



# Social Justice and Environmental Quality in Denver (SJEQ-D):

Optimization of a Do-It-Yourself Air Cleaner Design to Reduce Residential Air Pollution Exposure for a Community Experiencing Environmental Injustices

**SAM** (Sumit) Sankhyan, Nicholas Clements, Allison Heckman, Aniya K. Hollo, Dulce Gonzalez-Beltran, Jonathan Aumann, Cora Morency, Luke Leiden, Shelly Miller

AAAR 2023 Conference  
Portland, OR  
October 6<sup>th</sup>, 2023  
11AE Aerosol Exposure II



**American Association  
for Aerosol Research**



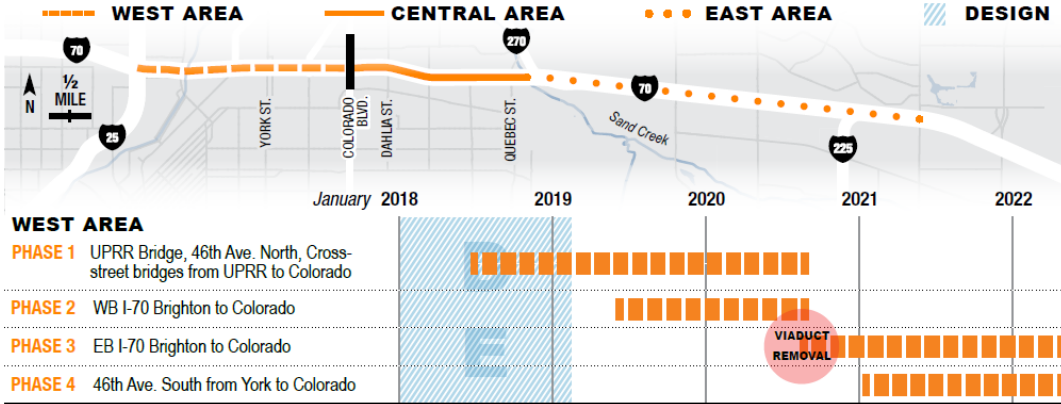
University of Colorado  
Boulder

# Motivation



## Central I-70 Project

### Expected Construction Phasing

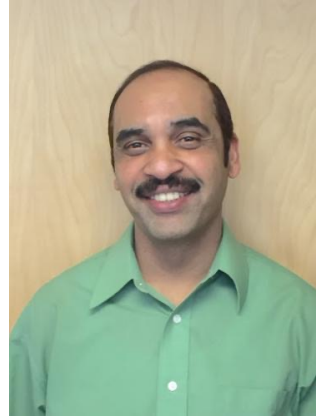


# SJEQ-D Study Team



## **Environmental Engineering** ***CU Boulder***

PI: Prof. Shelly Miller  
Dr. Nicholas Clements  
Dr. Sam (Sumit) Sankhyan  
Aniya Khalili  
Allison Heckman  
Dulce Gonzalez-Beltran  
Sophie Castillo  
Dr. Sergio Ibarra-Espinosa



## **Technology** ***CU Boulder***

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Omar Hammad  
Gopala Kanugo  
Rezwan Rahman  
Jacob McKinney

## **NSF Evaluator** ***CU Boulder***

Dr. Daniel Knight



## **Social Science** ***CU Denver***

PI: Prof. Esther Sullivan  
Prof. Marisa Westbrook  
Valentina Serrano-Salomon  
Jose Puente Puente  
La-Doniea Nisbeth  
Noemy Perez  
Jay Pecenka  
Emily Evans

# SJEQ-D Study Collaborators

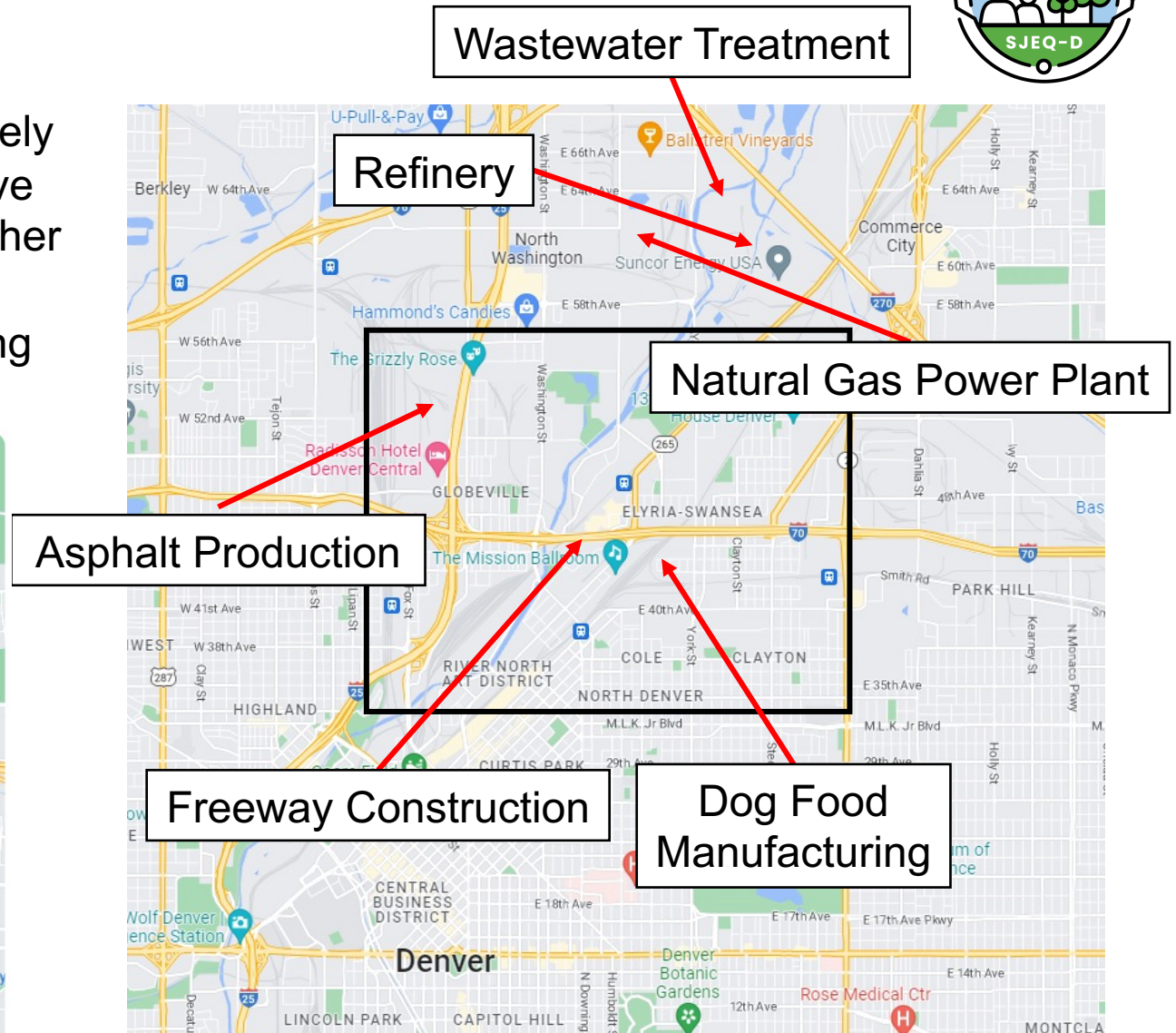
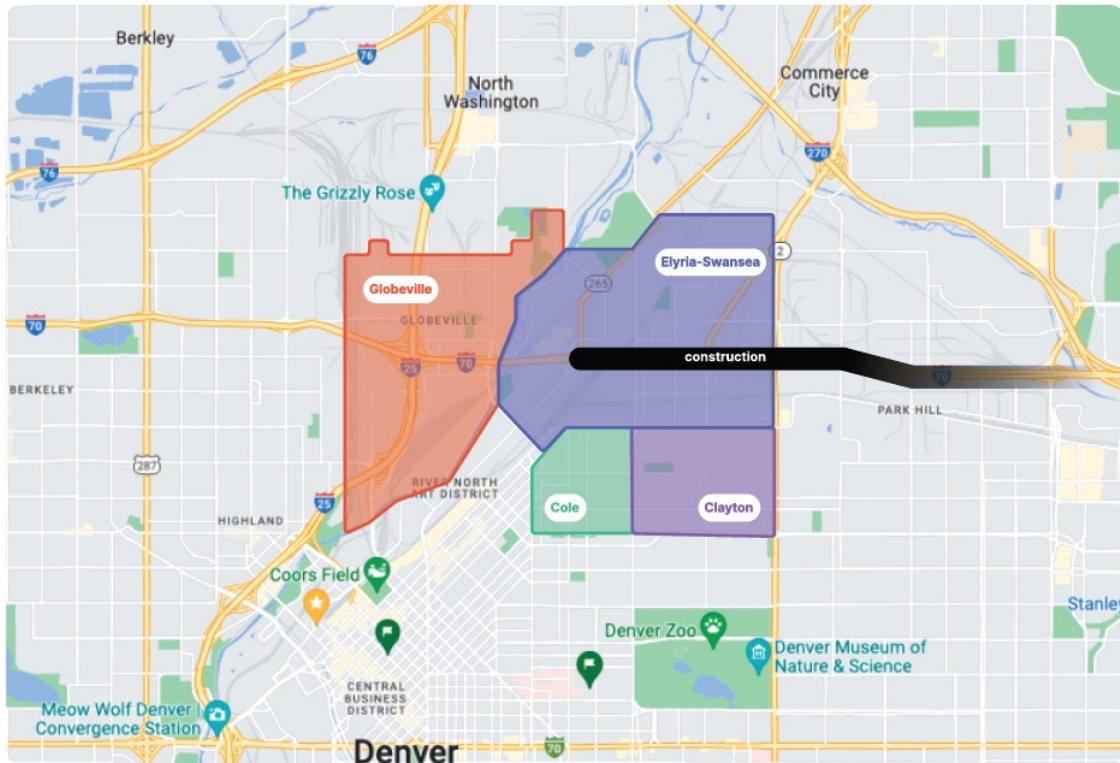


