Round 2

Welcome to the California Statewide Codes and Standards Enhancement (CASE) Team's Stakeholder Meeting on

Multifamily HVAC and Envelope Proposals

We will begin shortly.

In the meantime, please fill out the polls below.

CALIFORNIA ENERGY CODES & STANDARDS
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Pacific Gas and Electric Company

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Welcome: Connect Your Audio

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To view options, click on the  icon on the top ribbon, then select *Connect My Audio.*

1. **Dial-out:** receive a call from the meeting. *Please note this feature* ***requires a direct line.***
2. **Dial-in:** dial-in to the conference via phone. Conference phone number and room number code provided. *Please then* ***identify your line*** *by entering your unique user ID on your phone.*
3. Use the **microphone** from your computer/device.

Above*: audio conference settings pop-up box*

2022 TITLE 24 CODE CYCLE, PART 6

Second Utility-Sponsored Stakeholder Meeting

Multifamily HVAC and Envelope

Statewide CASE Team

March 25, 2020

CALIFORNIA ENERGY CODES & STANDARDS

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Meeting Guidelines

Part 1 of 3 - Muting

Muting Guidelines:

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- Please keep yourself **MUTED.**
- Wait for instructions and/or permission to unmute yourself during designated Q&A periods.

Two Options to Mute:

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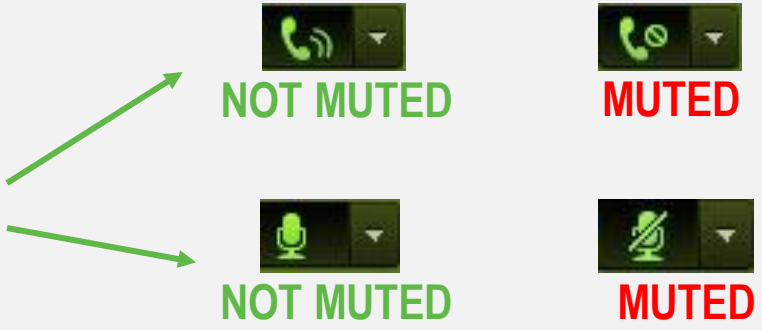


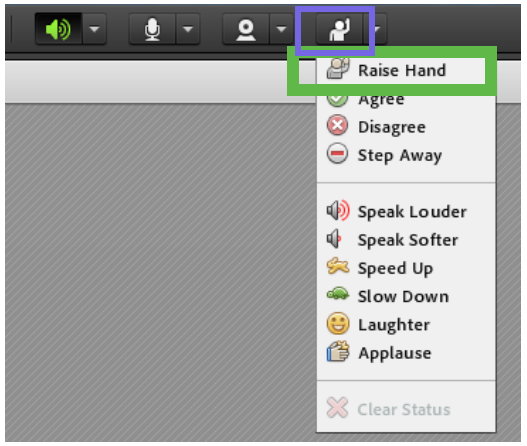
Meeting Guidelines

Part 2 of 3 - Participation

Participation Guidelines:

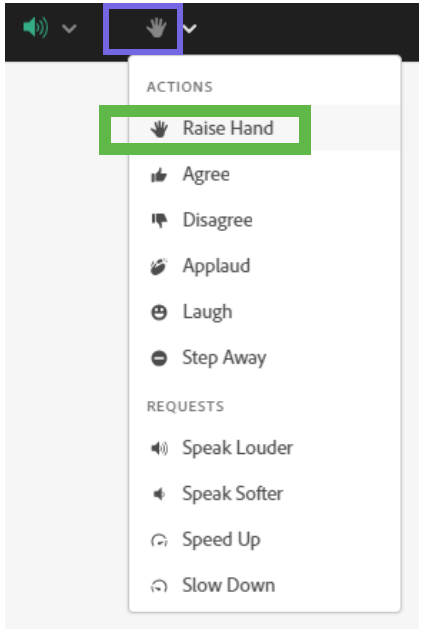
- **Questions & Comments**
  - Click **"*Raise Hand*"** if you would like to speak. Those with a hand raised will be called on by the speaker.
  - All questions and comments are also welcome via the chat window.

- **Other Meeting Feedback**
  - Provide live meeting feedback from the **top toolbar drop-down**.



***Above**: feedback view for Adobe Connect app users.*

***Below**: feedback view for HTML users.*



Meeting Guidelines

Part 3 of 3 – Discussion Ground Rules

- **We want to hear your thoughts.**
  - Supporting and opposing viewpoints are welcome.
- **When making comments, please:**
  1. Unmute yourself;
  2. Clearly state your name and affiliation prior to speaking; and
  3. Place yourself back on mute when done speaking.
- **Calls are recorded** for note development, recordings will not be publicized.
- Notes and presentation material will be posted on Title24Stakeholders.com/events.

Agenda

1	**Meeting Guidelines**	*8:30 am*
2	**Opening Remarks** from the California Energy Commission	*8:35 am*
3	**Overview & Welcome** from the Statewide Utility Team	*8:40 am*
4	**Presentation I:** Multifamily Indoor Air Quality	*8:45 am*
5	**Presentation II:** Multifamily High Performance Envelope	*10:45 am*
6	Wrap Up & Closing	*12:15 pm*

Opening Remarks:
California Energy Commission

Policy Drivers: Building Standards

The following policy documents establish the goal for new building standards:

- **2008 CPUC/CEC Energy Action Plan** – ZNE for residential buildings by 2020 and nonresidential buildings by 2030
- **SB 100** – Clean electricity by 2045
- **B-55-18** – Governor Jerry Brown's Executive Order to achieve carbon neutrality
- **AB 3232** – Assess the potential for the state to reduce the emissions of greenhouse gases from the state's residential and commercial building stock by at least 40 percent below 1990 levels by January 1, 2030

2022 Updated Standards Schedule

Estimated Date	ACTIVITY OR MILESTONE
November 2018 – November 2019	Updated Weather Data Files
November 2018 – December 2019	Metric Development
November 2018 - July 2019	Measures Identified and Approved
April 24, 2019	Present the Efficiency Measure Proposal Template for public to submit measures
October 17, 2019	Compliance Metrics and Climate Data Workshop
August 2019 – November 2019	First Round of Utility-Sponsored Stakeholder Workshops
January 2020	Research Version of CBECC Available with new weather data files and updated metric
March 2020 – April 2020	Second Round of Utility-Sponsored Stakeholder Workshops
March 10, 2020	Staff Workshop on the proposed changes for the ATTCP program
March 26, 2020	Staff Workshop on the EDR1
March 2020 – May 2020	All Initial CASE/PUBLIC Reports Submitted to Commission
July 2020 – August 2020	All Final CASE/PUBLIC Reports Submitted to the Commission
August 2020 – October 2020	Commission-Sponsored Staff Workshops
September 2020 – November 2020	Express Terms Developed (including New Multifamily Section)
February 2021	45-Day Language posted and sent to list serve, Start of 45-Day review/comment period
March 2021	Lead Commissioner Hearing
July 2021	Adoption of 2022 Standards at Business Meeting
September 2021	Final Statement of Reasons Drafted and Approved
July 2021	Adoption of CALGreen (energy provisions) - Business Meeting
December 2021	Approval of the Manuals
October 2021	Final Rulemaking Package delivered to CBSC
December 2021	CBSC Approval Hearing
January 2021	Software, Compliance Manuals, Electronic Documents Available to Industry
January 1, 2023	Effective Date

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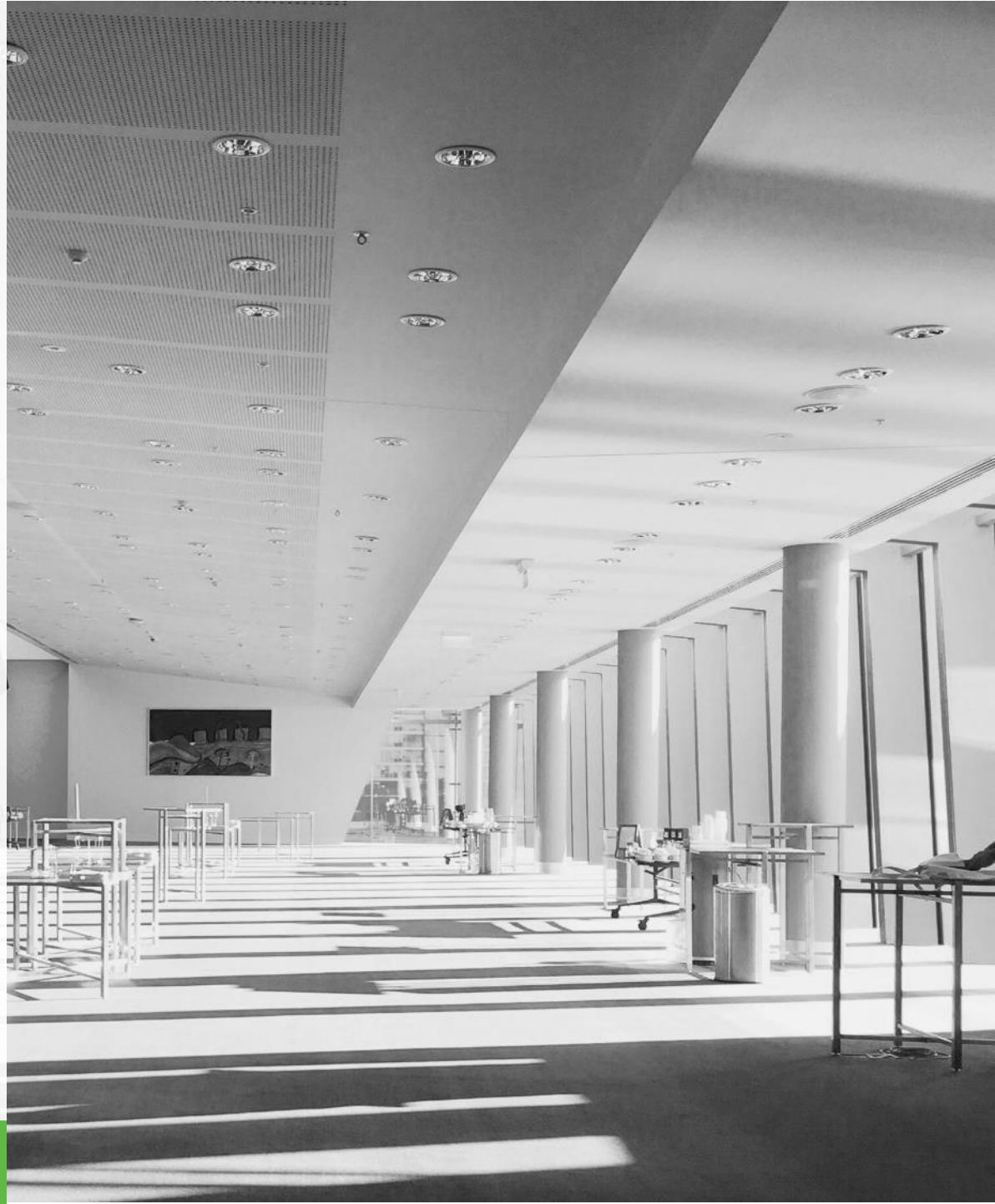
More information on pre-rulemaking for the 2022 Energy Code at:
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Title 24, Part 6 Overview

Kelly Cunningham
Codes and Standards
Pacific Gas & Electric



Statewide Utility Codes and Standards Team

Actively support the California Energy Commission in developing proposed changes to the Energy Code (Title 24, Part 6) to achieve significant statewide energy use reductions through the development of code change proposals for the 2022 cycle that are:

Feasible | Cost effective | Enforceable | Non-proprietary

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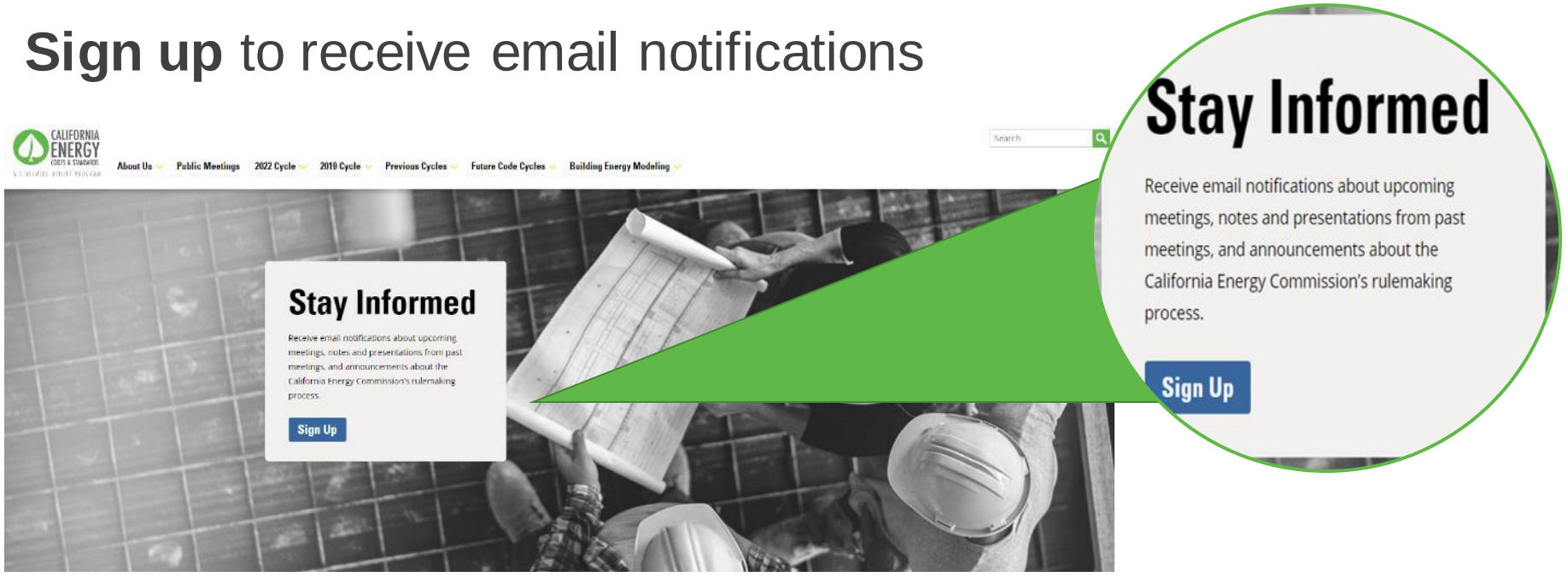
Utility-Sponsored Stakeholder Meetings

- All meetings can be attended **remotely**
- Check Title24Stakeholders.com/events for information about meetings and topic updates
- **Sign up** to receive email notifications

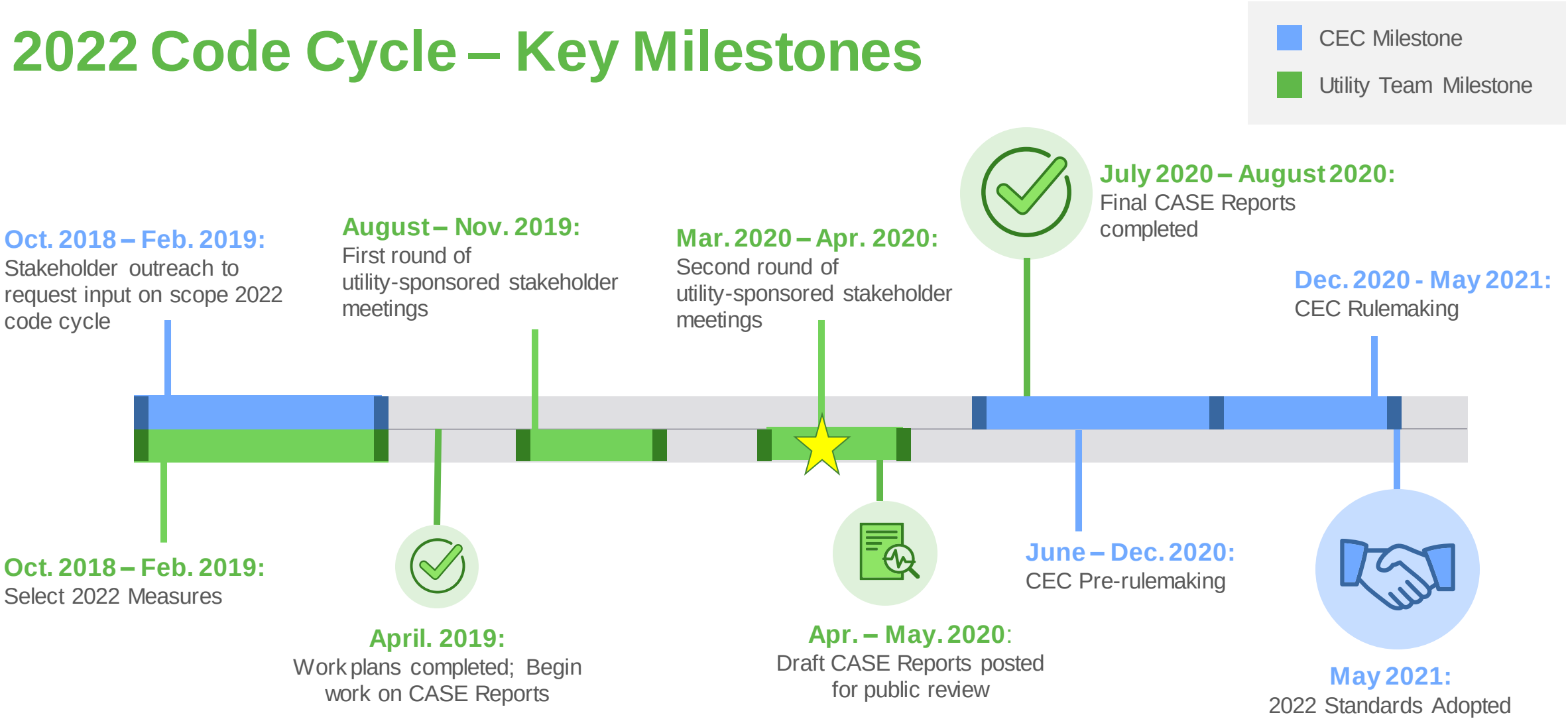


Second Round Utility-Sponsored Stakeholder Meetings

Meeting Topic	Building Type	Date
Lighting	*NR/MF*	*Tuesday, March 3, 2020*
Single Family Whole Building	*SF*	*Thursday, March 5, 2020*
Nonresidential and Single Family HVAC Part 1: Data Centers, Boilers, Air Distribution, Variable Capacity	*NR/SF*	*Thursday, March 12, 2020*
Water Heating and Multifamily All Electric Package	*MF*	*Tuesday, March 17, 2020*
Single Family Grid Integration	*SF*	*Thursday, March 19, 2020*
Multifamily HVAC and Envelope	**MF**	**Wednesday, March 25, 2020**
Covered Processes Part 1: Refrigeration System Opportunities	NR	Thursday, April 2, 2020
Nonresidential HVAC and Envelope Part 2: Reduced Infiltration, HVAC Controls (Air Efficiency, DOAS)	NR	Tuesday, April 14, 2020
Covered Processes Part 2: Controlled Environmental Horticulture	NR	Thursday, April 16, 2020
Nonresidential Envelope Part 1: High Performance Envelope	NR	Thursday, April 23, 2020
NEW Multifamily Restructuring	MF	Thursday, May 7, 2020

Sign up for all meetings at title24stakeholders.com/events/

2022 Code Cycle – Key Milestones



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Tools ♠ Training ♠ Resources

to help you decode Title 24, Part 6 and Title 20

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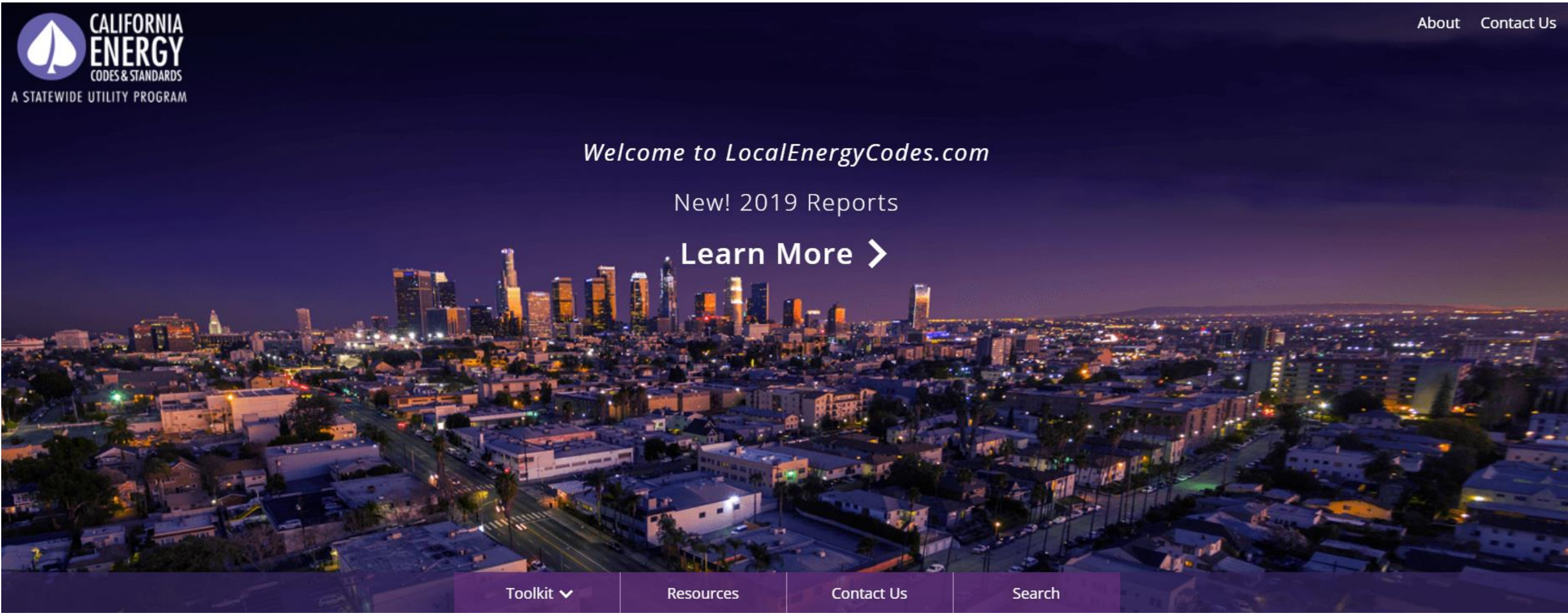
This program is funded by California utility customers and administered by Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E®), Southern California Edison Company (SCE), and Southern California Gas Company (SoCalGas®) under the auspices of the California Public Utilities Commission.



The **Codes and Standards Reach Codes Program** provides technical support to local jurisdictions considering adopting a local energy and efficiency ordinance

www.LocalEnergyCodes.com

This program is funded by California utility customers under the auspices of the California Public Utilities Commission and in support of the California Energy Commission.

