidence Factor	Watts
Baseload Watts	1	5,573
Heat Pump Watts	1	1,810
EV Charging Watts	1.25	7,680
Remaining Watts	0.4	25,526
Total Panel Watts		27,193
Total Panel Amps		113
Minimum Panel Size		**125**
Allowed Watts		66,641

An Eye on Economics: First Costs

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Poll: Do Central Heat Pumps have similar or lower installed costs than gas/electric split systems?

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

System Financial Considerations

Like-for-Like Replacement: 14.3 SEER2, 80 AFUE	Single stage, central heat pump : 14.3 SEER2, 7.5 HSPF2	Ducted mini split: 17 SEER2, 10 HSPF2	Ductless multi split: 22 SEER2, 10 HSPF2
• First Cost: $8,500 • Incentive: None • Annual Utility Bill: $2,480 • **Total Costs over 15 years: $45,700** • Difference: Baseline	• First Cost: $8,500 • Incentive: 4,840* • Annual Utility Bill: $2,747 ($267) • **Total Costs over 15 years: $44,865** • Difference: **$835**	• First Cost: $12,700 • Incentive: $4,840* • Annual Utility Bill: $2,358 **($122)** • **Total Costs over 15 years: $43,230** • Difference: **$2,470**	• First Cost: $17,500 • Incentive: $4,840* • Annual Utility Bill: $2,068 **($412)** • **Total Costs over 15 years: $43,680** • Difference: **$2,020**

Santa Maria 3 bed 2 bath, 2100 sf

*Incentives shown are based on stacking TECH, federal tax credits, and 3C-REN's Single Family Home Energy Savings Program ($1,840 for non-hard-to-reach customer saving 100 therms per year).

An Eye on Economics: Operating Costs

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How do heat pumps compare to gas/electric split systems in cost of operation?

