



**Low Cost Monitoring Project
(LCMP)
Cohort 48: Filtration Interventions**

7:00 PM Thursday, July 29, 2021

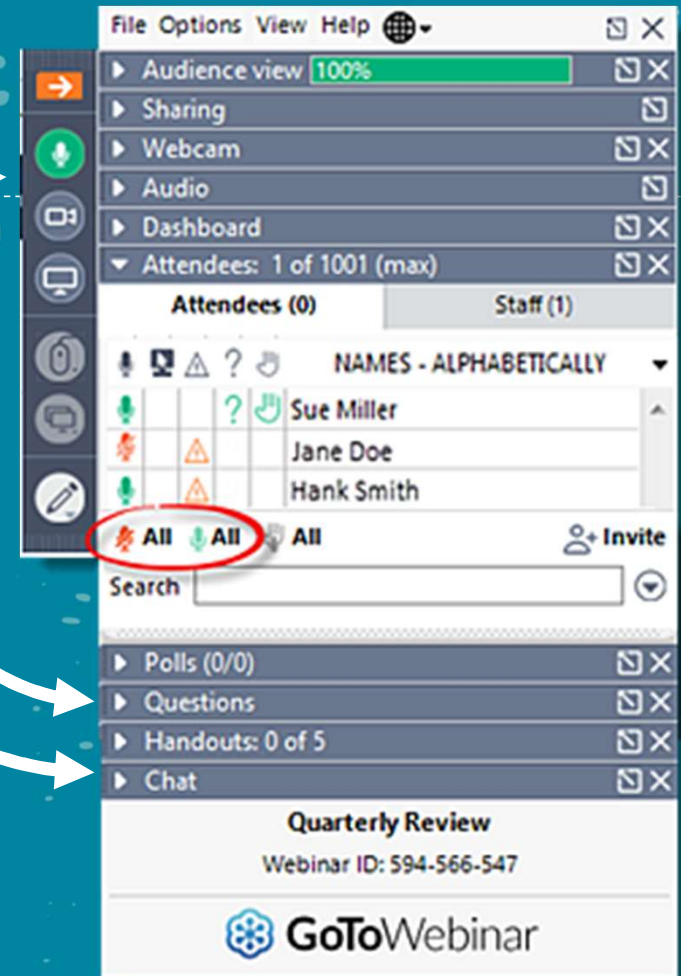
10:30 AM Friday, July 30, 2021

The Virtual Classroom

- Feel free to keep your mics on (mute if noisy)
- Use “Questions” tab in the control panel to ask questions, or raise hand
- All links will be placed in the “Chat” tab in the control panel. Comments can be added here as well.



This Meeting is Being Recorded





Your Name &
Who's with You



Your Location

01



Do you have a portable air
cleaner or high MERV
furnace/AC filter?

Introductions

Cohort 48



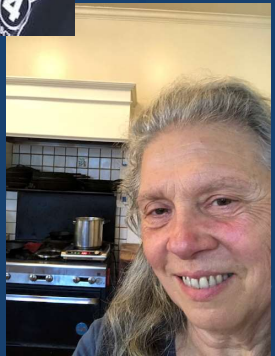
Bill's family



Alyssa's Family



George



Nickie

Scott

Kate

Cathy's Family

LCMP Team



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1. Identify 3 things essential to achieve particle reductions with a store-bought portable air cleaner
2. Be able to identify 2 applications for a fan/filter
3. Identify 2 reasons you should consult with a professional prior to using an air handler 24/7 for filtration with a high MERV filter

02

Meeting Objectives

Interventions: Filtration

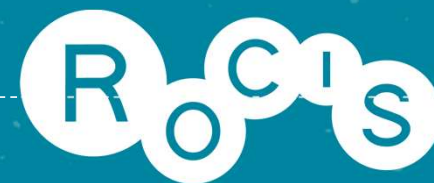
- Time for a
ROCIS video

03





**“... 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. “The health benefits are predicted to far exceed the costs for those interventions...”
William Fisk, LBNL**



Filtration Resources

- 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>

Digging Deeper

- IL Institute of Technology (Built Environment Research Group) (papers & presentations)

<http://built-envi.com/>

- IAQ Scientific Findings Resource Data Bank

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

Conclusions

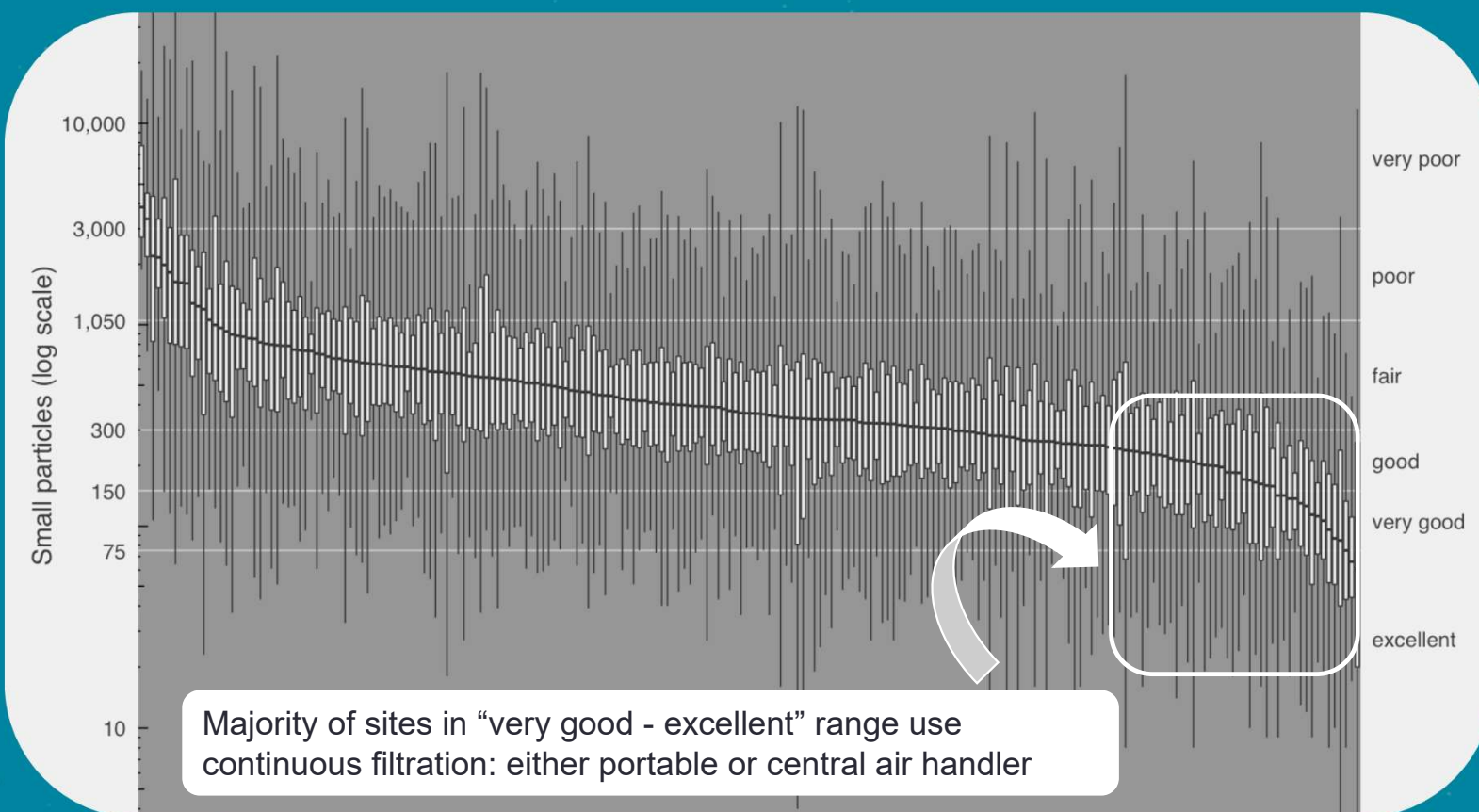
Insight to Date Re: ROCIS Interventions

- Air filtration can significantly reduce particle counts *if the application is appropriate*
- Low cost monitors reinforce use of filtration as well as source control
- Tighter the house, the greater the impact of filtration
- But, tighter the building, the more critical it is to control indoor sources
- In some cases, shift focus from building exposure to human exposure, i.e. bedrooms

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)

Indoor Particle Distribution: All Sites



More than 20 to 1
difference!
Median:
~1/2 Fair
~1/2 Good / Very Good

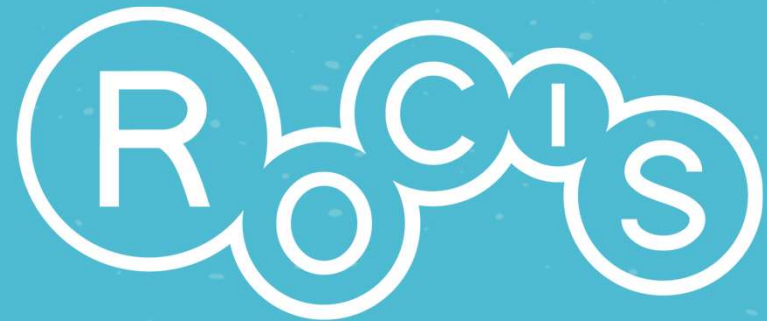
50% of observations are within
each vertical box
Particles 0.5+ μm (Dylos small)
Dylos Corporation scale (on right)

