Effects and Outcomes of IAQ & Advanced Heat Recovery

Presented By:

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Introductions

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Agenda

- Indoor Air Quality (IAQ) & Occupant Health
- HRV Technology & Building Energy Consumption
- Industry Trends
- Success Stories

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Outdoor Air Quality

TABLE 1 Nominal daily maximum CO_2 levels (ppm) at select urban sites compared with Mauna Loa values.

SITE	DATA YEAR	MAUNA LOA	URBAN	DIFFERENCE
Phoenix, Ariz.	2000	369	575[12]	206
Baltimore	2006	382	438[13]	106
Evanston, Ill.	2011	392	440[14]	48
Los Angeles	2015	400	622[15]	222

Mauna Loa Data from Reference 8. Data current as of July 2021.

8. NASA. 2021. "Global Climate Change Carbon Dioxide." NASA. https://tinyurl.com/ntvyuzha

Natural Mechanisms

Industrialization

Population

Outdoor Air Quality

TABLE 1 Nominal daily maximum CO_2 levels (ppm) at select
with Mauna Loa values.

SITE	DATA YEAR	MAUNA LOA
Phoenix, Ariz.	2000	369
Baltimore	2006	38
Evanston, Ill.	2011	3
Los Angeles	2015	

Mauna Loa Data from Reference 8.

8. NASA. 2021. "Global Climate Change Carbon Dioxide." NASA. https://tinyurl.com/ntvyuzha

Outdoor air quality is affected by many variables and is generally worse in urban areas

Natural Mechanisms

Industri

How IAQ affects building occupants

- Allergic Reactions
- Asthma
- Respiratory Infections
- Loss of Focus
- Reduced Productivity
- Cardiovascular Disease
- Cancer
- Legionnaire’s disease

How IAQ affects building occupants

Many buildings are failing their occupants by having unacceptable indoor air quality and leaving occupants vulnerable

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Productivity

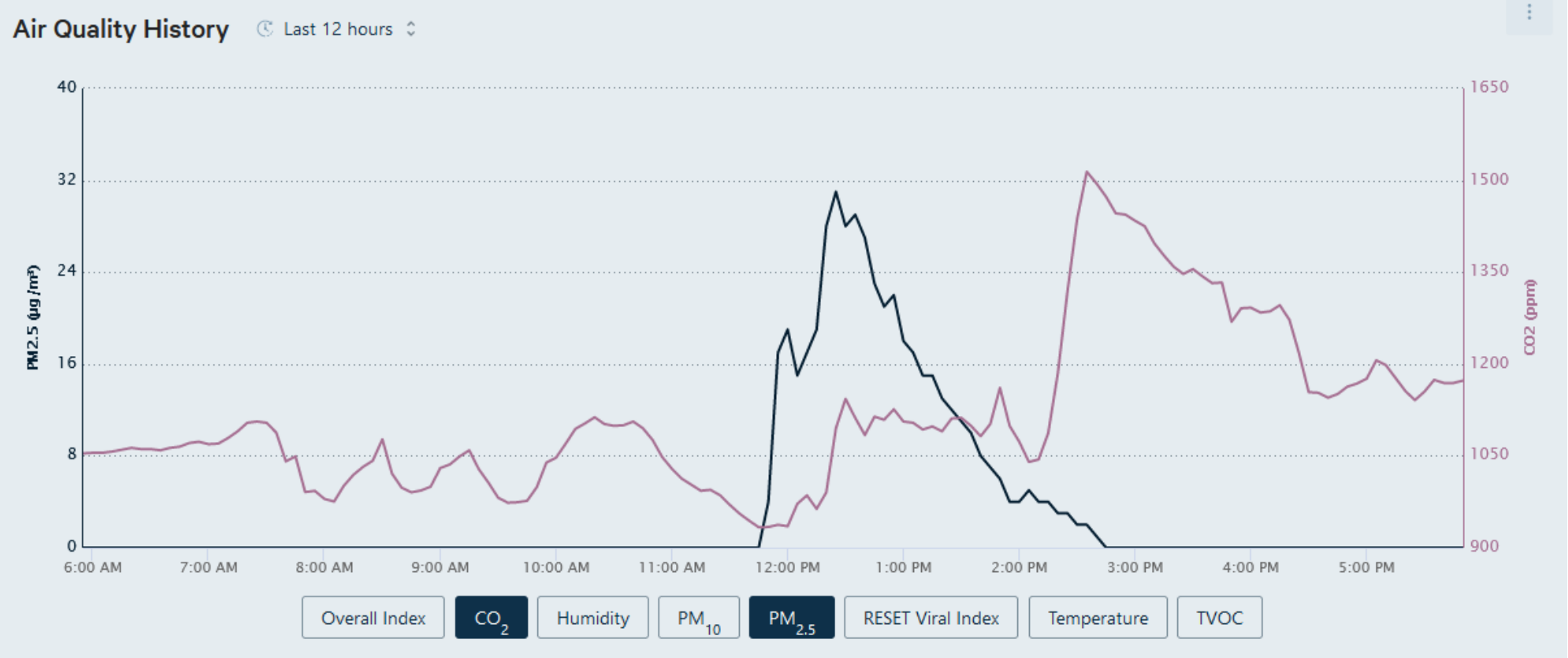
ascular Disease

er

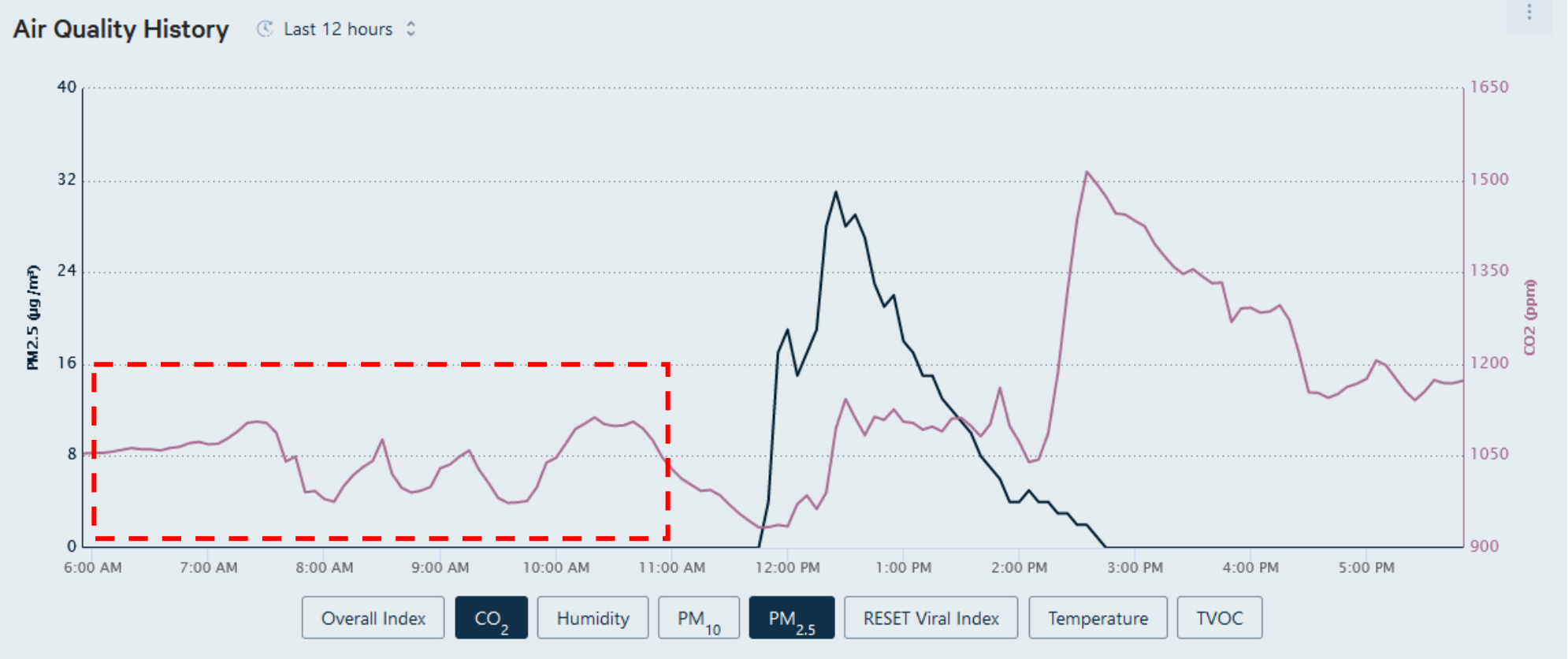
egionnaire's disease

How to Improve IAQ

Sensors and Monitoring



Sensors and Monitoring



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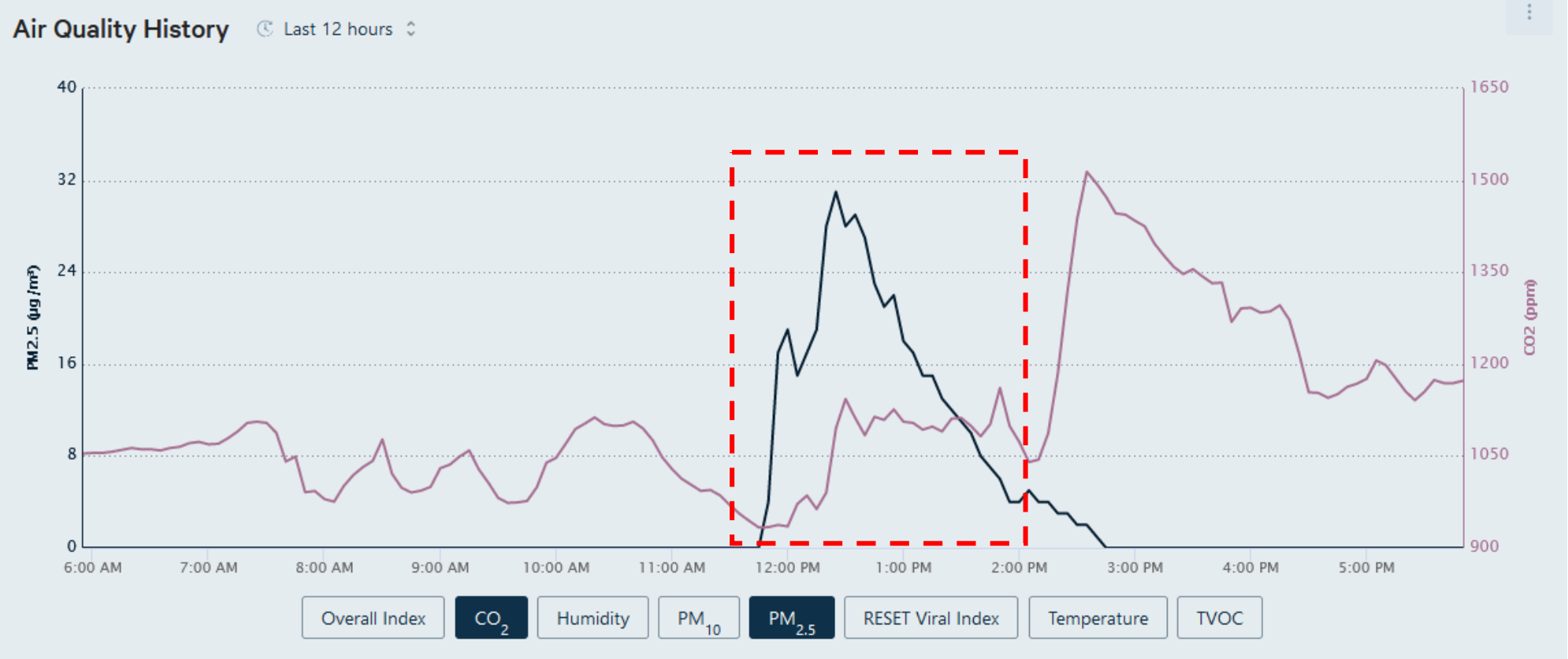

