



Reducing Outdoor Contaminants in Indoor Homes



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- 10:30-noon PDT
- Wednesday, August 3, 2022
- Energy OutWest
- Denver, CO
- Find this presentation here:
- <http://rocis.org/past-rocis-events>



**“A Southwestern
Pennsylvania initiative to
reduce the impact of exterior
pollution in indoor spaces”**



**Most of our
exposure to
outdoor
pollution
happens
INSIDE
buildings.**

<https://www.iaqscience.lbl.gov>





Focus on Particles

Also referred to as Particulate Matter (PM)

Worst 21 Cities for Year-Round Particle Pollution

#1: [Bakersfield, CA](#)

#2: [Fresno-Madera-Hanford, CA](#)

#2: [Visalia, CA](#)

#4: [San Jose-San Francisco-Oakland, CA](#)

#5: [Los Angeles-Long Beach, CA](#)

#6: [Medford-Grants Pass, OR](#)

#7: [Fairbanks, AK](#)

#8: [Phoenix-Mesa, AZ](#)

#9: [Chico, CA](#)

#10: [El Centro, CA](#)

#11: [Sacramento-Roseville, CA](#)

#12: [Cincinnati-Wilmington-Maysville, OH-KY-IN](#)

#13: [Indianapolis-Carmel-Muncie, IN](#)

#14: [Pittsburgh-New Castle-Weirton, PA-OH-WV](#)

#15: [Bend-Prineville, OR](#)

#16: [Detroit-Warren-Ann Arbor, MI](#)

#16: [Redding-Red Bluff, CA](#)

#18: [McAllen-Edinburg, TX](#)

#18: [Philadelphia-Reading-Camden, PA-NJ-DE-MD](#)

#18: [Eugene-Springfield, OR](#)

#21: [Yakima, WA](#)

As Wildfires Rage, PHI Study Links Air Pollution with Increased Risk for COVID Infection & Death

Link: https://www.phi.org/press/new-study-shows-connection-between-air-pollution-and-increased-risk-for-covid-infection-and-death-in-california/?utm_source=PHI+Newsletter&utm_campaign=bf82ac0290-aug-2022-two&utm_medium=email&utm_term=0_14767b3be6-bf82ac0290-48960901&mc_cid=bf82ac0290&mc_eid=b105ad4e84

More than 4,000 COVID-19 deaths could have been prevented in one year if California met National Ambient Air Quality Standards for fine particulate matter (PM2.5), finds a new study released today by PHI's Tracking California and the University of California, San Francisco.

Areas with the greatest concentration of PM2.5 were California's San Joaquin Valley and South Coast air basins/ When compared to those living in neighborhoods with the lowest PM2.5 exposure, researchers found that individuals living in neighborhoods with the highest long-term exposure were:

- At 20% higher risk of SARS-CoV-2 infections
- At 51% higher risk of COVID-19 mortality
- More likely to be Hispanic and from low-income communities

U.S. Environmental Protection Agency (EPA):

Particulate matter (PM), also known as particle pollution, is a complex mixture of extremely small particles & liquid droplets that get into the air. Once inhaled, these particles can affect the heart & lungs & cause serious health effects.



Particles (PM)



Dylos 1700
Our work horse!

PM_{2.5}: Particulate matter
<2.5 μm in diameter

ROCIS LCMP Dylos:
Particles $> 0.5 \mu\text{m}$
(1/100 of human hair!)

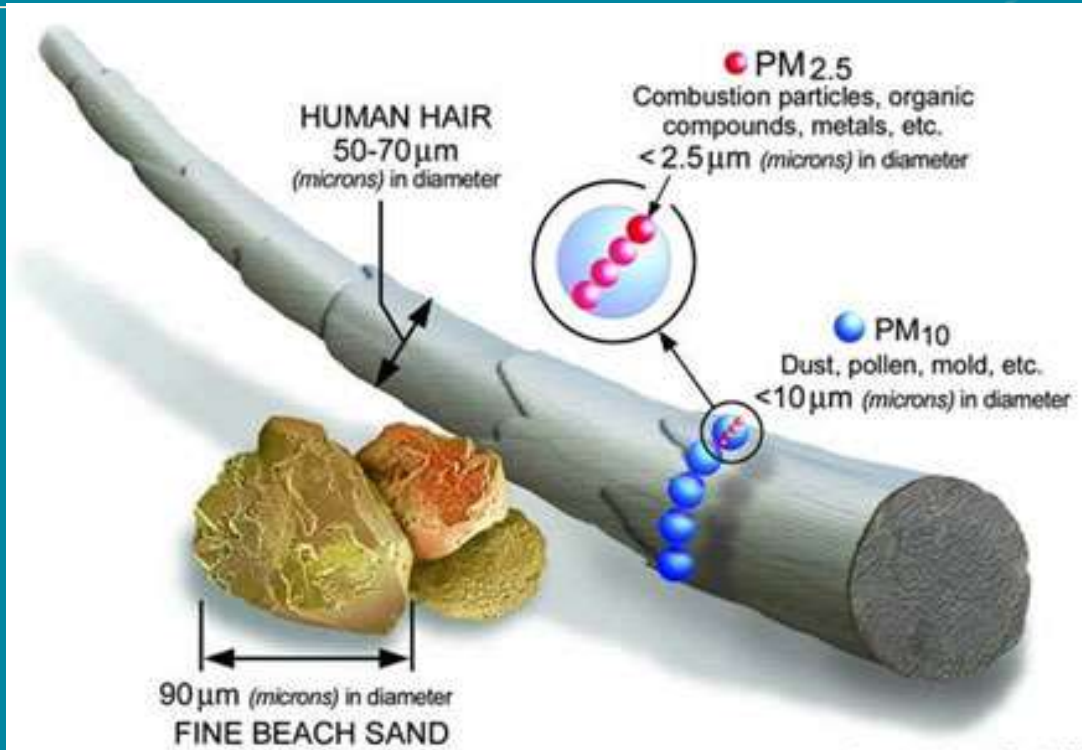
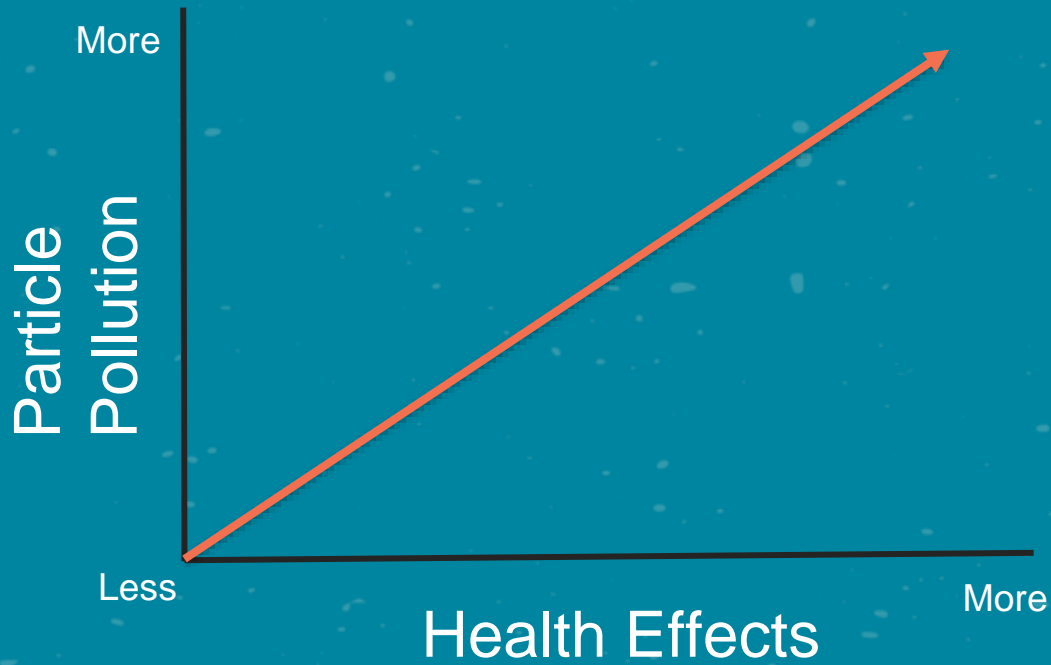


Image courtesy of the U.S. EPA

Health Concerns - Particles



- **Differ in toxicity**
- **Can be adverse synergy with other co-pollutants**
- **Ultrafine particles can be vehicles to increase exposure of toxic contaminants such as SVOCs & metals**
- **Our premise: “Precautionary principle” – avoid or minimize your exposure**



A clear concentration-response relationship between particle pollution & health effects has been established by scientific studies.



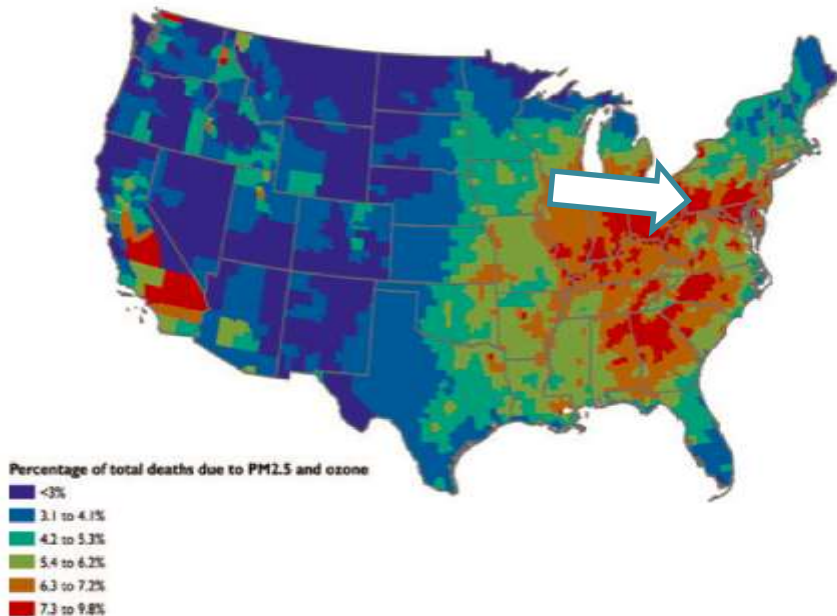
Higher particle concentration is associated with increased impacts to health.