**Filtration only
works when
it is ON!**

YOU ONLY
GET OUT
WHAT YOU
PUT IN

Portable Air Cleaners

03



Portable Air Cleaners (PAC) also referred to as Air Purifiers

- Designed to treat one room or zone
- Primarily reduce particles
- Some models offer added reduction of pollutants / odors



Performance: Filter Type

- **Particle Reduction:** (HEPA), *not HEPA Like*
- **Reduction of Gases, Vapors, & Fumes:** Carbon? How much?
 - Avoid Others (Plasma Wave, Ionization, PCO)
 - NOTE: No standard for reduction of gases, vapors, & fumes, or certifying performance

Performance: Area Served

Clean Air Delivery Rate (CADR)

- ✓ Industry standard for capacity of Air Cleaners

Factors Affecting Ability to Effectively Treat Area

- ✓ Volume
- ✓ Distribution of filtered air
- ✓ Leakiness (Openness to other areas or outside)
- ✓ Pollutant Load
- ✓ Air Cleaner (actual air flow (CFM) at the setting)

NOTE: CADR based on highest setting

Primary Occupant Concerns

- Maintenance
- Cost of Filter Replacement
- Energy Use /Energy Cost
- Noise
- Air Movement/Comfort
 - Comfort (summertime)
 - Discomfort (wintertime)
- Just particle reduction or concern for other pollutants?
- No “Good” or “Bad”, rather personal preference & context

Impact of Portable Air Cleaner

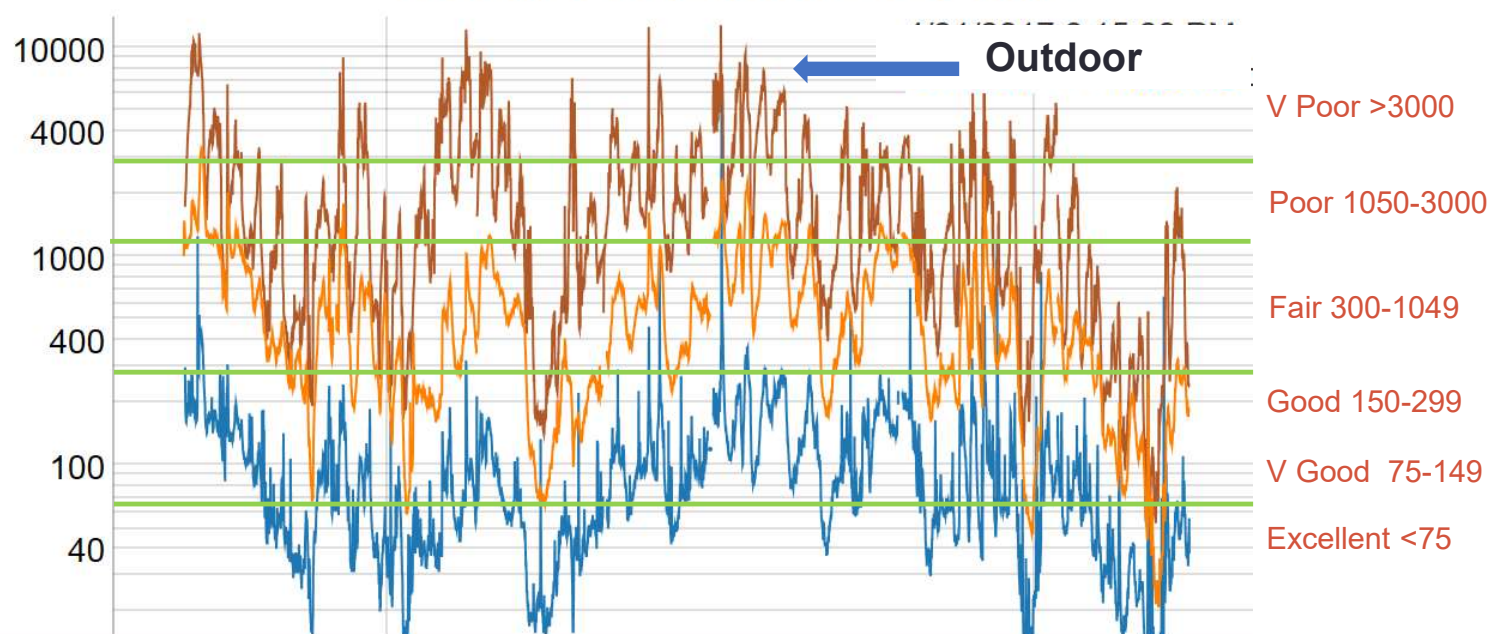
[http://rocis.org/rocis-data-explorer \(j1t8\)](http://rocis.org/rocis-data-explorer (j1t8))
0.5+ μm Particles by Time (15-min. avg.)

Blue: treated zone with
24/7 air cleaner
Orange: untreated zone
Red: outdoors

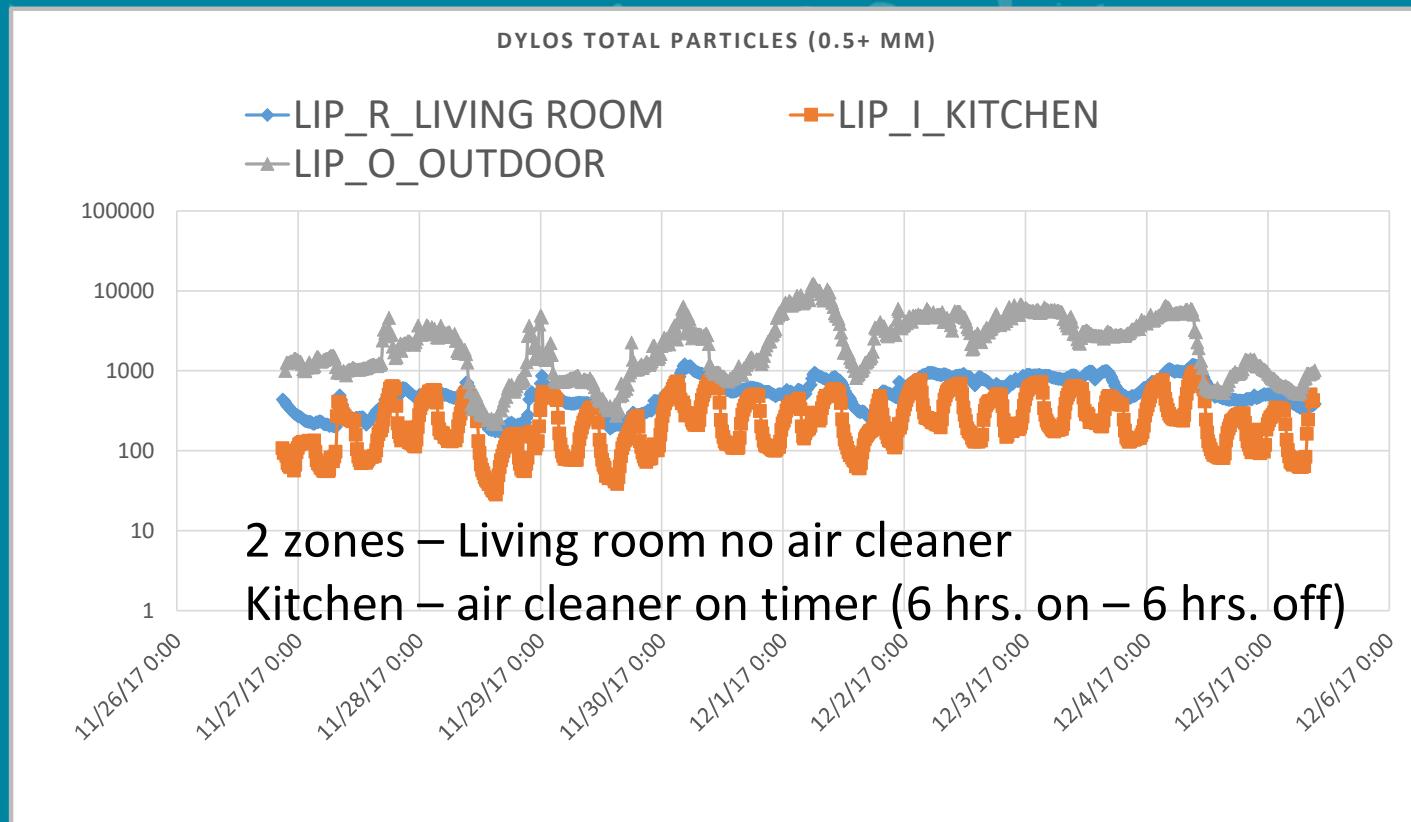
Tight, single family home
Though order of
magnitude lower; Indoor
(Blue/orange) tracks
Outdoor