Thank You

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CALIFORNIA ENERGY CODES & STANDARDS
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Meeting Guidelines Reminder

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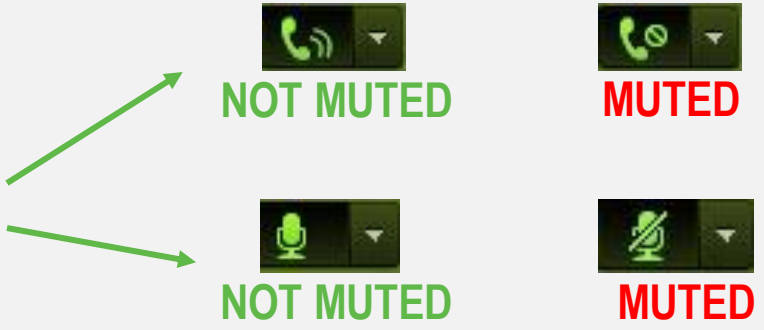


Meeting Guidelines Reminder

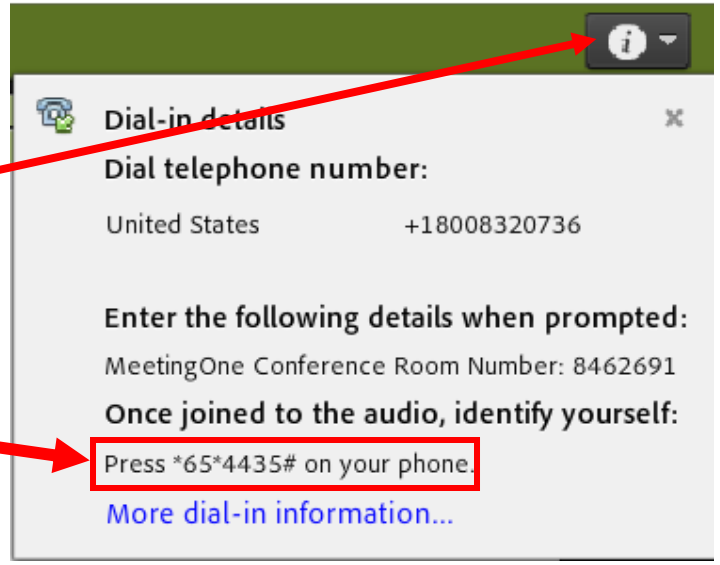
Pairing Guidelines:

If you dialed in to join the audio, please **pair your line**.

- Please keep yourself **MUTED**.
- Navigate to the (i) button in the top right of your screen.
- Click the pull-down menu and ***identify your line*** *by entering your unique user ID on your phone.*

Steps to Pair Line:

1. **Select (i) button** pull-down on the top right of Adobe Connect window;
2. Identify your line using your unique code.



2022 CALIFORNIA ENERGY CODE (TITLE 24, PART 6)

Multifamily Indoor Air Quality

Codes and Standards Enhancement (CASE) Proposal
Multifamily | Envelope

Marian Goebes, *TRC*
March 25, 2020

CALIFORNIA ENERGY CODES & STANDARDS
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Agenda

1. Heat or Energy Recovery Ventilation (HRV or ERV)
2. Kitchen Range Hood Minimum Capture
3. Central Ventilation Duct Sealing
4. Questions and Next Steps

Today's Objectives

The focus of today's meeting includes:

1. **Review** Energy and Cost Calculations
2. **Show** Market Analysis
3. **Show** Technical Feasibility
4. **Review** Compliance and Enforcement
5. **Discuss** Code Language

Code Change Proposal: Additional Resources

First-Utility Sponsored Meeting

The Statewide CASE Team held its first utility-sponsored stakeholder meeting for this topic on **August 22, 2019.**

Resources on Title24stakeholders.com

Presentation slides and **Submeasure summary** documents available that cover the following:

- ✓ Measure Background
- ✓ Market Overview & Analysis
- ✓ Technical Feasibility
- ✓ Compliance & Enforcement
- ✓ Draft Code Language

Also available in the **resources tab in today's presentation.**

Submeasure A: HRV or ERV

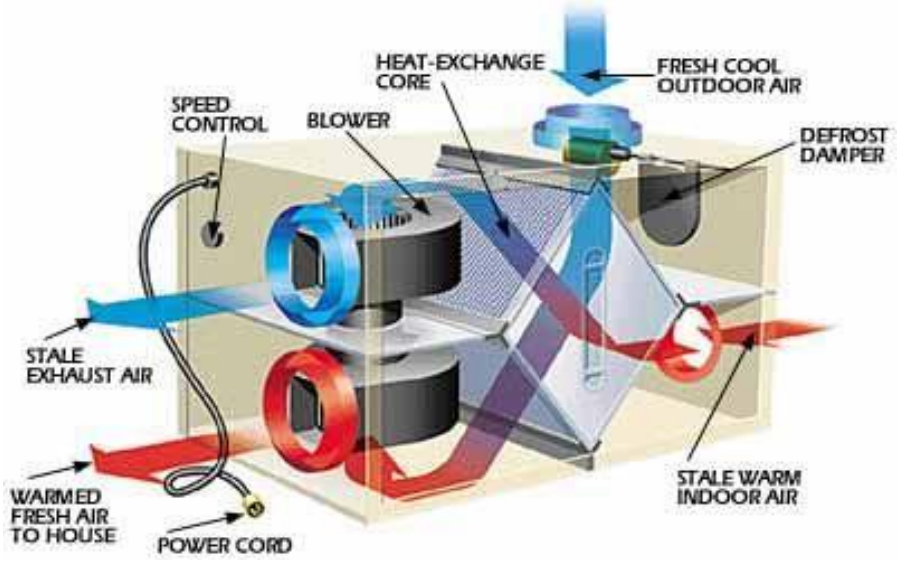
Submeasure B: Kitchen Range Hood Minimum Capture

Submeasure C: Central Ventilation Duct Sealing

Proposal Background

Context and History: HRV/ERV

- **Heating Recovery Ventilator (HRV) or Energy Recovery Ventilator (ERV)**
- **Why are we proposing this measure?**
  - Primarily for energy savings from pre-heating/ cooling ventilation supply air from conditioned exhaust air
  - Secondarily for improved thermal comfort



Popular Mechanics. August 1, 2000. https://www.popularmechanics.com/home/interior-projects/how-to/a149/1275121/

Code Change Proposal Summary

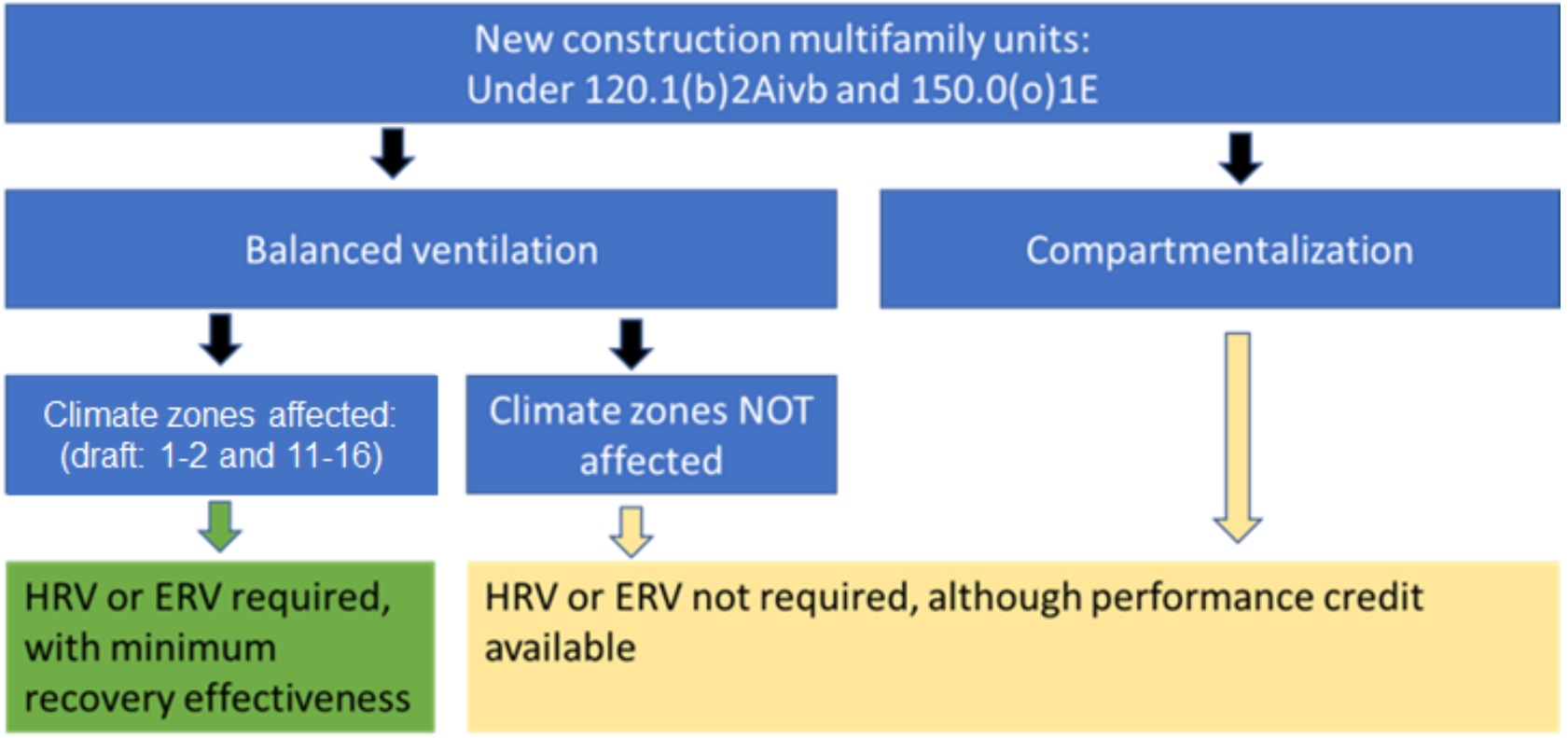
Submeasure	Type of Change	Software Updates Required	Sections of Code Updated	Compliance Documents Updated
Submeasure A: HRV/ERV	Mandatory	Y	120.1(b)Aivb1 – high-rise 150.0(o)1Ei – low-rise multifamily Nonresidential Appendix 2.4 Residential Appendix 3.4.4	CF1R, CF2R, CF3R, NRCA, NRCC, NRCV

Description of Changes

- This code change requires exhaust air heat or energy recovery for multifamily dwelling units using balanced ventilation in Climate Zones 1-2, and 11-16.
  - Dwelling units using compartmentalization, or in Climate Zones 3-10 are exempt
- Main changes from first stakeholder meeting:
  - Added that sensible heat recovery efficiency (SRE) must be at least 67 percent. This had been an unspecified value.

Draft Code Change Language: HRV/ERV

- Draft code language for this submeasure is available in the **resources tab**
- Flowchart shows overview of scope



Energy and Cost Impacts

- Assumptions & Methodology
- Energy Impacts
- Cost Impacts
  - Incremental costs
  - Maintenance costs
  - Energy cost savings
- Cost-effectiveness

Methodology for Energy Impacts Analysis

Tools Used	• **Low-rise Multifamily:** CBECC-Res v.0.1 Research Version for 2022 • **Midrise and High-rise Multifamily:** EnergyPlus
Building Prototypes Used	• Two-story garden style *(8 units)* • Three-story loaded corridor *(36 units)* • Five-story mixed use mid-rise *(88 units)* • Ten-story mixed use high-rise *(117 units)*
Climate Zones Modeled	**Modeled so far:** • Two-story garden style: All Climate Zones • Three-story loaded corridor: Climate Zone 12 only • Mid-rise and high-rise: All Climate Zones Remaining climate zones will be analyzed for Final CASE Report For cost-effectiveness analysis, all models assume mixed fuel prototypes, per Energy Commission guidelines.

Assumptions for Energy Impacts Analysis

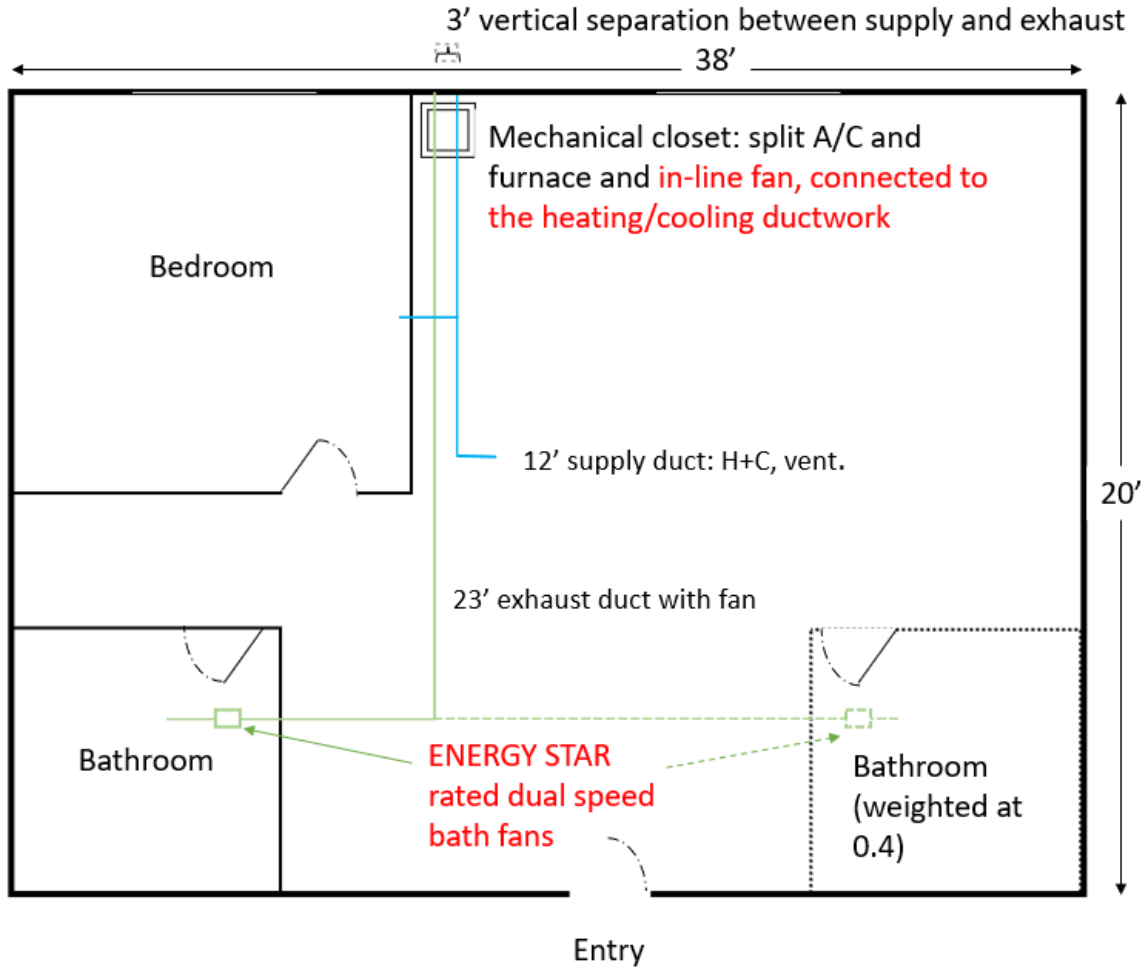
- Energy savings impact calculated based on the following:
  - **Infiltration assumptions:**
    - Low-rise multifamily: 7 ACH50 (per Title 24 Res ACM)
    - Mid-rise and high-rise multifamily: assumes 0.4 cfm 75/sf total *building envelope area*:
      - CBECC-Comm uses 0.4 cfm75/sf *building wall area*
      - Aligns with ASHRAE 90.1-2016 and is conservative compared to field measurements (RDH 2013 and CEE 2020)
  - **Period of evaluation:** 30 years, assumed replacement of all mechanical equipment (fans and ERVs) at year 15
  - **ERV strategy:**
    - Unitary ERV (one ERV per dwelling unit) for lowrise and mid-rise
    - Central ERV (each ERV serves multiple dwelling units) for high-rise
  - **SRE:** Assumed 67 percent, from average of ERVs with MERV 13 filtration in HVI database
  - **Fan efficacy:** 0.6 W/cfm for baseline and proposed cases for unitary ventilation, and 0.74 W/cfm for baseline and proposed cases for central system, based on ERVs used in cost analysis

Air Leakage Control in Multi-Unit Residential Buildings. April 2, 2013. https://www.rdh.com/wp-content/uploads/2017/07/Air-Leakage-Control-in-Multi-Unit-Residential-Buildings.pdf

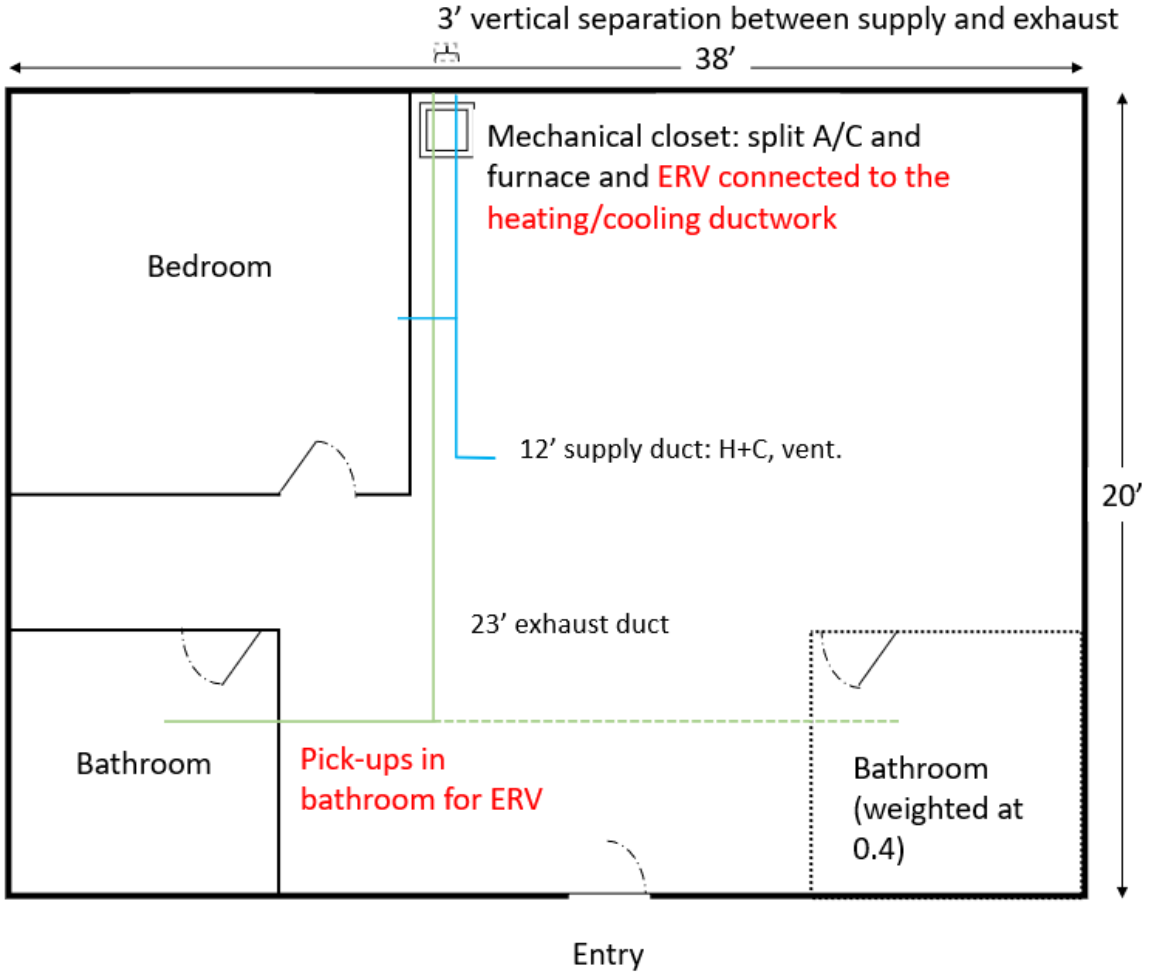
Center for Energy and Environment: "Preliminary Air Leakage Results for 16 Common entry Multi-unit Dwelling". 2019. Publication Pending.

