Indwell

zon engineering inc

Operating Passive House Multi-family Projects

lessons learned through thirteen projects together

Graham Cubitt, Director of Projects & Development

Greg Leskien, CET, CPHD, CPHC, PHIUS Verifier

OUR MISSION:

Indwell is a Christian charity that creates affordable housing communities that support
people seeking
health, wellness, and belonging.

OUR VALUES:

DIGNITY of all people as image bearers of God.
LOVE our neighbours as ourselves.
HOPE is the foundation of our actions.

Indwell's vision: Hope & Homes for All
supporting tenants since 1974
transforming lives through affordable housing and supports
1,000 tenants in seven municipalities
leader in social services, health, and construction sectors

Building communities for Health, Wellness, and Belonging

Lessons Learned by a PH Consultant on this Journey …

- experiences combine on each other
- practical & pragmatic solutions
- don’t be afraid to review results
- build on lessons learned
- learn from tenants & operators
- review energy data and adjust

Centralized ERVs

- centralized ERV has been standard approach

- roof-mounted ERV reduces indoor space for units & operating noise

- trunk and branch ducting to all suites w/ supply & return

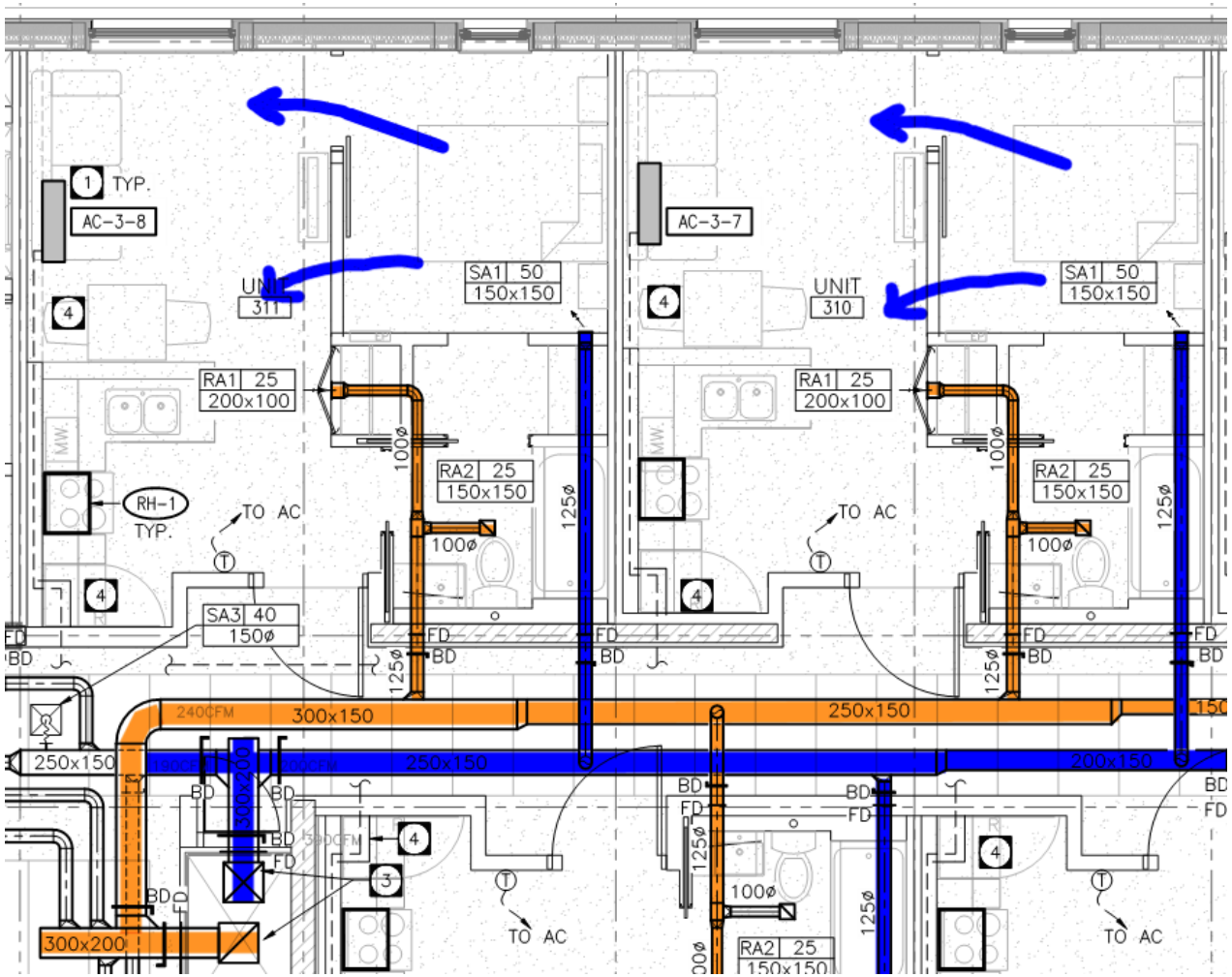
- reduced ducting within suites & minimal exterior openings

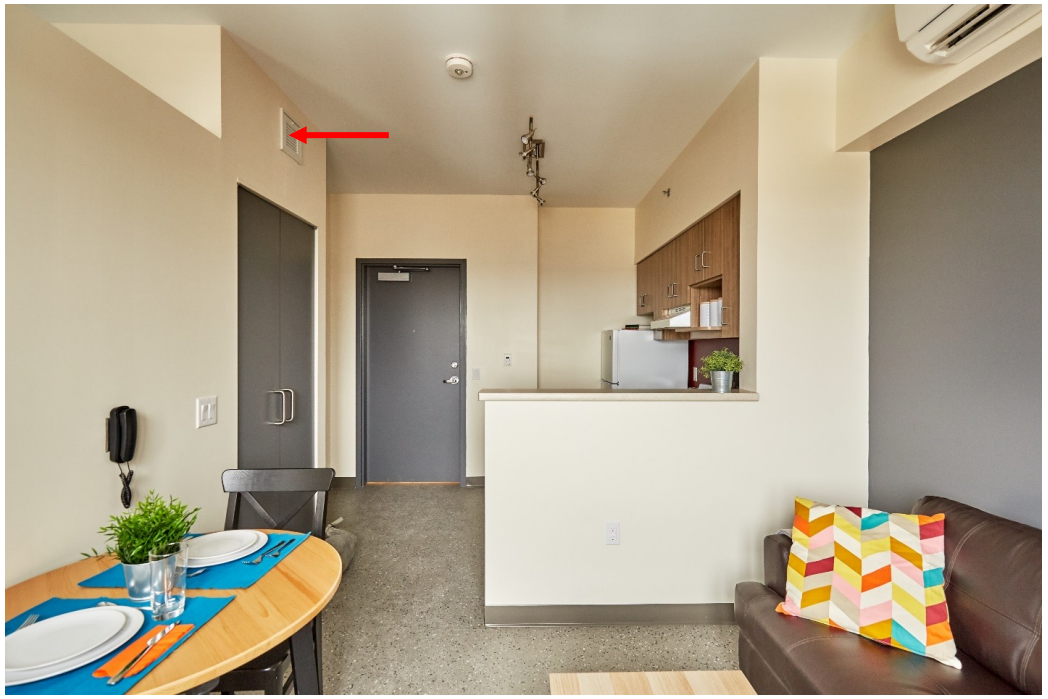
- one unit serves 20-30 units

- reduces some maintenance visits to suites; avoids access to apartments

- but, rethinking whether Central ERVs are the best approach for multi-family buildings …