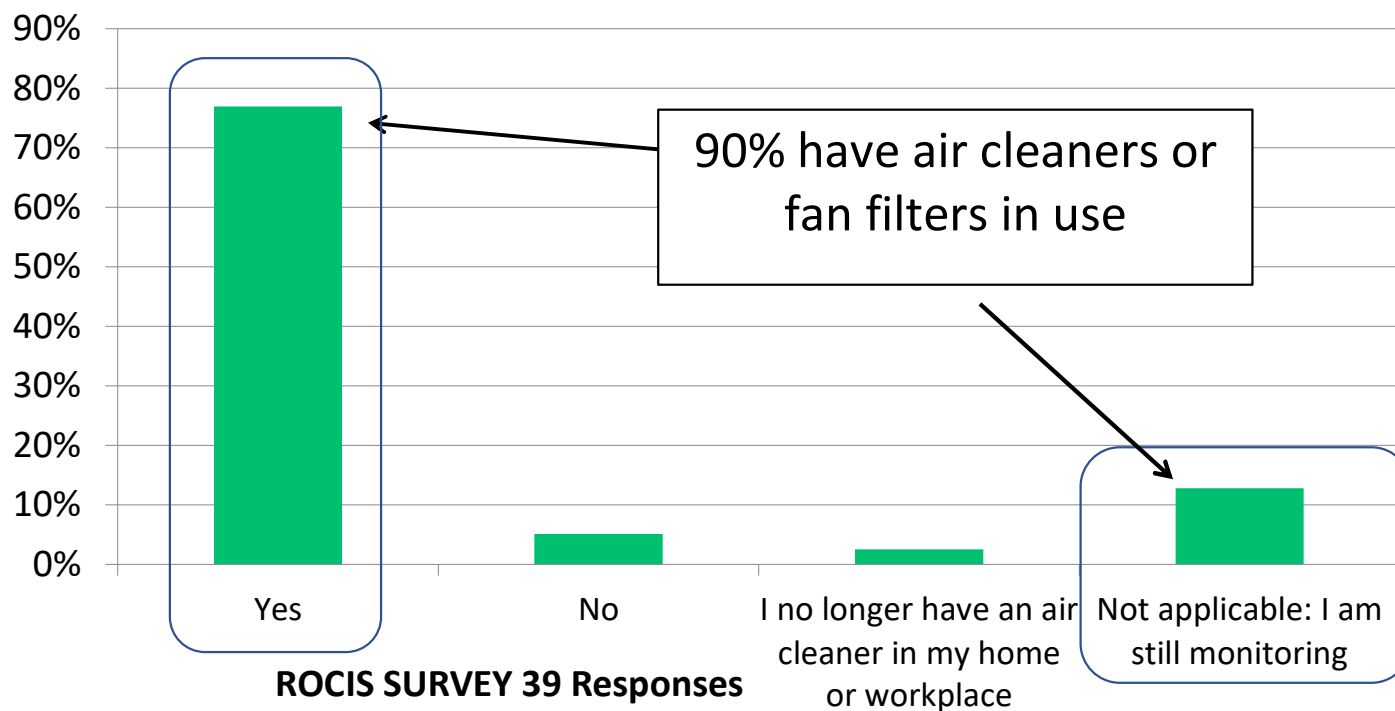
Your Indoor Particles vs. Time



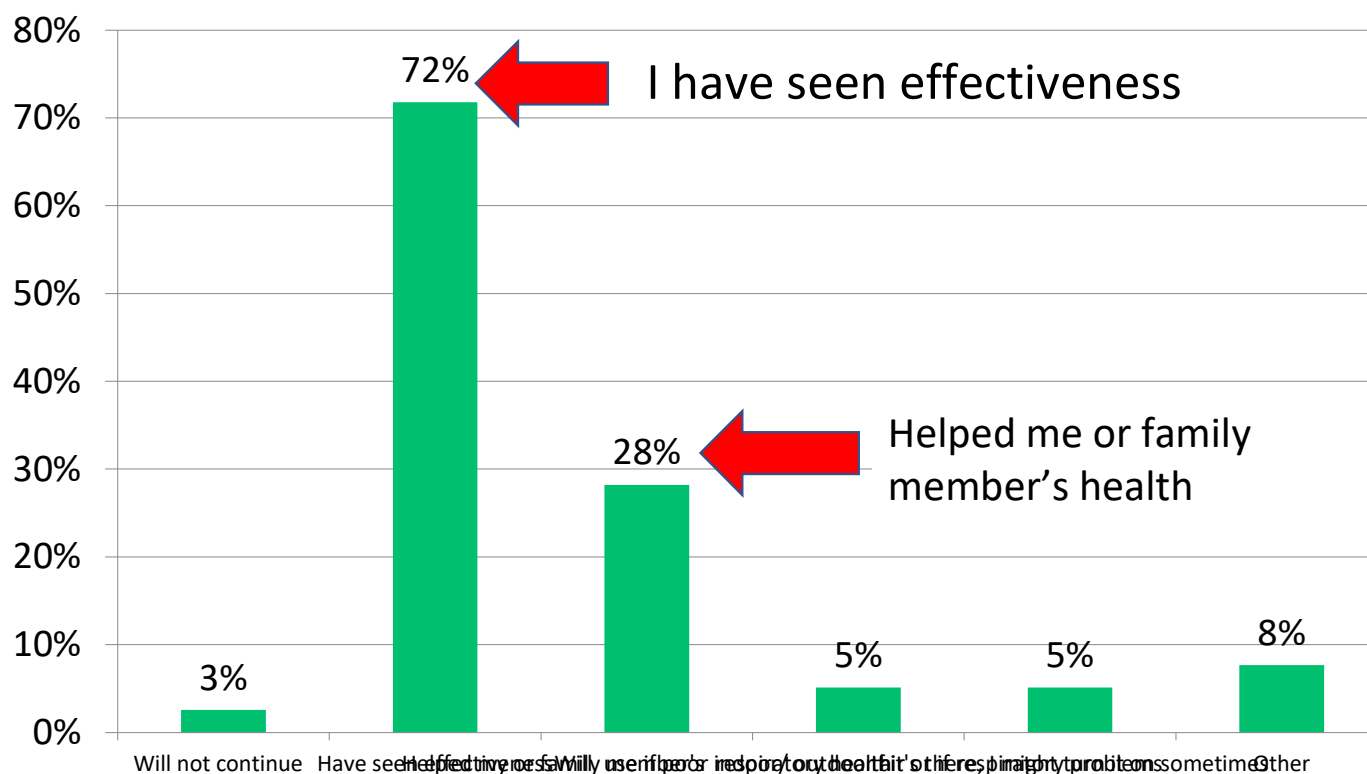
Air Cleaner Cycled On & Off (6 hrs.) House Unoccupied



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



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



Importance of Feedback & Behavior (Particle Reductions)

1) Strategies: How to Keep Air Cleaners on

2) New Equipment Features Offered:

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

Jeff Siegel ...

<https://www.cbc.ca/news/business/portable-air-purifier-tests-marketplace-1.5900782>

- “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.”

Recent Resources: Filtration, Portable Air Cleaners, DIY Fan Filters

- Nov. 06, 2020 <https://www.iaqradio.com/francis-bud-offermann-msme-pe-cih-ventilation-air-filtration-and-covid-19-avoiding-the-snake-oil-salesman/>
- Jan. 29, 2021 <https://www.iaqradio.com/jeffrey-siegel-ph-d-covid-19-risk-mitigation-a-researchers-perspective/>
- PDF here: [Beware: COVID 19 Snake Oil Salesman...](#)
- Feb. 06, 2021 <https://www.cbc.ca/news/business/portable-air-purifier-tests-marketplace-1.5900782>

“Siegel said a good air purifier can also help clear out coronavirus particles and reduce the air's viral load.”