Assumptions for Energy and Cost Impacts Analysis: Unitary ERV, for Lowrise and Midrise Prototypes

Base case: Supply and exhaust fans

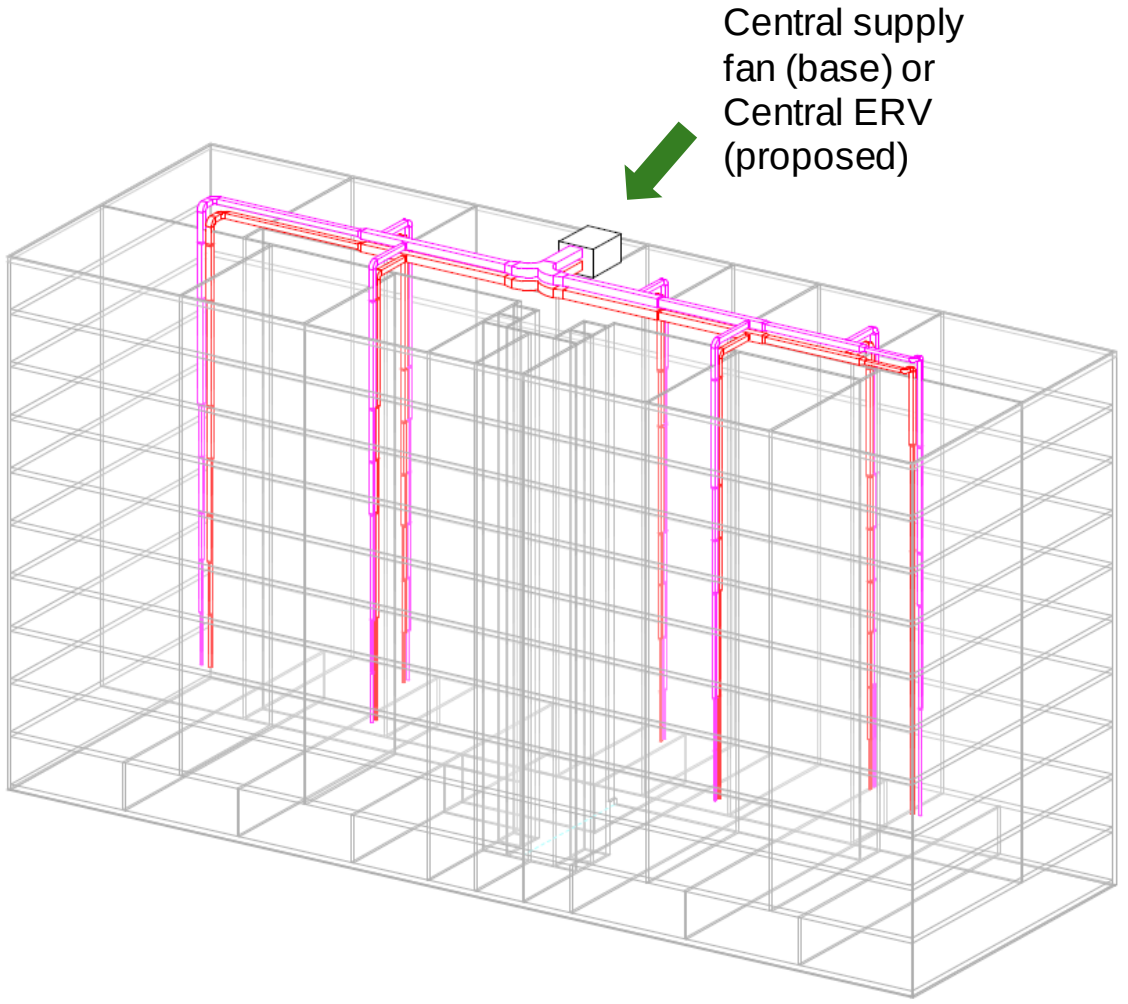


Proposed Case: ERV



Assumptions for Energy and Cost Impacts Analysis: Central ERV, for Highrise Prototype

- **Both** base and proposed cases assume rooftop equipment serving 1-2 dwelling units per floor



Baseline and Proposed Conditions – Unitary HRV/ERV: Low-rise and Mid-rise

Baseline Conditions

Unitary base case

- In-line supply fan with MERV 13
- ENERGY STAR bathroom fans exhausted through the wall. Assumes 1.4 bathrooms based on census data

Central base case

- 1 rooftop supply fan (Dedicated Outdoor Air Supply: DOAS) ventilation
- Central ductwork for supply air only. ENERGY STAR bathroom fans exhausted through the wall

Proposed Conditions

Unitary ERV

- Individual dwelling unit ERVs with MERV 13 filtration
- Pickups in bathroom instead of exhaust fan

Central ERV

- 1 rooftop ERV
- Central ductwork for supply *and* exhaust air

Incremental Cost Information – Unitary HRV/ERV

- Equipment was based on a similar **multifamily unit used in ASHRAE** Standard 90.1 proposal, with some revisions
  - Assumes furnace and split A/C per Energy Commission guidelines
  - Assumed MERV 13 filtration for supply fan (base) and ERV (proposed)
  - Number of bathrooms assumed to be 1.4 based on census data, instead of 2 in ASHRAE 90.1 proposal
- Cost of products collected from **RSMeans**.
- Same ductwork was assumed for both base and proposed cases.
- **MERV 13 filter** cost was found to be the same for base and proposed cases.

Incremental Per Unit Cost – Unitary HRV/ERV, for Low-rise and Mid-rise Analysis

Over 30 Year Period of Analysis

All costs include materials and labor.

Items	Low-rise Garden Style	
	Base Case	**ERV**
Broan Fresh In Supply Fan	$330	
Broan Ultra Green Multi-Speed Exhaust Fan	$228 x 1.4 = $319	
Panasonic Intelli-Balance 100 ERV		$1,030
MERV 13 Filter	$41	$40
Ductwork	$728	$728
Total	**$1,418**	**$1,798**
Incremental Cost, First Year		$380
Incremental Cost, Year 15 (2023 PV$). Assumes replacement of all fans and ERV		$244
Incremental Cost (2023 PV$)		**$624**

Incremental Cost Information – Central ERV/HRV

- **Mechanical engineering contractor developed Basis of Design (BOD) for base case and proposed case:**
  - Base case: A rooftop dedicated outdoor air supply (DOAS), and individual bathroom fans
  - Proposed: A rooftop ERV unit (Ruskin EVT-062) with a bypass function
- **Mechanical contractor developed costs based on the BOD:**
  - Assumed same budgets for:
    - Supply duct insulation within building: Supply ducts insulated to prevent condensation in base case and because air is conditioned in proposed case
    - Electrical costs: same number of central systems (1 central supply fan in base case, and 1 central ERV)
    - Balancing and commissioning, since same number of central systems

Incremental Per Unit Cost – Central ERV/HRV, for High-rise Analysis

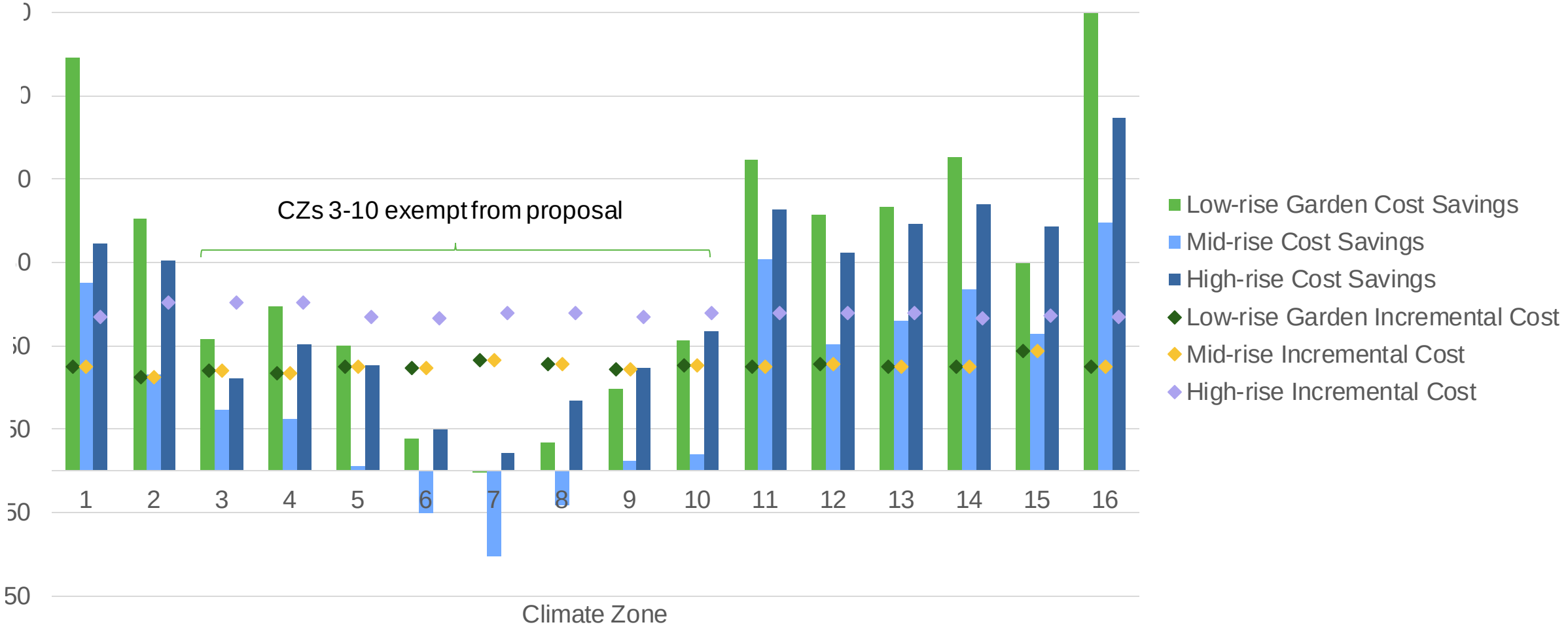
Over 30 Year Period of Analysis

Items		
	Supply Fans	**Central ERVs**
Filtered Supply Fans	$50,848	
Bathroom Exhaust Fans	$59,296	
ERVs		$40,848
Ductwork	$162,353	$189,395
Fire Smoke Dampers	$83,304	$166,608
Grilles, Registers and Louvers	$41,652	$16,871
Detailing & Material Handling/Rooftop Supply Insulation	$46,204	$79,476
Mark ups	$161,937*	$180,018*
Total	**$638,112***	**$705,735***
Incremental Cost for Building (117 Dwelling Units)		$67,623
Incremental Cost per Dwelling Unit, First Year		**$578**
Incremental Cost per Dwelling Unit, Year 15 (2023 PV$)**		**$365**
Incremental Cost per Unit (2023 PV$)		**$943**

*Mark ups are percentage of all costs, both listed costs and costs that are the same for base and proposed cases.
**Equipment replaced at 15 years are supply fans, exhaust fans, ERVs and fire smoke dampers.

Energy Cost Savings Results

Total 30 Year TDV Energy Cost Savings and Incremental Cost (2023 $/Dwelling Unit)



ERV/HRV: Market Overview

- HRV and ERV Strategies
- Current Market Conditions

HRV and ERV Strategies for Multifamily Buildings

- **Projects may choose either approach** of unitary E/HRVs, or a centralized E/HRV
- Preferred approach will likely vary by project

ERV/HRV Approach	Description	Pro	Con
Unitary	One ERV or HRV is provided per dwelling unit	Simple strategy that does not require central ventilation ducts or fire smoke dampers	More exterior penetrations, more units to maintain, accessibility to the equipment is more difficult
Centralized	ERV(s) or HRV(s) serves multiple dwelling units. Examples: rooftop E/HRVs serving vertical column of units or one E/HRV per floor	Does not require penetrations on the façade, maintenance centralized, and provides economies of scale for bypass function	More penetrations between units which require fire smoke dampers

HRV and ERV Market Conditions

E/HRVs in multifamily new construction:

- Have been rare
- May become more common under the 2019-Title 24 part 6 balanced ventilation path
- Are sometimes installed to meet San Francisco Article 38, which requires balanced or supply-only ventilation with MERV 13 filtration in areas of San Francisco with high outdoor $PM_{2.5}$

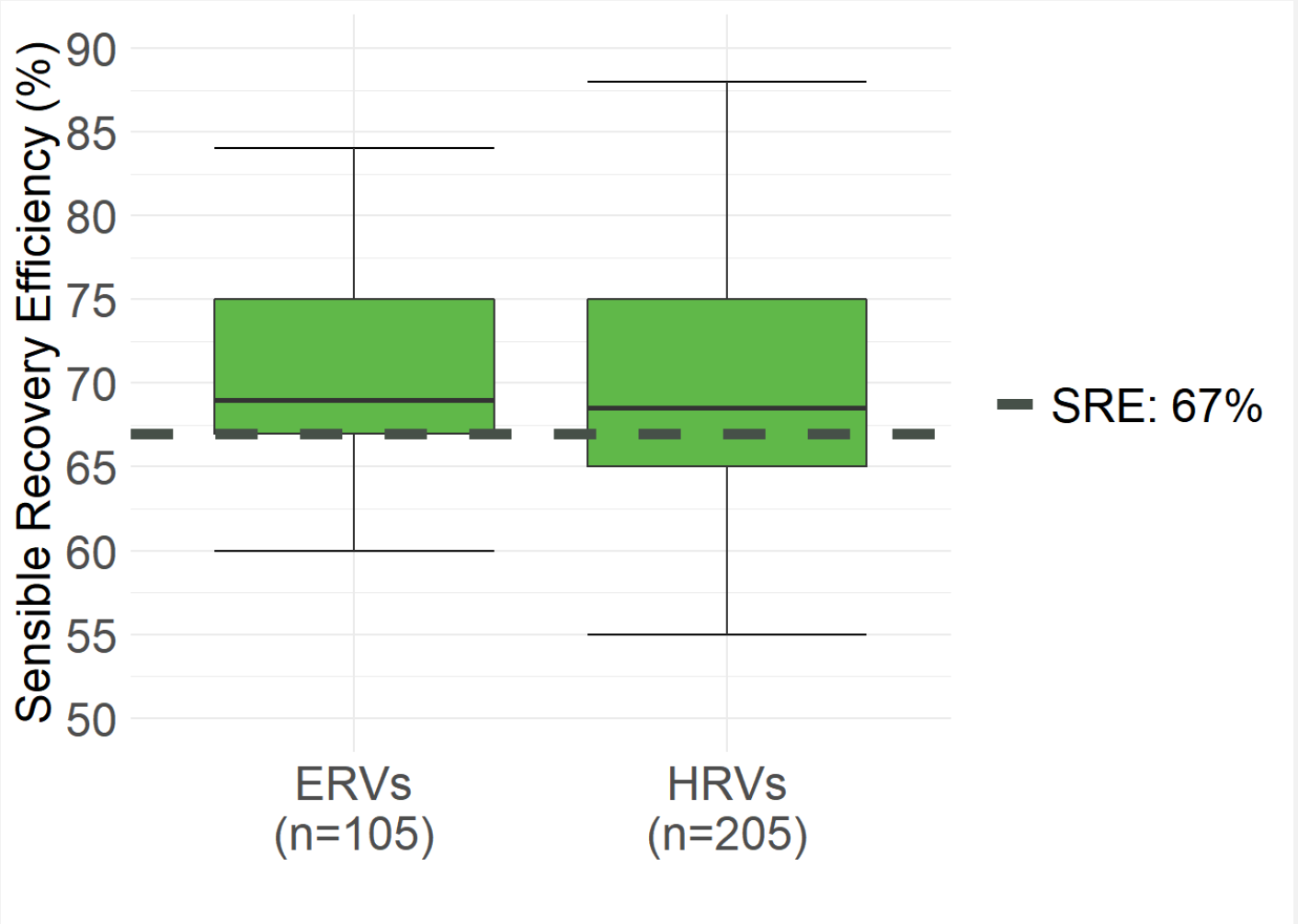
Casa Adelante (San Francisco) – uses unitary HRVs: one for each dwelling unit

Redwood Energy – A Zero Emissions All-Electric Multifamily Construction Guide. 2019. https://fossilfreebuildings.org/ElectricMFGuide.pdf

Mission Economic Development Agency. 2018. https://medasf.org/casa-adelante-2060-folsom-affordable-housing-for-families-closes/

ERV/HRV SRE Values in Home Ventilating Institute (HVI) Database

- Analysis conducted by Statewide CASE Team using data from HVI-Certified Products Directory
- Filtered for ERVs and HRVs with net airflow between 30 and 100 cfm



HVI-Certified Products Directory. Nov 15, 2019. https://www.hvi.org/hvi-certified-products-directory/section-iii-hrv-erv-directory-listing/ (TRC filtered data and generated graphs).

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance Verification Process: HRV/ERV

1. Design Phase

- Project team
  - **Identifies** if project is in a climate zone where requirement applies
  - If so, **specifies make and model** of HRV or ERV equipment and ensures it meets minimum SRE via compliance documentation
  - Designs and specifies duct system for desired air flow and wattage, and seals duct per California Mechanical Code (CMC) 603.10
  - Provides manufacturer and model number to compliance consultant for inclusion in the **NRCC or CF1R**

2. Permit Application Phase

- Project team
  - **Submits design documents** showing make and model of HRV or ERV equipment supported by compliance documentation
  - **Submits duct design** for approval
- **Plans examiner checks** that HRV/ERV meets proposed requirements

Compliance Verification Process: HRV/ERV *(continued)*

3. Construction phase

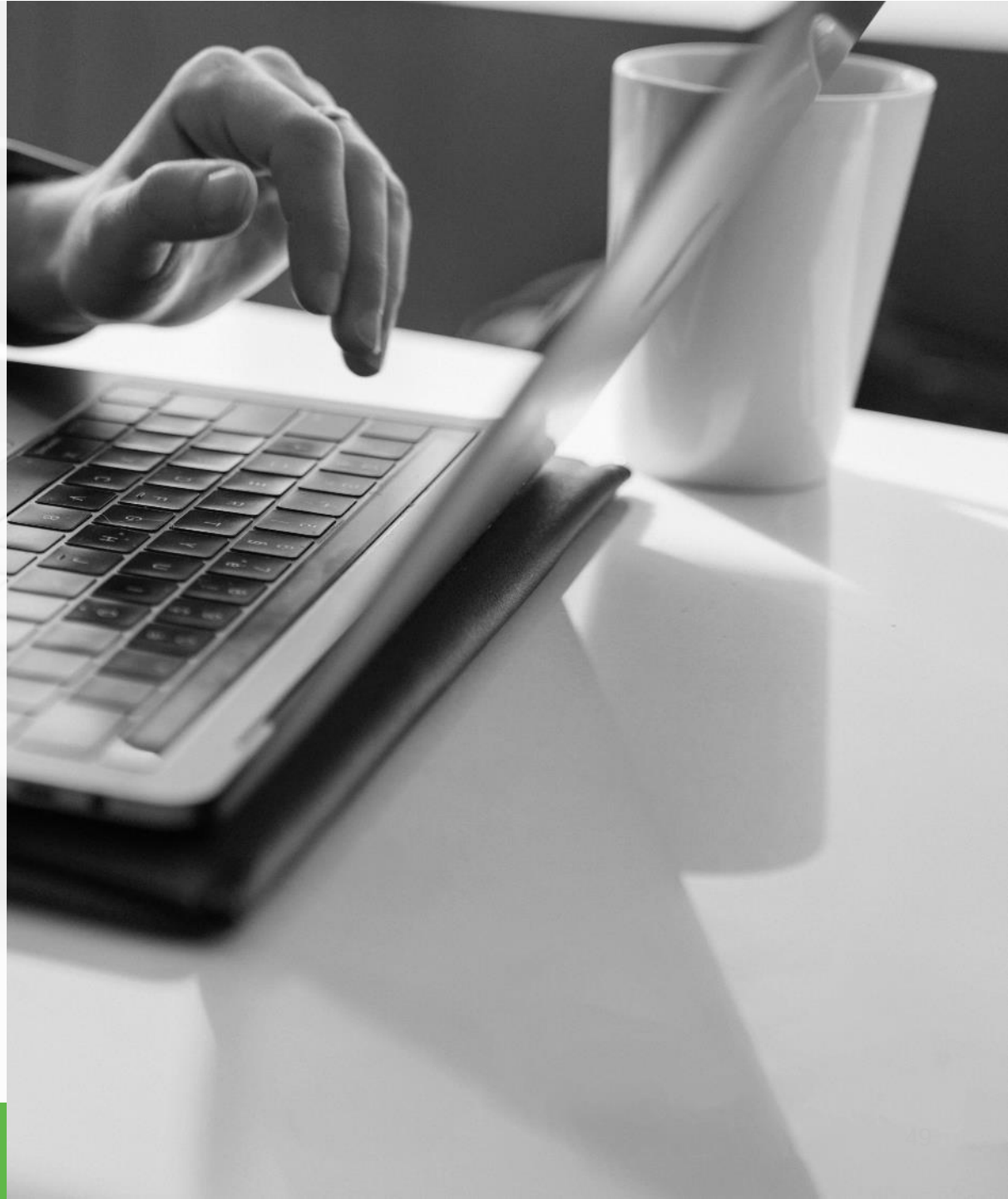
- **General contractor's** procurement staff checks that product ordered matches model number in plans
- If applicable, project team **installs ERV or HRV** equipment and ducts and seal ducts per CMC
- HVAC subcontractor ensures duct system is **properly installed**

4. Inspection Phase

- Code official **visually confirms ERV or HRV installed**
- HERS rater / ATT captures equipment model and **confirms** it meets the SRE requirement using cut sheet or online information

Proposed Code Changes

- Draft Code Change Language
- Proposed Software Updates



Draft Code Change Language: ERV/HRV

- **Updated** draft code language for this submeasure is available onscreen. Let's review.

Poll

In the climate zones where this will apply, how do you think your projects will most often meet the proposed requirement for multifamily units WITHOUT common corridors ("garden-style")? Select one.

A. Balanced ventilation with individual ERV/HRV
B. Balanced ventilation with central ERV/HRV
C. Compartmentalization
D. It depends: In chat, identify what it depends on

Poll

In the climate zones where this will apply, how do you think your projects will most often meet the proposed requirement for multifamily units WITH common corridors? Select one.

A. Balanced ventilation with individual ERV/HRV
B. Balanced ventilation with central ERV/HRV
C. Compartmentalization
D. It depends: In chat, identify what it depends on

Software Updates

- **For multifamily buildings using central E/HRVs, bypass will be required:**
  - CBECC-Comm already includes a bypass function
  - Statewide CASE Team is requesting that the Energy Commission update CBECC-Res to add a bypass function for ERVs or HRVs
- Bypass is encouraged (although not required) for unitary E/HRVs
- Statewide CASE Team found that bypass almost doubles energy savings in climate zones with high cooling loads

Submeasure A: HRV or ERV

Submeasure B: Kitchen Range Hood Minimum Capture

Submeasure C: Central Ventilation Duct Sealing

Proposal Background

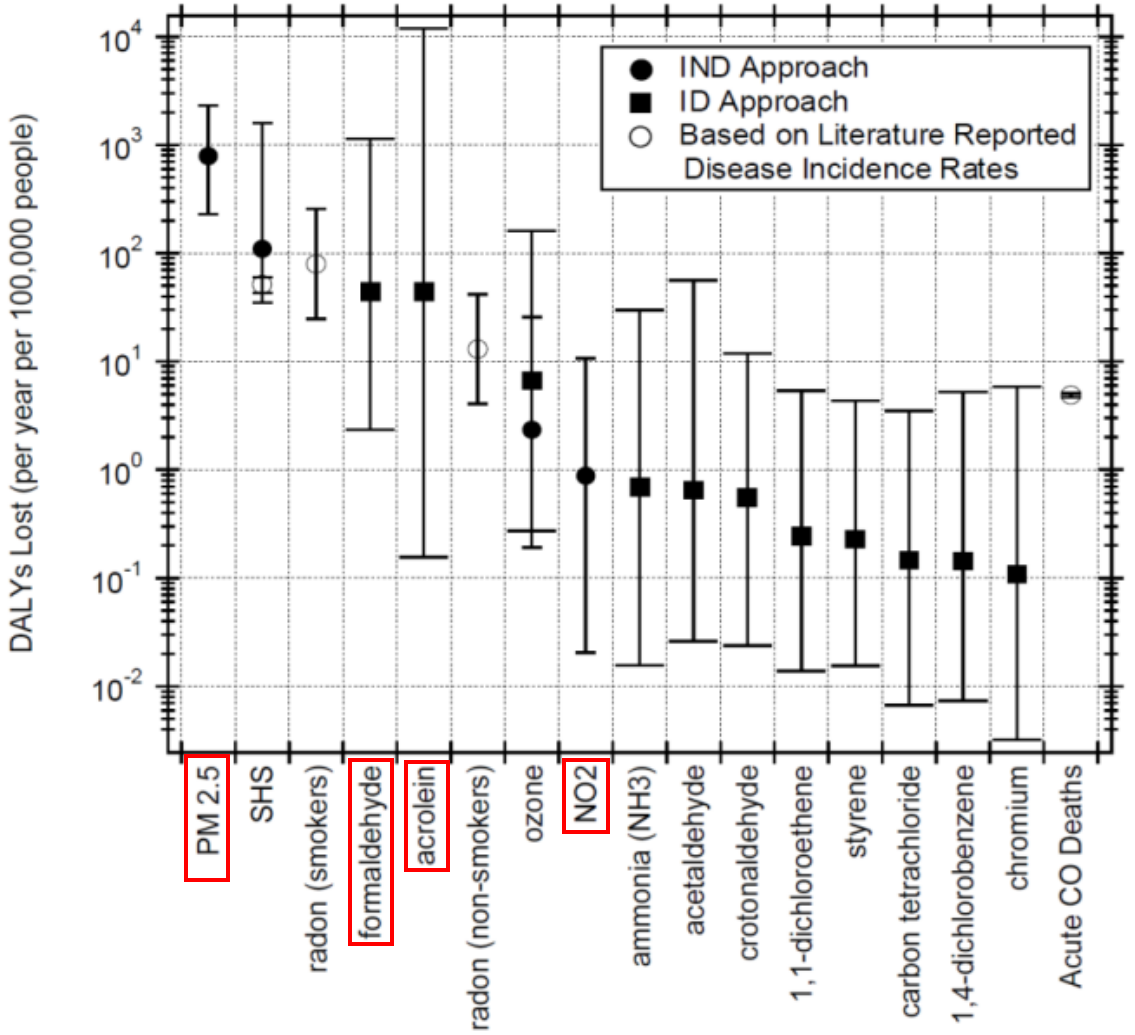
Context and History: Kitchen Range Hood Minimum Capture

- **Why are we proposing this measure?**
  - Multifamily buildings are getting tighter, increasing the importance of ventilation
    - 2019 Title 24, Part 6 requires Quality Insulation Installation (QII) for low-rise multifamily, and 2022-Title 24 part 6 proposals would extend a version of QII to high-rise multifamily
    - Tighter envelopes reduce energy use, but increase need for proper ventilation
    - Multifamily units have the risk of their own kitchen pollution, and pollution from adjacent (neighbors') kitchens.

