TITLE 24, PART 6 | 2025 CODE CYCLE

Ventilation Requirements for Heat Pump Water Heaters

Codes and Standards Enhancement (CASE) Proposal
Multifamily Domestic Hot Water

James Haile, Frontier Energy

Round 2 Utility Sponsored Stakeholder Meeting

May 1, 2023

CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Agenda

- Overview of Code Change Proposal
- Summary of Stakeholder Feedback
- Cost-Effectiveness, Energy Savings and Statewide Impacts
- Next Steps

Code Change Proposal

- Code Change Proposal
- Code Change Language
- Summary of Reasons for Proposal

Proposed Code Change Scope

This proposed code change involves:

- Mandatory ventilation air requirements for heat pump water heaters (HPWHs) in all occupancies.
- Only considering ventilation requirements for consumer integrated HPWHs as defined by federal code (CFR 430):
  - ≤ 120-gallon storage volume.
  - Electrical input < 24 amps at < 250 volts.

This proposed code change does not involve:

- Commercial integrated HPWHs.
- Split system HPWHs.
- Requiring HPWHs.

Draft code language for this measure is available in the **resources tab.**

Proposed Code Language

Draft code language for this measure is available in the resources tab.

This measure would include the following code changes:

- Add and adjust existing definitions in Section 100.1(b) to better differentiate HPWH types.
- Add a “Heat pump water heaters” section to the end of Section 110.3(c).
    - Proposed code change provides for four basic HPWH ventilation paths:
        1. Large unvented room/closet.
            - Larger of 100 ft^3 room volume / kBtu/h of compressor input capacity, or manufacturer specified requirements.
        2. Small vented room/closet.
            - Larger of 20 ft^3 room volume / kBtu/h of compressor capacity, or manufacturer specified requirements.
            - Larger of 125 in^2 net free area (NFA) plus 25 in^2 per kBtu/h of compressor capacity, or manufacturer specified requirements.
        3. Directly ducted to the HPWH inlet or outlet in any size room/closet.
            - Exhaust duct must be insulated, all ducts sealed using mastic, etc.
        4. Ventilation methods approved by the HPWH manufacturer. A letter from the manufacturer must be included with plans submitted to the building department.
    - HPWHs must be installed with backup heat if unconditioned air is used for ventilation and the compressor cutout temperature is above the Winter Median of Extremes in Joint Appendix 2.2, Table 2-3.

Proposed Software and Forms Changes

This measure would include the following forms changes:

- All forms have a table that lists mandatory requirements (for example, Section F in LMCC-PLB-01-E).
- This table will need to be updated on all forms to reference the new requirements.

This measure would require the following software changes:

- When any individual HPWH is included in the design:
  - Require the designer to check a box that states the mandatory ventilation requirements are met by the design.
  - Compliance report would list “HPWH ventilation (larger of either mandatory minimum or manufacturer specification) installed” under Required Special Features.

Summary of Stakeholder Feedback

- Summary of Feedback Received
- Measure Evolution
- Potential Barriers and Solutions

Summary of Feedback Received

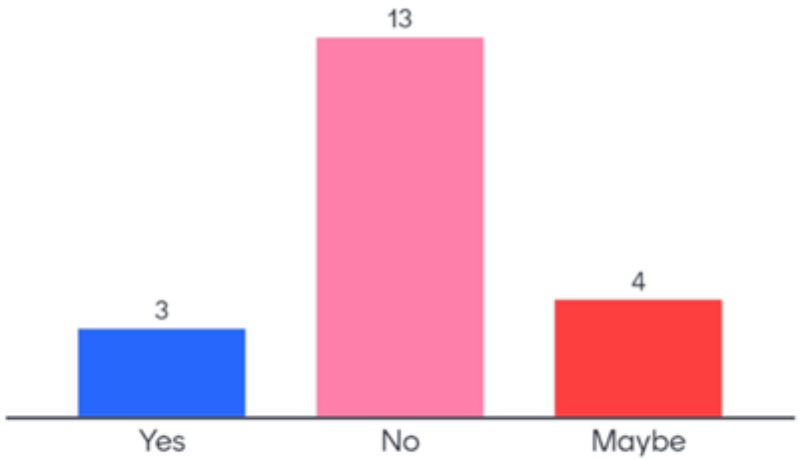
- One non-clarification question was asked at the stakeholder meeting:
  - Should MERV rated filters be required if only inlet is ducted from unconditioned air?
  - Response during the meeting was that this was not being considered, and HPWHs have built-in reusable filters on the inlet side.
- One comment was submitted to the docket, raising the following:
  - Proposed code establishes minimum ventilation requirements based on per kBtu/h compressor capacity, but there are no requirements for manufacturers to provide this information.
  - If manufacturers are required to provide HWPH compressor capacity, it should be measured in accordance with industry standards (such as AHRI 540).

Poll

Go to **www.menti.com** and use the code **2523 2024**

Should MERV filters be required if the HPWH is installed in conditioned space, but inlet is ducted from unconditioned space?

