

PITTSBURGH 2030 DISTRICT

DRIVING BUILDING PERFORMANCE AND ECONOMIC VITALITY

***PITTSBURGH 2030 DISTRICT IAQ PILOT OVERVIEW FOR THE
FEDERAL INTERAGENCY COMMITTEE ON INDOOR AIR QUALITY***

JUNE 8, 2016



THANK YOU.



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PITTSBURGH
2030
 DISTRICT
 DOWNTOWN - OAKLAND



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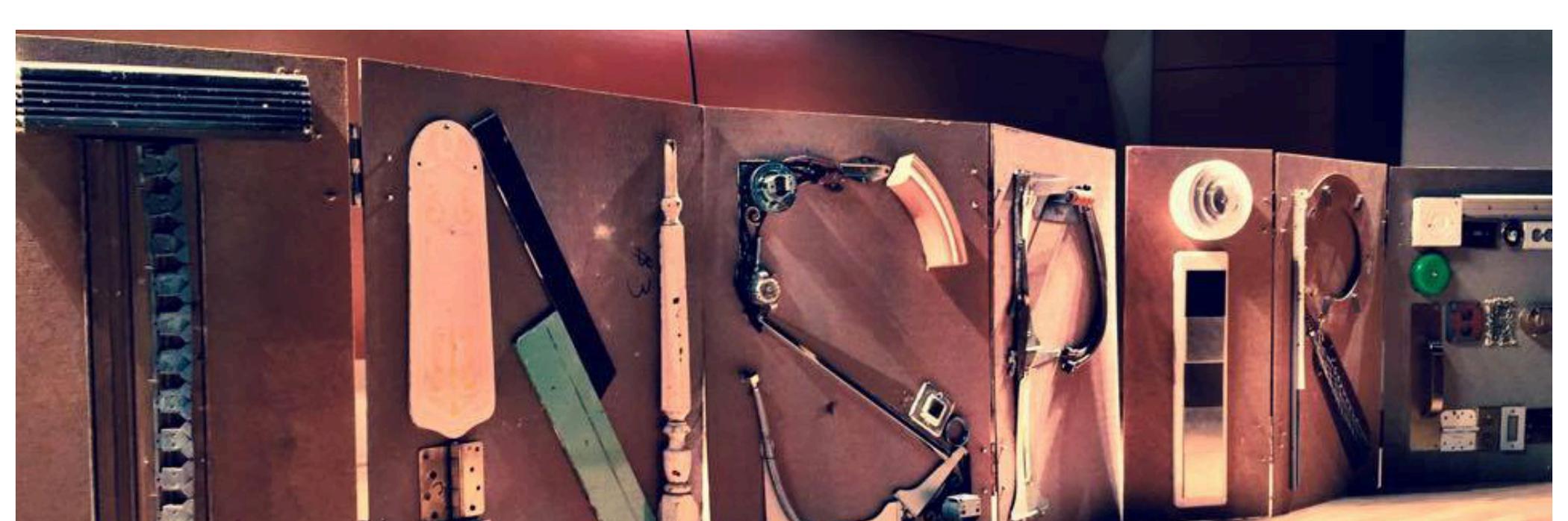
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GREEN BUILDING ALLIANCE

Mascaro Center
for Sustainable Innovation

Vision: The places where we live, work, learn, and play will be healthy and high performing.





GREEN BUILDING ALLIANCE

INSPIRE

PITTSBURGH
2030
DISTRICT
DOWNTOWN - OAKLAND



PROVE

**Policy &
Advocacy**

**Educational
Programs**

Learning
events, tours,
networking,
community,
case studies,
& resources.

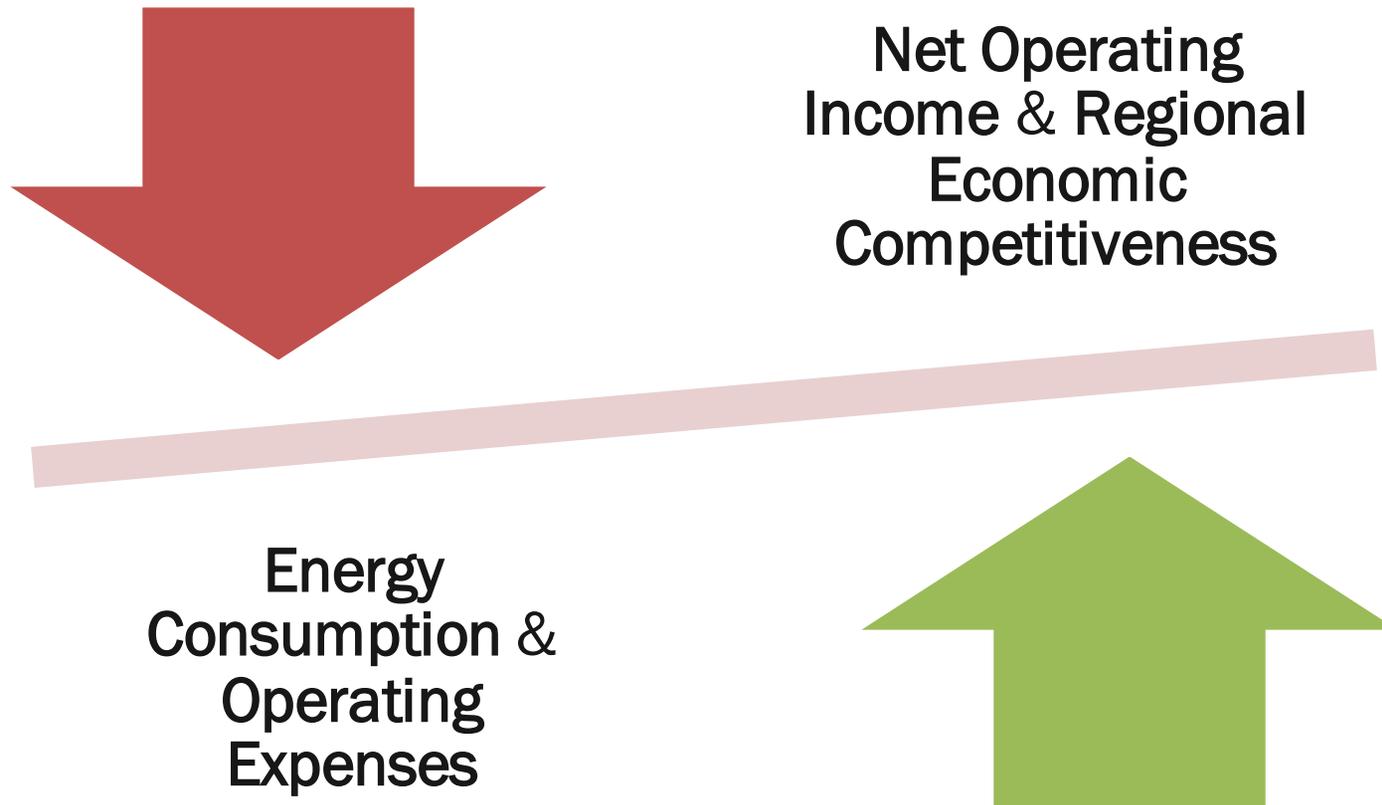
EQUIP

**Technical
Assistance**





WHAT DID PITTSBURGH NEED?



PITTSBURGH
2030
DISTRICT
DOWNTOWN - OAKLAND

A COLLABORATIVE, NATIONALLY-RECOGNIZED, LOCALLY-DRIVEN VOLUNTARY COMMUNITY OF BUILDINGS IN DOWNTOWN PITTSBURGH AND OAKLAND THAT ARE WORKING TOWARDS HIGH PERFORMANCE.

HIGH PERFORMANCE BUILDINGS HAVE PROVEN TRACK RECORDS:

- BUSINESS AND PROPERTY PROFITABILITY
- ASSET VALUE INCREASES
- ENVIRONMENTAL IMPROVEMENTS
- OCCUPANT HEALTH

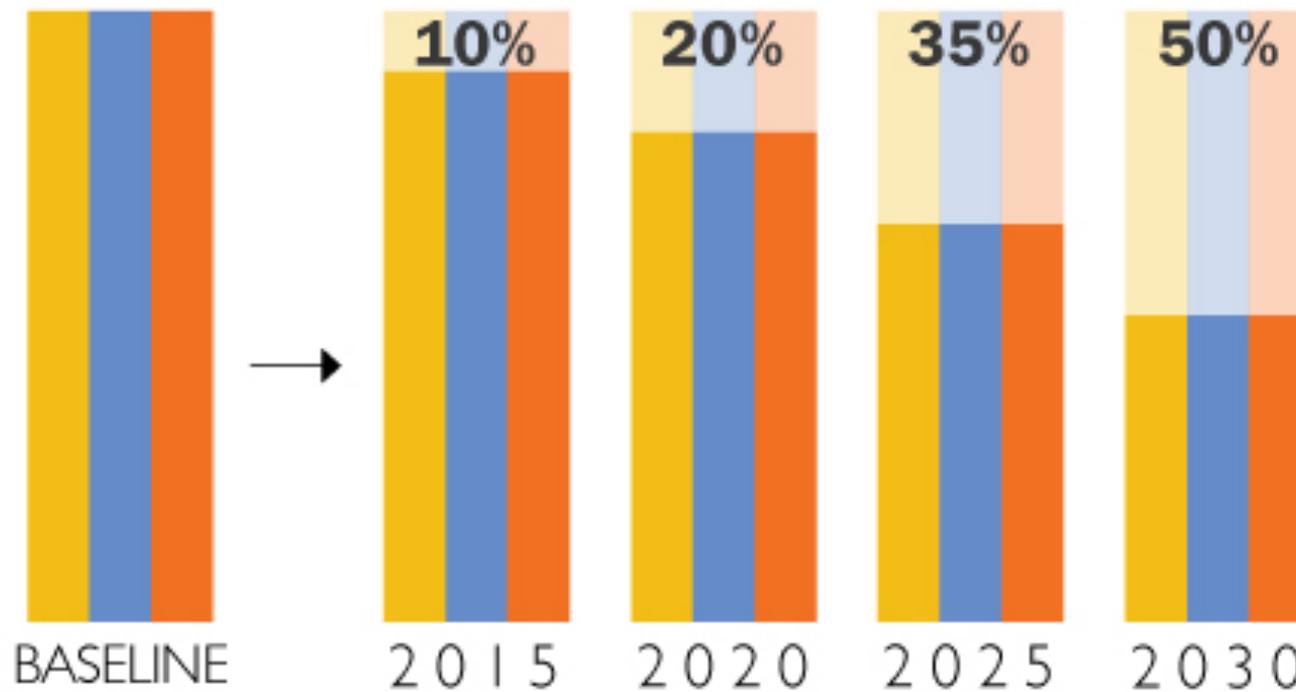
THE PITTSBURGH 2030 DISTRICT GOALS ARE INSPIRED BY THOSE SET NATIONALLY BY *ARCHITECTURE 2030* AND ITS 2030 CHALLENGE.

PITTSBURGH 2030 DISTRICT GOALS

- **ENERGY USE:** A MINIMUM 10% REDUCTION BELOW THE NATIONAL AVERAGE BY 2015, WITH INCREMENTAL TARGETS REACHING A 50% REDUCTION BY 2030.
- **WATER USE:** A MINIMUM 10% REDUCTION BELOW THE DISTRICT AVERAGE BY 2015, WITH INCREMENTAL TARGETS REACHING A 50% REDUCTION BY 2030.
- **TRANSPORTATION CO² EMISSIONS:** A MINIMUM 10% REDUCTION BELOW THE DISTRICT AVERAGE BY 2015, WITH INCREMENTAL TARGETS REACHING A 50% REDUCTION BY 2030.
- **INDOOR AIR QUALITY:** *TO BE DETERMINED LOCALLY.*



EXISTING BUILDING TARGETS

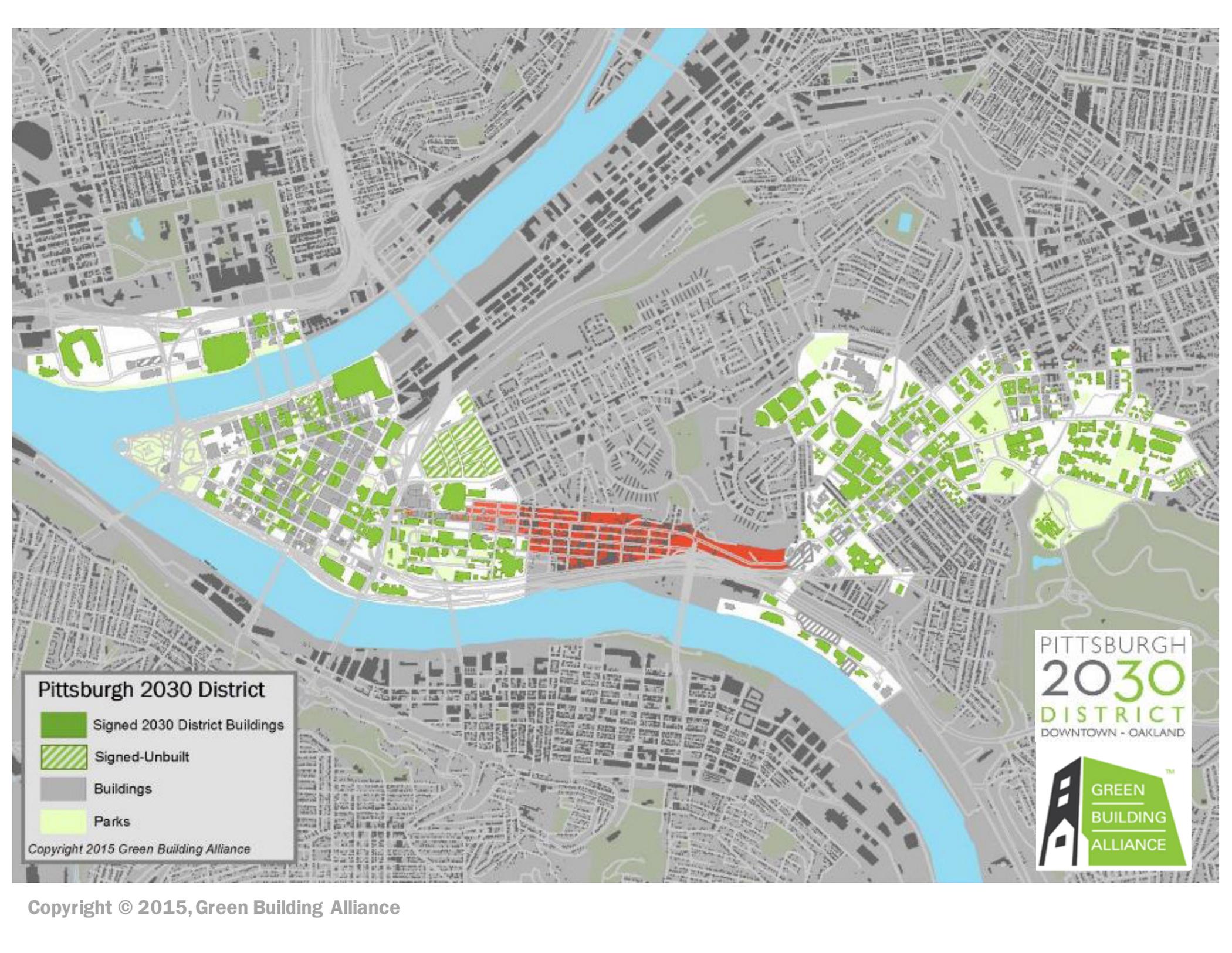


Energy, Water, and CO2 from Transportation Reduction

 Energy, Water, and CO2 from Transportation Consumption

The 2030 Challenge for Planning: Existing Buildings

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Pittsburgh 2030 District

-  Signed 2030 District Buildings
-  Signed-Unbuilt
-  Buildings
-  Parks

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PITTSBURGH 2030 DISTRICT COMMITMENTS

Mascaro Center
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PITTSBURGH
2030
DISTRICT
DOWNTOWN - OAKLAND

438 properties

68,210,816 ft²

69% of the

PITTSBURGH
2030
DISTRICT
DOWNTOWN - OAKLAND

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Building Alliance



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12 DISTRICTS INTERNATIONALLY

Mascaro Center
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2030 DISTRICTS NETWORK