Logue, et al. 2011. A Method to Estimate the Chronic Health Impact of Air Pollutants in U.S. Residences.

Context: *Research underscores the health effects of pollution from cooking*

- **Cooking releases harmful or irritating compounds**
  - PM2.5, Volatile organic compounds (VOCs), and acrolein are released from the cooking process
  - Nitrogen Dioxide (NO2), formaldehyde, and carbon monoxide (CO) are released from natural gas appliances



DALY: Disability adjusted life years
IND: Intake-Incidence-DALY
ID: Intake-DALYs

Logue, et al. 2011. A Method to Estimate the Chronic Health Impact of Air Pollutants in U.S. Residences.

Code Change Proposal Summary

Submeasure	Type of Change	Software Updates Required	Sections of Code Updated	Compliance Documents Updated
Submeasure A: Kitchen Range Hood Minimum Capture	Mandatory	N	120.1(b)Avi – high-rise 150.0(o)1G – low-rise multifamily Nonresidential Appendix 2.2.4.1.3 Residential Appendix 3.7.4.3	CF2R, CF3R, NRCA, NRCC, NRCV

Description of Changes

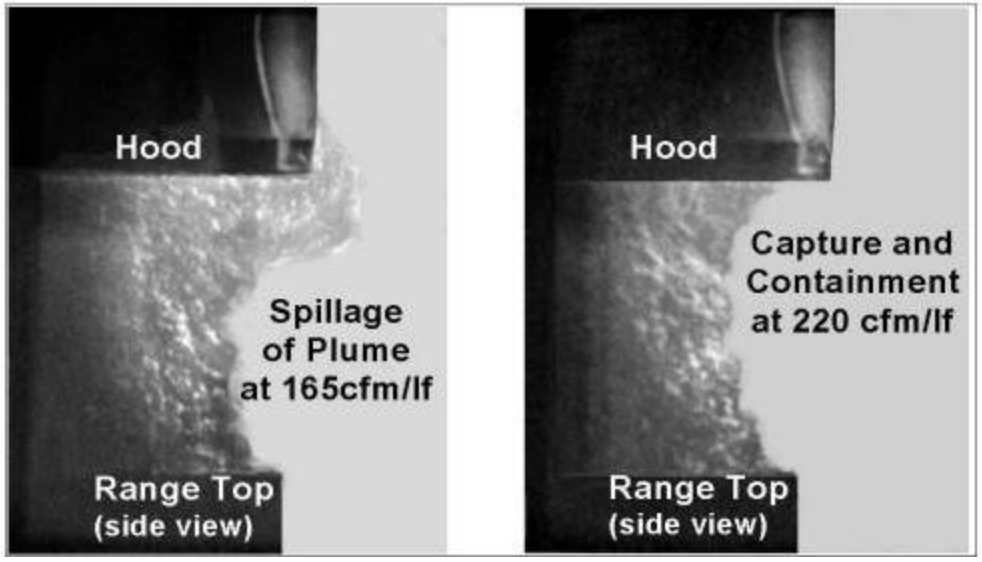
Multifamily new construction dwelling units must have kitchen exhaust that complies with *at least one* of the following:

1. A **vented range hood** with a minimum **capture efficiency of 70 percent** at nominal installed airflow defined in HVI Standard 920
2. A **vented range hood** with a minimum **airflow of 250 cfm** at ≥ 25 Pa (0.1” w.c.), or
3. A **downdraft** exhaust with a minimum **airflow of 300 cfm** at ≥ 25 Pa (0.1” w.c.), or
4. For **enclosed kitchens only**: **Continuous exhaust** of at least 5 kitchen air changes per hour (ACH)

HVI Publication 920. 2020. https://www.hvi.org/HVIORG/document-server/?cfp=HVIORG/assets/File/public/ratings/Publication_920_rev_022820.pdf

Description and Definition of Capture Efficiency

- "**Capture efficiency**" measures a kitchen range hood's capability in removing contaminants generated during cooking
  - Ratio of captured pollutant to total pollutant released, expressed as percent
  - Manufacturer would be responsible for contracting with a 3rd party lab to measure capture efficiency, using ASTM method E3087-18



Capture efficiency from same hood at 165 cubic feet per minute (cfm) and 220 cfm. Source: ASHRAE HVAC Applications Handbook, 2011, Chapter 33, Kitchen Ventilation

Comparison of Proposed and Current Requirements

- 2019-Title 24 part 6 150.0(o) and 120.1(b)2 require all dwelling units to meet all requirements of ASHRAE Standard 62.2-2016 (with an amendment)
  - Amendment is that sound requirement: ≤ 3 sones at ≥ 100 cfm cfm can be measured at working speed

Compliance Option: Proposed for 2022-Title 24	Current Compliance Options in 2019-Title 24 part 6 (Required by reference to 62.2)	Rationale for Proposed Path
1. **Vented range hood** with **capture efficiency ≥ 70%**	Not provided	Capture efficiency directly measures pollutant removal. Need ≥ 75% for acceptable levels of PM2.5 and NO2. Proposed ≥ 70% to ease market burden and align with airflow path (#2)
2. **Vented range hood** with **airflow ≥ 250 cfm**	Vented range hood with airflow **≥100 cfm**	Need ≥ 250 cfm airflow for 70% capture efficiency. Majority of products meet this path.
3. A **downdraft** exhaust with **airflow ≥ 300 cfm**	Same as proposed	Allowed per reference to 62.2-2016
4. For **enclosed kitchens only**: **Continuous exhaust** of at least 5 kitchen ACH	Same as proposed	Allowed per reference to 62.2-2016

Market Overview and Cost Impacts

- Assumptions & Methodology
- Cost Impacts

Current Market Conditions

- Statewide CASE Team reviewed 5 high-rise projects that participated in the 2016-2018 California Multifamily New Homes (CMFNH) program
  - All followed either 2013 or 2016-Title part 6, which followed ASHRAE Standard 62.1 (not 62.2) ventilation requirements
  - 2 projects would not comply with 2019-Title 24, part 6 kitchen exhaust requirements

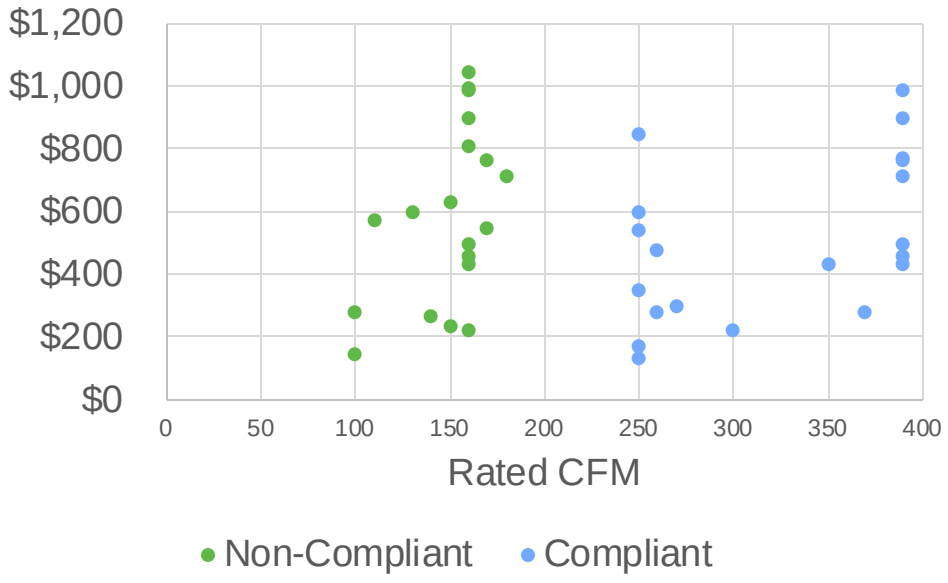
Kitchen exhaust approach	Would comply with 2019-Title 24 part 6?	Number of projects
Vented range hood > 100 cfm	Yes	2
Bathroom exhaust fan using continuous exhaust installed in *enclosed* kitchen	Yes	1
Bathroom exhaust fan using continuous exhaust installed in *non-enclosed* kitchen	No	1
Recirculating range hood	No	1

Incremental Cost Information

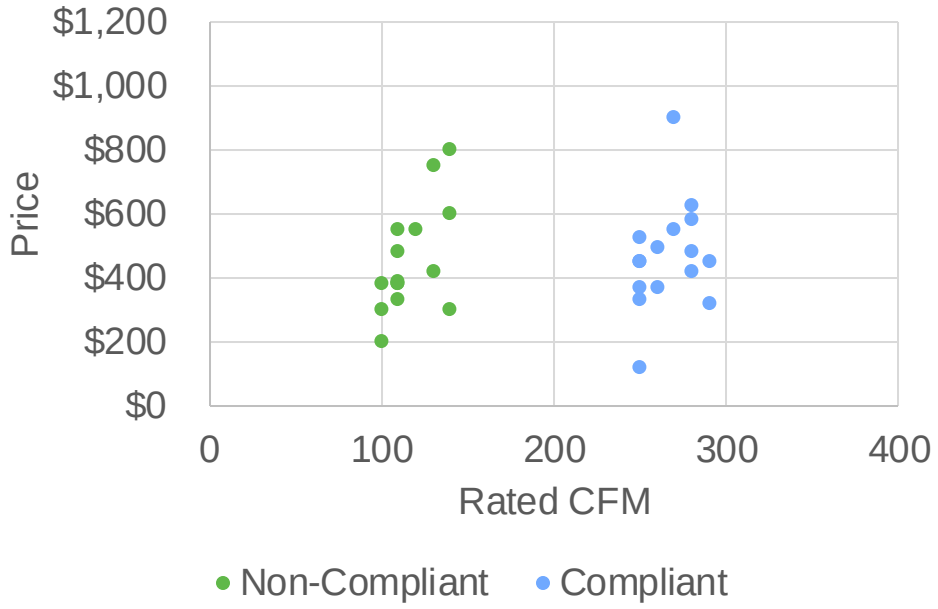
- **Market impact was assessed through:**
  1. Cost comparison of compliant and non-compliant products for Path 2: ≥ 250 cfm at ≥ 0.1” w.c., and
  2. Assessment of the fraction of range hood products that could comply with Path 2
- **Cost comparison**: A random sample of over-the-range microwave (16) and undercabinet range hoods (20) were taken from the HVI database for both the current and proposed range hood requirements
  - Costs searched online (Home Depot, Amazon, Best Buy)
  - All products comply with the current requirement: ≥ 100 cfm, ≤ 3 sones

Investigations of Cost Impact of Path 2: Airflow ≥ 250 cfm

Undercabinet Range Hood



Over-the-range Microwave Range Hoods



- "Non-Compliant" refers to range hood compliant under 2019 Title 24, Part 6 but not proposed requirements.
- Non-compliant and compliant have similar price ranges.

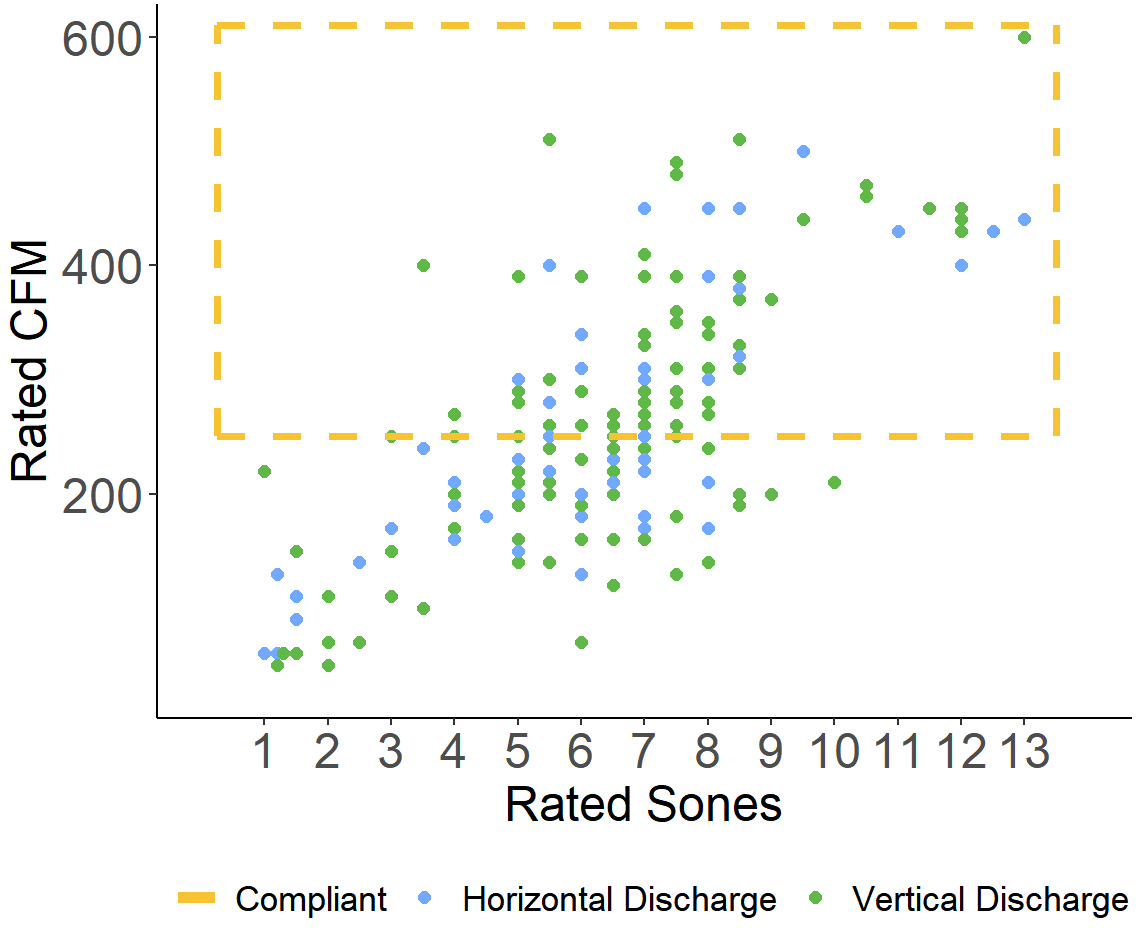
Investigations of Cost Impact of Path 2: Airflow ≥ 250 cfm

Incremental First Cost	Cost		Incremental Cost	P-Value
	Non-compliant with Proposal	Compliant with Proposal		
Over-the-range Microwave Range hood	$453	$464	$11	0.42
Undercabinet Range hood	$585	$508	($77)	0.19

- **Cost difference between Noncompliant and Compliant products were not found to be statistically significant**

Estimated Fraction of Range Hoods Complying with Path 2: Airflow ≥ 250 cfm

- Based on undercabinet and microwave range hood combination products in the HVI database:
  - 46 percent meet proposed requirement under horizontal discharge
  - 73 percent meet proposed requirement under vertical discharge

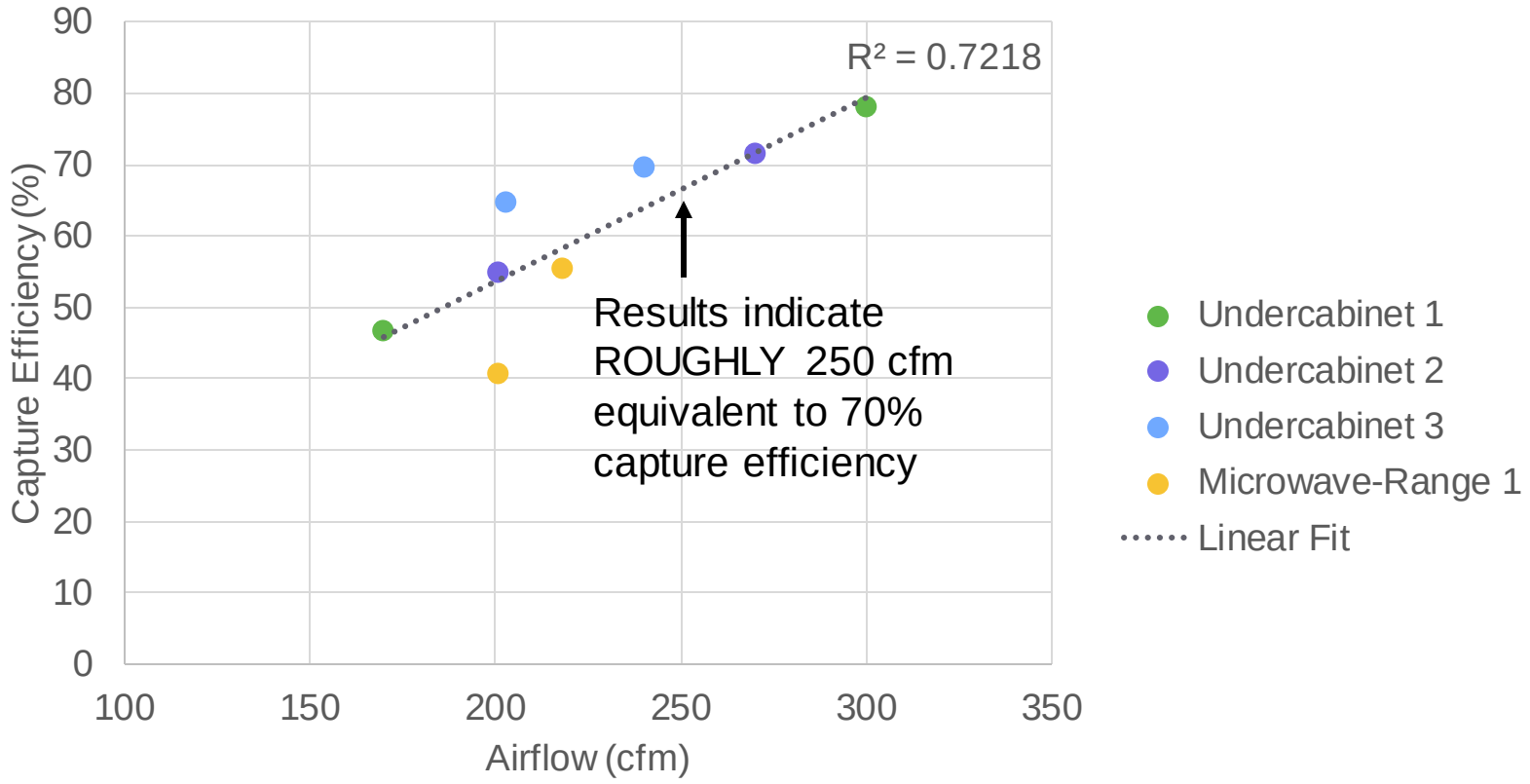


Poll

For multifamily dwelling units, do you typically install range hoods using a horizontal or vertical configuration?

A. Typically horizontal
B. Typically vertical
C. Roughly half horizontal, half vertical

Capture Efficiency of Example Equipment



- Based on testing at Texas A&M University commissioned by Statewide CASE Team
- Each rangehood was tested at its highest setting at two static pressures (0.1" w.c. and 0.25" w.c.) which resulted in two different airflows

Logue, et al. 2011. A Method to Estimate the Chronic Health Impact of Air Pollutants in U.S. Residences.

Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations

- **Technical Considerations:**
  - Project teams can review product materials (databases, cut sheets) to identify manufacturers' reported capture efficiency (once published) or airflow (available now) before specifying
- **Technical Barriers and Potential Solutions:**
  - Manufacturers are not yet reporting capture efficiency
  - HVI is in process of developing the HVI Range Hood Capture Efficiency Testing and Rating Procedure, which would refine the ASTM test method. 2022 Title 24, Part 6 requirement will encourage manufacturers to report capture efficiency and develop compliant equipment
  - In the meantime, project teams can follow alternative compliance paths based on airflow

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance Verification Process

1. Design Phase

- Building design team **selects kitchen exhaust system** that complies with one of the compliance paths
- Project team specifies duct system design and seals ducts per CMC 603.10
- Design team member may be architect, mechanical engineer/contractor or kitchen consultant

2. Permit Application Phase

- Project team **submits design documents** showing proposed kitchen exhaust equipment via compliance documentation
- Plan examiner **reviews drawings** and specifications to ensure kitchen exhaust system complies

Compliance Verification Process *(continued)*

3. Construction phase

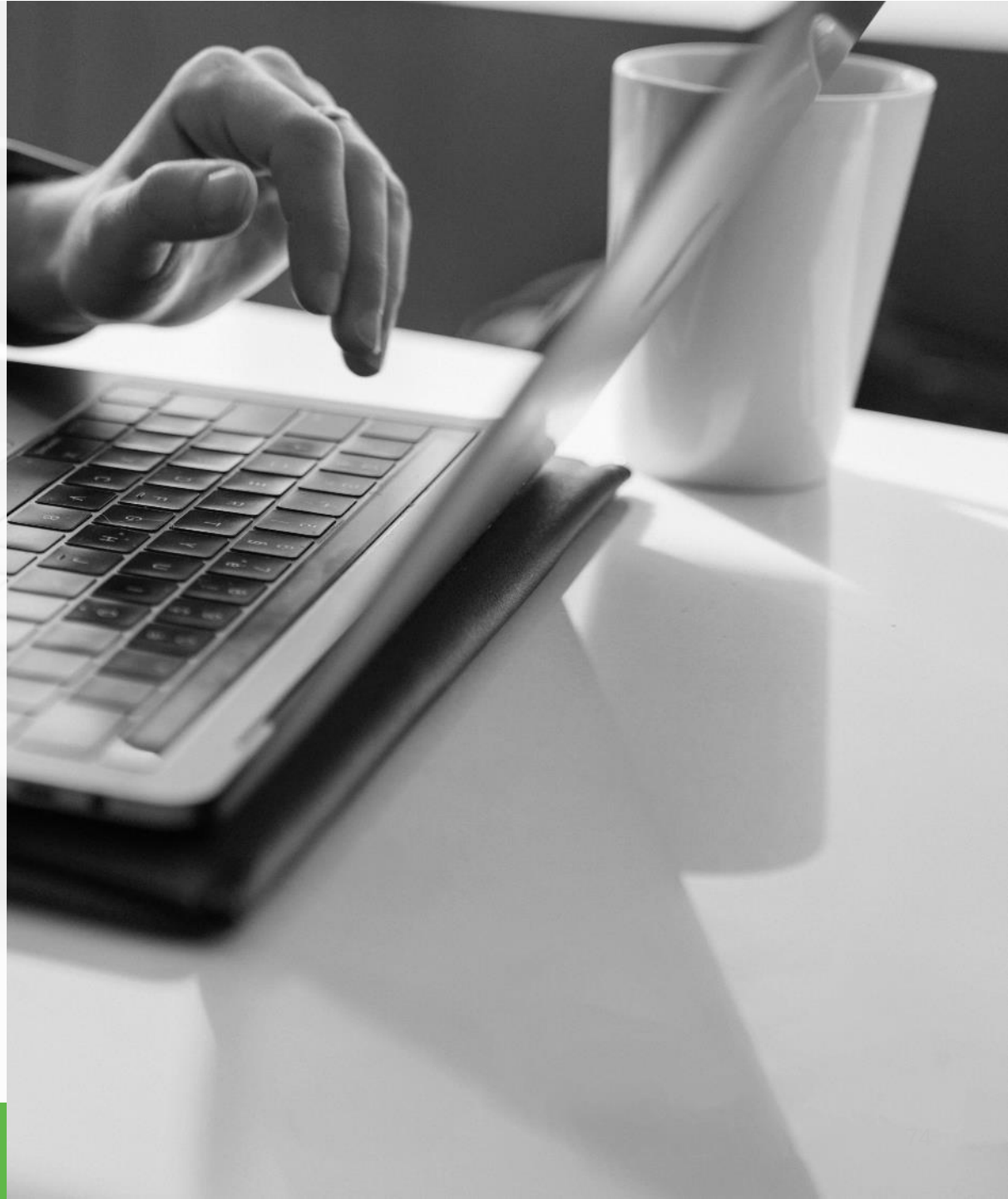
- Project team **installs** compliant kitchen exhaust documenting with compliance documentation, and seals ducts per CMC

4. Inspection Phase

- ATT or HERS Rater:
  - For capture efficiency or minimum airflow paths: conducts visual inspection of HVI label, and verifies that capture efficiency or airflow match value in the Certificate of Installation and Acceptance documents
  - For continuous exhaust path: visually verifies that kitchen meets definition of “enclosed” and that airflow meets value in the Certificate of Installation and Acceptance documents

Proposed Code Changes

- Draft Code Change Language
- Proposed Software Updates



Draft Code Change Language: Kitchen Range Hood Minimum Capture

- **Updated** draft code language for this submeasure is available onscreen. Let's review.

Submeasure A: HRV or ERV

Submeasure B: Kitchen Range Hood Minimum Capture

Submeasure C: Central Ventilation Duct Sealing

Proposal Background

Context and History: Central Ventilation Duct Sealing

- **Why are we proposing this measure?**
  - Primarily for energy savings:
    - Reduce ventilation fan power
    - Reduce heating and cooling energy from less air leakage from conditioned space
  - Secondarily, for improved IAQ for multifamily residents:
    - Central exhaust duct: Improves removal of bathroom pollution (moisture, smells, VOCs)
    - Central supply ventilation duct: Helps ensure supply air is evenly distributed

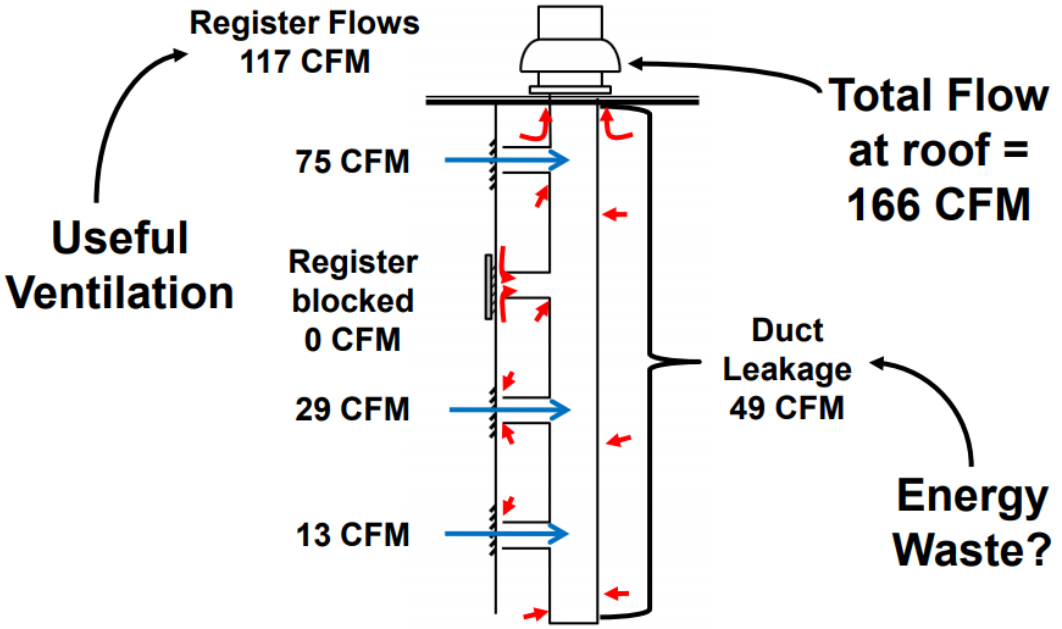


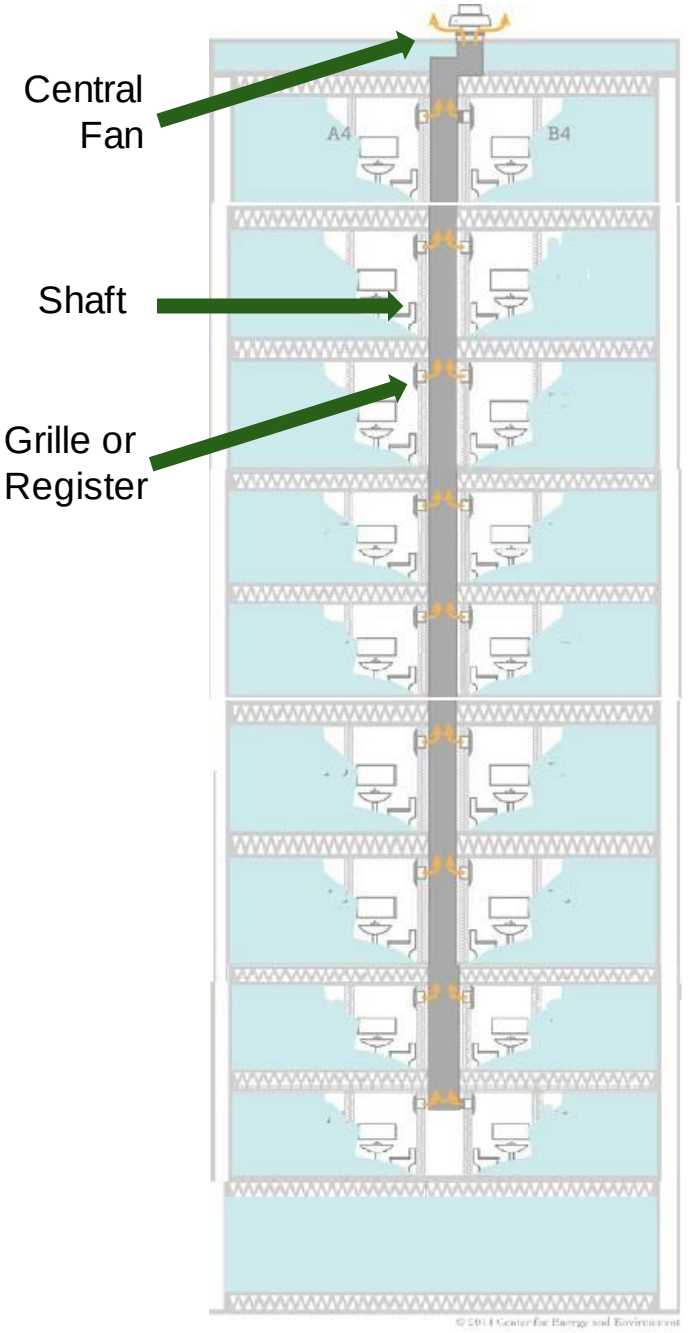
Image: Duct leakage. Source Steven Winter Associates, 2013. https://www.energy.gov/sites/prod/files/2013/12/f5/carb_ventilation_webinar.pdf

Terminology used in CASE Report

Central: serves multiple dwelling units

Central ventilation duct system components:

- **Central fan:** supplies airflow to or from dwelling units. Often located at roof
- **Shaft:** vertical duct that runs between floors: larger diameter and typically rectangular
- **Branches:** horizontal ductwork that connects the dwelling unit to the shaft: smaller diameter and typically round
- **Grille or register:** connection point for duct within unit



Minnesota Department of Commerce Multifamily Ventilation Assessment and Retrofit Guide. 2016. https://www.cards.commerce.state.mn.us/CARDS/security/search.do?method=showPoup&documentId=%7BDB45217D-CD15-483D-87EE-E657487CAA7F%7D&documentTitle=282726&documentType=6

Code Change Proposal Summary

Submeasure	Type of Change	Software Updates Required	Sections of Code Updated	Compliance Documents Updated
Submeasure A: Central Ventilation Duct Sealing	Mandatory	Y	120.5 and 140.4(l) for high-rise multifamily 150.0m(11) for low-rise multifamily Nonresidential Appendix 1.6.3 and 1.9.1 Residential Appendix 2.6.2 and 3.1.4.3.1	CF2R, CF3R, NRCA, NRCC, NRCV

Description of Changes

- Ducts servings multiple dwelling units that carry ventilation air to meet the balanced ventilation path, or other continuous ventilation airflows, must be sealed and tested using a fan pressurization test
- Allowable leakage should be no greater than 10 percent compared to nominal airflow rate of 50 Pa (0.2'' w.c.) – Equivalent to 6 percent at 25 Pa (0.1")
- Test should be conducted using ASTM fan pressurization test E1554 [Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization]
- HERS Rater or ATT can test a sample of ducts for leakage using sampling protocols in Reference Appendices

Energy and Cost Impacts

- Assumptions & Methodology
- Energy Impacts
- Cost Impacts
  - Incremental costs
  - Maintenance costs
  - Energy cost savings
- Cost-effectiveness

Methodology for Energy Impacts Analysis

- Used whole building energy modeling to analysis energy impacts

Tools Used	• EnergyPlus: allows different inputs of ventilation duct leakage
Building Prototypes Used	**Modeled to:** • Ten-story mixed use high-rise *(117 units)*
Climate Zones Modeled	**Modeled in:** • All climate zones **To be estimated for Final CASE Report:** • Three-story loaded corridor: all climate zones • Midrise mixed use: all climate zones

Assumptions for Energy Impacts Analysis

- **Energy savings impact calculated based on the following:**
  - Assumed infiltration rates used in CBECC-Com
  - Period of evaluation: 30 years
  - Assumed building had balanced ventilation with *central* exhaust for each dwelling unit (regulated by this proposal) but *unitary* supply ventilation (not regulated by this proposal)
    - Reduced fan energy, because fan runs less to supply minimum ventilation rate to lower units
    - Reduced heating and cooling loads, because leakage displaces conditioned air
  - Both central supply and central exhaust ducts would be covered by this requirement, but we assumed building had only one type of central ducts (exhaust) for the cost analysis
    - Energy savings would be higher for buildings with both central supply and central exhaust ducts, because savings from both

Definition of Baseline and Proposed Conditions – Central Ventilation Duct Sealing

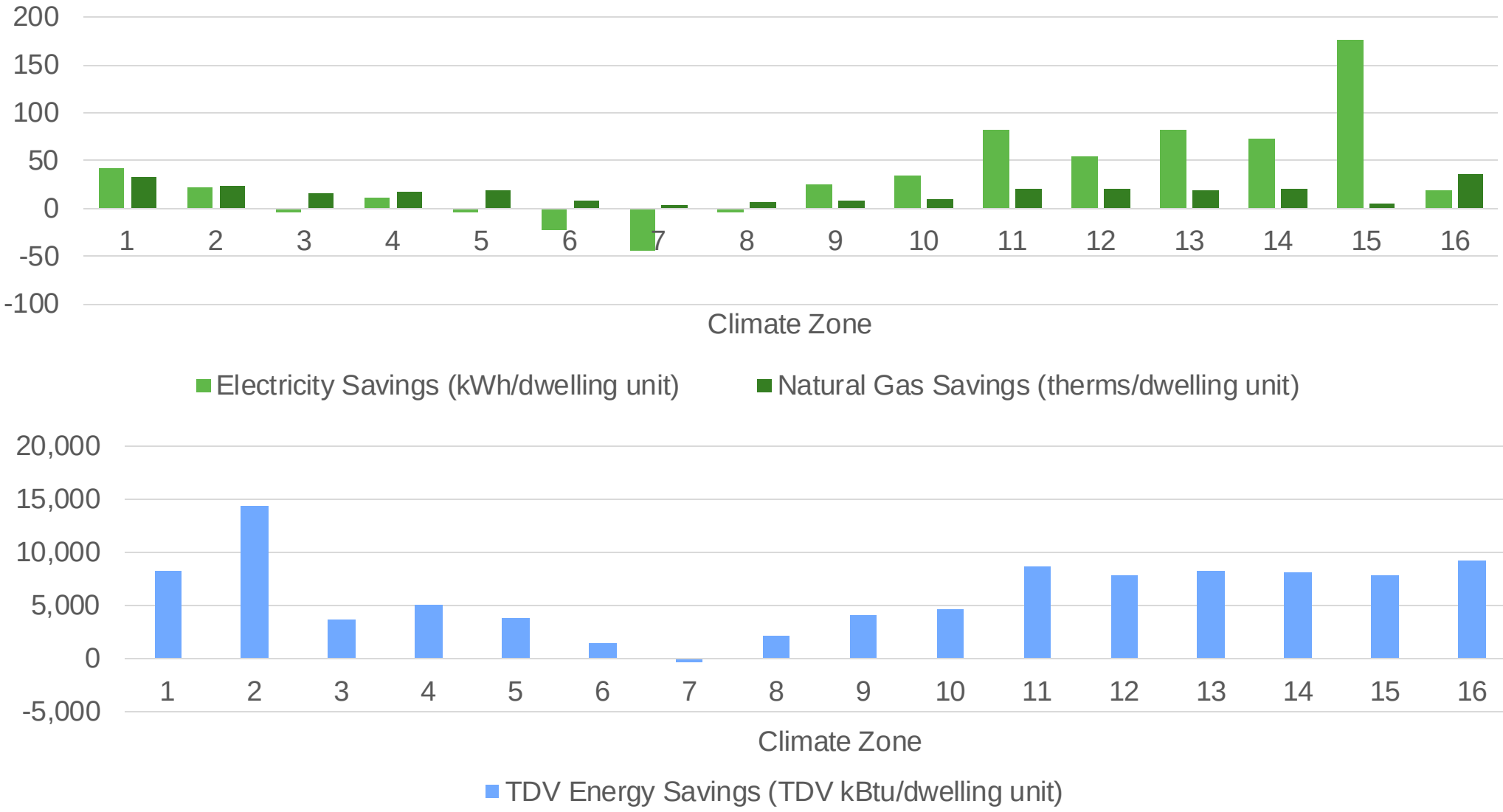
Baseline Conditions

- Air leakage of **39 percent at 50 Pa** (0.2” w.c.): Corresponds to 25 percent leakage at 25 Pa (0.1” w.c.), based on literature review
- Actual operating points: 50 percent leakage, static pressure 125 Pa (0.5” w.c.)
- All leakage from conditioned spaces

Proposed Conditions

- Air leakage of **10 percent at 50 Pa** (0.2” w.c.): Corresponds to 6 percent leakage at 25 Pa (0.1” w.c.) which aligns with 140.4(l) requirements
- Actual operating points: 13 percent leakage, static pressure at 103 Pa (0.4” w.c.)
- All leakage from conditioned spaces

Energy Savings Results: Central Ventilation Duct Sealing

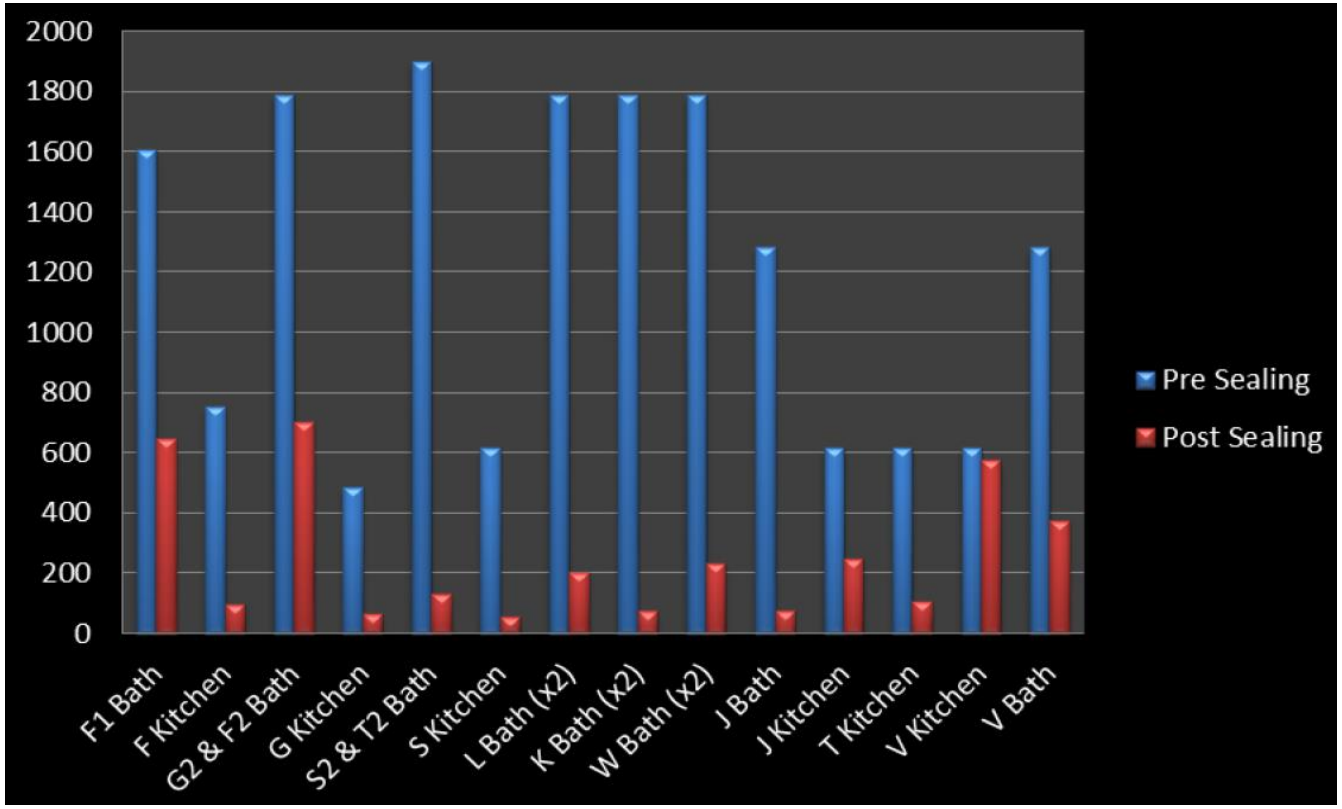


Energy Savings Results: Example from Case Study

- Measurements from retrofitted multifamily buildings show higher airflow reductions than assumed here

Central ventilation fan airflow (cfm) pre and post shaft sealing
(Courtesy: AEA 2012)

Leakage reduction averaged 76 percent, enabling rooftop fan airflow to be reduced by same amount



Poll

What is a typical static pressure in central ventilations ducts for continuous airflows for HIGH-RISE multifamily buildings (consider a 10-story building, of which 9 are residential)?

A. > 1” water column (w.c.)
B. 1” w.c.
C. 0.5” w.c.
D. 0.25” w.c.
E. < 0.25” w.c.

Poll

What is the typical static pressure in central ventilations ducts for continuous airflows for MIDRISE multifamily buildings (with 5 stories, of which 4 are residential)?

A. > 1” w.c.
B. 1” w.c.
C. 0.5” w.c.
D. 0.25” w.c.
E. < 0.25” w.c.

Poll

What is the typical static pressure in central ventilations ducts for continuous airflows for LOW-RISE multifamily buildings (with 3 stories, all of which are residential)?