Mentimeter



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Poll

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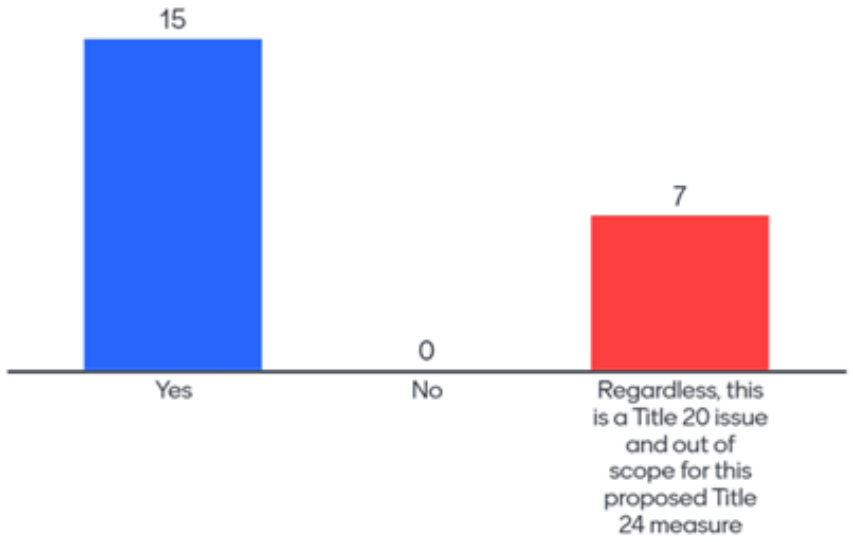
Mentimeter

Should Title 24 require that compressor capacity be measured and reported by manufactuers according to a specific industry standard?



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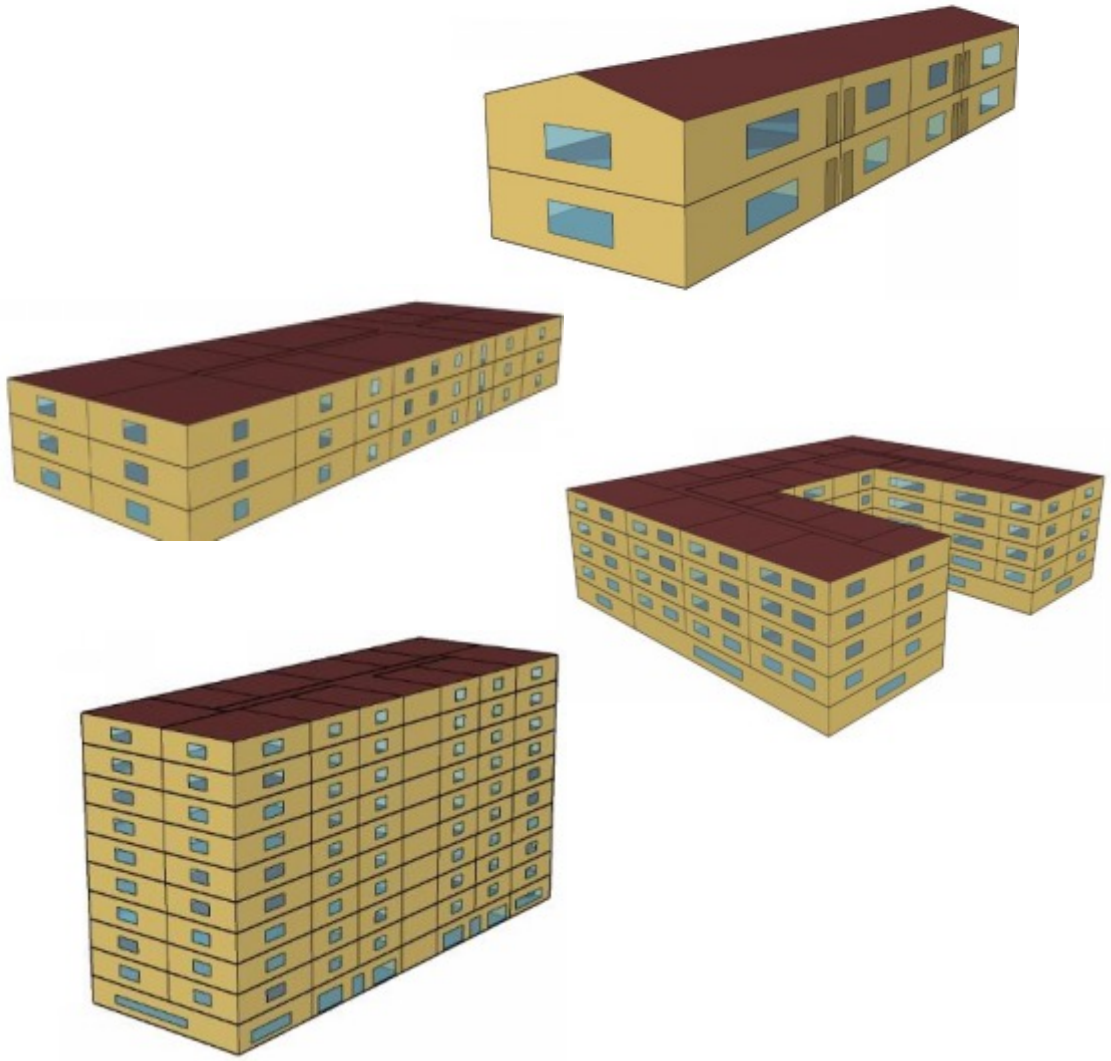
Energy and Cost Impacts Per Dwelling Unit

