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HVIâ€™s 2025 T24 Measure Proposal to the CEC HERV Requirements for Single-Family Dwelling Units

HVI appreciates the opportunity to submit a measure proposal to CEC for consideration in the 2025 Title 24 rulemaking process. This proposal would establish requirements for HERVs in single-family homes within the prescriptive path in climate zones where CECâ€™s cost-effectiveness criteria can be achieved.

Additional submitted attachment is included below.

2025 California Energy Code

Measure Proposal to the

California Energy Commission

HERV Requirements for single-family dwelling units

RESIDENTIAL HVAC

Prepared by: The Home Ventilating Institute June 2023

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Document Information

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EXECUTIVE SUMMARY

Introduction

The Home Ventilating Institute (HVI) sponsored this effort. This report proposes specific energy efficiency actions that could result in further reductions of wasteful, uneconomic, inefficient, or unnecessary consumption of energy in the state of California. The code change proposal, or "measure", described in this report is provided to the California Energy Commission (CEC) for consideration and possible inclusion in the California Energy Code (also known as the Energy Code, or Building Energy Efficiency Standards, or Title 24 Part 6). This measure will be considered, may be modified, and could be assembled as part of a comprehensive regulatory package proposed and adopted by the CEC. Measures proposed for inclusion in the Energy Code must be found to be cost-effective and technically feasible.

Code Change Description

This measure seeks to establish prescriptive path requirements for heat recovery ventilators or energy recovery ventilators (HERVs) in single-family homes where cost effectiveness of HERVs can be demonstrated versus an exhaust-only reference system that has a lower first cost.

Scope of Work

HERV Requirements for Single-Family Dwelling Units will modify the Energy Code sections, reference appendices, and supporting documents listed in Table 1.

Table 1: Title 24 Code Change Scope of Work

Affected Parameter	Description
Applicable Climate Zones	Mandatory: All climate zones Prescriptive: Climate zones 1, 2, 5, 11, 12, and 16
Mandatory Measures	150.0(o)1C
Prescriptive Measures	New construction: Section 150.1(c) Additions: 150.2(a)1C Alterations: 150.2(b)1
Performance Measures	Additions: 150.2(a)2C
Appendices	JA15, RA3.7.4.5
ACM Reference Manual	2.4.10
Compliance Software	Standard design modified for applicable climate zones
Compliance Documents	CF1R-ADD-01-E, CF1R-ALT-01-E, CF1R-NCB-01-E, CF2R-MCH-27-H, and CF3R-MCH-27-H
Compliance Manual	Single-Family Residential Sections 4.6.2, 4.6.3

Compliance and Enforcement

Compliance forms will need to be updated to report accessibility of HERVs and presence/absence of a CEC-certified fault indicator display (FID). However, because there are existing mechanisms for FID and accessibility to be reported and inspected, no significant increase in compliance transaction costs is expected. See Section 2.4 for more information.

Market Assessment

CEC has required whole-dwelling unit ventilation systems to be installed in new single-family dwelling units for the past several cycles of Title 24. For single-family homes complying with the prescriptive path of Title 24, this measure would require HERVs to be where cost-effectiveness has been determined in accordance with CEC guidance. Homes complying with the performance path would not be required to install an HERV. HERVs are readily available and can be installed by the trades that currently install whole-dwelling unit ventilation systems using similar components (i.e., electrical connection, fan(s), ducts, terminations, and controllers are components shared by both exhaust systems and HERVs). Significant job creation or job elimination is not expected. See Section 3 for more information.

Cost-effectiveness

Cost-effectiveness is demonstrated for the HERV in Climate Zones 1, 2, 5, 11, 12, and 16 for all prototypes except the 500 ft^2 prototype. For this reason, small dwelling units are proposed to be exempted from this measure. Table 2 summarizes the estimated benefits, costs, and resulting benefit-cost ratio (BCR) by California climate zone (CZ) for the proposed measure when applied to a size-weighted prototype. BCRs greater than or equal to 1.0 are considered cost effective. See Section 4 for more information.

Table 2: Cost-effectiveness Summary

Climate Zone	Benefit: Total Incremental LSC Savings and Other Savings (PV$)	Cost: Total Incremental First Costs and Maintenance Costs (PV$)	Benefit-Cost Ratio (BCR)
Climate Zone 1	$6,864	$2,035	3.4
Climate Zone 2	$3,674	$2,035	1.8
Climate Zone 3	$1,138	$2,035	0.6
Climate Zone 4	$1,438	$2,035	0.7
Climate Zone 5	$2,601	$2,035	1.3
Climate Zone 6	$266	$2,035	0.1
Climate Zone 7	$241	$2,035	0.1
Climate Zone 8	$139	$2,035	0.1
Climate Zone 9	$470	$2,035	0.2
Climate Zone 10	$616	$2,035	0.3
Climate Zone 11	$3,181	$2,035	1.6
Climate Zone 12	$2,988	$2,035	1.5
Climate Zone 13	$900	$2,035	0.4
Climate Zone 14	$1,340	$2,035	0.7
Climate Zone 15	$520	$2,035	0.3
Climate Zone 16	$4,558	$2,035	2.2

Statewide Energy Impacts

Table 3 summarizes the estimated statewide energy savings that will be accrued over the first 30 years of affected dwelling units' useful life, based on the expected single-family starts within the first year that the proposed

measure is implemented. Table 4 summarizes the estimated statewide greenhouse gas (GHG) emissions savings that will be realized in the first year in which this proposed measure is implemented. See Section 5 for more information.

Table 3: "First-Year Savings" – Estimated Statewide Energy Savings over the First 30 Years of Affected Dwelling Units' Useful Life

	First Year Statewide Site Electricity Savings (GWh)	First Year Statewide Power Demand Reduction (MW)	First Year Statewide Site Natural Gas Savings (Million Therms)	First Year Statewide Source Energy Savings (Billion Btu)	First Year Statewide Electricity LSC Savings (Million PV$)	First Year Statewide Natural Gas LSC Savings (Million PV$)	First Year Statewide Total LSC Savings (Million PV$)
HERV	-3.7	-0.4	0.8	70	-23.0	104.9	81.8

Table 4: Estimated Statewide Greenhouse Gas Emission Savings

	First Year Statewide GHG Emission Savings (MT CO_2e/year)	First Year Statewide GHG Emissions Savings (PV$)
HERV	4648	$527,393

ACRONYMS

Acronym	Definition
BCR	Benefit-Cost Ratio
BEM	Building Energy Modeling
BTU	British Thermal Units
CBECC	California Building Energy Code Compliance software
CBECC-Res	California Building Energy Code Compliance software for single-family buildings
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CZ	California Climate Zone

FID	Fault Indicator Display
GHG	Greenhouse Gas
GWh	Gigawatt-Hour
HERV	Heat Recovery Ventilator or Energy Recovery Ventilator
HVAC	Heating, Ventilation and Air Conditioning
HVI	Home Ventilating Institute
IECC	International Energy Conservation Code
kWh	Kilowatt-Hour
kWh/year	Kilowatt-Hour Per Year
LSC	Long-term System Cost (30-year $)
MT CO2e	Metric Tons of Carbon Dioxide Equivalent
MW	Megawatt
P500	CEC's 500 ft^2 prototype
P2100	CEC's 2,100 ft^2 prototype
P2700	CEC's 2,700 ft^2 prototype
PV$	Present Value Dollars
PW	CEC's weighted prototype
RACMRM	Single-Family Residential Alternative Calculation Method Reference Manual
SRE	Sensible Recovery Efficiency

1. INTRODUCTION

This report proposes specific energy efficiency actions that could result in further reductions of wasteful, uneconomic, inefficient, or unnecessary consumption of energy in the state of California. The code change proposal, or "measure", described in this report is provided to the CEC for consideration and possible inclusion in the California Energy Code (also known as the Energy Code, or Building Energy Efficiency Standards, or Title 24 Part 6). This measure will be considered, may be modified, and could be assembled as part of a comprehensive regulatory package proposed and adopted by the CEC. Measures proposed for inclusion in the Energy Code must be found to be cost-effective and technically feasible.

Consistent with California Law (Public Resources Code 25000), an energy efficiency measure is cost-effective if the BCR is 1.0 or greater, when amortized over the economic life of the structure. BCR is calculated by dividing the total dollar benefit of the measure by the total dollar cost of the measure, over a period of analysis of 30 years.

To calculate benefit, Long-term System Cost (LSC) is used to determine the dollar value of energy efficiency measures in the Energy Code. LSC hourly factors help the state account for long-term benefits associated with policies needed to meet the statewide climate actions goals – such as 100% renewable generation, proliferation of electric transportation, and drastic reductions in fossil fuel combustion occurring in buildings. Today's energy costs do not adequately account for these long-term values to California's energy system. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are more valuable, and times off-peak demand are less valuable. LSC hourly factors are not utility rates or energy rate forecasts. LSC is not a predicted utility bill.

