

Small Firm Forum:  
2019 Energy Code Solutions for Small Homes  
9/10/20

Presented by Dan Johnson, AIA  
[Collaborate@BeyondEfficiency.us](mailto:Collaborate@BeyondEfficiency.us)



# Agenda

## Course Description

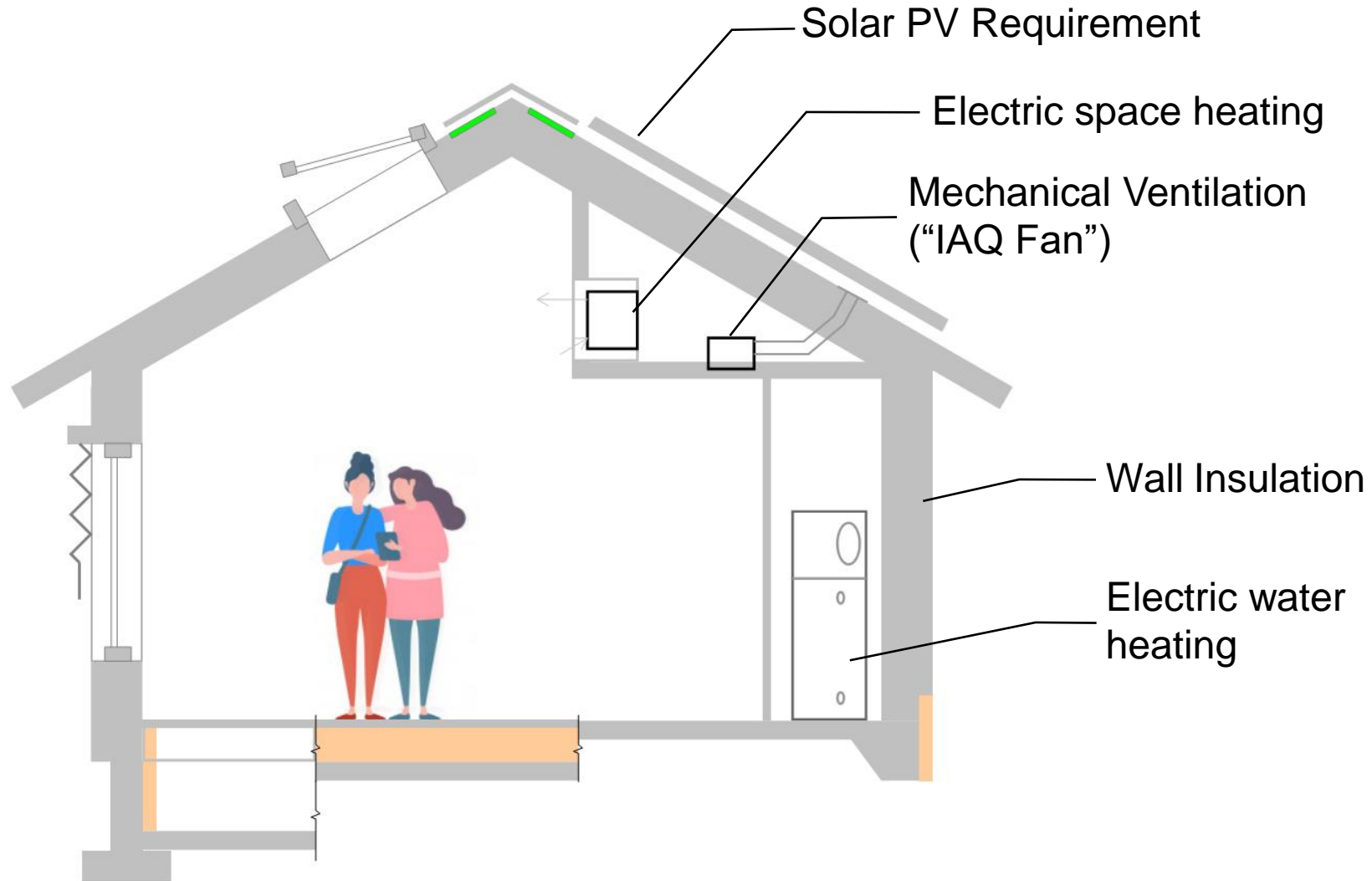
This presentation will look at particulars of the 2019 California Energy Code as it relates to residential additions and new houses, including Accessory Dwelling Units. We will discuss trigger points for insulation, water heating, and ventilation that have changed since the 2016 code. We will discuss common Energy compliance strategies for this project type. We will discuss electric space-heating and water-heating options to replace the gas-fired equipment that designers may have specified in the past.

## Objectives, Learning Goals

After attending this program, participants will be able to:

1. **Apply** the 2019 California Energy Code to a residential project to understand requirements that are new or unfamiliar this code cycle;
2. **Describe** the parts of a home or addition, especially Accessory Dwelling Units, that are affected uniquely by the 2019 California Energy Code;
3. **Discuss** the pros and cons of different approaches to compliance, seeking design flexibility and ease of constructability; and
4. **Identify** HVAC and water-heating solutions to eliminate gas combustion from the project

## Topics Being Discussed Today



### 2019 Energy Code issues:

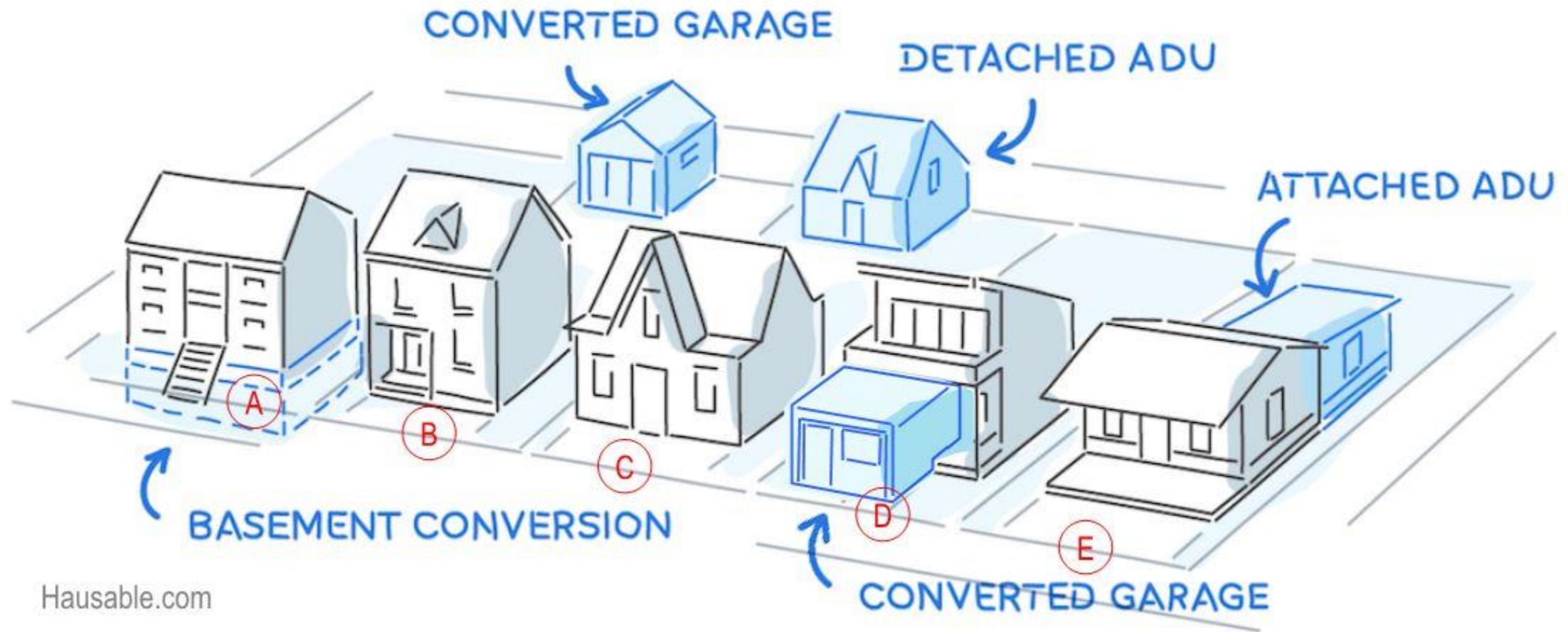
- Triggers: Type & Size
- Solar PV requirement
- Mechanical ventilation
- Wall Insulation