Sensors and Monitoring

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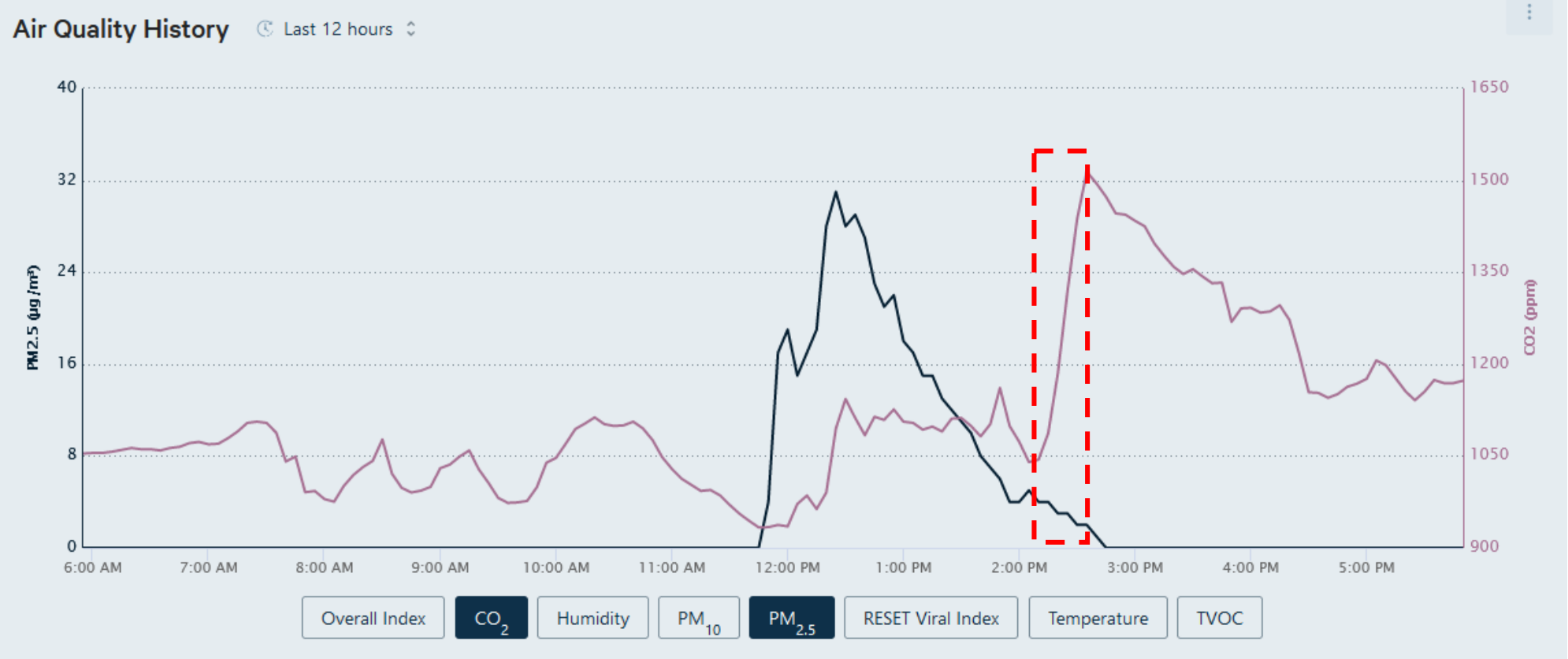

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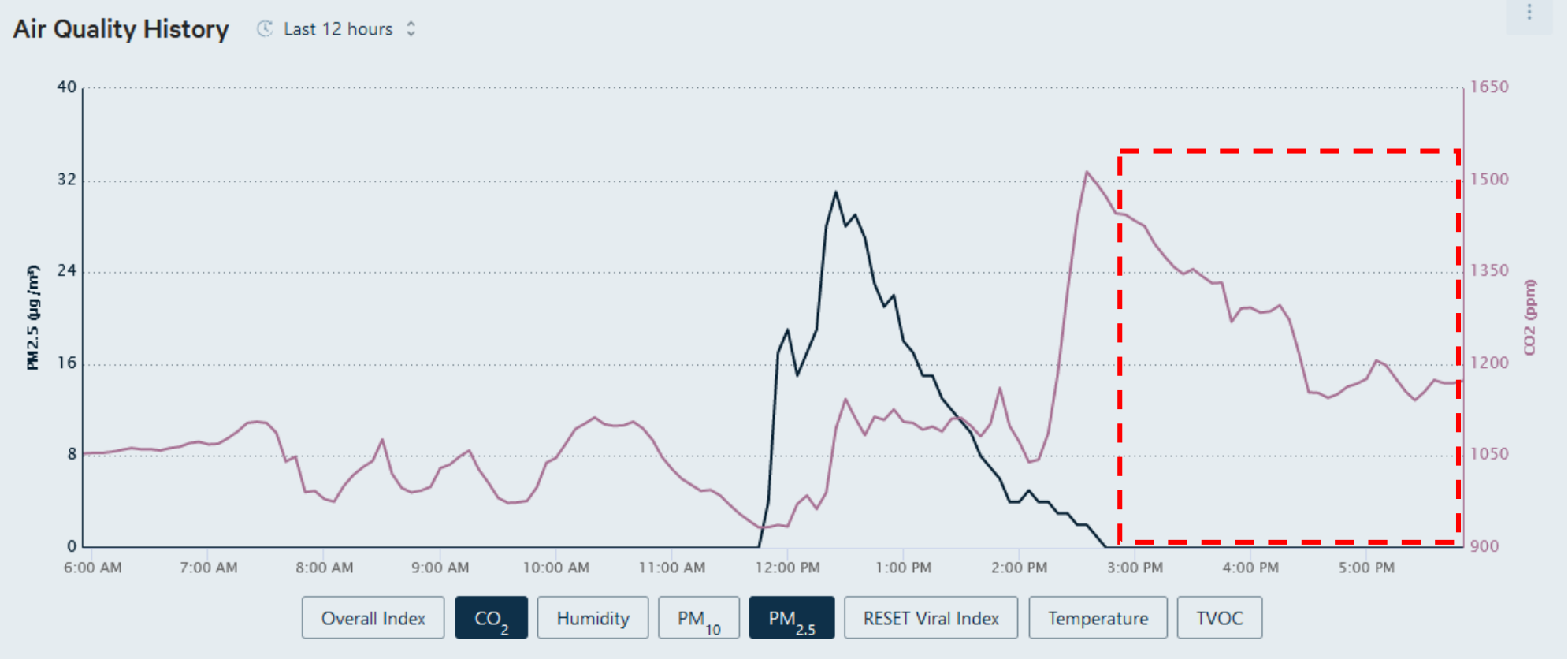

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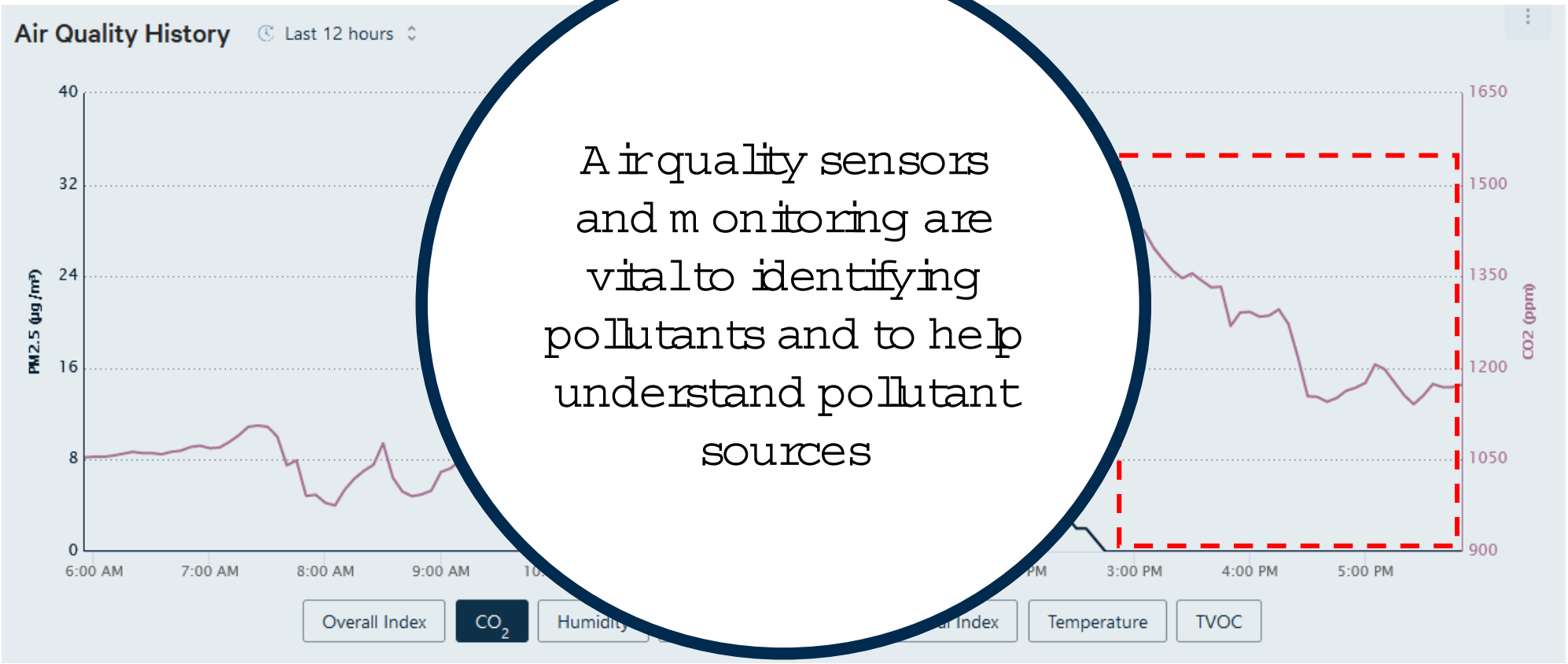
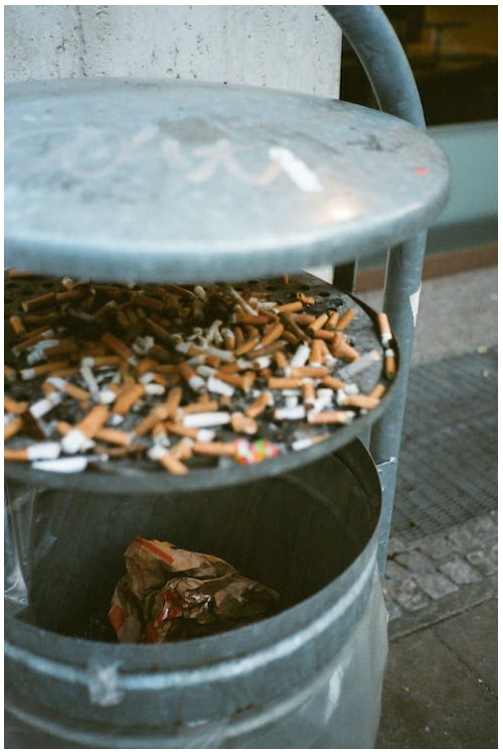


Air quality sensors and monitoring are vital to identifying pollutants and to help understand pollutant sources

Reducing Pollutants

Avoid High VOC Products

Avoid Tobacco Products



Promote Building Policies

Reducing Pollutants

Avoid High VOC Products

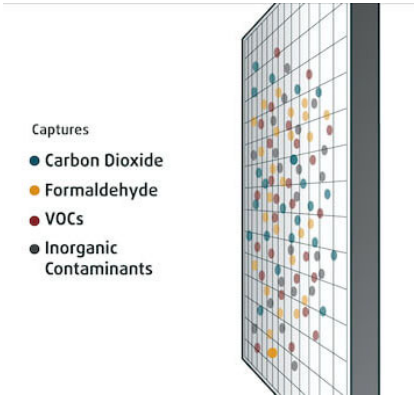
Reducing pollutants contributes to a healthier building

