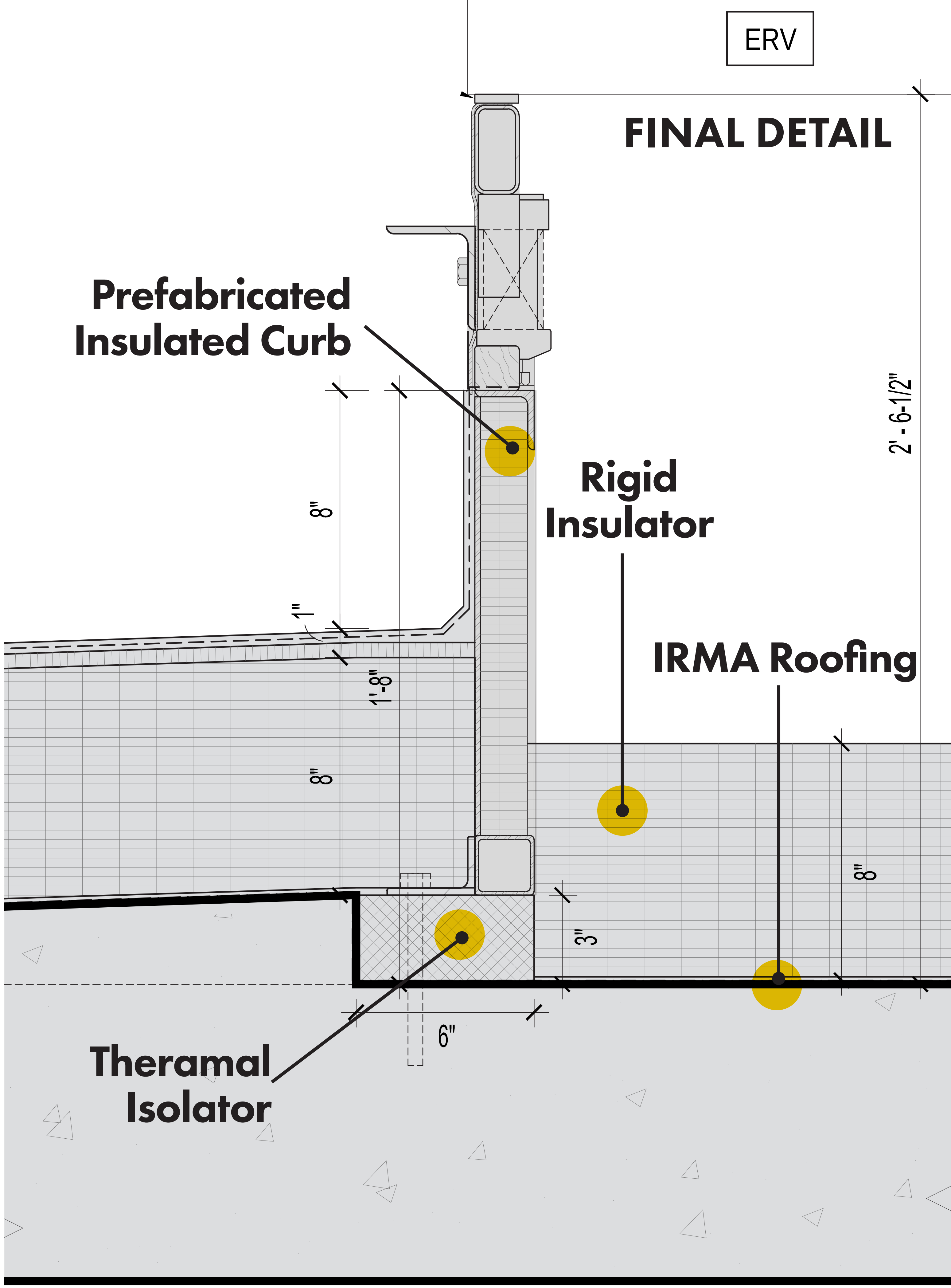
The House: Theory vs. Practice

BEFORE PANEL SUPPORTS SEALED

AFTER PANEL SUPPORTS SEALED

Eliminate Thermal Bridging



Eliminate Thermal Bridging

Passive House planning: **SPECIFIC ANNUAL HEATING DEMAND (monthly method)**

(This page displays the sums of the monthly method over the heating period)

Climate:	NY, New York	Interior temperature:	68 °F
Building:		Building type:	
Spec. Capacity:	19 BTU/(ft²°F)	Treated floor area A_{TFA}:	189,012 ft²

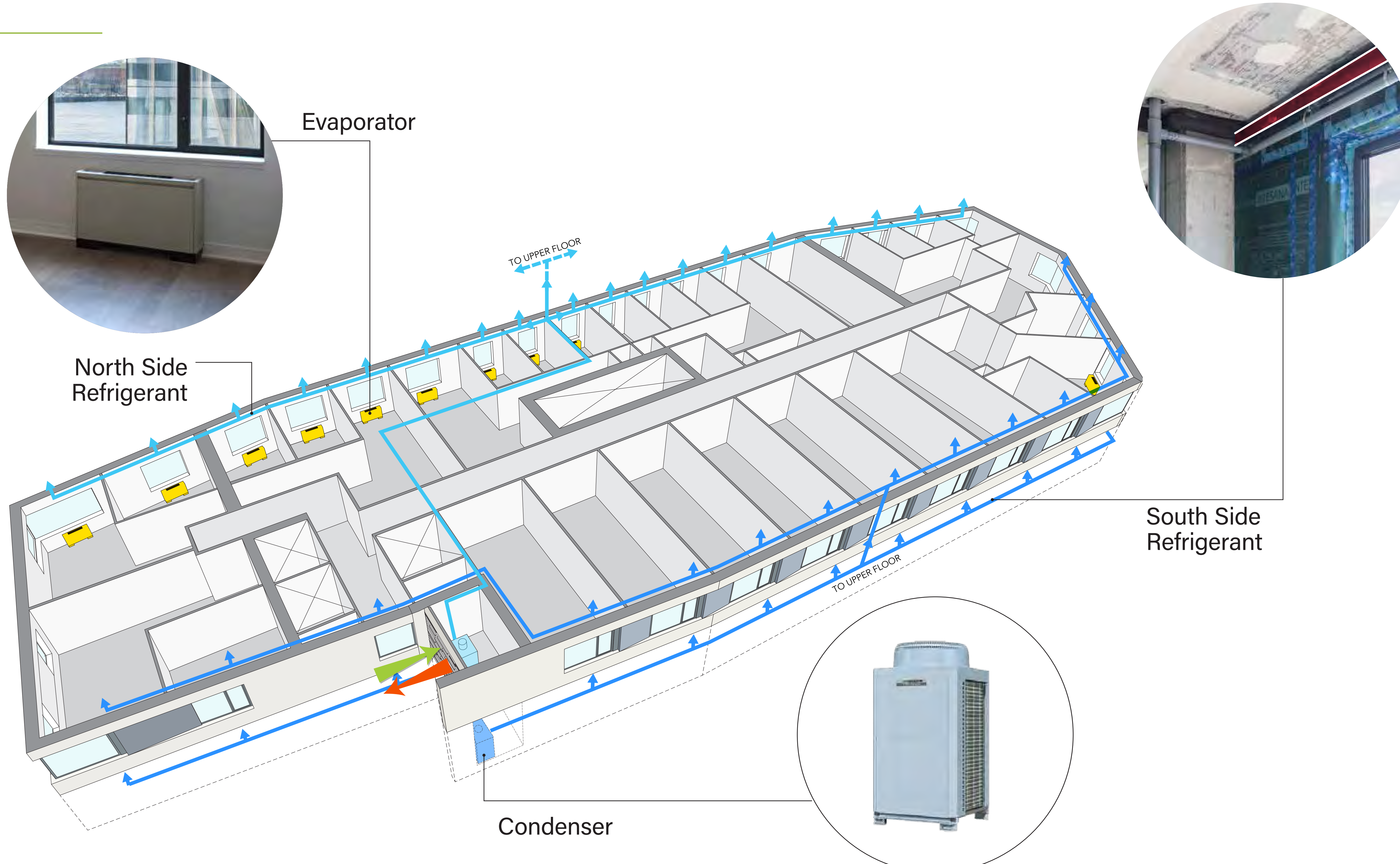
Building assembly	Temperature zone	Area ft²		R-Value hr.ft².°F/BTU		Month. red. fac.		G_t °F.day/yr		kBTU/yr	per ft² treated floor area
Exterior wall - Ambient	A	91719	* 1/	23.6	*	1.00	*	5673	=	528826	2.80
Roof/Ceiling - Ambient	A	10972	* 1/	34.2	*	1.00	*	5673	=	43631	0.23
Floor slab / Basement ceiling	B	10788	* 1/	3.6	*	1.00	*	708	=	51051	0.27
Windows	A	30231	* 1/	4.2	*	1.00	*	5673	=	977446	5.17
Exterior door	A	600	* 1/	28.0	*	1.00	*	5673	=	2917	0.02
Exterior TB (length/ft)	A	18904	*	0.041	*	1.00	*	5673	=	106418	0.56
Transmission heat losses Q_T									Total	1710290	9.05 kBTU/(ft²yr)

= 6 % of the total heat loss through the facade.

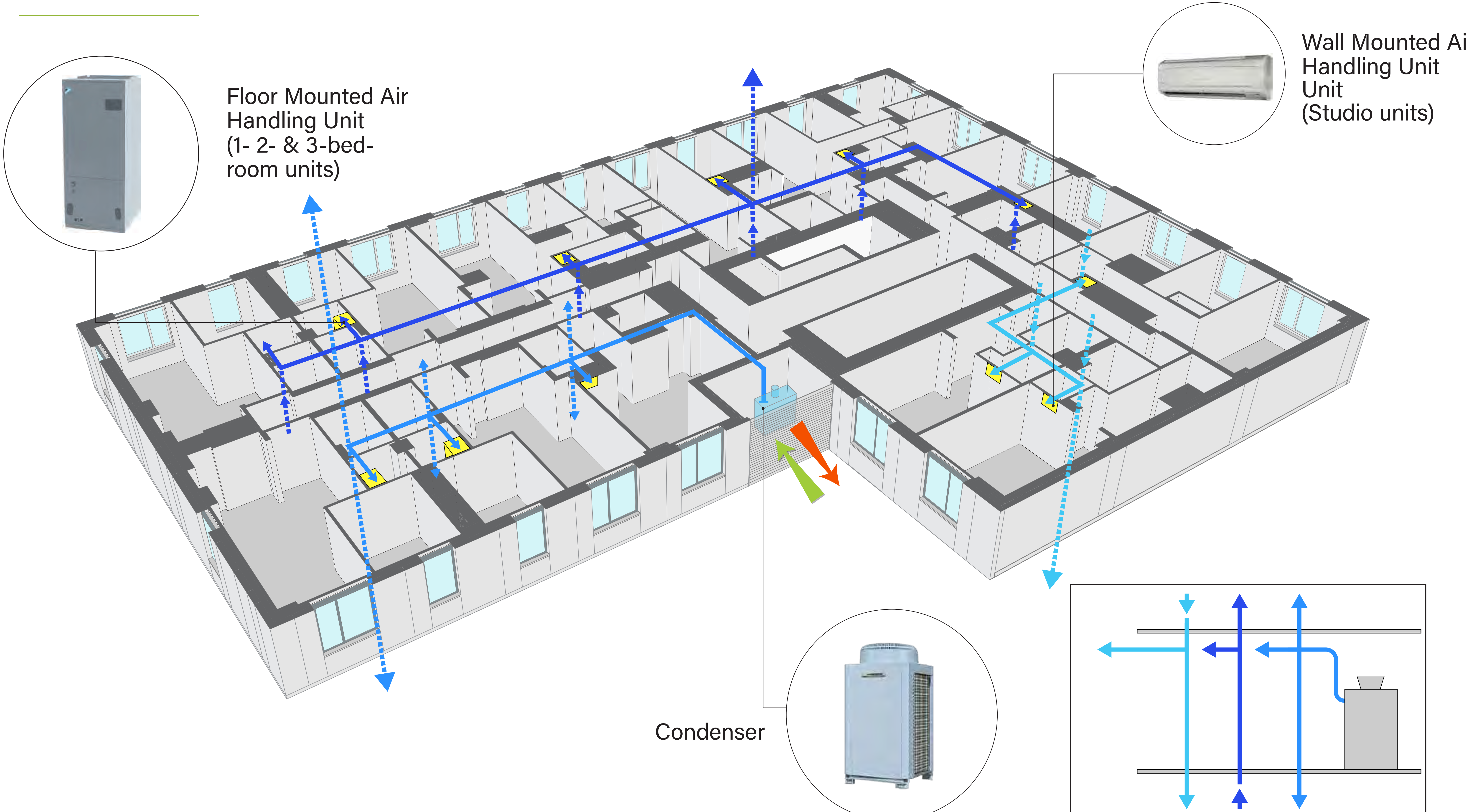
Thermal bridge inputs

Nr.	Thermal bridge description	Group Nr.	Assigned to group	Qty	User deter-mined length [ft]	-	Length ℓ [ft]	Input of thermal bridge heat loss coefficient BTU/hr.ft.F	Ψ BTU/hr.ft.F
6	Wall Panel Bridges					-		Wall Panel Bridges	
7	Panel to panel (H1)	15	Thermal bridges Ambient	1	8131.80	-	8131.80	Panel to panel (H1)	0.072
8	Panel corner	15	Thermal bridges Ambient	2	253.00	-	506.00	Panel corner	-0.038
9	Shallow over Deep (SO	15	Thermal bridges Ambient	1	3949.50	-	3949.50	Shallow over Deep (SO	0.012
10	Deep over shallow (S)	15	Thermal bridges Ambient	1	3949.50	-	3949.50	Deep over shallow (S)	0.015
11	Vertical Joint (V1)	15	Thermal bridges Ambient	1	1828.78	-	1828.78	Vertical Joint (V1)	0.029
12						-			
13	Roof Bridges					-		Roof Bridges	
14	TB1	15	Thermal bridges Ambient	1	7.58	-	7.58	TB1	0.099
15	TB2	15	Thermal bridges Ambient	1	207.22	-	207.22	TB2	0.136
16	TB3	15	Thermal bridges Ambient	1	24.27	-	24.27	TB3	0.072
17	TB4	15	Thermal bridges Ambient	1	24.27	-	24.27	TB4	0.087
18	TB6	15	Thermal bridges Ambient	1	23.84	-	23.84	TB6	0.021
19	TB7	15	Thermal bridges Ambient	1	23.84	-	23.84	TB7	0.130
20	TB8	15	Thermal bridges Ambient	1	70.24	-	70.24	TB8	0.143
					Total : 18,904				