LOS ANGELES
2030
DISTRICT®

SEATTLE
2030
DISTRICT®

GRAND RAPIDS
2030
DISTRICT®

SAN ANTONIO
2030
DISTRICT

CLEVELAND
2030
DISTRICT®

PITTSBURGH
2030
DISTRICT®
DOWNTOWN - OAKLAND

DENVER
2030
DISTRICT®

STAMFORD
2030
DISTRICT®

Established Districts

- 1087 Buildings
- 311 Property Partners

ALBUQUERQUE
2030
DISTRICT®

SAN FRANCISCO
2030
DISTRICT®

DALLAS
2030
DISTRICT®

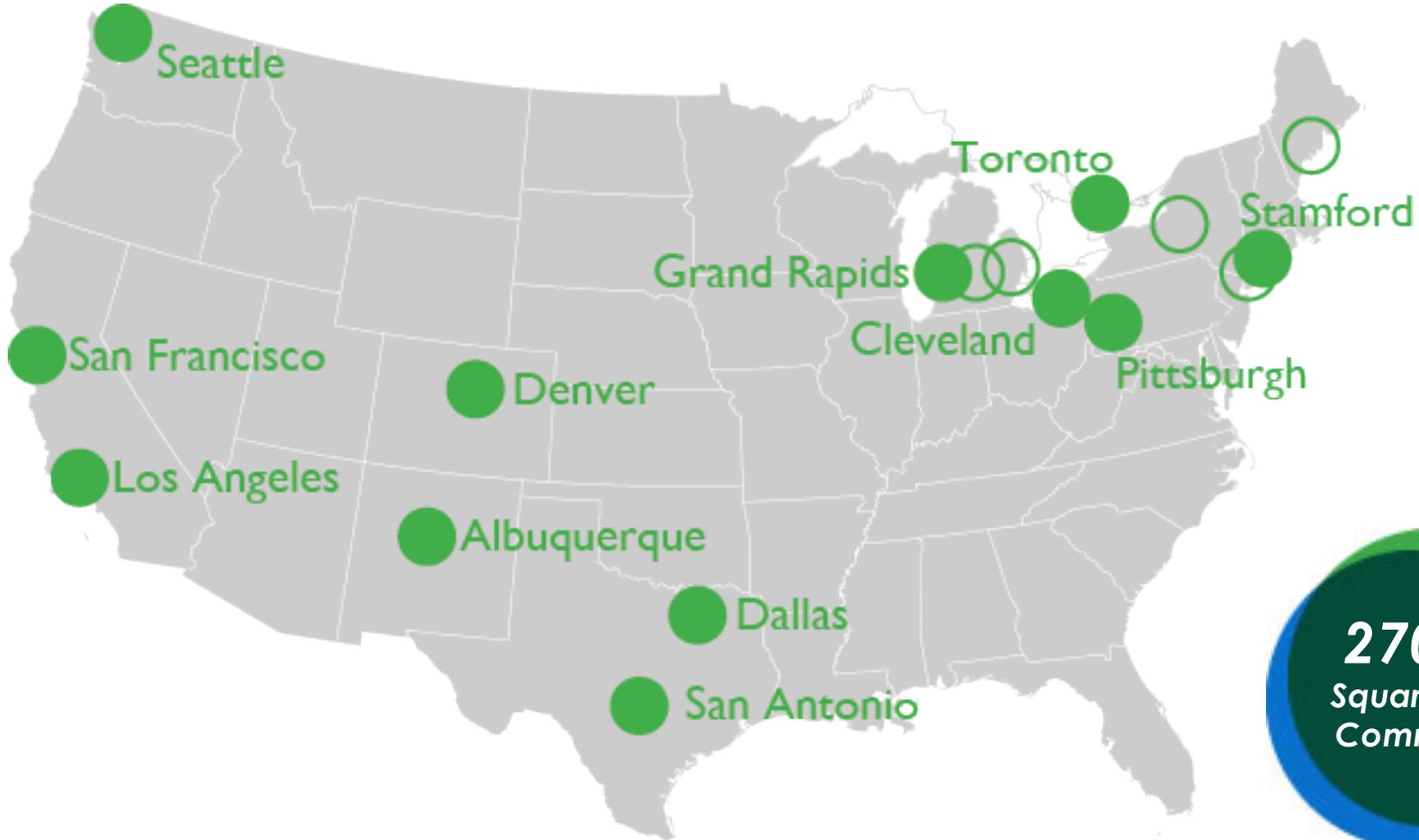
TORONTO
2030
DISTRICT®



University of Pittsburgh

A GROWING NETWORK

Mascaro Center
for Sustainable Innovation



270 M
Square Feet
Committed

● Established 2030 District ○ Emerging 2030 District

Energy = ↓ **12.5%**

Water = ↓ **10.3%**

Transportation

Emissions = ↓ **24.2%**

Indoor Air Quality

WHAT IS HAPPENING WITH INDOOR AIR QUALITY?

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Vaclav Hasik

Graduate Student, Department of Civil and Environmental Engineering

Motivation

2030 District goals:

- Energy use – 50% reduction
- Water use – 50% reduction
- Transportation – 50% reduction in CO2 emissions
- Indoor air quality - *To be determined*



Our research goals:

- Establish baseline IAQ in 2030 District buildings
- Evaluate direct & indirect impacts of energy reductions on IAQ
 - Direct = changes to building characteristics (e.g. ventilation, materials)
 - Indirect = life-cycle energy impacts on regional outdoor air quality
- Develop goals and strategies for improvements in IAQ metrics
- Utilize long-term LCA models to link energy, water, and traffic reductions to ambient air quality predictions and environmental impacts



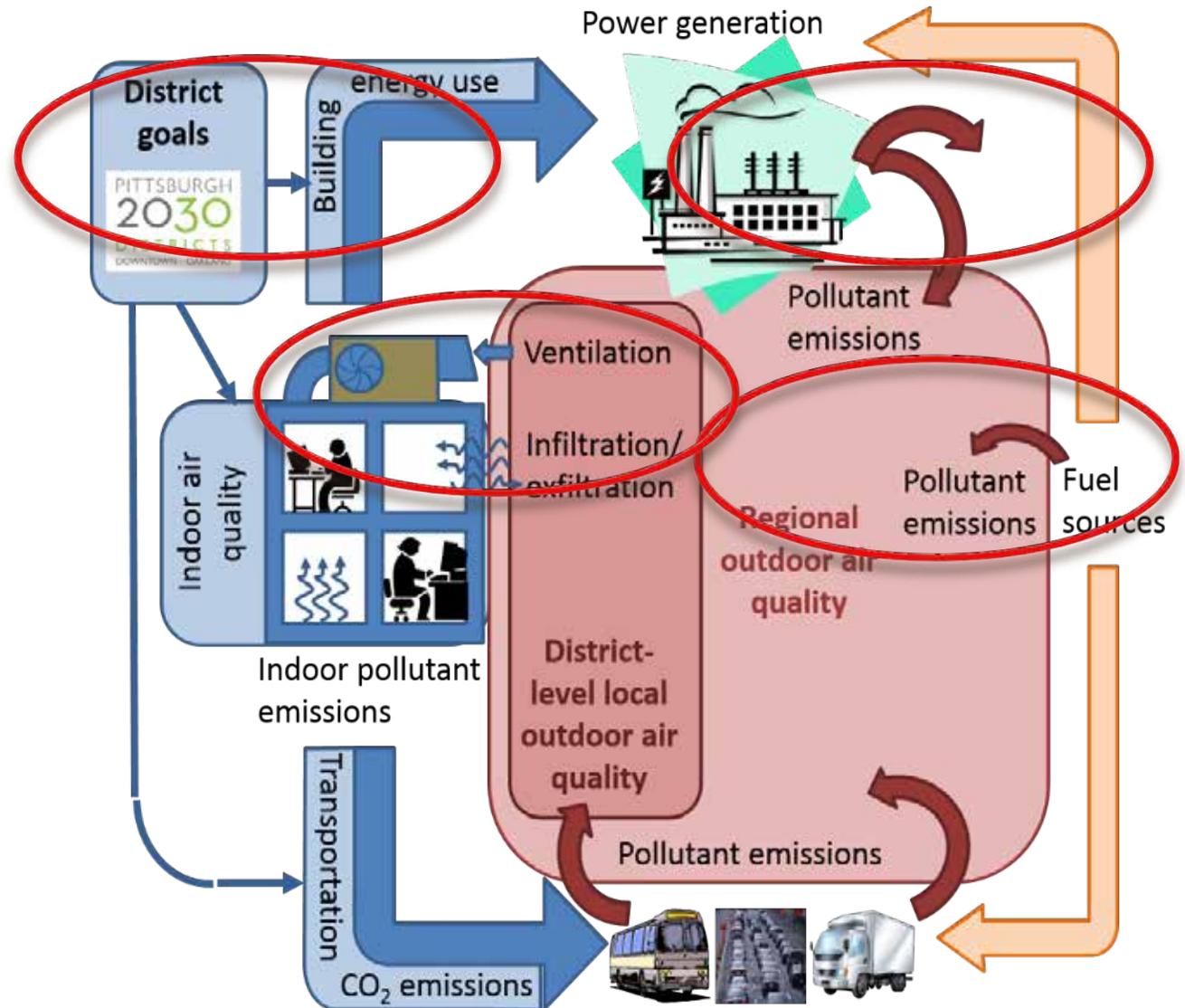
Problem

- **Allegheny county** residents are at **twice the cancer risk**, as those living in surrounding counties (PRETA, 2013)
- Pittsburgh is ranked: **8th** for annual particle pollution out of **171** metropolitan areas (American Lung Association, 2015)
- **13 to 14 percent** of Pittsburghers suffer from asthma, compared with **8 to 10 percent** of people nationwide. (Sostek, 2014)
- As many as **half of all Pittsburgh students** have asthma, far exceeding Pennsylvania's 11.3 percent child asthma rate. (Smeltz, 2014)