### Jurisdictions with Gas-free mandates:

- Electric space heating
- Electric water heating

## Triggers: Project Type

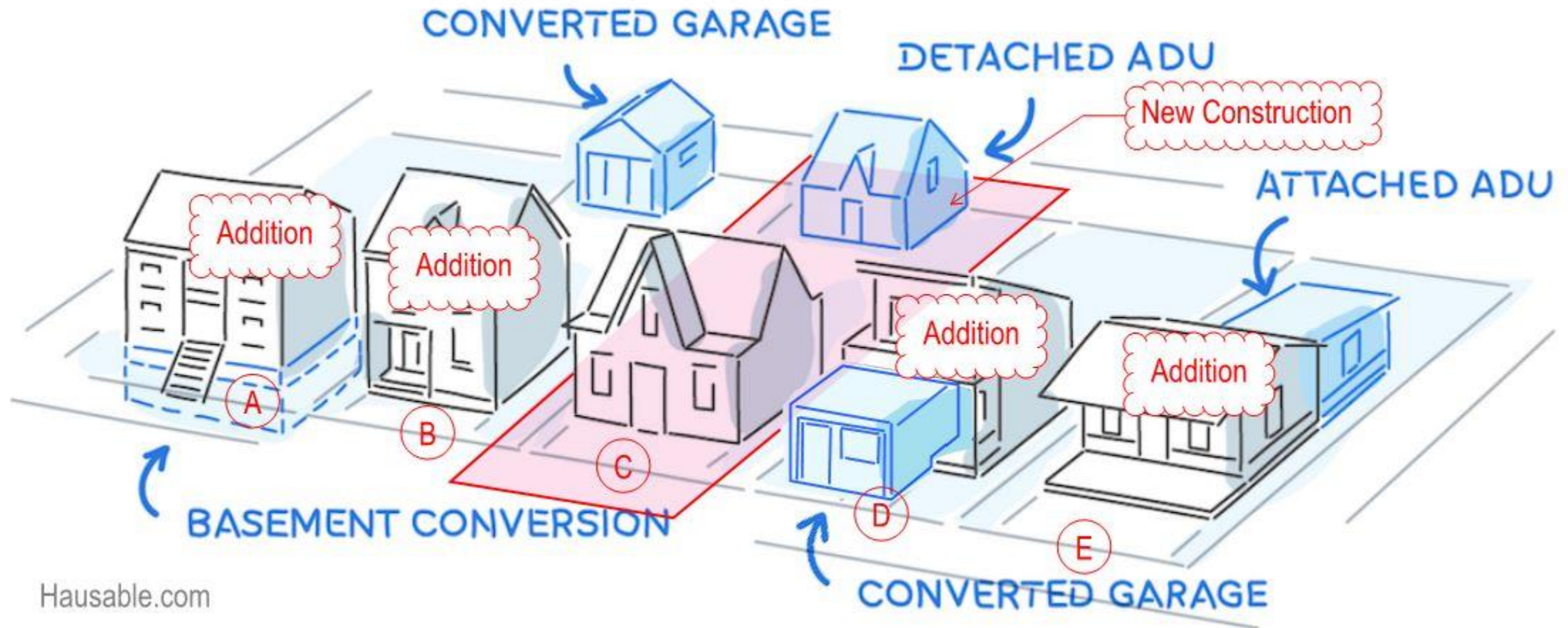
**Quiz: Which of these projects are “New Construction” in the Energy Code? Which are “Additions”?**



Hausable.com

## Triggers: Project Type

**Answer Key:**



Hausable.com

## Triggers: Project Floor Area

**Table of Issues x Triggers**

<u>Type of project:</u>	Solar PV	IAQ Fan	Wall Insulation	Hot Water	Space Heat
• New, ground-up, including ADUs	Yes, always	Yes, always	2x6 + R4 + QII	HPWH*	Heat pump
• Home Addition	No	1000 ft <sup>2</sup>	+Exceptions: 1000 ft <sup>2</sup> , 700 ft <sup>2</sup>	Flexible	Flexible
• ADU conversion (existing space)	No	Yes, always	+Exceptions: 1000 ft <sup>2</sup> , 700 ft <sup>2</sup>	HPWH*	Heat pump
• Remodel only (no new space)	No	No	Insulate cavity	Flexible	Flexible

\*HPWH = heat pump water heater



# Solar Photovoltaic (PV) Requirement for New Construction



Sufficient solar PV panels are required to match the standard electric consumption of a gas-fired home.

1. Compliance software re-creates your Proposed design using the Prescriptive envelope, and gas-fired heat & hot water
2. Software calculates the annual electricity consumption
3. Software calculates a solar PV size to match this annual electricity
4. The designer must match this PV size (with exceptions)

# Solar PV Requirement for New Construction: Prescriptive

Solar PV Size Requirement in kWdc					
New Construction, single detached home					
	Conditioned Floor Area, ft <sup>2</sup>				
Climate Zone	250	500	1000	2000	4000
North Bay - 2	1.4	1.5	1.8	2.5	3.7
Cool Bay - 3	1.3	1.4	1.7	2.4	3.6
South Bay - 4	1.4	1.5	1.8	2.4	3.6
Deep East Bay - 12	1.6	1.7	2.0	2.6	3.9

Poll: what size PV arrays are going on to your projects?

Cannot credit PV against envelope etc.





# Mechanical Ventilation (“IAQ Fan”) Requirement

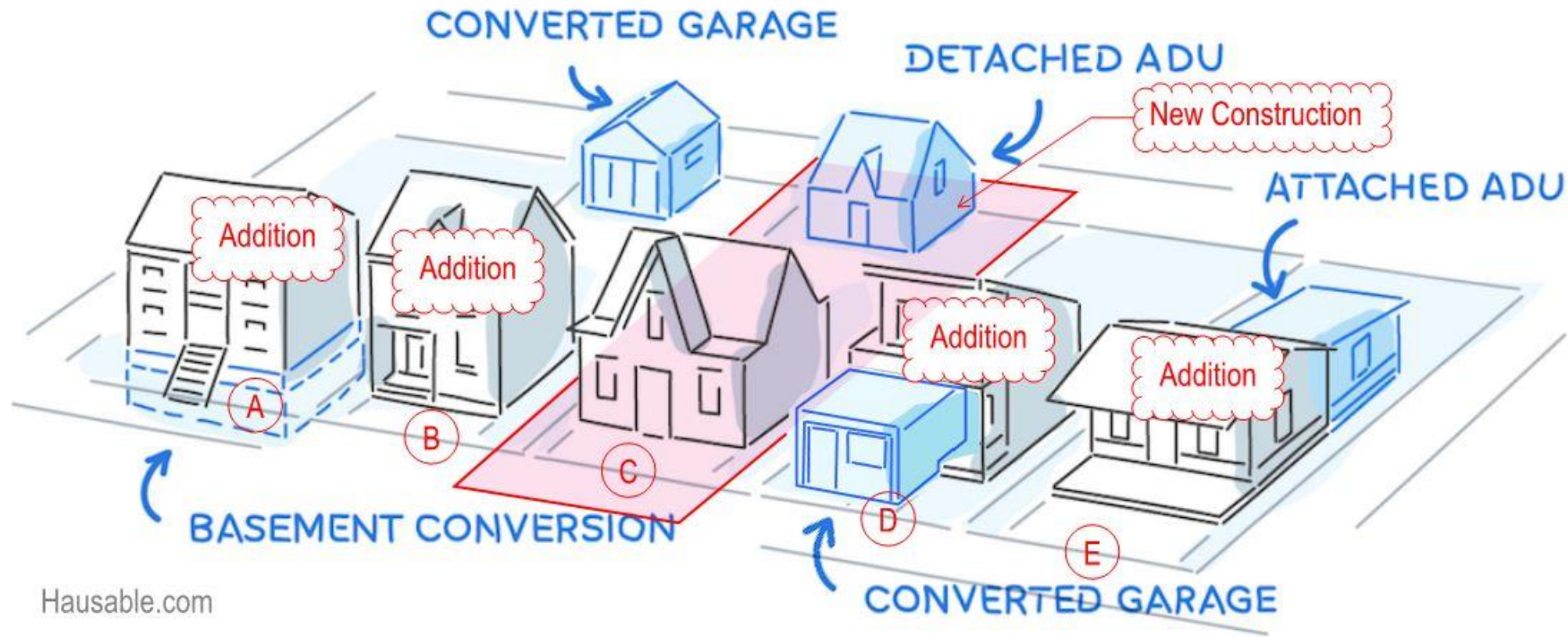
## Required?

New construction – YES

New ADU – YES




Addition <1000 ft<sup>2</sup> – NO

Addition >1000 ft<sup>2</sup> – YES, retroactive to include existing home



Hausable.com

# Mechanical Ventilation (“IAQ Fan”) Requirement

	Exhaust	Source of Fresh Air
<b>System type</b>  Code minimum IAQ fan		Leaks & Cracks
Better		Supply fan with filter 
<b>Best:</b> <ul style="list-style-type: none"> <li>• No cold drafts</li> <li>• Compliance credit</li> </ul>	Exhaust 	Supply

## Ventilation Rate Formula

$$\text{Fan Flow } Q = 0.03 \times (\text{Floor Area ft}^2) + 7.5 \times (\# \text{ bedrooms} + 1)$$