Central Ventilation System





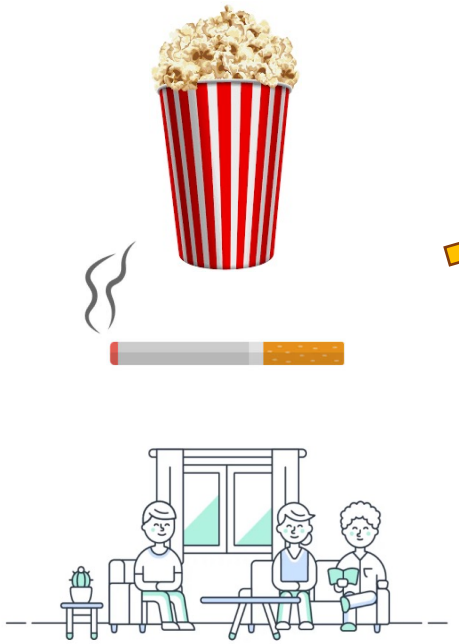
Project: McQuesten Lofts, Hamilton, ON

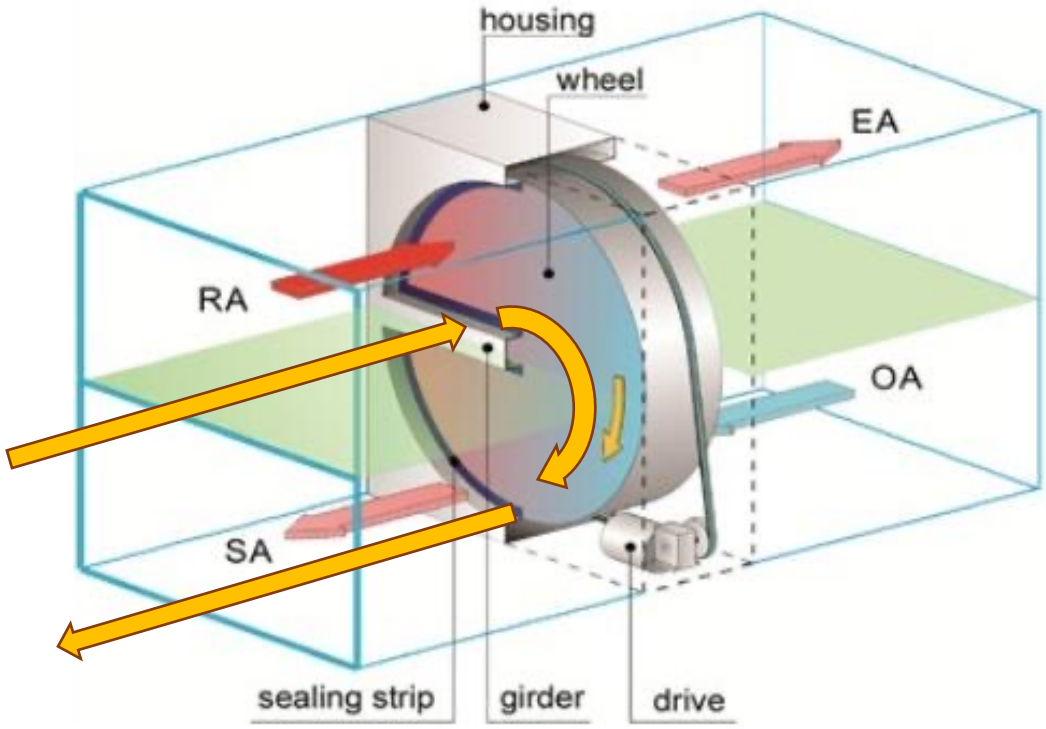
Central Ventilation System

Project: McQuesten Lofts, Hamilton, ON

Experience 1: Outgoing odours can be transferred to incoming air

- Observations so far …
  - Tobacco smoke odour in commercial tenant's unit
  - Tobacco smoke odour in common areas and other apartments
  - Discolouration of enthalpy wheel (ERV) and inside of ERV





Source: Holtop

Experience 1: Outgoing odours can be transferred to incoming air

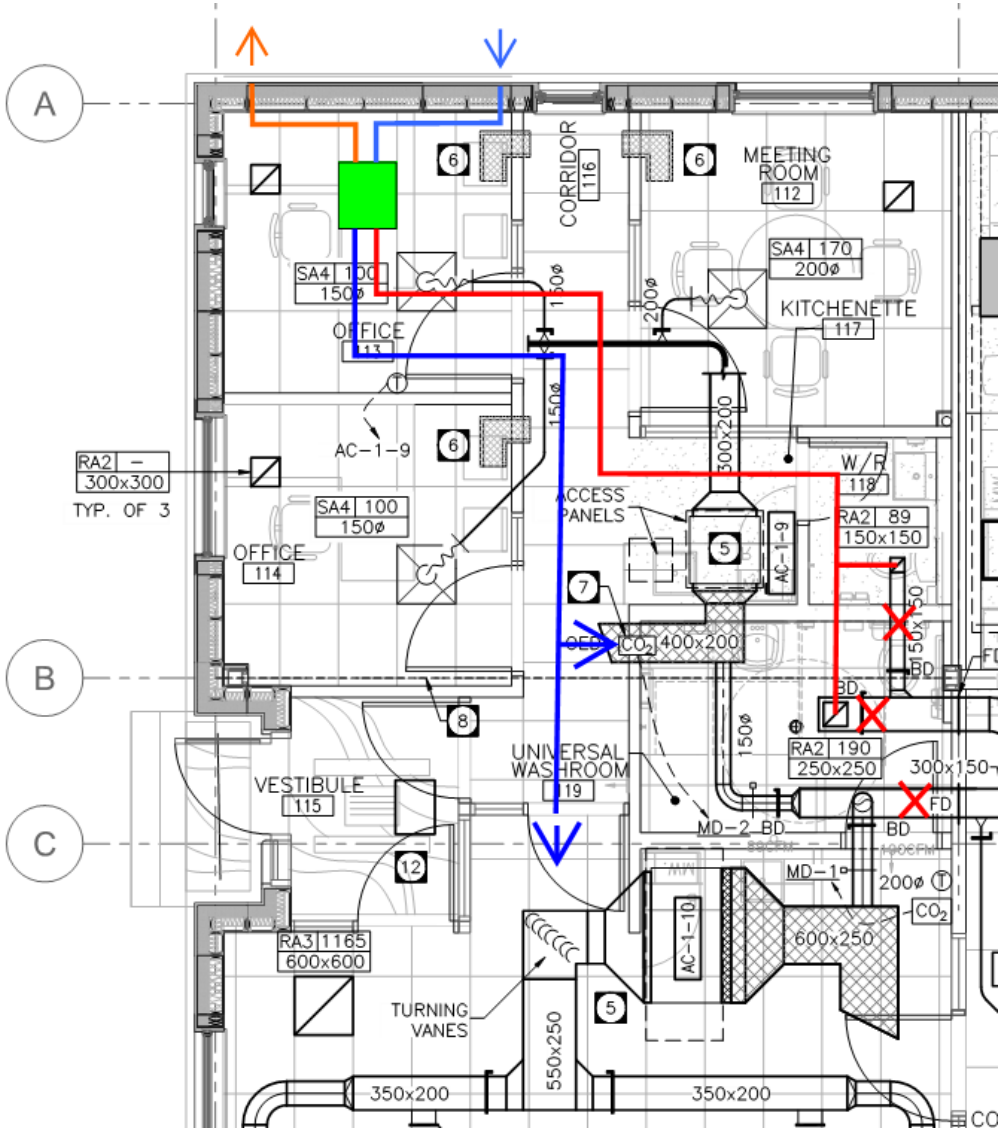
- Observations so far …
  - Tobacco smoke odour in commercial tenant’s unit
  - Tobacco smoke odour in common areas and other apartments
  - Discolouration of enthalpy wheel (ERV) and inside of ERV

Fresh Air Side

Return Air Side

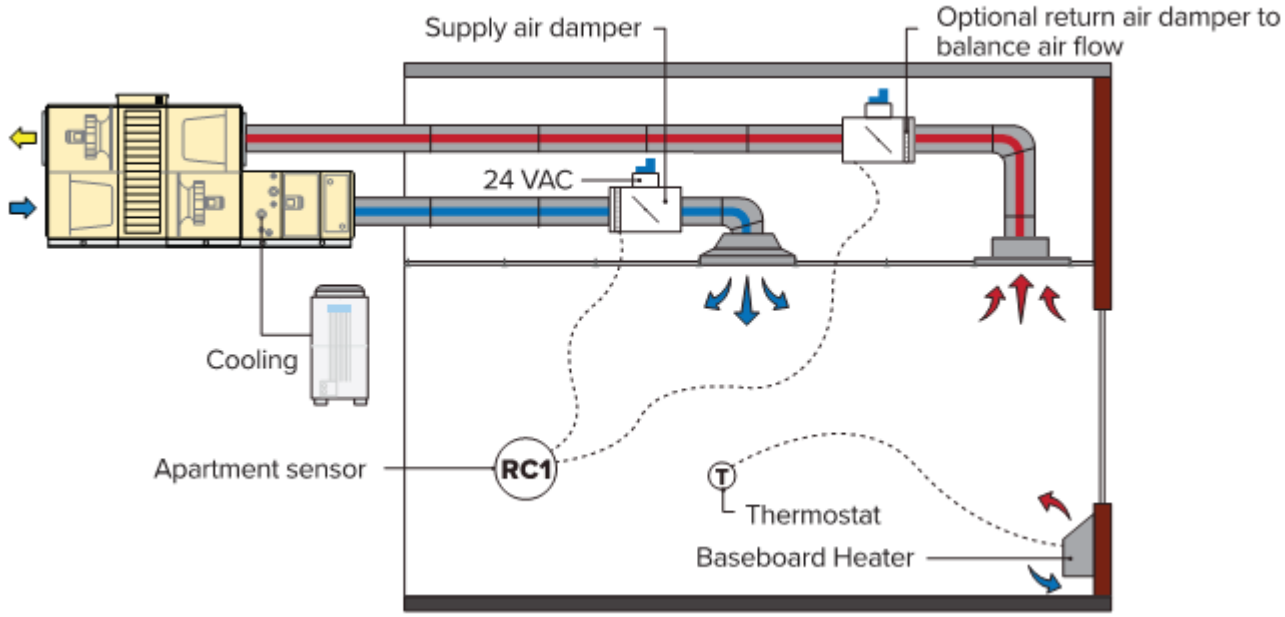
Experience 1: Outgoing odours can be transferred to incoming air

- Measures taken so far …
  - Decouple commercial tenant from apartments by providing stand-alone ERV
  - Adding carbon pre-filters to ERV before wheel
  - Tenant education / communication
- Other measures not taken …
  - Duct cleaning (quote for $17,000; 1 year after building was occupied)
- Possible solutions
  - Source control; prohibit smoking
  - Point source filtration / treatment
  - HRV wheel???



