

Smarter Campus Environments: Turning Data into Actionable Insights

October 1, 2026 | Speakers: Carl Bengtsson | Sarah Grady | Brandon Rose |

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Meet today's speakers



Brandon Rose

Digital Account Executive

Siemens



Carl Bengtsson

Smart Air Quality Program Manager

Siemens



Sarah Grady

Project Developer, Critical Spaces & Energy Engineering

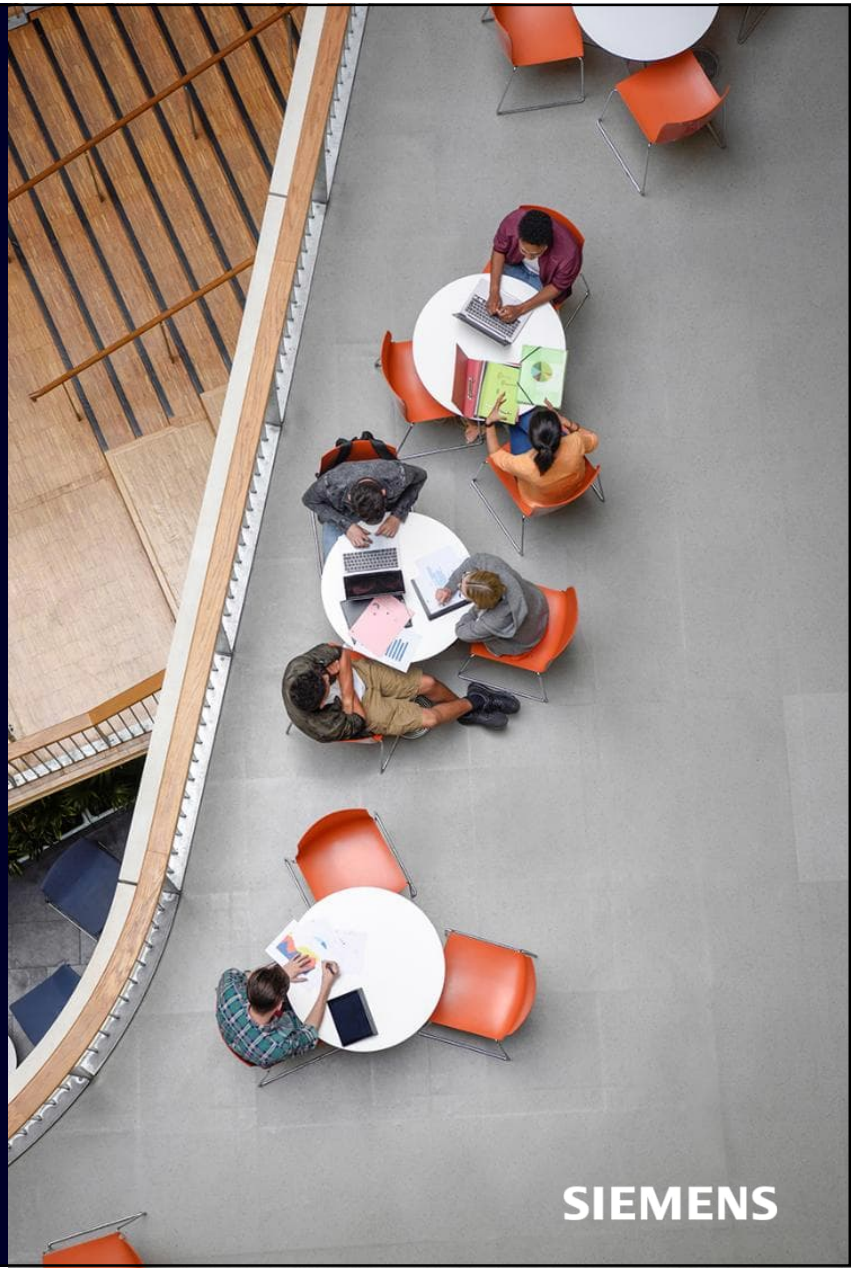
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Learning objectives

1. Learn how a cloud-based Building Management System intelligence layer above individual buildings and campuses can aggregate real-time building, energy, and environmental data into a single source of truth and how to leverage that central data lake in a data visualization dashboard.
2. Understand how insights by continuous and comprehensive indoor air quality and contaminant monitoring, aligned with the latest ASHRAE guidance, can improve health and comfort in learning, living, and research environments while also enhancing energy and operational efficiency.
3. Develop a practical approach for indoor air quality monitoring and ventilation optimization in critical environments such as research laboratories to enhance researcher safety, strengthen compliance, and reduce energy consumption.



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Higher Education is shaping the future as they shape their own



Education

Attract and develop talent
Deliver outstanding student experiences
Improve graduate outcomes

Teaching + research

Enable breakthrough discoveries
Foster innovation ecosystems
Integrate technology into academics to develop career skills via living labs

Financial resiliency + social responsibility

Help budgets be stable, more resilient
Advance your mission as an intuition
Address society's greatest challenges

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Higher Education is at an inflection point

Three forces driving change

Campus Experience

Competition for top students and faculty/researchers is high.

Students are digital natives and expect a seamless, tech-enabled campus life.

Quality of living and learning environments is a must have, from healthy air quality and comfort to safety and security across campus

Financial Challenges

Declining enrollment impacts available budget and capitol planning.

Rising utility costs, along with aging infrastructure and inefficient systems, impact overall operational costs.

Facilities teams are challenged to keep the campus operating smoothly and efficiently under pressure with maintenance backlogs and student expectations.

Energy Efficiency + Decarbonization

Older infrastructure and systems are inefficient and may be at end of life; often siloed.

Initiatives to decarbonize are often unclear with no roadmap to achieve.

Utility rebates and additional funding tied to improved efficiency, better utility management.

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Expand IAQ awareness and data analysis:
For smarter energy, operations, health, and safety decisions

Data Repositories with Building X

Leverage Cloud-based data lakes for actionable insights across entire campus



Smart Air Quality

Comprehensive air quality data for insights and supporting broad operational efficiencies



Smart Labs

Comprehensive continuous air quality monitoring for automation and demand-controlled lab ventilation



One connected data environment

Building X ingests IAQ, HVAC, and lab data from Siemens and third-party systems into a common data environment

Context that makes data usable

A building knowledge platform maps every sensor to space, system, and asset so readings become decision-ready

Analytics that drive action

Continuous monitoring turns into alerts, KPIs, and ventilation strategies for smart air quality and smart labs

Open, secure, and scalable

Cybersecure cloud platform with open APIs to share data across operations, sustainability, and enterprise systems

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Let’s move from **separate data silos …**



- Inefficient and high maintenance
- Limited insights and access to data
- Compliance and cybersecurity risks

… to **one cloud platform.**



- Cross domain use cases
- Holistic and centralized insights
- Scalable and flexible
- Designed to be cybersecure
- Proper governance

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From data to actionable insights to decisions

Three layers that turn campus data into action — on any platform.

CONNECT
Get data out of your systems

Digital infrastructure you already own
Edge devices | Cloud-to-cloud | Connectivity
Your BAS, controllers, meters and sensors (Desigo or third-party)

ANALYZE
Put data in context

Common data platform (Siemens: Building X)
Data aggregation | Analytics | Device management | Open APIs

ACT
Act on what the data says



Operations & sustainability apps

Data-enabled services

Third-party apps (open marketplace)

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Create ROI by transforming your campus to be smarter, more efficient

Campus Experience

Increase of space utilization	up to **15%**
Improvement of indoor air quality	up to **25%**
Less cost on housing maintenance	up to **15%**

Energy Management + Decarbonization

Reduction in general energy consumption	up to **30%**
Reduction in cooling energy consumption	up to **50%**
Cuts in utility spending	up to **20%**

Research Facility Optimization

Reduction of lab downtime	up to **50%**
Reduction of ventilation energy consumption	up to **50%**
Improvement in lab space utilization	up to **10%**

A Smarter Campus

Increase in operational efficiency
up to 20%

Reduce maintenance cost
up to 25%

Reduce false fire alarms
up to 20%

+ additional ROI

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Transform to a smart, efficient student-centric campus where the best teaching, learning, research and exploring happens

Campus Experience

Attract and retain students and faculty/researches with digital-now, healthy, comfortable, and safe environments.

Energy Management + Decarbonization

Stabilize budgets and advance sustainability initiatives with efficient, resilient performance.

Research Facility Optimization

Advance research excellence through efficient, reliable, high-performance labs.

A Smarter Campus

A unified campus foundation can help:

- Develop insights for real-time data visibility across integrated systems and infrastructure.
- Ensure healthy, safe and efficient environments for your campus community.
- Automate processes to work smarter, not harder.
- Streamline maintenance staff priorities, even proactively finding issues before they become problems.