## Example

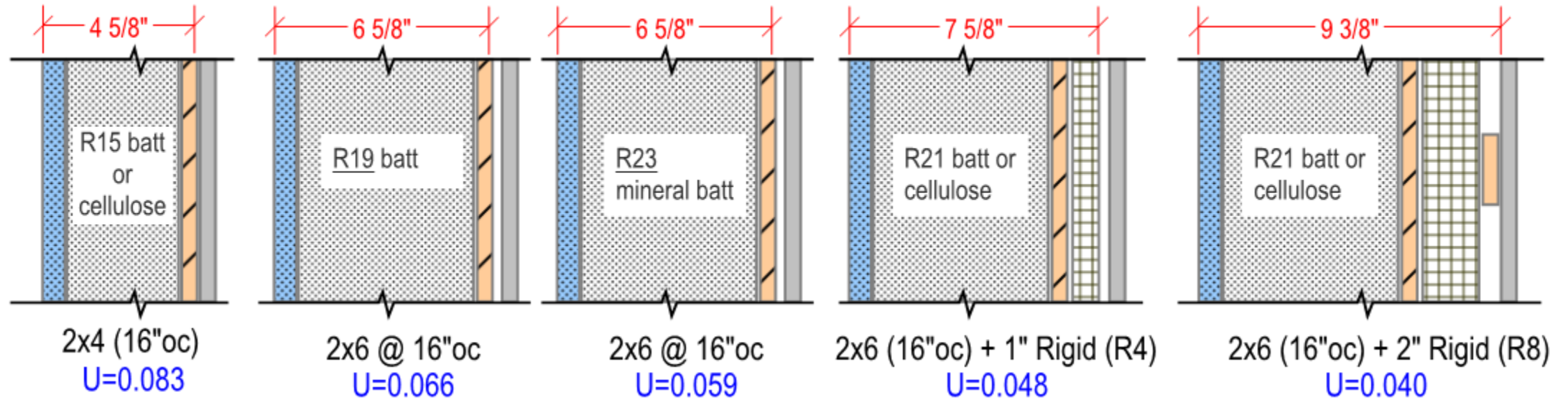
$$Q = 0.03 (400) + 7.5 (1+1)$$

$$Q = 27 \text{ cubic feet per minute (CFM)}$$

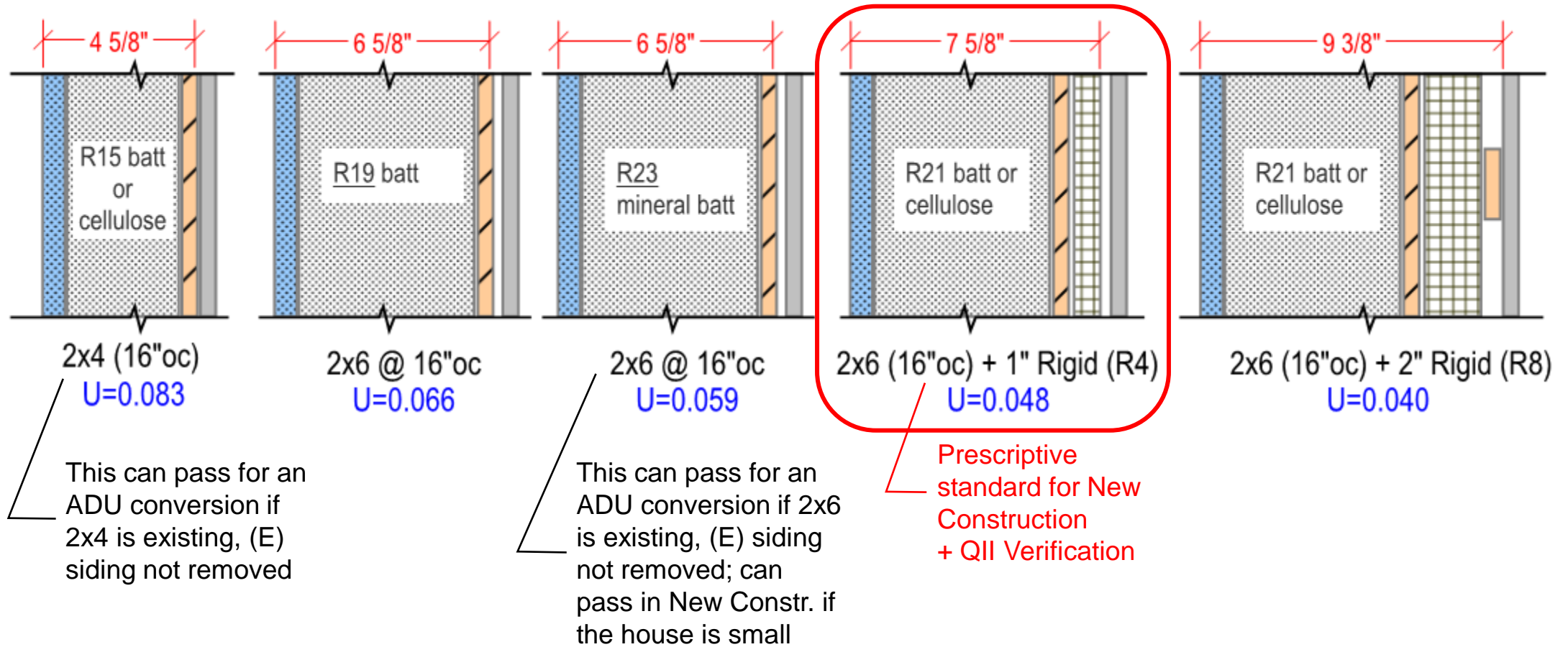
30 CFM provided (continuous bath exhaust fan)

# Wall Insulation Requirements

**Quiz: Which is the 2019 Prescriptive Energy Code wall for new homes in the Bay Area?**



# Wall Insulation

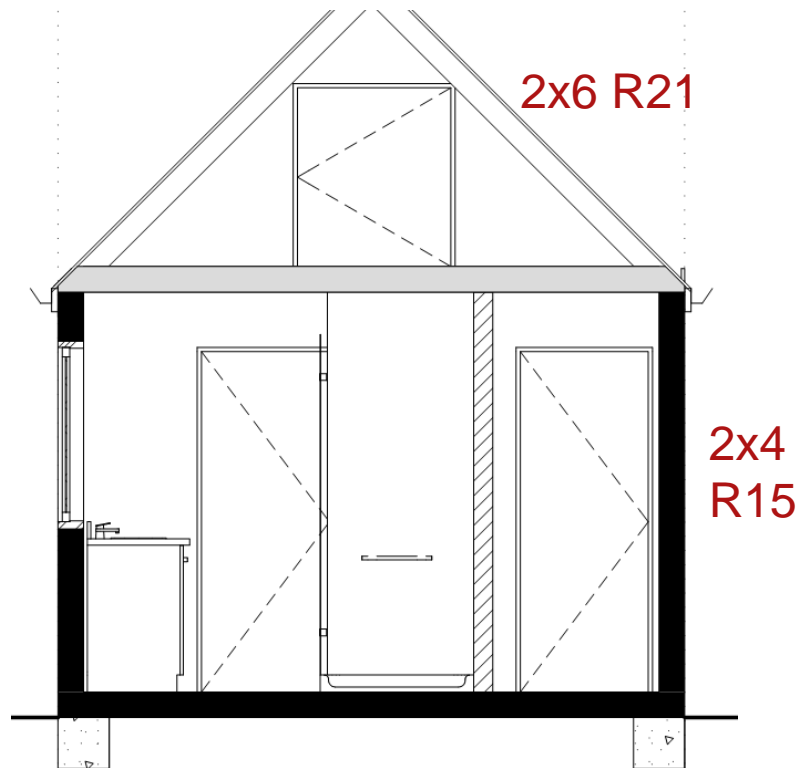


## Wall Insulation Examples: Additions

**ADU garage conversion, 363 ft<sup>2</sup>.**

**2x4 R15 walls, 2x6 R21 roof.**

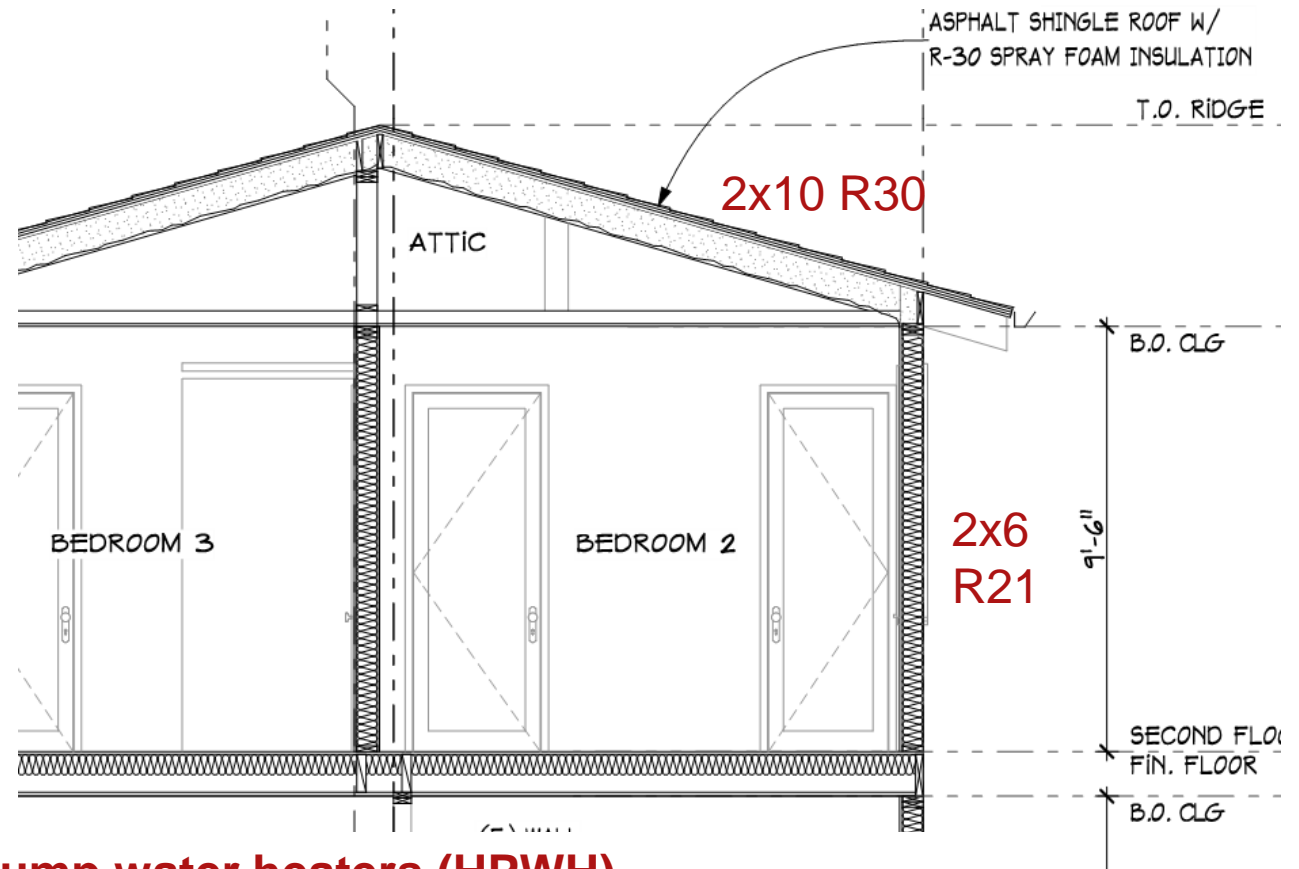
**Exception: existing studs & siding  
(couldn't pass with gas hot water)**



