Mon, July 24th
11:30 AM MT | 1:30 PM ET

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CLEAN AIR FOR SCHOOLS

Live Webinar

CDPHE Clean Air For Schools

Dr. Mark Hernandez

Professor | Registered P.E. (California)
University of Colorado
Boulder

Dr. Serene Almomen

CEO & Co-Founder
Attune

Trusted by: CCSD Clark County School District · District of Columbia Public Schools · PWCS Prince William County Public Schools Launching Thriving Futures · Montgomery County Public Schools · Denver Public Schools · University of Colorado Boulder

Agenda

- Speakers Introduction
- Clean Air for Schools (CAFS) Program Overview
- Why real-time IAQ monitoring
- Real-time IAQ monitoring use cases
- The IAQ Monitoring Solution
- What is Next for CO Schools
- Tips to be successful
- Resources
- Q & A

Speakers

Professor • Registered P.E. (California)

University of Colorado Boulder

28 years

CEO, Co-founder
Attune (fka Senseware)

Vienna, VA

9 years

Clean Air for Schools Program Overview

Program Mission: provide schools access to evidence-based building performance information (ventilation & comfort) through real-time indoor air quality monitoring.

- Installing **2,400** IAQ monitors in **369** Colorado K-12 Schools
  - IAQ Monitors covering **25% of classrooms** in each school
- **Each enrolled school receives:**
  - **Installed indoor air quality (IAQ) monitoring system:** Temperature, Humidity, CO_2, PM_1, $PM_{2.5}$, PM_{10} & TVOC
  - **Access and ownership of IAQ Dashboard and all historical data (includes complete ownership of data):** schools own all data, and decide who has access to the data. The data is secure! Includes a 2-year subscription to access dashboard and analytics software platform.

Program Funding: This project is part of the Colorado Department of Public Health and Environment (CDPHE) Disease Control and Public Health Response Division's Indoor Air Quality Program, and is supported by the Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services (HHS) as part of an award totaling $173,450,305 with 0% percentage financed with non-governmental sources. The contents are those of the author(s) and do not necessarily represent the official views of, nor an endorsement, by CDC, HHS, or the U.S. Government.

Why Real-Time IAQ Monitoring?

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Pandemic Building Science Lesson: IAQ tech is a part of "the school conversation"?

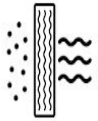
Nationwide: various school community audiences address institutional IAQ changes

Leverage tech we have now

Demonstrate the power of affordable IAQ monitoring

IAQ Widget

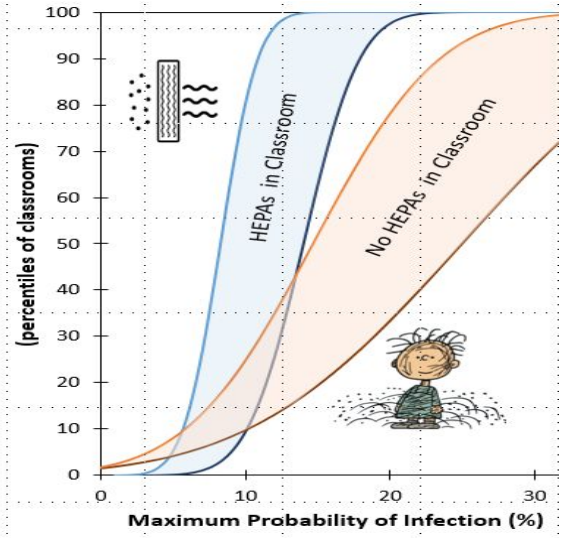
Classroom 205					Now
71.3 °F	49.5 %	1107 ppm	261 ppb	0.46 µg/m³	0.55 µg/m³
Temperature	Humidity	CO_2	VOC	PM2.5	PM10



HEPA

Trust but verify

Models are fine, data is better!



Cooperatively disseminate

Hand-n-hand with Districts, Local, Regional, National

PTA

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COLORADO
Department of Public Health & Environment

NATIONAL ACADEMY OF SCIENCES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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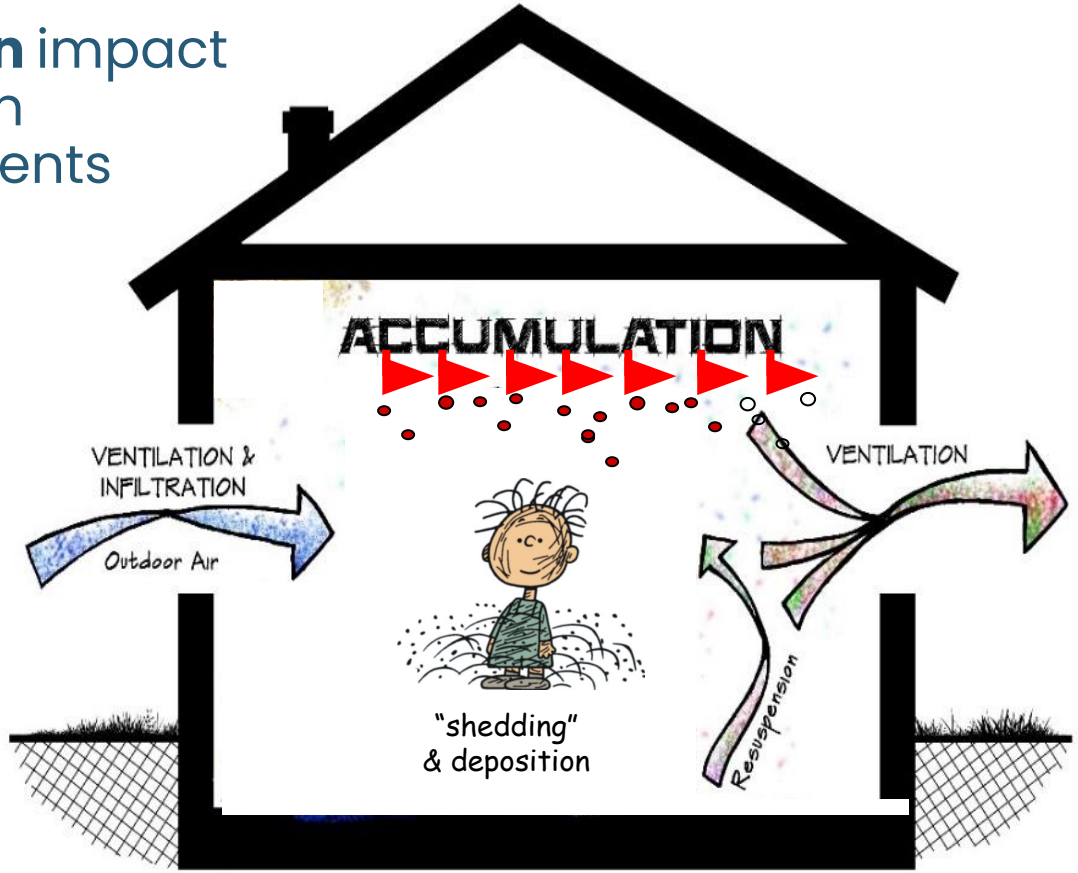
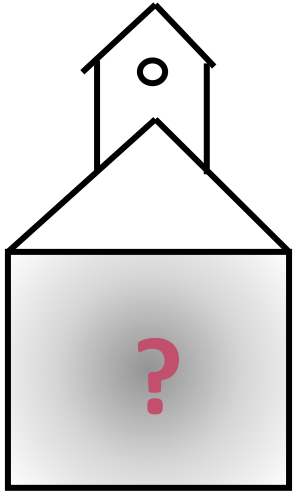
Occupants and ventilation impact bioaerosol accumulation in occupied indoor environments

The higher the FRESH air exchange rate the better

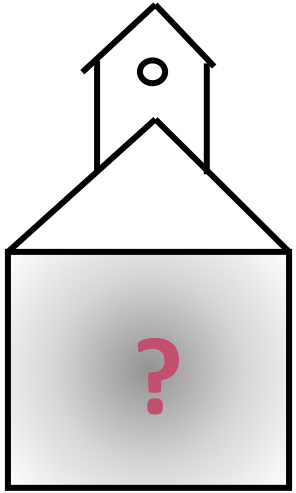


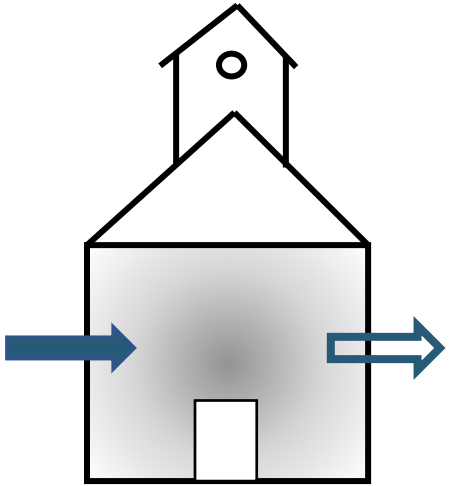
The primary bioaerosol removal mechanism is ventilation

