BOOTCAMP

Residential Space Conditioning & Water Heating

PRESENTED BY LARRY WATERS

ELECTRIFY MY HOME

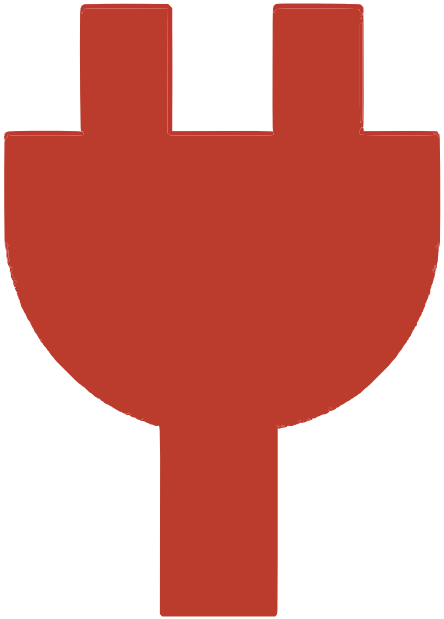
Icebreaker

- Name
- Experience in the trade
- Current Position
- What the electrification movement means to you ?
  (in 1 sentence)
- What you are hoping to learn

Class Rules

- Have fun!
- Keep an open mind
- Silence your cell phone
- Note questions for Q&A time

Course Overview



- This course will offer you an inside look at Residential Electrification in existing housing stock
- Offer information on WHY now is the time
- Introduce the principles of “Install Small” Right Sizing and “Good Electrification”
- Share the business opportunity that is presenting itself now

Why Are We Here?

- California is littered with poorly performing systems
- Customers with huge bills and little comfort
- There’s a clear need to reduce pollution and emissions
- Challenges with electrical grid infrastructure
- Industry prioritizing sales over performance
- GIANT opportunities for differentiation

BOOTCAMP Explained

- No push-ups required
- Dozens of new concepts in a short period of time
  - Some will be repeated. This is BY DESIGN.
  - Based on building science and real-world application
- Our goal – provide info and confidence to:
  - Speak confidently about the electrification transition
  - Incorporate new ideas into your business
  - Take a whole-house approach
  - Identify new products to install or advise

Who's This Dude?

- 1982 (UTI), with these tools

- Certs along the way

- 2015 – only heat pumps

- 2020, founded Electrify My Home

Larry Waters
President, Electrify My Home

Day 1, Part 1: Electrification Basics 101

Upon completion of this part of the course, participants will be able to:

- Identify four rationales for electrifying existing homes
- Explain the heat pump heat transfer mechanism and how it produces more energy than it consumes
- Apply correct HVAC system sizing practices
- Describe three characteristics of the building enclosure that influence HVAC system design

First Terms

Electrification

The act of replacing gas-powered technologies with technologies powered by electricity

Good Electrification

The act of removing a gas appliance and replacing it with the best, most efficient electric solution

Decarbonization

The final result of electrification with respect to pollution mitigation

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ENVIRONMENT, POLICY, CULTURE

- SEGMENT 1 -

Topics Covered in Segment 1

- Overview of old fuels and old technology; the impact of fossil fuels on the environment*
- Home improvement boom as it relates to the electrification boom*
- Policy and drivers of electrification: SB32, other legislation, timelines and benchmarks*
- Rising energy cost
- Energy production coal, gas, renewables
- The coming transition away from gas; why electrification is not going away
- Contractor's responsibility to provide options for electrification to all customers moving forward

* presented on video

Intro Video

ENERGY PRODUCTION

Gas- Nuclear- Renewable

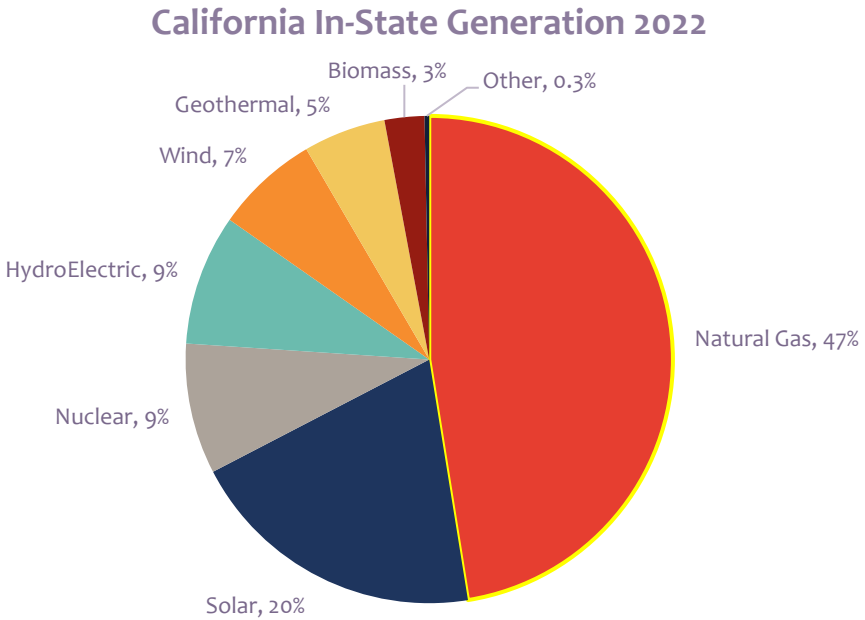
What is Natural Gas?

- Main component naturally occurring methane, may also contain carbon dioxide, nitrogen, hydrogen, or helium
- Non-renewable energy for heating, cooking, and electricity generation
- Odorized for your safety

Natural Gas is a Greenhouse Gas

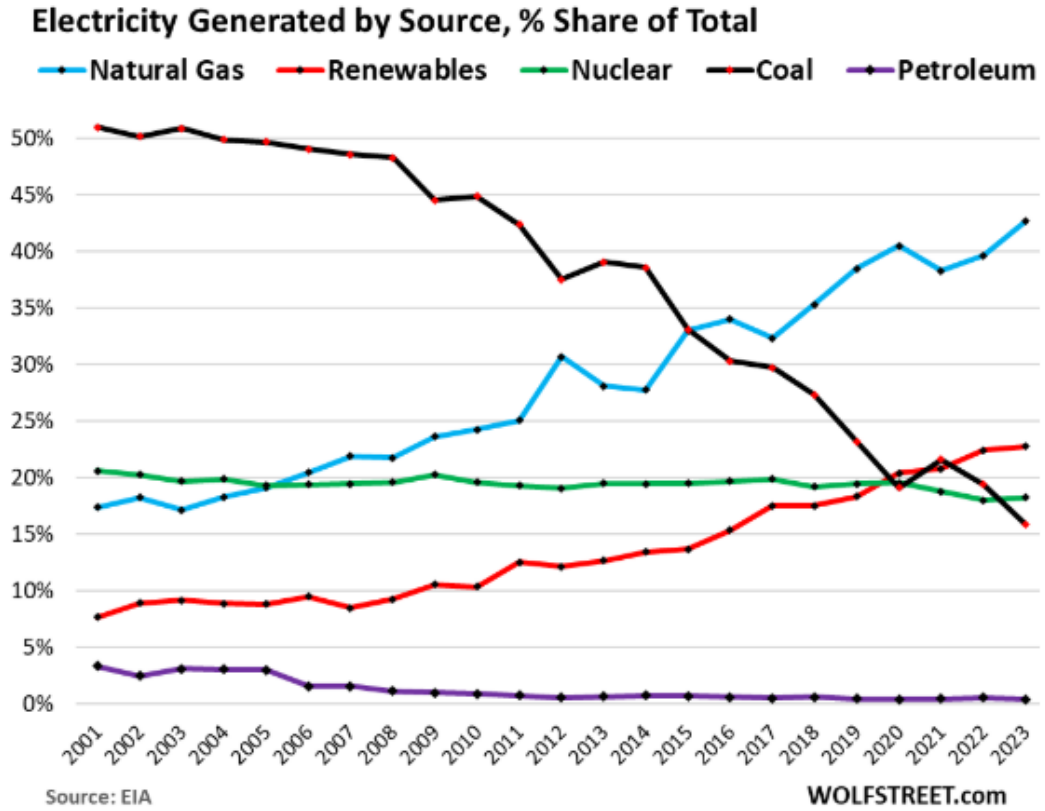
- Experts say natural gas is a significant driver of **climate change**
- Greenhouse gases **trap heat** and make the planet warmer
- Mainly from the **combustion** of fossil fuels -- coal, petroleum and natural gas
- According to the EPA, largest source comes from **burning fossil fuels**
- Methane (Gas leaks) have **80X warming power** of Carbon Dioxide

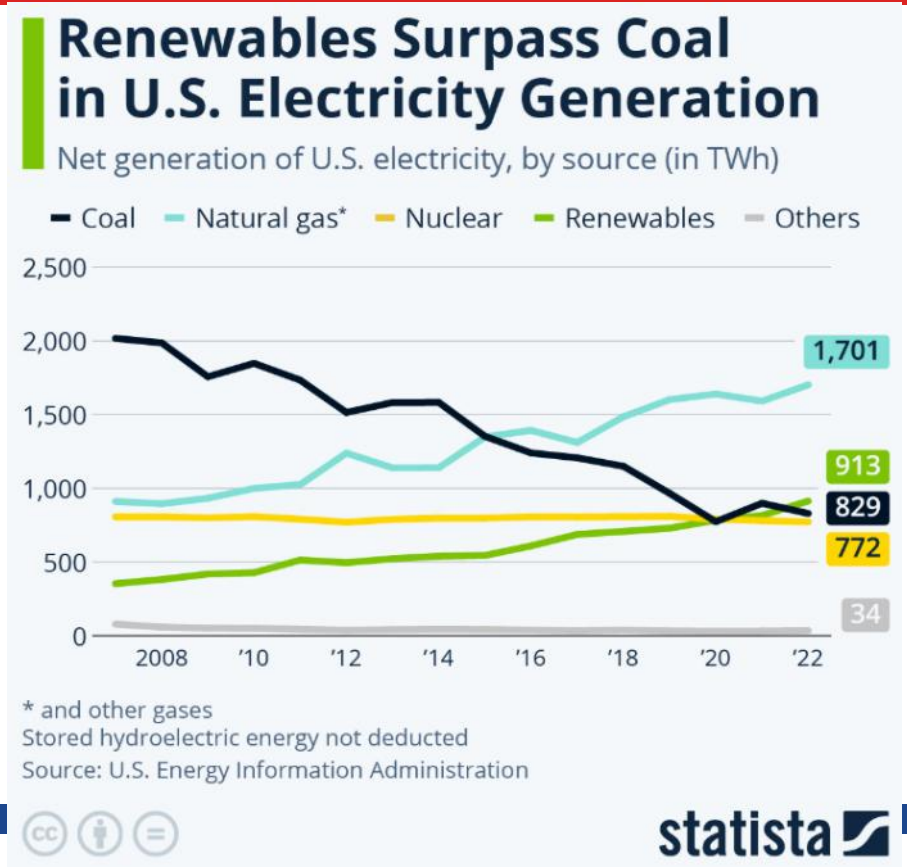
Natural Gas – Electric Generation



All data from Energy Information Administration (EIA)

The Use of Natural Gas Was on the Rise, Now Being Offset by Solar and Wind




Renewables Surpass Coal in U.S. Electricity Generation
Net generation of U.S. electricity, by source (in TWh)
Coal
Natural gas*
Nuclear
Renewables
Others
2,500
2,000
1,500
1,000
500
0
2008
'10
'12
'14
'16
'18
'20
'22
1,701
913
829
772
34
* and other gases
Stored hydroelectric energy not deducted
Source: U.S. Energy Information Administration
statista

Nuclear Power
"California's last nuclear plant too vital to shut down"

- Diablo Canyon only NPP left in California
- Was slated for decommissioning in 2025
- With electrification on the horizon this clean power source to vital to shut down.
- Provides 9% of power 24/7/365

Diablo Canyon

RENEWABLE ENERGY

Solar, Wind, Storage, Hydro

4/29/2021:

Los Angeles Times

California just hit 95% renewable energy. Will other states come along for the ride?

A short ride. "On Saturday just before 2:30 p.m., one of the world's largest economies came within a stone's throw of getting there."

"There are several caveats. For one thing, Saturday's 94.5% figure — was fleeting, lasting just four seconds. It was specific to the state's main power grid, which covers four-fifths of California"

4/30/2022:

San Francisco Chronicle

California wants 100% renewable power. It just hit that milestone — briefly

But we're making progress!

"…the share of [illegible] peaked at 99.87% — marking a record for the state, albeit a fleeting one"

"That continued for about an hour until demand slipped above production at 5:05 p.m."

Wind, Water & Solar Is Starting To Work!

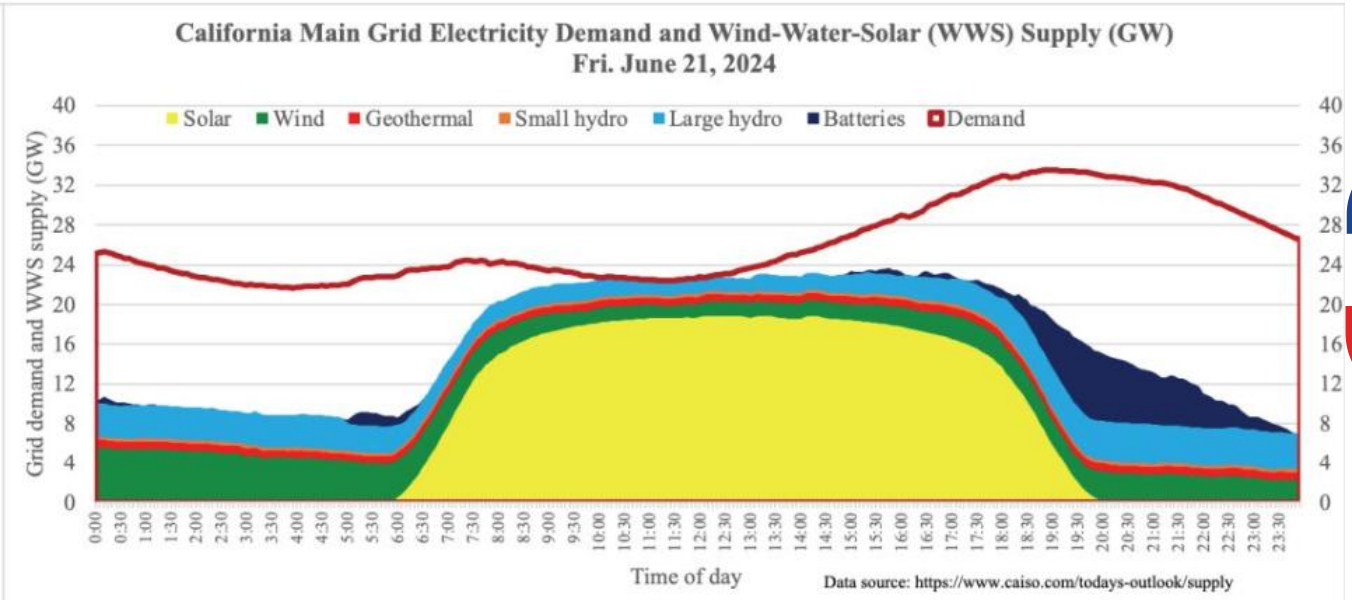
Mark Z. Jacobson
@mzjacobson · **Follow**

It has happened

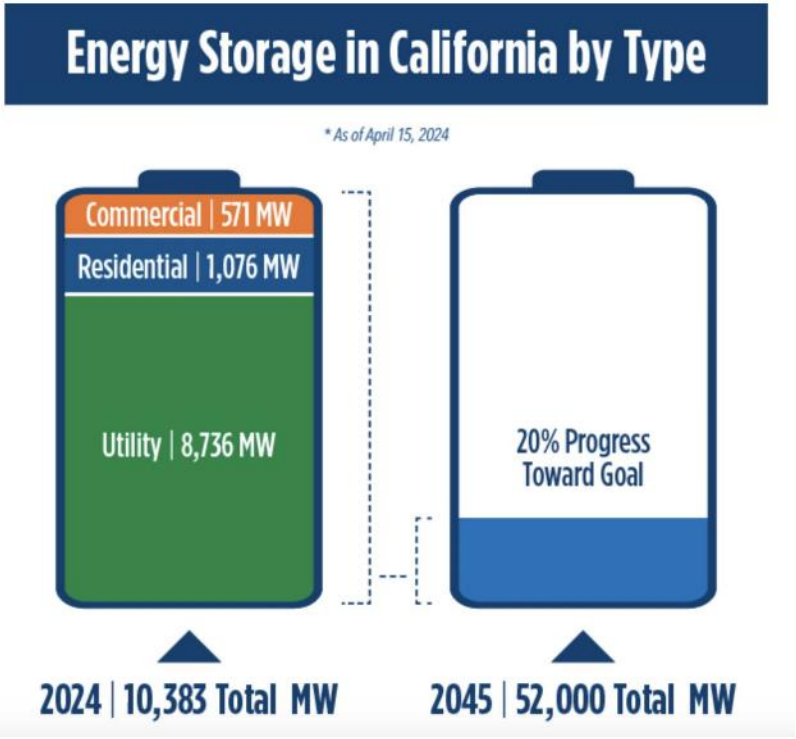
100 days of 100% #WindWaterSolar

Sun, July 28, California reached a milestone. The world's 5th-largest economy met 100% of @California_ISO demand with >100% WWS for the 100th day since March 7. July 27 was day 99 (for 4.9 h)

Strong summer winds helped



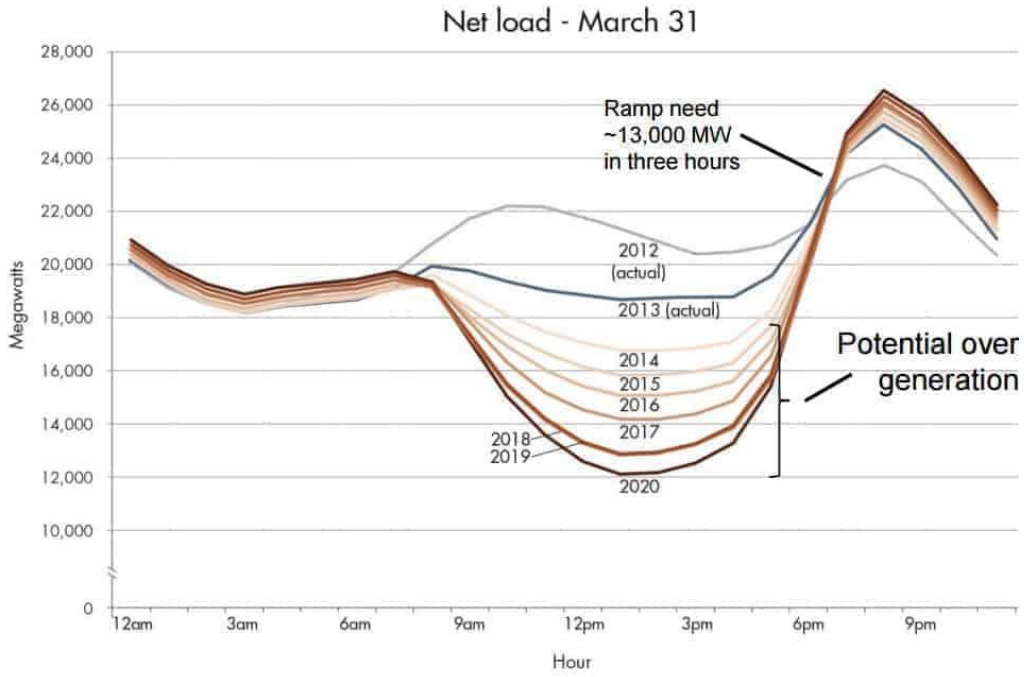
Energy Storage – Necessary & Gaining Traction



2024 values as of April 2024

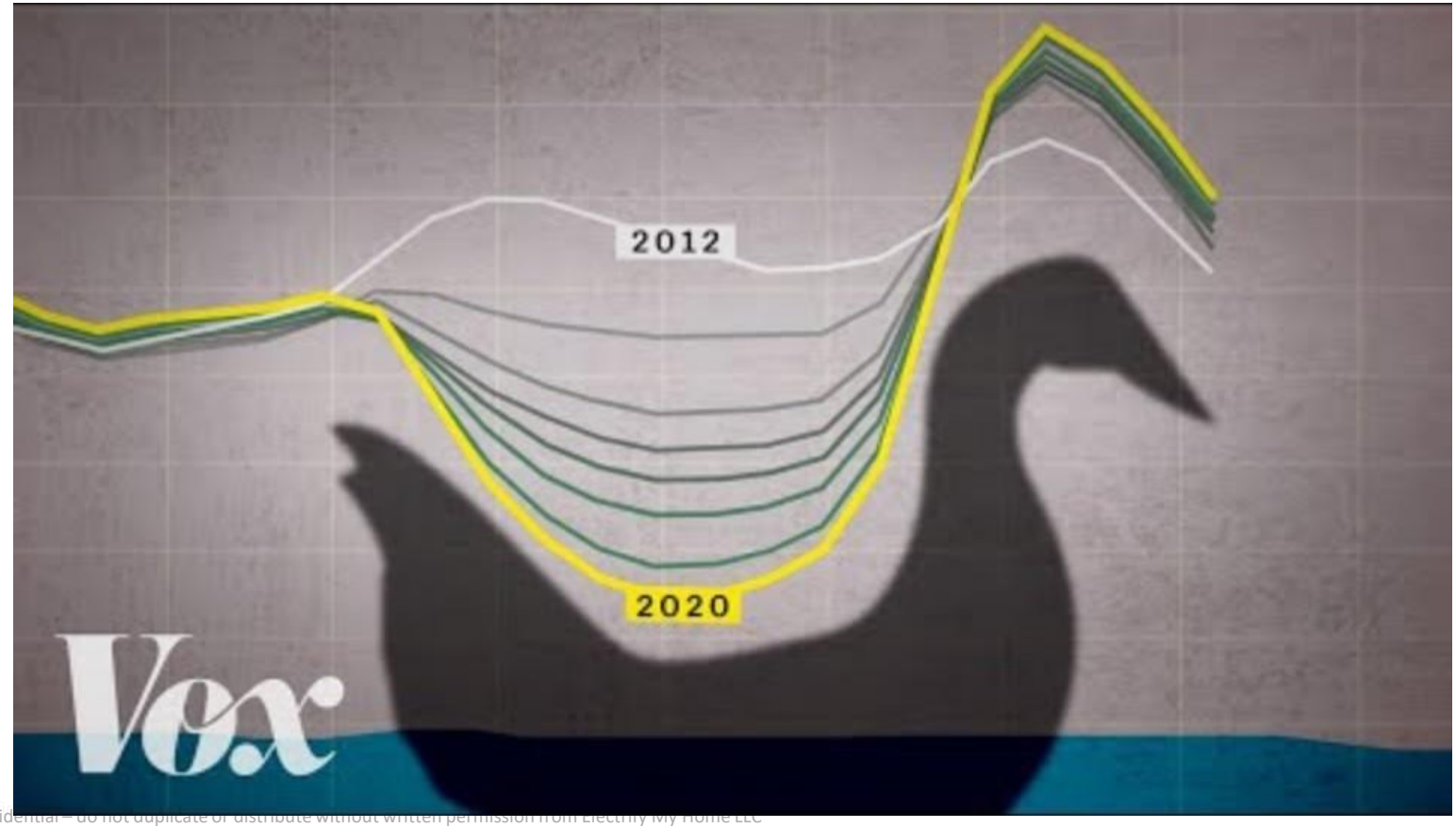
Duck Curve

- Net electricity demand, which is total system load **minus** solar generation
- The evening ramp (neck of the duck) is particularly important, as it demonstrates the **significant ramp** needed as the sun begins to set and solar goes offline

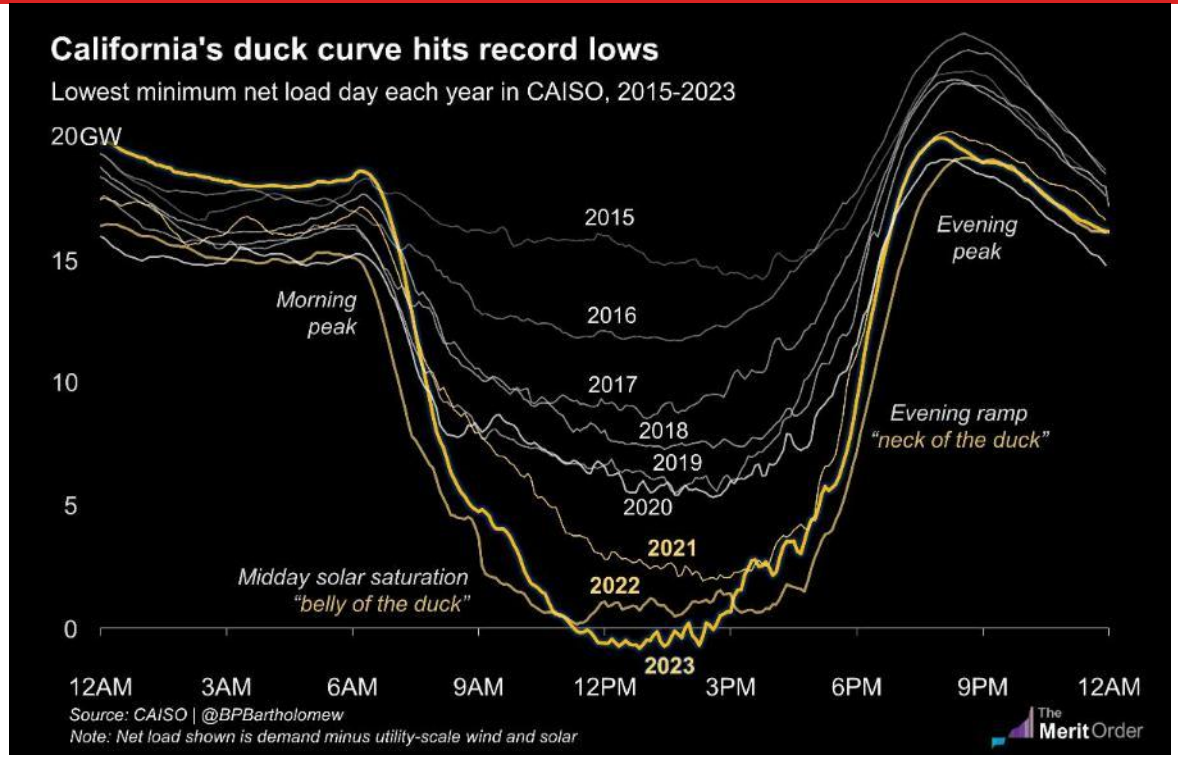


The Duck Curve energy load profile

The Duck Curve



2023 Duck Curve



Wind: When It Blows It Goes

- California now has over 500 high production turbines
- More than 7% of our energy
- Offshore wind to provide 13% by 2045
  - Major project outside Humboldt approved by CEC
- 13,920 Gigawatts

Hydro Takes a Hit with Drought

2023: 13.5% of total electric generation

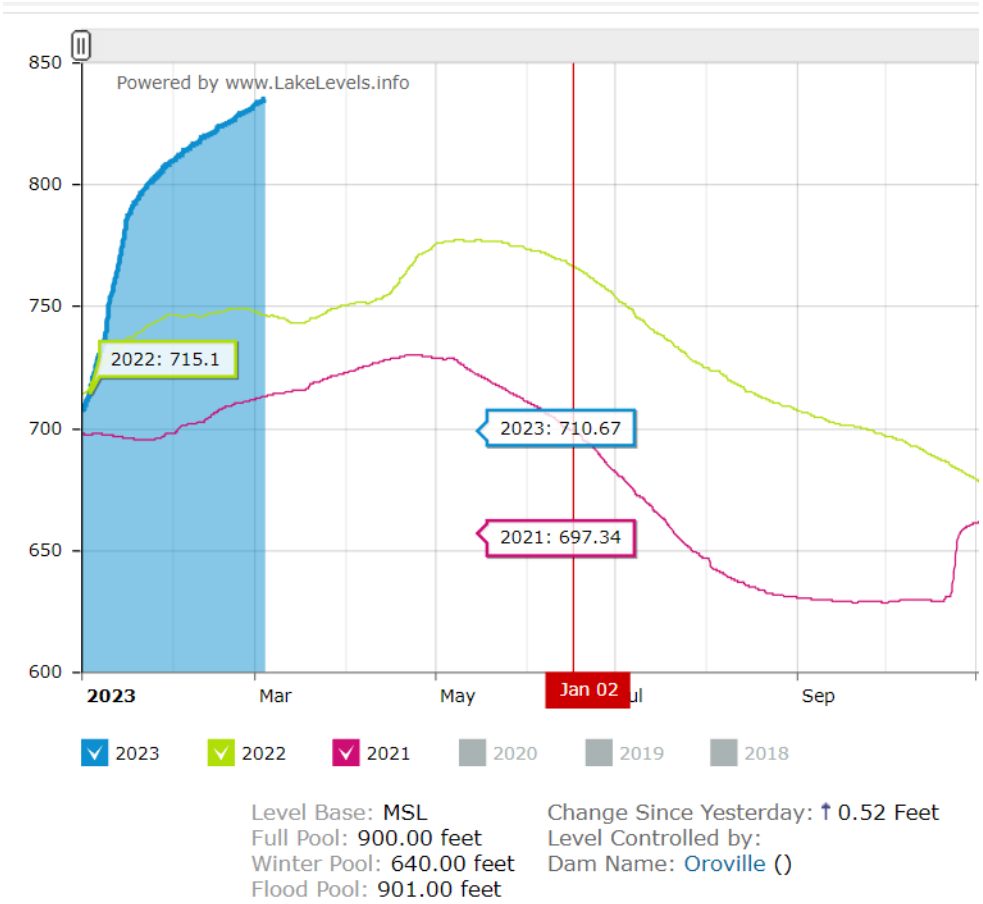
2022: 10.4% of total electric generation

2020: Hydro in CA drops 44% from 2019

2017: 17.9% of total electric generation

2023: Storms Bring Much Needed Water For Hydro!