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Expand IAQ awareness and data analysis:
For smarter energy, operations, health, and safety decisions

Data Repositories with Building X

Leverage Cloud-based data lakes



Smart Air Quality

Comprehensive air quality data for insights and supporting broad operational efficiencies



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IAQ Contaminant Awareness

- ✓ Contaminant types and characteristics
- ✓ Challenges of outdoor air in ventilation

IAQ management interaction & levers

- ✓ Managed air quality allow building code to operate differently to improve efficiency, sustainability, resilience, and retrofit options

Comprehensive IAQ data interpretation

- ✓ Example of a report and actionable items

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IAQ Contaminant Awareness

Contaminants grouped in 3 broad categories:

Consider:

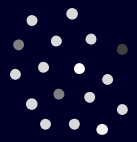
- Source origin and location
- Effective mitigation technologies
- Harm potential

Gas Contaminants



VOCs (& Formaldehyde), NO_2, O_3
Radon, CO_2

Particle Contaminants



Sand, Dust, Smoke
Respiratory droplets

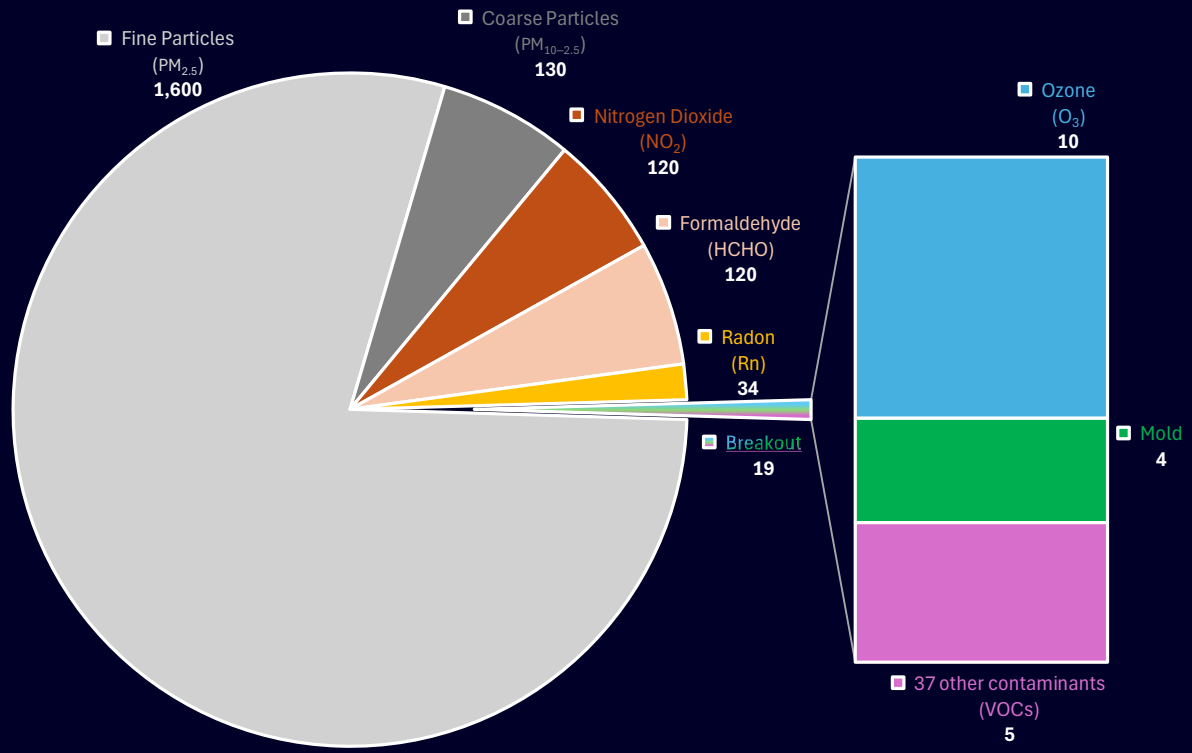
Biological Contaminants



Pollen, Mold, Bacteria, Mycotoxins, Viruses
Microbial-VOC, Biofilm (ECM & EPS)

Harm from IAQ Contaminants [1]

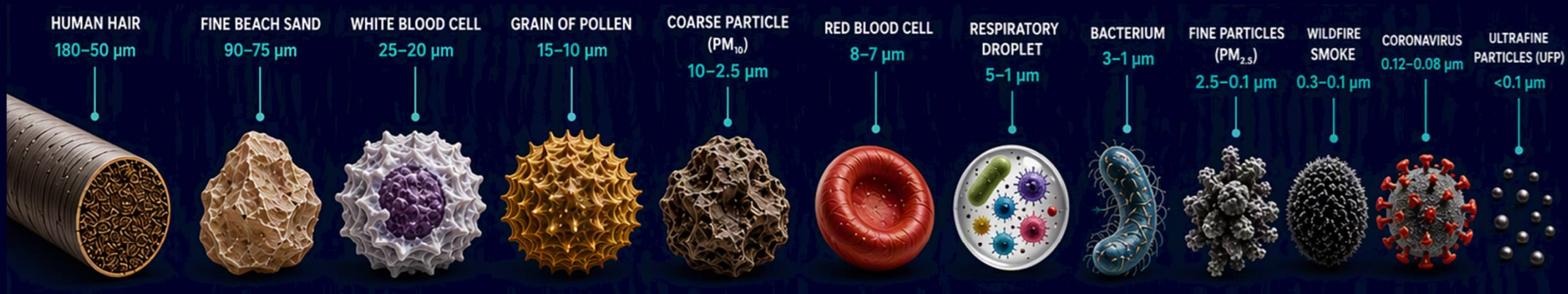
[DALY, Disability-Adjusted Life Years/10^5 person/year]

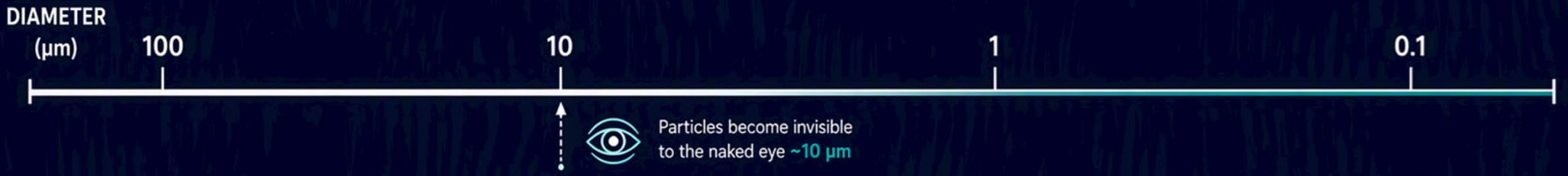


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The Relative Size of Particles & Implications

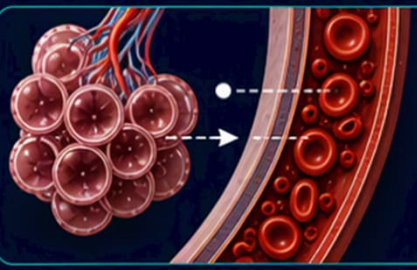




Wildfire smoke can persist in the air for several days, and even months.

Respiratory droplets have the potential to carry smaller particles within them, such as dust or coronavirus.

Particles at or below submicron size are most capable of deep lung penetration and systemic impact.



BLOOD–AIR BARRIER

Submicron-sized particles (PM_1) can cross the thin blood-air barrier in the alveoli and enter the bloodstream.

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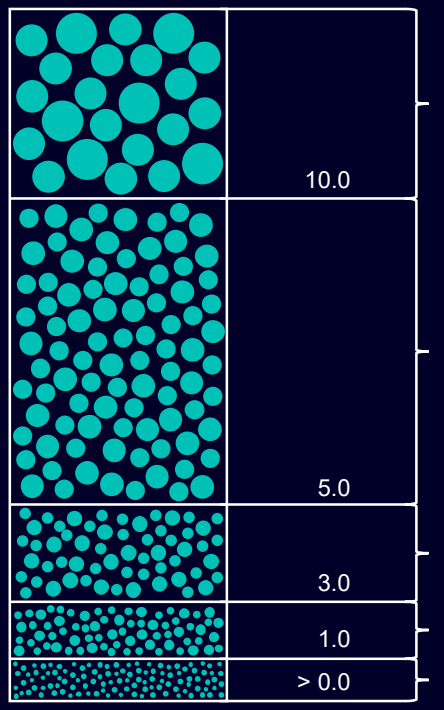
Comprehensive Air Quality Monitoring:
Particle Size Matters, and Number Concentration counts

The most abundant & harmful particle size group is not represented well by traditional PM-measurements

PM_X reads total **weight** of particulate matter [**µg/m³**]

The comprehensive air quality monitor should:

- Measure submicron-sized particles (resolution)
- Offer Particle Number Concentration values (count)
- Offer ease-of-calibration (maintenance)
- Offer install option for monitoring the outdoor air (reference)



