TRI-COUNTY
REGIONAL ENERGY NETWORK
SAN LUIS OBISPO • SANTA BARBARA • VENTURA

Recovery Ventilators: 2022 Energy Code Energy Savings and Compliance Credit

Nick Brown
Build Smart Group

March 5, 2025

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RECOVERY VENTILATORS

ENERGY SAVINGS AND COMPLIANCE CREDIT IN THE ENERGY CODE

NICK BROWN

President
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Long Beach

BUILD SMART

OUR TIME TOGETHER

Recovery Ventilators

IAQ appliances and HVAC energy savers in one

Mechanical Ventilation

Why the energy code requires it and how much is needed

How RVs Work

Balanced ventilation with heat recovery

Energy Savings

How much energy do RVs save in various California climate zones?

Compliance Credit

How much do RVs help comply with Title 24?

Tips for Specifying RVs

Making sure the right RV is installed right

BASED ON RESEARCH FOR:

SoCalGas

SMALL PLANET SUPPLY

PLAN IT WITH THE PLANET IN MIND

SoCalGas

A Sempra Energy utility

BUILD SMART

RECOVERY VENTILATORS: IMPACT ON MODELED ENERGY USE, ENERGY CODE COMPLIANCE, GREENHOUSE GAS EMISSIONS, AND PEAK ELECTRICITY DEMAND IN CALIFORNIA HOMES AND MULTIFAMILY BUILDINGS

February 16, 2022

By Nick Brown, Build Smart Group

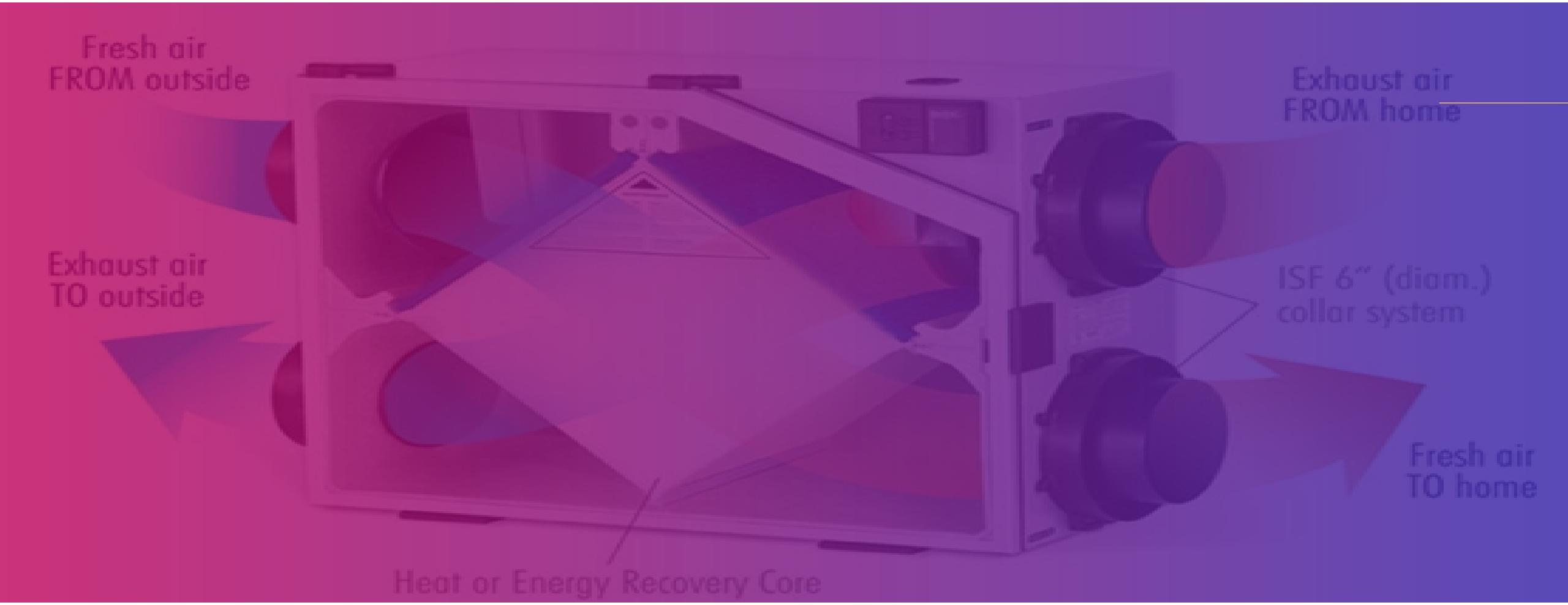
& Luke Morton, Morton Green Building Services

LET'S GET ENGAGED

slido

What does "Heat Recovery Ventilators" make you think?

ⓘ Start presenting to display the poll results on this slide.



RECOVERY VENTILATORS

Let You Live Better, Sleep Better, and Work Better, and Your HVAC Run Better

WHY RECOVERY VENTILATORS?

Indoor Air Quality

- RVs provide continuous ventilation for indoor spaces to dilute pollutants and enhance IAQ
- They ventilate more effectively than spot ventilation fans such as bathroom exhaust
- They keep neutral pressure in the home, which improves control of IAQ

Energy Savings

- RVs temper the incoming fresh air using the outgoing stale air
- This reduces the burden on the space conditioning system

WHY RECOVERY VENTILATORS?

Energy Code Compliance

- RVs are one of the most powerful compliance credits available because of the energy savings they can generate
- By using RVs in your energy models, you can compensate for features that are not up to code, add extra glazing, etc.

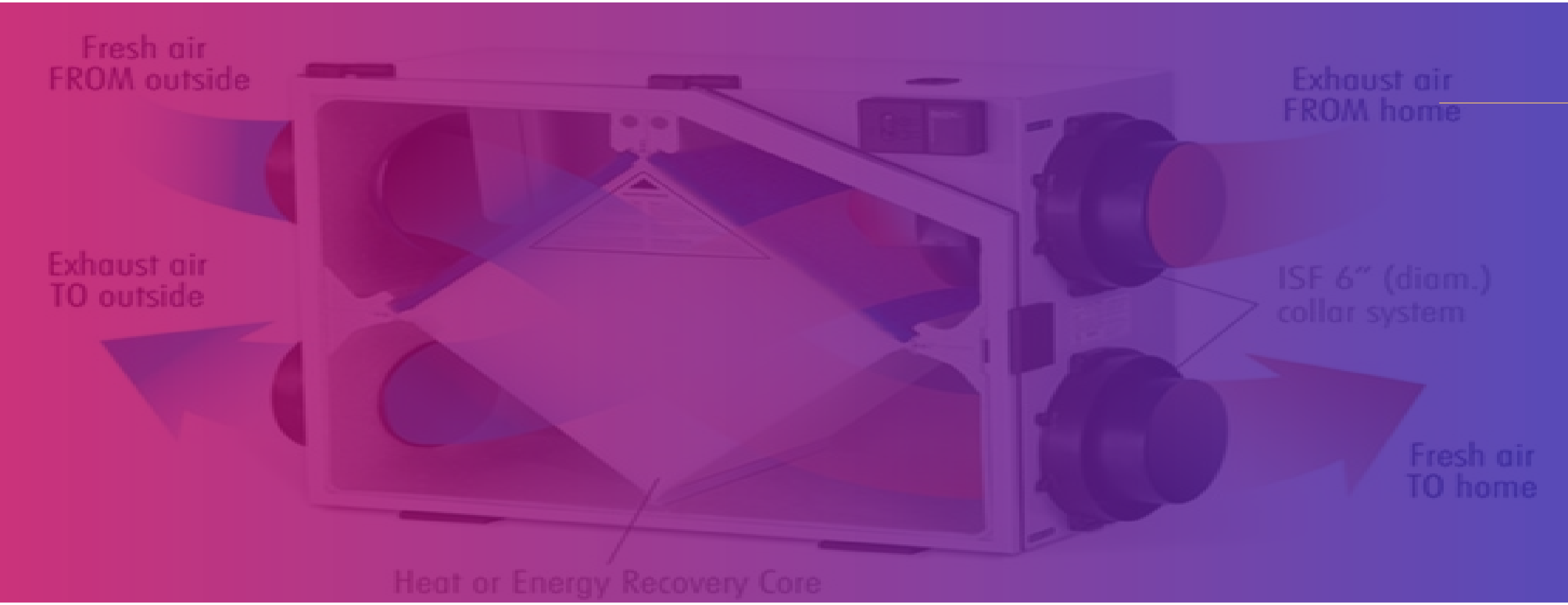
Health

- RVs allow you to boost ventilation in your home when needed, when the house is full or germs are going around
- By getting fresh air behind closed bedroom doors and into home offices, you perform better

slido

What is your experience level with RVs?

ⓘ Start presenting to display the poll results on this slide.



MECHANICAL VENTILATION

Why we need it, How to do it, How much?

INDOOR AIR QUALITY

- Source Control
- Dilution of Pollutants
    - Mechanical Ventilation
        - Spot sources
            - Bathrooms
            - Kitchens
        - Whole home

- Mechanical Ventilation
    - ASHRAE 62.1 (nonres) & 62.2 (residential)
    - Title 24 adopts ASHRAE 62.2 for residential standards

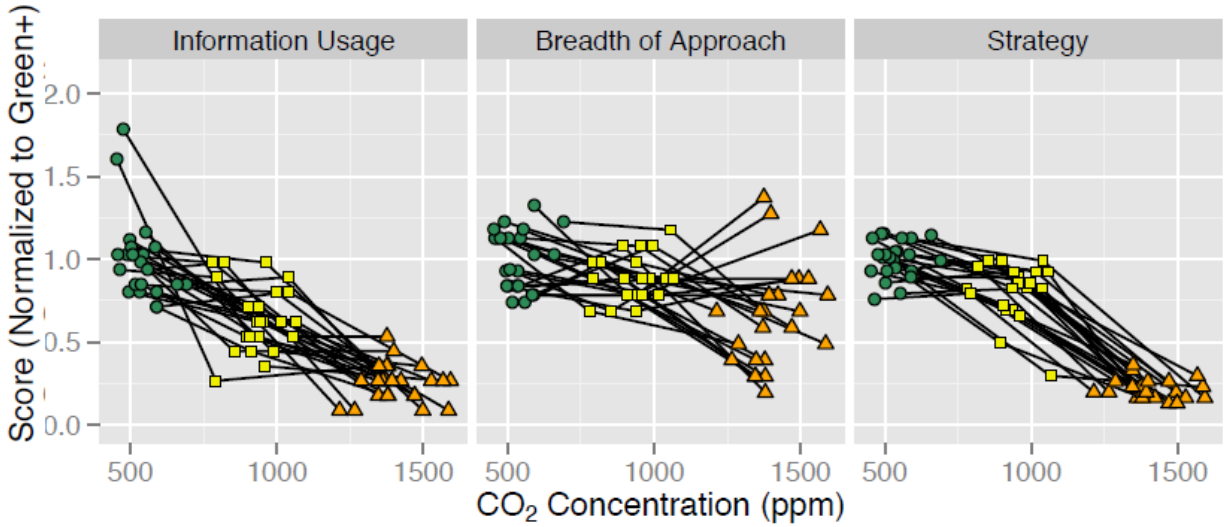
INDOOR AIR QUALITY

- "Increasing ventilation rates will reduce respiratory illness and associated sick leave, reduce sick building symptoms, and increase productivity"

  ~ *California Energy Commission*

- "Reduced ventilation brought down people's ability to think and perform higher order analysis by 60%"

  ~ *Harvard study*

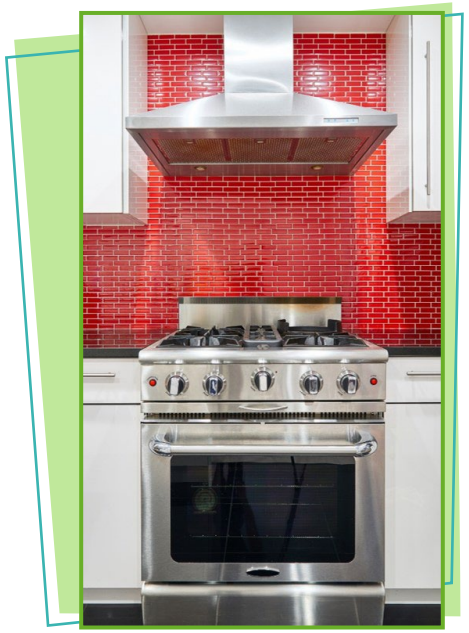


Allen, MacNaughton, et al, "Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, …" Environmental Health Perspectives, October 2015

Range Hoods

§150.0(o)1.G.iii

New Standards Introduced for 2022



- Must meet requirements of Table 150.0-G by EITHER :
  - capture efficiency (CE) OR
  - Air flow (cfm)
- Higher air flow and CE required for gas ranges.
- In all cases, max 3.0 sones applies via ASHRAE 62.2, Section 7.2

HERS Verification Required

Dwelling Unit Floor Area (ft^2)	Hood Over Electric Range	Hood Over Natural Gas Range
>1500	50% CE or 110 cfm	70% CE or 180 cfm
>1000 - 1500	50% CE or 110 cfm	80% CE or 250 cfm
750 - 1000	55% CE or 130 cfm	85% CE or 280 cfm
<750	65% CE or 160 cfm	85% CE or 280 cfm

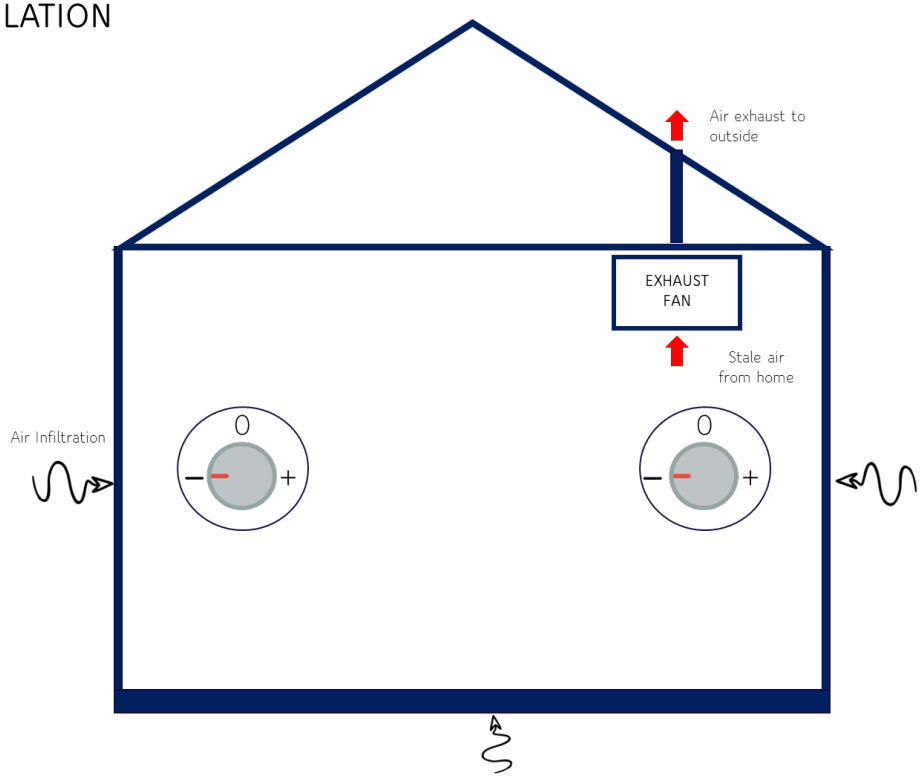
HOW TO VENTILATE?