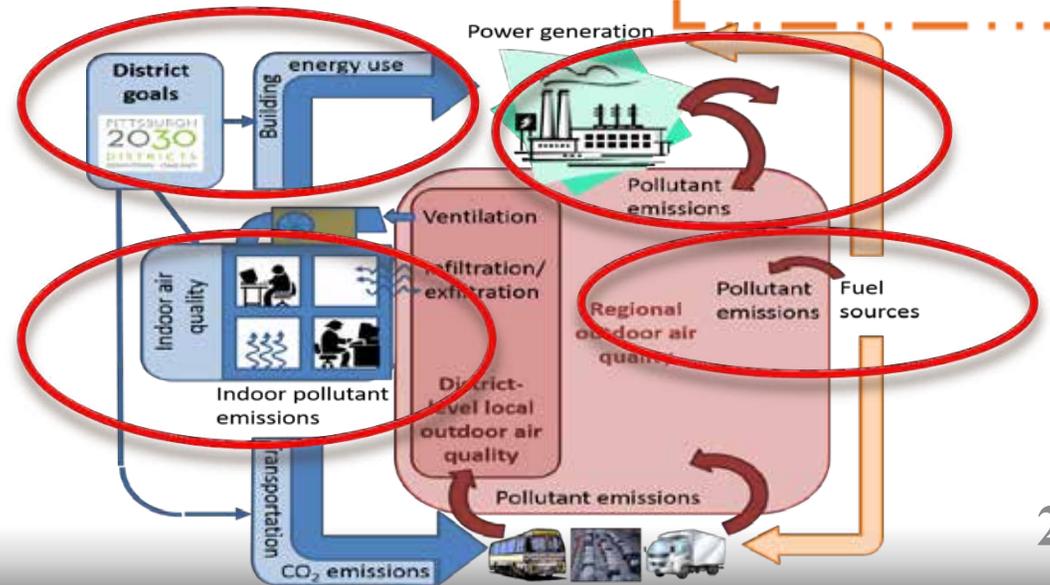
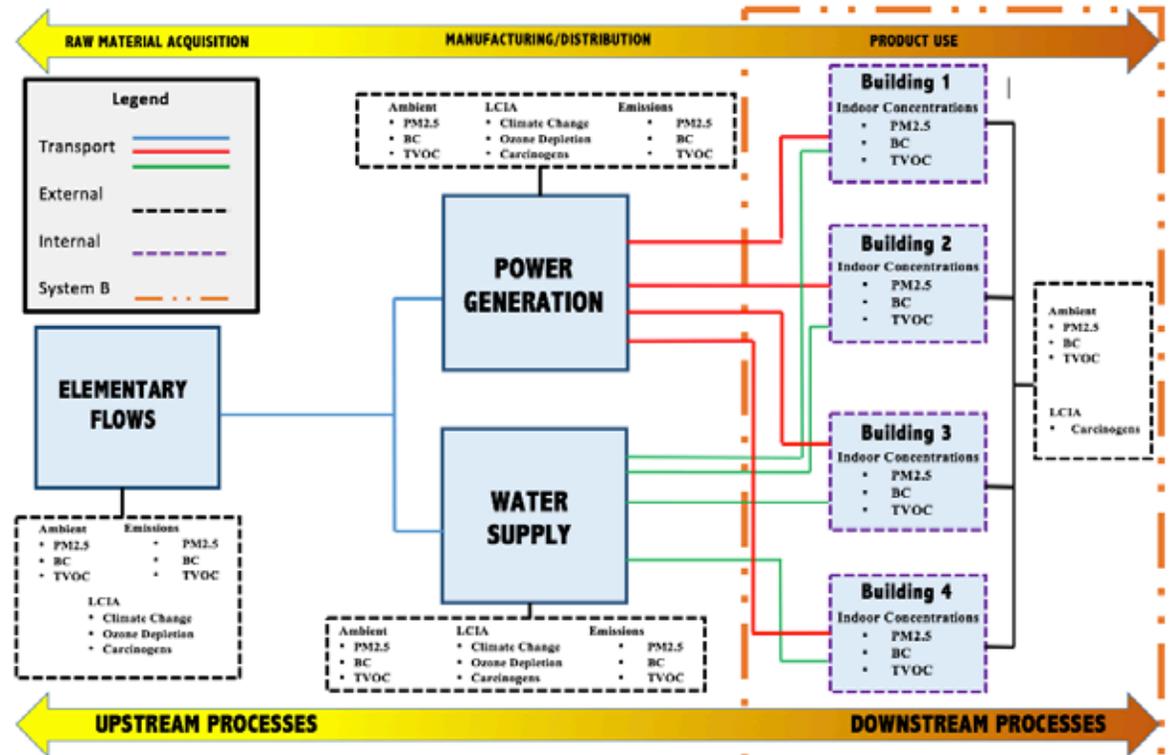
INDOOR AIR QUALITY & 2030 DISTRICTS

The vision of this work is centered on answering the question:
How can the 2030 district impact indoor air quality?



RESEARCH QUESTIONS

1. How does energy conservation impact indoor and ambient air quality?
2. What structural, non-structural, and mechanical systems in the built environment significantly influence pollutant concentrations?
3. Is there strong temporal variability in indoor air quality parameter across seasons?
4. Will reductions in energy use, water consumption, and carbon emissions on a community scale have longitudinal impacts on climate change?
5. What impact does IEQ have on perceived worker productivity?



WHY?



www.worldwatch-europe.org

We spend 90% of our time inside buildings.



Approach

- Building Assessment Survey and Evaluation (BASE)
- 100 randomly selected public and commercial office buildings
- Collected using a standardized protocol
- Provides normative IAQ data and symptom incidence in typical office buildings (EPA 2006c)

- Steps:
 1. Visit the building and site
 2. Select study areas and monitoring locations
 3. Building characterization and monitoring
 4. Data management and analysis
 5. ~~Administer occupancy survey~~



United States Environmental Protection Agency

A unique opportunity to...

Get a comprehensive data set on indoor air quality in U.S. office buildings



BASE

Building Assessment Survey and Evaluation Study

<http://www.epa.gov/iaq/base/>

APPROACH

IAQ Variables	Potential sources	Effects/Importance
Particulate Matter (PM)	Diesel engines, dust, soot, smoke, fireplaces, wood stoves, unpaved roads, agricultural practices	Aggravate asthma, allergies, coughing, shortness of breath, chronic bronchitis, decreased lung function
Carbon Dioxide (CO₂)	Carbon combustion, biological respiration, overcrowding coupled with poor ventilation	Headache, hypercapnia, unconsciousness, asphyxiate, loss of mental acuity
Temperature (T)	HVAC (Climate control), Outdoor	occupant comfort, decreased productivity
Relative Humidity (RH)	plumbing, roof/window leaks, flooding, condensation, pipe sweating, drain pans, poorly-vented kitchenettes	Mold and fungi growth, occupant comfort
Carbon Monoxide (CO)	Leaking vented combustion appliances, car exhaust, parking garages, furnaces	Shortness of breath, mild nausea, mild headaches, reduce oxygen delivery to organs and tissue, death
Ozone (O₃)	Smog, VOCs + NO _x , cars burning gasoline, petroleum refinery, industrial facilities, chemical manufacturing	Chest pain, coughing, throat irritation, and congestion, worsened bronchitis, emphysema, and asthma, reduce lung function, scar lung tissue.
Volatile Organic Compounds (VOC)	Paints, cleaning supplies, pesticides, building materials and finishes, copiers and printer, glues and adhesives, permanent markers, candles, cologne/perfume	Nose and throat discomfort, headache, allergic skin reaction, fatigue, dizziness, carcinogen, damage to liver and kidney
Formaldehyde	Insulation, Combustion devices, Wood products	Cancer and skin/eye/respiratory irritation



Equipment



Micro Aethalometer
• Black Carbon

Formaldehyde
<10 ppb – 1000 ppb



GrayWolf FM-801

Particles

- 0.3 - 0.5 μm
- 0.5 - 1.0 μm
- 1.0 - 2.5 μm
- 2.5 - 10.0 μm
- > 10.0 μm

- Total VOC's
- Carbon Dioxide
- Ozone
- Carbon
- Temperature
- Relative Humidity