Experience 2: Limited User Control at Affordable Price

- Constant airflow is the most cost-effective approach, but …
  - No boost mode for tenants
  - Energy penalty to run at higher continuous exhaust rate
- Solutions to provide boost exist …
  - Higher capital cost



Source: Swegon

April 2022 price: $1,250 CDN per damper; 2 dampers per apartment (excludes labour and controls wiring)

Experience 3: High Cost of Smoke/Fire Damper (Ontario)

- Fire Dampers:
  - 2 dampers per suite
  - 6” round: ~$210 each + $25 install = ~$250
    - 50 suites = $25,000
- Fire / smoke damper:
  - 2 dampers per suite
  - 6”: ~$500 each + $500 for install and electrical
    - 50 suites = $100,000
  - Need to be reset after they are tripped for smoke events (nuisance trips have been frequent)

SENEZ CONSULTING LTD
FIRE SCIENCE & ENGINEERING

Guidance for the Development of a Performance-Based Solution for Smoke Dampers

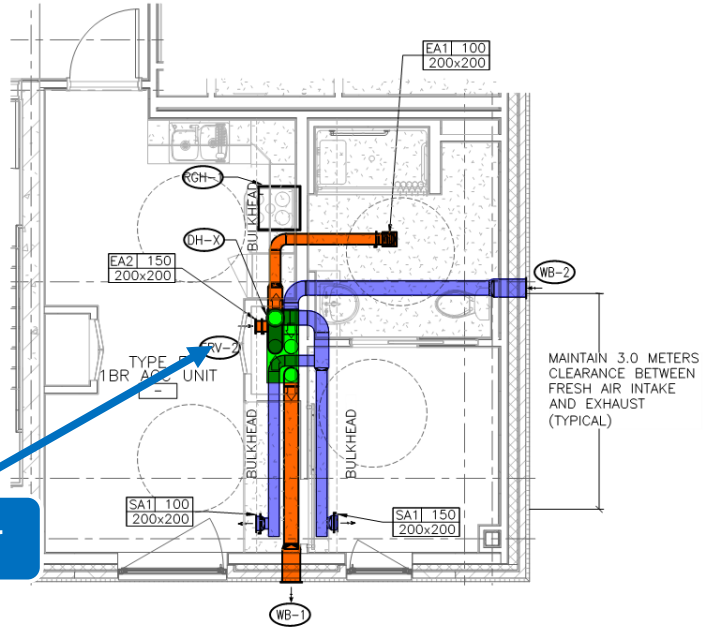
Our File Name: BCH Smoke Damper AS
Our File Number: 200003
Date of Guide: March 11, 2020

Prepared for:
BC Housing
1701 – 4555 Kingsway
Burnaby, BC
V5H 4V8

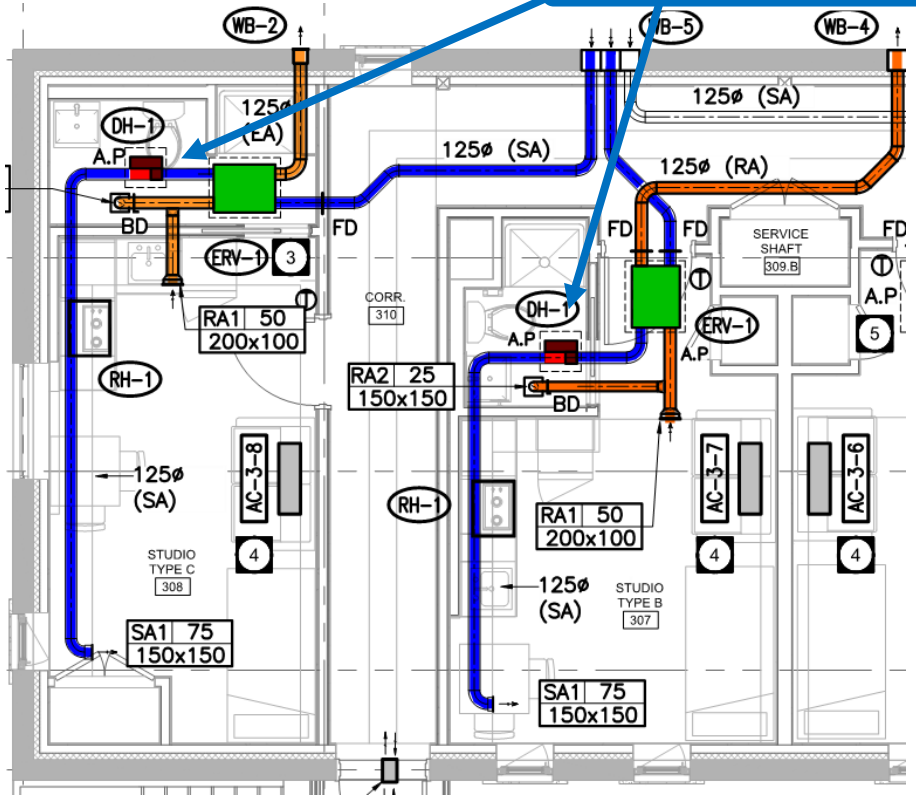
Prepared by:
Senez Consulting Ltd.
202-1777 56th Street
Delta, BC
V4L 0A6
www.senezco.com

Keith [illegible] Eng., P.Eng.

Peter Senez, M.Eng., P.Eng.



Electric duct heater



decentralized ventilation strategies are evolving
overcomes high costs of smoke dampers related to code changes
Reduces transfer of odours from one unit to next
provides full tenant control & electricity cost responsibility

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Decentralized ERVs & Minotair all-in-one systems

started using natural gas; now using heat pumps (COP > 3 vs. electric: COP = 1.0, natural gas: COP < 1)

capturing waste heat from indoor transformers

Semi-decentralized: one unit serves ~ 4-6 suites; reduces recirculation energy

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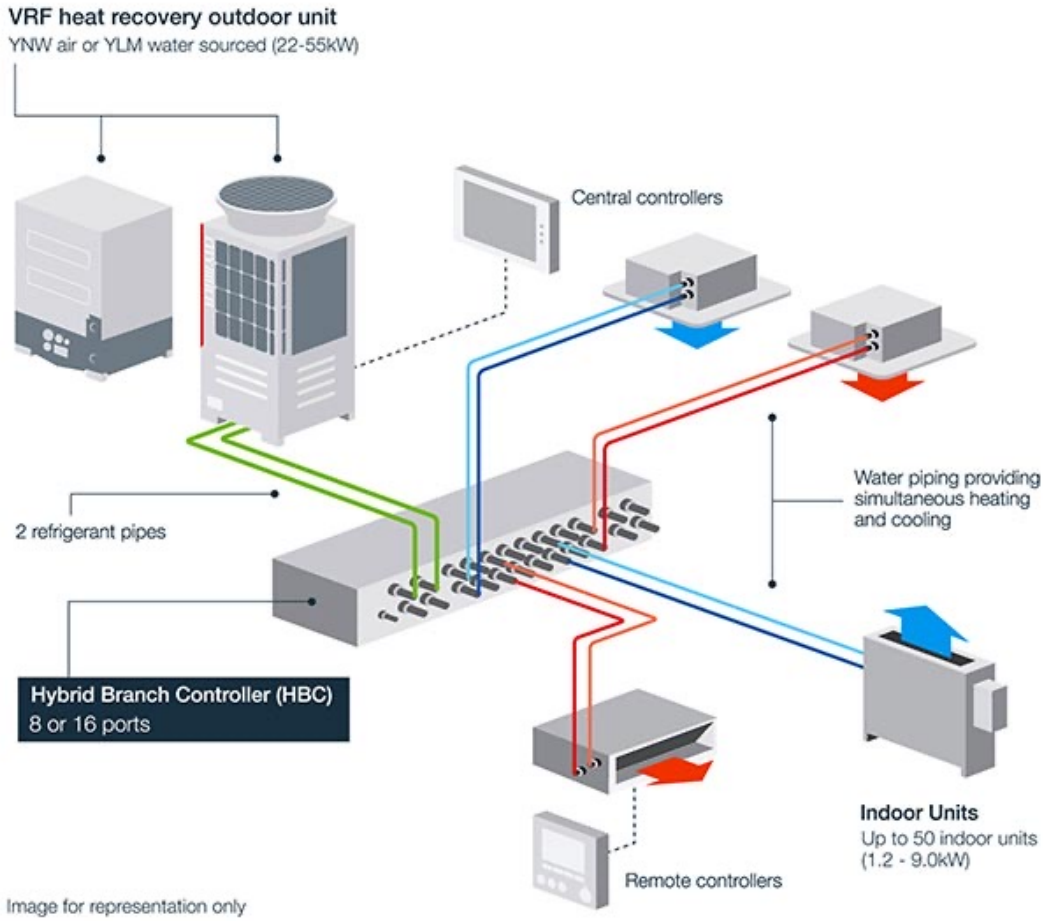
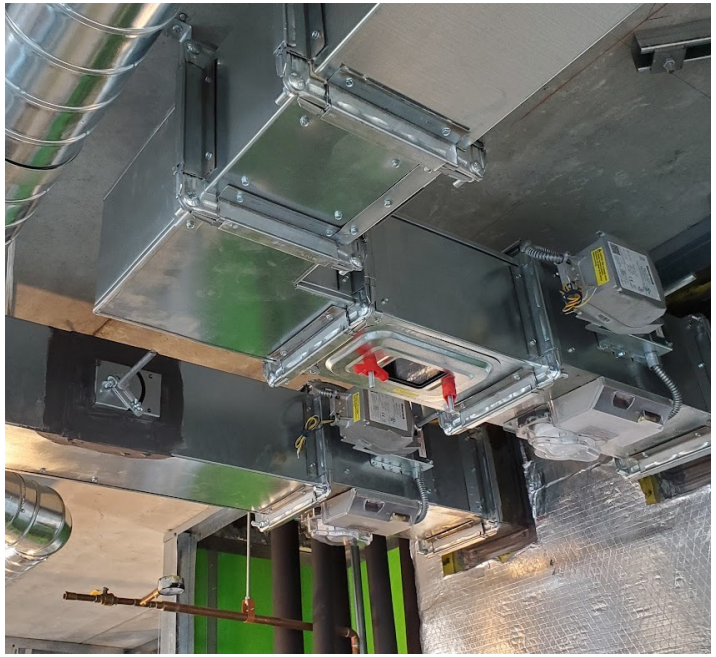
Semi-decentralized & Decentralized Domestic Hot Water



don’t be tempted by the capital cost savings of basic VRF
need ability to share energy; simultaneous heat & cool modes
it’s easy to overheat, and cooling is essential

VRF heat pumps: balancing efficiency with effectiveness



communicate duct leakage requirements early
provide balancing devices on drawings
locate diffusers so that airflows can be measured
allow for duct leakage between H/ERV and diffusers;
account for increased airflow in energy model

Critical Value of Air Sealing & Balancing

	<--- colour denotes field measurements Retrotec Flowfinder MK2 (with current calibration) and a plug-in watt meter