A. > 1” w.c.
B. 1” w.c.
C. 0.5” w.c.
D. 0.25” w.c.
E. < 0.25” w.c.

Incremental Cost Information

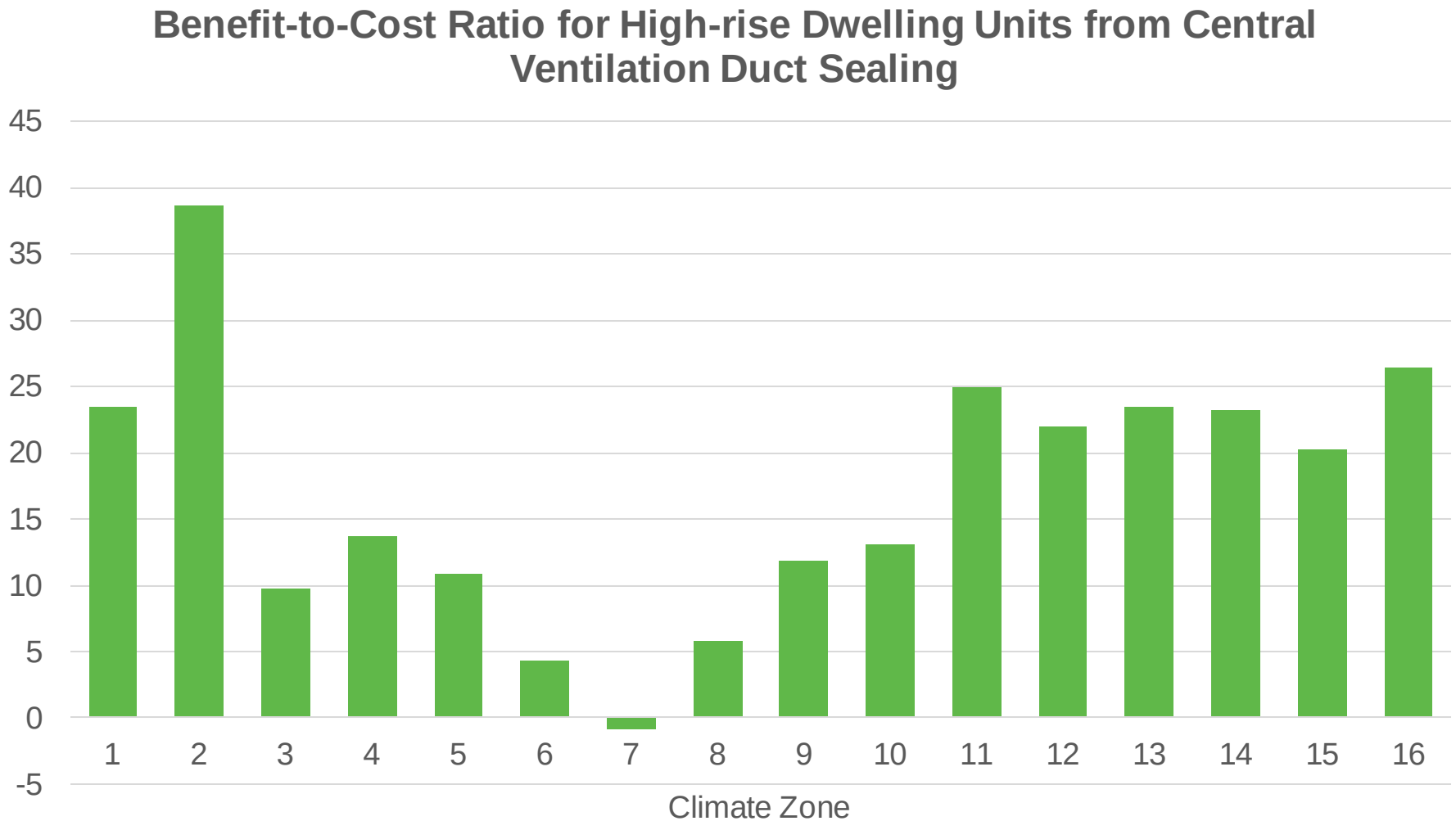
- **Labor costs from RSMeans:**
  - Duct sealing cost could not be separated from total cost for duct installation in RSMeans
  - Duct sealing labor assumed to be equivalent to painting labor, since similar process
- **Material costs** based on coverage data given by manufacturers and pricing found on the web for water-based mastic in gallons
- **Assumed HERS rater/ATT uses sampling** to verify leakage
  - Builds off existing Title 24-2019, Part 6 sampling protocol of testing at least 1 in 7
    - Considering requiring a minimum sampling rate of 1 in 3 for central ventilation duct testing
  - Proposal adds language that each sampling group include all airflows of the same type (either supply or exhaust air), and be served by central fan with same model number
  - For high-rise prototype building, means that 2 duct systems would be tested, because 7 total systems with 2 fan models

Incremental Per Unit Cost

Over 15/30 Year Period of Analysis

Items				Totals	
	Labor Hours	Labor Cost	Material Cost	Total without Sampling	Total with Sampling
Sealing using Brush Application	47	$3,343	$1,015	$4,358	$4,358
Testing without Sampling	57	$3,217	$41	$3,258	
Testing with Sampling	16	$2,040	$12		$2,083
Total Cost (117 Dwelling Units)				$7,616	$6,411
Total Cost per Dwelling Unit				$65	**$55**

Cost Effectiveness Results



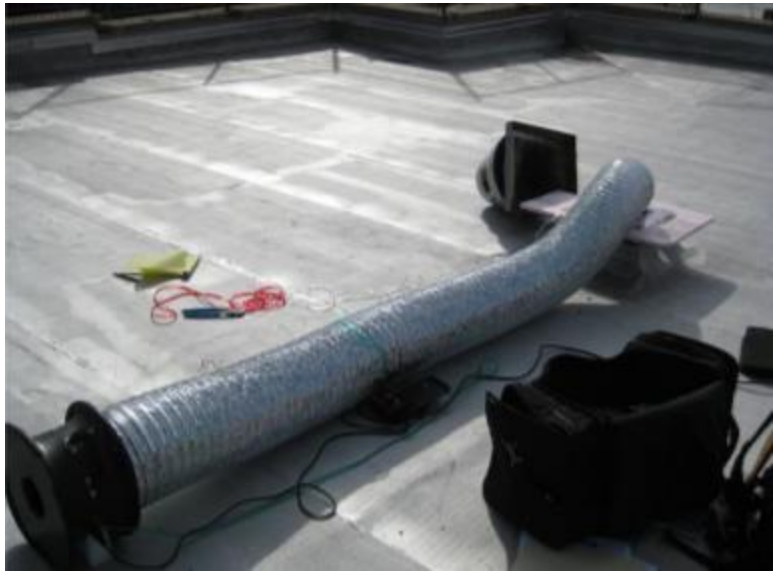
Market Overview

- Current Market Conditions

Current Market Conditions

- Market is equipped to meet duct sealing requirement, but not currently testing these ducts
  - Duct sealing is required under CMC 603.10
  - Duct sealing *and testing* is required for
    - Residential ducts carrying conditioned air under Title 24, part 6 Section 150.0(m)11c
    - Some commercial duct systems under Title 24, Part 6, Section 140.4(l)
  - Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) HVAC Air Duct Leakage Test Manual recommends testing ductwork at pressure classes > 3" w.c., and SMACNA is changing guidance to recommend that all ductwork be tested.
- Pressures necessary for leakage testing can be achieved in most cases with a standard duct blaster.

Leakage testing of central ventilation duct in an existing building with a duct blaster
(Courtesy: AEA 2012)



Technical Considerations

- Technical Considerations
- Potential Barriers and Solutions

Technical Considerations: Central Ventilation Duct Sealing

- **Technical Considerations:**
  - Industry standard practice is to not seal ventilation ducts due to their low pressure class (typically 0.5 to 1” w.c.)
  - Sealing to required level: 10 percent at 50 Pa (0.2” w.c.) – corresponds to 6 percent at 25 Pa (0.1” w.c.) – is required for other ductwork in 2019 Title 24 part 6 Section 140.4(l) and can be achieved with traditional sealing (mastic)

- **Potential Barriers and Solutions:**
  - HERS Rater or ATT can provide visual inspection or smoke pencil tests of central ventilation duct and sealing at multiple points during construction, to identify leakage points

Sealing with mastic. Source: Green building advisor. https://www.greenbuildingadvisor.com/article/sealing-ducts-whats-better-tape-or-mastic

Compliance and Enforcement

- Design
- Permit Application
- Construction
- Inspection

Compliance and Enforcement

1. Design Phase

- Project team identifies location of central ventilation ducts and **specifies sealing materials and sealing strategies**
- Project team **develops specifications** supporting tight ductwork
- Project team includes duct sealing specifications in design documents

2. Permit Application Phase

- Project team submits design documents showing location of central ventilation ducts and sealing materials
- Building inspectors confirm these elements during plan review

Compliance and Enforcement

3. Construction Phase

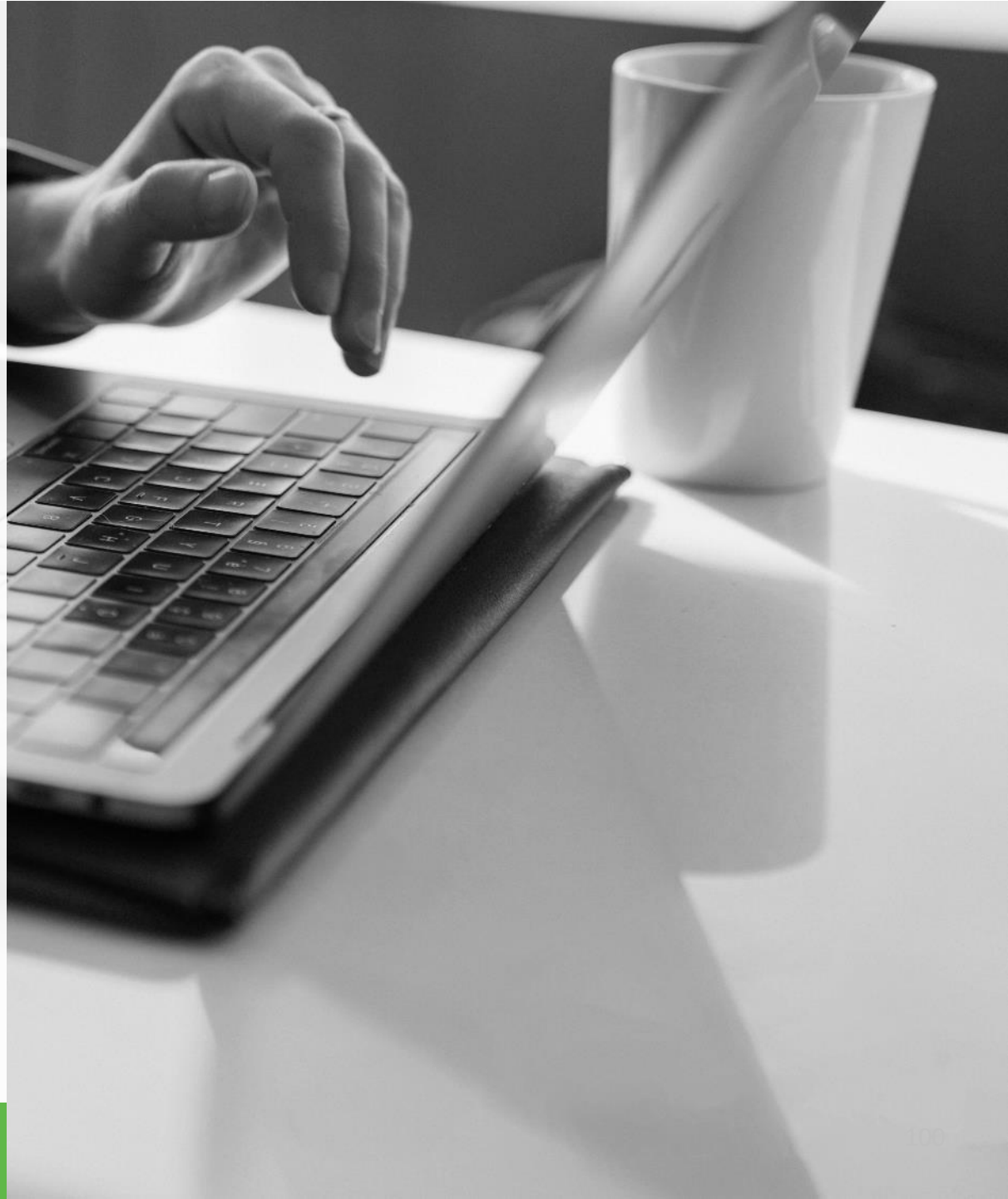
- Project team **seals each central ventilation duct** documenting installation and verification procedures via compliance documentation

4. Inspection Phase

- ATT or HERS Rater conducts leakage test on a sample of central ventilation ducts to ensure flow rate is 10 percent or less of nominal flow rate at 50 Pa
- Code official confirms leakage results are submitted and meet requirement

Proposed Code Changes

- Draft Code Change Language
- Proposed Software Updates



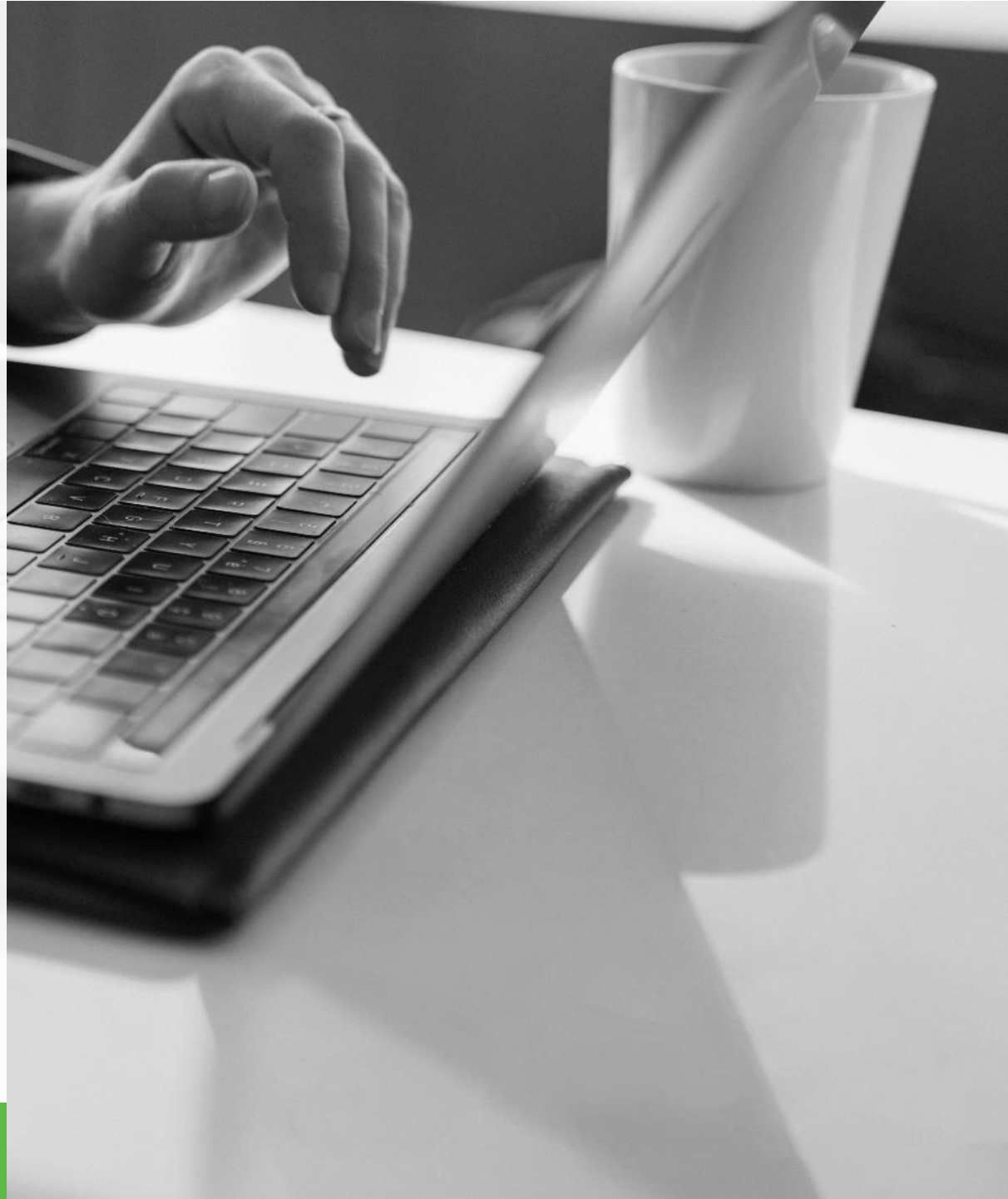
Draft Code Change Language – Central Ventilation Duct Sealing

- **Updated** draft code language for this submeasure is available onscreen. Let's review.
- Note we marked up Sections 120.5 and 140.4(l) for proposed change, but we may shift requirements to 120.4 and 120.5

Software Updates

- Statewide CASE Team proposes that Energy Commission update CBECC-Res and CBECC-Comm to allow project team to enter average leakage rate for sampled ventilation ducts
  - Will allow project teams to claim energy savings from ductwork that is tighter than requirement

2023 Construction Forecasts



2023 New Construction Forecast: ERV/HRV

Prototype	ERV/HRV		
	Market Penetration (a)	CZs Affected (% of construction forecast) (b)	Percent Affected (a x b)
Low-Rise Garden	80%	1,2,11-16 (25%)	20%
Loaded Corridor	80%	1,2,11-16 (25%)	20%
Mid-Rise Mixed Use	80%	1,2,11-16 (25%)	20%
High-Rise Mixed Use	80%	1,2,11-16 (25%)	20%
Percent of Statewide New Construction Impacted			20%

- Project team's choice of balanced ventilation (triggers HRV/ERV proposal in select climate zones) or compartmentalization (does not trigger HRV/ERV proposal) is unknown because Title 24, Part 6 2019 just took effect
- Assumed most projects will follow balanced ventilation (instead of compartmentalization) based on Energy Commission assumptions and poll conducted during the first stakeholder meeting

2023 New Construction Forecast: Kitchen Exhaust Effectiveness

Prototype	Kitchen Exhaust Effectiveness		
	Market Penetration (a)	CZs Affected (% of construction forecast) (b)	Percent Affected (a x b)
Low-Rise Garden	100%	All	100%
Loaded Corridor	100%	All	100%
Mid-Rise Mixed Use	100%	All	100%
High-Rise Mixed Use	100%	All	100%
Percent of Statewide New Construction Impacted			100%

- Measure is applicable to all new construction

2023 New Construction: Central Ventilation Duct Sealing

Prototype	Central Ventilation Duct Sealing		
	Market Penetration (a)	CZs Affected (% of construction forecast) (b)	Percent of Statewide New Construction Affected (a x b)
Low-Rise Garden	0%	100%	0%
Loaded Corridor	10%	100%	10%
Mid-Rise Mixed Use	39%	100%	39%
High-Rise Mixed Use	60%	100%	60%
Percent of Statewide New Construction Impacted			29%

- Market penetration reflects percent of multifamily projects with central (not unitary) ventilation ducts
- Frequency of central ventilation ducts based on industry judgment and data from 38 multifamily buildings from Gabel Energy

2023 Construction Forecast: New Construction

Measure	Building Type	Total Statewide New Construction Permitted in 2023 (dwelling units)	Percent of Statewide New Construction Impacted by Proposal	Statewide New Construction Impacted by Proposal in 2023 (dwelling units)
ERV/HRV	Multifamily	51,996	20%	10,360
Kitchen Exhaust Effectiveness	Multifamily	51,996	100%	51,996
Central Ventilation Duct Sealing	Multifamily	51,996	29%	15,029

2023 Construction Forecast – Additions and Alterations

- All measures would affect additions the same as new construction
- Proposed requirements would affect few alterations
  - Any replaced ventilation equipment would be subject to requirements
  - Retrofits that do not replace ventilation equipment are not subject to requirements

Questions and Next Steps

Acknowledgments: Thank you MF IAQ CASE Team and commenters!

- **TRC:** Mia Nakajima, Gwen McLaughlin, Bob Grindrod, Neil Perry, Elizabeth McCollum, Cathy Chappell
- **Frontier Energy:** Alea German, Josh Pereira, Dave Springer
- **UC Davis:** Nelson Dichter, Curtis Harrington
- **Assoc. for Energy Affordability:** Nick Young
- **Other IOU consultants:** Jon McHugh, Marshall Hunt, Ana Cotham, Gina Rodda
- **Contributors:** TX A&M, Ecotope, Western Allied Mechanical
- **IOU Staff:** Mark Alatorre, Kelly Cunningham
- The many stakeholders that have submitted comments so far
- And many more!

Thank You

Questions?

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CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

2022 CALIFORNIA ENERGY CODE (TITLE 24, PART 6)

Multifamily
High Performance Thermal Envelope

Codes and Standards Enhancement (CASE) Proposal
Multifamily| High Performance Envelope

Matthew Christie & Julianna Wei, *TRC*
March 25, 2020

CALIFORNIA ENERGY CODES & STANDARDS
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Agenda

1	Today's Objectives	*5 min*
2	Proposal Background	*5 min*
3	Quality Insulation Installation • Proposed QII Protocol • Cost and Energy Calculations	*20 min*
4	Questions and Next Steps	*10 min*

Today's Objectives

The focus of today's meeting includes:

1. **Update** on moved and dropped submeasures
2. **Discuss** Snapshot QII protocol concept
3. **Review** energy and cost calculations
4. **Receive** stakeholder feedback

Proposal Background

Submeasure Status Update

Submeasure	Status
QII	Moving forward with Snapshot QII for larger MF buildings
Reduced thermal bridging	*Moved to future code cycles*

The following submeasures will be discussed during the **Multifamily Restructuring Stakeholder Meeting** May 7, 2020

- Fenestration thermal properties
- Wall area metric
- Wall assembly U-factor

Sign up at title24stakeholders.com/events/

Context and History

- **Why are we proposing this measure?**
  - Extend quality insulation installation (QII) requirements to all multifamily, with new protocols as deemed practical and cost effective

Code Change Proposal Summary

Submeasure	Type of Change	Software Updates Required	Sections of Code Updated	Compliance Documents Updated
QII Verification	Prescriptive	Y	Section 150.1(c)1E TABLE 150.1-B Section 140.3 TABLE 140.3-C	CEC-CF1R-NCB-01-E CEC-CF2R-ENV-21-H CEC-CF3R-ENV-21-H CEC-CF2R-ENV-22-H CEC-CF3R-ENV-22-H NRCC-ENV-01-E NRCI-ENV-01-E-Envelope NRCV-ENV-01-Envelope

Description of Changes

- Creates a new "Snapshot" QII protocol for larger (≥40,000 sq.ft.) multifamily buildings

Changes since first stakeholder meeting

Moved to Multifamily Restructuring CASE Report:

- Fenestration thermal properties
- Window area limit
- Wall assembly thermal properties

Dropped:

- Thermal bridging

Code Change Proposal: Additional Resources

First-Utility Sponsored Meeting

The Statewide CASE Team held its first utility-sponsored stakeholder meeting for this topic on **August 22, 2019.**

Resources on Title24stakeholders.com

Presentation slides and **Submeasure summary** documents available that cover the following:

- ✓ Measure Background
- ✓ Market Overview & Analysis
- ✓ Technical Feasibility
- ✓ Compliance & Enforcement
- ✓ Draft Code Language

Also available in the **resources tab in today's presentation.**

Methodology for Energy Impacts Analysis

Tools Used	CBECC-Com 2022.0.1 RV (1113) CBECC-Res 2022.0.1 RV (1113) CASE's Excel savings workbooks
Building Prototypes Used	1. Low-Rise Loaded Corridor: 3 story, 40,000 SF; 36 units 2. Mid-Rise Mixed-Use: 5 story; 113,100 SF; 88 units 3. High-Rise Mixed-Use: 10 story; 125,400 SF; 117 units
Climate Zones Modeled	All climate zones
Analysis Period	30 years
Energy Impact Results	2022 Interim TDV; results per dwelling unit

Quality Insulation Installation Verification

QII – Proposed Measure

2019

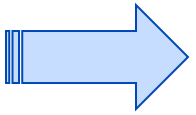
Low-Rise Residential Code

Requirement	Climate Zone
QII Required	All but CZ 7
No Requirement (NR)	CZ 7

2019

High-Rise Non-Residential Code

Requirement	Climate Zone
None	-



2022

Unified Multifamily Code

Requirement	Climate Zone
Buildings < 40,000SF of CFA QII Required	All but CZ 7
Buildings ≥ 40,000 SF of CFA QII Snapshot required	All but CZ 7

Snapshot QII – Proposed Protocol Concept

- Introduce a CFA threshold – proposed 40,000 sq.ft. (All CZs except 7)
  - Below which full QII is prescriptively required;
    - or Snapshot QII may be taken for *reduced* performance compliance credit
  - At and above which Snapshot QII is prescriptively required;
    - or full QII may be taken for *additional* performance compliance credit
- QII Snapshot designed to be possible in a single visit or two
- Verification visit(s) timed with construction milestones
  - Projects with cavity installation only – visit timed with ~ 20% to 40% drywall installation
  - Projects with exterior installation – visit timed with ~ 20% to 40% window installation

Snapshot QII – Proposed Protocol Concept

- Metal buildings (i.e. curtainwalls) excluded
- The verification is of *all* available envelope surfaces at the time of inspection
  - Includes roof or attic insulation as available
  - Includes floor-over-unconditioned insulation as available
- 20 percent minimum percentage of total (gross) wall area coverage back-stop. Additional visits required if unfulfilled in the first
  - 20 percent for air sealing inspection at framing stage
  - Another 20 percent after insulation and before drywall installation
  - No attic/roof or floor-over-unconditioned backstops
- Allowance of exterior insulation verification from the ground at a distance

Poll

Poll Request – Snapshot QII Area Threshold

At what size multifamily building does staged-construction practices begin to make full QII prohibitively difficult to conduct?