The higher the **FRESH air exchange rate** the better



Air Exchange Rate: *The average amount of time it takes to replace one entire indoor room volume with "fresh" outdoor air*



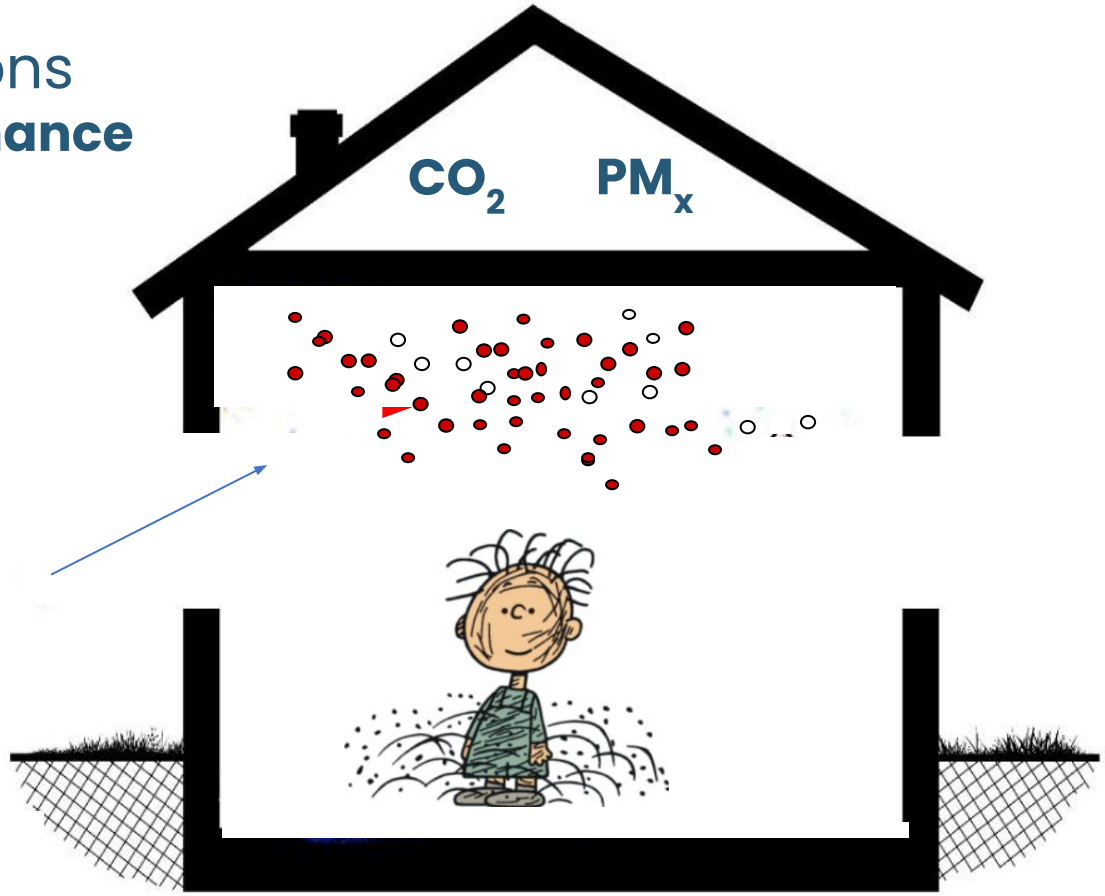


Under actual conditions
“as is” ventilation performance

CO_2 & PM = ?

IAQ Widget

Classroom 205					Now
71.3 °F	49.5 %	1107 ppm	261 ppb	0.46 µg/m³	0.55 µg/m³
Temperature	Humidity	CO_2	VOC	PM2.5	PM10



Longitudinal Observations

“business as usual” in occupied classrooms

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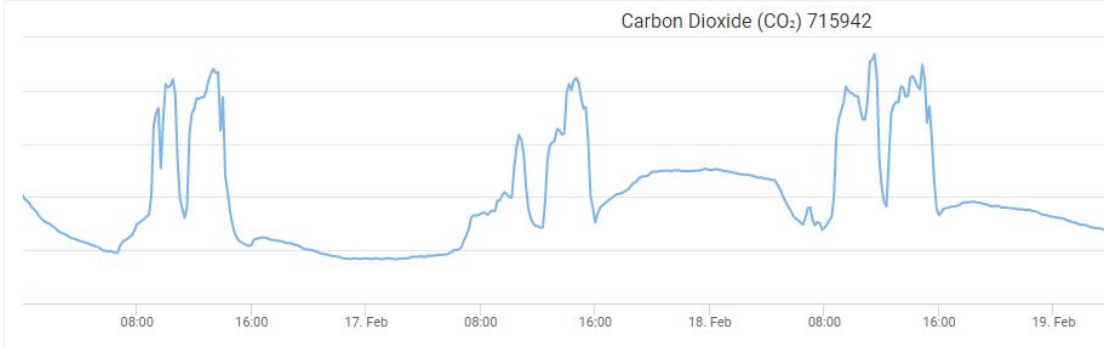
Schools decide:

- What data to view
- Who has access to the data
- Who to share the data with



IAQ Widget

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Attune IAQ monitors in Colorado schools

Measured Parameters:

- Temperature,
- Humidity,
- CO_2, PM_1, $PM_{2.5}$, PM_{10}
- TVOC

All data is stored and accessible in a secure archive

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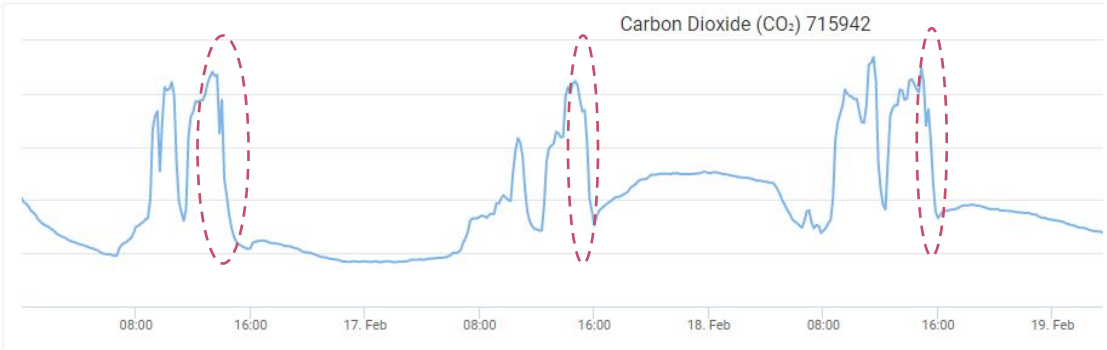
~~(near)~~ real-time airborne (bio)chemical sensors

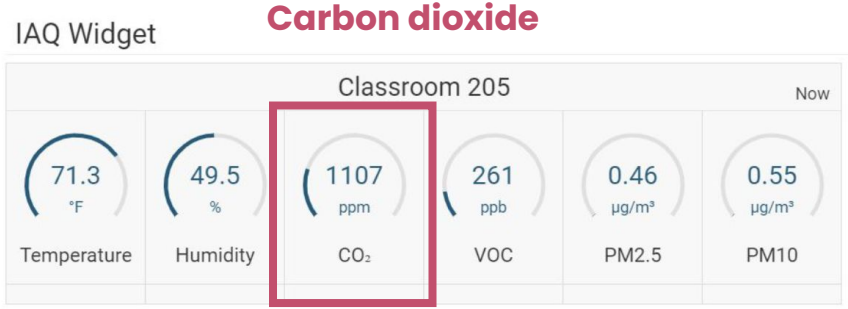
All IAQ data are securely archived



HVAC performance monitoring

- Occupant density
- Fresh air exchange rate

Carbon dioxide



You can't manage what you don't measure

IAQ Guidelines to help understand measured IAQ data

Measurement	IAQ Guidelines
Temperature	68-75°F in winter / 75-80°F in summer [ASHRAE]
Relative Humidity	30-60% [US EPA]
Carbon Dioxide (CO_2)	CO_2 can estimate ventilation rates in occupied classrooms [CDC]. Indoor CO_2 levels can be up to 800-1350 ppm_v above local outdoor background levels [ASHRAE & EU]
Particulate Matter (PM) PM_{10} & $PM_{2.5}$	Outdoor $PM_{2.5}$<35 ug/m^3 on average over a 24hr period; PM_{10}<150 ug/m^3 [EPA NAAQs]. Outdoor $PM_{2.5}$ 24-hour average <15 ug/m^3; PM_{10}<45 ug/m^3 [WHO].
Volatile Organic Carbon (VOC)	Can monitor cleaning/custodial activities or other activities that may elevate local VOC levels include vaping, smoking, spray paint use, chemistry experiments, etc.