GrayWolf
HANDHELD 3016
Airborne Particle
Counter



AdvancedSense
Data Logger



IAQ-610
DirectSense
Probe



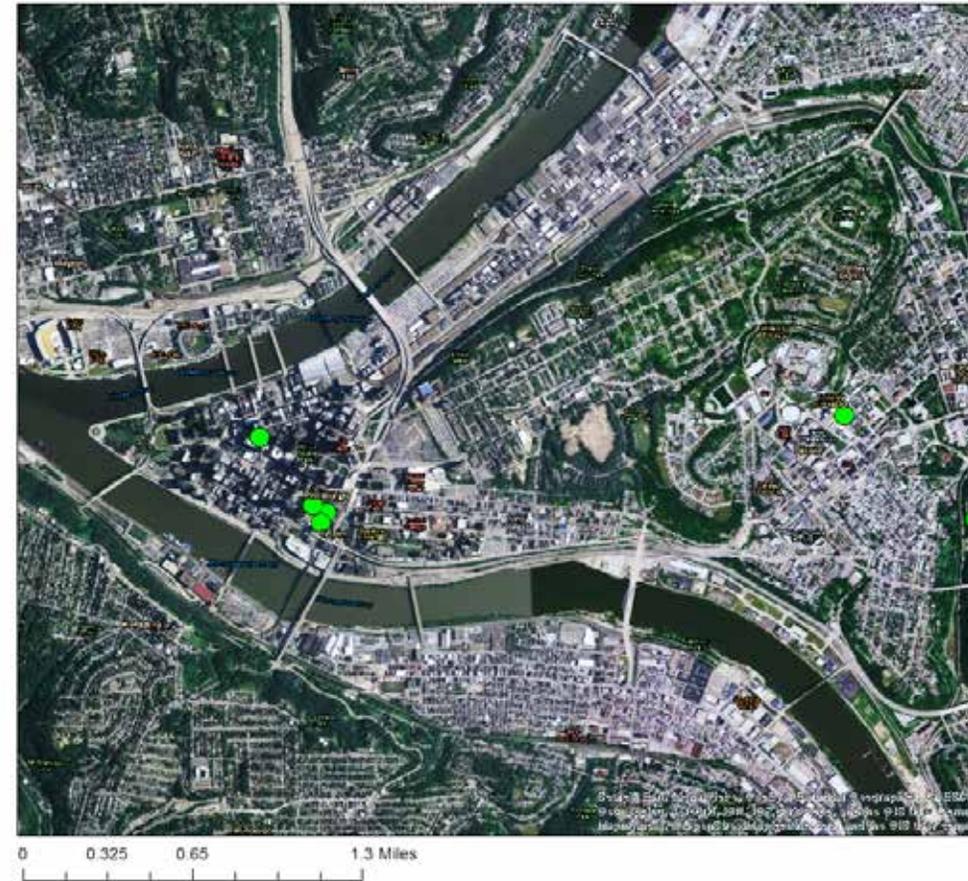
Dylos Air Quality
Monitor

Particles

- 0.5 μm – 2.5 μm
- 2.5 μm – 10.0 μm

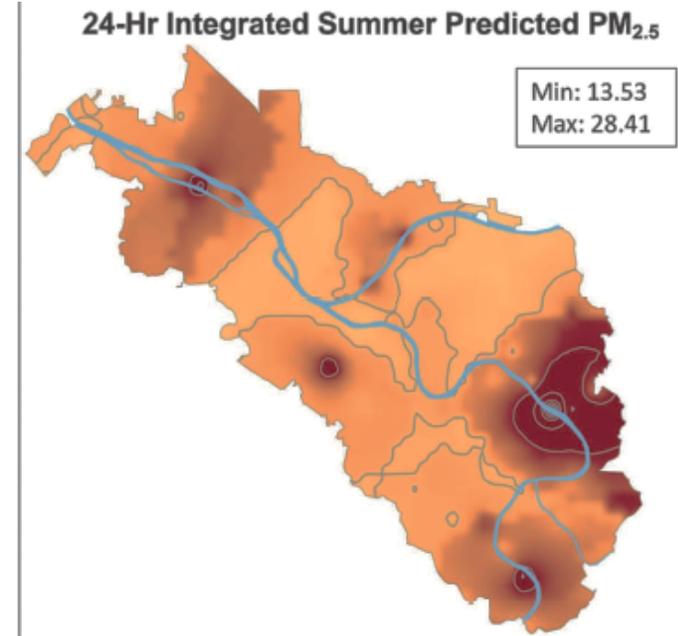
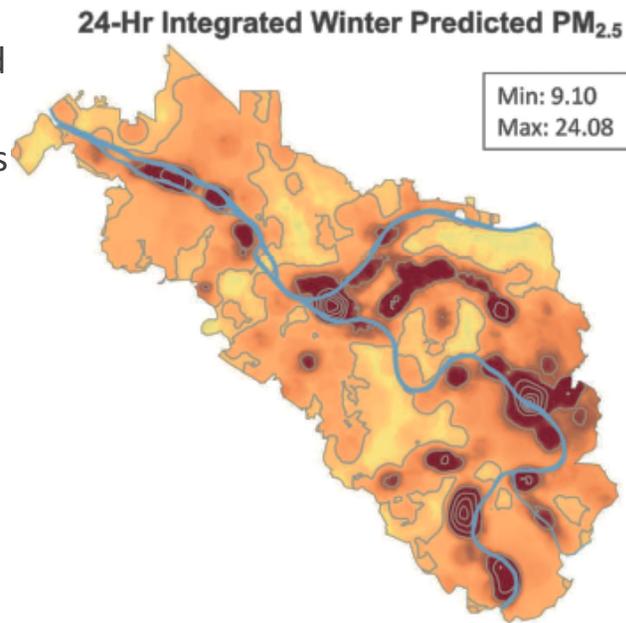


- 6 DIVERSE BUILDINGS
 - HVAC vs. WINDOW UNITS/RADIATORS (HEATING MONTHS)
 - Particulate Matter (PM 2.5 & PM 10)
- ~1900 BUILDING
 - Total Volatile Organic Compounds (TVOC)
 - Carbon Dioxide (CO₂)
 - Carbon Monoxide (CO)
 - Temperature (T)
- HEATING VS. NON-HEATING MONTHS
 - Particulate Matter (PM 2.5 & PM 10)
- SPATIAL VARIABILITY ACROSS FLOORS
- I/O RATIOS



1900s Building

- Mixed HVAC type
- Interstate highways I-376, I-579, and I-279, surround Downtown, along with Amtrak and dense bus corridors
- Inversion events along the Monongahela and Allegheny River valleys also enable pollution to hover
- Tested during Heating & Non-Heating Months



Seasonally-averaged predicted PM_{2.5} exposure surface maps for inversion-focused 24-h integrated summer and winter (right) sampling – from Tunno et al. 2015

Sampling Locations

■ 1st Floor

- North wing: lunch room, file storage, small office, clerk area; mostly open and public spaces with hard floors; wall mounted radiators

■ 1st Floor Mezzanine

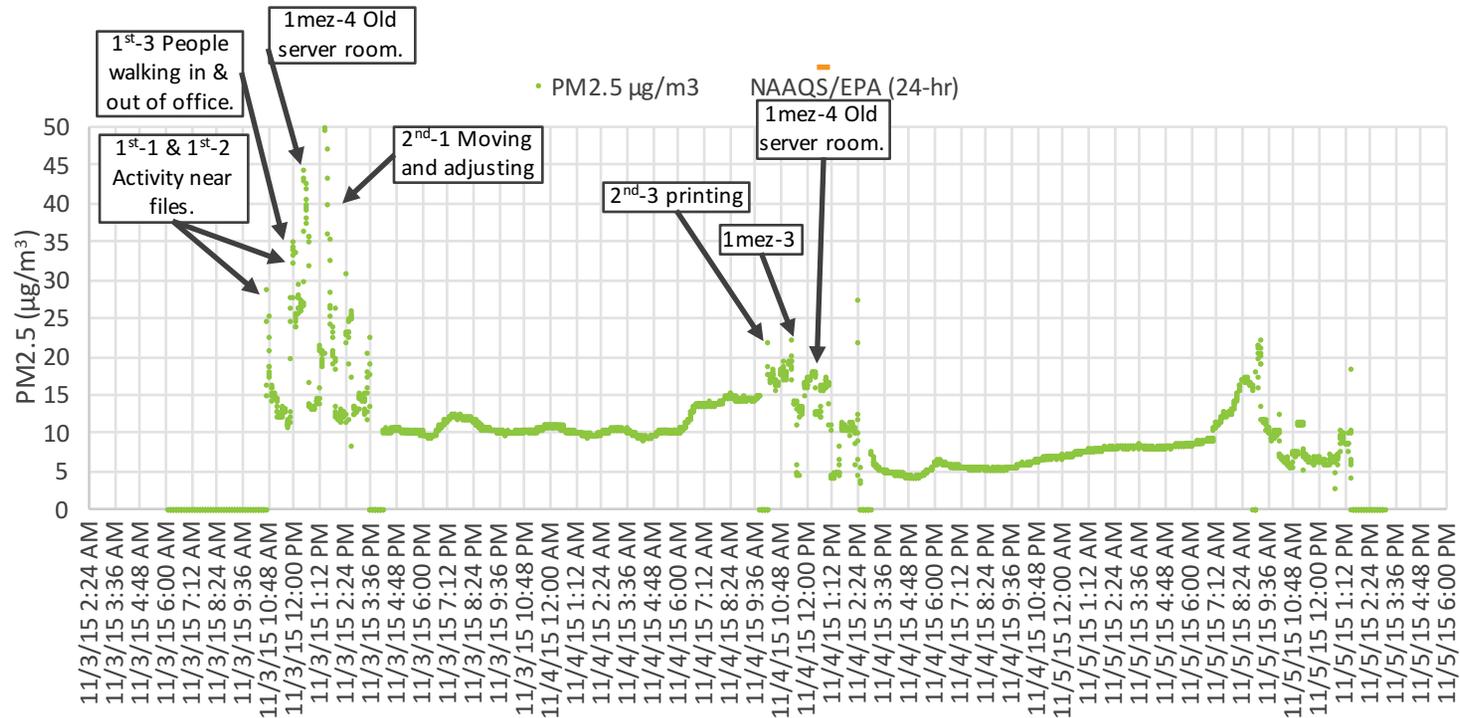
- North wing: lunch room, file storage, small offices, computer area; mostly open and public spaces with hard floors; window AC units and wall mounted radiators

■ 2nd Floor

- North wing: large carpeted office spaces, public file storage area with hard floors; window AC units and wall mounted radiators