## External Outreach and Collaboration

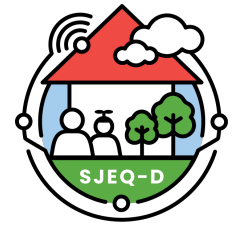
- **Groundwork Denver**
  - Cindy Chang
  - Erika Delzell
  - Rey Gallegos
- Green Latinos
- Growhaus
- Cultivando
- Compost Colorado
- GES Coalition
- Swansea Elementary
- Garden Place Elementary
- DSST Cole School
- Valdez-Perry Library
- Denver DPHE
- Colorado DPHE
- CDOT
- Denver City Council, D9
- CO School of Public Health
- CSU
- Birdseed Collective
- Energy Outreach CO
- CREA Results
- EGS & Partners

# Motivation

- North Denver Communities of **Globeville, Elyria-Swansea, Cole, and Clayton** are disproportionately impacted by industrial and traffic pollution and have elevated asthma and COPD rates compared to other regions in Colorado
- Construction in the area (I-70) exacerbates existing environmental injustices

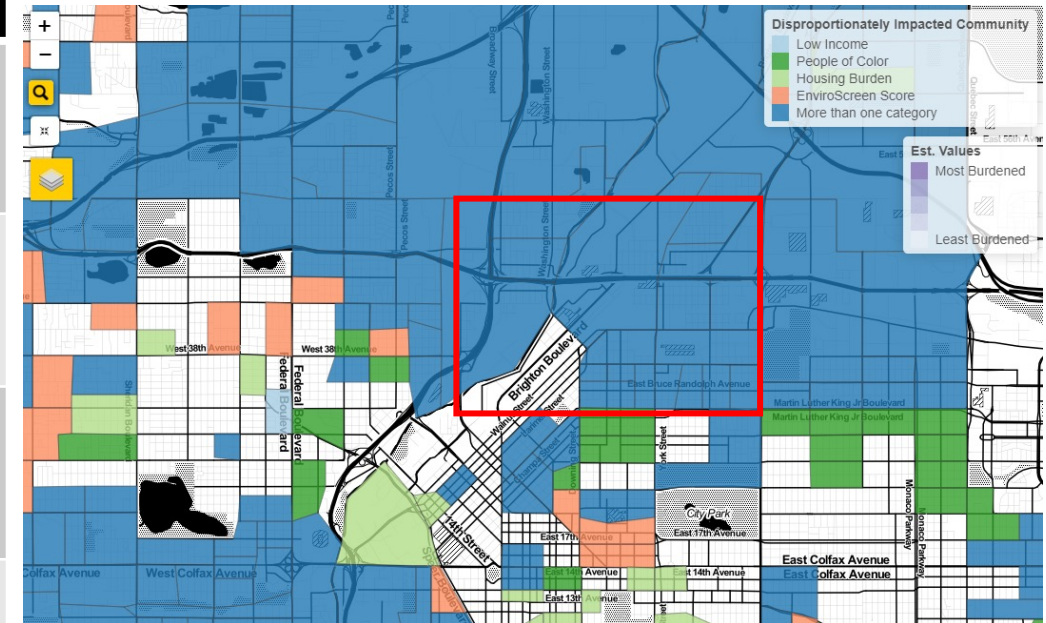


# Motivation



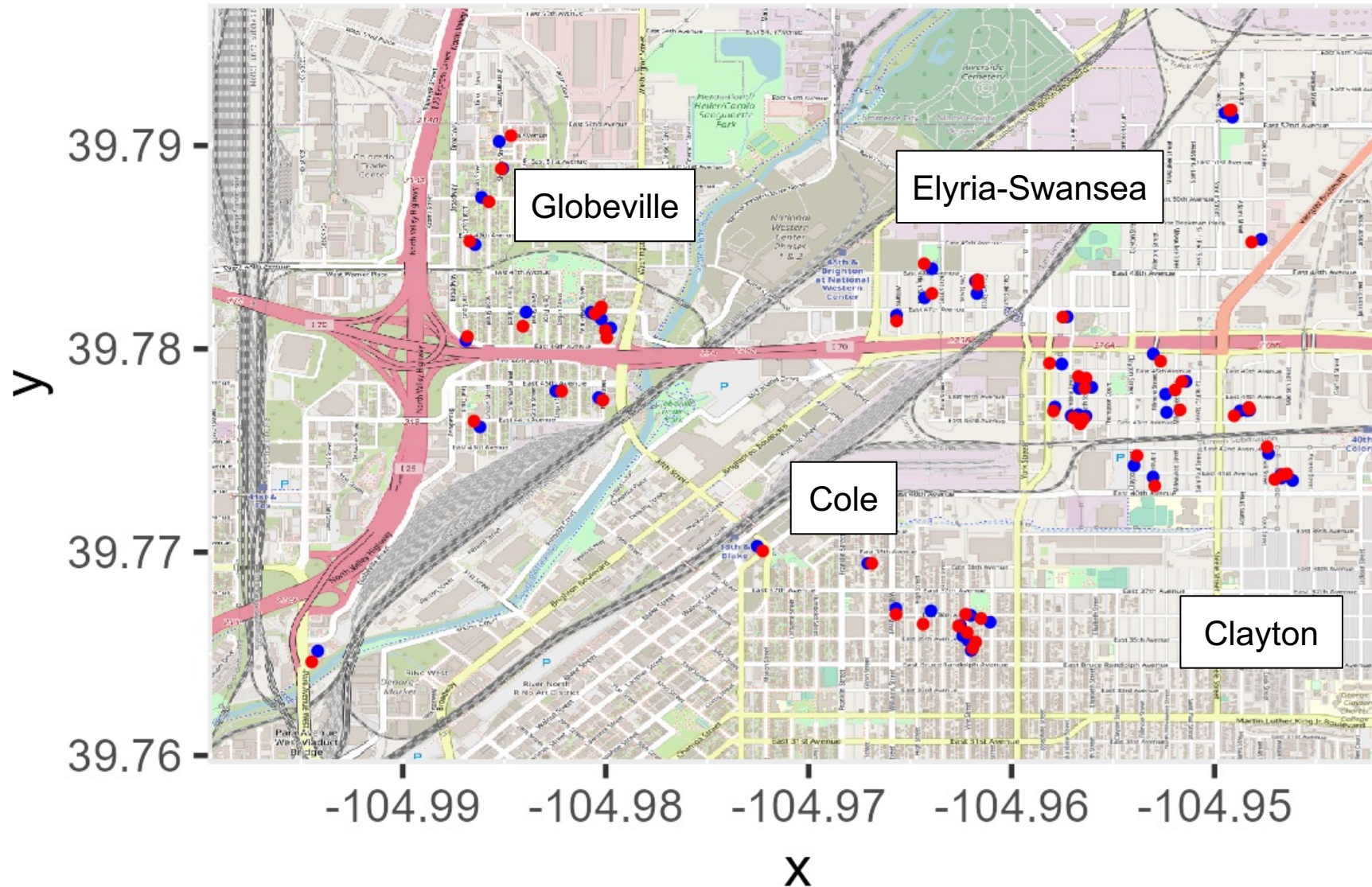
In the state of Colorado, the neighborhoods of Globeville, Elyria-Swansea, Cole, and Clayton are categorized as Disproportionately Impacted Communities