- Good year for boating as well!



POLICY DRIVERS & THE SHIFT

Spurring the Electrification Market

Policies & Decisions Leading to This Point
Primary Drivers = Health, Air Quality, Climate Change

1963

US clean Air Act Amended 1965/67

1970/77

1968

C.A.R.B. Board Forms

1970

Clean Air Act shifts Fed's role allowing states to limit

1976

A.Q.M.D formed across the state

1988

CA Clean Air Act becomes Law

1990

Clean Air Act amended & admin by US EPA

2005

CA EO S-3-05 sets GHG emission targets

2006

AB 32 CA Global Warming Solutions Act

2016

SB 32 40% below 1990 levels by 2030

2018

Executive Order B-55-18 takes a step further… requires carbon neutrality by 2045

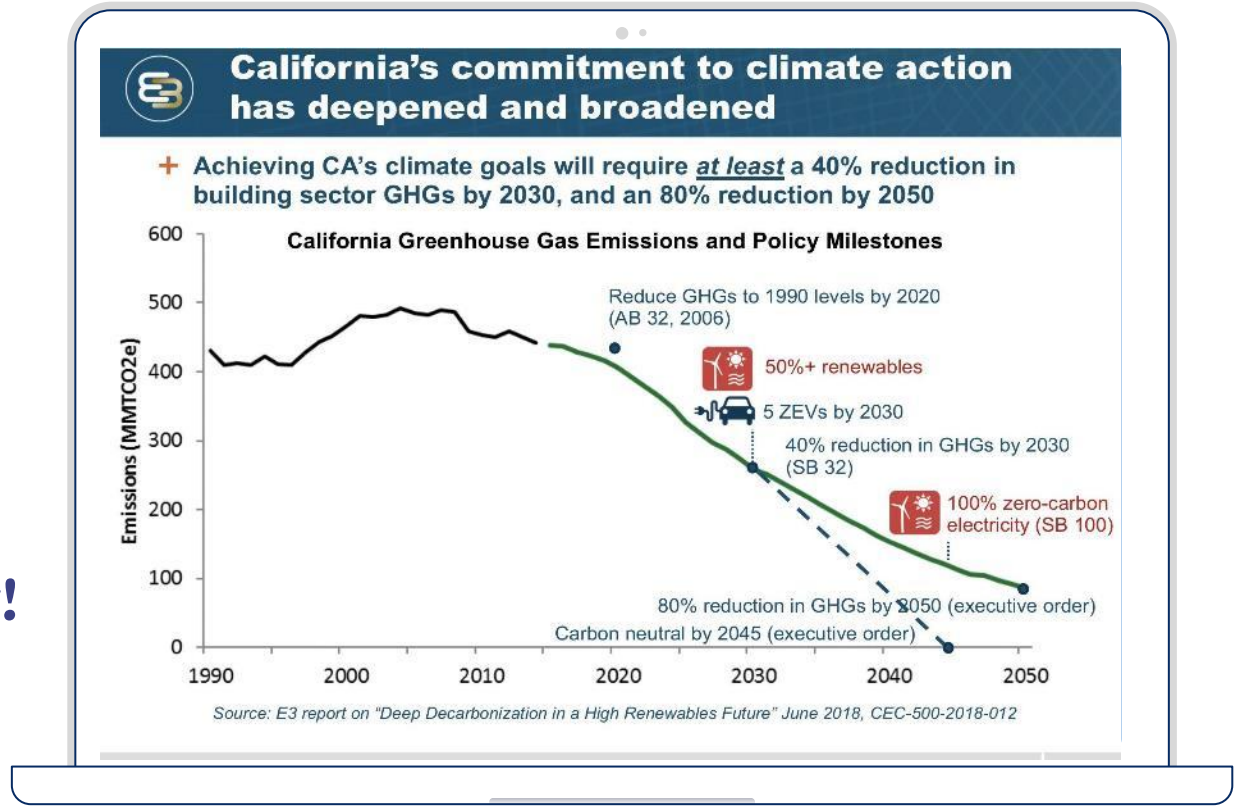
2018

SB 1477 Technology & Equipment for Clean Heating (TECH) Initiative

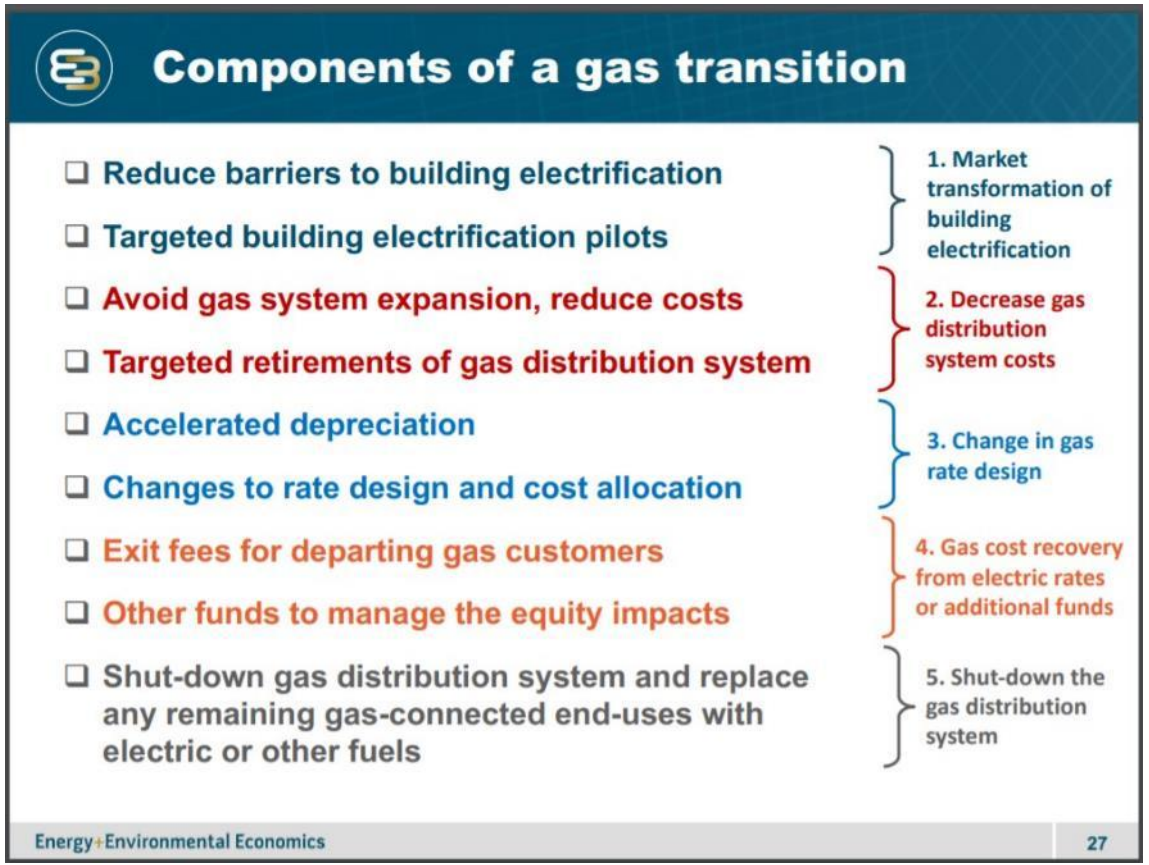
California Decarbonization is happening

Transitioning away from gas

Electrification is NOT going away!



The Long-Term Plan for Gas in California



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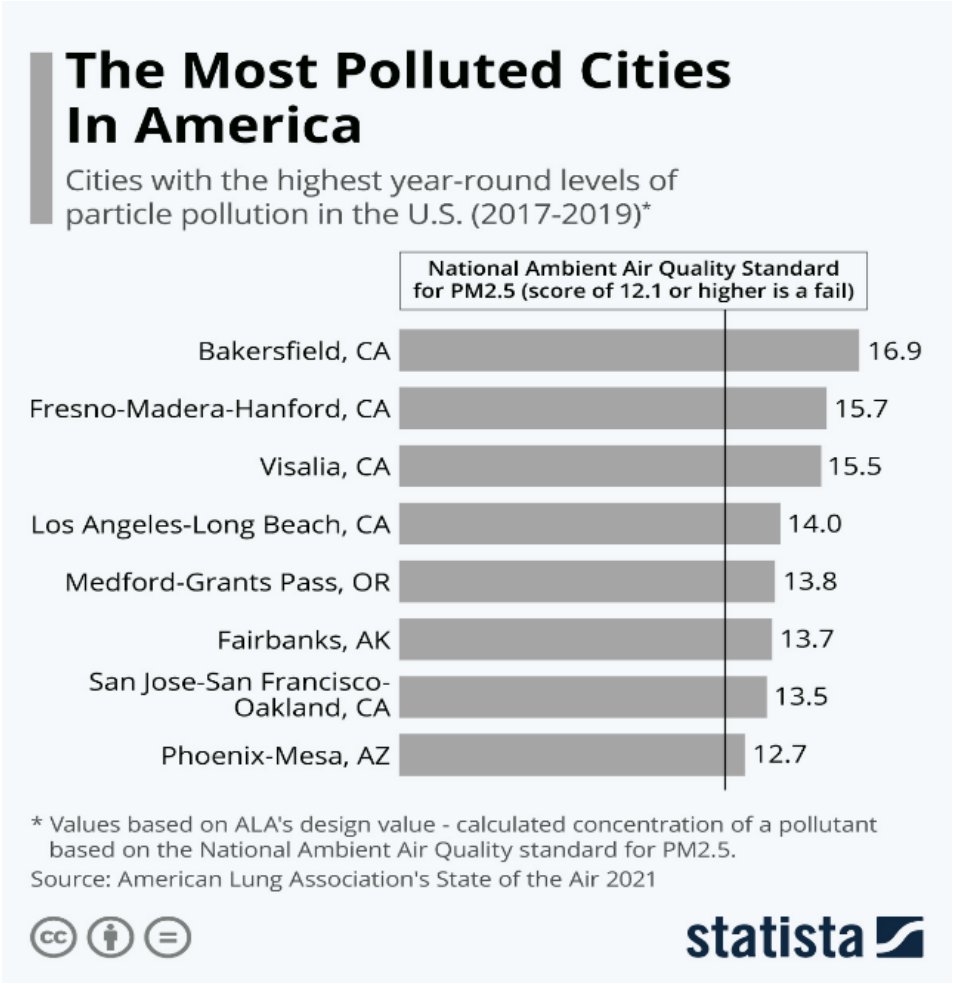
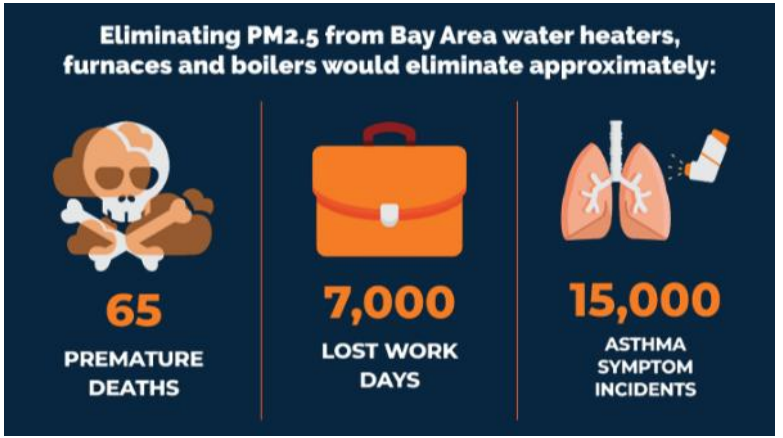


Gas Appliance Pollution

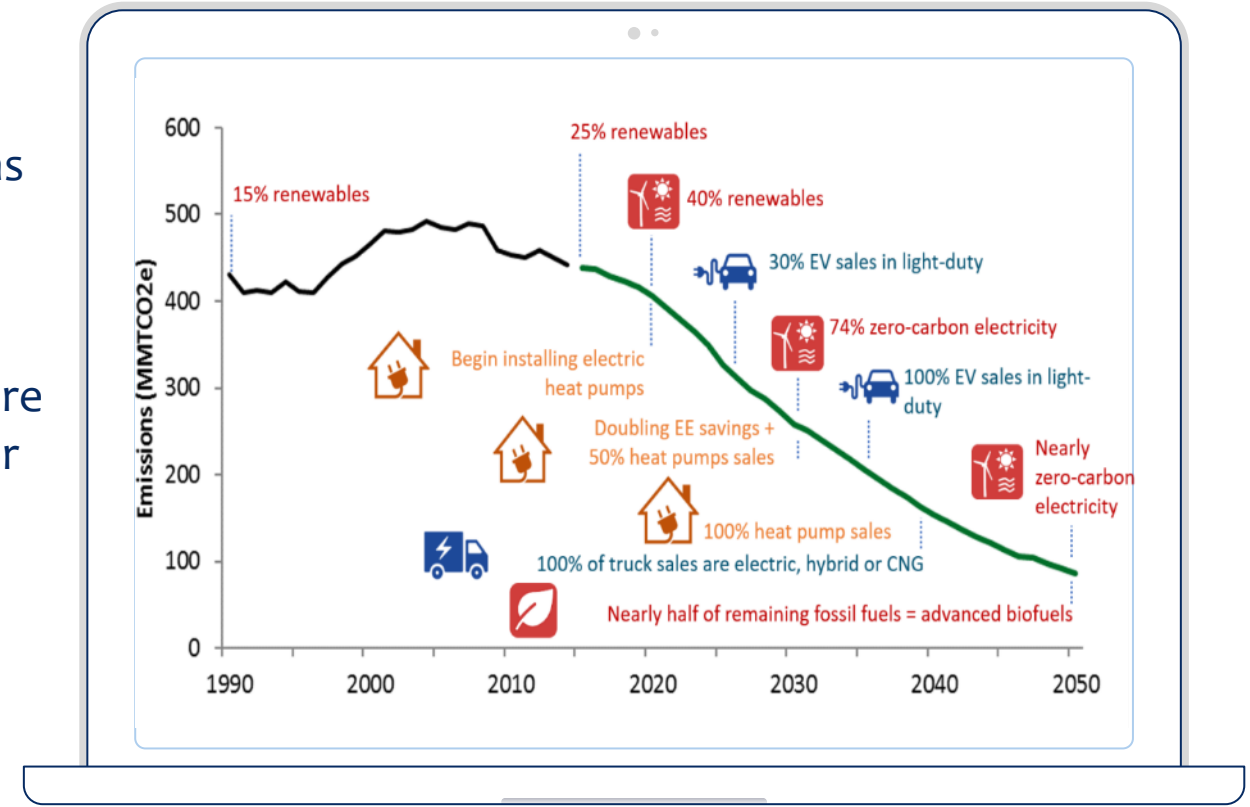
- "Appliance pollution in CA is responsible for **470 deaths** and **>$5 billion** in health impact costs per year in California" – RMI
- "Replacing all residential gas appliances in CA would prevent **354 premature deaths**, 596 acute cases of bronchitis, and 304 cases of chronic bronchitis"



Source: Gas Appliances and Smog: California's Hidden Air Pollution Problem. Sierra Club, SPUR, RMI. 2022.

Policy and Drivers of Electrification

- **10 million** CA homes have gas as primary heating source
- All these homes are an opportunity for electrification



Renewables, EVs and heat pumps all have a phase-in date

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70+ Cities Have Adopted Building Codes to Phase Out Gas in New Buildings

1.Carlsbad
2.Berkeley
3.Windsor
4.San Luis Obispo
5.San Mateo
6.Santa Monica
7.Menlo Park
8.San Jose
9.Davis
10.Marin County
11.Mountain View
12.Morgan Hill
13.Palo Alto
14.Alameda
15.Milpitas
16.Santa Rosa
17.Pacifica
18.Mill Valley
19.Saratoga
20.Brisbane
21.Healdsburg
22.Los Gatos
23.Cupertino
24.San Francisco
25.Los Altos Hills
26. Campbell
27. San Mateo County
28. Richmond
29. Hayward
30. Santa Cruz
31. Burlingame
32. San Anselmo
33. Piedmont
34. Redwood City
35. East Palo Alto
36. Los Altos
37. Millbrae
38. Sunnyvale
39. Ojai
40. Oakland
41. Albany
42. San Carlos
43. Daly City
44. Petaluma
45. South San Francisco
46. Sacramento
47. Santa Barbara
48. Emeryville
49. Fairfax
50. Encinitas
51. Santa Clara
52.Solana Beach
53.Santa Clara County
54.Contra Costa County
55.Half Moon Bay
56.Belmont
57.Hillsborough
58.Hercules
59.Pasadena
60.Martinez
61.San Bruno
62.Livermore
63.Portola Valley
64.Ventura County
65.Pleasanton
66.San Leandro
67.Glendale
68.Dublin
69.Corte Madera
70.Atherton
71.Riverside
72.San Rafael
73.Los Angeles
74.San Pablo
75.Agoura Hills
76.Carpinteria

Image Source: Sierra Club

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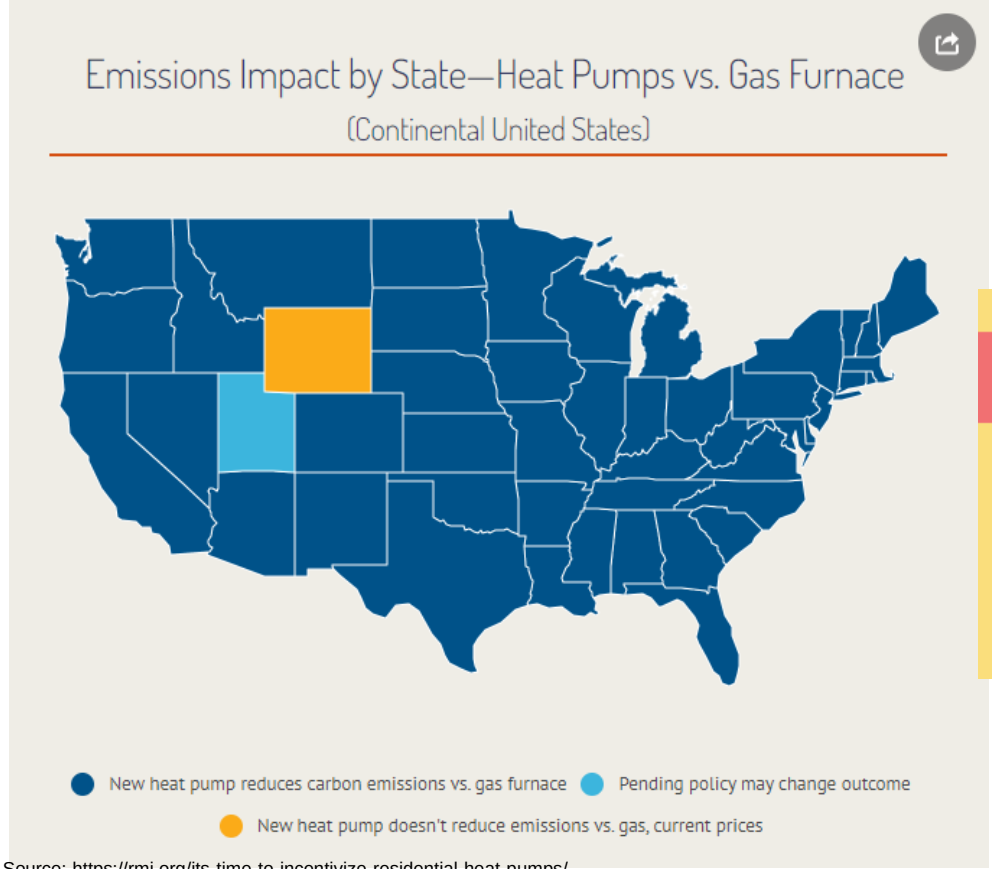
BUILDINGS

Governor Newsom Sets Bold Clean Buildings Goals

It mobilizes the state to achieve the following goals:

- 6 million heat pumps in buildings by 2030, as recommended by the California Energy Commission,
- 3 million climate-ready and climate-friendly homes by 2030,
- 7 million climate-ready and climate-friendly homes by 2035 (half of all CA homes!),
- And with at least 50 percent of funding to meet these goals directed toward disadvantaged communities.

Why Electrification is a Cleaner Option



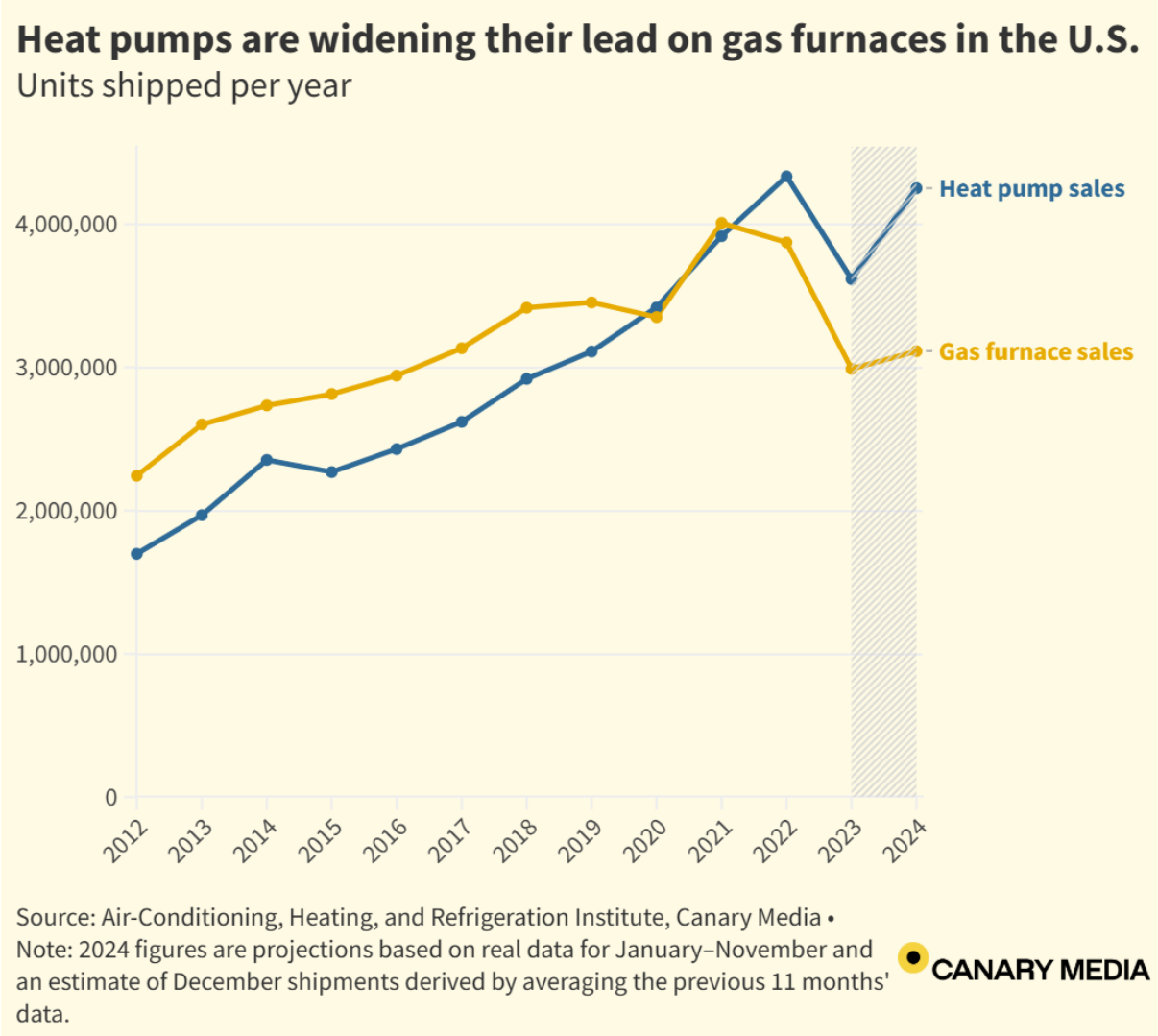
Source: https://rmi.org/its-time-to-incentivize-residential-heat-pumps/

Did you know?