Promote Building Policies

Cleaning the Air

Mechanical Filtration

Air Scrubbing



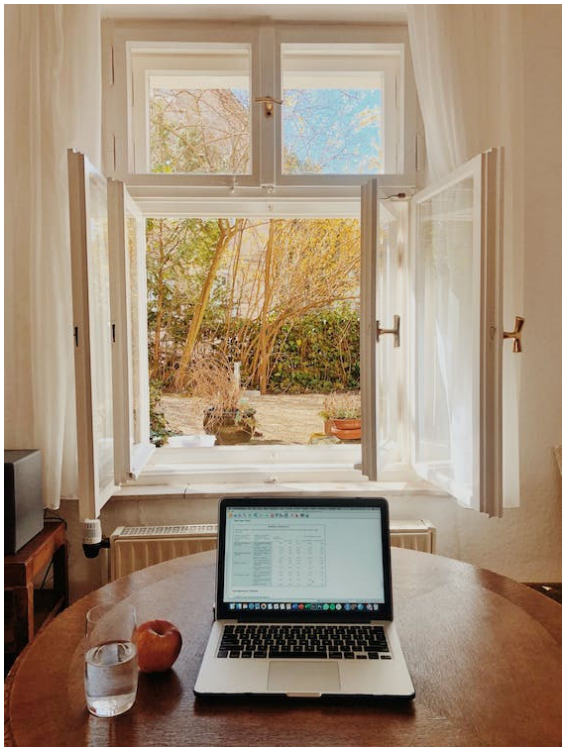
Bipolar Ionization

UV Light Systems

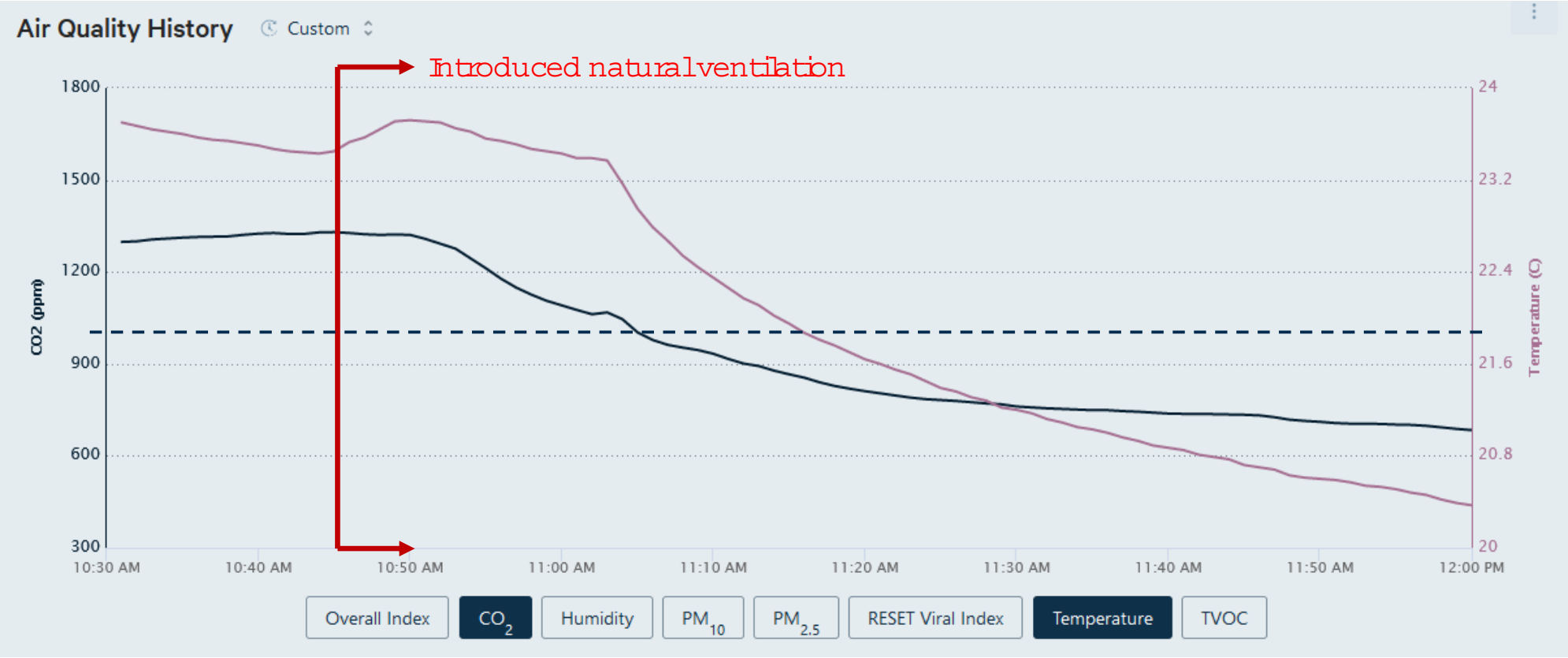
Increasing Fresh Air

Mechanical Ventilation

Natural Ventilation



Increasing Fresh Air with Natural Ventilation



Increasing Fresh Airwith NaturalVentilation

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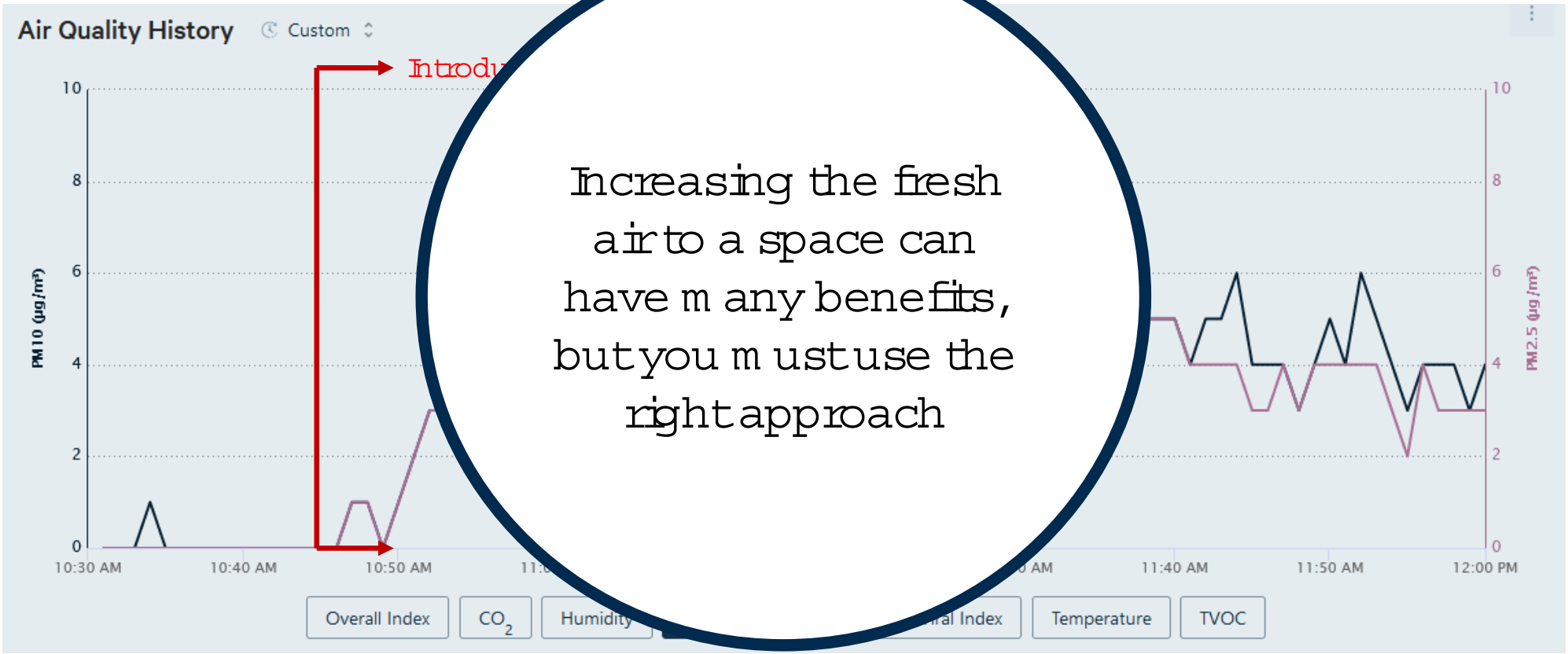
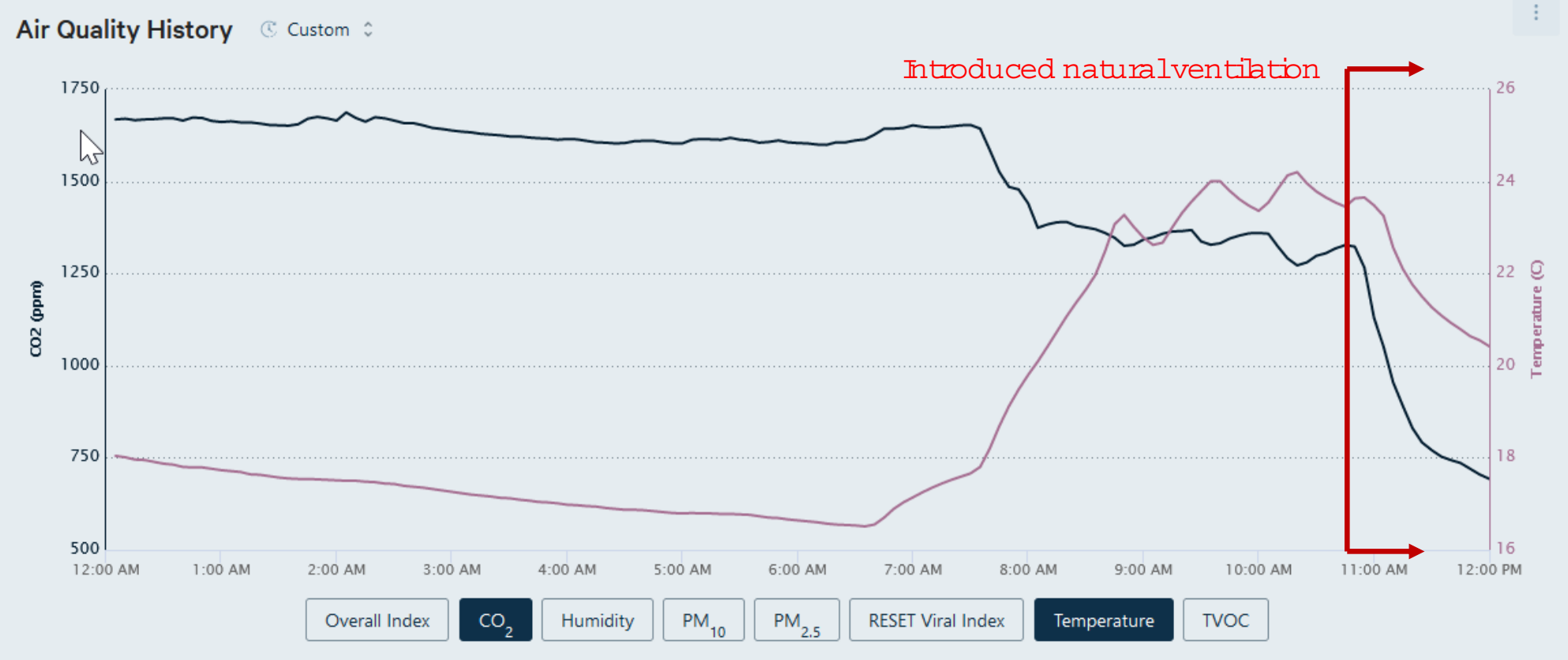


Increasing the fresh air to a space can have many benefits, but you must use the right approach

Increasing Fresh Air with Natural Ventilation

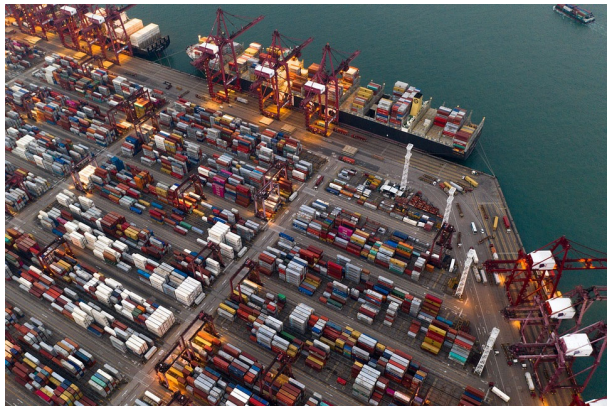


What's coming up in IAQ?

More Stringent Regulations

Greater Awareness on Health Effects

Economic Trends

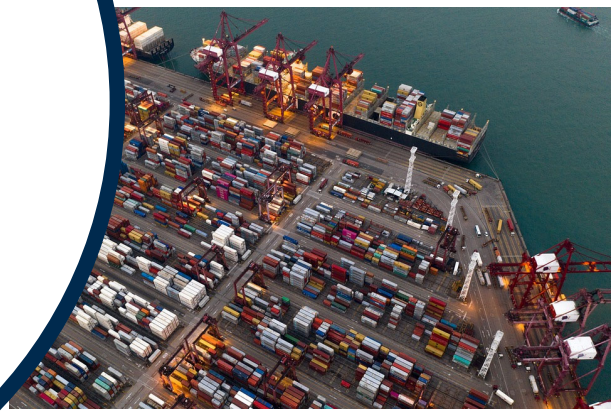


What's coming up in IAQ?