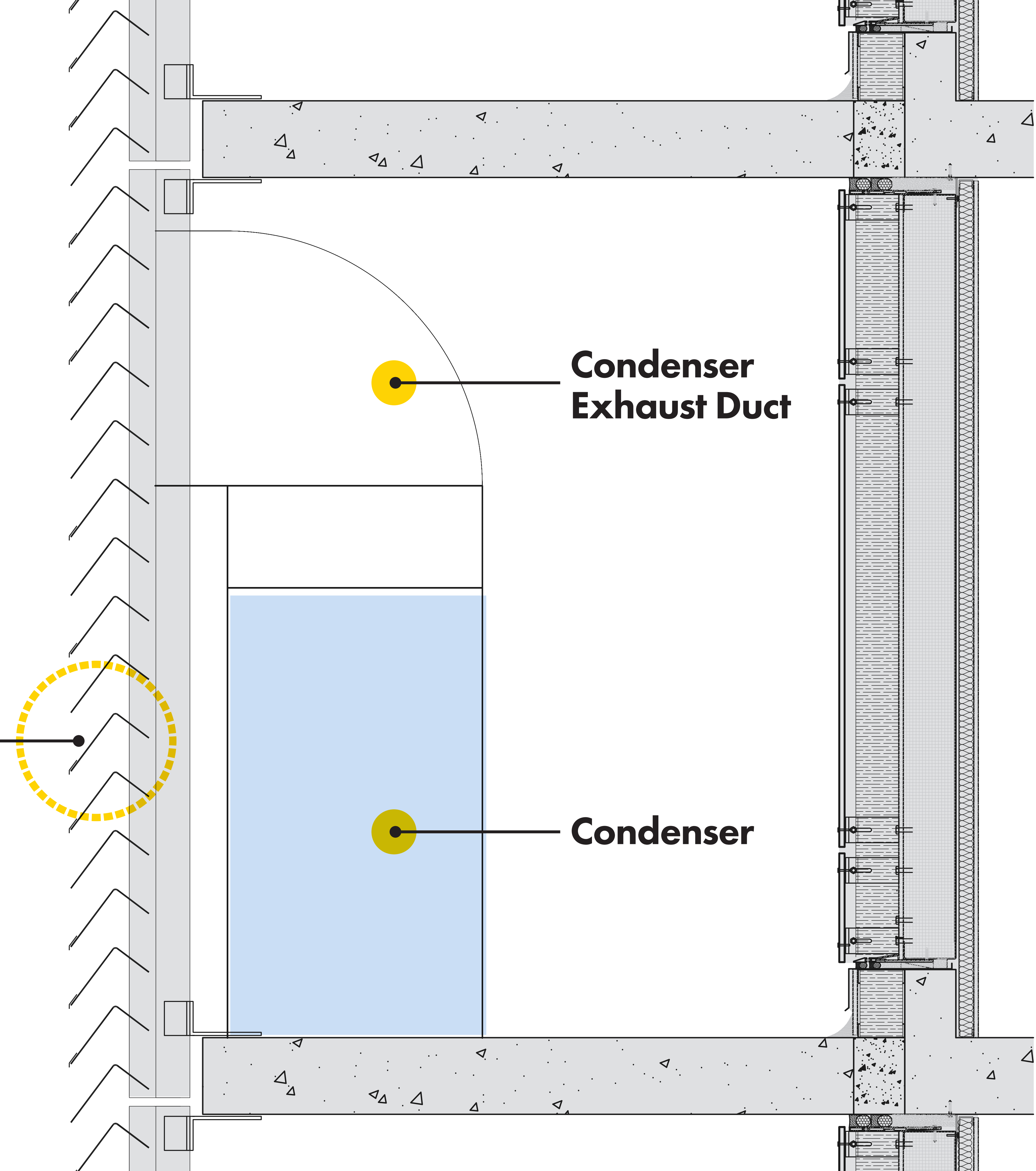
The House: Heating & Cooling



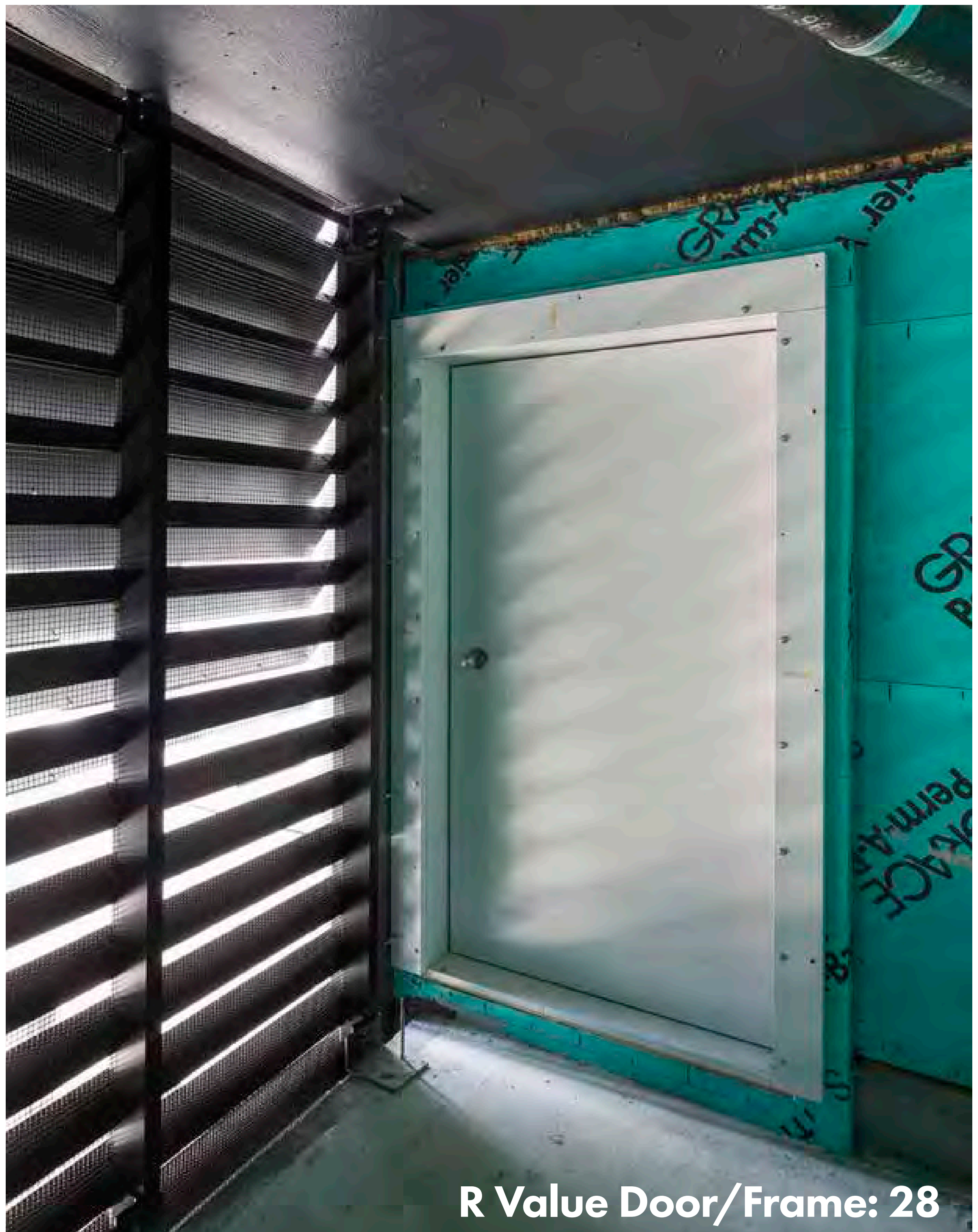
Sendero Verde: Heating & Cooling



Vertical Reveal Grille



Lessons Learned

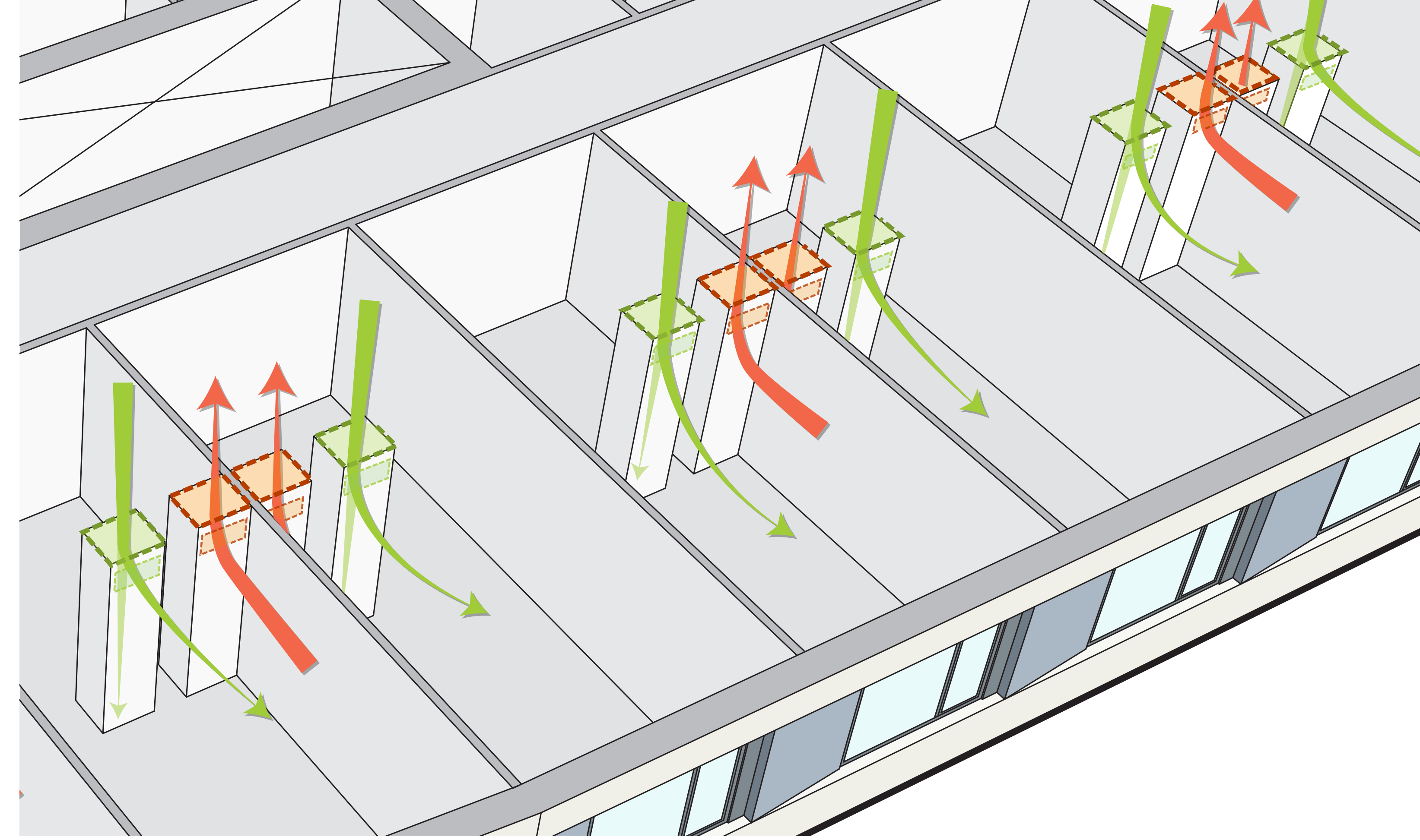


Ventilation

BALANCED VENTILATION WITH HEAT RECOVERY
CENTRAL SYSTEMS

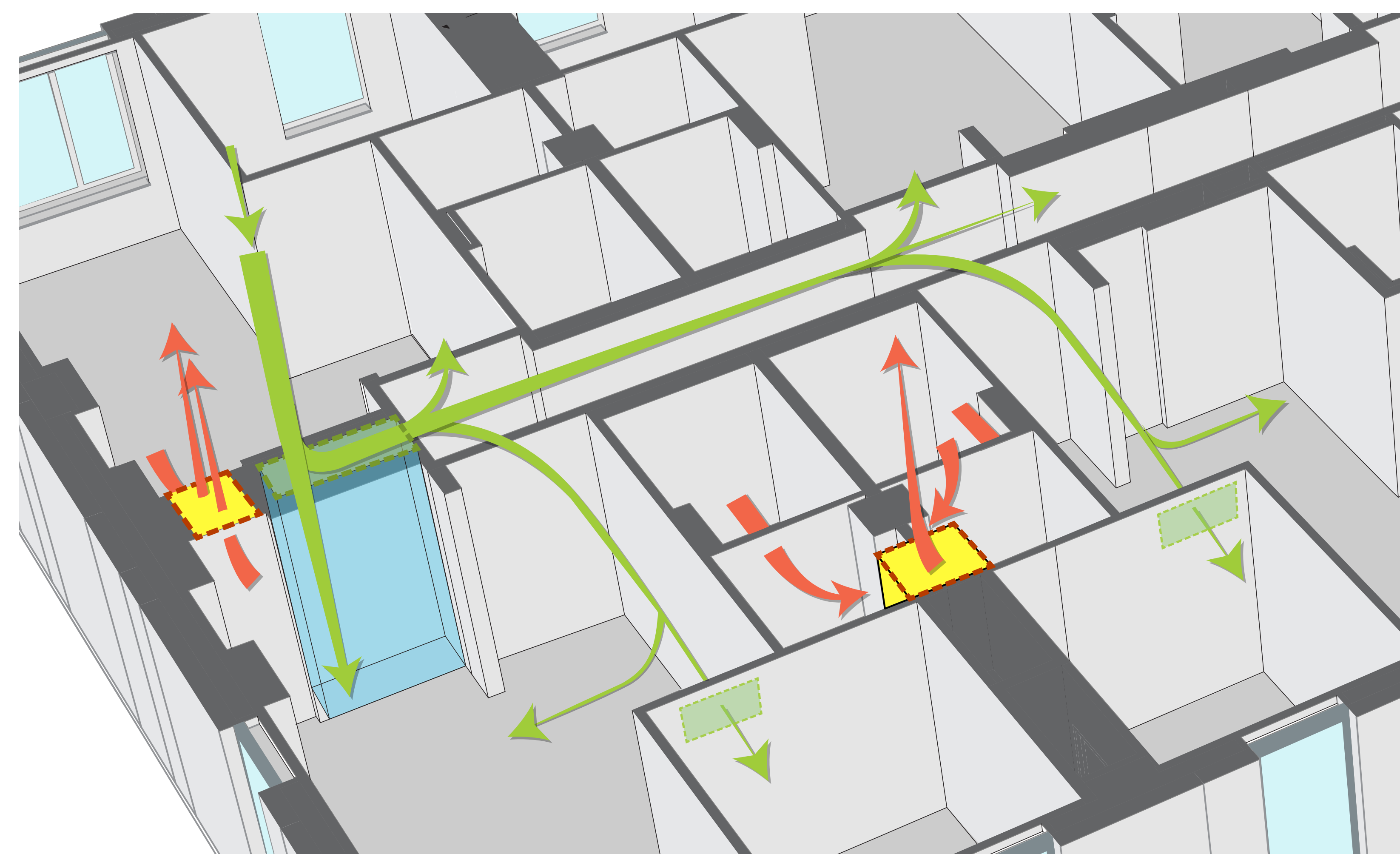
