

Nonresidential HPWH Ventilation Clean-Up



Ryan Allen, James Haile, Marc Hoeschele, Russell Hedrick,
Keith Saechow, Frontier Energy.

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Draft CASE Report



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Authors:	Ryan Allen, James Haile, Marc Hoeschele, Russell Hedrick, Keith Saechow (Frontier Energy)
Project Support:	Joe Singer, Ben Lalor, Erica DiLello (Compliance Improvement Team)
Prime Contractor:	Frontier Energy
Project Management:	California Statewide Utility Codes and Standards Team: Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas & Electric Company

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Acronyms

Table 1 presents a list of acronyms used in this report. Title24stakeholders.com also maintains a [glossary of terms](#).

Table 1: List of Acronyms

Acronym	Definition
ACM	Alternative Calculation Method
ADA	Americans with Disabilities Act
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
ATT	Acceptance Test Technician
BCR	Benefit-to-cost Ratio
BEM	Building Energy Modeling
Btu	British Thermal Units
CALGreen	California Green Building Standards Code
Cal/OSHA	California Division of Occupational Safety and Health
CARB	California Air Resources Board
CASE	Codes and Standards Enhancement
CBSC	California Building Standards Commission
CBECC	California Building Energy Code Compliance Software
CCDEH	California Conference of Directors of Environmental Health
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CBO	Community-Based Organization
COP	Coefficient of Performance
CPUC	California Public Utilities Commission
CSE	California Simulation Engine
CTF	Conduction Transfer Functions
CZ	Climate Zone
DAC	Disadvantaged Community
DGS	California Department of General Services
DOAS	Dedicated Outdoor Air System
DOSH	Division of Occupational Safety and Health
ECC	Energy Code Compliance
EIR	Environmental Impact Report
EPIC	Electric Program Investment Charge

Acronym	Definition
ESJ	Environmental and Social Justice
FSOR	Final Statement of Reasons
GHG	Greenhouse Gas
GWh	Gigawatt-Hour
HVAC	Heating, Ventilation, and Air Conditioning
HPWH	Heat Pump Water Heater
IAQ	Indoor Air Quality
IDF	Input Data File
IECC	International Energy Conservation Code
IOU	Investor-Owned Utility
ISOR	Initial Statement of Reasons
Kg/s	Kilograms per Second
kWh	Kilowatt-Hour
kWh/year	Kilowatt-Hour Per Year
LED	Light Emitting Diode
LPD	Lighting Power Density
LSC	Long-term System Cost
MAEDdS	Modernized Appliance Efficiency Database System
MeasureSET	CASE Measure Savings Estimation Template
MG	Million Gallons of Water
NFA	Net Free Area
NPDI	Net Private Domestic Investment
PEP	Public Engagement Plan
PV	Present Value
SDD	Standards Data Dictionary
SME	Subject Matter Expert
SOC	Standard Occupational Classification
SPMS	Saturation Pressure Measurement Sensors
SRIA	Standardized Regulatory Impact Assessment
UEF	Uniform Energy Factor
UL	Underwriters Laboratories
W	Watt

1. Introduction

This is a draft report. The Statewide Codes and Standards Enhancement (CASE) Team encourages readers to provide comments on the proposed code changes and supporting analyses. The CEC will evaluate proposals that the Statewide CASE Team and other stakeholders submit and may revise or reject proposals. More information about the rulemaking schedule and how to participate in the process can be found on CEC’s 2028 code cycle website. Suggested revisions will be considered when refining proposals and analyses. The final CASE Report will be submitted to the CEC later in 2026.

For this report, the Statewide CASE Team is requesting input on the following:

- *Is the updated code language clear that both intake and exhaust ducts are needed when ventilating a HPHW to the outdoors?*
- *Are the estimates for the percentage of buildings that can implement dual ventilation ducts representative?*

Email comments and suggestions to info@title24stakeholders.com and rallen@frontierenergy.com. Comments will not be attributed to their authors unless these are publicly docketed or with permission of the contributor.

1.1 Report Context

This proposal describes specific energy efficiency code changes (referred to as “measures”) aimed at reducing wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. These measures are submitted to the California Energy Commission (CEC) for consideration and potential inclusion in California’s Energy Code (Title 24, Part 6), which sets statewide energy efficiency requirements for newly constructed buildings and for additions and alterations to existing buildings. Measures may also be considered for inclusion in CALGreen (Title 24, Part 11) as voluntary energy efficiency standards, which would take effect only if adopted by a local jurisdiction seeking to exceed the minimum requirements of the Energy Code. Measures submitted to the CEC will be reviewed, may be modified, and may be incorporated into a broader regulatory package proposed and adopted by the CEC. To be included in the Energy Code, proposed measures must be both cost-effective and technically feasible.

1.2 Proposal Sponsors

Three California Investor-Owned Utilities (IOUs) — Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison sponsored this effort as a

group. Where the term, “Statewide CASE Team” is used in this report, it refers to the authors of the CASE report and the Codes & Standards programs of the supporting California Investor-Owned Utilities.

1.3 Stakeholder Engagement to Inform Proposal

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with many industry stakeholders including the California Energy Commission (CEC), utilities (PGE, SCE, and SDG&E), plumbers, contractors, electricians, subject matter experts (SMEs), and the compliance improvement team. This proposal incorporates the following:

- On October 23, 2025, the Statewide CASE Team held a public stakeholder workshop that included survey questions.
- From September 20, 2025, through November 3, 2025, the Statewide CASE Team distributed an online survey to plumbers and program managers.
- From October 30, 2025, through December 12, 2025, the Statewide CASE Team distributed an online survey to public stakeholders via email, LinkedIn, the Title 24 Stakeholder website, stakeholder webinars, and targeted personal outreach. Maintenance personnel, engineers, and designers provided survey feedback.
- In January of 2025, the Statewide CASE Team subject matter experts working with HPWHs in food service applications shared HPWH implementation feedback.

Key takeaways from stakeholder outreach and stakeholder meetings include:

- 1) The HPWH Ventilation Clean-Up topic is a high priority among HPWH topics proposed during measure selection.
- 2) A maximum duct length requirement is needed if there is a diameter requirement for HPWH’s with axial fans.
- 3) There will be no new compliance implementation cost by the state for this measure since it is a small change to 2025 code requirements. This update will be included as part of the standard new code roll out education.
- 4) Without the proposed code change, there may be negative impacts to the uptake of HPWHs in nonresidential buildings as a result of moisture and indoor air quality (IAQ) issues caused by a single duct connecting the HPWH intake to the outdoors while the exhaust vents into the HPWH room.
- 5) The survey of plumbers and program directors indicates that water heaters are typically being installed indoors. These water heaters are typically HPWHs installed without ducts. Installing HPWHs with ducts in new construction is almost always feasible, but retrofits are only sometimes feasible. Survey findings

indicate that the percentage of HPWH currently being installed in small rooms less than 700 square feet varies significantly from installer to installer. Some installers report that 5 to 10 percent of HPWHs are being installed in small rooms while others indicated that more than 75 percent of HPWHs are being installed in small rooms.

- 6) Three responses from a survey question presented during the stakeholder meeting on October 23rd, 2025, indicates that approximately eight percent of newly constructed quick service restaurants and small office buildings will implement a HPWH with either an intake duct or an exhaust duct. Four stakeholder survey responses indicate that it is uncommon (two percent on average) for water heater retrofits to be a HPWH with either an intake duct or an exhaust duct. Additionally, five stakeholder survey responses indicate that stakeholders expect quick service restaurants are twice as likely to install a HPWH with an intake or exhaust ducts than small offices.
- 7) Nine responses from a group of operation and maintenance personnel, engineers, and designers also indicate that it is uncommon for water heater retrofits to be a HPWH with either an intake duct or an exhaust duct. Responses from this this same group indicate that it is also uncommon (two percent on average) for water heater retrofits to have both intake and exhaust ducts.
- 8) Discussions with subject matter experts working with HPWHs in food service applications indicate that it is very uncommon (less than one percent) for water heater installations in new quick service restaurants to include consumer integrated HPWHs with an intake or exhaust duct.

See Appendix F for details on the Statewide CASE Team's stakeholder engagement.

2. Measure Description

This section provides a general description of the proposed HPWH ventilation clean-up measure for nonresidential buildings code measure in the following topics:

- Proposed Code Change
- Benefits of Proposed Change
- Background Information
- Modifications to the Energy Code Documents, and
- Measure Context

2.1 Proposed Code Change

This proposed code change would simplify the four existing unitary HPWH ventilation compliance pathways implemented in the 2025 code to make unitary HPWH installation decision making simpler, as well as improving consumer-sized HPWH performance in nonresidential buildings.

Under the 2025 code, allowed methods of providing ventilation air included those approved by the manufacturer, installing the HPWH in a large unvented room of minimum size, installing in a closet with minimum ventilation area to adjacent spaces via louvers or a duct, and directly ducting the unit to the outdoors or to an adjacent space. The Statewide CASE Team recommends improvements to this code language for clarity, and adjustments to requirements to reflect new research and better align with other codes in development.

This proposal also recommends eliminating the following from the 2025 code:

- Two ducting configurations:
 - Intake air ducted from outside with no exhaust duct, and
 - Exhaust air ducted to outside with no intake duct
- Two louvered wall/door ventilation configurations:
 - Louvered door/wall for the exhaust of the HPWH to the outdoors, and
 - Louvered door/wall for the exhaust of the HPWH to a communicating space.

Table 2 summarizes the scope of the proposed code change.

Table 2: Scope of Proposed Code Change

A indicates the proposed code change is relevant.

Building Type(s)	Construction Type(s)	Type of Change	
<input type="checkbox"/> Single Family	<input checked="" type="checkbox"/> New Construction	<input checked="" type="checkbox"/> Mandatory	
<input type="checkbox"/> Multifamily	<input checked="" type="checkbox"/> Additions	<input type="checkbox"/> Prescriptive	
<input checked="" type="checkbox"/> Nonresidential	<input checked="" type="checkbox"/> Alterations	<input type="checkbox"/> Performance	
Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals
Climate Zones 1-16	<ul style="list-style-type: none"> Part 6, Section 110.3(c)7 	CEC-NRCC-PLB-E row 22	N/A
Third Party Verification)		Updates to Compliance Software	
<input checked="" type="checkbox"/> No changes to third party verification		<input type="checkbox"/> No updates	
<input type="checkbox"/> Update existing verification requirements		<input checked="" type="checkbox"/> Update existing feature	
<input type="checkbox"/> Add new verification requirements		<input type="checkbox"/> Add new feature	

2.2 Benefits of Proposed Change

The proposed code change will decrease moisture damage risk, air quality issues and space conditioning load impacts.

Typical unitary HPWH’s, installed and vented within conditioned spaces provide minimal impact on space conditioning loads when the space is 450 cubic feet or larger. However, ducting only the HPWH inlet or exhaust to outside can negatively impact IAQ and increase heating and cooling load (ENERGY STAR n.d., Klein 2025).

A HPWH with minimal airflow restrictions typically moves 176 CFM of air across the evaporator coil,¹ but some models can bring in as much as 475 cfm (C. Colon 2013). This HPWH airflow would depressurize or pressurize the HPWH room depending on whether the HPWH has only one exhaust duct or one intake duct connected to the outdoors. In addition, some installation practices can lead to increased moisture damage risk which is a health and safety concern. These installation practices include placing the outlet of the HPWH too close to other surfaces, inappropriately sized and uninsulated ducting, and using louvered a door/wall for the exhaust of HPWHs. Updated code language in this measure would reduce moisture damage risk, IAQ issues, and health and other safety concerns.

¹ Larson, Larson and Gantley, Code Readiness: Laboratory Testing of Heat Pump Water Heater Performance: Impact of Airflow and Space Conditioning 2023

2.3 Background Information

Consumer integrated heat pump water heaters are defined under U.S. DOE CFR 431 as HPWHs with storage volumes of 120 gallons or less with an electrical input of less than 24 amps at less than 250 volts. The 2025 California energy code defines integrated heat pump water heater as “a HPWH that has all components, including fans, storage tanks, pumps, or controls necessary for the device to perform its function contained in a single factory-made assembly.” This report will use the generic HPWH term, but the proposed code language will use the more formal “consumer integrated HPWH” terminology.

HPWHs are an efficient water heating appliance utilizing a refrigeration cycle (compressor, heat exchangers, working fluid, and a fan). The fan pulls in air (either from the surrounding environment or from a duct) to transfer heat to water inside the storage tank. HPWH compressor operation is two to three times more efficient than using the resistive electric element, common to 208/240V HPWHs to provide supplemental heating under high load events. Maximizing HPWH compressor operation is the goal to increase HPWH efficiency within the California Title 24, Part 6 code. In addition, maximizing HPWH compressor operation results in lower peak winter morning electrical demand, as the compressor draws roughly one-eighth the demand as an electric resistive element.

The fan used to pull air across the condenser heat exchanger in HPWHs can be an axial fan or a centrifugal fan. Axial fans look like a propellor with fan blades that extend out from the center of the fan. Centrifugal fans look like a mouse’s running wheel with fan blades that extend away from a back plate, see Figure 1. Axial fans can move large volumes of air efficiently, but they are not ideal for ducted applications with high static pressure as airflow decreases quickly with increasing back pressure. Centrifugal fans are good for high static pressure duct applications and are quieter than axial fans but are less efficient and typically more expensive (AS Engineers n.d.).



Figure 1. Example of an Axial Style Fan (left) and a Centrifugal Style Fan (right).

Source: (CFM Continental Fan n.d., PBM n.d.)

HPWHs are installed in different configurations with either no ducts, one duct, or two ducts (i.e. “fully ducted”), see Figure 2. Ducts are used to connect the intake and/or exhaust of the HPWH to the outside (duct crosses the building pressure boundary) OR connect to a larger interior space within the building (duct connects to a communicating interior space within the same pressure boundary).

If no ducts are used during the installation, then the size of the room must be larger than a certain size (450 to 700 cubic feet depending on the compressor size) to prevent the room from being excessively cooled by the HPWH exhaust air. HPWH efficiency decreases by 6 to 54 percent in these small closet cases without proper ventilation, see Appendix A for more information.



Figure 2. Example of a HPWH with No Ducts (left), One Duct (center) and Two Ducts (right) Also Known as Fully Ducted.

Source: (Home Depot n.d., San Jose Clean Energy n.d., Arctic Heat Pumps n.d.)

The [2025 Multifamily Domestic Hot Water CASE report](#) involved updating Section 110.3 of the 2025 Energy Code to include ventilation requirements for HPWHs. Allowed methods of providing adequate ventilation included those approved by the manufacturer, installing the HPWH without any additional ducting in a large unvented room larger than a defined minimum size, installing the HPWH in a room less than the defined size mentioned above with the addition of louvers in the wall or door large enough to provide the minimum net free area (NFA) for ventilation, and installing the HPWH with ventilation ducts on the intake or exhaust side of the heat pump. With this proposal, the Statewide CASE Team recommends improvements to existing code language for clarity to better reflect new research and align with other codes in development.

This CASE measure proposal for the 2028 code cycle recommends elimination of two currently allowed ducting configurations and two louvered wall/door configurations:

- Two ducting configurations:
 - Intake air ducted from outside with no exhaust duct, and
 - Exhaust air ducted to outside with no intake duct
- Two louvered wall/door ventilation configurations:
 - Louvered door/wall for the exhaust of the HPWH to the outdoors, and
 - Louvered door/wall for the exhaust of the HPWH to a communicating space

The two ducting configurations interfere with the operation of balanced and central indoor ventilation systems and increase space conditioning loads. The two louvered wall/door ventilation configurations cause a risk of moisture damage.

2.4 Modifications to Energy Code Documents

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 7: Proposed Language of this report for detailed revisions to code language.

2.4.1 Energy Code Change Summary

Modifications to Title 24, Part 6 are summarized in this section.

SECTION 110.3 – MANDATORY REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT

Subsection 110.3(c)7B: The proposed regulations have been separated into Residential and Nonresidential to keep the requirements clear for each. Section 7B keeps the same code language that was implemented in 2025 for residential buildings.