**Second story addition, 1157 ft<sup>2</sup>.**

**2x6 R21 walls, 2x10 R30 roof.**

**(No exceptions available, *barely passing!*)**



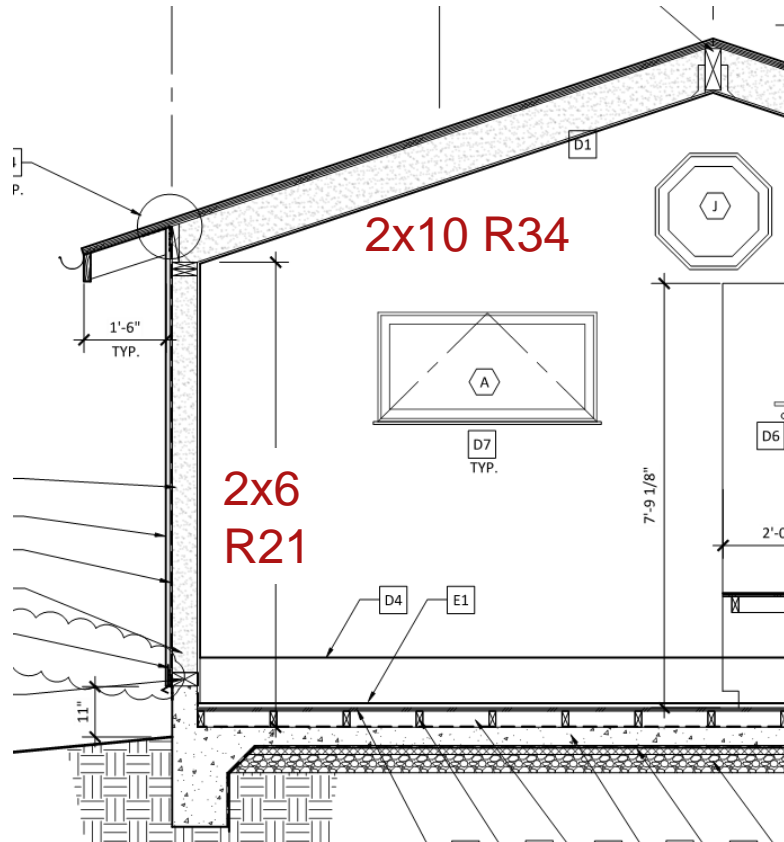
**Both use heat pump water heaters (HPWH)**



## Wall Insulation Examples: New Construction

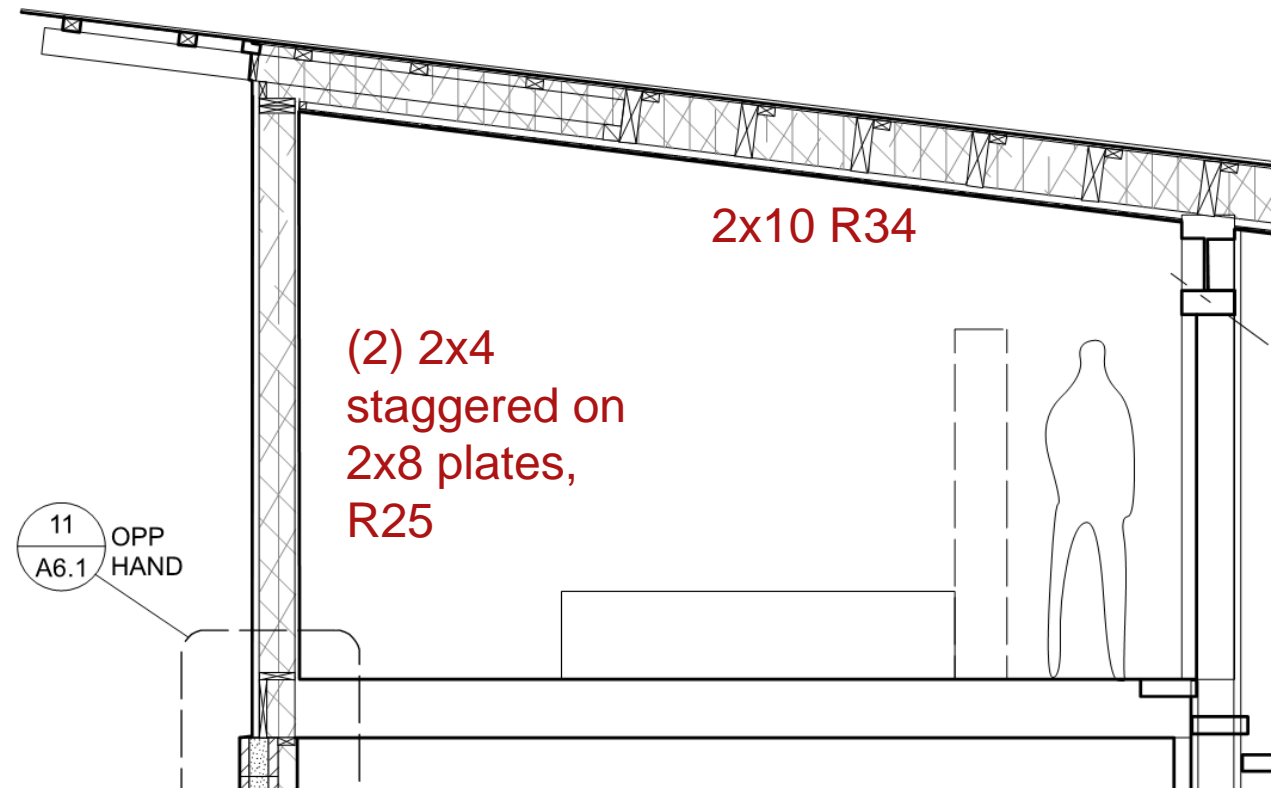
**New ADU, backyard site, 560 ft<sup>2</sup>.**

**2x6 R21 walls, 2x10 R34 roof.**



**New home, rural site, 2156 ft<sup>2</sup>.**

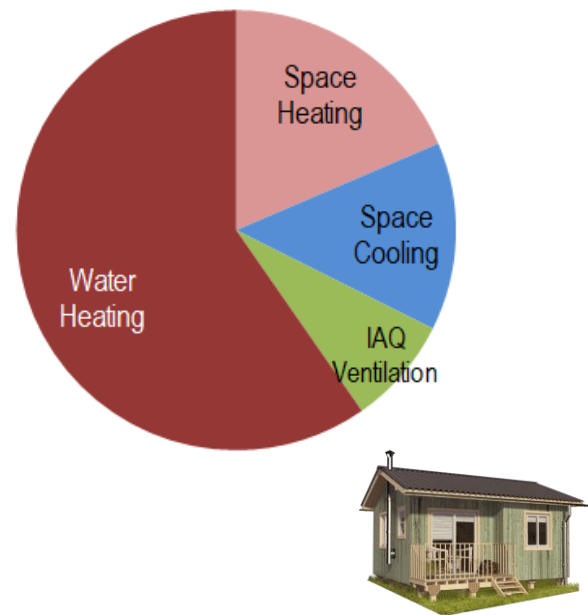
**Staggered stud R25 walls, 2x10 R34 roof.**