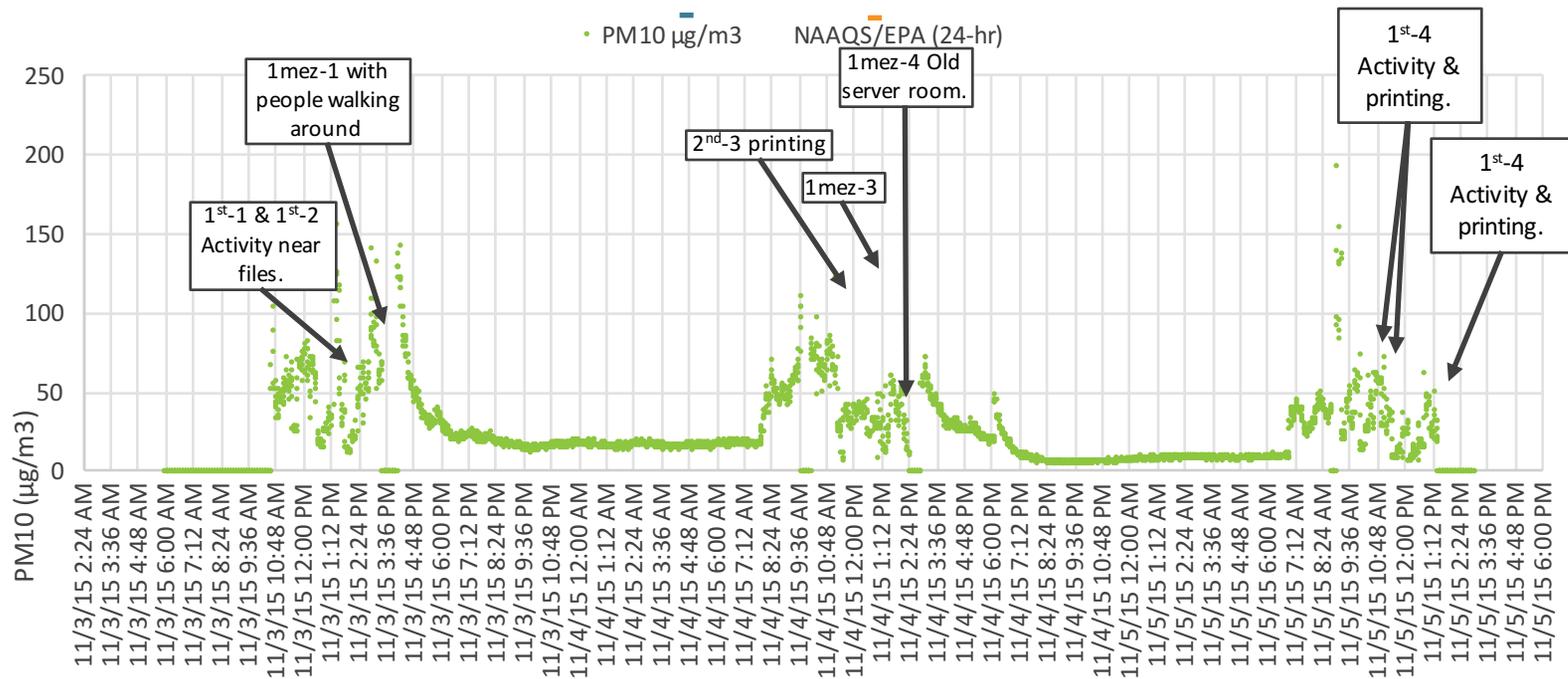
PM 2.5 – Continuous readings

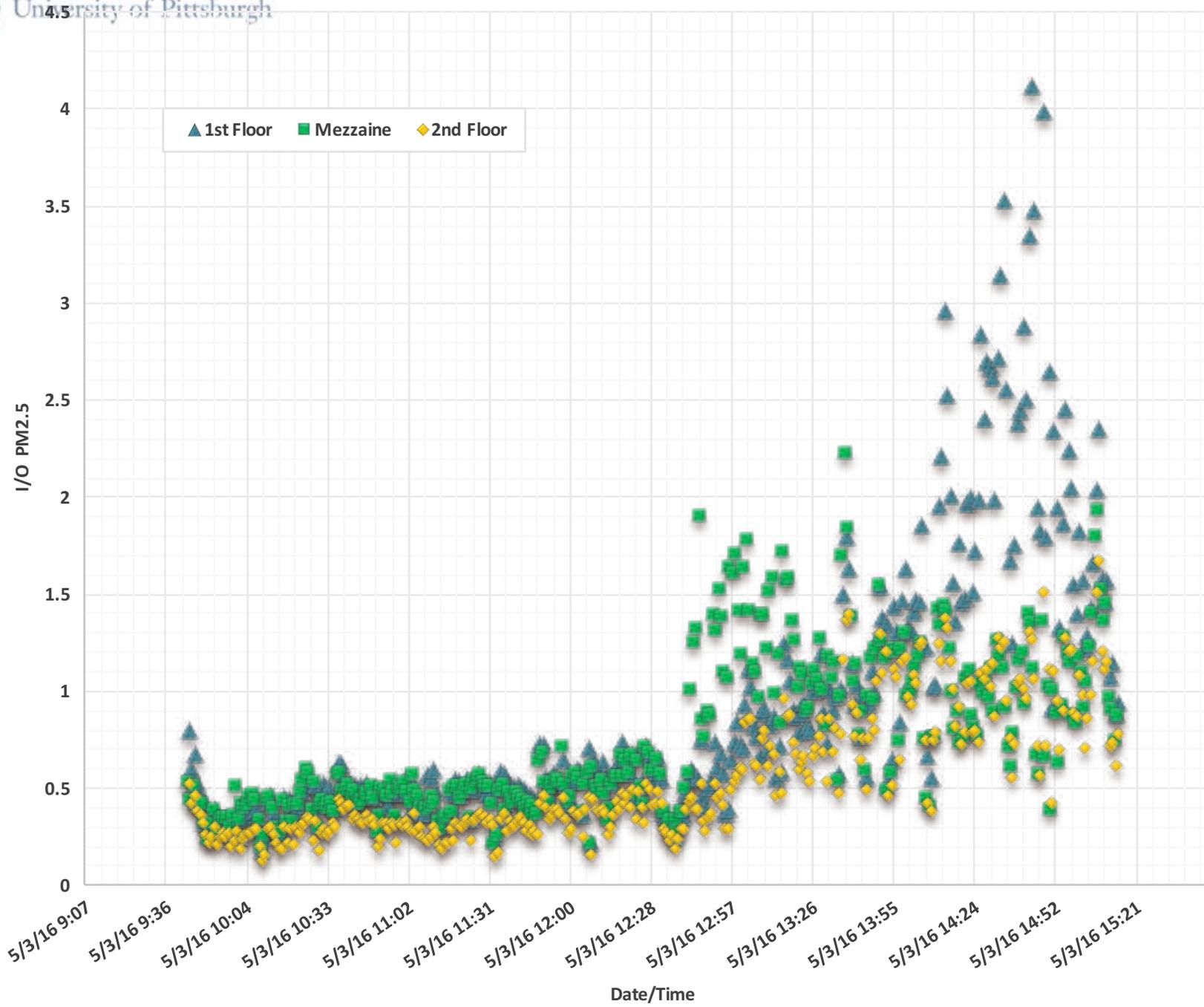
- **Guidelines:**
 - 15 $\mu\text{g}/\text{m}^3$ (ASHRAE 62-2013) - annual
 - 35 $\mu\text{g}/\text{m}^3$ (NAAQS/EPA 2012) – 24-hr
- Older building, with no forced air supplied to work space
- No way of filtering airborne particles, resulting in constant re-suspension of particles
- Elevated PM 2.5 levels influenced by indoor activities and building envelope
- 1mez-4 has an HVAC system, but filters are past replacement date



PM 10 – Continuous readings

- **Guidelines:**
 - 50 $\mu\text{g}/\text{m}^3$ (ASHRAE 62-2013) - annual
 - 150 $\mu\text{g}/\text{m}^3$ (NAAQS/EPA 2012) – 24-hr
- Elevated indoor levels of PM 10 due to infiltration from outdoors, high activity levels, public access, and/or dust from deteriorating files and in old carpets.
- Complaints from employees related to frequency of cleaning schedule