All new homes must have continuously operating mechanical ventilation systems (or equivalent intermittent)

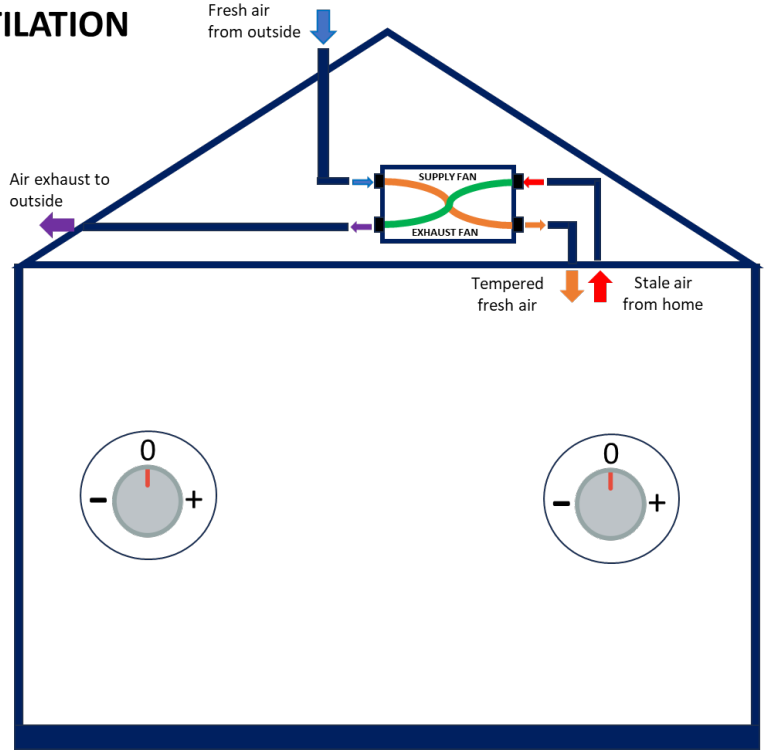
- Exhaust only
- Supply only
- Balanced

WHAT KIND OF VENTILATION?

EXHAUST VENTILATION



HEAT RECOVERY VENTILATION



HOW MUCH VENTILATION?

2022 Energy Code requires minimum whole house ventilation rate:

Total Required Ventilation Rate (Equation 150.0-B)

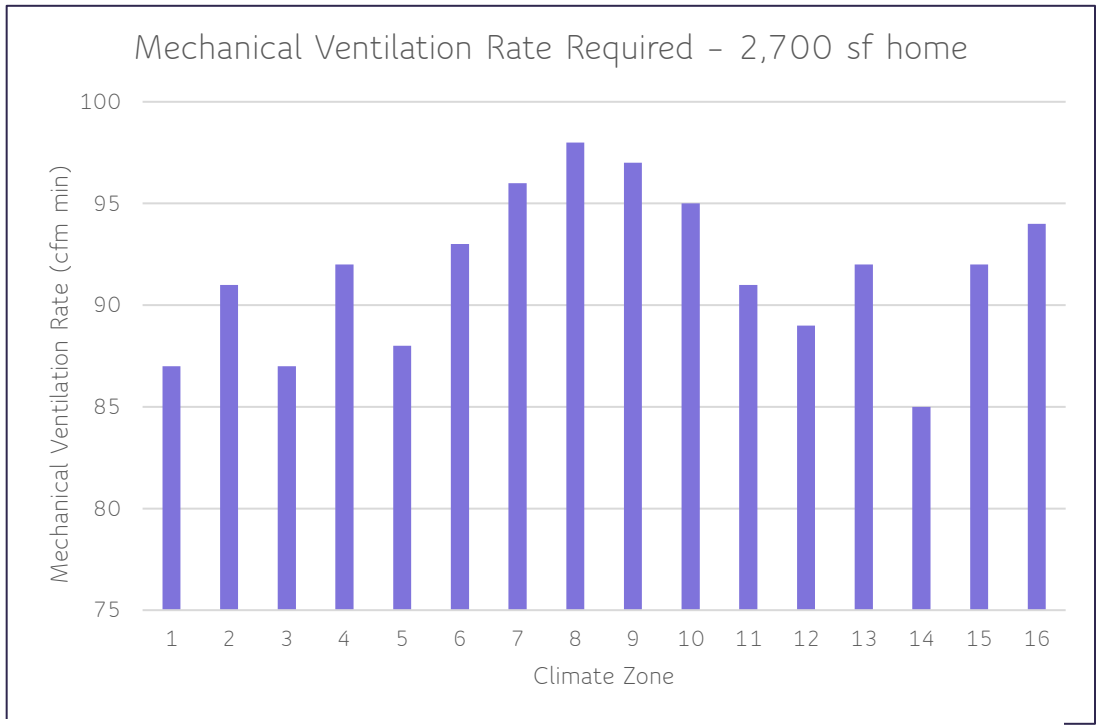
$$Q_{tot} = 0.03 \times A_{floor} + 7.5 \times (N_{br} + 1)$$

Q_{tot} = Total required ventilation rate, cfm

A_{floor} = Dwelling-unit floor area, ft^2

N_{br} = Number of bedrooms (not to be less than 1)

Note that the Fan airflow is determined using Q_{tot} and several equations to represent air infiltration.



INDOOR AIR QUALITY (IAQ) FANS								
01	02	03	04	05	06	07	08	09
Dwelling Unit	Airflow (CFM)	Fan Efficacy (W/CFM)	IAQ Fan Type	Includes Heat/Energy Recovery?	IAQ Recovery Effectiveness - SRE	Includes Fault Indicator Display?	HERS Verification	Status
SFam IAQVentRpt	84	0.35	Exhaust	No	n/a	No	Yes	

VENTILATION AFTER COVID-19

- Air flow rates often set higher than code minimum
- Filtering return air more important
- Air cleaners, UV lights gained traction

Sci Rep. 2019; 9: 2185. PMCID: PMC6379436
Published online 2019 Feb 18. doi: 10.1038/s41598-019-38825-y PMID: 30778136

Setting ventilation to code requirement = Vaccinating 50-60% against flu

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VENTILATION AFTER COVID-19

- "You building designers have a bigger impact on health than we clinicians"
- "Darn architects put wood on the walls [of our hospital] and it was peeling off the walls because it was dry in there. We added humidity to keep the wood trims on the wall and brought down infection rates by accident."

40TO60RH.COM
THE HEALTHY HUMIDITY

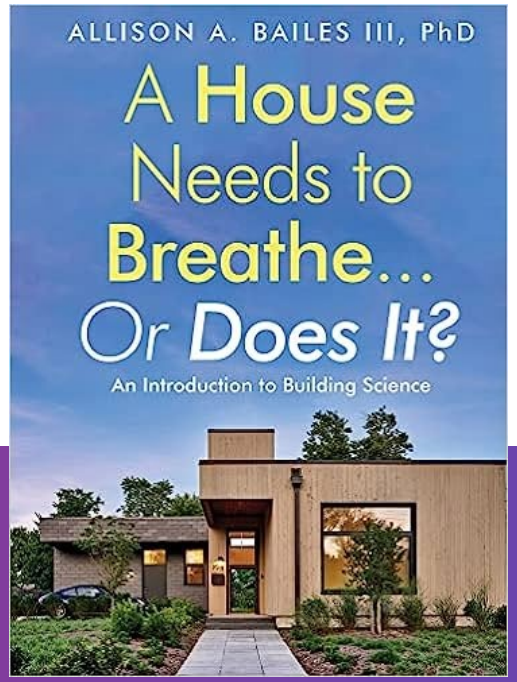
TO "E" OR TO "H"; THAT IS THE QUESTION

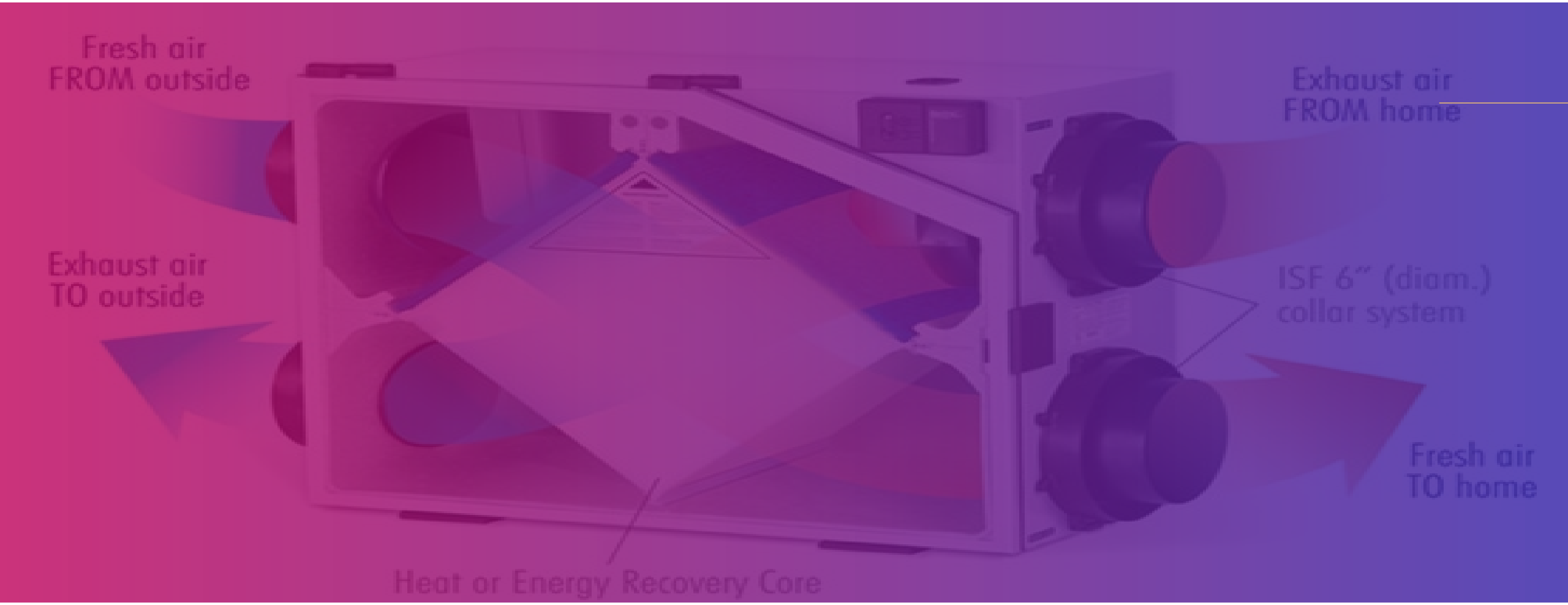
- ERVs have membranes that temper the incoming air using the humidity of the exhaust air
- HRVs do not swap moisture (just heat)
- Title 24 doesn't care about E vs H when it comes to RVs …
- But occupants might care

  Mild climates: HRVs better

  Other climates: ERVs better

- *"The choice between an ERV and an HRV should land on ERV most of the time."*
- *"it's only in mild climates where it doesn't get too cold, humid, or dry where HRVs make sense…"*





HOW RVs WORK

Fresh filtered supply air + Exhaust stale air + Heat recovery

HOW RECOVERY VENTILATORS WORK

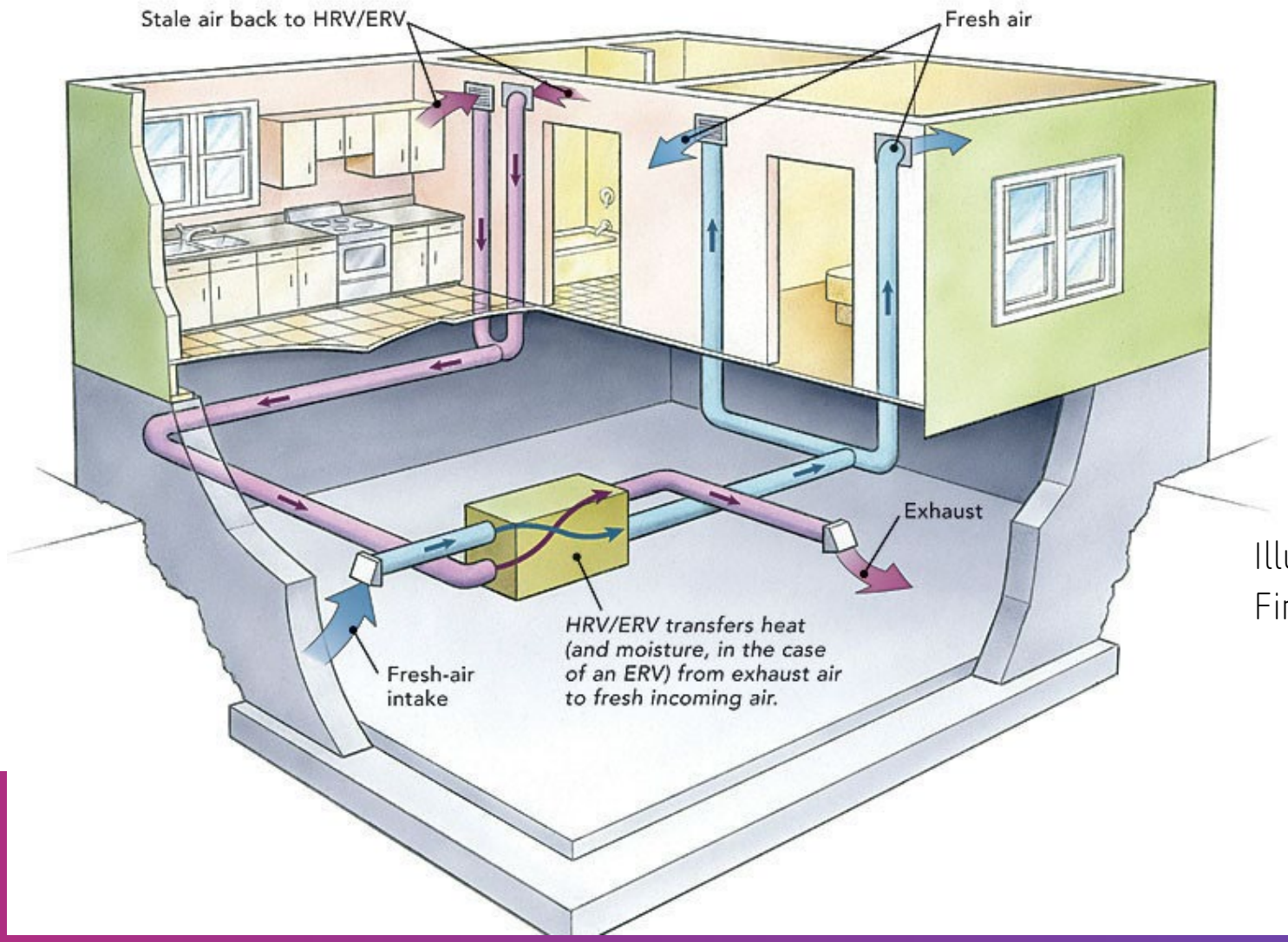


Illustration courtesy of Fine Homebuilding

HOW RECOVERY VENTILATORS WORK

- Fresh air brought in from known location & filtered
    - Supplied in ducts to bedrooms and living areas
- Stale air removed from areas with moisture
    - typically kitchen and bathrooms