Methodology and Assumptions

- Energy Savings Methodology and Results
- Cost Impacts Methodology and Results
  - Incremental costs
  - Energy cost savings

Methodology for Energy Impacts Analysis

- Analysis will be conducted using standard California Building Energy Code Compliance (CBECC) prototypes for single family.
- Savings are expected to be the same for single family and multifamily, as water heating loads for individual units are dependent on the number of bedrooms, not other factors.
- Results from CBECC will be compared to lab test results, and savings will be calculated assuming heat pump water heater (HPWH) ventilation uses only the minimum NFA for a 36 kBtu gas-fired storage water heater as the baseline.
- CBECC assumes perfect ventilation, so lab test results will be used to adjust CBECC model outputs to non-ideal ventilation conditions.



Assumptions for Standard and Proposed Designs

Standard Design

- CBECC results adjusted to reflect poor ventilation using laboratory test results

Proposed Design

- Existing CBECC HPWH model

Incremental Cost Information

- How we collected costs of base case technology and proposed technology:
  - Collected data on costs of louvered doors and other ventilation methods.
  - Obtained contractor pricing for incremental labor cost to install adequate ventilation.
  - **Included first material costs and installation costs.**
- Equipment costs were found to range from <$100 to $2000 per dwelling unit, depending on the ventilation method and louvered door styling.
- Seeking additional cost data from additional designers and installers.

Ventilation Method	Sub Method	Incr. Materials Cost	Incr. Labor Cost
Large Space	NA	$0	$0
Small Vented Space	Louvered Door	$200 to $2000	NC: $0 Add/Alt: $97.50
	Louver Sections	$1.70 per sq. in. NFA ($510 for 300 sq.in. NFA)	$195
	Grilles	< $100	$97.50
Ducted Any Size Space	NA	$200	$195

Cost Effectiveness and Energy Savings

Methodology and Assumptions

- Energy Savings Methodology and Results
- Cost Impacts Methodology and Results
  - Incremental costs
  - Energy cost savings

Preliminary Energy Savings Estimates Per Dwelling Unit

	Interior Closet		Exterior Closet	
First Year…	New Construction and Additions	Alterations	New Construction and Additions	Alterations
Electricity Savings (kWh/yr)	772	746	835	766
Natural Gas Savings (Therms/yr)	0	0	0	0
Peak Demand Reduction (W)	56	54	64	62
Life Cycle Energy Cost Savings (2026 PV$/yr)	5037	4873	5453	5036
Source Energy Savings (kBTU/yr)	1172	1129	1321	1214
Avoided GHG Emissions (kg CO_2e)	60	58	68	63

Incremental Per Unit Cost

Over 30 Year Period of Analysis

Incremental First Cost	
Equipment	$80.00
Installation	$97.50
Commissioning	$0.00
Other	$0.00
Total	**$177.28***

Incremental Maintenance Cost	
Equipment Replacement	$0.00
Annual Maintenance	$0.00
Total	**$0.00**

Cost data came from:

- Survey of grills available for retail sale.
- Contractors

Total incremental cost over 30 year period of analysis: **$177.28***

*Average for all climate zones and prototypes.

Cost Effectiveness

Climate Zone	Benefits *Life Cycle Energy Cost Savings + Other PV Savings* (2026 PV$)	Costs *Total Incremental PV Costs* (2026 PV$)	Benefit-to-Cost Ratio
1	$6,980	$170	40.97
2	$5,899	$200	29.46
3	$5,839	$188	31.08
4	$5,379	$200	26.91
5	$6,216	$201	30.99
6	$5,152	$173	29.74
7	$4,979	$174	28.54
8	$4,740	$172	27.54
9	$4,748	$171	27.68
10	$4,967	$172	28.82
11	$5,139	$174	29.57
12	$5,456	$178	30.74
13	$5,020	$177	28.42
14	$4,960	$170	29.26
15	$3,888	$169	22.98
16	$5,945	$173	34.44

Statewide Impacts

Methodology and Assumptions

Statewide Economic Impacts Methodology

The Statewide CASE Team estimates annual statewide impacts by multiplying **A x B x C**:

A. per-unit energy impacts (discussed in previous section)
B. number of units of new construction/additions/alterations of each applicable building type
C. portion of affected units in each climate zone

Example:

Per Unit Impacts

Savings type	**Savings** per square foot
Electricity	[X] kWh
Peak demand	[X] Watts
Natural gas	[X] Therms
GHG emissions	[X] Tons CO_2e

×

Affected New Construction

Climate Zone	**Large Office** sq ft	**Assembly** sq ft
1	100	20
2	1,000	1,500
…		
16	5,000	3,000

=

Statewide Energy Impacts

Climate Zone	**Elec Savings** (GWh)	…	**GHG savings** (MT CO_2e)
1	20		1,500
2	50		3,000
…			
16	100		2,000

2026 Construction Forecast

Key Assumptions:

- HPWHs will achieve 100% market share of individual water heaters by 2050.
- New Construction will adopt HPWHs faster than Existing.
- Exterior closets are less likely to be implemented in New Construction Mid and High Rise.