	Globeville	Elyria-Swansea	Cole	Clayton
<b>Over 40% of Households are Low Income</b>	Yes (44%)	No (34%)	Yes (57%)	Yes (50%)
<b>Over 40% of Households are People of Color</b>	Yes (73%)	Yes (69%)	Yes (78%)	Yes (62%)
<b>Over 40% of Households are Housing Burdened</b>	No (30%)	No (34%)	No (25%)	No (22%)
<b>EnviroScreen Score (Percentile) is over 80</b>	Yes (90%)	Yes (92%)	No (77%)	Yes (81%)



Source: [Colorado EnviroScreen](#)

# Spatial Distribution of Participant Homes



Note: Points are jittered to anonymize participant home locations

# DIY Air Cleaner Prototypes





# DIY Air Cleaner Prototypes



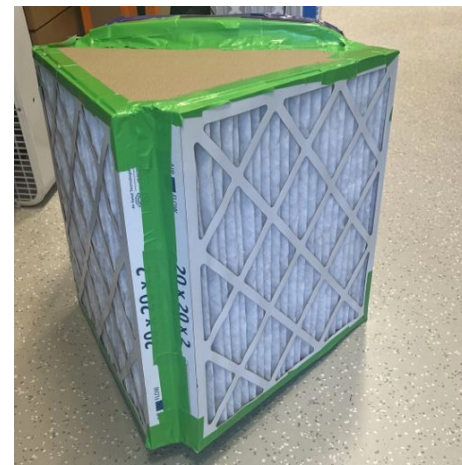
# DIY Air Cleaner Prototypes



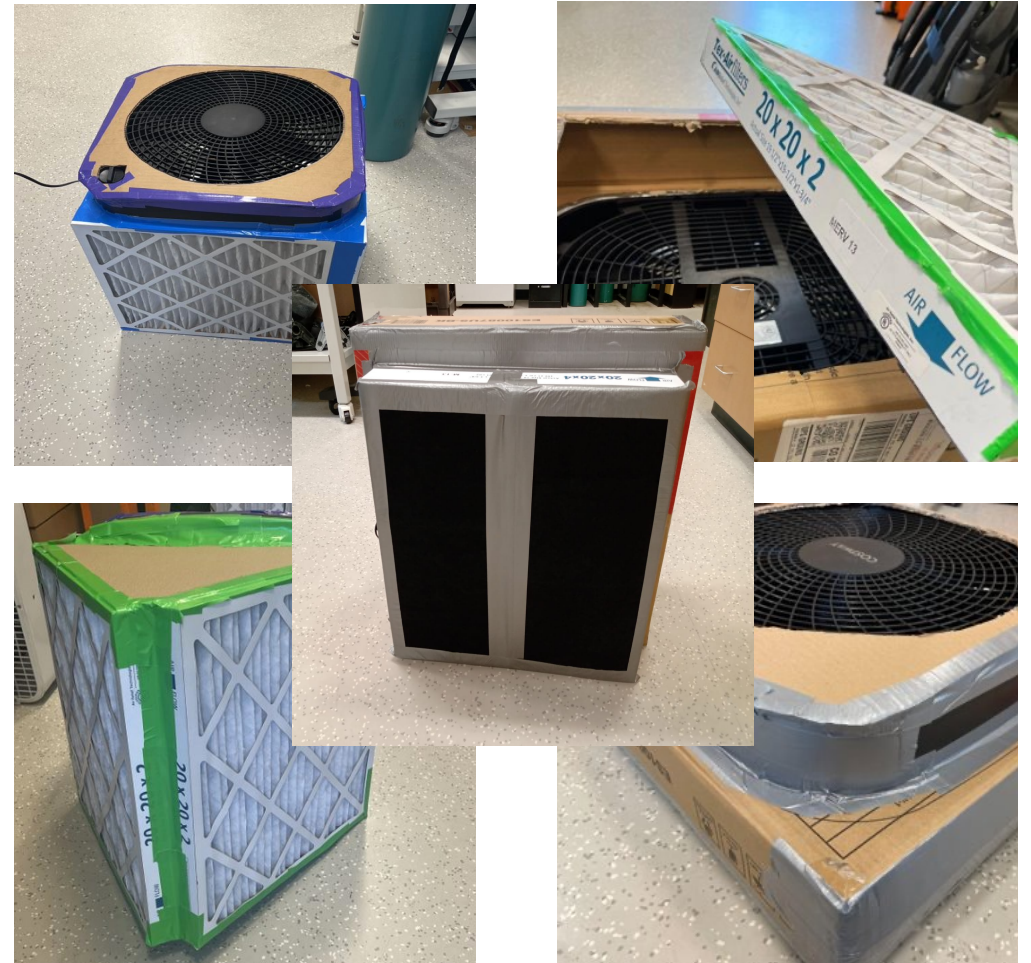
# DIY Air Cleaner Prototypes



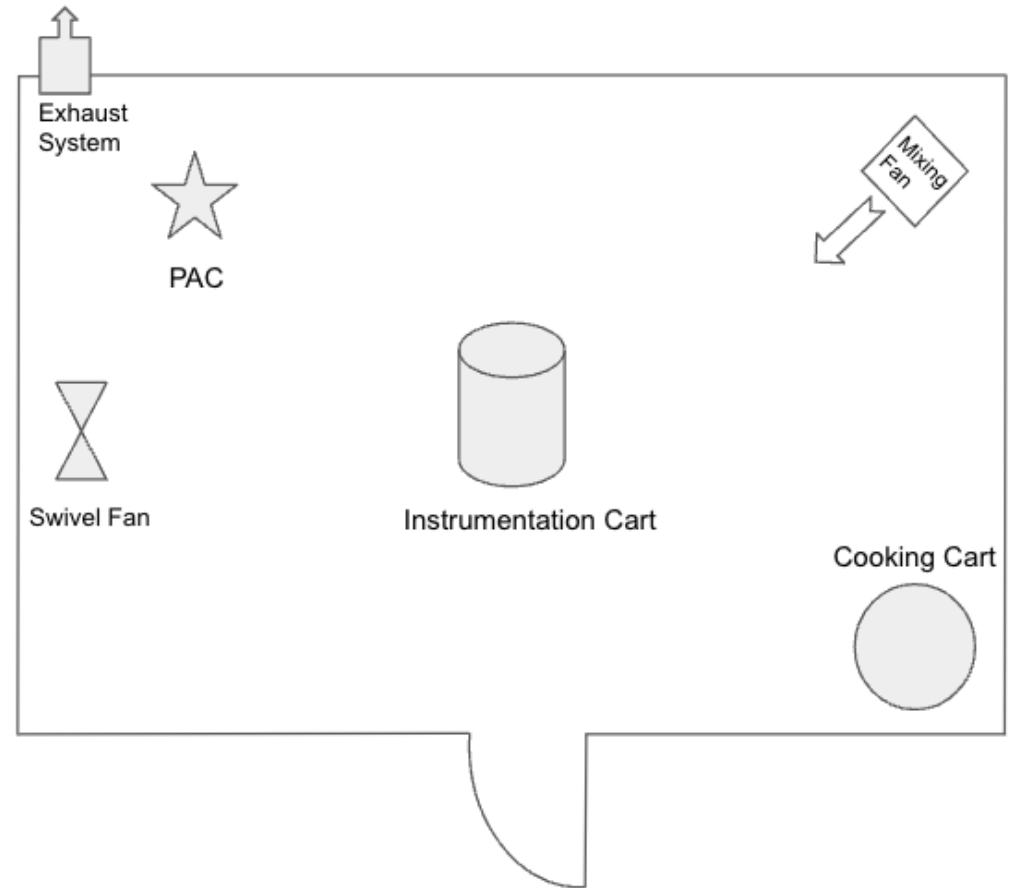
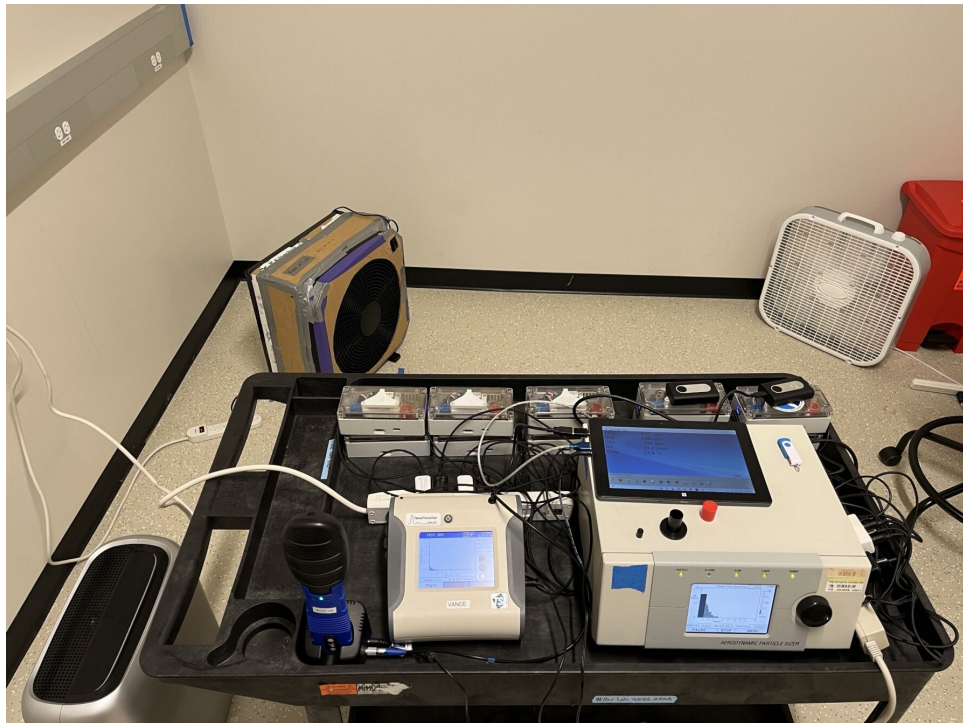
# DIY Air Cleaner Prototypes



# DIY Air Cleaner Prototypes

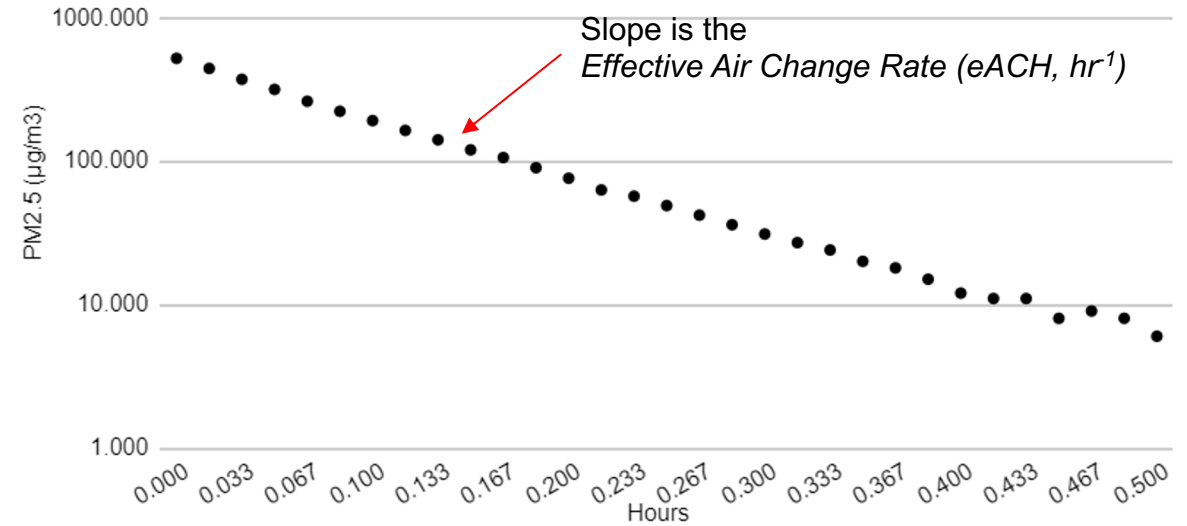
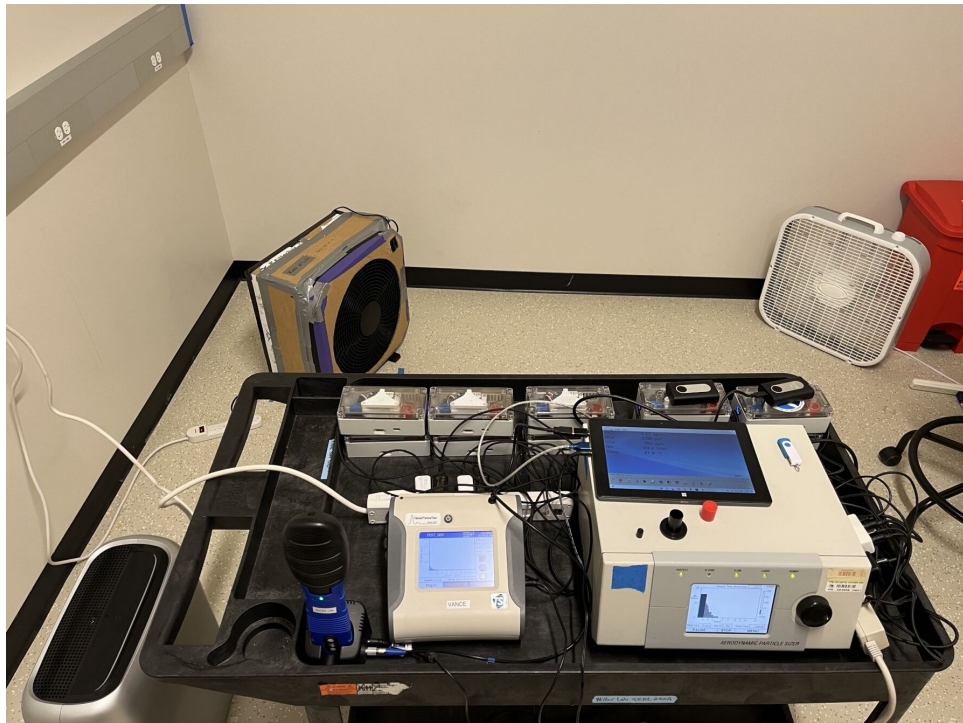