LSC hourly conversion factors are developed and published by the CEC for each code cycle. These LSC hourly factors are used to convert predicted site energy use – an output common to building energy modeling (BEM) software – to 30-year present value to California's energy system.

Energy savings for proposed measures are estimated using both LSC hourly factors and CEC-established model prototypes. Large sets of survey data are used to create prototypes that act as averaged representations of common building types in California. These prototypes are created for use in BEM software to provide accuracy and consistency amongst energy models that are used to determine energy savings for the state. CEC-developed prototypes and LSC hourly factors are published by the CEC ahead of each code cycle integral to research versions of CEC's reference Energy Code

compliance software (CBECC-Res and CBECC). For this reason, CBECC-Res and CBECC are the CEC-recommended BEM software tool when assessing energy savings of proposed measures. This proposal relies on simulations performed using CBECC-Res 2025.0.2 RV.

To calculate cost, first costs and ongoing maintenance costs must be assessed for proposed measures and accounted for over a period of analysis of 30 years. In the BCR, both the benefits and the costs are assessed incrementally, meaning in comparison to the latest adopted version of the Energy Code.

Similar to LSC hourly factors, the CEC develops and publishes conversion factors for Source Energy, and for GHG Emissions for each code cycle. These three sets of hourly factors are published on CEC's website and formatted to be accessible and usable in combination with broadly available BEM tools.

2. MEASURE DESCRIPTION

This measure proposes requirements for HERVs within Title 24's prescriptive compliance paths for single-family homes. Title 24 has required whole-dwelling unit ventilation for such homes for the past several cycles but, for systems other than central fan integrated systems, has not addressed the energy use associated with these systems. Affected sections include 150.0(o)1c, 150.1(c)10, 150.2(a)1C, 150.2(a)2C, 150.2(b)1, JA15, RA3.7.4.5, Single-Family Residential Alternative Calculation Method Reference Manual (RACMRM) 2.4.10, and multiple compliance documents.

The reference system assumed for the measure is an ENERGY STAR, exhaust-only, whole-dwelling unit ventilation system, which is the most ubiquitous whole-dwelling unit ventilation system specified for single-family homes in California, complies with the Title 20 minimum requirements for bathroom exhaust fans, and has the lowest first cost across available system types. The proposed system is an HERV with a CEC-certified FID. The specification of an HERV affects a home's consumption of ventilation fan energy, space heating energy, and cooling energy. Energy savings attributed to HERVs are affected by the climate zone (higher savings in more extreme climates), the performance of the HERV (e.g., fan efficacy and heat/energy transfer effectiveness), the number of exhaust fans that can be replaced by the HERV, and the performance of the space heating and cooling equipment, among other variables. The combined effect of these variables on total HERV energy savings is estimated using CBECC-Res BEM software.

2.1 Measure Modifications to Energy Code Documents

This section provides descriptions of how the proposed measure will affect each Energy Code document. See Section 6 for detailed revisions to code language.

2.1.1 Energy Code Change Summary

Section 150.0(o)1Civ: This section stipulates mandatory requirements for balanced and supply ventilation systems that are primarily derived from the 2022 RACMRM and from the California Mechanical Code. The language is also generally aligned with CASE's proposed language (Goebes et al., 2023).

Section 150.1(c)10A: This section introduces single-family, new construction, prescriptive path requirements for HERVs in climate zones where they are shown to be cost-effective (i.e., 1, 2, 5, 11, 12, and 16); also established are sensible recovery efficiency (SRE), FID, and fan efficacy criteria for prescriptive path compliance. Fan efficacy and SRE criteria are stipulated to align with existing prescriptive requirements for HERVs serving dwelling units of multi-family

buildings in Title 24 Section 170.2(c)3Biv. The 2022 RACMRM notes that the "standard design… incorporates an FID." By introducing a requirement for an HERV FID in the prescriptive path, this proposed change supports alignment between the prescriptive path and the RACMRM. An exception is added for dwelling units with a floor area of 500 ft^2 or less because cost effectiveness was not demonstrated for the 500 ft^2 prototype.

Section 150.1(c)10B: The 2022 RACMRM notes that the "standard design… incorporates an FID." This subsection introduces a requirement for a supply fan FID in the prescriptive path, which supports alignment between the prescriptive path and the RACMRM.

Table 150.1-A: A row is added for ventilation systems to communicate that the system shall comply with Section 150.1(c)10. The row for central fan integrated ventilation systems is deleted because it is now covered within Section 150.1(c)10.

Section 150.2(a)1Ci: This section contains prescriptive requirements for additions. No requirements for HERVs are proposed for additions to existing dwelling units. Where a whole-dwelling unit ventilation system is required, the builder may specify an exhaust, supply, or balanced system with or without heat recovery. The specified system must comply with any minimum prescriptive path requirements for the system located in Section 150.1(c)10. Where a new dwelling unit is constructed as an addition to an existing building, the dwelling unit's whole-dwelling unit ventilation system would need to comply with the prescriptive requirements for whole-dwelling unit ventilation systems of new dwelling units in Section 150.1(c)10. Note that an HERV would not be required for dwelling units up to 500 ft^2. References to Sections 150.0(o)1E and 150.0(o)1F are deleted because there are no such sections in Title 24.

Section 150.2(a)1Cii: References to Sections 150.0(o)1E and 150.0(o)1F are deleted because there are no such sections in Title 24.

Section 150.2(b)1: This section contains prescriptive path requirements for alterations. The language is amended to require that where an HERV was required within a previous building permit, the replacement system must be an HERV complying with Section 150.1(c)10. In 2022 Title 24, existing requirements for alterations that are contingent upon requirements of a previous building permit include whole-dwelling unit ventilation airflow, ventilation system air filtration, and kitchen local exhaust.

2.1.2 Reference Appendices Change Summary

JA15: The RACMRM requirements for certified FIDs are relocated to Reference Appendix JA15. This aligns with CASE's proposal (Goebes et al., 2023) and

provides a framework to easily reference FID requirements from the single-family and multi-family compliance paths.

2.1.3 Compliance Manuals Change Summary

The changes proposed for the Single-Family Residential Compliance Manual clarify where an HERV is required and the information that must be recorded for whole-dwelling unit ventilation systems.

2.1.4 ACM Reference Manuals Change Summary

The text in Section 2.4.10 of the RACMRM related to FID qualification criteria is deleted and moved to Reference Appendix JA15.

2.1.5 Compliance Forms Change Summary

CF1R-ADD-01-E Prescriptive Residential Additions 1,000 Ft^2 or Less: Add a reference to Section 150.2(a)1C for IAQ requirements and provide a summary of proposed requirements and exceptions.

CF1R-ALT-01-E Prescriptive Residential Alterations: Add references to Section 150.2(b)1 for IAQ requirements and provide a summary of proposed requirements and exceptions. Provide inputs for IAQ system parameters.

CF1R-NCB-01-E Prescriptive Newly Constructed Building: Communicate proposed requirements for the IAQ system that are applicable to supply (including central fan integrated) and balanced whole-dwelling unit ventilation systems. Add inputs for FID and HERV SRE.

CF2R-MCH-27-H and CF3R-MCH-27-H, Indoor Air Quality and Mechanical Ventilation: Add inputs for FID and HERV SRE.

2.2 Measure Context

2.2.1 Comparable Model Code or Standard

Prescriptive path requirements for HERVs in dwelling units are included in the International Energy Conservation Code (IECC) and in ASHRAE 90.1.

2.2.2 Conflicts with Other Regulations or Certifications

There are no known conflicts with other regulations or certifications. The prescriptive path requirements for HERVs proposed in this measure go beyond the minimum prescriptive path requirements of the IECC for single-family homes, but this is supported by a cost-effectiveness analysis that complies with CEC requirements.

2.3 Compliance and Enforcement

Existing compliance forms will need to be modified to align with changes in the RACMRM that were made by CEC following the completion of the Title 24 2022 rulemaking. Namely, the RACMRM currently requires that the accessibility of supply and balanced systems and the presence/absence of an FID certified to the Energy Commission be determined as a precondition to receiving credit for improved energy performance of such systems versus the standard design. To align the compliance forms with the RACMRM, compliance forms are expected to be updated to clarify that the HERS Rater is responsible for field-verifying the FID and that the building inspector is responsible for field verifying compliance with accessibility requirements. Because there are existing mechanisms for FID and accessibility to be reported and inspected, no significant increase in compliance transaction costs is expected.

3. MARKET AND ECONOMIC ANALYSIS

For the proposed measure, this section provides the author's assessment of product availability, incremental cost, potential market size, and potential economic and fiscal impacts to the state – including potential impacts on the creation or elimination of jobs in the state.