Real-Time IAQ Monitoring Use Cases

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HEPA Filters

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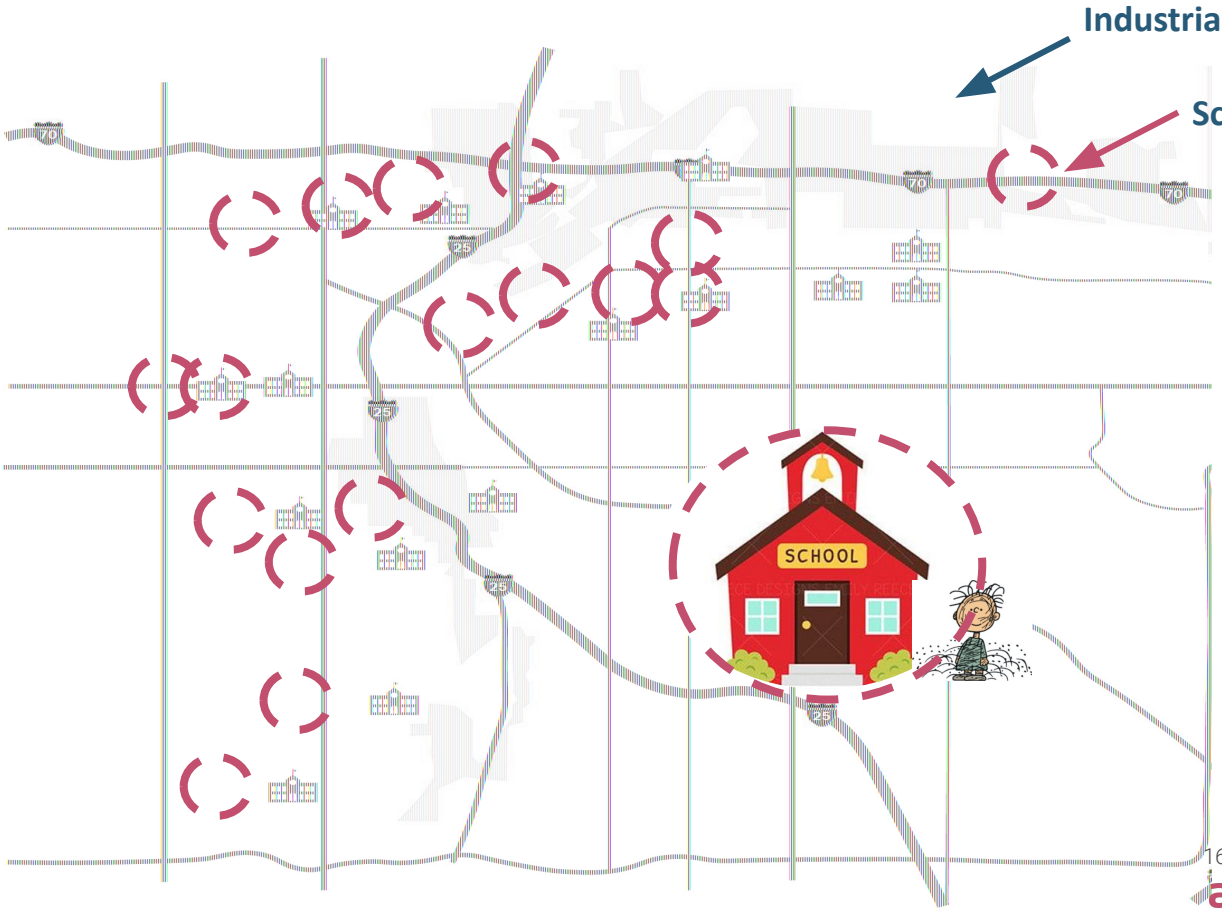
Classroom HEPA air purifier effectiveness demonstration in OCCUPIED K-5 Classrooms

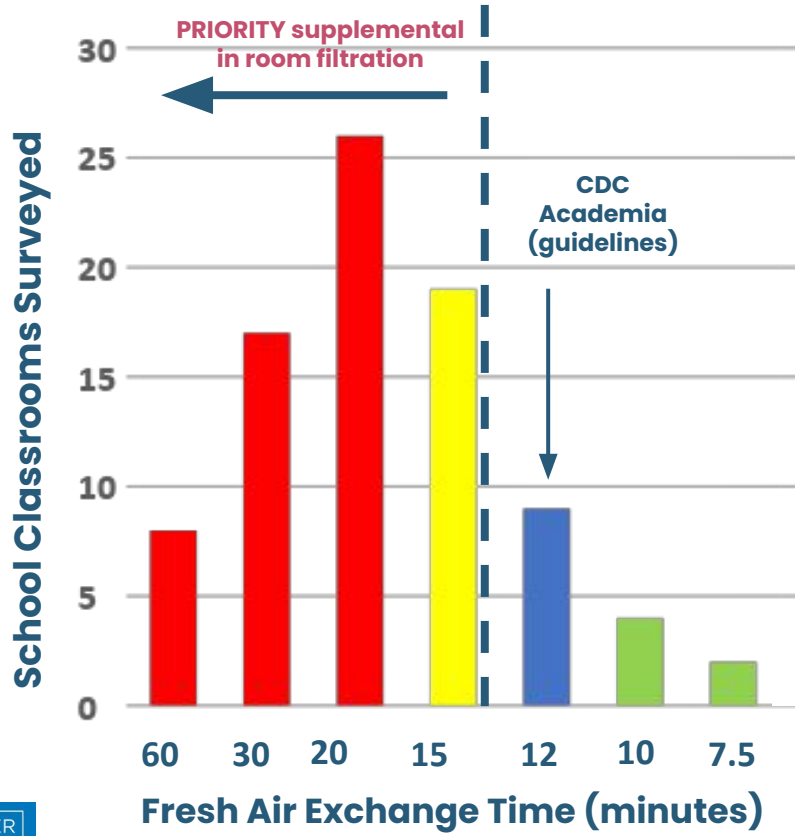
20 Elementary Schools

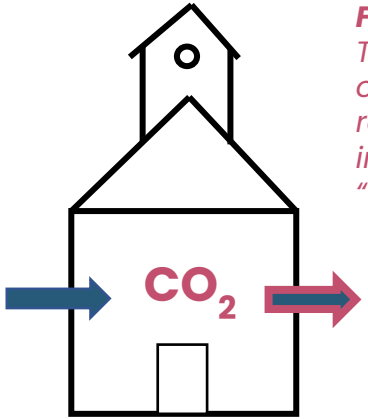
socioeconomic backgrounds stratified (6 bilingual schools)

bordering commercial, suburban, industrial zones & interstate highways



Strategy for classroom HEPA air purifier installations





Fresh Air Exchange Time: *The average amount of time it takes to replace the entire indoor volume with "fresh" outdoor air*

TARGET IS AT LEAST 5 TOTAL AIR CHANGES PER HOUR

10 min	*Ideal (6 ACH)*
12 min	*Excellent (5-6 ACH)*
15 min	*Good (4-5 ACH)*
20 min	*Bare minimum (3-4)*
30 min	*Low (<3 ACH)*

ACH translated to minutes

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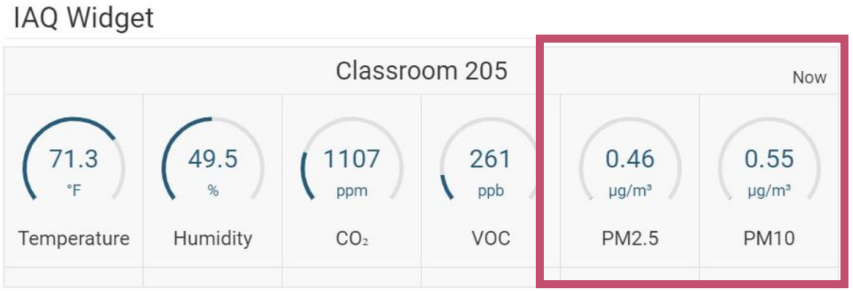
~~(near)~~ real-time airborne (bio)chemical sensors



Airborne microscopic particulate matter (PM) in respirable size ranges (includes bioaerosols)

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Classroom HEPA air purifier effectiveness demonstration in OCCUPIED K-5 Classrooms