- May 2021 <https://www.motherjones.com/politics/2021/05/air-purifier-covid-asthma-unproven-science-coronavirus-ionization/>

Clairton Air Filter Distribution Program

Summer 2020

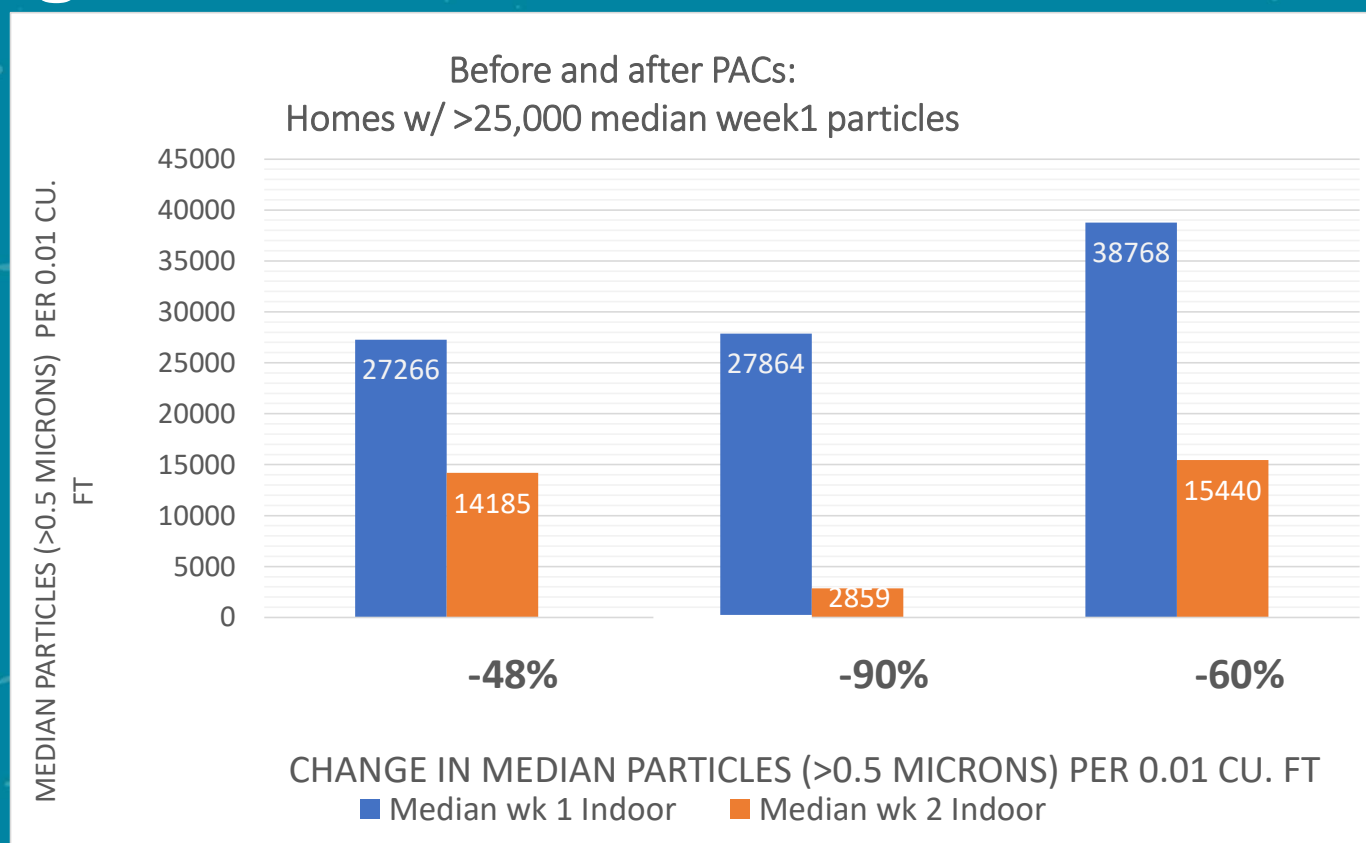


- Funded by The Heinz Endowments
- Filtration Goal: To treat all regularly occupied spaces
 - Pre & post particle monitoring over at least 3 weeks
 - Weekly contact for feedback
- Results
 - 47 households served
 - 153 portable air cleaners (3.25/home)
 - \$870 - Average PAC cost per home
 - Portable Air Cleaner Performance & Data is available

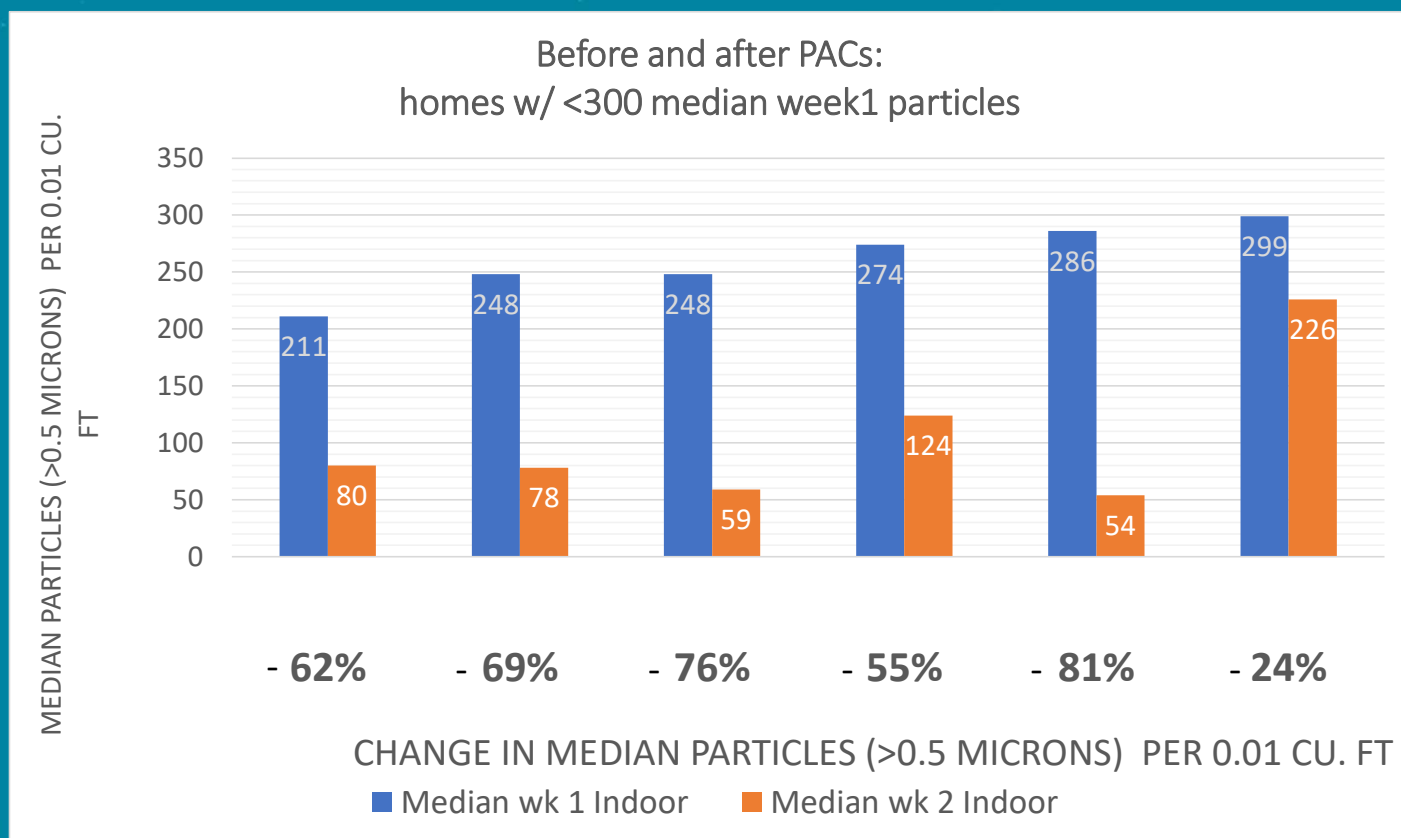
<http://rocis.org/clairton-air-filter-project>