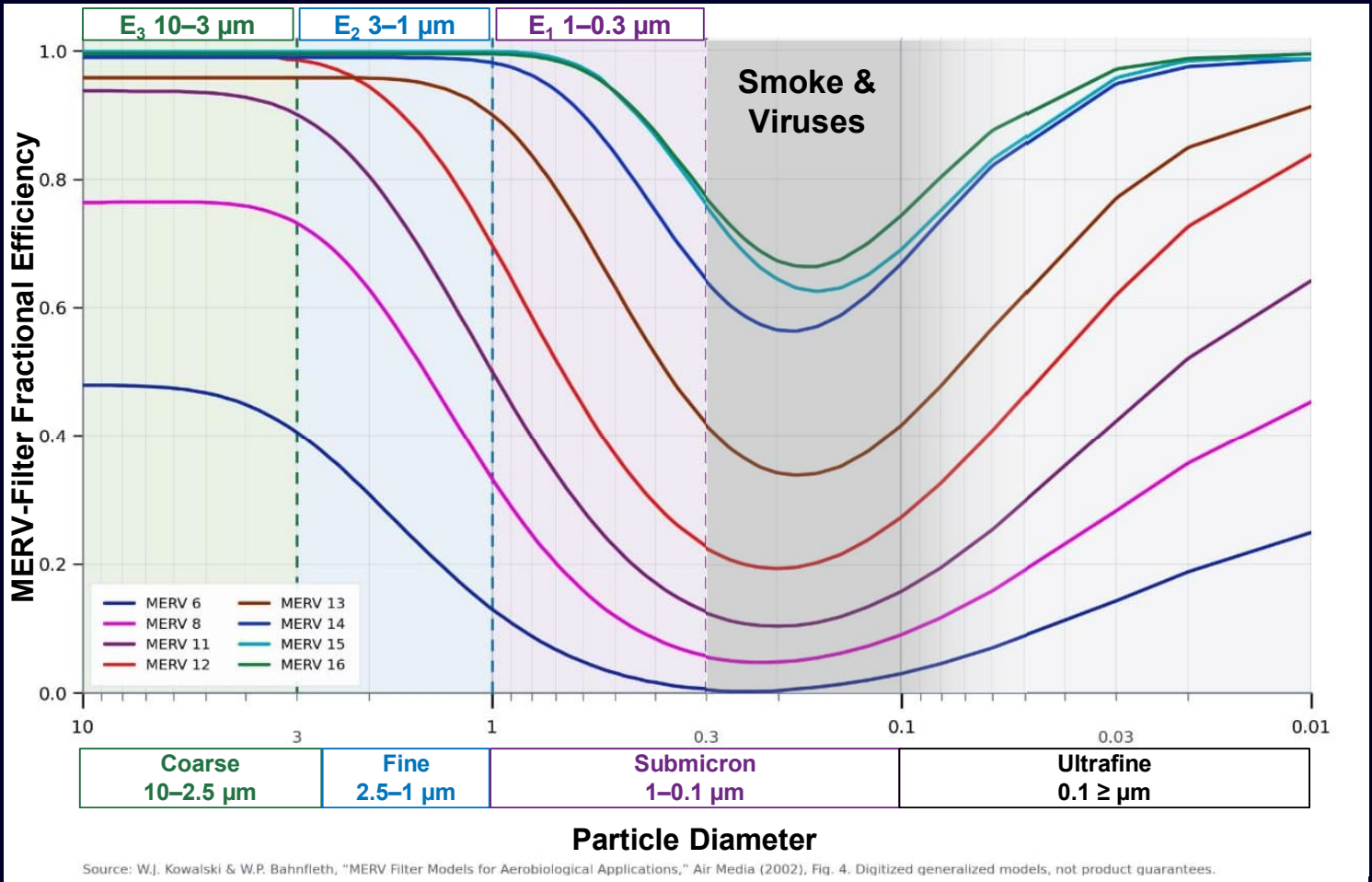
Particle Size (microns)	Mean Particle Size (microns)	Percent by Particle Count	Percent by Weight
30.0 – 10.0	20.0	0.005%	28%
10.0 – 5.0	7.5	0.175%	52%
5.0 – 3.0	4.0	0.25%	11%
3.0 – 1.0	2.0	1.07%	6%
1.0 – > 0.0	0.5	**98.5%**	**3%**

Source: Particle Size Distribution in the Atmosphere. Adapted from NAFA (2006)

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Minimum Efficiency Reporting Value (MERV)-rated Filters:
Are they the solution to harmful particle exposure?



Source: W.J. Kowalski & W.P. Bahnfleth, "MERV Filter Models for Aerobiological Applications," Air Media (2002), Fig. 4. Digitized generalized models, not product guarantees.

Abundant & harmful submicron particles are difficult to filter & mitigate:

- MERV-ratings cover sizes down to 0.3 µm, most effective ≥ 3 µm
  - Smoke & viruses are MPPS (most penetrating particle size)
- Drop in submicron filtration efficiency is due to physics
- Brownian motion (intermolecular collisions) 'diffuse' UFPs flow, suppressing displacement ventilation, but enhances UFP-filtration at point-of-filtration
- Comprehensive continuous AQM can be used to validate filter performance and maintenance

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Outdoor Air hazards & Wildfire Smoke Particles
Far-reaching health & building resilience impacts

Generally, smoke is **more harmful to health** than equivalent-sized particles. [1] Generates ozone & VOCs [2]

Dominant contributor to $PM_{2.5}$ exposure [3, 4, 5]

44% of the US population in 2026 live in counties where the average outdoor air is **not healthy** [6]

South & Midwest US had **120-220 days** with elevated particle backgrounds in recent years [7]

2024 wildfire smoke caused **>16K premature US deaths** [8]

Wildfire smoke prevalence push US counties into EPA NAAQS nonattainment status (the Clean Air Act)
→ Building Code considerations!

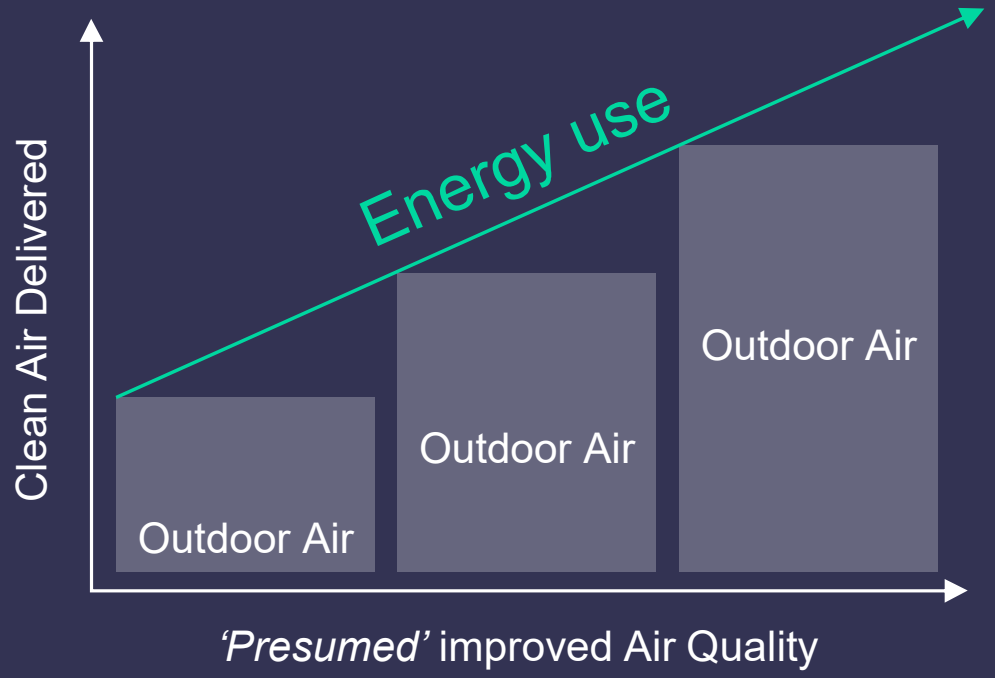


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Outdoor Air comes at a cost

VRP: Ventilation Rate Procedure

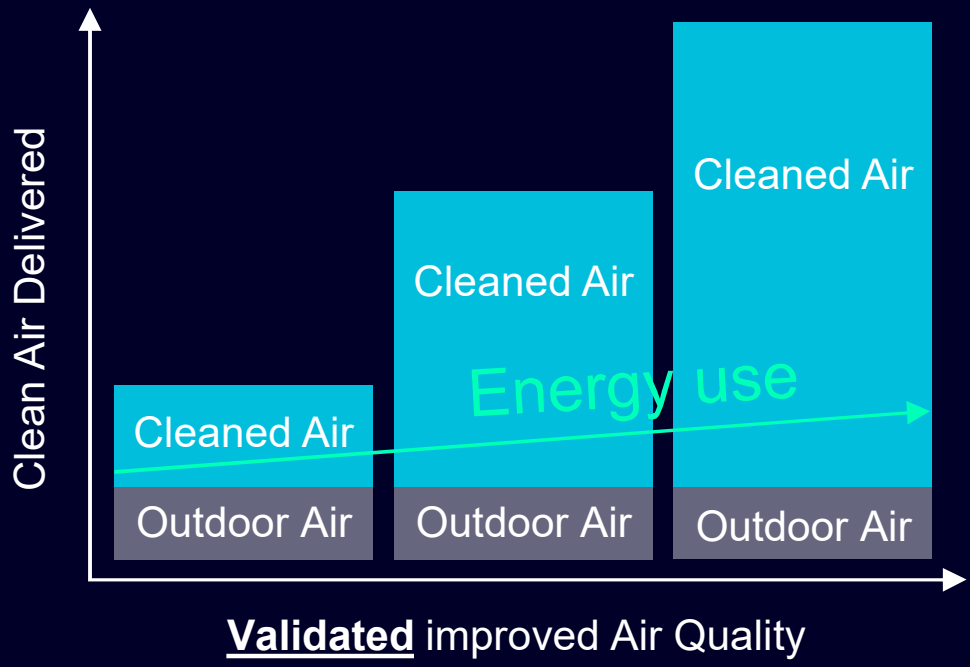
Prescriptive method for dilution/displacement
& presumptive contaminant mitigation