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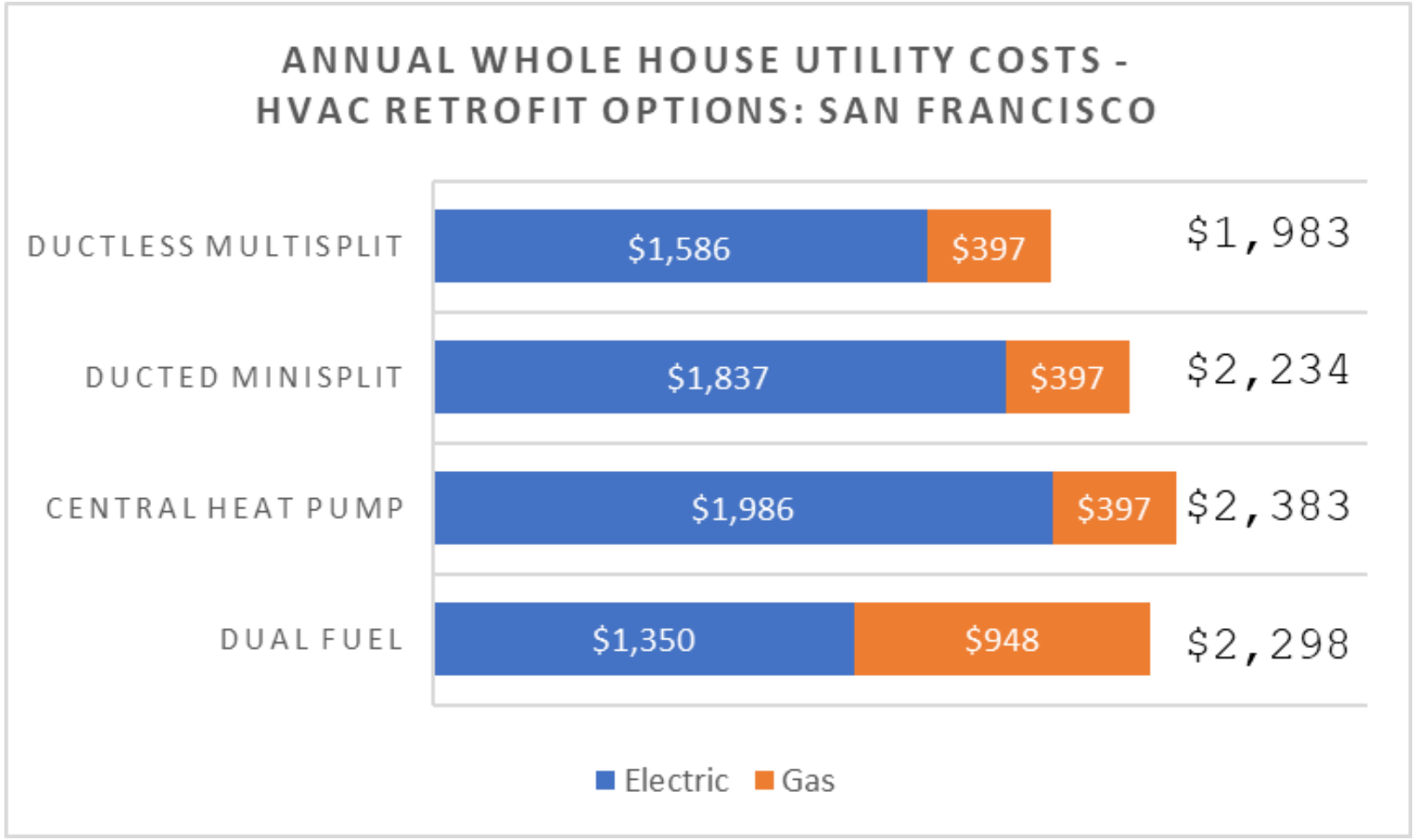
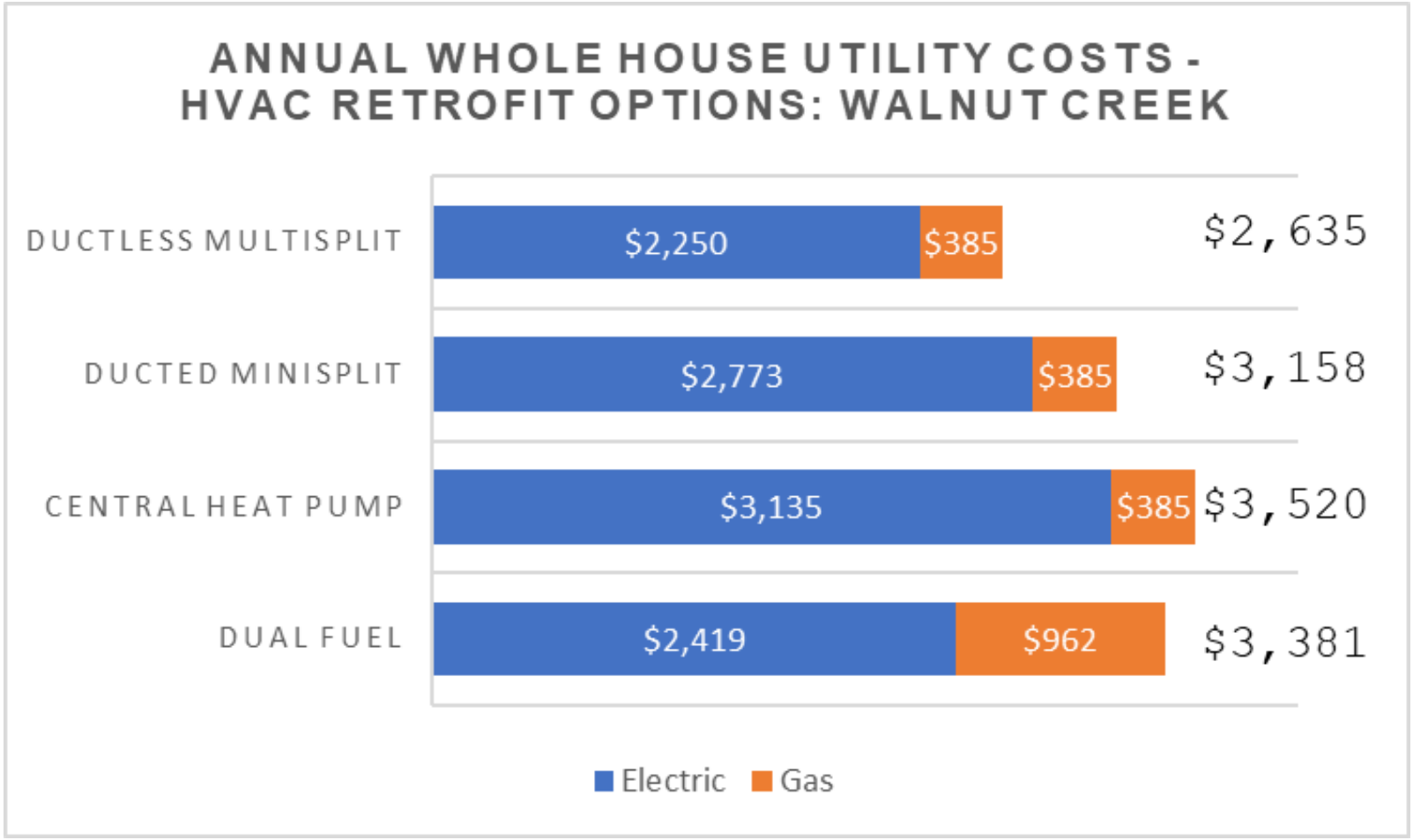
Operating Costs - Savings by System Replacement*