THE HOUSE

CENTRAL: RISER PER UNIT



SENDERO VERDE BLDG A

CENTRAL: MAIN RISER

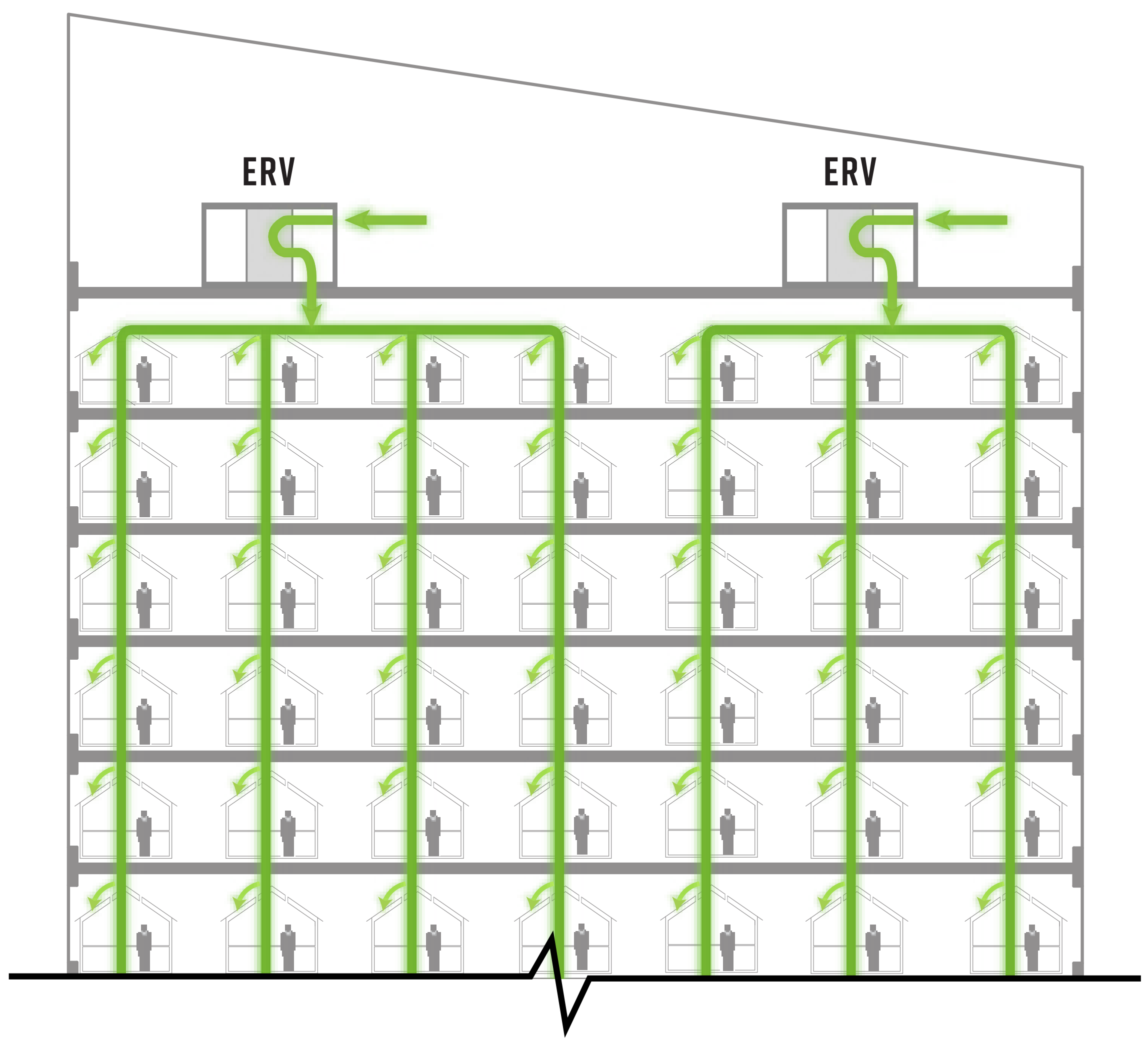


Fresh Air

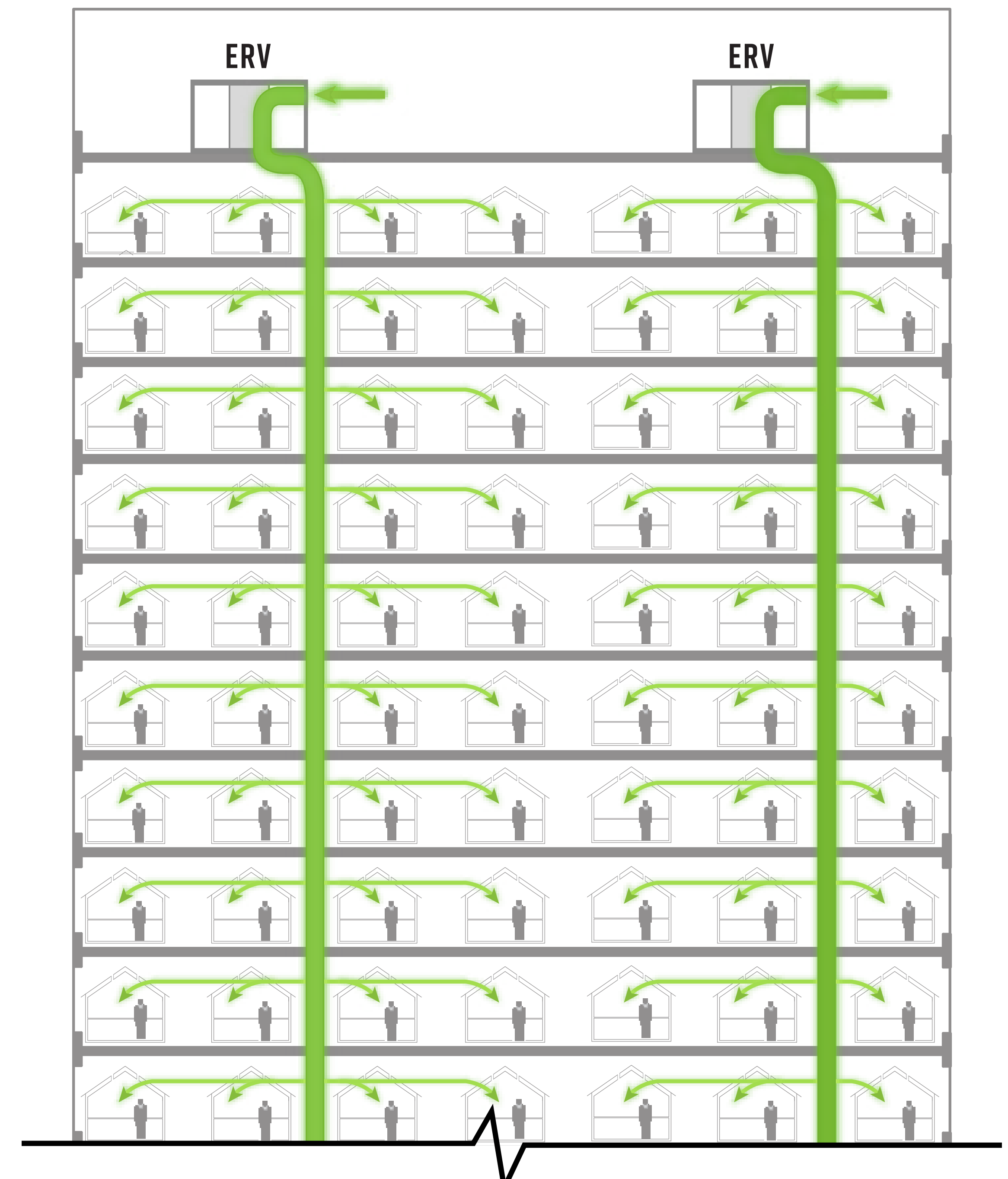
Exhaust Air

Ventilation: Horizontal Distribution

Fresh Air



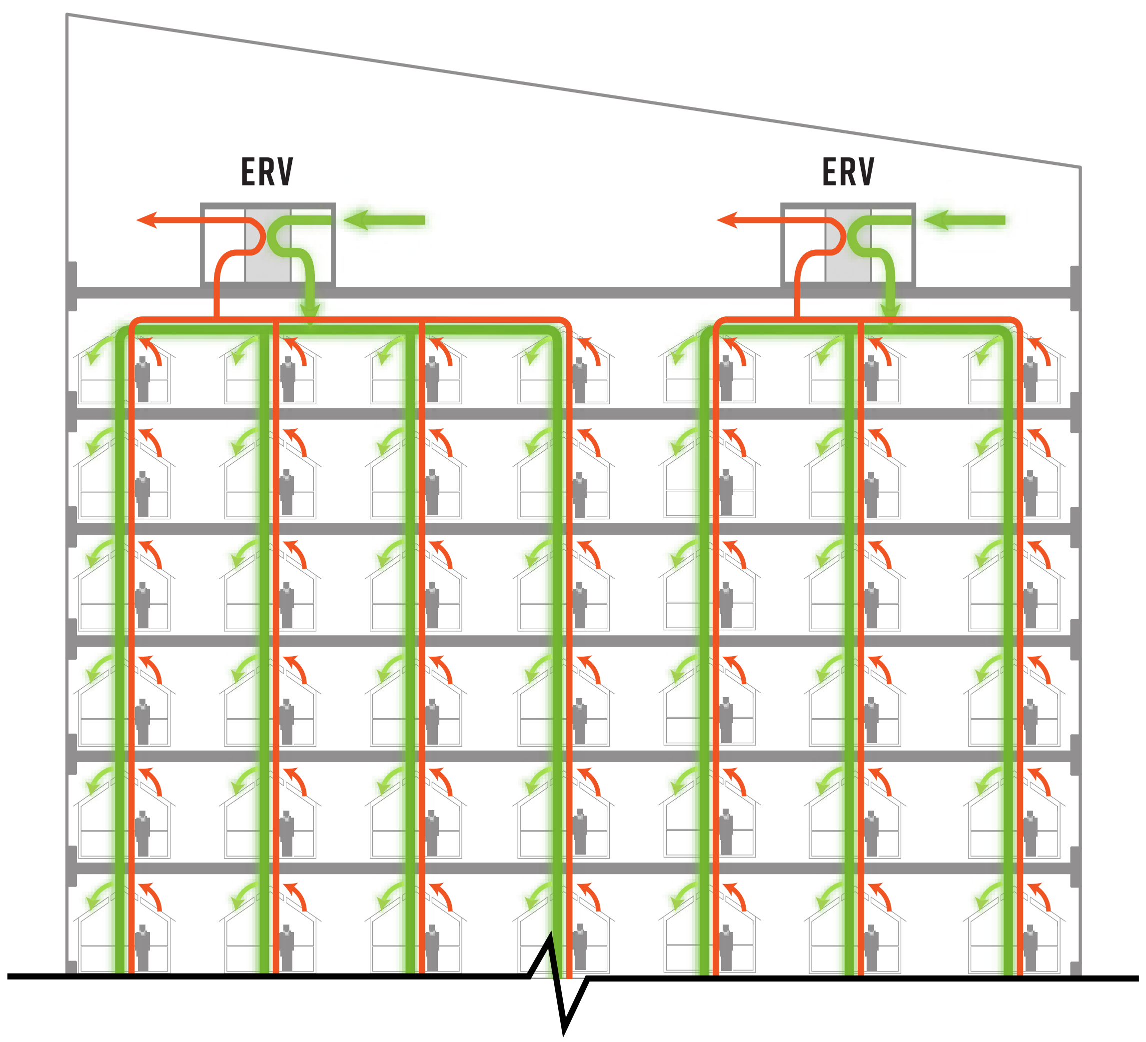
THE HOUSE



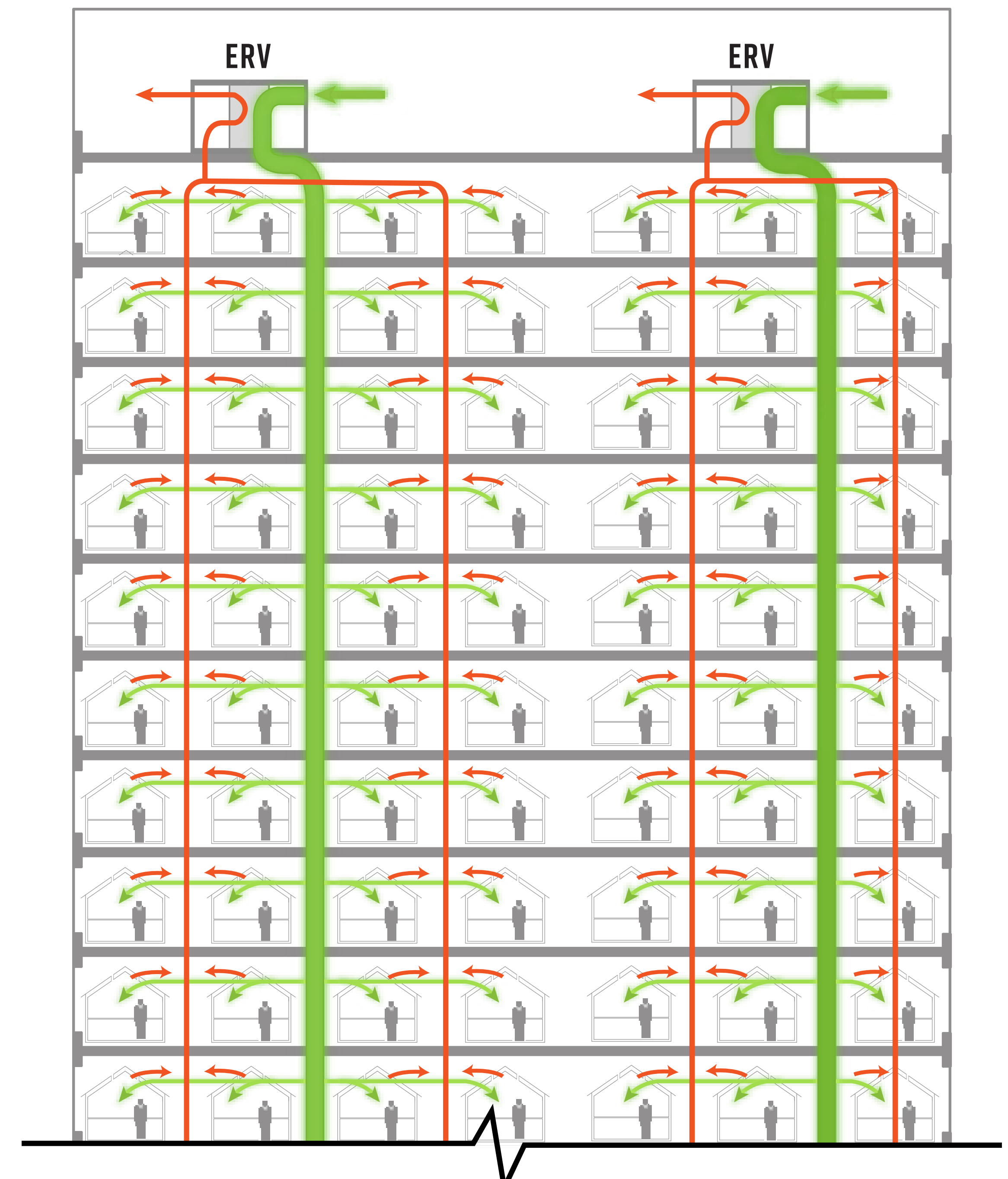