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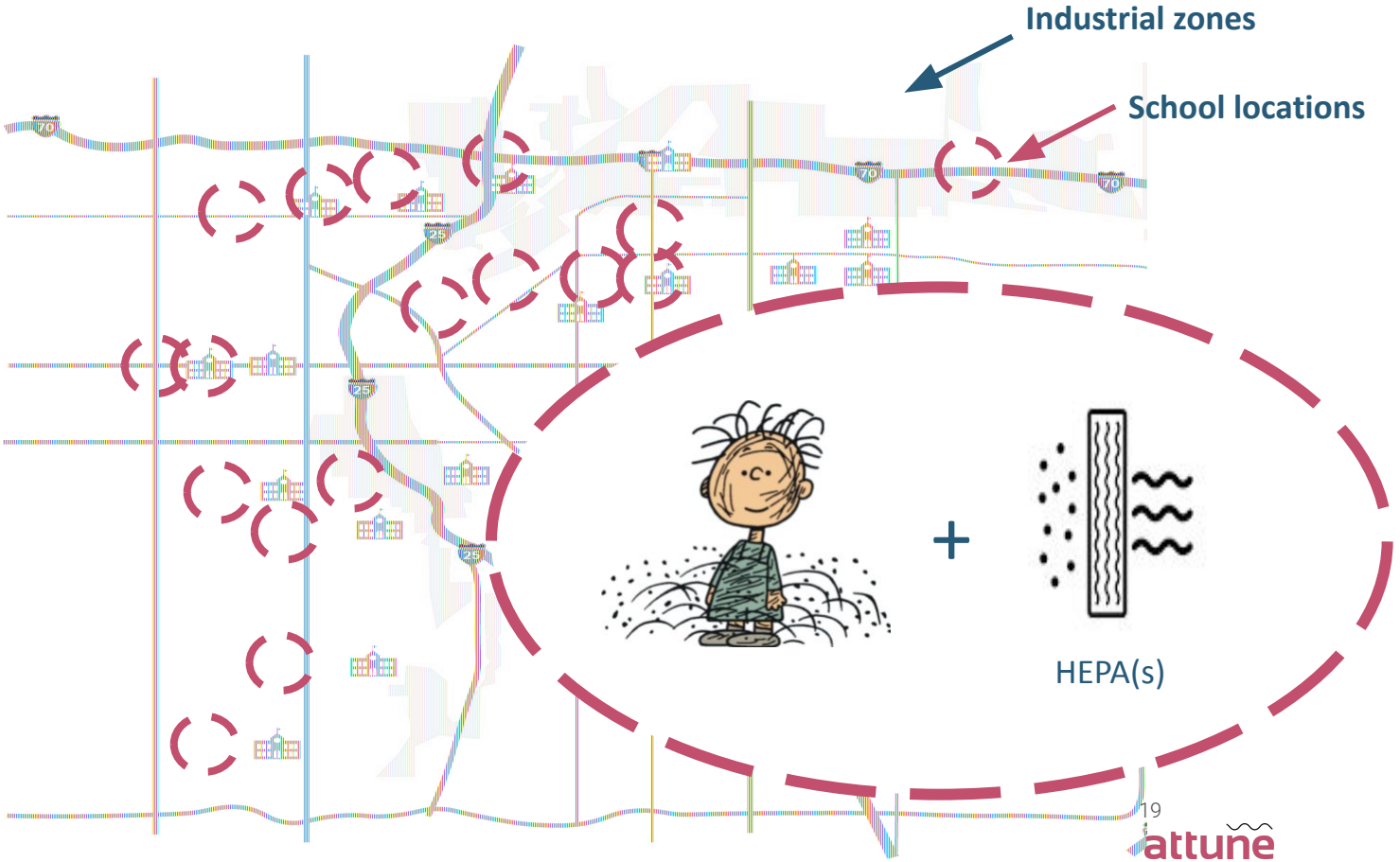
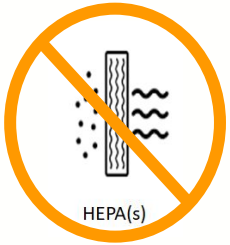
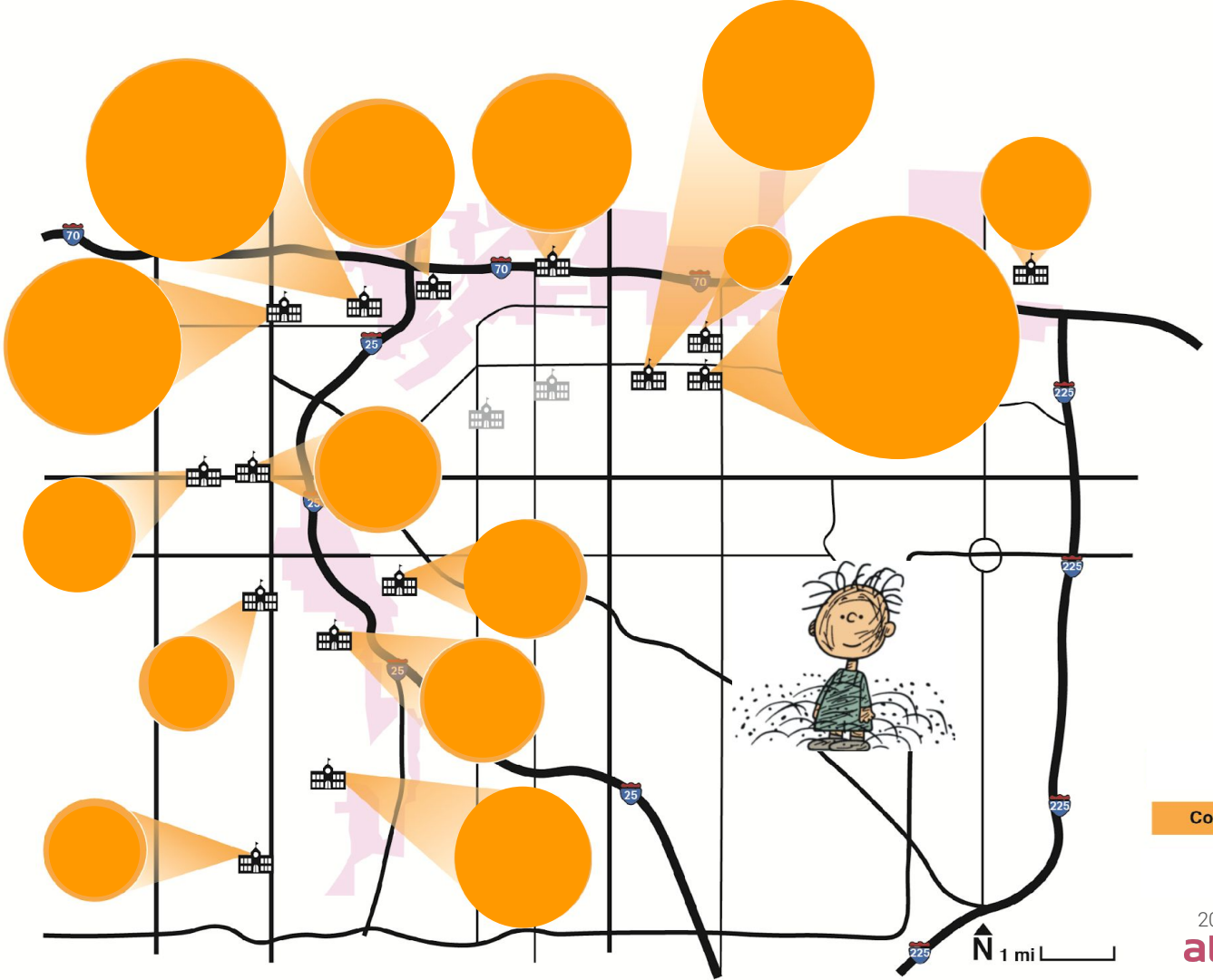


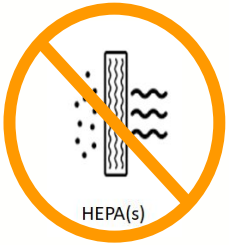


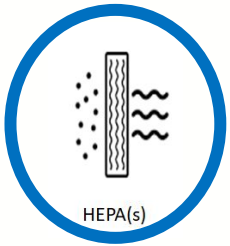
Max [PM $_{10-2}$] =
3×10^4 #/m^3
(per occupant)

Min [PM $_{10-2}$] =
6×10^3 #/m^3
(per occupant)