THE HEINZ
ENDOWMENTS

Reductions: Very High Pre-Particles

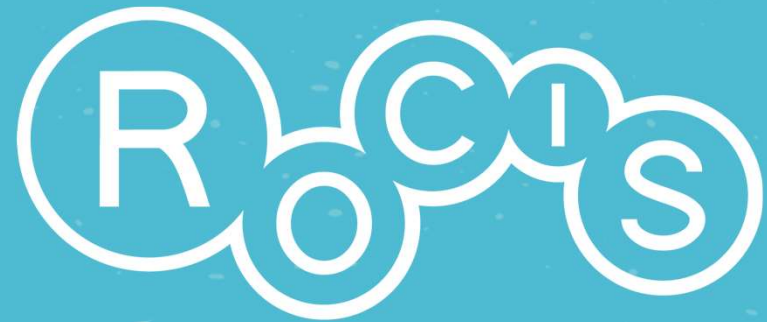


Reductions: Low Pre-Particles



DIY Fan Filters

04



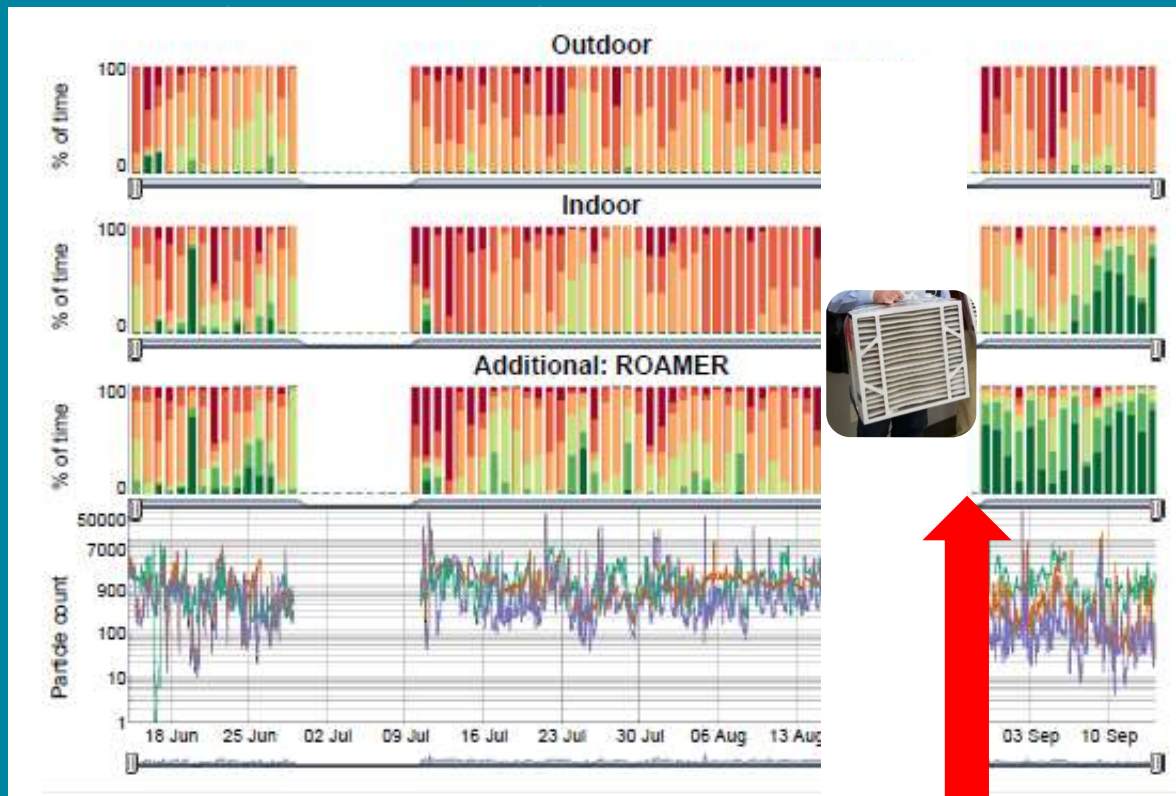
Fan/Filter Intervention: Low Cost, MERV 13

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)

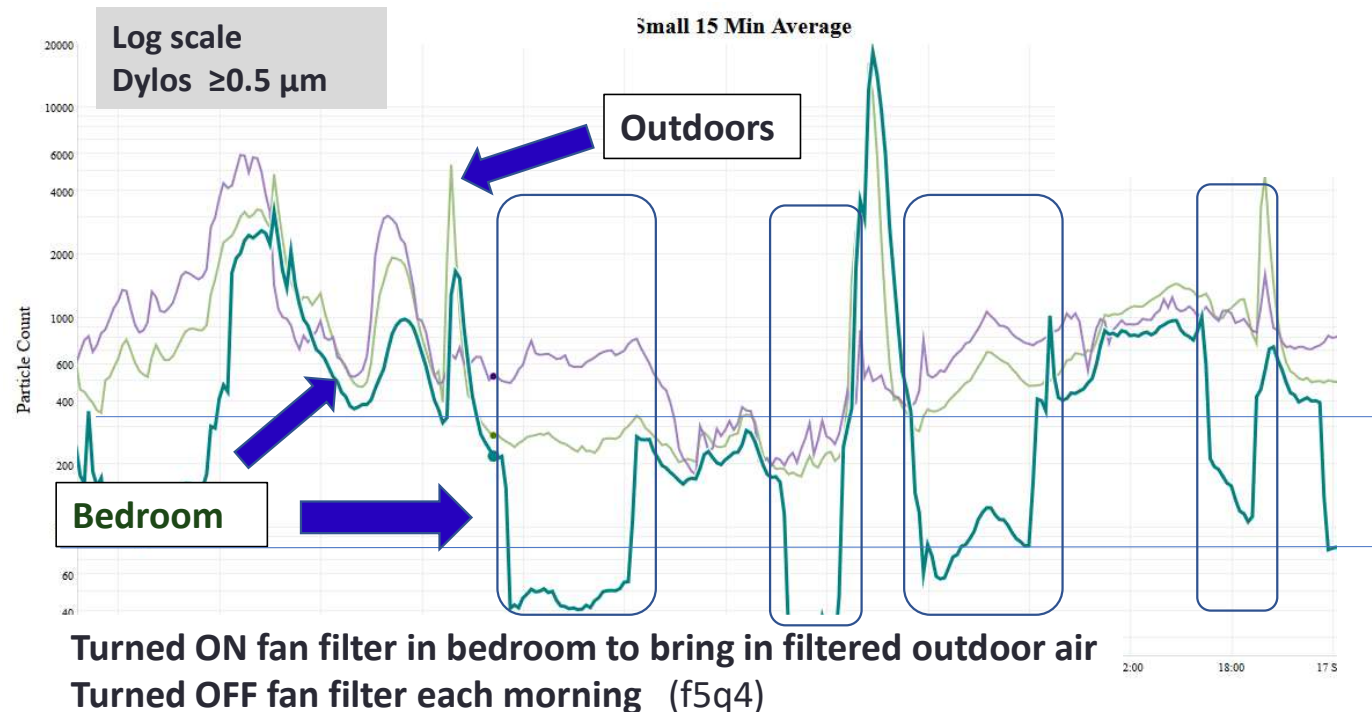


Added fan/filter here

Fan/Filter Intervention: Bedroom Window at Night



Open window
with/without
box fan & filter
on = Indoor
tracks outdoor
closely



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?>

Air Cleaners or Fan Filters

- Any questions?

Air Handler / High MERV Inquiry

05



Filtering Air with Forced Air Home Heating & Air Conditioning Systems

Simultaneously...

- *Significant missed opportunity* to reduce particles
- *Major liabilities* (energy use, energy cost, equipment life, & performance)

Our solutions reduce fine particles by 50-80% while minimizing risk

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

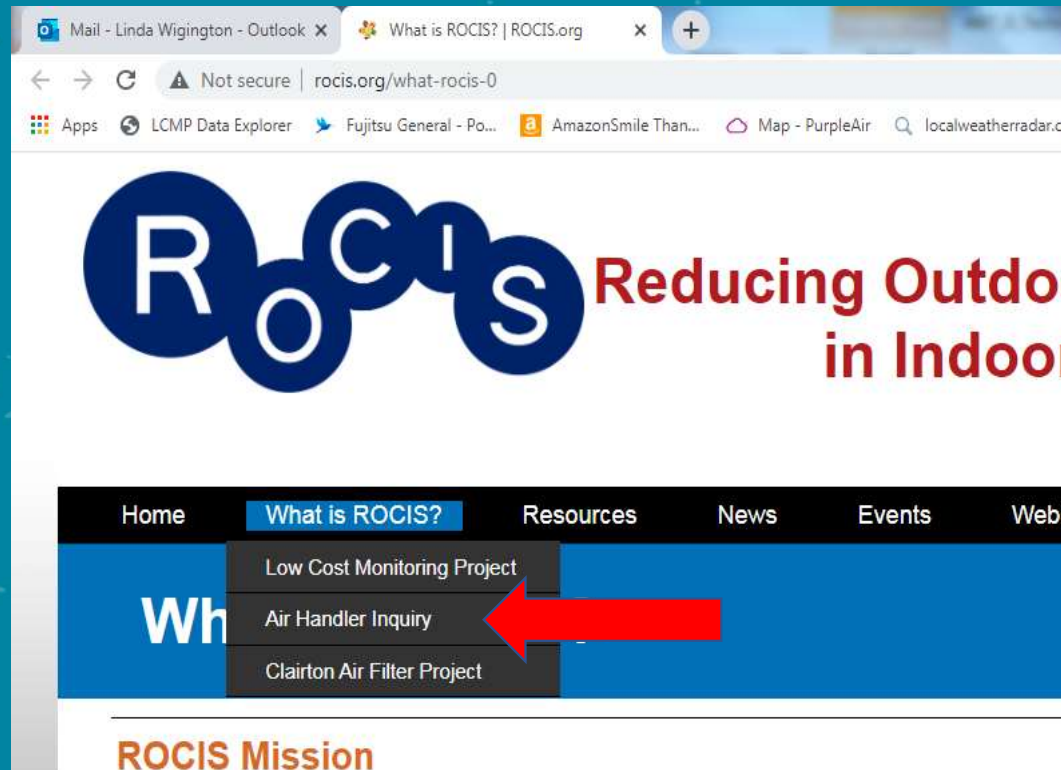
Initial Question...