Level	Room Name		Supply				Exhaust				Damper / Grill Settings
			Design Rates		Measured Rate		Design Rates		Measured Rate		
-	WUFI Passive Model	Drawings	Normal	Turbo	Normal	Turbo	Normal	Turbo	Normal	Turbo	
-	-	-	cfm	cfm	cfm	cfm	cfm	cfm	cfm	cfm	
0	Bathroom	Guest Bath					20.0	27.8	21.7	27.7	metal damper; no adjustment at grille
0	Kitchen	Kitchen					60.0	83.3	53.0	67.0	1 1/3 from being all the way out
1	Master Bed En.	Master Ensuite					20.0	27.8	20.6	24.7	2.5 turns from closed
1	-	Master Ensuite WC					20.0	27.8	20.0	22.3	2.5 turns from closed
1	Powder Room	Powder Room					20.0	27.8	20.2	24.7	1.5 turns out from closed
0	Dining Area	Dining	18.0	25.0	20.0	25.2					Adjustable damper fully open
0	Guest Bed	Guest Bedroom	21.6	30.0	21.2	27.7					metal damper; no adjustment at grille
0	Library	Library/AV	18.0	25.0	18.7	24.1					3.25 turns out from closed
0	Living Room	Living Room	21.6	30.0	21.2	25.8					Adjustable damper fully open
1	Master Bed	Master Bed	28.8	40.0	30.6	37.0					No adjustment at grille
1	Office	Office	15.8	22.0	17.1	20.0					No adjustment at grille
1	-	Study	15.8	22.0	18.2	22.3					18 turns out from closed
		Sum of Room Measurements:	140	194	147.0	182.1	140	194	135.5	166.4	
						81%				81%	
		Measured Flow Rates Through ERV (at exterior intake/exhaust):	-	-	182.0	230.0	-	-	183.0	236.0	
		Airflow Lost Between Exterior Intake/Exhaust and Rooms:			35.0	47.9			47.5	69.6	
					19%	21%			26%	29%	
		Fan Power Measurements:									
		"Continuous", W	68	0.37							
		"Turbo", W	127	0.55							

AIR OUTLET TEST REPORT

Submitted by Air Audit Inc-Cambridge Ont.

PROJECT: INDWELL BLOSSOM PARK REDEVELOPMENT — **SYSTEM:** ERV-1 (SUPPLY)

TEST INSTRUMENT: ADM 860 W/AIRFOIL — **DATE:** OCT. 27/2020

AREA SERVED	#	OUTLET DATA TYPE	SIZE	AK	DESIGN VEL	DESIGN CFM	TEST # 1	TEST # 2	TEST # 3	FINAL VEL	FINAL CFM
2ND FLOOR											
201	1	PIPE	6"	0.20	300	60	298			298	60
202	2	PIPE	6"	0.20	300	60	277			277	55
203	3	PIPE	6"	0.20	300	60	260			260	52
204	4	PIPE	6"	0.20	300	60	225			225	45
205	5	PIPE	6"	0.20	300	60	288			288	58
206	6	PIPE	6"	0.20	300	60	265			265	53
218	7	GRILLE	6 X 6	0.18	167	30	314			170	31
1ST FLOOR											
109	8	GRILLE				30					NA
101	9	PIPE	6"	0.20	300	60	399			310	62
102	10	PIPE	6"	0.20	300	60	202			311	62
103	11	PIPE	6"	0.20	300	60					NA
104	12	PIPE	6"	0.20	300	60	117			290	58
105	13	PIPE	6"	0.20	300	60					NA
106	14	PIPE	6"	0.20	300	60	307			310	62
107	15	PIPE	6"	0.20	300	60	285			286	57
108	16	PIPE	6"	0.20	300	60	323			305	61

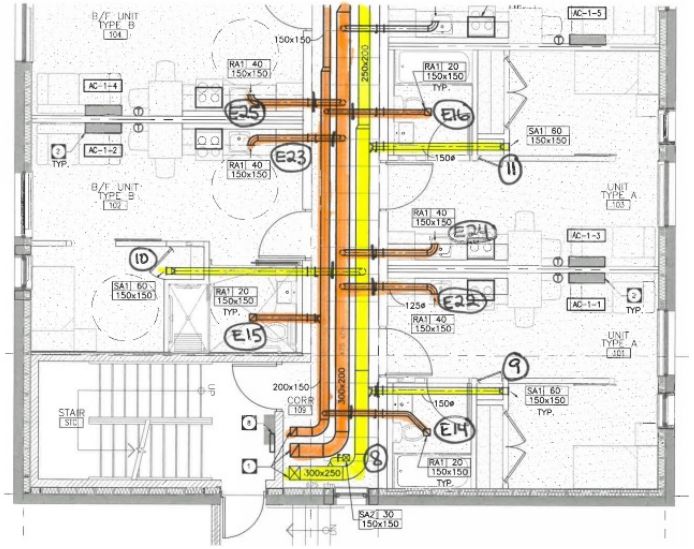
These flow rates vary from the design values by more than the 5% listed in the project specifications (15100 12.13.d).

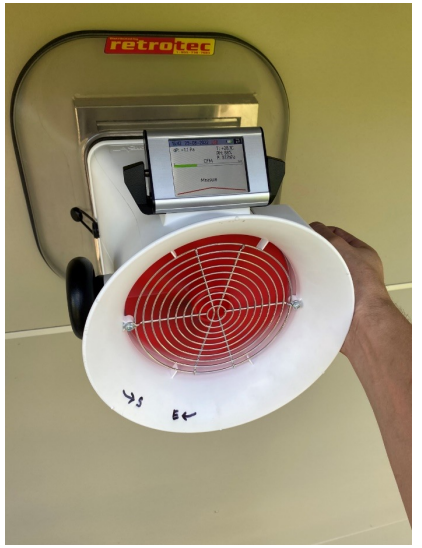
What does this mean? Is this supply duct missing?

REMARKS-

- OUTLET #8 WAS NOT INSTALLED.
- OUTLETS #11 AND #13 WERE UNABLE TO MEASURE DUE TO CEILING RESTRICTIONS (PIPES TOO CLOSE TOGETHER, NO ROOM TO TRAVERSE).
- UNABLE TO OBTAIN AIRFLOW MEASUREMENTS INSIDE THE UNITS DUE TO COVID-19 PROCEDURES AND PROTOCOLS.

Certified Member of the National Environmental Balancing Bureau (NEBB) PAGE # 5





preinstallation briefing with trades & suppliers
Confirm all supply and return boots are installed
witness the balancing process
thoroughly review balancing reports
choose a TAB contractor; don't leave Contractor to choose
Incl. TAB equipment requirements, especially for low air flows

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Critical Value of Air Sealing & Balancing

Coordinate Controls Early

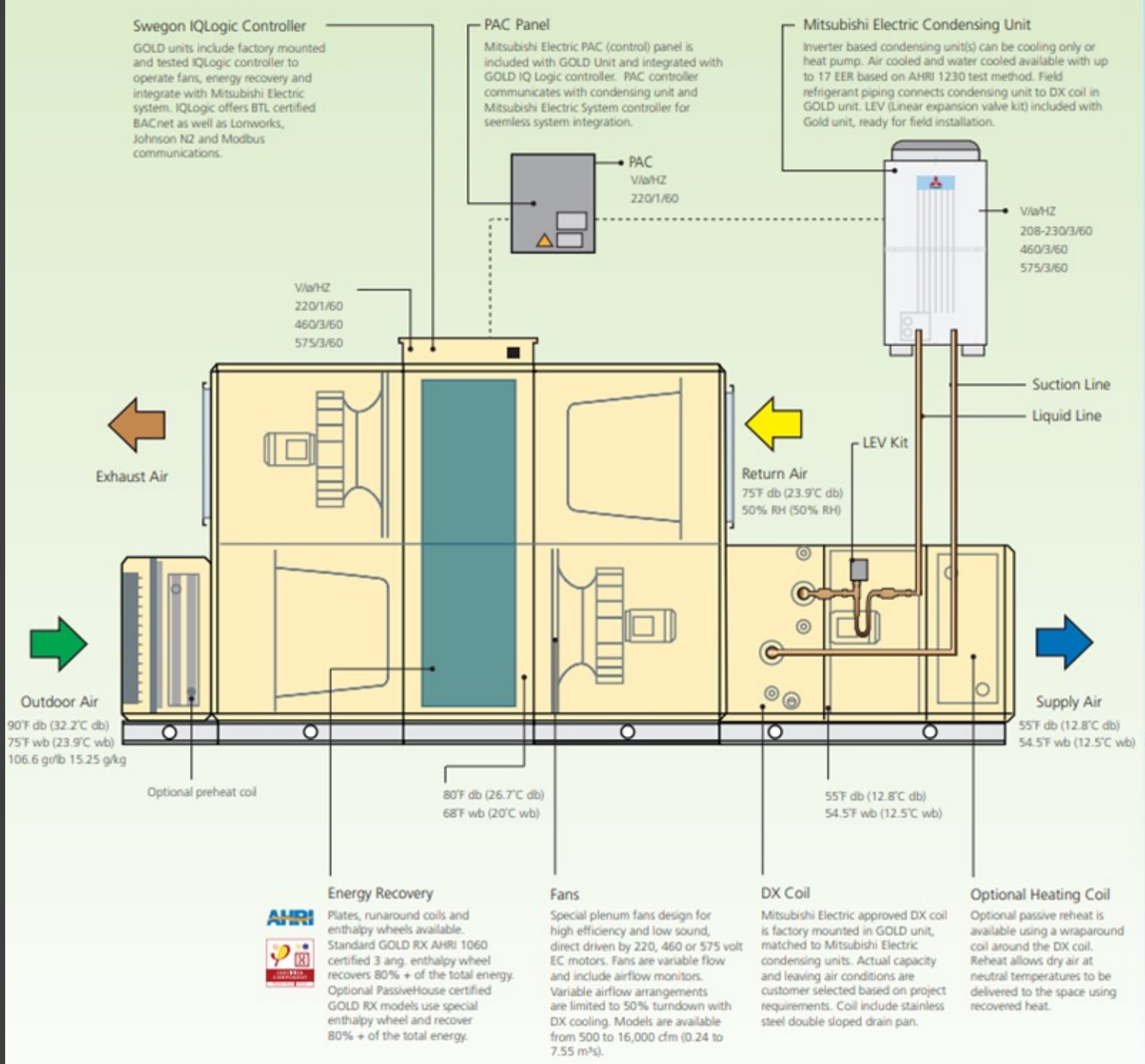
- even simple systems can be setup incorrectly, e.g. sensor placements