3.1 Market Structure and Availability

Installation of whole-dwelling unit mechanical ventilation has been a pillar of Title 24 compliance for the past several cycles. This proposal would add a prescriptive path requirement for a certain type of whole-dwelling unit mechanical ventilation, HERVs, in select climate zones where cost effectiveness is demonstrated. Builders who elect to follow the performance path (approximately 99% of dwelling units; Goebes et al., 2023) will continue to have options to install exhaust, supply, and balanced ventilation systems without heat recovery. Builders electing to specify an HERV should encounter a robust market structure to support them in this choice, with many options for product specification and installation across manufacturers, suppliers, and contractors. Builders following the prescriptive path (~1% of dwelling units) would be required to specify an FID with the HERV, which would result in fewer product choices, but CEC's database of certified FIDs currently contains three manufacturers providing a total of 72 options of models and eligible controls, and more are expected to be added prior to the effective date of the 2025 version of Title 24.

3.2 Design and Construction Practices

HERVs are commonly installed near space heating and cooling equipment, which is typically located in an attic or in a mechanical closet. Locating an HERV in an attic or behind a ceiling-mounted panel that is accessible from living space can maximize the occupiable space available in a home. Because these units have very low power consumption (e.g., less than 60 watts at typical airflow rates for HERVs meeting the minimum proposed fan efficacy requirements), electrical service needs are minimal. Occupant comfort is supported by tempering the outdoor air via heat recovery from the exhaust air stream prior to its delivery. As compared to exhaust-only ventilation, an HERV can also support improvements in indoor air quality by providing outdoor ventilation air from a known source instead of providing ventilation air from the path of least resistance, which could be an adjacent garage, attic, crawlspace, or attached dwelling unit.

3.3 Impacts on Market Actors

Where implemented, this measure would increase first costs by a weighted average of $1,358 over the prototypes modeled, or $87 annually, assuming a 30-year mortgage with a 5% interest rate. Maintenance costs add another $7 per year in the year of implementation. These costs are offset by monetized energy savings of $18 - $94 in the year of implementation, assuming rates of $0.26/kWh for electricity and $1.98/therm (based on U.S. Energy Information Administration data from 2022 for the State of California; EIA 2023a, 2023b). Looking more broadly, the monetized savings to California's energy system in the year of implementation could be estimated as $129 - $340 (i.e., by solving for the year-zero value of the LSC derived from the 30-year LSC using a 3% discount rate), in the climate zones addressed by this measure (i.e., 1, 2, 5, 11, 12, and 16). Additionally, because the measure is proposed for the prescriptive path, market actors will have an opportunity to continue to specify their ventilation system of choice (i.e., no HERV required) where they are able to achieve the minimum energy performance requirements of the performance path, providing them with additional flexibility to pursue other energy efficiency measures at their discretion.

Like all ventilation systems, an HERV system requires maintenance. Where an HERV is specified, building owners or occupants will need to replace filters and occasionally vacuum the core. The frequency with which filters need to be replaced and the cost of replacement filters can be mitigated by specifying a filter box accepting larger filters than can be accommodated within HERVs. See the section on Incremental Maintenance Costs for more information.

Impacts on builders, developers, and designers are expected to be minimal. Builders are already required to specify whole-dwelling unit ventilation systems for new dwelling units, and HERVs can be specified using widely available materials and components without affecting usable space. Training may be needed for contractors who are unfamiliar with installing HERVs, but the transition to HERVs from other ventilation systems should not be excessively disruptive, because most of the components of the system from an installer's and builder's perspective are similar (i.e., electrical connection, fan(s), ducts, terminations, and controllers are components of exhaust systems and HERVs).

As compared to the installation of an exhaust system, additional considerations are needed regarding locating the HERV, locating the outdoor air intake, and locating the outdoor air supply grille. The accessibility requirements associated with this proposal are based on current requirements for achieving HERV energy performance credits in the ACM and are meant to align with the 2025 Title 24 CASE proposal on this topic (Goebes et al. 2023); they should therefore not be disruptive to current industry practice.

3.4 Impacts on Jobs and Businesses

The effect of this measure on jobs and businesses in California is expected to be minimal because whole-dwelling unit mechanical ventilation systems are already required by Title 24, and the same trades that are involved in the installation of Heating, Ventilation, and Air Conditioning (HVAC) systems should continue to be involved in the installation of HVAC systems moving forward. In some cases, the trades that install the whole-dwelling unit mechanical ventilation system could change, resulting in shifting revenue from one trade to another (e.g., where an electrician currently installs all the exhaust ventilation systems in a home, the HVAC contractor may begin installing the HERV). However, trades that wish to retain current work related to ventilation system installation could train personnel to install HERVs if desired. Significant job creation or elimination is therefore not expected either inside or outside the state. That said, studies have reported that energy efficiency measures can generate between 0.17 and 0.59 net job-years per GWh saved (Wei et al., 2009). For context, CASE (Goebes et al. 2023) recently estimated approximately 300 jobs would be created by a similar measure (i.e., a prescriptive path requirement for HERVs in multi-family dwelling units combined with compartmentalization).

No effects on small business are anticipated. The measure is also not expected to effect California businesses disproportionately in comparison to competing businesses located outside the state, as, where applied, the conditions of the measure are not affected by the location of a business.

3.5 Economic and Fiscal Impacts

3.5.1 Mandates on Local Agencies or School Districts

This measure applies to single-family dwelling units and does not introduce any mandates for local agencies or school districts.

3.5.2 Costs to Local Agencies or School Districts

Building inspectors for local agencies will have additional energy performance measures to inspect, should this proposal be adopted. However, reporting of those measures is generally already required by Title 24 wherever an HERV is specified, so the net inspection burden is limited in this regard (see Section 3.6). There are no costs to school districts, which are not affected by this proposal.

3.5.3 Costs or Savings to Any State Agency

No ongoing costs to state agencies are expected.

3.5.4 Other Non-Discretionary Cost or Savings Imposed on Local Agencies

Local agencies are not expected to incur other non-discretionary costs or savings because of this measure.

3.5.5 Costs or Savings in Federal Funding to the State

No net change in federal funding is anticipated because of this measure.

3.6 Cost of Compliance and Enforcement

Incremental costs related to verifying and enforcing compliance are expected to be minimal. Title 24 prescriptive compliance forms already require reporting of ventilation system parameters such as system type, airflow, and in some cases, fan efficacy. HERS verification is required for ventilation system type, airflow, fan efficacy, and, where HERVs are specified, SRE. There are no current requirements for reporting the accessibility of HERVs or presence/absence of an FID within compliance forms; however, the RACMRM requires that these be determined, and reporting of these items are CBECC-Res inputs, so it is expected that CEC will add these items to compliance forms within this cycle. Presumably, because there are existing mechanisms for each of these measures to be reported and inspected, no significant changes will be needed to existing training programs or enforcement protocols.

4. COST-EFFECTIVENESS

This section provides a summary of energy savings estimates, costs, and overall cost-effectiveness analysis for the proposed measure. Energy savings, costs, and cost effectiveness of proposed measures are assessed incrementally, meaning in comparison to the latest adopted version of the Energy Code. Best available data are used, and references to those data sources are provided to clearly substantiate energy savings, costs, and cost effectiveness.

4.1 Energy Savings Methodology

Consistent with California Law (Public Resources Code 25000), an energy efficiency measure is cost-effective if the BCR is 1.0 or greater, when amortized over the economic life of the structure. BCR is calculated by dividing the total dollar benefit of the measure by the total dollar cost of the measure, over a period of analysis of 30 years.

To calculate benefit, LSC is used to determine the dollar value of energy efficiency measures in the Energy Code. LSC hourly factors help the state account for long-term benefits associated with policies needed to meet the statewide climate actions goals – such as 100% renewable generation, proliferation of electric transportation, and drastic reductions in fossil fuel combustion occurring in buildings. Today's energy costs do not adequately account for these long-term values to California's energy system. LSC hourly factors weigh the long-term value of each hour differently, where times of peak demand are more valuable, and times off-peak demand are less valuable. LSC hourly factors are not utility rates or energy rate forecasts. LSC is not a predicted utility bill.

LSC hourly conversion factors are developed and published by the CEC for each code cycle. These LSC hourly factors are used to convert predicted site energy use – an output common to BEM software – to 30-year present value to California's energy system.

Energy savings for proposed measures are estimated using both LSC hourly factors and CEC-established model prototypes. Large sets of survey data are used to create prototypes that act as averaged representations of common building types in California. These prototypes are created for use in BEM software to provide accuracy and consistency amongst energy models that are used to determine energy savings for the state. CEC-developed prototypes and LSC hourly factors are published by the CEC ahead of each code cycle integral to research versions of CEC's reference Energy Code compliance software (CBECC-Res and CBECC). For this reason, CBECC-Res and CBECC are the CEC-recommended BEM software tool when assessing energy savings of proposed measures.