Clean Air delivered efficiently

IAQP: Indoor Air Quality Procedure

Performance-based method for
contaminant-specific mitigation



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Comprehensive Air Quality data as levers in facility management priorities:
Integral, but seldom understood for its indirect relevance across all 8 top priorities



TOP ORGANIZATIONAL PRIORITIES

Eight leading priorities — Share of respondents selecting each priority

	ORGANIZATIONAL PRIORITY	2024	2025	CHANGE
1	Improving Operational Efficiency / Reducing Costs	55%	56%	▲ +1 pp
2	Implementing Sustainable Practices & Technologies	40%	44%	▲ +4 pp
3	Improving Occupant Experience & Amenities	36%	36%	• 0 pp
4	Retrofitting Buildings for New Uses	32%	36%	▲ +4 pp
5	Improving Facility & System Resiliency & Reliability	36%	32%	▼ -4 pp
6	Complying With & Adapting to Regulations	30%	25%	▼ -5 pp
7	Improving Indoor Environmental Quality	N/A	16%	NEW
8	Augmenting Existing Labor Force	9%	11%	▲ +2 pp

Largest gain: sustainable practices and retrofits (+4 pp each) **Largest decline: regulatory compliance (-5 pp)** **Source**: ASHB, 2025

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Comprehensive Air Quality Monitoring:
Insightful & actionable IAQ Reports

Example AQM data to interpret

- *Southern US Uni Campus*
- Residence Hall
- May 01–31
- Executive Summary



IAQ Contaminant Awareness



IAQ management interactions



IAQ building optimization, energy-efficiency, resilience, sustainability, retrofit etc.

Location	**Temp** [°F]	**RH** [%]	**CO2** [ppm]	**TVOC** [Index]	**0.3 µm PNC** [count]	**$PM_{2.5}$** [µg/m^3]	**Ozone** [ppb]
Outdoor Air	**82.2**	**56.4**	**419**	**393**	**637,586**	**14.5**	**1.0**
3rd floor average	71.2	62.9	438	243	339,615	9.9	0.3
2nd floor average	69.8	61.2	441	153	283,256	8.1	0.2
1st floor average	70.6	62.1	459	325	305,747	8.6	6.8
Ground average	70.6	60.8	434	113	279,809	7.8	1.2

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Use data and laboratory use analysis to improve optimization
For smarter energy, operations, health, and safety decisions

Data Repositories with Building X

Leverage Cloud-based data lakes



Smart Air Quality

Comprehensive air quality data for insights and supporting broad operational efficiencies



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Understanding Laboratory Energy Use

- ✓ Prioritize safety and compliance
- ✓ High levels of outdoor air in ventilation

Understanding what drives energy

- ✓ Mechanical systems
- ✓ Control sequences

Using data to monitor performance

- ✓ Monitor Indoor Air Quality
- ✓ Monitor energy use
- ✓ Monitor ventilation

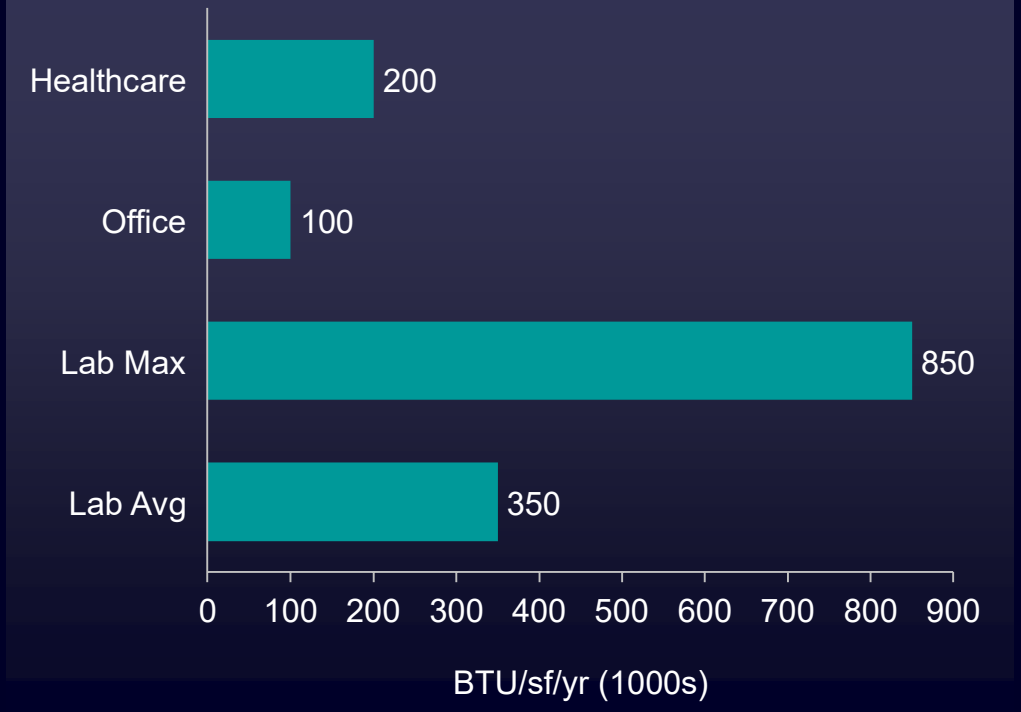
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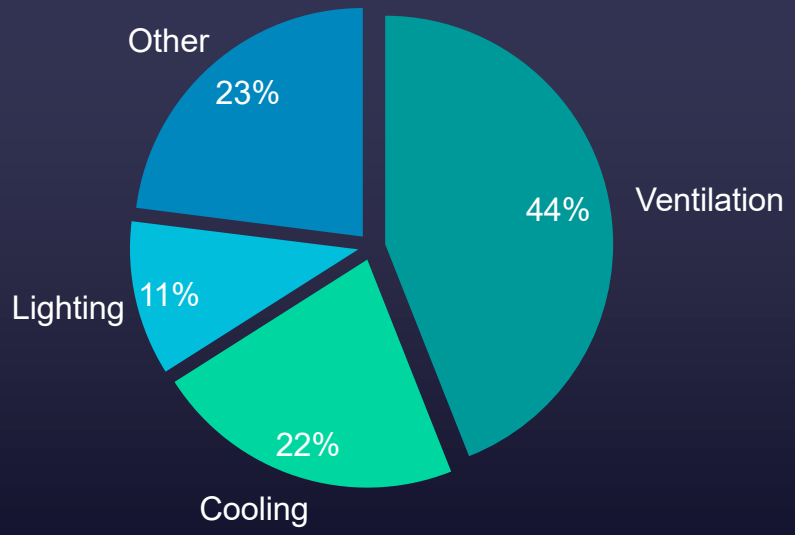
Why Laboratories?