More Stringent Regulations

More awareness will drive new changes in both policies and the economy focused on incentivizing better air quality

Economic Trends



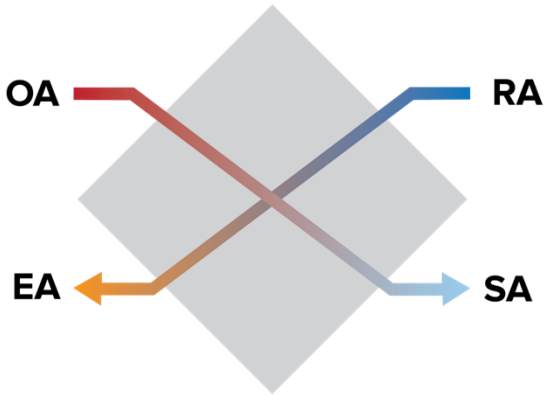
Agenda

- IAQ & Occupant Health
- HRV Technology & BC Building Code
- Industry Trends
- Success Stories

The Basics

Heat/Energy Recovery

- A device that recovers energy from indoor or outdoor spaces while providing this space with more fresh air. During this process, it recovers heat to minimize heating/cooling bads in the space it is serving.



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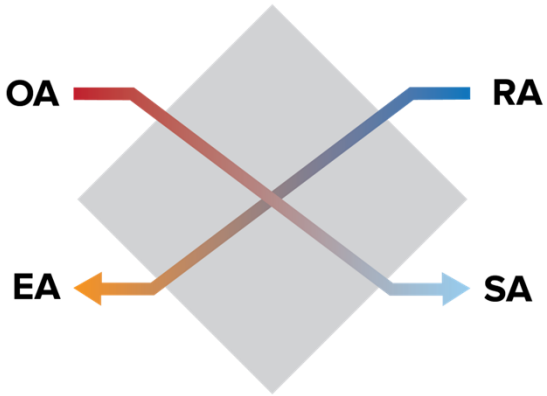
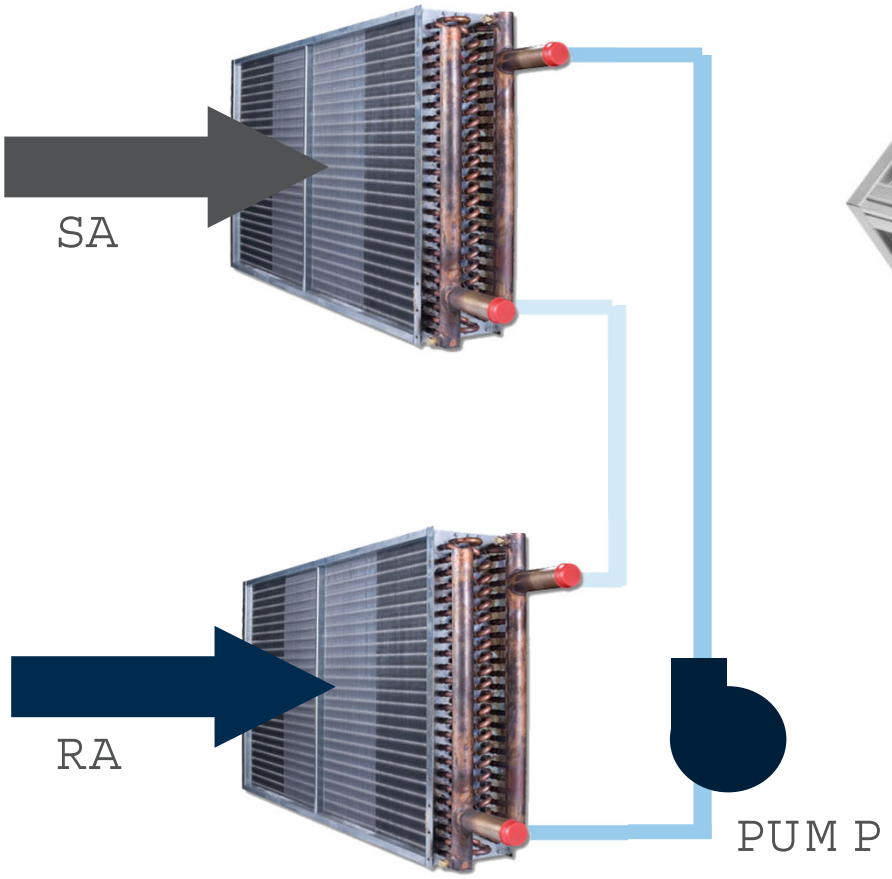
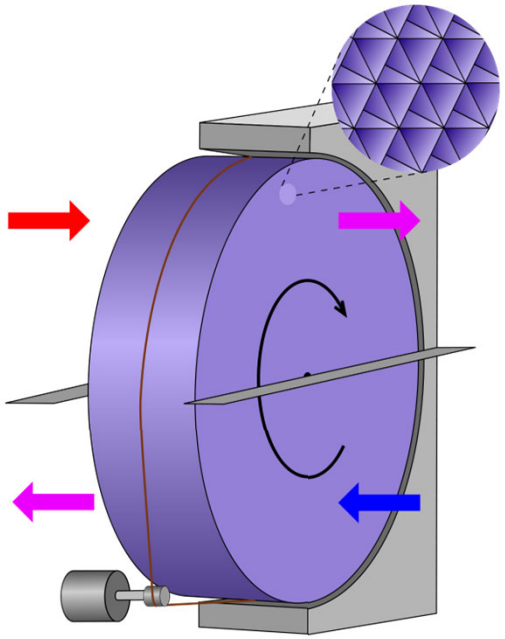


HRV vs ERV?

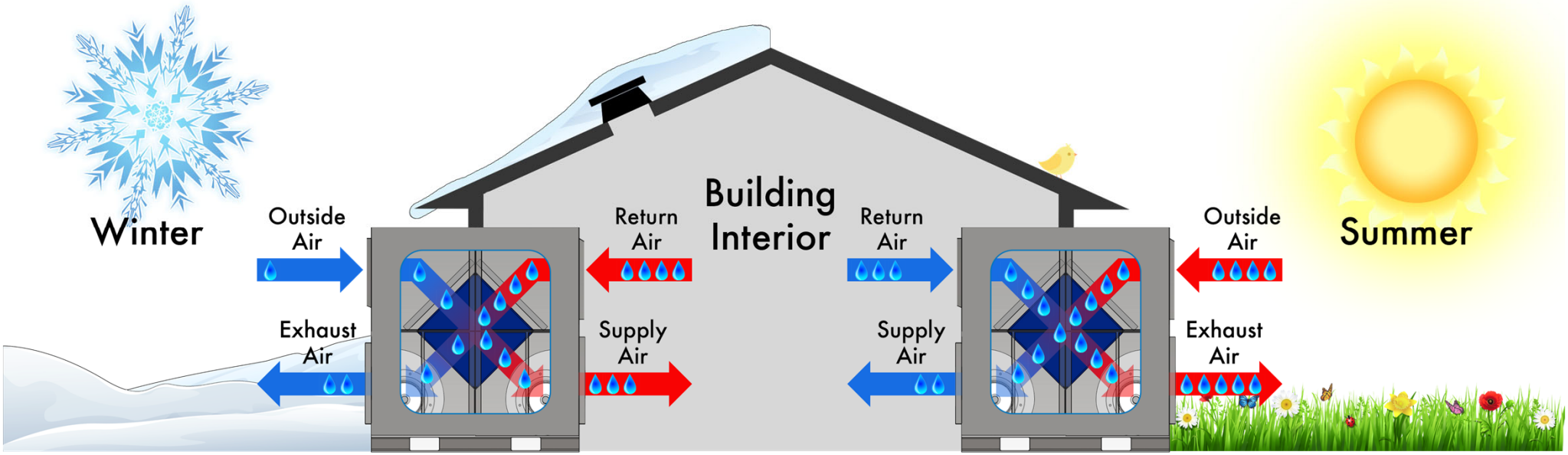
- HRV (typically plastic or aluminum) systems recover only heated or cooled air, depending on the season, while ERV (typically paper or polymer-based) systems recover heat and relative humidity.
- ERV = Sensible & Latent Recovery
- HRV = Sensible Only Recovery

The Options





Balanced Ventilation with Energy Recovery

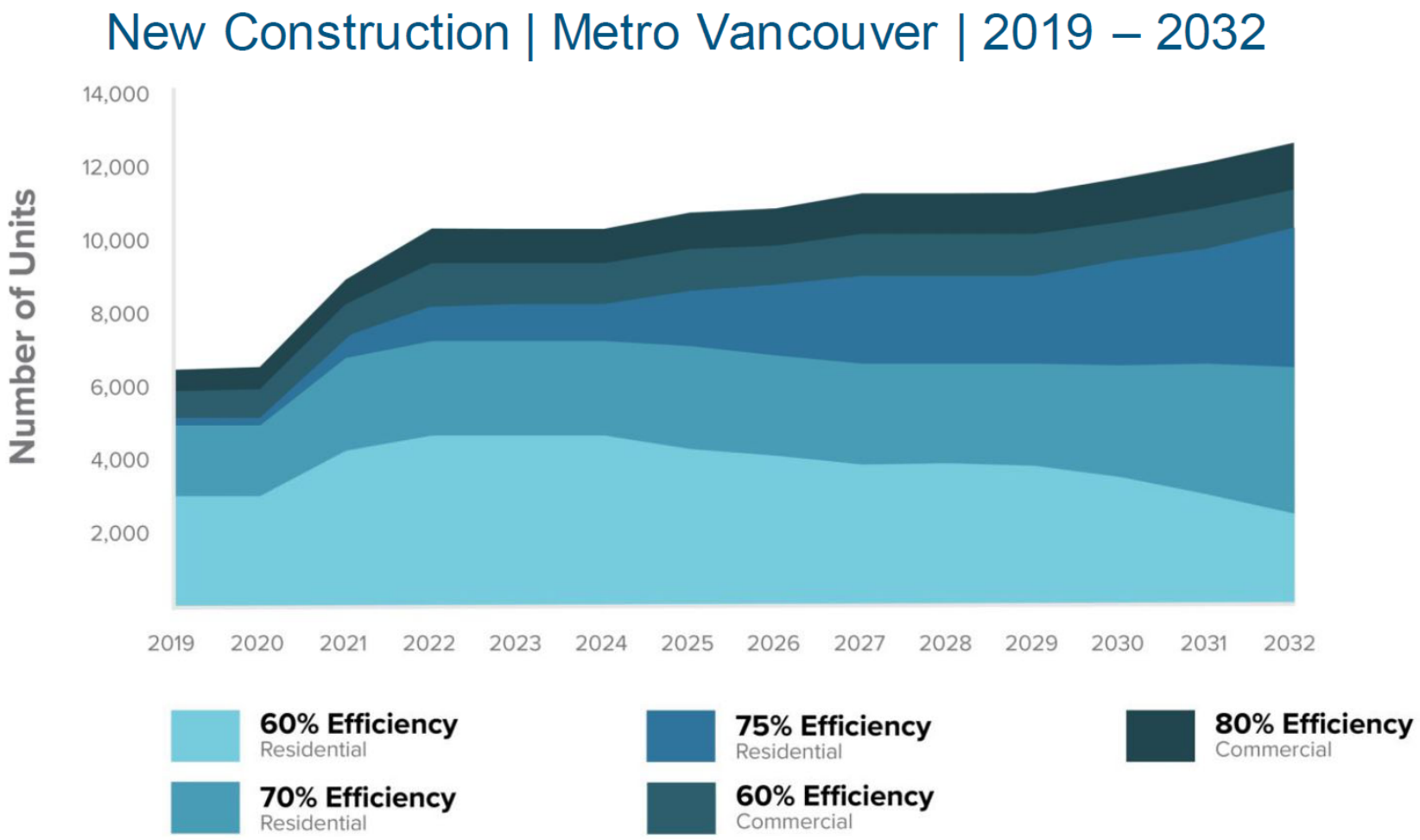


Humidifies in winter and dehumidifies in summer.
Reduces energy costs and provides fresh air and optimal indoor comfort.