To calculate cost, first costs and ongoing maintenance costs must be assessed for proposed measures and accounted for over a period of analysis of 30 years. In the BCR, both the benefits and the costs are assessed incrementally, meaning in comparison to the latest adopted version of the Energy Code.

Similar to LSC hourly factors, the CEC develops and publishes conversion factors for Source Energy, and for GHG Emissions for each code cycle. These three sets of hourly factors are published on CEC's website and formatted to be accessible and usable in combination with broadly available BEM tools.

4.2 Energy Savings Results

In prior cycles, CEC's standard procedure for estimating total energy savings for a single-family measure was to use two prototypes of 2,100 ft² (P2100) and 2,700 ft² (P2700) and to apply weightings to the results to develop a generalized single-family residential result for a proposed measure. For the 2025 cycle, CEC introduced a 500 ft² prototype (P500) and assigned weightings of 2% for the 500 ft² unit, 42% for the 2,100 ft² unit, and 56% for the 2,700 ft² unit. See Table 5 for a summary of the prototypes used in this analysis. Within this report, the weighted prototype is referred to as "PW."

Predicted site energy for heating, cooling, and ventilation end uses was converted to LSC using the hourly factors imbedded within CBECC-Res 2025.0.2 RV (i.e., LSC was directly output by the engine for the targeted end uses).

Table 5: Single-Family Residential Prototype(s) Used for Energy, Cost, and Environmental Analysis

Prototype ID	Floor Area (ft²)	Number of Stories	Source of Simulation file; Description	Weighting Used in Analysis
P500	500	1	CASE; HERV offsets one exhaust fan	2%
P2100	2,100	2	CBECC-Res; HERV offsets two exhaust fans	42%
P2700	2,700	2	CBECC-Res; HERV offsets two exhaust fans	56%
PW	N/A	N/A	Combination of P500, P2100, and P2700 developed by applying CEC-approved weightings	N/A

Electricity LSC savings attributed to the specification of an HERV were generally negative, due to higher fan energy consumption for an HERV versus an exhaust system. Exceptions to this observation occurred in climate zones where an air source heat pump was used to provide space heating; in these cases, electricity savings related to the HERV's heat or energy recovery offset

the HERV's additional fan energy use and resulted in positive electricity LSC savings. Natural gas LSC savings were positive wherever the prototypes used a gas furnace for heating and were zero where the prototypes used an electric heat pump for heating. Taken together, the sum of the electricity and gas LSC savings were positive in each climate zone for PW, P2100, and P2700. For P500, the LSC savings were mixed, with some mild climates showing negative savings. LSC savings were generally lower for P500 than for other prototypes based on lower dwelling unit ventilation rates and the assumption that only one exhaust fan is replaced by the HERV, instead of the two exhaust fans that are replaced by the HERV within P2100 and P2700. See Tables 6a-6d.

Table 6a: LSC Savings Over 30-Year Period of Analysis, PW

Climate Zone	30-Year Electricity LSC Savings (PV$)	30-Year Natural Gas LSC Savings (PV$)	30-Year Total Energy LSC Savings (PV$)
1	($722)	$7,586	$6,864
2	($925)	$4,623	$3,674
3	$1,138	$0	$1,138
4	$1,438	$0	$1,438
5	($968)	$3,561	$2,601
6	($1,224)	$1,499	$266
7	($1,136)	$1,377	$241
8	($1,447)	$1,586	$139
9	($1,233)	$1,703	$470
10	($1,200)	$1,816	$616
11	($760)	$3,950	$3,181
12	($960)	$3,948	$2,988
13	$900	$0	$900
14	$1,340	$0	$1,340
15	($262)	$767	$520
16	($1,022)	$5,604	$4,558

Table 7b: LSC Savings Over 30-Year Period of Analysis, P500

Climate Zone	30-Year Electricity LSC Savings (PV$)	30-Year Natural Gas LSC Savings (PV$)	30-Year Total Energy LSC Savings (PV$)
1	($190)	$1,890	$1,685
2	($220)	$1,160	$915
3	$150	$0	$150
4	$405	$0	$405
5	($265)	$180	($125)
6	($445)	$0	($480)
7	($425)	$0	($445)
8	($535)	$0	($555)
9	($460)	$20	($450)
10	($455)	$10	($465)
11	($245)	$1,010	$740
12	($330)	$1,095	$765
13	$330	$0	$330
14	$495	$0	$495
15	($190)	$0	($195)
16	($365)	$1,595	$1,250

Table 8c: LSC Savings Over 30-Year Period of Analysis, P2100

Climate Zone	30-Year Electricity LSC Savings (PV$)	30-Year Natural Gas LSC Savings (PV$)	30-Year Total Energy LSC Savings (PV$)
1	($630)	$8,505	$7,875
2	($861)	$4,977	$4,095
3	$1,407	$0	$1,407
4	$1,533	$0	$1,533
5	($924)	$3,969	$3,066
6	($1,092)	$1,554	$441
7	($1,029)	$1,407	$378
8	($1,260)	$1,617	$357
9	($1,113)	$1,785	$672
10	($1,071)	$1,911	$840
11	($609)	$4,137	$3,507
12	($903)	$4,200	$3,297
13	$1,155	$0	$1,155
14	$1,512	$0	$1,512
15	($147)	$567	$420
16	($903)	$5,922	$4,998

Table 9d: LSC Savings Over 30-Year Period of Analysis, P2700

Climate Zone	30-Year Electricity LSC Savings (PV$)	30-Year Natural Gas LSC Savings (PV$)	30-Year Total Energy LSC Savings (PV$)
1	($810)	$7,101	$6,291
2	($999)	$4,482	$3,456
3	$972	$0	$972
4	$1,404	$0	$1,404
5	($1,026)	$3,375	$2,349
6	($1,350)	$1,512	$162
7	($1,242)	$1,404	$162
8	($1,620)	$1,620	$0
9	($1,350)	$1,701	$351
10	($1,323)	$1,809	$486
11	($891)	$3,915	$3,024
12	($1,026)	$3,861	$2,835
13	$729	$0	$729
14	$1,242	$0	$1,242
15	($351)	$945	$621
16	($1,134)	$5,508	$4,347

4.3 Incremental First Cost

First costs for the reference and proposed systems are developed using a combination of data sourced from CASE (Goebes et al. 2023), RS Means (Gordian 2023), and internet-accessible retail pricing. The primary assumptions and sources used to develop incremental first costs are as follows:

1. Labor rates and time required for installation of ventilation system components are determined from data collected by CASE in support of its 2025 Multifamily Indoor Air Quality report (Goebes et al. 2023).
2. Ventilation system duct layouts and lengths for the P2100 and P2700 prototypes are developed based on takeoffs from a representative floor plan used by CASE for a proposal in a previous cycle (Hoeschele 2017), scaled to align with the P2100 and P2700 prototypes' floor area. Because the P500 prototype is new this cycle and no representative floor plans exist, a representative floor plan is developed to estimate duct layouts and lengths. The duct type is assumed to be insulated 6" flex. The time required to install each linear foot of duct is estimated using RS Means data.
3. Material costs for ventilation system components were primarily sourced from major online retailers (e.g., Home Depot, Lowes, SupplyHouse, Zoro, HVACQuick, etc.), with the exceptions that pricing for HERV supply grilles, exhaust grilles, and FIDs were sourced from CASE's 2023 study. Key components of the reference exhaust system and the HERV system were as follows:
    a. Exhaust system: ENERGY STAR fan located in a bathroom and rated to meet the targeted whole-dwelling unit ventilation system airflow at 0.25 in. w.g., timer control to set airflow equal to the minimum allowable by Title 24, exhaust ducting and termination, commissioning (i.e., controller programming by installer). In P2100 and P2700, one additional entry-level ENERGY STAR exhaust fan with humidity control in compliance with CALGreen is specified for local exhaust in a separate bathroom.
    b. HERV system: HERV with an FID having an average SRE ≥ 67 and average fan efficacy ≤ 0.6 W/cfm (specifying an FID introduces higher first costs for the HERV but ensures that the HERV receives full credit for its energy savings when modeled with CBECC-Res); for the P2100 and P2700 prototypes, the HERV replaces one exhaust whole-dwelling unit ventilation system and one local exhaust fan in a bathroom; for the P500 prototype, the HERV replaces one exhaust whole-dwelling unit ventilation system and no local exhaust fans; a separate filter box is assumed for the MERV 13 filter required by Title 24; ventilation airflow controls are provided with the FID; the control is programmed during commissioning.