# Experimental Design



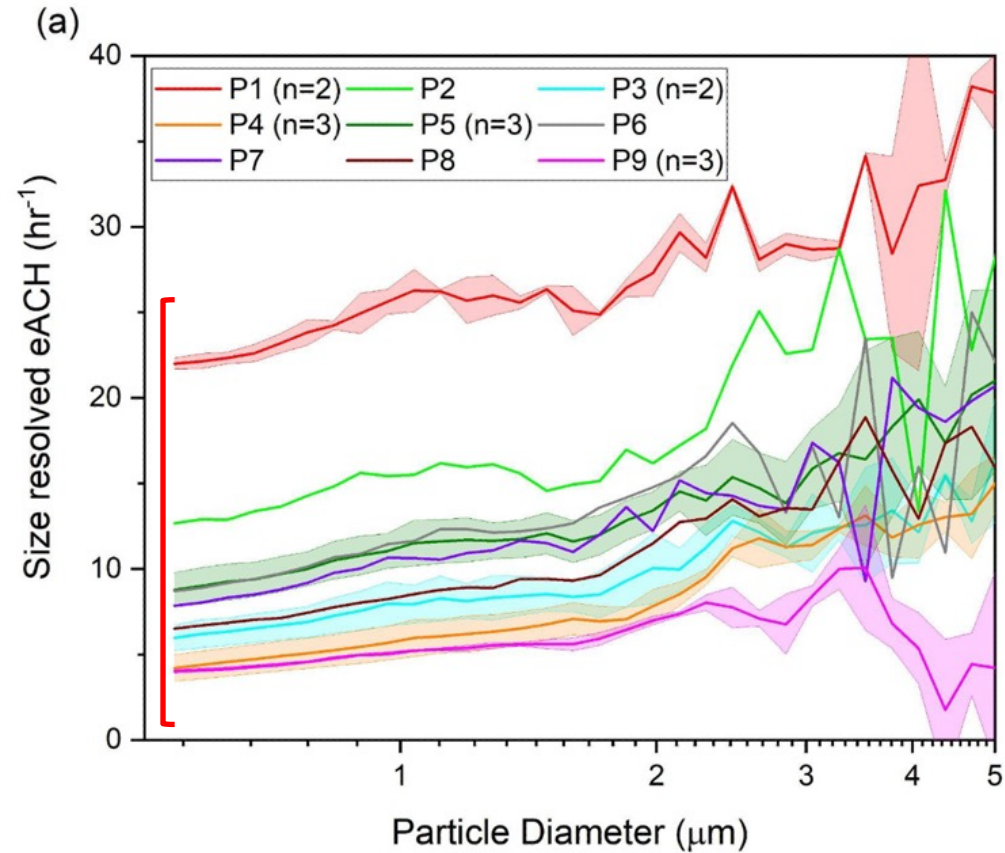
Hamburger patties were cooked with vegetable oil on a frying pan over a coil hot plate.

# Experimental Design

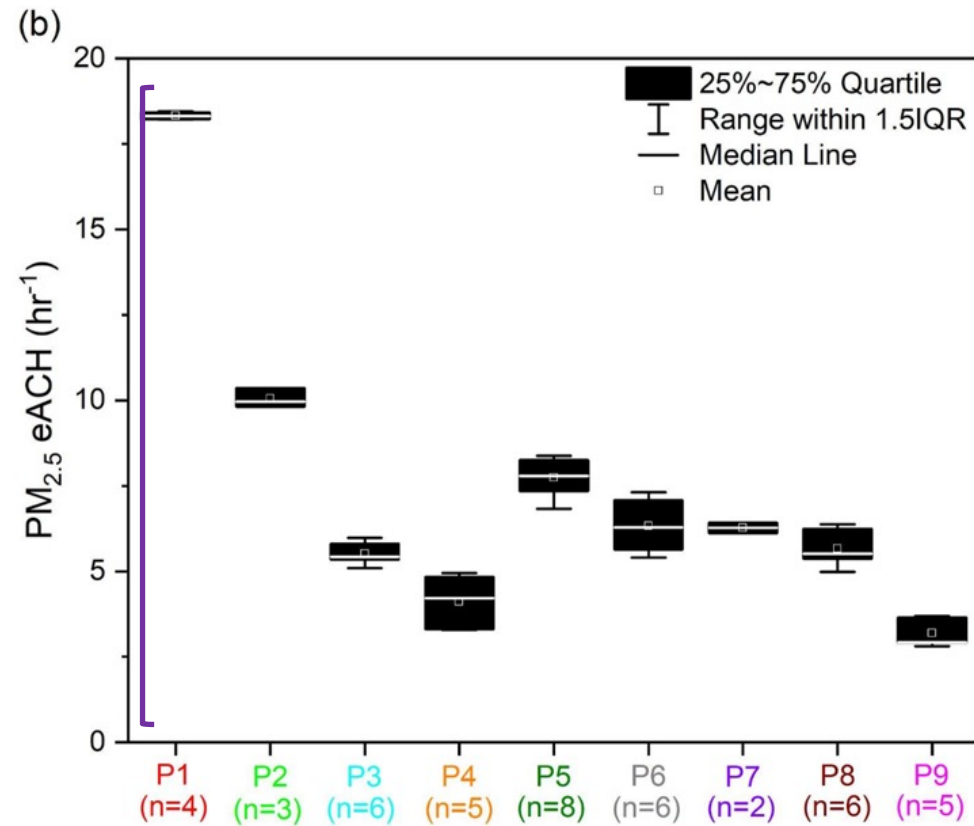


The CADR was then calculated by multiplying the eACH with the chamber volume (37.9 m<sup>3</sup>).

# PM removal rates (eACH)



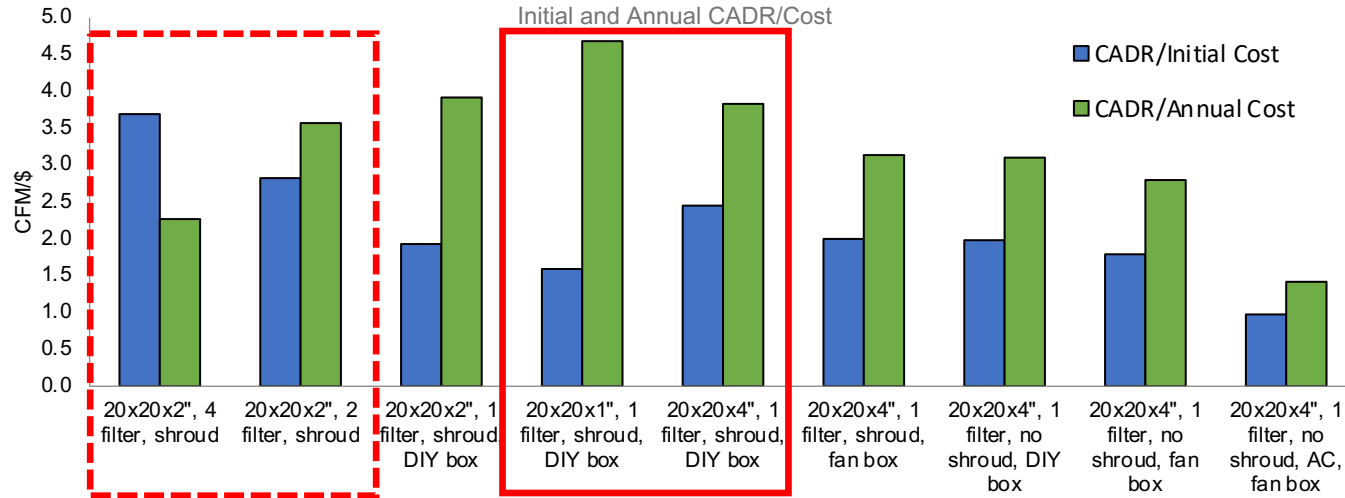
TSI APS (Research Grade)