Benefit: Reduction of energy consumption and improved safety in Laboratories

Energy usage is typically 3 to 8 times greater in labs than other buildings



Approx. 2/3 of energy use in labs is associated with ventilation



Data shown is the annual electricity use in the Louis Stokes Laboratory, National Institute of Health, Bethesda, MD

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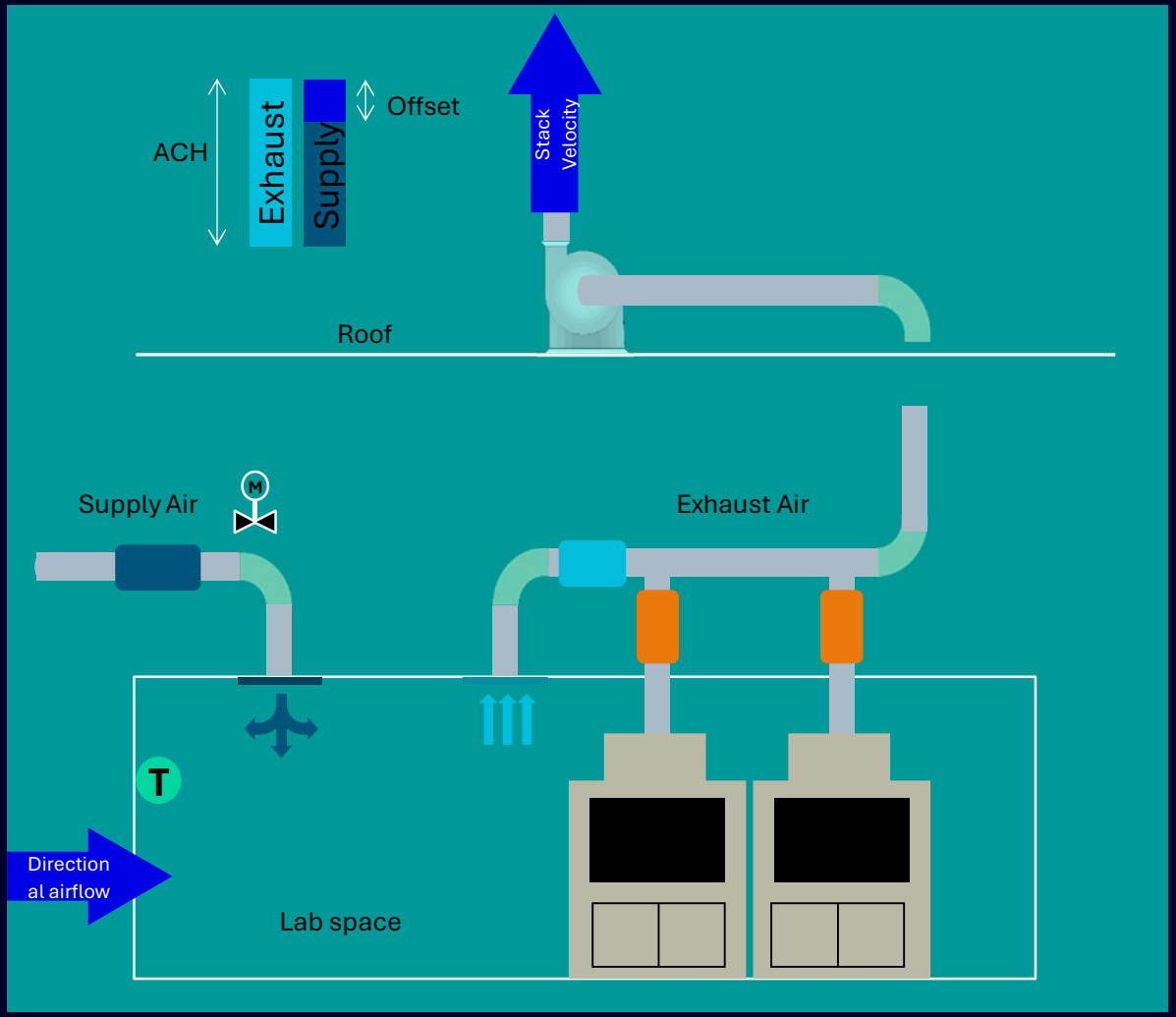
Lab Ventilation System Layout

Airflow Drivers

- **Hood Fume Exhaust Flow**
- **Room Ventilation (ACH)**
  - Fan Energy Driver
- **Thermal Loads**
  - Waste Heat Recovery
  - Chiller Optimization
  - Decouple Air from Cooling

Ranked conservation levels

- Use less air
- Improve heating and cooling processes
- Move air more efficiently



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Ventilation Risk Assessment

Reduce Dilution Ventilation (ACH)

Match Rate to Risk

Reductions achieved through analyzing existing ACH & Mechanical systems.

- Safety professionals evaluate the hazards
- Re-evaluate using high air changes (dilution) for safety
- Evaluate Ventilation Effectiveness as opposed to random ACH
- Consider Control Banding

Requirements

- Updated controls / VAV system
- Coordination with customer safety team / lab management team

Risk Factor Score	Risk Control Band (RCB)	Description
< 16	0	Negligible
16-40	1	Low
41-64	2	Moderate
65-88	3	High
89-120	4	Extreme "Special"

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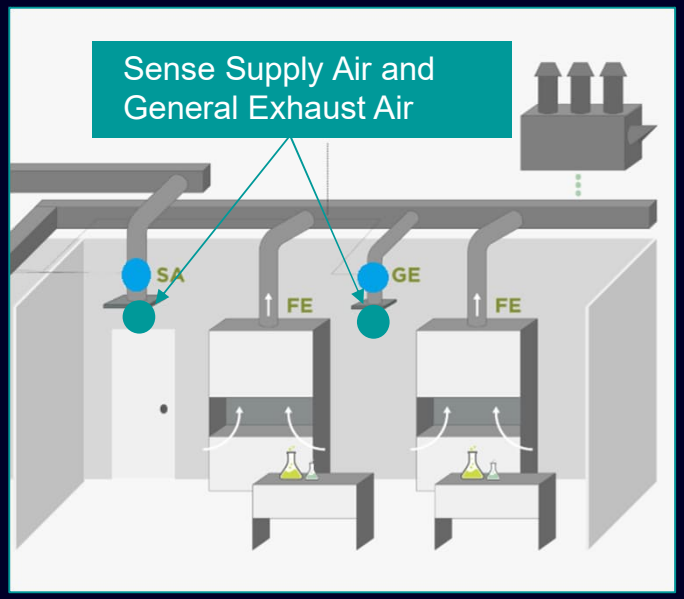
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Elements of the Siemens Smart Lab Solution:
Lab Energy Savings Strategies

DCV Strategy
Monitor exposure to manage ventilation & match risk

Contaminant monitoring and lab demand control ventilation enable much lower flows when no hazard is detected.

- Design for known hazards and chemicals that indicate activity
  (Anticipate future changes to chemistry, hazards)
- Central monitoring or distributed/discrete sensors
- Commission for clearing rates and ventilation effectiveness
- The "new" math is powerful
  12ACH 8 hr/wk, 2ACH 160 hr/wk
  = 2.5ACH average. **80% reduction!**
- Treat every "event" as a chance to learn and improve safety