Control





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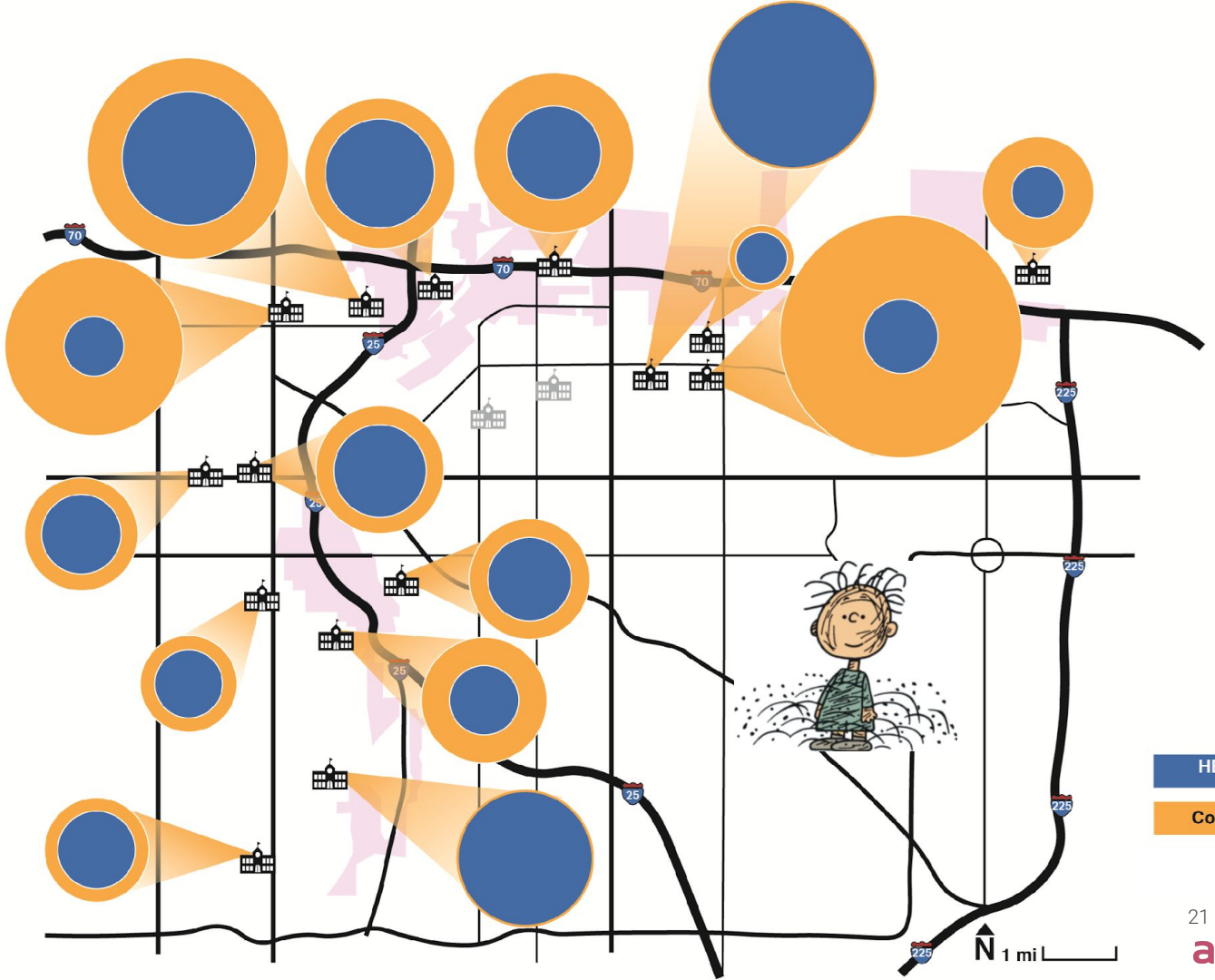

HEPA

Control

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Establish Normalized Seasonal Trends for PM Exposure

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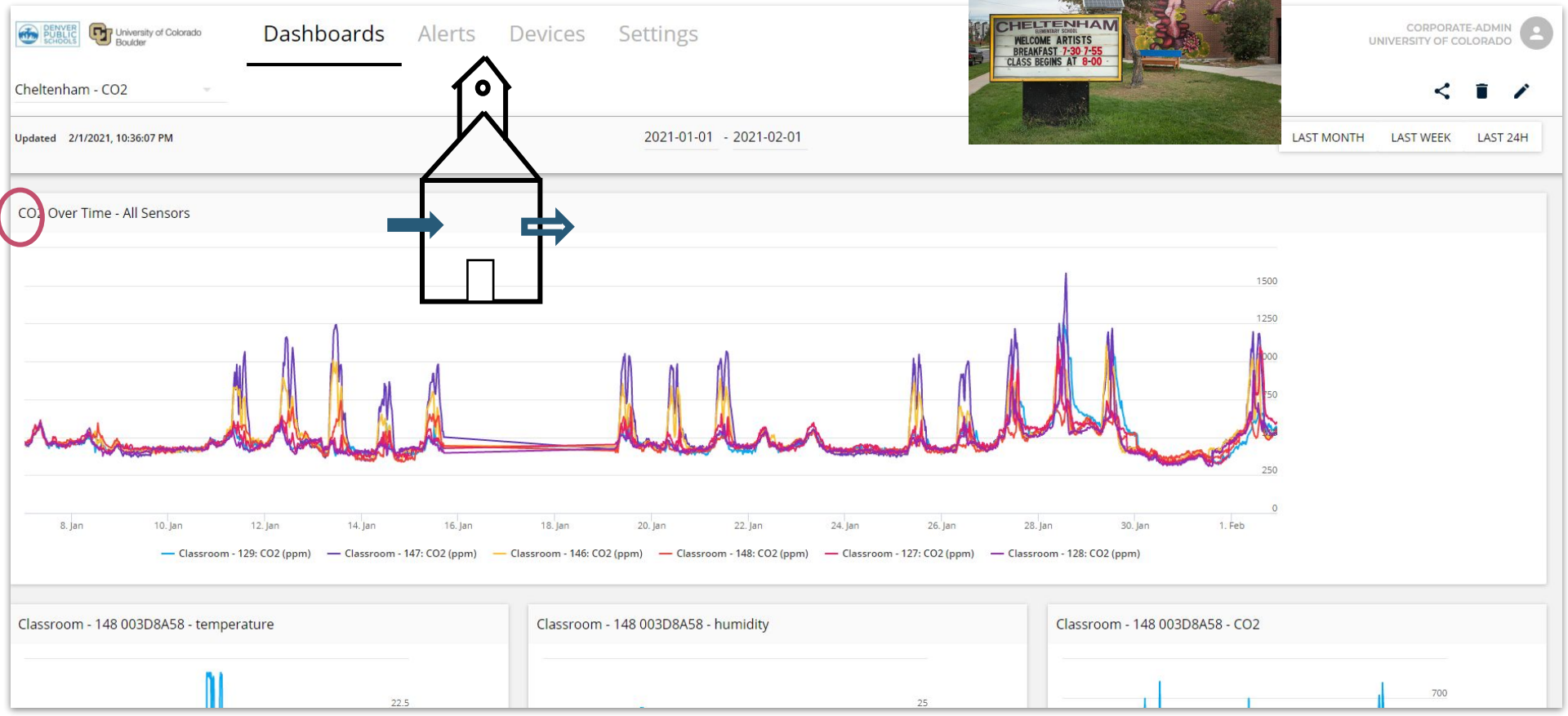
Real Time Ventilation Monitoring



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Real Time Airborne Particle Monitoring

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Dashboards | Alerts | Devices | Settings

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UNIVERSITY OF COLORADO

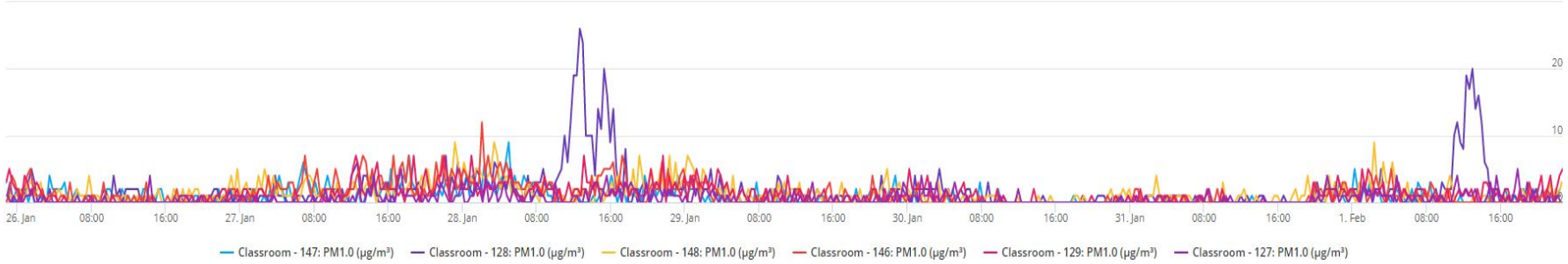
Cheltenham - PM

Updated 2/1/2021, 10:43:00 PM

2021-01-25 - 2021-02-01

LAST MONTH | LAST WEEK | LAST 24H

PM 1.0 Over Time - All Sensors



PM 2.5 Over Time - All Sensors

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Real Time Airborne Particle Monitoring