Subsection 110.3(c)7C: Section 7C is a modified version of 7B that is proposed to be added below the residential section to clarify ventilation options for integrated HPWHs in nonresidential buildings. This language will require both intake and exhaust ducts instead of either an intake OR an exhaust duct that crosses pressure boundary to the outdoors. This requirement cost-effectively increases the stringency of the Energy Code, thereby minimizing the energy use of nonresidential buildings and maintains the pressure balance and indoor air quality (IAQ) of the room that the HPWH is located, which in turn improves the state's economic and environmental health. Intake and exhaust duct configurations and exhaust only duct configurations where the duct connects to another space can still be used if there are louvers in the room that connect it to a communicating space, but the single duct cannot be used when connected to the outdoors.

2.4.2 Reference Appendices Change Summary

There are no proposed changes to the reference appendices.

2.4.3 Compliance Manuals Change Summary

There are no proposed changes to the compliance manuals.

2.4.4 Alternative Calculation Method Reference Manual Change Summary

There are no proposed changes to the alternative calculation method reference manual.

2.4.5 Compliance Forms Change Summary

The check box in the CEC-NRCC-PLB-E-22 compliance form in row 22 dropdown should be updated with a new ventilation options list proposed for the 2028 code to reflect updates to section 110.3(c)3 for nonresidential buildings, see Figure 3.



Multifamily Water Heating Equipment Serving Individual Dwelling Units- §170.2(d)1, §180.2(b)3C

Equipment Type (select all that apply):		
System Name:		
16	<input type="checkbox"/>	Gas/propane instantaneous water heater with input rating ≤ 200,000 BTUH and no storage tank. Note: Cannot comply using the prescriptive path with a storage tank per Exception 1 §170.2(d)1 (New Construction and Additions Only)
	<input type="checkbox"/>	A single 240-volt heat pump water heater serving the dwelling unit. (New Construction and Additions Only, §170.2(d)1A)
	<input type="checkbox"/>	A single 120-volt heat pump water heater serving a dwelling unit with 1 bedroom or less. (New Construction and Additions Only, Exception 2 to §170.2(d)1)
	<input type="checkbox"/>	A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher (§170.2(d)1B or §180.2(b)3).
	<input type="checkbox"/>	A single heat pump water heater with storage tank located in the garage or conditioned space and be placed on an incompressible, rigid insulated surface with minimum R-10. The water heater shall be installed with a communication interface that meets either the requirements of 110.12(a) or has an ANSI/CTA-2045-B communication port. (Alterations Only)
	<input type="checkbox"/>	If the existing water heater is an electric resistance water heater, a consumer electric water heater. (Alterations only, §180.2(b)3)
17	<input type="checkbox"/>	Replacement or altered gas or propane water heater (Alterations only, §180.2(b)3c)

Water Heating Equipment All Occupancies - §110.3(c)3, §140.5(a)

	Yes	No	NA	Requirement
System Name:				
18	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Unfired storage tank insulation shall have Internal + External ≥ R-16 OR External ≥ R-3.5. Label required per §110.3(c)3
19	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	New state buildings 60% of energy for service water heating from site solar energy or recovered energy per §110.3(c)5
20	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Isolation valves for instantaneous water heater with input rating > 6.8 kBTUH or 2 kW has been specified per §110.3(c)6
21	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	School buildings < 25,000ft ² and < 4 stories must install a heat pump water heating system per §140.5(a)1. Water heating systems serving an individual bathroom space may be an instantaneous electric water heater.
Air-Source Heat Pump Water Heaters (HPWHs) (§110.3(c)7)				
22	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Backup heat is required when inlet air is unconditioned unless the compressor cut-off temperature is below the Heating Winter Median of Extremes for the closest location listed in Table 2-3 from Reference Joint Appendix JA2.
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Consumer integrated HPWHs shall meet one of the following ventilation requirements: Dropdown

Figure 3. CEC-NRCC-PLB-E Compliance Form Section for Water Heating Equipment All Occupancies Row 22 Requires that the Ventilation Option for Consumer Integrated HPWH Installation to be Selected.

2.5 Measure Context

This measure would clarify requirements for nonresidential HPWH ventilation in small spaces within nonresidential buildings by removing the single-duct installation option when connecting to the outdoors and establishing a minimum duct diameter and effective duct length for axial-fan units. Comparable codes or standards that specify HPWH ducting configurations are limited in detail and do not provide mandatory requirements specific to HPWHs, see section 2.5.1. This proposal addresses installation and ventilation practices and would not interfere with other codes and standards.

2.5.1 Comparable Model Codes or Standards

There are no directly comparable model code requirements that prescribe HPWH ducting for nonresidential spaces. ASHRAE 62.1 establishes space-level IAQ and ventilation criteria but does not prescribe equipment-specific HPWH ducting (ASHRAE 2022).

Nonregulatory guidance aligned with this measure includes ENERGY STAR®'s "Heat Pump Water Heater Design Considerations", which warns against ducting only the intake or exhaust due to pressure imbalances: "Do not duct only the Heat Pump Water Heater intake air or exhaust air to the outside. Doing so will create a pressure imbalance that will lead to air infiltration or exfiltration, increasing the load on the space heating and cooling systems" (ENERGY STAR n.d.). The proposed changes are consistent with this guidance in that they prohibit single-duct configurations that connect to the outdoors.

2.5.2 Interactions with Other Regulations

There are no federal, state, or local regulatory requirements that explicitly require or prohibit HPWH ducting and ventilation requirements in small nonresidential spaces.

3. Compliance and Enforcement

This section details the compliance and enforcement evaluation of the proposed code measure for HPWH ventilation clean-up for nonresidential buildings with following topics:

- Compliance Considerations
- Impact on Market Actors
- Compliance Software Updates, and
- Cost of Enforcement

3.1 Compliance Considerations

The compliance forms for water heaters were updated in 2025 code to provide ventilation compliance path options for HPWH implementation. Under this 2028 code change proposal, only the certificate of compliance form in CEC-NRCC-PLB-E row 22 would be updated to reflect the updated ventilation compliance options for HPWHs in nonresidential buildings established in this document. The compliance form process has not changed from the 2025 code cycle, therefore there is little extra burden to the compliance team.

The feasibility of compliance is high because there are still multiple compliance approaches that can be selected for the specific HPWH installation space type and project type. Installations that would have used one duct to comply with 2025 code would require two ducts to comply with this 2028 code change proposal and this will have minimal effect on the feasibility of installation. Feasibility will decrease slightly for installations that would have used a fully louvered door, upper and lower louver, and upper louver with a door undercut because these will now require an exhaust duct to be installed which requires enough space to run the duct, making a hole in the wall, and having some free space for the exhaust air to travel before reaching nearby surfaces.

3.2 Impact on Market Actors

Market actors were introduced to the idea of HPWH ducting in the 2025 code. This proposal aims to further refine the 2025 code in the name of improved efficiency, less space conditioning load impacts, and improved IAQ. The most impacted market actors are designers and installers. Builders, code officials, are less impacted. Table 3 summarizes the impacts on market actors and suggests outreach and education that might be helpful to support those market actors as they prepare for the effective date of the requirements.

Table 3: Impacts on Market Actors and Suggested Training and Education Opportunities

Market Actor	Impact(s)	Suggested Outreach and Education
Builders^a	Require installing ducting, couplers, and vents through interior or exterior walls when a HPWH is installed in a small space and an intake wall/door louver is not implemented.	Send a newsletter/email announcement of new requirements and/or webinar/video to design professionals to raise awareness of installation best practices for updated HPWH ventilation compliance options and associated benefits. Ongoing communication could also be used to share this information via trade organizations and publications.
Design Professionals^b	Require plans to include two ducts versus one for HPWHs in small spaces exchanging air with the outdoors and an exhaust duct when connecting a small space to a communicating space.	Send a newsletter/email announcement of new requirements and/or webinar to educate on best practices, need for the proposed change, and estimated cost for updated HPWH ventilation compliance options. Update compliance options CEC-NRCC-PLB-E-22 form with ventilation compliance options.
Construction Team^c	Require installing ducting, couplers, and vents through interior or exterior walls when a HPWH is installed in a small space and wall/door louvers are not implemented.	See Builders section above.
Building Departments^d	Being aware of code change and benefits.	Send a newsletter/email announcement of new requirements and/or webinar to educate on benefits including energy savings, improved air quality (no airborne particulate, gases or contaminants from outdoors), reduced moisture risk and even balanced pressure in the room.
Verification Testers^e	No changes from 2025 code cycle	No changes from 2025 code cycle
Building Owners, Managers, and Occupants	Being aware of code change and benefits when planning projects.	See building departments section.
Manufacturers and Distributors	Being aware of code change and updating installation options in product literature to align with CA requirements.	Provide publicly available updated requirements and send a newsletter/email announcement of new requirements and/or webinar to communicate best practices and need for the proposed change.

a. Builders include builders and developers.

- b. Design professionals include architects, interior designers, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.
- c. Construction team includes general contractors, design-build contractors, installation subcontractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.
- d. Building departments include plan reviewers, building inspectors, specialty inspectors, permit counter technicians and sustainability department staff.
- e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The 2028 CASE Methodology Report presents a quantitative assessment of how changes to the California building code impact builders, building designers, and energy consultants, and building owners and occupants. The analysis in the methodology report is not specific to the code change presented in this report. The following provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

This code change is not expected to change the workflow of current market actors, compliance processes or additional skills required for achieving compliance.

Builders. The proposed change would likely affect residential and/or commercial builders; however, it would likely not impact firms focused on the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction. The proposed change would not affect all firms and workers in the residential and commercial building industries equally; instead, it would primarily affect specific subsectors within the industry. Table 4 shows the commercial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report.

Table 4: Specific Subsectors of the California Commercial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)

Construction Subsector	Establishments*	Employment	Annual Payroll (Billions \$)
Commercial Building Construction	5,491	87,450	\$10.6
Nonresidential Plumbing & HVAC Contractors	2,270	55,182	\$5.8

Source: Analysis by the Title 24 CASE Team of QCEW data from the California Employment Development Department <https://labormarketinfo.edd.ca.gov/cgi/dataanalysis/areaselection.asp?tablename=industry>

*An establishment is single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. <https://www.bls.gov/opub/hom/cew/concepts.htm>

Construction Team. The proposed change would affect the construction team because they will need to know how to install HPWH ventilation ducts to comply with the code.

Design Professionals. The proposed change would affect design professionals because they will need to understand the code change to specify the appropriate ventilation for the application and design ducting configurations.

Building Departments. Building departments will need to understand compliance requirements and benefits of the code, see Building occupants (owners and tenants).

3.3 Compliance Software Updates

This code change in CBECC is low priority compared to prescriptive and high energy impact measures. CBECC could be updated and would need additional functionality to quantify pressure imbalances for single duct HPWH systems and additional analysis nodes are needed to quantify airflow, HPWH inlet and outlet temperatures, and IAQ parameters.

3.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

The real training and educational cost for authorities having jurisdiction (AHJs) is not insignificant across all 2029 energy code updates for this code cycle, however the costs relating to this HPWH ventilation proposal are minor. There are no proposed enforcement changes for this measure and education for stakeholders will be satisfied with newsletters/email announcements that are part of every code's update outreach and education activities. Education will need to cover the topics listed in Section 3.2 to ensure that all market actors understand the benefits and requirements for implementing the updated HPWH ventilation guidelines. The primary cost associated with implementing this code measure will be time associated with summarizing this information in slides and flyers, as well as some effort to host webinars to share the proposed changes.

4. Market and Economic Analysis

This section details the market and economic analysis evaluation of the proposed HPWH ventilation clean-up measure with the following topics:

- Market and Economic Analysis
- Design and Construction Practices
- Energy Equity and Environmental Justice Impacts
- Impacts on Jobs and Businesses, and
- Economic and Fiscal Impacts

4.1 Market Structure and Availability

This section details the market structure and market challenges for HPWHs and HPWH ventilation ducts in 2025.

4.1.1 Current Market Structure and Availability

As mentioned in the [2025 Multifamily DHW Title 24 CASE report](#), the consumer integrated HPWH market is comprised of over 100 HPWH models certified by the CEC (and listed in the MAEDbS) and over 200 HPWH models certified by ENERGY STAR. All of these models can be ducted and have minimum ventilation requirements defined in their specification sheets. HPWHs and components to duct these HPWHs are commonly stocked items at local retailers like Home Depot, Lowes and HD Supply, and warehouses like Supply House and Grainger. The commonly stocked products include 6- inch to 20-inch flexible ventilation ducts, band clamps or tape for ducts, couplers, and duct hanger straps. Although couplers that connect HPWHs ducts are available from major HPWH manufacturers (Rheem, Rinnai, AO Smith, Bradford White, LG, GE, and Bosch), they typically have a ten-day lead time. Two manufacturers provide integrated couplers for quick duct implementation. In addition to market actors listed in Section 2.2.2, manufacturers and suppliers of ducts, hanger brackets, couplers, tape, and vents are affected by this code change.

4.1.2 Market Challenges and Solutions

The primary market challenges for HPWH ducts include added cost, unfamiliarity with ducting, code clarity, coordination between trades/sub, product fit, and market acceptance. Each challenge is described below.

- **Cost.** Adding a second duct or building a vented enclosure can add labor and material costs for building owners. The solution to this market challenge is to

require dual duct installation, which will increase product sales and reduce costs. See section 5 about installation costs.

- **Unfamiliarity.** Many installers have limited experience with dual-duct configurations or the 2025 ventilation requirements. The solution for this market challenge is to survey installers and designers to document current practice, then educate them via newsletter/email announcements with links to webinars/videos that discuss the best practices in more detail during the 2028 code language roll out to ensure that the installation of ducting is a familiar practice. The difference between single duct and dual duct installation primarily involves accommodating the added duct and wall penetration.
- **Code Clarity.** Some 2025 language has been read inconsistently. In Title 24, Part 6: 110.3(c)7B4iv says: “With a ducted inlet, the minimum NFA shall be equal to the cross-sectional area of the duct. With a ducted exhaust, the minimum NFA shall be the larger of 20 square inches or the minimum NFA provided by the manufacturer for this method.” The duct selection options are confusing because the language can lead to three different net free area targets. The solution for this market challenge is additional education (via newsletter/email announcements with links to webinars/videos that discuss the best practices in more detail) to clarify terms like communicating space, NFA, and pressure boundary, to remove the single-duct options that drive infiltration, and to clarify the requirements for both connection sealing and insulation in the updated code language.
- **Product Fit.** Many consumer integrated HPWHs are not shipped with dual-duct accessories by default. The solution for this market challenge is to review manufacturer and retailer offerings to understand available kits, axial vs centrifugal fan airflow delivery capabilities, and recommended duct sizes to streamline the procurement process.
- **Market Acceptance.** Market acceptance of HPWHs may be impacted due to air quality, room pressure imbalance, and condensation issues with single duct options allowed in 2025 code. Single duct configurations can result in moisture damage to small rooms over time and negative user experiences with HPWHs as a technology. The solution for this market challenge is to share lab and field findings on airflow, pressure balance, and IAQ with designers, installers, manufacturers and raters via a newsletter/email announcement with a link to a webinar/video summarizing how the updated code reduces these issues using the dual duct approach when connecting the HPWH to the outdoors. The Statewide CASE Team also invites stakeholder input on where training or exceptions are most needed.

HPWHs have been widely available in the market for over a decade. As a result of programs like [TECH Clean California](#), Home Electrification, and Appliance Rebates

([HEEHRA](#)) rebates, [SMUD Home Performance Program \(HPP\)](#), and the [Golden State Rebates program](#), which have been developed to increase adoption and provide education of HPWHs, market awareness of the technology is growing.

See Section 3 for a description of workforce training that may be needed to ensure effective design, installation, and commissioning.

4.2 Design and Construction Practices

This section details design and implementation practices, health and safety considerations, and other implementation challenges associated with HPWHs and HPWH ventilation ducts in 2025.

4.2.1 Current Design and Construction Practices

Current design and construction practices include installing the HPWH in a room larger than the minimum volume (450 cubic feet to 700 cubic feet depending on the compressor size), installing a HPWH in a small room with louvered doors, ventilation grills, and door undercuts with a minimum NFA for air to pass through from the HPWH room to another connecting space, and installing the HPWH in a room of any size with either an intake duct, exhaust duct or both. Based on feedback collected during the October 23rd, 2025 stakeholder meeting, and based on a survey of utility program managers and installers, more than 92 percent of HPWH installations in nonresidential buildings in the past 12 months were installed without any ducts. Because the 2025 code language was put into effect six months before this draft report, it is assumed that a limited number of HPWHs were installed with ducts before 2025. An unducted HPWH provides good performance when the HPWH is installed in a room larger than the recommended minimum (450 to 700 cubic feet). It is possible for a HPWH to deliver energy efficient performance when properly installed in small rooms if connected to an adjacent space with adequate volume using one duct or via louvers doors or walls, however, locating the outlet of the HPWH's exhaust too close to nearby surfaces can cause condensation and water damage.