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



Air Handler, or Air Handling Unit

(often abbreviated to AHU), is a device used to regulate and circulate air as part of a heating, ventilating, & air-conditioning (HVAC) system¹

Includes: ductwork, blower/motor, filter, coil, & controls

- ¹ Wikipedia

Return
Drop



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”



Blower / Motor



Blower



ECM (electronically commutated motor)

This multi-speed model also allows us to set up a very low continuous movement of air for filtration, ~400 - 700 CFM, @120 - 180 Watts of power.

Not as efficient (or expensive) as the variable speed ECMs in many new heating & air conditioning systems.

Big Issues with 24/7 High MERV Filter

Air handler (AHU) energy use 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/year¹)

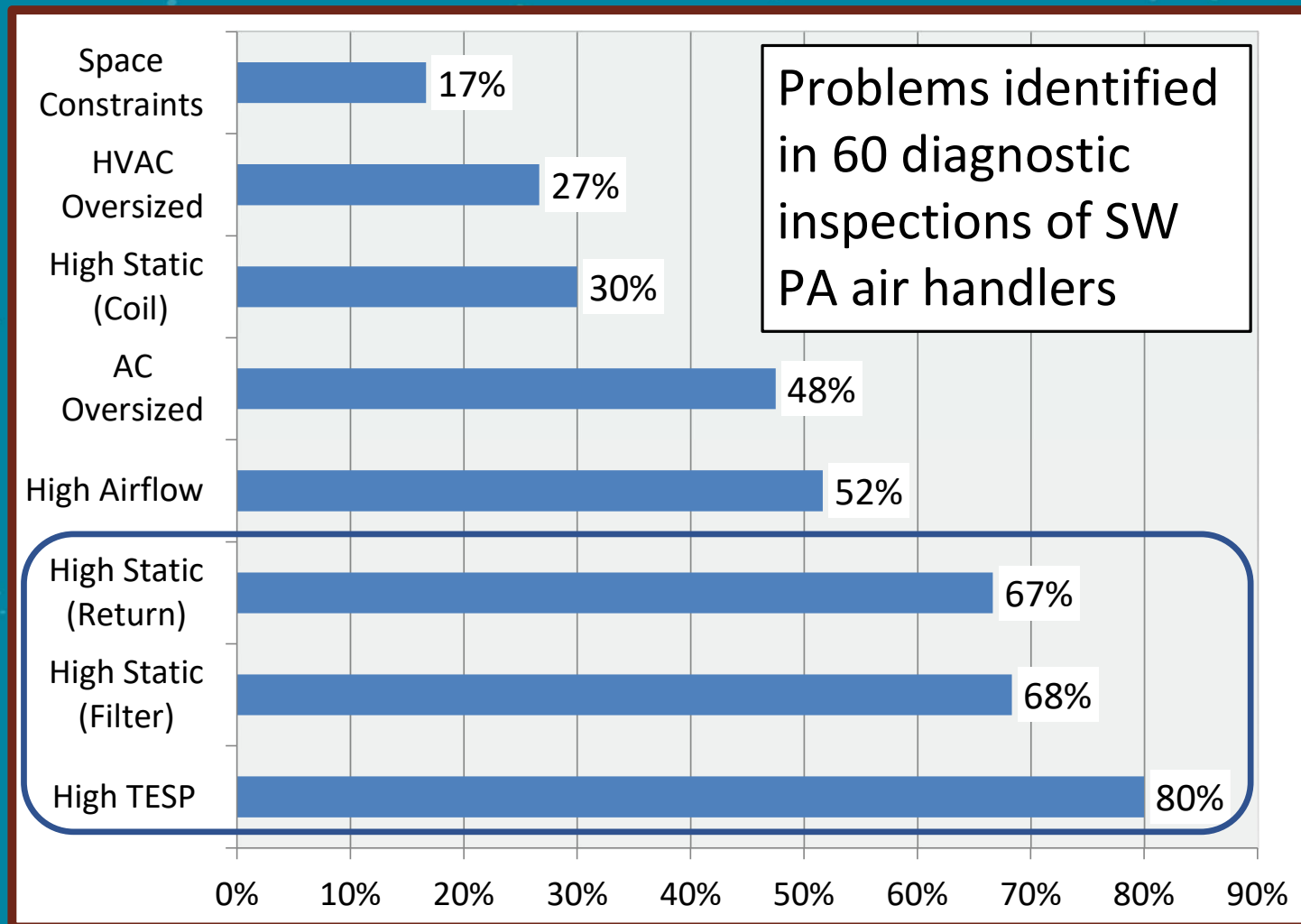
Wrong blower speed

- 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



Filter Bypass: Relatively Common in Homes



Elements for 24/7 Operation of AHU

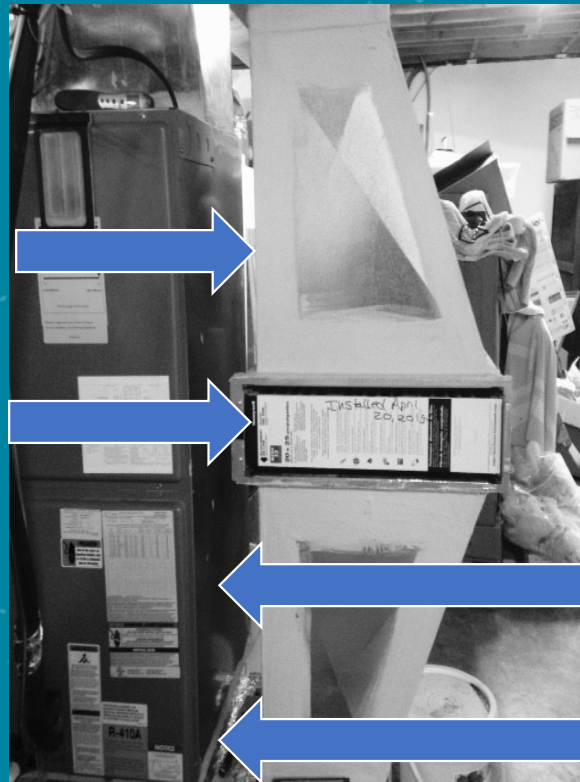
- **ECM (electronically commutated motor) Blower**
 - Increase control to optimize (& lower) air flow
 - Drops electricity use, **but only if static pressure** is low/correct
- **4" Pleated MERV 13 filter – ideally also larger area**
 - Lower air flow thru filter increases reduction of smaller particles
 - 4" deep filter longer life without clogging
 - Option for 2nd filter (pre or post)
- **Good Duct System**
 - Minimal leaks to outside
 - Air flow & TESP within name plate specifications

NOT RECOMMENDED:
1" pleated MERV 11 or 13
filter (equivalent) without
performance testing for
TESP, air flow, & watt-draw