98% of U.S. households would cut their carbon emissions by installing a heat pump today.

Source: Rewiring America study including fugitive gas emissions

The Tide
~~is Turning~~
has turned



With just this information, what's your responsibility to your customers?

- Will this change the way **you** present to your clients?
- Will this change your opinion on your own gas systems?
- Does it make sense to include an electric option every time?


YOU THINK IT'S EXPENSIVE HIRING
A GOOD HVAC TECH
TRY HIRING A BAD ONE

Break Time?

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THE CLEAN ELECTRIC HOME SOLUTION

- SEGMENT 2 -

Topics Covered in Segment 2

- Heat pump & furnace history and evolution
- Overview of heat pump types to be discussed in this course
- What is required for “Good Electrification”
- Technical terminology: SEER, EER, COP, HSPF, R-value, kilowatts and kilowatt-hours, electrical panels

Everyone in this class has at least one heat pump in their house!

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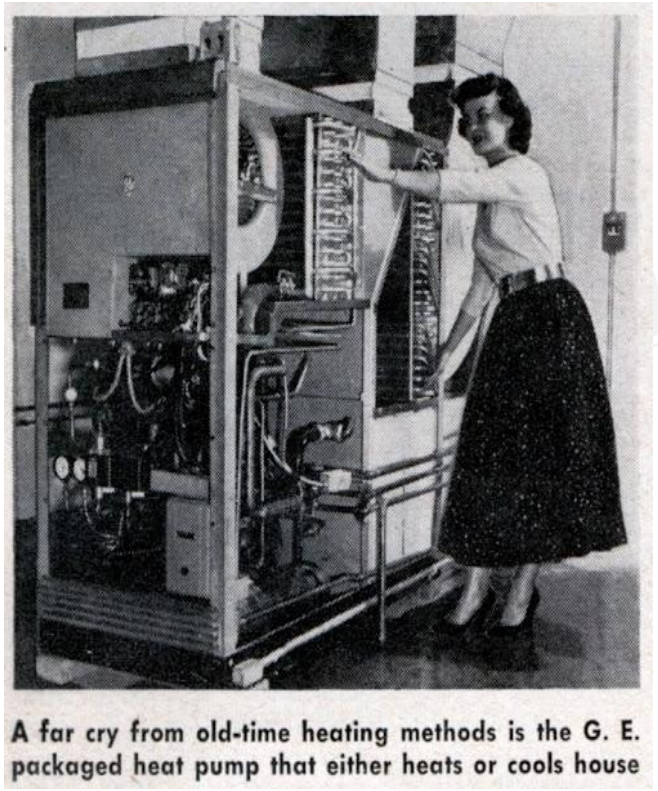
Quick Heat Pump History

- 1852 Lord Kelvin developed the idea
- 1855-1857 Peter von Rittinger built the first one
- 1950s GE proved anyone could have game changing heat pump technology, only requirement 50 extra square feet of space
- No COP or dB info on this monster.



A far cry from old-time heating methods is the G. E. packaged heat pump that either heats or cools house

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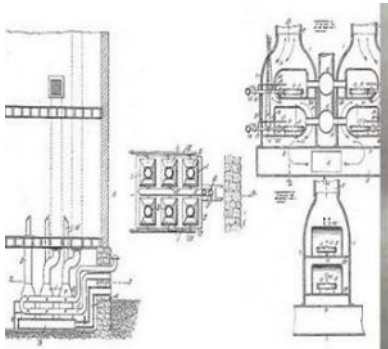
Gas Furnace History: 150-year-old Technology Basically the Same

1855, Dr. Bunsen, German scientist figures out how to mix air with a flame to burn cleanly.

In **1919,** Alice Parker followed her dream to have a warm house and not have to keep a fire going.

Information is unclear on how Alice actually got the furnace built.



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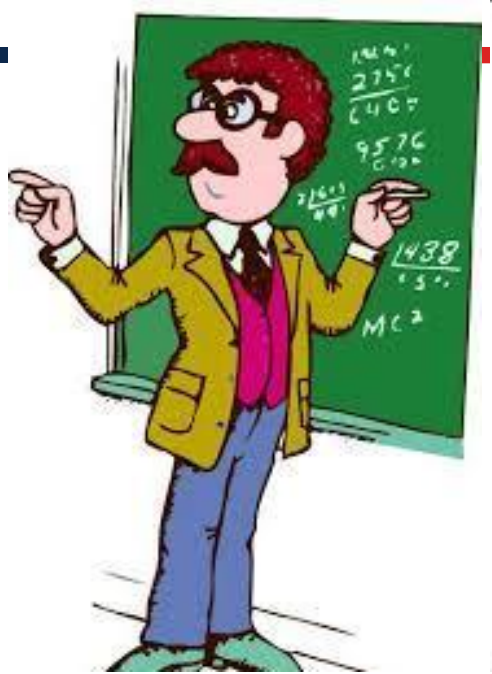

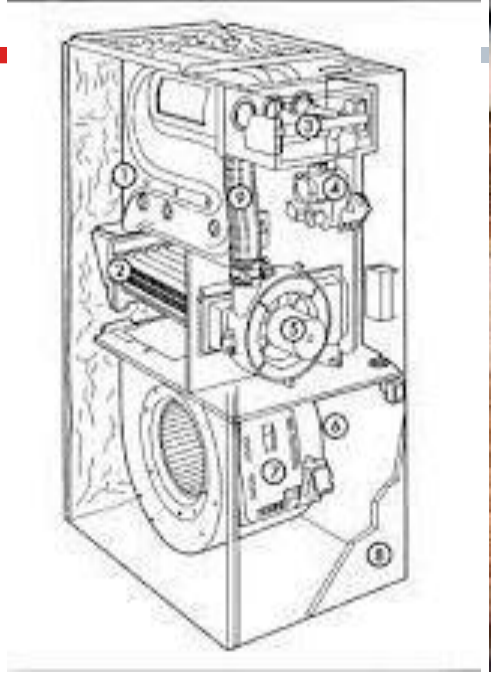

How Much Has it Changed? 150-year-old Technology

Automobiles Have Evolved as Well

Starting to Make Sense?

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First HPWH? 1940's Robert C Webber

- In the late 1940's, **Robert C. Webber**, a cellar inventor, was experimenting with his **deep freezer**. He dropped the temperature in the freezer and touched the outlet pipe and **almost burned his hand**. He realized **heat was being thrown away**, so he ran outlets from his freezer to his boilers and provided his family with **more hot water than they could use**! There was still wasted heat, so he piped hot water through a coil and used a small fan to distribute heat through the house to save coal. Mr. Webber was so pleased with the results that he decided to build a **full size heat pump** to generate heat for the entire home.

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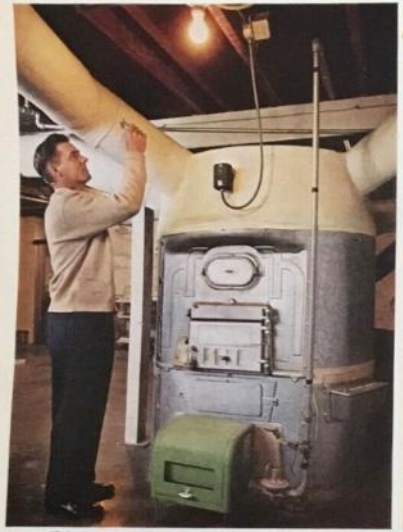
1930s: Electricity Became a Celebrated National Utility

Slide courtesy of Redwood Energy

Live Better, Electrically – 1956

Live Better Electrically - 1961

Total Electric Living is a clean break with the past



"Before we switched to electric heat, this monster took up a lot of living space."

"Switching to electric heat gave us the space for a new family room. We love it."

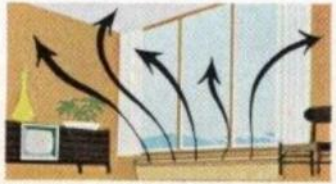
"We swapped a 'monster' for a new family room when we modernized with flameless electric home heating"

Lady, you'll just love flameless electric water heating
(almost this much)

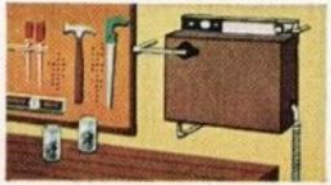
Only electricity offers flameless heating and cooling—and so many different types of equipment to choose from.

Heat pump heats in winter, cools in summer. One setting keeps any desired year-round temperature.

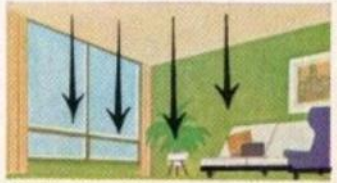
Electric furnace with air filter. Combines with cooling and humidity control for year-round comfort.



Electric baseboards save space, blend with room decor. Permit individual room temperatures.



Hot water system. Small boiler hangs on wall. Circulates hot water through baseboard units.



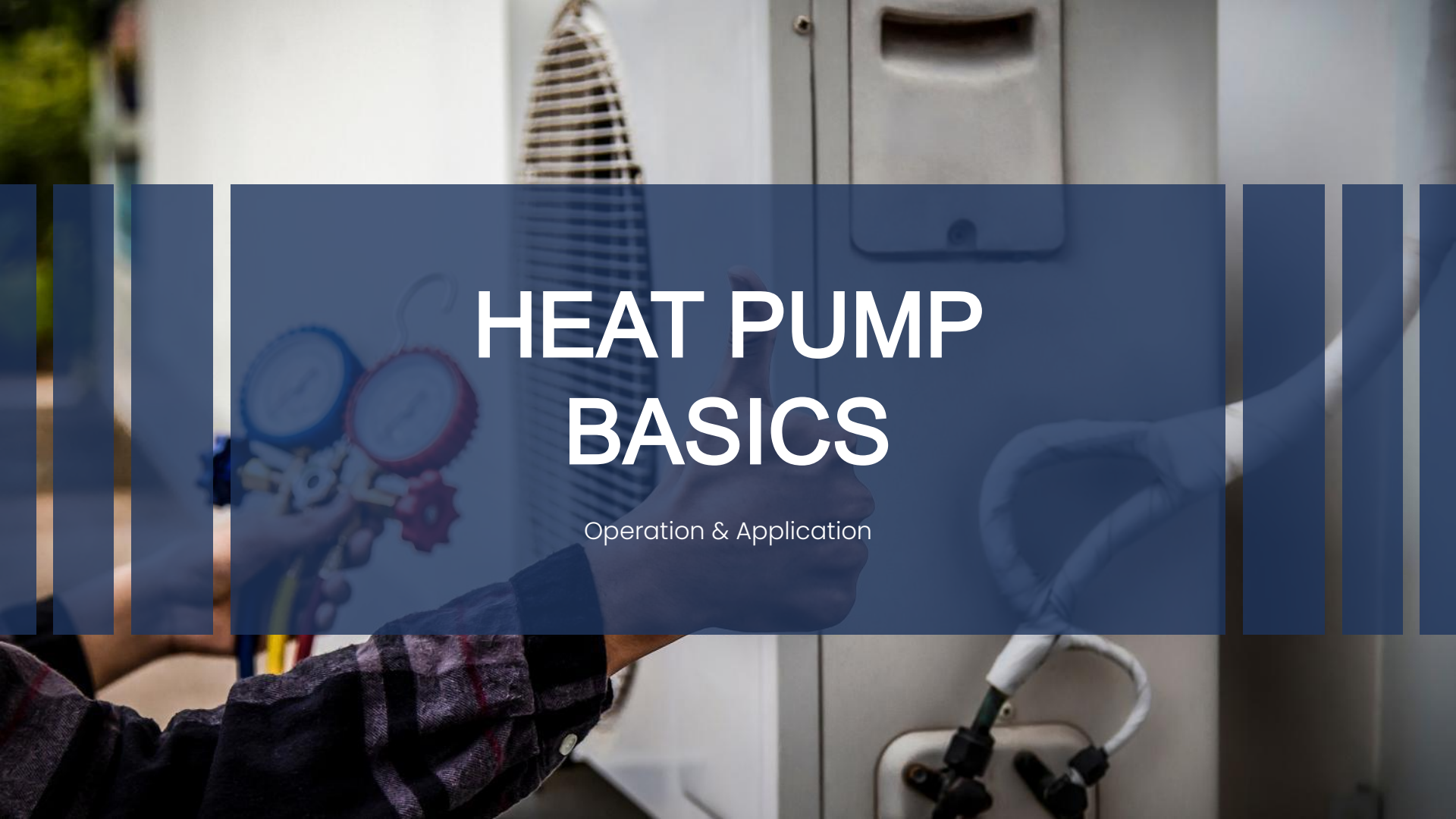
Radiant ceiling heating is invisible. Each room's temperature can be individually controlled.

Heat Pumps – Traditionally Disappointing in Cold Weather

Common complaints:

- Blows cold air!
- Noisy
- Energy guzzlers
- Noisy (The Gush)

You've heard of the S hitting the Fan.

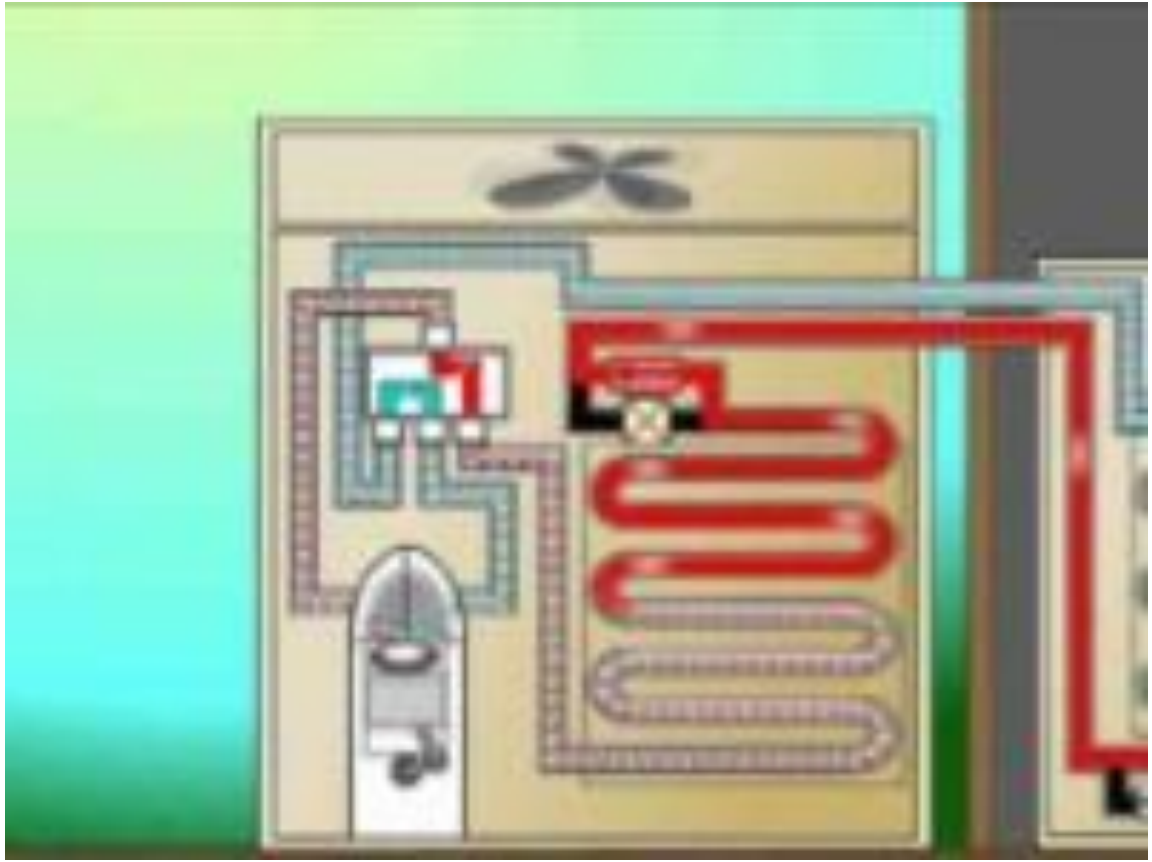


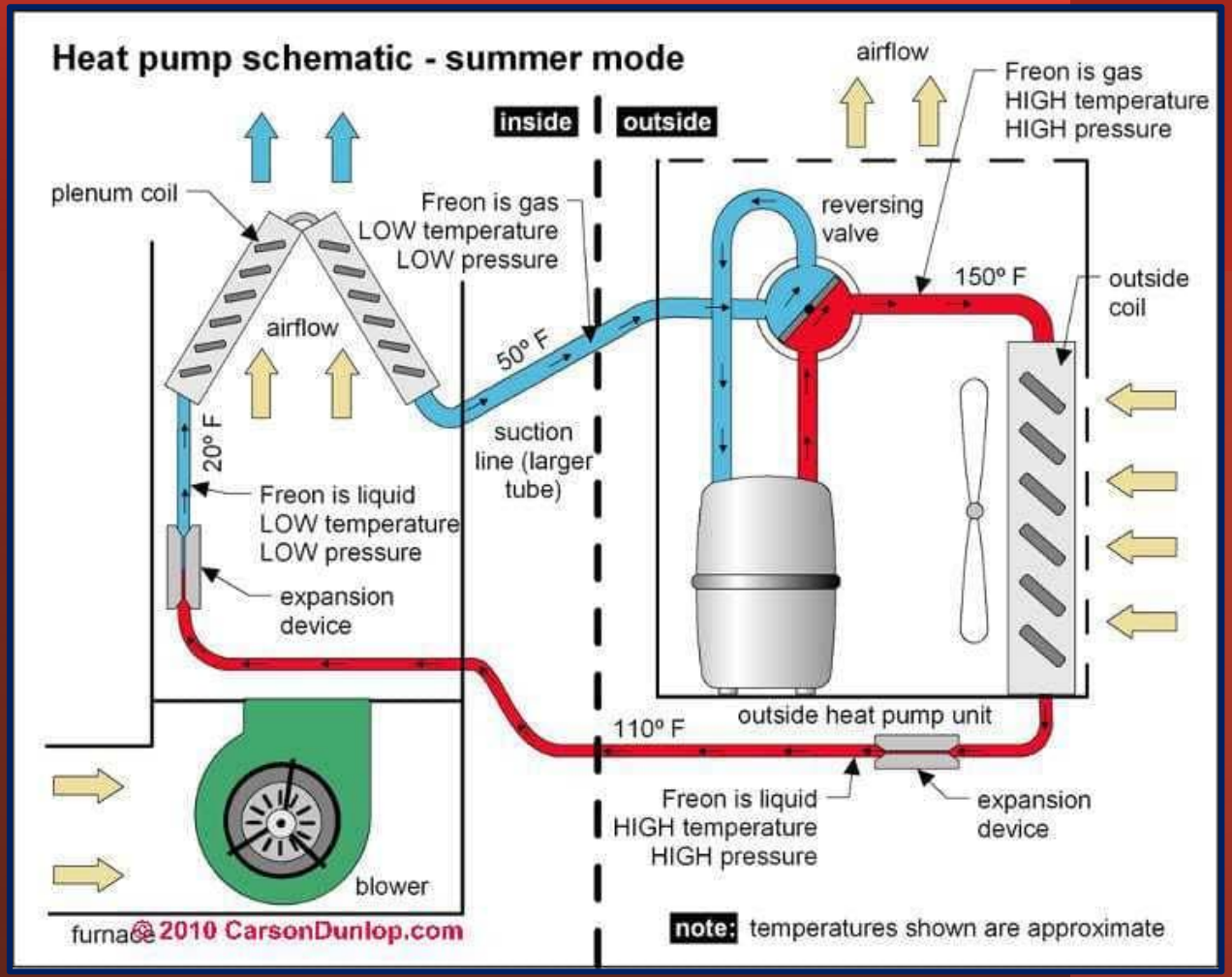
HEAT PUMP BASICS

Operation & Application

The Process of Moving Heat

How a Heat Pump Works




Heat pump schematic - summer mode
inside
outside
airflow
Freon is gas
HIGH temperature
HIGH pressure
plenum coil
Freon is gas
LOW temperature
LOW pressure
reversing
valve
150° F
outside
coil
airflow
50° F
20° F
suction
line (larger
tube)
Freon is liquid
LOW temperature
LOW pressure
expansion
device
110° F
outside heat pump unit
Freon is liquid
HIGH temperature
HIGH pressure
expansion
device
blower
furnace
© 2010 CarsonDunlop.com
note: temperatures shown are approximate

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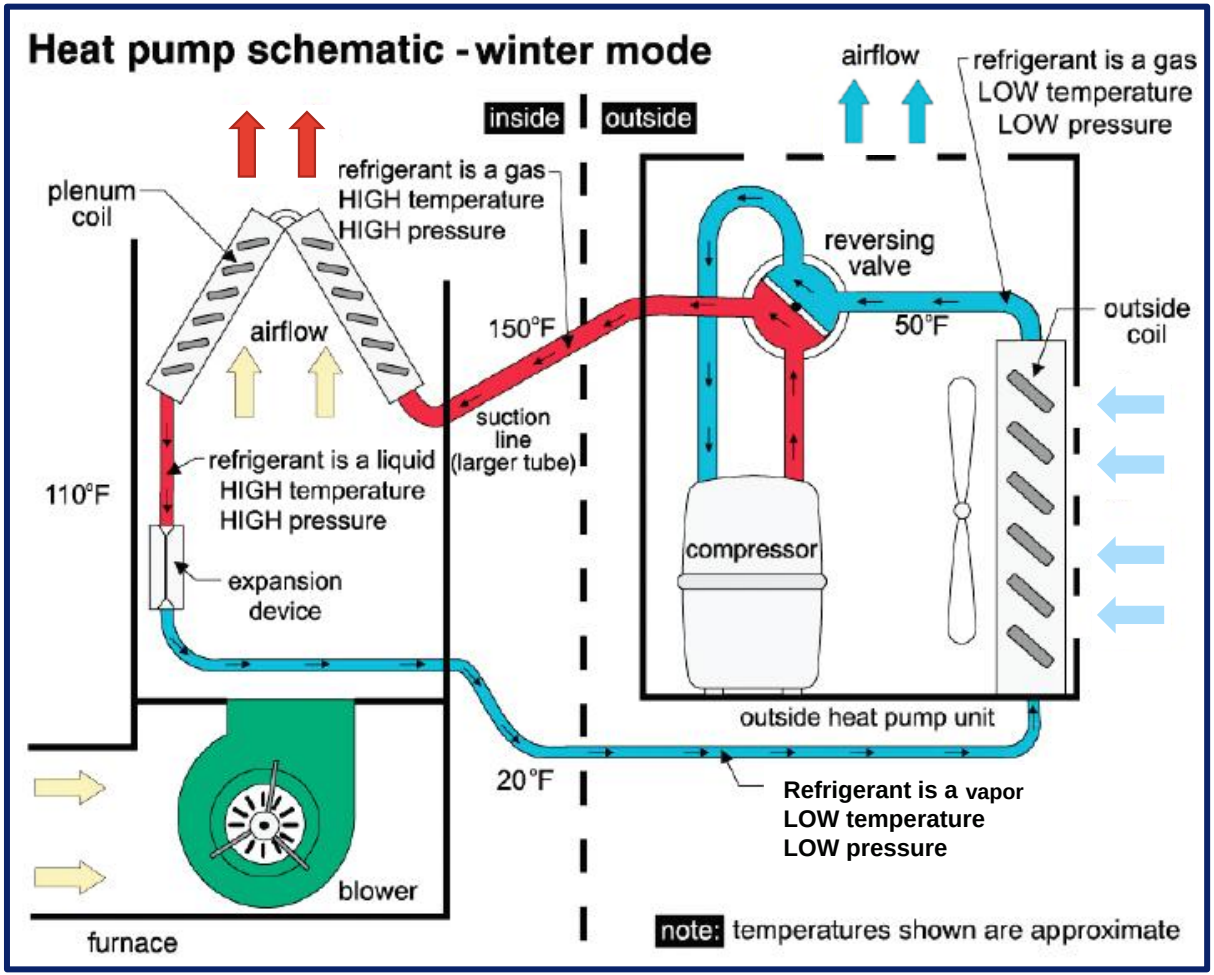

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Do You Explain "How It Works" To Your Customers?

Intro to Heat Pump Application vs Furnace and Unitary ASHP

Photos of work performed by A-1 Guaranteed Heating & Air Inc. Vallejo, CA

What is Good Electrification?

4 Rationales:

- Reduced carbon at the source
- Safer appliances
- Healthier
- More comfortable

What does that mean?