4.2.2 Health and Safety Considerations

The proposed code change is expected to improve the health and safety of HPWH installations in small rooms by preventing outside air from being drawn into the HPWH room due to pressure imbalances (Klein 2025). Air from the outdoors can carry moisture, particulates, gases, and bacteria into the building. By requiring the second HPWH duct, the outdoor air is exhausted to the outdoors instead of indoors. With a closed system, moisture will be condensed and drained through the condensate line. The dual duct configuration will keep the air quality of the room consistent as it would be without the HPWH. In addition, the dual duct configuration maintains a neutral room

pressure resulting in minimized air transfer between the HPWH room and connected rooms and outdoors. One consideration is that wall intake and exhaust vents and couplers exiting the building envelope will need to be sealed to prevent air and water ingress from the outdoors. In addition, HPWHs without an exhaust duct in small spaces that have a louvered wall/door can blow cold exhaust air onto other surfaces which could lead to condensation and moisture concerns.

4.2.3 Design and Construction Challenges and Solutions

Design and construction challenges remain the same as the 2025 energy code. It is important to consider intake and exhaust port locations on HPWHs when locating the HPWH in the room to minimize bends in the ductwork, since bends add significant pressure drops. Using flexible duct instead of rigid duct increase. Restricting HPWH airflow across the coil could result in a 36 percent lower COP, more details are provided in Appendix A.

See Table 3 in Section 3.2 for a description of workforce training that could support effective design, installation, and commissioning.

4.3 Energy Equity and Environmental Justice

The American Lung Association study titled “State of Air 2025” indicates that disadvantaged communities are also more susceptible to health impacts (American Lung Association 2025). Ingress of this polluted outdoor air into buildings can have.

California cities constitute several of the top 25 most polluted air areas of the United States in three different categories including 1) Ozone where 8 of 25 locations are in CA, 2) Daily Particulate Mass (PM) where 8 of 25 locations are in CA, and 3), Annual PM where 7 of 25 locations are in CA (American Lung Association 2025). Most of these California locations are in disadvantaged communities based on a review of the [CalEnviroScreen](#) website and California Environmental Protection Agency (CalEPA) [Senate Bill \(SB\) 535 Disadvantaged Communities](#) interactive map tool. These sources indicate that buildings in disadvantaged communities in general are more likely to be in areas of low air quality too.

Applying dual duct HPWHs will improve the health, safety, and comfort of low-income nonresidential buildings and reduce unexpected costs for moisture damage as a result of implementing HPWHs with improper ventilation like a single intake duct to the outdoors. Installing a second duct does result in a higher first costs which may negatively affect low-income communities initially, but higher frequency implementation of dual duct systems will lead to lower costs. Nonresidential building owners and tenants will benefit from reduced electricity bills also.

The Statewide CASE Team evaluated the potential impact on environmental and social justice (ESJ) communities,² including impacts related to race, class, and gender.

The Statewide CASE Team identified potential impacts of the proposed code change via research and stakeholder input. While the listed potential impacts should be comprehensive, they may not yet be exhaustive. Recognizing the importance of engaging ESJ communities and gathering their input to inform the code change process and proposed measures, the Statewide CASE Team is working to build relationships with community-based organizations (CBOs) to facilitate meaningful engagement. Please reach out to rallen@frontierenergy.com if you have input on how this proposal may impact ESJ communities or if you would like to offer your perspective.

4.4 Impacts on Jobs and Businesses

This section will be completed for the Final CASE Report.

4.5 Economic and Fiscal Impacts

This section will be completed for the Final CASE Report.

² The CPUC refers to ESJ communities as “low-income or communities of color that have been underrepresented in the policy setting or decision-making process, are subject to a disproportionate impact from one or more environmental hazards, and likely to experience disparate implementation of environmental regulations and socio-economic investments in their communities” (CPUC 2022). ESJ communities also include the CPUC definition for Disadvantaged Communities, which comprises “(1) Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0 (1,984 tracts); (2) Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps, but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores (19 tracts); (3) Census tracts identified in the 2017 DAC designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0 (307 tracts); and (4) Lands under the control of federally recognized Tribes (OEHHA 2022).

5. Cost Effectiveness

This section details the cost effectiveness evaluation of the proposed HPWH ventilation clean-up measure for the following topics:

- Cost Effectiveness Methodology
- Energy and Energy Cost Savings Results
- Incremental First Cost
- Incremental Maintenance and Replacement Cost, and
- Cost Effectiveness

Enforcement practices are the same as the 2025 code. The primary impact is the need for education of enforcement officials on the code change which is expected to be included in the standard new code cycle education materials so there is no added enforcement cost.

5.1 Cost Effectiveness Methodology

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost inclusion parameters. The 2028 CASE Methodology Report and Appendix B provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on Long-term System Cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code. The analysis excludes design costs and incremental code compliance verification costs.

5.2 Energy and Energy Cost Savings Results

Energy and energy cost savings were calculated for this measure using CBECC models that were minimally compliant with the 2025 Title 24 requirements. These models were adjusted to include a HPWH, then modified and analyzed with EnergyPlus software.

The Statewide CASE Team iterated through small office and quick service restaurant building models in CBECC to select appropriate consumer integrated HPWH sizes to meet the hot water demand requirements of buildings in Climate Zone 12. Parameters selected after iterating through the HPWH sizes include the following:

- HPWH type: Integrated
- HPWH Capacity: One 50 gallon tank for small offices and two 80 gallon tanks for Café buildings within the quick service restaurant building category
- UEF³: 3.62
- Power: 380W
- First Hour Rating: 63 gallons for small office building and 87 gallons for quick service restaurants

A review of ENERGY STAR Certified HPWHs and the [MAEDbS](#) provided average values used to define the model criteria listed above, see Table 5.

Table 5: Summary of Average HPWH Storage Tank Size, First Hour Rating and UEF for Given HPWH Tank Size Filter Criteria for HPWHs on the ENERGY STAR Certified List and MAEDbS Database.

Source	HPWH Storage Tank Range Filter (Gal)	HPWH Storage Tank size (Gal)	Average [Median] First Hour Rating (Gal)	Average [Median] UEF
ENERGY STAR Certified HPWHs	46 to 53	50	63.5 [66.0]	3.51 (3.46)
MAEDbS Database	46 to 53	50	63.2 [65.0]	3.46 (3.68)
ENERGY STAR Certified HPWHs	59 to 74	65	78.7 (80.0)	3.77 (3.90)
MAEDbS Database	59 to 74	65	78.2 (80)	3.70 (3.70)
ENERGY STAR Certified HPWHs	75 to 83	80	90.6 (91.0)	3.62 (3.48)
MAEDbS Database	75 to 83	80	91.3 (92.0)	3.70 (3.88)

³ Uniform Energy Factor is a ratio of how much the HPWH heats the water and how much energy the HPWH uses.

Source	HPWH Storage Tank Range Filter (Gal)	HPWH Storage Tank size (Gal)	Average [Median] First Hour Rating (Gal)	Average [Median] UEF
ENERGY STAR Certified HPWHs	36 to 82	All	72.4 [69.00]	3.62 [3.68]
MAEDbS Database	36 to 82	All	72.2 [70.0]	3.67 [3.75]

Source: (ENERGY STAR n.d., CALIFORNIA ENERGY COMMISSION n.d.)

A UEF of 3.62 was chosen as a conservative value relative to the average for all HPWHs. In addition, the first hour ratings used in the analysis are slightly lower than the average in the table which will result in slightly more energy consumption than the average HPWH. A 380-Watt compressor correlates to approximately 160 CFM of airflow across the evaporator coil in CBECC version 2.0 Release Candidate (RC which is the newest testing version of CBECC) model which is in line with ventilation studies done by Larson Energy. At the time of this draft report, only one climate zone model was available in CBECC for each of the two buildings of interest (small office and quick service restaurants). The HPWH system was defined in CBECC for one climate zone for each building type, then exported as an IDF file to be analyzed in EnergyPlus.

EnergyPlus version 25 was used to import the building configurations, HPWH details, and weather data from the CBECC IDF file. Then the models were modified to include two analysis nodes. One node represented the intake air for the HPWH, and the other node represented the exhaust for the HPWH. Four ventilation configurations were modeled in EnergyPlus including:

1. Intake and Exhaust Duct to Communicating Space - Keep both intake and exhaust nodes for the HPWH connected to the indoor zone (temperature, humidity, latent gains, etc.) which is modeled as an unducted HPWH.
2. Single duct (intake only) – Set intake node air to match outdoor air conditions for intake duct (temperature, humidity, latent gains, etc.) but keep the exhaust node connected to the indoor zone. In addition, an intake fan is added to account for the airflow requirement between the outdoors and the indoor zone. This is the standard design for comparing other ventilation configurations.
3. Single duct (exhaust only) – Opposite of single duct (intake only).
4. Dual ducts (intake and exhaust to outside) - Set both the HP intake node and exhaust air to match outdoor air conditions for the intake duct (temperature, humidity, latent gains, etc.) but keep the tank inside the indoor zone.

Non-energy benefits associated with this code change include reduced moisture damage risk inside, improved indoor air quality by removing the ingress risk of airborne particulates, gases, and bacteria originating outdoors and exhausting into the room, and

neutral pressure balance in the room where the HPWH is installed. More details on the non-energy benefits are provided in Section 6.6.

Table 6, Table 7, and Table 8 present the first-year electricity, peak demand, and natural gas savings per climate zone. The LSC methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods. The peak power savings attributed to this code change is 126 Watts per HPWH or 0.023 Watts per square foot for small office buildings. Table 9 presents a breakdown of total first year source energy savings (kBtu) per square foot LSC savings. Table 10 presents total per square foot energy cost savings for newly constructed buildings and additions in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV\$) from electricity and natural gas cost savings for the prototypical building.

Table 6: First Year Electricity Savings (kWh) Per Square Foot – Nonresidential HPWH Ventilation Clean-up

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Small Office (Single Intake Duct vs Dual Duct)	0.21	0.21	0.19	0.21	0.17	0.14	0.14	0.14	0.16	0.16	0.24	0.22	0.21	0.20	0.12	0.52
Small Office (Single Exhaust Duct vs Dual Duct)	0.05	0.06	0.04	0.09	0.06	0.07	0.07	0.07	0.03	0.03	0.08	0.10	0.11	0.07	0.09	0.07
Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	0.10	0.12	0.10	0.12	0.09	0.08	0.08	0.08	0.09	0.09	0.14	0.13	0.13	0.13	0.08	0.16
Small Office (Average)	0.12	0.13	0.11	0.14	0.11	0.10	0.10	0.10	0.09	0.09	0.15	0.15	0.15	0.13	0.10	0.25
Quick Service Restaurant (Single Intake Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Average)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									

Table 7: First Year Peak Demand Reduction (W) Per Square Foot – Nonresidential HPWH Ventilation Clean-up

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Small Office (Single Intake Duct vs Dual Duct)	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.02	0.03	0.06
Small Office (Single Exhaust Duct vs Dual Duct)	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01
Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02
Small Office (Average)	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03
Quick Service Restaurant (Single Intake Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Average)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									

Table 8: First Year Natural Gas Savings (kBtu) Per Square Foot – Nonresidential HPWH Ventilation Clean-up

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Small Office (Single Intake Duct vs Dual Duct)	N/A	N/A	N/A	N/A	N/A	N/A	N/A									
Small Office (Single Exhaust Duct vs Dual Duct)	N/A	N/A	N/A	N/A	N/A	N/A	N/A									
Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	N/A	N/A	N/A	N/A	N/A	N/A	N/A									
Small Office (Average)	N/A	N/A	N/A	N/A	N/A	N/A	N/A									
Quick Service Restaurant (Single Intake Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Average)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									

Table 9: First Year Source Energy Savings (kBtu) Per Square Foot – Nonresidential HPWH Ventilation Clean-up

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Small Office (Single Intake Duct vs Dual Duct)	0.36	0.37	0.38	0.37	0.35	0.29	0.28	0.33	0.36	0.37	0.45	0.43	0.44	0.40	0.34	0.64
Small Office (Single Exhaust Duct vs Dual Duct)	0.17	0.19	0.14	0.19	0.13	0.12	0.13	0.14	0.13	0.13	0.21	0.20	0.21	0.21	0.19	0.10
Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	0.20	0.23	0.19	0.26	0.19	0.16	0.16	0.18	0.19	0.20	0.27	0.26	0.26	0.28	0.21	0.28
Small Office (Average)	0.24	0.26	0.24	0.27	0.22	0.19	0.19	0.22	0.23	0.23	0.31	0.30	0.30	0.30	0.25	0.34
Quick Service Restaurant (Single Intake Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Average)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									

Table 10: Total 30-Year LSC Savings (2029 PV\$) Per Square Foot – Nonresidential HPWH Ventilation Clean-up

Prototype	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16
Small Office (Single Intake Duct vs Dual Duct)	1.71	1.76	1.69	1.72	1.39	1.23	1.15	1.21	1.34	1.39	2.00	1.86	1.82	1.65	1.23	3.45
Small Office (Single Exhaust Duct vs Dual Duct)	0.53	0.63	0.44	0.82	0.49	0.54	0.56	0.60	0.38	0.39	0.77	0.90	1.00	0.67	0.88	0.49
Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	0.89	1.03	0.86	1.10	0.75	0.70	0.68	0.71	0.79	0.81	1.24	1.13	1.16	1.11	0.89	1.24
Small Office (Average)	1.04	1.14	1.00	1.21	0.88	0.82	0.80	0.84	0.84	0.86	1.34	1.30	1.33	1.14	1.00	1.73
Quick Service Restaurant (Single Intake Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									
Quick Service Restaurant (Average)	TBD	TBD	TBD	TBD	TBD	TBD	TBD									

5.3 Incremental First Cost

Incremental first costs for installing HPWH ducts are provided for labor and equipment cost. Labor cost estimates were collected from commercial mechanical or plumbing contractors and commercial builders via email and phone surveys of contractors. Equipment costs were gathered from an average of retailer and distributor costs (including Menards, Supply House, Grainger and Amazon) for each component required for the HPWH ventilation duct. The incremental first cost for the duct equipment and labor is expected to be higher for retrofits than new construction/additions. This is due to the need for covering existing wall/door vents used for existing gas water heaters and added cost for ventilation duct elbows used to direct air away from walls/ceiling close to the retrofit HPWH exhaust port.

Installing a ventilation duct for a Heat Pump Water Heater (HPWH) involves several components and steps, including:

- **Wall Vent/Outdoor Grill:** Connects the duct in the room where the HPWH is located to the outdoors.
- **Boot:** Connects the duct to the wall vent/outdoor grill when there is no round connector integrate into the wall vent/outdoor grill.
- **Coupler:** Connects to the intake or exhaust port on the HPWH.
- **Band Clamps or Tape:** Secures the flexible duct to the coupler.
- **Flexible Ventilation Duct:** Facilitates airflow between the HPWH and the connected space.
- **Duct Hanger Straps:** Attaches the duct to the ceiling for stability.

The installer must cut a hole in the wall of the HPWH room to connect to the outdoors, and both sides of the wall vent must be sealed to prevent air and water leakage. Once sealed, the boot, duct, hanger straps, and coupler are installed to complete the ventilation setup.

The incremental cost for adding a second 24 foot long, 8-inch diameter HPWH ventilation duct is 399 dollars in materials and 120 dollars and within the range of 125 to 315 dollars for labor and 235 to 575 dollars for components that is defined in Table 9 of "The Amazing Shrinking Room" report (Larson and Larson, Heat Pump Water Heaters in Small Spaces Lab Testing: "The Amazing Shrinking Room" 2022). [2025 Multifamily Domestic Hot Water CASE report](#) and within the range of 125 to 315 dollars for labor and 235 to 575 dollars for components that is defined in Table 9 of "The Amazing Shrinking Room" report (Larson and Larson, Heat Pump Water Heaters in Small Spaces Lab Testing: "The Amazing Shrinking Room" 2022).

The 399-dollar material cost is a conservative estimate because this number was derived from retail pricing rather than wholesale pricing. Installers with a contractor's license will purchase materials from a wholesaler or have a discounted retailer pricing.