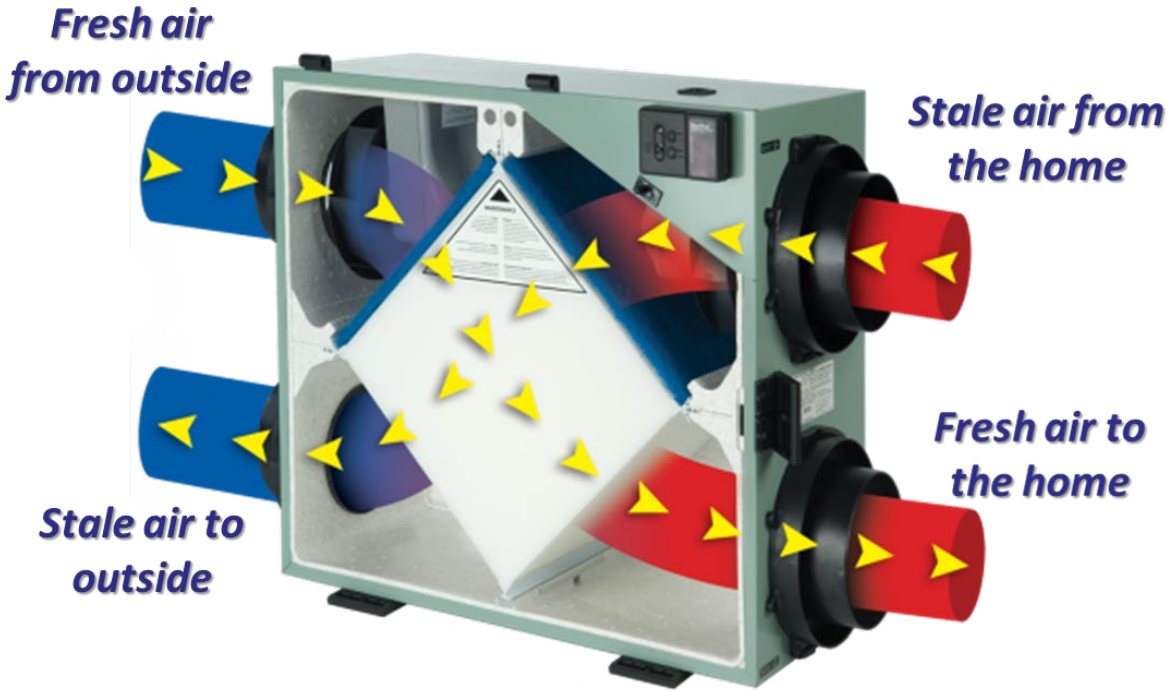
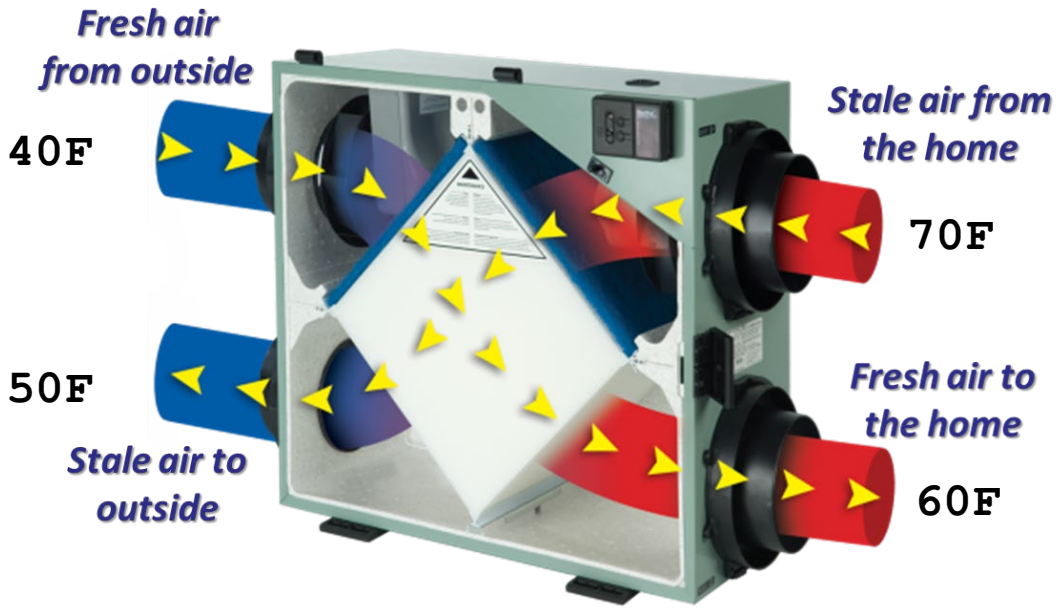


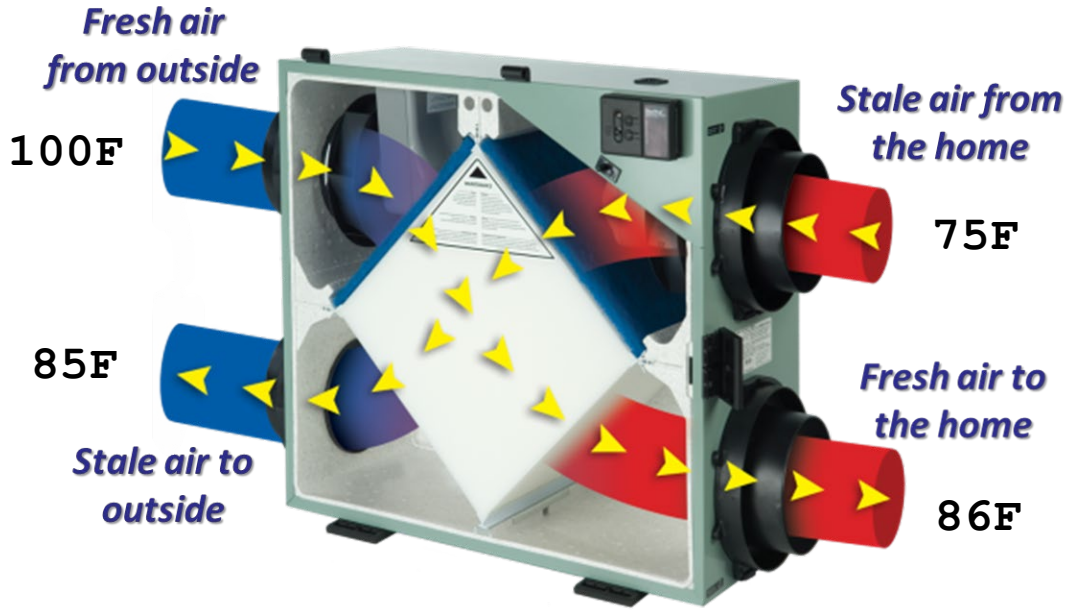
Illustration courtesy of Field Controls

THE HEAT RECOVERY PART

WINTER



SUMMER

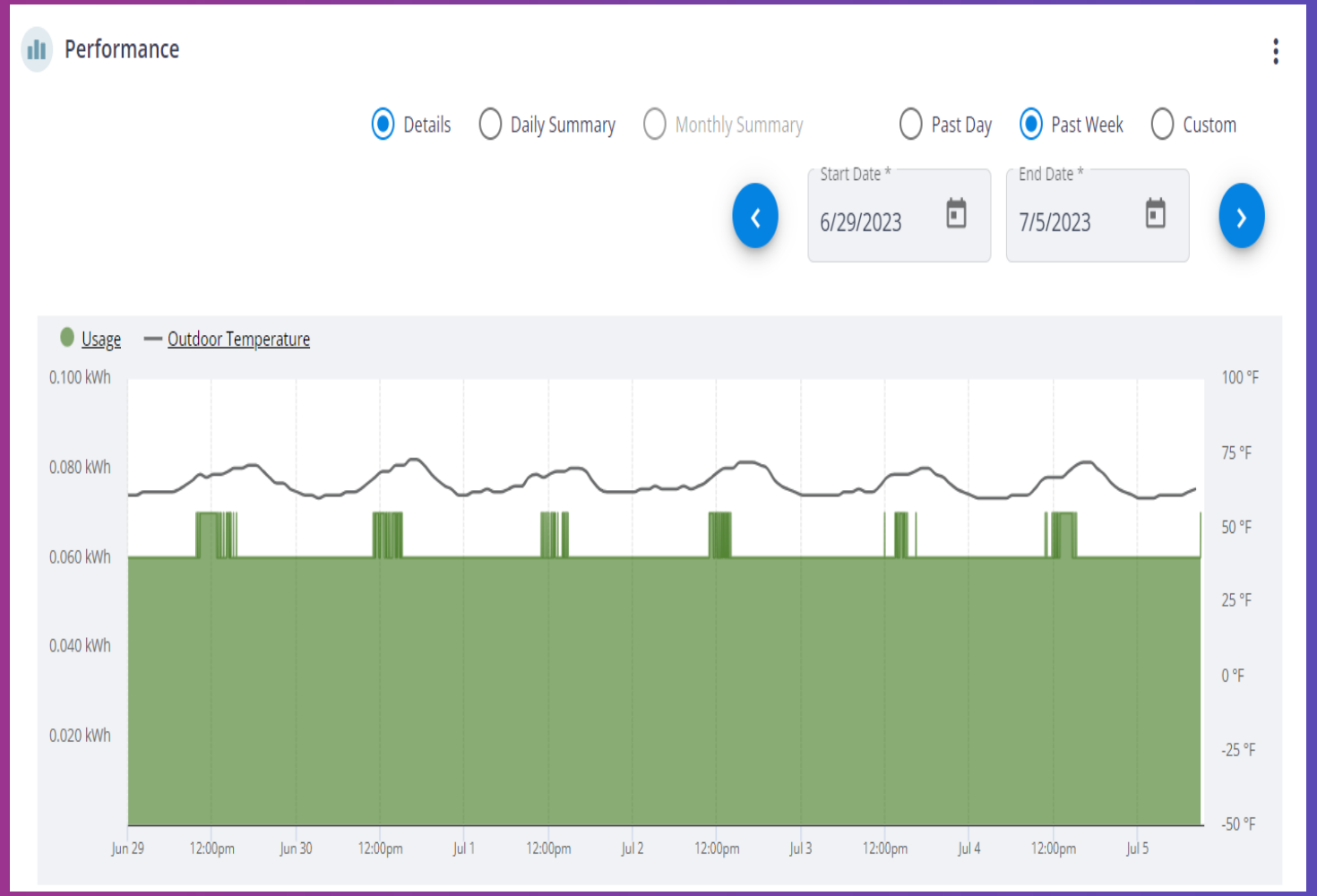


MY RECOVERY VENTILATORS

DATA FROM MY RVs

ADU ERV

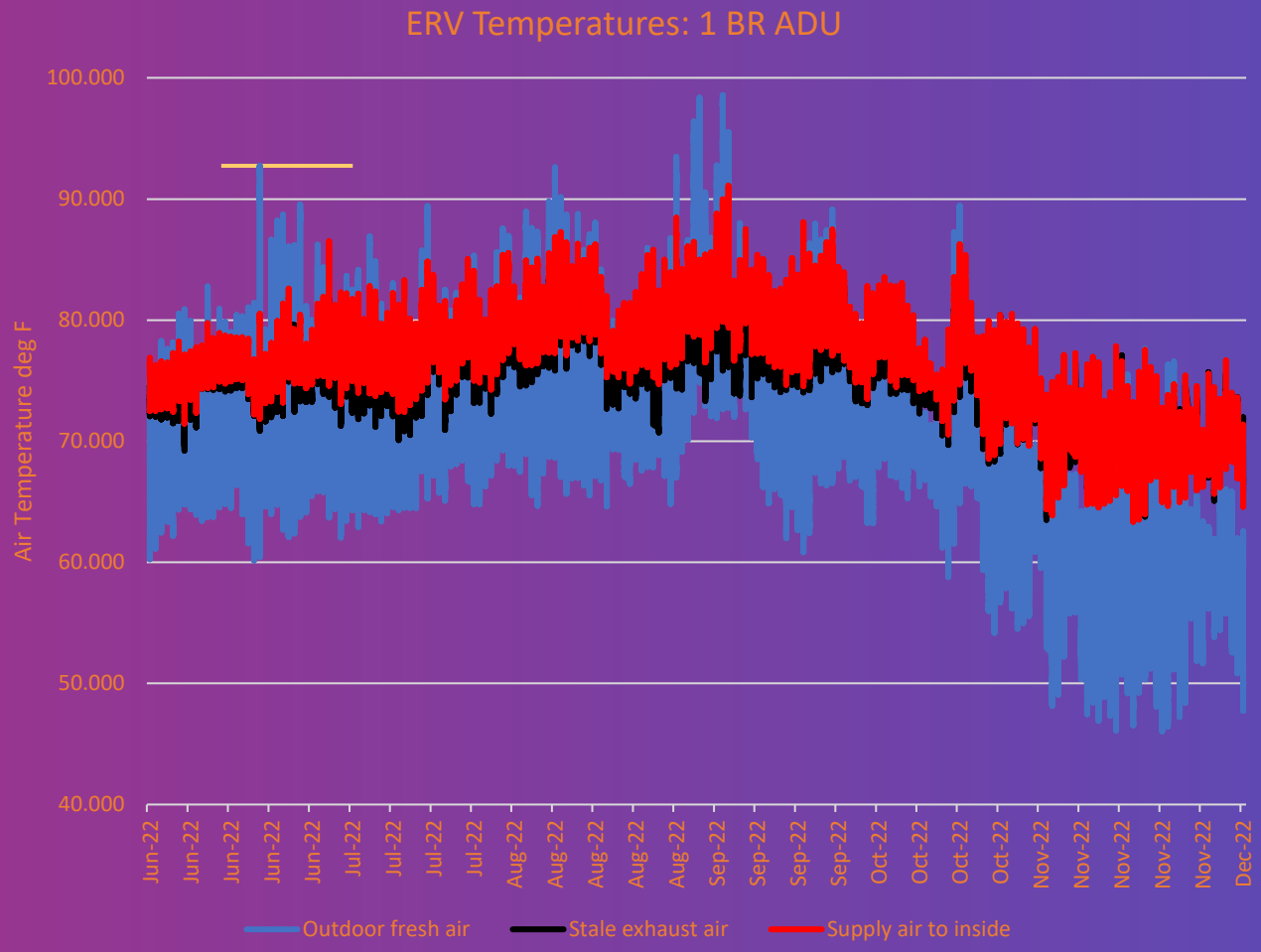
- 60 Watts continuous
- 60 cfm
- Boosts up to 70 Watts when humidity spikes