Metrics of Performance

METRIC	WHEELS	FIXED PLATE	HEAT PIPE	RUN AROUND LOOP
Performance (SRE)	70 – 90%	60 – 85%	50 – 60%	40 – 50%
EATR	1 – 10%	0 – 5%	0 – 1%	0% (separate channels)
OACF	0.95 – 1.5	0 – 1.06	0.99 – 1.01	1.0
Moving Parts	Motor/Belt/Bearing	None	None	Pump
Application	High flow rate Compact size	Low cross contamination Low maintenance	Low cross contamination	Class 4 air retrofit

Heat Recovery Ventilator Market: Metro Vancouver



BC Building Code: Ventilation Requirements

- BC Building Code (BCBC) is a provincial regulation that governs how new construction, building alterations, repairs and demolitions are completed.
- Prescribes ventilation requirements based on dwelling type
  - This typically references ASHRAE 62.1 or 62.2
- Applies province-wide
- Carbon pollution standards for new construction are stated

Ventilation Standards: ASHRAE 62.1

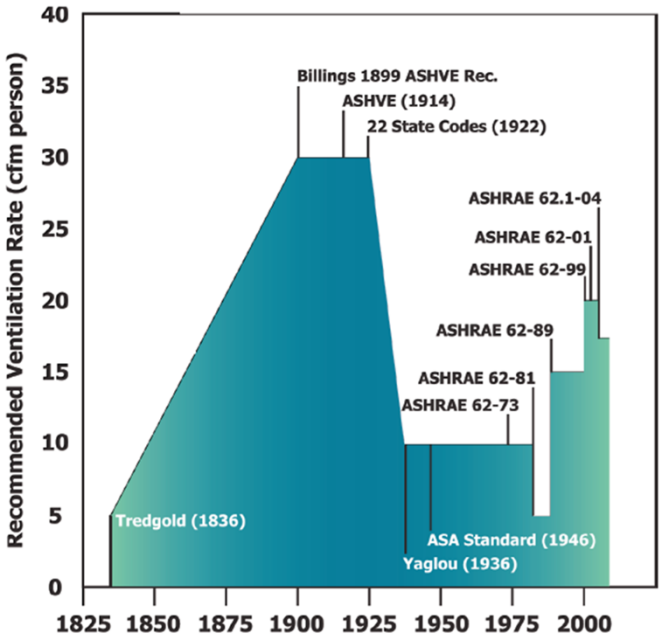


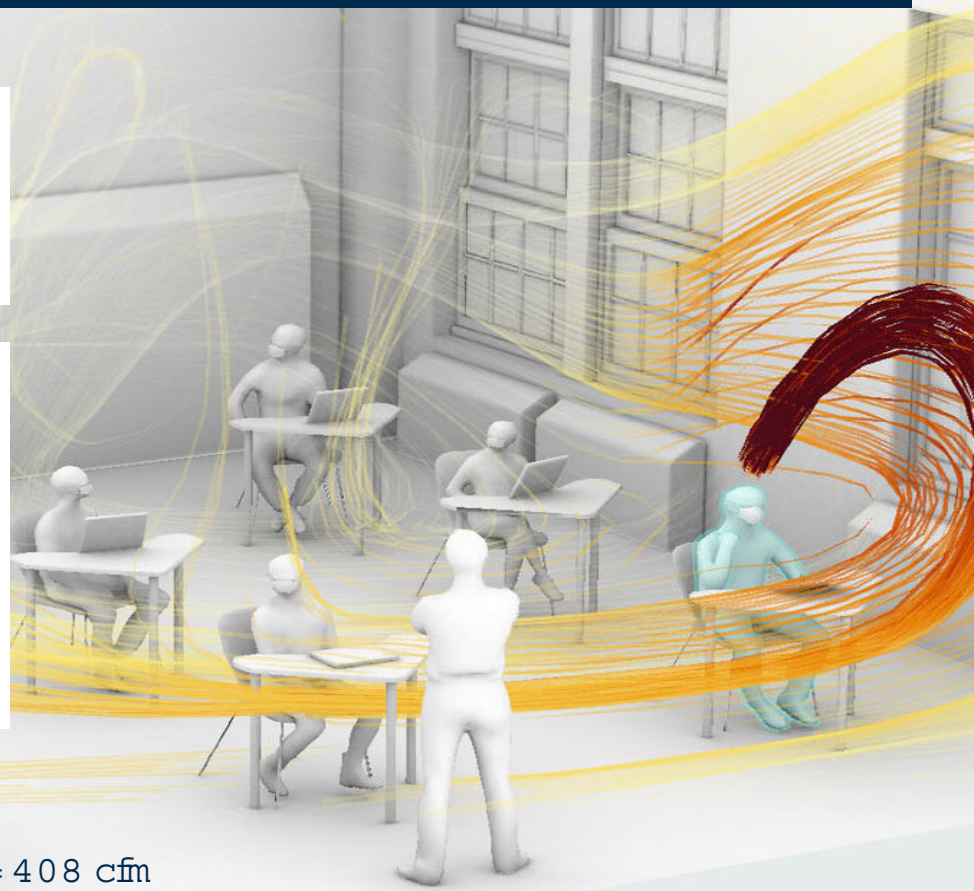
TABLE 6.2.2.1 Minimum Ventilation Rates in Breathing Zone *(Continued)*
(Table 6.2.2.1 shall be used in conjunction with the accompanying notes.)

	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a			Default Values			
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
Occupancy Category	cfm/person	L/s person	cfm/ft²	L/s m²	Notes	#/1000 ft² or #/100 m²	cfm/person	L/s person	Air Class
Residential									
Dwelling unit	5	2.5	0.06	0.3	F,G, H	F			1
Common corridors	—	—	0.06	0.3	H				1
Retail									
Sales (except as below)	7.5	3.8	0.12	0.6		15	16	7.8	2
Mall common areas	7.5	3.8	0.06	0.3	H	40	9	4.6	1
Barbershop	7.5	3.8	0.06	0.3	H	25	10	5.0	2
Beauty and nail salons	20	10	0.12	0.6		25	25	12.4	2
Pet shops (animal areas)	7.5	3.8	0.18	0.9		10	26	12.8	2
Educational Facilities									
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6	2
Daycare sickroom	10	5	0.18	0.9		25	17	8.6	3
Classrooms (ages 5–8)	10	5	0.12	0.6		25	15	7.4	1
Classrooms (age 9 plus)	10	5	0.12	0.6		35	13	6.7	1
Office Buildings									
Breakrooms	5	2.5	0.12	0.6		50	7	3.5	1
Main entry lobbies	5	2.5	0.06	0.3	H	10	11	5.5	1
Occupiable storage rooms for dry materials	5	2.5	0.06	0.3		2	35	17.5	1
Office space	5	2.5	0.06	0.3	H	5	17	8.5	1
Reception areas	5	2.5	0.06	0.3	H	30	7	3.5	1
Telephone/data entry	5	2.5	0.06	0.3	H	60	6	3.0	1
Multiuse assembly	7.5	3.8	0.06	0.3	H	100	8	4.1	1

ASHRAE 62.1 Minimum Ventilation Rate Procedure

TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values: Occupant Density (see Note 4)	Default Values: Combined Outdoor Air Rate (see Note 5)		Air Class
	cfm/person	L/s·person	cfm/ft²	L/s·m²		#/1000 ft² or #/100 m²	cfm/person	L/s·person	
Educational Facilities									
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6	2
Daycare sickroom	10	5	0.18	0.9		25	17	8.6	3
Classrooms (ages 5–8)	10	5	0.12	0.6		25	15	7.4	1
Classrooms (age 9 plus)	10	5	0.12	0.6		35	13	6.7	1
Lecture classroom	7.5	3.8	0.06	0.3		65	8	4.3	1
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3		150	8	4.0	1
Art classroom	10	5	0.18	0.9		20	19	9.5	2
Science laboratories	10	5	0.18	0.9		25	17	8.6	2
University/college laboratories	10	5	0.18	0.9		25	17	8.6	2
Wood/metal shop	10	5	0.18	0.9		20	19	9.5	2
Computer lab	10	5	0.12	0.6		25	15	7.4	1



- Assume: 30 students in a 30'x30'x9' classroom
- ASHRAE 62.1: 30 x 10 cfm/person + 0.12 cfm/ft2 x 900 ft2 = 408 cfm
- Air Changes/Hour: (408 x 60)/(30 x 30 x 9) = 3 ACH

Healthy Buildings

BUILDING FOR HEALTH

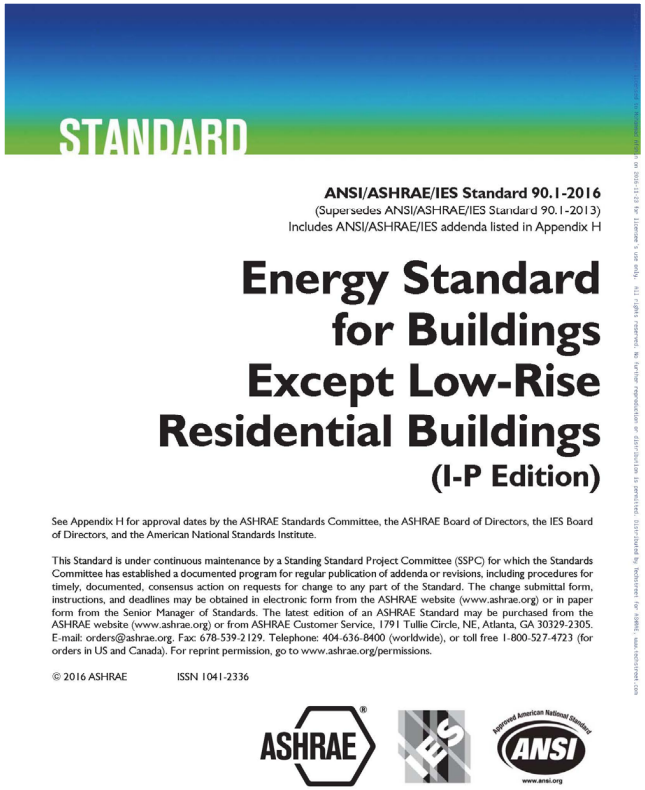
HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

HEALTHY BUILDINGS

TARGET IS AT LEAST 5 TOTAL AIR CHANGES PER HOUR

- *Ideal (6 ACH)*
- *Excellent (5-6 ACH)*
- *Good (4-5 ACH)*
- *Bare minimum (3-4)*
- *Low (<3 ACH)*

ASHRAE Standard 90.1: Energy Efficiency


STANDARD

ANSI/ASHRAE/IES Standard 90.1-2016
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2013)
Includes ANSI/ASHRAE/IES addenda listed in Appendix H

Energy Standard for Buildings Except Low-Rise Residential Buildings
(I-P Edition)

See Appendix H for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IES Board of Directors, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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ASHRAE IES ANSI

The standard that provides minimum requirements for energy efficiency in buildings

6.5.6.1 Exhaust Air Energy Recovery.

Energy recovery systems required (by table 6.5.6.1) shall have at least 50% total ratio.

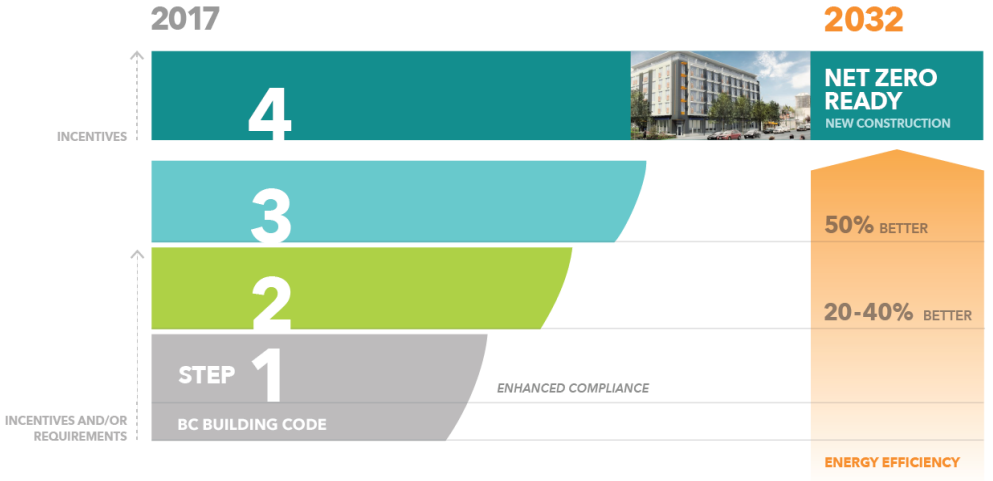
(This) shall mean a change in the enthalpy of the outdoor air supply equal to 50% of the difference between the outdoor air and return air enthalpies at design conditions.