**Both use heat pump water heaters (HPWH) and space heating**

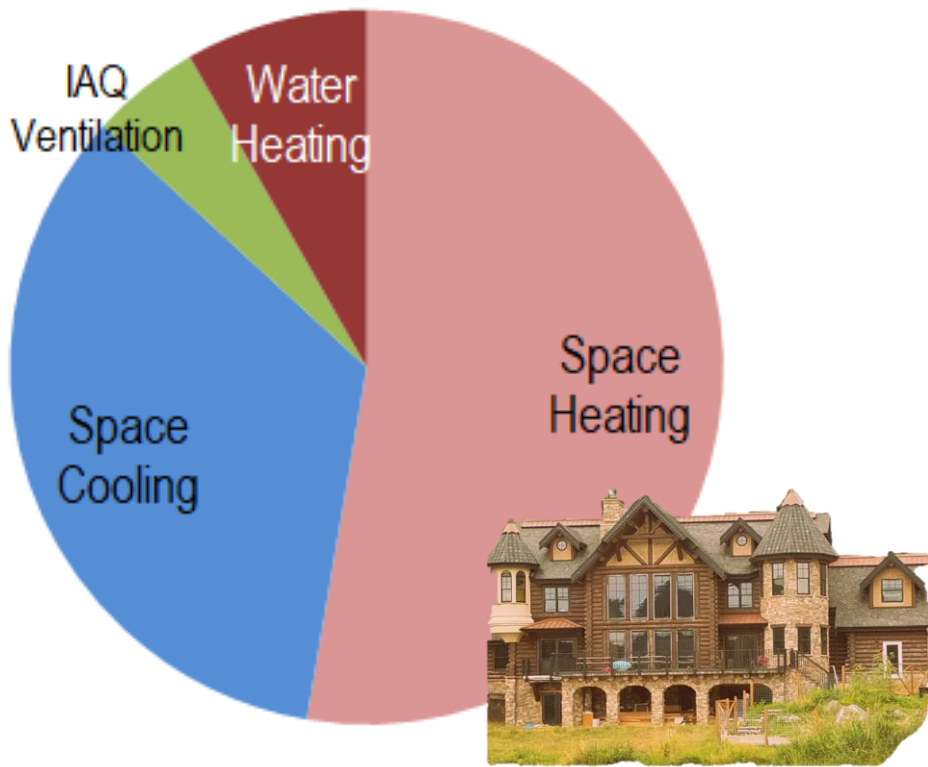
# Wall Insulation

300 ft² Accessory Dwelling Unit



**Floor area less than 600 ft² is dominated by *water heating***

6900 ft² Custom Home



**Floor area greater than 1500 ft² is dominated by *space conditioning***

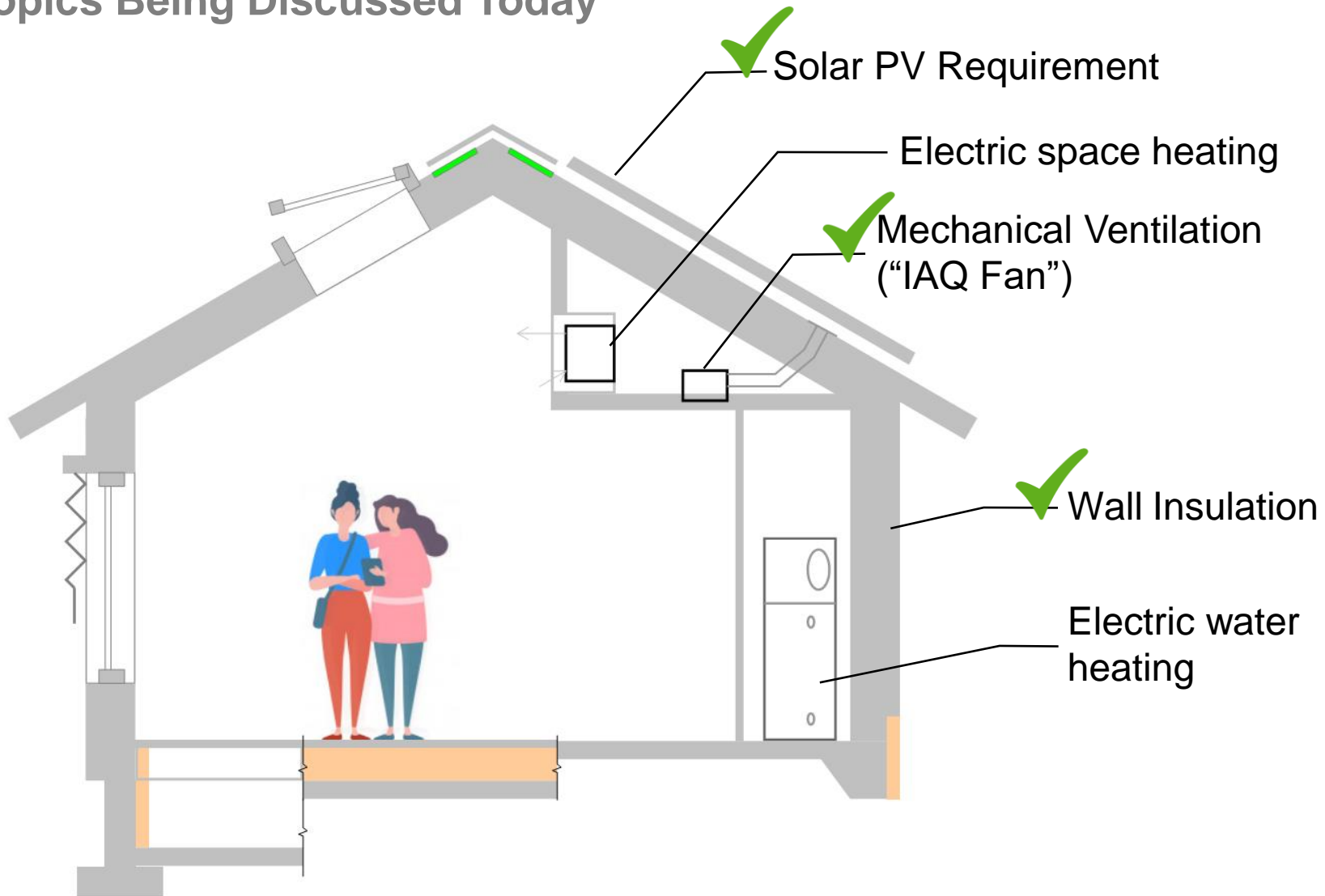
# Wall Insulation Examples: New Construction ADU



2019 Energy Code Standard	Proposed Design
Wall: 2x6, R21, + R6 <i>continuous insulation, + QII inspection</i>	<b>2x6, R21.</b>
Roof: R30	same
Water heater: Heat Pump, tank-type, EF-2.5	Heat Pump, tank-type, <b>EF-3.7</b>
<b>Results</b> Space heating: 31 TDV* Water heating: <u>90 TDV</u> 121 TDV	47 TDV <u>73 TDV</u> 120 TDV <b>PASS!</b>

\*TDV = Time Dependent Value, the scoring metric

## Topics Being Discussed Today



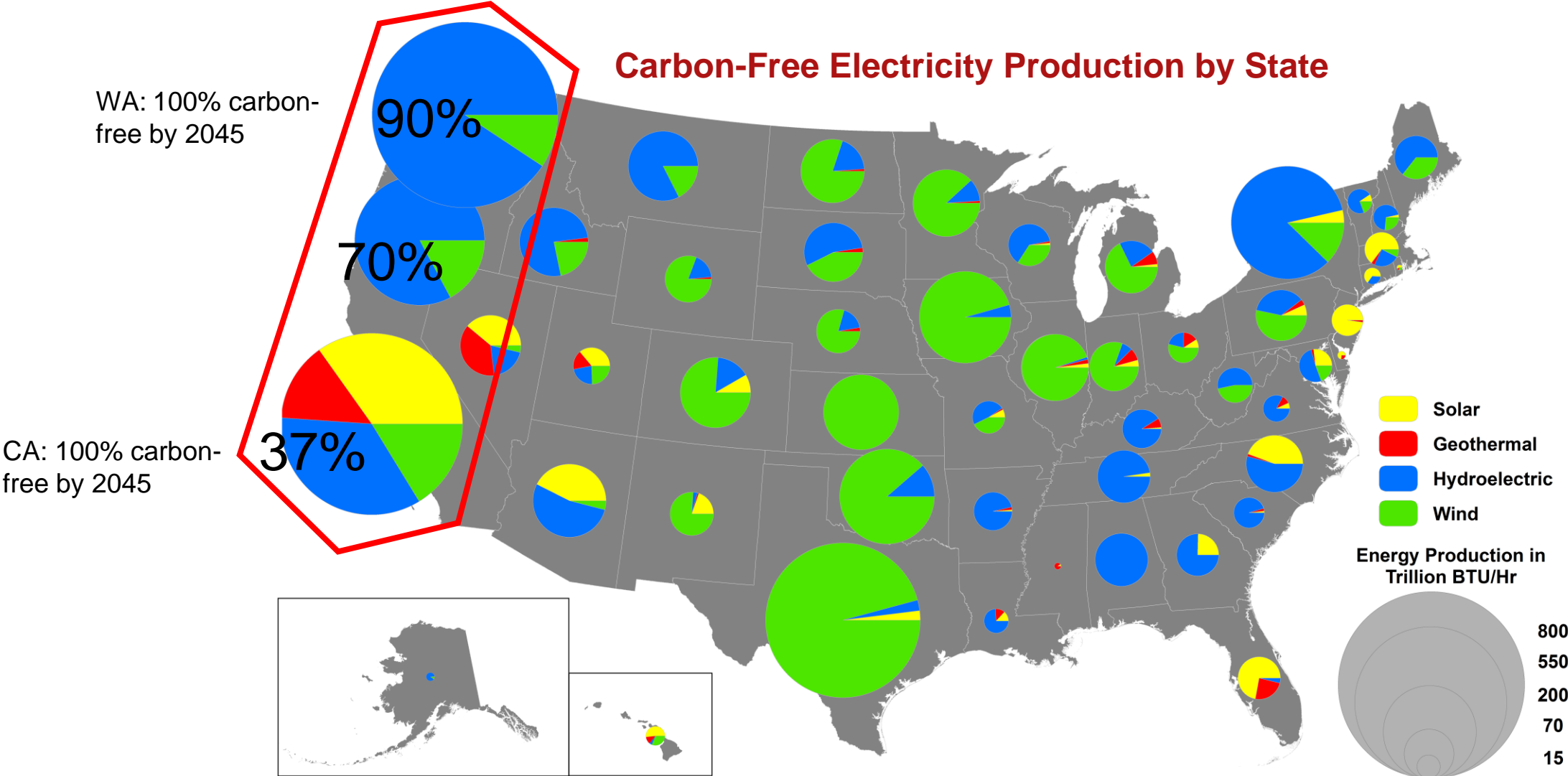
### 2019 Energy Code issues:

- ✓ • Triggers: Type & Size
- ✓ • Solar PV requirement
- ✓ • Mechanical ventilation
- ✓ • Wall Insulation