	Exterior Closets		Interior Closets	
Construction Forecast Building Type	Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)	Newly Constructed Floorspace Impacted (%)	Existing Floorspace Impacted (%)
SF500	1.76%	0.16%	33.35%	2.94%
SF2100	1.76%	0.09%	1.76%	0.22%
SF2700	1.76%	0.09%	1.76%	0.22%
Low-rise Garden	8.00%	1.29%	2.86%	1.29%
Loaded Corridor	3.51%	0.81%	1.17%	0.81%
High-rise Multifamily	0.00%	0.01%	0.15%	0.23%
Mid-rise Multifamily	0.00%	0.05%	4.49%	1.53%

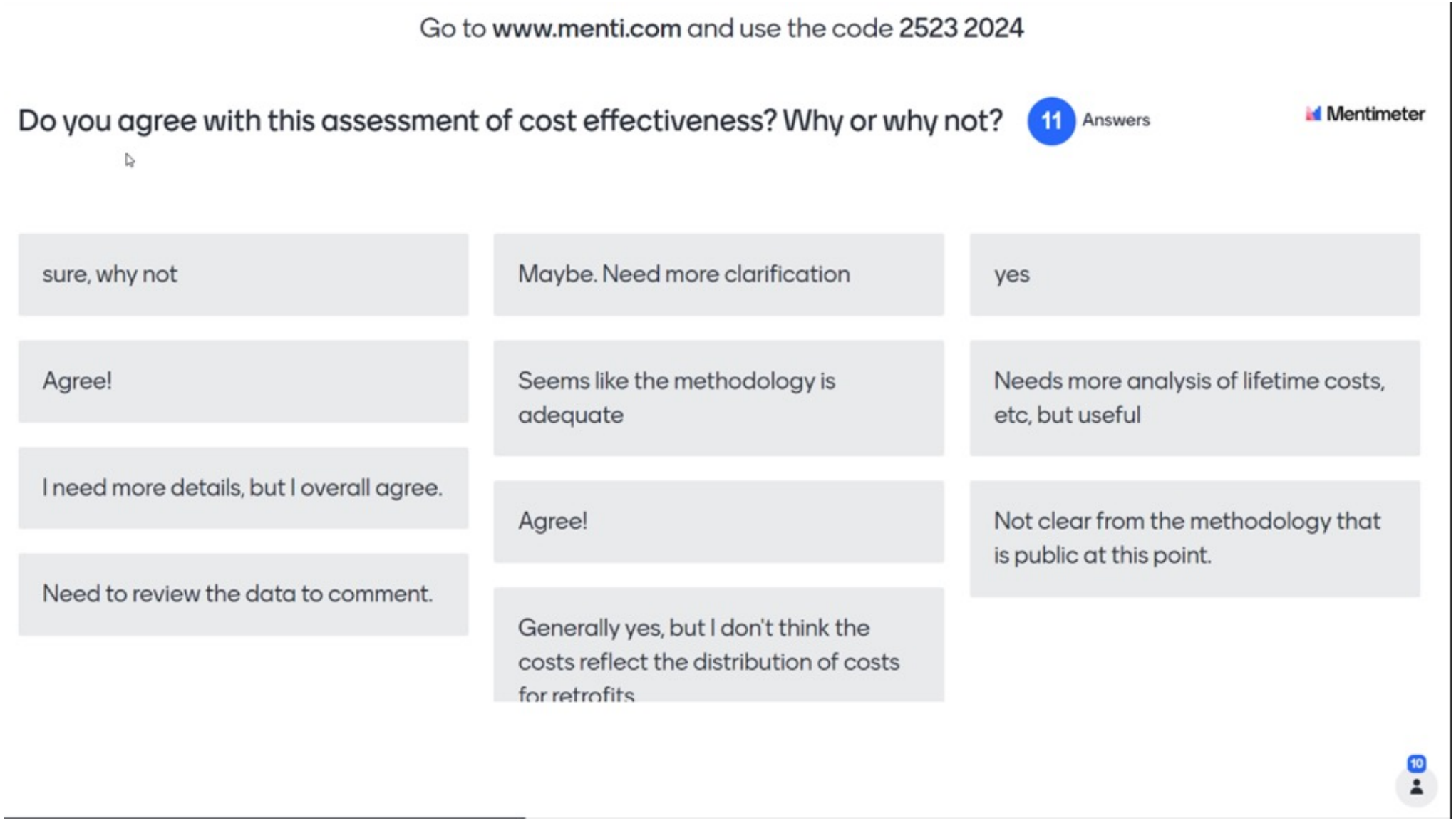
Statewide Impacts Results

Climate Zone	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (million Therms)	First-Year Source Energy Savings (million kBtu)	30-Year Present Valued Energy Cost Savings (million 2026 $PV)
1	0.03	0.00	0	0.04	$0.18
2	0.15	0.01	0	0.23	$1.01
3	0.55	0.04	0	0.83	$3.61
4	0.27	0.02	0	0.42	$1.80
5	0.04	0.00	0	0.07	$0.28
6	0.17	0.01	0	0.27	$1.12
7	0.31	0.02	0	0.48	$2.02
8	0.52	0.04	0	0.82	$3.44
9	0.61	0.05	0	0.95	$3.98
10	0.48	0.03	0	0.75	$3.12
11	0.27	0.02	0	0.41	$1.73
12	0.84	0.06	0	1.29	$5.46
13	0.30	0.02	0	0.48	$1.96
14	0.20	0.01	0	0.31	$1.28
15	0.10	0.01	0	0.17	$0.64
16	0.09	0.01	0	0.13	$0.59
TOTAL	**4.93**	**0.37**	**0**	**7.61**	**$32.22**

Statewide Impacts Results

First Year Savings	
Electricity (GWH/yr)	4.93
GHG Emissions from Electricity ($MTCO_2e$)	391.29
Total Value of GHG Emissions from Electricity ($)	$48,186
Embodied GHG (MTCO2e)	(23.85)
Net GHG Emissions (MTCO2e)	367.44
Total Value of Net GHG Emissions ($)	$45,249

Poll


Go to www.menti.com and use the code 2523 2024
Do you agree with this assessment of cost effectiveness? Why or why not?
11 Answers
Mentimeter
sure, why not
Agree!
I need more details, but I overall agree.
Need to review the data to comment.
Maybe. Need more clarification
Seems like the methodology is adequate
Agree!
Generally yes, but I don't think the costs reflect the distribution of costs for retrofits
yes
Needs more analysis of lifetime costs, etc, but useful
Not clear from the methodology that is public at this point.
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Discussion and Next Steps

We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the chat
- More information on pre-rulemaking for the 2025 Energy Code at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency

Comments on this measure are due by May 15th, 2023. Please send comments to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

Thank You

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CALIFORNIA ENERGY CODES & STANDARDS
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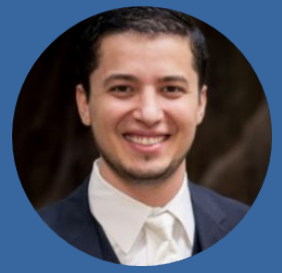
TITLE 24, PART 6 | 2025 CODE CYCLE

Individual Heat Pump Water Heater Electric Ready Cleanup

Codes and Standards Enhancement (CASE) Proposal
Multifamily | Domestic Hot Water



Jose Garcia, TRC

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- Overview of Code Change Proposal
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- Data Gaps and Additional Feedback Requested
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Code Change Proposal