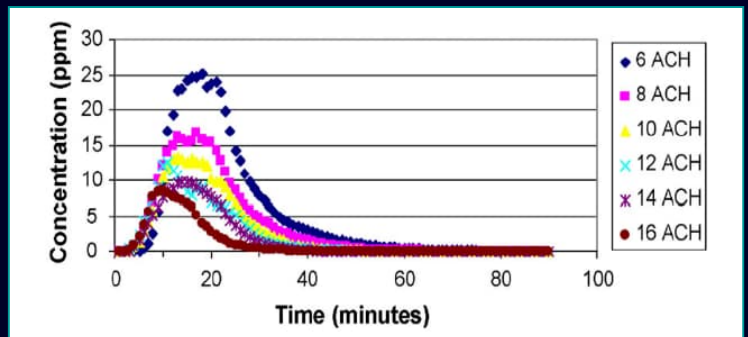


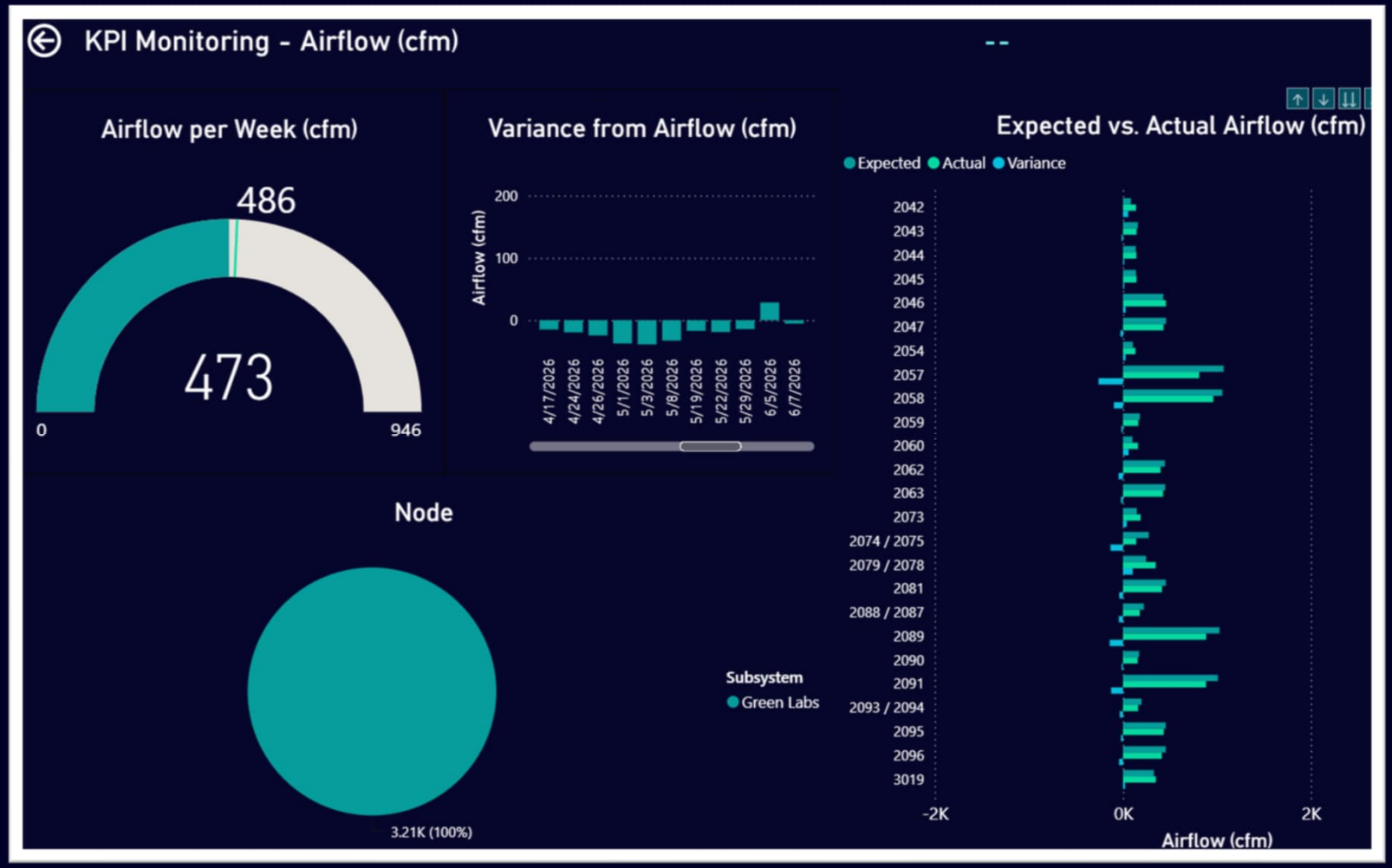
Fig. 2. Chemical concentrations generated from small spills of diethyl ether at floor level under varying ACH rates, as measured by photoionization detection from the exhaust duct centerline.

Journal of Chemical Health & Safety, September/October 2009

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KPI monitoring allows for easy commissioning and performance verification



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Building X: Critical Space Monitoring

The single-entry point for all critical environment data

Sample Daily Report



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The vision for smarter, more efficient campuses

Status Quo: Limited transparency

Value: Proactive efficiency

Value: Continuous optimization

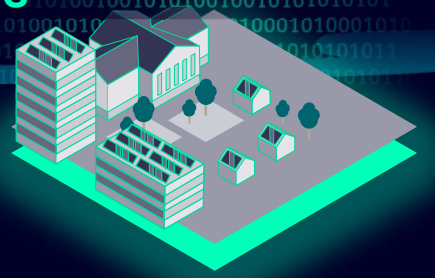
Traditional/Automated campus



Smart Campus



Humancentric Autonomous Campus



From …

- Complex integration of new technologies
- On-site management solutions
- Siloed control of building services
- Reactive on-site maintenance

To …

- Predictable campus budgets
- Fewer disruptions to learning & research
- AI-enabled remote operations
- Easy integration of new tech

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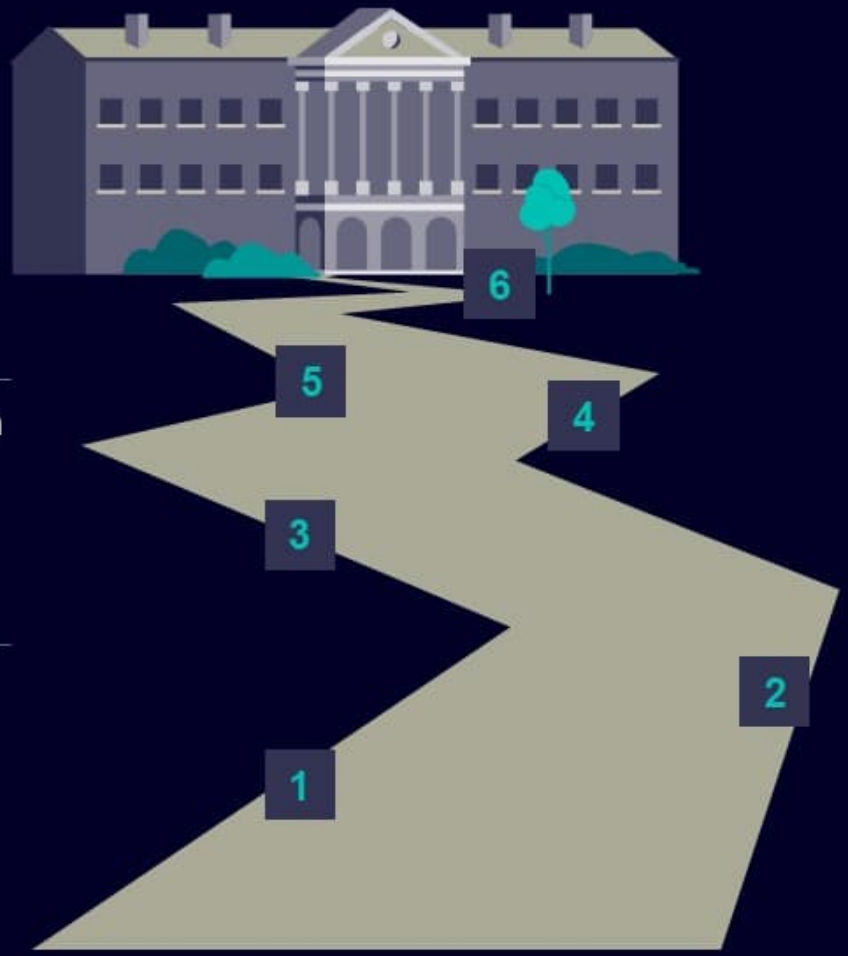
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A proven process to design, implement, and finance digital innovation

5 | Transform to a smart campus
- implement transformation
- Leverage tech and services for continuous optimization

3 | Build a Smart Campus foundation
- upgrade critical infrastructure and IoT
- implement metering and control
- Define KPIs

1 | Create a vision
- involve key stakeholders
- Incorporate smart infrastructure improvements



6 | Enhance your status as a college or university of choice
- bring technology into the classroom
- showcase research & teaching spaces

4 | Determine the best way to fund
- determine optimal funding
- consider funding grants

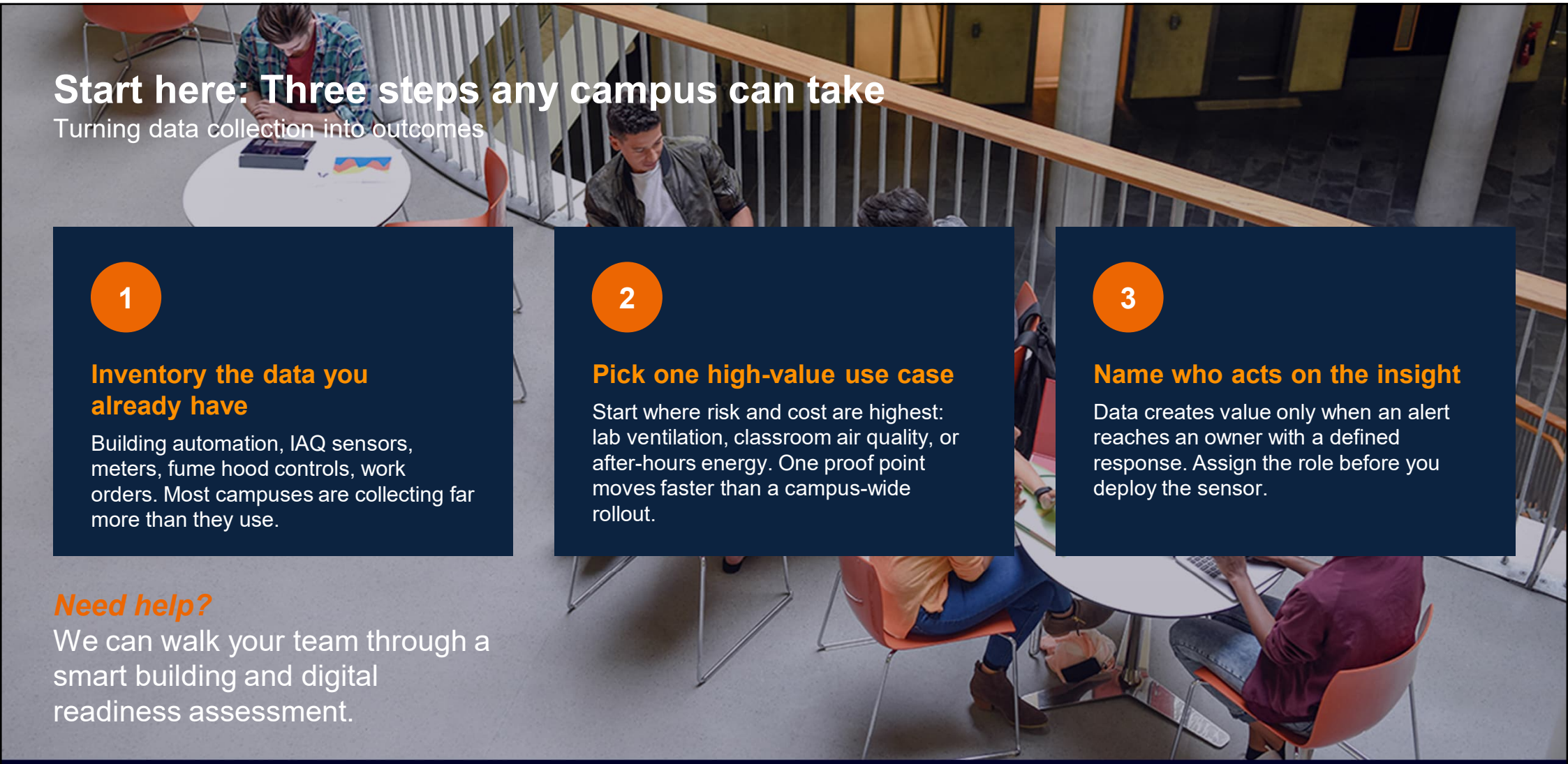
2 | Assess current infrastructure and digital readiness
- engage facility team
- perform a smart campus readiness assessment