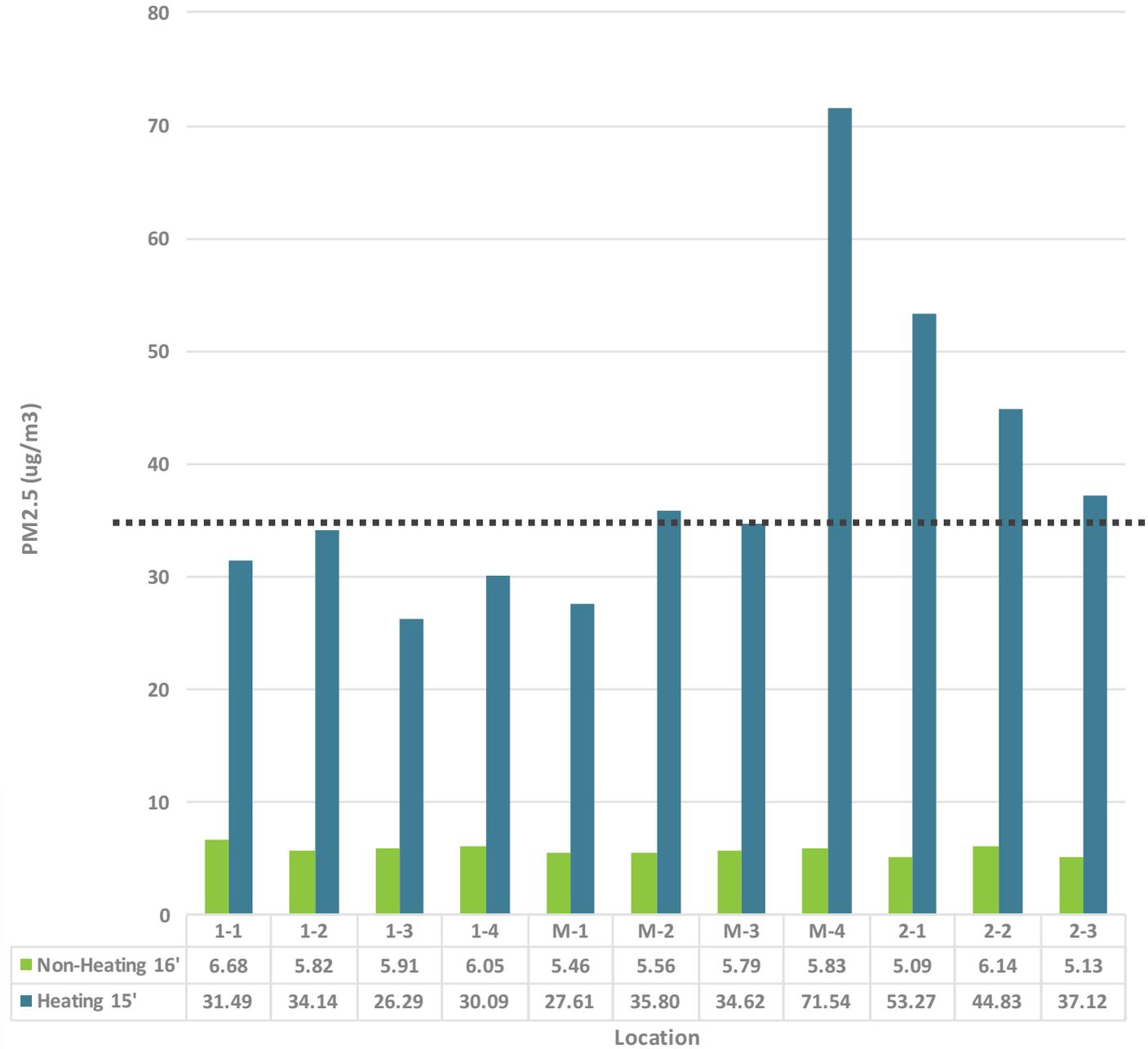
PM 2.5

- Guidelines:
 - 35 $\mu\text{g}/\text{m}^3$ (NAAQS/EPA 2012) – 24-hr
- Fuel combustion a dominant source of Particulate Matter

Averages Across Seasons



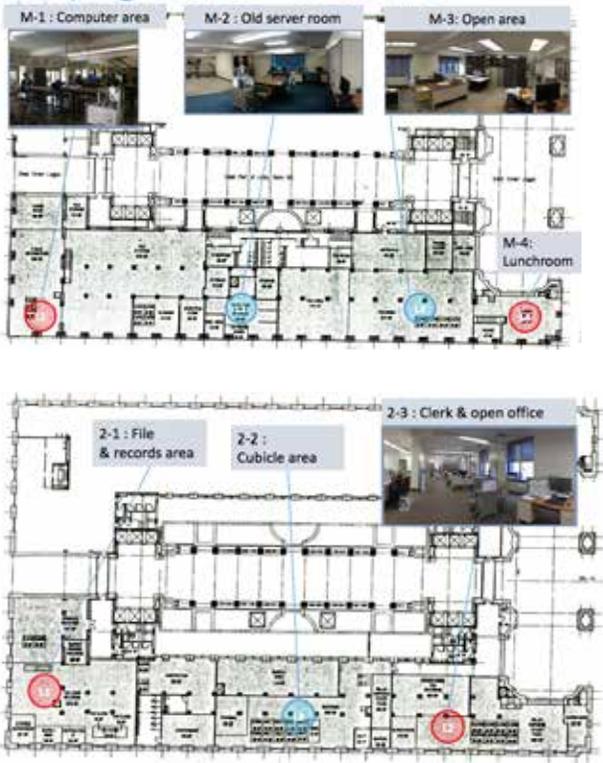
PM2.5 (ug/m3)



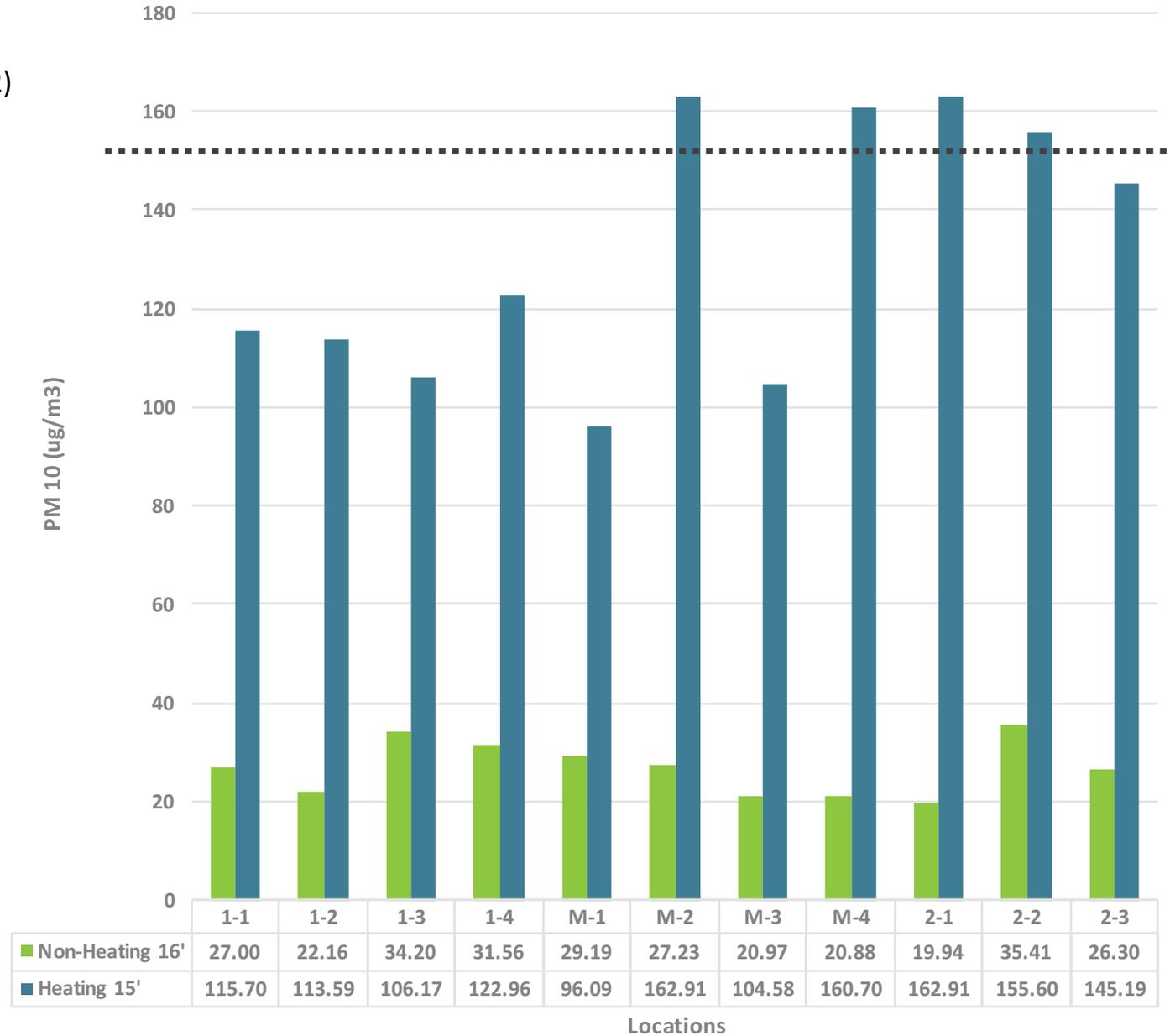
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PM 10 – Continuous mass readings

- **Guidelines:**
 - 150 $\mu\text{g}/\text{m}^3$ (NAAQS/EPA 2012) – 24-hr
- Elevated levels during heating season
- Fuel combustion a dominant source of Particulate Matter
- Locates M-2, M-4, 2-1, & 2-2