- Code Change Proposal
- Code Change Language

Proposed Code Change

This mandatory measure would make future retrofits from gas or propane individual water heaters to individual heat pump water heaters (HPWH) more technically and financially feasible.

This measure proposal is a cleanup of language developed under the 2022 Title 24, Part 6 update to address the following factors:

- Branch circuit sizing should be based on conductor current rating
- Individual HPWHs require more space than individual gas or propane water heaters
- Individual HPWHs require more ventilation than individual gas or propane water heaters

Draft Code Change Language

2022

Title 24 Part 6, Section 160.4(a)

- A reserved additional single pole circuit breaker space for future 240 volt use
- Conductor: 120/240 volt 3 conductor **10 AWG copper** branch circuit to future location
- Dedicated 125 volt 20 amp receptacle
- Condensate drainage

Proposed 2025

Title 24 Part 6, Section 160.9(d)

- A reserved additional single pole circuit breaker space for future 240 volt use
- Conductor: 120/240 volt 3 conductor branch circuit **rated at 30 amps min.** to future location
- **Entire building electrical system must be sized to meet future load**
- Dedicated 125 volt 20 amp receptacle
- Condensate drainage
- **Minimum space size: 39”x39”x96” (W,L,H)**
- **Ventilation**
  - **(a) Installed in space with minimum volume of 450 cu. ft., or**
  - **(b) Installed in a smaller space vented to a total space 450 cu. ft. or larger (including the volume of the smaller space) via louvers or grilles with a total of 250 sq. in. net free area**
  - **(c) Installed with two 8” capped ducts, venting to exterior**

Draft code language for this measure is available in the resources tab.

Summary of Stakeholder Feedback

- Summary of Feedback Received
- Measure Evolution
- Potential Barriers and Solutions

Summary of Feedback Received

With the addition of 120-volt HPWH options, we considered whether our proposal should enable the retrofit of 240-volt and 120-volt options, or only 120-volt options

- We asked stakeholders at the first stakeholder meeting if the proposal should enable the retrofit of 240-volt and 120-volt options
- We got multiple responses in support, and no responses against

We did more outreach and found that 120-volt options result in slightly higher on-site energy use and higher GHG emissions than 240-volt options

Based on this stakeholder feedback, we are not proposing changes to the breaker voltage

Evolution of the Measure

- Ventilation
  - When the future HPWH will be installed in a space with volume less than 450 cubic feet
    - We initially proposed that the space must ventilate to a larger space with a minimum volume of 450 cubic feet
    - We are now proposing that the spaces that communicate via louvers or grilles need to have a combined minimum volume of 450 cubic feet
  - This change was made for better alignment with plumbing code and mechanical code requirements for combustion air