Outdoor Particles (PM) & Human Health

“Our best estimates of the US mortality burden associated with total PM_{2.5} exposure in 2012 range from ~230,000 to ~300,000 deaths.”

Azimi, P., & Stephens, B. (2018). *Journal of exposure science & environmental epidemiology*.

Outdoor particulate matter and human health



Health Concerns - $\text{PM}_{2.5}$



Established PM-associated diseases:
cardiovascular disease, asthma, & lung cancer

Recent associations with PM exposure include:
idiopathic pulmonary fibrosis, type 2 diabetes, Alzheimer's disease, & decreased cognitive function as well as premature birth



ROCIS LCMP

Low Cost Monitoring Project

- Started in 2015
- Mostly homes, some workplaces
- 410 participants

LCMP Objectives

1. **Learn how low-cost monitors empower occupants**
2. **Examine the impacts of outdoor on indoor air**
3. **Explore Interventions to improve indoor air quality**
4. **Support & develop champions!**





LCMP Design

Not a Regulatory Focus

- **Measuring particle count, not mass; 1-min. resolution**
- **Focus on indoor / outdoor comparison**
- **Proof of concept – exploration of interventions**

Making Sense out of Millions of Data Points!

DATA



SORTED



ARRANGED



PRESENTED
VISUALLY



EXPLAINED
WITH A STORY

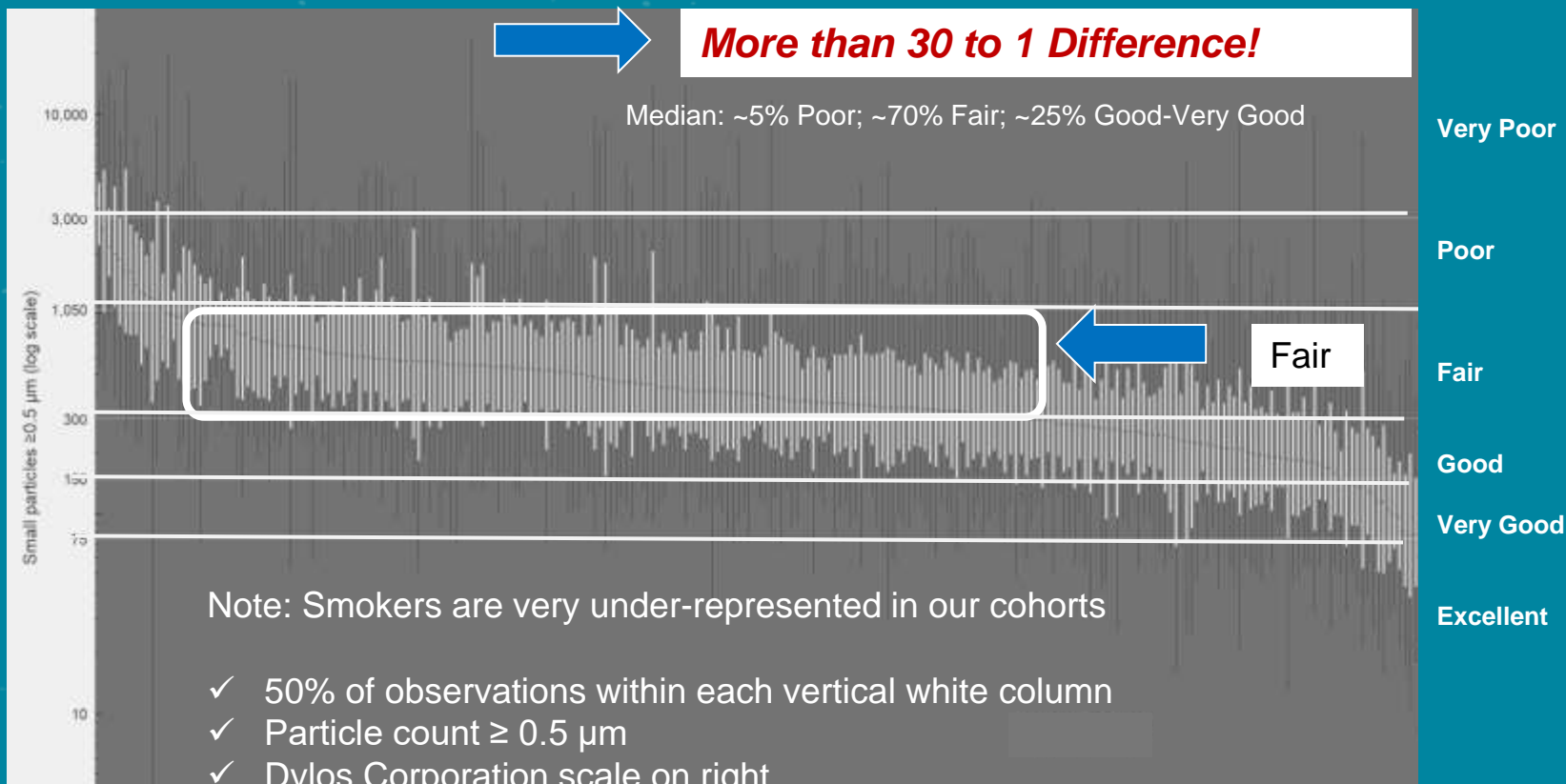


On FaceBook *Andreas von der Heydt*, the VP of Chewy, identified the difference between Raw Data and the Stories Data can tell.

Indoor Particle Distribution

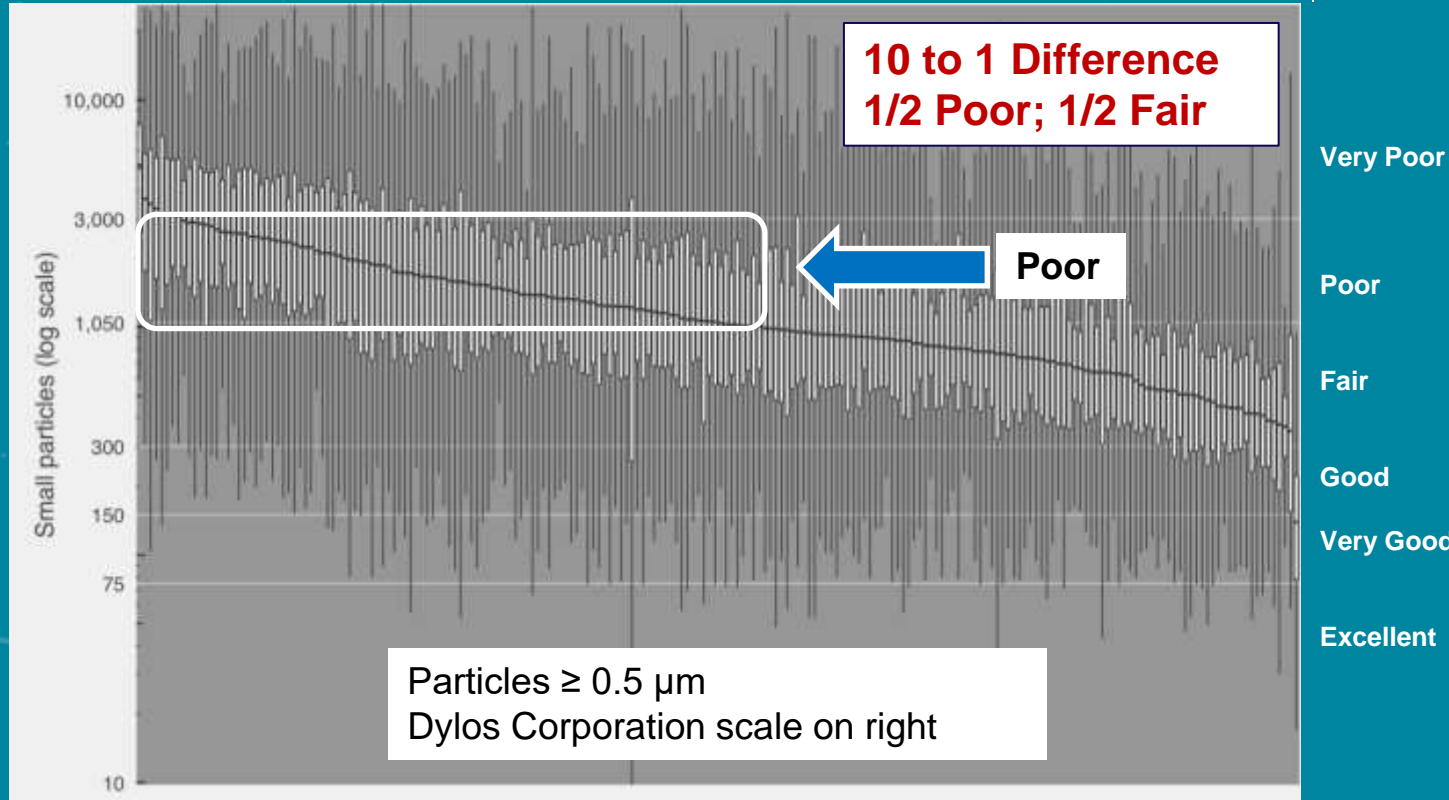


250 LCMP Residential Sites



Outdoor Particle Distribution

All Sites



LCMP Cohorts



- **Participants borrow monitoring equipment to measure:**

- **Particles (0.5+ & 2.5+ μm)**
- **Carbon dioxide (CO_2)**
- **Carbon monoxide (CO)**
- **Radon**
- **Temperature**
- **Relative humidity**



- **During the course of the 4-week cohort, participants:**

- **Learn from the ROCIS team**
- **Benefit from each other's experiences**
- **Receive weekly individualized feedback in response to their data, observations, & questions**



Good Readings ≠ Good Indoor Air Quality

**Know the limitations of our particle monitoring
What we cannot easily monitor could be important!**

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)

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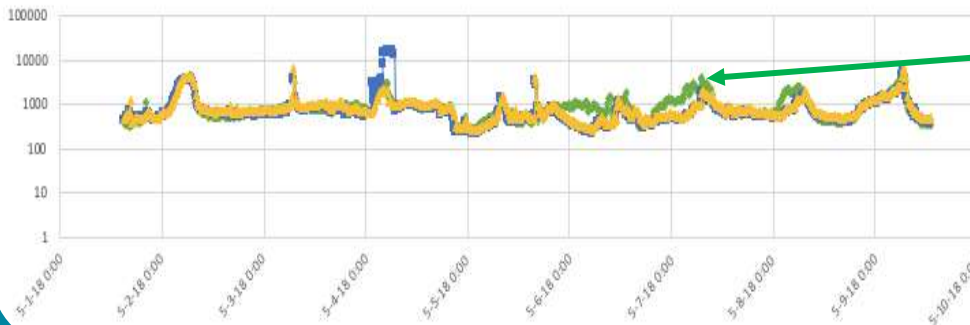
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House with Wide Open Windows