DENVER PUBLIC SCHOOLS | University of Colorado Boulder

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EXCURSION

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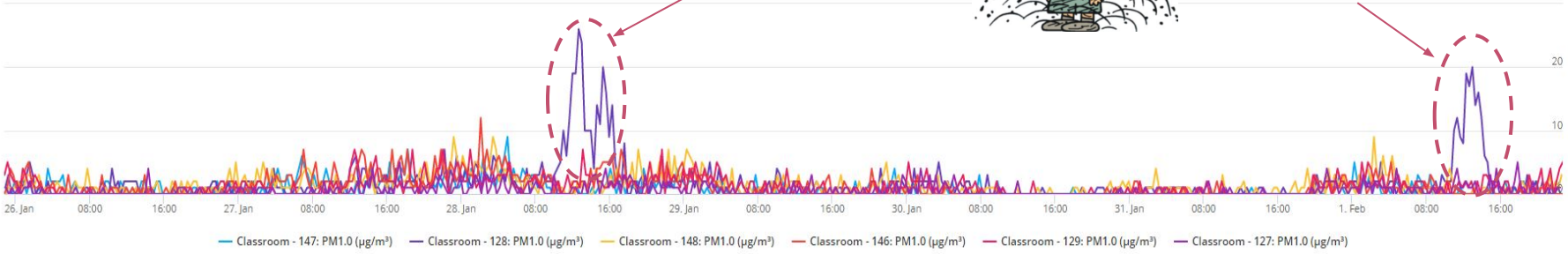

PM 2.5 Over Time - All Sensors

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Classroom Cleaning & Building Flushout

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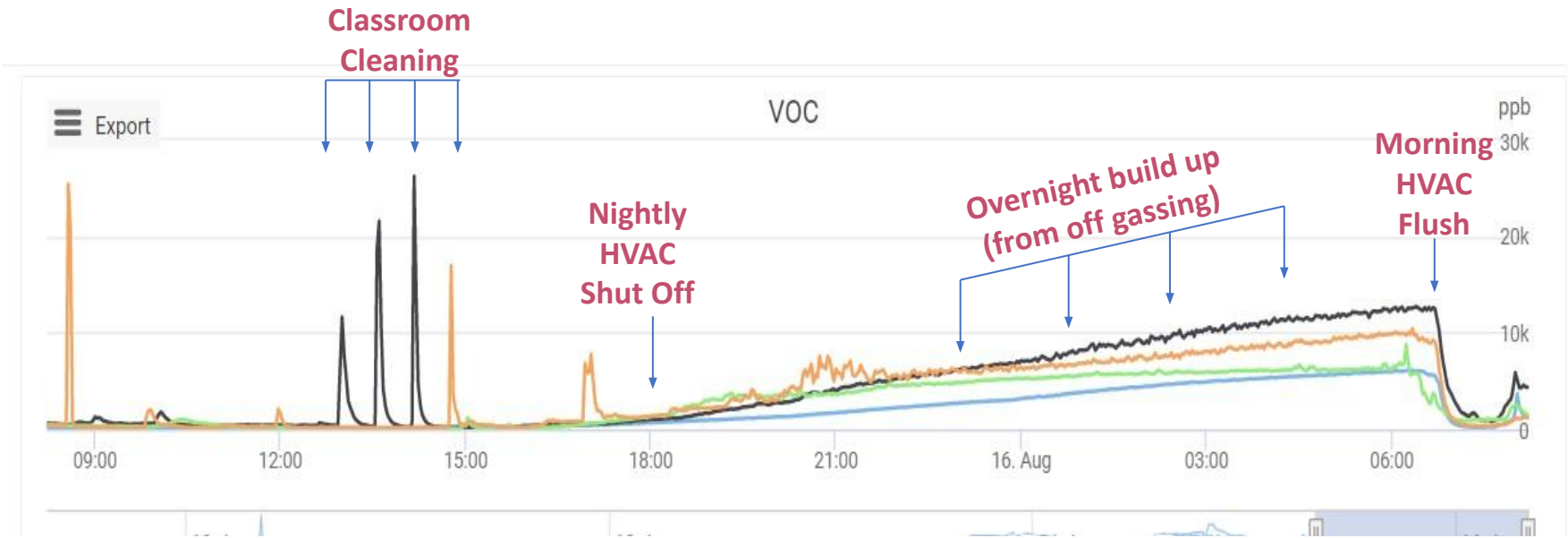
VOC patterns verify classroom cleaning and beneficial effect of building ventilation flushing



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Understanding Building Hygiene Indicators –

EXAMPLE FOR INDICATION OF NEED FOR DUCT/HVAC SYSTEM COMPONENT CLEANING

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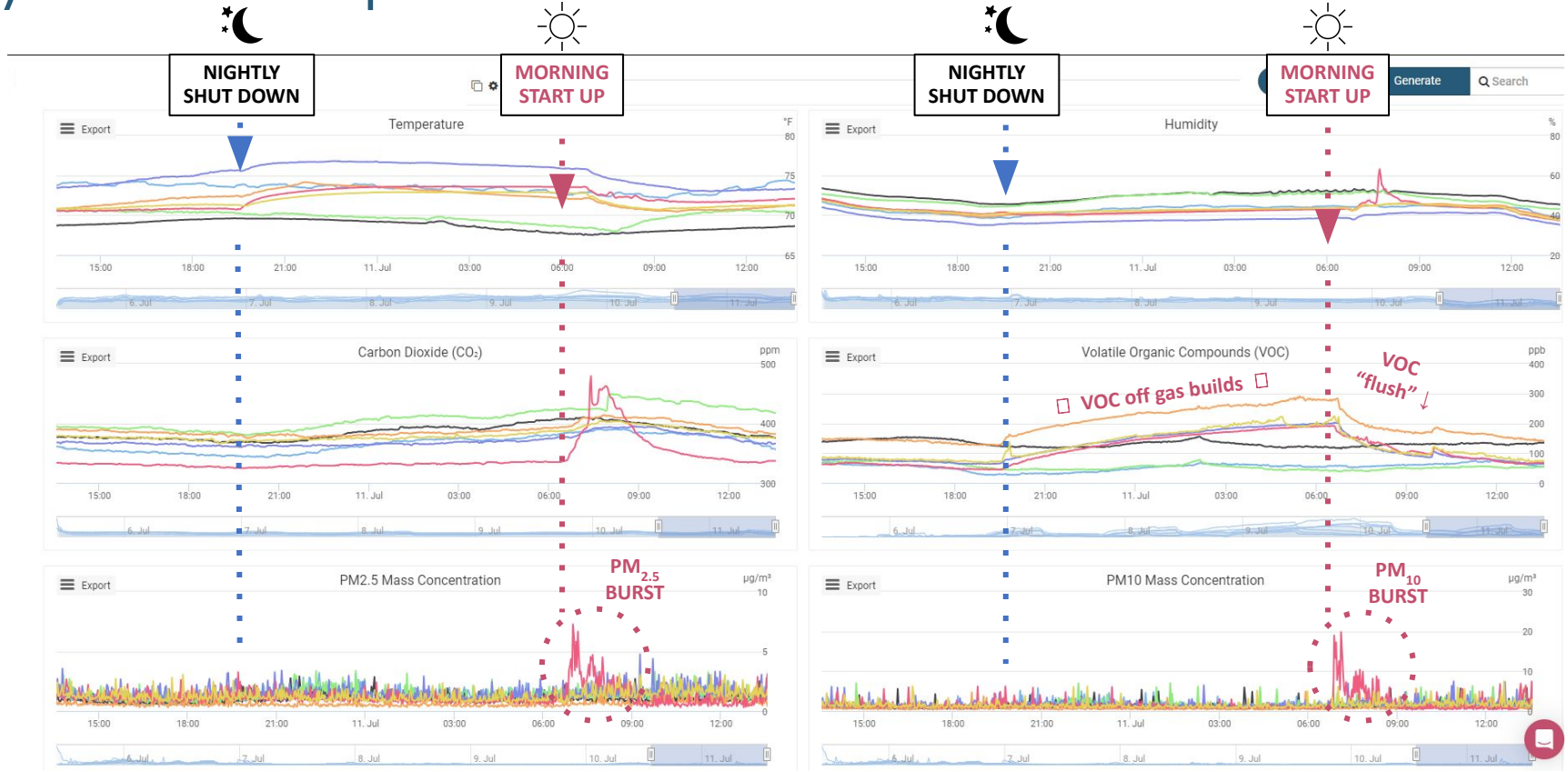
Sloughing & Resuspension of Duct PM following daily HVAC system start up



