REDUCING EXPOSURE TO AIRBORNE PARTICLES

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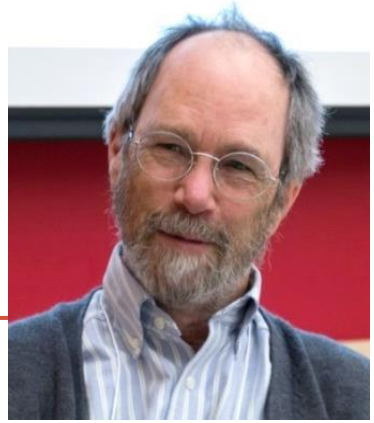
7 - 8:30 PM; Feb. 25, 2021
SWPA Environmental Health Project
Infectious Lung Disease & Air Pollution PANEL

Frustration Alert!
Lots of links & text

Find this presentation here:
http://rocis.org/past-rocis-events



Don Fugler
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Why focus on buildings??

Most of our exposure
to outdoor pollution
happens
IN buildings

https://www.iaqscience.lbl.gov

ROCIS LCMP
Low Cost Monitoring Project
Upcoming Virtual Cohort

Next Virtual Cohort: April 8 - May 7

Introductory Webinar: March 29-30
Sign-up: http://www.ROCIS.org

- Started 5 years ago
- Mostly homes, some work places
- 375+ participants
- Monitor particles, radon, CO_2, & CO
- 3-4 week monitoring period

Reducing Health Impact of Outdoor PM

"… the greatest potential comes from using better filtration to reduce indoor concentrations of outdoor PM, thus reducing the morbidity & mortality associated with outdoor air PM."

William Fisk, LBNL

2016, National Academy of Sciences, Health Risks of Indoor Exposure to Particulate Matter: Workshop Summary

https://pubmed.ncbi.nlm.nih.gov/27748088/

4 Strategies to Reduce Indoor Particles

- **Reduce air exchange from outside**
  - Close windows
  - Tighten home or building
- **Reduce indoor sources**
  - Use an effective ducted kitchen hood!
  - Use induction cook top & other good practices w/ cooking
- **Reduce resuspension**
  - HEPA vacuum; thoroughly clean hard surfaces
  - Walk-off mats
  - Get rid of carpets, old upholstered furniture
- **Filter the air**
  - Portable air cleaners
  - DIY Fan Filters
  - Central air handler (furnace, AC, or ventilation)

4 Options to Reduce Indoor Particles

- **Reduce air exchange from outside**
  - Close windows
  - Tighten home; then mechanically ventilate with filtered air
- **Reduce indoor sources**
  - Use an effective ducted kitchen hood!
  - Use induction cook top & other good practices w/ cooking
- **Reduce resuspension**
  - HEPA vacuum
  - Walk-off mats
  - Get rid of carpets, old upholstered furniture
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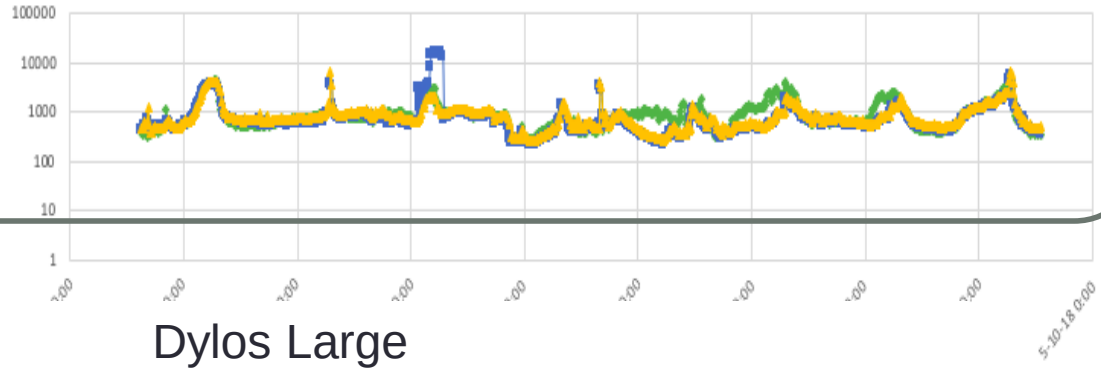
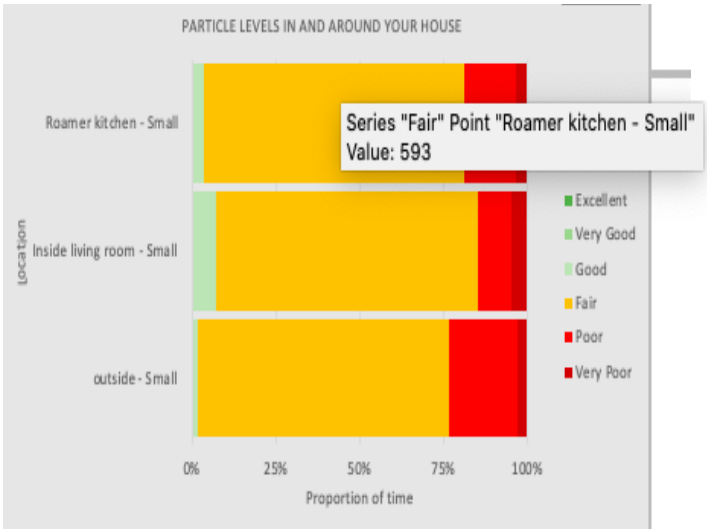
House with Wide Open Windows

Dylos Small

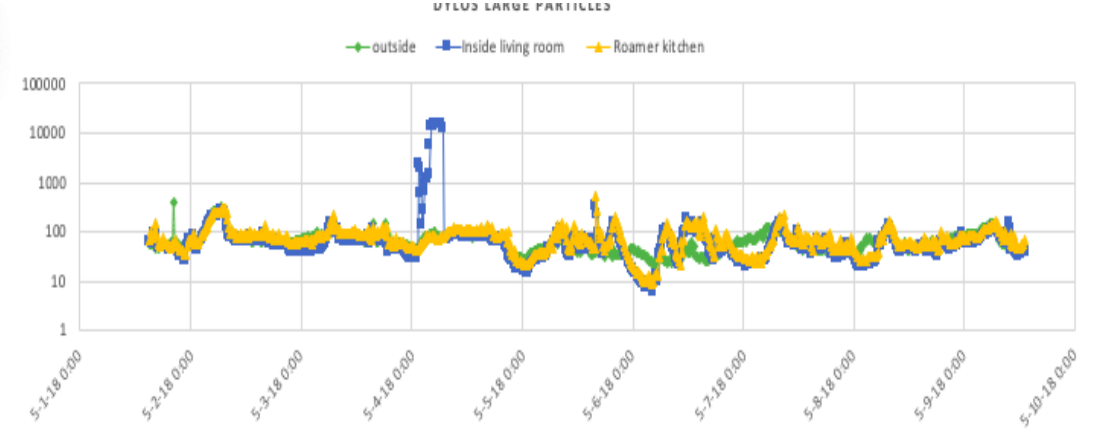
Green (Outside); Blue (I); Yellow (R)





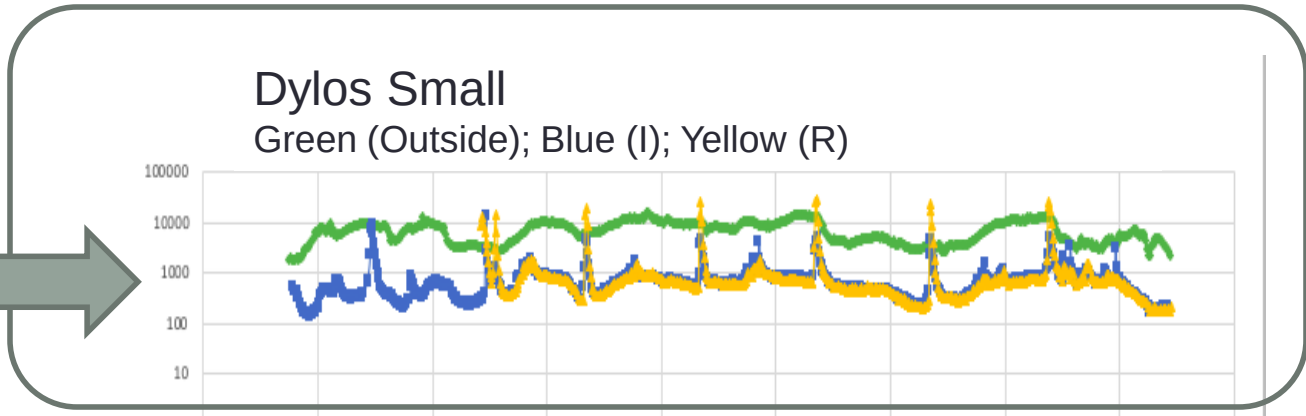
Dylos Large

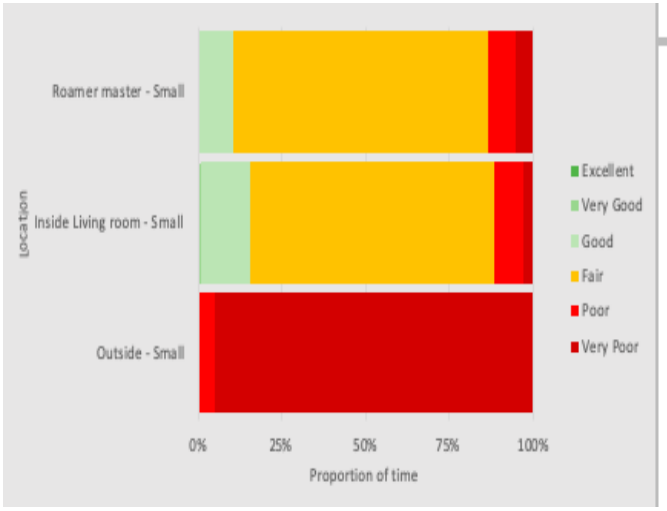
Green (Outside); Blue (I); Yellow (R)