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Start here: Three steps any campus can take

Turning data collection into outcomes



1

Inventory the data you already have

Building automation, IAQ sensors, meters, fume hood controls, work orders. Most campuses are collecting far more than they use.

2

Pick one high-value use case

Start where risk and cost are highest: lab ventilation, classroom air quality, or after-hours energy. One proof point moves faster than a campus-wide rollout.

3

Name who acts on the insight

Data creates value only when an alert reaches an owner with a defined response. Assign the role before you deploy the sensor.

Need help?

We can walk your team through a smart building and digital readiness assessment.

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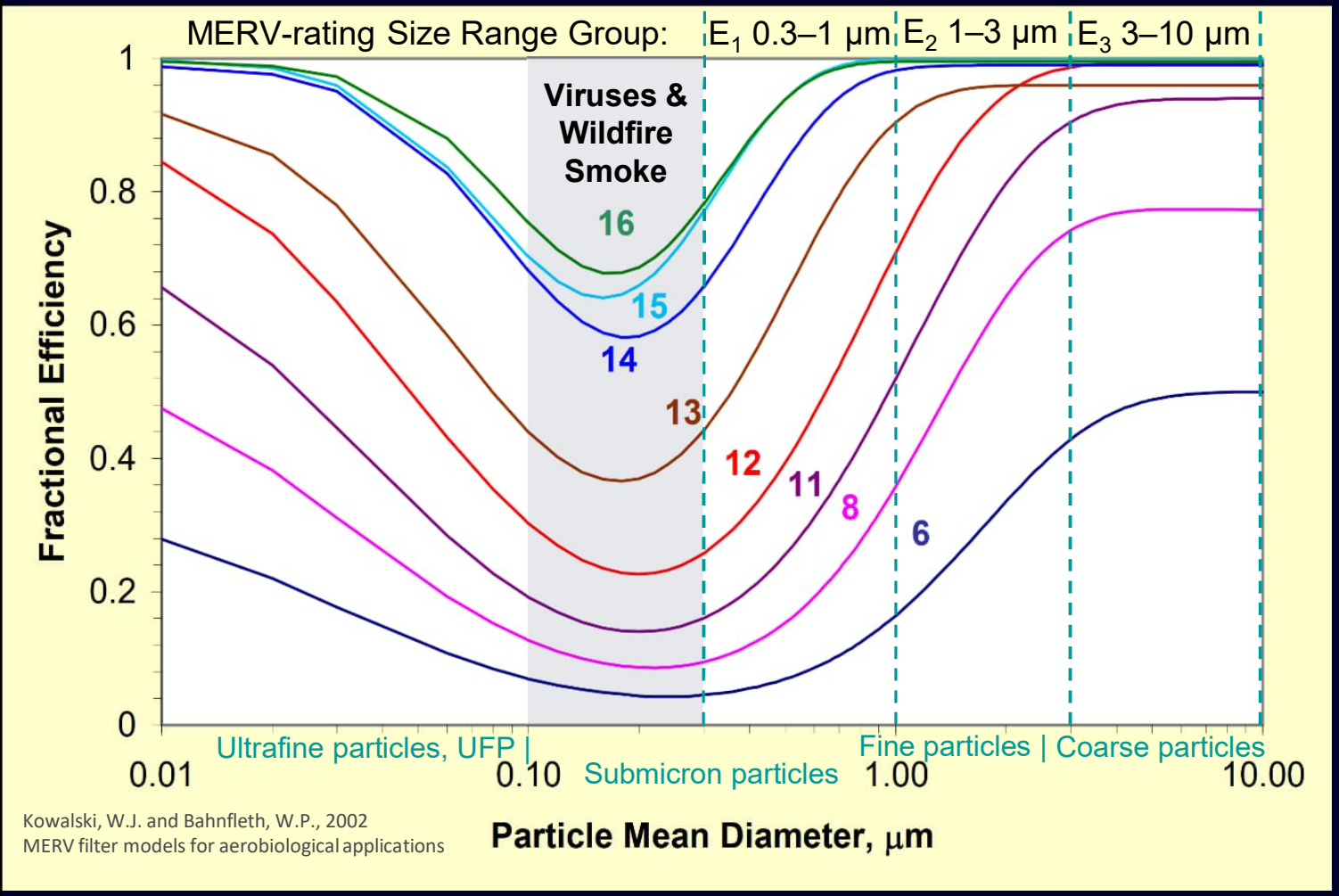
Learn more, visit:
www.siemens.com/SmartCampus



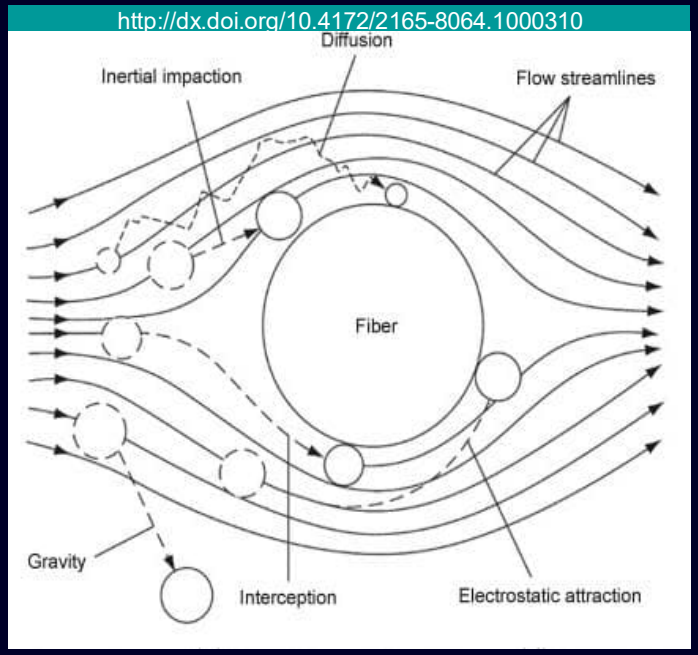
Appendix

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MERV-rated Filters: The Particle Solution? Extended Performance curves



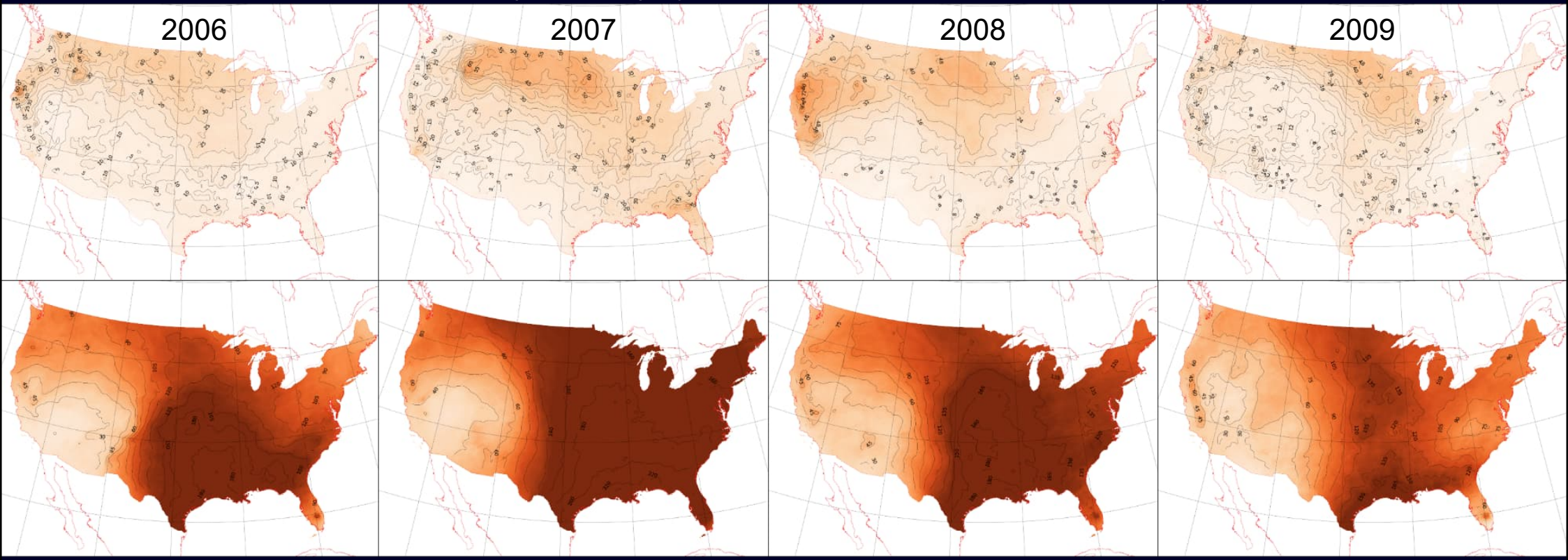
Kowalski, W.J. and Bahnfleth, W.P., 2002
MERV filter models for aerobiological applications