- don’t let the contractors and suppliers off the hook by installing and leaving the site

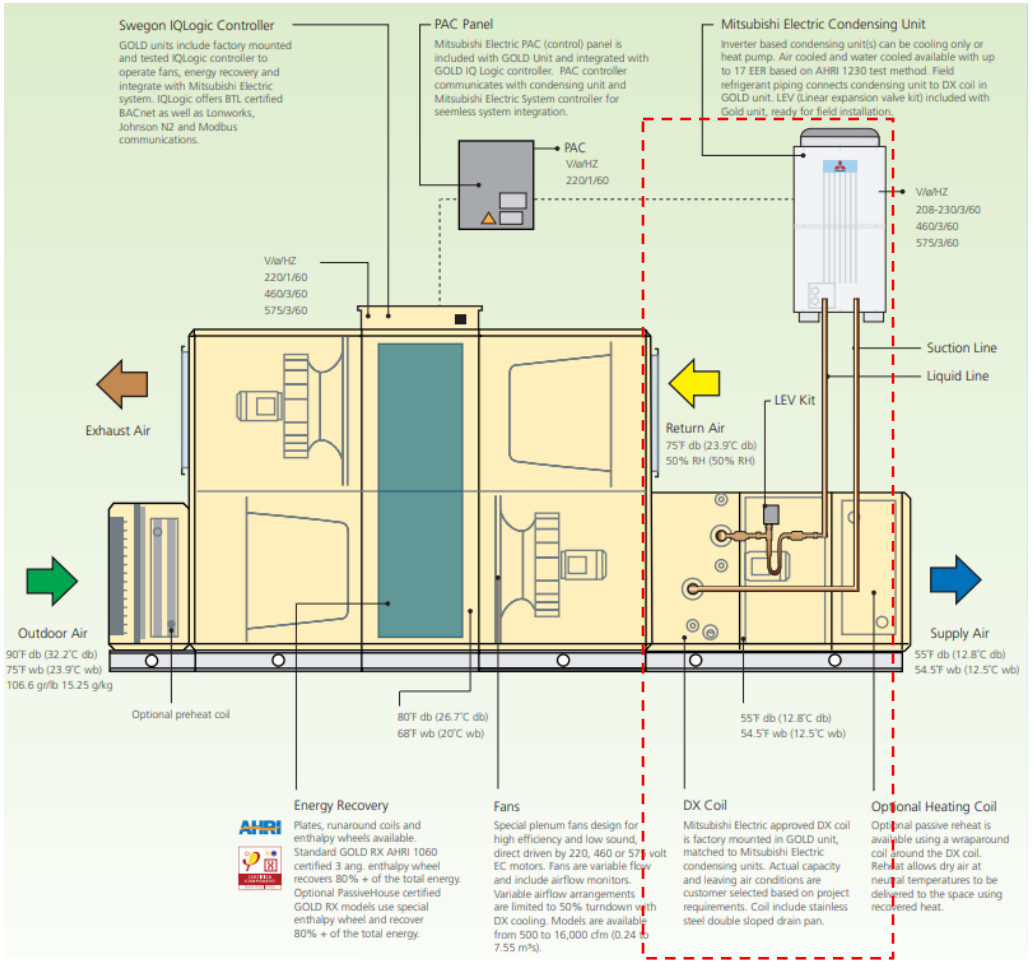
- make installers work with manufacturers and controls contractor

- robust control specifications with full sequences are advisable

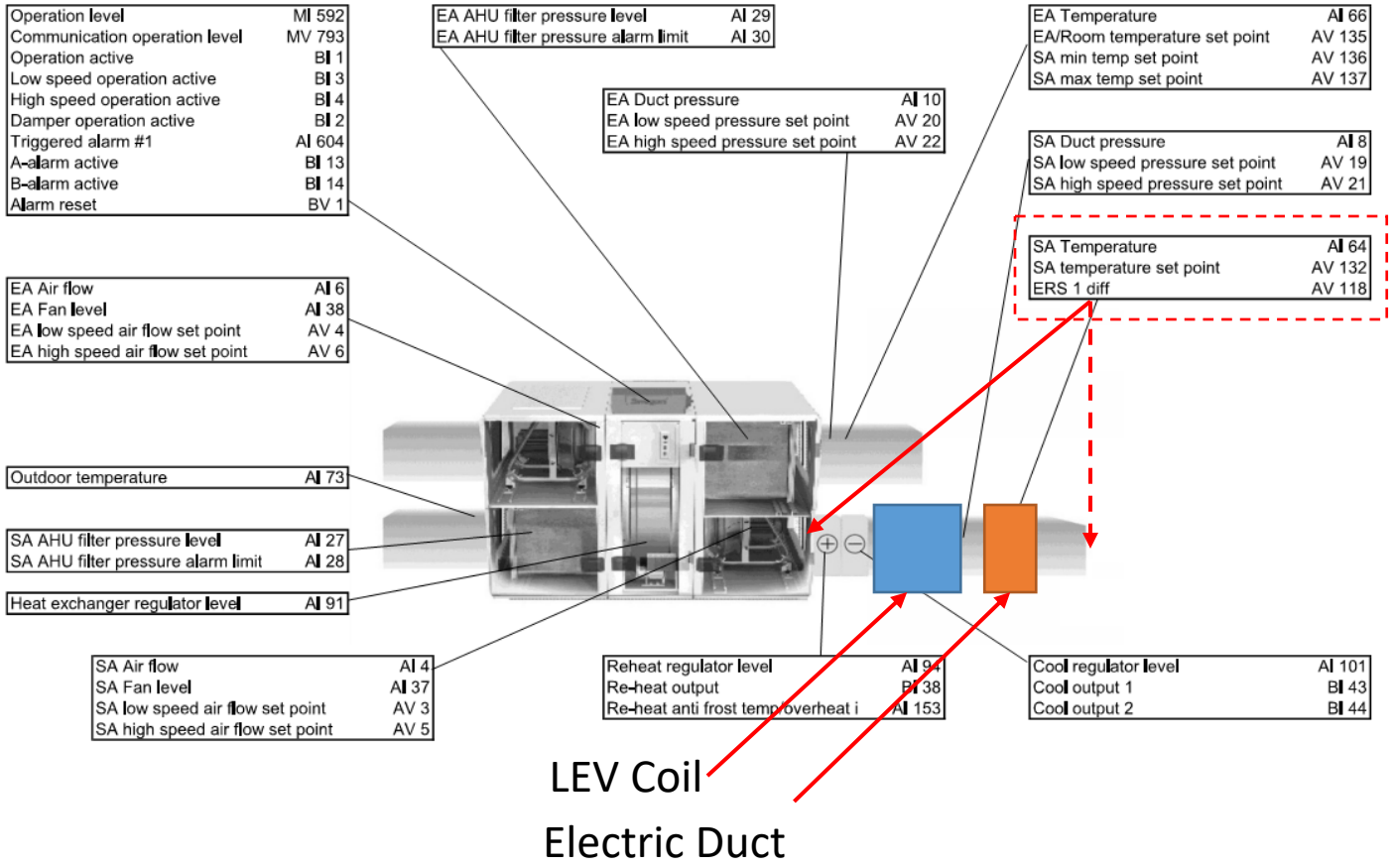
- use a different approach than conventional design-bid-build may be advisable for controls



Example – Incorrect Placement of Temperature Sensor



Source: Swegon



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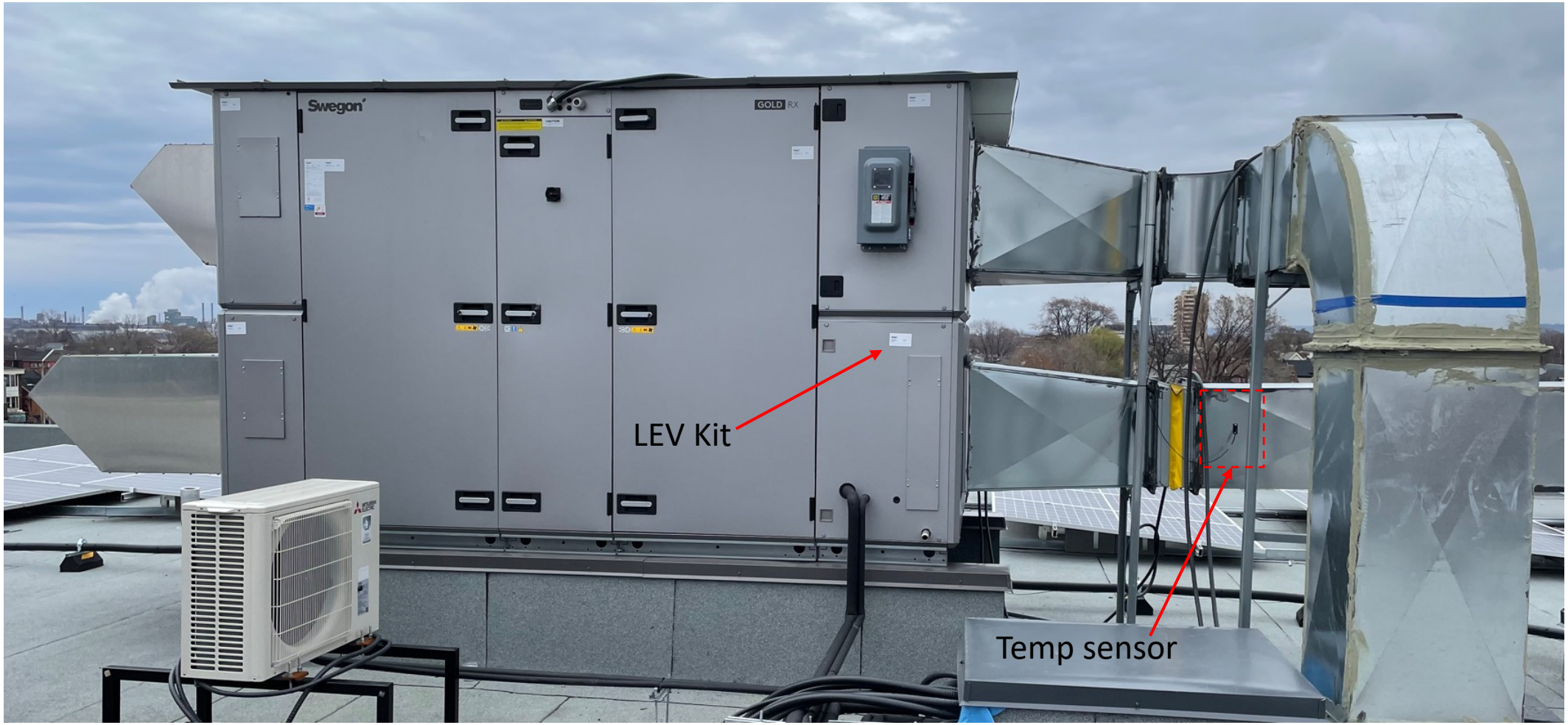