- Installing the most efficient solutions
- Utilizing existing infrastructure when possible
- Consider all electrification requirements from the start

“Good Electrification” Starts with Being a Good Steward for your Customer and their Electric panel

- Steward is: One who directs the affairs in best way possible
- Always most efficient solution!
- Your customers process will be unique to them
- Avoid panel change until necessary
- Take all future loads in a consideration

What Loads to Consider – Breaker Spaces

Most homes converting from gas, will need:

- Heat Pump circuit 2 to 6 spaces
- Dryer 2 spaces (30a)
- Hot water 2 spaces (15a or 30a)
- Range 2 spaces (50a)
- EV charger 2 spaces (30-50a)

Heat Pumps We Will Be Discussing In This Course

Air to Air

- Mini split
- Ductless and ducted
- Unitary

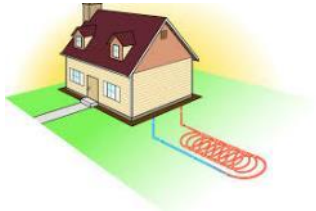
Air to water

- Hydronic heat hot water only
- Hydronic heat and cool

Water heating

- Unitary HPWH
- Water heating split

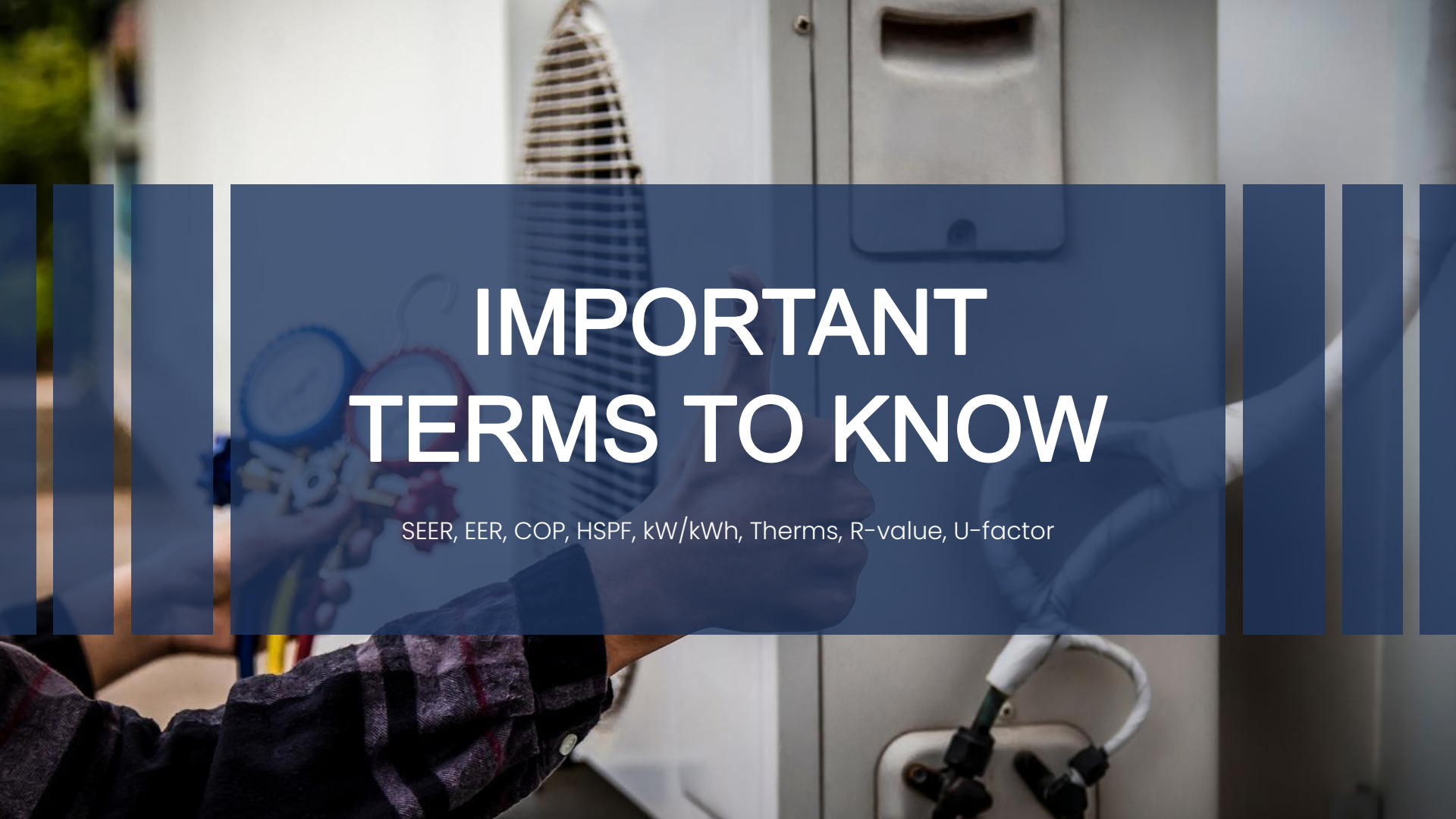
Ground source (geothermal)




PROBABLY THE TXV
FieldPulse

ELECTRIFY MY HOME

FYI This is not a Ducted Mini Split!

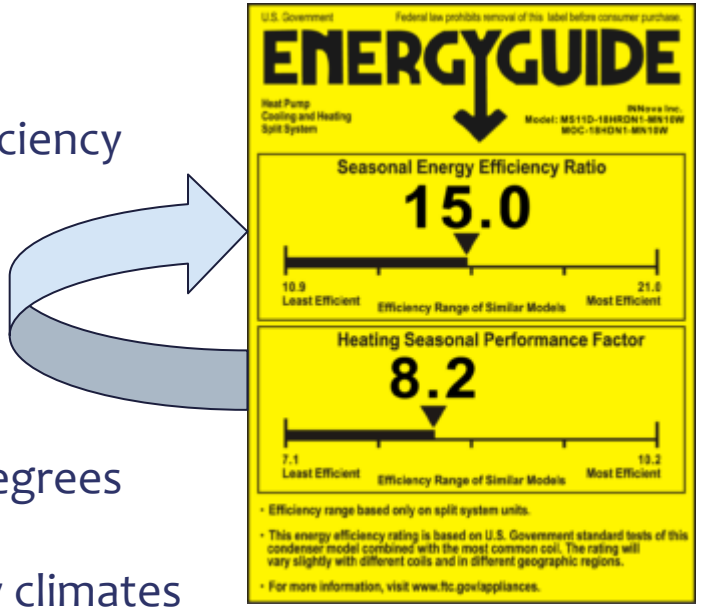


IMPORTANT TERMS TO KNOW

SEER, EER, COP, HSPF, kW/kWh, Therms, R-value, U-factor

SEER (Seasonal Energy Efficiency Ratio)

- The SEER rating is summer <u>average</u> cooling efficiency
- SEER is a federally mandated rating
- Average across the country
- The SEER rating average temperature is 84.5 degrees
- Averaging takes into consideration wet and dry climates
- Areas with high humidity run their air conditioners at much lower temperatures



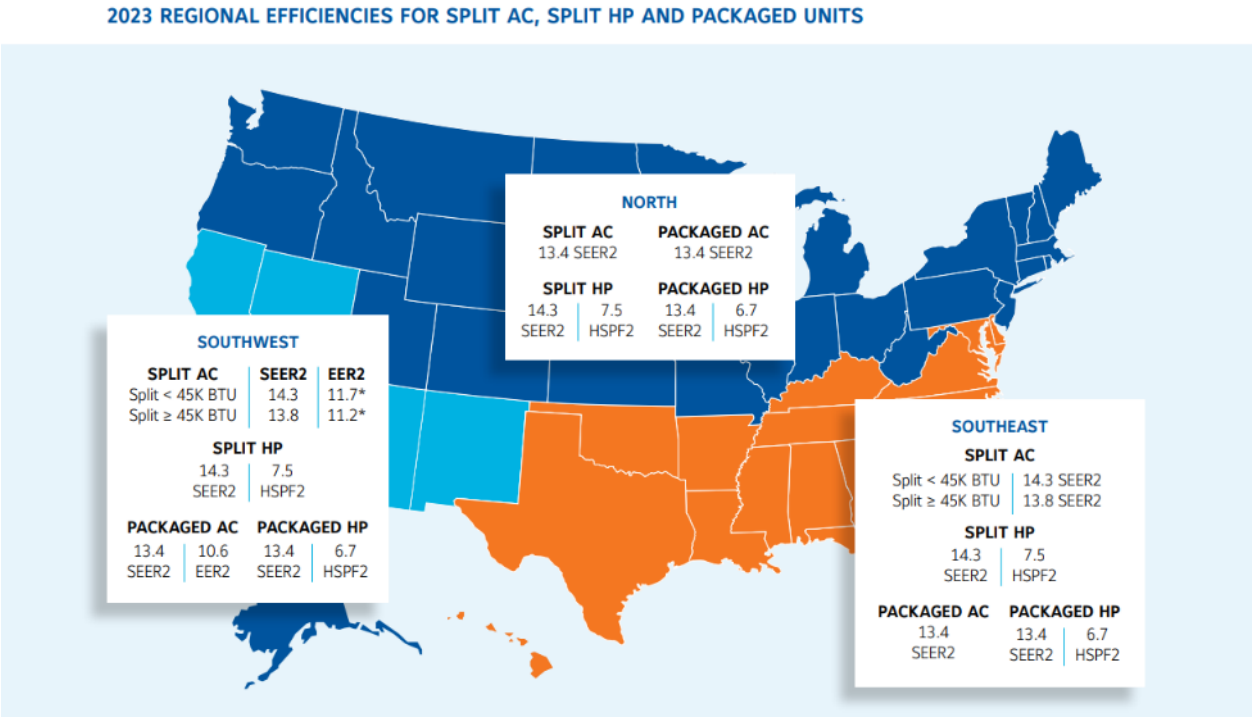
SEER vs EER

- Average SEER temp is 84 degrees
- EER temperature is 95 degrees
- Communicating EER can help you get the sale

	Dry bulb temperature	Wet bulb temperature	Relative humidity	Dew Point
Outdoor conditions	95°F (35°C)	75°F (24°C)	40%	67°F (19°C)
Indoor conditions	80°F (27°C)	67°F (19°C)	51%	60°F (16°C)

Table 1. Usual test conditions to evaluate EER

SEER 2 is Here !



Differences:
1) GEOGRAPHIES
Southwest
North
Southeast

2) STATIC PRESSURE
SEER 1 = 0.1” water column
SEER 2 = 0.5” water column

AHRI Rating Sheets Based on Testing in Perfect Conditions

AHRI CERTIFIED® www.ahridirectory.org

Certificate of Product Ratings

AHRI Certified Reference Number : 5953915 Date : 11-21-2021 Model Status : Active

AHRI Type : RCU-A-CB (Split System: Air-Cooled Condensing Unit, Coil with Blower)

Outdoor Unit Brand Na[redacted]

Outdoor Unit Model Number (Condenser or Single Package) : 4TTX8024A1

Indoor Unit Brand Name : ADP

Indoor Unit Model Number (Evaporator and/or Air Handler) : H,TG31(6,9)24

Furnace Model Number : *UD2C080ACV4

Region : All (AK, AL, AR, AZ, CA, CO, CT, DC, [illegible], MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, N[illegible]A, VT, WA, WV, WI, WY, U.S. Territories)

Region Note : Central air conditioners manufactured prior to January 1, 2015 are eligible to be installed in all regions until June 30, 2016. Beginning July 1, 2016 central air conditioners can only be installed in region(s) for which they meet the regional efficiency requirement.

The manufacturer of this ADP product is responsible for the rating of this system combination.

Rated as follows in accordance with the latest edition of AHRI 210/240 with Addendum 1, Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Cooling Capacity (A2) - Single or High Stage (95F), btuh : 24000

SEER : 17.00

EER (A2) - Single or High Stage (95F) : 12.50

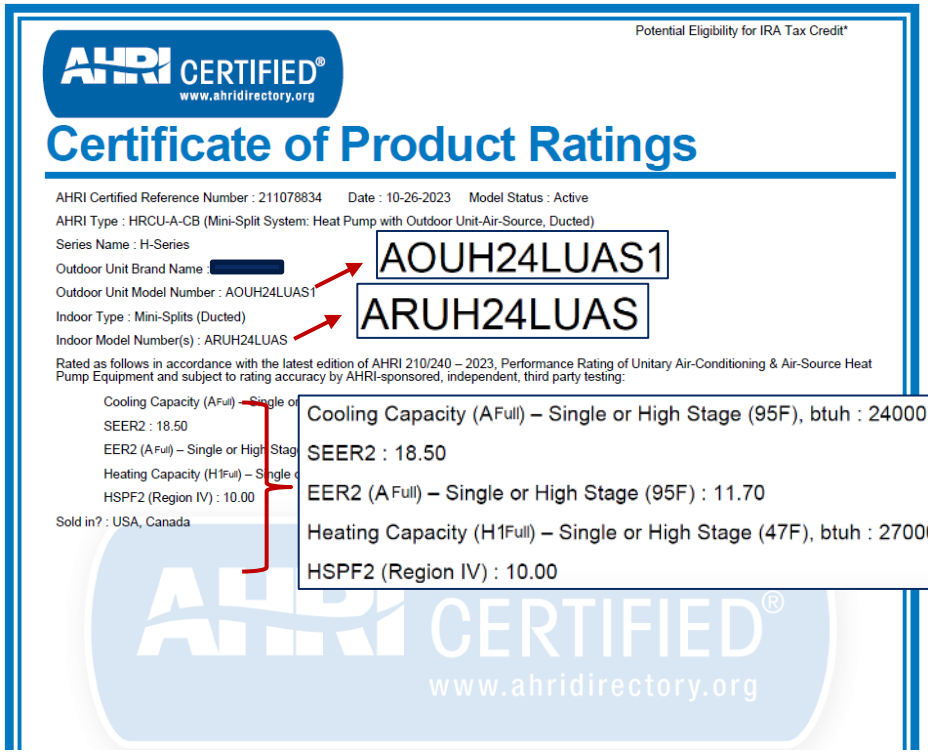
4TTX8024A1

H,TG31(6,9)24

*UD2C080ACV4

SEER : 17.00

EER (A2) - Single or High Stage (95F) : 12.50



Potential Eligibility for IRA Tax Credit*

AHRI CERTIFIED® www.ahridirectory.org

Certificate of Product Ratings

AHRI Certified Reference Number : 211078834 Date : 10-26-2023 Model Status : Active

AHRI Type : HRCU-A-CB (Mini-Split System: Heat Pump with Outdoor Unit-Air-Source, Ducted)

Series Name : H-Series

Outdoor Unit Brand Name : [redacted]

Outdoor Unit Model Number : AOUH24LUAS1

Indoor Type : Mini-Splits (Ducted)

Indoor Model Number(s) : ARUH24LUAS

Rated as follows in accordance with the latest edition of AHRI 210/240 – 2023, Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Cooling Capacity (AFull) – Single or

SEER2 : 18.50

EER2 (AFull) – Single or High Stag

Heating Capacity (H1Full) – Single

HSPF2 (Region IV) : 10.00

Sold in? : USA, Canada

AOUH24LUAS1

ARUH24LUAS

Cooling Capacity (AFull) – Single or High Stage (95F), btuh : 24000

SEER2 : 18.50

EER2 (AFull) – Single or High Stage (95F) : 11.70

Heating Capacity (H1Full) – Single or High Stage (47F), btuh : 27000

HSPF2 (Region IV) : 10.00

COP: Coefficient of Performance

$$\mathbf{COP} = \frac{\boldsymbol{Useful\ heating\ or\ cooling\ provided}}{\boldsymbol{Energy\ required}} = \frac{\boldsymbol{Energy\ OUT}}{\boldsymbol{Energy\ IN}}$$

- Higher COPs equate to higher efficiency
- Good Heat pumps are COP 3 or better
- Strip heat is COP of 1
- The most efficient furnace at 98% AFUE would be 0.98 COP

Explaining COP in Reference to a Gas Furnace

A bucket holding $100 of electricity

COP of 3

=

You get $300 of heat

A bucket holding $100 of gas

Most Efficient Furnace

=

You get $98 of heat

Doesn't always mean bill savings!

ELECTRIFY MY HOME

HSPF: Like SEER in Winter for Heat Pumps

$$\boldsymbol{HSPF}\left(\frac{BTU}{W \cdot h}\right) = \frac{Seasonal\ heating\ delivered\ (BTU/h)}{Seasonal\ electricty\ input\ (W)}$$

- HSPF the efficiency of air source heat pumps
- HSPF average efficiency over the heating season

Takeaway:

- Higher HSPF = more energy efficient. An electrical resistance heater (not considered efficient) has an HSPF of 3.41
- Higher HSPF = lower operational cost
- HSPF of 10 + is best and found almost only in inverter technology

Kilowatts and Kilowatt Hours

- A kilowatt (kW) is 1000 watts
- A kilowatt is a lot of energy
- Using a kilowatt of energy for one hour is 1 kWh
- Most electric plug-in heaters are 1500 watts or 1.5 kilowatts
- A typical blow dryer is 1.5 to 1.85 kilowatts

THE KILOWATTS

Kilowatt Hour (kWh)

- The kilowatt-hour is one kilowatt (kW) of energy sustained for one hour
- The kilowatt-hour is used as a billing unit by electric utilities
- A plug-in appliance uses 1000 watts for 1 hour you used 1 kWh
- PG&E rate is tiered between $0.36 and $0.61 per kWh
- The average nationally is $0.14 per kWh

Therms

- 1 Therm = ~100,000 BTUs
- The gas measurement factor used in utility billing
- Calculate the energy content delivered, not the volume. Volume is measured in cubic feet
- Ratepayers pay for therms. The cost of maintaining the gas system is carried on the therm

R-Value as it Pertains to Insulation

R-value is a measure of the resistance to the conductive flow of heat

- Measured R-Value varies per material
- R is resistance to energy (heat) flow
- Communicate as 1 degree resistance per R
  - i.e. R50 = 50 degrees resistance

Part 1, Quiz 1: Environment, Policy, & Culture + History

1) What is the main chemical component of natural gas?

A. Methane
B. Nitrous Oxide
C. Ozone
D. Propane

2) How many CA Cities have codes aimed at phasing out gas?

A. 50+
B. 18
C. 4
D. 1

3) How many homes in CA will need electrification?

A. 200,000
B. 900,000
C. 10 million
D. 500 million

4) What is the carbon reduction level required by CA in 2030?

A. 30%
B. 15%
C. 10,000 metric tons
D. 40%

5) Which of the following are rationales for Good Electrification?:

A. Higher profit projects
B. Increased emissions at the source
C. Healthier
D. More Comfortable
E. All of the Above
F. Both C and D

6) When a heat pump operates at low outdoor temperatures what is used for removing frost?

A. Heat strip
B. Off cycle
C. Reversing valve
D. Pan Heater

2) During the heat pump heating cycle, what causes the outdoor coil to frost?

A. Low airflow
B. Low refrigerant charge
C. Refrigerant temperature below freezing

ELECTRIFY
MY HOME

INSTALL SMALL
(i.e., the RIGHT size)

- SEGMENT 3 -

Topics Covered in Segment 3

- Introduction to inverter heat pump application versus the oversized furnace
- Mini-splits: ductless versus ducted
- Using mini-splits for the central solution
- What is “Install Small?” (Installing right-sized)
- Do your homework: the value of load calculations with electrification
- Calculating the opportunity for the downsize
- Poor workmanship examples from the field
- Considerations of ducts and registers

Oversized furnaces may never achieve optimal efficiency

- Oversize furnaces short cycle
- Short cycles can't warm up all the way
- Condensation in the early cycle
- Furnace must run to dry
- Causes massive rusting
- You've seen this
- Must run 20 Min to reach design state

Oversized Furnace, Keep This in Mind

- Bigger is not better
- Every furnace is too big
- Furnace size is often determined by SEER goals
- Use the smallest BTU biggest fan
- Never settle because “it’s what they have in stock”
- Furnace does not reach steady state until temperature has stabilized; when a furnace is too big, it never stabilizes
- A furnace that is too large can waste significant energy

Inverter Heat Pump vs Traditional Unitary

Size matters! Is smaller better? With inverter heat pumps it is.

- Traditional unitary is big, heavy, loud
- With Db ratings 75 to 72 range, can't be installed in many areas
- Most are 14 SEER
- Most require additional 240V for air handler and heater strip
- Standard models cost more over the life of the system

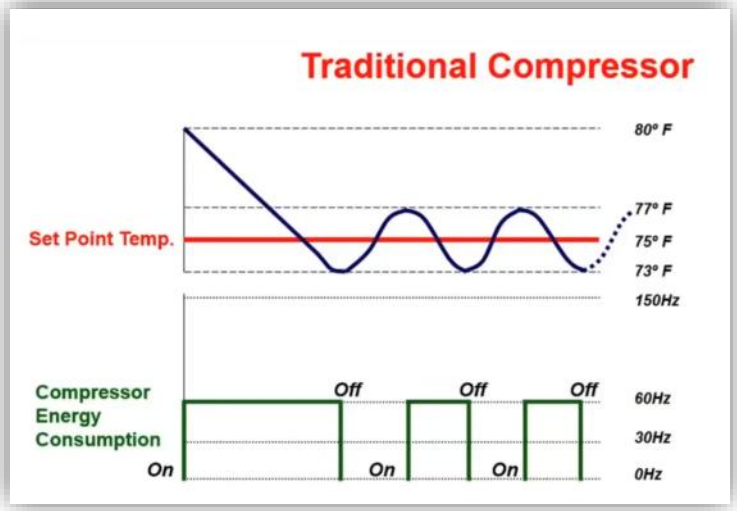
Mini Split will do Anything a Unitary* will do, but Better!

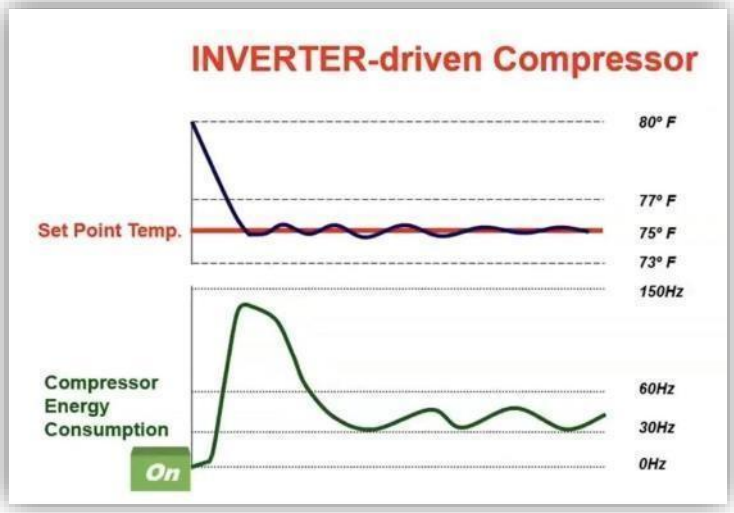
- Mini split tech does the same things, only better!
- Inverter gives large range of operating capacity
- Slim to fit - just 20 inches off the wall
- 56 Db is a loud one; some are <47 Db
- One power wire for most applications
- Low static pressure models for small applications
- Mid static products open new opportunities
- Forgivingly sizeable

* Traditional single/dual stage unitary

Inverter vs Traditional: Inverter Wins Every Time!

- Traditional systems cycle too much
- Uncomfortable temperature swings for the occupants
- More oversized the more negative comfort affects
- Cycling allows the building to dictate comfort

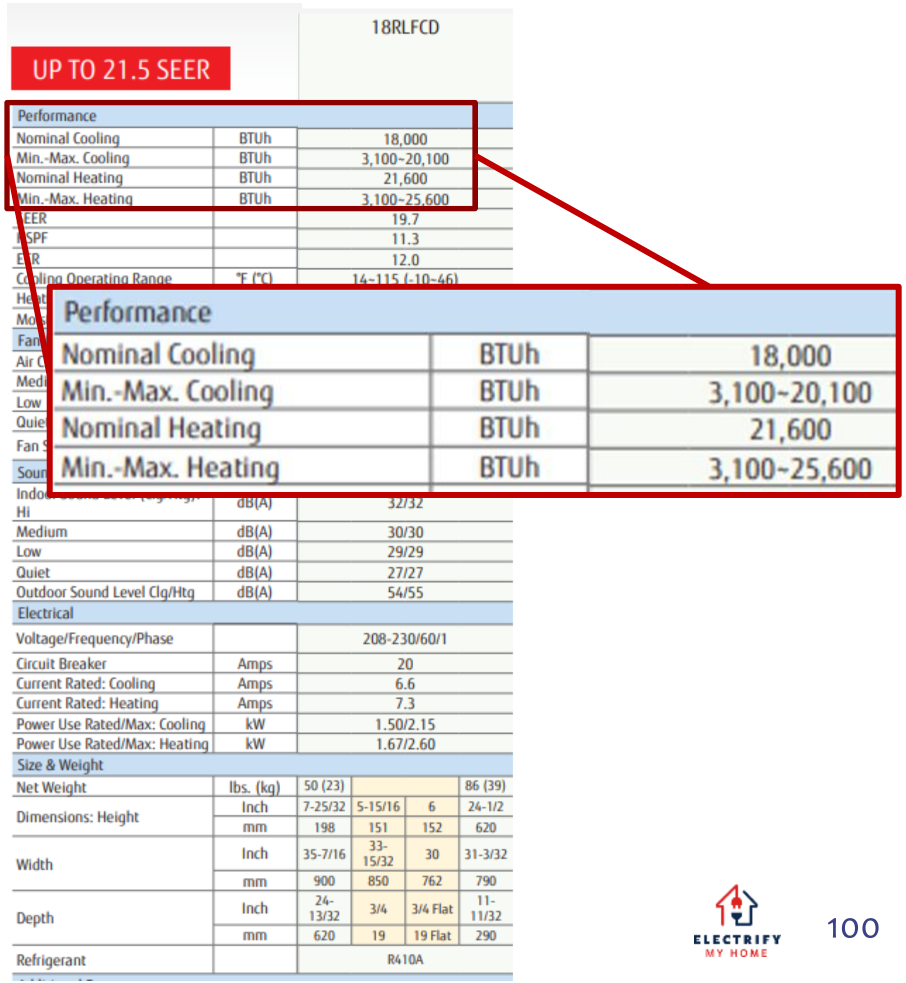




ELECTRIFY MY HOME

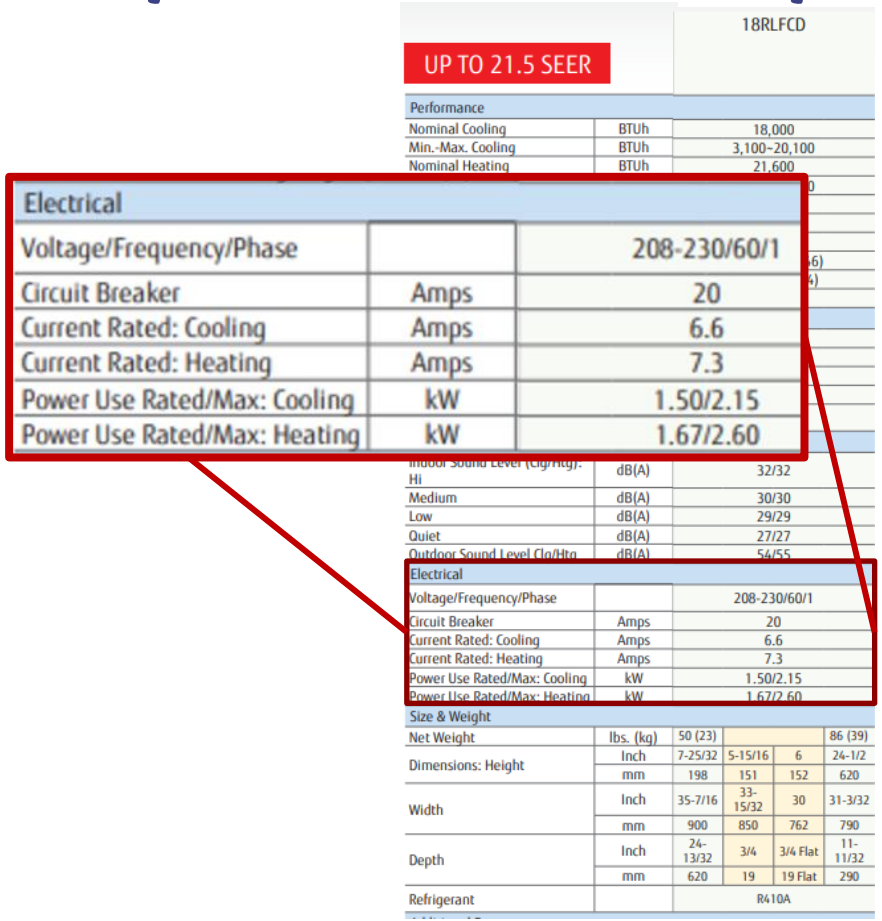
The BTU Range

- The low range is referred to as basement BTU's
- Some brands have nominal ratings with higher maximum outputs
- Some brands spec sheets show BTU rating at max output
- Size nominal to load calc BTU
- Extended output above nominal will use more energy