DATA FROM MY RVs

ADU ERV

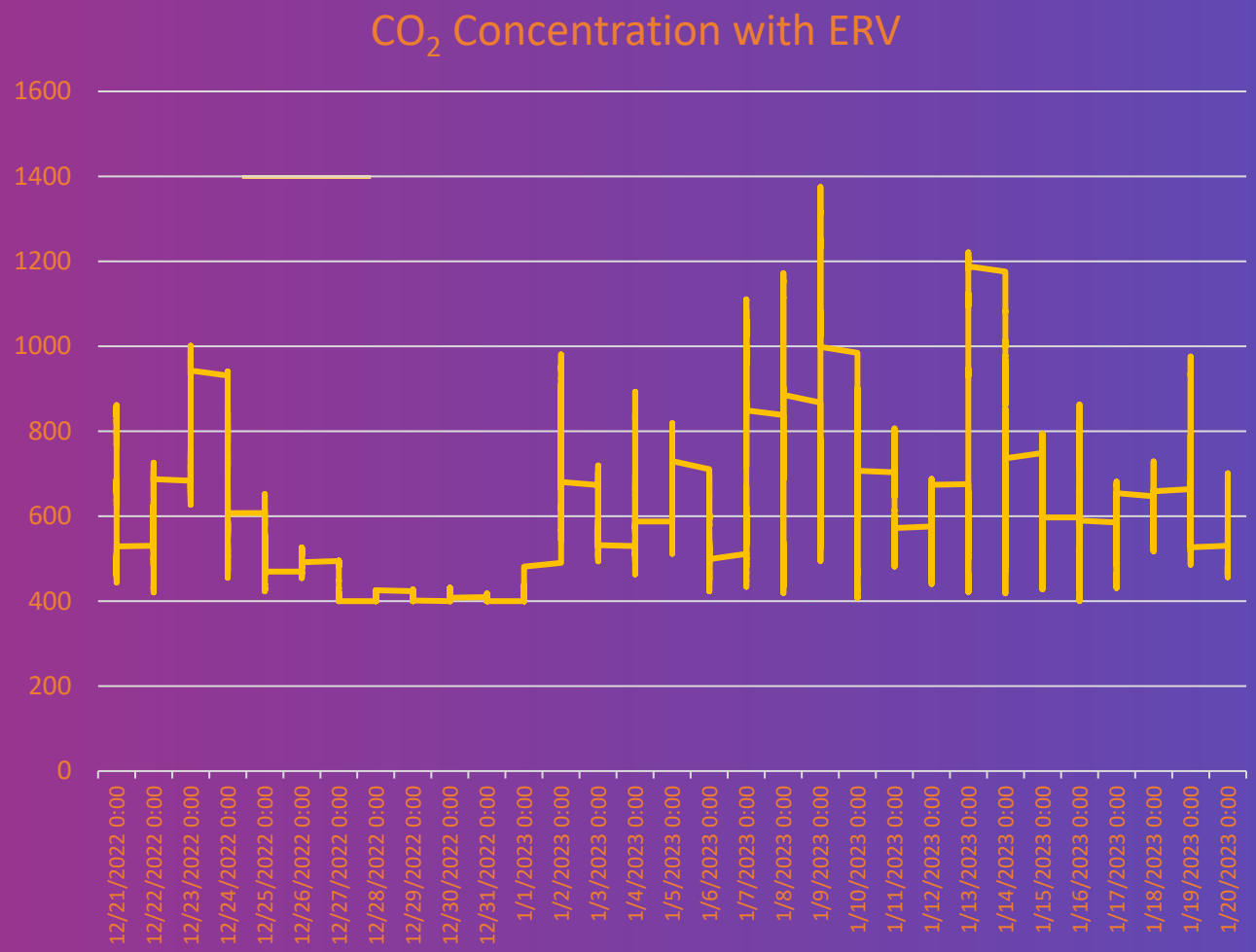
- Supply air to space tempered in ERV
- Winter outdoor temps into 40s while supply air in mid-60s
- Summer outdoor temps to 100 while supply air in high-80s



DATA FROM MY RVs

ADU ERV

- CO_2 maintained under 800 in Winter months with windows closed
- Spikes up to 1,400 cfm occur with extra people in space – hence the need for Boost mode

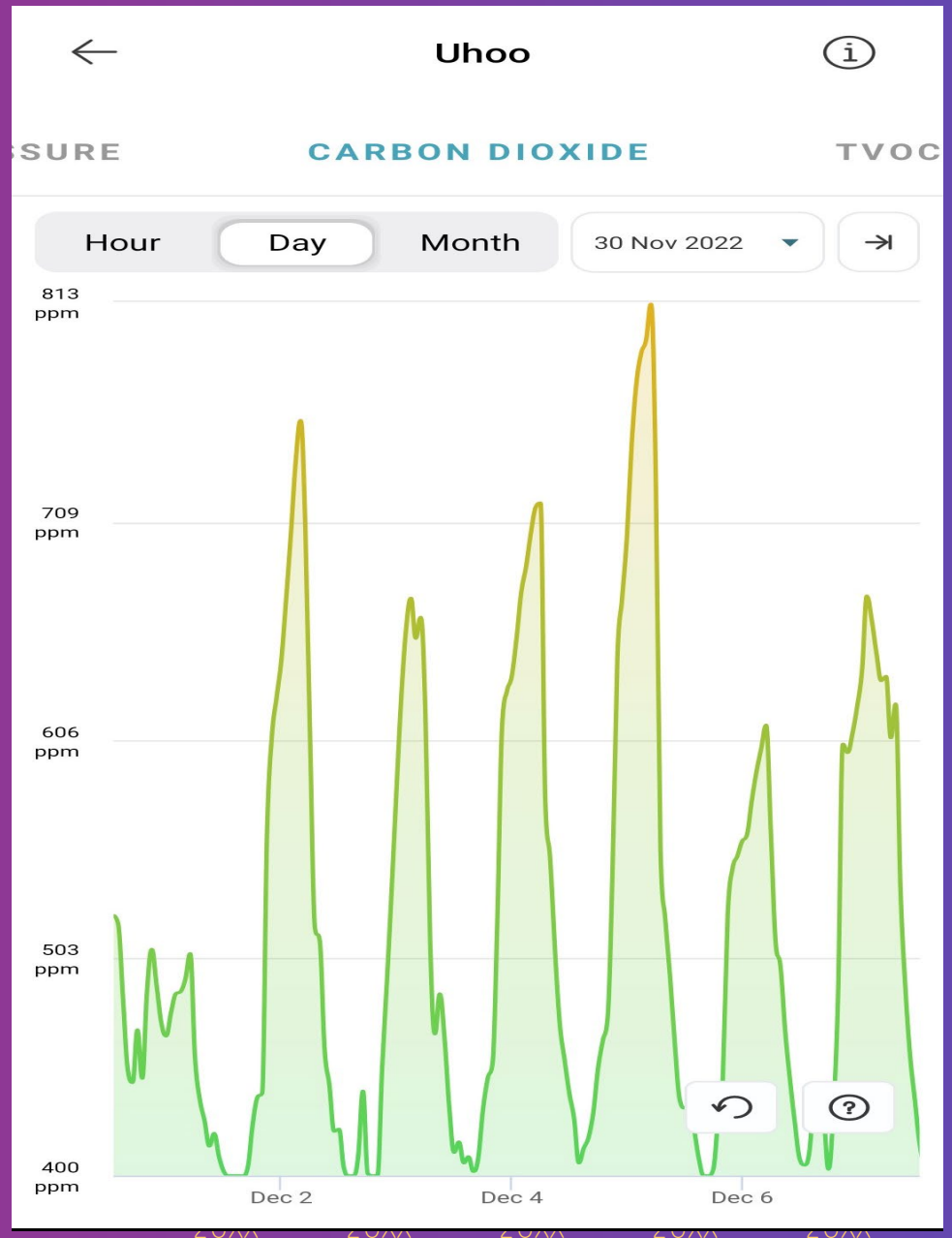


DATA FROM MY RVs

Fresh Air Behind Closed Bedroom Doors

CO_2 in bedroom spiked to 1,000-1,200 cfm during night time sleep before HRV connected

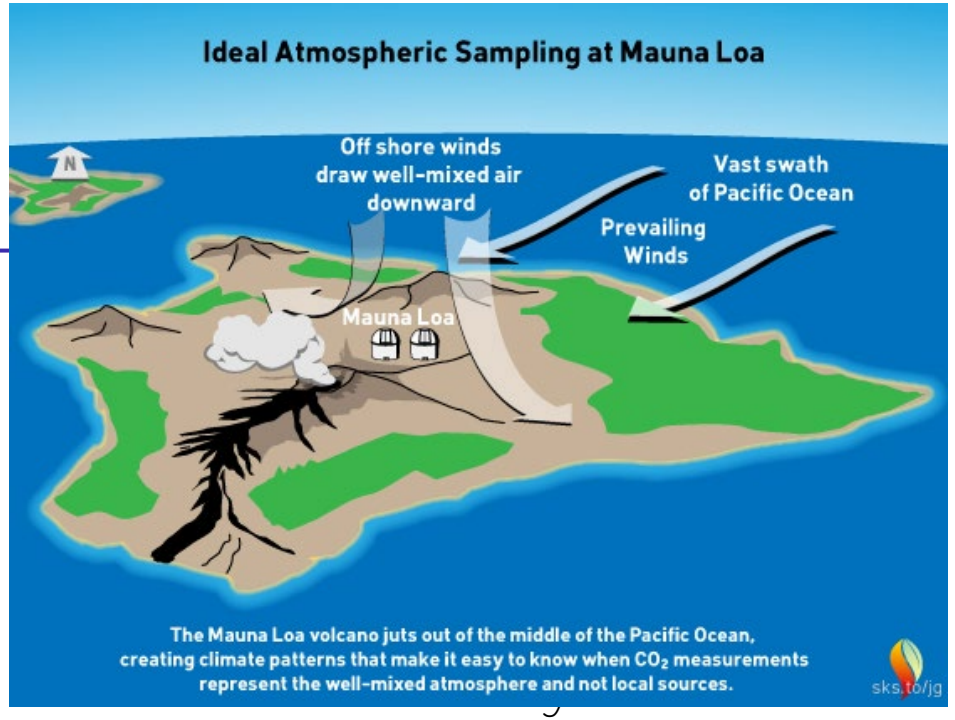
With HRV, CO_2 spikes limited to 700-800 cfm



IAQ IMPACT

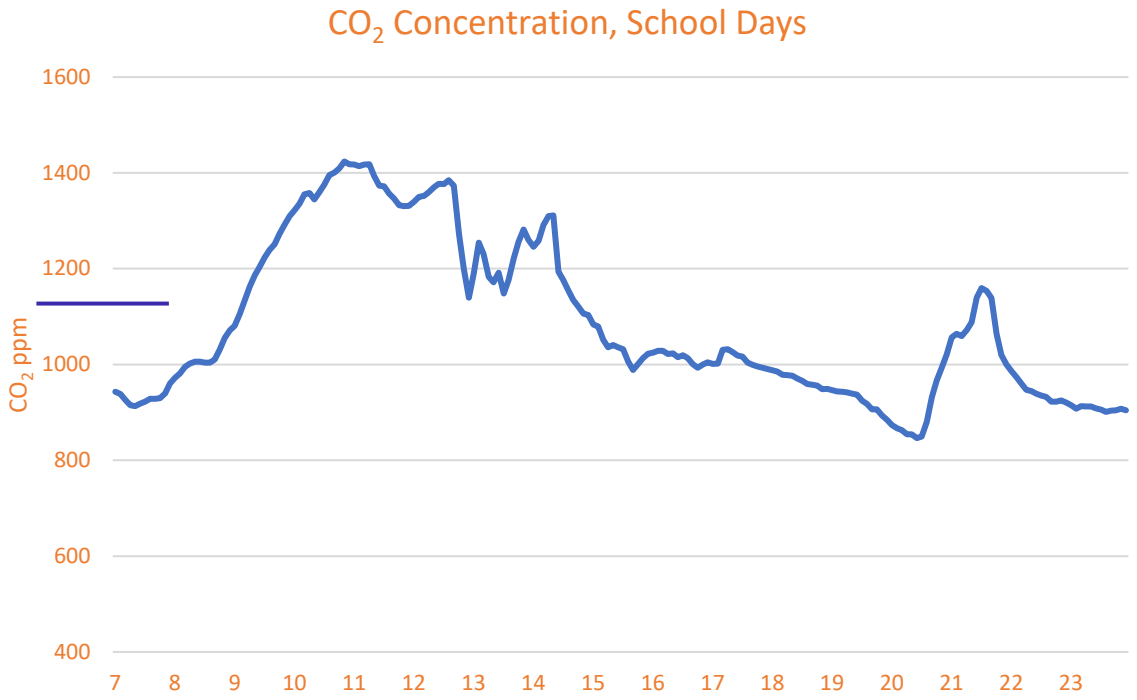
HOW MUCH CO_2 IS TOO MUCH?

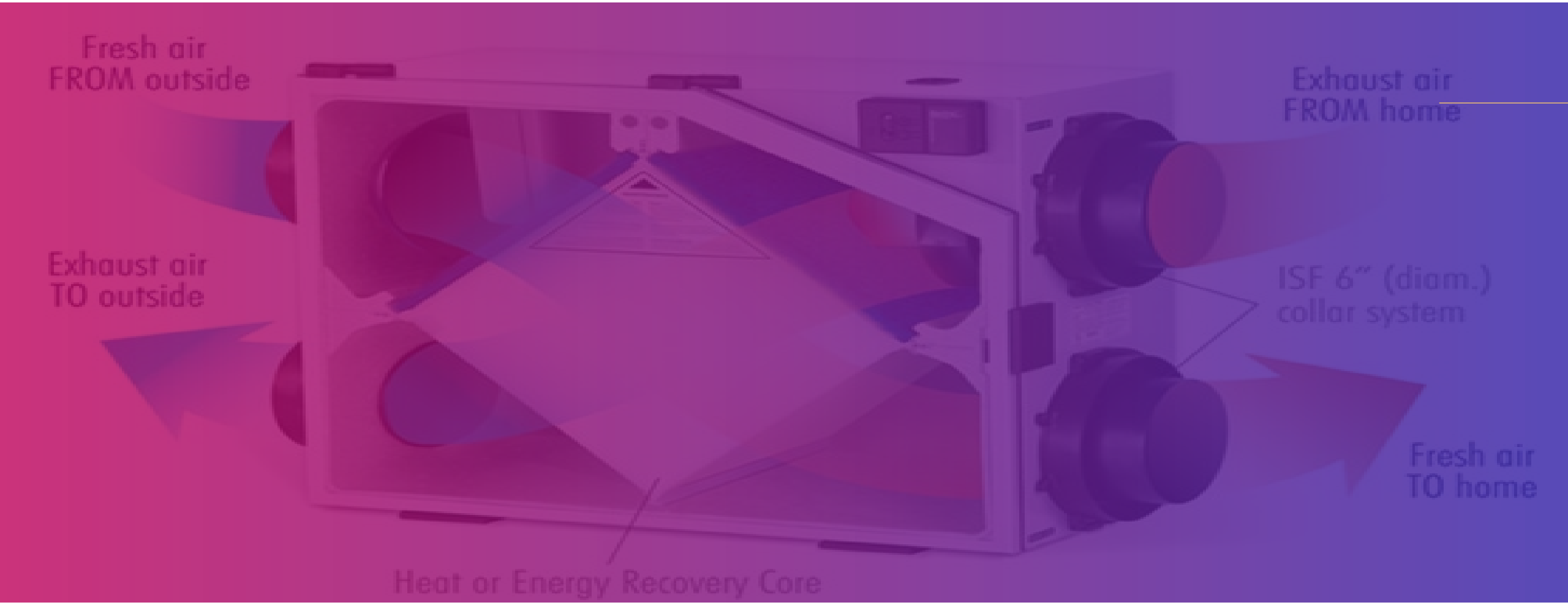
- Earth is at 424 ppm
- Harvard study used:
  - 950 ppm = typical indoor levels
  - 1,400 ppm = extreme
- CBRE used 800 ppm for their buildings
- Title 24 uses outdoor + 600 ppm for demand-control ventilation



COVID19 CLASSROOM CASE STUDY

- CO_2 steadily climbed to 1,400 ppm with 3 students on hot September day with windows closed
- HRV at 30 cfm into classroom kept CO_2 under 1,000 ppm





HOW MUCH ENERGY CAN THEY SAVE?