### Jurisdictions with Gas-free mandates:

- Electric space heating
- Electric water heating

# The West Coast Electric Grid is Increasingly Carbon-Free



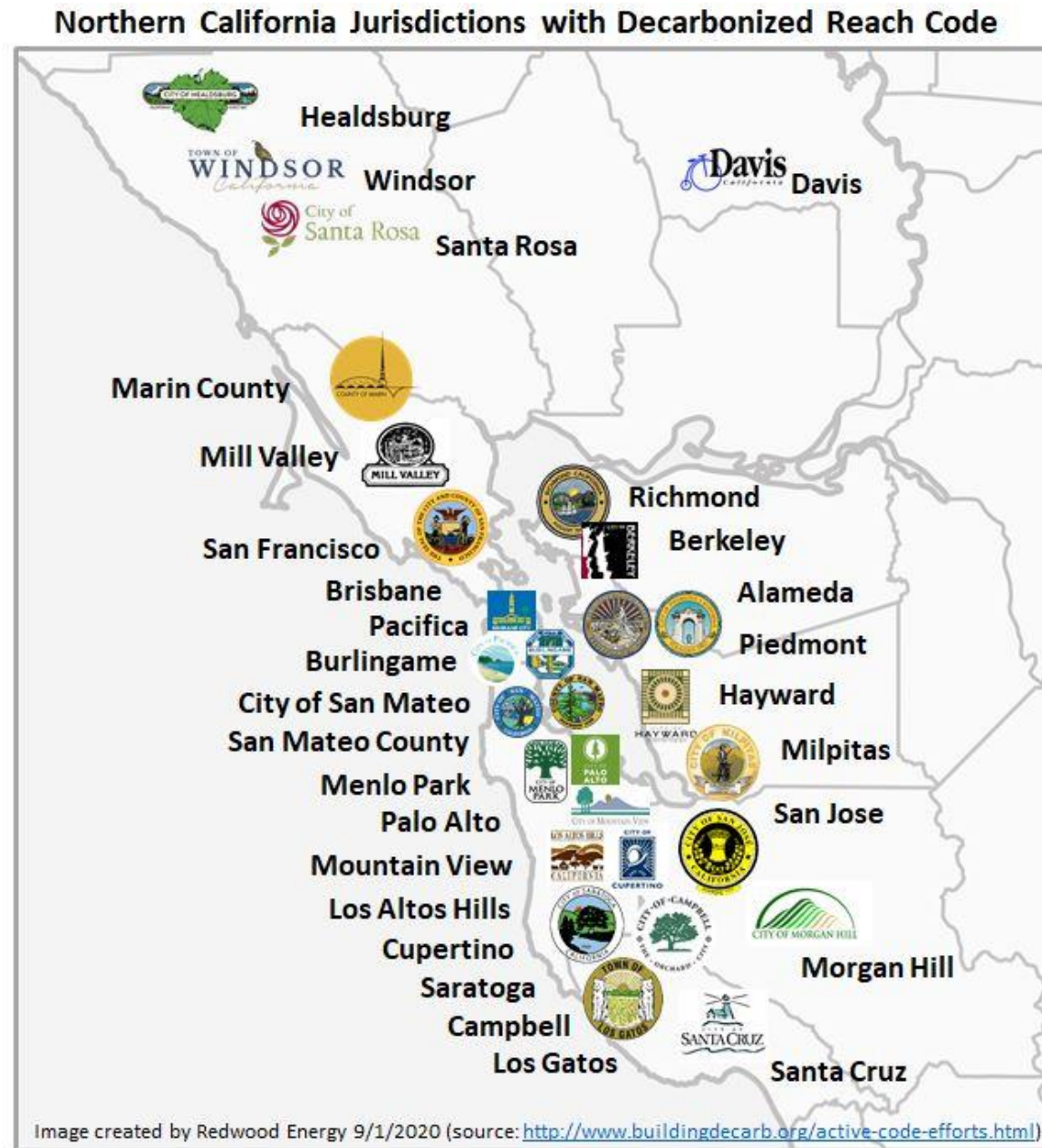
These data were made available by the Energy Information Administration

[https://www.reddit.com/r/MapPorn/comments/aapz43/by\\_state\\_comparison\\_of\\_renewable\\_resource\\_energy/](https://www.reddit.com/r/MapPorn/comments/aapz43/by_state_comparison_of_renewable_resource_energy/)  
<https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx>





# Gas-Free Mandates for New Construction



# Water Heating Choices

## 1. “Split” Heat Pump

**Most flexible** option,  
\$3000-7000 installed



## 2. Unitary Heat Pump

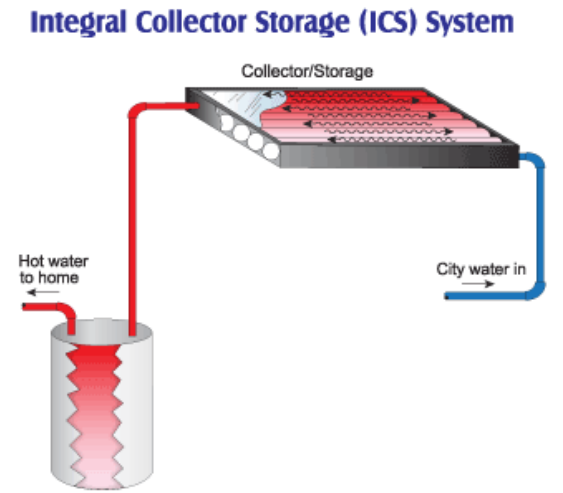
**Least expensive** option,  
\$2500-5500 installed

**“Retrofit Ready”** versions  
this year from Rheem and  
AO Smith: 120V, less  
expensive



## 3. Solar Thermal + Electric Resistance

**Smallest** option  
(least interior  
space)



## 4. ~~Tankless Electric alone~~



Energy Code penalty cannot  
be overcome in performance  
calculation

Exception: replacing existing  
water heaters *where no gas  
is connected*

## Water Heating Comparison

### 1. “Split” Heat Pump



Most flexible; no tank venting; high efficiency

Tank venting?

none

Installation cost\*

\$3000-7000

Pollution vs. gas

↓ 60-80%

### 2. Unitary Heat Pump



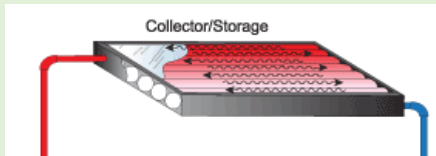
Least expensive

Locate “outdoors,” or duct the cool air to a pantry

\$2500-5500  
(lower for “retrofit ready” models?)

↓ 60-80%

### 3. Solar preheat + Electric resistance



Resiliency; Least indoor space

none

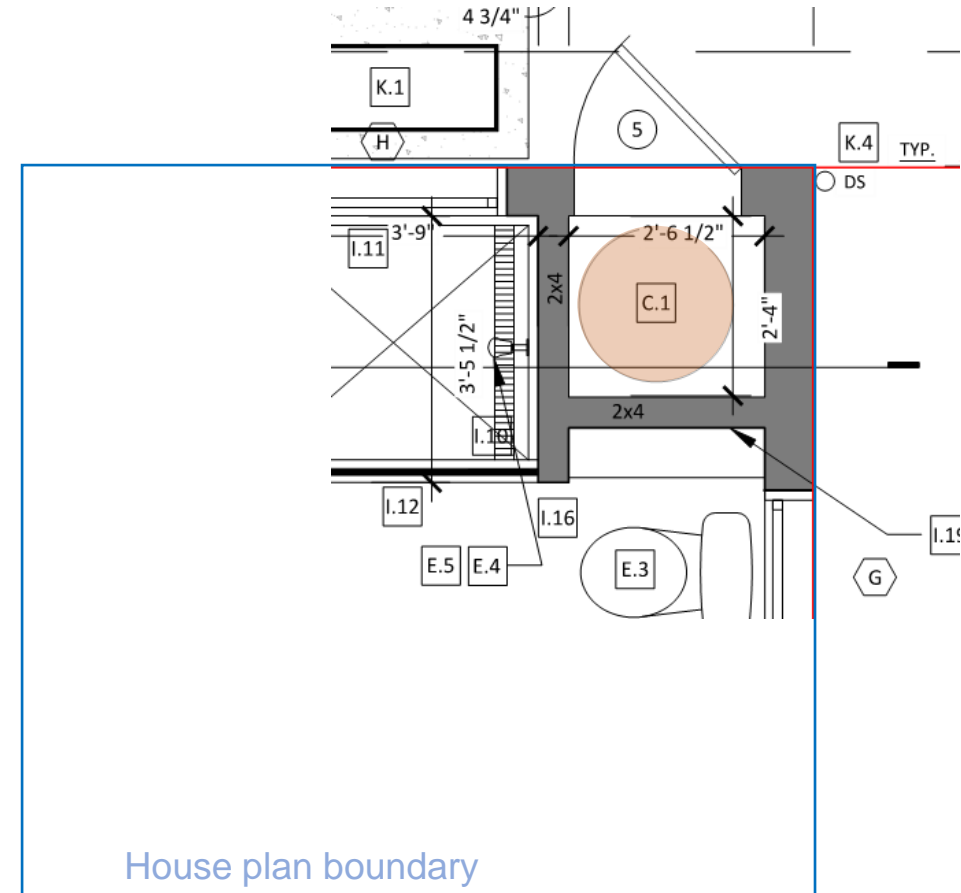
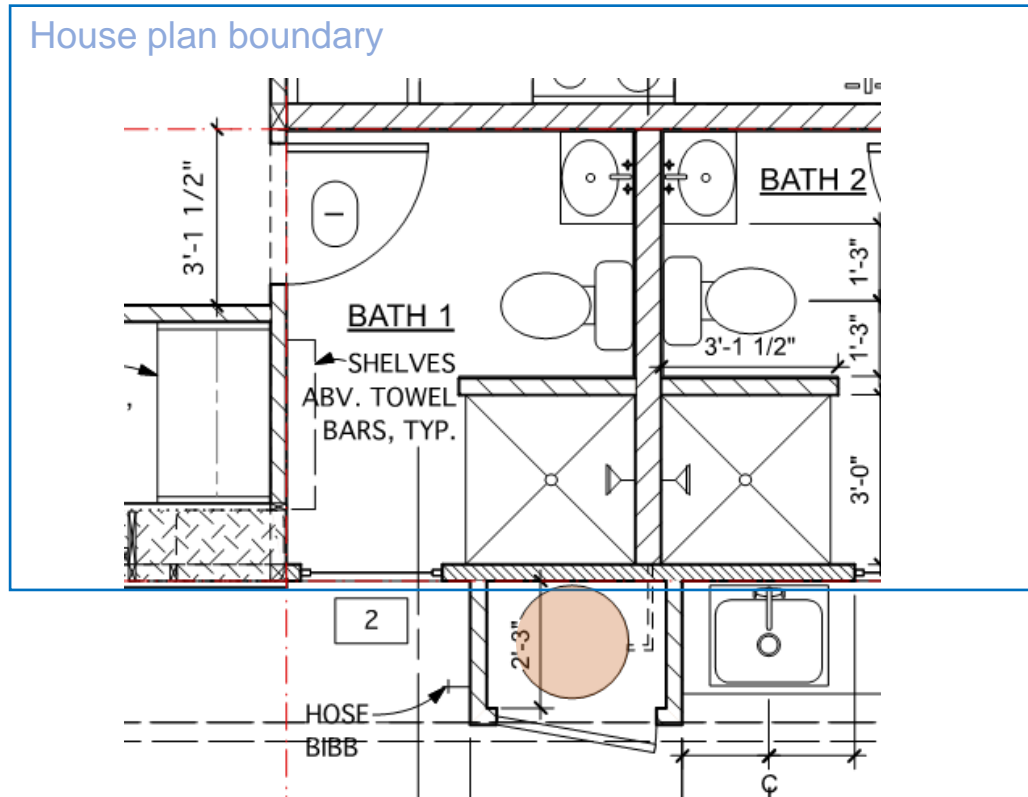
\$5900+