A. Clearly lower than the proposed 40,000 square feet level
B. 40,000 square feet is about right
C. Clearly greater than the proposed 40,000 level
D. Square footage generally should not be the basis, instead it should be ___ (write into the comments box)

Poll

Poll Request – Snapshot Verification Scheduling

What is your reaction to the logistics of scheduling the site visit for snapshot QII?

A. It allows for flexibility and randomization
B. It will be difficult or impossible to conduct without deep coordination, and thus minimal chance for randomization
C. It will be difficult or impossible to fulfill the proposed minimum verification coverage limits at or near the proposed milestones
D. Other (specify in the comments)

Poll

Poll Request - Min Verification Coverage

What is the likelihood of seeing enough wall area at each inspection stage (framing and insulation) to meet the proposed 20 percent back-stops in one visit?

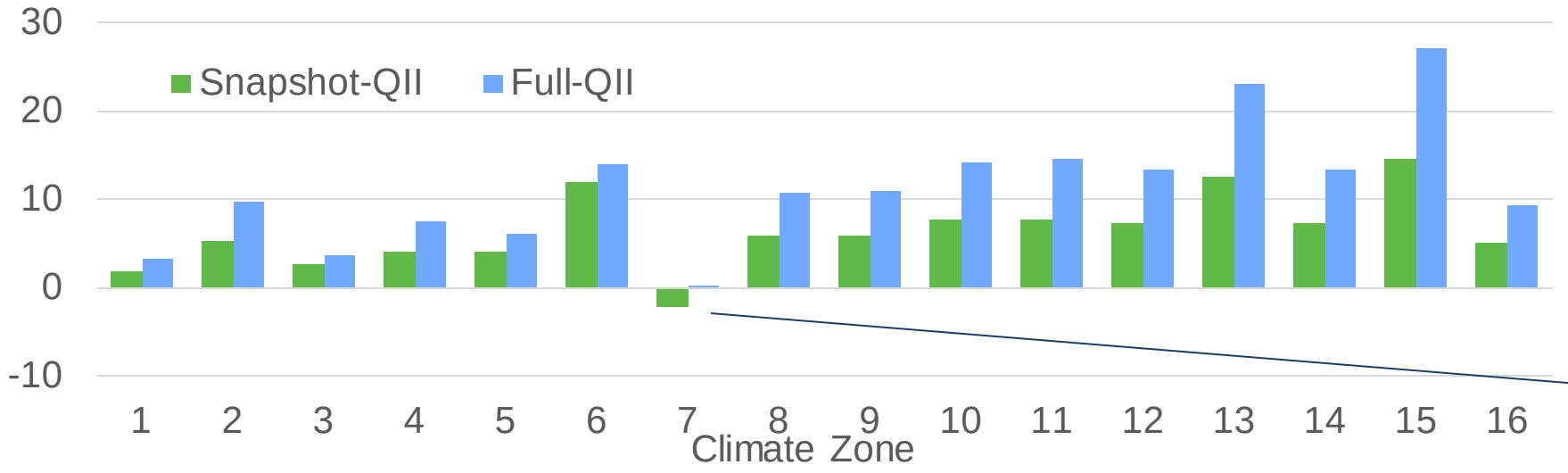
A. Viable for both inspection stages
B. Framing will be difficult, but insulation will be viable
C. Framing will be viable, but insulation will be difficult
D. Difficult on both counts
E. It depends.... too many variables to determine for typical cases

Energy and Cost Impacts

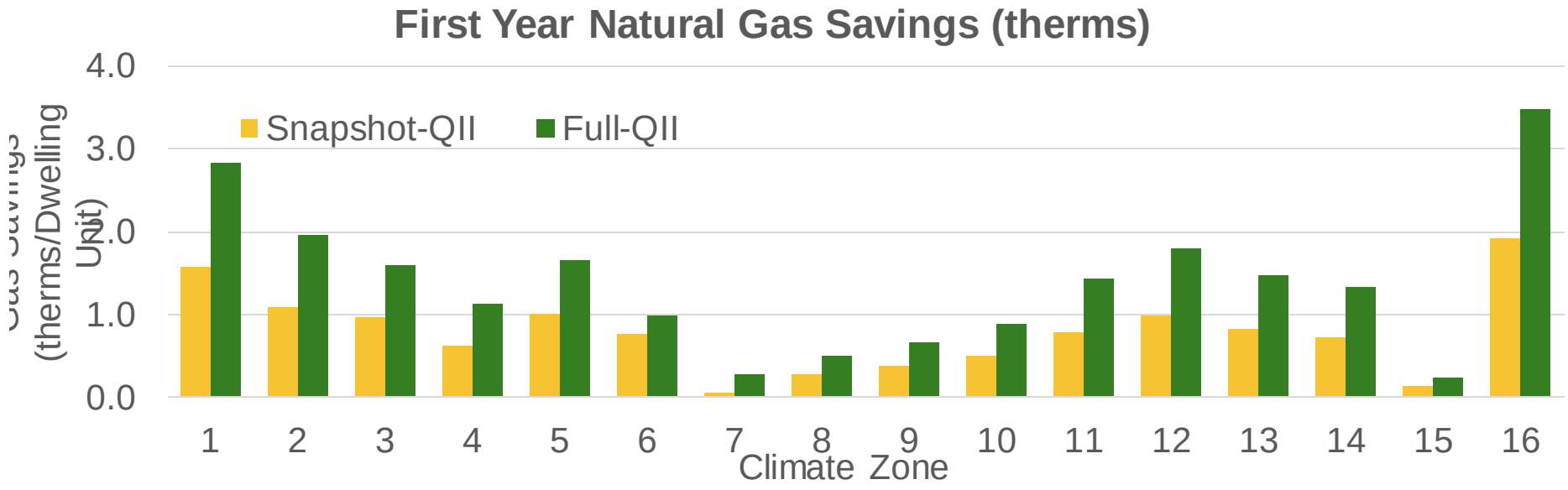
- Assumptions & Methodology
- Energy Impacts
- Cost Impacts
  - Incremental costs
  - Maintenance costs
  - Energy cost savings
- Cost-effectiveness

Methodology and Assumptions for Energy Impacts Analysis

- CBECC-Com allows direct input of cavity insulation R-value with wood-framed walls
- Two scenarios analyzed, both with base case (no verification) of 30 percent cavity insulation R-value derate
  1. Snapshot-QII proposed case – 15 percent derate (equivalent to 50 percent credit back)
  2. Full-QII proposed case – 0 percent derate (equivalent to 100 percent credit back)

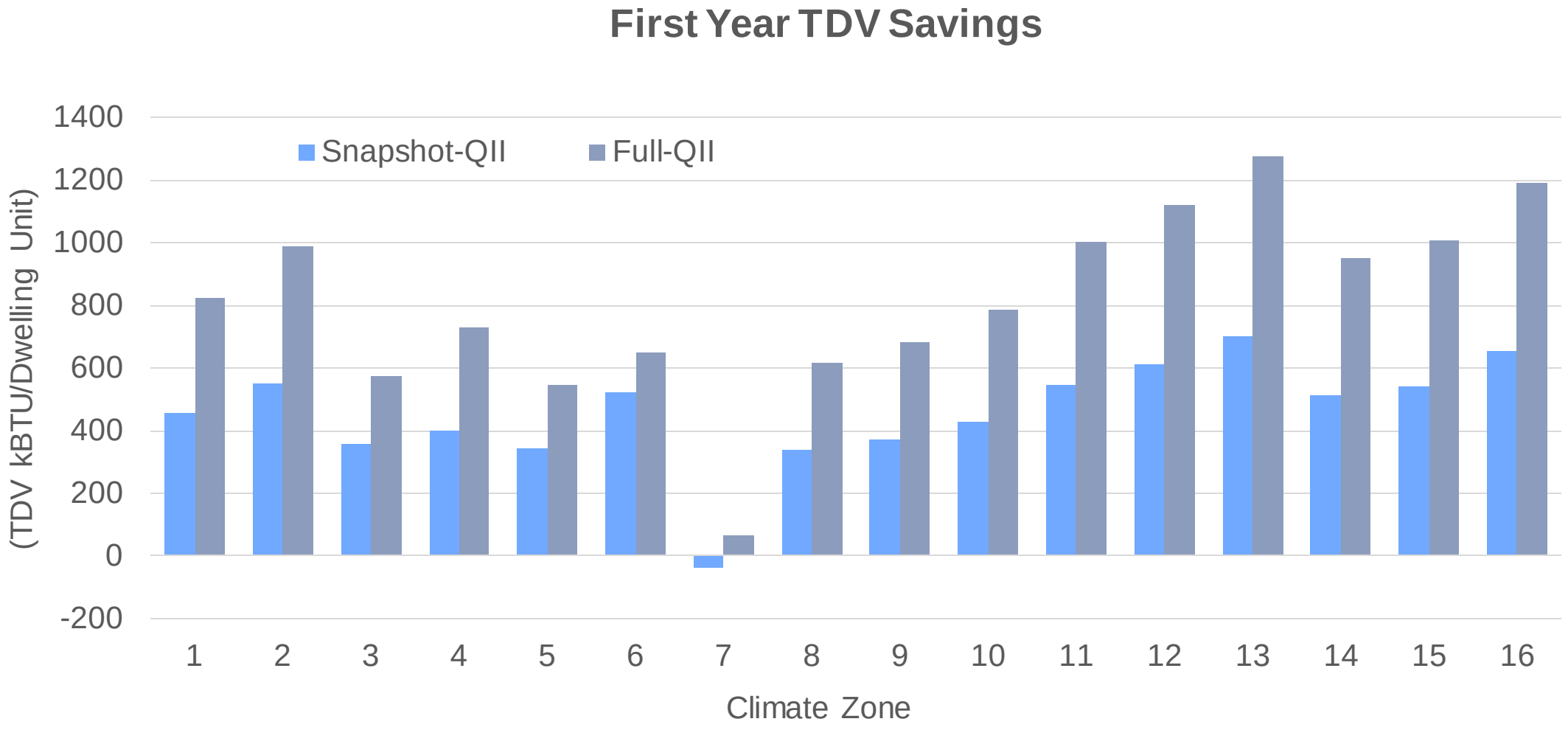


Negative electric savings – in CZ 7 for Snapshot

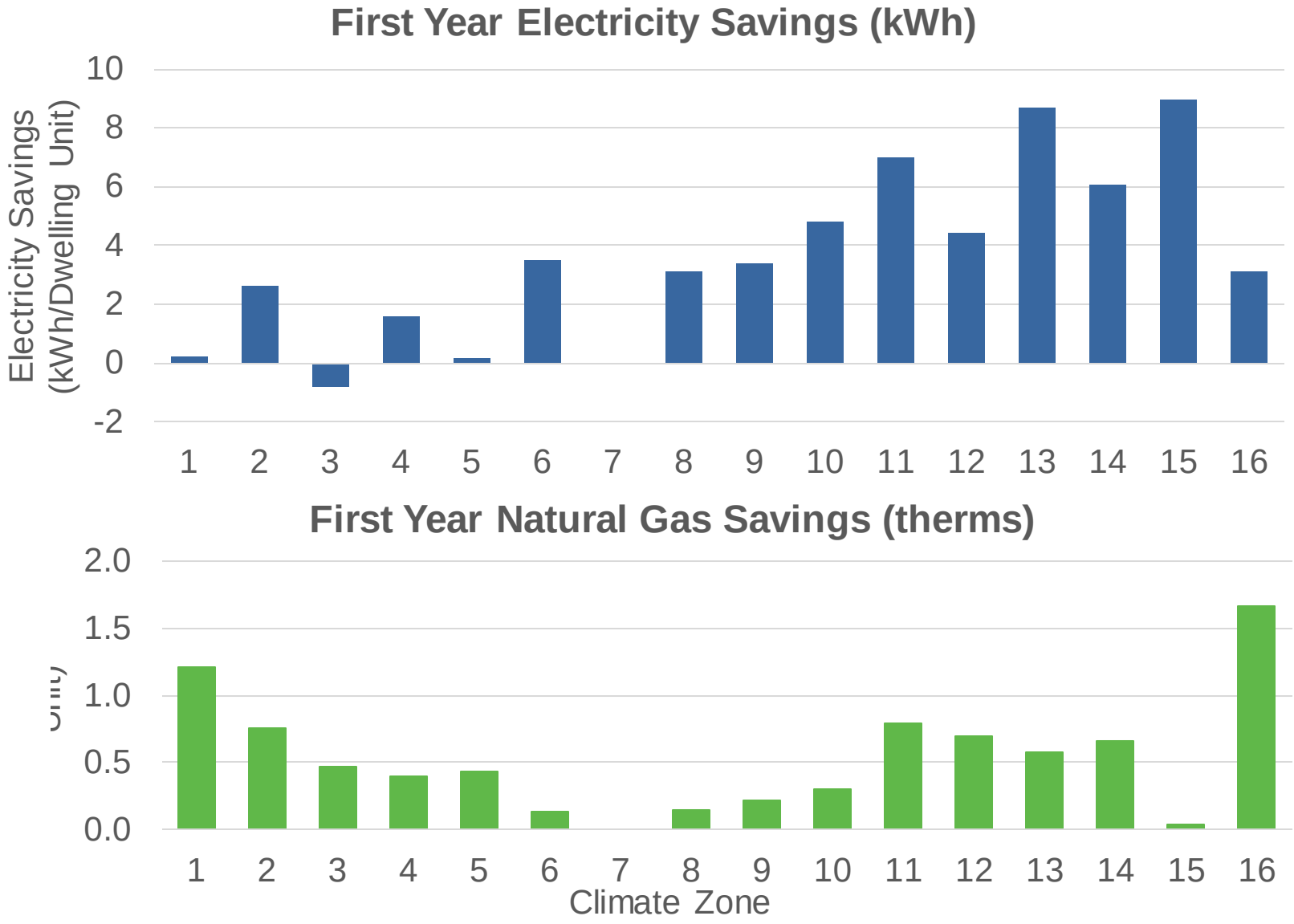


Gas savings in all climate zones

TDV Savings Results: QII, Mid Rise Prototype



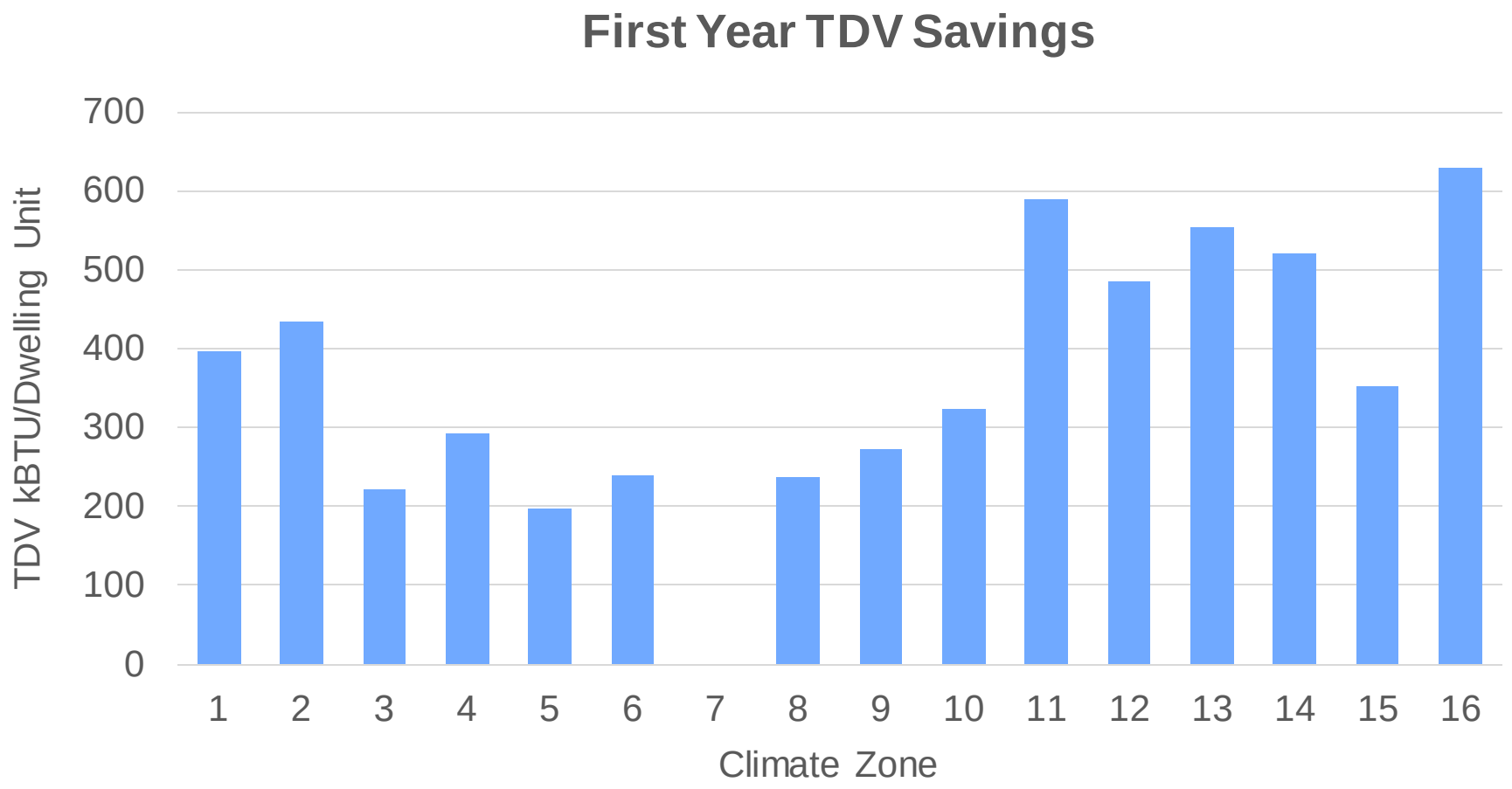
Energy Savings Results: Snapshot QII, High Rise Prototype



Negative electric savings – in select climate zones

Gas savings in all climate zones

TDV Savings Results: Snapshot QII, High Rise Prototype



Incremental Cost Information

- Costs method based on exceeding minimum coverage area – 25 percent gross wall area
- Cost method, hourly rates, verification trip assumptions vetted with feedback from HERS Raters
  - $80/ hour on site; maximum of 5 hours during each trip
  - 20 minutes of air-sealing inspection for a 500 square foot wall section
  - 30 minutes of insulation installation inspection for a 500 square foot wall section
    - Time estimates inclusive of visual verification, documentation of findings, transition between spaces, and communication of verification failures with trades for mitigation.
  - Travel expense of $0.55/mile for 100 miles for each trip
- Labor costs adjusted to climate zones based on cost indices
- Submeasure has no maintenance costs associated

Incremental Per Building and Per Unit Cost

Over 30 Year Period of Analysis

Incremental First Cost		Incremental Maintenance Cost	Total Cost – MR prototype[a]	Total Cost – HR prototype[b]
Labor Hour	$80/hr	-	~ 14.10 hours	~ 17.07 hours
Trip Quantity	Max 5 hr on-site	-	4 trips	5 trips
Labor Cost	$	-	$1,410	$1,706
Travel Cost	$0.55/mi for 100 mi	-	$220	$275
Total	**$**	**$0**	$1,630 per building $18.52 per dwelling unit	$1,981 per building $16.94 per dwelling unit

[a] 113,100 total CFA with 88 dwelling units; 20% of gross wall area → ~ 8,460 sq.ft.

[b] 125,400 total CFA with 117 dwelling units; 20% of gross wall area → ~ 10,240 sq.ft.