Intersection of Indoor Air Quality, Energy Efficiency, & Preventive Maintenance

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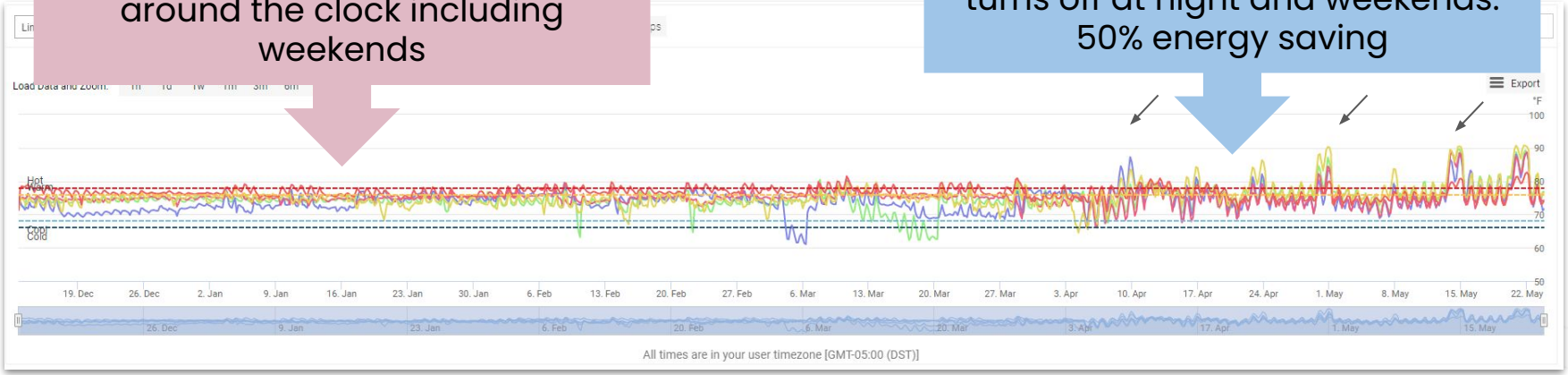
Adjusting HVAC Operations

Pre Thermostat Upgrade: HVAC around the clock including weekends

Post Thermostat Upgrade: HVAC turns off at night and weekends. 50% energy saving



Effect of Ventilation Strategies During Wildfires

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Compare IAQ to OAQ

Additional Critical Data to Decide Where Is the Cleanest Air for Students

Office Building

Wildfire PM Impact

Public Schools

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Solution: Real Time Customizable IAQ monitors

- **Wireless Sensors**
  - Temperature & Humidity
  - CO2
  - PM (1, 2.5, 10)
  - TVOC
  - UL2905 Certified

- **Cloud-software**
  - Real-time dashboard
  - Real-time alerts
  - Lobby View
  - Map View

Full Suite of Cloud Software

Flexible Dashboards, analytics, indexes

Admin

- High level map view of entire campus with Red/Yellow/Green
- Lobby View

Facilities

- Real-time Texts and Email Alerts
- Daily or Weekly Reports

Engineering

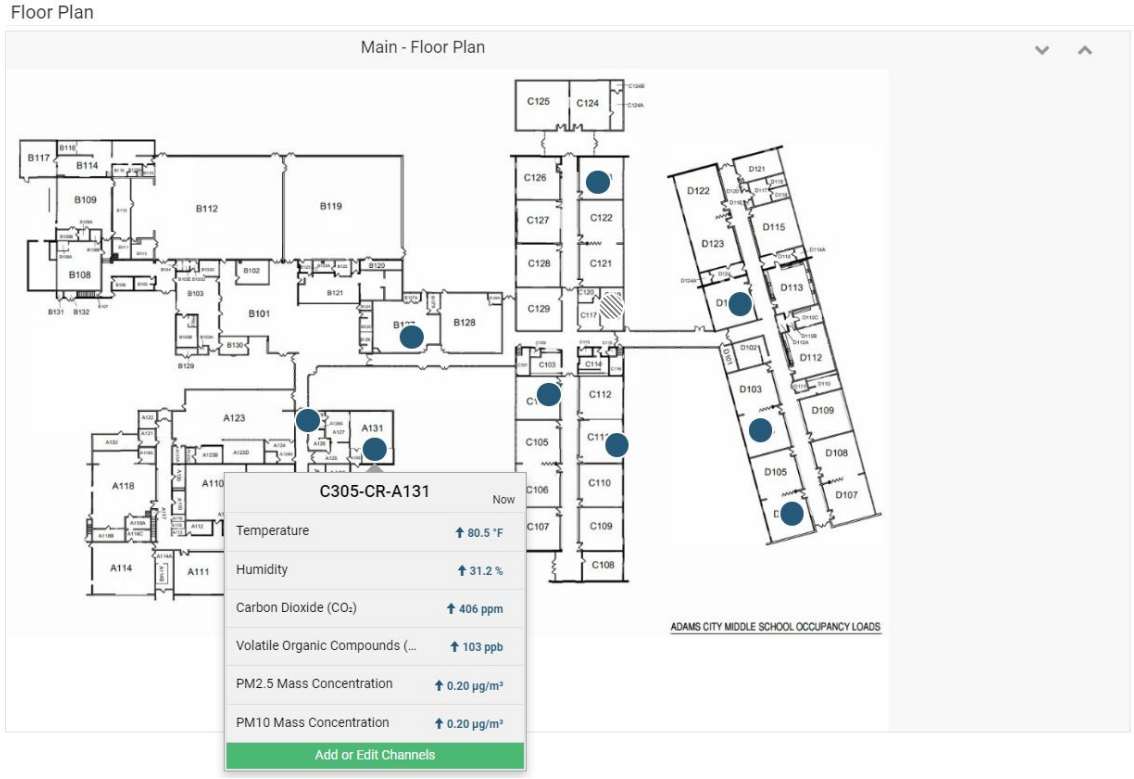
- Ventilation Performance Score
- Weekly Reports

Parents

- Tell them monitoring IAQ
- Aggregate of data during entire month or term

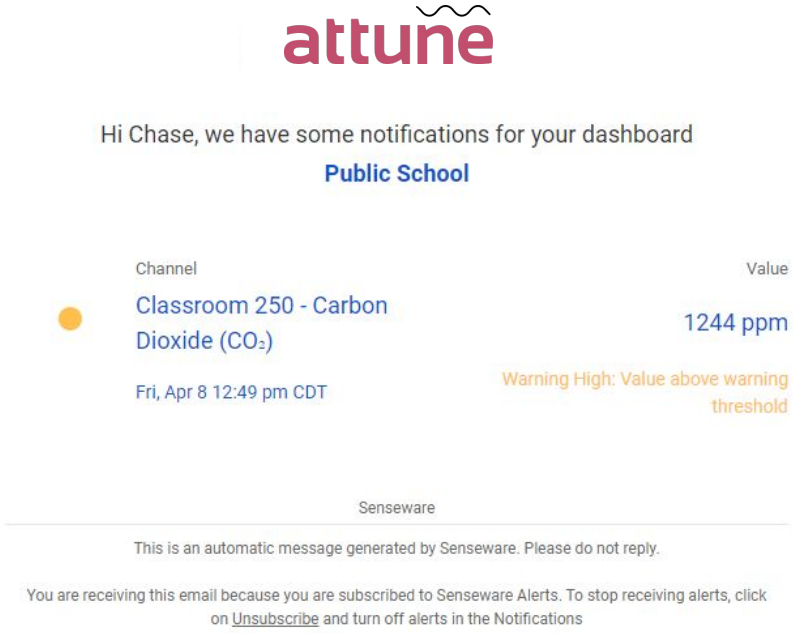
Floor Plans

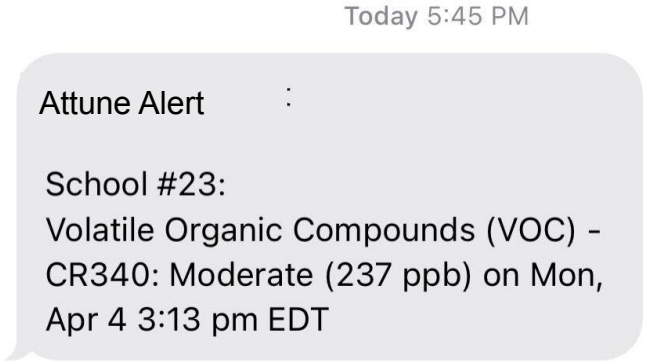
Simple snapshot of IAQ levels on a floor plan