*Data taken from BeOpt energy modeling, Build Smart Group, 2020

Operating Costs - Savings by System Replacement*



*Data taken from BeOpt energy modeling, Build Smart Group, 2020

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What surprises you about this information about the costs of heat pumps?

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

Incentives

Incentives Available Now

New Home incentives through Energy -Smart Homes
- All-Electric: start at $3,000

TECH Retrofit Heat Pump incentives:
- $1,000 for HVAC heat pumps
- $3,100 for Heat pump water heaters
- Multifamily slightly lower incentives

Energy-Smart Homes Retrofit incentives:
- $4,250 whole home electric retrofit
- $2,200 ADUs
- $250 Heat pump clothes dryer & $1,000 Electrical infrastructure

3C-REN Single Family Energy Saving Homes Program:
- Savings up to $3,000 possible for HVAC and water heating
- ~3X savings for hard-to-reach populations

TECH
CLEAN CALIFORNIA

CALIFORNIA
ENERGY-SMART
HOMES

STATE OF CALIFORNIA
ENERGY COMMISSION

BUILD
Building Initiative for Low-Emissions Development Program

THE SWITCH IS ON

IRA and Federal Incentives

Long-term to encourage market transformation

30% Tax Credit extended for PV systems

- Heat Pumps & HPWHs and electrical panels now eligible
- Up to $2,000

High Efficiency Electric Homes Programs

- Income qualified
  - <80% of area median income: 100% of cost (LA = $91K)
  - 80-150%: 50% of cost (LA=$137K)
- Point-of-sale rebates for:
  - Heat Pump $8,000
  - HPWH $1,750
  - Electric Cooking $840
  - HP Dryer $840
  - Electrical panel upgrade $4,000

MAX $14,000 TOTAL

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Top 2 take-aways from today

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

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What questions do you still have about heat pumps?