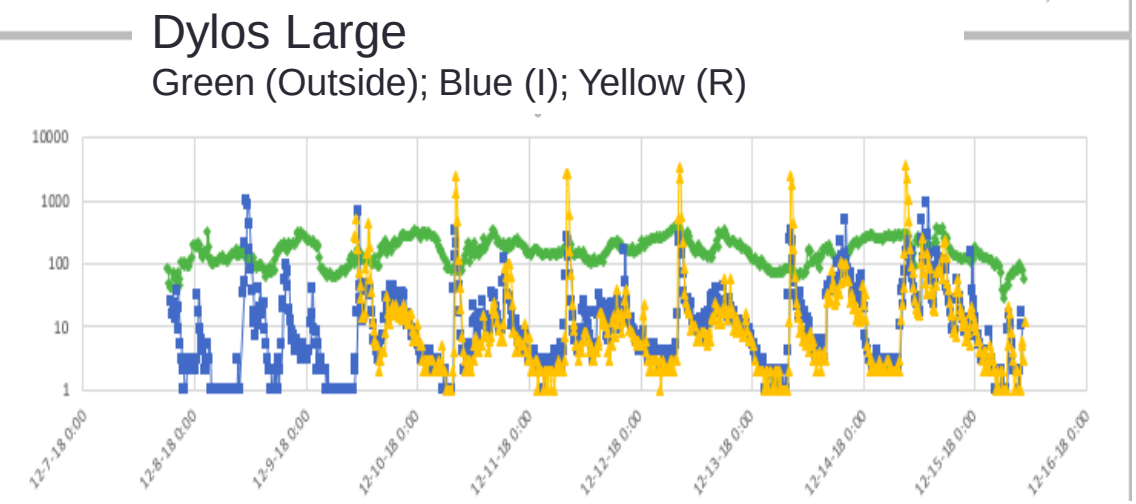


1941 House in Winter with High Outside Particle Counts

Big reduction –
But still not great

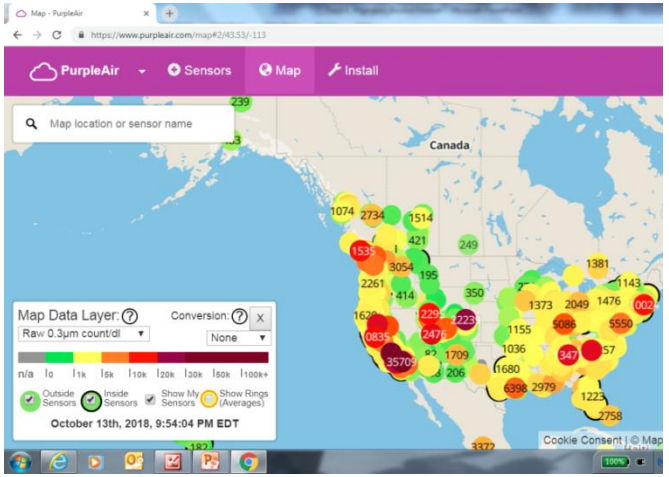






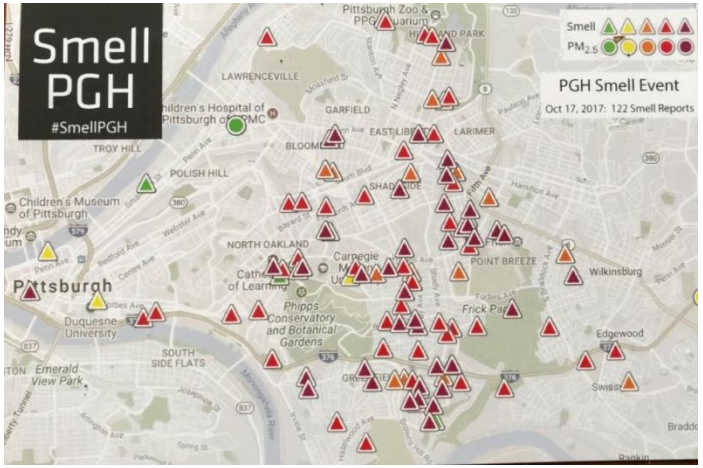
Should I Open My Windows??

- Purple Air Map - https://www.purpleair.com/map



- Smell Pittsburgh - https://smellpgh.org

- US EPA AirNow - https://www.airnow.gov/

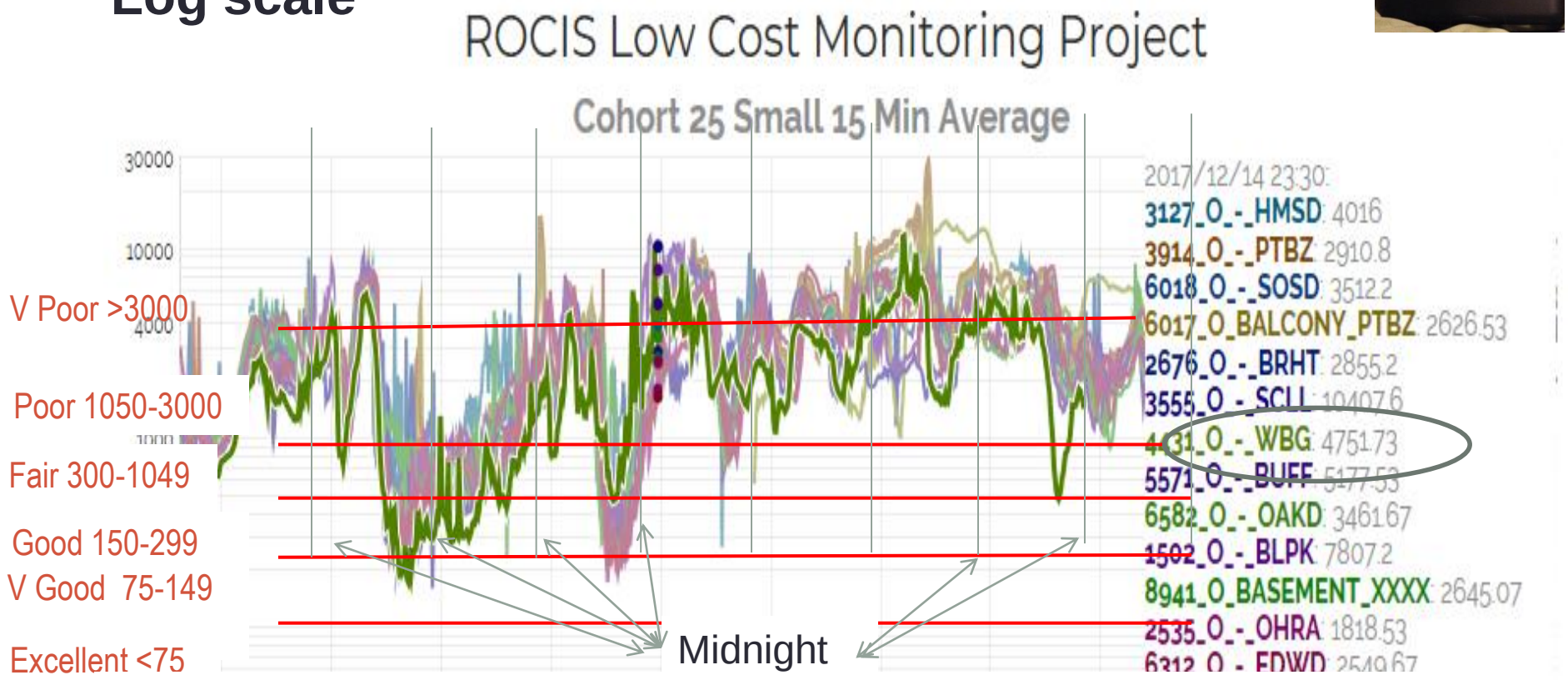


- Create Lab VOC Monitor map - https://voc.createlab.org/?c=tVOC

NOTE: May not be conservative enough for vulnerable populations

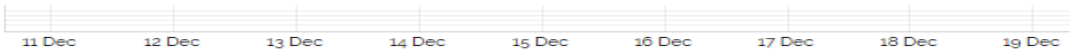
Outdoor Data by Cohort - (70 mile spread) - Readings track

Log scale



We share the same air shed!

Rapid variations in outdoor particles – particularly worse at night



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  - Get rid of carpets, old upholstered furniture
- **Filter the air**
  - Portable air cleaners
  - Central air handler (furnace, AC, or ventilation)

Indoor-Generated Sources

Here's what we have seen:

Cooking-related

Tap water in ultra-sonic humidifier (should use distilled water)

Cleaning products (avoid scented & toxic!!)

Personal care products

Recreational combustion

- Cigarettes, vaping…
- Candles, incense, diffusers

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Clean it Up or Don't Disturb it

Many particle spikes from activity are resuspended – not generated

- Carpet
- Hard surface floor
- Couch - Upholstery
- Bedding
- Laundry
- Remodeling (attics, building cavities)

What was the original source?
Emissions from 50 years ago?
Residue from remodeling?
Particles from open windows?
Tracked in lead dust?