Averages Across Seasons



BUILDING-SPECIFIC IAQ (PM) RESULTS

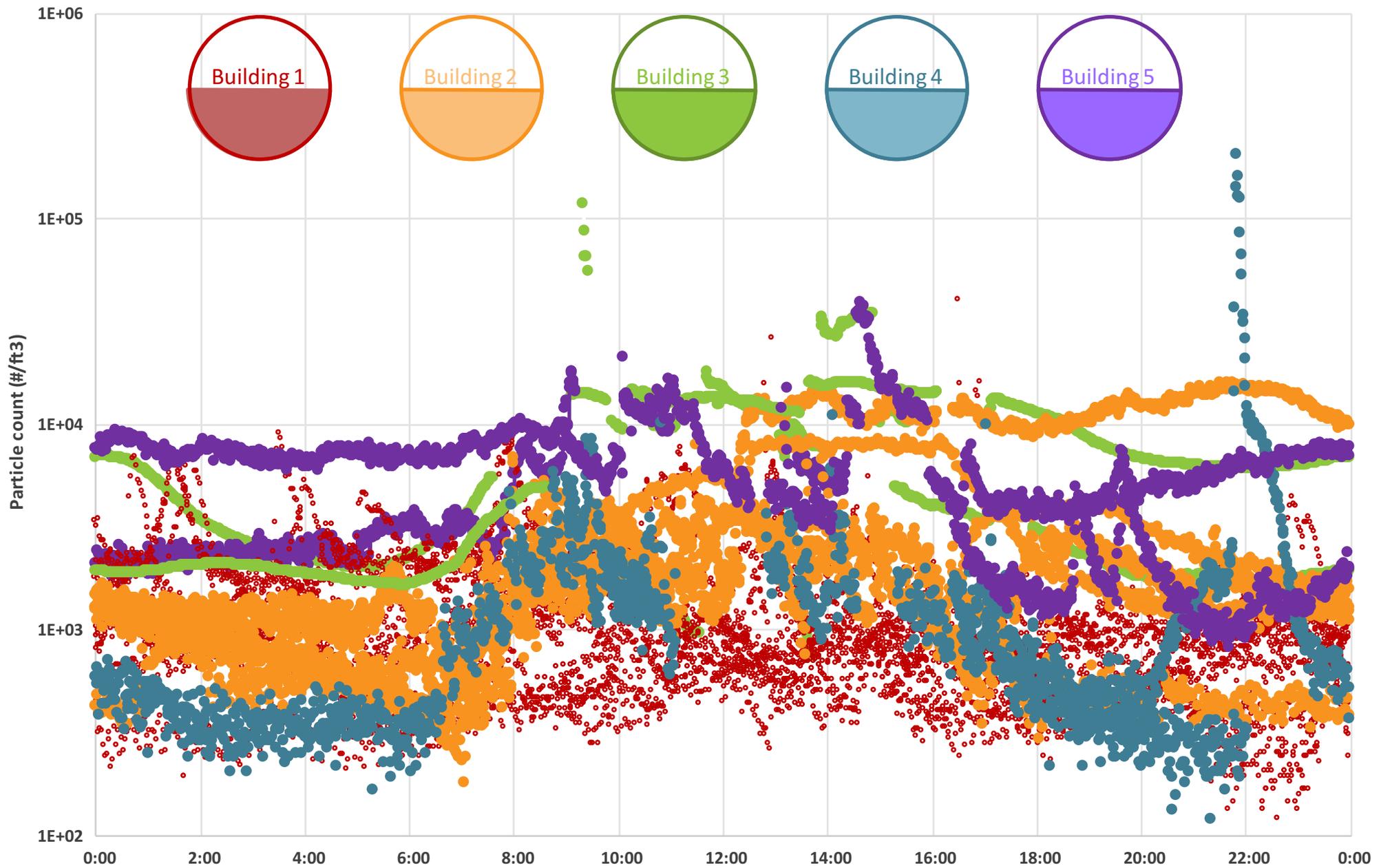
COMPARING BUILDINGS

THE CHALLENGERS

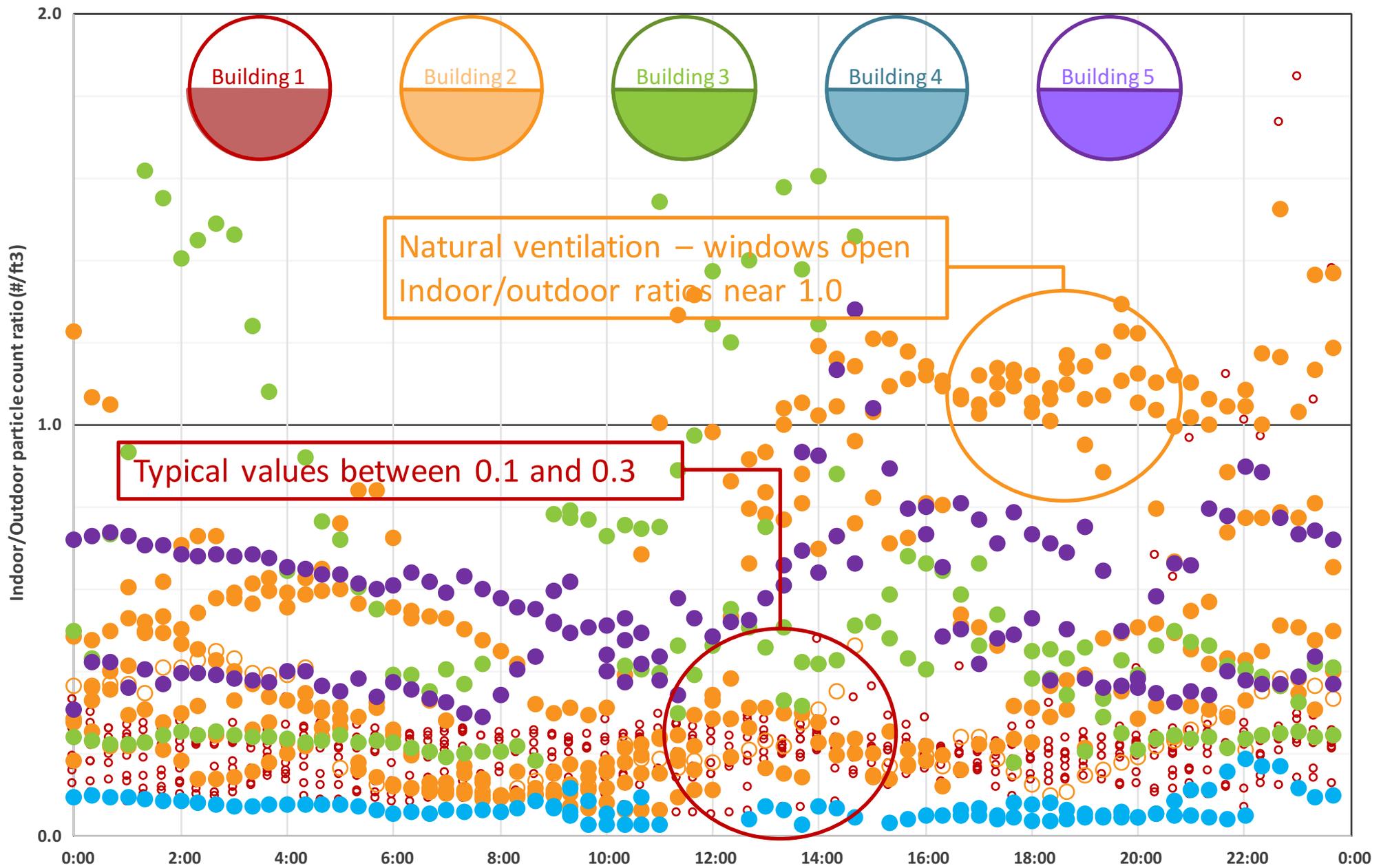
THE INCUMBENT



Indoor counts for PM between 1.0 and 2.5 μm – Indoor and outdoor sources



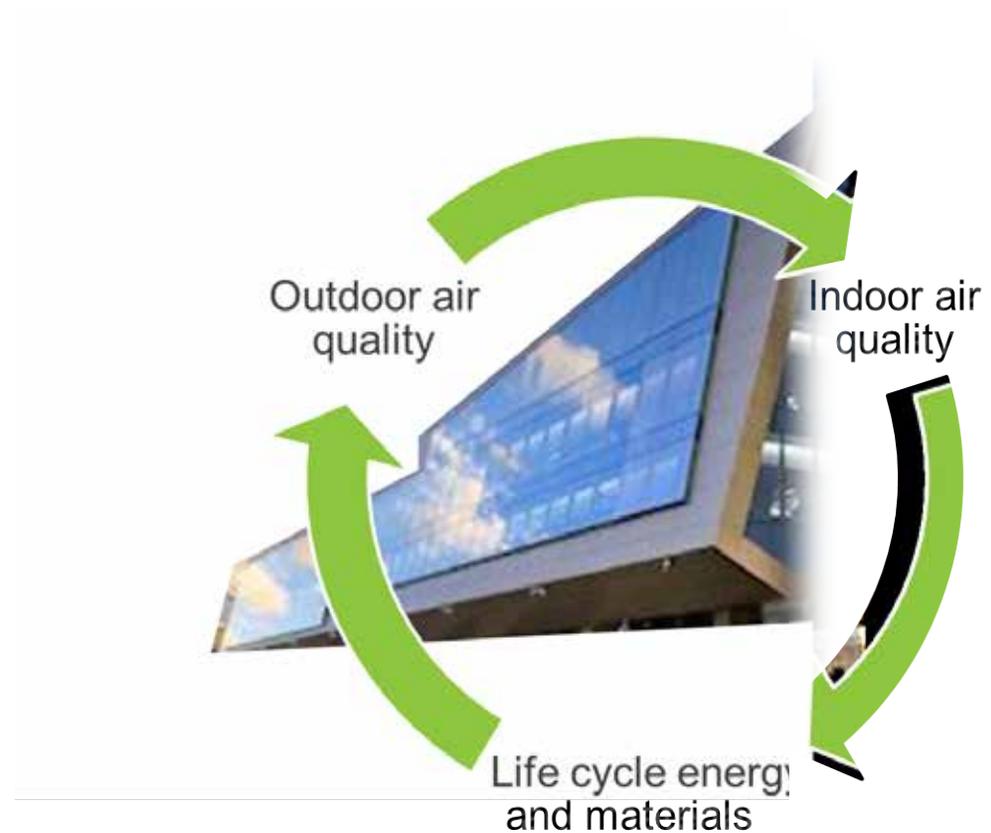
Indoor to outdoor ratios for PM between 0.3 and 0.5 μm – Outdoor sources



FUTURE WORK

- **IAQ**

- Perform IAQ assessments in 20+ Buildings within the 2030 Districts
- Couple Occupancy Surveys and employee complaints with IAQ findings
- Mechanical System: Traditional HVAC, Window Units + Radiators
- Flooring Type: Carpet vs. Hard Surfaces



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QUESTIONS?

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