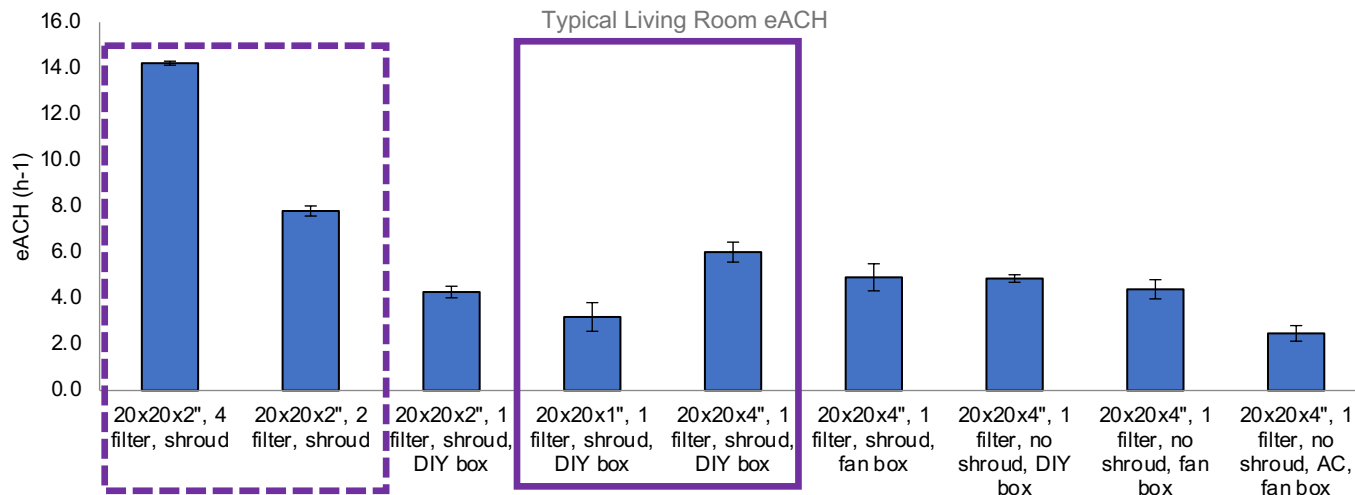
Atmotube Pro (Low-cost)



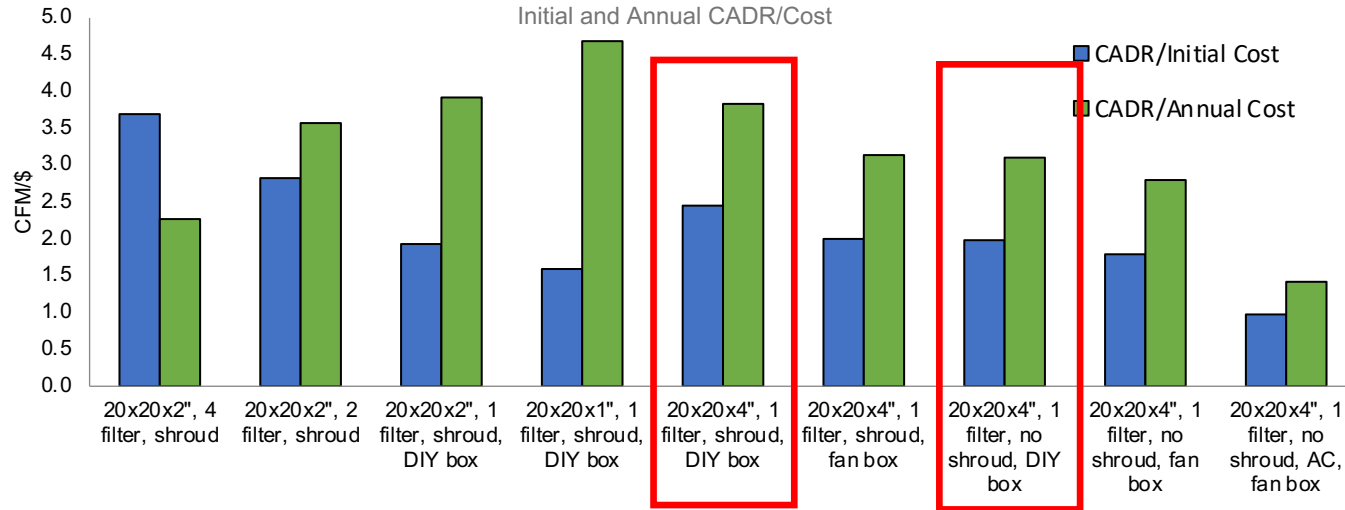
# Optimization of a DIY Air Cleaner Design to Reduce Residential Air Pollution Exposure for a Community Experiencing Environmental Injustices



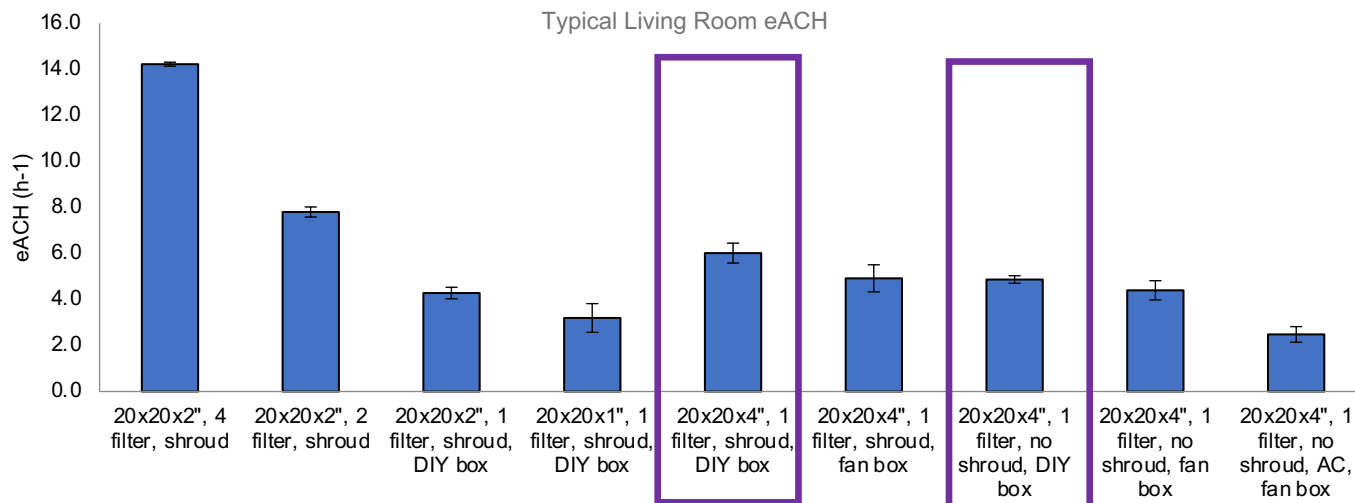
- In general, single filter prototypes had higher CADR/Annual Cost values than multiple filter configurations even though the CADR values for these prototypes was lower.