DYLOS SMALL PARTICLES

outside inside living room Roamer kitchen



Outdoor

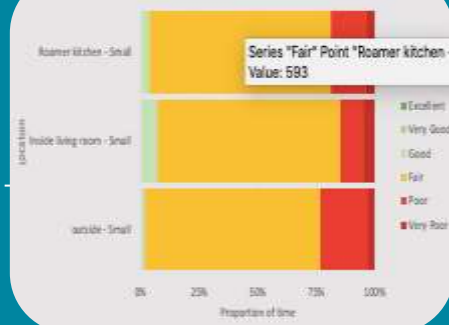
Dylos Large

DYLOS LARGE PARTICLES

outside inside living room Roamer kitchen



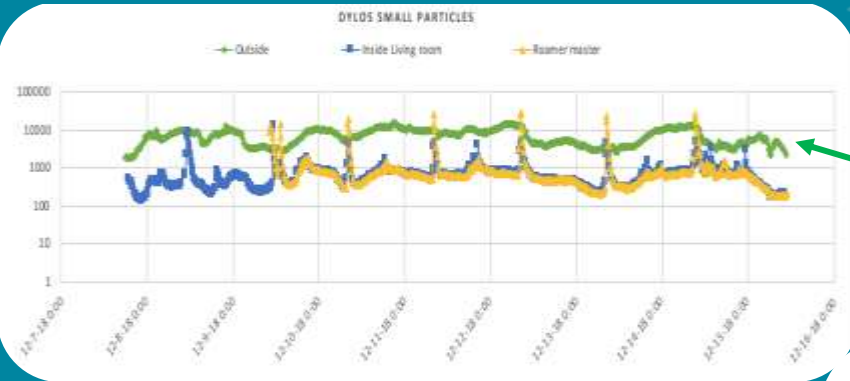
PARTICLE LEVELS IN AND AROUND YOUR HOUSE



Green (O), Blue (I), Yellow (R)

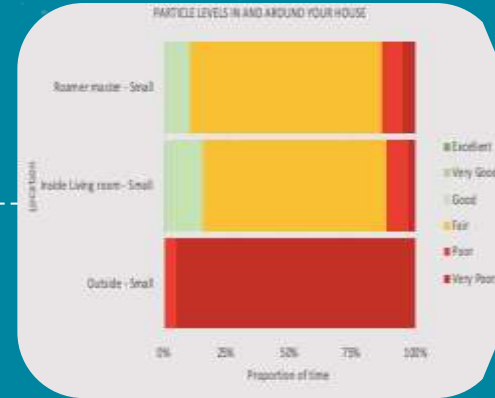
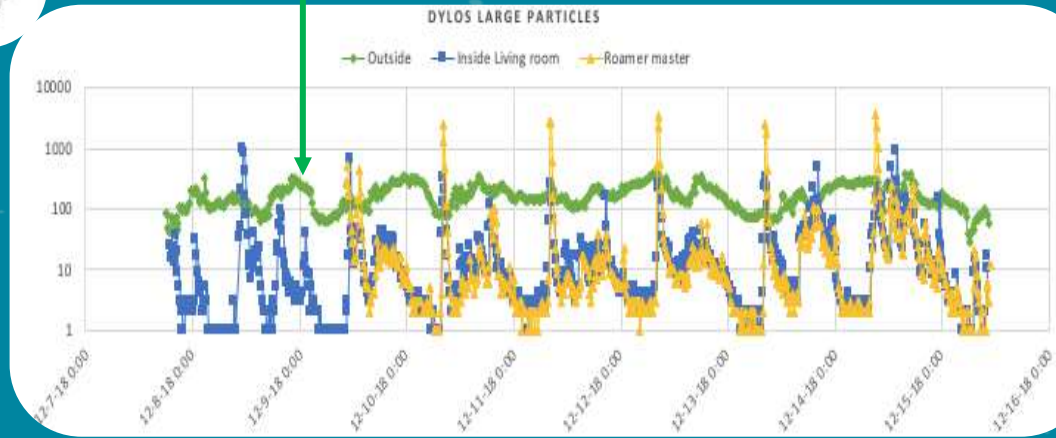
1941 House in Winter with High Outside Particle Counts

Dylos Small



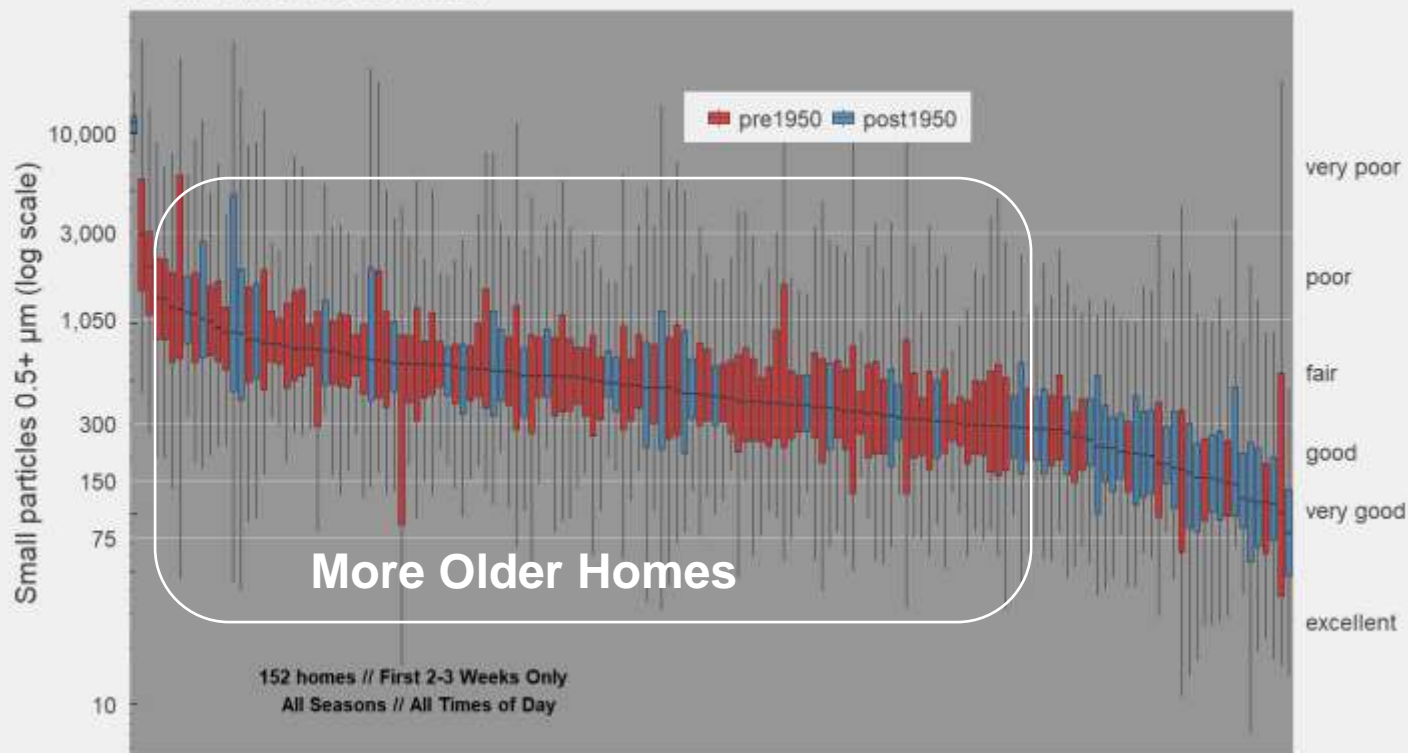
Outdoor

Dylos Large



Was home BUILT PRIOR TO 1950?

Small Particle Levels: Indoor



Check out Current Ambient Air US EPA AirNow

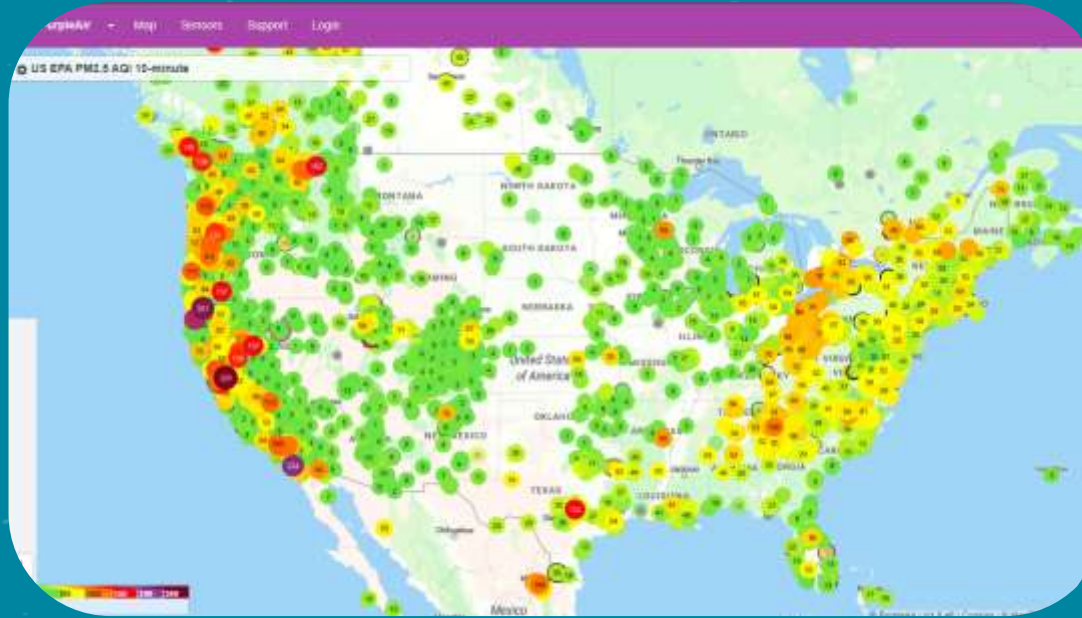
- Current & *projected* air quality
- International, national, or regional in scope
- Animation
- Reports PM 2.5, PM 10, & ozone
- Archive
- Plan to engage Purple Air data base for better local resolution (incorporated now in wildfire/smoke map)