Air Handler Inquiry – Intervention

Modified return drop to reduce static pressure & accommodate **bigger filter**

4" MERV 13 filter (plus 1 or more specialty filters) all in horizontal location

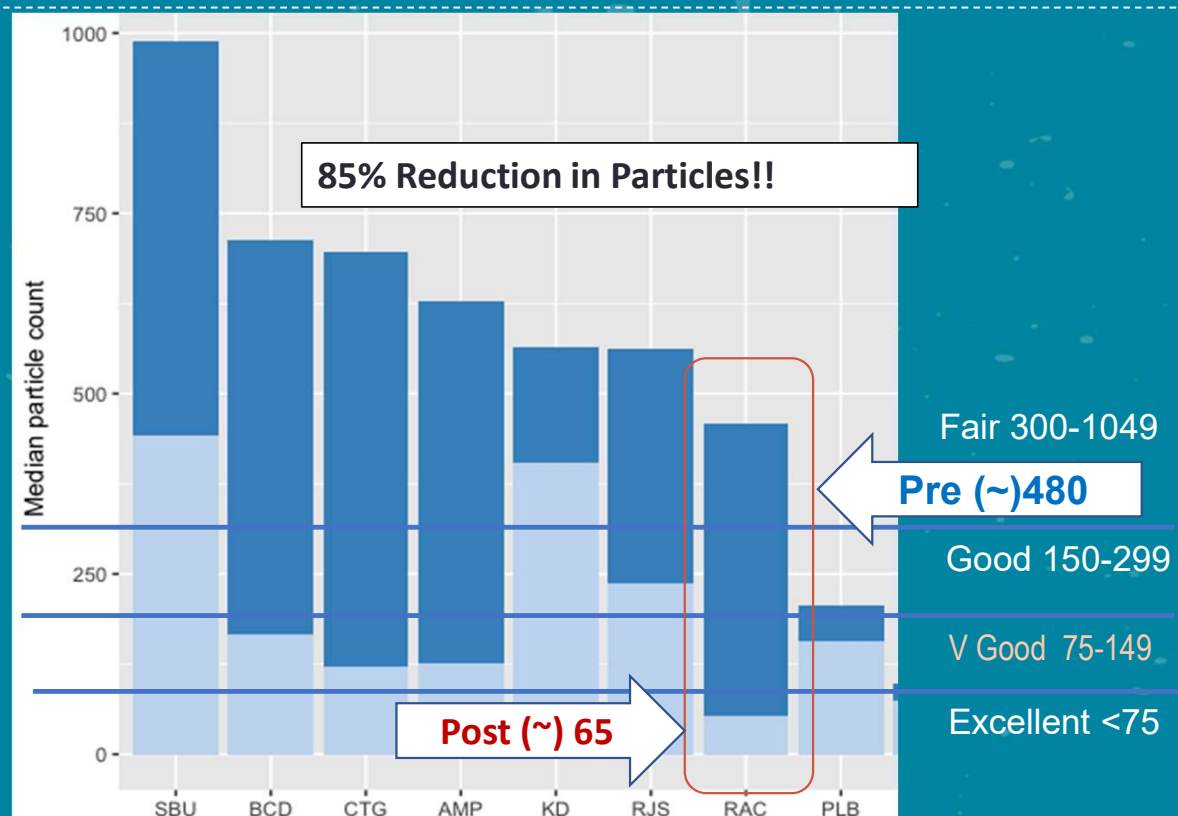


Adjust blower speed for continuous/longer operation

Consider **ECM replacement**

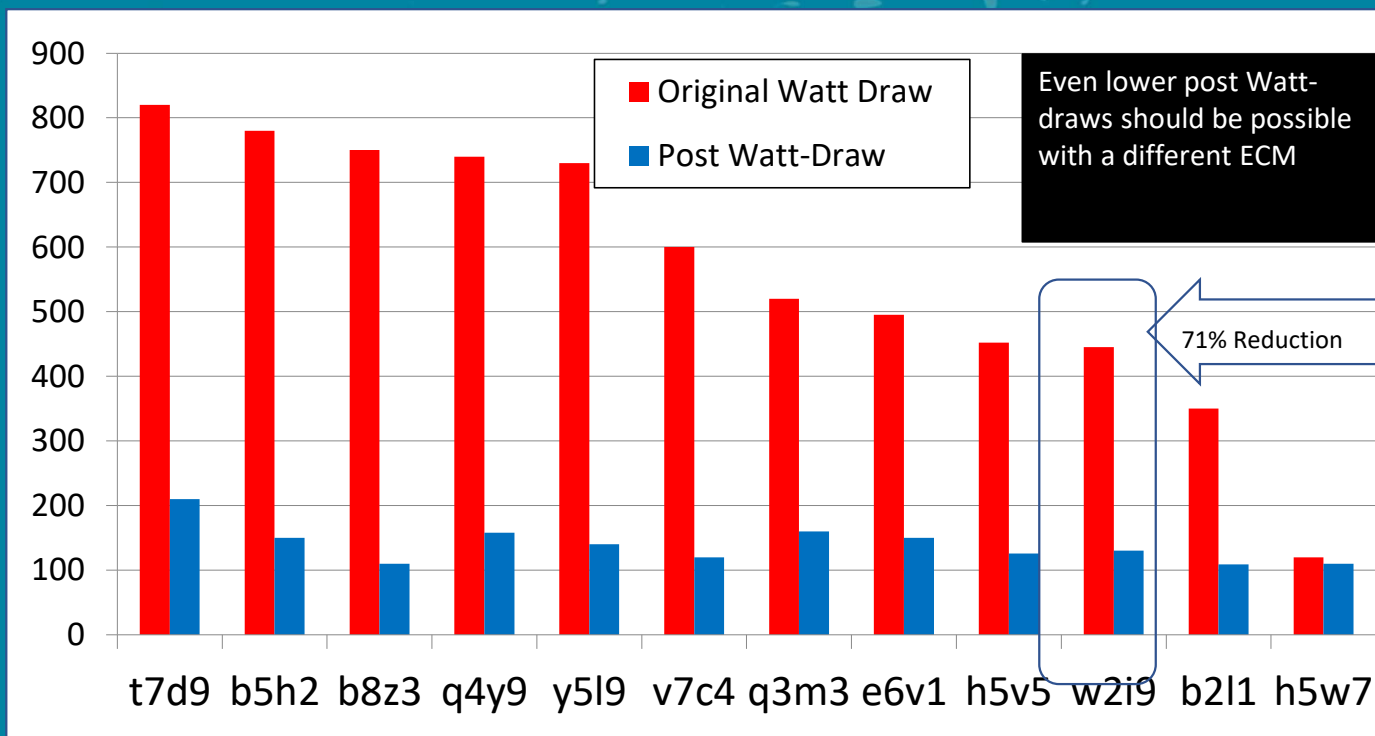
Selected ROCIS Intervention Homes Pre-Post Median Particle Count

Use 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 <http://rocis.org/rocis-data-explorer>

1st Air Handler Retrofit

Pre



16x25x1 MERV 12

Post



20x25x4 MERV 13

Case 2: Air Handler Retrofit 2.0

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)

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

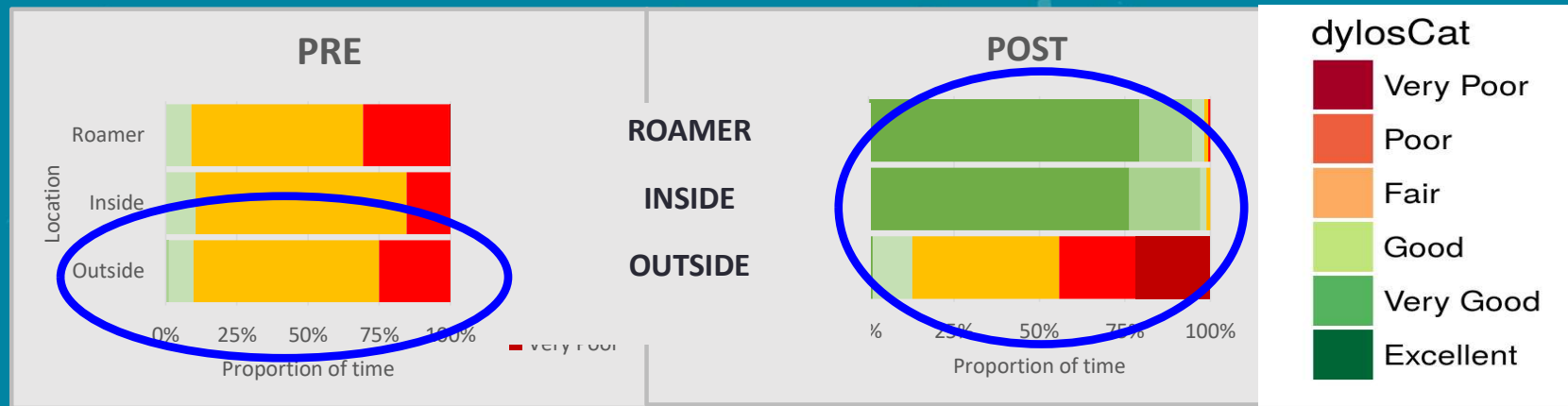


ECM replacement

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

Case 2: Pre & Post Particles

Air Handler Retrofit



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

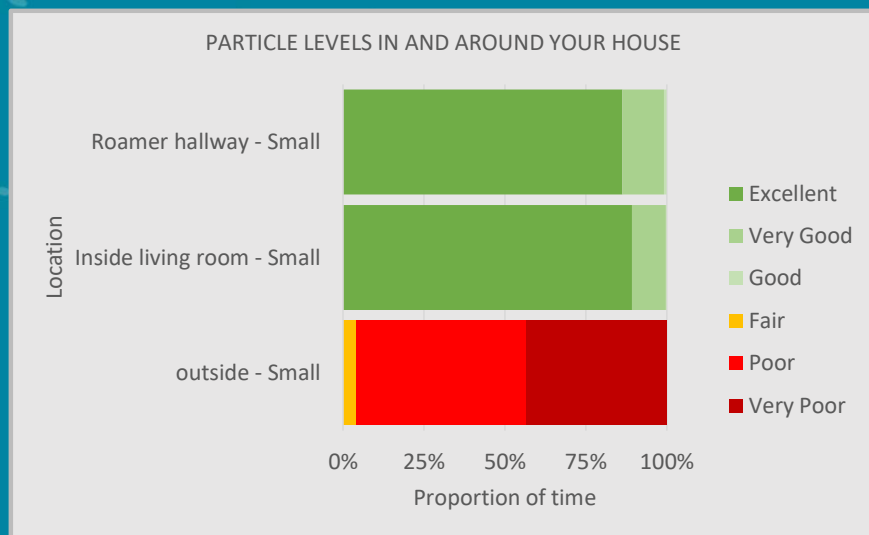
INTERVENTION:

ECM blower (lower air flow & energy cost on continuous setting)

New return (larger 20" x 25" MERV 13 filter & pre-filter)