Image Credits (L to R):
Bradford-White, A. O. Smith, and Rheem

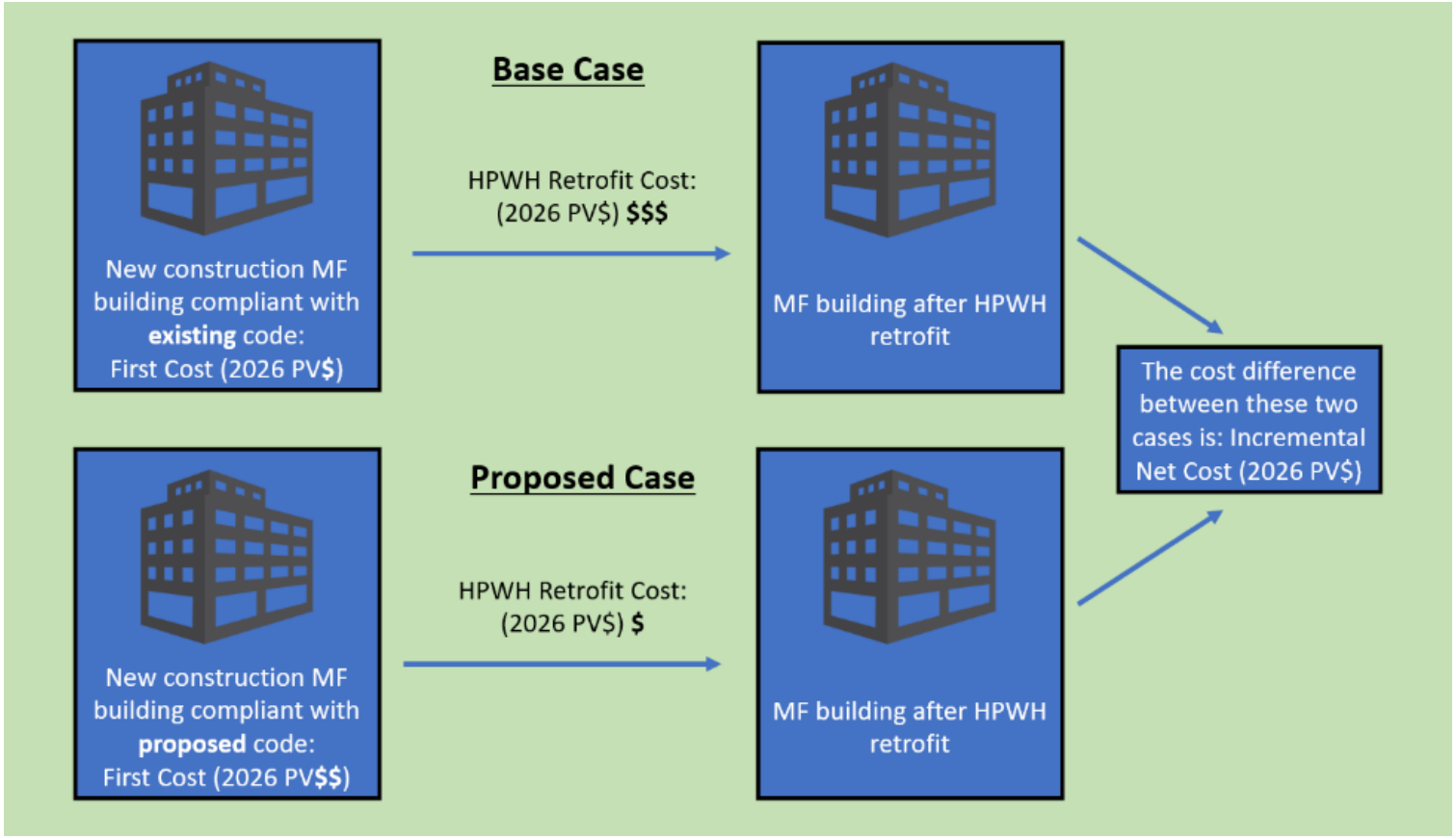
Cost Effectiveness

Methodology and Assumptions

- Cost Effectiveness Assumptions
- Incremental Cost and Future Cost Methodology
- Incremental Cost Components
- Incremental Per Unit Cost
- Cost Effectiveness

Cost Effectiveness Assumptions

- For electric readiness, analysis is based on 2026 PV$ incremental net cost
- Costs at new construction are assumed to be in 2026 PV$
- Costs at retrofit are assumed to occur in 20 years, and adjusted to 2026 PV$ based on a 3% discount rate



Incremental Cost Methodology

How we collected costs:

- Experienced plumbing engineer provided basis of design (BOD) for HPWH design for the four prototypes
  - Input from Statewide CASE Team based on interviews with designers, design consultants, or contractors
  - Input from Statewide CASE Team based on market research
- Cost data collection for closet construction costs from a cost database
- Contractor pricing for incremental cost to install adequate ventilation