ASHRAE

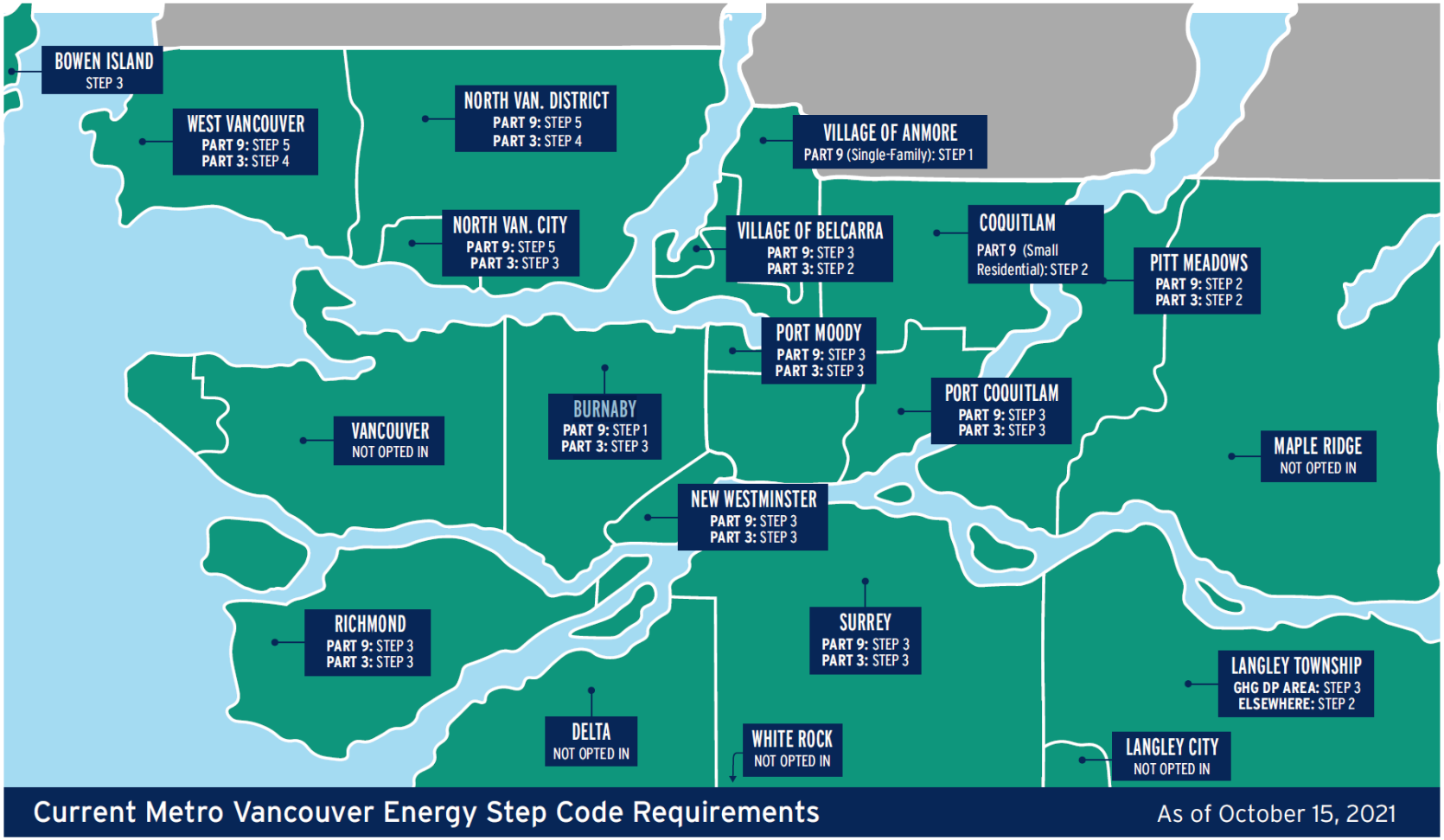
BC Energy Step Code

- Optional compliance path in the BC Building Code that municipal governments can use to incentivize a level of energy efficiency in new construction.
- Depending on building type, there are 4 to 5 Steps in the Code
- Step 1: Standard BC Building Code
- Step 4/5: Net zero design (similar to Passive House)
- Municipalities adopt each step on their own accord
- Design to encourage a performance approach vs a prescriptive approach
- Provincial BC Energy Step Code has accelerated the level of step code required for Commercial and Residential buildings by 20% for 2022.

ENERGY STEPCODE
BUILDING BEYOND THE STANDARD

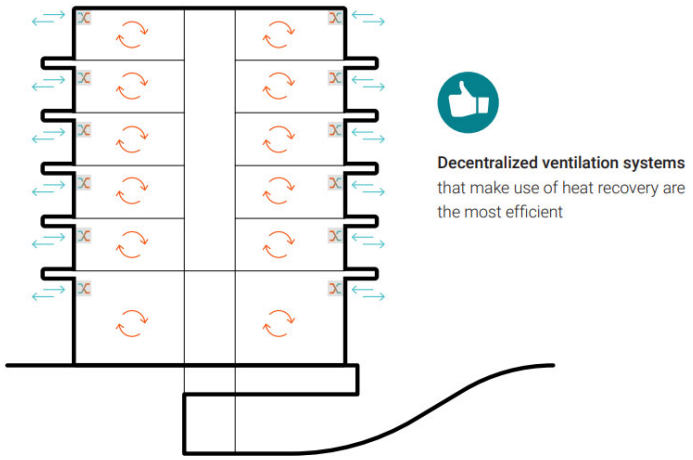


BC Energy Step Code – Adoption Timeline



BC Energy Step Code & Energy Recovery

- Step Code does not require minimum levels of heat recovery efficiency since it is a performance approach metric
- When achieving higher efficiencies on a HRV or ERV, the envelope and glazing doesn't have to be as robust
- Primary metric of focus is the TEDI & TEUI
- By 2032, market for High-Efficiency HRV's (>75%) to achieve over half of HRV sales in Metro-Van



Decentralized ventilation systems that make use of heat recovery are the most efficient

Table 3.2 Modeled heating and cooling energy savings of HRV compared to continuous balanced ventilation with no HRV

Location	Heating Degree Days†	Annual Energy Cost Savings Per Suite and % Reduction in Ventilation Heating and Cooling Energy Due to an HRV‡	
		Gas Furnace & Central AC	Electric Baseboard & No Cooling
Vancouver	2825	$170 (78%)	$300 (67%)
Toronto	3520	$170 (70%)	$580 (66%)
Montreal	4200	$120 (73%)	$360 (67%)

*Provided by BC Housing, HRV assumed to achieve 65% SRE at 97 cfm per suite: https://www.bchousing.org/sites/default/files/rcg-documents/2022-04/Heat-Recovery-Ventilation-Guide-MURBs.pdf

Generally, Step 3 requires >75% SRE and Step 4/5 requires >80% SRE for H/ERVs.

Understanding TEDI & TEUI

TEDI (Thermal Energy Demand Intensity)

How much heat does a building require?

The Step Code TEDI and airtightness testing requirements ensure that the building loads are reduced to a reasonable level.

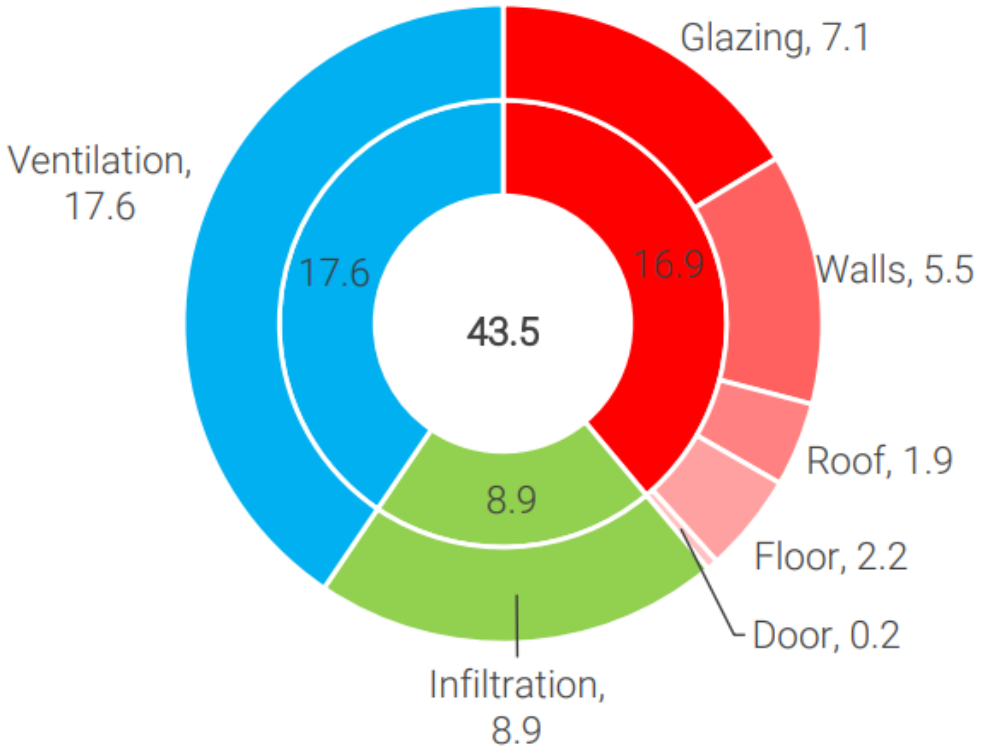
TEUI (Total Energy Use Intensity)

How much energy does a building consume?

The Step Code TEUI requirements ensure that the building equipment and systems use energy efficiently.

For buildings attempting to achieve a low TEDI, heat recovery from ventilation air is essential.

HRV Impact on TEDI



Step 2 MURB

- TEDI Requirement = 45kWh/m²/year

Step 4/5 MURB (or Passive House)

- TEDI Requirement = 15kWh/m²/year

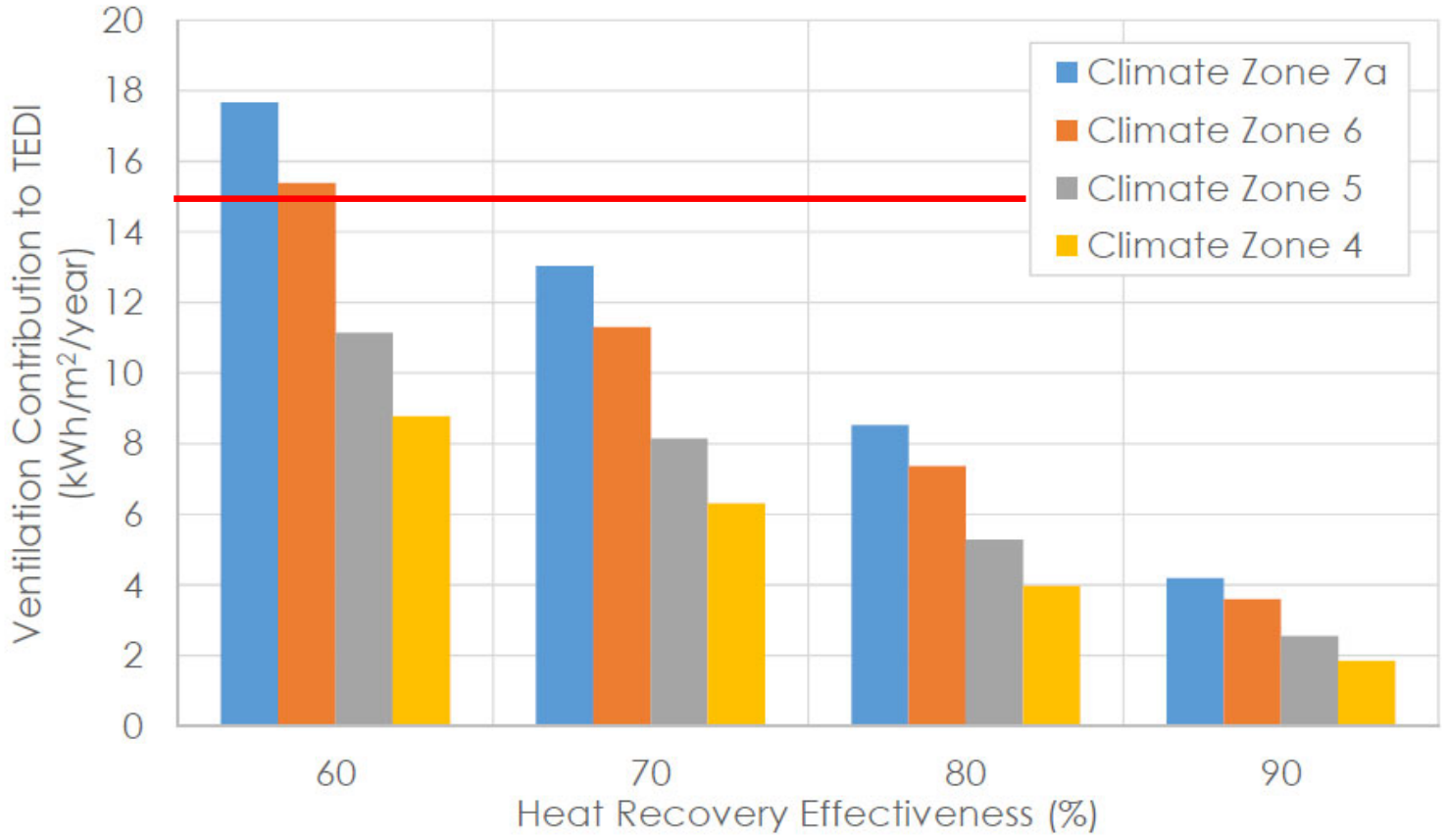
- 1995 Canadian National Household Average: 325 kWh/m²/yr
- 2015 Canadian National Household Average: 203 kWh/m²/yr