In addition to the new construction HPWH ventilation costs, in retrofit applications, any existing wall/door vents will need to be covered with a wood, metal or plastic panel to prevent airflow between the water heater closet and the outdoors. It is assumed that a 100 dollar additional installation cost

above what is needed for a new construction installation. This added 100 cost will be required once. This cost includes one hour of labor at 80 dollars per hour (DIR.CA.GOV n.d.) to cut out the panel to cover the louvers and nail or screw it into place with the addition of some adhesive to seal it. The panel material cost is estimated at 20 dollars plus an adhesive cost of ten dollars because only half of a twenty-dollar tube of adhesive will be used.

An additional 60 dollar cost in retrofit applications is required to attach an elbow to the exhaust side of the HPWH to divert the air away from nearby surfaces when installed in a very small room. All retrofit ventilation installations requiring two ducts are expected to be in very small rooms. This cost includes half an hour of labor at 80 dollars per hour (DIR.CA.GOV n.d.) to attach the elbow to the HPWH duct coupler with a band clamp and aluminum duct tape, then wrap the elbow in insulation taken from the extra length of duct purchased above. The material cost is estimated at 12 dollars for the elbow and 8 dollars for one extra duct clamp.

5.4 Incremental Maintenance and Replacement Costs

The incremental maintenance and replacement costs, as well as estimation of present value of maintenance and replacement costs, are provided for HPWH ducts assuming that they have a longer life than HVAC distribution ducts, which is ten or more years,⁴ because the HPWH ventilation ducts are not exposed to the high temperature of the attic space like HVAC ventilation duct typically are. Given this assumption, the CASE authors are assuming no incremental maintenance or duct replacement costs during the 30-year analysis period. The HPWH will be replaced during the 30-year horizon, but the ducts can be re-used.

Two other assumptions were applied as maintenance costs. Incremental maintenance costs include drywall damage from moisture and exterior vent re-sealing with adhesive.

An intake duct connected to the outdoors without an insulated exhaust duct or no exhaust duct to the outdoors (HPWH exhausts air into the small room) could result in moisture damage which has a maintenance cost associated with it. It is assumed that a ⁵ drywall replacement will be required once every ten years. This cost includes six hours of labor at 90 dollars per hour⁽⁶⁰⁾ to cut out drywall, inspect, size new drywall, install, texture, and paint. The drywall cost is estimated at 40 dollars plus 40 dollars for texture and paint. It is assumed that this will only occur in one percent of single duct installations.

The exterior vent will require additional adhesive to prevent water ingress. Since one duct would have already been present at the building, only five minutes of time is necessary to apply the new adhesive at a rate of 80 dollars per hour and the adhesive will cost ten dollars because only half of a twenty-dollar tube of adhesive will be used per HPWH duct vent. The new adhesive is expected to need to be applied every 15 years.

⁴ Environmental Heating & Air Solutions n.d.

⁵ <https://www.dir.ca.gov/oprl/pwappwage/wage/25202144.html?VarWageld=25234144>

5.5 Cost Effectiveness

Cost effectiveness is determined by using the energy savings, incremental first cost, and incremental maintenance costs over a 30-year period. Assumptions were discussed with subject matter experts, stakeholders and data was collected in surveys of contractors between September 28th and November 3rd.

Results of the per-unit cost-effectiveness analyses are presented in Table 11 through Table 14 represent new construction/additions in small office buildings while Table 15 through Table 18 represent new construction/additions in quick service restaurants. Similarly, Table 19 through Table 22 represent new alterations in small office buildings while Table 23 through Table 26 represent alterations in quick service restaurants.

In the tables below, all values are presented in 2029 present value dollars (2029 PV\$). Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current maintenance costs, and incremental residual value if proposed residual value is greater than current residual value at the end of the 30-year period of analysis. Costs represent the total incremental PV cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero, the benefit-cost ratio (BCR) is considered infinite. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate. If there are no total incremental PV costs, the BCR is infinite.

Table 11: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Small Office (Single Intake Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	1.71	0.10	17.90
2	1.76	0.10	18.40
3	1.69	0.10	17.67
4	1.72	0.10	18.00
5	1.39	0.10	14.53
6	1.23	0.10	12.92
7	1.15	0.10	12.02
8	1.21	0.10	12.67
9	1.34	0.10	14.08
10	1.39	0.10	14.56
11	2.00	0.10	20.98
12	1.86	0.10	19.50
13	1.82	0.10	19.07

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
14	1.65	0.10	17.26
15	1.23	0.10	12.92
16	3.45	0.10	36.18
Total	1.63	0.10	17.06

Table 12: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Small Office (Single Exhaust Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	0.53	0.10	5.55
2	0.63	0.10	6.59
3	0.44	0.10	4.57
4	0.82	0.10	8.47
5	0.49	0.10	5.10
6	0.54	0.10	5.64
7	0.56	0.10	5.78
8	0.60	0.10	6.25
9	0.38	0.10	3.91
10	0.39	0.10	4.00
11	0.77	0.10	8.03
12	0.90	0.10	9.39
13	1.00	0.10	10.36
14	0.67	0.10	6.92
15	0.88	0.10	9.17
16	0.49	0.10	5.05
Total	0.68	0.10	7.03

Table 13: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	0.89	0.09	9.46
2	1.03	0.09	10.87
3	0.86	0.09	9.15
4	1.10	0.09	11.65
5	0.75	0.09	7.93
6	0.70	0.09	7.40
7	0.68	0.09	7.20
8	0.71	0.09	7.57
9	0.79	0.09	8.43
10	0.81	0.09	8.57
11	1.24	0.09	13.12
12	1.13	0.09	12.02
13	1.16	0.09	12.26
14	1.11	0.09	11.78
15	0.89	0.09	9.42
16	1.24	0.09	13.18
Total	0.97	0.09	10.33

Table 14: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Small Office (Average)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	1.04	0.10	10.97
2	1.14	0.10	11.95
3	1.00	0.10	10.46
4	1.21	0.10	12.71
5	0.88	0.10	9.19
6	0.82	0.10	8.65
7	0.80	0.10	8.33
8	0.84	0.10	8.83
9	0.84	0.10	8.81
10	0.86	0.10	9.04
11	1.34	0.10	14.04

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
12	1.30	0.10	13.64
13	1.33	0.10	13.90
14	1.14	0.10	11.99
15	1.00	0.10	10.50
16	1.73	0.10	18.14
Total	1.09	0.10	11.47

Table 15: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Quick Service Restaurant (Single Intake Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

Table 16: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

Table 17: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

Table 18: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – New Construction and Additions Quick Service Restaurant (Average)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

Table 19: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Small Office (Single Intake Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	1.71	0.12	13.72
2	1.76	0.12	14.10
3	1.69	0.12	13.54
4	1.72	0.12	13.80
5	1.39	0.12	11.13

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
6	1.23	0.12	9.90
7	1.15	0.12	9.21
8	1.21	0.12	9.71
9	1.34	0.12	10.80
10	1.39	0.12	11.16
11	2.00	0.12	16.08
12	1.86	0.12	14.94
13	1.82	0.12	14.61
14	1.65	0.12	13.23
15	1.23	0.12	9.90
16	3.45	0.12	27.73
Total	1.67	0.12	13.38

Table 20: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Small Office (Single Exhaust Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	0.53	0.13	4.26
2	0.63	0.13	5.06
3	0.44	0.13	3.51
4	0.82	0.13	6.51
5	0.49	0.13	3.92
6	0.54	0.13	4.33
7	0.56	0.13	4.44
8	0.60	0.13	4.80
9	0.38	0.13	3.00
10	0.39	0.13	3.07
11	0.77	0.13	6.17
12	0.90	0.13	7.21
13	1.00	0.13	7.96
14	0.67	0.13	5.32
15	0.88	0.13	7.04
16	0.49	0.13	3.88
Total	0.70	0.13	5.62

Table 21: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	0.89	0.12	7.23
2	1.03	0.12	8.31
3	0.86	0.12	7.00
4	1.10	0.12	8.91
5	0.75	0.12	6.06
6	0.70	0.12	5.65
7	0.68	0.12	5.50
8	0.71	0.12	5.79
9	0.79	0.12	6.44
10	0.81	0.12	6.55
11	1.24	0.12	10.03
12	1.13	0.12	9.19
13	1.16	0.12	9.37
14	1.11	0.12	9.00
15	0.89	0.12	7.20
16	1.24	0.12	10.08
Total	0.99	0.12	8.04

Table 22: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Small Office (Average)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	1.04	0.12	8.40
2	1.14	0.12	9.16
3	1.00	0.12	8.02
4	1.21	0.12	9.74
5	0.88	0.12	7.04
6	0.82	0.12	6.63
7	0.80	0.12	6.38
8	0.84	0.12	6.77
9	0.84	0.12	6.75
10	0.86	0.12	6.93
11	1.34	0.12	10.76

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
12	1.30	0.12	10.45
13	1.33	0.12	10.65
14	1.14	0.12	9.18
15	1.00	0.12	8.05
16	1.73	0.12	13.90
Total	1.12	0.12	9.01

Table 23: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Quick Service Restaurant (Single Intake Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

Table 24: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

Table 25: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

Table 26: 30-Year Cost-Effectiveness Summary Per Nonresidential Building/Square Foot – Alterations Quick Service Restaurant (Average)

Climate Zone	Benefits LSC Savings + Other PV Savings (2029 PV\$)	Costs Total Incremental PV Costs (2029 PV\$)	Benefit-to-Cost Ratio
1	TBD	TBD	TBD
2	TBD	TBD	TBD
3	TBD	TBD	TBD
4	TBD	TBD	TBD
5	TBD	TBD	TBD
6	TBD	TBD	TBD
7	TBD	TBD	TBD
8	TBD	TBD	TBD
9	TBD	TBD	TBD
10	TBD	TBD	TBD
11	TBD	TBD	TBD
12	TBD	TBD	TBD
13	TBD	TBD	TBD
14	TBD	TBD	TBD
15	TBD	TBD	TBD
16	TBD	TBD	TBD

6. Statewide Impacts

This section details the statewide impacts evaluation of the proposed HPWH ventilation clean-up measure for nonresidential buildings code measure with the following topics:

- Statewide Energy and Energy Cost Savings
- Statewide Greenhouse Gas
- Statewide Water Use Impacts
- Statewide Material Impacts
- Environmental Impacts
- Other None-Energy Benefits

Each topic is detailed below.

6.1 Statewide Energy and Energy Cost Savings

Statewide energy and cost impacts were determined by applying both intake and exhaust ventilation ducts to ventilate the HPWH to the outside of small office buildings and quick service restaurants.

The number of applicable new construction buildings affected by the proposed HPWH ventilation code change is based on the [2029 Construction Forecast](#) from the 2028 Code cycle MeasureSET Excel document. The square footage of small office buildings was divided by 5500 square feet⁶ to determine the number of available buildings where water heaters are used. This number of available buildings with water heaters is scaled by the percentage of the buildings that are expected to implement a HPWH with ducts in the next year and this number of buildings is used to estimate the statewide energy and energy cost savings per HPWH.

Stakeholders indicated that eight percent water heaters installed in new construction will implement a HPWH with either an intake or an exhaust duct which means that these would require dual ducting with the proposed updates to the 2028 code language. Because the next stakeholder survey question indicated that there are likely two times the amount of quick service restaurant installations for these HPWHs than small offices, the eight percent implementation rate gets split into five percent of small offices and ten percent of quick service restaurant where water heater retrofits will implement the proposed requirement for dual duct HPWH ventilation system. After discussions with other researchers working on an updated sizing guideline for water heaters in food service applications, the quick service restaurant implementation rate was identified as being too high due to the 2020 California Conference of Directors of Environmental Health (CCDEH) [Guideline for Sizing Water Heaters](#). This guideline focuses on the heating energy delivered by the electric resistive heating element in HPWHs, not the combined electric resistive heating element and heat pump. It is more conservative to say that it is very uncommon (much less than one percent) of new quick service

⁶ Based on the Commercial Reference Building Models from the U.S. Department of Energy: <https://www.energy.gov/eere/buildings/commercial-reference-buildings>

restaurants are expected to install consumer integrated HPWHs with ducts following the San Francisco Department of Public Health Technical Bulletin titled "[Heat Pump Plan Review for Food Facilities](#)."

A similar process was used to estimate the number of retrofit water heaters that will implement the newly required dual duct HPWH ventilation system in existing buildings. The existing building stock square footage data for small offices were divided by 5500 square feet and restaurant building stock square footage was divided by 2500 square feet to determine the number of available buildings where water heaters are used. It is assumed the commercial building water heaters are replaced every ten years, so ten percent of the water heaters in the existing floor space will be replaced during the first year that the code is implemented. Then, stakeholders indicated that it would be uncommon (two percent on average) for retrofit water heaters to implement a HPWH with either an intake or an exhaust duct which would require dual ducting with the proposed updates to the 2028 code language. Because the next survey question indicated that there are likely two times the amount of quick service restaurant installations for these HPWHs than small offices, the two percent implementation rate is split into one percent of small offices and three percent of quick service restaurants water heater retrofits. Applying the ten percent derating was applied to these values to account for a typical ten year⁷ [OBJ] for water heaters which results in one tenth of all water heaters being replaced annually. After applying the ten percent derating, much less than one percent of small office water heater replacements and less than one percent of quick service restaurant water heater replacements would implement the proposed dual duct HPWH ventilation system. Following the guidance from other researchers working on an updated sizing guideline for water heaters in food service applications is very uncommon (much less than one percent).

See the 2028 CASE Methodology Report for details on how statewide savings are calculated. Appendix D presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact.

For more details on the methodology and context about estimating the current market share rate, as well as statewide energy and energy cost savings, see the 2028 CASE Methodology Report.

The tables below present the first-year statewide energy and LSC savings from newly constructed buildings and additions (Table 27 through and Table 30) alterations (Table 31 through Table 34) by climate zone. The Statewide CASE Team is still conducting the energy analysis modeling needed to finalize cost savings numbers. Additional data will be presented in the Final CASE Report.