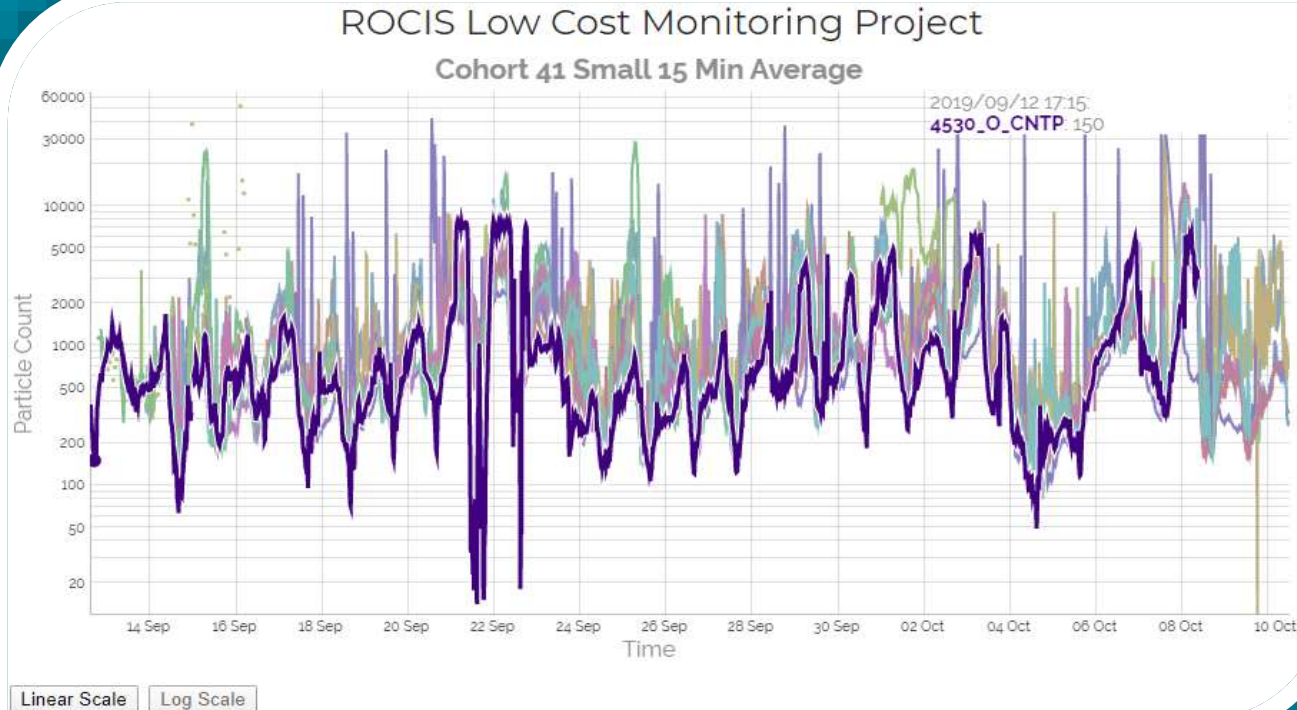
www.airnow.gov

Check out Current Ambient Air PurpleAir Map

- Global monitor network
- Real time & historic
- Reports from individually owned monitors
- Indoor & outdoor data
 - PM, Temperature, RH, VOCs
- Toggleable key



ROCIS Weebly Outdoor Dylos Dygraphs



Different particle patterns in different regions

Shows impact of pollution sources, wind, temperature, regional weather patterns

Note: not corrected for humidity, so some of morning spikes are due to fog.

lcmp-test.weebly.com/

Comments or Questions?

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- **Filter the air**

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Reduce Cooking Emissions

Check out ROCIS guidance document & webpage

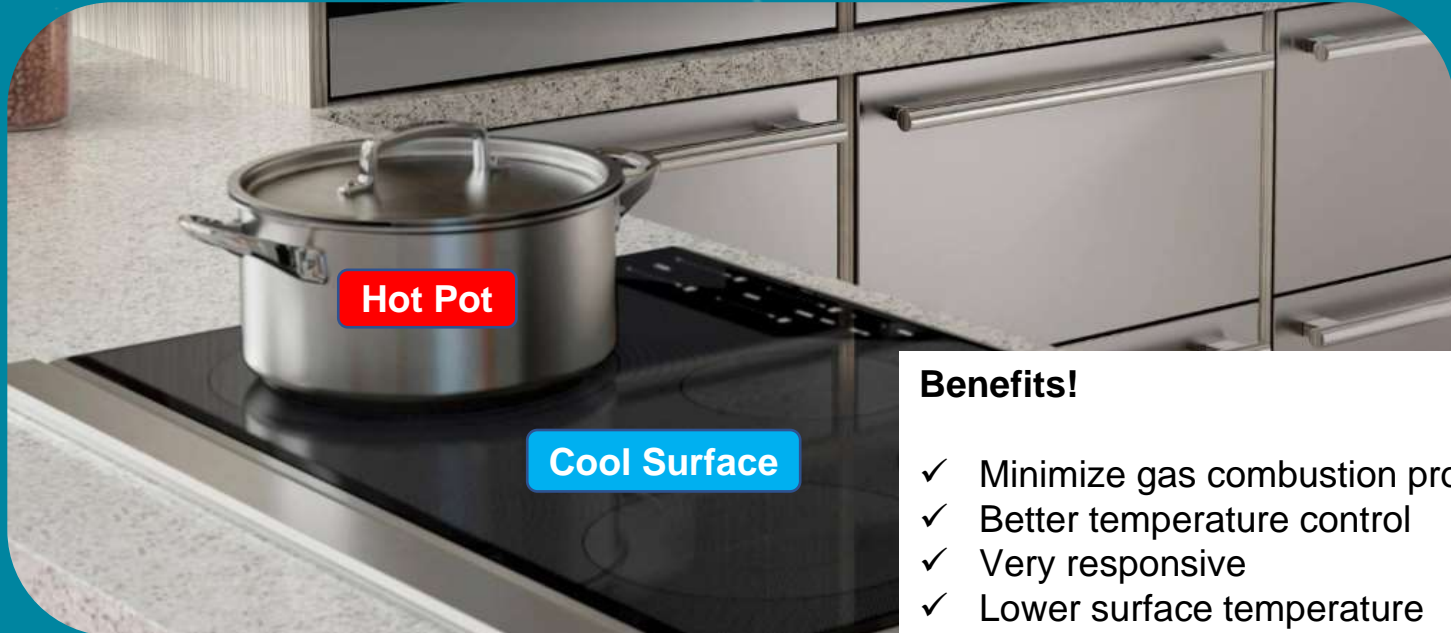
- ROCIS ISSUE BRIEF, *Ducted Range Hoods: Recommendations for New and Existing Homes*

<http://rocis.org/kitchen-range-hoods>

Webinar Recording from 12/2020



Induction Cooktops “Trick the Pot” into Creating its Own Heat



Benefits!

- ✓ Minimize gas combustion products
- ✓ Better temperature control
- ✓ Very responsive
- ✓ Lower surface temperature

More Cooking Considerations!



Particle generation during cooking:

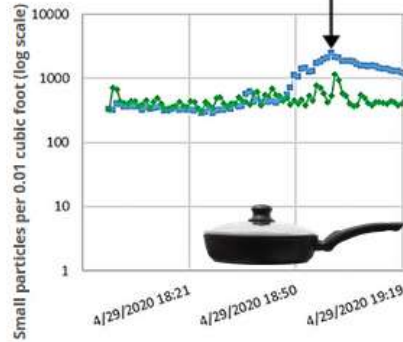
- *Vented* range hood?
- Cooking style (steam vs. fry)
- Use of lids
- Heat: High & fast vs low & slow?
- When to add salt & pepper?
- Various oils vs. butter?



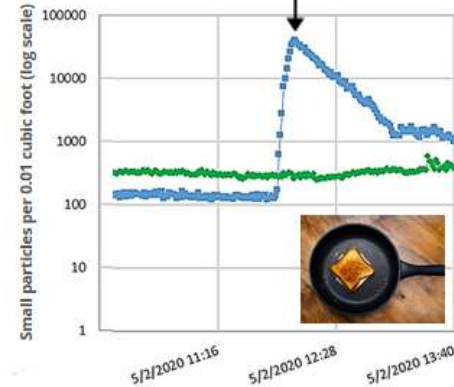
COOKING OIL SMOKE POINT CHART	
KNOWYOURPRODUCE.COM	
450°F+	AVOCADO OIL 520 RICE BRAN OIL 490 ALGAE OIL 485 CLARIFIED BUTTER (GHEE) 485 SOY BEAN OIL 450 PEANUT OIL 450
400°F	SUNFLOWER OIL 440 CORN OIL 440 OLIVE OIL 410 VEGETABLE OIL 400 CANOLA OIL 400 GRAPESEED OIL 392
350°F	LARD 370 VEGETABLE SHORTENING 360 EXTRA VIRGIN OLIVE OIL 350 COCONUT OIL 350 BUTTER 350 SESAME OIL (REFINED) 350
DON'T COOK WITH	
TOASTED OILS AND SOME SEED OILS	
These oils have a very low smoke point, it's best to add these oils once you remove the food from the heat.	

Data, Story, Behavior Change

Indoor particles peaked at 2,500 with a grilled cheese sandwich in a covered pan



Indoor particles peaked at 40,750 with a grilled cheese sandwich in an uncovered pan



"After reflecting on both of these cooking experiences and looking at the data for particle counts, it seems that covering the cooking surface may make a bigger difference in keeping particles from escaping into the indoor environment than some of the other actions. I recognize the importance of these behavior changes more than before and will consciously try to use them moving forward." - ROCIS participant Sara

Other Indoor-Generated Sources



Here's what we have seen:

- Humidifier using tap water (when distilled water is recommended)
- Cleaning products
- Recreational combustion
 - Cigarettes, vaping...
 - Candles, incense, diffusers



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- **Filter the air**

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***Why Indoor Chemistry Matters* report**

Why Indoor Chemistry Matters is available to download for free from the National Academies Press website. The consensus study, commissioned by EPA, the Alfred P. Sloan Foundation, CDC, and NIEHS, considers the state-of-the science regarding chemicals in indoor air and how indoor chemistry findings fit into context of what is already known about the link between chemical exposure, air quality, and human health.