Alerting

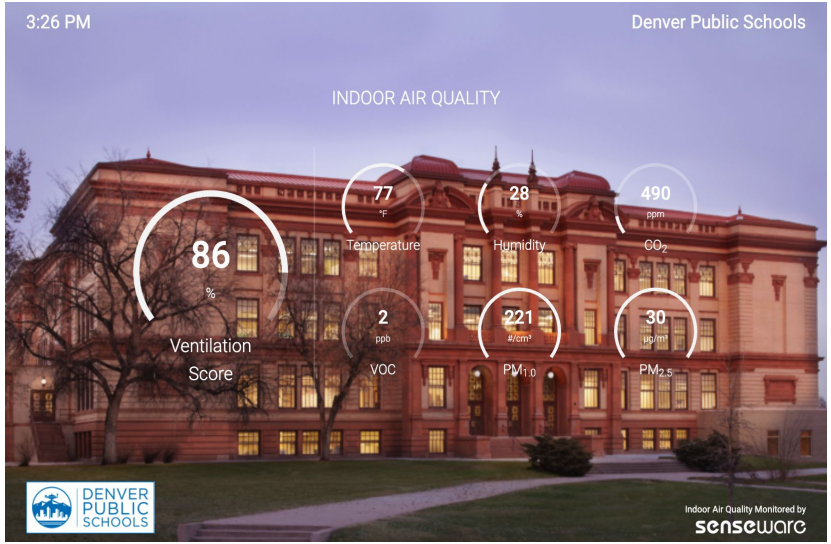
Receive customizable email and text notifications





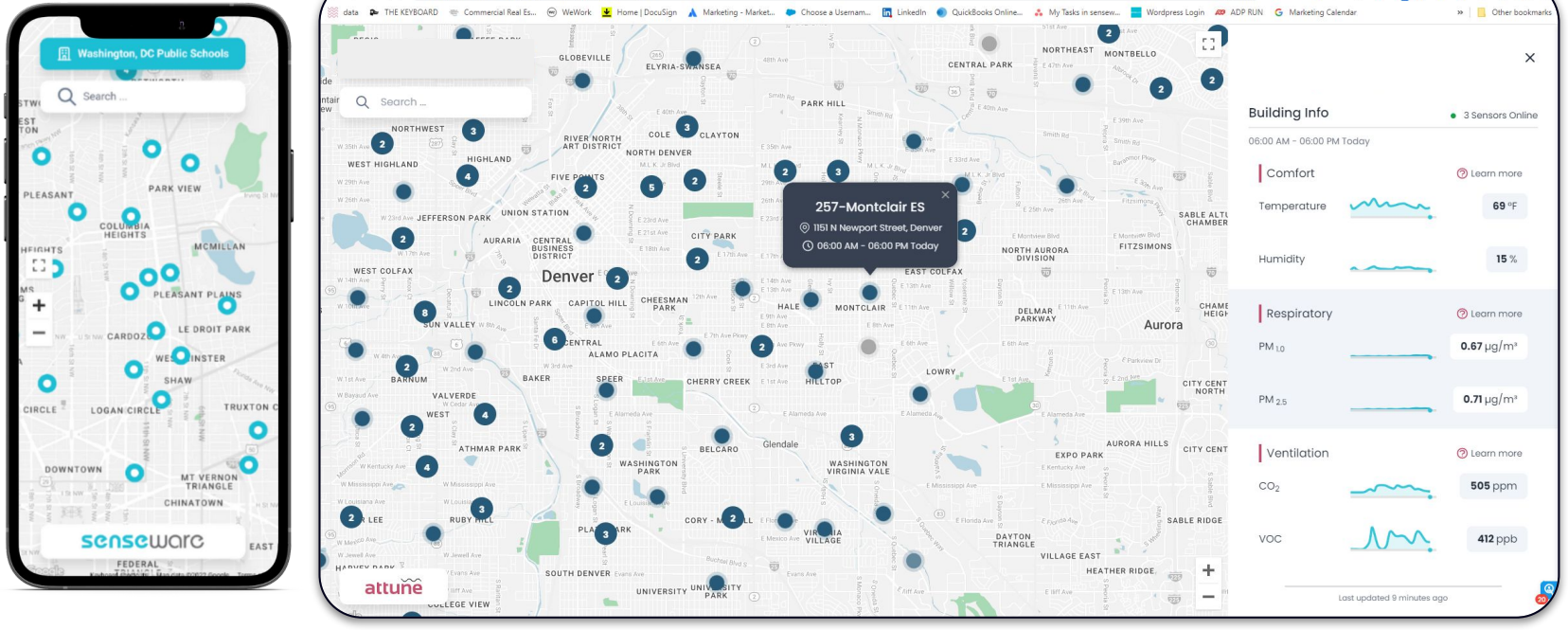
School Lobby View

Display IAQ data on a public-facing dashboard in your school. Accessible 24/7 via URL.



School Map View

Easily navigate a map view of the entire school district. Accessible 24/7 via URL for your staff, teachers and families.



Attune Hardware

Gateway

Collects and sends data collected by Nodes or IAQ Packages to the cloud via ethernet internet connection. Each gateway is equipped with local memory storage.

IAQ Package

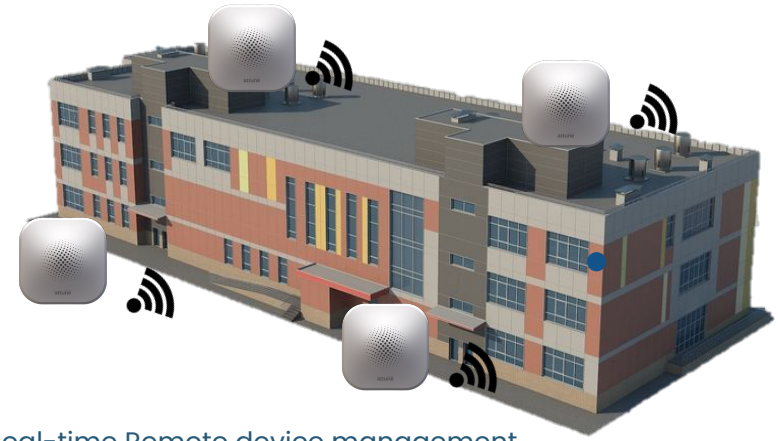
Collects and transmits indoor air quality data wirelessly to the Gateway. The package is powered via a wall outlet or line-powered and will also relay data collected by other IAQs.

Node

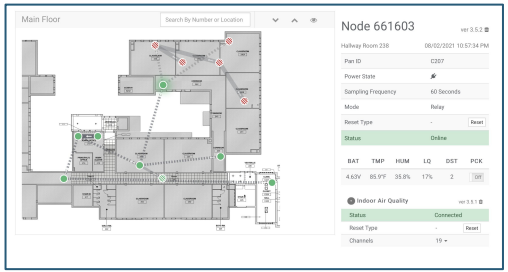
Connects with Bridges to collect and transmit data wirelessly to the Gateway. Nodes can also be used to relay data from other Nodes or IAQ Packages that are too far away.

Installation Process & Timeline

Non-intrusive & discrete



Real-time Remote device management



Simple implementation

1. Plug and Play
2. Less than 6 minutes per monitor installation
3. Wireless (retrofittable)
4. Not Wifi-based (no IT Network interference)
5. Can be managed remotely after installation

What is Next
Beyond the Data

- Assess building HVAC systems performance
- Verify efficacy of HVAC systems improvements
- Make the case of HVAC replacement or upgrade
- Prioritize ventilation infrastructure upgrades

Tips for success

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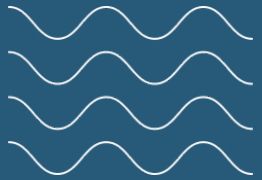
- **Learn more** in an **IAQ Dashboard Training Session** and Additional IAQ Resources provided
- **Set up an IAQ monitoring and management plan.** What can you learn from your IAQ data when buildings are empty and when occupied? How will you determine IAQ outliers for your school classrooms? How will, and who in, your schools will address those issues? How often do you plan to check in on the IAQ data (you can set up your own alerts)
- **Assign ownership of data access and monitoring** to your administrators and staff appropriately. Designate a main IAQ Point of Contact with your District and/or School(s). Who will communicate and address IAQ issues at your school(s)?
- **Communicate your IAQ monitoring and management plan** with school administrators, facility managers, staff and teachers
- **Educate** administrators, staff, teachers, and students about what impacts school IAQ and what your school(s) are doing to maintain good IAQ

Additional IAQ Resources

- What Schools Need to Know: Transitioning from Pandemic to Endemic IAQ Management (EPA Webinar)
- **EPA Indoor Air Quality Tools for Schools Action Kit**
- US Green Building Council Center for Green Schools
  - **USGBC Green Schools Indoor Air Quality Fellow Application or Leaders in Sustainability Fellowship**
  - **School IAQ Workshop Fall 2023**
- ASHRAE Technical Resources for Schools
- CDC Operational Guidance for K-12 Schools and Early Care and Education Programs to Support Safe In-Person Learning
- DOE Efficient and Healthy Schools Campaign & Resources
- American Lung Association Clean Air at School

Key Takeaways

- → Can’t manage what you don’t measure
- → Affordable
- → Many resources are available
- → Join the training sessions



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Q&A

Dr. Mark Hernandez: mark.hernandez@colorado.edu
Dr. Serene Almomen: serene@attuneiot.com, info@attuneiot.com
Dr. Odessa Gomez: odessa.gomez@state.co.us