⁷ <https://www.nachi.org/lifespan-water-heater.htm>

Table 27: Statewide Energy and LSC Impacts – New Construction and Additions Small Office (Single Intake Duct vs Dual Duct)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	2	0.52	0.07	N/A	0.91	4.27
2	2,771	592.20	66.77	N/A	1,034.00	4,865.69
3	507	95.77	17.37	N/A	191.22	855.00
4	6	1.23	0.17	N/A	2.22	10.17
5	60	10.28	1.56	N/A	20.93	83.02
6	318	45.89	7.88	N/A	92.24	392.52
7	794	109.30	19.50	N/A	221.36	911.10
8	369	52.81	10.46	N/A	121.55	445.82
9	1,881	296.51	56.35	N/A	676.71	2,528.80
10	2,521	402.30	76.29	N/A	942.51	3,501.95
11	126	30.33	4.12	N/A	57.47	253.02
12	4,301	963.25	137.09	N/A	1,865.21	8,002.44
13	2,154	454.32	76.06	N/A	937.31	3,919.23
14	28	5.75	0.70	N/A	11.13	46.38
15	160	19.50	5.25	N/A	53.93	197.71
16	16	8.31	0.98	N/A	10.22	55.02
Total	16,015	3088.26	480.61	N/A	6238.90	26,072.13

Table 28: Statewide Energy and LSC Impacts – New Construction and Additions Small Office (Single Exhaust Duct vs Dual Duct)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	2	0.13	0.04	N/A	0.43	1.34
2	2,771	168.89	58.22	N/A	527.43	1,756.75
3	507	19.16	7.64	N/A	69.08	222.94
4	6	0.55	0.11	N/A	1.10	4.83
5	60	3.77	0.63	N/A	7.93	29.41
6	318	20.76	3.73	N/A	39.56	172.80
7	794	52.64	8.79	N/A	101.33	441.64
8	369	26.28	4.76	N/A	53.44	221.80
9	1,881	55.82	29.37	N/A	250.79	707.42
10	2,521	76.45	34.84	N/A	320.02	971.12
11	126	10.51	2.97	N/A	26.53	97.72
12	4,301	448.60	78.66	N/A	845.71	3,886.49
13	2,154	241.53	45.21	N/A	454.46	2,149.04
14	28	1.89	0.56	N/A	5.98	18.76
15	160	13.89	3.05	N/A	29.69	141.60
16	16	1.07	0.16	N/A	1.53	7.75
Total	16,015	1,141.94	278.75	N/A	2,735.00	10,831.40

Table 29: Statewide Energy and LSC Impacts – New Construction and Additions Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	2	0.26	0.04	N/A	0.50	2.23
2	2,771	324.46	59.10	N/A	638.41	2,842.13
3	507	49.37	8.60	N/A	95.38	437.81
4	6	0.73	0.15	N/A	1.51	6.50
5	60	5.45	0.90	N/A	11.42	44.81
6	318	26.17	4.48	N/A	50.61	222.15
7	794	64.02	10.87	N/A	124.88	539.45
8	369	30.58	5.85	N/A	66.49	263.48
9	1,881	166.62	33.42	N/A	360.13	1,495.50
10	2,521	226.06	42.98	N/A	492.69	2,036.98
11	126	18.01	3.09	N/A	34.35	156.42
12	4,301	560.99	103.42	N/A	1,107.31	4,878.16
13	2,154	277.93	54.79	N/A	555.18	2,491.00
14	28	3.61	0.69	N/A	7.76	31.28
15	160	13.35	3.42	N/A	33.70	142.55
16	16	2.59	0.35	N/A	4.51	19.82
Total	16,015	1,770.20	332.14	N/A	3,584.85	15,610.27

Table 30: Statewide Energy and LSC Impacts – New Construction and Additions Small Office (Average)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	2	0.30	0.05	N/A	0.61	2.61
2	2771	361.85	61.36	N/A	733.28	3,154.86
3	507	54.77	11.20	N/A	118.56	505.25
4	6	0.84	0.14	N/A	1.61	7.17
5	60	6.50	1.03	N/A	13.43	52.41
6	318	30.94	5.36	N/A	60.80	262.49
7	794	75.32	13.05	N/A	149.19	630.73
8	369	36.56	7.02	N/A	80.49	310.37
9	1881	172.98	39.71	N/A	429.21	1,577.24
10	2521	234.94	51.37	N/A	585.07	2,170.02
11	126	19.62	3.39	N/A	39.45	169.05
12	4301	657.61	106.39	N/A	1272.74	5,589.03
13	2154	324.59	58.69	N/A	648.98	2,853.09
14	28	3.75	0.65	N/A	8.29	32.14
15	160	15.58	3.91	N/A	39.11	160.62
16	16	3.99	0.50	N/A	5.42	27.53
Total	16015	2000.13	363.83	N/A	4186.25	17,504.60

Table 31: Statewide Energy and LSC Impacts – Alterations Small Office (Single Intake Duct vs Dual Duct)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	87	18.16	2.49	N/A	31.82	149.34
2	813	173.76	19.59	N/A	303.38	1,427.62
3	2,463	465.07	84.34	N/A	928.63	4,152.17
4	642	132.92	18.72	N/A	240.36	1,102.95
5	282	48.33	7.33	N/A	98.41	390.41
6	874	125.98	21.62	N/A	253.22	1,077.51
7	363	49.92	8.91	N/A	101.09	416.09
8	882	126.29	25.01	N/A	290.67	1,066.09
9	2,180	343.65	65.30	N/A	784.28	2,930.78
10	2,985	476.39	90.33	N/A	1,116.08	4,146.88
11	562	134.88	18.30	N/A	255.56	1,125.15
12	9,656	2,162.69	307.80	N/A	4,187.77	17,967.09
13	2,305	486.25	81.41	N/A	1,003.19	4,194.73
14	124	25.41	3.08	N/A	49.17	204.88
15	191	23.24	6.26	N/A	64.26	235.58
16	36	18.67	2.20	N/A	22.97	123.66
Total	24,445	4,811.60	762.69	N/A	9,730.87	40,710.95

Table 32: Statewide Energy and LSC Impacts – Alterations Small Office (Single Exhaust Duct vs Dual Duct)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	87	4.44	1.43	N/A	14.99	46.72
2	813	49.55	17.08	N/A	154.75	515.44
3	2,463	93.05	37.09	N/A	335.46	1,082.67
4	642	60.17	12.11	N/A	119.04	523.76
5	282	17.74	2.94	N/A	37.28	138.30
6	874	56.98	10.23	N/A	108.59	474.35
7	363	24.04	4.02	N/A	46.28	201.69
8	882	62.85	11.39	N/A	127.79	530.38
9	2,180	64.69	34.04	N/A	290.65	819.87
10	2,985	90.53	41.25	N/A	378.96	1,149.97
11	562	46.74	13.22	N/A	117.98	434.57
12	9,656	1,007.20	176.62	N/A	1,898.78	8,725.94
13	2,305	258.51	48.39	N/A	486.41	2,300.11
14	124	8.33	2.49	N/A	26.42	82.88
15	191	16.55	3.64	N/A	35.38	168.72
16	36	2.41	0.35	N/A	3.43	17.42
Total	24,445	1,863.78	416.30	N/A	4,182.20	17,212.79

Table 33: Statewide Energy and LSC Impacts – Alterations Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	87	9.18	1.46	N/A	17.65	78.01
2	813	95.20	17.34	N/A	187.31	833.90
3	2,463	239.78	41.75	N/A	463.19	2,126.17
4	642	79.52	15.94	N/A	164.23	705.72
5	282	25.64	4.21	N/A	53.68	210.71
6	874	71.84	12.30	N/A	138.94	609.82
7	363	29.24	4.96	N/A	57.03	246.36
8	882	73.13	14.00	N/A	159.00	630.05
9	2,180	193.10	38.74	N/A	417.38	1,733.22
10	2,985	267.69	50.90	N/A	583.42	2,412.12
11	562	80.07	13.72	N/A	152.77	695.60
12	9,656	1,259.53	232.19	N/A	2,486.14	10,952.45
13	2,305	297.47	58.64	N/A	594.21	2,666.10
14	124	15.94	3.06	N/A	34.27	138.19
15	191	15.91	4.07	N/A	40.16	169.86
16	36	5.82	0.79	N/A	10.13	44.54
Total	24,445	2,759.06	514.07	N/A	5,559.53	24,252.81

Table 34: Statewide Energy and LSC Impacts – Alterations Small Office (Average)

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2026 (Square Feet)	First-Year Electricity Savings (kWh)	First-Year Peak Electrical Demand Reduction (W)	First-Year Natural Gas Savings (Therms)	First-Year Source Energy Savings (kBtu)	30-Year Present Valued LSC Savings (2029 PV\$)
1	87	10.59	1.79	N/A	21.49	91.36
2	813	106.17	18.00	N/A	215.15	925.65
3	2463	265.97	54.39	N/A	575.76	2,453.67
4	642	90.87	15.59	N/A	174.54	777.48
5	282	30.57	4.83	N/A	63.12	246.47
6	874	84.93	14.72	N/A	166.92	720.56
7	363	34.40	5.96	N/A	68.13	288.05
8	882	87.42	16.80	N/A	192.49	742.17
9	2180	200.48	46.03	N/A	497.44	1,827.96
10	2985	278.20	60.83	N/A	692.82	2,569.66
11	562	87.23	15.08	N/A	175.44	751.77
12	9656	1476.47	238.87	N/A	2857.56	12,548.49
13	2305	347.41	62.81	N/A	694.60	3,053.65
14	124	16.56	2.88	N/A	36.62	141.98
15	191	18.57	4.66	N/A	46.60	191.39
16	36	8.97	1.11	N/A	12.18	61.87
Total	24445	3144.81	564.35	N/A	6490.87	27,392.18

6.2 Statewide Greenhouse Gas Emissions Reductions

Table 35 through Table 38 present the estimated first-year reduction in GHG emissions resulting from the proposed code change in small office buildings. Similarly, Table 39 through Table 42 present the estimated first-year reduction in GHG emissions resulting from the proposed code change in quick service restaurant buildings. In this initial year, the Statewide CASE Team expects to avoid 0.56 metric tons of carbon dioxide equivalent (CO₂e) emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC’s 2028 Metrics Report. See the 2028 CASE Methodology Report for additional information.

Table 35: First-Year Statewide GHG Emissions Impacts Small Office (Single Intake Duct vs Dual Duct)

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO ₂ e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO ₂ e)	Total Reduced GHG Emissions (Metric Ton CO ₂ e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	0.33	N/A	0.33	41
Alterations	0.51	N/A	0.51	63
Total	0.84	N/A	0.84	104

Table 36: First-Year Statewide GHG Emissions Impacts Small Office (Single Exhaust Duct vs Dual Duct)

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO ₂ e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO ₂ e)	Total Reduced GHG Emissions (Metric Ton CO ₂ e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	0.14	N/A	0.14	18
Alterations	0.227	N/A	0.22	27
Total	0.37	N/A	0.37	45

Table 37: First-Year Statewide GHG Emissions Impacts Small Office (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Construction Type	Reduced GHG Emissions from Electricity	Reduced GHG Emissions from Natural Gas	Total Reduced GHG Emissions (Metric Ton	Total Monetary Value of Reduced GHG
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	Savings (Metric Tons CO2e)	Savings (Metric Tons CO2e)	CO2e)	Emissions (\$)
New Construction & Additions	0.19	N/A	0.19	23
Alterations	0.29	N/A	0.29	36
Total	0.48	N/A	0.48	60

Table 38: First-Year Statewide GHG Emissions Impacts Small Office (Average)

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	0.22	N/A	0.22	27
Alterations	0.34	N/A	0.34	42
Total	0.56	N/A	0.56	70

**Table 39: First-Year Statewide GHG Emissions Impacts Quick Service Restaurant
(Single Intake Duct vs Dual Duct)**

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	TBD	TBD	TBD	TBD
Alterations	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD

Table 40: First-Year Statewide GHG Emissions Impacts Quick Service Restaurant (Single Exhaust Duct vs Dual Duct)

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	TBD	TBD	TBD	TBD
Alterations	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD

Table 41: First-Year Statewide GHG Emissions Impacts Quick Service Restaurant (Single Exhaust Duct vs Intake and Exhaust Duct to Communicating Space)

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	TBD	TBD	TBD	TBD
Alterations	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD

Table 42: First-Year Statewide GHG Emissions Impacts Quick Service Restaurant (Average)

Construction Type	Reduced GHG Emissions from Electricity Savings (Metric Tons CO2e)	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Ton CO2e)	Total Monetary Value of Reduced GHG Emissions (\$)
New Construction & Additions	TBD	TBD	TBD	TBD
Alterations	TBD	TBD	TBD	TBD
Total	TBD	TBD	TBD	TBD

6.3 Statewide Water Use Impacts

The proposed code change will not result in water use impacts.

6.4 Statewide Material Impacts

The proposed code change will result in more HPWH ventilation ducts. Installing a HPWH ventilation duct involves several components and steps, including:

- **Wall Vent/Outdoor Grill:** Connects the duct in the room where the HPWH is located to another room or outdoors.
- **Boot:** Connects the duct to the wall vent/outdoor grill when there is no round connector to integrate into the wall vent/outdoor grill.
- **Coupler:** Connects to the intake or exhaust port on the HPWH.
- **Band Clamps or Tape:** Two band clamps secure the flexible duct to the coupler.
- **Flexible Ventilation Duct:** One duct facilitates airflow between the HPWH and connected space with R6 insulation.
- **Duct Hanger Straps:** Three straps attach the duct to the ceiling for stability.
- **Coupler:** One coupler connects to the intake or exhaust port on the HPWH.
- **Silicone:** Silicone adhesive for sealing the exterior wall vent to the building.

Total material weights for each HPWH duct installation which includes all of the components above with an eight-inch diameter and twenty-five-foot-long duct has been tabulated, see Table 43. Material weights came from sources used to identify the incremental first costs for equipment. Equipment cost estimates were collected from an average of retailer and distributor product listings (including Menards, Supply House, Grainger, and Amazon) for each component required for the HPWH ventilation duct.

For more information on the Statewide CASE Team’s methodology and assumptions used to calculate embodied GHG emissions, see the 2028 CASE Methodology Report.

Table 43: First-Year Statewide Impacts on Material Use

Material	Impact (response options: Increase, Decrease, No Change)	Per-Unit Impacts (Pounds per HPWH Unit)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO2e)
Mercury	No Change	0	0	0
Lead	No Change	0	0	0
Copper	No Change	0	0	0
Concrete	No Change	0	0	0
Steel	Increase	5.40	484	-0.27
Insulation	Increase	7.50	672	-0.74
Wood	No Change	0.00	0	0
Plastic	Increase	4.92	441	-0.37

Material	Impact (response options: Increase, Decrease, No Change)	Per-Unit Impacts (Pounds per HPWH Unit)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO2e)
Refrigerants	No Change	0.00	0	0
Glass	No Change	0.00	0	0
Silicone (added)	Increase	0.32	29	-0.18
Aluminum (added)	Increase	5.40	484	-3.15
Polyester (added)	Increase	1.50	134	-0.86
TOTAL	N/A	17.82	2,242	-5.58

6.5 Environmental Impacts

In addition to understanding the energy impacts of this measure, the following environmental impacts are a result of this code change.

Eliminating the single duct exhaust ventilation configuration to the outside removes risk of expelling airborne particulates, gases, and bacteria originating in the HPWH room and exiting into the outdoor environment. With the updated code language for two ducts, outdoor air enters the intake of the HPWH and exits the HPWH back into the environment OR indoor air enters the intake of the HPWH and exits the HPWH back into the indoor environment.

6.6 Other Non-Energy Impacts

In addition to understanding the environmental impacts of this measure, the following potential non-energy impacts are a result of this code change.

Appropriately sized and insulated ducting for HPWHs will reduce condensation potential on surfaces (Rheem Manufacturing Company 2024) and moisture damage risk inside the conditioned space and/or other small water heater locations which is a health and safety improvement (Klein 2025). Also, potential air quality risks are removed by eliminating the single duct intake ventilation configuration where outdoor air enters the HPWH room. These air quality risks are caused by ingress of airborne particulates, gases, and bacteria originating outdoors that enter the room. Updating the ventilation language to require two ducts also eliminates the HPWH’s induced pressure imbalance in the room where the HPWH is installed (Colon, Martin and Parker 2016). The pressure imbalance can cause cold/hot, dry/humid air to enter the room through the cracks in the siding, vapor barrier, wall insulation, and drywall which could lead to additional building maintenance. Alternately, cold air from indoors could be forced back outdoors due to the pressure imbalance through the wall structure.

7. Proposed Language Code

This section details the proposed language for the HPWH ventilation clean-up measure for nonresidential buildings code measure. This measure would simplify the four existing 2025 compliance pathways to make unitary HPWH installation planning simpler, as well as improving consumer-sized HPWH performance in nonresidential buildings.

7.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

7.2 Administrative Code (Title 24, Part 1)

There are no proposed changes to Title 24, Part 1.

7.3 Energy Code (Title 24, Part 6)

There are proposed changes to Title 24, Part 6, see below.

Title 24, Part 6: 110.3(c)7

Air-Source Heat Pump Water Heaters (HPWHs). HPWH shall meet the following requirements:

- A. Backup Heat.** Backup heat is required for systems when inlet air is unconditioned, unless the compressor cut-off temperature is below the Heating Winter Median of Extremes for the closest location listed in Table 2-3 from Reference Joint Appendix JA2. Backup heat may be internal or external to the HPWH.
- B. Ventilation – Residential.** Consumer integrated HPWHs servicing single-family or multifamily dwelling units shall meet one of the ventilation requirements below. Minimum volume and opening size requirements shall be the sum of all HPWHs installed within the same space. Compressor capacity shall be determined using AHRI 540 Table 4 reference conditions for refrigeration with the “High” rating test point:
 1. Installed using a method provided by the manufacturer to meet or exceed the level of performance provided by the ventilation requirements of Section 110.3(c)7B2 through Section 110.3(c)7B4.
 2. For HPWH installation without ducts, the installation space shall have a volume not less than the greater of 100 cubic feet per kBtu per hour of compressor capacity, or the minimum volume provided

by the manufacturer for this method; or

3. For HPWH installation without ducts, the installation space shall be vented to a communicating space via permanent openings, according to the following requirements:
 - i. Communicating space shall meet the minimum volume of Section 110.3(c)7B2 above, minus the volume of the HPWH installation space; and
 - ii. Permanent openings shall consist of a single layer of fixed flat slat louvers or grilles, with a total minimum Net Free Area (NFA) the larger of 125 square inches plus 25 square inches per kBtu per hour of compressor capacity, or the minimum provided by the manufacturer for this method. The permanent openings shall be fully louvered doors or two openings of equal area, one in the upper half of the enclosure and one in the bottom half of the enclosure. The top of the upper opening must be 12 inches or less from the enclosure top and the bottom of the lower vent must be 12 inches or less from the enclosure bottom; or
4. For HPWH installations with ducts, the following requirements shall be met:
 - i. The space joined to the installation space via ducts shall meet the minimum volume of Section 110.3(c)7B2 above, minus the volume of the HPWH installation space; and
 - ii. All duct connections and building penetrations shall be sealed; and
 - iii. Exhaust air ducts and all ducts which cross pressure boundaries shall be insulated to minimum of R-6; and
 - iv. Where only the HPWH inlet or outlet is ducted, installation space shall include permanent openings that consist of a single layer of fixed flat slat louvers or grilles in the bottom half of the room, and/or a door undercut. With a ducted inlet, the minimum NFA shall be equal to the cross-sectional area of the duct. With a ducted exhaust, the minimum NFA shall be the larger of 20 square inches or the minimum NFA provided by the manufacturer for this method; and
 - v. Where the inlet and outlet ducts shall both terminate within the same pressure boundary, airflow from the termination points shall be diverted away from each other; or.