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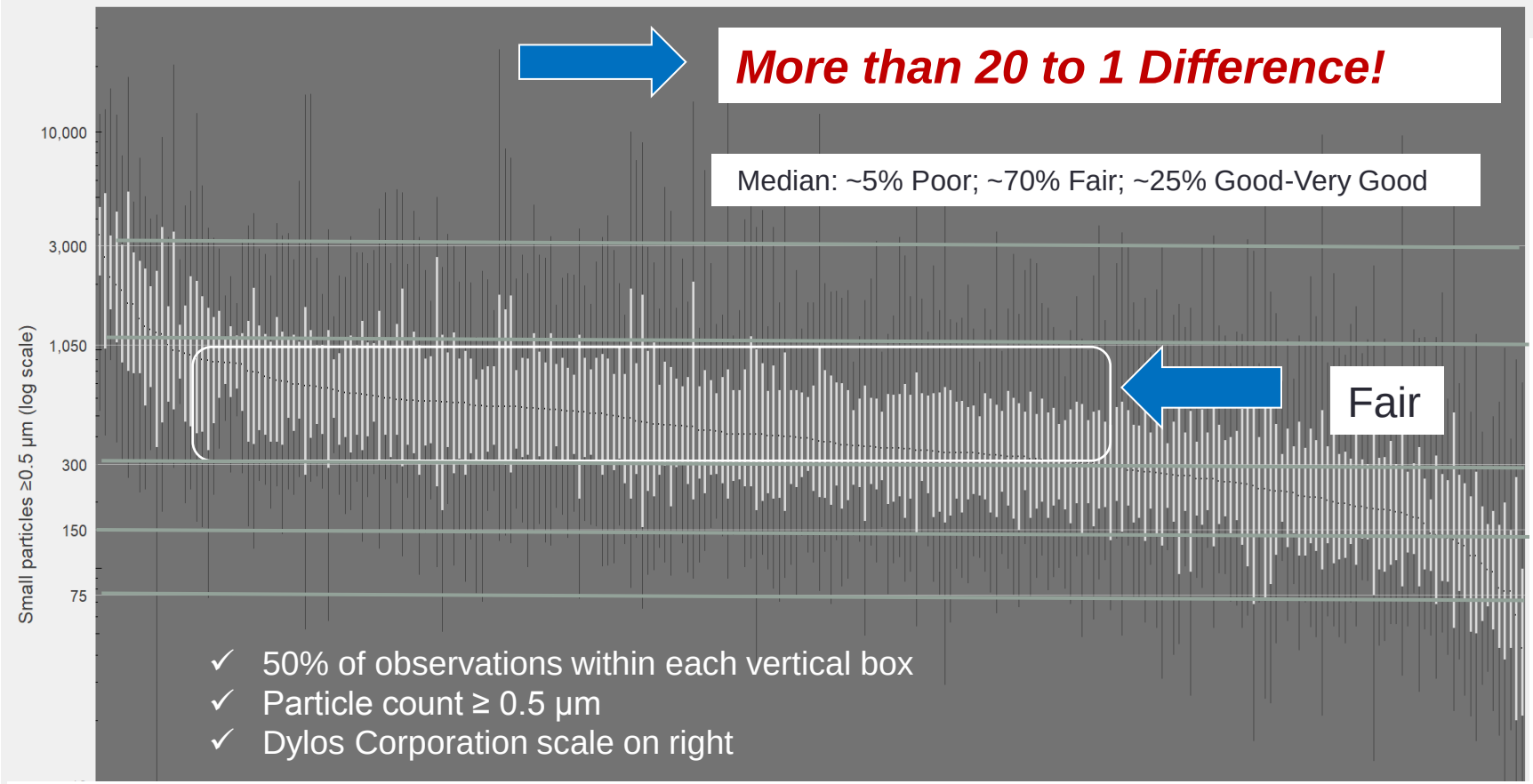
- **Filter the air**
  - Portable air cleaners
  - DIY Fan/Filter
  - MERV 13 filter in central air handler (furnace, AC, or ventilation)

Indoor Particle Distribution – 250 LCMP Residential Sites



For additional information: http://rocis.org/past-rocis-events

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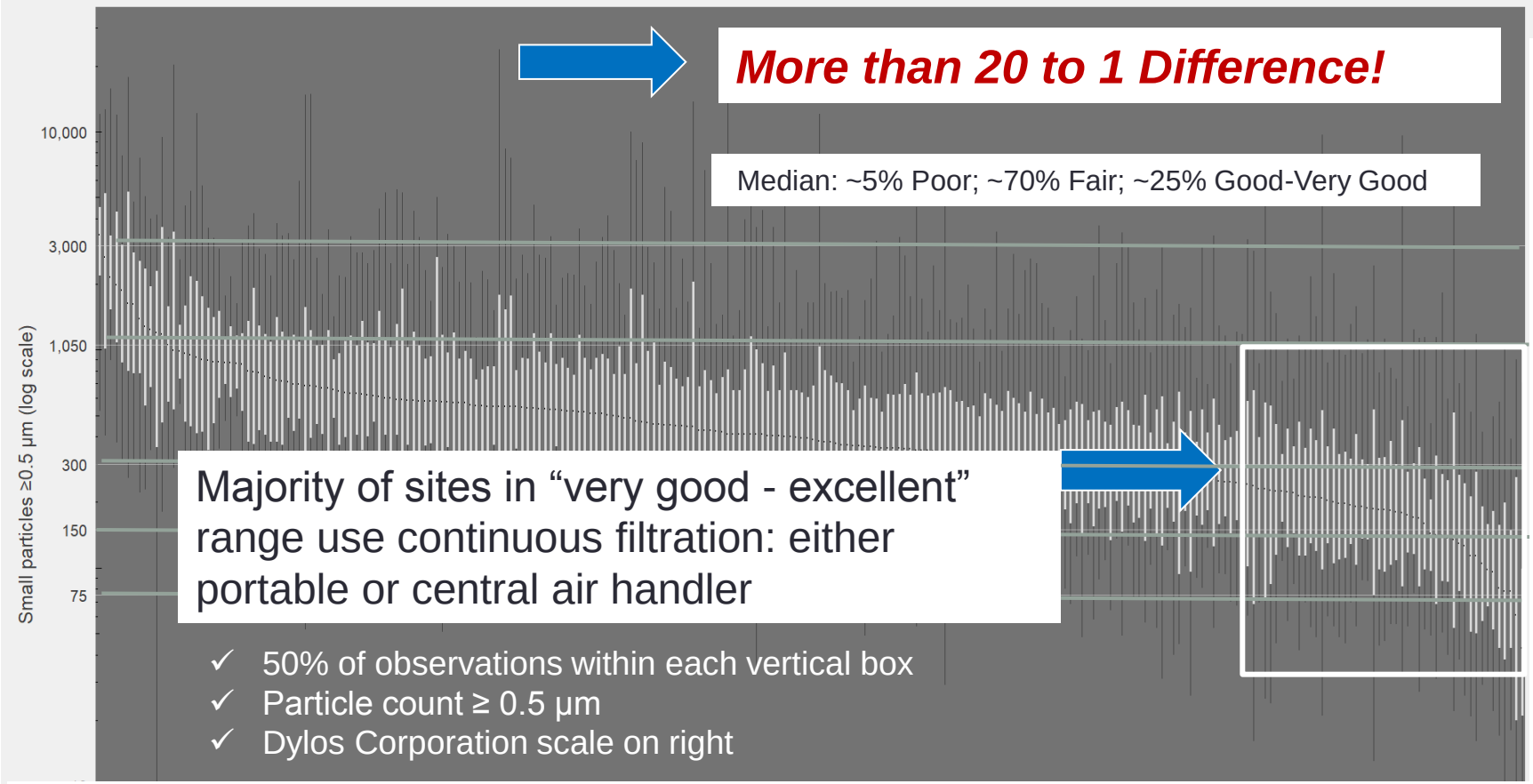

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Portable Air Cleaners

Also referred to as Air Purifiers

Air Cleaners:
Only Effective When it is On!

FACTORS AFFECTING OPERATION

Maintenance

Cost of Filter Replacement

Energy Use /Energy Cost

Noise

Air Movement/Comfort –

- Comfort (summertime)
- Discomfort (wintertime)

Portable Air Cleaners (or Air Purifiers)

- Designed to treat one room or zone
- **True HEPA filter** for best particle reduction
- Some models offer added reduction of pollutants / odors with activated charcoal
- Properly size (CADR or CFM = 2/3 of Ft^2 of room)
- Example:
- CADR of 200 could serve a 300 Ft^2 (20'x15') room

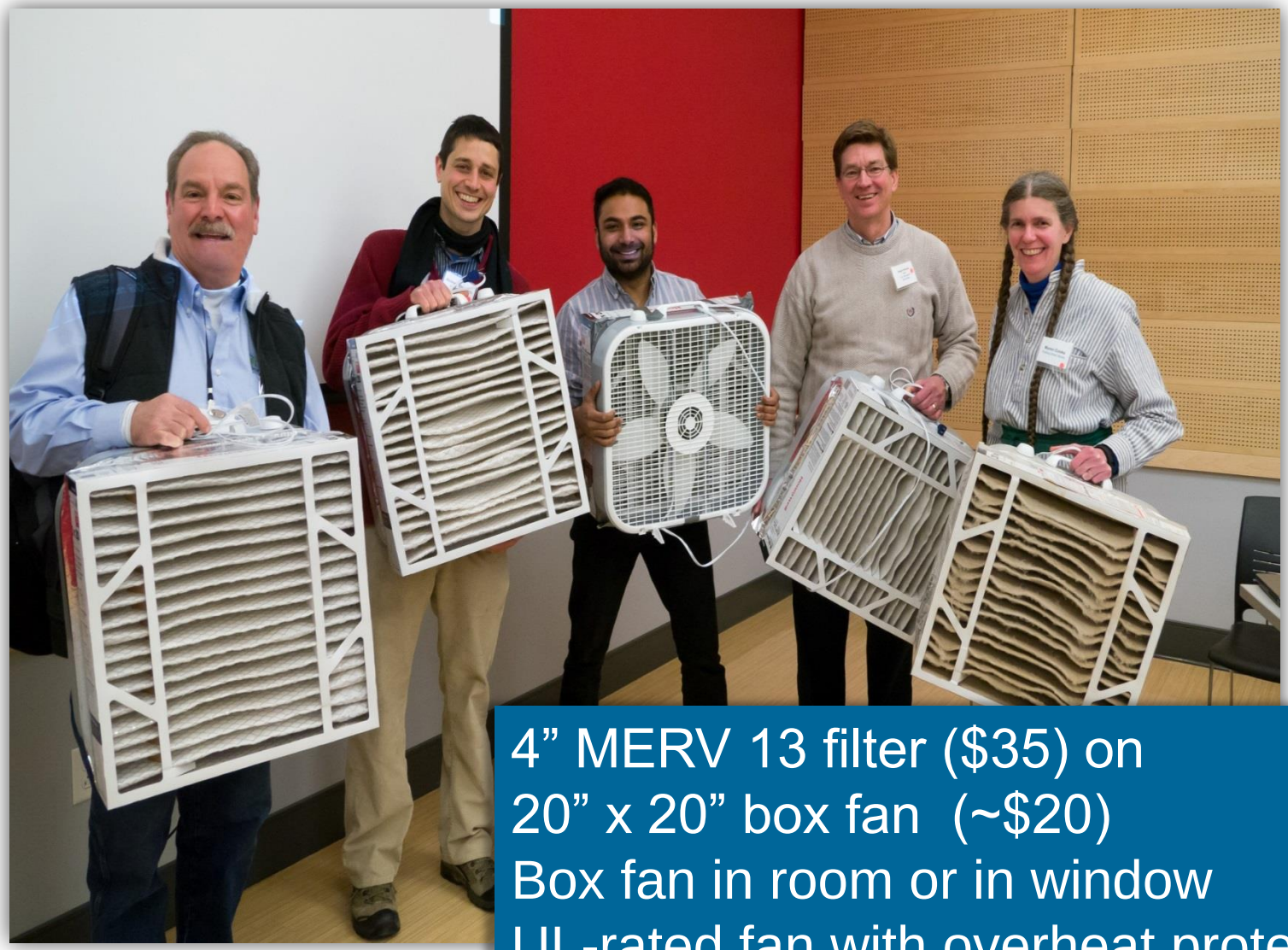
Equipment Features Offered:

- Air quality sensor (sometimes with color indicator)
- Auto boost when spike is sensed
- Timer
- Plasma Wave, ionization, PCO etc. ***To be avoided!!***

- *"Jeffrey Siegel …you should avoid ion generators & plasma air cleaners, which can emit ozone, a respiratory hazard that can cause serious health problems.*
- *Avoid* air cleaners with photocatalytic oxidation (PCO). PCO air cleaners have been *shown to generate formaldehyde, acetaldehyde, nitrogen dioxide, and carbon monoxide.*
- *"Siegel said a good air purifier can also help clear out coronavirus particles and reduce the air's viral load."*
- ***From CBC News, Feb .6, 2021***
- https://www.cbc.ca/news/business/portable-air-purifier-tests-marketplace-1.5900782

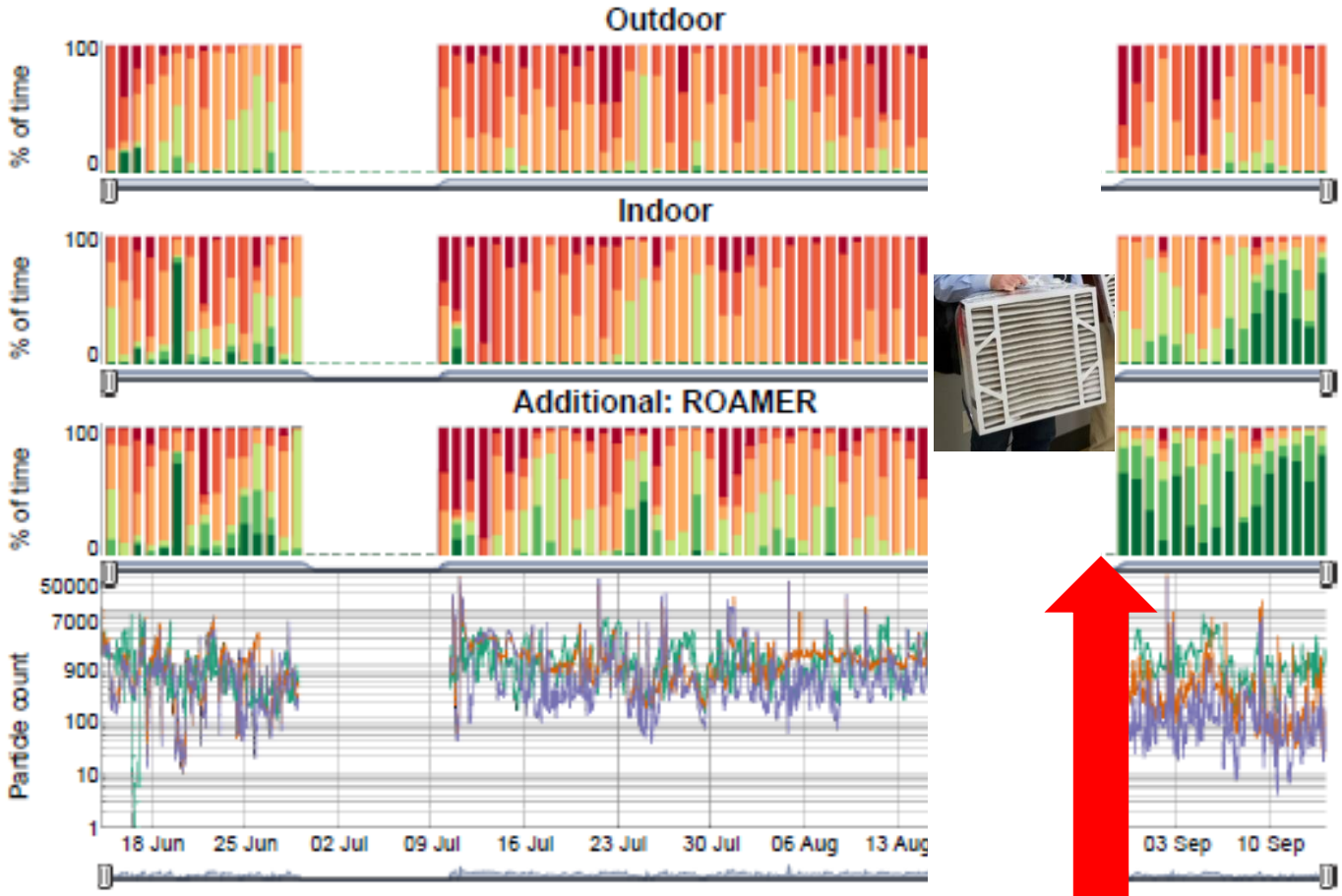
DIY Fan Filters

DIY Fan/Filter Intervention: Low Cost, MERV 13



4” MERV 13 filter ($35) on
20” x 20” box fan (~$20)
Box fan in room or in window
UL-rated fan with overheat protection

Indoor Fan/Filter 24/7 Impact



http://rocis.org/rocis-data-explorer (k4x3)

Fan/Filter Options
20” Box Fan w High MERV Filters

- **Some use multiple filters (2 in V, or 4 in box)**

https://www.treehugger.com/build-own-covid-19-air-filter-5081272?

Image Credit: Comparetto Comfort Solutions

Air Handler/high MERV Inquiry

Air Handler Operation

Thermostat usually set to “Auto”, not “On”

Average annual run-time is ~15%

Inadequate for filtration

Call for heat & cool does not align with need for filtration

With smart thermostats more control of “on time”

High MERV Filter - Air Handler (Filter/AHU) Inquiry

Initial Question…

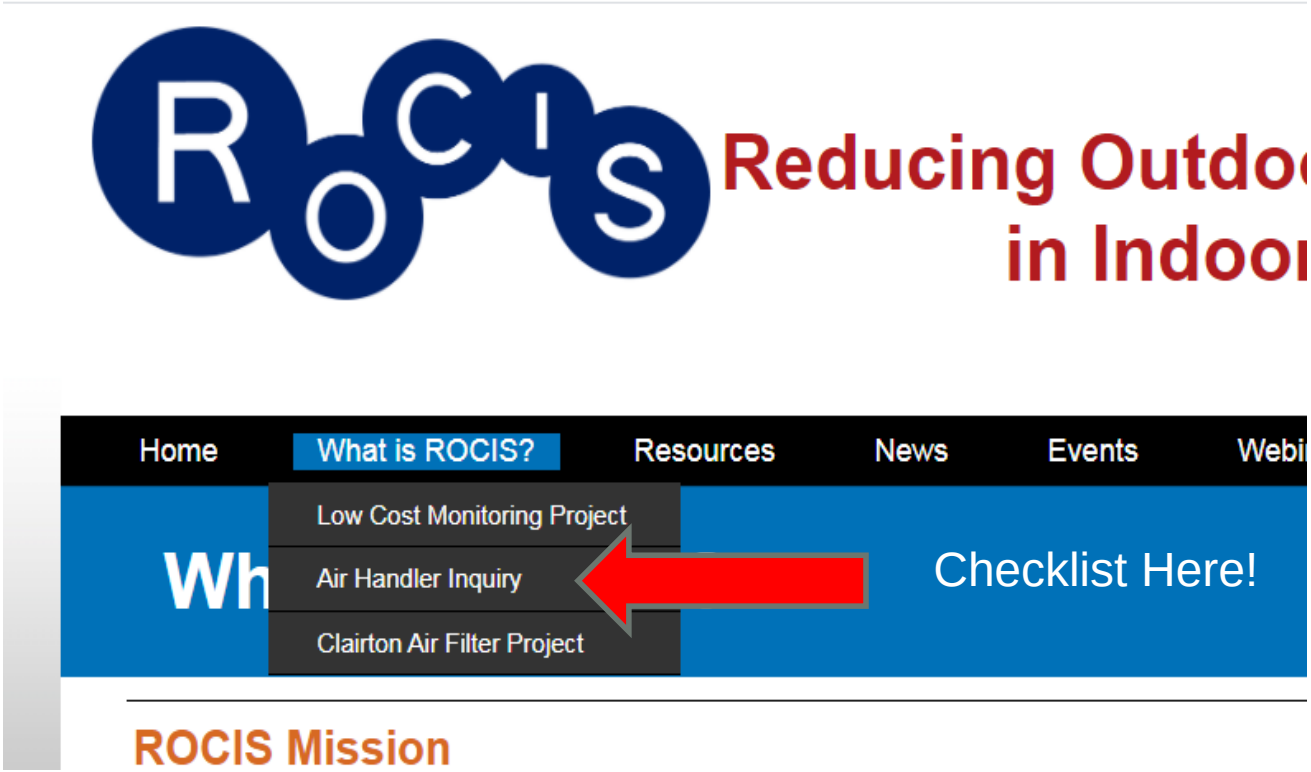
Based on our 65 tests, is there an **easy way** to determine if I can use a high MERV filter with a **longer air handler run-time** without causing problems ($, equipment durability, performance, or GHG emissions)?

NO !!