4 Page Summary Report

https://nap.nationalacademies.org/resource/26228/Indoor_Chemistry_Report_Highlights.pdf

Implications for Practitioners: Episode 662 (Part 1) iaqradio.com

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)

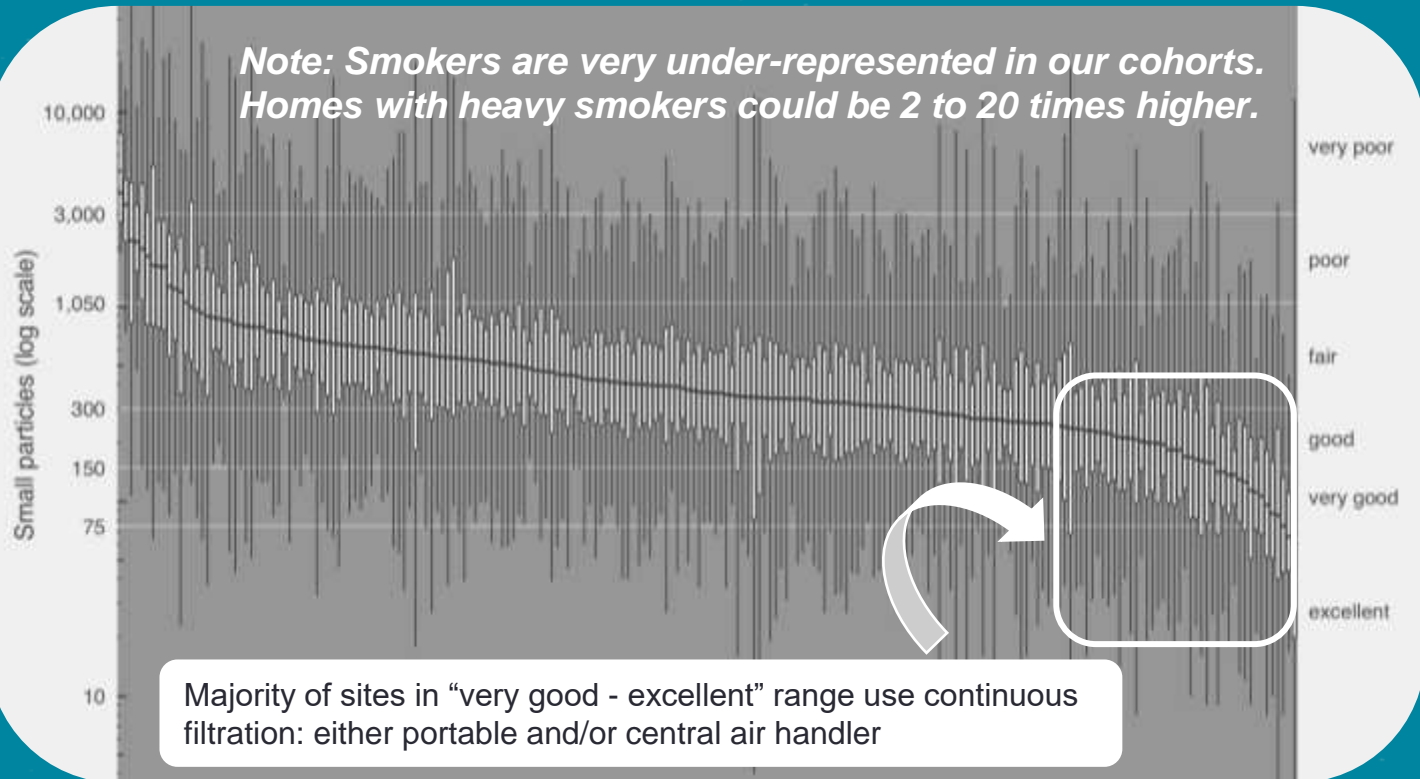
What was the original source?

Emissions from 50 years ago?
Residue from remodeling?
Particles from open windows?
Tracked in lead dust?

Comments or Questions?

Indoor Particle Distribution: All Sites

*Note: Smokers are very under-represented in our cohorts.
Homes with heavy smokers could be 2 to 20 times higher.*



More than 30 to 1
difference!
Median:
~70% Fair
~25% Good / Very
Good

50% of observations are within
each vertical box
Particles $0.5+ \mu\text{m}$ (Dylos small)
Dylos Corporation scale on right

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“... 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 only
works when
it is ON!**

YOU ONLY
GET OUT
WHAT YOU
PUT IN

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
 - Promises to “Kill”? Do not buy/use

Impact of Portable Air Cleaner

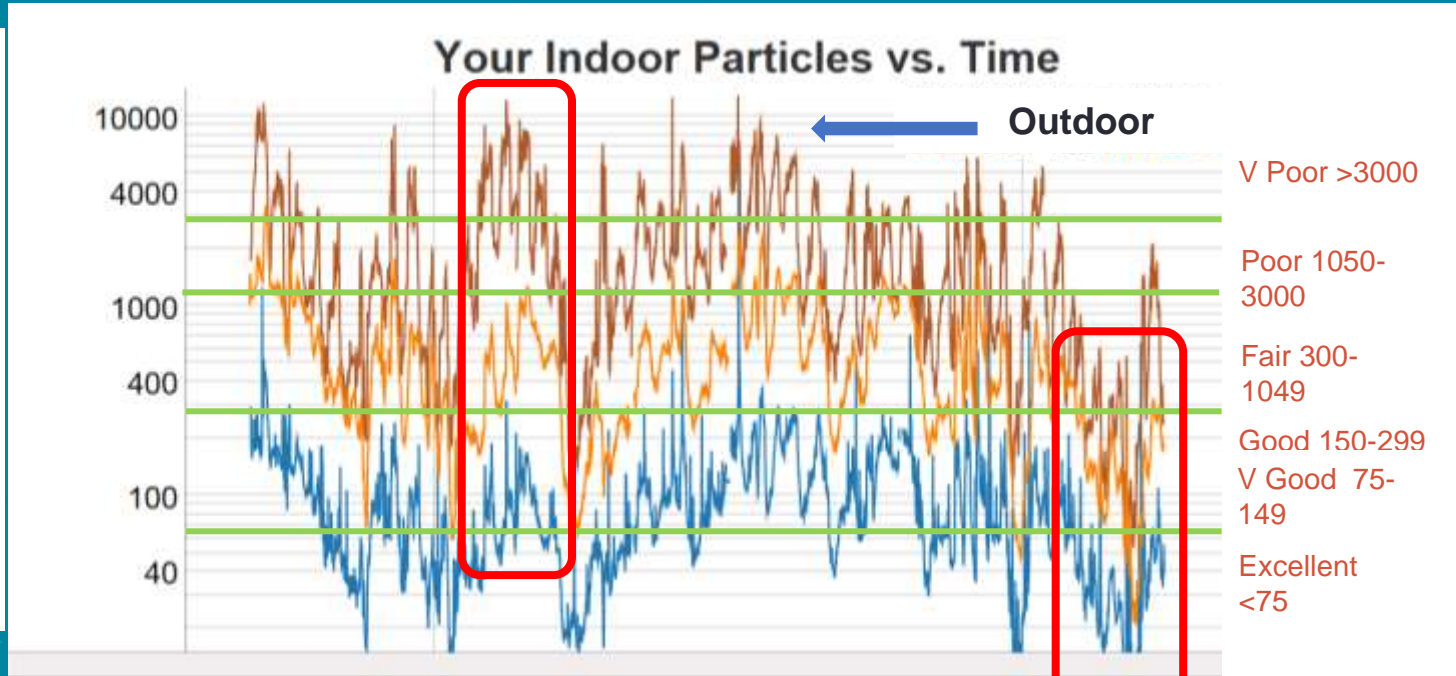
[http://rocis.org/rocis-data-explorer \(j1t8\)](http://rocis.org/rocis-data-explorer (j1t8))
0.5+ μm Particles by Time (15-min. avg.)



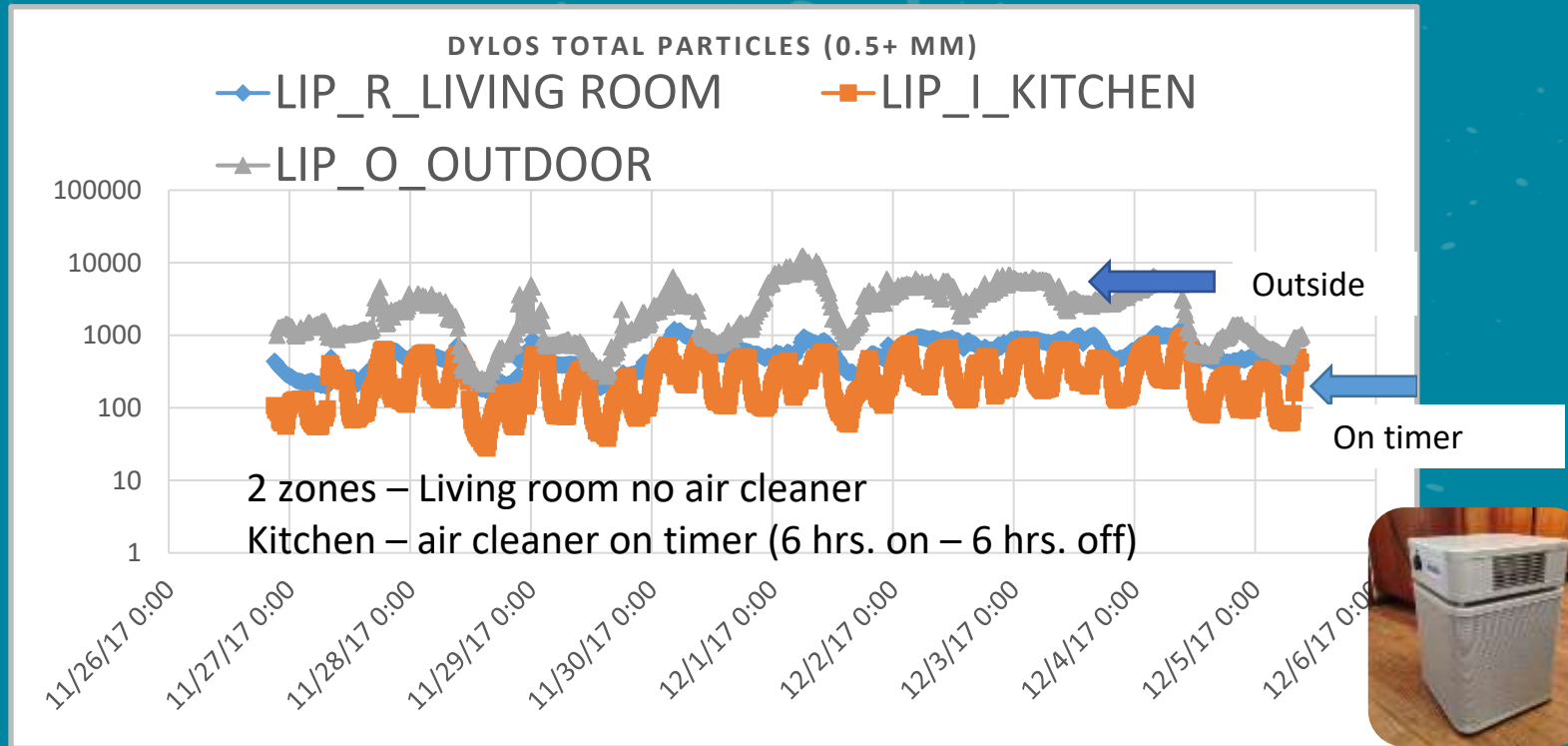
Brown: outdoors
Orange: untreated zone
Blue: treated zone with
24/7 air cleaner

