

JUMP into STEM

Equal Access to Healthy Indoor Air

August 16, 2021

[Jumpintostem.org](https://jumpintostem.org)



Background

The IAQ Problem

Poor Indoor Air Quality (IAQ) in buildings can result from:

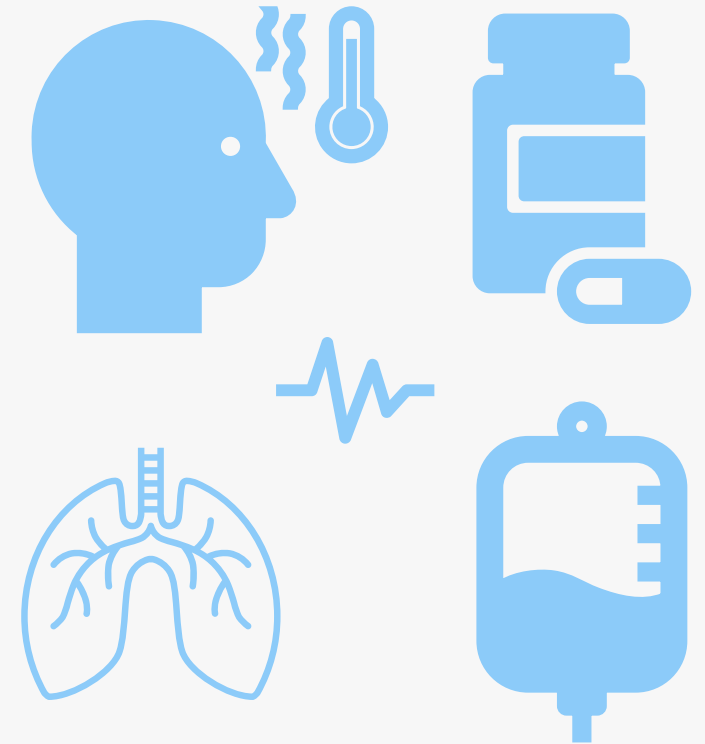
- Infiltration of **outdoor** air pollutants: Examples include pollutants generated by power plants and industries, traffic emissions from major highways or roads, and wildfires.
- **Indoor** sources: Examples include cooking, combustion equipment and appliances, installed or stored products and materials (off-gassing of volatile organic compounds from furniture, cleaning products, and building materials), mold, pests, pets, indoor smoking, radon, legacy building and materials like lead and asbestos.
- The degradation of IAQ is exacerbated by poor ventilation.



Background

Consequences of Poor IAQ

- Most Americans spend ~ **90% of their time indoors**, where air pollutants can be **two to five times** more concentrated than outdoors.
- Poor IAQ can lead to respiratory and cardiovascular **health problems** including respiratory infections, allergies, asthma, chronic obstructive pulmonary disease, bronchitis, sick building syndrome, and lung cancer.
- Acute (short-term) exposure to air pollutants can cause irritation to the nose, throat, and eyes and aggravate asthma, lung disease, bronchitis, and respiratory disease in susceptible individuals.



Background

Consequences of Poor IAQ



- More than **100 people die each year** in the U.S. from unintentional exposure to carbon monoxide gas (**CO**) from portable generators and other fuel burning appliances and products.
- **Radon** is the number one cause of lung cancer in the U.S. among non-smokers, and **secondhand smoke** is the 3rd leading cause of lung cancer, responsible for an estimated **3,000 lung cancer deaths every year**.
- Poor IAQ may also lead to increased school and work absenteeism and loss of work productivity due to reduced cognitive performance. In extreme cases, poor IAQ can lead to **death**.



Background

Factors Contributing to IAQ Inequity



- **Lower socioeconomic status** can lead to higher indoor air pollutant concentrations, increased infectious disease transmission, injuries, asthma symptoms, lead poisoning, and mental health problems.
- **Other factors** can also lead to IAQ inequities, such as the age of the occupants, density of housing, home ownership status (renter versus homeowner), race, ethnicity, occupation, and infrastructure dependence.



“That all people should have free access to air and water of acceptable quality is a fundamental human right.”

- World Health Organization, Air Quality Guidelines for Europe, 2nd ed.



Background

Optimizing for IAQ and Energy Efficiency



Recent technological developments in **indoor environmental sensing, modeling,** and **control** capabilities can be leveraged to potentially:

- Optimize for IAQ and energy efficiency
- Improve the affordability and access of these solutions to a wider population



Background

Ventilation and COVID-19



- IAQ improvement solutions such as **increased ventilation** rates in buildings can even reduce the incidence and transmission of respiratory diseases including COVID-19.