Cost Effectiveness Results – QII, Mid Rise Prototype

Mid-Rise Mixed Use Prototype

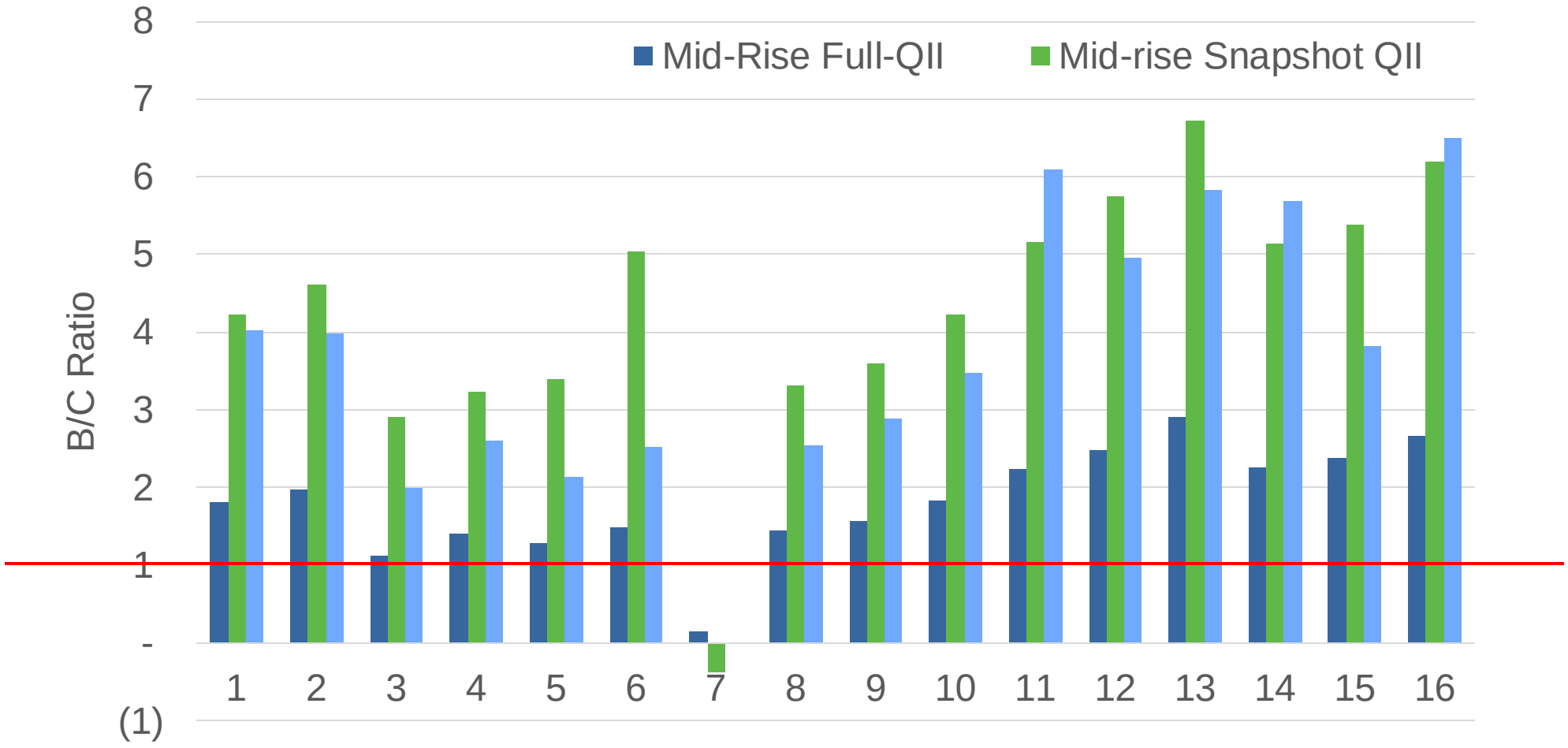
Climate Zone	Benefits – 2023 Present Value		Costs – Incremental Present Value		Benefit-to-Cost Ratio	
	Snapshot-QII	Full-QII	Snapshot-QII	Full-QII	Snapshot-QII	Full-QII
1	$ 79	$ 142	$ 19	$ 79	4.24	1.81
2	$ 95	$ 172	$ 21	$ 87	4.61	1.97
3	$ 62	$ 99	$ 21	$ 89	2.91	1.11
4	$ 69	$ 126	$ 21	$ 90	3.24	1.40
5	$ 60	$ 95	$ 18	$ 74	3.40	1.28
6	$ 90	$ 112	$ 18	$ 76	5.04	1.48
7	$ (6)	$ 11	$ 17	$ 72	NA	0.15
8	$ 59	$ 107	$ 18	$ 74	3.32	1.44
9	$ 64	$ 118	$ 18	$ 76	3.59	1.56
10	$ 74	$ 136	$ 18	$ 74	4.22	1.83
11	$ 95	$ 174	$ 18	$ 77	5.16	2.25
12	$ 106	$ 194	$ 19	$ 78	5.74	2.48
13	$ 121	$ 221	$ 18	$ 76	6.72	2.91
14	$ 89	$ 164	$ 17	$ 73	5.15	2.25
15	$ 94	$ 175	$ 17	$ 74	5.38	2.37
16	$ 113	$ 206	$ 18	$ 77	6.19	2.66

Cost Effectiveness Results – QII Snapshot, High Rise Prototype

High-Rise Mixed Use Prototype

Climate Zone	Benefits	Costs	Benefit-to-Cost Ratio
	2023 PV $ Energy Cost Savings + Other PV Savings per Dwelling Unit	Total Incremental PV Costs	
1	$ 69	$ 17	4.03
2	$ 75	$ 19	3.99
3	$ 38	$ 19	1.99
4	$ 51	$ 20	2.60
5	$ 34	$ 16	2.14
6	$ 42	$ 16	2.53
7			
8	$ 41	$ 16	2.54
9	$ 47	$ 16	2.88
10	$ 56	$ 16	3.47
11	$ 102	$ 17	6.10
12	$ 84	$ 17	4.96
13	$ 96	$ 16	5.82
14	$ 90	$ 16	5.69
15	$ 61	$ 16	3.83
16	$ 109	$ 17	6.51

Cost-Effective Results: QII, Multifamily Prototypes



Statewide Energy Savings

Quality Insulation Installation

2023 Construction Forecast: New Construction, QII

Building Type	Total Statewide New Construction Permitted in 2023 (dwelling units)	Percent of Statewide New Construction Impacted by Proposal		Statewide New Construction Impacted by Proposal in 2023 (dwelling units)
Low-rise Garden	2,079	Full QII	100%	0
		Snapshot QII	0%	0
		No QII	0%	0
Loaded Corridor	17,149	Full QII	76%	0
		Snapshot QII	22%	3,773
		No QII	2%	343
Mid-Rise Mixed Use	30,140	Full QII	13%	3,918
		Snapshot QII	72%	21,701
		No QII	15%	0
High-Rise Mixed Use	2,598	Full QII	0%	0
		Snapshot QII	7%	182
		No QII	93%	0

No impact.
Full QII already the Standard

No impact.
No QII already the Standard

Statewide Energy Savings – QII

Climate Zone	Statewide New Construction Impacted by Proposed Change in 2023	First-Year Electric Savings	First-Year Natural Gas Savings	Total TDV Energy Savings	30-Year Present Valued Energy Cost Savings
	(dwelling units)	(MWh)	(thousand therms)	(TDVMBtu)	(thousand 2023 PV$)
CZ01	151	0.20	0.20	53	$9
CZ02	895	4.23	0.84	410	$71
CZ03	4,342	9.13	3.70	1,266	$219
CZ04	2,262	7.73	1.22	757	$131
CZ05	402	1.42	0.36	117	$20
CZ06	1,918	20.10	1.29	862	$149
CZ07	-	-	-	-	-
CZ08	2,696	13.91	0.72	776	$134
CZ09	6,331	33.10	2.13	1,989	$344
CZ10	2,237	14.83	0.97	797	$138
CZ11	639	4.01	0.41	265	$46
CZ12	3,605	22.42	3.09	1,813	$314
CZ13	1,052	11.11	0.74	597	$103
CZ14	478	2.75	0.28	186	$32
CZ15	311	3.65	0.04	131	$23
CZ16	193	0.82	0.31	100	$17
Total	**27,512**	**149.42**	**16.29**	**10,118**	**$1,750**

Questions and Next Steps

Thank You

Questions?

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CALIFORNIA ENERGY CODES & STANDARDS
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We want to hear from you!

+ Stakeholder meeting feedback informs utility-sponsored CASE Reports.
+ Draft CASE Reports for today's topics will be published in **April 2020.**

*Comments will be considered as they are received. Stakeholders are invited to submit feedback on today's presentation, and the Draft CASE Report to help shape the **Final** CASE Report submitted to the Energy Commission.*

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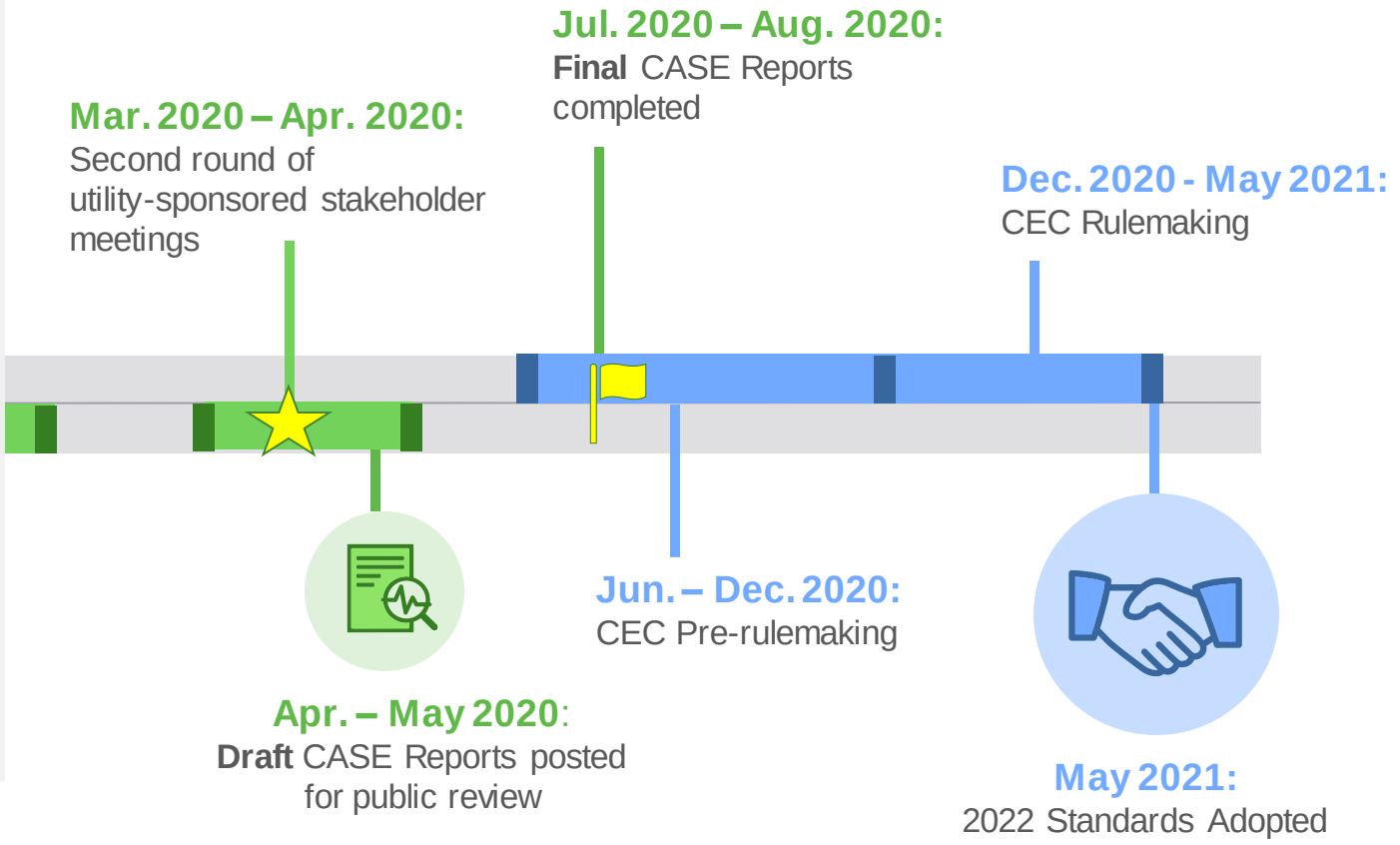

Upcoming Meetings

Meeting Topic	Building Type	Date
Lighting	NR/MF	Tuesday, March 3, 2020
Single Family Whole Building	SF	Thursday, March 5, 2020
Nonresidential and Single Family HVAC Part 1: Data Centers, Boilers, Air Distribution, Variable Capacity	NR/SF	Thursday, March 12, 2020
Water Heating and Multifamily All Electric Package	MF	Tuesday, March 17, 2020
Single Family Grid Integration	SF	Thursday, March 19, 2020
Multifamily HVAC and Envelope	MF	Wednesday, March 25, 2020
Covered Processes Part 1: Refrigeration System Opportunities	NR	Thursday, April 2, 2020
Nonresidential HVAC and Envelope Part 2: Reduced Infiltration, HVAC Controls (Air Efficiency, DOAS)	NR	Tuesday, April 14, 2020
Covered Processes Part 2: Controlled Environmental Horticulture	NR	Thursday, April 16, 2020
Nonresidential Envelope Part 1: High Performance Envelope	NR	Thursday, April 23, 2020
NEW Multifamily Restructuring	MF	Thursday, May 7, 2020

Thank you for your participation today

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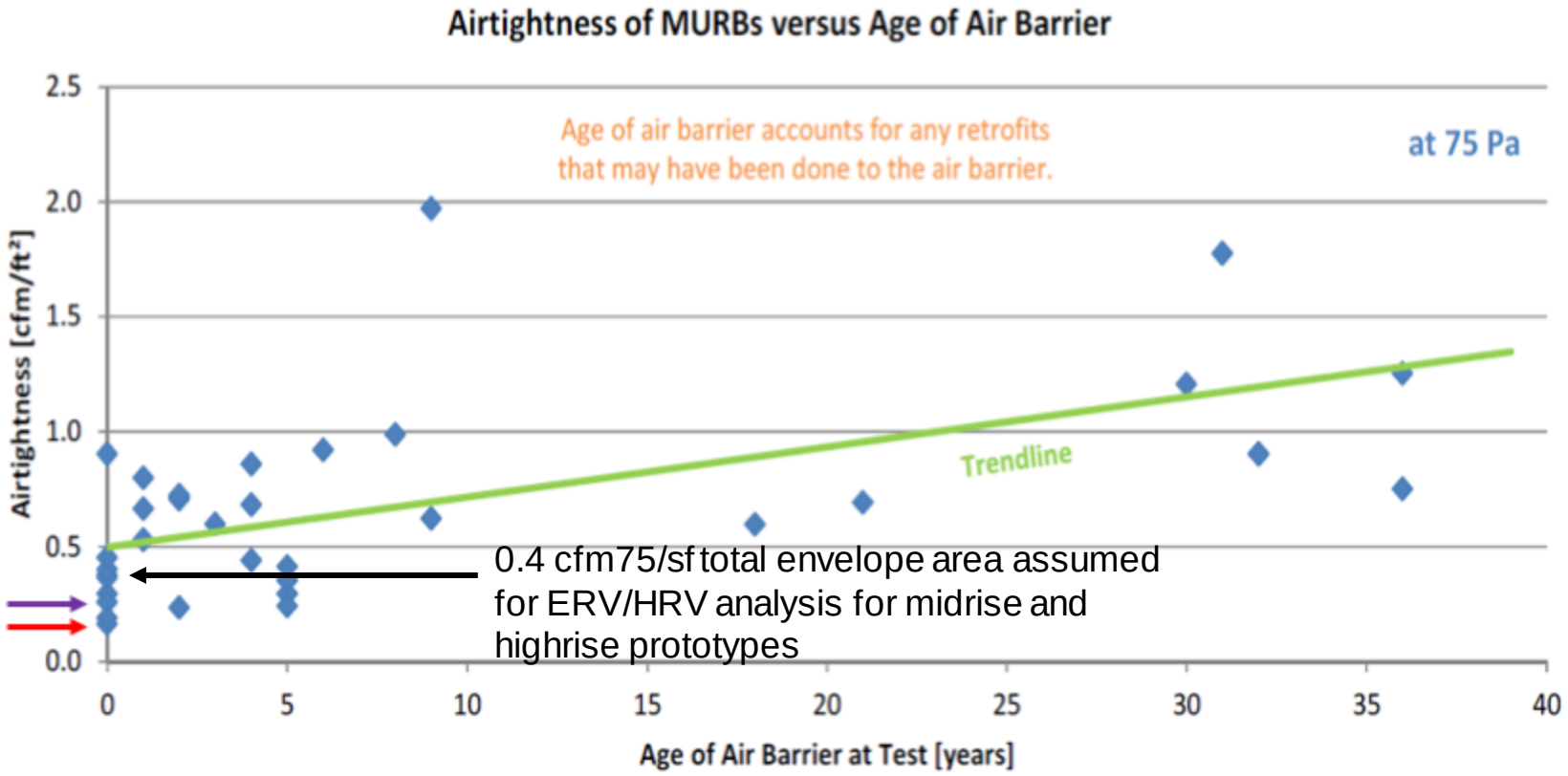
Please complete the closing polls below

Appendix

Airtightness of multifamily buildings versus age of air barrier



Under CBECC-Comm assumptions of 0.4 cfm75/sf **wall area**, midrise prototype has 0.17 cfm75/sf **total envelope**, and highrise has 0.27 cfm75/25 total envelope

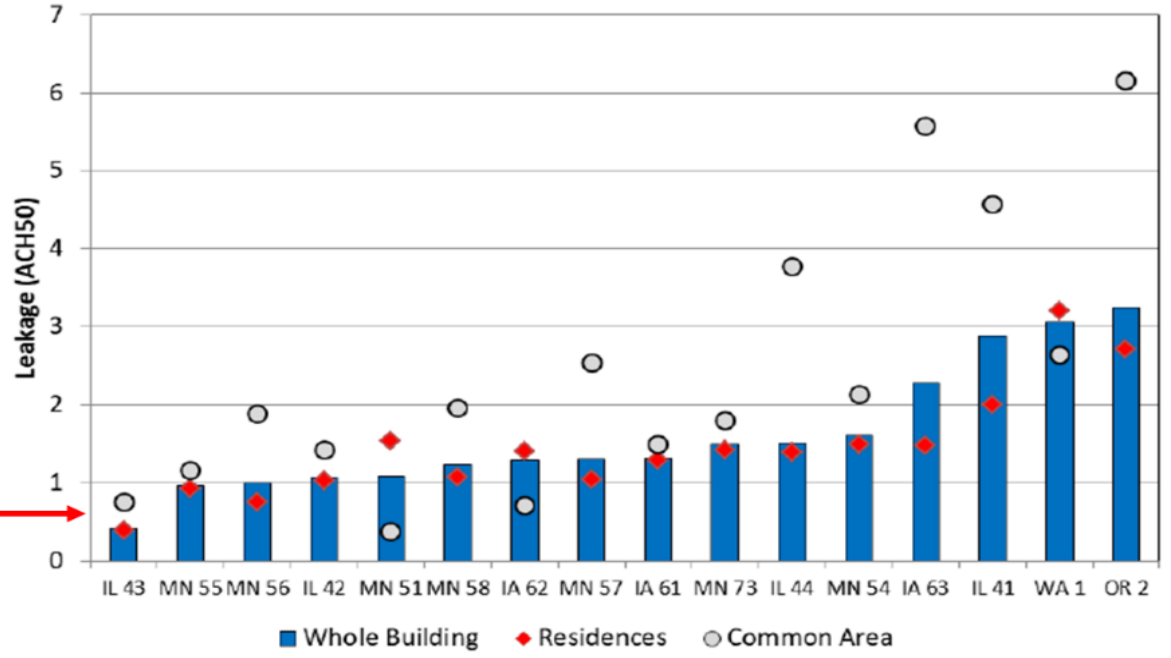
0.4 cfm75/sf total envelope area assumed for ERV/HRV analysis for midrise and highrise prototypes

RDH Air Leakage control in Multi-Unit Residential Buildings. 2017. https://www.rdh.com/wp-content/uploads/2017/07/Air-Leakage-Control-in-Multi-Unit-Residential-Buildings.pdf

Multifamily leakage (measured at whole building level) compared to CBECC-Comm infiltration assumption

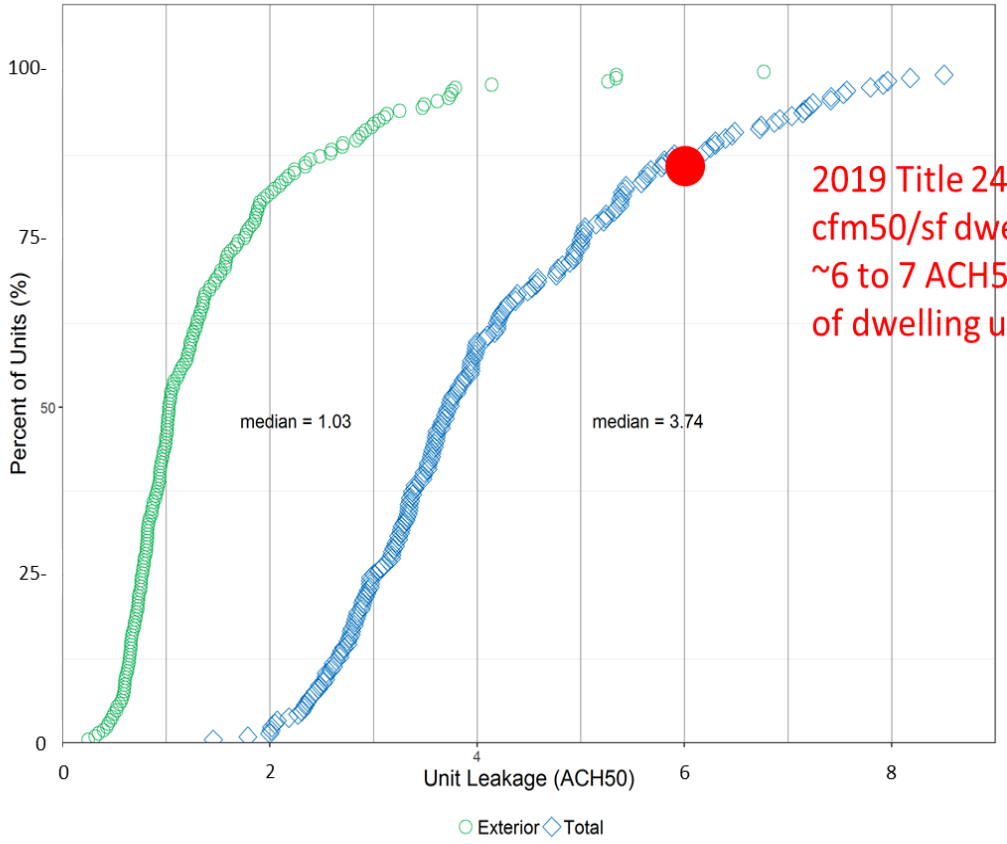
Whole building exterior leakage ranges from 0.4 to 3.3 ACH50 with a median of 1.3 ACH50. The leakage for only the residential portion of the buildings ranges from 0.4 to 3.2 ACH50 with a median 1.4 ACH50. Common area leakage computed by subtracting residential portion from total. Common area leakage ranges from 0.4 to 6.2 ACH50 with a median of 1.9 ACH50 (chart below).

Under CBECC-Comm assumptions, midrise prototype has 0.68 ACH50



Leakage results in multifamily dwelling units: Total envelope leakage and exterior leakage only

Measurements of total (blue) and exterior (green) leakage (ACH50) of 6-12 units in each building.
Sorted by median exterior leakage.



2019 Title 24 requirement of 0.3 cfm50/sf dwelling unit enclosure area is ~6 to 7 ACH50, higher than the median of dwelling unit leakage of 3.74 ACH50

Center for Energy and Environment: "Preliminary Air Leakage Results for 16 Common entry Multi-unit Dwelling". 2019. Publication Pending.