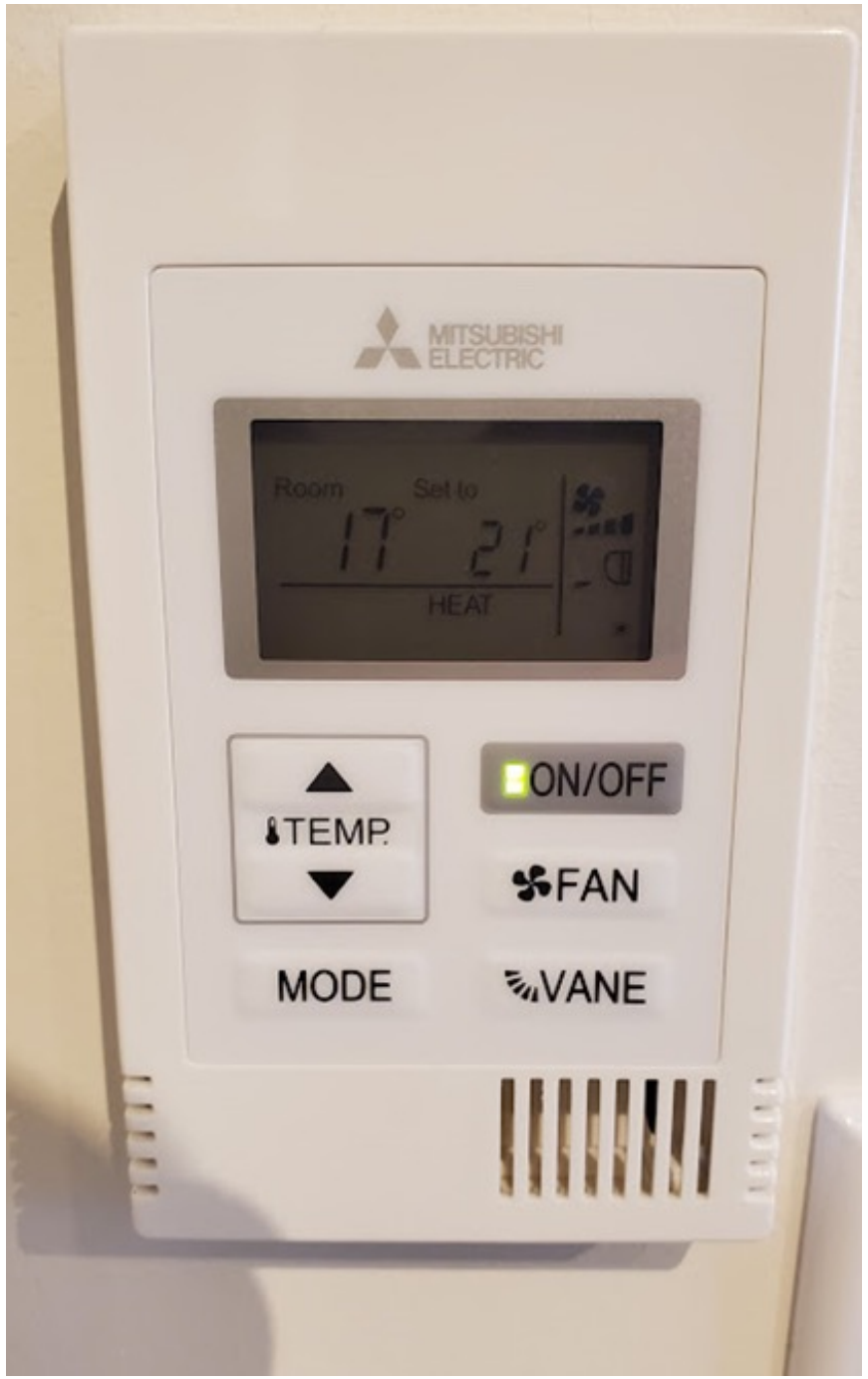

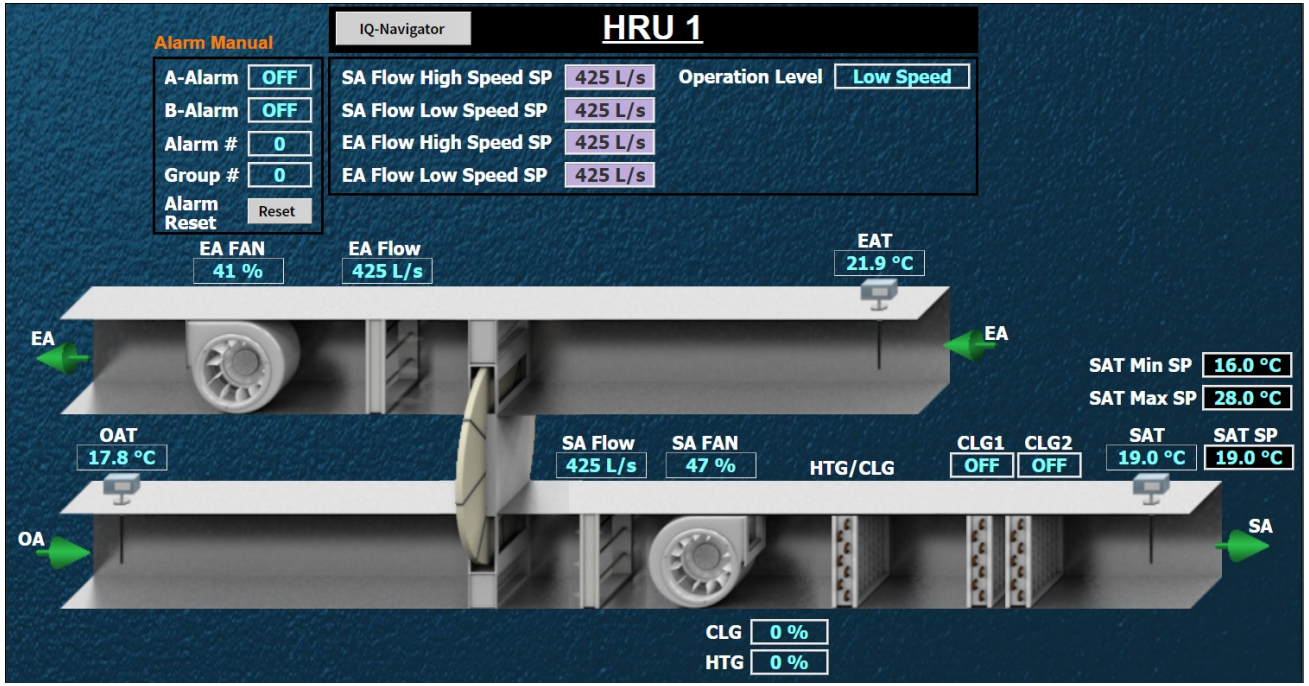

legible and intuitive thermostats are necessary
BAS system integration and displays need to reflect operations
attention to tracking and controlling desired outcome measures

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Simplifying controls for both staff & tenants

mixed-use: 50 apartments & Hamilton Public Library branch
PHIUS certified February 2021
$258/sf on total area of 34,850sf
completed December 2020

McQuesten Lofts, Hamilton

mixed-use: church and 45 apartments
PHI certification pending
$226/sf on total area of 62,400sf
completed August 2020

North End Landing, Hamilton

Build on what you learned with the last project …

- don’t invent a new approach with each new project; build on the last project and examples from your peers

- improve details with each project

- material choices and construction optimization can be refined

- less education required for design teams & clients on successive projects

-keep the same team together to build on the collective experience while establishing new relationships

developing 13 passive house projects with 625 homes together
multi-family & mixed-use projects from 10,000-100,000sf
not burning fossil fuel is feasible
homes people love in buildings that can be maintained

Building low-emission multi-family housing is possible

Indwell

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CET, CPHD, CPHC, PHIUS Verifier
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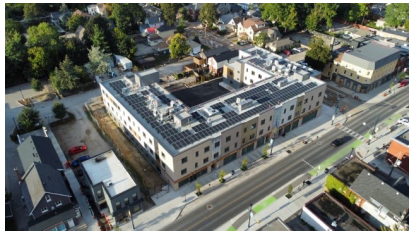
Bonus: Energy Monitoring