Diagnostic Screen is Required

ROCIS 24/7 Air Handler Checklist

http://rocis.org/air-handler-inquiry



Big Issues with 24/7 High MERV Filter

Air handler (AHU) energy use & cost can be high due to 500 to 1,500 watt-draw

- High cost of running air handler continuously (360 kWh to 1080 kWh/month = ~$500 to $1500/year[1])

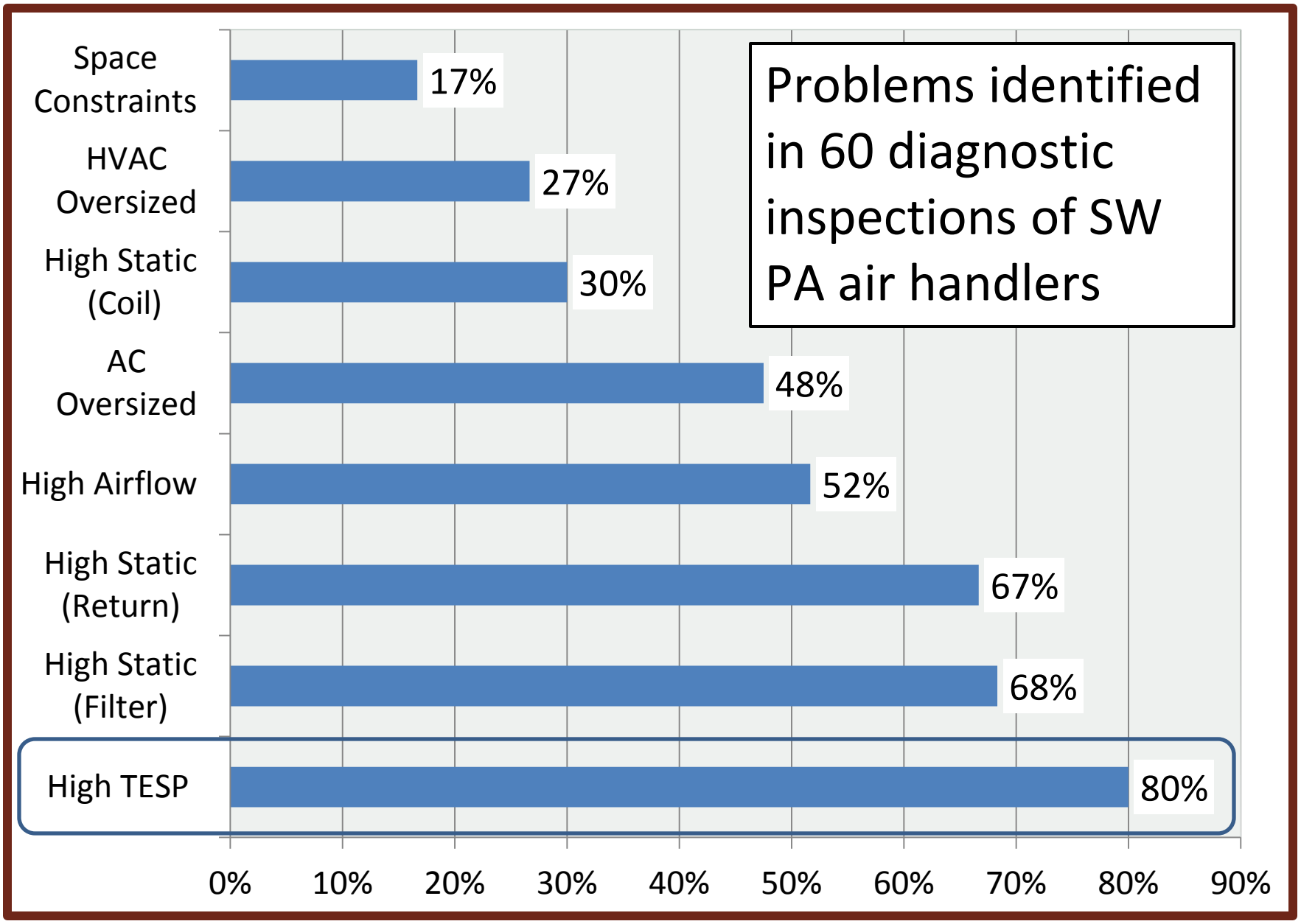
Wrong blower speed

- Seldom set in field
- Often defaults to high speed, not low, in continuous mode
- Higher energy cost, less effective filtration

Ductwork issues introduce additional problems

- Static pressure too high (can lead to equipment failure)
- Duct leaks (energy waste & pressure-related problems)

[1] **$0.12/kWh**


Problems identified in 60 diagnostic inspections of SW PA air handlers
Space Constraints
17%
HVAC Oversized
27%
High Static (Coil)
30%
AC Oversized
48%
High Airflow
52%
High Static (Return)
67%
High Static (Filter)
68%
High TESP
80%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%

Pre

16x25x1 MERV 12

Post

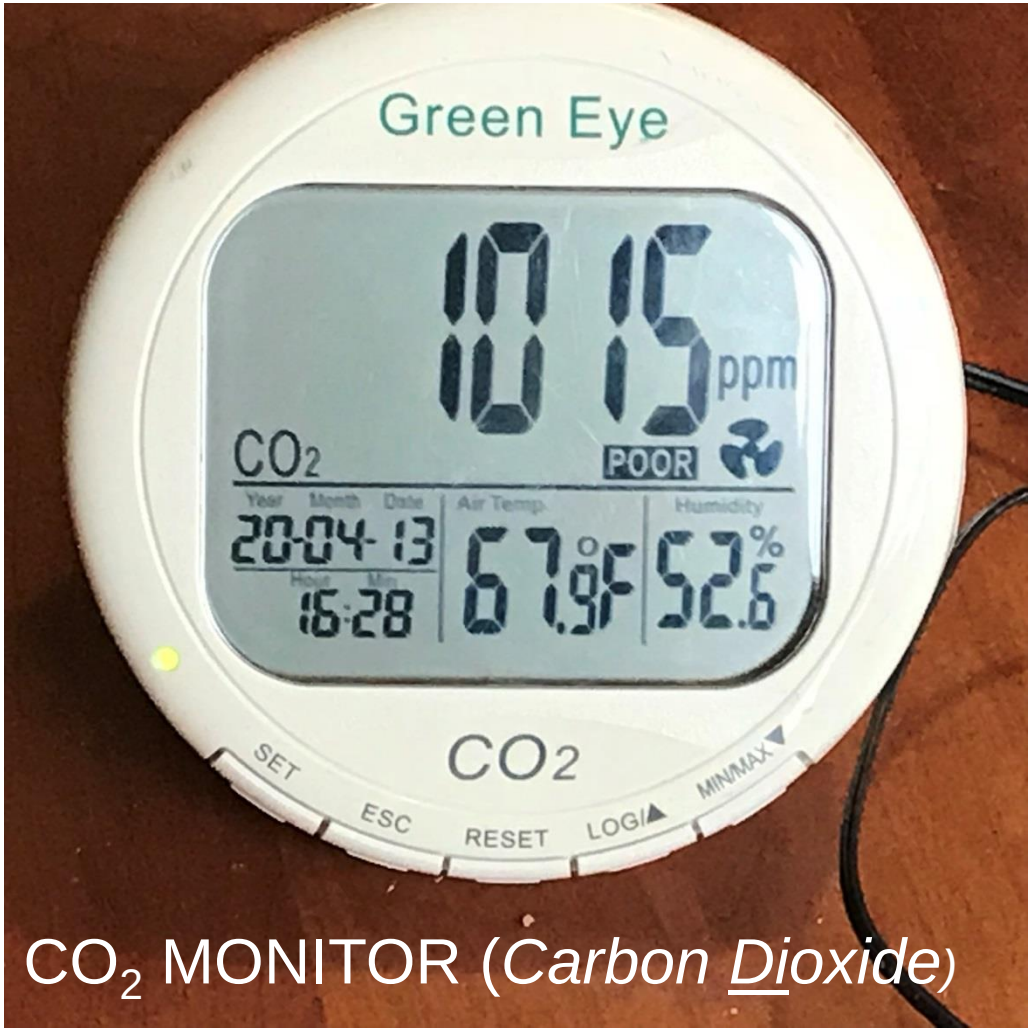
20x25x4 MERV 13

Labor & material cost: ~$1,000
24/7 monthly operating cost: ~$12.50

CASE STUDY: Indoor Air Quality Interventions
Chris Guignon, evolveEA

Adequate Ventilation???

- CO_2 is an indication of the ventilation rate & building occupancy



CO_2 MONITOR (*Carbon Dioxide*)

RESOURCES Preventing Exposure

EPA Guidelines - Air Cleaners & Air Filters in the Home

https://www.epa.gov/indoor-air-quality-iaq/air-cleaners-and-air-filters-home-0

ROCIS website - http://rocis.org/air-handler-inquiry

http://rocis.org/clairton-air-filter-project

IAQ Scientific Findings Resource Data Bank

https://iaqscience.lbl.gov/indoor-air-quality-iaq-scientific-findings

With a focus on COVID-infectious disease:

Richard Corsi - https://corsiairquality.wordpress.com/

ASHRAE (includes COVID response updates)
https://www.ashrae.org/technical-resources/resources

Reducing COVID-19 Transmission in Home
https://bpa.connectedcommunity.org/blogs/macie-melendez1/2021/02/23/reducing-covid-19-transmission-in-homes

SUMMARY

Bottom Line!

1. ***Particle exposure in the home can be significantly reduced***
2. ***Improving outdoor air quality is the most comprehensive solution***
3. ***The most effective low cost monitor is a motivated, knowledgeable occupant***

Thanks to The Heinz Endowments for support of the ROCIS initiative (Reducing Outdoor Contaminants in Indoor Spaces)

And 375+ LCMP participants

Questions & Comments Welcome!

This presentation:

http://rocis.org/past-rocis-events

Upcoming Cohort - sign up **http://ROCIS.org/**

Access to resources & research results

- LCMP http://rocis.org/rocis-low-cost-monitoring-project
- ROCIS Brief - Ducted Range Hood (Tom Phillips)
  - http://rocis.org/kitchen-range-hoods
- Air Handler Inquiry http://rocis.org/air-handler-inquiry
- ROCIS Data http://rocis.org/rocis-data
- Clairton Air Filter Project
  - http://rocis.org/clairton-air-filter-project