Note: Ducting only the inlet or the exhaust across the pressure boundary could interfere with balanced ventilation systems. This should be considered when specifying HPWH location and ventilation method.

[C. Ventilation – Nonresidential. Consumer integrated HPWHs serving nonresidential occupancies shall meet one of the ventilation](#)

requirements below. Minimum volume and opening size requirements shall be at least the sum of the required openings and volumes for all HPWHs installed within the same space. Compressor capacity shall be determined using AHRI 540 Table 4 reference conditions for refrigeration with the “High” rating test point:

1. Installed using a method not covered by Section 110.3(c)7C2 through Section 110.3(c)7C3 provided by the manufacturer to meet or exceed the level of performance provided by the ventilation requirements of Section 110.3(c)7C2 through Section 110.3(c)7C3; or
2. Installed without ducts in an unvented room, the installation space shall have a volume not less than the greater of 100 cubic feet per kBtu per hour of the combined compressor capacity for all HPWHs in the space or the minimum total unvented room volume recommended by the manufacturer; or
3. Installations with ducts, the following requirements shall be met:
 - i. Where both the inlet and outlet are ducted, all ducts shall terminate on the same side of the building pressure boundary (both outside or both inside the building) with airflow at the termination points diverted away from each other and/or separated by a minimum of 24 inches; and
 - ii. The space joined to the installation space via ducts shall meet the minimum volume of Section 110.3(c)7C2 above; and
 - iii. All duct connections and building penetrations shall be sealed to prevent air and moisture ingress; and
 - iv. All ducts shall be insulated to minimum of R-6; and
 - v. Where only the HPWH outlet is ducted to a communicating space, installation space shall include permanent openings for HPWH inlet air. Permanent openings shall be the larger of the minimum Net Free Area (NFA) provided by the manufacturer or a minimum NFA not less than the cross-sectional area of the HPWH manufacturer’s exhaust duct kit flange. NFA refers to the unobstructed open space in a vent, grille or louver which is a fraction of the total vent, grille or louver total gross area. Permanent openings shall consist of a single layer of fixed flat slat louvers or grilles 12 inches or less from the HPWH installation space/door bottom, and/or a door undercut. Exhaust air shall exit the installation space to the communicating space through a duct 12 inches or less from the HPWH installation space top; and
 - vi. Where the HPWH uses an axial fan, the minimum nominal duct diameter shall be no less than 8 inches for

a duct length no longer than 0.66 times the manufacturer specified length for a nominal duct diameter of 8 inches.

7.4 Reference Appendices

There are no proposed changes to the Reference Appendices.

7.5 Compliance Manuals

The Statewide CASE Team will provide CEC with recommended revisions to compliance manuals after the 45-Day Language is published.

7.6 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

7.7 Compliance Forms

As discussed in Section 2.4.5, the drop down list of available HPWH ventilation options in CEC-NRCC-PLB-E-22 would be updated to reflect the proposed change in Section 110.3(c). The Statewide CASE Team can support the CEC in implementing these updates if the proposed change is adopted.

8. Bibliography

- A.O. Smith. 2024. *Installation Instructions and Use & Care Guide - Hybrid Electric Heat Pump Water Heater*. May. https://pdf.lowes.com/productdocuments/553ad3ac-2ab0-4bd2-af07-0d5ec33f5bb5/67262306.pdf?_gl=1*p9e1v*_gcl_aw*R0NMLjE3NjEzMjEyMjcuRUFJYUIRb2JDaE1JbU9fdTZaaTlrQU1WTEwJREFCM1dWeIRZRUFBUFTQUFFZ0tMeGZEX0J3RQ..*_gcl_dc*R0NMLjE3NjEzMjEyMjcuRUFJYUIRb2JDaE1JbU9f.
- American Lung Association. 2025. "State of the Air 2025 Report." Report, Chicago. <https://www.lung.org/getmedia/5d8035e5-4e86-4205-b408-865550860783/State-of-the-Air-2025.pdf>.
- Arctic Heat Pumps. n.d. *Heat Pump Hot Water Tanks: To Vent or not to Vent?* Accessed October 2nd, 2025. <https://www.arcticheatpumps.com/heat-pump-hot-water-tanks-to-vent-or-not-to-vent.html>.
- AS Engineers. n.d. *Axial Fans vs. Centrifugal Fans: Understanding the Differences*. Accessed October 11th, 2025. <https://theasengineers.com/axial-fans-vs-centrifugal-fans-understanding-the-differences/>.
- ASHRAE. 2022. *ANSI/ASHRAE Standard 62.1-2022: Ventillation and Acceptable Indoor Air Quality*. Atlanta, GA: ASHRAE.
- California Energy Commission. 2025. "BUILDING ENERGY EFFICIENCY STANDARDS FOR RESIDENTIAL AND NONRESIDENTIAL BUILDINGS." *energy.ca.gov*. July. Accessed September 17, 2025. https://www.energy.ca.gov/sites/default/files/2025-07/CEC-400-2025-010-F_0.pdf.
- . 2022. "Final Staff Workshop on Energy Accounting for the 2025 Building Energy Efficiency Standards." *California Energy Commission*. Prepared for the California Energy Commission. November 10. <https://www.energy.ca.gov/event/workshop/2022-11/final-staff-workshop-energy-accounting-2025-building-energy-efficiency>.
- CALIFORNIA ENERGY COMMISSION. n.d. *Quick Search*. Accessed October 9th, 2025. <https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx>.
- CFM Continental Fan. n.d. *DXP Motorized EC Axial Fans*. Accessed October 27th, 2025. <https://continentalfan.com/e-catalog/oem/ec-fans-oem/dxp-motorized-ec-axial-fans/>.
- Colon, C. 2013. "Heat Pump Water Heater Performance in Laboratory House." *Energy.gov*. April 29. Accessed October 26, 2025. <https://www.energy.gov/eere/buildings/articles/heat-pump-water-heater-performance>.
- Colon, Carlos, Eric Martin, and Danny Parker. 2016. *Effect of Ducted HPWH on Space-Conditioning and Water Heating Energy Use—Central Florida Lab Home*. Cocoa: U.S. Department of Energy | Energy Efficiency & Renewable Energy.

- DIR.CA.GOV. n.d. *General Prevailing Wage Determination Made by the Director of Industrial Relations Pursuant to California Labor Code 7, Chapter 1, Article 2, Sections 1770, 1773 and 1773.1 for Commercial Build, Highway, Heavy Construction and Dredging Projects*. Accessed November 3rd, 2025. <https://www.dir.ca.gov/oprl/2025-2/PWD/Determinations/Subtrades/SAC.html>.
- ENERGY STAR. n.d. *ENERGY STAR Certified Heat Pump Water Heaters*. Accessed October 9th, 2025. <https://www.energystar.gov/productfinder/product/certified-heat-pump-water-heaters/results>.
- Energy Star. n.d. *Heat Pump Water Heater Design Considerations*. Accessed April 18, 2025. https://www.energystar.gov/partner-resources/residential_new/educational_resources/sup_program_guidance/heat_pump_water_heater_guide/design_considerations.
- ENERGY STAR. n.d. *Heat Pump Water Heater Design Considerations*. Accessed October 6, 2025. https://www.energystar.gov/partner-resources/residential_new/educational_resources/sup_program_guidance/heat_pump_water_heater_guide.
- Environmental Heating & Air Solutions. n.d. *The Lifespan of Different Types of Air Ducts*. Accessed October 3rd, 2025. <https://ehasolutions.com/the-lifespan-of-different-types-of-air-ducts/>.
- Federal Reserve Economic Data (FRED). n.d. *Data series relied on: Net Domestic Private Investment, Corporate Profits After Taxes*. Accessed September 18, 2022. <https://fred.stlouisfed.org> .
- Feng, Jingjuan "Dove", Amin Delagah, Cathrine Chappell, Yiyi Chu, Daniel Hacking, Ben Seeley, Mitra Debrunda, and James Haile. 2025. *2025 Energy Code Results Report - Multifamily Domestic Hot Water*. March.
- Home Depot. n.d. *ProTerra 40 Gal. 120-Volt Plug-in Smart Heat Pump Water Heater with Leak Detection and Auto Shutoff and 10-Year Warranty*. Accessed October 2nd, 2025. <https://www.homedepot.com/p/Rheem-ProTerra-40-Gal-120-Volt-Plug-in-Smart-Heat-Pump-Water-Heater-with-Leak-Detection-and-Auto-Shutoff-and-10-Year-Warranty-XE40T10HMS00U0/317100818#overlay>.
- Klein, Gary. 2025. *Air Source HPWH - Where Does the Warm Intake Air Come From? Where Does the Cold Exhaust Air Go?* March 4.
- Larson, Ben, and Sam Larson. 2022. *Heat Pump Water Heaters in Small Spaces Lab Testing: "The Amazing Shrinking Room"*. Northwest Energy Efficiency Alliance.
- Larson, Ben, Sam Larson, and Maya Gantley. 2023. "Code Readiness: Laboratory Testing of Heat Pump Water Heater Performance: Impact of Airflow and Space Conditioning." *ENERGY TRANSITION COORDINATION COUNCIL*. December. Accessed

September 18, 2025. <https://www.etcc-ca.com/reports/code-readiness-laboratory-testing-heat-pump-water-heater-performance-impact-airflow-and>.

OEHHA. 2022. *SB 535 Disadvantaged Communities*. Accessed 2025. <https://oehha.ca.gov/calenviroscreen/sb535>.

PBM. n.d. Accessed October 26th, 2025. <https://www.pbmmf.com/product/108mm-ec-ac-forward-curved-centrifugal-fan-pf3n108b2em.html>.

Rheem Manufacturing Company. 2024. *Use & Care Manual*. Accessed October 2nd, 2025. <https://www.rheem.com/product/rheem-professional-prestige-proterra-hybrid-electric-heat-pump-with-leakguard-and-top-water-connections-proph80-t2-rh400-so/related-documents/271817/>.

Rheem Manufacturing Company. n.d. *Professional Prestige ProTerra Hybrid Electric Heat Pump with LeakGuard and Top Water Connections*. Accessed October 8th, 2025. <https://www.rheem.com/product/rheem-professional-prestige-proterra-hybrid-electric-heat-pump-with-leakguard-and-top-water-connections-proph80-t2-rh400-so/>.

San Jose Clean Energy. n.d. *Heat Pump Water Heater*. Accessed October 2nd, 2025. <https://sanjosecleanenergy.org/heat-pump-water-heater/>.

SBW Consulting, Inc. 2022. *Water-Energy Calculator 2.0 Project Report*. Project Report, San Francisco: California Public Utility Commission.

State of California. n.d. *Employment Development Department, Quarterly Census of Employment and Wages (data search tool)*. Accessed September 1, 2022. <https://www.labormarketinfo.edd.ca.gov/cgi/dataanalysis/areaselection.asp?tablename=industry>.

Taylor Engineering. 2025. *Stakeholder Meeting 4: Covered Processes, NR Envelope, NR Water Heating* (October 22nd).

Appendix A: Technical Summary of HPWH Ventilation Effects on Performance

This section summarizes of the [Larson and Larson, Heat Pump Water Heaters in Small Spaces Lab Testing: "The Amazing Shrinking Room"](#) study funded by the Northwest Energy Efficiency Alliance (NEEA) in 2022 with key findings relative to the CASE report highlighted here. Please refer to the full report for more details. This section was added to provide a summary of key content that is reference within the body of the CASE report, without having to provide the details in the body.

The goal of the “The Amazing Shrinking Room” lab evaluation was to quantify how HPWH efficiency changes in different sized rooms and how different ventilation configurations impact efficiency.

A photo of the basic room configuration is shown here:



Figure 4. Shrinking Room HPWH Location (left) and Overall 960 Cubic Foot Room within the Lab Space (Right)

The test setup included a freestanding room with adjustable size through removable walls to evaluate HPWH performance when operating in room sizes of 83.5, 200, 453, 707 and 960 cubic feet. These different room sizes were chosen to represent common HPWH installation space from a small closet to basement or mechanical room. Fourteen different ventilation configurations (identified as “interventions” in the report) were implemented to determine HPWH performance in the 83.5 cubic foot room and one ventilation configuration in a 200 cubic foot room see Figure 5. The free standing room was located inside a lab space with an average temperature of 67.2 degrees Fahrenheit, although there were small variations during the tests.

Ventilation configurations evaluated are as follows:

- Duct-SmMakeup-Full: Straight 8-inch diameter exhaust duct and a floor slot representative of a door undercut with a NFA of 18 square inches.
- Duct-LgMakeup-Full: Straight 8-inch diameter exhaust duct and wall grill in the upper part of the wall with a NFA of 130 square inches.
- Duct-LgMakeup-Half: Straight 8-inch diameter exhaust duct that is 50 percent blocked off and wall grill in the upper part of the wall with an NFA of 130 square inches.
- DirectedExhaust: HPWH exhaust rotated to face an upper louver panel on the door with an NFA of 129 square inches and a floor slot representative of a door undercut with a NFA of 18 square inches.
- Shelf: Upper door holes covered with a wire mesh with a NFA of 25 square inches, a shelf that separates the upper section of the room with the HPWH intake from the exhaust section of the HPWH where lower door holes covered with a wire mesh with a NFA of 25 square inches.
- Louvers-Full: A fully louvered door with a NFA of 218 square inches.
- Louvers-Half: Half of the width of the fully louvered door for a NFA of 109 square inches.
- Doorstop: 1-1/2 inch gap between the door and the door jamb for a NFA of 114 square inches.
- Grille-Upper: A single upper wall grille with a NFA of 130 square inches.
- Grille-Lower: A single lower wall grille with a NFA of 130 square inches.
- Grilles-Both: A lower wall grille with a NFA of 130 square inches and the same size lower wall grille.
- Grilles-Both(200): A lower wall grille with a NFA of 130 square inches and the same size lower wall grille in a 200 cubic foot room instead of the 83.5 cubic foot room used for the other tests.
- VentCaps-HighNFA: Upper door holes covered with wire mesh with a NFA of 25 square inches and the same size lower door holes with wire mesh.
- VentCaps-LowNFA: Upper door holes covered with plastic vent caps with a NFA of 11 square inches and the same size lower door holes of the same size covered with plastic vent caps.
- DownElbow: 90 degree elbow on the exhaust of the HPWH to direct cold air to the bottom of the small closet.