HVAC ENERGY SAVINGS

- Typical RVs: savings of 11-15% in CZ 1-5 vs exhaust only ventilation
- Best-in-Class RVs: 21-31% HVAC energy savings in CZ 1-5
- CZ 10-14 & 16 also show savings
- CZ 6-9 & 15 less well suited for energy savings with HRVs

The Math

TYPICAL RV

80 cfm exhaust fan: 28 Watts

80 cfm typical RV: ~56 watts

Annual extra ventilation energy = 245 kWh

Cooling energy savings, CZ5 = 0

Heating energy savings, CZ5 = 290 kWh

BEST-IN-CLASS RV

80 cfm B-I-C RV: ~40 Watts

Annual extra ventilation energy = 105 kWh

Cooling energy savings, CZ5 = 0

Heating energy savings, cZ5 = 395 kWh

HVAC ENERGY SAVINGS - TYPICAL RV

Climate Zone	HVAC Savings kWh	HVAC Savings therms	HVAC Savings mmbtu	Pct savings HVAC mmbtu	Cooling Savings kWh	Heating Savings kWh	Ventilation Savings kWh
1	301.8	-	1.0	6.9%	-	482.6	(180.6)
2	76.2	-	0.3	3.0%	15.0	256.2	(195.4)
3	21.7	-	0.1	1.5%	-	218.3	(195.4)
4	(17.9)	-	(0.1)	-1.2%	2.7	179.9	(199.0)
5	45.1	-	0.2	3.0%	-	235.2	(189.0)
6	(115.5)	-	(0.4)	-16.3%	5.3	95.7	(215.3)
7	(138.9)	-	(0.5)	-24.5%	(2.3)	76.8	(211.5)
8	(166.7)	-	(0.6)	-16.7%	(15.6)	69.4	(218.4)
9	(126.8)	-	(0.4)	-10.8%	(6.1)	90.3	(209.4)
10	(97.1)	-	(0.3)	-5.8%	(12.1)	120.8	(204.2)
11	44.4	-	0.2	1.4%	12.9	231.5	(199.0)
12	6.5	-	0.0	0.3%	2.2	203.0	(197.5)
13	(17.4)	-	(0.1)	-0.6%	24.0	163.7	(204.2)
14	31.0	-	0.1	1.0%	4.2	218.2	(190.4)
15	(103.5)	-	(0.4)	-2.3%	71.1	26.3	(199.0)
16	173.3	-	0.6	3.8%	(1.1)	376.1	(200.5)

Table 5: Impact of Changing Ventilation from Exhaust to HRV in 1-story Single Family Home with Heat Pump

Source: "Recovery Ventilators: Impact on Modeled Energy Use…", SoCal Gas, Feb 2022

HVAC ENERGY SAVINGS – B-I-C RV

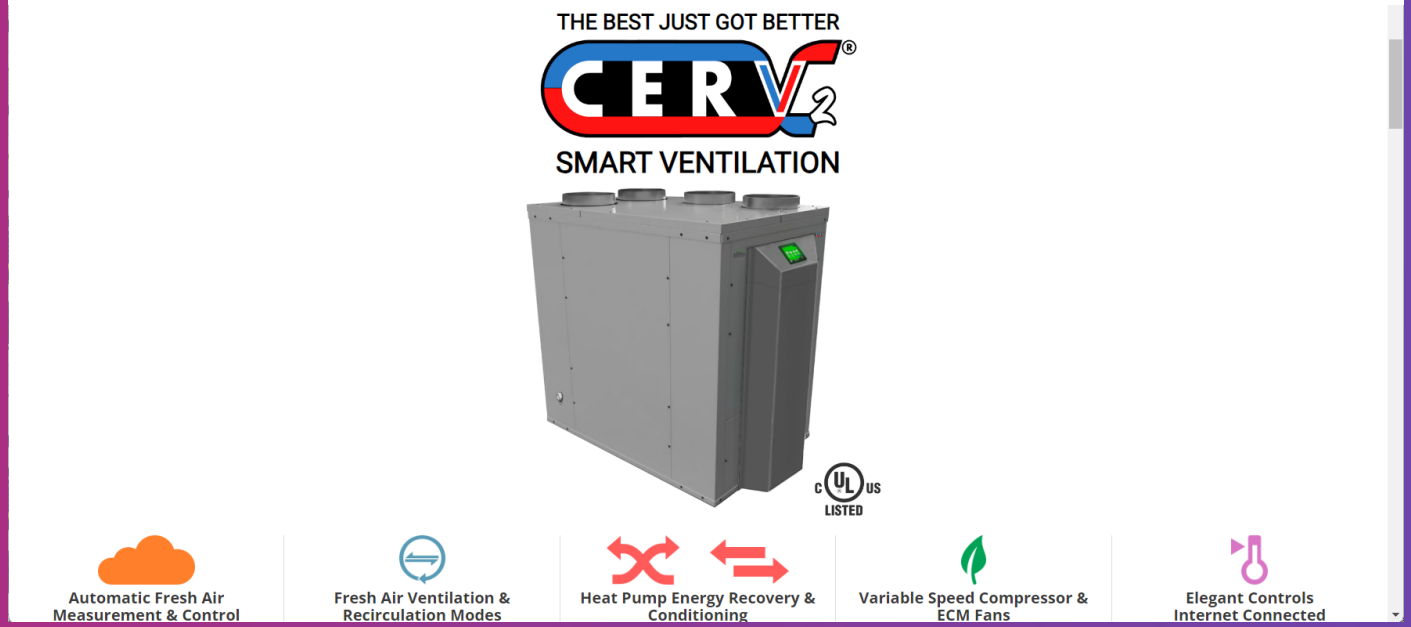
Table 5: Energy impact of Best-in-class HRV in 2100 sq ft SFH with HP

Climate Zone	HVAC Savings kWh	HVAC Savings therms	HVAC Savings mmbtu	Pct savings HVAC mmbtu	Cooling Savings kWh	Heating Savings kWh	Ventilation Savings kWh
1	720.3	-	2.5	16.6%	-	810.1	(89.8)
2	394.3	-	1.3	15.7%	17.1	478.3	(101.0)
3	259.7	-	0.9	17.4%	-	360.7	(101.0)
4	200.8	-	0.7	13.9%	4.7	299.9	(103.7)
5	299.6	-	1.0	19.9%	-	395.7	(96.1)
6	42.2	-	0.1	5.7%	2.2	156.1	(116.2)
7	(5.2)	-	(0.0)	-1.5%	(10.0)	118.1	(113.3)
8	(27.7)	-	(0.1)	-3.1%	(18.1)	109.0	(118.6)
9	38.7	-	0.1	3.1%	(2.2)	152.5	(111.6)
10	101.0	-	0.3	5.9%	(1.2)	209.9	(107.7)
11	341.2	-	1.2	10.6%	47.9	397.0	(103.7)
12	267.0	-	0.9	9.2%	12.3	357.3	(102.6)
13	249.8	-	0.8	8.1%	64.6	292.9	(107.7)
14	337.2	-	1.1	10.6%	32.4	402.1	(97.2)
15	110.4	-	0.4	2.4%	180.6	33.6	(103.7)
16	554.4	-	1.9	12.2%	(4.8)	664.1	(104.9)

Source: *"Best In Class Recovery Ventilators: Energy Savings Code Compliance", Small Planet Supply, June 2022*

BEST-IN-CLASS RVs CAN DO MORE

- Ventilation Cooling via Bypass mode
  - Small Planet Supply study found 50 kWh cooling savings possible (Zehnder)
- Boost mode when added air flow needed
- Humidistat drives boost after a shower
- Demand control ventilation via CO_2 sensors



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What is the trade-off we make when using RVs?

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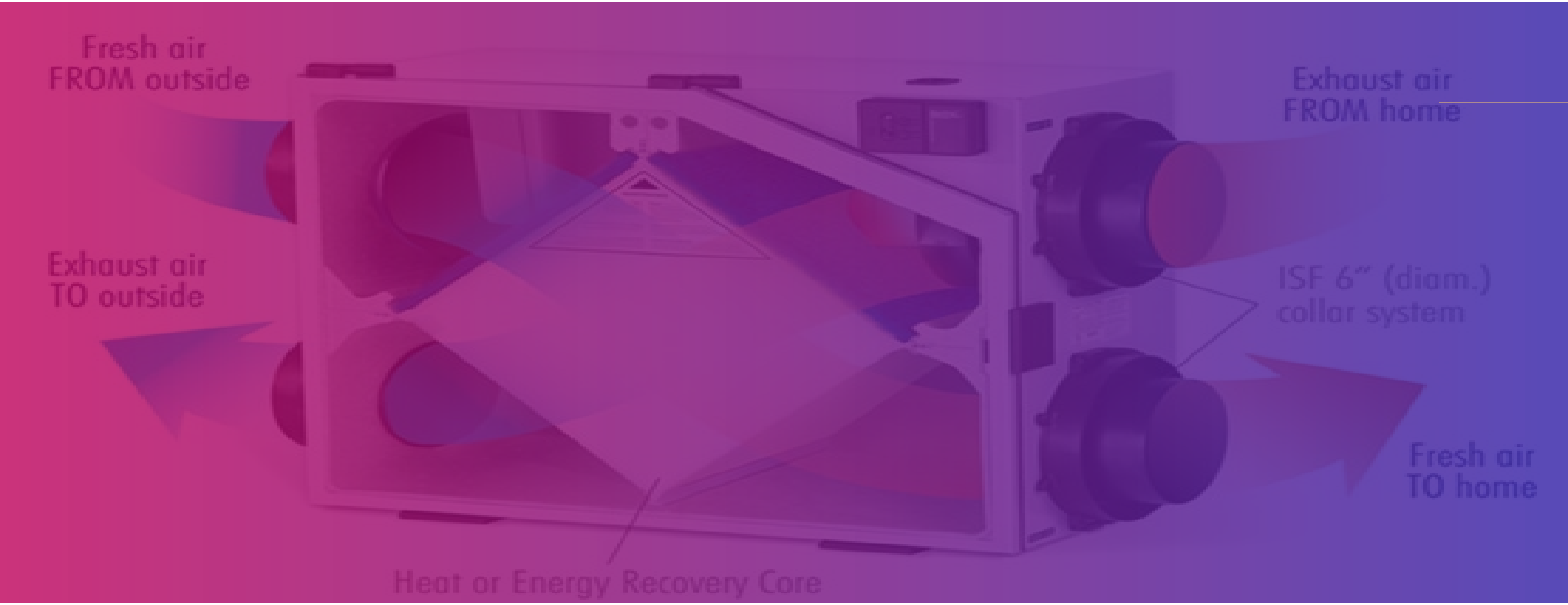
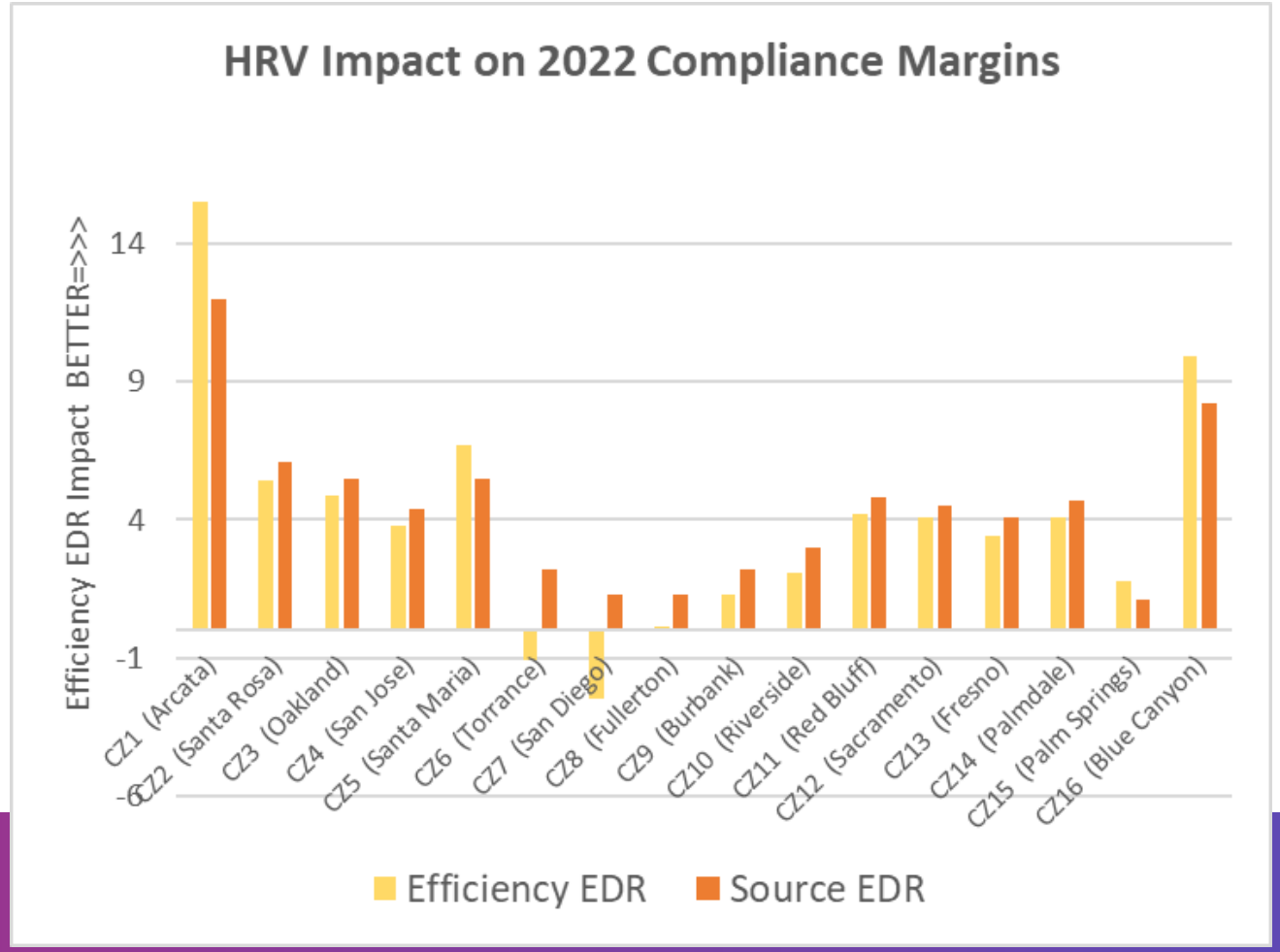


CODE COMPLIANCE & RVs

Miracle Workers in a White Box

RVs ARE POWERFUL IN COMPLIANCE

- Typical RVs:
  - Efficiency EDR Impact ~10%
  - Highest in CZ 1,2,3,5,16
- B-I-C RVs:
  - Efficiency EDR Impact ~14%



WHAT ABOUT MULTIFAMILY?