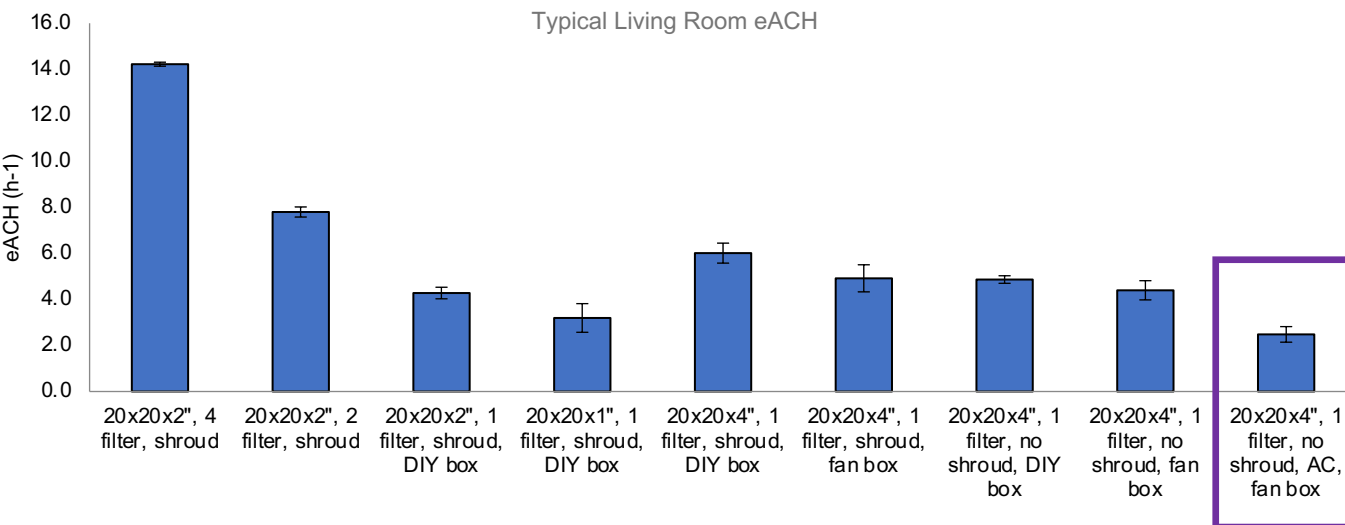
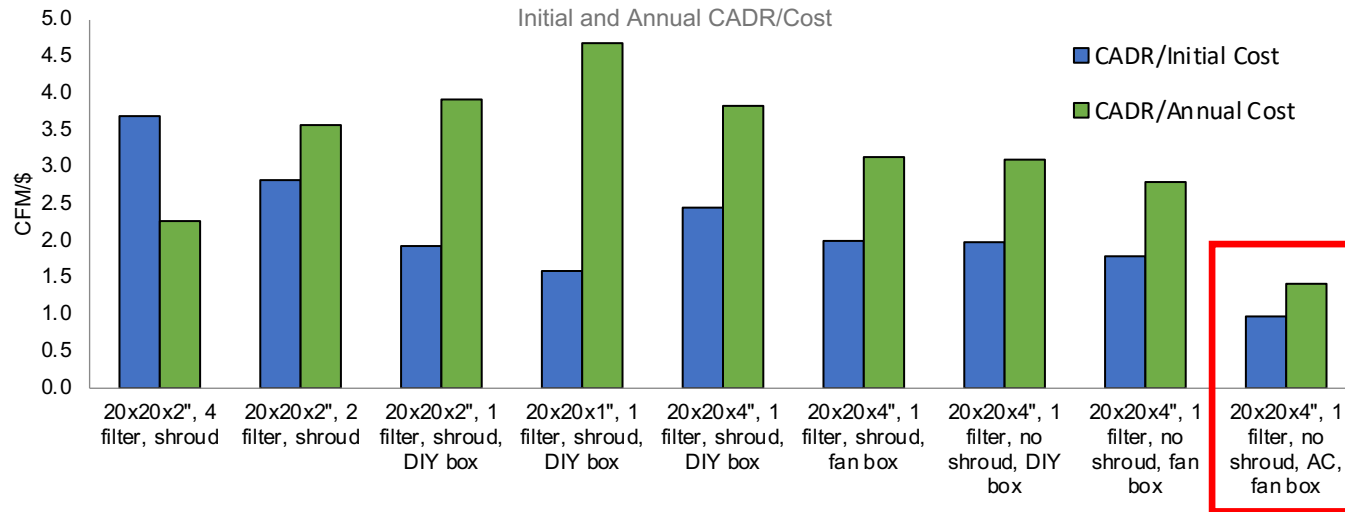
# Optimization of a DIY Air Cleaner Design to Reduce Residential Air Pollution Exposure for a Community Experiencing Environmental Injustices



- In general, single filter prototypes had higher CADR/Annual Cost values than multiple filter configurations even though the CADR values for these prototypes was lower.
- The presence of shroud does lead to CADR increase but also leads to the complexity of the build.

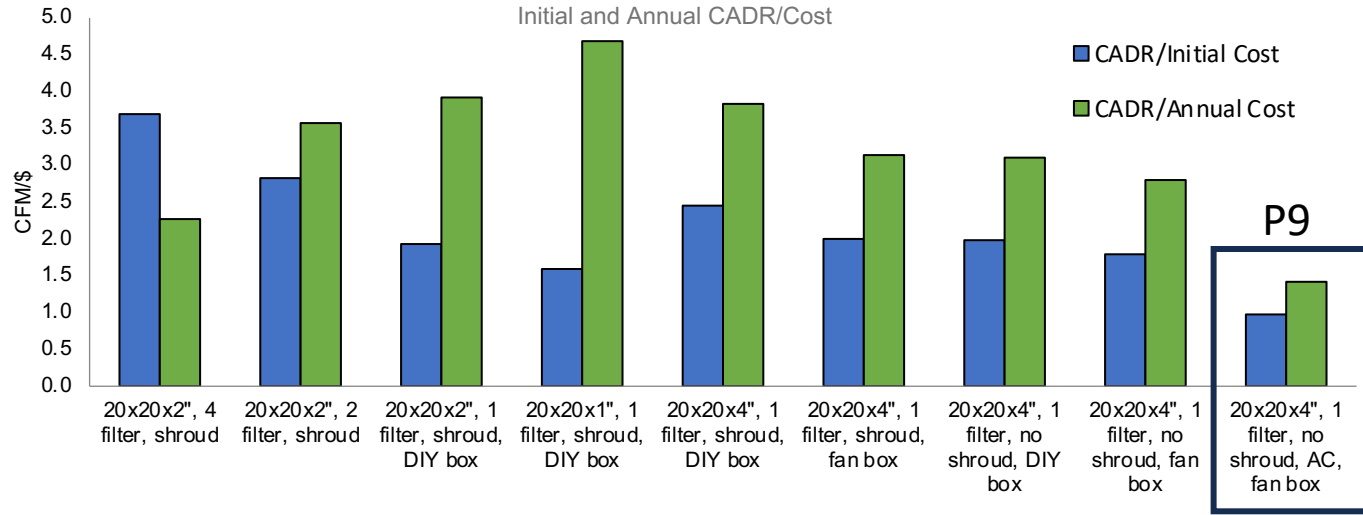


# Optimization of a DIY Air Cleaner Design to Reduce Residential Air Pollution Exposure for a Community Experiencing Environmental Injustices