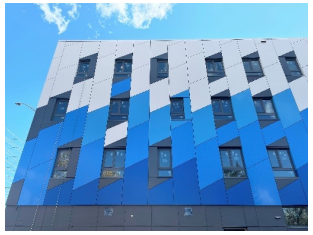
Buildings with end-use monitoring …









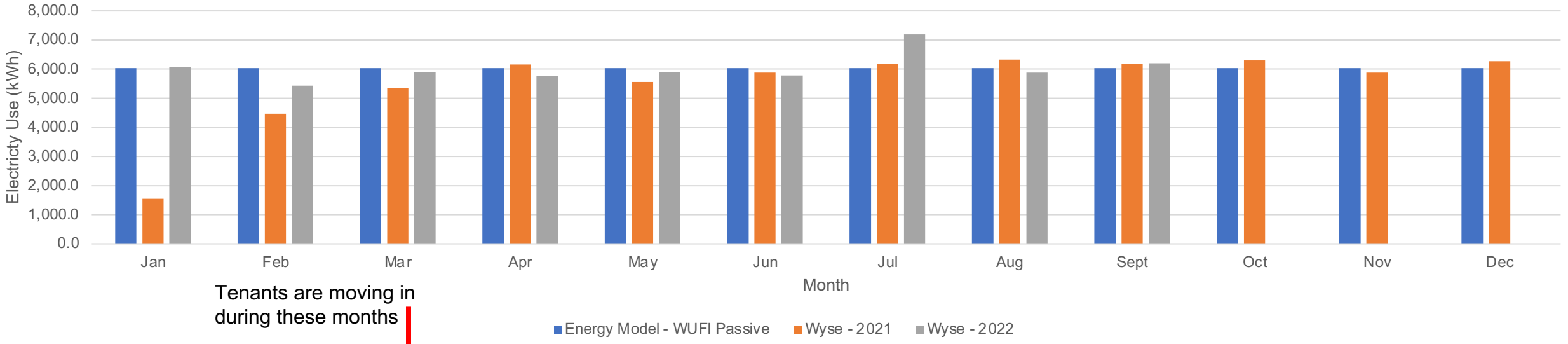



McQuesten Lofts – Hamilton, ON

- PHIUS+ 2015 Certified (January 2021)
- 50 1-bedroom units
- Public library space on ground floor
- 4 storeys + basement
- iCFA: 31,657 ft^2

Apartment Electricity Use

Includes:
- Cooking (Ceramic cooktop, electric oven)
- Refrigerator (GE GPE12FGKWW)
- Interior lighting (100% LED lamps)
- MELs

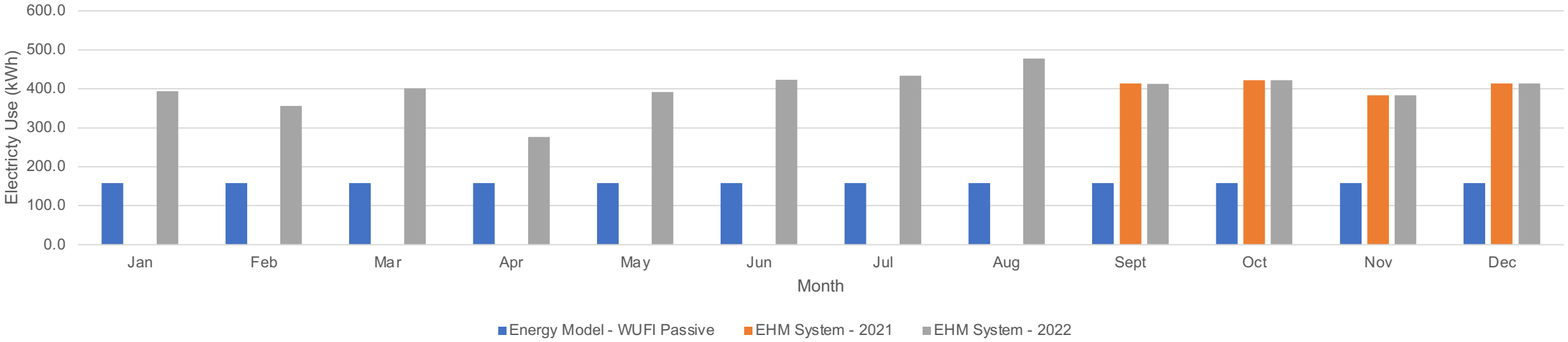


Tenants are moving in during these months

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Energy Model - WUFI Passive	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	6,027.6	72,331.0
Wyse - 2021	1,540.7	4,467.9	5,351.5	6,153.3	5,562.1	5,885.8	6,178.5	6,327.1	6,166.0	6,297.9	5,880.4	6,264.7	66,075.9
Actual vs. WUFI Passive	-74%	-26%	-11%	2%	-8%	-2%	3%	5%	2%	4%	-2%	4%	-9%
Wyse - 2022	6,078.6	5,432.4	5,890.2	5,762.2	5,899.4	5,786.4	7,192.0	5,876.5	6,204.0	*6,297.9*	*5,880.4*	*6,264.7*	72,564.6
Actual vs. WUFI Passive	1%	-10%	-2%	-4%	-2%	-4%	19%	-3%	3%	*4%*	*-2%*	*4%*	0%
2022 Energy Use Intensity	24.7	kWh/m2/yr											

Elevator Electricity Use

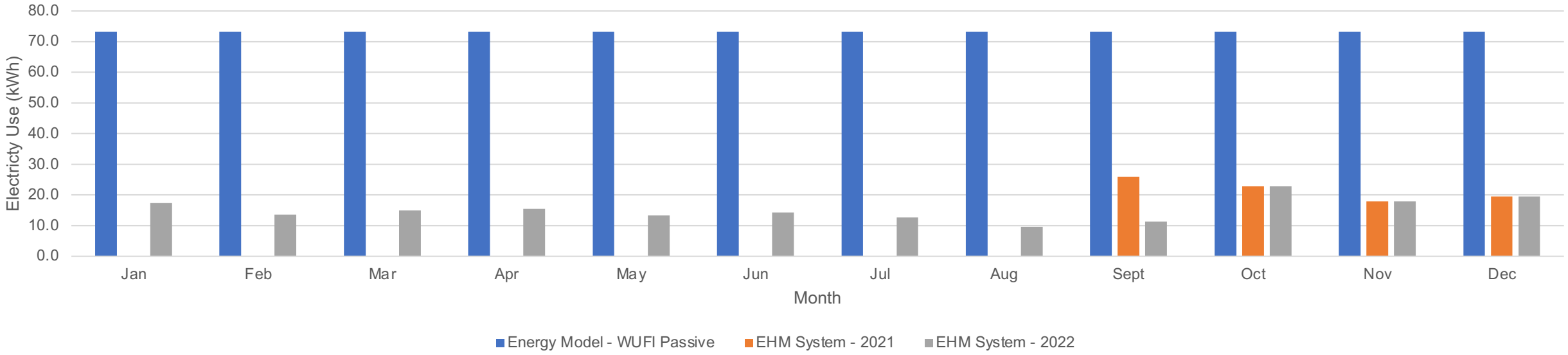
Includes:
- 2 machine-room-less (MRL) traction elevators serving 4 storeys + basement
- Delta



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Energy Model - WUFI Passive	158.3	158.3	158.3	158.3	158.3	158.3	158.3	158.3	158.3	158.3	158.3	158.3	1,900.0
EHM System - 2021									414.0	422.3	383.5	413.9	
Actual vs. WUFI Passive									161%	167%	142%	161%	
EHM System - 2022	393.5	356.2	401.5	276.8	391.7	423.0	433.7	478.0	412.6	*422.3*	*383.5*	*413.9*	4,786.6
Actual vs. WUFI Passive	149%	125%	154%	75%	147%	167%	174%	202%	161%	*167%*	*142%*	*161%*	152%
2022 Energy Use Intensity	1.6	kWh/m2/yr											

Clothes Washer Electricity Use

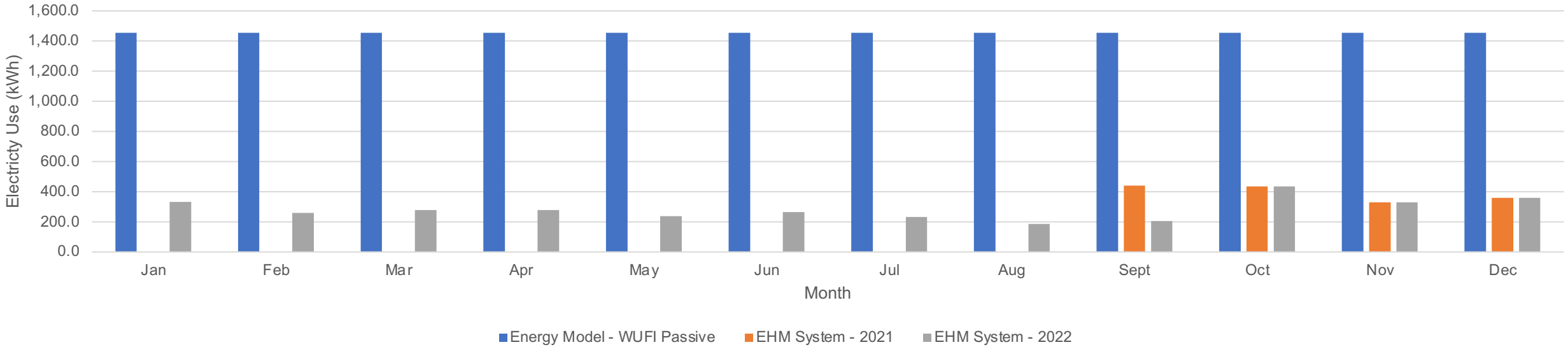
Includes:
- 3 commercial front load washers
- Huebsch HFNNERSP115CW01 (ENERGYSTAR Certified)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Energy Model - WUFI Passive	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	877.8
EHM System - 2021									26.0	22.8	17.9	19.5	
Actual vs. WUFI Passive									-64%	-69%	-76%	-73%	
EHM System - 2022	17.4	13.6	14.9	15.5	13.3	14.2	12.7	9.5	11.3	*22.8*	*17.9*	*19.5*	182.8
Actual vs. WUFI Passive	-76%	-81%	-80%	-79%	-82%	-81%	-83%	-87%	-85%	*-69%*	*-76%*	*-73%*	-79%
2022 Energy Use Intensity	0.1	kWh/m2/yr											