SENDERO VERDE BLDG A

Ventilation: Individual Risers vs. Common Riser Return

Fresh Air
Exhaust Air



THE HOUSE

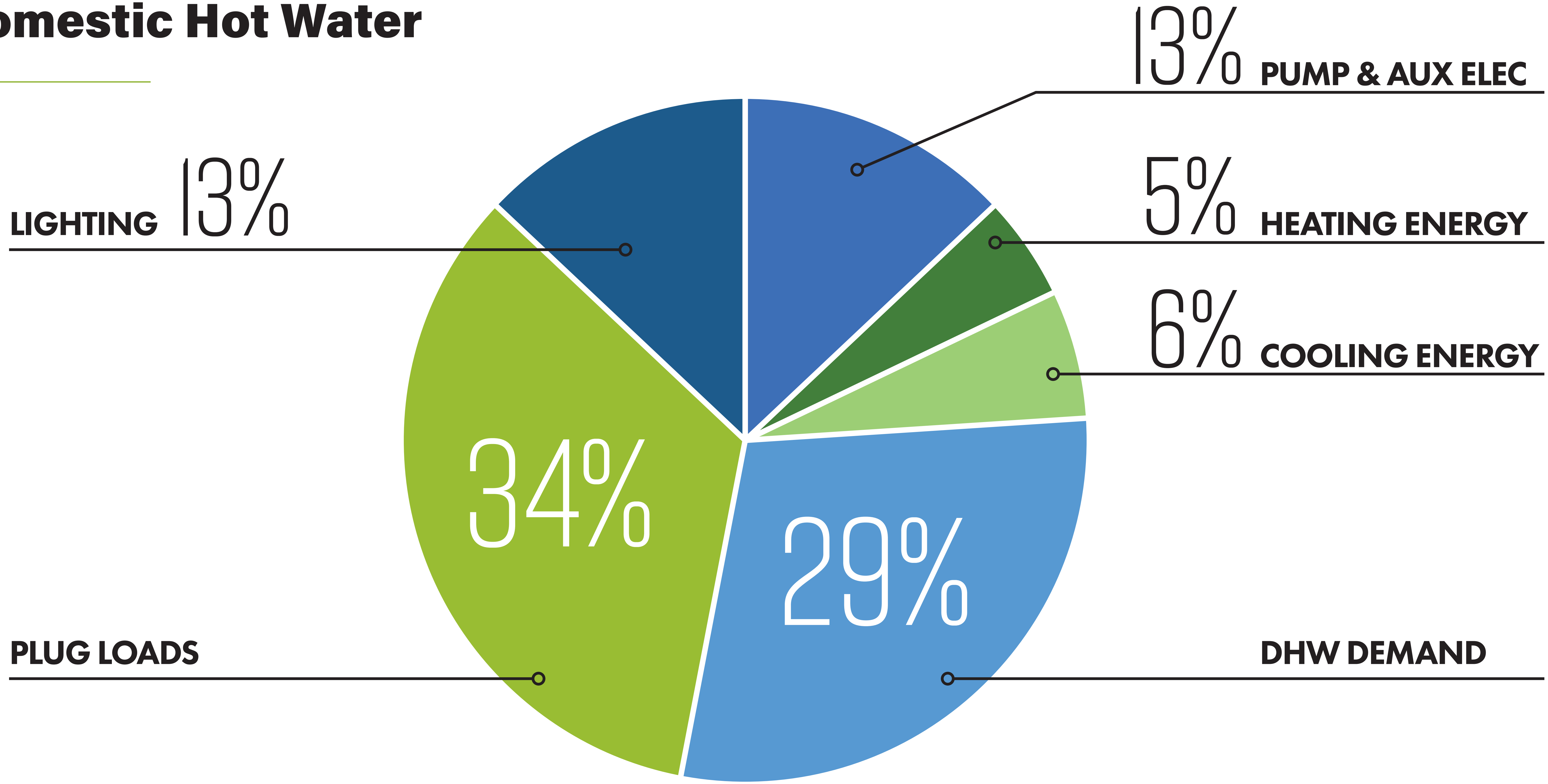


SENDERO VERDE BLDG A

Domestic Hot Water

- Hot water used for drinking, food prep, sanitation, and personal hygiene
- NOT for heating, swimming pools, commercial cooking, etc.