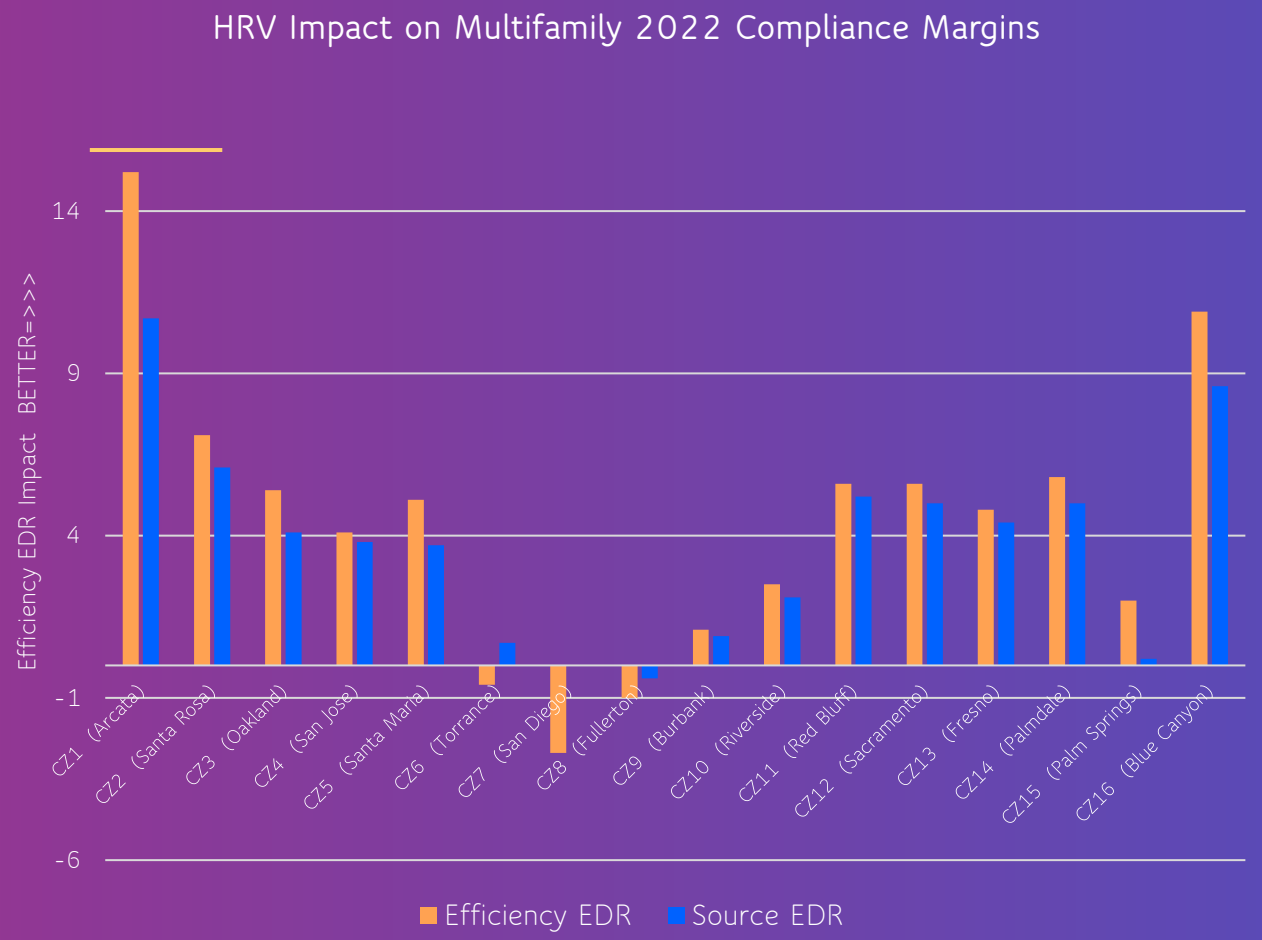
Multifamily is Different

Title 24 requires balanced ventilation in multifamily units

- Unless builder does blower door testing on all units

Therefore, no added fan energy to upgrade to RV

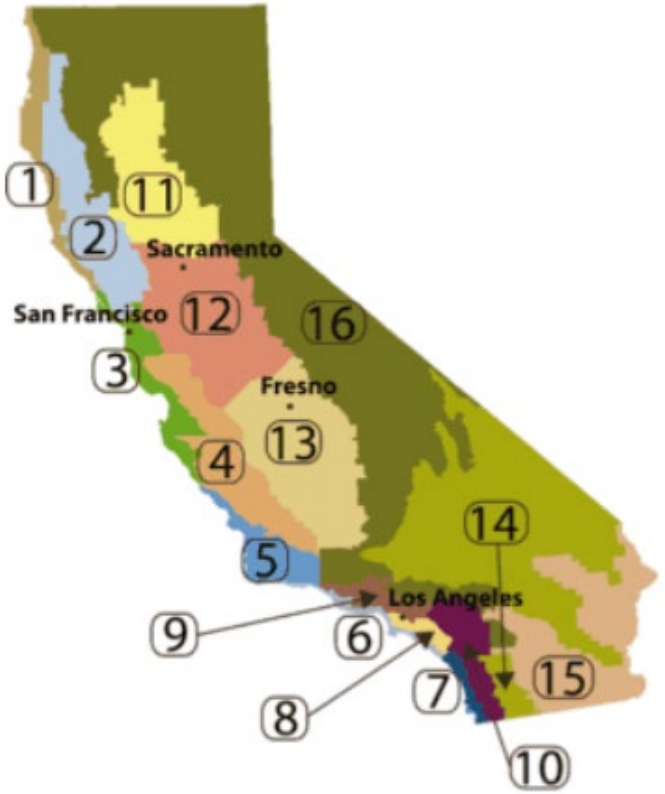
- Energy savings larger
- Title 24 compliance impact larger than single family



When Are RVs Required?

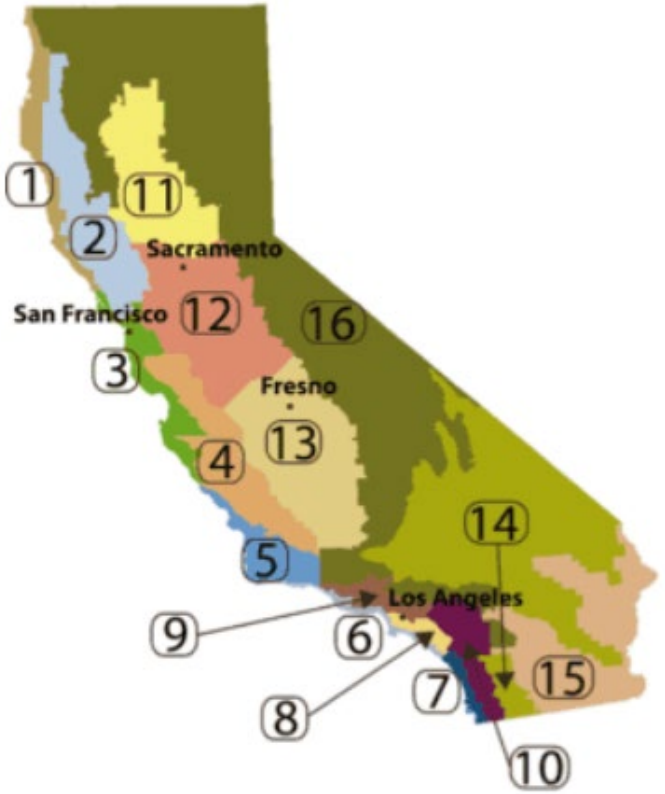
§170.2(c)3Biv (Prescriptive)

- RVs are NEVER mandatory in Residential buildings
- But they are Prescriptive Standard in half the state for multifamily
  - *Multifamily buildings have two choices for IAQ ventilation:*
  1) *Balanced ventilation in all dwelling units; OR*
  2) *Any ventilation method and blower door testing of all units (<0.3 cfm per sqft envelope)*
  - *When balanced ventilation used in MF, RVs are prescriptive standard in CZ 1,2,11-16*
    - *Min 67% SRE @ 32F and max 0.6 W/cfm*
  - *If projects in those CZs don't use RVs, they take a stiff compliance penalty (~10%)*
- Separate prescriptive standards for balanced ventilation systems serving multiple units in HRMF buildings



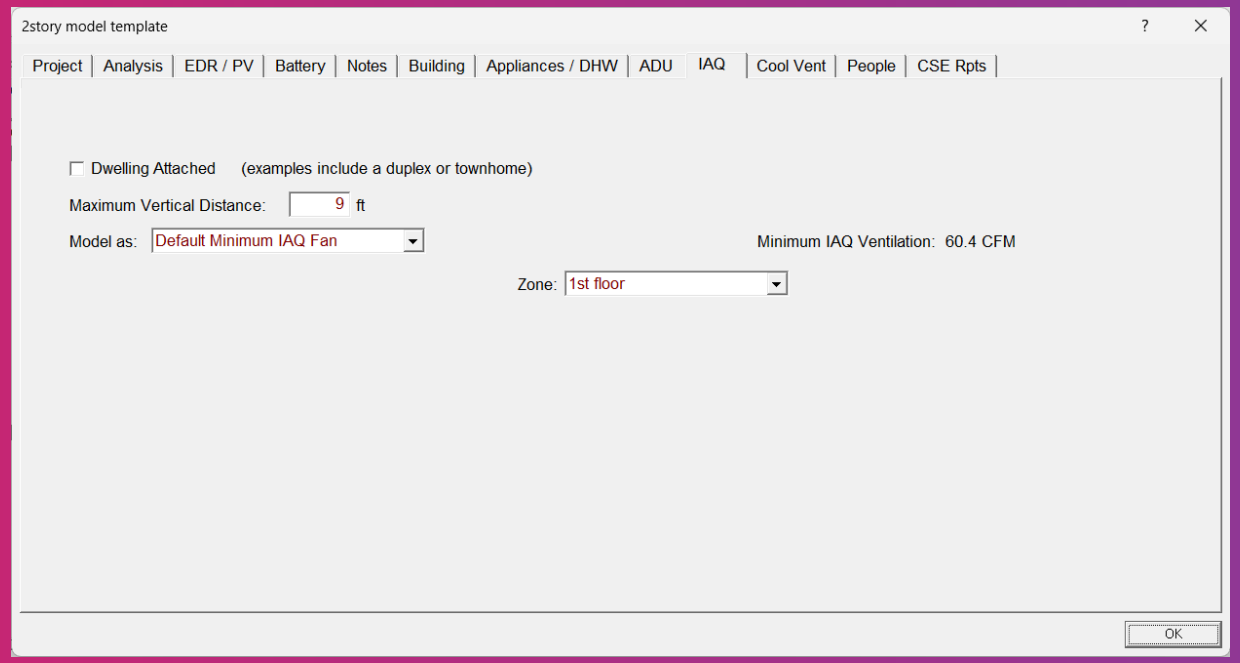
Will the 2025 Code Push RVs?

- RVs are still not mandatory in multifamily buildings
- But MF buildings must use balanced or supply ventilation (not exhaust!)
  - *And perform blower door compartmentalization test*
- they are Prescriptive Standard in half the state for multifamily
  - *RVs are prescriptive standard in CZ 1,2, 4, 11-14, 16*
    - *Min 67% SRE @ 32F and max 0.6 W/cfm*
    - *Equipped with Fault Indication Display (FID)*
  - *If projects in those CZs don't use RVs, they take a stiff compliance penalty (~10%)*
- Separate prescriptive standards for balanced ventilation systems serving multiple units in HRMF buildings