4. Overhead and profit: In alignment with CASE's cost-aggregation approach, a 10% adjustment to materials and labor costs is applied to account for overhead and profit.

4.4 Incremental Maintenance Costs

The incremental maintenance cost is the incremental cost of replacing the equipment or parts of the equipment, as well as periodic maintenance required to keep the equipment operating relative to current practices over the period of analysis of 30 years. The present value of equipment and maintenance costs or savings is calculated using the following equation:

$$\text{Present Value of Maintenance Cost} = \text{Initial Maintenance Cost} \times \left[\frac{1}{1+\text{d}}\right]^{\text{n}}$$

Where:
d = the discount rate of 3%
n = the year in which maintenance is completed

This study accounts for maintenance of the HERV associated with changing the MERV 13 filter required by Title 24 and with vacuuming of the HERV's core. To reduce the frequency of filter changes required, a separate filter box is specified for the HERV that can accommodate a filter with a larger face area than would otherwise be accommodated if locating the MERV 13 filter within the HERV. For example, a MERV 13 filter fitting within an HERV cabinet might measure approximately 9" x 9". By locating the filter outside the HERV cabinet in a separate filter box, this area can be increased to a more standardized size; 14" x 14" is assumed for this study, which is more than double the face area of a typical 9" x 9" filter. Increasing the filter face area has the benefits of reducing velocity, loading, and pressure drop, and improving HERV fan efficacy. This study assumes that by doubling the face area, filter life could also be doubled. Using the CASE study estimate of 6-month life for a MERV 13 filter within the HERV cabinet (Goebes et al. 2023), this study therefore assumes a 12-month life for larger MERV 13 filters located in a separate filter box. Retail pricing for MERV 13 filters through Amazon.com is approximately $7 for a 14" x 14" filter. The study assumes that homeowners are responsible for changing the MERV 13 filter annually and vacuuming the HERV core quarterly. Note that similar vacuuming cycles would be recommended for the reference whole-dwelling unit exhaust fan. The present value of the 30-year incremental maintenance costs associated with filter replacement is calculated as $144.

Exhaust and HERV systems are assumed to have a useful life of 20 years. This value is conservatively derived from ASHRAE estimates for useful life of fans, which range from 15-25 years, with centrifugal fans (i.e., the type used by the

exhaust and HERV systems assumed for this study) at 25 years (ASHRAE, 2019). At the end of the equipment's useful life, all system components except for the duct system, filter box, and terminations are assumed to be replaced.

4.5 Cost Effectiveness

Cost-effectiveness analysis is required to determine the economic impact of proposed measures over a 30-year period of analysis. This analysis must consider and include incremental energy savings for all impacted energy sources (electricity and natural gas), incremental first costs, and incremental maintenance costs over a 30-year period of analysis. Design costs and incremental costs associated with code compliance are not included in this analysis.

For purposes of the California Energy Code, a measure is cost-effective if the BCR is equal to or greater than 1.0. BCR is calculated by dividing the total present value cost benefits by the total present value costs. The incremental total installed equipment and maintenance costs of the proposed system (HERV) versus the reference system (exhaust) over 30 years is calculated using a discount rate of 3%. This value is $2,511 for the P500, $2,016 for the P2100, and $2,032 for the P2700 prototypes, resulting in a weighted value of $2,035 for PW. The incremental cost is highest for the prototype with the smallest footprint based on higher incremental equipment costs. For very small homes, lower capacity and lower cost exhaust fans are widely available, but lower capacity and lower cost HERVs with FID are not readily available at this time, so the same HERV with FID was assumed for the P500 prototype as for the P2700 prototype, with the assumption that the HERV with FID would be operated intermittently in the P500 prototype to meet the whole-dwelling unit ventilation rate required by Title 24.

Using the prototype weightings prescribed by CEC (which considered cost effectiveness for each prototype) this measure is shown to be cost-effective in climate zones 1, 2, 5, 11, 12, and 16. For the P500 prototype, the measure was not found to be cost-effective in any climate zone. Therefore, the language proposed by this measure provides an exception for dwelling units that are not greater than 500 ft^2.

Table 10: Cost-Effectiveness Summary, Benefit-Cost Ratio

Climate Zone	Benefit-Cost Ratio (BCR), P500	Benefit-Cost Ratio (BCR), P2100	Benefit-Cost Ratio (BCR), P2700	Benefit-Cost Ratio (BCR), PW
CZ 1	0.7	3.9	3.1	3.4
CZ 2	0.4	2.0	1.7	1.8
CZ 3	0.1	0.7	0.5	0.6
CZ 4	0.2	0.8	0.7	0.7
CZ 5	0.0	1.5	1.2	1.3
CZ 6	-0.2	0.2	0.1	0.1
CZ 7	-0.2	0.2	0.1	0.1
CZ 8	-0.2	0.2	0.0	0.1
CZ 9	-0.2	0.3	0.2	0.2
CZ 10	-0.2	0.4	0.2	0.3
CZ 11	0.3	1.7	1.5	1.6
CZ 12	0.3	1.6	1.4	1.5
CZ 13	0.1	0.6	0.4	0.4
CZ 14	0.2	0.7	0.6	0.7
CZ 15	-0.1	0.2	0.3	0.3
CZ 16	0.5	2.5	2.1	2.2

5. STATEWIDE ENERGY IMPACTS

This section provides the first-year statewide savings of the proposed measure. For all metrics except LSC, first-year savings are annual savings accrued in the first year. For LSC, first-year savings are the 30-year savings associated with the new single-family construction expected in the first year of this measure (i.e., 2026). This analysis is to help determine overall value of the proposed measure to the State of California, and not used to determine cost effectiveness of the proposed measure. To assist with this analysis, a statewide new construction forecast was developed by the CEC for 2026, which is presented in more detail in *Appendix A: Statewide Savings Methodology*. The first-year energy impacts represent the first-year annual savings from all single-family residential dwelling units forecasted to be completed in 2026 within the climate zones addressed by this measure.

5.1 Statewide Energy and Energy Cost Savings

Estimated statewide first-year energy savings are shown in Table 8, based on prototype-weighted CBECC-Res simulation outputs for single-family dwelling units forecasted for construction in 2026 in climate zones 1, 2, 5, 11, 12, and 16. The source energy savings are 70 billion Btu. Electricity use actually increases with this measure because the fan energy use of the HERV exceeds the fan energy use of the reference exhaust fan, and space heating energy savings are primarily natural gas savings. First-year natural gas energy savings are 0.8 million therms, and the net first-year LSC savings are $81.8 million.

Table 11: Estimated Statewide Energy Savings

	First Year Statewide Site Electricity Savings (GWh)	First Year Statewide Power Demand Reduction (MW)	First Year Statewide Site Natural Gas Savings (Million Therms)	First Year Statewide Source Energy Savings (Billion Btu)	First Year Statewide Electricity LSC Savings (Million PV$)	First Year Statewide Natural Gas LSC Savings (Million PV$)	First Year Statewide Total LSC Savings (Million PV$)
HERV	-3.7	-0.4	0.8	70	-23.0	104.9	81.8

5.2 Statewide Greenhouse Gas Emissions Savings

First-year statewide GHG Emissions savings are shown in Table 9, based on prototype-weighted CBECC-Res simulation outputs for single-family dwelling units forecasted for construction in 2026 in climate zones 1, 2, 5, 11, 12, and 16. The monetized annual value of the saved emissions is $527,393, calculated assuming a cap-and-trade value of $123.15 per metric ton of CO_2 equivalent emissions (Goebes et al., 2023).

Table 12: Estimated Statewide Greenhouse Gas Emissions Savings

	First Year Statewide GHG Emission Savings (MT CO_2e/year)	First Year Statewide GHG Emissions Savings (PV$)
HERV	4648	$527,393

5.3 Statewide Water Savings

This proposal does not affect water use in single-family dwelling units.

5.4 Other Non-Energy Impacts

No other non-energy impacts are anticipated by this proposal.

6. Proposed Code Language

This section has specific recommended modifications to 2022 Title 24. Proposed modifications are shown in legislative text. Underlines are used for new language, and ~~strikethroughs~~ are used for deletions.

6.1 Energy Code (Title 24, Part 6)

Section 150.0(o)1C

Whole-dwelling unit mechanical ventilation for single-family detached and townhouses.

iv. Requirements for balanced and supply ventilation systems.

a. **Ventilation system component accessibility.** Access to fans, motors, heat exchangers, and other serviceable components of balanced and supply ventilation systems shall be provided in accordance with California Mechanical Code Section 304.0 Accessibility for Service.

b. **Ventilation system air filters and heat or energy recovery core accessibility.** Ventilation system air filters and HRV/ERV heat or energy recovery cores shall be located such that they are accessible for regular service from within occupiable space, basements, or garages, or from balconies or roofs. Filters and heat or energy recovery cores behind access panels, access doors, or grilles located no more than 10 ft above a walking surface comply with this requirement.