Domestic Hot Water

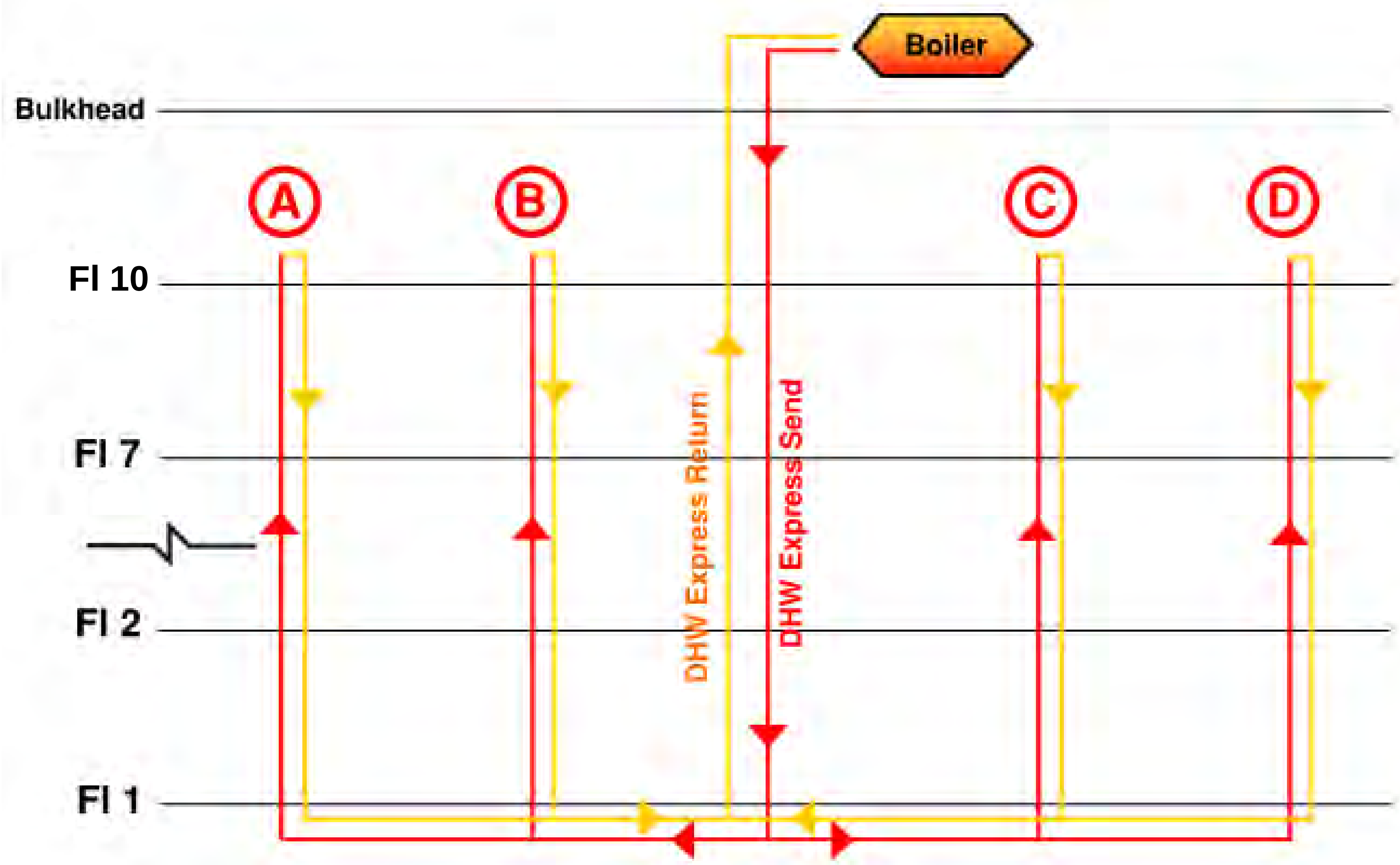


PASSIVE HOUSE HIGH RISE: NYC

Most Common Mid & Highrise: Central Gas w/Recirculation

Individual Riser Recirculation

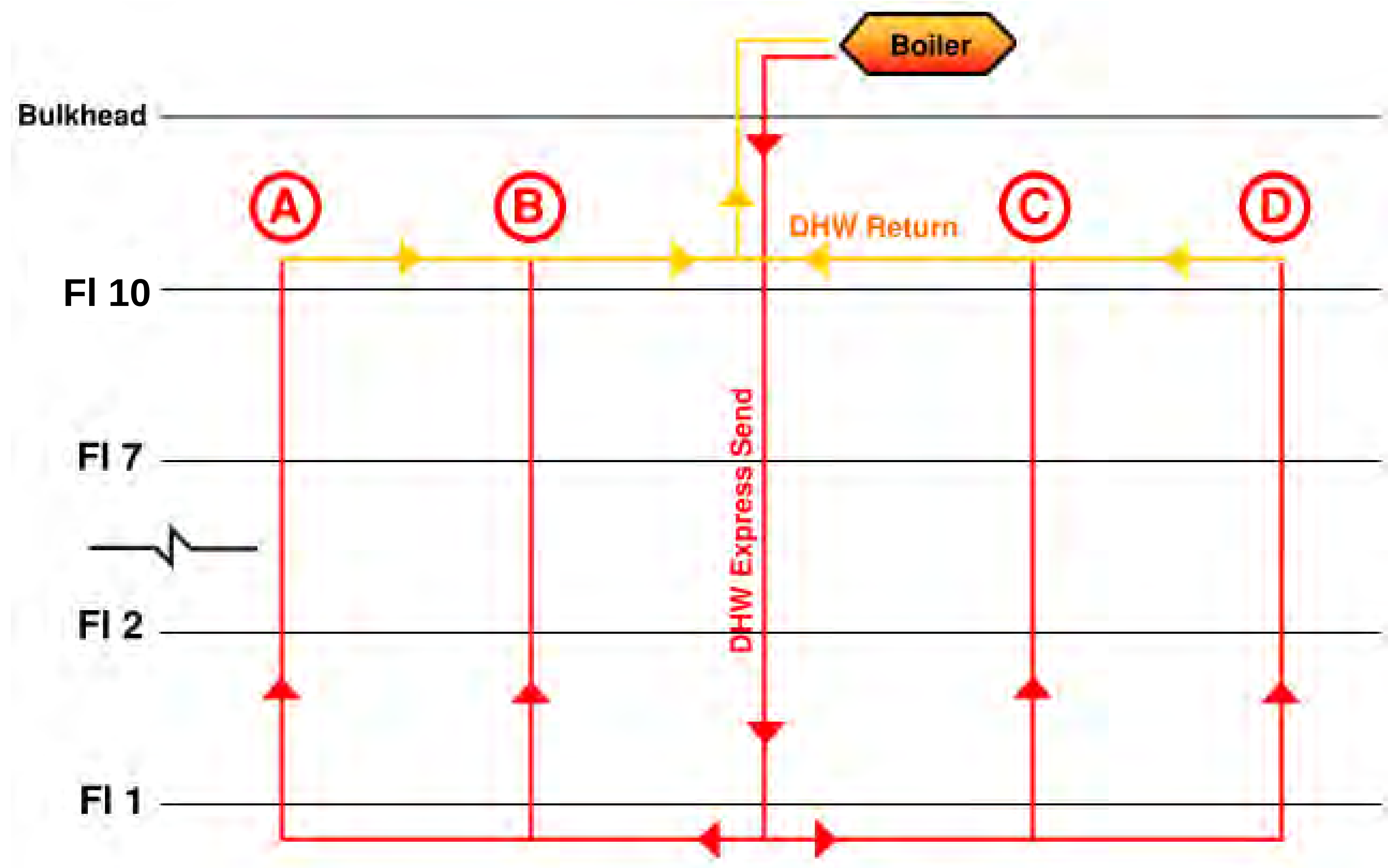
1. Dedicated recirculation pipe per riser
2. Automatic venting through fixtures
3. Single floor for distribution and return
4. Less distribution floors required per zone
5. Quickest hot water delivery
6. High energy loss due to extensive piping



Riser Diagram - Base Design

Central Recirculation

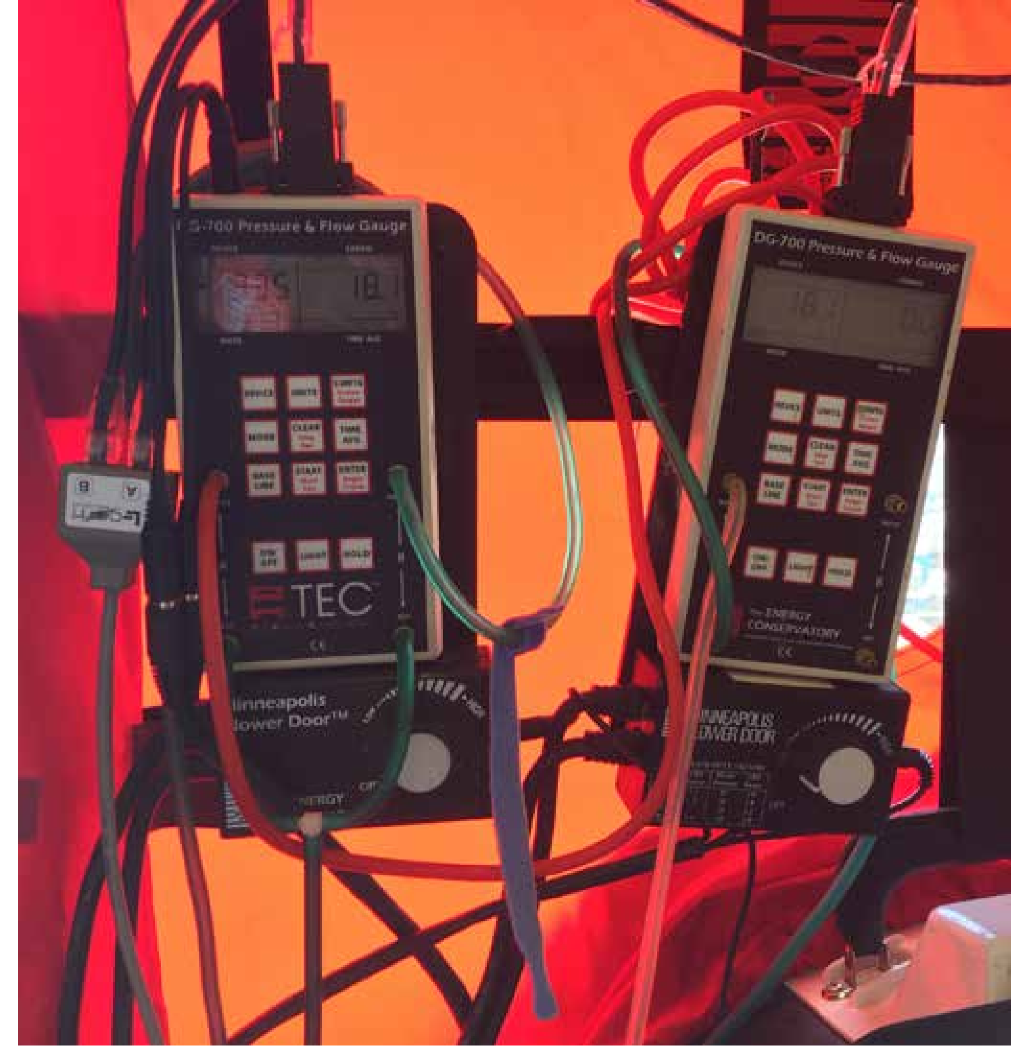
1. Common recirculation pipe
2. Individual vents per riser that require access
3. Separate distribution and collection loop located on different floors
4. Additional floor height is typically required
5. Reduction in total installed pipe and heat loss - much more energy efficient
6. Slower hot water delivery response time

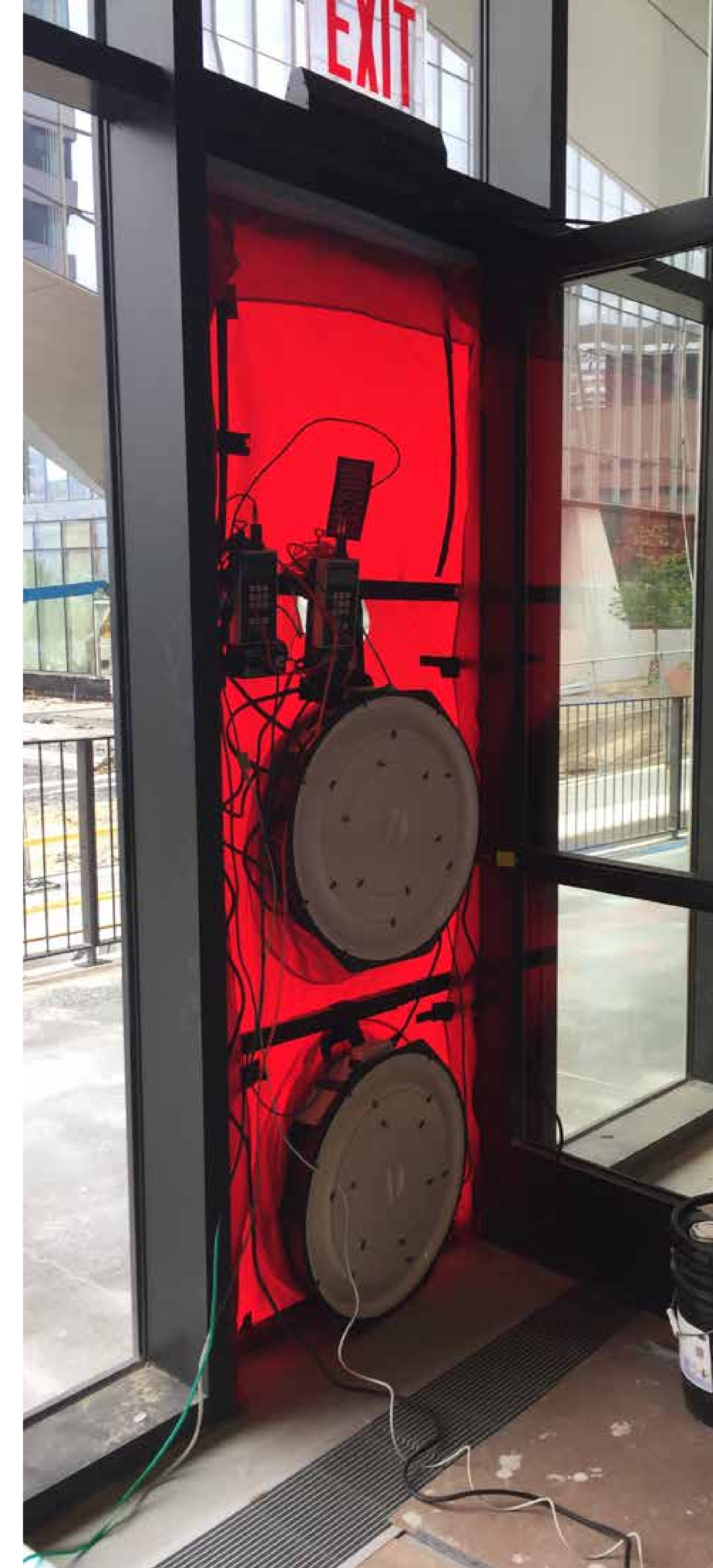


Riser Diagram - Better Design

Final Blower Door Test

- Final Blower Door Test results for The House were .15 Air Change/ Hour (ACH).
- Passive House requirements allow a maximum .6 ACH.





The House

Sendero Verde

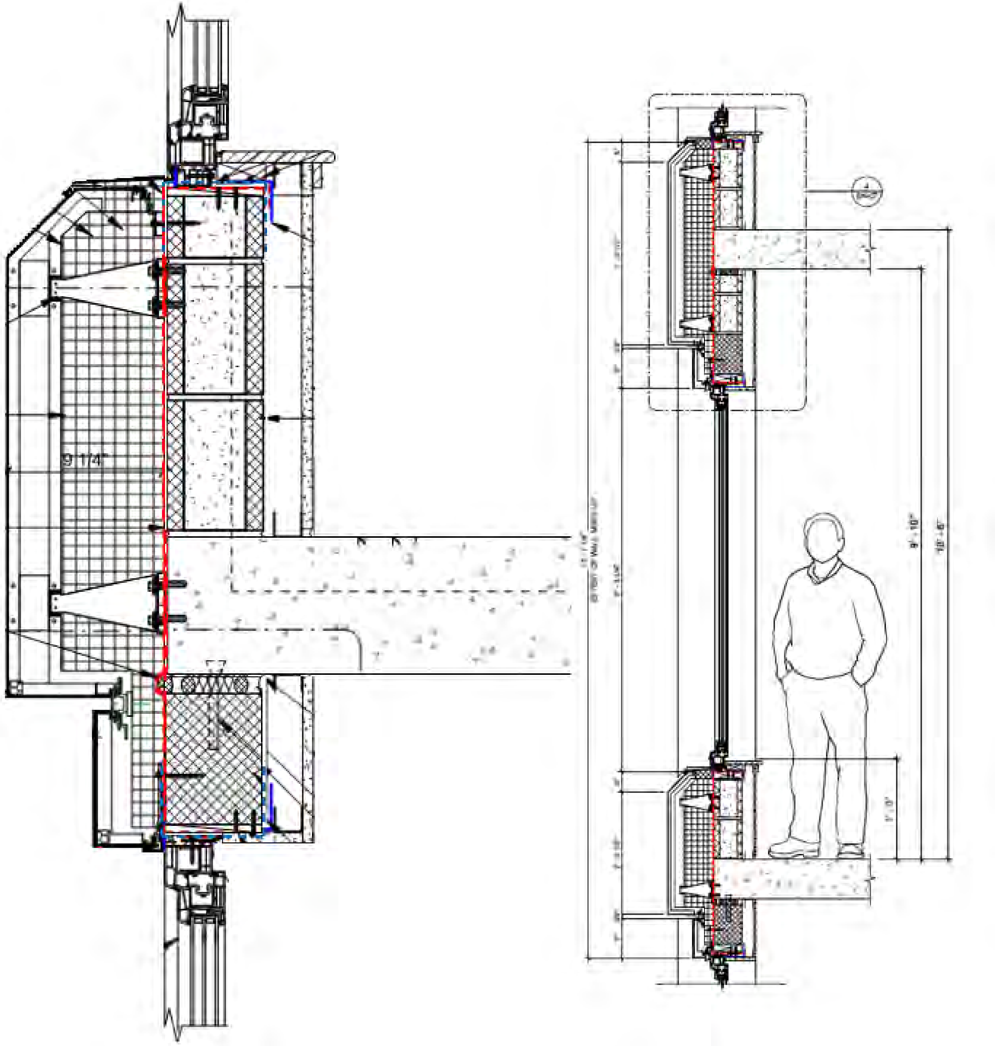
425 Grand Concourse Mixed Use

- Residential
- Medical facility
- Educational facility
- Cultural facility
- Retail
- Parks comfort station