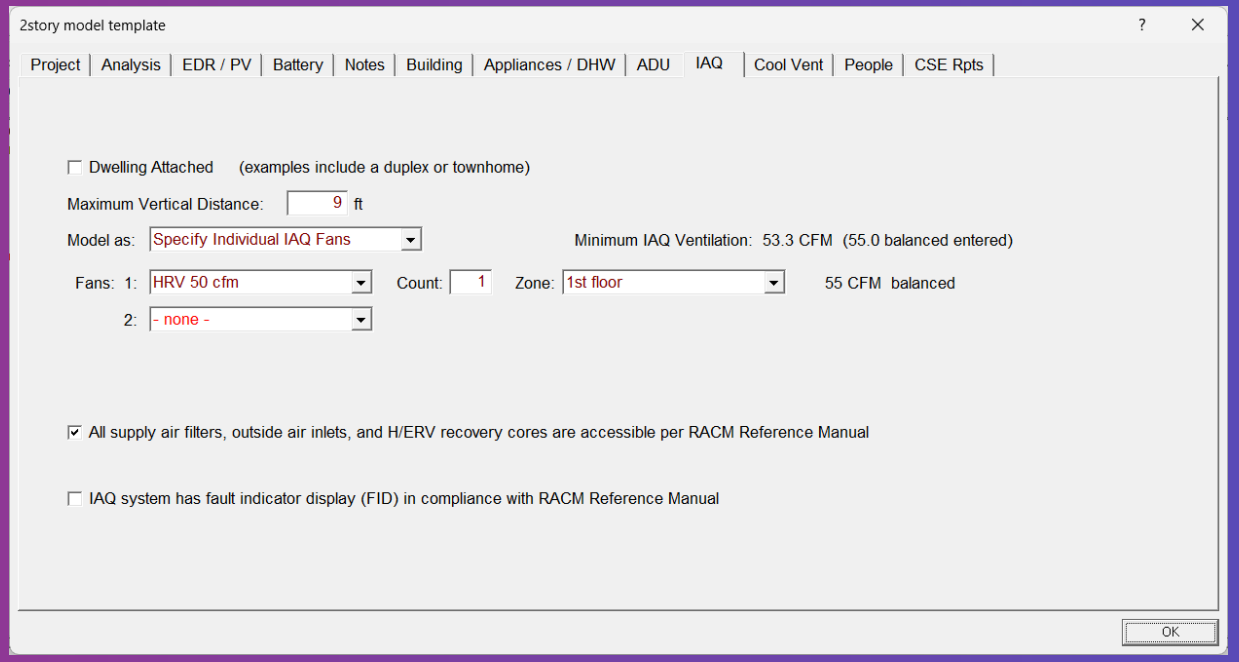


MODELING RVs

Default exhaust ventilation



RV added



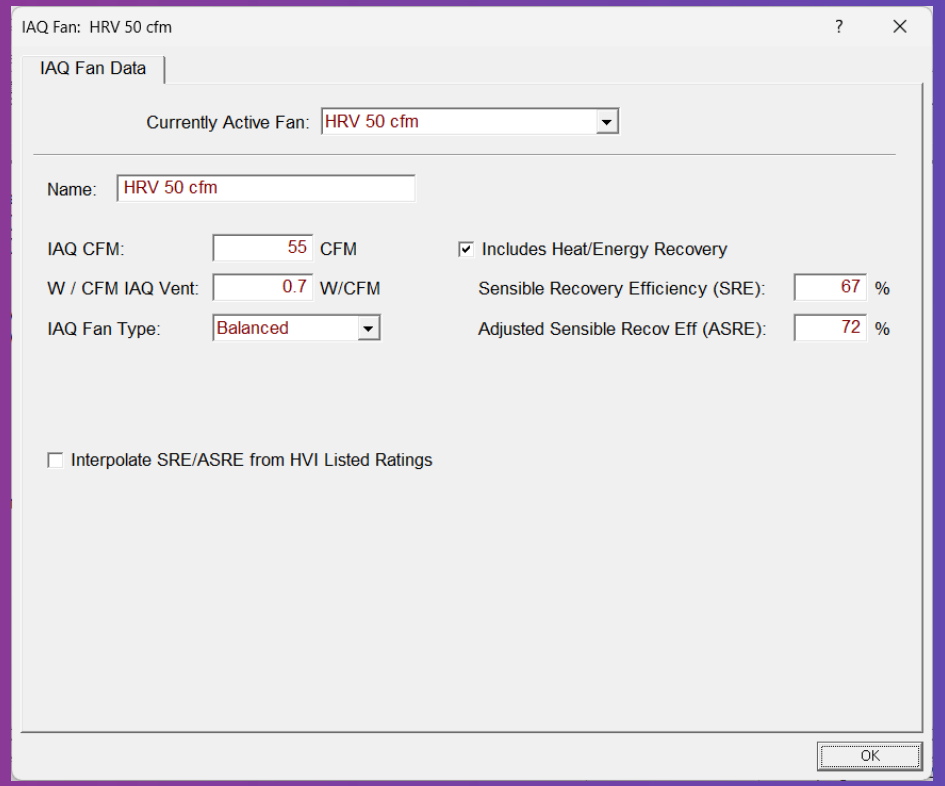
MODELING RVs

What Happens When I add an RV?

- Proposed Design:
  - Airflow you entered
  - Watts per CFM you entered
  - Outdoor air cfm at temperature calculated using Recovery Efficiency you entered
- Standard Design***
  - Airflow you entered up to 125% of code minimum
  - Watts per CFM is default (0.70)
  - Outdoor air cfm at actual outdoor temperatures (no heat recovery)

*** except in MF CZs where prescriptive standard, an HRV is standard design

Defining the RV



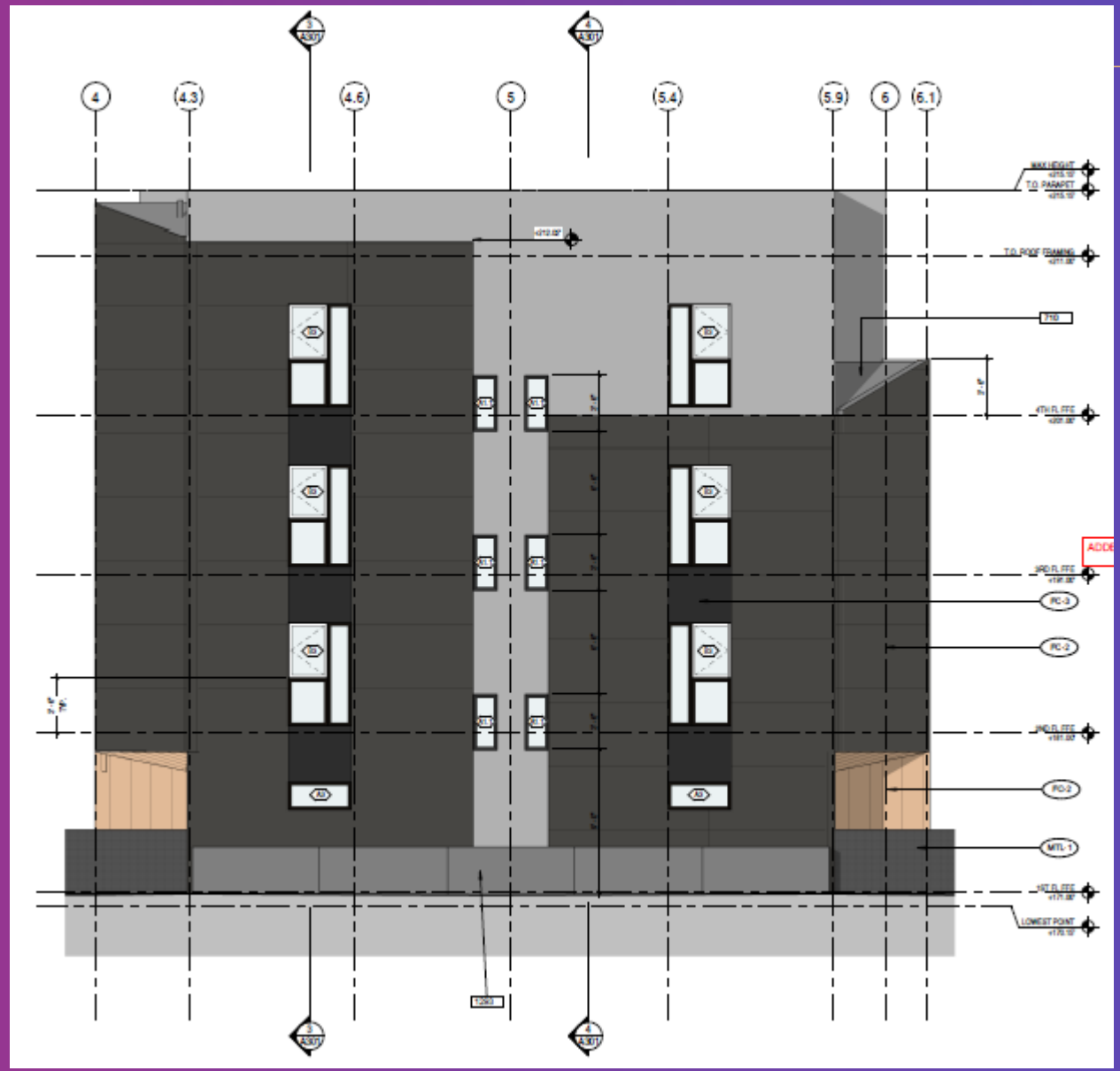
RV CASE STUDY

6 new duplexes
Los Angeles, CZ 8
Original compliance models had:

- VCHP credit for ductless minisplit heat pump
- Condensing gas tankless WH uef .95

Builder missed those features, instead used:

- Central ducted heat pump
- Standard gas tankless WH uef .81



HOW RVs CAN SAVE A PROJECT

Nick Brown <nick@buildsmartgroup.com>
to [redacted]

Jun 22, 2023, 2:02 PM

Guys:

I have done the what-ifs on 36th Street and have two options for you to get these to comply with Title 24. If you remember, we specified the VCHP credit for HVAC and a condensing gas tankless with uef=0.95 for water heating but they did a ducted standard heat pump (16 SEER, 9 HSPF) and standard gas tankless (uef=0.81). As a result, we were tight on compliance with margins of 0.1 and 0.2 on Units 1-4 (5&6 were not as tight), so we have to compensate for the extra energy use. Here are two options:

1) Add rigid foam to walls R-4 and above roof deck R-6 or more
2) Add a heat recovery ventilator. You will need to find space for the 4" ducts to get the air around the house and inlet and outlet through the walls somewhere, or we may be able to make do with two through-the-wall units that attach to the wall and don't need ducts

What do you think the client's preference would be? I've modeled these options on Units 1&2 and they seem like they could do the trick. I assume if it works on 1&2, it will work on units 3-6 as well.

Nick

•••

As-Built

36th St. Duplexes Building A Unit 1 asbuilt v2

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Energy Design Ratings: Efficiency[1] (EDR)	Energy Design Ratings: Total[2] (EDR)	Compliance Margins: Efficiency[1] (EDR)	Compliance Margins: Total[2] (EDR)
Standard Design	45.9	20.7		
Proposed Design	47.1	21.9	-1.2	-1.2

Result[3]: DOES NOT COMPLY

[1] Efficiency measures include improvements like a better building envelope and more efficient equipment
[2] Total EDR includes efficiency, photovoltaics and batteries
[3] Building complies when all efficiency and total margins are greater than or equal to zero

Standard Design PV Capacity: 2.78 kWdc

PV System resized to 2.78 kWdc (a factor of 1.390) to achieve 'Standard Design PV' PV scaling

With HRV 72% SRE, 0.6 W/cfm

36th St. Duplexes Building A Unit 1 asbuilt HRV

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

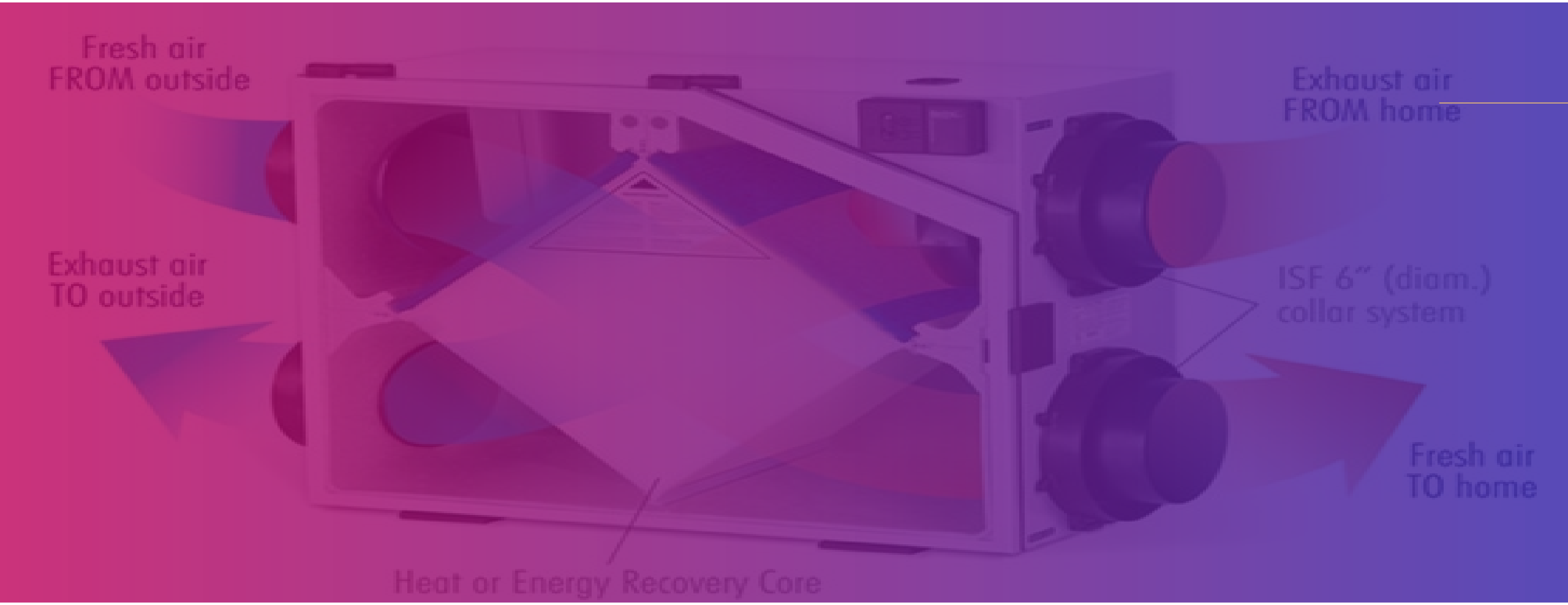
	Energy Design Ratings: Efficiency[1] (EDR)	Energy Design Ratings: Total[2] (EDR)	Compliance Margins: Efficiency[1] (EDR)	Compliance Margins: Total[2] (EDR)
Standard Design	47.1	21.4		
Proposed Design	46.8	21.2	0.3	0.2

Result[3]: COMPLIES
(not current)

[1] Efficiency measures include improvements like a better building envelope and more efficient equipment
[2] Total EDR includes efficiency, photovoltaics and batteries
[3] Building complies when all efficiency and total margins are greater than or equal to zero

Standard Design PV Capacity: 2.89 kWdc

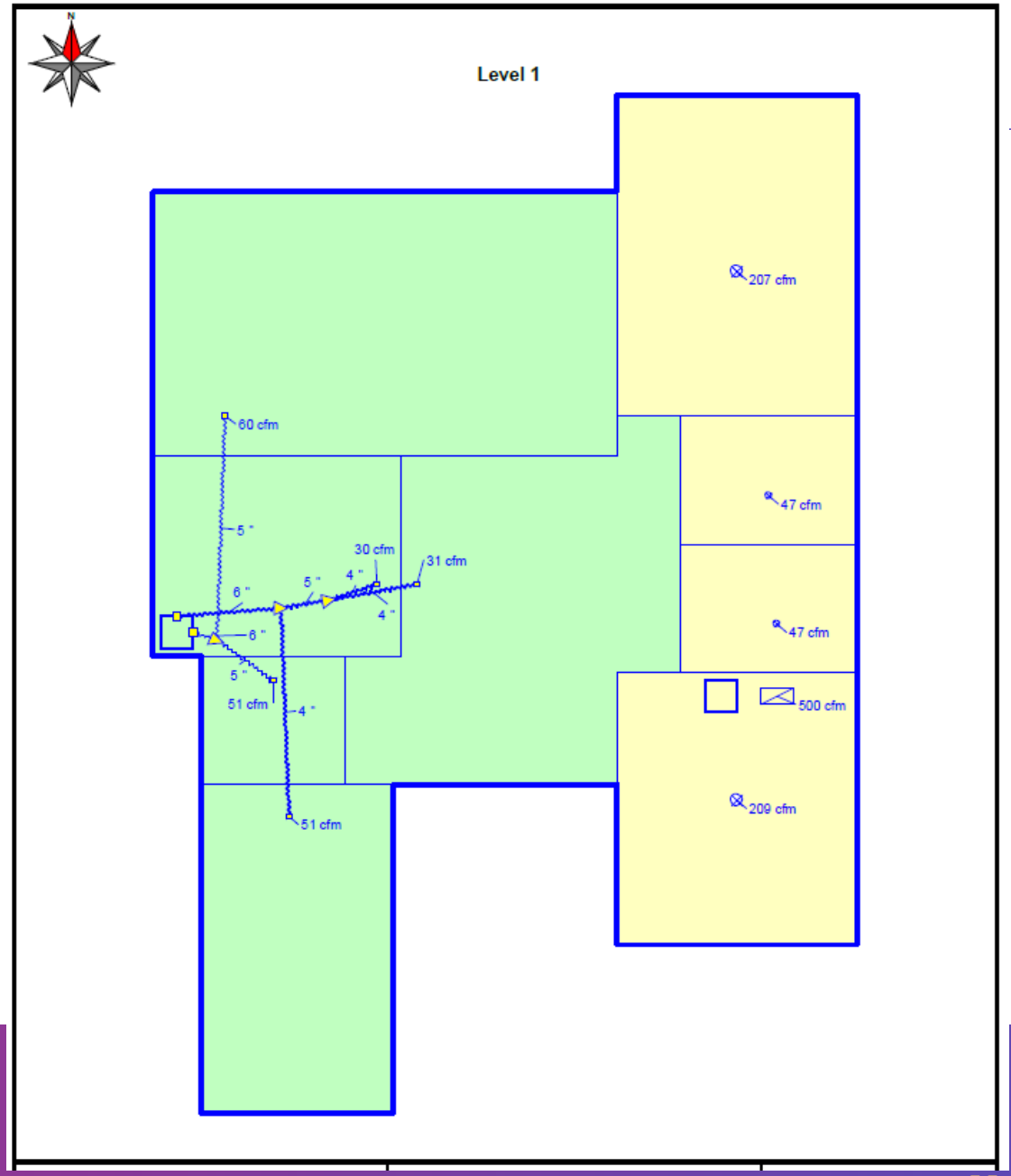
PV System resized to 2.89 kWdc (a factor of 1.444) to achieve 'Standard Design PV' PV scaling