Compare the big 3 losses

- Ventilation (~40% of TEDI)
- Envelope – Infiltration
- Envelope – Assemblies

*https://edgesustainability.com/improvements-to-tedi-and-the-associated-impacts/

HRV Impact on TEDI



- For Step 4/5, TEDI Requirement = 15kWh/m²/year
- In Climate zone 4, implementing a high-efficiency HRV provides the following contribution to the overall TEDI score:
  - 60% SRE: 8.5 kWh/m²
  - 70% SRE: 6.2 kWh/m²
  - 80% SRE: 4.0 kWh/m²
  - 90% SRE: 1.8 kWh/m²

*Report by Morrison Hershfield
**Zone 4: Vancouver, Zone 5: Kamloops/Penticton, Zone 6: Prince George, Zone 7a: Dawson Creek

Agenda

IAQ & Occupant Health

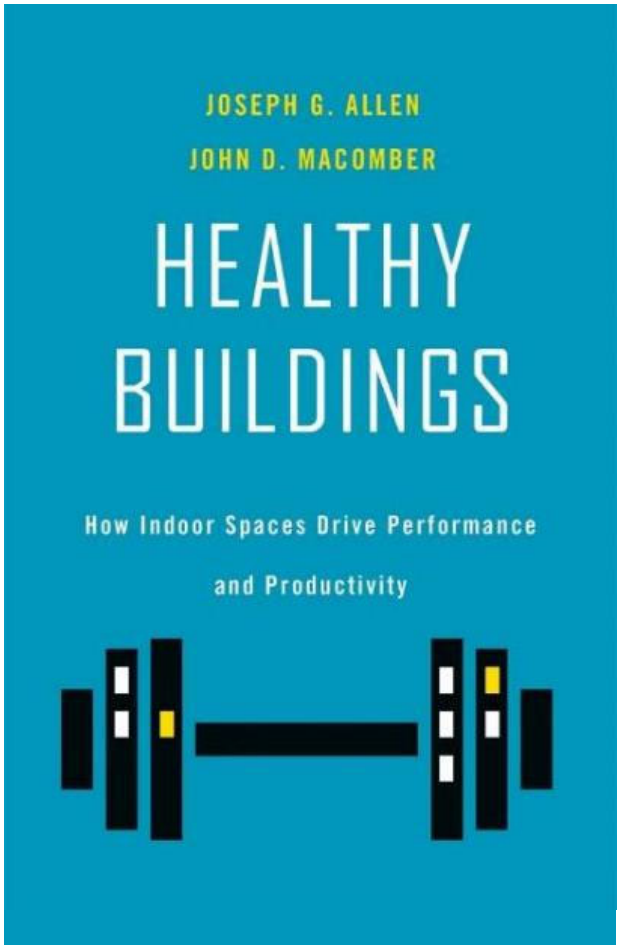
HRV Technology & BC Building Code

Industry Trends

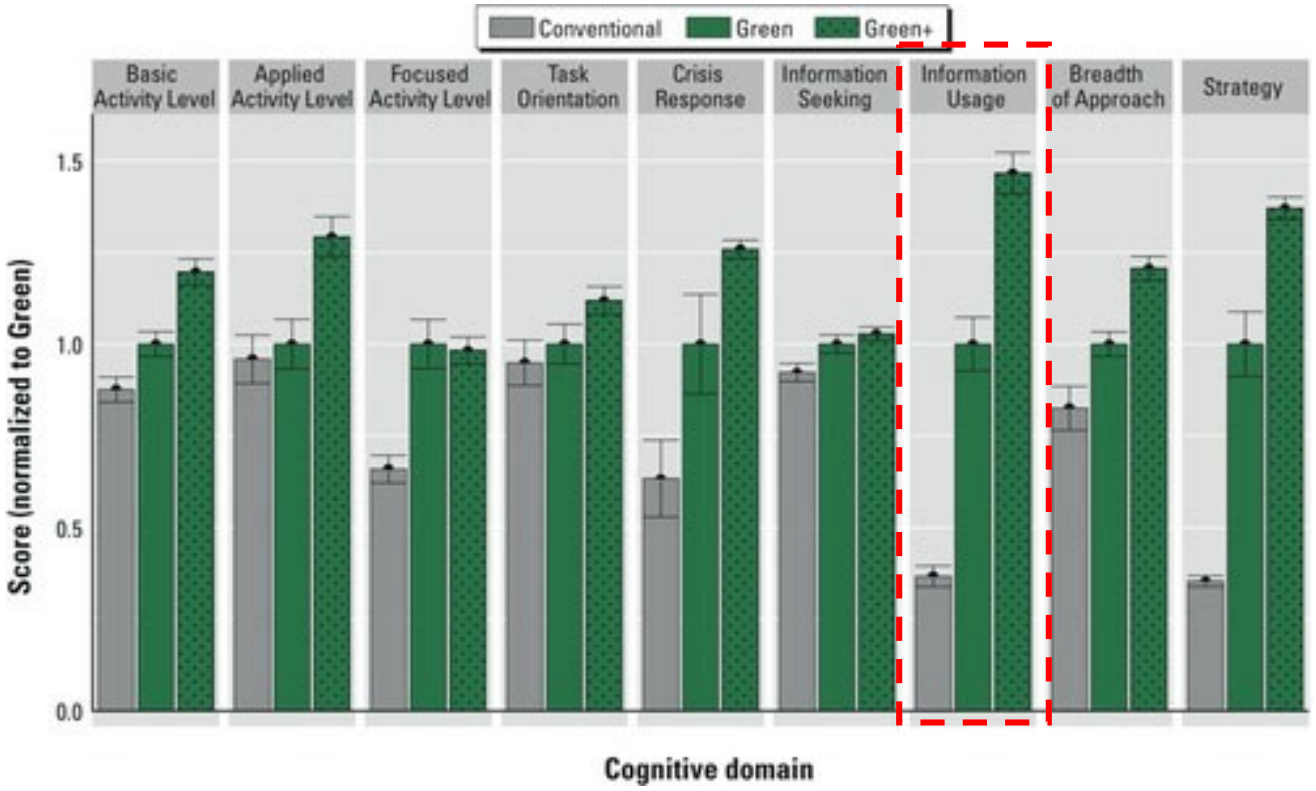
Success Stories

Greater Awareness on the Impact of IAQ on Health

Healthy Buildings and Cognitive Function



Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments



https://www.forbes.com/sites/jamiehailstone/2022/10/21/can-energy-efficiency-for-buildings-and-indoor-air-quality-ever-be-reconciled/?sh=3431f5651edf

Yes: Increase Ventilation Rates with a Low Energy Penalty

"Increase ventilation rates from 20 cfm/person to 40 cfm/person with a cost of less than $10/person/year"

Joseph Allen

High Efficiency Energy Recovery Ventilation

Less Fan Energy: ECM Fans, Lower Pressure Drop from Short Duct Runs

Free Cooling with Bypass and Natural Ventilation

Heat-Pumps with a High COP

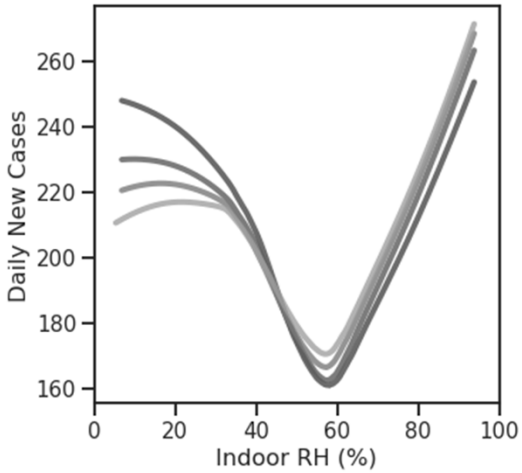
Smart Controls: Demand Control Ventilation

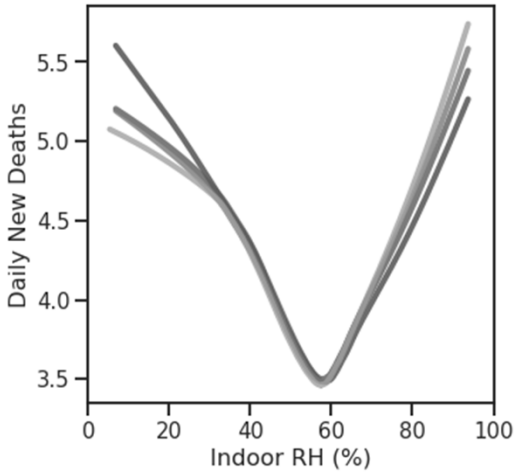
Importance of Relative Humidity

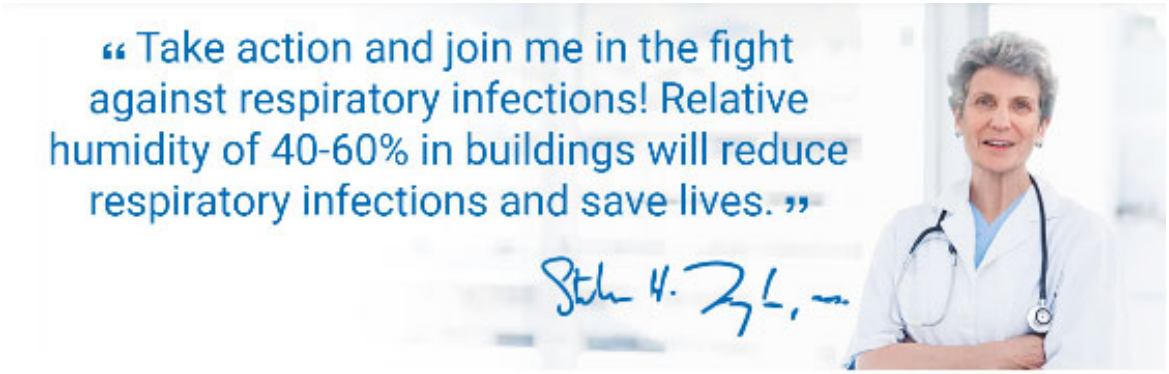
HEALTH

The Right Level of Humidity May Be Important Weapon in Fighting Coronavirus, New Studies Show