425 Grand Concourse Ground Floor Plan

425 Grand Concourse
Residential Floor Plan

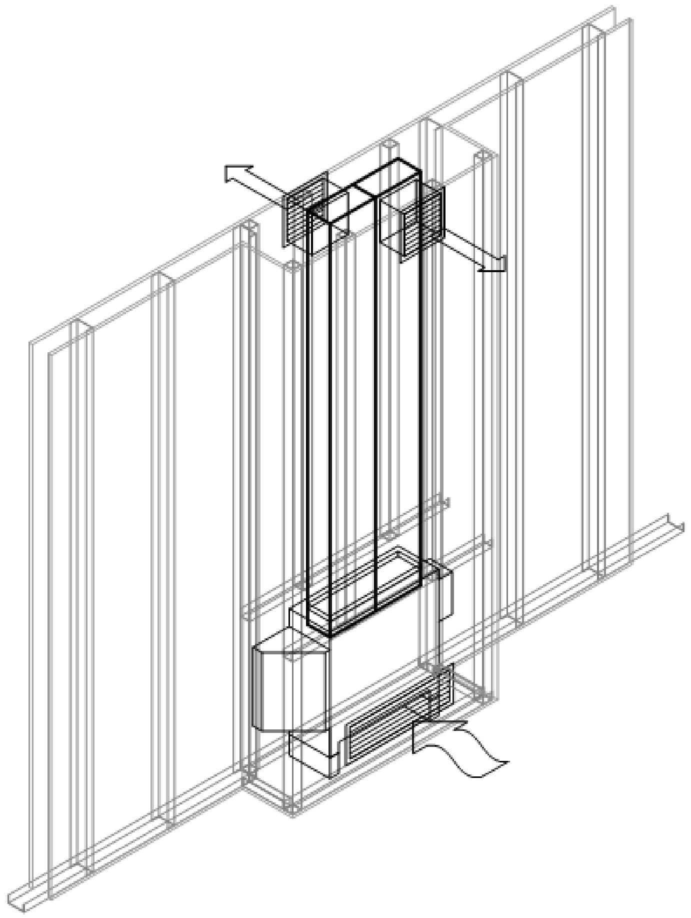
425 Grand Concourse
Energy Efficiency - Envelope



Envelope Efficiency Requirements	
Roof	R-30
Above Grade Walls	R-20 effective
Below Grade Walls	R-10
Windows – Effective U-value	0.25 Btu/hr.ft².F
Glazing SHGC	0.27
Façade Air Tightness	0.08 cfm/sf-façade @ 50 Pascals

425 Grand Concourse
Energy Efficiency – Heating & Cooling

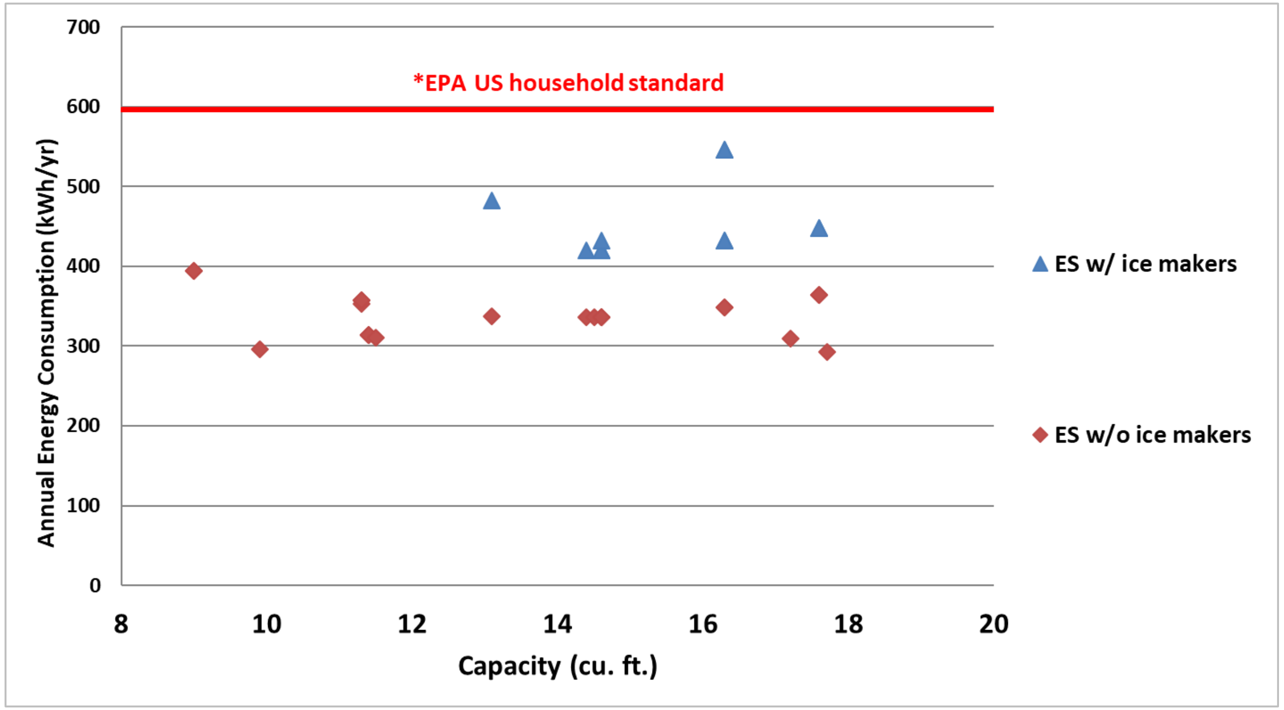
- In order to not oversize equipment
  - Utilized single "ductless" console unit to serve two rooms, where possible
  - Worked with manufacturer to allow condensing units to be overconnected
  - Worked with manufacturer to limit the capacity of the evaporator units, as needed



425 Grand Concourse
Energy Efficiency – Appliances, Plugs

- Appliances
  - All Energy Star appliances
    - Except for commercial dryers
  - No ice makers in refrigerators
- Dwelling unit plug loads are a big wild card in MF buildings
  - Energy monitoring w/ tenant dashboard proposed

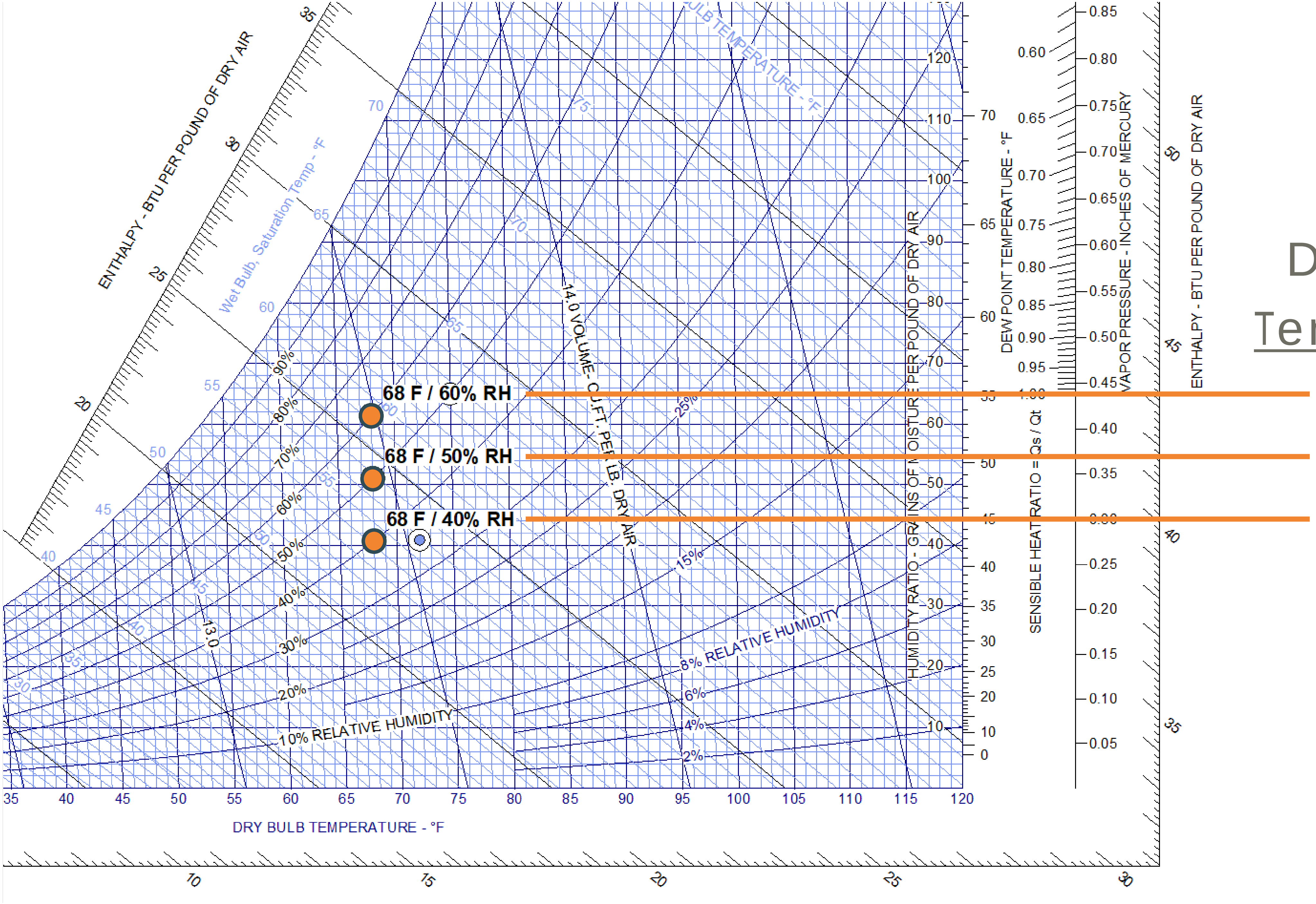
Energy Star Refrigerators



Moisture Control & Affordable Housing

- Greater occupant density
- Interior moisture generation rates ↑
- All exhaust air through an H/ERV
- PH natural infiltration very low (0.03 cfm/sf. @ 10 mph wind)
  - 5 to 10 times less than typical buildings
  - Moisture must get out through ventilation air
- ERV vs HRV…

Why Care About Internal Moisture?