   Exception to Section 150.0(o)1Civa: Ventilation system filters and heat or energy recovery cores that are located in an accessible attic and that have an FID meeting the requirements of Reference Appendix JA15.

c. **Outdoor air intake protection**. Outdoor air intake protection shall be provided in accordance with California Mechanical Code Section 402.4.

d. **Outdoor air intake accessibility**. Outdoor air intakes shall be accessible. Outdoor air intakes located not more than 10 feet above a walking surface comply with this requirement. Access for outdoor air intakes located on roofs shall be provided in accordance with California Mechanical Code Section 304.3.1.

Exception to 150.0(o)1Civd: Outdoor air intakes not located on roofs and serving a ventilation system with an FID meeting the requirements of Reference Appendix JA15.

Section 150.1(c)

10. Whole-dwelling unit mechanical ventilation systems. The whole-dwelling unit mechanical ventilation system shall meet the following requirements.

A. **Balanced ventilation systems with heat or energy recovery**. In Climate Zones 1, 2, 5, 11, 12, and 16, a balanced ventilation system shall be used to provide the whole-dwelling unit mechanical ventilation rate required by Section 150.0(o)1C. The system shall:

i. Be an energy recovery ventilator (ERV) or heat recovery ventilator (HRV).

ii. Have a sensible recovery efficiency (SRE) not less than 67 percent, determined in accordance with Reference Residential Appendix RA3.7.4.4.4.

iii. Have a fan efficacy less than or equal to 0.60 W/cfm, determined in accordance with Reference Residential Appendix RA3.7.4.4.3.

iv. Have a Fault Indicator Display (FID) that meets the requirements of Reference Appendix JA15, as confirmed by HERS field verification.

Exception to 150.1(c)10A: Balanced ventilation with energy recovery or heat recovery shall not be required for dwelling units with a floor area of 500 ft^2 or less.

B. **Supply ventilation systems**. Supply ventilation systems used to provide the whole-dwelling unit mechanical ventilation rate required by Section 150.0(o)1C shall have an FID that meets the requirements of Reference Appendix JA15, as confirmed by HERS field verification.

i. **Central fan integrated ventilation systems.** Central forced air system fans used to provide outside air shall have an air-handling unit fan efficacy less than or equal to the maximum W/cfm specified in ~~A, B, or C~~a, b, or c. The airflow rate and fan efficacy requirements in this section shall be confirmed through field verification and diagnostic testing in accordance with all applicable procedures specified in Reference Residential Appendix RA3.3. Central fan integrated ventilation systems shall be certified to the Energy Commission as intermittent ventilation systems as specified in Reference Residential Appendix RA3.7.4.2.

a. 0.45 W/cfm for gas furnace air-handling units.

b. 0.58 W/cfm for air-handling units that are not gas furnaces.

c. 0.62 W/cfm for small duct high velocity air-handling units.

Exception to Section 150.1(c)10~~A~~Bi: Gas furnace air-handling units manufactured prior to July 3, 2019 shall comply with a fan efficacy value less than or equal to 0.58 W/cfm as confirmed by field verification and diagnostic

testing in accordance with the procedures given in Reference Residential Appendix RA3.3.

Table 150.1-A COMPONENT PACKAGE – Single- Family Standard Building Design

			Climate Zone															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
HVAC System	~~Central System Air Handlers~~	~~Central Fan Integrated Ventilation System Fan Efficacy~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~	~~REQ~~
	Ventilation Systems		System Shall meet Section 150.1(c)10															

SECTION 150.2 – ENERGY EFFICIENCY STANDARDS FOR ADDITIONS AND ALTERATIONS TO EXISTING SINGLE-FAMILY RESIDENTIAL BUILDINGS

150.2(a)1C. Mechanical ventilation for indoor air quality. Additions to existing buildings shall comply with Section 150.0(o) and 150.1(c)10 subject to the requirements specified in subsections i and ii below.

i. **Whole-dwelling unit mechanical ventilation**.

a. Dwelling units that meet the conditions in subsections 1, or 2 below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section~~s~~ 150.0(o)1C~~, 150.0(o)1E, or 150.0(o)1F~~.

1. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1,000 square feet.

2. Junior Accessory Dwelling Units (JADU) that are additions to an existing building.

b. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 150.0(o)1C~~, 150.0(o)1E, or 150.0(o)1F as applicable~~. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area. The whole-dwelling unit mechanical ventilation airflow shall be provided by an exhaust, supply, or balanced ventilation system that shall meet the applicable requirements of Section 150.1(c)10.

c. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 150.0(o)1C~~, 150.0(o)1E, or 150.0(o)1F as applicable~~. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit. The whole-dwelling unit mechanical ventilation system shall comply with Section 150.1(c)10.

ii. **Local mechanical exhaust**. Additions to existing buildings shall comply with all applicable requirements specified in 150.0(o)1G and 150.0(o)2.

150.2(a)2C. **Whole-dwelling unit mechanical ventilation**.

a. Dwelling units that meet the conditions in subsections 1, or 2 below shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Sections 150.0(o)1C~~, 150.0(o)1E, or 150.0(o)1F~~.

1. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by less than or equal to 1000 square feet.

2. Junior Accessory Dwelling Units (JADU) that are additions to an existing building.

b. Additions to an existing dwelling unit that increase the conditioned floor area of the existing dwelling unit by more than 1,000 square feet shall have mechanical ventilation airflow in accordance with Section 150.0(o)1C~~, 150.0(o)1E, or 150.0(o)1F as applicable~~. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the entire dwelling unit comprised of the existing dwelling unit conditioned floor area plus the addition conditioned floor area.

c. New dwelling units that are additions to an existing building shall have mechanical ventilation airflow provided in accordance with Section 150.0(o)1C~~, 150.0(o)1E, or 150.0(o)1F as applicable~~. The mechanical ventilation airflow rate shall be based on the conditioned floor area of the new dwelling unit.

ii. **Local mechanical exhaust**. Additions to existing buildings shall comply with all applicable requirements specified in 150.0(o)1G and 150.0(o)2.

150.2(b)1

L. **Mechanical ventilation for indoor air quality - entirely new or complete replacement ventilation Systems**. Entirely new or complete replacement ventilation systems shall comply with all applicable requirements in Section 150.0(o) and with applicable requirements of Section 150.1(c)10. An entirely new or complete replacement ventilation system includes a new ventilation fan component and an entirely new duct system. An entirely new or complete replacement duct system is constructed of at least 75 percent new duct material, and up to 25 percent may consist of reused parts from the dwelling unit's existing duct system, including but not limited to registers, grilles, boots, air filtration devices and duct material, if the reused parts are accessible and can be sealed to prevent leakage.

Exception to 150.2(b)1L. The system shall not be required to be a balanced ventilation system with heat or energy recovery except where a previous permit required the system to be a balanced ventilation system with heat or energy recovery.

M. **Mechanical ventilation for indoor air quality - altered ventilation systems**. Altered ventilation system components or newly installed ventilation equipment serving the alteration shall comply with Section 150.0(o) as applicable subject to the requirements specified in subsections i and ii below.

i. **Whole-dwelling unit mechanical ventilation**.

a. **Whole-dwelling unit airflow**. ~~If the~~ Where a whole-dwelling ventilation ~~fan~~ system that was required by a previous building permit to comply with the whole-dwelling unit airflow requirements of Section 150.0(o) is altered or replaced, ~~then~~ it shall comply with ~~one of the following~~ subsections 1 and ~~or~~ 2 ~~shall be used for compliance as applicable~~.

1. ~~Dwellings that were required by a previous building permit to comply with the whole-dwelling unit airflow requirements in Section 150.0(o)~~ The system shall ~~meet or exceed~~ comply with the whole-dwelling unit mechanical ventilation airflow specified in Section 150.0(o)1C~~, 150.0(o)1E or 150.0(o)1F~~ as confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.7.

2. The system shall comply with the applicable requirements of Section 150.1(c)10.

Exception to 150.2(b)1Mia2. The system shall only be required to be a balanced ventilation system with heat or energy recovery where a previous permit required the system to be a balanced ventilation system with heat or energy recovery. ~~Dwellings that were not required by a previous building permit to have a whole-dwelling unit ventilation system shall not be required to comply with the whole-dwelling unit ventilation airflow specified in Section 150.0(o)1C, 150.0(o)1E or 150.0(o)1F.~~

6.2 Reference Appendices

Add Joint Appendix JA15 as follows:

Joint Appendix JA15

Appendix JA15 – Qualification Requirements for Whole-Dwelling Unit Mechanical Ventilation System Fault Indicator Displays

JA15.1 Introduction

Joint Appendix JA15 (JA15) provides the technical specifications for fault indicator displays (FIDs) that are certified to the CEC to provide visual and/or audible feedback on the performance of balanced or supply-only ventilation system equipment over their useful life.