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Wildfire smoke fine particle exposure frequency (days) is generally increasing

Cumulative Smoke Distribution (CONUS) by NOAA/NESDIS Hazard Mapping System [1]



Southwest and Midwest recently had 120–220 days with elevated particle backgrounds!

Remember, smoke prevalence projected to increase coming years!

Additionally, smoke drives air pollution also by secondary air chemistry!

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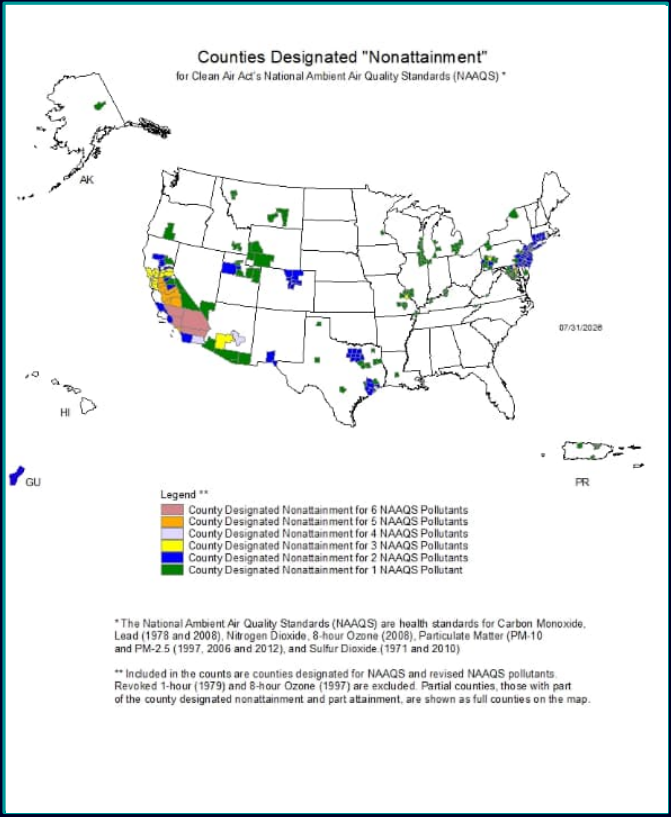
Unhealthy Outdoor Air promotes change in ventilation strategies for acceptable IAQ

44% of our population in US live in counties where the outdoor air is considered unhealthy by the US Clean Air Act's National Ambient Air Quality Standards (NAAQS)

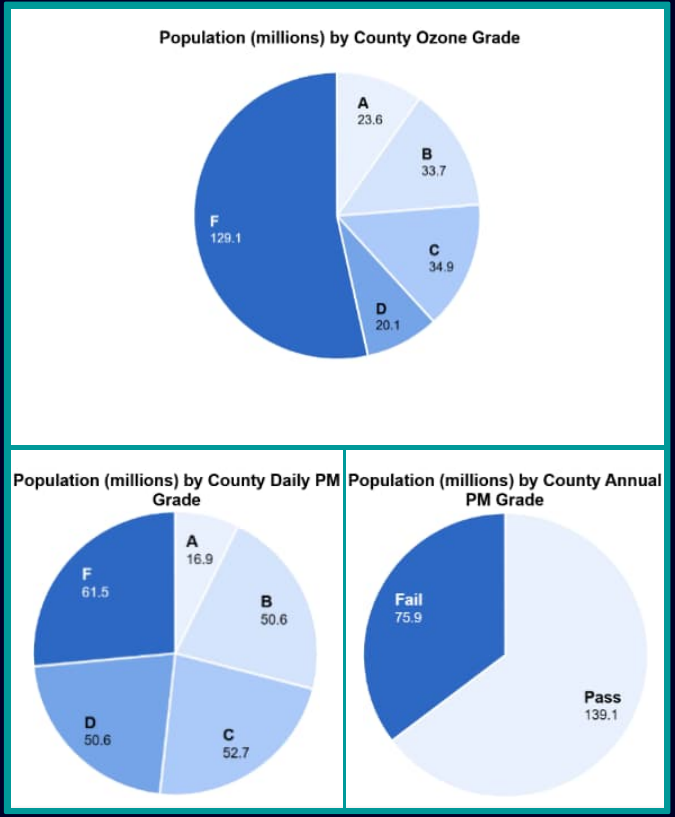
Top contributing pollutants are:

- Ozone
- Particles

EPA Green Book [1]



American Lung Association's 2026 State of the Air Report [2]

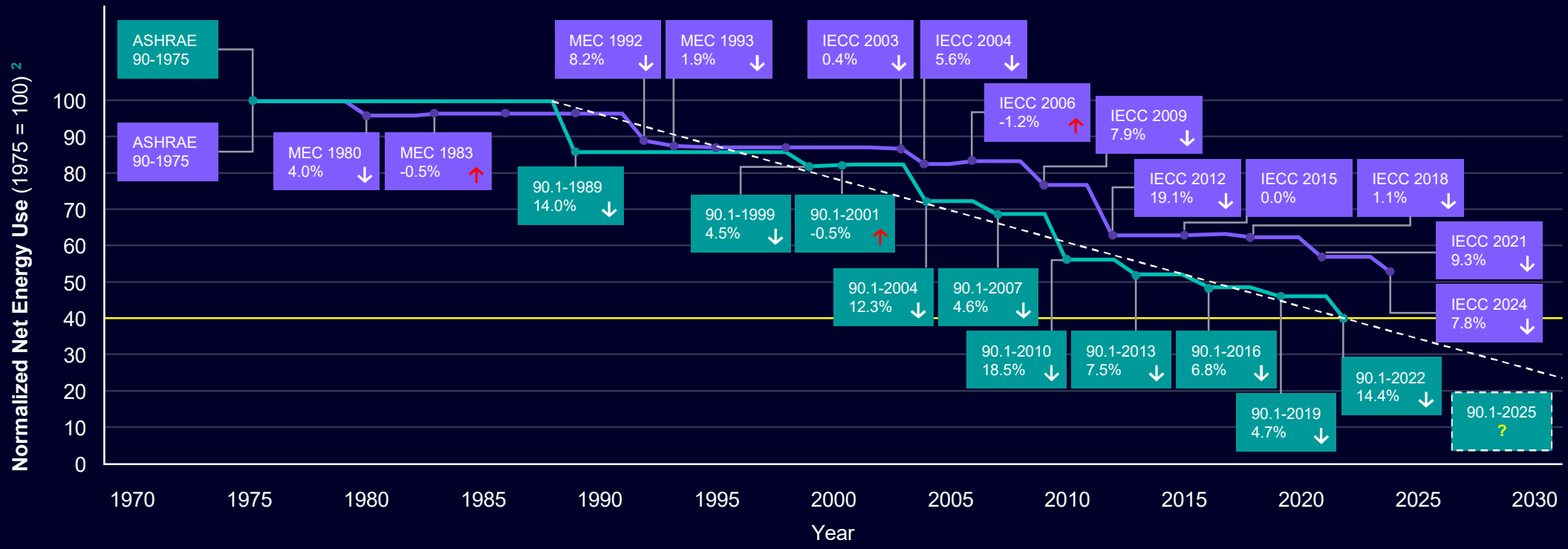


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US DOE Estimated improvement in Residential and Commercial Energy Codes [1]

1975 – 2024, and the "other side" of Outdoor Air ventilation… the Energy!



Advanced energy codes driving expected energy efficiency

Commercial Residential

1 https://www.energycodes.gov/infographics

2 Net energy use includes the contribution of renewable energy generation

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