BY **DAVID H. FREEDMAN** ON 6/2/20 AT 5:30 AM EDT







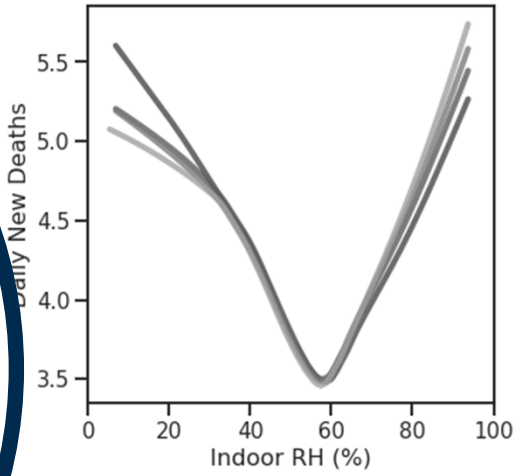
Importance of Relative Humidity

HEALTH

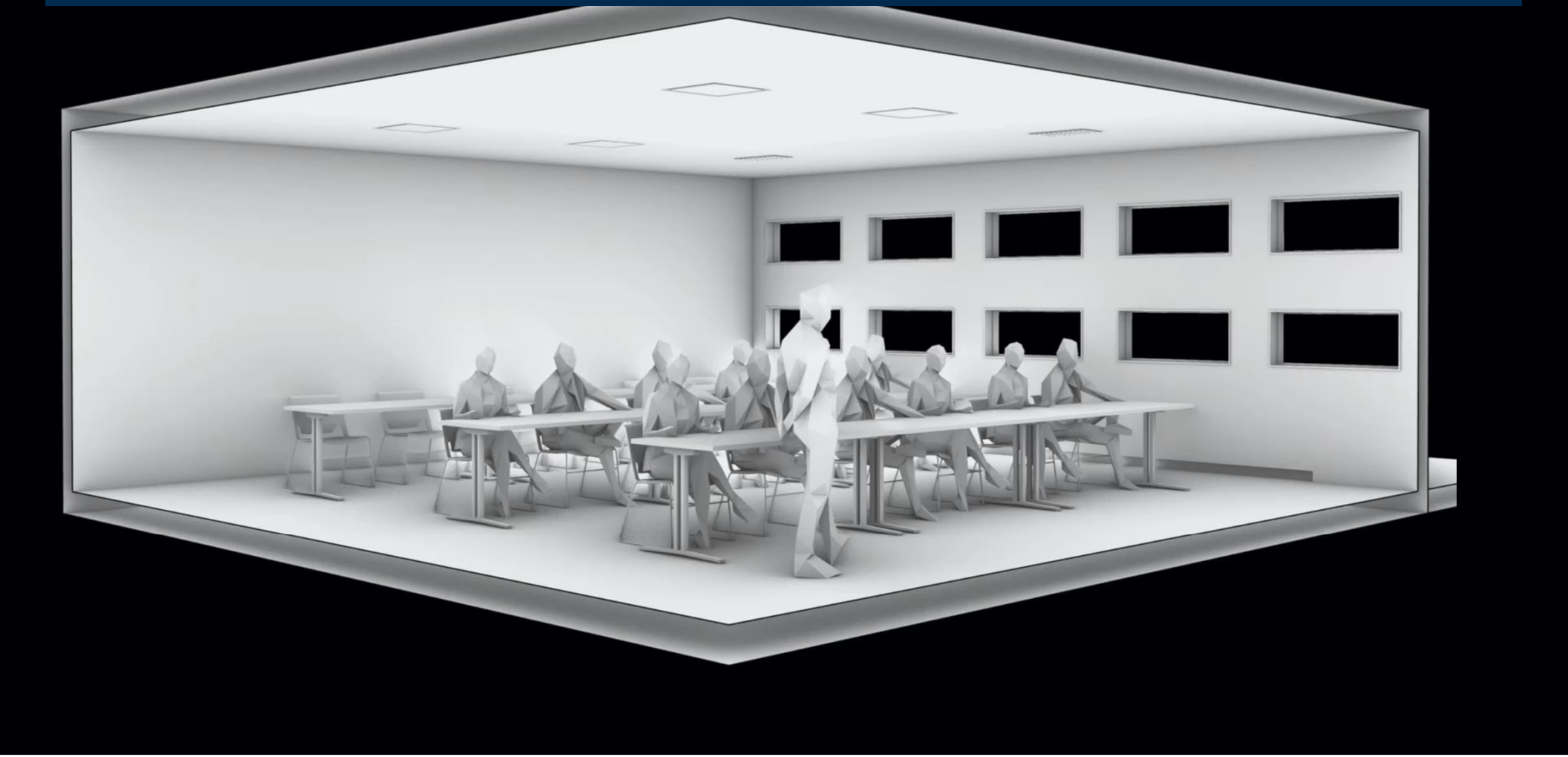
The Right Level of Humidity May Be I… Weapon in Fighting Coronavirus, Ne…

BY **DAVID H. FREEDMAN** ON 6/2/20 AT 5:30 AM EDT

Healthy indoor spaces with greater productivity and wellbeing are achievable at low costs



CFD Analysis: Traditional Overhead Ventilation



CFD Analysis: Traditional Overhead Ventilation

Agenda

- IAQ & Occupant Health
- HRV Technology & BC Building Code
- Industry Trends
- Success Stories

Innovative Fitness Studio Ventilation Retrofit

Average CO_2 Levels dropped from 2000 ppm to 800 ppm after installing the system

Innovative Finess Studio Ventilation Retrofit

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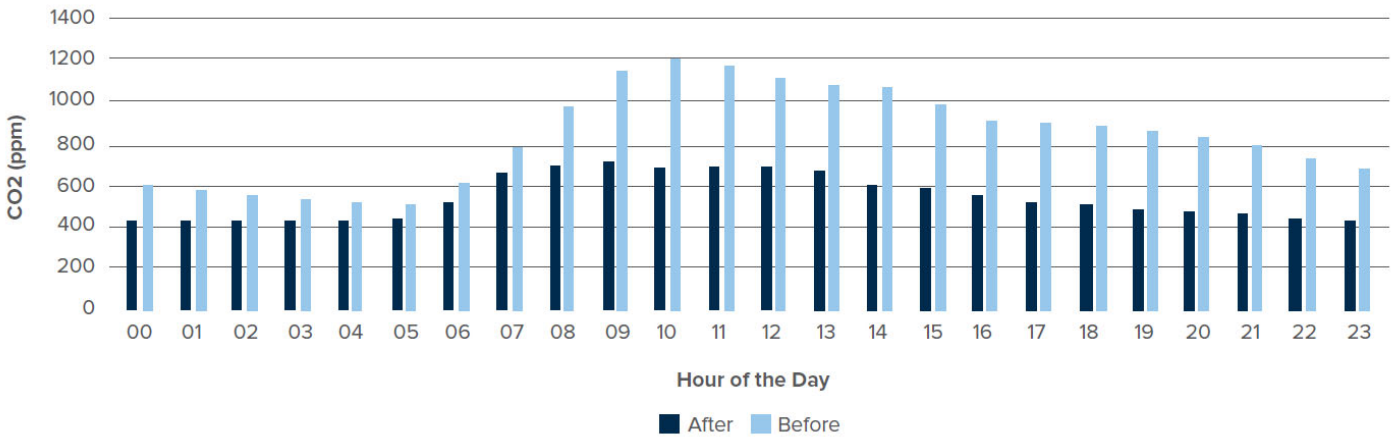

fig 1. CO2 Average Before and After Installation

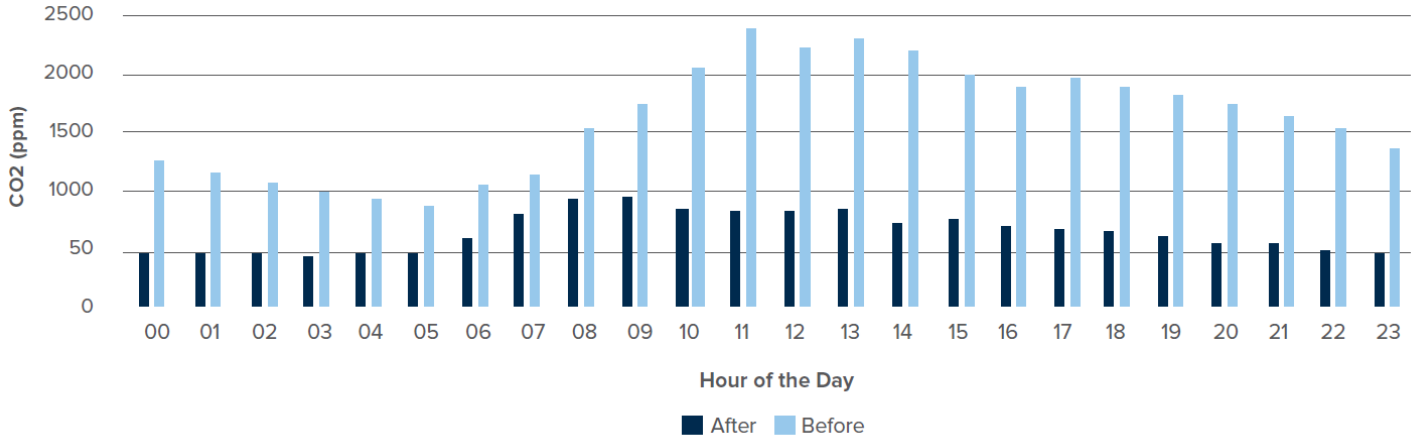

fig 1. CO2 Peaks Before and After Installation

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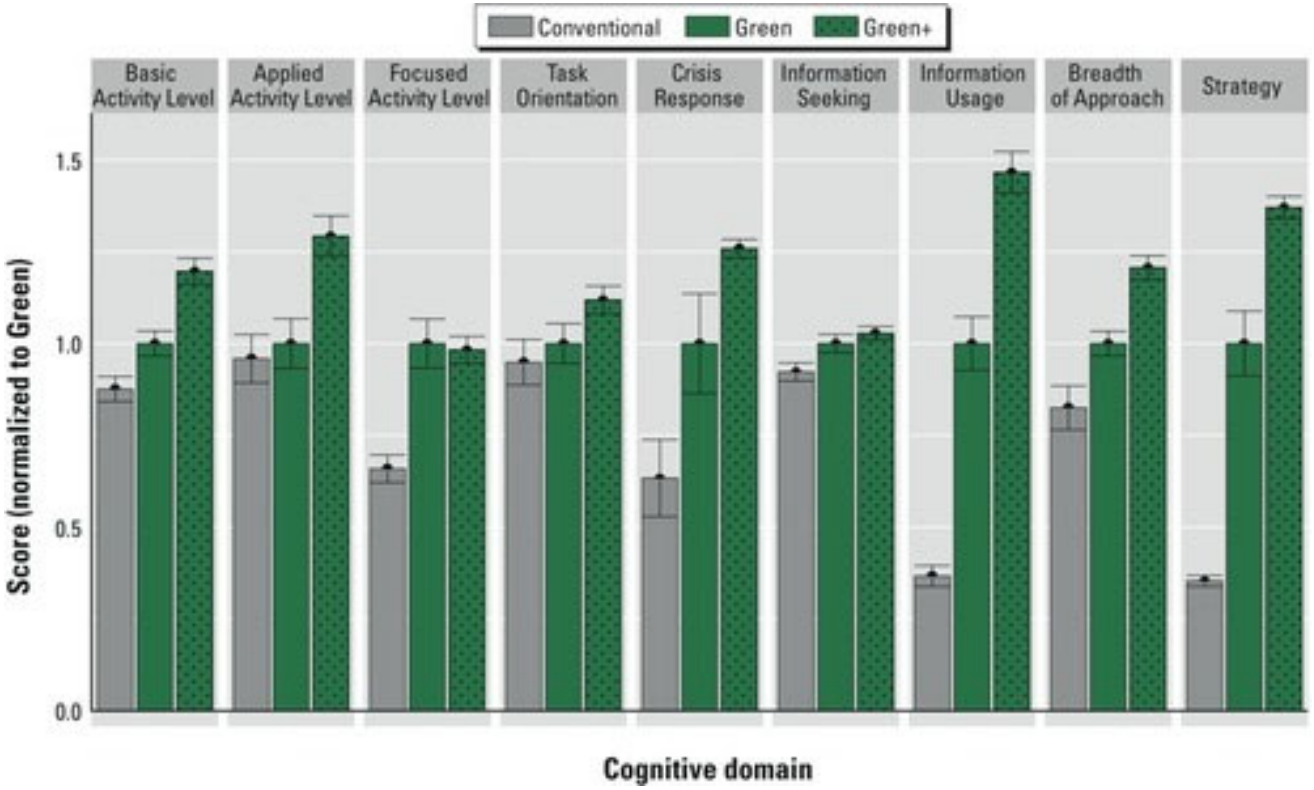

https://pubmed.ncbi.nlm.nih.gov/26502459/

Ask yourself how you can improve the health of the buildings you're in.