JA15.2 Fault Indication Categories

FIDs shall respond to the following fault categories:

(a) Filter check or maintenance, either based on performance or a predetermined schedule.

(b) Low supply airflow.

(c) Low exhaust airflow (balanced systems only).

(d) Sensor failure for sensors that assist in monitoring or controlling for the following operations, where such operations are provided: airflow regulation, frost control, supply air tempering, and economizing.

JA15.3 Fault Indication Means

Fault indication shall use one or more of the following means:

(a) A visual display that is readily accessible to occupants of the dwelling unit.

(b) An electronic application.

(c) An audible alarm accompanied by a visual display.

JA15.4 Instrumentation and Reporting

Instrumentation shall measure and report the following:

(a) Airflow.

(b) Fan power.

JA 15.5 Certification

To qualify, manufacturers shall certify to the CEC that the FID system meets the requirements of JA15.2 – JA15.4.

Note: A listing of certified products is provided at the following location:

https://www.energy.ca.gov/media/7020

Add new Section to the Residential Appendices as follows:

RA3.7.4.5 Fault Indicator Display (FID) Verification

Where an FID is specified to comply with the requirements of Section 150.1(c)10, the FID shall be certified to the CEC in accordance with Reference Appendix JA15.5.

6.3 Compliance Manuals

Modify the Single-Family Residential Compliance Manual as follows:

4.6.2 Types of Mechanical Ventilation Systems

The key requirements for most newly constructed buildings are summarized below:

1. A whole-dwelling unit mechanical ventilation system shall be provided. Typical solutions are described in Section 4.6.4 below. Heat or energy recovery ventilators (HERVs) are required in Climate Zones 1, 2, 5, 11, 12, and 16 for homes following the prescriptive path. The airflow rate provided by the system shall be confirmed through field verification and diagnostic testing in accordance with the applicable procedures specified in RA3.7.

2. Kitchens and bathrooms must have local exhaust systems vented to outdoors.

3. Clothes dryer exhaust shall be vented to outdoors.

4.6.3 Compliance and Enforcement

Compliance with ASHRAE 62.2 requirements must be verified by the enforcement agency, except for the following requirements that must be HERS verified in accordance with the procedures in Residential Appendix RA3.7:

- Whole-dwelling unit ventilation airflow rate, type, and performance metrics
- HVI or AHAM ratings for kitchen local mechanical exhaust fan airflow or capture efficiency, and sound.

4.6.3.1 Certificate of Compliance Reporting Requirements

The performance certificate of compliance (CF1R-PRF-01) will report the following parameters for the whole-dwelling unit ventilation system:

1. Minimum mechanical ventilation airflow rate (calculated value) that must be delivered by the system.
2. Type of ventilation system (exhaust, supply, balanced, CFI).
3. Fan efficacy (W/CFM) for the selected system.
4. Recovery efficiency (%) applicable only to HRV or ERV systems.
5. For CFI systems--HERS verification of air handler fan efficacy is required.
6. Presence or absence of fault indicator display (FID) that is certified to the Energy Commission, applicable only to HRV, ERV, and supply ventilation systems.

4.6.3.2.1 CF2R-MCH-27

The following information must be provided on the CF2R-MCH-01 for each ventilation fan/system in the dwelling that will require HERS verification.

For dwelling unit ventilation systems:

1. System type, name, and location
2. Control type
3. Minimum required continuous airflow rate
4. Ventilation fan or system manufacturer, and model number
5. Energy Commission certification number for variable system/control (if any)
6. Presence or absence of FID that is certified to the Energy Commission, applicable only to HRV, ERV, and supply ventilation systems
7. Sensible Recovery Efficiency (SRE), applicable only to HRVs and ERVs

4.6.3.2.3 CF3R-MCH-27

The following additional information must be provided on the CF3R-MCH-27 to document compliance with §150.0(o):

For dwelling unit ventilation systems:

- Measured airflow rate of the installed dwelling unit ventilation system. For balanced systems, both exhaust and supply airflows must be measured and recorded.
- Presence or absence of FID that is certified to the Energy Commission, applicable only to HRV, ERV, and supply ventilation systems
- Sensible Recovery Efficiency (SRE), applicable only to HRVs and ERVs

6.4 ACM Reference Manuals

Modify the RACMRM as follows:

2.4.10 Indoor Air Quality Ventilation

Systems with supply ducts (balanced and supply-only) are simulated with increased fan wattage and reduced SRE and ASRE to account for maintenance and installation factors affecting system efficacy. For these systems, fan wattage is increased by a factor of 1.10 (10 percent increase in wattage) and SRE and ASRE are reduced by a factor of 0.90 (10 percent decrease in recovery efficiencies). For IAQ systems with fault indicator displays (FID) meeting the requirements of Reference Appendix JA15 ~~below specifications~~, these factors do n'ot apply.

~~1. Fault indication responding to the following categories:~~

~~a. Filter check or maintenance, either based on performance or a predetermined schedule.~~

~~b. Low supply airflow.~~

~~c. Low exhaust airflow.~~

~~d. Sensor failure for sensors that assist in monitoring or controlling for the following operations, where such operations are provided: airflow regulation, frost control, supply air tempering, and economizing.~~

~~2. Fault indication using one or more of the following means:~~

~~a. A visual display that is readily accessible to occupants of the dwelling unit and located on or within one foot of the IAQ system control.~~

~~b. An electronic application.~~

~~c. An audible alarm accompanied by a visual display.~~

~~3. Instrumentation and reporting of the following:~~

~~a. Airflow.~~

~~b. Fan power.~~

~~4. FID certified to CEC by the manufacturer as meeting the above requirements.~~

~~To receive compliance credit relative to the standard design, balanced and supply-only systems must have accessible supply air filters, outside air inlets, and heat/energy recovery cores (if applicable) as specified in Title 24 Part 6 Section 150.0(o)1Civ.Table 22: IAQ System Component Accessibility Criteria. For systems not meeting these requirements, compliance credit will be neutralized. (See IAQ system standard design for details.)~~

6.5 Compliance Forms

Proposed modifications to compliance forms are expected to improve compliance verification for authorities having jurisdiction by providing them with information on the whole-dwelling unit ventilation system that is specified.

1. CF1R-ADD-01-E Prescriptive Residential Additions 1,000 Ft^2 or Less

   M. Indoor Air Quality (IAQ) Fan Information

   IAQ compliance for an addition is described in Section 150.2(a)1C. Additions less than or equal to 1,000 ft^2 are not required to comply with the whole-dwelling unit ventilation airflow specified in Section 150.0(o)1C. Additions greater than 1,000 ft^2 are required to be provided with an exhaust, supply, or balanced ventilation system meeting the

applicable requirements of Section 150.1(c)10 and the airflow requirements of Section 150.2(a)1Cib.

1. Fan Name: Provide a unique name for each unique indoor air quality (IAQ) fan type in the building.

2. IAQ Type: Supply, Exhaust, Balanced, Balanced – ERV, Balanced – HRV, Central Fan Integrated (CFI), Central Ventilation System – Supply, Central Ventilation System – Exhaust, or Central Ventilation System – Balanced.

2. CF1R-ALT-01-E Prescriptive Residential Alterations

K. Indoor Air Quality Systems (Section 150.2(b)1)

Requirements of the standards apply to an IAQ system alteration based on the type of alteration and the existing system type (Section 150.2(b)1). A completely new system will meet all mandatory and prescriptive requirements, which vary by climate zone (based on Section 150.2(b)1L; note that balanced ventilation systems with heat or energy recovery are not required except where a previous permit required the system to be a balanced ventilation system with heat or energy recovery). Where an existing IAQ system is altered or is partially replaced, the requirements of Section 150.2(b)1M are applicable.