Background

- Examples of technological solutions for IAQ improvement:
 - Air purifiers,
 - Upgrades to heating, ventilating, and air conditioning filters,
 - Kitchen range hoods that vent exhaust outside,
 - Heat recovery ventilators,
 - Motion-activated mechanical exhaust fans, etc.
- Affordability and easy accessibility to wider population remains a challenge.



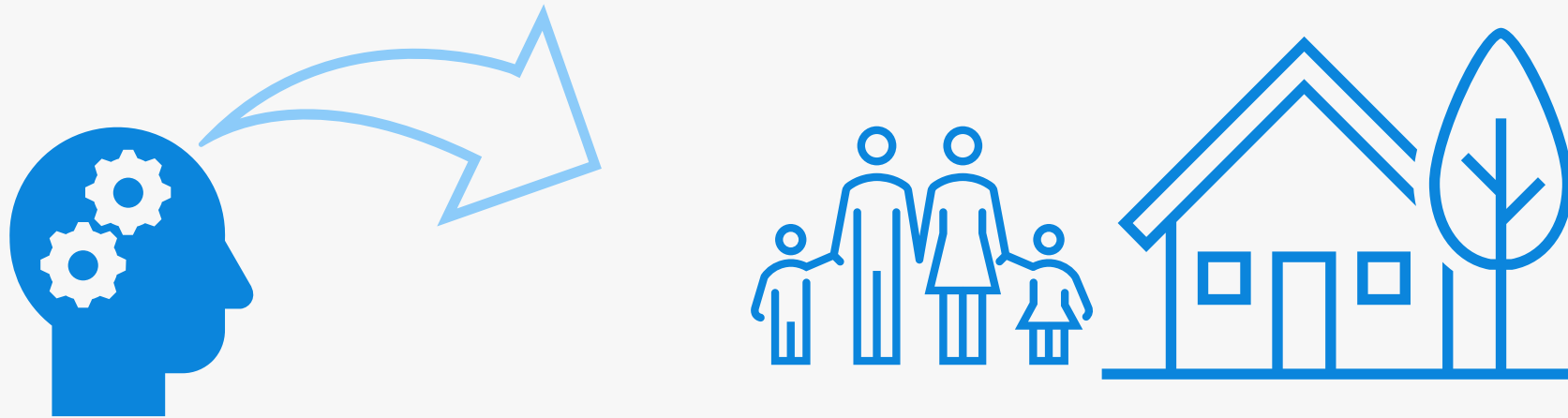
Background

- **Holistic solutions** are needed to address IAQ inequity problem, not just technological.
- **Policies, codes and standards:** The **health and safety inspections** and **necessary corrective actions** built into the operating procedures of the U.S. Department of Energy (DOE)'s Weatherization Assistance Program (**WAP**) and the U.S. Department of Housing and Urban Development (**HUD**) programs.
- **Collaboration** between existing programs and agencies can co-address IAQ issues in tandem with energy and economic efficiency such as the *OneTouch* program model that connects WAP, Lead hazard abatement, and HUD rehab-funded programs; Zero Energy Ready Homes (*ZERH*); and Home Performance with ENERGY STAR® (*HPwES*).



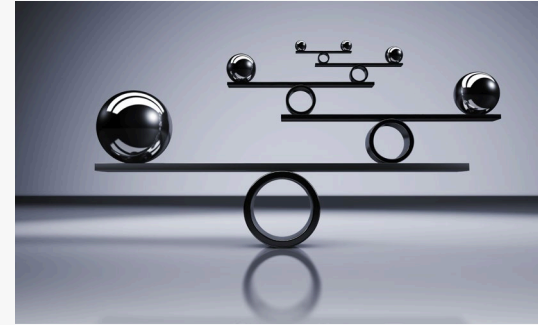
Background

- Need to effectively, economically, and impactfully deliver solutions to the **end-users**.



The Challenge

- The JUMP into STEM competition asks teams to investigate **holistic solutions** and explore impactful factors (such as science, policies, awareness, information technology, and economics) behind **inequities in IAQ**.
- Teams must develop a problem statement to address IAQ inequities for a **specific stakeholder group** and present a holistic response.