Incremental Cost Components

- Closet enlargement
  - Labor and Materials
  - Demolition of original closet (3 walls)
  - Gas system closet size of 39”x23”x96”
  - HPWH closet size of 39”x39”x96”
  - Neglected some demolition costs, such as wiring and plumbing
- Ventilation via grilles
  - Labor and Materials
  - Retrofit grilles with adequate NFA
- No incremental electrical costs

Poll

Go to **www.menti.com** and use the code **2523 2024**

Do you agree with the components listed? If not, please tell us what you would improve and why:

5 Answers

Mentimeter

Nothing to add	I agree	Yes
.	120/208 and 277/480V needs to be added	

Incremental Per Unit Cost

Incremental First Cost (2026 PV$)	
Material	$89
Installation	$109
Total	**$198**

Incremental Retrofit Cost Savings (2026 PV$)	
Material	$146
Installation	$332
Total	**$478**

No incremental maintenance costs

Data is presented for Climate Zone 12

Climate Zone specific data is presented on the following slide

Cost Effectiveness

Climate Zone	Incremental First Cost (2026 PV$)	Incremental Retrofit Cost Savings (2026 PV$)	Incremental Net Cost (2026 PV$)	Cost Effective?
1	$ 188	$ 461	$ (273)	YES
2	$ 228	$ 581	$ (353)	YES
3	$ 213	$ 536	$ (324)	YES
4	$ 229	$ 580	$ (351)	YES
5	$ 228	$ 571	$ (343)	YES
6	$ 192	$ 464	$ (272)	YES
7	$ 193	$ 466	$ (273)	YES
8	$ 190	$ 461	$ (271)	YES
9	$ 189	$ 460	$ (271)	YES
10	$ 191	$ 463	$ (272)	YES
11	$ 193	$ 470	$ (277)	YES
12	$ 198	$ 478	$ (281)	YES
13	$ 196	$ 474	$ (277)	YES
14	$ 187	$ 457	$ (269)	YES
15	$ 187	$ 457	$ (269)	YES
16	$ 192	$ 469	$ (278)	YES

Discussion and Next Steps

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Central Heat Pump Water Heater Electric Ready

Codes and Standards Enhancement (CASE) Proposal
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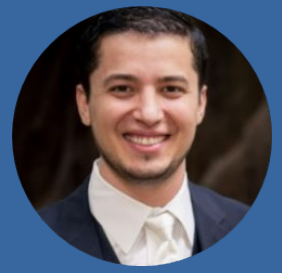

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Code Change Proposal

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Proposed Code Change

This mandatory proposal would make future retrofits from gas or propane central water heaters to central heat pump water heaters (HPWH) more technically and financially feasible. It applies to **new projects with central gas water heaters**.

- Retrofitting to HPWH can be technically challenging in existing buildings
- New construction would include the infrastructure required to enable the retrofit to central HPWH in the future

Draft Code Change Language

2022

No Requirements

Proposed 2025

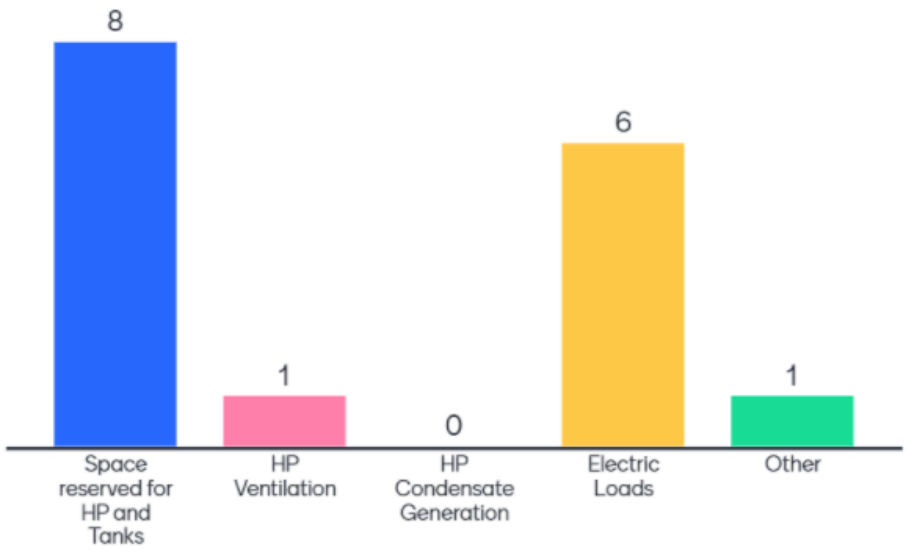
Title 24 Part 6, Section 160.9(e)

- Space reserved for HP and tanks
- Plan for HP ventilation
  - Can be located outside, or
  - Reserve space for ducting and plan for envelope penetrations
- Plan for HP condensate generation
- Plan for electrical loads
  - HP
  - Temperature Maintenance Tank
- Can be sized based on code prescribed factors, or design team can design the future heat pump system

Poll

Go to **www.menti.com** and use the code **2523 2024**

Which components do you think are neccessary for Central HPWH Electric Readiness. Select all that apply:



Code Prescribed Sizing Factors

Sizing Factors (<200 MBH Gas or Propane Input)	Minimum Requirement
Heat Pump – Physical Space*	2.0 sq. ft. per 10 MBH gas or propane input
Tank – Physical Space	4.4 sq. ft. per 10 MBH gas or propane input
Heat Pump - Air Flow	70 CFM per 10 MBH gas or propane input
Heat Pump - Tons of Refrigeration for Condensate Pipe Sizing	0.2 tons refrigeration per 10 MBH gas or propane input
Heat Pump – Electrical	0.1 kVA per 10 MBH gas or propane input
Temperature Maintenance Tank – Electrical	1.0 kVA per 10 MBH gas or propane input

Sizing Factors (>= 200 MBH Gas or Propane Input)	Minimum Requirement
Heat Pump – Physical Space*	3.6 sq. ft. per 10 MBH gas or propane input
Tank – Physical Space	3.6 sq. ft. per 10 MBH gas or propane input
Heat Pump - Air Flow	420 CFM per 10 MBH gas or propane input
Heat Pump - Tons of Refrigeration for Condensate Pipe Sizing	0.7 tons refrigeration per 10 MBH gas or propane input
Heat Pump – Electrical	1.1 kVA per 10 MBH gas or propane input
Temperature Maintenance Tank – Electrical	0.6 kVA per 10 MBH gas or propane input

To ensure adequate service and air flow clearance, minimum linear dimension of space reserved shall be

- 48” for systems < 200 MBH gas or propane input
- 84” for systems >= 200 MBH gas or propane input

Poll

Go to **www.menti.com** and use the code **2523 2024**

Are there any questions about the prescribed sizing factors? **3** Answers

Mentimeter

If a building is using solar thermal, is there a way to account for that in terms of sizing an ASHP?

NA

Ensuring that capacities are adequate when replacing gas systems

Summary of Stakeholder Feedback

- Summary of Feedback Received
- Measure Evolution
- Potential Barriers and Solutions

Summary of Feedback Received

We heard the following:

- **“The dimensional and air flow requirements are difficult to dictate with technology changing so quickly and there are over 100 new systems coming to the market this fall. How do we adapt to this new technology coming onto the market?”**

Our response was

- We acknowledge this as a challenge
- Reserving adequate space for the heat pump outdoors would go a long way to addressing this concern
  - This is easiest way to meet the proposed air flow requirements
  - There is adequate space to accommodate the HPWH tanks in a mechanical room designed for gas water heating equipment

Evolution of the Measure

- We originally proposed **one** set of prescribed sizing factors.
- Now proposing **two** sets of prescribed sizing factors to further address concerns about dimensional and air flow impacts
- We originally proposed that the main service, conduit from the main service to the central equipment, and the central equipment main panel, be sized for future HPWH electrical load
- Now proposing that only the building main service be sized for the future HPWH electrical load since
  - Specific details of the future HPWH layout are not known, and
  - We found that these items were not cost-effective for central HPWH

Cost Effectiveness and Energy Savings

Methodology and Assumptions

- Cost Impacts Methodology
- Cost Impact Results
  - Incremental costs
  - Cost Effectiveness

Incremental Cost and Future Cost Methodology

How we collected costs of base case technology and proposed technology:

- Experienced plumbing engineer provided basis of design (BOD) for HPWH design for the four prototypes
  - Input from Statewide CASE Team based on interviews with designers, design consultants, or contractors
  - Input from Statewide CASE Team based on market research
- Experienced electrical engineer provided basis of design (BOD) for electrical system design for the four prototypes
  - Electrical sizing did not change for the four prototypes, so cost data methodology is not applicable

Incremental Per Unit Cost

Over 20 Year Period of Analysis

There is no Incremental first cost, retrofit cost, or maintenance cost because there is no change to the required components for the prototype buildings.

Cost data includes:

- **Building Main Service**
  - **Main Service Conduit**
  - **Switchboard**
    - Pull Section
    - Main Breaker
    - Feeder Breakers
    - Utility Meters Section

Assume retrofit occurs at year 20

True for all 16 Climate Zones

Impact on EEEJ Citizens and Communities

- Increased installation costs may reduce housing affordability
  - Studies show that home purchase and rental prices are driven primarily by demand rather than cost inputs
  - Land costs and developer characteristics have the most significant effect on affordable housing costs.

- Electric ready measure benefits include
  - Future improved outdoor air quality due to elimination of on-site combustion for water heating
  - Future reduced risk of carbon monoxide hazards through removal of combustion appliances
  - Central HPWH is the last remaining equipment that provides a necessary (i.e. hot water is mandated by building code) service in MF buildings that is not required to be electric ready; as such, this measure has outsized potential to allow low-income residents to eliminate on-going costs related to gas or propane systems when performing future electrification retrofits.

Discussion and Next Steps

We want to hear from you!

- Provide **any last comments or feedback** on this presentation now verbally or over the GoTo Webinar Questions Pane
- More information on pre-rulemaking for the 2025 Energy Code at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2025-building-energy-efficiency

Comments on this measure are due by May 15, 2023. Please send comments to info@title24stakeholders.com and copy CASE Authors (see contact info on following slide).

Thank You

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