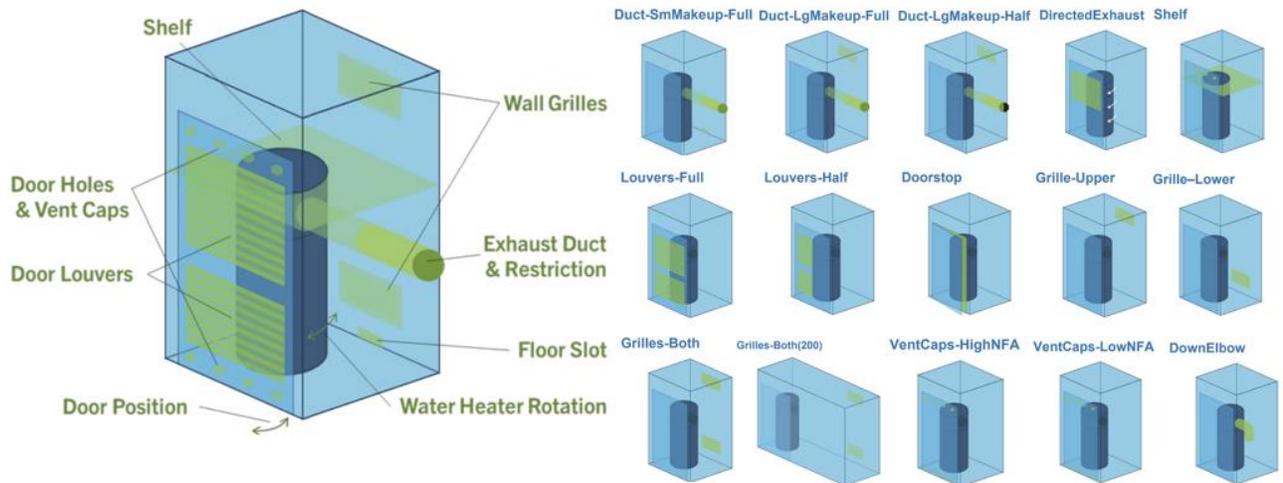


Figure 5. HPWH Ventilation Test Configurations Where Green Surfaces Indicate Ventilation Locations

Data collected during this lab testing included air temperatures, water temperature and flow sensors, HPWH condenser coil airflow rate and electrical energy used by the HPWH.

The test configurations most relevant to this 2028 CASE Report include:

- Grille–Lower: This ventilation configuration is representative of a HPWH installed as a retrofit for a gas water heater in a small room that uses airflow from outside or a communicating space via a grille low on the wall.
- Duct-SmMakeup-Full: This ventilation configuration is representative to a HPWH installed in a small room that uses airflow from a communicating space via door undercut for the intake air and an 8-inch diameter duct connected to the same communicating space to keep cold exhaust air out of the small room. This is one of the compliance paths proposed in this 2028 code change proposal.
- Louvers-Full: This ventilation configuration is representative of a HPWH installed in a small room that uses a fully louvered door to exchange air with outside or a communicating space. This is one of the compliance paths in the 2025 energy code, but is proposed to be removed in the 2028 HPWH ventilation clean-up proposal.
- Duct-LgMakeup-Half: This ventilation configuration is representative of a HPWH installed in a small room that uses airflow from a communicating space via door undercut for the intake air and an 8-inch diameter duct connected to the same communicating space to keep cold exhaust air out of the small room. In this case the 50 percent blocked duct is meant to represent a long duct, a ducts with many bends or a duct that is smaller than is designed for the HPWH which causes extra head pressure and reduced airflow.

The HPWH efficiency testing involved operating the HPWH with an 18 hour water demand profile under both high use (84 gallons total) and medium use (55 gallons total) draw schedule for each of the different sized rooms. All of the HPWH ventilation configuration tests used the medium demand water draw profile. The draw profiles are shown in Figure 6.

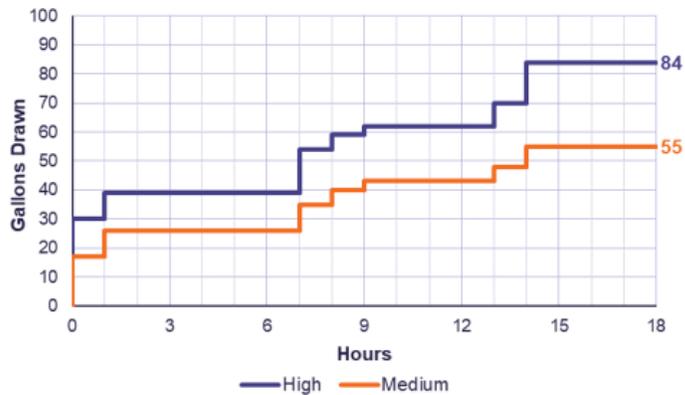


Figure 6. HPWH Water Draw Profiles Used During Testing

Key results related to HPWH room size and ventilation configuration include the following:

- HPWH exhaust air is typically ten degrees Fahrenheit cooler than the intake air.
- The size of the room must be larger than 450 to 700 cubic feet depending on the compressor size to prevent the room from being excessively cooled by the HPWH exhaust air. HPWH performance decreases by 6 to 54 percent in these small room cases without proper ventilation⁸. As the room size decreased, the minimum air temperature in the room was 14, 14, 18, 22 and 33 degrees lower than the average temperature of the lab space surrounding the room for the room sizes of 1000, 700, 450, 200 and 84 cubic feet respectively during the 18 hours of water draws.
- A HPWH installed in an 84 cubic foot room with a fully louvered door (286 square inch NFA) has a six percent lower COP than a HPWH with a floor slot (18 square inch NFA) and an 8-inch diameter exhaust duct.
- A HPWH installed in an 84 cubic foot room with a grill in the lower part of the wall/door (130 square inch NFA) has a 54 percent lower COP than a HPWH with a floor slot (18 square inch NFA) and an 8-inch diameter exhaust duct.
- A HPWH with an axial fan connected to an 8-inch diameter exhaust duct that is fifty percent blocked while an upper wall grill (130 square inches of NFA) is used for the intake has a 36 percent lower COP than an unrestricted 8-inch exhaust duct while an upper wall grill (130 square inches of NFA) is used for the intake. The 50 percent

⁸ These results were based on a 55 gallon water draw per day. Larger water draw days will have a larger penalty for sub optimal ventilation approaches.

blocked case is intended to represent airflow restrictions from too many bends in the duct, small diameter ducts, and long duct lengths.

- Table 9 of the report provides a range of 125 to 315 dollars for labor and 235 to 575 dollars for components to install HPWH ducts.

Appendix B: Assumptions for Cost-effectiveness Analysis

This section details the assumptions for the cost-effectiveness evaluation of the proposed HPWH ventilation clean-up measure for nonresidential buildings code measure in the following topics: Key Assumptions for Energy Savings Analysis and Energy Savings Methodology per Prototypical Building.

Key Assumptions for Energy Savings Analysis

The energy savings for the HPWH ventilation clean-up measure evaluates the benefits of implementing both intake and exhaust ducts that vent to the outdoors instead of only one duct (intake or exhaust venting to the outdoors). Two nonresidential building types were used for this analysis including small office and quick service restaurant buildings defined for climate zone twelve. Weather files for all sixteen climate zones were evaluated to identify if there were any climate zones that result in no savings. It is assumed that both new construction and alterations will have the same HPWH performance because the effect that the building envelope change will have on the HPWH will be insignificant.

HPWH storage capacities were selected by running CBECC simulations with minimally compliant buildings for both small office and quick service restaurants in climate zone 12 for HPWHs rated with a 380 Watt compressor, UEF of 3.62 and storage tank size of 40, 50, 65 or 80 gallons with first hour ratings of 58, 63, 77 and 87 gallons respectively. These sizes and ratings were gathered from the consumer integrated HPWHs listed on the EnergyStar database and MAEDbS database⁹. The CBECC models were run with each HPWH size until a large enough HPWH tank size was chosen to provide enough hot water for the demand in that building. Then, the model with the HPWH operating with zone air temperature for the HPWH air intake and exhaust back into the zone was exported and edited in EnergyPlus to include outdoor air temperatures for the HPWH intake and an exhaust to outside.

Two standard designs were used, both have one HPWH ventilation duct but one has an intake ventilation duct to the outdoors and an exhaust into the building without a duct while the other standard design has one exhaust ventilation duct to the outdoors and an intake inside the building without a duct. The corresponding exhaust and intake without a duct connect to the installation space's air conditions. The proposed design was the same model just without airflow crossing the pressure boundary by using either a dual ducted HPWH with ducts connecting to the outdoors or a HPWH with dual ducts connecting to a communicating space within the building. A HPWH with both intake and exhaust ducts results in negligible room air temperature changes while the HPWH is operating because no air from the outdoors enters the room directly, only within the ventilation ducts.

⁹ <https://cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx>

The standard design with a single intake duct connecting to the outdoors based on the dual duct HPWH building model with the addition of a heat transfer calculation to quantify heating and cooling energy needed to account for the airflow into the building through the exhaust of the HPWH and air exiting the building at the zone air temperature. It was assumed that there was a 10°F temperature drop across the HPWH condenser so air that enters the building is 10°F lower than the outdoor air temperature when the compressor is running and that same mass of air leaves the building at the zone air temperature. The HPWH compressor does not operate below the 37°F intake cutoff temperature. This airflow occurred only when the HPWH consumed a power value greater than zero (i.e. it followed the HPWH schedule) in the model which equated to approximately 44 CFM on average during each 24-hour day. The models were run with HPWH intake temperatures equal to the hourly value from the 2029 weather data files for each climate zone to determine HPWH energy consumption during one full year of operation to quantify the negative effect on space temperature which resulted in more heating load in the building in the standard design with a single duct connected to outside than the proposed design with dual ducts to outside.

Opposite of the single intake duct standard design, the single exhaust duct standard design is based on the unducted HPWH building model with the addition of a heat transfer calculation to quantify heating and cooling energy needed to account for the airflow entering the building and leaving the building through the exhaust of the HPWH. It was assumed that outdoor air is pulled into the building at the outdoor air temperature and the same mass of air at the zone temperature is exhausted outside.

Energy Savings Methodology per Prototypical Building

The 2028 CASE Methodology Report provides details on estimating energy savings per prototypical building and unit. The CEC directed the Statewide CASE Team to model energy impacts using specific prototypical building models that represent typical building geometries for different building types. Table 44 presents the prototype buildings used in the analysis.

Table 44: Prototype Buildings Used for Energy, Demand, Cost, and Environmental Impacts Analysis

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
Standard Design – Small Office – Exhaust Duct	1	5500	The small office prototype is the same as the proposed design with an intake and exhaust duct connected to a communicating space, except a heat transfer calculation was then used to quantify heating and cooling energy needed to account for the airflow into the building at the outdoor conditions that is mixed with the indoor air and later exits the building through the HPWH exhaust.
Standard Design – Quick	1	2500	The quick service restaurant prototype is the same as the proposed design with an intake and exhaust duct

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
Service Restaurant – Exhaust Duct			connected to a communicating space, except a heat transfer calculation was then used to quantify heating and cooling energy needed to account for the airflow into the building at the outdoor conditions that is mixed with the indoor air and later exits the building through the HPWH exhaust.
Standard Design – Small Office – Intake Duct	1	5500	This prototype is the same as the small office proposed design with an intake and exhaust duct connected to the outdoors, except a heat transfer calculation was then used to quantify heating and cooling energy needed to account for the airflow into the building at 10°F lower than the outdoor air temperature after it passes through the HPWH evaporative coil and air exiting the building at the zone air temperature.
Standard Design – Quick Service Restaurant – Intake Duct	1	2500	This prototype is the same as the quick service restaurant proposed design with an intake and exhaust duct connected to the outdoors, except a heat transfer calculation was then used to quantify heating and cooling energy needed to account for the airflow into the building at 10°F lower than the outdoor air temperature after it passes through the HPWH evaporative coil and air exiting the building at the zone air temperature.
Proposed Design – Small Office – Intake and Exhaust Duct	1	5500	This prototype is the same as the small office proposed design with an intake and exhaust duct to communicating space, but this model was exported and edited in EnergyPlus to include an intake node that matches the outside air conditions and the exhaust is expelled outdoors also.

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
Proposed Design – Quick Service Restaurant – Intake and Exhaust Duct	1	2500	This prototype is the same as the proposed quick service restaurant design with an intake and exhaust duct to communicating space, but this model was exported and edited in EnergyPlus to include an intake node that matches the outside air and the exhaust is expelled outdoors also.
Proposed Design – Small Office – Intake and Exhaust Duct to	1	5500	This prototype is the same as the small office CBECC model with minimally compliant systems. The water heater was modified to include a 50 gallon integrated HPWH located inside the smallest building zone where the intake and the exhaust for the HPWH use the zone air conditions. It was assumed that duct

Prototype Name	Number of Stories	Floor Area (Square Feet)	Description
Communicating Space			heat transfer losses would be negligible in this case.
Proposed Design – Quick Service Restaurant – Intake and Exhaust Duct to Communicating Space	1	2500	This prototype is the same as the quick service restaurant CBECC model with minimally compliant systems. The water heater was modified to include two 80 gallon integrated HPWH located inside the smallest building zone where the intake and the exhaust for the HPWH use the zone air conditions. It was assumed that duct heat transfer losses would be negligible in this case.

There is an existing Title 24, Part 6 requirement that covers the HPWH vented with only one duct connected to the outdoors and applies to both new construction/additions and alterations, so the Standard Design is a minimally compliant building with the 2025 Title 24 requirements and a HPWH with an intake duct that connects to the outdoors, but an exhaust duct the delivers air into the room. The HPWH compressor power rating, tank size and UEF rating were also specified.

The Proposed Design was identical to the Standard Design in all ways except for the revisions that represent the proposed changes to the code. Table 45 presents the parameters modified and the values used in the Standard Design and Proposed Design. Specifically, the proposed conditions assume that there is no airflow entering the building from outside, it is contained within the ducting to the HPWH because this is a balance ventilation system.

Table 45: Modifications Made to Standard Design in Each Prototype to Simulate Proposed Code Change

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
Standard Design – Small Office – Intake Duct	All	Airflow into HPWH room	M _{OutdoorAir}	M _{OutdoorAir} = 40CFM	M _{OutdoorAir} = 40CFM
		HPWH intake air Temp.	T _{IntakeAir}	T _{IntakeAir} = {Outside Air Temp}	T _{IntakeAir} = {Outside Air Temp}
Standard Design – Quick Service Restaurant – Intake Duct	All	Airflow into HPWH room	M _{OutdoorAir}	M _{OutdoorAir} = 40CFM	M _{OutdoorAir} = 40CFM
		HPWH intake air Temp.	T _{IntakeAir}	T _{IntakeAir} = {Outside Air Temp}	T _{IntakeAir} = {Outside Air Temp}
Standard Design – Small	All	Airflow into HPWH room	M _{OutdoorAir}	M _{OutdoorAir} = -40CFM	M _{OutdoorAir} = -40CFM

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
Office – Exhaust Duct		HPWH intake air Temp.	T _{IntakeAir}	T _{IntakeAir} = {Zone Air Temp}	T _{IntakeAir} = {Zone Air Temp}
Standard Design – Quick Service Restaurant – Exhaust Duct	All	Airflow into HPWH room HPWH intake air Temp.	M _{OutdoorAir} T _{IntakeAir}	M _{OutdoorAir} = -40CFM T _{IntakeAir} = {Zone Air Temp}	M _{OutdoorAir} = -40CFM T _{IntakeAir} = {Zone Air Temp}
Proposed Design – Small Office – Intake and Exhaust Ducts	All	Airflow into HPWH room HPWH intake air Temp.	M _{OutdoorAir} T _{IntakeAir}	M _{OutdoorAir} = 40CFM T _{IntakeAir} = {Outside Air Temp}	M _{OutdoorAir} = 0CFM T _{IntakeAir} = {Outside Air Temp}
Proposed Design – Quick Service Restaurant – Intake and Exhaust Ducts	All	Airflow into HPWH room HPWH intake air Temp.	M _{OutdoorAir} T _{IntakeAir}	M _{OutdoorAir} = 40CFM T _{IntakeAir} = {Outside Air Temp}	M _{OutdoorAir} = 0CFM T _{IntakeAir} = {Outside Air Temp}
Proposed Design – Small Office – Intake and Exhaust Duct to Communicating Space	All	Airflow into HPWH room HPWH intake air Temp.	M _{OutdoorAir} T _{IntakeAir}	M _{OutdoorAir} = 40CFM T _{IntakeAir} = {Zone Air Temp}	M _{OutdoorAir} = 0CFM T _{IntakeAir} = {Zone Air Temp}

Prototype ID	Climate Zone	Objects Modified	Parameter Name	Standard Design Parameter Value	Proposed Design Parameter Value
Proposed Design – Quick Service Restaurant – Intake and Exhaust Duct to Communicating Space	All	Airflow into HPWH room HPWH intake air Temp.	M _{OutdoorAir} T _{IntakeAir}	M _{OutdoorAir} = 40CFM T _{IntakeAir} = {Zone Air Temp}	M _{OutdoorAir} = 0CFM T _{IntakeAir} = {Zone Air Temp}

The energy impacts of the proposed code change do vary by climate zone. The Statewide CASE Team simulated the energy impacts in climate zone 12 then ran this mode with

weather files from all 16 climate zones and applied the climate-zone- specific LSC hourly factors when calculating energy and LSC impacts.