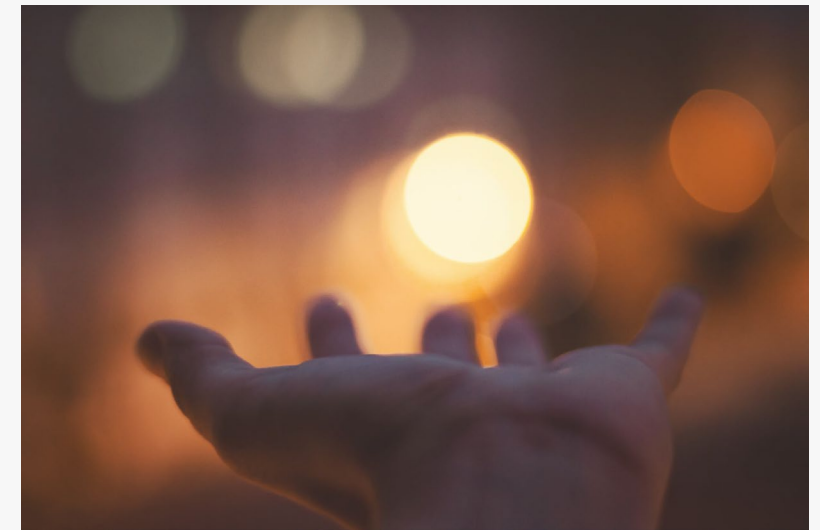


The Challenge

Ideas for Student Teams (not limited to):



- Better characterizing indoor air quality to provide better guidance for policy development (developing novel metrics related to IAQ).
- Managing IAQ in buildings through targeted sensing and ventilation strategies.
- Focusing on a specific pollutant source, building type, or geographical location.



The Challenge

Ideas for Student Teams (not limited to):



- Generating/analyzing data through mobile applications, machine learning, and databases for making informed decisions at the building or community level.
- Developing innovative financing mechanisms to upgrade existing buildings with improved IAQ, etc.
- Identifying new mechanisms of collaboration between existing programs and agencies that can co-address IAQ issues in tandem with other issues such as energy and economic efficiency.



The Challenge

Requirements



- Develop a **problem statement** and **propose a solution** related to building or community-scale IAQ issues.
- Describe the **scope and context** of the problem based on a real building and/or stakeholder group in the United States.
- Identify **affected communities**, making sure to include socioeconomically vulnerable communities when compared against groups with high socioeconomic status.
- Develop a **holistic solution** including technical, policy-related, economic aspects, commercialization, or codes and standards to address the IAQ problems at the building or community scale.



The Challenge

Requirements



- Discuss appropriate and expected **impacts and benefits** of the proposed solution. This should include:
 - Cost/benefit analysis of the proposed solution
 - Non-economic impacts whenever possible (environmental impact, noise level, security challenges, logistical challenges, health risks, safety hazards, workmanship quality, and speed of implementation)
- Develop a plan that describes how the team envisions bringing its idea **from concept to a final implementation**:
 - Detailed plan to convert the idea to a commercially viable, market-ready product for existing buildings and/or communities; or
 - A roadmap to integrate the idea into a new construction or retrofit project



Additional Resources



- **US EPA Resources**
 - <https://www.epa.gov/indoor-air-quality-iaq>
 - <https://www.epa.gov/air-sensor-toolbox>
- **IAQ and DOE Weatherization Assistance Program**
 - <https://www.energy.gov/eere/wap/weatherization-assistance-program>
 - https://weatherization.ornl.gov/wp-content/uploads/pdf/WAPRetroEvalFinalReports/ORNL_TM-2014_345.pdf
- **HUD Resources**
 - <https://www.hud.gov/>
 - https://www.hud.gov/sites/documents/DOC_12480.PDF
 - https://www.hud.gov/sites/documents/DOC_12483.PDF
 - https://www.hud.gov/sites/documents/DOC_12381.PDF
 - https://www.hud.gov/sites/documents/IEPWG_RADONWORKER_FINAL.PDF
 - https://www.hud.gov/sites/documents/DOC_13701.PDF
 - https://www.hud.gov/program_offices/healthy_homes/tribal_healthy_homes
- **One Touch Program Example**
 - https://nascsp.org/wp-content/uploads/2018/02/ellen_one_touch_nascsp_march2012.pdf
- **Zero Energy Ready Homes**
 - <https://www.energy.gov/eere/buildings/zero-energy-ready-homes>
- **Home Performance with ENERGY STAR®**
 - <https://www.energy.gov/eere/buildings/home-performance-energy-starr>



Thank you!