Dew Point Temperature

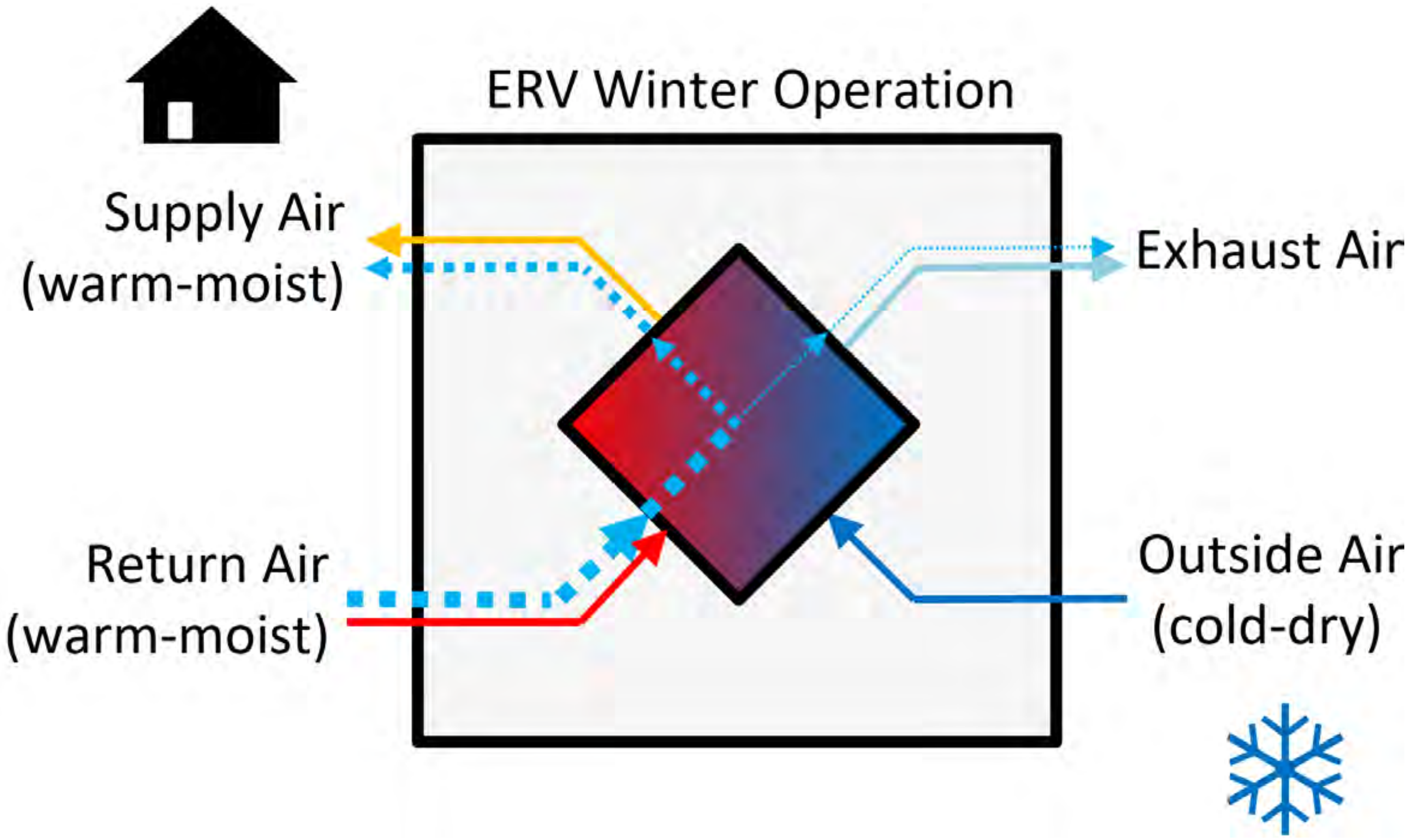
53°F

49°F

43°F

Individual ERV Design

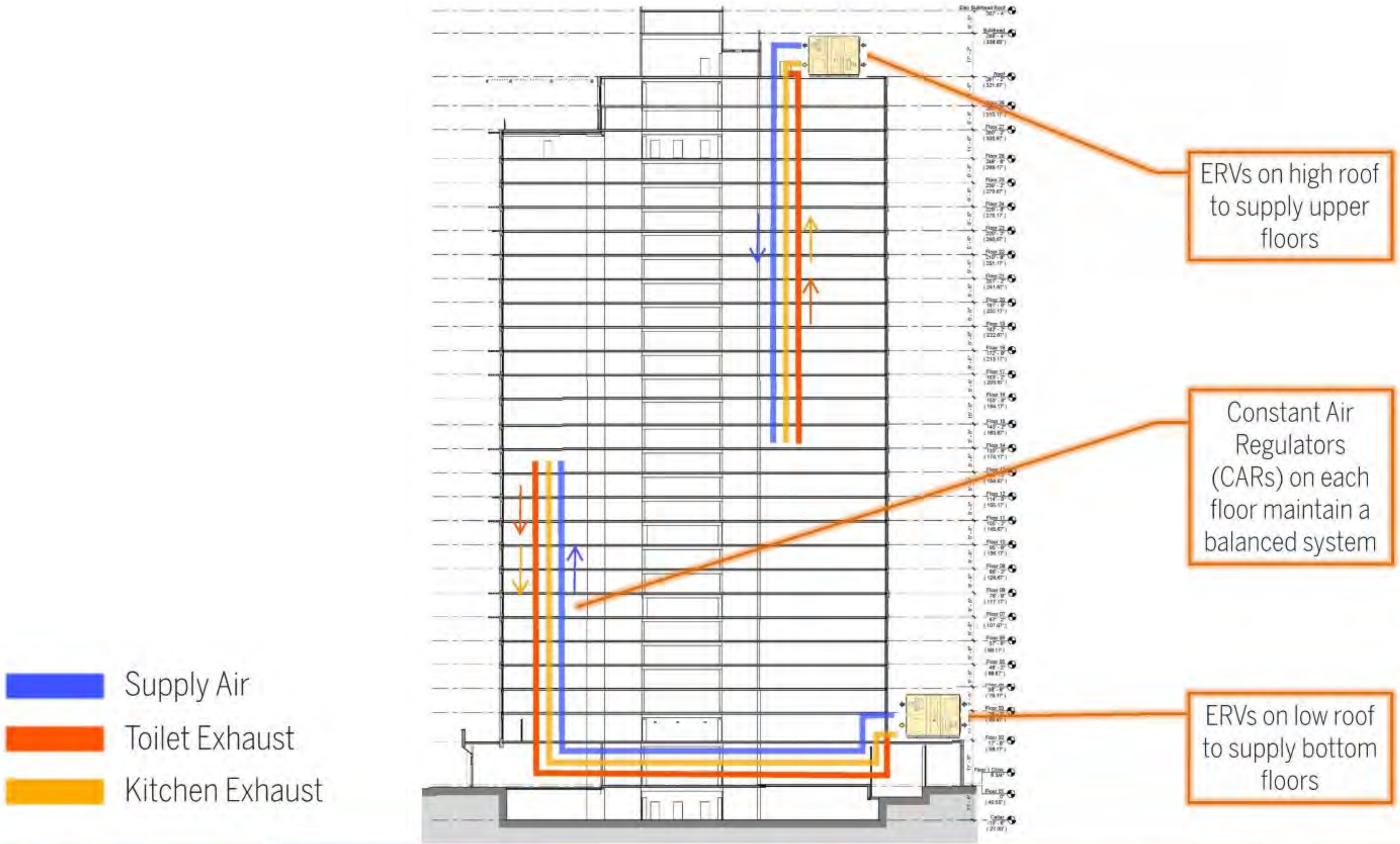
- Sensible recovery efficiency = 80%
- Moisture recovery efficiency
  - Summer = 61%
  - Winter = 77%
- Code minimum vent rates
  - 0.48 ACH for dwelling units on average
  - Option to boost (1.11 ACH)



Moisture Modeling - Results

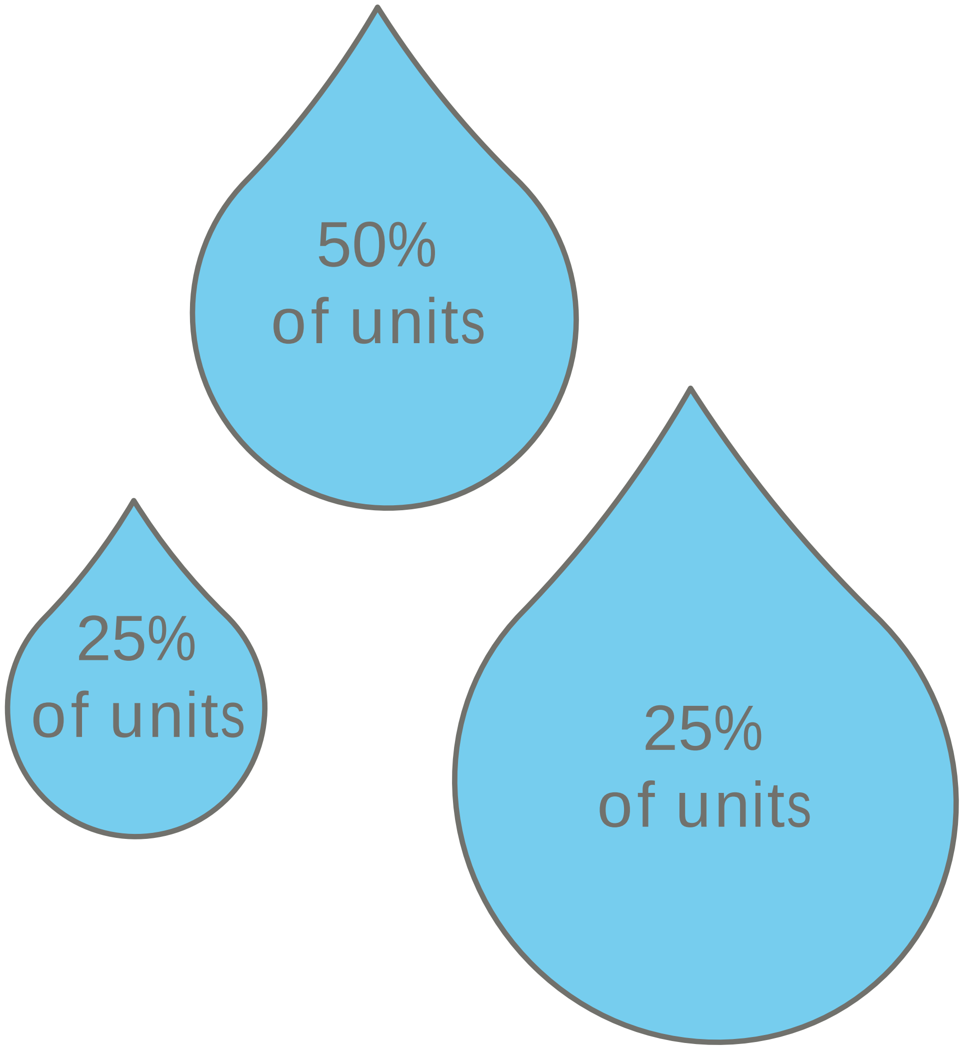
- Goal: how high will interior RH get?
  - Answer
    - Weekdays – peak conditions between 50-63%
    - Weekends – most of the day between 50-70%
- Goal: is ERV boost enough?
  - Answer
    - Does help, but not enough
    - Supplemental dehumidification required