- Stay Tuned
  - Video Shorts - Telling the Story

Linda Wigington

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ROCIS Initiative
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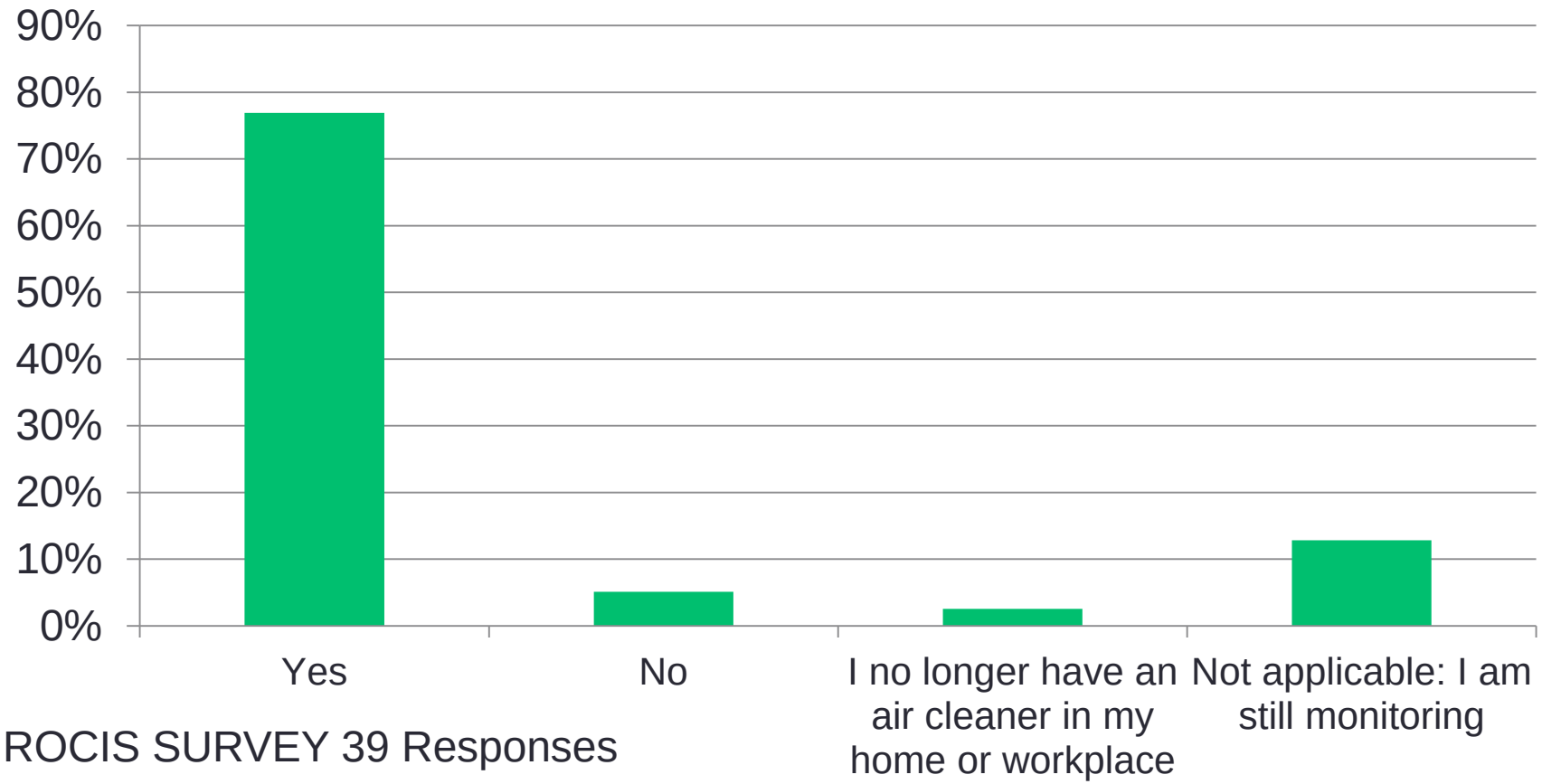
http://ROCIS.org/

EXTRAS

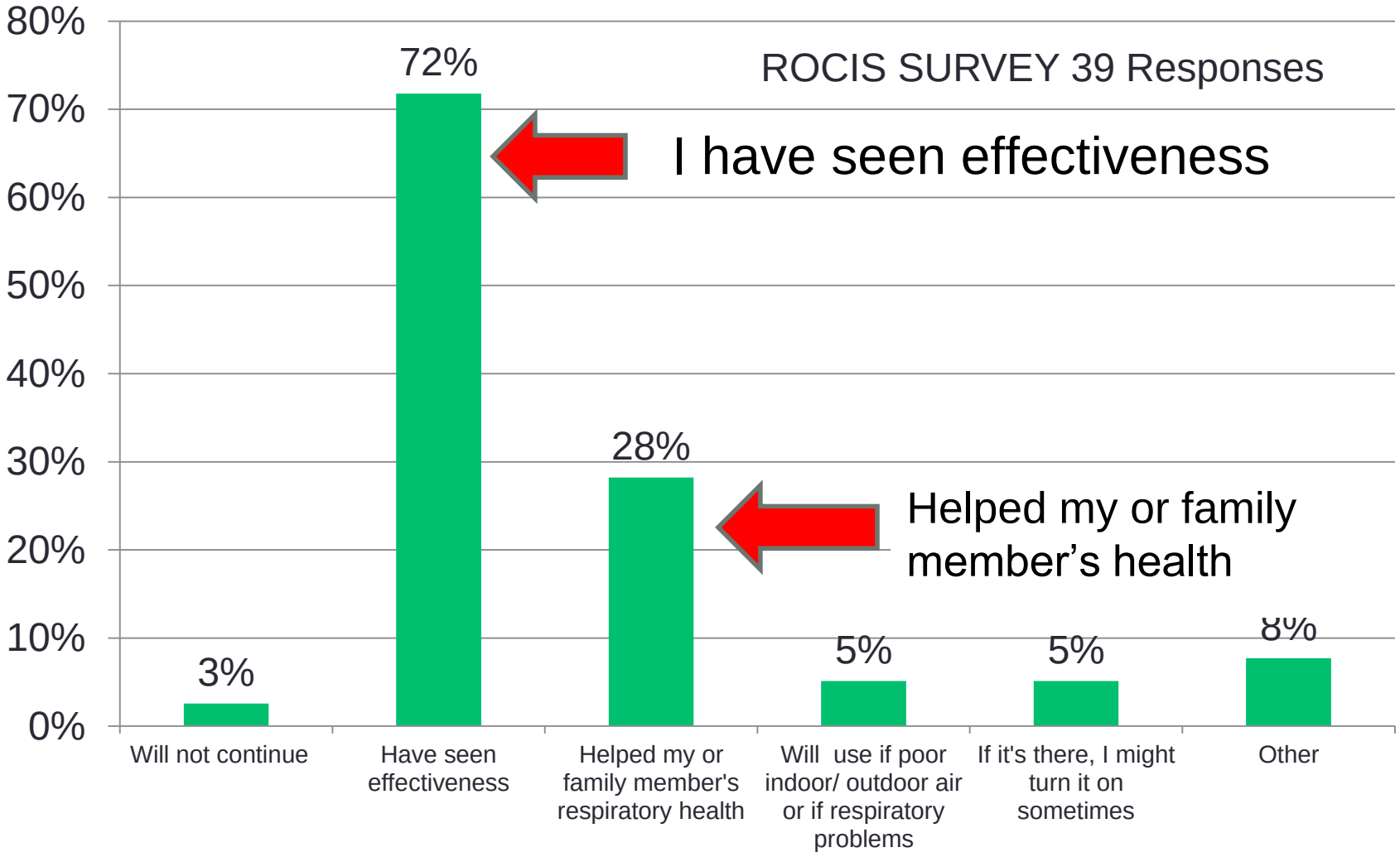
INSIGHTS / RESULTS FROM ROCIS INTERVENTIONS

Did You Continue Using Your Air Cleaner or Fan/filter After ROCIS Monitoring?



ROCIS SURVEY 39 Responses

Why Continue to Use an Air Cleaner or Fan/Filter?



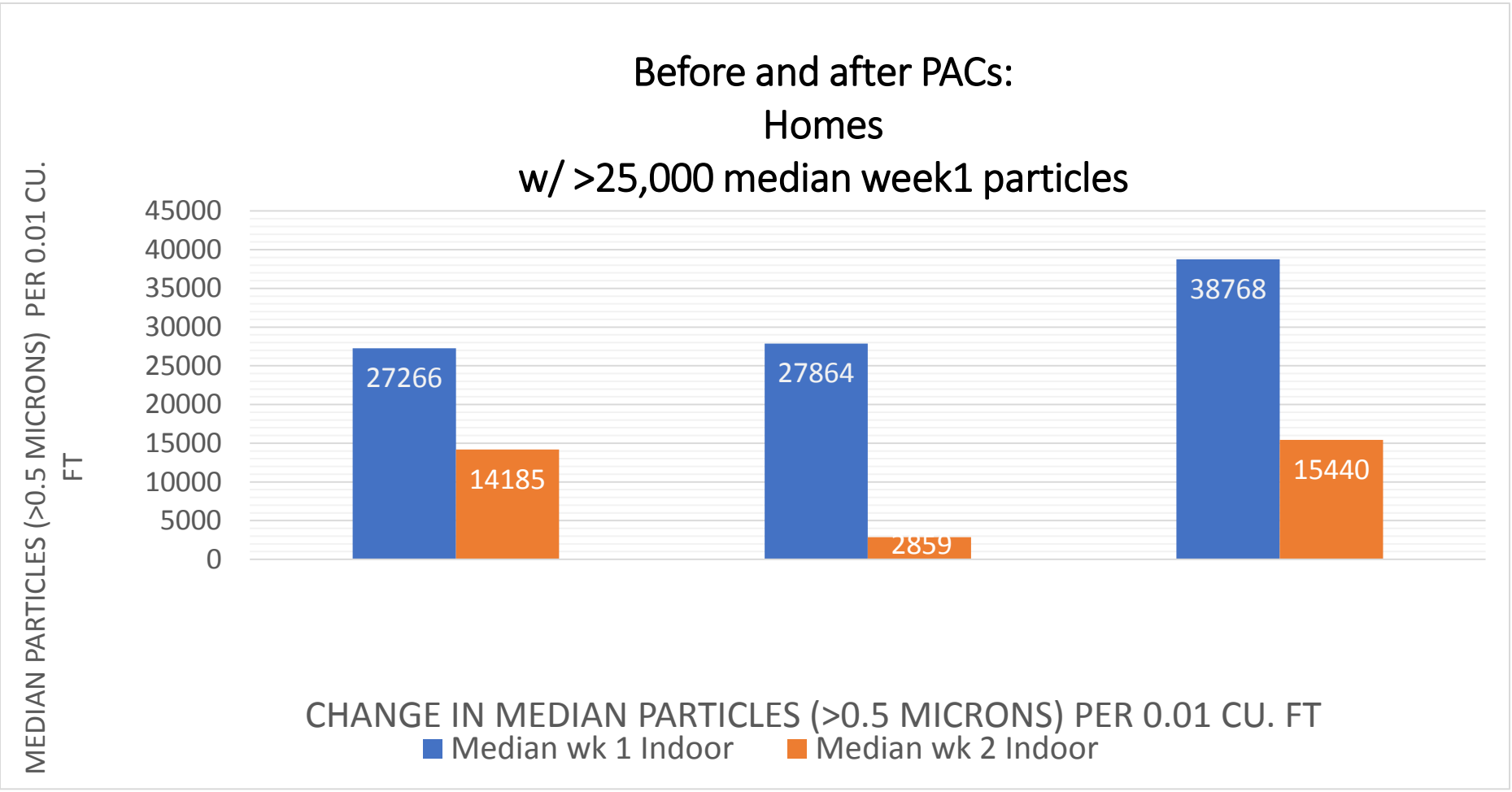
Clairton Air Filter Distribution Program