Watt Draw is Exceptionally Low (think hair dryer)

- Rated current 6.6a cooling
- Rated current 7.3a heat
- Cooling at nominal output 1.5 kw
- Most of these smaller ducted 1000 watts per ton +/-
- Heat at nominal 1.67
- Typical hair dryer 1800 watts



UP TO 21.5 SEER

18RLFCD

Performance		
Nominal Cooling	BTUh	18,000
Min.-Max. Cooling	BTUh	3,100-20,100
Nominal Heating	BTUh	21,600

Electrical		
Voltage/Frequency/Phase		208-230/60/1
Circuit Breaker	Amps	20
Current Rated: Cooling	Amps	6.6
Current Rated: Heating	Amps	7.3
Power Use Rated/Max: Cooling	kW	1.50/2.15
Power Use Rated/Max: Heating	kW	1.67/2.60

Hi	dB(A)	32/32
Medium	dB(A)	30/30
Low	dB(A)	29/29
Quiet	dB(A)	27/27
Outdoor Sound Level Clg/Htg	dB(A)	54/55

Electrical		
Voltage/Frequency/Phase		208-230/60/1
Circuit Breaker	Amps	20
Current Rated: Cooling	Amps	6.6
Current Rated: Heating	Amps	7.3
Power Use Rated/Max: Cooling	kW	1.50/2.15
Power Use Rated/Max: Heating	kW	1.67/2.60

Size & Weight					
Net Weight	lbs. (kg)	50 (23)			86 (39)
Dimensions: Height	Inch	7-25/32	5-15/16	6	24-1/2
	mm	198	151	152	620
Width	Inch	35-7/16	33-15/32	30	31-3/32
	mm	900	850	762	790
Depth	Inch	24-13/32	3/4	3/4 Flat	11-11/32
	mm	620	19	19 Flat	290
Refrigerant		R410A			

ELECTRIFY MY HOME

Quiet

- 55 dB is typical
- Some as low as 47 dB
- Traditional systems are 72 to 76 dB
- Install with big return air ducts and grilles
- Standard static unit shown

		18RLFCD
Sound		
Indoor Sound Level (Clg/Htg): Hi	dB(A)	32/32
Medium	dB(A)	30/30
Low	dB(A)	29/29
Quiet	dB(A)	27/27
Outdoor Sound Level Clg/Htg	dB(A)	54/55
Heating Operating Range	F (C)	-5-75 (-21-24)
Moisture Removal	Pt./h (l/h)	4.2 (2.0)
Fan (Cooling Mode)		
Air Circulation: Hi	CFM (m3/h)	554 (940)
Medium	CFM (m3/h)	518 (880)
Low	CFM (m3/h)	483 (820)
Quiet	CFM (m3/h)	442 (750)
Fan Speed Stage		4+auto
Sound		
Indoor Sound Level (Clg/Htg): Hi	dB(A)	32/32
Medium	dB(A)	30/30
Low	dB(A)	29/29
Quiet	dB(A)	27/27
Outdoor Sound Level Clg/Htg	dB(A)	54/55
Electrical		
Voltage/Frequency/Phase		208-230/60/1
Circuit Breaker	Amps	20
Current Rated: Cooling	Amps	6.6
Current Rated: Heating	Amps	7.3
Power Use Rated/Max: Cooling	kW	1.50/2.15
Power Use Rated/Max: Heating	kW	1.67/2.60
Size & Weight		
Net Weight	lbs. (kg)	50 (23) / 86 (39)
Dimensions: Height	Inch	7-25/32 / 5-15/16 / 6 / 24-1/2
	mm	198 / 151 / 152 / 620
Width	Inch	35-7/16 / 33-15/32 / 30 / 31-3/32
	mm	900 / 850 / 762 / 790
Depth	Inch	24-13/32 / 3/4 / 3/4 Flat / 11-11/32
	mm	620 / 19 / 19 Flat / 290
Refrigerant		R410A

Lunch Time

Interested in Learning more?

3-month cohort program available

- 3 C REN wants you to succeed!
- Program available to six vetted contractors
- No cost, just a commitment
- What's included? Weekly web video calls to discuss your progress, prospects, planning and problems
- Traveling on-site training for your install technicians*

Additional costs:

- * On-site visits * Design services * Load calc services *

Inverter Vs Inverter – Different Approaches

Feature	Fully modulating and communicating inverter	Temperature-sensing and pressure-based inverter
SYSTEM TYPE	Mini-split based; some very high end unitary	Unitary
EFFICIENCY	Based on nominal rated outputs	Great efficiencies
CONTROLLER	Manufacturer communicating controller	Traditional on/off thermostat, 24-volt
CONTROL FEATURE	Adjusts output based on control setting	Does not respond to t-stat changes in real time
COMPRESSOR SPEED	Up to 700+ points of communication	Based on coil temp
AIR SPEED	No fixed air speed	Fixed blower speed ECM
COMPONENT COMMUNICATION	All components	NA
POWER (Air Handler)	Wire from AH to ODU (typically)	AH requires its own circuit
CAPACITY	Some run 20% to 130%	Adjustable based on setting

Mini Split Heat Pumps Ductless vs Ducted

Ductless Advantages

- Single zones 1-1 wall mounts efficiency up to 31 SEER +
- Lots of configurations and styles
- Great for 1-3 room with multi zone

Ductless Disadvantages

- Condensation drain dictates location
- Outside wall or pump
- Difficult for service
- Tough sell for because of aesthetics

Single Zone Ducted

Advantages

- Multiple rooms with 1 unit
- Smaller capacity needed compared to multiple wall units
- Quieter
- Discrete
- Higher efficiencies in one-to-one application
- Easier Sell to the aesthetic eye
- Works like central forced air

Disadvantages

- More involved installation
- Needs “better install quality”
- Needs a load calc for best result
- Labor hours
- Correct registers

Multi-Zone Systems: Ductless

Advantages

- Flexibility for multi-room solutions
- Houses with a separate climate zones
- Branch boxes reduce line set lengths
- Less space needed

Disadvantages

- More refrigerant
- More chance for leaks
- Capacity penalty
- Less efficient
- No redundancy
- More difficult to repair
- More complicated installation

What Do You Think of This?

In this application multi zone, may be a better option

Getting Closer?

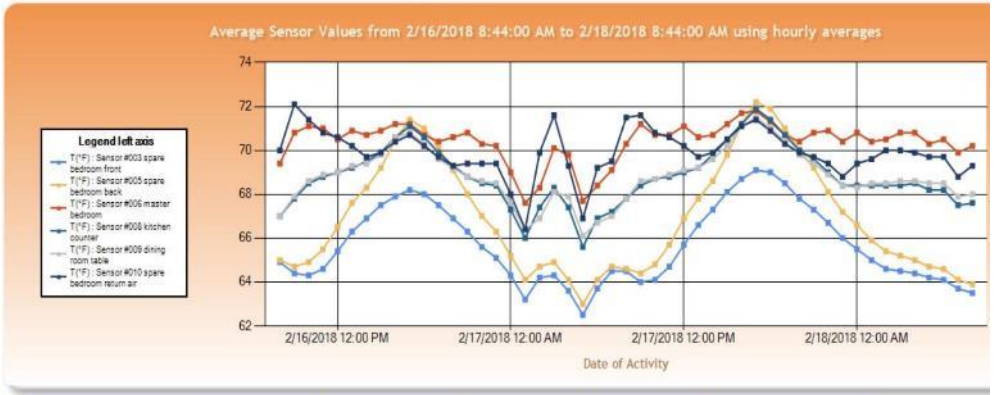
LEFT: 36K Multi-Zone Unit, RIGHT: 1x 18k Unit + 2x 9k Units

Photos of work performed by A-1 Guaranteed Heating & Air Inc. Vallejo California

ELECTRIFY MY HOME

Choose the Right Setup: What's Better, MZ or Multiple 1-to-1 units?

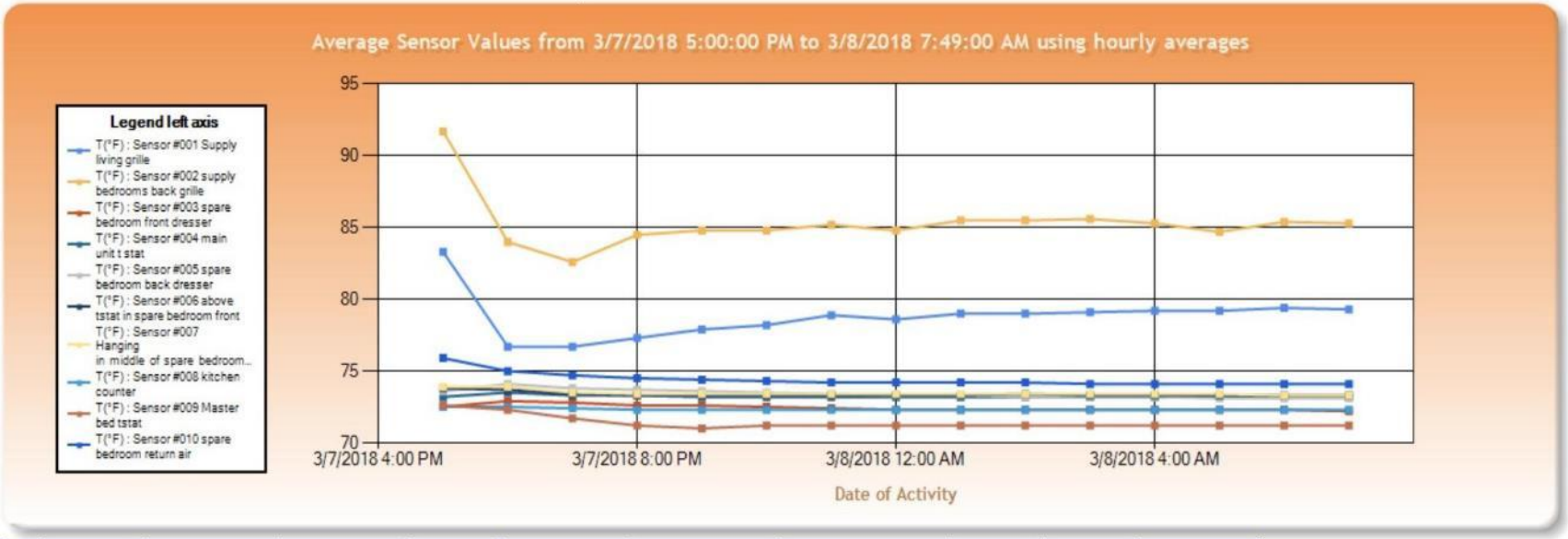
- Originally a 3-ton outdoor unit with three ducted air handlers
- Customer was not satisfied
- Erratic temperatures
- Part of house was less efficient and required more runtime
- System can only modulate down so far
- When a lower output than the minimum BTUs refrigerant will be sent to other zones
- System waived all night



	T(°F) : Sensor #003 spare bedroom front	T(°F) : Sensor #005 spare bedroom back	T(°F) : Sensor #006 master bedroom	T(°F) : Sensor #008 kitchen counter	T(°F) : Sensor #009 dining room table	T(°F) : Sensor #010 spare bedroom return air
min	62.50	63.00	67.60	65.60	66.10	66.40
max	69.10	72.20	71.80	71.90	71.50	72.10
diff	6.60	9.20	4.20	6.30	5.40	5.70

No data found for sensor ID 22F0022C, Sensor #004 main unit return air

Switching to 3-1 to 1 Made Amazing Difference...Expensive Mistake!



	T(°F) : Sensor #001 Supply living grille	T(°F) : Sensor #002 supply bedrooms back grille	T(°F) : Sensor #003 spare bedroom front dresser	T(°F) : Sensor #004 main unit t stat	T(°F) : Sensor #005 spare bedroom back dresser	T(°F) : Sensor #006 above tstat in spare bedroom front	T(°F) : Sensor #007 Hanging in middle of spare bedroom front	T(°F) : Sensor #008 kitchen counter	T(°F) : Sensor #009 Master bed tstat	T(°F) : Sensor #010 spare bedroom return air
min	76.70	82.60	72.20	73.20	73.10	73.30	73.30	72.30	71.00	74.10
max	83.30	91.70	72.90	73.50	74.10	73.80	73.90	72.50	72.60	75.90
diff	6.60	9.10	0.70	0.30	1.00	0.50	0.60	0.20	1.60	1.80

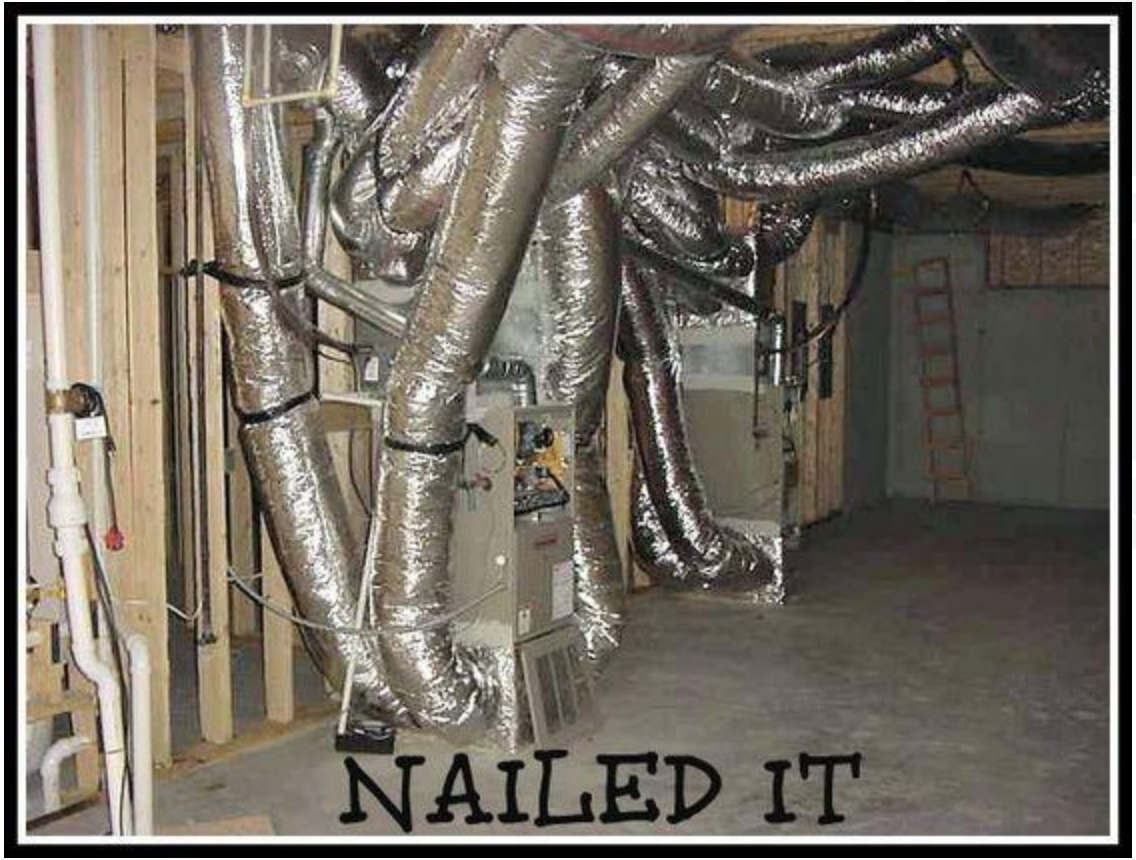
Photos of work performed by A-1 Guaranteed Heating & Air Inc. Vallejo California

Space Saving Design Creates Opportunities

- Great for tight attics
- Keep ducts low for burial
- OK if not all ducts can be buried
  - Use R-8 in those instances

Vertical Tuckaway Install is Possible with Some Brands* - Check First

*Not all brands can be installed vertically. This is Fujitsu ARU series low static.


NAILED IT

More Opportunity for Retrofit

- In an alcove
- Or drop a ceiling in a hallway
- Always install dampers on each run

Direct Replacement in Furnace Location

This Method
Not
Recommended

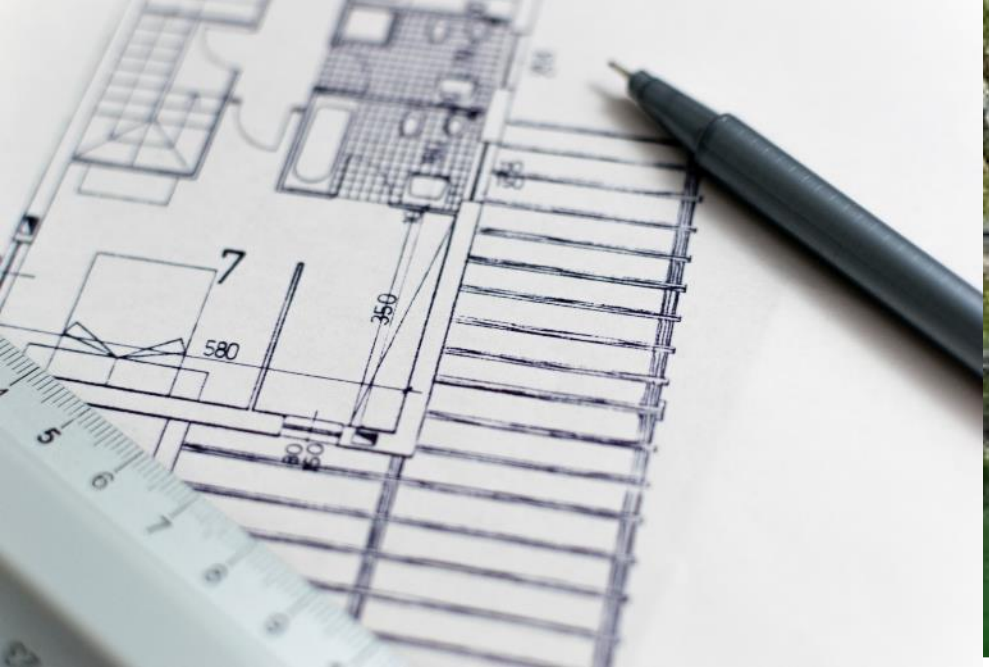
What is Install Small?

- Install Small means putting in the **right sized** system!
- Industry experts agree most 60% +HVAC systems installed in California every day are oversized
- Remember the term **“install small”** to remind you to be observant
- Install smaller can’t be done without understanding how to lower the load
- You must use the whole house approach. (House as a system)

ELECTRIFY MY HOME

Key Points of Installing Small

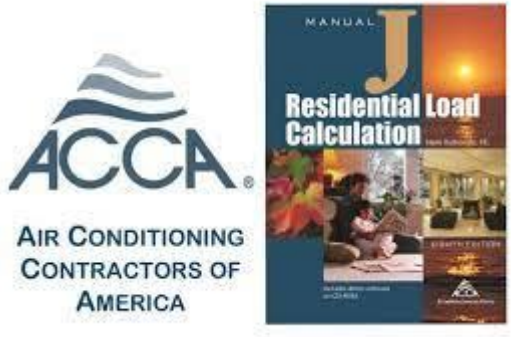
- DO A LOAD CALC
- Our typical system 750 to 900 sq ft per ton
- If tight, up to 1,150 sq ft per ton
- Some contractors up to 2,250 sq ft in new construction
- Our smallest 9,000 BTUs on 975 sq ft
- In some situations, we do not downsize as aggressively
- Some air sealing is always included
- Insulation must be addressed

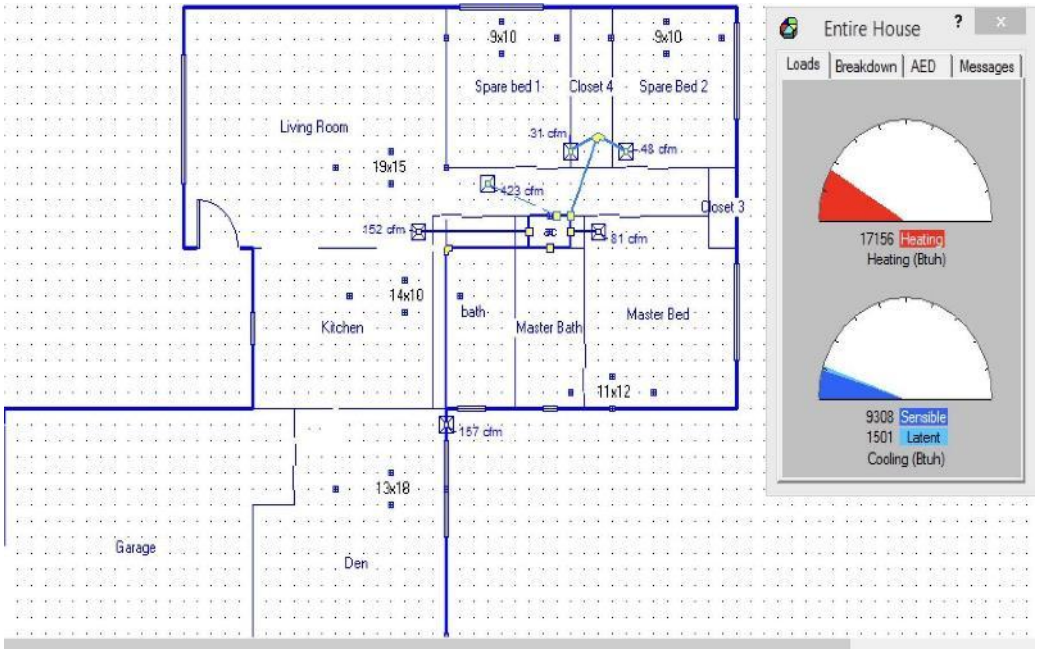


The Value of Load Calculations With Electrification

Downsizing Requires Thought and Pre-Planning

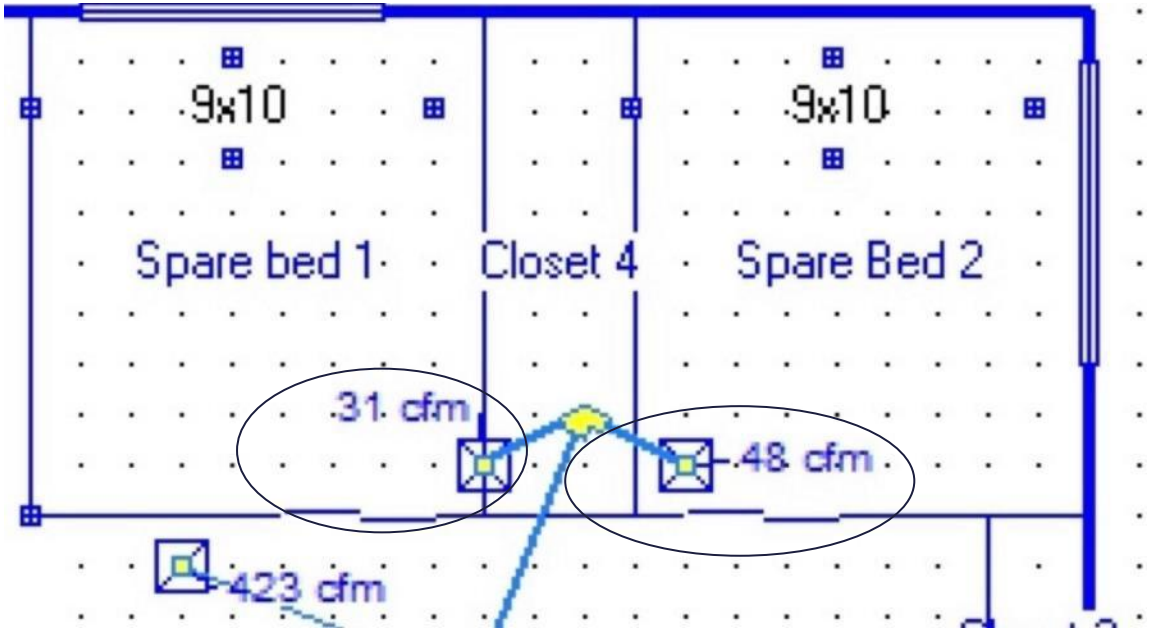
- A load calculation is required
- You will be surprised how small of a system you will need



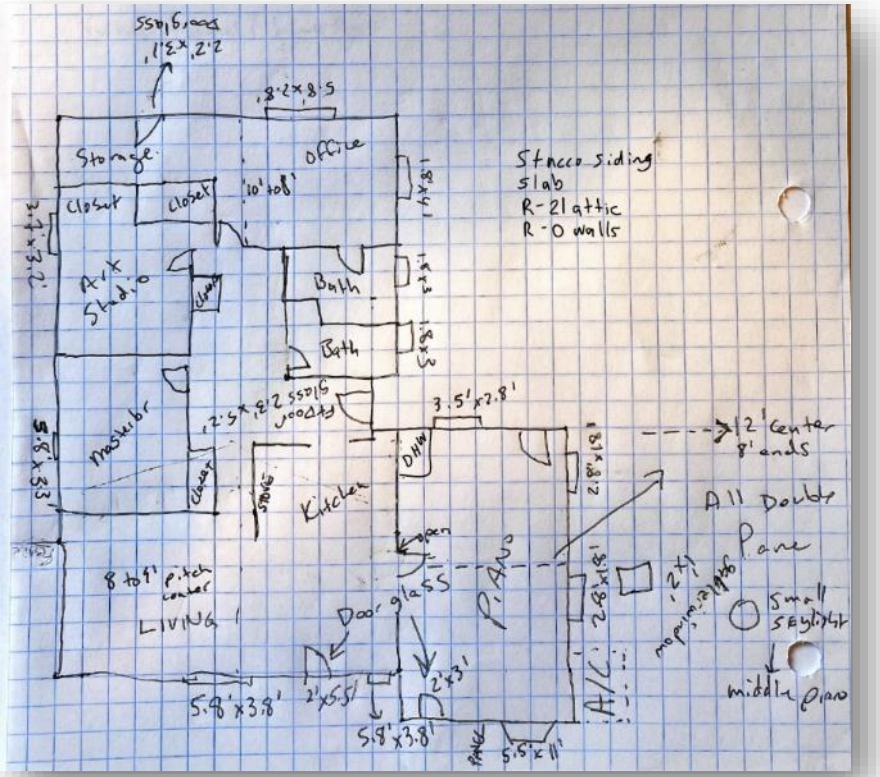


Without a Calculation How Would you Know?