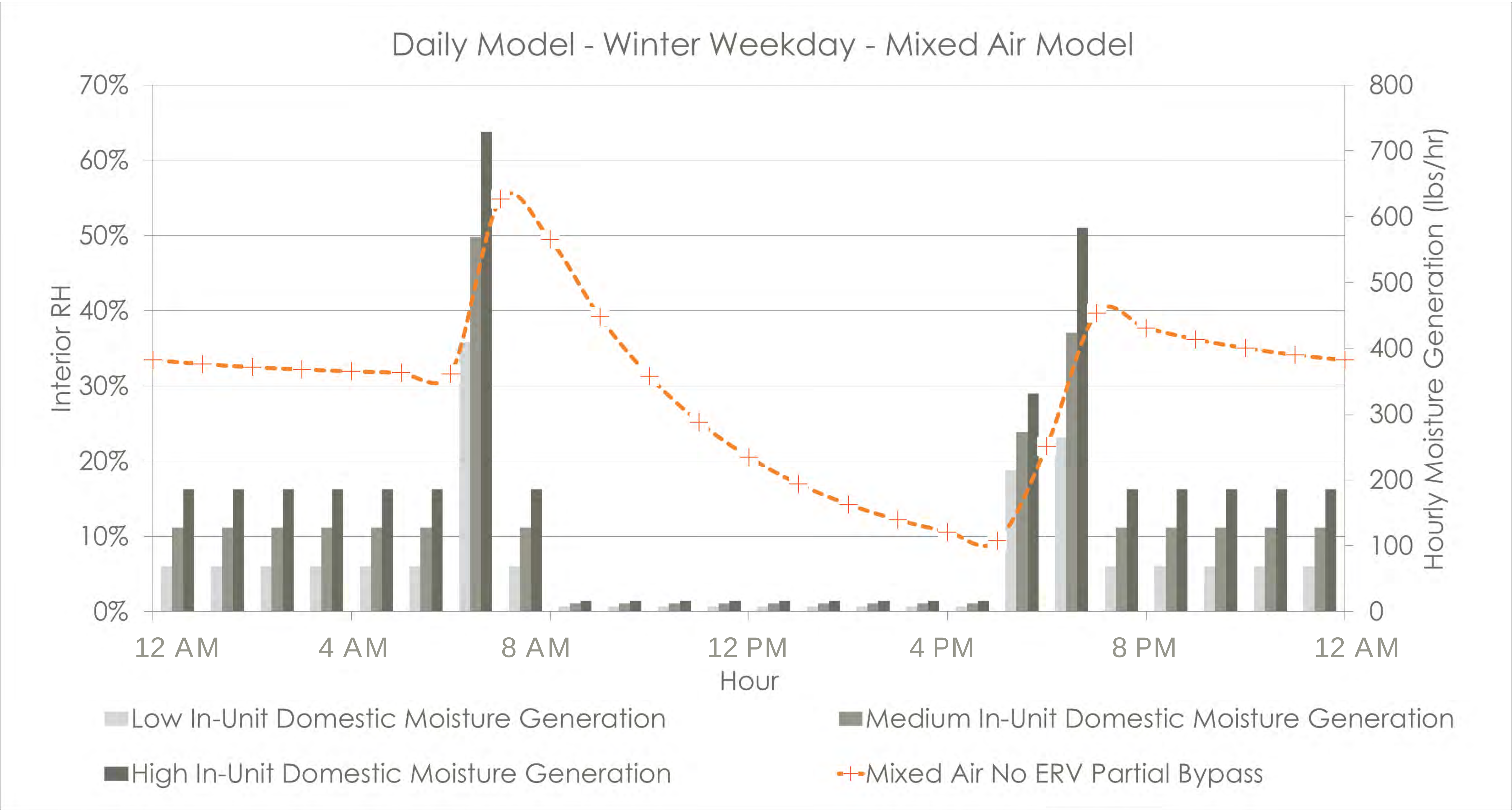
Central ERV Design



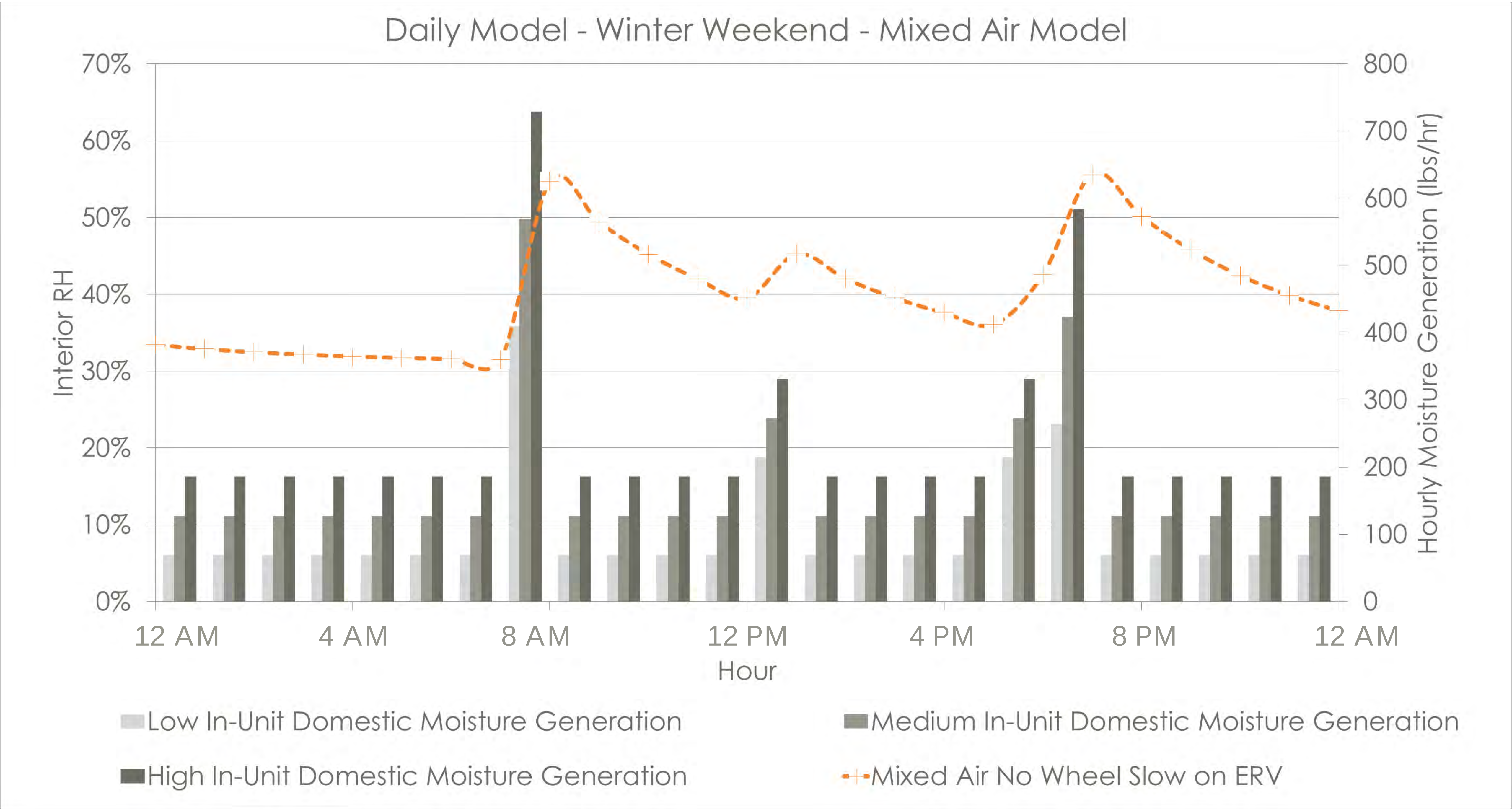
Revised Modeling Parameters

- Output – RH of interior air in apartments @ 68°F
- Same moisture generation assumptions
- Central ventilation → air mixing of moisture generation
- Moisture recovery efficiency
  - Summer Time = 72%
  - Winter Time = 83%
- Continuous code minimum exhaust
  - 0.60 ACH for dwelling units on average

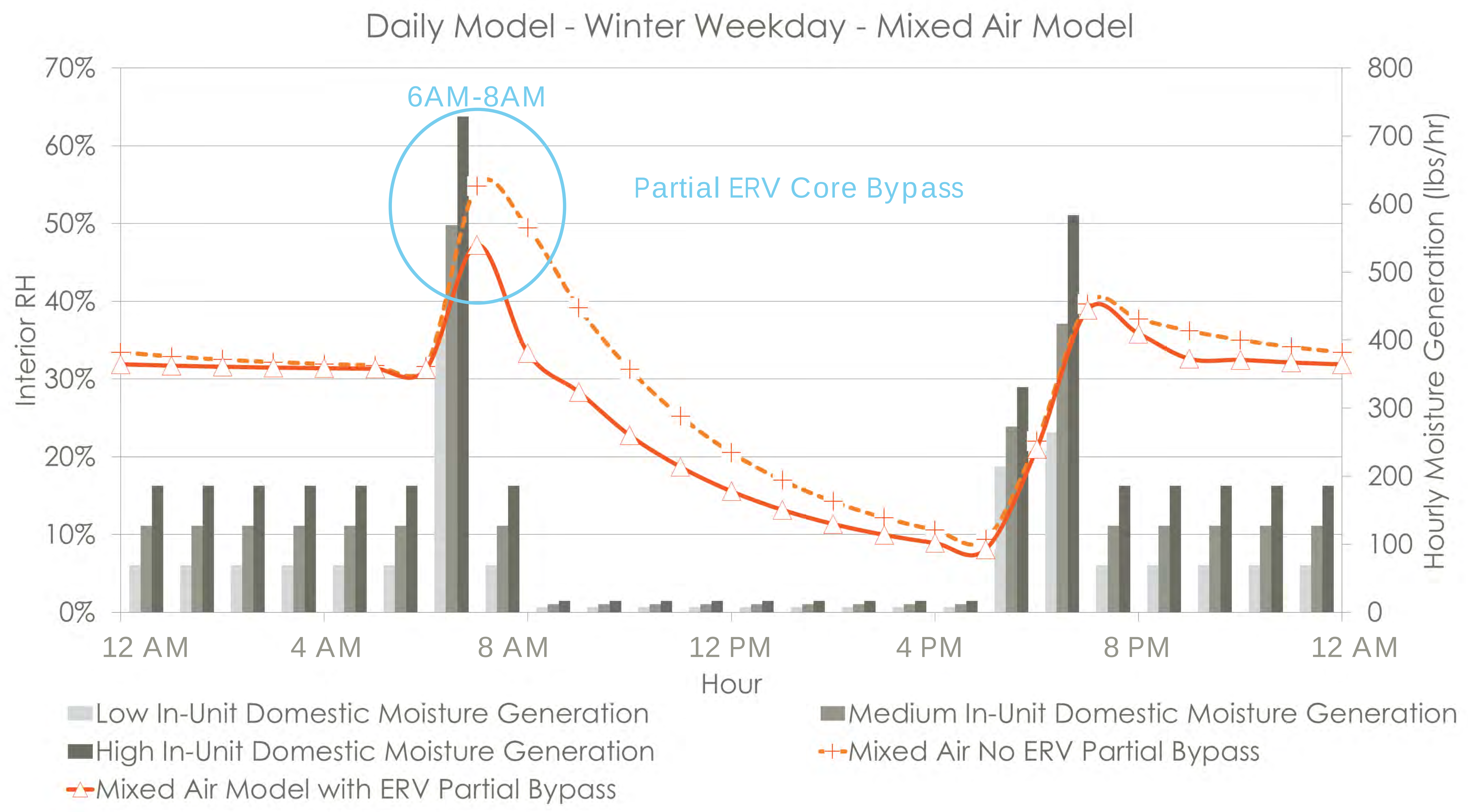




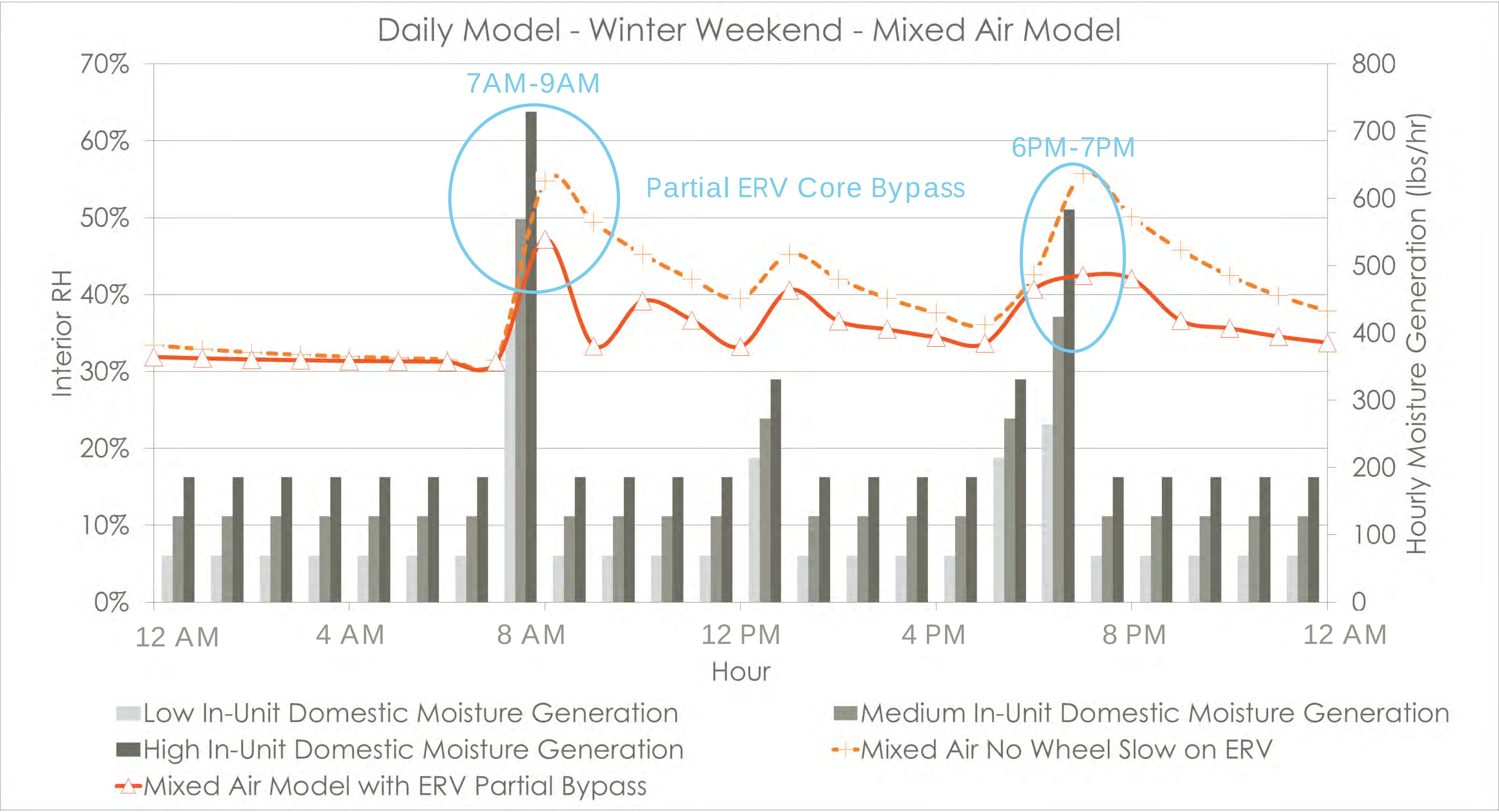
Daily Model - Winter Weekday - Mixed Air Model
Interior RH
70%
60%
50%
40%
30%
20%
10%
0%
Hourly Moisture Generation (lbs/hr)
800
700
600
500
400
300
200
100
0
12 AM
4 AM
8 AM
12 PM
4 PM
8 PM
12 AM
Hour
Low In-Unit Domestic Moisture Generation
Medium In-Unit Domestic Moisture Generation
High In-Unit Domestic Moisture Generation
Mixed Air No ERV Partial Bypass



Daily Model - Winter Weekend - Mixed Air Model
Interior RH
70%
60%
50%
40%
30%
20%
10%
0%
800
700
600
500
400
300
200
100
0
Hourly Moisture Generation (lbs/hr)
12 AM
4 AM
8 AM
12 PM
4 PM
8 PM
12 AM
Hour
Low In-Unit Domestic Moisture Generation
Medium In-Unit Domestic Moisture Generation
High In-Unit Domestic Moisture Generation
Mixed Air No Wheel Slow on ERV



Daily Model - Winter Weekday - Mixed Air Model
6AM-8AM
Partial ERV Core Bypass
Interior RH
70%
60%
50%
40%
30%
20%
10%
0%
Hourly Moisture Generation (lbs/hr)
800
700
600
500
400
300
200
100
0
12 AM
4 AM
8 AM
12 PM
4 PM
8 PM
12 AM
Hour
Low In-Unit Domestic Moisture Generation
Medium In-Unit Domestic Moisture Generation
High In-Unit Domestic Moisture Generation
Mixed Air No ERV Partial Bypass
Mixed Air Model with ERV Partial Bypass


Daily Model - Winter Weekend - Mixed Air Model
7AM-9AM
6PM-7PM
Partial ERV Core Bypass
Interior RH
70%
60%
50%
40%
30%
20%
10%
0%
Hourly Moisture Generation (lbs/hr)
800
700
600
500
400
300
200
100
0
12 AM
4 AM
8 AM
12 PM
4 PM
8 PM
12 AM
Hour
Low In-Unit Domestic Moisture Generation
Medium In-Unit Domestic Moisture Generation
High In-Unit Domestic Moisture Generation
Mixed Air No Wheel Slow on ERV
Mixed Air Model with ERV Partial Bypass

What We Learned & Key Factors

1. Occupant density is extremely important
   – As low as 200 sf/person in 2 & 3-BR units
2. Winter-time ERV moisture transfer
   – About 70-80%
   – Summer-time efficiencies can be much lower
3. Façade exfiltration rates
   – Very low for in super-airtight construction
4. Condensation risk @ thermal weak-points in façade
   – Usually window to wall connections
5. Potentially significant utility costs for supplemental dehum.
   – $2-$15 per unit per month







Questions?

Thank you!

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