↓ 50-90%

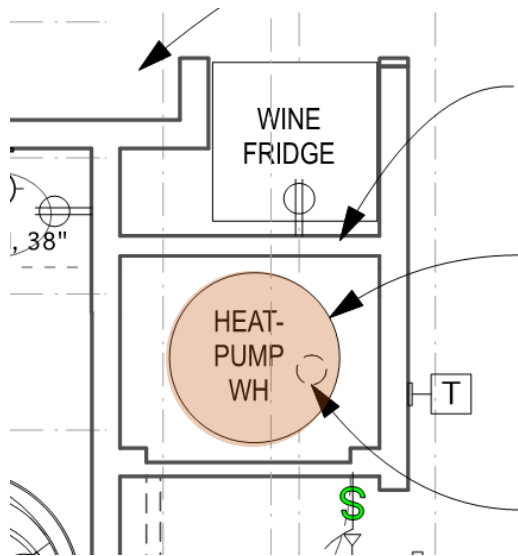
\*Your results may vary

## Small homes & ADUs: provide an “outdoor” closet for storage tank

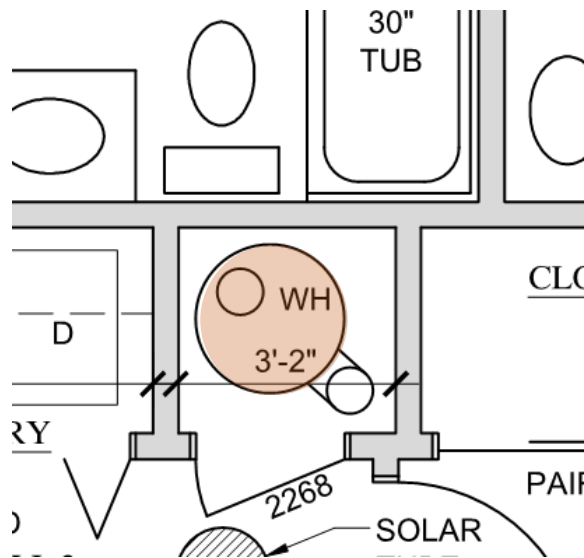
### Collected screenshots showing “outdoor” HPWH tank locations



Bigger homes & remodels: Provide a central indoor closet for storage tank



House plan boundary



House plan boundary



# Location-based considerations for a heat pump water heater

## Bay Area Climate Zones



Considerations based on Energy Code scoring

### Air conditioning Climate Zones 2, 4, 12:

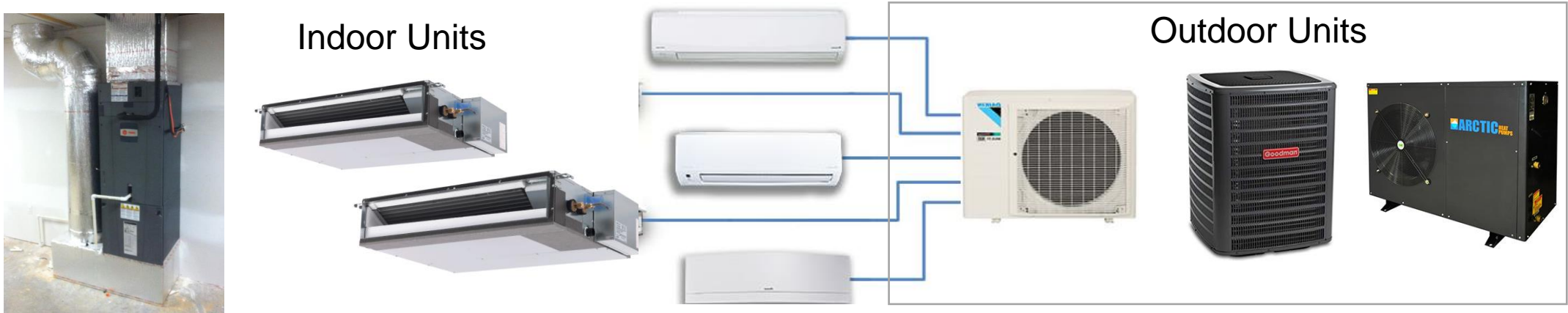
- Locate the Heat Pump Water Heater **indoors**, behind a louvered door, or duct the air-conditioned exhaust to:
  - a pantry, or
  - behind the refrigerator

### Historically cool-summer Climate Zone 3:

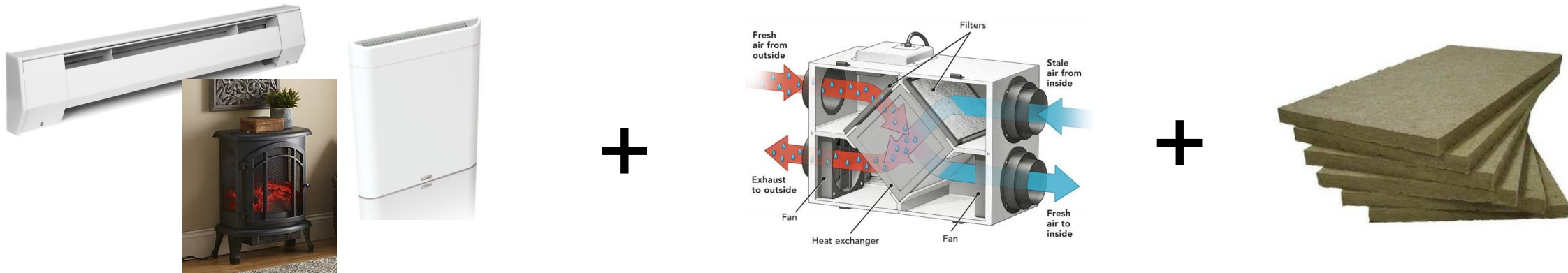
- Locate the Heat Pump Water Heater in an **“outdoor”** closet...
- Especially if using electric-resistance heat
- Or, use a custom solution

# Space Heating Choices: Two paths

## A. Heat Pump



## B. 1) Electric resistance + 2) Heat-recovery ventilation + 3) Good insulation



# Space Heating: Pro/Con

## A. Heat Pump



(Many distribution choices)



Best for...

Best for homes **>1000 ft<sup>2</sup>** and/or lots of exposure to outdoors,  
*Provides A/C*