- Same size rooms
- Same size windows
- Same side of the house
- Different requirements

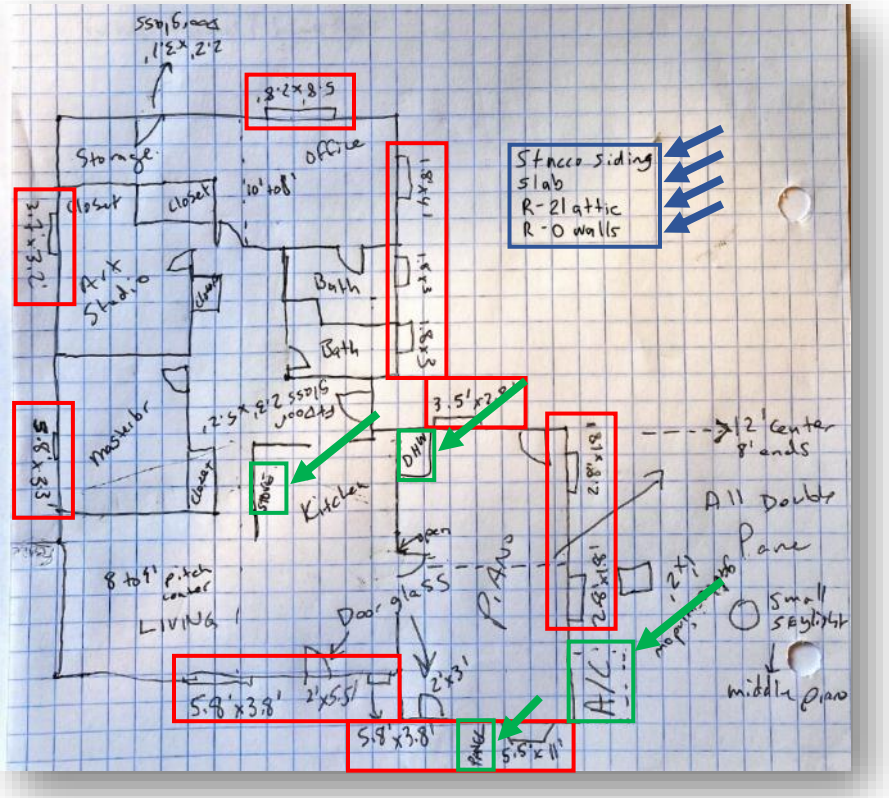


Site Plan Creation



- Keep scale consistent – 2’ per square
- Use laser measurer to save time
- Don’t worry about getting it down to the last half inch!

Site Plan Data



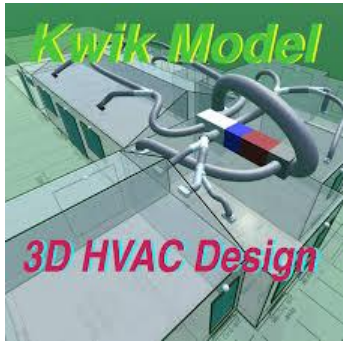
- Windows – note size & type
  - E.g., 5.8’ x 2.8’, double pane vinyl
  - U-factor & SHGC if available
- Siding – list type (stucco or wood)
- Foundation – Slab/Crawl/Mix
- Insulation levels & type
- Locations of appliances
  - Panel(s)
  - Indoor & Outdoor Unit
  - Water heater
  - Range/Stove

Approved ACCA Manual J Software Options

MiTek WRIGHTSOFT

Elite Software

EnergyGauge®
Energy and Economic Analysis Software



HeatCAD® 2024

conduit tech

CARMEL SOFTWARE

Amply
Amp up your heat pump business

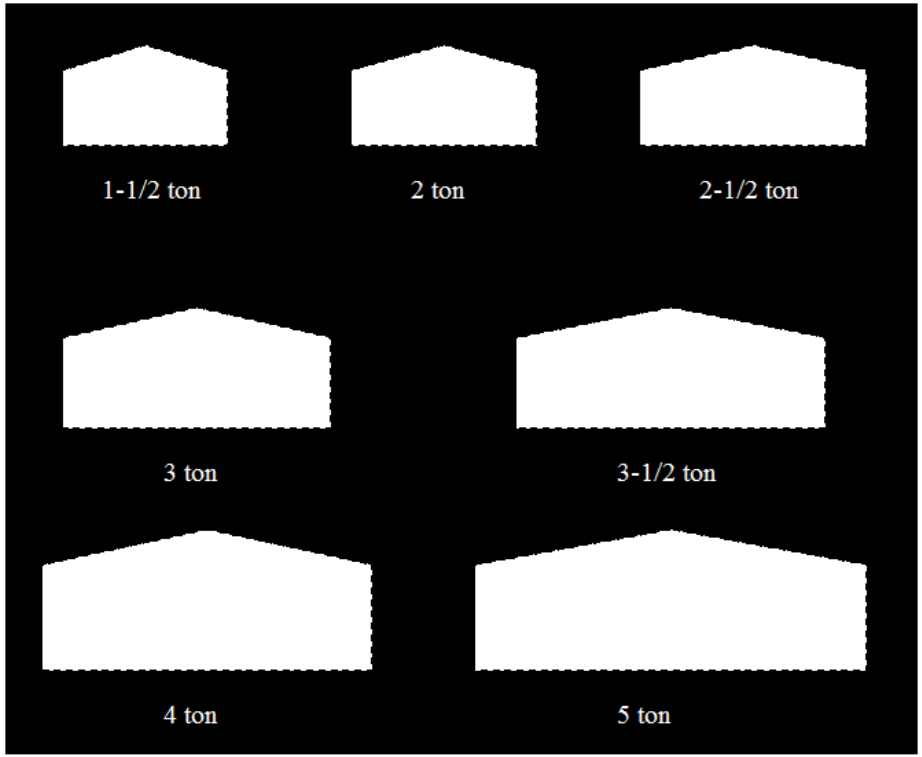
Cool Calc Manual J

ADTEK SOFTWARE

Free HVAC Load Calculator

Instructions:

1. Print template and cut out the white area of each house
2. Stand across the street in front of the home
3. Hold template out at arms length
4. Beginning with the smallest cut-out, look through each cut-out at home,
5. Select the first cutout that is completely filled by the homes' image
6. Below the selected cut-out will be the correct air conditioner size



ELECTRIFY MY HOME

Small Inverters Are The Best Option For Electrification

- Extra care when installing ductwork
- Half the cfm of old system
- Duct installed straight with mechanical elbows at every sharp turn
- Duct pulled tight to eliminate the interior ripple effect to manage static pressure
- Great care should be given to this process

Sizing for Performance

- General sizing rules should be followed for best results
- Shoot for 750 to 1 ton per thousand square feet
- But only if you've made the improvements shown in the sections above
- Inverter makes possible no more than 15,000 BTUs for 1,000 ft²
- More airflow is better (Why we set the airflow to high level)
- Look for a narrow split temperature 17 to 20 degrees no more
- Larger split temperatures mean you're not moving enough air

HVAC EQUIPMENT CAPACITY	
Check Numbers (New Systems)	Description
15,000 Btu/h per 1,000 ft² (Conditioned space)	**Target maximum installed heating capacity.** Lower Btu/h per 1,000 ft2 are better, because the higher Btu/h of furnace capacity needed to heat 1,000 ft2, the less effective is the current heating system. (Greater potential for improvement)
1 Ton per 1,000 ft² (Conditioned space)	**Target maximum installed cooling capacity.** Lower # of tons per 1,000 ft2 are better, because the higher the tons per 1,000 square feet, the less effective is the current cooling system. (Greater potential for improvement)
450 - 500 cfm per ton of AC system capacity	**Target minimum total supply air flow** Lower flow rates are not efficient in the dry California climate
60°F	**Lowest desirable coil-leaving air temperature** during cooling operation
90°F	**Highest desirable coil-leaving air temperature** during heating operation

What Needs to be Done to Downsize: First, Never Upsize

- It is almost never necessary to upsize
- Air flow problems rarely mean you need a bigger system
- Adding additional square footage onto an old house often reduces load
- Never sizes system for a future expansion remodel
- Stop telling the customers their ducts are fine; they're usually not

Photo Credit: Bailes, Allison (2014). *My Big Fat Oversized Air Conditioner*. Energy Vanguard.

How to Recognize an Oversized System

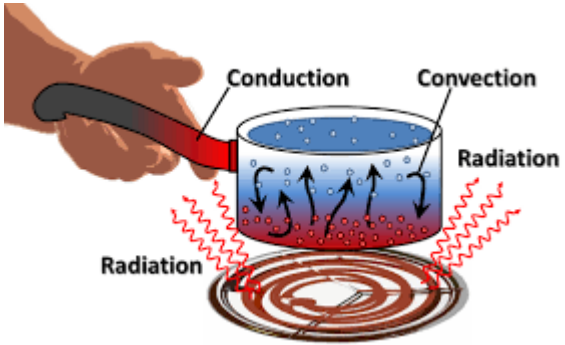
OVERSIZED SYSTEM	RIGHT-SIZED SYSTEM
Louder	Quiet
Higher Heat Rise	Warms House, Not Heat It
Short Cycles	Longer Cycles, Good Air Mixing
Causes Discomfort	Not Noticed

The 3 Types of Heat Transmittance

Conduction

Convection

Radiation



KNOW YOUR LOAD!

The Prerequisite to Downsizing

Understand the Envelope (Thermal Barrier)

Attic Insulation Intro:

- When heat is radiated onto the roof surface, the attic space heats up via **conduction**
- A sparsely insulated attic will heat the house via **radiation**
- The **conduction** on the ceiling causes very aggressive heat gain
- Insulating to R-49 will give us a 49-degree barrier

Understand existing condition of the envelope & plan for improvements

Calculating the Duct Gain

- Square footage of the home X 0.4
- T/D of the attic and the cold air in duct 125-55=70 degrees
- Determine the R-value of the ductwork

$$Duct\ Gain = \frac{square\ feet\ \times 0.4\ \times temp.difference}{R - value\ of\ ductwork}$$

EXAMPLE → 1500 sq ft home, 125 degree attic, 55 degrees supply air, R3 insulation

With R-3 ducts: $\frac{1{,}500\ \times 0.4\ \times (125\ -\ 55)}{3} = \frac{42{,}000}{3} = 14{,}000\ BTU\ (1.2\ TONS)$

That is over one ton of cooling lost to the attic space!

Buried ductwork (R-30): $\frac{1{,}500\ \times 0.4\ \times (125\ -\ 55)}{30} = \frac{42{,}000}{30} = 1{,}400\ BTU\ (0.1\ TONS)$ *lost to the hot attic*

Insulation/Radiation Savings Example
Total attic BTU savings!

Ceiling Heating Loss or Gain Calc:

$$u\ factor \times sqft \times temp.difference$$

Example: 1,500 sq ft ceiling, Attic is 125°F, room is 75°F

6,000 btus per hour savings ½ ton

With R-10 insulation: $\frac{1}{10} \times 1500 \times (125 - 75) = 0.1 \times 1500 \times 50 = 7{,}500\ BTU$

With R-49 insulation: $\frac{1}{49} \times 1500 \times (125 - 75) = 0.02 \times 1500 \times 50 = 1{,}500\ BTU$

Differential: $= 6{,}000\ BTU$

ELECTRIFY MY HOME

Combined Calculated BTU Savings with Insulation

1500 square foot example

Air Conditioner Size	36,000 BTU
Savings from burying ducts	-12,000 BTU
Savings from insulating attic to R-49	-5,700 BTU
New reduced load	*18,300 BTU!*

Remember Velocity

Your supply registers need double the velocity of the return air.

Meaning they should blow twice as hard as a return pulls.

AIR DISTRIBUTION DESIGN	
Check Numbers for New Systems	Description
500 - 700 fpm	**Minimum and maximum discharge velocity** from supply air diffusers
250 fpm	**Maximum velocity through return air grills and filters**
0.35" to 0.45" wc	**Duct design target - Max external static pressure for the air handler's fan.** (Maximum combined resistance of supply and return duct systems, including coils, filters, supply diffusers and return grills)
50 cfm_{25} or 5% of measured fan flow, whichever is less	**Maximum combined total air leakage from supply and return sides of the system.** (The real goal is zero air leakage, and 20 cfm_{25} is commonly achieved in practice by well-trained crews)
4,250 Btu/h per 1,000 ft^2 of occupied floor space	**Cooling load from attic duct work** Maximum conductive heat gain from attic duct work per 1,000 ft^2 of occupied space (Based on R-8 insulation, 40% of occupied floor space as duct surface, attic temperature of 140°F and supply air temperature of at least 55°F)
2,500 Btu/h per 1,000 ft^2 of occupied floor space	**Heating load from attic duct work** Maximum conductive heat loss from attic duct work per 1,000 ft^2 of occupied space (Based on R-8 insulation, 40% of occupied floor space as duct surface, attic temperature of 40°F and supply air temperature of no more than 90°F)

Steps to Optimizing the Duct System

- ❑ Keep Ducts as short as possible
- ❑ Use mechanical elbows at every 90-degree turn
- ❑ Install a damper in every duct
- ❑ Be mindful with your installation of the ducts; don't double back off a wye
- ❑ Ducts sit flat on the ceiling rafters with the damper handles facing up
- ❑ Measure to verify your ducts are not too short
- ❑ Use mastic on the inside of the duct and slide it over the metal connection
- ❑ Secure the duct with flexible plastic duct tape or Panduit strap
- ❑ Pull insulation from the duct to cover all metal
- ❑ Always have the ***goal of zero leakage*** in mind
- ❑ Tape all the seams on the air handlers to prevent air leakage

Use This Chart for Sizing the Duct Work

The chart was created by **Rick Chitwood**

These numbers are critical with lower static product

The sizes will seem foreign to you. Notice the 6 x 4 x 6 and the 8 x 6 x 8

EMH Notes

- I use an 8 x 4 x 6 and the 8 x 6 x 8 most all the time. I also use an 8 x 4 x 4 for bathrooms.
  - *I did that so there were some standardization*
- I get most of the styles I need from StatAir

SUPPLY AIR DUCT & GRILLE SIZING 100 of 146

Air flow (cfm)	Duct Diameter	Curved Blade Ceiling Grille [1]	Floor Grille [2]	High Sidewall Grille [3]
50	5″	4″ x 4″	10″ x 2.25″	4″ x 4″
75	6″	6″ x 4″	8″ x 4″	6″ x 4″
100	7″	6″ x 6″	10″ x 4″	8″ x 4″
125	7″	6″ x 6″	12″ x 4″	10″ x 4″
150	8″	8″ x 6″	10″ x 6″	8″ x 6″
175	8″	10″ x 6″	10″ x 6″	10″ x 6″
200	9″	8″ x 8″	12″ x 6″	10″ x 6″
250	10″	14″ x 6″	12″ x 8″	10″ x 8″
300	10″	14″ x 8″	14″ x 8″	12″ x 8″

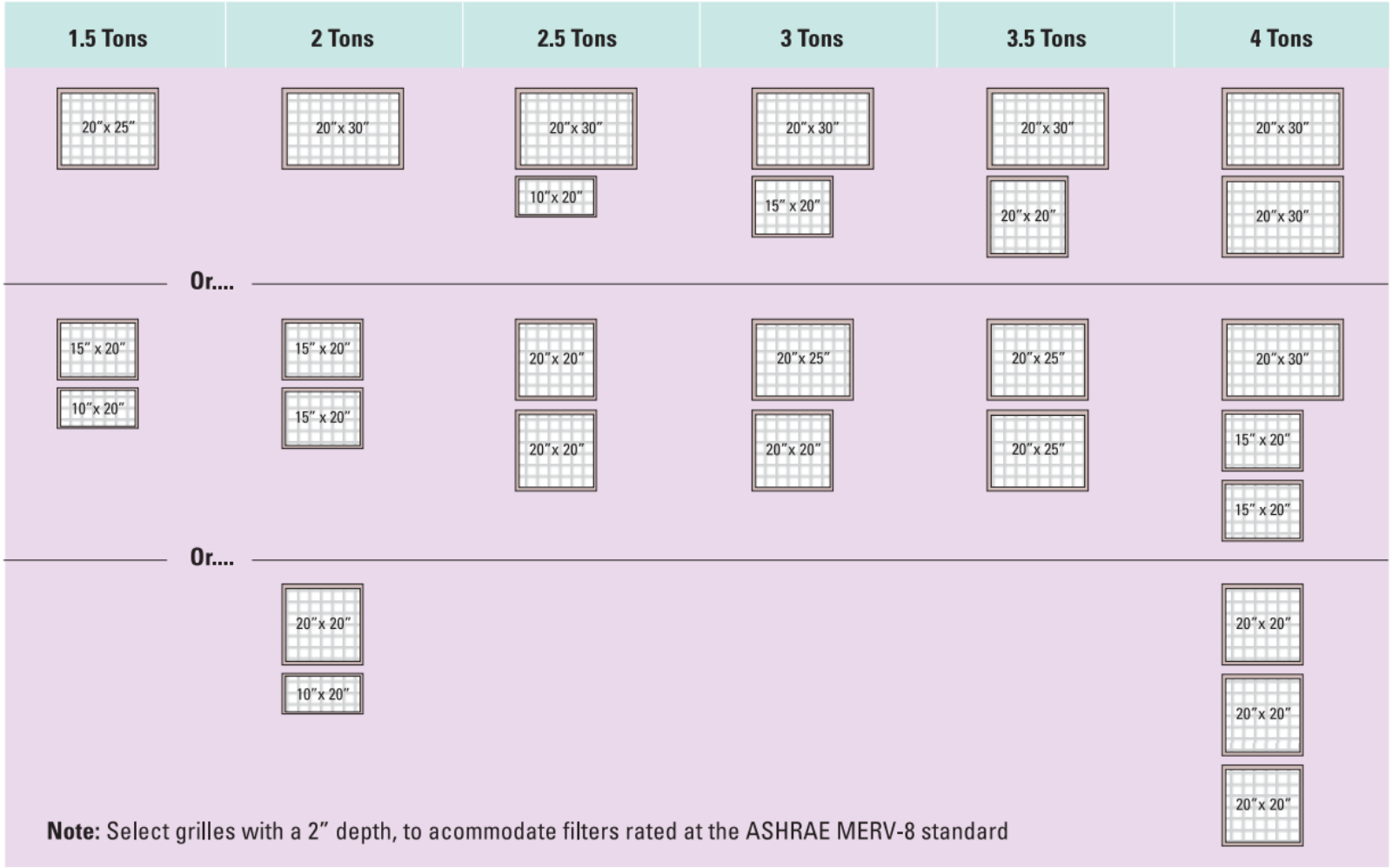
1. Typically a commercial-grade extruded aluminum grille
2. Simple bar-type grille (non-diffusing)
3. Typical residential double-deflection type grille

Rick Chitwood

1.5 Tons	2 Tons	2.5 Tons	3 Tons	3.5 Tons	4 Tons
16″	18″	18″ 10″	18″ 12″	18″ 14″	18″ 18″
Or....					
12″ 10″	14″ 12″	14″ 14″	16″ 14″	16″ 16″	14″ 14″ 14″
Or....					
	14″ 14″				16″ 14″ 14″

Rick Chitwood

Table 8.5 Check numbers for return air duct sizes



Rick Chitwood

Table 8.4 Check numbers for return air grilles

Quick Break?

REAL WORLD EXAMPLES

Install Small is Possible!

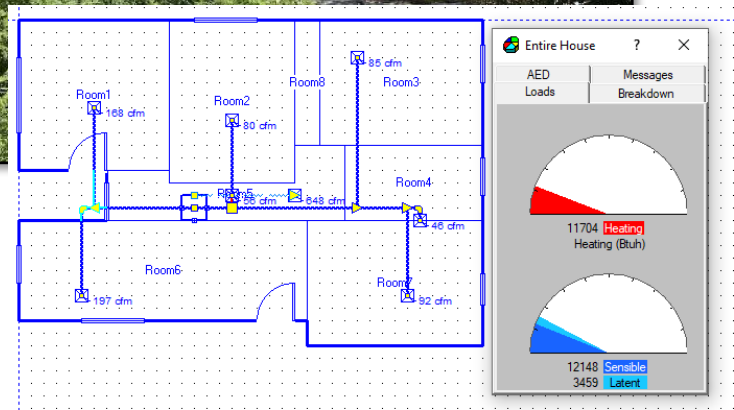
Example #1: Norvell St. [695 sqft/ton]

Client:

- City of Berkeley Sustainability Outreach Specialist
- Competing recommendation 40,000 BTU gas, 24,000 cooling

Site conditions:

- *Year Built*: 1948
- *Size*: 1042 sq ft
- *Envelope*: Insulation blown in to R44, cellulose (by others)
- *Existing System*: 60,000 btu 90% efficient gas furnace in the crawl space
- *New System*: 18,000 BTU



Example #2: Corte Madera [1,111 sqft/ton]

Client:

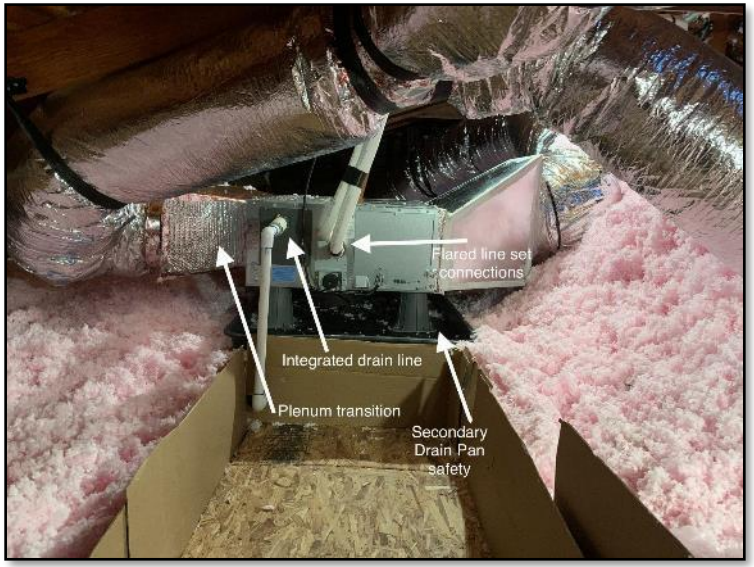
- Energy Advocate & Architect

Site conditions:

- *Year Built*: 1962
- *Size*: 1,420 sq ft
- *Envelope*: Attic poorly insulated; nasty crawlspace
- *Existing System*: 80,000 btu 90% efficient gas furnace
- *New System*: 18k BTU mid static

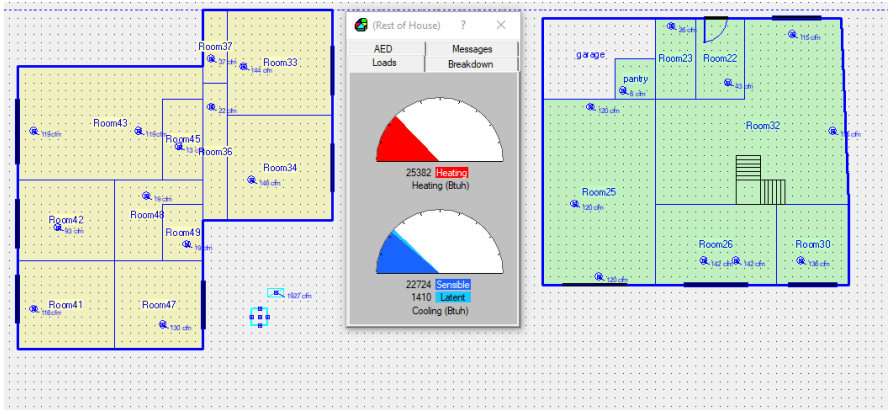
ELECTRIFY MY HOME

Corte Madera Project: Finished Product



- 18k BTU mid static
- Outdoor unit on rack for rising tide
- Attic insulation installed at R-49 to R-60
- Use cardboard as in insulation dam
- Better heat comfort than furnace
- Had to go back and adjust air flow down

Example #3: Petaluma 2-Story [550 sqft/ton]



Client Situation:

- Tile Contractor

Site conditions:

- *Year Built*: 1980's
- *Size*: 2,200 sq ft
- *Envelope*: Big South-facing Windows
- *Existing System*: 1x 100,000 BTU gas furnace
- *New System*: 2x 24,000 BTU mid-static systems

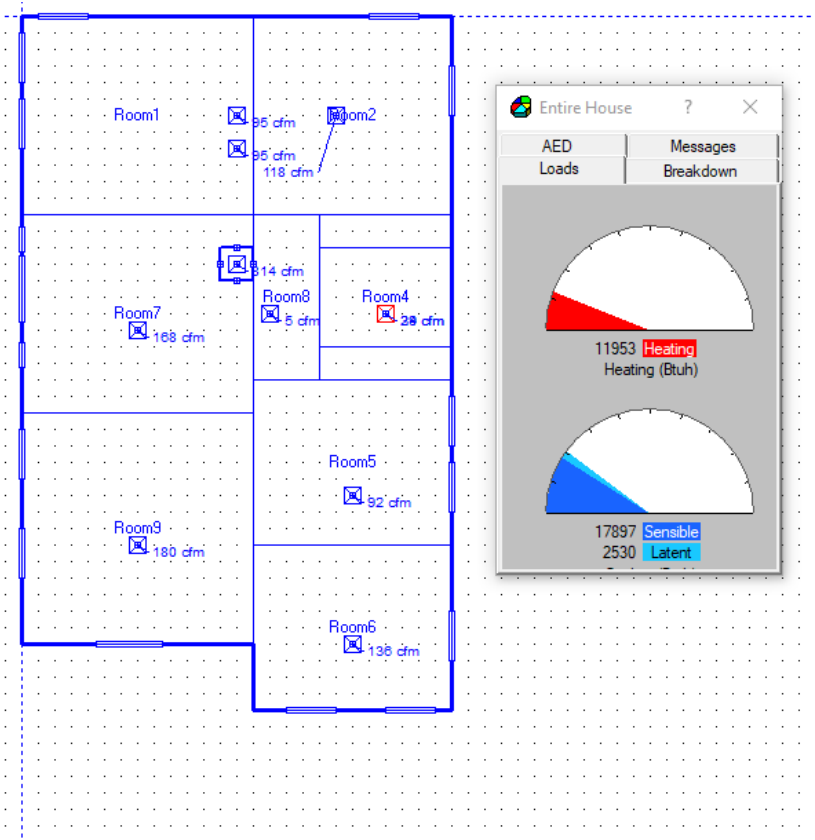
Example #3: Small House in Berkeley [726 sqft/ton]