Tight, single-family
home

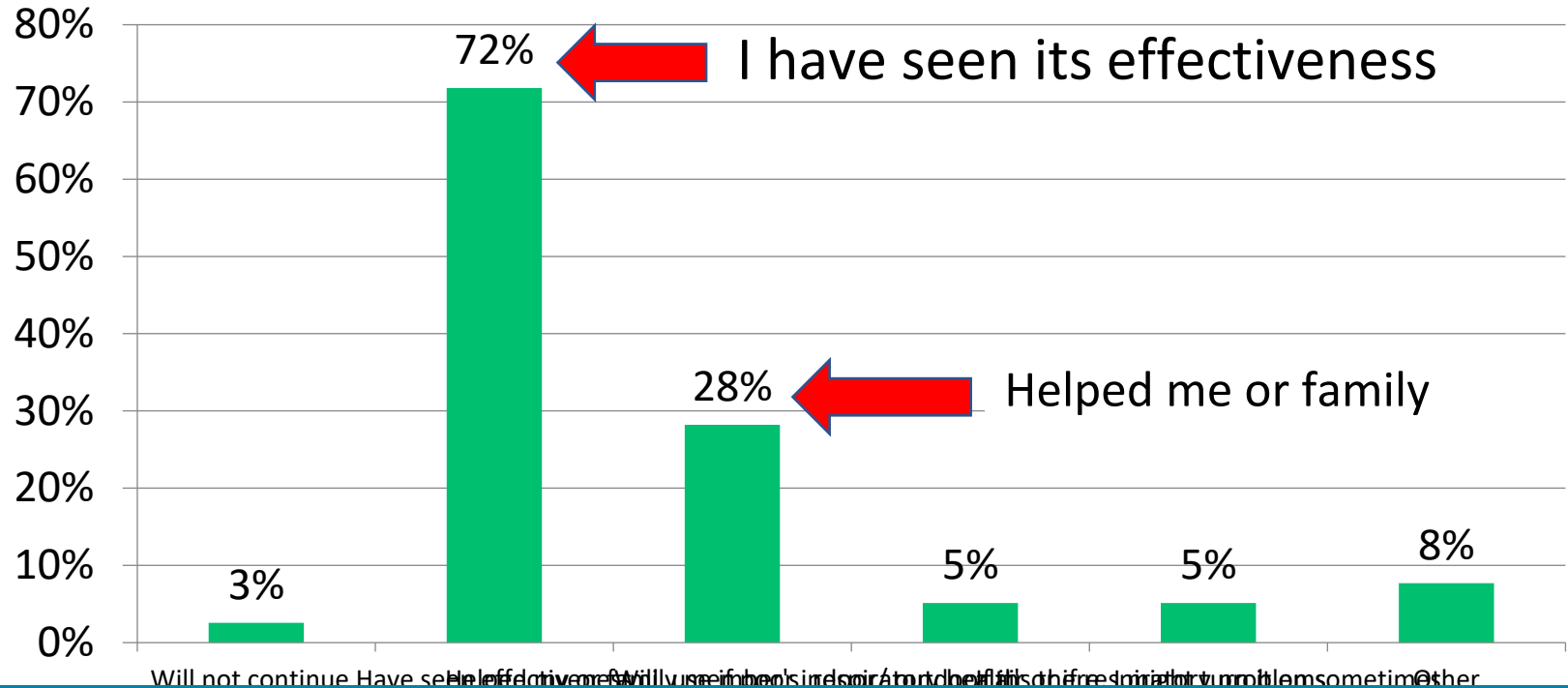
Though order of
magnitude lower,
Indoor (Blue/orange)
tracks Outdoor (brown)



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



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



Clairton Air Filter Distribution Program

**Summer 2020
(Pilot)**



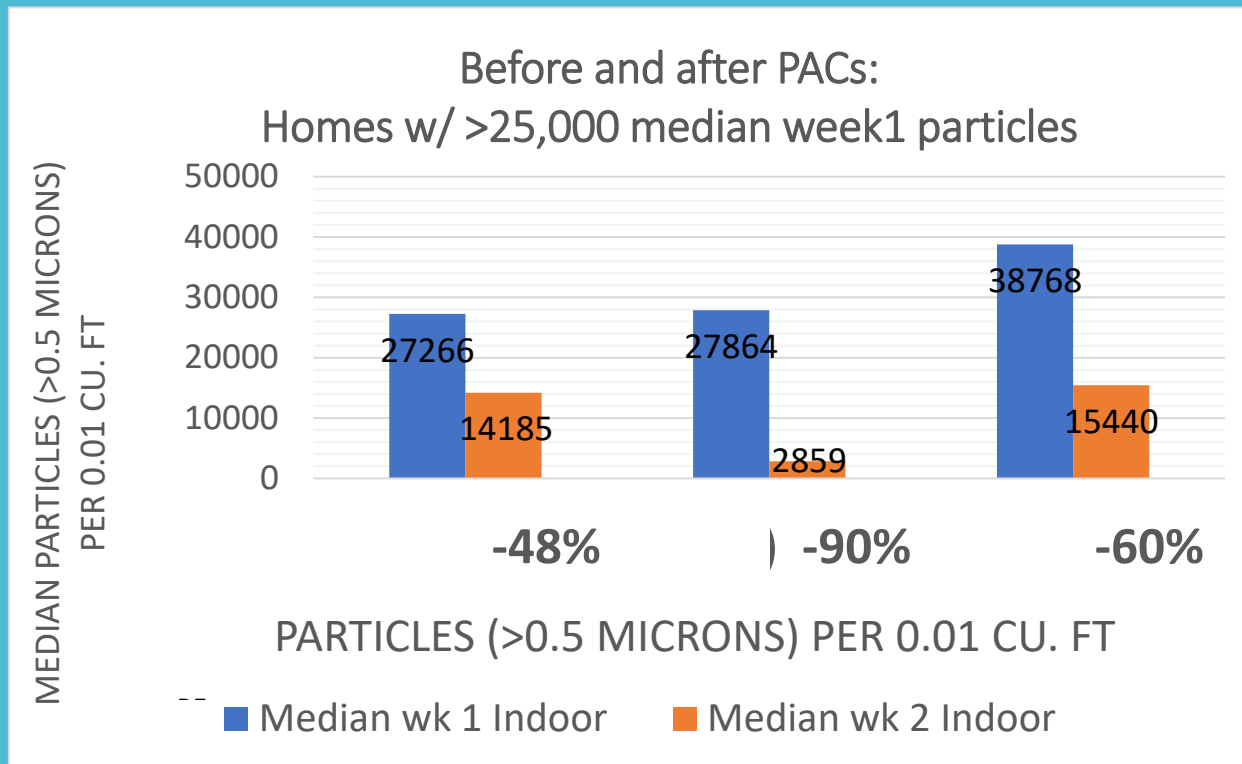
- Funded by The Heinz Endowments
- Filtration Goal: To treat all regularly occupied spaces
 - Pre & post particle monitoring over 3 weeks
 - Weekly contact for feedback
- Results
 - 47 households served
 - 153 portable air cleaners (3.25/home)
 - \$870 - Average total PAC cost per home
 - Portable Air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

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

THE HEINZ
ENDOWMENTS

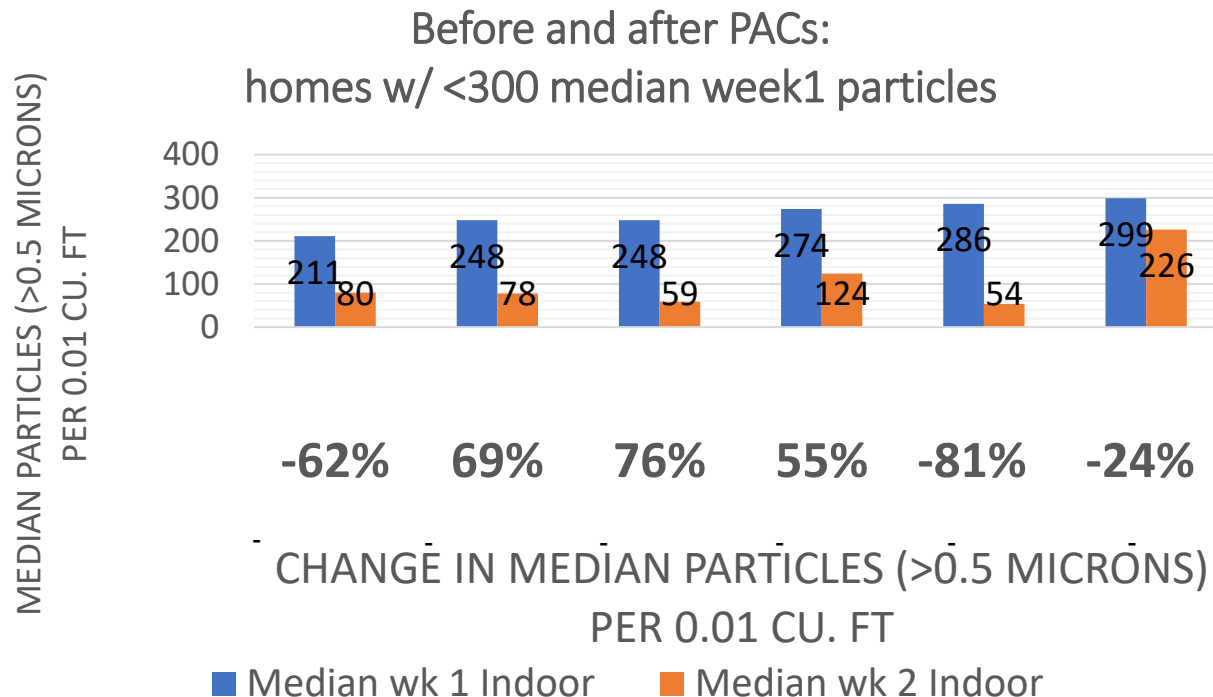
Reductions:

3 Homes with Very High Pre-Particles



Reductions:

Homes with Lowest Pre-Particle Counts



Importance of Feedback & Behavior (Particle Reductions)

- 1) Strategies: How to Keep Air Cleaners on
- 2) New Equipment Features Offered (not recommended yet):
 - 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!***

May 2021

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

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.”
- Jan. 29, 2021 <https://www.iagrado.com/jeffrey-siegel-ph-d-covid-19-risk-mitigation-a-researchers-perspective/>
- *“Siegel said a good air purifier can also help clear out coronavirus particles and reduce the air's viral load.”*

Fan/Filter Intervention: Low Cost, MERV 13

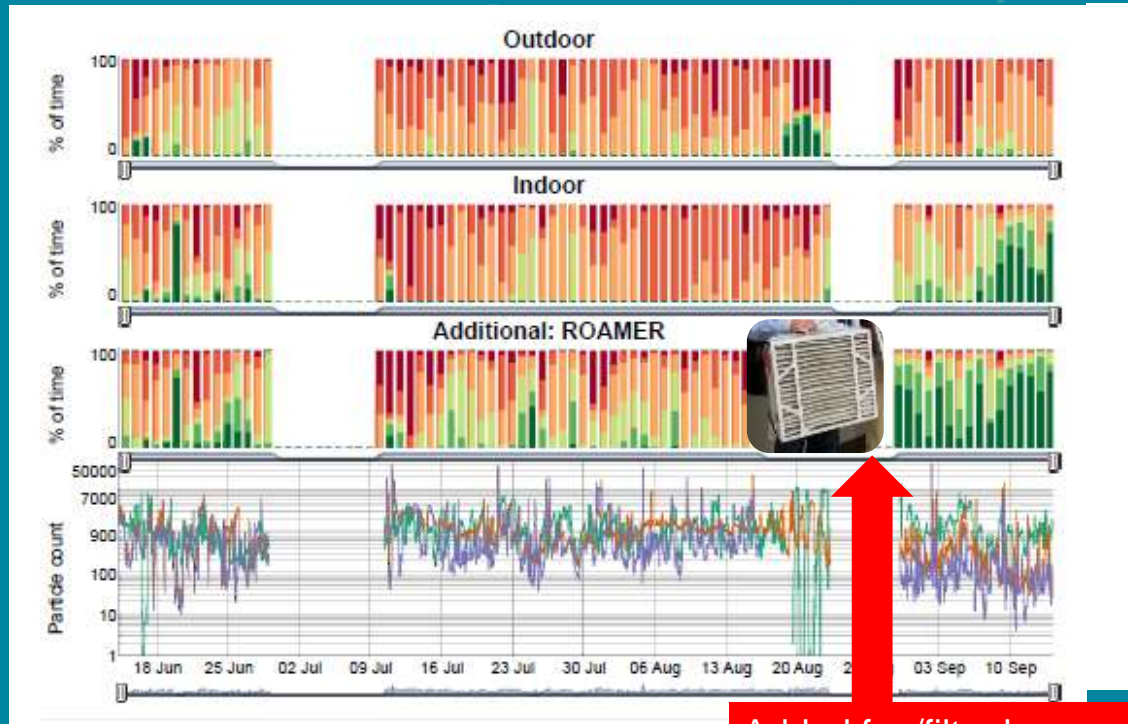
4" MERV 13 filter (\$45) on
20" x 20" box fan (~\$20)

Box fan in room or in window

UL-rated fan with overheat
protection (newer than 2012)



Indoor Fan/Filter 24/7 Impact



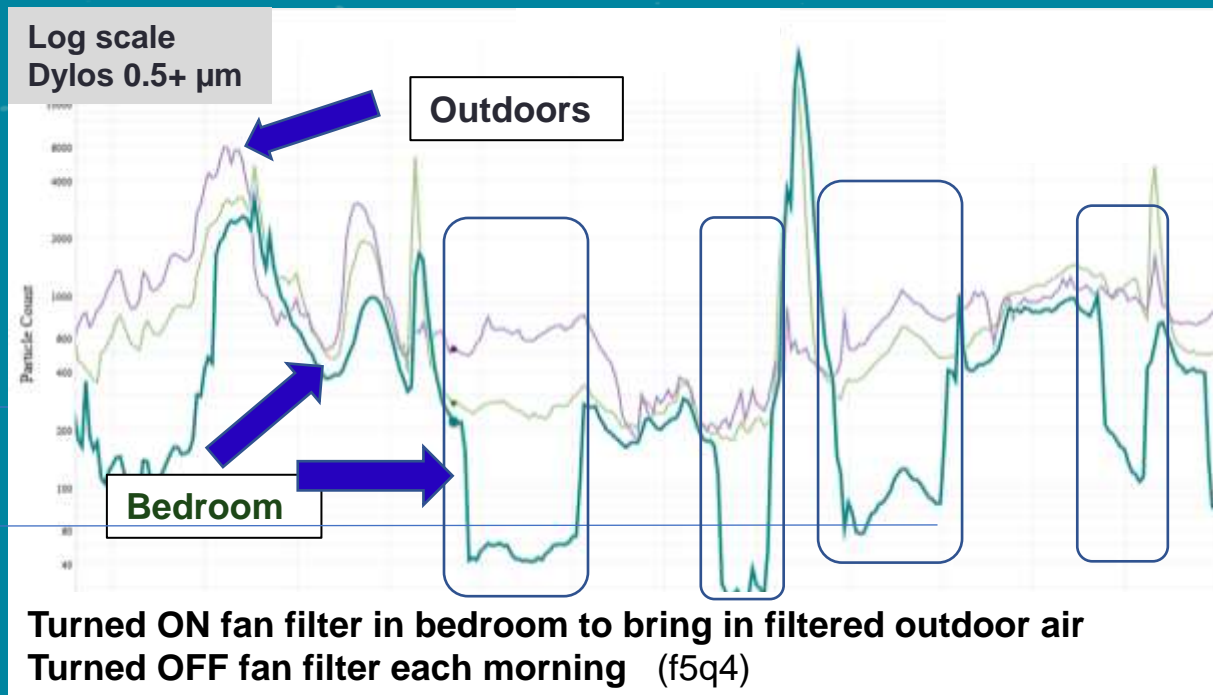
Added fan/filter here

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

Fan/Filter Intervention— Bedroom Window at Night



Open window
without fan/filter on:
Indoor tracks
outdoor closely



Research on DIY Air Cleaners to Reduce Wildfire Smoke Indoors

On this page:

- [Study Overview](#)
- [UL Safety Report Findings](#)
- [Frequently Asked Questions](#)
- [DIY Air Cleaner to Reduce Wildfire Smoke Indoors Infographic](#)
- [Related Resources, Presentations, and References](#)

Study Overview

Everyone deserves access to clean indoor air during wildfire smoke events. But commercial air cleaners can be difficult to obtain when there are smoky conditions from wildfires because of limited availability or high cost. Many health and air quality agencies and nonprofits are providing instructions and parts for making Do-it-Yourself (DIY) air cleaners as a solution to reducing smoke indoors. DIY air cleaners are made by attaching an air filter to a box fan with tape, brackets or a bungee cord. With their use, concerns have been raised about the potential for the box fans to overheat when operated with a filter attached, which could pose a fire or burn risk.

At this time, there is minimal information on how effective DIY air cleaners are at removing smoke particles. Limited data published in the scientific literature, preliminary testing results from EPA and several anecdotal reports from state, local, and tribal agencies suggest these DIY air cleaners may help reduce exposure to the particles in smoke.

EPA is conducting research to evaluate DIY air cleaners to answer questions from EPA partners and the public about their effectiveness and safety. The research is part of a multi-faceted study called the Wildfire Advancing Science Partnerships for Indoor Reductions of Smoke Exposures (ASPIRE) Study. The objectives of the Wildfire - ASPIRE Study are to compare indoor and outdoor fine particulate matter ($PM_{2.5}$) concentrations, a main component of wildfire smoke, and to develop strategies for reducing indoor pollutant concentrations in public buildings during wildland fire smoke events.



EPA researcher, Heidi Vreeland, testing a DIY air cleaner.

<https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors>

Slide Credit:
Allison A. Bailes III

- "Preliminary results show that throughout the testing, temperatures of all fan components remained safely below recognized temperature safety standards. **None of the scenarios tested posed any observable fire hazards.**"

**Slide Credit:
Allison A. Bailes III**

Corsi–Rosenthal Box

From Wikipedia, the free encyclopedia

The **Corsi–Rosenthal Box**, also called a **Corsi–Rosenthal Cube** or a **Comparetto Cube**, is a design for a [do-it-yourself air purifier](#) that can be built comparatively inexpensively. It was designed during the [COVID-19 pandemic](#) with the goal of reducing the levels of [airborne viral particles](#) in indoor settings.