Summer 2020

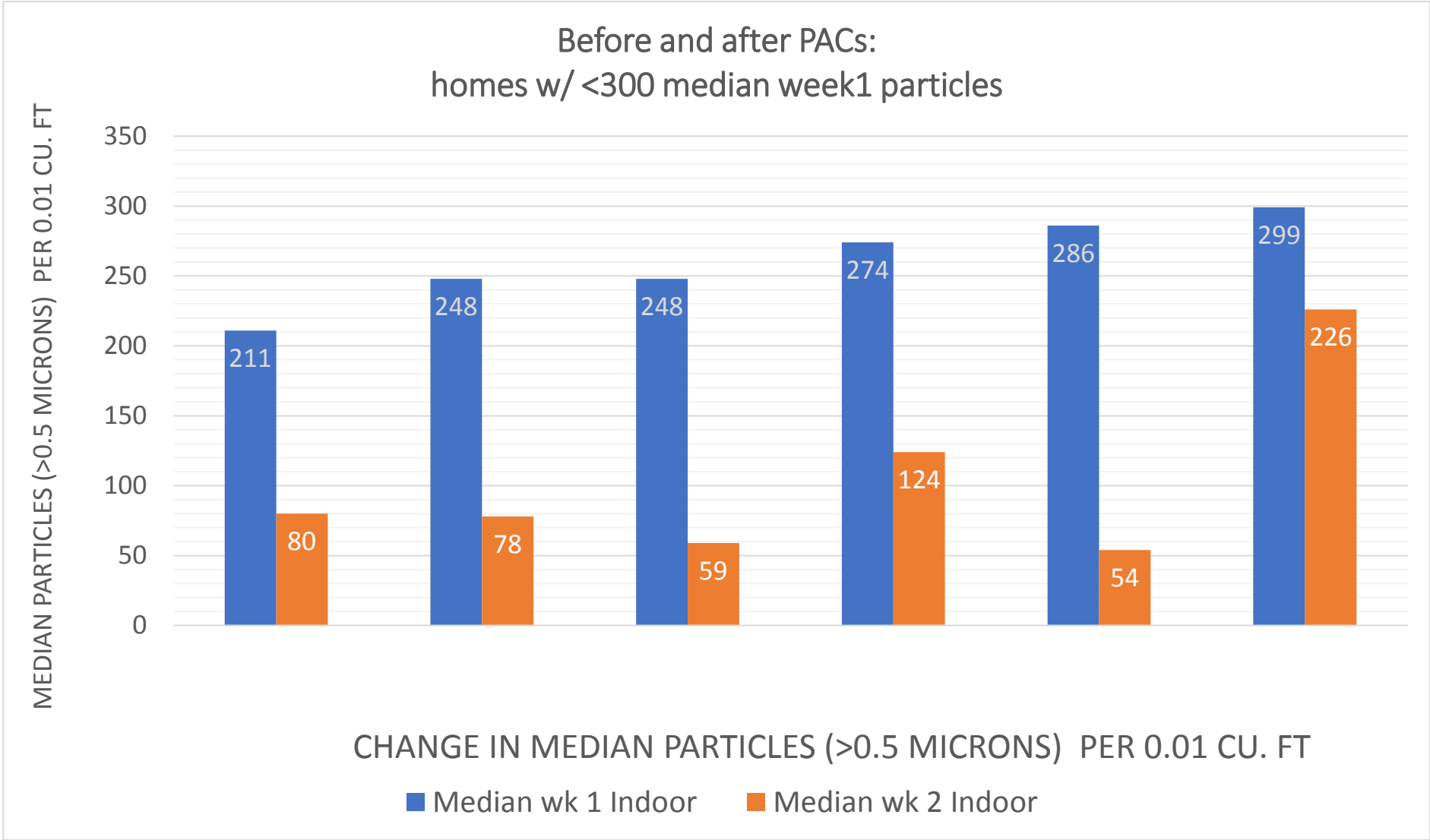
- 47 households served
- Goal: treat all regularly occupied spaces
- 153 portable air cleaners (3.25/home)
- Pre & post particle monitoring (~weeks)
- Weekly contact for feedback
- $870 - Average PAC cost per home
- **Portable Air Cleaner Performance & Data here**