Cost – labor & materials: \$1,000

RESULTS: Lower CO₂ in bedroom
24/7 annual operating cost: \$131.40

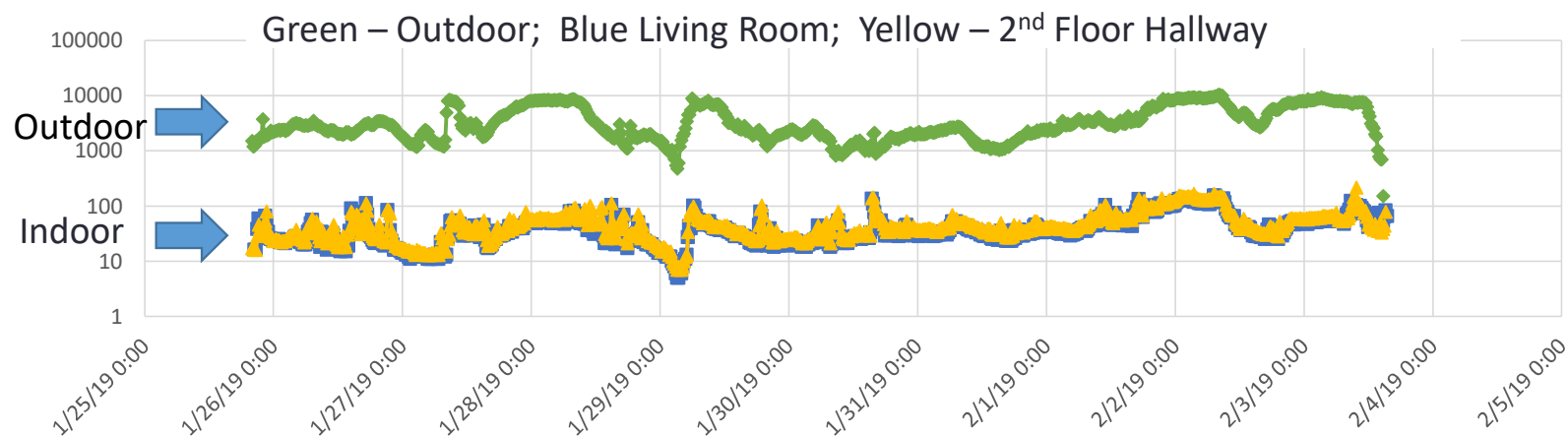


LCMP Top Performer Air Handler 24/7 – MERV 13 Filter

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) (#/100 ft³)



Big Opportunity at HVAC Replacement

- *Downsize HVAC to reduce static pressure!!*
- Incorporate return drop modification & option for larger, deeper filter
- Set blower speeds for optimal performance
- Address duct system shortcomings
- To ponder...
 - Could potential filtration health & comfort benefits add impetus to getting HVAC systems designed & installed correctly?

Filter Essentials

- Use large filter (surface area)
- Use deep filter (we prefer 4")
- Use low resistance filter (check label on filter)
- Minimize filter bypasses
- Use MERV 13 to reduce 0.3 to 0.5 μm particles (MERV is like R-Value; *performance depends on installation/operation*)
- Provide adequate run/on time (if system passes diagnostic screening)

Bottom Line – Air Handlers 24/7 w High MERV Filtration

- Can be very effective!
- Do not operate air handler 24/7 without confirming
 - Fan cost (electricity)
 - Minimal duct leakage to outside (big issue w/attic ducts)
 - Static pressure within operating range
- NOTE: One-inch pleated filters can be very restrictive

Conclusions:

Insight to Date on Interventions

- Air filtration can **significantly reduce particle counts** *if the application is appropriate*
- **Low cost monitors reinforce use of filtration** as well as source control
- Tighter the house, the greater the impact of filtration
- But, tighter the building, the more critical it is to control indoor sources
- In some cases, shift focus from building exposure to human exposure, i.e. bedrooms

Opportunity for You! (Pittsburgh participants)

(Now) Use & keep a fan/filter



(Soon or later) Schedule an
Air Handler Diagnostic visit



Bottom Line!

Integrated solutions are needed to enhance health, resilience, energy efficiency, comfort, & durability (engagement, building tightness, source control, operation & maintenance)

Ideally, improve outdoor air quality!

Cohort 48 Challenge

Any Questions?

Step 1: Select a Dylos spike (with a known specific source) you have observed that ideally occurs several times a week

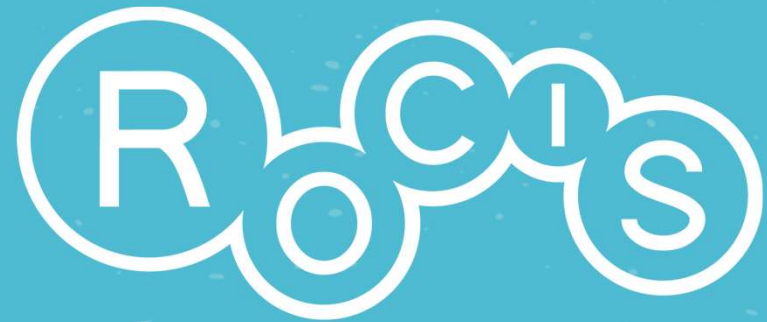
Step 2: Identify several ways you can reduce the intensity and/or duration of that spike

Step 3: Experiment to reduce that spike as much as possible

Step 4: At the Wrap-up meeting, let us know what you learned & what worked!

Wrap-Up

06



1. Identify 3 things essential to achieve particle reductions with a store-bought portable air cleaner
2. Be able to identify 2 applications for a fan/filter
3. Identify 2 reasons you should consult with a professional prior to using an air handler 24/7 for filtration with a high MERV filter



07

Meeting Objectives Review

Need Help? Who to Contact

- **Coordination & Logistics:**
 - Emily Dale - text: 724-833-8223 or ke_dale@hotmail.com
- **Equipment issues:**
 - Rob Busher - text: 412-437-8454 or robb@rocis.org
 - Samantha Tottoni - text: 217-390-1842 or skc35@pitt.edu
- **Interpretation of monitoring readings:**
 - Don Fugler - dfugler@gmail.com
- **Social Media Postings:**
 - Jessie Kester - text: 814-937-7365 jessicalkester@gmail.com



Accessing Cohort 48 Resources

- Limited Access Website page*
 - Handouts
 - Forms
 - Slide decks from meetings
 - Links to recordings

<http://rocis.org/rocis-lcmp-cohort-48>



Schedule & Topics

75-minute Online Meetings
7 PM Mon. & Thurs., Repeated 10:30 AM Tues. & Fri.

Important Dates:

- July 31 Dylos Downloads
- Aug 7 - Upload with photos of log & incident report
- Aug 10 Kit Pick up



Meetings:

- Aug 2 or 3 Health Impacts of Particles and YOUR questions Answered
- Aug 5 or 6** **Wrap-up Meeting**
 - please consider contributing your experiences

Meetings in **blue** are required.

Thanks!

**Thanks to Phil Johnson & The Heinz Endowments for
support of the ROCIS initiative
(Reducing Outdoor Contaminants in Indoor Spaces)
and our 385+ LCMP participants**

QUESTIONS?



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Air Quality Education Coordinator
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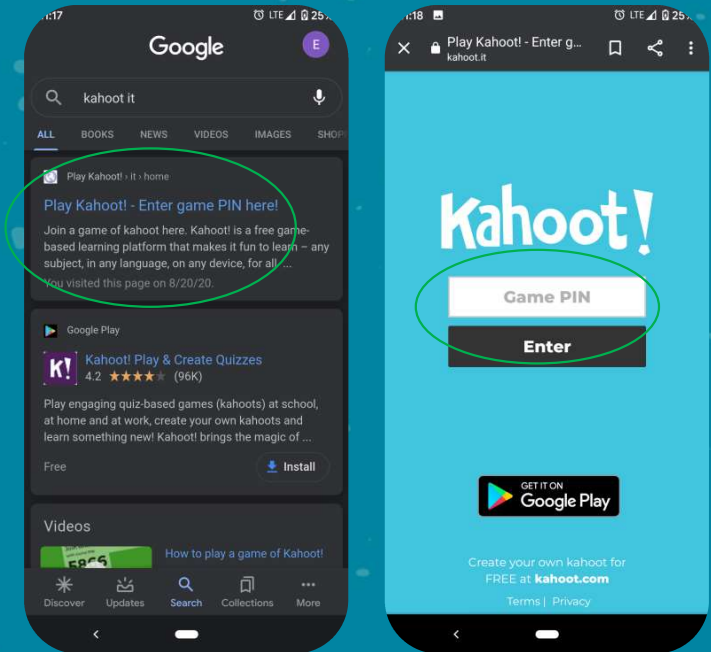
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QUIZ!

ROCIS FILTRATION INTERVENTIONS

- Type kahoot.it in your browser
- We will give you the pin



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