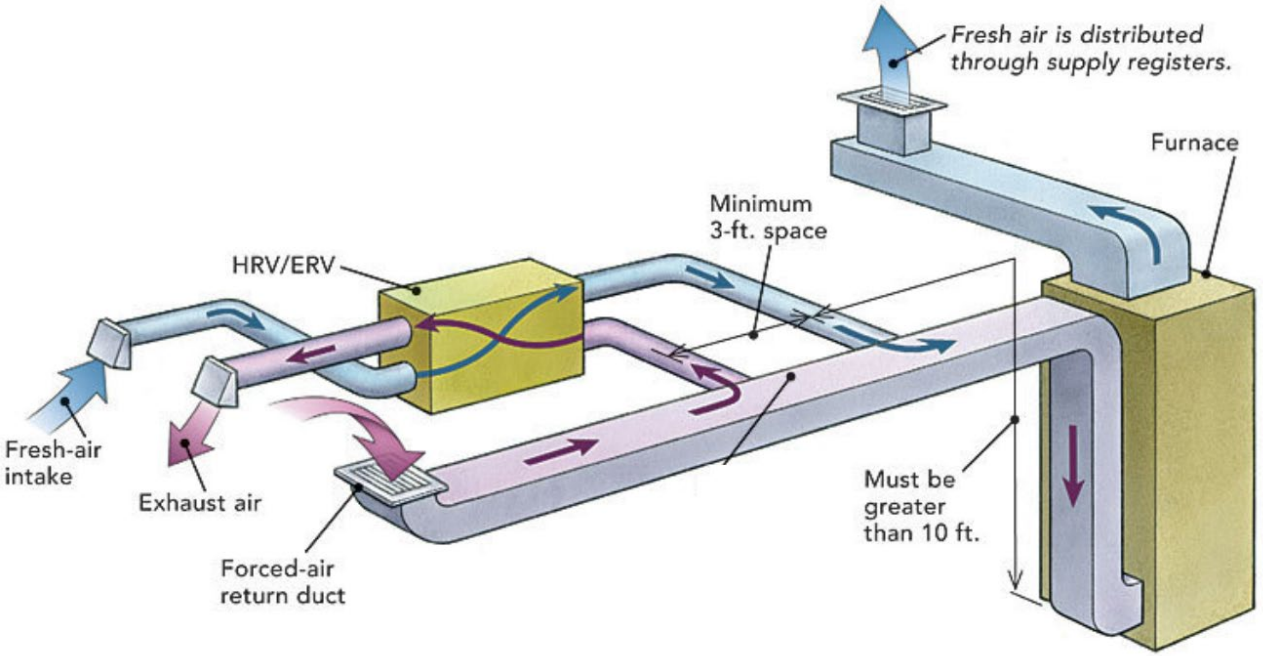
SPECIFYING & INSTALLING RVs

KEY QUESTIONS

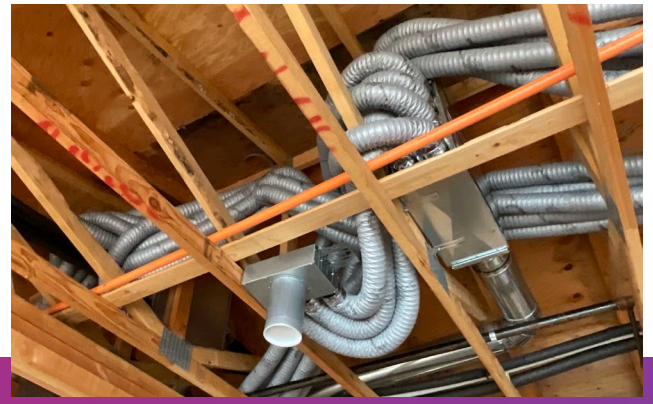
- Location of unit
- Duct routes
- CFM by room
- Supply & exhaust registers
- Envelope penetrations for ducts to outside
- Occupant controls



OTHER RV CONFIGURATIONS



DISTRIBUTION SYSTEMS



Photos Courtesy of Scott Kelly, https://www.highperformance.build/

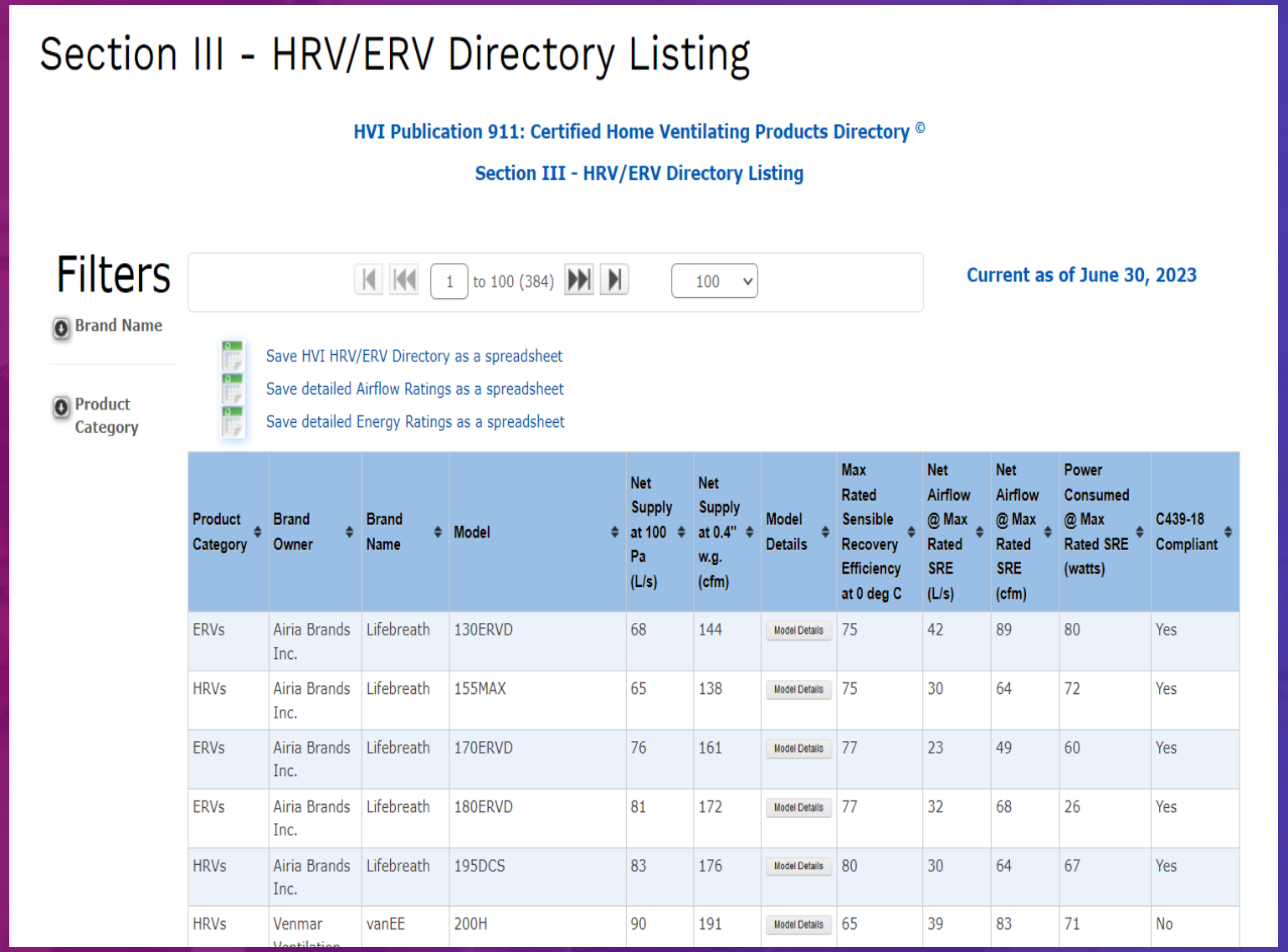
RVs & Ductless Mini Allow for Vaulting

- RV replaces bathroom exhaust fan
  - Only requires 20 cfm in bathroom if continuous
- Ductless minisplit doesn't need an attic or closet location
- Ducted minisplit can fit in 16" soffit as an alternative to ductless

HVI Directory

The best place to find your RV performance statistics:

- CFM
- Watts
- Sensible Recovery Effectiveness (SRE)
- Apparent Sensible Recovery Effectiveness (ASRE)



Section III - HRV/ERV Directory Listing

HVI Publication 911: Certified Home Ventilating Products Directory ©

Section III - HRV/ERV Directory Listing

Filters

Brand Name

Product Category

1 to 100 (384) 100

Current as of June 30, 2023

Save HVI HRV/ERV Directory as a spreadsheet

Save detailed Airflow Ratings as a spreadsheet

Save detailed Energy Ratings as a spreadsheet

Product Category	Brand Owner	Brand Name	Model	Net Supply at 100 Pa (L/s)	Net Supply at 0.4" w.g. (cfm)	Model Details	Max Rated Sensible Recovery Efficiency at 0 deg C	Net Airflow @ Max Rated SRE (L/s)	Net Airflow @ Max Rated SRE (cfm)	Power Consumed @ Max Rated SRE (watts)	C439-18 Compliant
ERVs	Airia Brands Inc.	Lifebreath	130ERVD	68	144	Model Details	75	42	89	80	Yes
HRVs	Airia Brands Inc.	Lifebreath	155MAX	65	138	Model Details	75	30	64	72	Yes
ERVs	Airia Brands Inc.	Lifebreath	170ERVD	76	161	Model Details	77	23	49	60	Yes
ERVs	Airia Brands Inc.	Lifebreath	180ERVD	81	172	Model Details	77	32	68	26	Yes
HRVs	Airia Brands Inc.	Lifebreath	195DCS	83	176	Model Details	80	30	64	67	Yes
HRVs	Venmar	vanEE	200H	90	191	Model Details	65	39	83	71	No

slido

What are your take-aways on RVs?

ⓘ Start presenting to display the poll results on this slide.

RVs ALLOW YOU TO BE YOUR MOST PRODUCTIVE SELVES

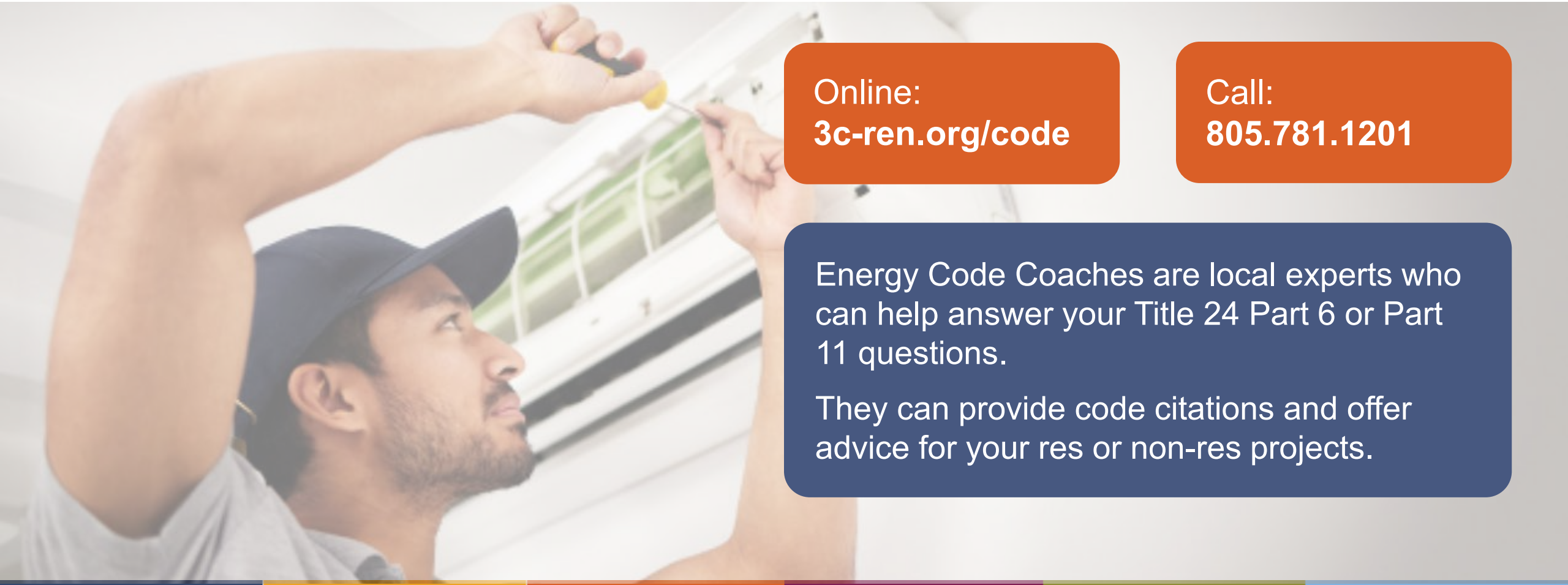
March 5, 2025

THANK YOU!

nick@buildsmartgroup.com

Questions about Title 24?

3C-REN offers a *free* Code Coach Service



Online:
3c-ren.org/code

Call:
805.781.1201

Energy Code Coaches are local experts who can help answer your Title 24 Part 6 or Part 11 questions.

They can provide code citations and offer advice for your res or non-res projects.

Thank you!

More info: **3c-ren.org**

Questions: **info@3c-ren.org**

Email updates: **3c-ren.org/newsletter**

3C-REN

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- Nonresidential Energy Code Implementation Series (3/12)
- Diagnosing Heating and Cooling Comfort Problems in Homes (3/18)
- Batteries: Options and Implementation for a Building's Energy Storage System (3/20)

Any phone numbers who joined? Please share your name!