Clothes Dryer Electricity Use

Includes:
- 3 commercial electric dryers with direct-to-outdoors exhaust
- Huebsch HDENERGS173CW01

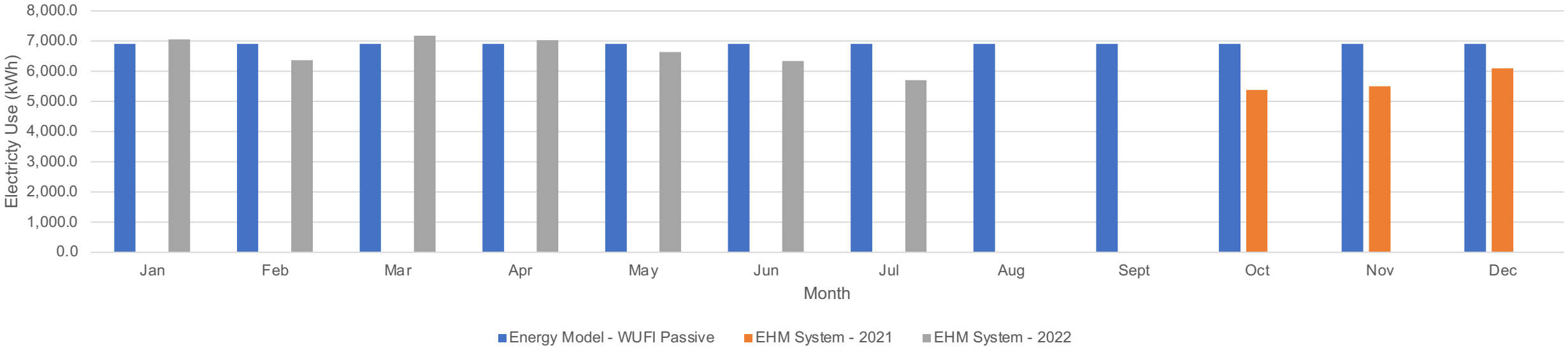


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Energy Model - WUFI Passive	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	1,454.7	17,456.3
EHM System - 2021									440.8	433.8	330.1	360.0	
Actual vs. WUFI Passive									-70%	-70%	-77%	-75%	
EHM System - 2022	333.2	260.3	276.9	276.9	237.3	264.8	231.9	186.6	206.0	*433.8*	*330.1*	*360.0*	3,398.0
Actual vs. WUFI Passive	-77%	-82%	-81%	-81%	-84%	-82%	-84%	-87%	-86%	*-70%*	*-77%*	*-75%*	-81%
2022 Energy Use Intensity	1.2	kWh/m2/yr											

Domestic Hot Water Gas Use

Includes:

- Central water heating system with recirculating loop
- (2) Bradford-White EF100T150E3N2 (100 gal.)

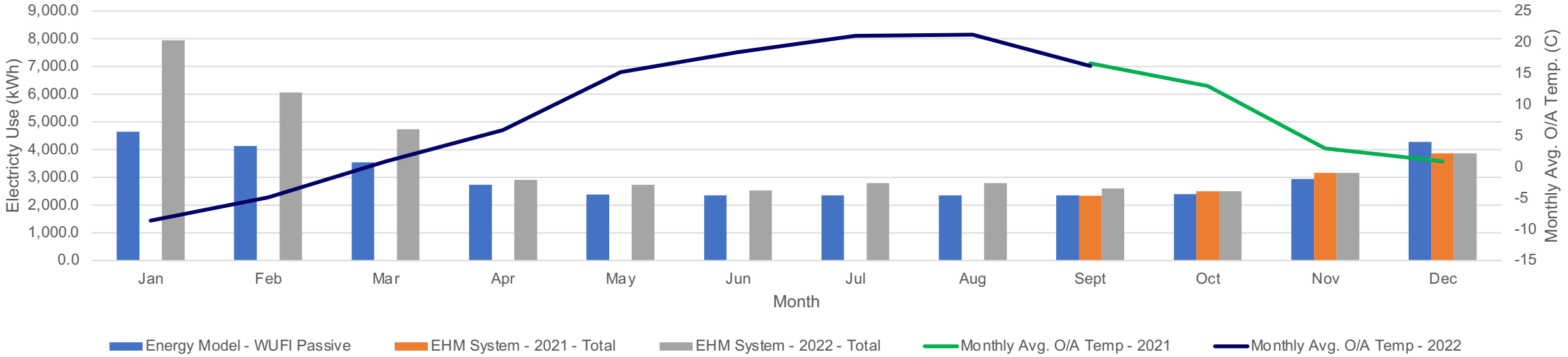


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Energy Model - WUFI Passive	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	6,911.2	82,934.4
EHM System - 2021										5,378.2	5,502.8	6,102.3	
EHM System - 2021 ÷ WUFI										-22%	-20%	-12%	
EHM System - 2022	7,055.5	6,367.7	7,180.0	7,033.4	6,638.4	6,345.2	5,706.2						
Actual vs. WUFI Passive	2%	-8%	4%	2%	-4%	-8%	-17%						

Ventilation Electricity Use

Includes:

- (2) Swegon Gold 12RX ERVs with VRF LEV kit and 8.0 kW electric post-heater



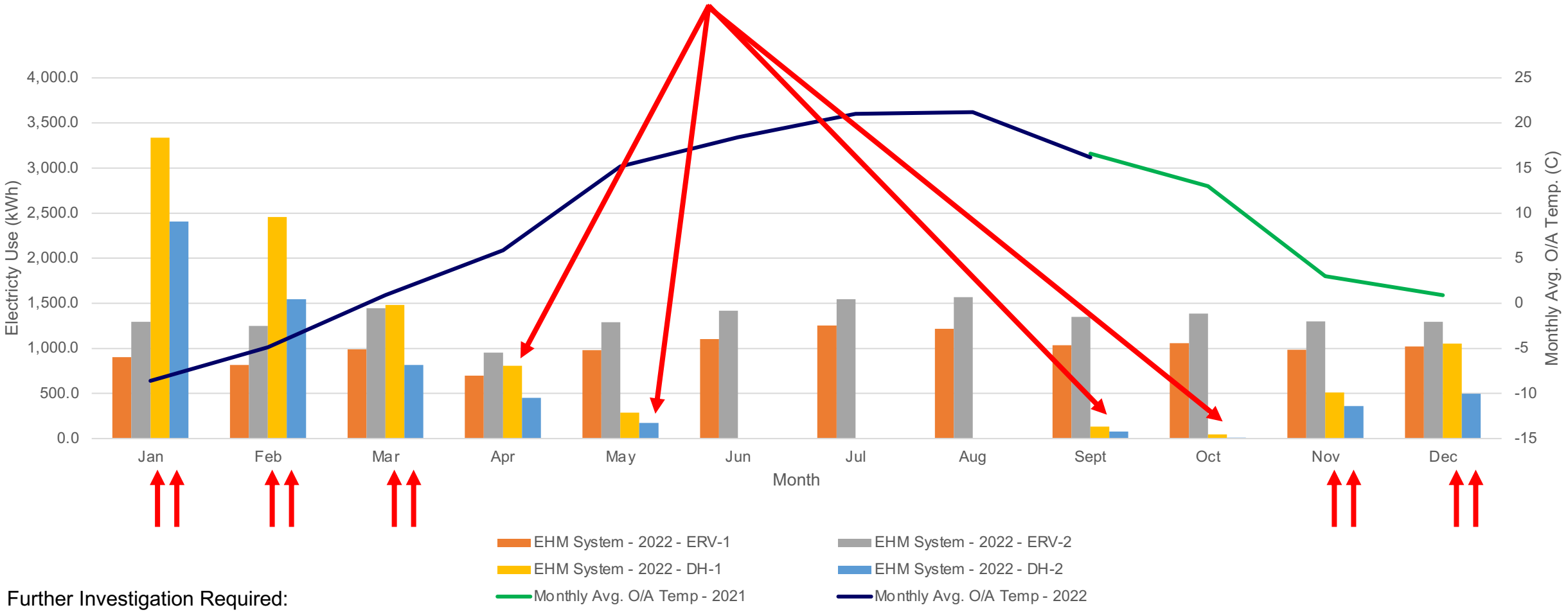
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Energy Model - WUFI Passive	4,647.6	4,135.5	3,549.9	2,735.8	2,374.4	2,355.1	2,355.1	2,355.1	2,355.1	2,394.9	2,946.7	4,279.3	36,484.5
EHM System - 2021 - Total									2,340.8	2,497.8	3,160.9	3,866.1	
Actual vs. WUFI Passive									-1%	4%	7%	-10%	
EHM System - 2022 - Total	7,937.0	6,065.7	4,733.5	2,905.5	2,729.7	2,523.7	2,798.7	2,788.8	2,599.4	*2,497.8*	*3,160.9*	*3,866.1*	44,606.6
Actual vs. WUFI Passive	71%	47%	33%	*6%*	15%	7%	19%	18%	10%	*4%*	*7%*	*-10%*	22%
2022 Energy Use Intensity	15.2	kWh/m2/yr		*Metering system was missing data in April 2021 and was smoothed based on outdoor temperature									

Ventilation Electricity Use

Would expect electric duct heater to be off during these months; VRF LEV kit should have capacity to heat SA to 17C.

Includes:

- (2) Swegon Gold 12RX ERVs with VRF LEV kit and 8.0 kW electric post-heater



Further Investigation Required:
Check sequence of operations and temp. setpoints; electric post-heater should only turn on if VRF LEV kit cannot. Also review ERV wheel speed at these times.