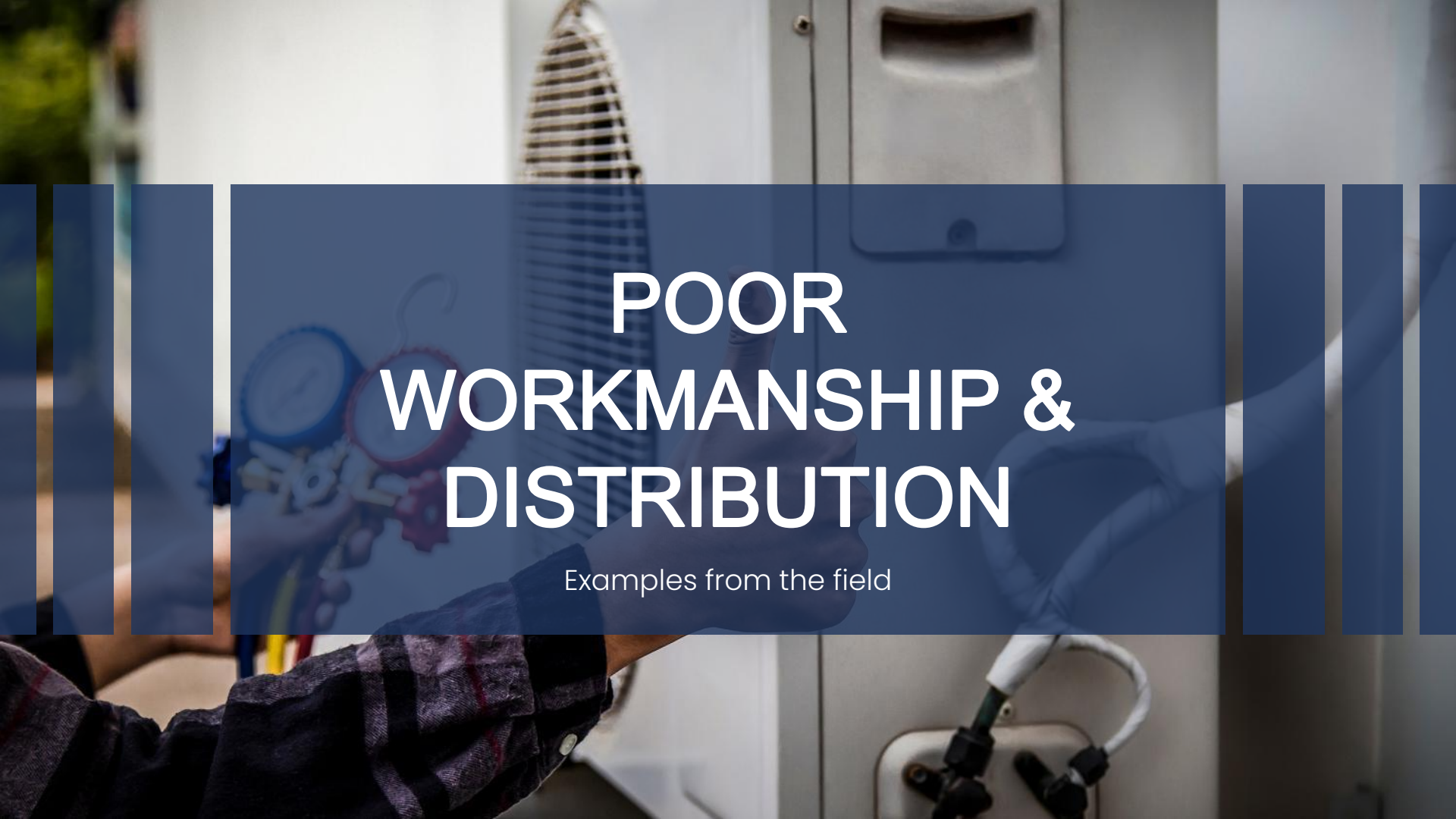
Client Situation:

- Recently purchased remodel

Site conditions:

- *Year Built*: 1920's
- *Size*: 1,089 sq ft
- *Envelope*: 17k BTUs of cooling Southern Exposure on old windows
- *Existing System*: 60,000 BTU Gas Furnace
- *New System*: 18,000 BTU Slim Duct





POOR WORKMANSHIP & DISTRIBUTION

Examples from the field

Gut Check!
Gas Furnaces in California, Will you Still Only Offer This Option?

- Your customers are counting on you!
- Will you offer a clean electric solution every time?
- What or who will prevent you?
- Do you have the confidence?
- An advocate for your customer?
- It may require deviating from the path of least resistance!
- Gas bans – this will impact you and your customers

ELECTRIFY MY HOME

Your Duty to Your Customers

The following slides show POOR installation practices:

- Blatant disregard to quality
- Evidence of technicians' lack of knowledge

Keep in mind:

- Poor workmanship skills negatively affect customers
- You should deliver the best system under all conditions
- Taking shortcuts cost your customer thousands in wasted energy
- The customer has trusted you

Ducts are a Main Reason Systems are Oversized

Poorly installed ducts cause high static pressure and reduce capacity

High static pressure

Poorly installed ducts

ELECTRIFY MY HOME

Hmm…

Duct constricted by two bends leaving plenum

Comments?

Yikes!

Really?

Sloppy HVAC Mechanics
Braeden Telstad · 2d ·

Hey guys I installed one of those "inverter" units. How did I do?

7:55

Sloppy HVAC Mechanics
Terril Johnson · 3h ·

Like Comment Send Share

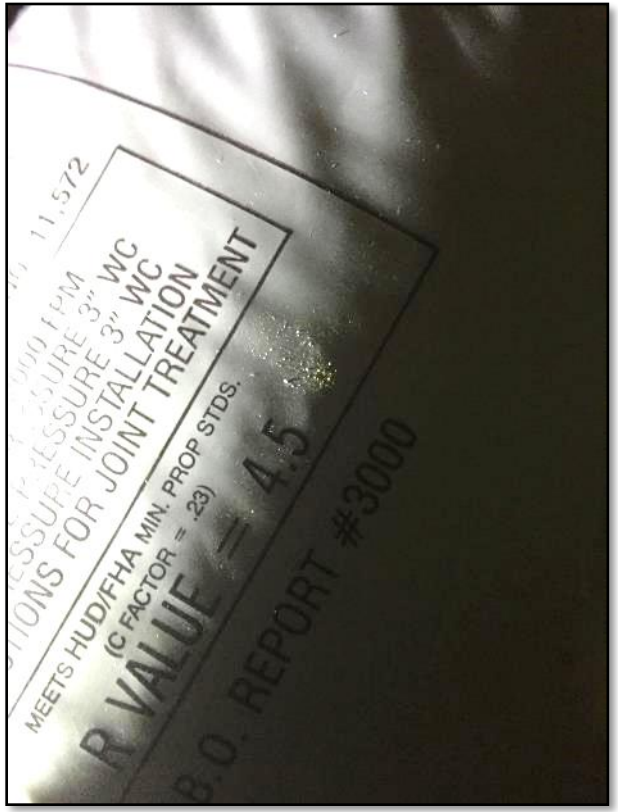
Comment as Alex Sloan

Cully Cangelosi · 2nd
Here to solve all of your RoofTop HVAC mounting needs - pitched roof, flat ro...
Visit my website
2h ·

+ Follow

The new Super Charged AC System. Call Today to get yours lol....

Low R-Value



Bad Planning

Consider Thermal Implications in Your Plan

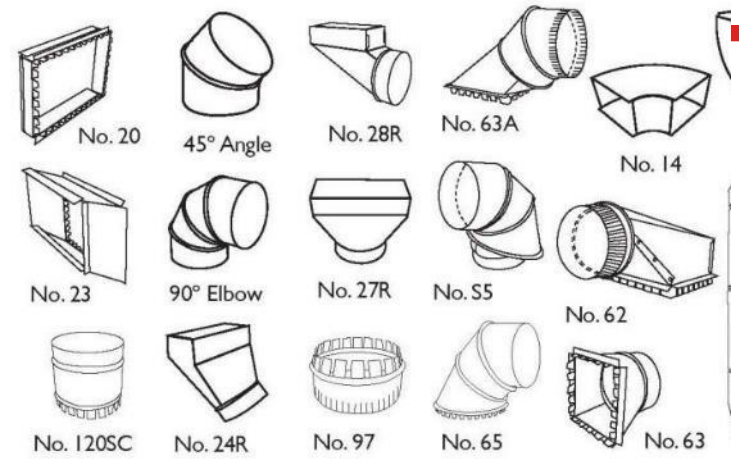
Looks slick, good intention, but bad result

Extra ductwork surface area robs energy.

How could this be better executed?

ELECTRIFY MY HOME

When Running a HP Duct System, Keep in Mind the Equivalent Length



EQUIVALENT LENGTHS		
PLENUM/DUCT FITTINGS		
No. 23	Offset starting collar	10' EL
No. 20	Straight starting collar	35' EL
No. 120SC	Snap collar, round	35' EL
ROUND ELBOWS & ANGLES		
	90° elbows	30' EL
	45° angles	10 - 20' EL
REGISTER BOOTS		
No. 24R	90° register boot	30' EL
No. 27R	Straight register boot	5' EL
No. 28R	End register boot	50' EL
ROUND FITTINGS (TAKEOFFS)		
No. 97	Round starting collar	35' EL
No. 63	Square to round straight	15' EL
No. 63A	Square to round elbow	40 - 45' EL
No. 62	Square to round elbow	40' EL
No. S5	Round to round (adjustable)	20 - 25' EL
No. 65	Round to round	20 - 25' EL

EQUIVALENT LENGTHS	
DUCT ELBOWS, RADIUS THR	
No. 14	Up to 11"
	12" to 21"
	22" to 27"
	28" to 33"
DUCT ELBOWS, SQUARE THR	
No. 16	Up to 11"
	12" to 15"
	16" to 21"
	22" to 27"
	28" to 33"
RETURN AIR SYSTEM	
No. 810	Cold air boot, collar, duct

STATIC PRESSURE KILLS PERFORMANCE!

- The fittings you use cause static pressure
- Always use a hard elbow on 90's
- Straight boots are better than PH2 or angled sidewall boots
- Even a start collar has an equivalent length
- It is easy to add equivalent length keep them straight when you can

ELECTRIFY MY HOME

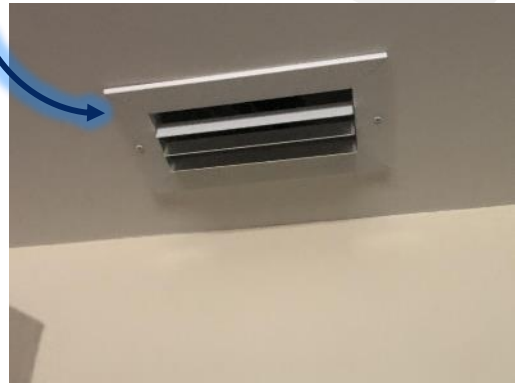
Registers Matter!

STOP using these for everything!

Registers are Really Important

Straight throw from floor and side walls

Curved blade from ceilings single direction!



Be aware of Wood Floor Registers

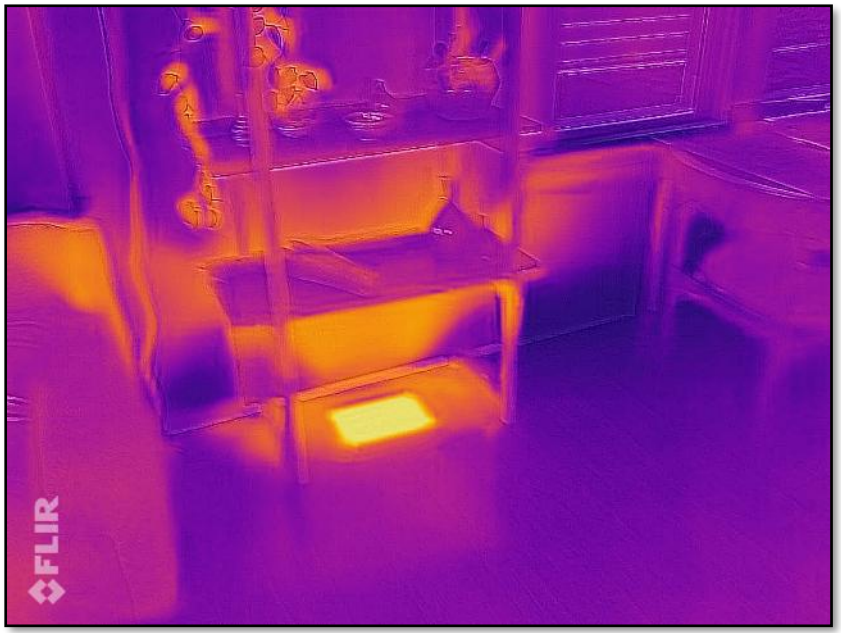
- Nothing worse for static pressure
- Massive pressure drop can be measured with manometer
- If the customer insists - walk away or get them to sign a release form
- Easy to measure 60 to 70% air restriction

Stamp Face Registers/Grilles

- No air stream mixture just adjacent hot spots
- Prevent air mixture stops venturi effect
- Causes hot and cold spots

Insist No Furniture is Placed Over Floor Registers

A 2-way register under a shelf will stop the stream and prevent air mixture

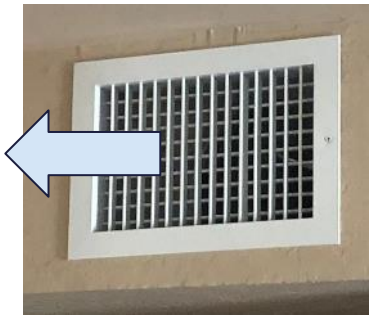


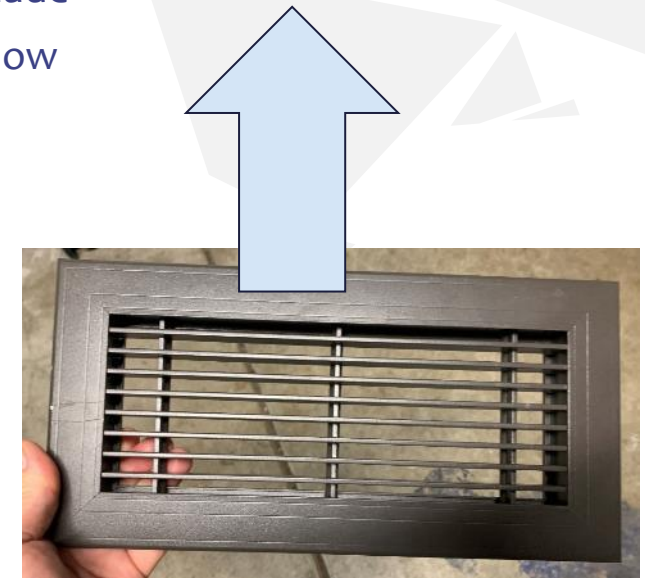
A 2-way register next to a chair creates a hot-spot. A straight stream will prevent this

ELECTRIFY MY HOME

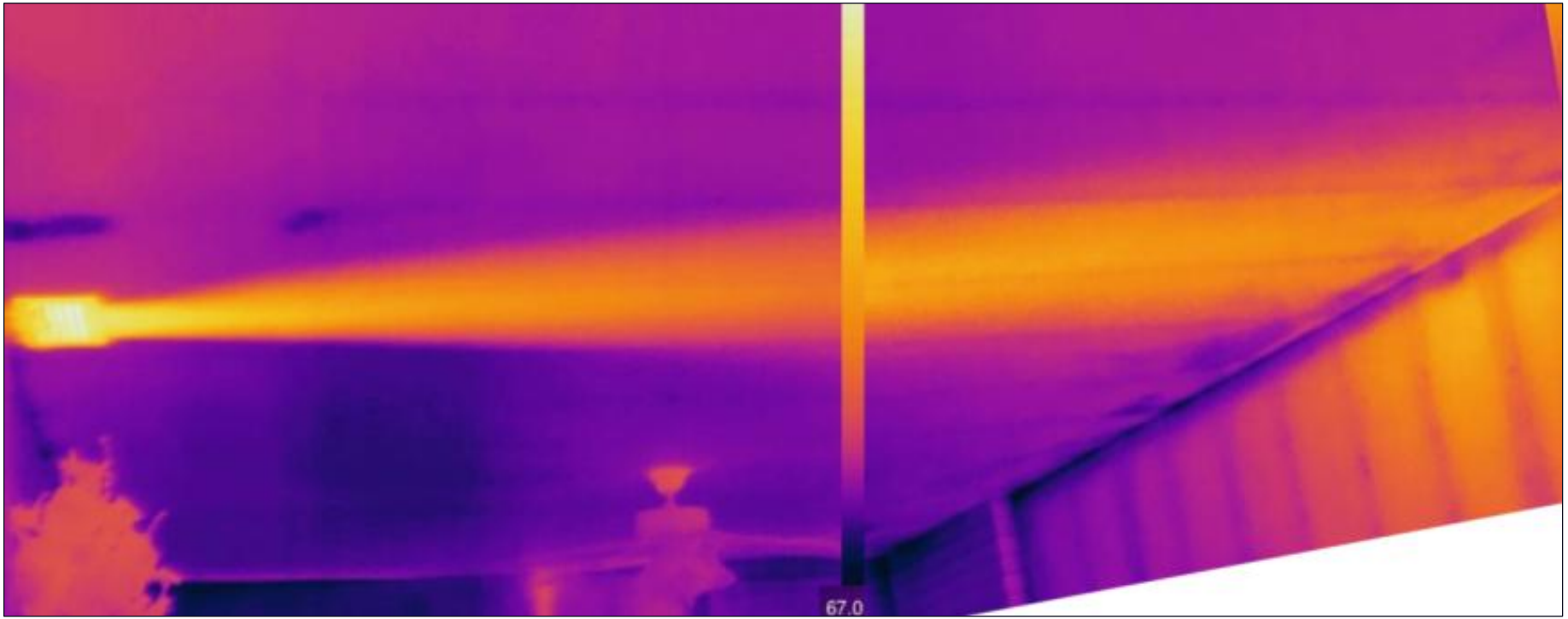
Longer Runtimes Mix Air Better: Correct Registers are Key

- Air stream mixes by venturi effect
- Directional air flow control
- Three-way registers are almost never the proper register
- When mixing by venturi effect, conceptualize registers as a nozzle
- Ceiling curve blade
- Sidewall high flow

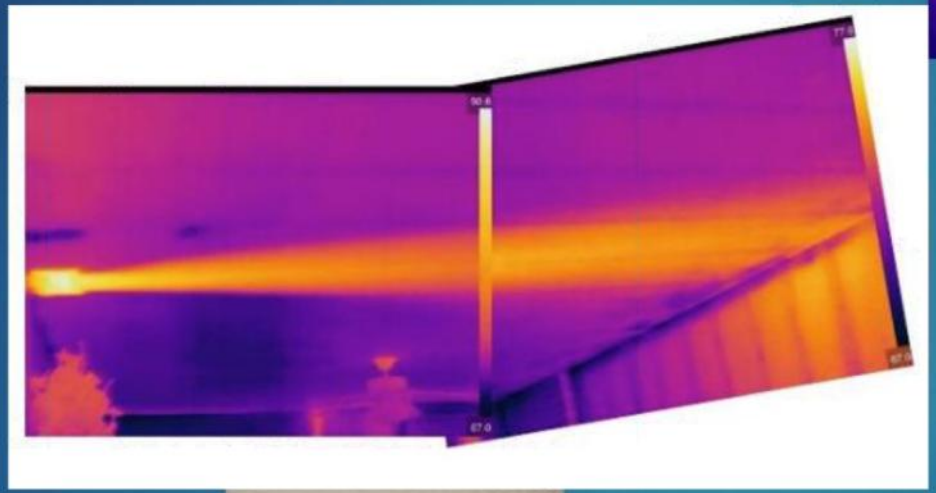


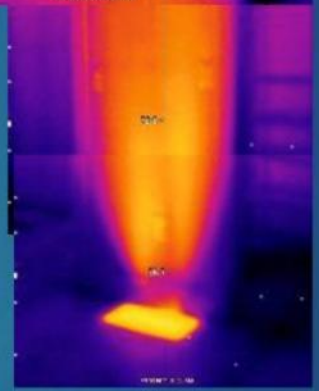


Register Throw Is Important For Air To Reach Other Side Of Room



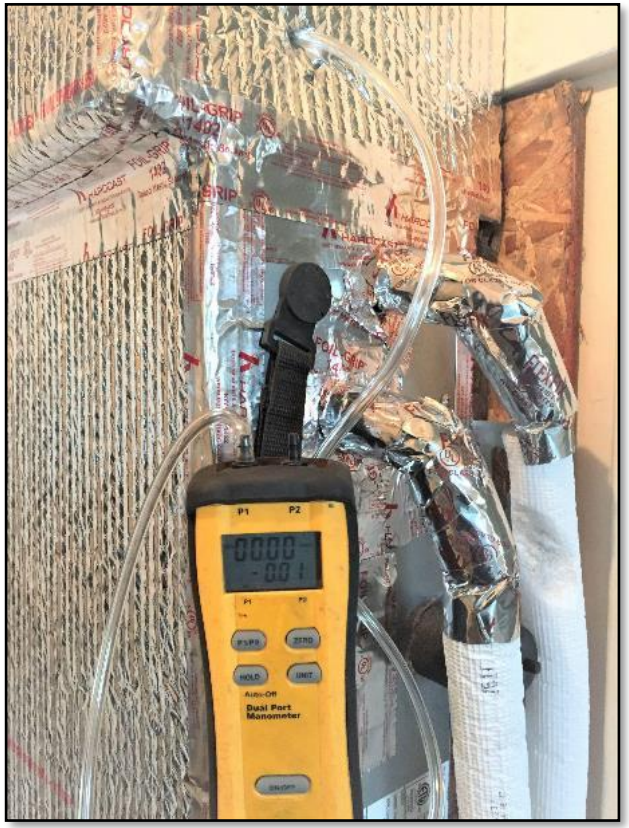
Can the system mix the room air?



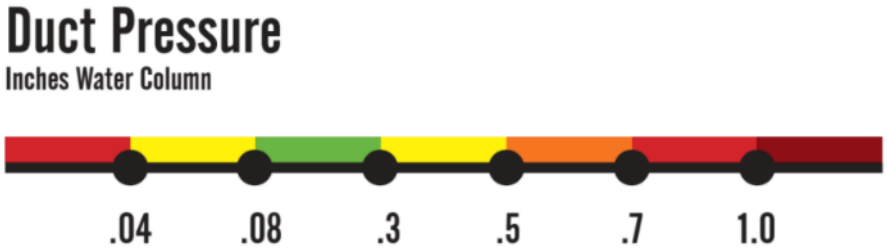


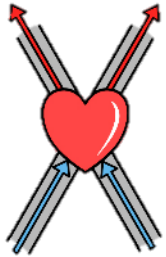
Do You Own a Manometer?

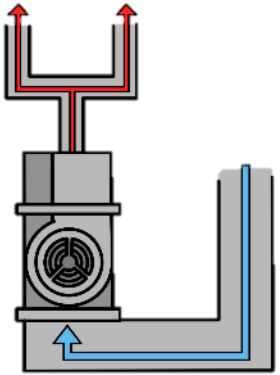
A very important tool – make sure you have one!



Explanation to Customer = Duct Pressure







Source: Nate Adams

Part 1, Quiz 2: “Install Small”

1. “Install Small” refers to:

A. Using smaller ducts
B. Using smaller line set
C. Installing smaller systems
D. Installing the correct size system

2. Filtration systems can cause static pressure

TRUE FALSE

3. The term equivalent length refers to?

A. The total number of 25-foot boxes of duct used
B. The factor to calculate BTU loss
C. The total length of all line sets
D. The calculated length of all ductwork installed including fittings

4. Flex duct should be pulled tight in order to:

A. Save on material cost
B. Be easier to find when buried under insulation
C. Reduce static pressure
D. A and C

5. A good reason to choose an inverter over unitary system.

A. Smaller footprint
B. Quieter operation
C. Install flexibility
D. Better Comfort
E. All of the above

6. 3-way registers are the best solution for all applications

TRUE FALSE

7. Heat pumps are more efficient than any gas furnace

TRUE FALSE

Break

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MY HOME

THE HOT WATER OPPORTUNITY

- SEGMENT 5 -

The Hot Water Opportunity

- Heat Pump Water Heaters known as … HPWH
- California banking on energy storage (BIG incentives)
- HPWH present a fast path to reduction in carbon emissions
- Great first Electrification measure
- More efficient than gas
- Far better than regular electric resistance

Energy Program Incentives Coming on Strong: Consumer Facing and Midstream (Contractor)

- Unmatched Energy Efficiency: Efficiencies (COP's) over 4.0 as compared to 0.62 Average Gas Tank replacement
- Huge rebates available
- Local, SGIP, REN, Tech, and Federal rebates/credits
- Midstream incentives
- Represent a possible 75% reduction in cost to the consumer

How Does A Heat Pump Water Heater Work?