Efficiency

300-400%+

Installation Cost

Roughly the same as gas-fired heat;  
*large variation in bids*  
\$\$\$

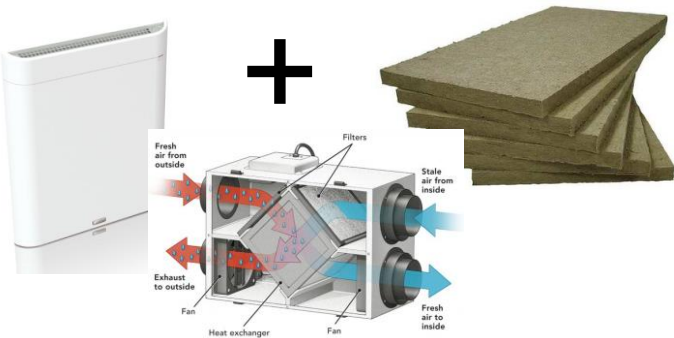
Operating Cost

Roughly the same as gas-fired heat, depending on many factors  
\$

Lifecycle cost

\$\$

## B. Electric resistance heat + HRV + insulation



Best for homes **<600 ft<sup>2</sup>** and/or highly insulated  
*No Cooling*

99% Max

Inexpensive to install  
\$

3x the running cost of the heat pump  
\$\$\$

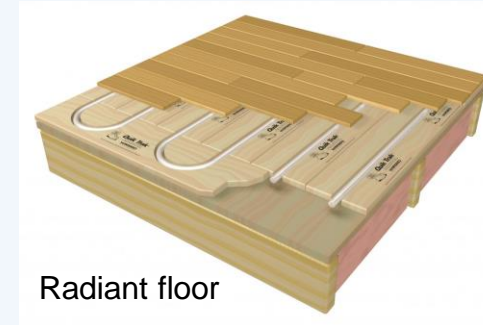
\$\$

# Heat Pumps: Distribution Choices

## Ducted Forced Air    Mostly single-zone



## Radiant Floors



## Ducted Mini-Split    Slim, horizontal; multiple zones

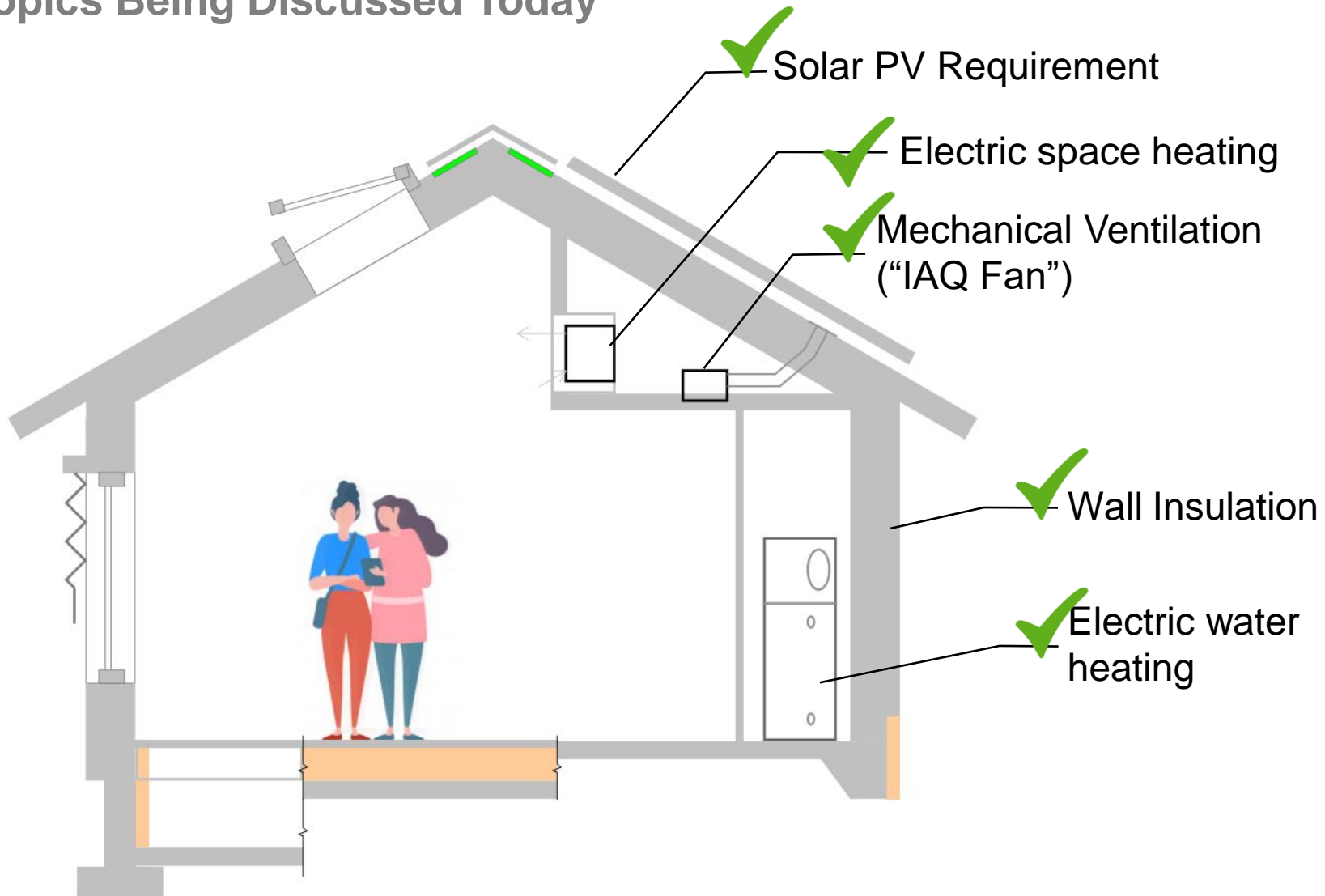


## Ductless Mini-Split    Many styles; multiple zones





## Topics Being Discussed Today



### 2019 Energy Code issues:

- ✓ • Triggers: Type & Size
- ✓ • Solar PV requirement
- ✓ • Mechanical ventilation
- ✓ • Wall Insulation

### Jurisdictions with Gas-free mandates:

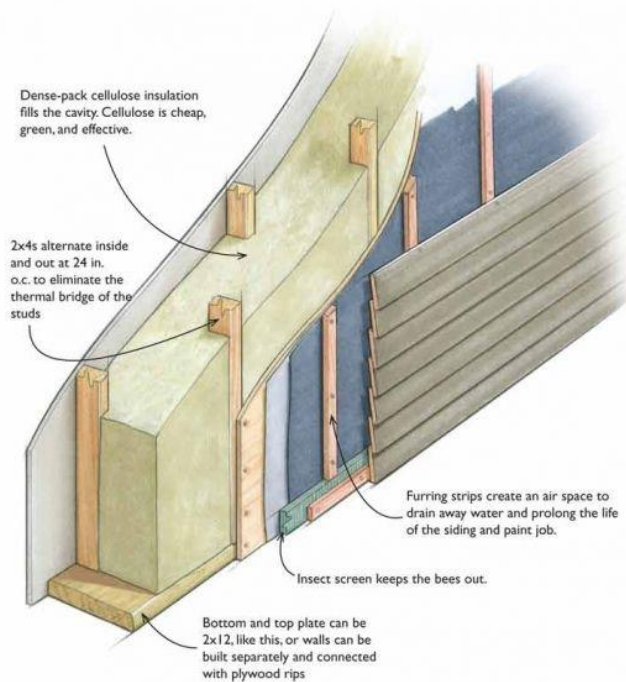
- ✓ • Electric space heating
- ✓ • Electric water heating



**Extra slides follow...**

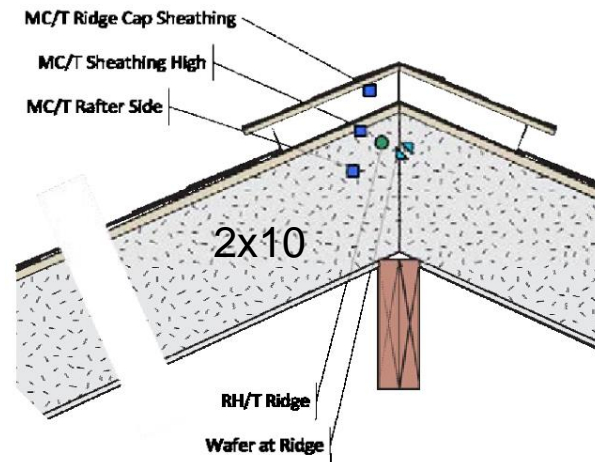
# Our 2020 Envelope Work: eliminate foamed plastic, achieve high R-values

## Exterior walls Staggered stud 2x4 @ 24"



## Roofs

Unvented, dense-pack  
cellulose  $\geq 2x10$



New unvented options in  
2019 Residential Code

## Foamed Plastic

- HFCs – climate impact
- Flame retardants
- End-of-life



## Natural Rigid Insulation

- Great stuff!
- Expensive = not for every project



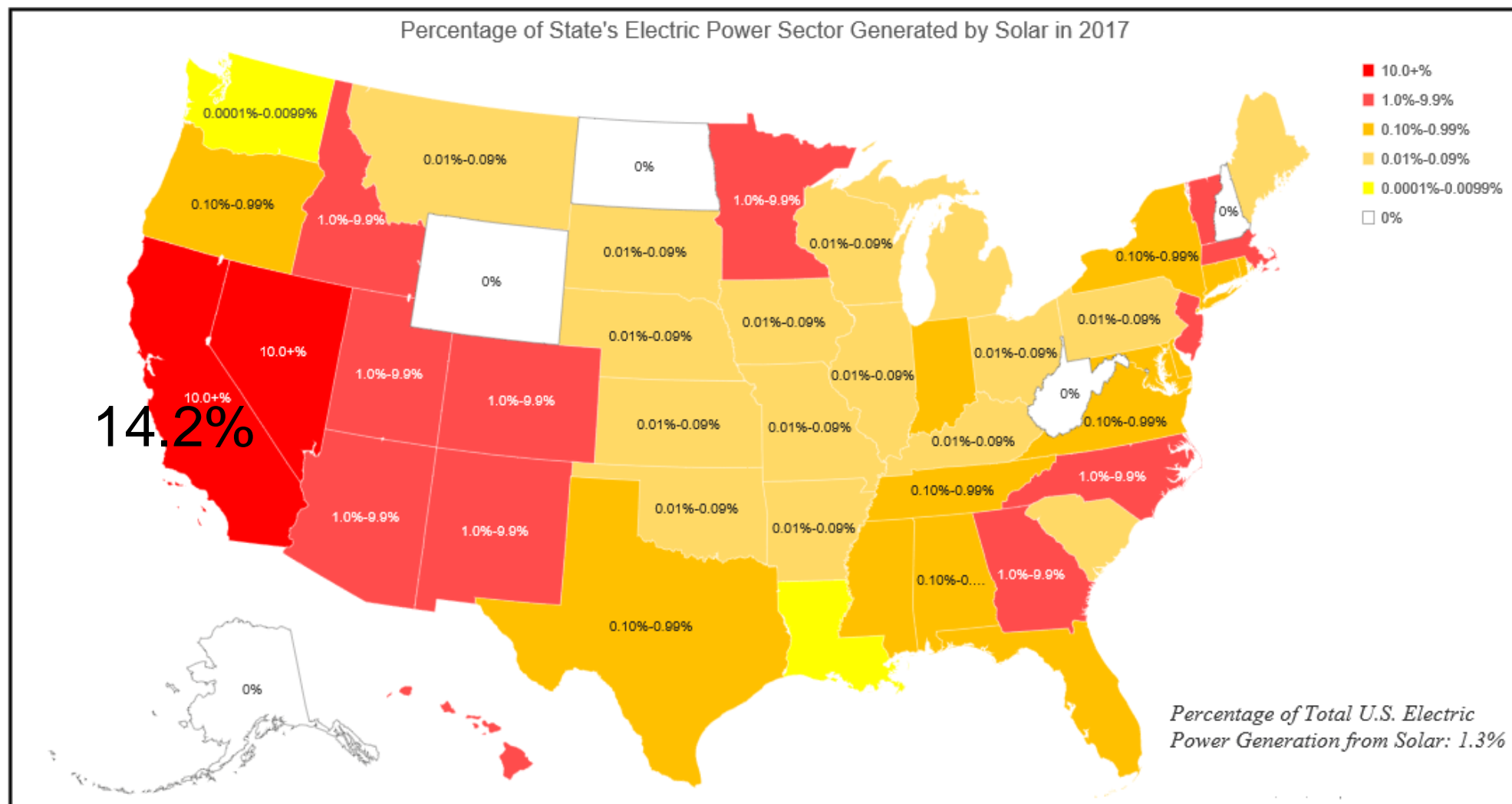


## Advice #1: “Boxy But Beautiful” #BBB



# Solar PV Requirement

Is California unique in the % of grid electricity generated by solar PV?



Data Source: U.S. Energy Information Administration

ChesterEnergyandPolicy.com



# Solar PV Requirement

When did this solar explosion begin?

Total Renewable Generation Serving California Load by Resource Type