Appendix C: Purpose and Necessity of Proposed Code Changes

Introduction

The sections below provide the purpose and necessity of proposed changes to Title 24, Part 1; Title 24, Part 6; and the reference appendices. This section intends to provide the CEC with the information needed for the Initial Statement of Reasons.

See Section 7 of this report for marked-up code language.

Purpose and Necessity of Changes to Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

Purpose and Necessity of Changes to Title 24, Part 6

The purpose and necessity of changes to Title 24, Part 6 include the following:

Section: 110.3(c)7B

Purpose: The purpose of this change is to simplify the four existing compliance pathways implemented in the 2025 code to make unitary HPWH installation decision making simpler, as well as improving consumer-sized HPWH performance in nonresidential buildings.

Under the 2025 code, allowed methods of providing ventilation air included those approved by the manufacturer, installing the unit in a large unvented room of minimum size, installing in a closet with minimum ventilation area to adjacent spaces, and directly ducting the unit. The Statewide CASE Team recommends improvements to this code language for clarity and adjustments to requirements to reflect new research and better align with other codes in development. This proposal also recommends eliminating two ducting configurations from the 2025 code: inlet air ducted from outside with no exhaust duct and exhaust air ducted to outside with no inlet duct and remove the option to use wall/door louvers to connect to a communicating space.

Necessity: The necessity for this change is to remove the possibility for ingress of moisture, airborne particulates, gases, and bacteria among other health and safety concerns caused by intake ducts connected to outdoor vents and increased space conditioning load impacts when only one duct is used or condensation on nearby surfaces when a HPWH is in a small room and relying on a louvered wall/door to exchange exhaust air with a connecting space. In addition, the acceptance of HPWHs will increase because of proper HPWH ventilation.

Purpose and Necessity of Changes to the Reference Appendices

There are no proposed changes to reference appendices.

Appendix D: Assumptions for Statewide Savings Estimates

The Statewide CASE Team is anticipating updated construction forecasts to be released by the California Energy Commission in February 2026. This will impact statewide energy savings but not the cost effectiveness of the proposal. The final CASE Report will present the updated savings based on the new forecasts.

Once energy savings values were tabulated, the energy savings were weighted for each climate zone based on the new construction data provided by the CEC, and the existing buildings floor space data available for each climate zone divided by 2500 square feet for quick service restaurants and 5500 square feet for small office building to provide the total number of buildings instead of total square feet of buildings.

The Statewide CASE Team estimated statewide impacts for the first year by multiplying per-unit savings estimates by statewide construction forecasts provided by the CEC. The 2028 CASE Methodology Report includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

The statewide savings and cost estimates take the current market share rate into account. The Statewide CASE Team estimated that there is a negligible percent of current market share for the proposed code change for the new construction market and for the retrofit market. The current market share rate was estimated based on interviews with researchers and installers. Retrofit market adoption is expected to reach eighty percent of retrofit installations due to small business owners installing HPWHs themselves or installations taking place without knowledge of the updated code language based on Statewide CASE Team's professional judgment.

Table 46 presents the projected nonresidential new construction that the proposed code change will impact in 2026. Table 47 shows the projected nonresidential existing statewide building stock that the proposed code change would affect through alterations in 2026. The Statewide CASE Team developed these estimates using the methods described in this section.

The Statewide CASE Team estimated the percentage of newly constructed floor space that the proposed code change would impact. Table 48 shows the assumed percentage of affected floor space by building type. If a proposed code change does not apply to a specific building type, the Statewide CASE Team assumes that zero percent of the floor space would be impacted. If the assumed percentage is non-zero, but less than 100 percent, the proposal is expected to affect some—but not all—buildings. Table 49 represents the assumed percentage of affected floorspace by climate zone.

Table 46: Estimated New Nonresidential Construction Impacted by Proposed Code Change in 2026, by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Small Office	0.01	0.30	0.13	0.01	0.04	0.10	0.16	0.11	0.25	0.29	0.06	0.38	0.27	0.03	0.07	0.02	2.25
Restaurant	0.01	0.06	0.23	0.12	0.02	0.24	0.14	0.35	0.57	0.29	0.05	0.22	0.10	0.07	0.03	0.02	2.52
TOTAL	0.02	0.36	0.36	0.13	0.06	0.34	0.3	0.46	0.82	0.58	0.11	0.6	0.37	0.1	0.1	0.04	4.77

Table 47: Estimated Existing Nonresidential Floorspace Impacted by Proposed Code Change in 2026 (Alterations), by Climate Zone and Building Type (Million Square Feet)

Building Type	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Small Office	3.34	10.20	17.75	9.06	6.00	10.58	6.81	10.62	16.70	19.54	8.48	35.15	17.18	3.99	4.94	2.14	182.51
Restaurant	0.49	2.89	11.78	6.00	1.24	13.17	8.58	19.02	32.00	25.93	2.81	13.56	6.19	5.49	2.76	1.52	153.42
TOTAL	3.83	13.09	29.53	15.06	7.24	23.75	15.39	29.64	48.7	45.47	11.29	48.71	23.37	9.48	7.7	3.66	335.93

Table 48: Percentage of Nonresidential Floorspace Impacted by Proposed Code Change in 2026, by Building Type

Building Type	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
Small Office	4.8%	0.144%
Restaurant	0.048*%	0.014*%

*Assuming 40 percent of restaurant floor space is quick service restaurants.

Table 49: Percentage of Nonresidential Floorspace Impacted by Proposed Measure, by Climate Zone

Climate Zone	New Construction Impacted (Percent Square Footage)	Existing Building Stock (Alterations) Impacted (Percent Square Footage)
1	0.40%	1.82%
2	13.33%	5.54%
3	5.70%	9.63%
4	0.62%	4.92%
5	1.96%	3.26%
6	4.52%	5.74%
7	7.14%	3.70%
8	4.86%	5.77%
9	10.99%	9.06%
10	12.72%	10.61%
11	2.85%	4.60%
12	16.61%	19.08%
13	11.76%	9.32%
14	1.34%	2.16%
15	3.21%	2.68%
16	1.01%	1.16%

Appendix E: Environmental Analysis

This section discusses the California Environmental Quality Act (CEQA)'s requirements for a proposal's potential environmental impacts for the proposed measure with the following topics:

- Potential Significant Environmental Effect of Proposal
- Direct Environmental Impacts (Benefits and Adverse Impacts)
- Indirect Environmental Impacts (Benefits and Adverse Impacts)
- Mitigation Measures
- Reasonable Alternatives to Proposal
- Water Use and Water Quality Impacts Methodology

Each topic is detailed below.

Potential Significant Environmental Effect of Proposal

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal, including—but not limited to—an evaluation of factors contained in the California Code of Regulations, Title 14, section 15064, and has determined that the proposal will not result in a significant effect on the environment.

Direct Environmental Impacts

The proposed measure has direct environmental benefits and minor adverse environmental impacts.

Direct Environmental Benefits

Direct benefits associated with this measure include energy savings, and GHG emission reductions as a result of requiring both intake and exhaust ventilation ducts to terminate outdoors rather than one duct terminating to the outdoors because this increases HPWH efficiency and decreases heating and cooling energy by limiting pressure imbalance (outdoor air ingress into the building and indoor air egress) in the building.

Direct Adverse Environmental Impacts

Direct adverse environmental impacts associated with this measure are GHG emission increases due to the manufacturing of additional components necessary to implement a second ventilation duct for the HPWH. The additional components necessary for this installation include a second ventilation duct, boot, hanger straps, exterior vent, adhesive to provide an air/water seal between the exterior vent and the exterior wall, coupler to connect the vent to the HPWH intake/exhaust port and band clamps or tap to

secure the ventilation ducts to each component while limiting air leakage. Potential mitigation measures are provided below in the section titled “Mitigation Measures.”

Indirect Environmental Impacts

The proposed measure has indirect environmental benefits, but no minor indirect adverse environmental impacts.

Indirect Environmental Benefits

Indirect environmental benefits associated with this measure include reduced manufacturing of drywall and paint products as a result of mitigating HPWH room moisture damage with proper HPWH ventilation to the outdoors. This would impact the need for drywall replacement and repainting.

Indirect Adverse Environmental Impacts

There are no indirect adverse environmental impacts associated with this measure.

Mitigation Measures

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine this measure would result in significant direct or indirect adverse environmental impacts and therefore, did not develop any mitigation measures

Reasonable Alternatives to Proposal

Alternatives to the proposed code change to require both intake and exhaust ducts when ventilating HPWH to the outdoors instead of allowing one duct (intake or exhaust) to the outdoors include: 1) disallowing an intake ventilation duct that connects the HPWH to the outdoors and 2) disallowing dual duct HPWH ventilation configurations altogether. The benefits and adverse impacts of these alternatives to the proposal are detailed below.

Alternate option 1: Disallowing HPWH intake ducts to the outdoors would have the benefit of reducing the manufacture of ducting components because dual ducted HPWHs would not be required, however HPWHs operating with indoor air temperatures instead of outdoor temperature in hot climates year-round will use more energy.

Alternate option 2: Disallowing dual duct installations would have the benefits and adverse impacts of alternate option 1, plus reducing the manufacture of ducting components because dual ducted HPWHs would not be a code compliance option when installing a HPWH in a small room that is intended to be connected to another

room, however HPWHs not all wall/door louver systems are cost effective for small rooms due to custom sizes or construction types. A second duct may be cost effective.

Water Use and Water Quality Impacts Methodology

There are no impacts to water quality or water use.

Appendix F: Summary of Stakeholder Engagement

Introduction to Stakeholder Engagement

Collaborating with stakeholders who may be affected by proposed code changes is a core component of the Statewide CASE Team's process. The Statewide CASE Team engages interested parties to identify and address issues related to the proposals, with the goal of submitting recommendations to the CEC in this Draft CASE Report that reflects broad support. Public stakeholders provide valuable feedback on draft analyses and help identify and address adoption challenges, including cost effectiveness, market and technical barriers, compliance and enforcement, and potential impacts on human health or the environment. Some stakeholders also provide data that the Statewide CASE Team uses to support analyses.

This section summarizes the stakeholder engagement conducted by the Statewide CASE Team during the development and refinement of the report's recommendations.

Utility-Sponsored Stakeholder Meetings

Utility-sponsored stakeholder meetings provide an opportunity to learn about the Statewide CASE Team's role in the advocacy effort and to hear about specific code change proposals that the Statewide CASE Team is pursuing for the 2025 code cycle. The goal of these meetings is to solicit input on proposals from stakeholders early enough to ensure the proposals and the supporting analyses are vetted and have as few outstanding issues as possible. To promote transparency in the development of code change proposals, the Statewide CASE Team uses stakeholder meetings to solicit feedback on:

- Proposed code changes
- Draft code language
- Draft assumptions and results of analysis
- Data to support assumptions
- Compliance and enforcement
- Technical and market feasibility

The Statewide CASE Team hosted one stakeholder meeting for the Nonresidential HPWH ventilation clean-up via webinar, as described in Table 50. Please see below for dates and links to event pages on [Title24Stakeholders.com](https://www.title24stakeholders.com). Materials from each meeting, such as slide presentations, proposal summaries with code language, and meeting notes, are included in the bibliography section of this report.

Table 50: Utility-Sponsored Stakeholder Meetings

Meeting Name and Link to Materials	Meeting Date	Summary of Items Discussed
First Round of Stakeholder Meeting 4: Covered Processes, NR Envelope, NR Water Heating Utility-Sponsored Stakeholder Meeting	Thursday, October 23, 2025	<ul style="list-style-type: none"> • Purpose: Update mandatory HPWH ventilation code language for nonresidential buildings to reflect new research and better align with other codes in development. This measure also recommends eliminating two ducting configurations from the 2025 code: inlet air ducted from outside with no exhaust duct and exhaust ducted to outside with no inlet duct. • Proposed code change • Benefits: Simplify the HPWH ventilation decision-making process, reduce building energy consumption, prevent IAQ issues, remove moisture damage risk, and alleviate health and safety concerns. • Applicable code section • Current market conditions • Market barriers and solutions • Feedback requested: What percentage of new construction small office buildings and quick service restaurants are implementing HPWHs with ventilation ducts? What percentage of retrofit small office buildings and quick service restaurants are implementing HPWHs with ventilation ducts? Are HPWHs with either an intake or an exhaust duct installed more frequently in one of the buildings? • Technical considerations • Modeling assumptions - standard design and proposed design • Compliance verification • Compliance barriers and solutions

The first round of utility-sponsored stakeholder meetings began in October 2025 and served as an early forum to promote transparency and gather stakeholder feedback on measures under consideration by the Statewide CASE Team.

The objectives of the first round of stakeholder meetings were to solicit input on the scope of the 2025 code cycle proposals; request data and feedback on the specific approaches, assumptions, and methodologies for the energy impacts and cost-effectiveness analyses; and understand potential technical and market barriers. The Statewide CASE Team also presented the initial draft code language for stakeholders to review.

Three survey questions were asked during the first stakeholder meeting to quantify the prevalence of HPWHs with either an intake duct or an exhaust duct in small office and quick service restaurant buildings for new construction and alterations and separately for retrofits. The third question asked whether these installations were more common in

small office buildings or quick service restaurants. These three questions aimed to quantify the market share of HPWHs with single ducts that would be required to implement dual ducts if their project occurred in 2028. Three responses were collected for the question about new construction and alterations. The average percent implementation was 8 percent with a range of 0.1 percent to 25 percent of building estimated to have implemented HPWHs with a single duct annually. The retrofit install base provided a lower average from four responses. The average percentage of retrofits was 2.4 percent with a range of 0.1 to 5 percent. Lastly, five stakeholders answered the question about what building type has more HPWH installations with single ducts. The average was two times more installations in quick service restaurants than small offices with a range of ten times more in small offices than quick service restaurants and ten times more in quick service restaurants than small offices.

Utility-sponsored stakeholder meetings were open to the public. For each stakeholder meeting, two promotional emails were distributed from info@title24stakeholders.com. One email was sent to the full Title 24 Stakeholders listserv, which includes over 3,000 individuals. A second email targeted specific recipients based on their subscription preferences.

The Title 24 Stakeholders listserv is an opt-in service comprising participants from a diverse industries and trades, such as manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was announced on the Title 24 Stakeholders LinkedIn page and cross-promoted on the CEC LinkedIn page approximately two weeks in advance to engage individuals, organizations, and broader channels outside beyond the listserv. The Statewide CASE Team conducted extensive personal outreach to stakeholders identified in initial work plans who had not yet opted in to the listserv. Exported webinar meeting data captured attendance numbers, individual comments, and results from live attendee polls to help evaluate stakeholder participation and support.

Statewide CASE Team Communications

The Statewide CASE Team held personal communications over email and phone with numerous stakeholders when developing this report, listed in Table 51.

Table 51: Engaged Stakeholders

Organization/Individual Name	Market Role	Mentioned in CASE Report Sections
CEC	Codes and Standards	1.3
NORESCO	Code Compliance	1.2, 3.1, 3.3, 3.4, 5.1
James Haile, Frontier Energy	HPWH Subject Matter Expert	Provided guidance on code language and benefits sections 7.3 and 2.2 respectively.

Organization/Individual Name	Market Role	Mentioned in CASE Report Sections
Marc Hoeschele, Frontier Energy	HPWH Subject Matter Expert	Provided general guidance throughout the document.
Gary Klein, Gary Klein & Associates	HPWH Subject Matter Expert	2.2, 4.2.2, 6.6
SDG&E	Utility	Summarized in 1.3
Various Plumbers	Plumbers/Installers	Summarized in 1.3 and assumptions in 5.1, 5.2 and 6.1.
Taylor Engineering	Designer	1.3 and influenced decision to add duct length limit to code language in 7.3.
Ben Larson, Larson Energy Research	HPWH Subject Matter Expert	Provided guidance on guidance on code language in section 7.3
Amin Delagah, TRC	HPWH Subject Matter Expert	Provided guidance on section 6.1
Maya Gantley, 2050 Partners	HPWH Subject Matter Expert	Provided guidance on section 6.1

Engagement with ESJ communities

The Statewide CASE team contacted plumbers in ESJ communities via phone to gather installation practices in these communities. The CASE team plans to contact these communities more in 2026.