01	02	03	04	05	06	07	08
Tag/ID	Alteration Type for IAQ System	Proposed IAQ Type	Proposed Fan Efficacy (W/cfm)	Proposed SRE for ERV or HRV	Previous Permit Requirement for Balanced Ventilation System with Heat or Energy Recovery?	IAQ Type and Performance Required	Compliance Statement

A. General Information

13. Project Scope: Check all that apply – insulation, roof replacement > 50%, kitchen remodel, space heating system, space cooling system, duct system, indoor air quality system, water heating, adding fenestration/glazing, replacing fenestration/glazing, adding fenestration/glazing less than or equal to 75 ft^2 windows, replacing fenestration/glazing less than or equal to 75 ft^2 window, adding fenestration/glazing less than or equal to 16 ft^2 skylight and or replacing fenestration/glazing skylights,

K. Indoor Air Quality Systems (Section 150.2(b)1)

1. Tag/ID: A label (if any) from the plans, for example, IAQ system.

2. Alteration Type for IAQ System: entirely new, complete replacement, altered or replaced.

3. Proposed IAQ Type: Supply, Exhaust, Balanced, Balanced – ERV, Balanced – HRV, Central Fan Integrated (CFI), Central Ventilation System – Supply, Central Ventilation System – Exhaust, or Central Ventilation System – Balanced.
4. Proposed Fan Efficacy (W/cfm): Enter the fan efficacy. See Reference Residential Appendix RA3.7.4.4.3.
5. Proposed SRE for ERV or HRV: Enter the sensible recovery efficiency only in the case that the proposed system type is Balanced-ERV or Balanced-HRV. See Reference Residential Appendix RA3.7.4.4.4.
6. Previous Permit Requirement for Balanced Ventilation System with Heat or Energy Recovery: If the dwelling unit previously was permitted with a requirement for a balanced ventilation system with heat or energy recovery, select Yes. Otherwise, select No. If permit records are not readily available, base the answer to this question on the existing IAQ system type.
7.-8. Automatically completed entries; no user input required.

3. CF1R-NCB-01-E Prescriptive Newly Constructed Building

O. Indoor Air Quality (IAQ) Fan Information – Section 150.1(c)10

Notes: In Climate Zones 1, 2, 5, 11, 12, and 16, a balanced ventilation system with energy or heat recovery is required for dwelling units with a floor area exceeding 500 ft^2.

01	02	03
Fan Name	IAQ Type	Comments

P. HERS Verification Summary

The enforcement agency shall pay special attention to the HERS Measures specified in this checklist below. A registered Certificate of Verification for all the measures specified shall be submitted to the building inspector before final inspection.

~~Central System Air Handlers – Air Flow and Fan Efficacy Verification – Section 150.0(m)13~~

- ~~Airflow (minimum 350 cfm/ton) and Fan Efficacy (max 0.45 Watts/cfm for gas furnace air handlers, and 0.58 Watts/cfm for air handlers that are not gas furnaces) on systems with ducted air conditioning as field verified by a HERS rater or Return Duct and Filter System Design according to Tables 150.0-B/C will be HERS verified.~~
- ~~Heat-only systems with Central Fan Integrated (CFI) ventilation are required to have less than 0.45 Watts/cfm as verified by a HERS rater.~~
- ~~Small duct high velocity systems: airflow (minimum 250 cfm/ton) and fan efficacy (max 0.62 Watts/cfm) as verified by a HERS rater.~~

Indoor Air Quality (IAQ) Mechanical Ventilation – Section 150.0(o)

- Mechanical ventilation airflow rate according to American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 62.2 is required to be verified by a HERS rater (Reference Appendices, Residential Appendix, RA3.7).
- Balanced Ventilation Systems with Heat or Energy Recovery – Section 150.1(c)10A
  - Balanced ventilation systems are required in Climate Zones 1, 2, 5, 11, 12, and 16 for dwelling units with a floor area exceeding 500 ft^2 and shall:
    - Be an energy recovery ventilator (ERV) or heat recovery ventilator (HRV).
    - Have a sensible recovery efficiency (SRE) not less than 67 percent, determined in accordance with Reference Residential Appendix RA3.7.4.4.4.
    - Have a fan efficacy less than or equal to 0.60 W/cfm, determined in accordance with Reference Residential Appendix RA3.7.4.4.3.
    - Have a Fault Indicator Display (FID) that meets the requirements of Reference Appendix JA15 as verified by a HERS rater.
- Supply Ventilation Systems – Section 150.1(c)10B
  - Supply ventilation systems are required to have a fault indicator display (FID) meeting the requirements of Reference Appendix JA15.
  - Central System Air Handlers – Air Flow and Fan Efficacy Verification – Section 150.0(m)13 and 150.1(c)10Bi
    - Airflow (minimum 350 cfm/ton) and Fan Efficacy (max 0.45 Watts/cfm for gas furnace air handlers, and 0.58 Watts/cfm for air handlers that are not gas furnaces) on systems with ducted air conditioning as field verified by a HERS rater or Return Duct and Filter System Design according to Tables 150.0-B/C will be HERS verified.
    - Heat-only systems with Central Fan Integrated (CFI) ventilation are required to have less than 0.45 Watts/cfm as verified by a HERS rater.
    - Small duct high velocity systems: airflow (minimum 250 cfm/ton) and fan efficacy (max 0.62 Watts/cfm) as verified by a HERS rater.

4. CF2R-MCH-27-H and CF3R-MCH-27-H Indoor Air Quality and Mechanical Ventilation

A. Whole-Dwelling Mechanical Ventilation - General Information

01	Dwelling Unit Name	
02	Building Type	
03	Project Scope	
04	Total Conditioned Floor Area of Dwelling Unit (For addition projects the conditioned floor area equals existing area plus addition area)	
05	Number of Bedrooms in Dwelling Unit	

	(For addition projects the number of bedrooms equals the existing bedrooms plus addition bedrooms)	
06	Ventilation System Type	
07	Ventilation Operation Schedule	
08	Fault Indicator Display	

D2. HRV or ERV Information

Balanced ventilation systems shall comply with appropriate requirements in 150.0(o)2C.

01	**02**	**03**	**04**
Manufacturer Make	Manufacturer Model Number	Fan Efficacy Performance Rating (W/CFM)	Sensible Recovery Efficiency (SRE)

CF2R-MCH-27a-H User Instructions

Section A. General Information

8. Fault Indicator Display – Users shall select Yes if the ventilation system has a fault indicator display that is certified to the Energy Commission in accordance with Reference Appendix JA15 and shall select No otherwise.

Section D2. HRV or ERV Information

1. Manufacturer Make – User input text
2. Manufacturer Model Number – User input text
3. Fan Efficacy Performance Rating – Reference information from CF1R or be user input
4. Sensible Recovery Efficiency (SRE) – Reference information from CF1R or be user input

7. REFERENCES

7.1 Reference List

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APPENDICES

Appendix A: Statewide Savings Methodology

Estimated statewide energy savings for the first year that the Energy Code becomes effective (2026) were generated by multiplying the proposed measure's per unit savings (weighted by prototype) by the provided statewide construction forecasts in this appendix.

Table 13: Statewide Residential New Construction (2026)

Climate Zone	Single-Family Units
1	359
2	1,861
3	3,035
4	2,689
5	616
6	1,719
7	1,869
8	4,163
9	4,286
10	7,950
11	5,840
12	14,542
13	7,257
14	3,739
15	3,160
16	1,937
Total	65,022

Appendix B: Embedded Electricity in Water Methodology

There are no on-site water savings associated with the proposed measure.

Appendix C: Environmental Impacts Methodology

Greenhouse Gas Emissions Impacts Methodology

GHG emissions are sourced directly from CBECC-Res 2025.0.2 RV, which incorporates the latest applicable GHG Emissions hourly factors published by the CEC.

Water Use and Water Quality Impacts Methodology

There are no on-site water savings associated with the proposed measure.

Potential Significant Environmental Effect of Proposal

The CEC is the lead agency under the California Environmental Quality Act (CEQA) for the 2025 Energy Code and must evaluate any potential significant environmental effects resulting from the proposed Energy Code. A "significant effect on the environment" is "a substantial adverse change in the physical conditions which exist in the area affected by the proposed project." (Cal. Code Regs., tit. 14, § 15002(g).)

This measure is expected to have a net environmental benefit based on avoided emissions and reduced energy use; there is therefore no "significant effect on the environment."

Direct Environmental Impacts

Direct Environmental Benefits

Based on modeled energy savings, this measure is anticipated to reduce GHG emissions by 4648 metric tons CO2e in the first year that it is implemented, with additional savings accruing in outlying years. See Section 5.2 for more information.

Direct Adverse Environmental Impacts

No direct adverse environmental impacts were identified.

Indirect Environmental Impacts

Indirect Environmental Benefits

No indirect environmental benefits were identified.

Indirect Adverse Environmental Impacts

No indirect adverse environmental impacts were identified.

Mitigation Measures

No mitigation is proposed because there is no "significant effect on the

environment" associated with this measure.

Reasonable Alternatives to Proposal

No alternatives are proposed because there is no "significant effect on the environment" associated with this measure.

Appendix D: CBECC Software Specification

CBECC-Res 2025.0.2 RV contains all the components necessary to characterize an HERV. The software would need to be modified to change the standard design in climate zones 1, 2, 5, 11, 12, and 16 to be an HERV meeting the prescriptive path requirements.