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

Recap: Overcoming Installation Challenges for HVAC Heat Pumps

Today, we discussed:

- The value that heat pump HVAC systems can offer to your business
- How heat pumps work
- The technical and financial advantages heat pumps have over other systems
- Key installation hurdles, including:
  - Existing ductwork
  - MERV-13 filtration
  - Ducted vs. ductless systems and options
  - Cold weather performance
  - Sizing
  - Electrical panel upgrades

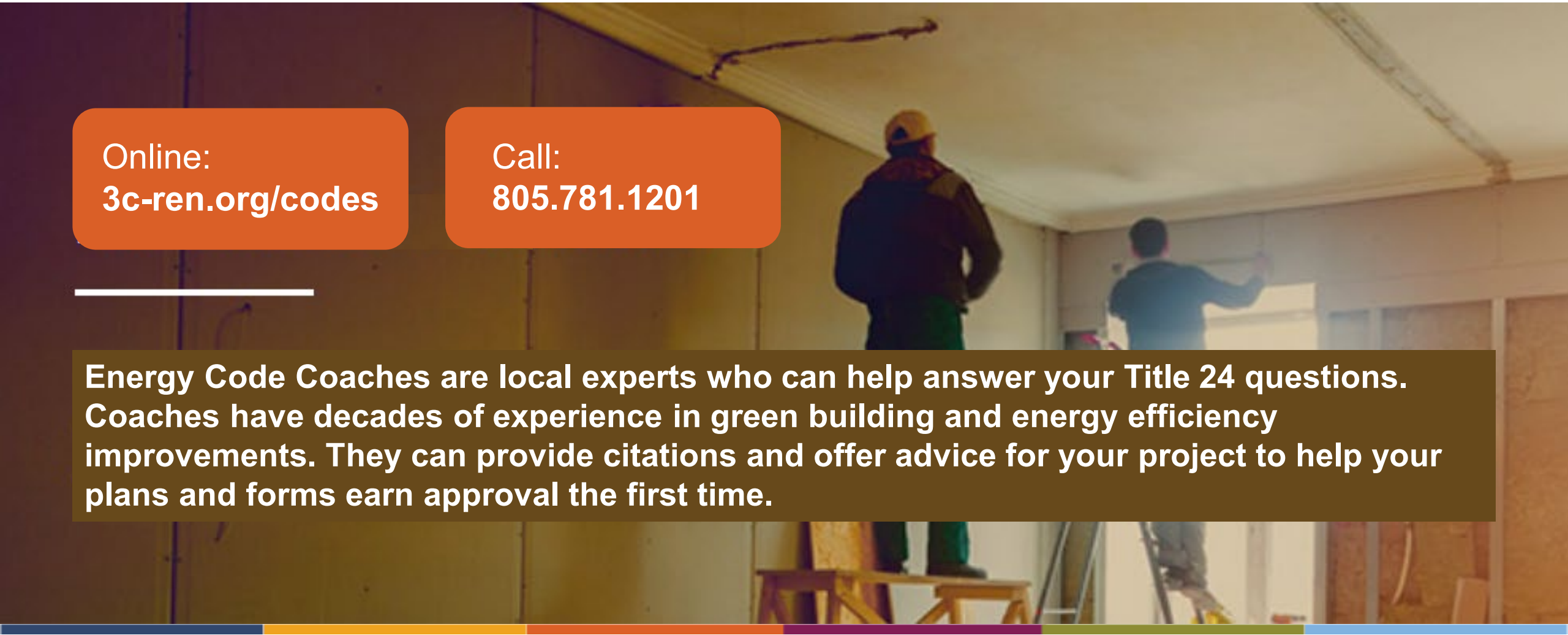
Additional questions or inquiries

Nick Brown, Build Smart Group
nick@buildsmartgroup.com

Bobby Hahn, Pacific Systems Group
bobby@psghvac.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 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:
  - April 17th - Code Compliance for Tiny Homes and ADUs – In person in San Luis Obispo
  - April 23rd - Building With Hemp – Green Building Speaker Series
  - May 3rd - High Performance Envelope + Balanced Ventilation – In person in Santa Barbara
  - May 3rd - Detailing for High Performance Roofs and Walls – In person in Santa Barbara
  - May 8th - Energy Code Implementation: Accessory Dwelling Units (ADUs)
  - **May 15th - 3C-REN Regional Forum: The Past, Present, and Future of HERS Raters**
- 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

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