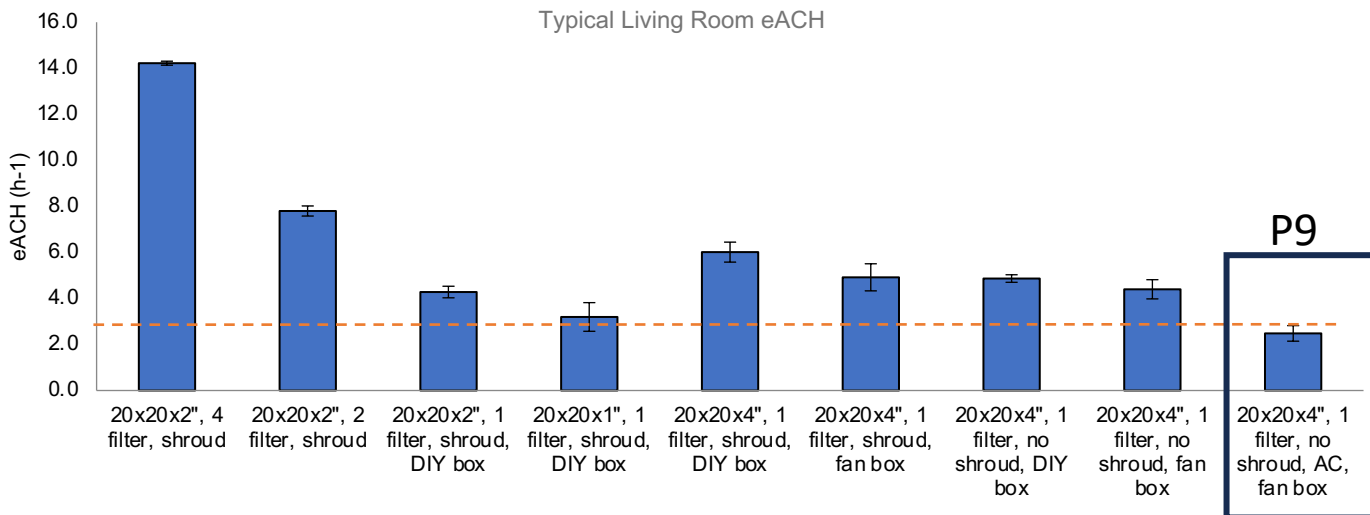


- In general, single filter prototypes had higher CADR/Annual Cost values than multiple filter configurations even though the CADR values for these prototypes was lower.
- The presence of shroud does lead to CADR increase but also leads to the complexity of the build.
- Including activated carbon layer over HEPA filter also led to lower removal rate values.

# Optimization of a DIY Air Cleaner Design to Reduce Residential Air Pollution Exposure for a Community Experiencing Environmental Injustices

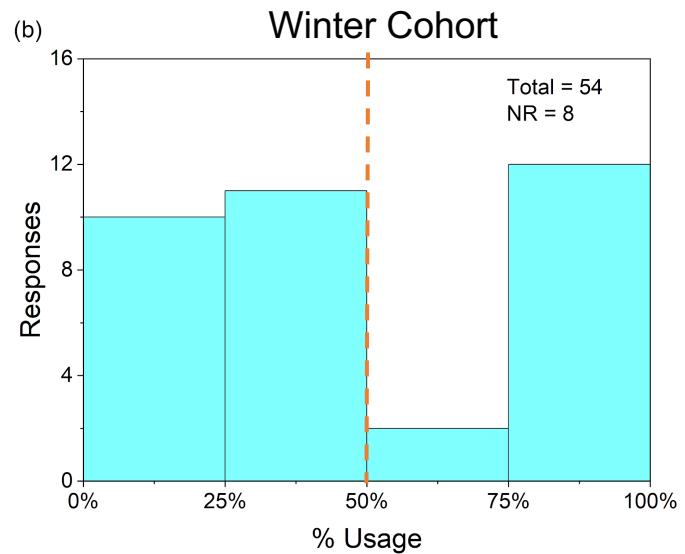
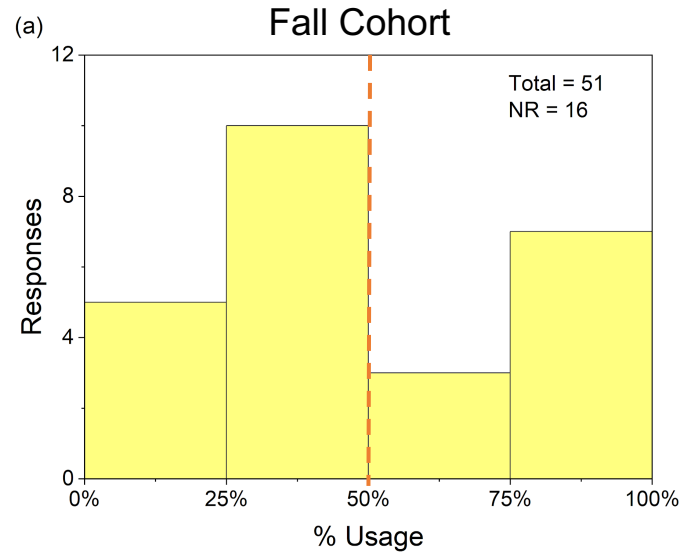


P9 was selected based on combination of factors such as ease of build, floor area occupied, and to include the additional TVOC removal rate of  $\sim 0.7 \text{ hr}^{-1}$  associated with it.

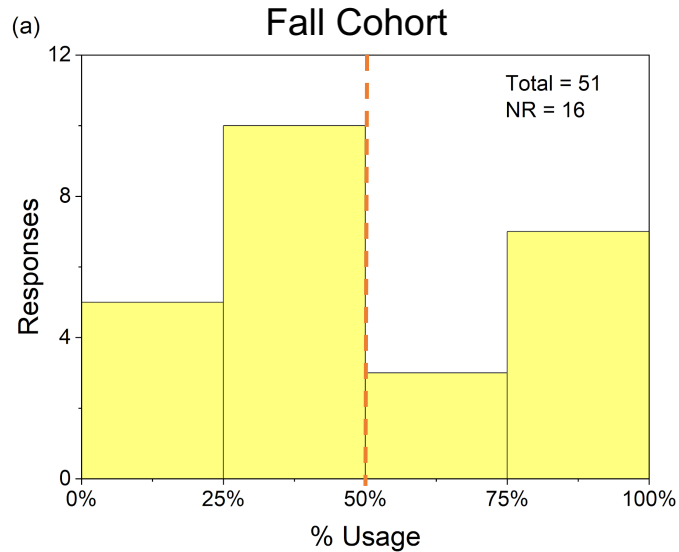


120 of these were deployed in around 50 homes in Denver metropolitan area

# Still a lot of awareness is needed to promote their consistent use

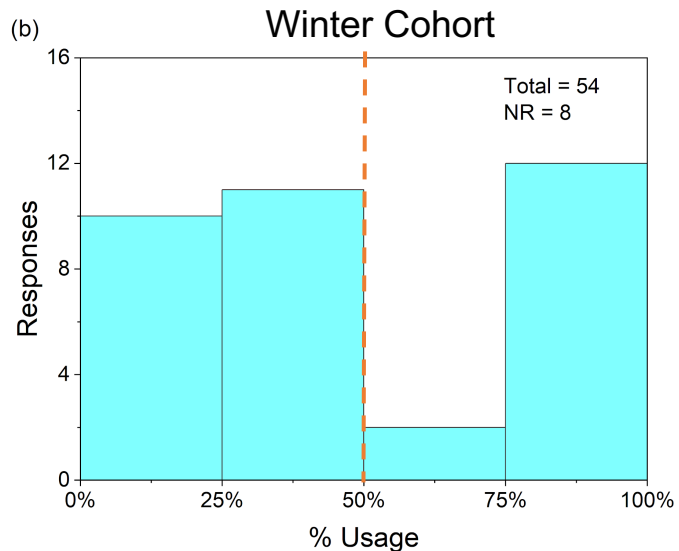


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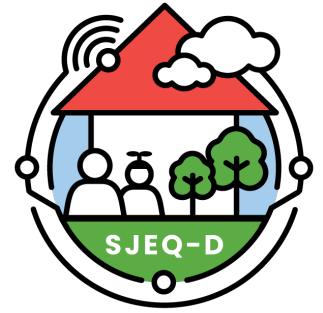
"I did use the air cleaner fan this past week almost everyday during the day time. But only on the days that the temperature was warmer. **Too cold to run it on cold days & during sleep.**"

"just whenever I decide to turn it on , mostly at night. It's very big & takes up space. **If it was smaller & fit the aesthetic** of our space (lol) **I would use it "**



**"seemed to hold atm measurements to good air except when cooking"**

"all the time, we use it I. Our basement since the **airflow isn't as good as our main floor"**



Please check out our project website for more details regarding the PM exposure summary and DIY air cleaner build instructions