http://rocis.org/clairton-air-filter-project

Clairton Air Filter Project Reductions – Very High Pre-Particles

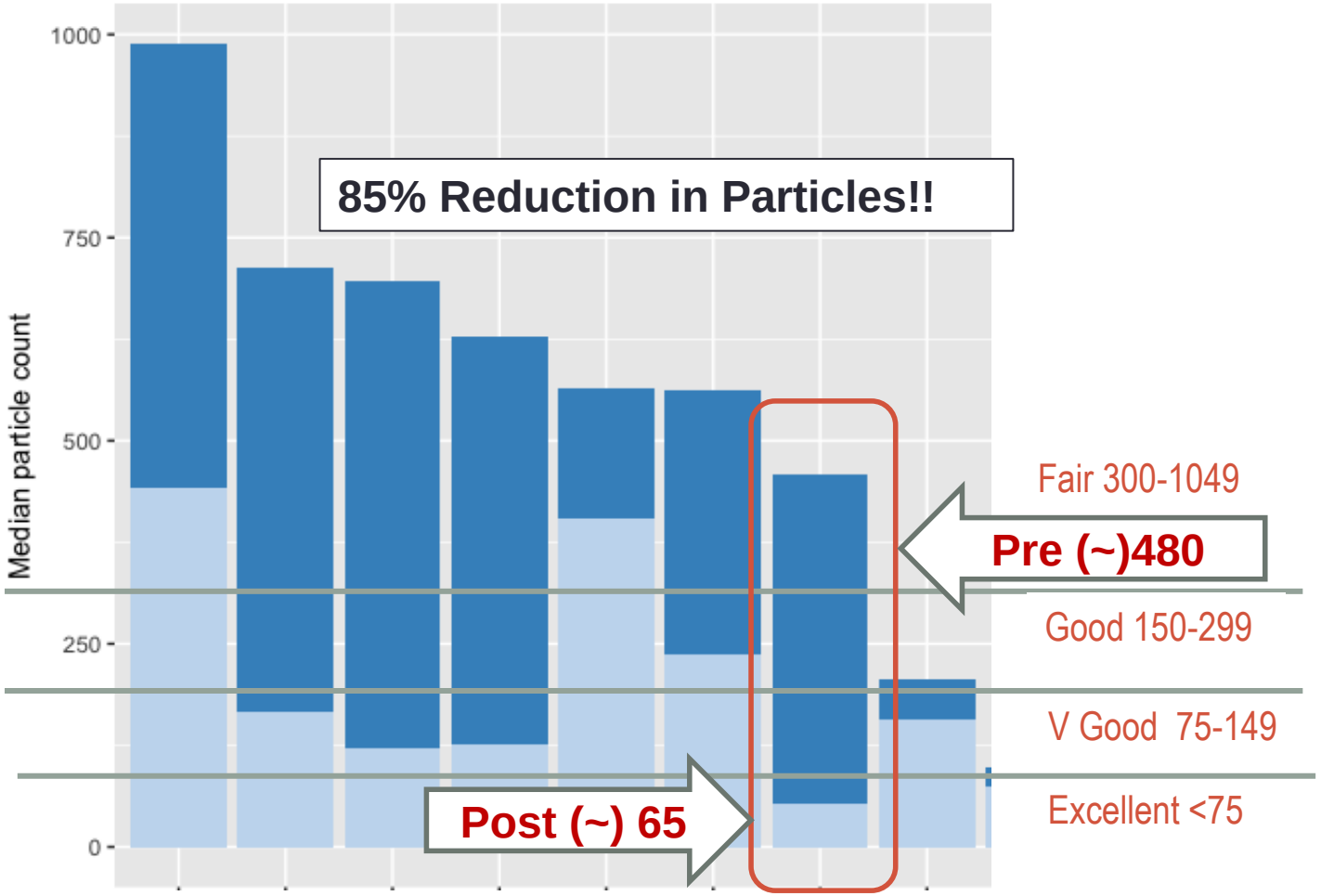


Clairton Air Filter Project
Reductions: Low Pre-Particle Count



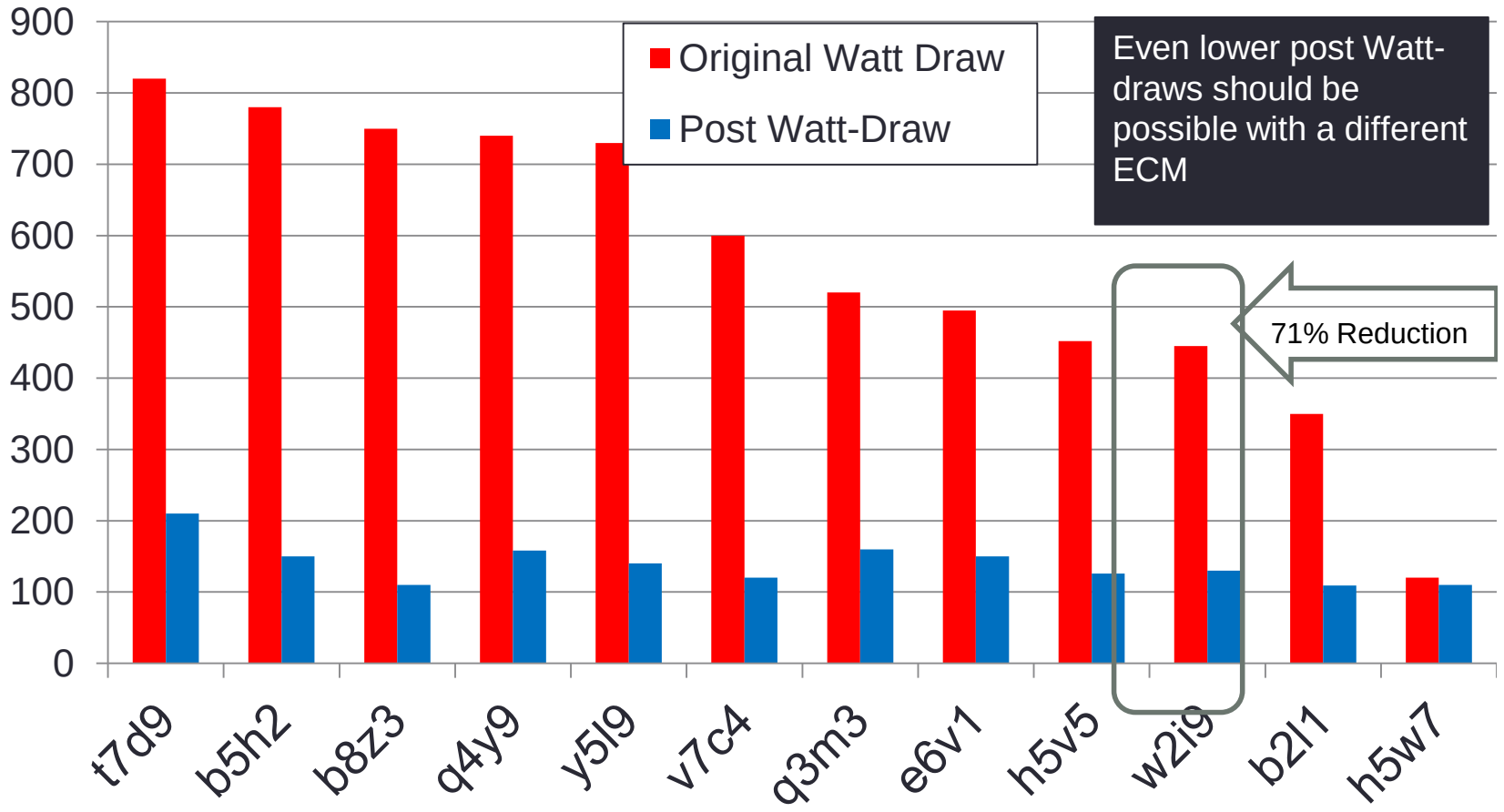
Air Handler/high MERV Inquiry

Selected ROCIS Intervention Homes Pre-Post Median Particle Count



Use above code **(w2i9)** to view data on ROCIS LMCP Data Explorer
http://rocis.org/rocis-data-explorer

Air Handler Interventions
Pre-Post Continuous Watt-Draw



Use these codes **(w2i9)** to view particle data on ROCIS LMCP Data Explorer
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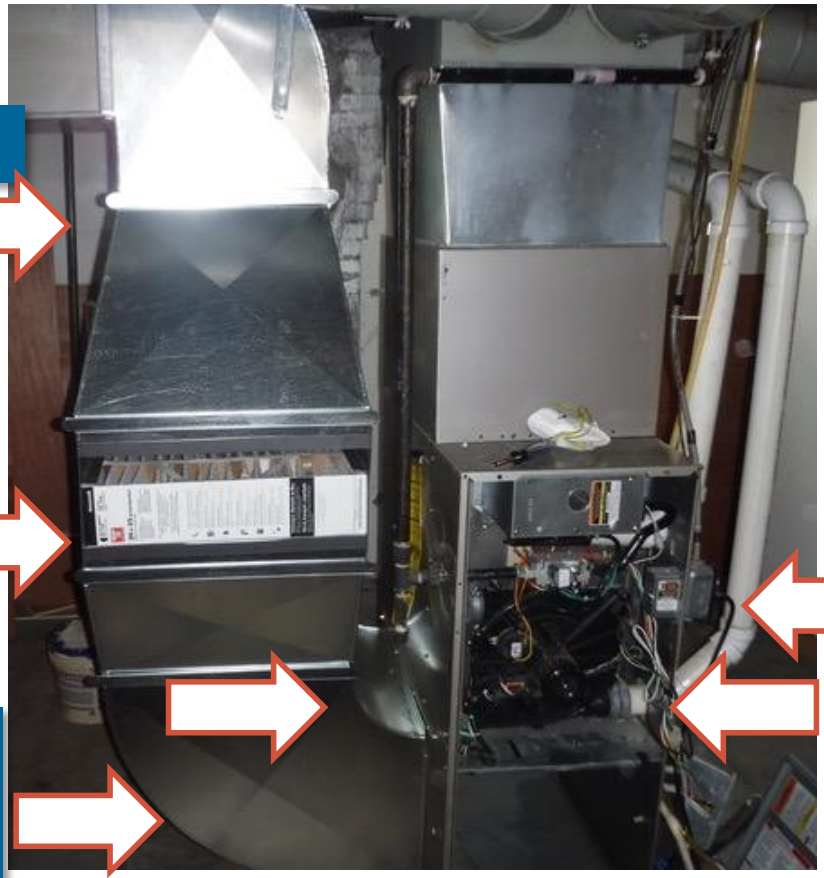
Case 2: Air Handler Retrofit 2.0

Larger return drop

2-part filter rack (20” x 25”) Horizontal (4” MERV 13 + 2” pre or post filter)

90 degree transition designed for better air flow (heel & throat); lower static



ECM replacement

Fan speed adjusted to optimize heating, cooling, & continuous performance.

RESULTS:

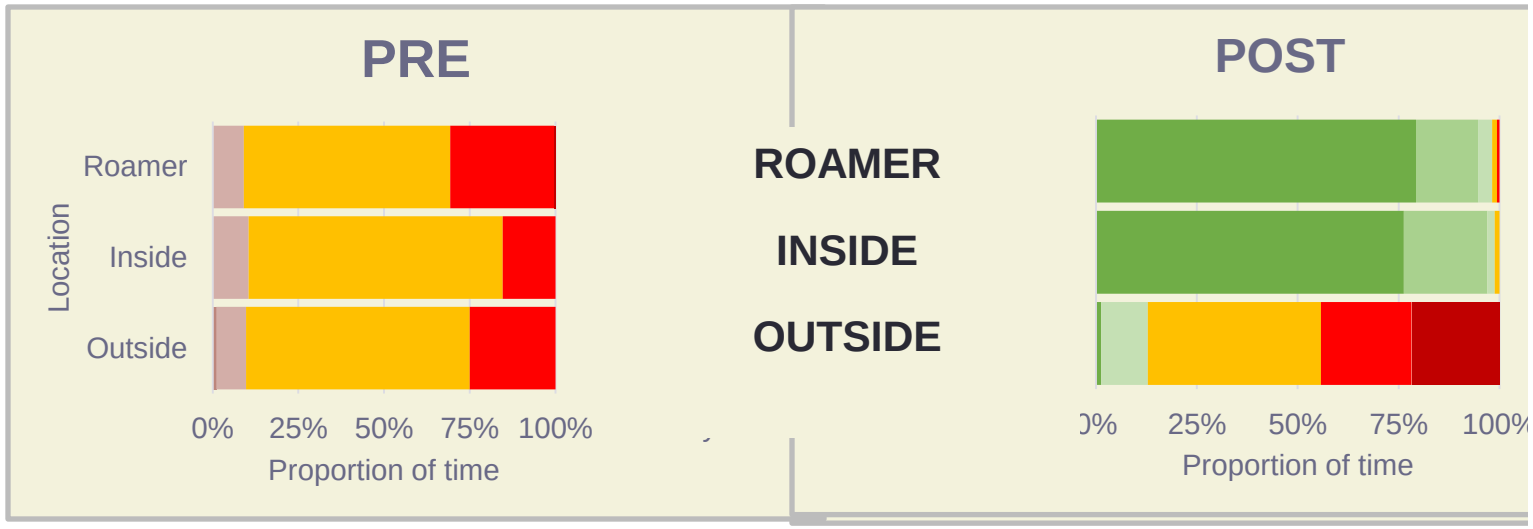
In continuous mode:

- 4.27 CFM/watt
- 120 Watts

- Pressure drop across filter Pre: 93 Pa, Post: 16 Pa
- **Allowable TESP: 125 Pa**
- **(total system)**

Case 2 Pre & Post Particles

Air Handler Retrofit

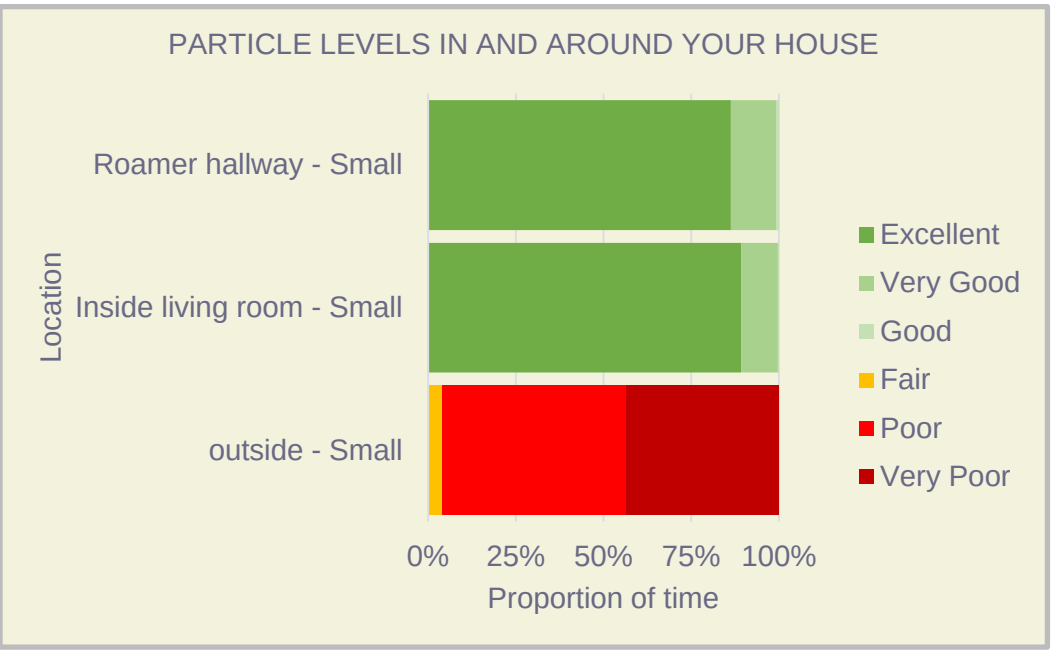


Week ending 5-24-2017 **(windows open)** vs. 7-31-2017, poorer outdoor counts

INTERVENTION:

ECM blower (lower air flow & energy cost on continuous setting)
New return (larger 20” x 25” MERV 13 filter & pre-filter)

Labor & material cost: $1,000
24/7 monthly operating cost: ~$12.50



LCMP Top Performer Air Handler 24/7 – MERV 13 Filter

Indoor tracks outdoor
Indoor uniform – 2 locations
Also – 2nd fl portable air cleaner

Continuous Mode: **$12/month**
Post: 110 watts; 500 CFM
(Pre-Post: 400 watt reduction)

Dylos small (0.5+ microns) (#/1/100 ft³)