Contents [hide]

- [Background and history](#)
- [Design](#)
- [Efficacy](#)
- [References](#)

Background and history [edit]

Since [COVID-19](#) was declared a [pandemic](#) by the [World Health Organization](#) on 11 March 2020,^[1] evidence, including increasing amounts of [peer-reviewed](#) research, has been accumulating that [severe acute respiratory syndrome coronavirus 2](#) (SARS-CoV-2), the virus causing COVID-19, [is airborne](#).^{[2][3][4]} [Superspreading events](#) are generally associated with indoor gatherings.^{[5][6]} In response to the emerging evidence and recommendations of infectious disease researchers,^{[7][8]} engineers have begun to consider how improved ventilation may reduce indoor [viral loads](#).^[9]



An example of a homemade Corsi–Rosenthal Box air filtration unit

Slide Credit:
Allison A. Bailes III

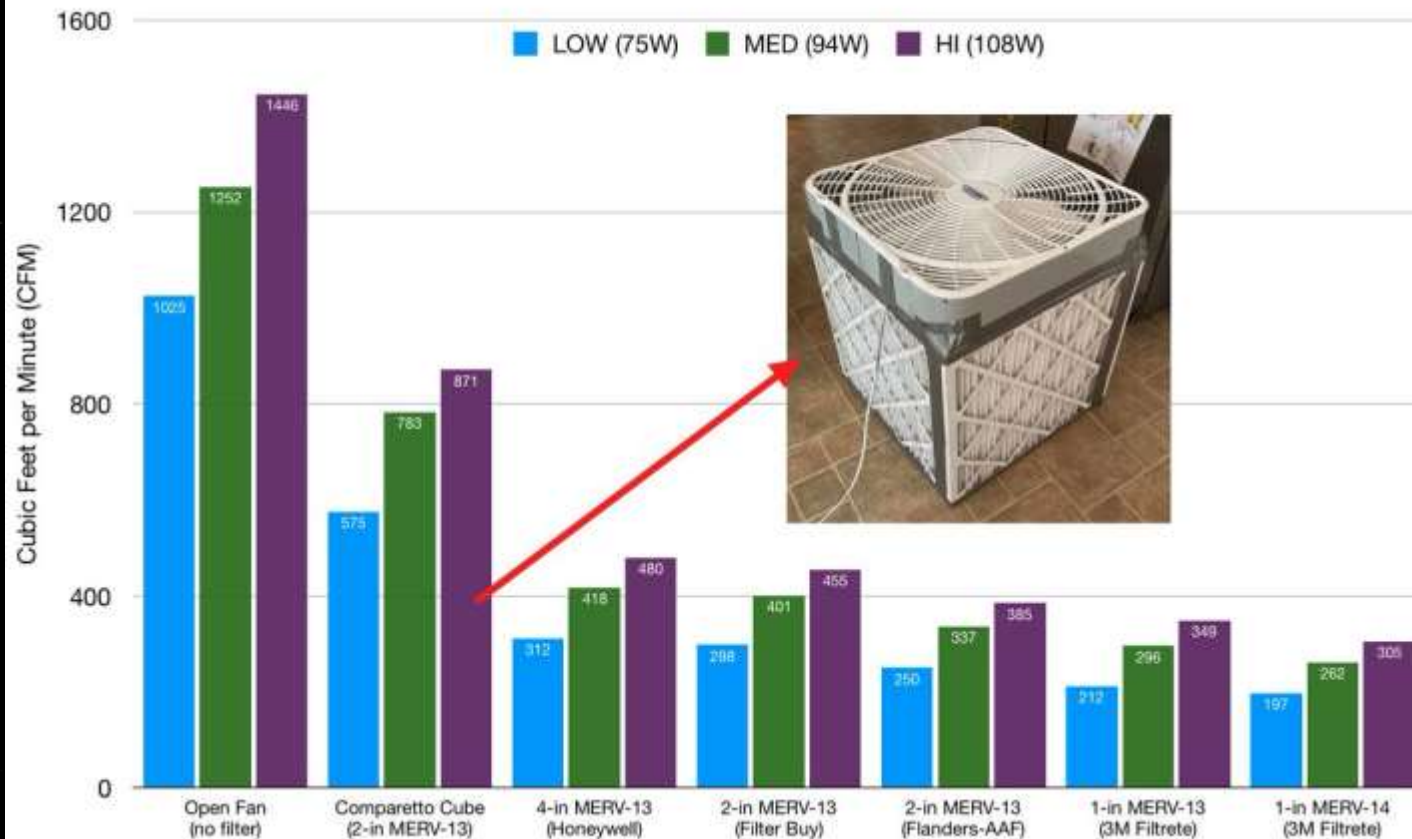


Slide Credit:
Allison A. Bailes III
Images from Jim
Rosenthal



Slide Credit:
Allison A. Bailes III

BOX FAN FILTER TESTING - OCTOBER 2020



Slide Credit:
Allison A. Bailes III



TECHNICAL NOTE



OPEN ACCESS



Characterizing the performance of a do-it-yourself (DIY) box fan air filter

Rachael Dal Porto^a, Monet N. Kunz^a, Theresa Pistochini^{a,b}, Richard L. Corsi^{a,c}, and Christopher D. Cappa^a 

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ABSTRACT

Air filtration serves to reduce concentrations of particles in indoor environments. Most standalone, also referred to as portable or in-room, air filtration systems use HEPA filters, and cost generally scales with the clean air delivery rate. A “do-it-yourself” lower-cost alternative, known as the Corsi-Rosenthal Box, that uses MERV-13 filters coupled with a box fan has been recently proposed, but lacks systematic performance characterization. We have characterized the performance of a five-panel Corsi-Rosenthal air cleaner using both research-grade instrumentation (an aerodynamic particle sizer, APS) and a low-cost particle sensor. Measurements of size-resolved and overall decay rates of aerosol particles larger than 0.5 microns emitted into rooms of varying size with and without the air cleaner allowed for determination of the apparent clean air delivery rate—both as a function of size and integrated across particle sizes for a number-weighted median particle diameter of 1.2 ± 0.12 microns. The measurements made in the different rooms produced similar results, demonstrating the robustness of the method used. The size-integrated effective clean air delivery rate increases with fan speed, from about 600 to $850 \text{ ft}^3 \text{ min}^{-1}$ (1019 to $1444 \text{ m}^3 \text{ h}^{-1}$) as determined with the APS. The low-cost sensor yields similar clean air delivery rates as the APS, demonstrating a method by which others who lack access to research-grade instruments can determine the effectiveness of Corsi-Rosenthal Boxes that use components that differ from those used here. Overall, our results demonstrate that our Corsi-Rosenthal air cleaner efficiently reduces suspended particle concentrations in indoor environments.

ARTICLE HISTORY

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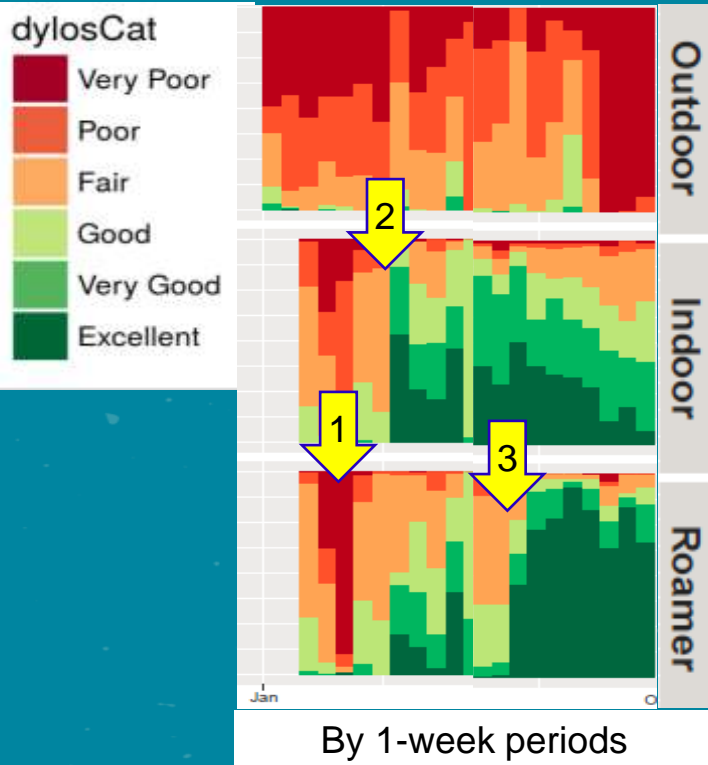
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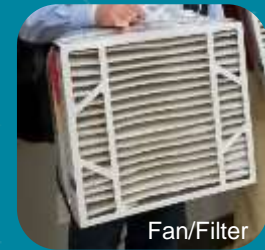
Slide Credit:
Allison A. Bailes III

Behavior *Plus* Technical Intervention Motivated Occupant



2-burner Induction Stove Top (h9j2 example 2)

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



Interventions:

1. Change use of humidifier
2. Add induction stove top & use fan filter (living room)
3. Add fan filter (bedroom)

Comments or Questions?

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



Reducing Outdoor Contaminant
in Indoor Spaces

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Wh

[Low Cost Monitoring Project](#)[Air Handler Inquiry](#)[Clairton Air Filter Project](#)

ROCIS Mission

Reduce the impact of exterior environmental pollution in southwestern Pennsylvania to improve healthy and energy efficient indoor enviro

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

1st Air Handler Retrofit

Pre



Post



Replaced
PSC motor
w/ ECM
motor

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

CASE STUDY: Indoor Air Quality Interventions
Chris Guignon, evolveEA

Big Opportunity - 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?

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

More on Air Handler Interventiions

- Today! 2:45 to 3:45

In Conclusion

Integrated solutions are needed to enhance health, resilience, energy efficiency, comfort, & durability

Improve outdoor air quality!

Develop champions!

The most effective monitor is a motivated, knowledgeable occupant!

Thanks!

**Thanks to Phil Johnson & The Heinz Endowments for
support of the ROCIS initiative
(Reducing Outdoor Contaminants in Indoor Spaces)
and our 410 LCMP participants**

This presentation: <http://rocis.org/past-rocis-events>

Upcoming Cohort (sign up for intro session)

<http://ROCIS.org> (limited slots for out of region participants)

Access to resources & research results

- LCMP <http://rocis.org/rocis-low-cost-monitoring-project>
- ROCIS Brief - Ducted Range Hood
<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



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