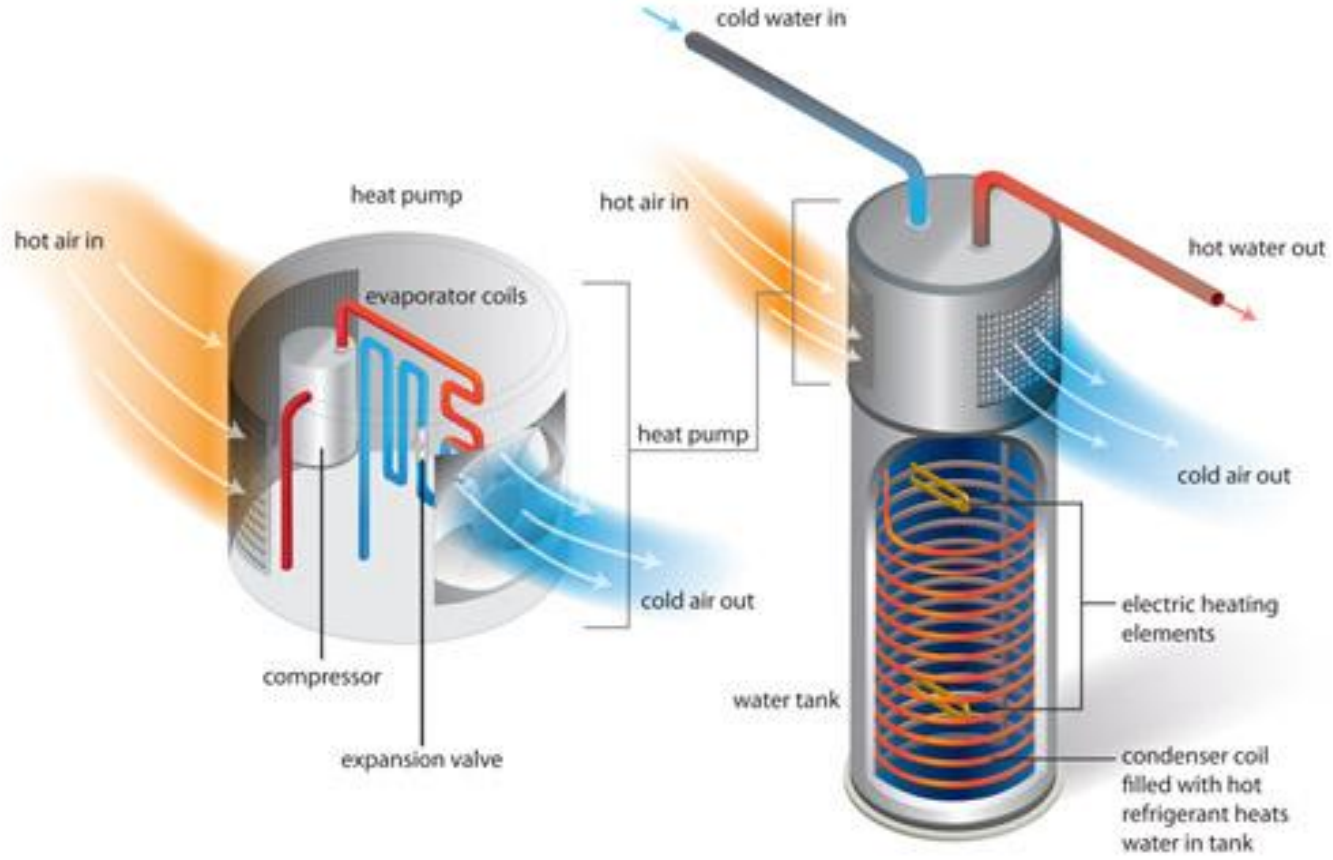

Image Source: ENERGY STAR.

The Hot Water Opportunity: Heat Pump Water Heaters

Hot water electric conversion

Converting gas to standard electric is not

"Good Electrification"

Operational savings can be vary

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Cost Savings – It Depends

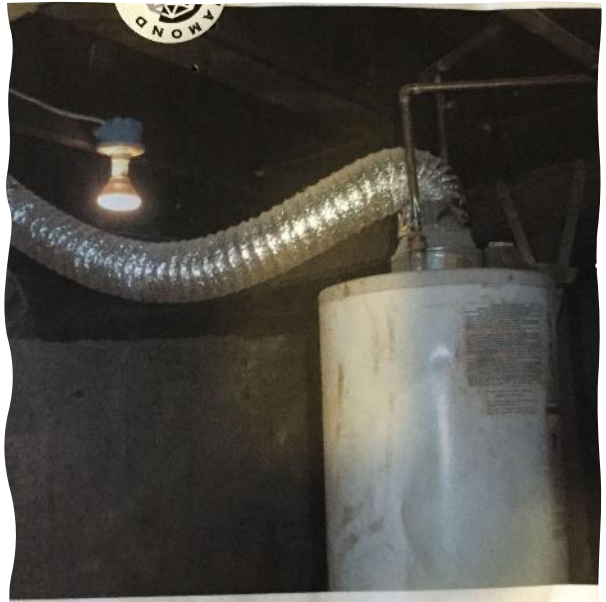
- **Electric Resistance to HPWH –** No Brainer!
- **Customer has solar –** Great Option
- **Gas Tank to HPWH –** Depends
- **Tankless to HPWH –** Depends

- **Recommendation:** be careful guaranteeing energy savings. Gas prices likely to rise and gas units not available after 2030. Optimize with right-sizing, proper controls setup, customer education.
- **Recommendation:** utilize a third-party calculator if customer is demanding a yearly operational cost estimate

SCAN: Free Cost Tool - RMI

Gas Water Heaters Can Kill You!

… Even if they're properly functioning (providing hot water)



Not understanding how this works can make your customer sick!

Advantages of HPWH's for Installers

- Multifunctional
- Various capacities and voltages
- Solves venting problems
- Higher profit!

Sellable Benefits to Communicate to Your Customers

- ✓ Small kWh usage for solar offset
- ✓ A Great, First Electrification-Step
- ✓ Incentives and Rebates/Offsets
- ✓ Carbon Footprint Reduction
- ✓ Load shifting to lower energy cost

Won't Kill Them!

Alternatives to Traditional Water Heaters?

The Financials

- Great **Incentives** consumer and dealer
- **Only responsible way** to replace any electric tank
- Cost of unit is higher, **operational cost is** mostly lower
- **HP only** mode OK for most CA climate zones
- Greater **profit margin**

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WHICH ONE DO YOU WANT?

Gas Tank Sale

Item	Amount
Sales Price	$2,450
Appliance	$950
Miscellaneous	$150
Permits	$150
Other	$0
Direct Fixed Costs	$1,250
Labor (5 hrs @ $95)	$475
Overhead (@25%)	$613
Variable Costs	$1,088
Total Cost	$2,338
Net Profit $	$113
Net Profit %	4.6%

HPWH Sale

Item	Amount
Sales Price	$6,850
Appliance	$1,665
Miscellaneous	$265
Permits	$300
Other Electrical	$1,000
Direct Fixed Costs	$3,230
Labor (12 hrs @ $95)	$1,140
Overhead (@25%)	$1,713
Variable Costs	$2,853
Total Cost	$6,083
Net Profit $	$768
Net Profit %	11.2%
TECH Clean CA	($3,100)
Federal Tax Credit	($1,125)
Net Price for Customer	$2,625

W/ help of rebates (when avail) even more attractive.

With Rising Costs, You Should Revisit Your Pricing Often

- Multiple price increases since 2020
- 50 Gallon models $1300-$1800
- 80-gallon models pricing $2200 - $2950
- Ancillary materials have risen as much as 50% since Jan 2021

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SCAN: Free Cost & Climate Benefits Tool - RMI

Lower Operation Cost & Renewable Offset

I am awesome!

...so are we!

The estimated annual energy cost of the HPWH is easily offset with less than two 350-watt solar panels

Several Brands Available, 110v/220v, top/side connections, top/side discharge

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Split Configuration Helps with Application Challenges

Split system HPWH solves several problems

- Location
- Sound – 37 DbA
- Faster Heat – 115 gal (83-gal system) 145°F temp
- Best for environment – CO_2 = GWP of 1
- 15A breaker
- Works well at low temperatures
- Inverter-based

Disadvantages

- Higher cost [But higher margin!]
- Additional time required
- Outdoor unit must be kept upright and level

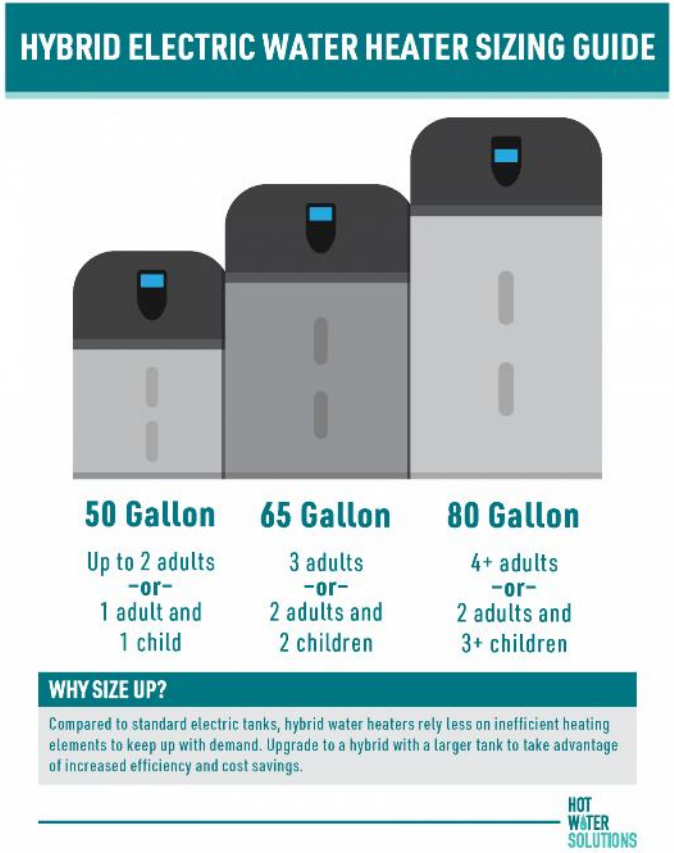
Heat Pump Water Heater Sizing Considerations

Calculate the first-hour rating:

- Add the peak demand
- # of showers x20 gallons
- Dish washer x7 gallons
- Clothes washer (top-load 25; front-load 15)
- Match to first hour rating

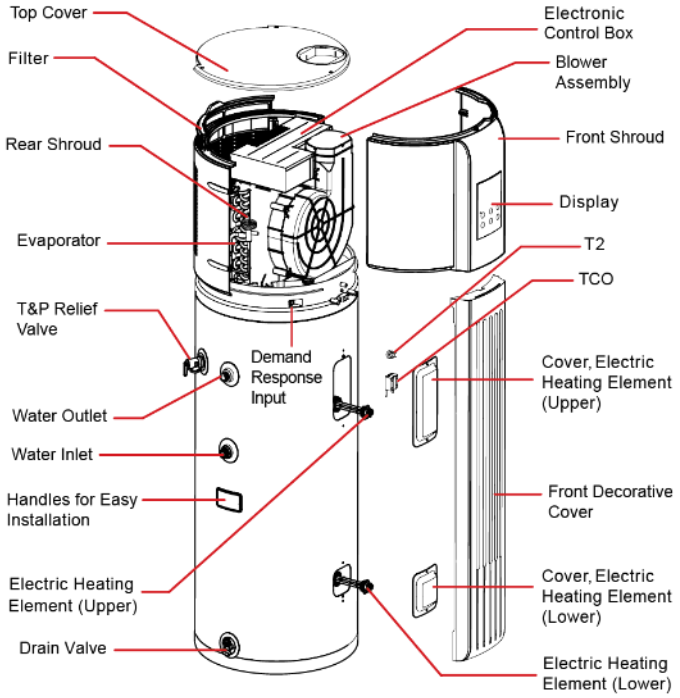
Appropriate tank size:

- 1-2 people: 50 gallon
- 2-3 people: 65 gallon
- 4+ people: 80 gallon



Considerations & Pitfalls of HPWH's

- ✓ Initial cost is higher
- ✓ Most require a 30-amp circuit
- ✓ Plumbing is more complicated and cumbersome
- ✓ Could complicate permit process
- ✓ Takes longer to install
- ✓ Requires two people for the larger models (300+ lb)
- ✓ Has a filter that needs servicing



Gas vs Electric vs Heat Pump

Feature	50-gal Gas	50-gal HPWH
Fuel	Gas Line	30A circuit
Uniform Energy Factor	0.63	3.88
BTU Rating	38,000 Btu/h	4,200 Btu/h + 4500W Elements
Recovery Rate*	40	27
First Hour Rating**	86	67
Width x Height (“)	20.5” x 58.4”	22.3” x 62”
Weight (lb)	150	218
Vent	Atmospheric	Optional
Smart Controls?	None	WiFi, Smart Home

**Recovery Rate @90F: # of gallons of water heated in 1 hour with temp rise of 90F

*1st Hr Rating: # of gallons of hot water a fully heated tank can deliver in one hour.

Things to Remember

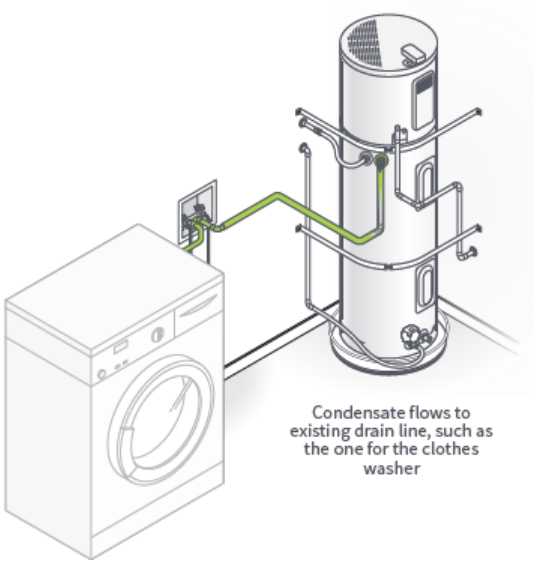
- **Take up a more space**
- **Not suitable for small areas**
  - 500-700 cu ft min depending on mfr
  - Venting a possible solution
- **Require additional project planning**
- **HPWH compressor makes noise**
- **Filter needs occasional cleaning**

Pro Tips

- Complete insulation of the lines is important
- Remove the top cover screw from the back if installing against the wall
  - Keep the pipes out of the way of the filter
- Rotate unit for best airflow with side discharge
- Put on your company stickers before taking any pictures
- Relocate existing straps so that they don't land around critical areas
- Consider ease of the serviceability during install
- Remember there is a corrosion rod
- Consider wraparound plumbing
- Insulate behind the water heater before putting it in
- Make sure you have a good lifting device with you

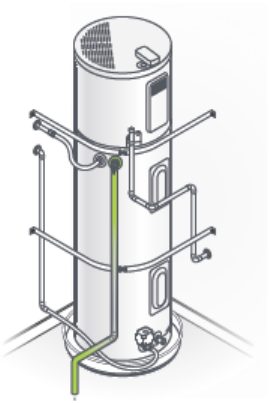
Condensate Options

Option 1: Drain to local waste line



Condensate flows to existing drain line, such as the one for the clothes washer

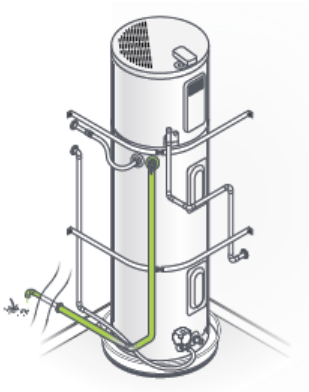
Option 2: Drain to floor



Drain

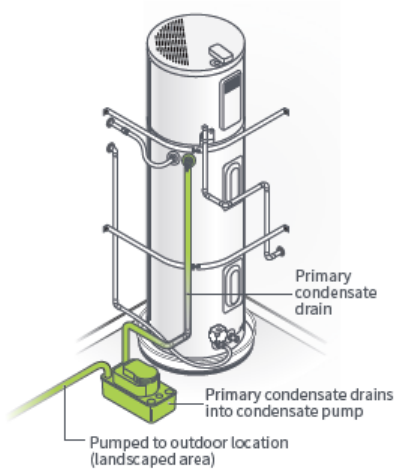
Use existing floor drain if connected to waste line(rather than draining to crawl space)

Option 3: Drain to landscaping outdoors (if local codes allow)

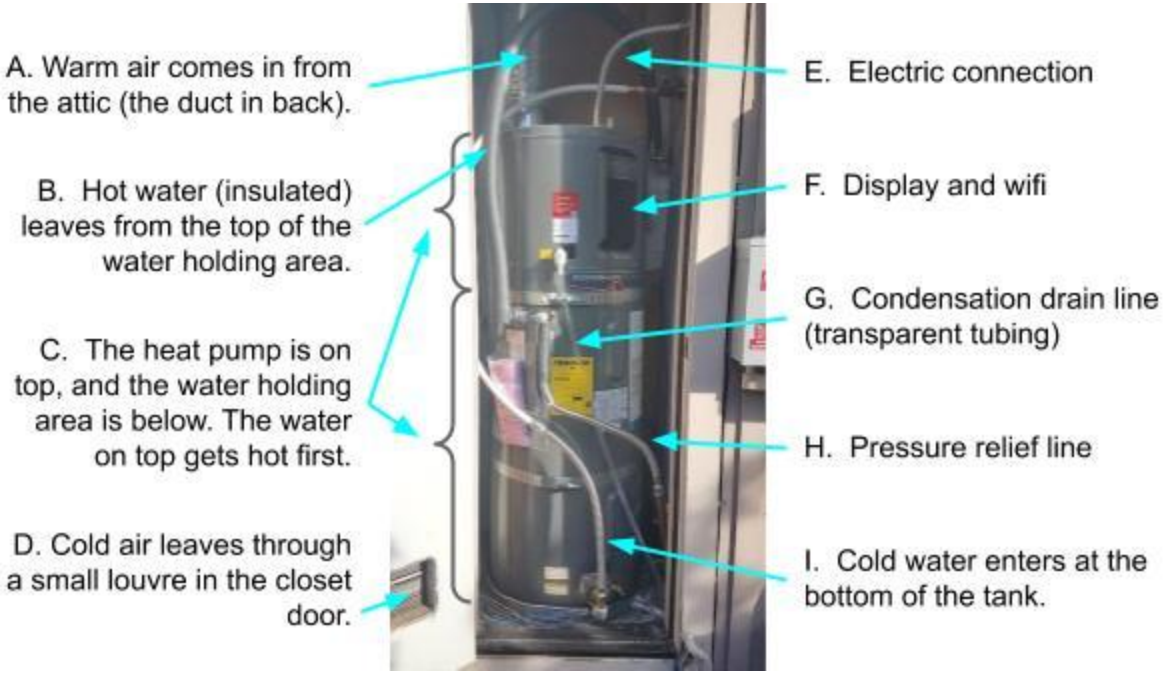


Make sure the grade slopes away from any structures

Option 4: If below ground level, drain to condensate pump



Just Like a Gas Tank, Right? Cheapskate DIY not advised



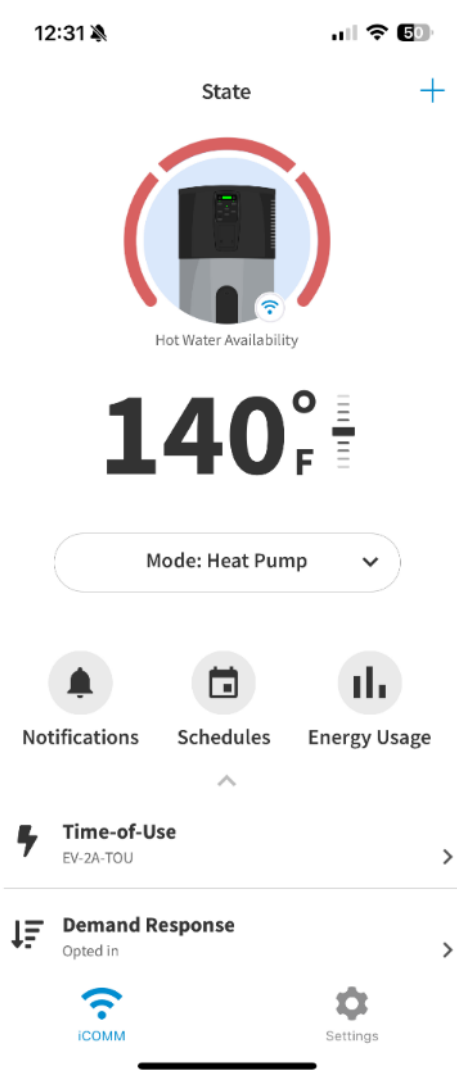
Tip: Don't install near the HVAC t-stat!

Thermostatic Mixing Valve (TMV)

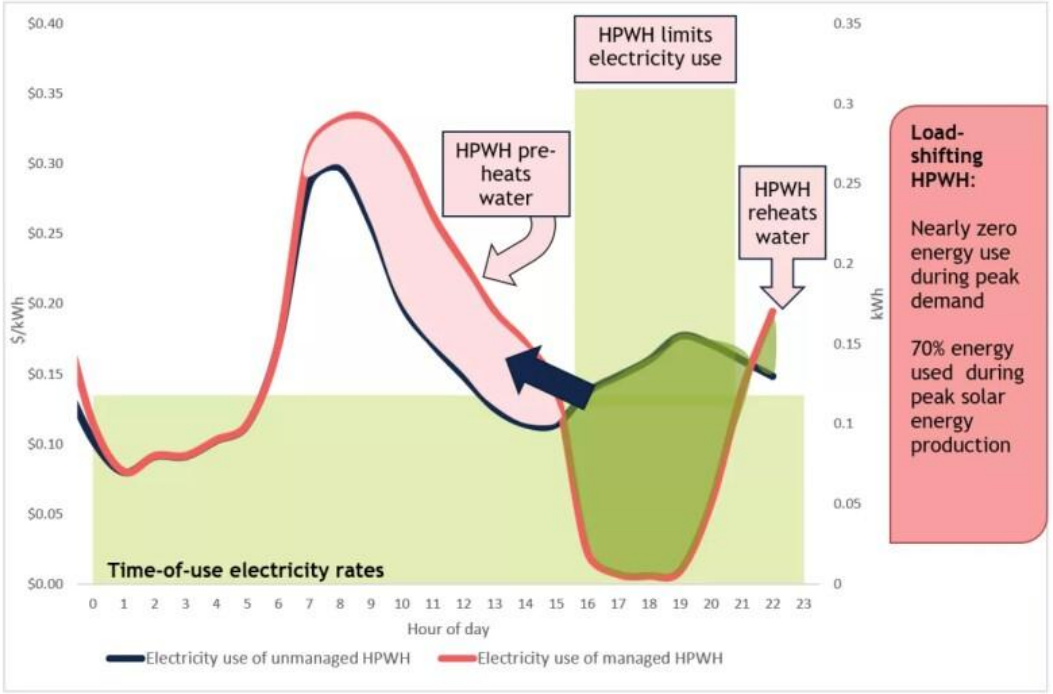
- Mixes hot & cold water to provide more capacity
- Allows you to turn tank temperature up
  - Extends deliverable capacity
- Required for TECH Clean CA, which also requires demand response and time of use enrollment

Operation – Mode

- **The goal is to always have the unit run in heat pump mode**
- **This will lead to longer runtimes – this is normal**
- **Best to leave the settings in most efficient mode unless you experience delivery issues**
- **Other modes (names change based on unit):**
  - **Hybrid** – activates electric resistance backup for quicker recovery (conservative)
  - **Electric** – exclusively electric resistance. Not recommended unless heat pump isn't working
  - **Vacation** – for periods of vacancy. Use this instead of shutting breaker off since protective anode requires power.



HPWHs = Excellent For Time-Based Utilization



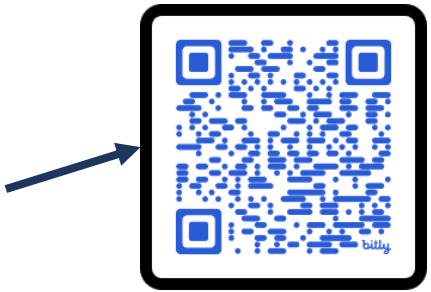
Citation: NRDC, 2018

- CTA-2045 Protocol
- Smart communication standard
- Protocol for devices to talk to each other, utility, and DR providers
- Control based on real-time data
- Communicate to other devices in home

Controls: Wi-Fi & Rate Plan

- Technicians should have the app on their phone
- Get customer's WiFi login information first
- Have customers install the app on their phone
- Go through app setup process with the customer
- Each brand is different – get specific instructions from that manufacturer

A Great Resource:
TECH Clean CA
Contractor Hub



Bradford White Connect™ 17+
Smart Water Heater Control
Bradford White
Designed for iPhone
Free

Ruud EcoNet 4+
For Homeowners: Smart AC & H2O
Rheem Manufacturing Company
Free

State Water Heaters 4+
State Industries, Inc
Designed for iPad
Free

Customer Communication At Install

- Discuss customer's water habits and patterns
- Programming of unit (Wi-Fi/App, rate plan, HP/Hybrid/Electric/Vacation)
  - HP only (lowest op cost), Hybrid (quicker recovery)
  - If mechanical issues, switch to Elec Only
- Filter instructions
- Temperature settings
- Various sound profiles
- Run time before first water use
- Be mindful of hot water operation for first few days

What About Electric Tankless?

- Not practical (whole home)
- Huge capacity penalty
- Non-Compliant for retrofit

- Buyer Beware
- Luke-warm showers = upset spouse

Leftover Infrastructure

- **Existing electric resistance – not much to worry about; utilizing existing wire most of the time**
- **Gas**
  - **Removal of old flue**. Capping of vent recommended. If leaving in place, always get customer buy-in
  - **Capping gas line.** Best practice to cut line as far back as possible. If leaving longer gas pipe runs in place, make sure to get customer buy-in and ensure safety.

Bonus & Transition: Is This How You Sell?

Part 1, Quiz 3: Quiz time! Heat Pump Water Heaters

1) A Heat Pump Water Heater requires how much free open space?

A. 600 sqft
B. 700 cu ft
C. 500 ln ft
D. Depends on manufacturer and venting scenario

2) A home with 4 occupants & 4 bathrooms needs what size HPWH?

A. 65
B. 50
C. 80
D. 65-80

3) Most heat pump water heaters require a 30 amp circuit.

TRUE
FALSE

4) A heat pump water heater is a good choice to solve venting problems.

TRUE
FALSE

5) According to the energy guides, a heat pump water heater costs more to operate than gas.

TRUE
FALSE

6) SanCO2 water heaters use a different refrigerant that is more earth friendly.

TRUE
FALSE

7) One factor of "Good Electrification" is considering all the needs for complete electric conversion upfront.

TRUE
FALSE

8) A traditional heat pump can use up to six breaker spaces.

TRUE
FALSE

9) Complete electrification could use up to 12 breaker spaces.

TRUE
FALSE

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Questions?

Turn it on. Relax. We've got you covered.

Larry Waters

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