

# Breathe Easy: Mechanical Ventilation, Indoor Air Quality and Asthma Executive Summary

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The primary authors of this report are Insung Kang<sup>1</sup>, Anna McCreery<sup>2</sup>, and Brent Stephens<sup>1</sup> (co-PI). The study team also includes Kari Abromatis<sup>1</sup>, Parham Azimi<sup>3</sup>, Griselda Baca<sup>2</sup>, Timothy Crowder<sup>2</sup>, Amanda Escobar-Gramigna<sup>2</sup>, Anne Evens<sup>2</sup> (co-PI), Marjorie Issacson<sup>2</sup>, Rachel Scheu<sup>2</sup> and Yicheng Zeng<sup>1</sup>.

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For more information on this project and to request the full report, contact [EmergingTech@ComEd.com](mailto:EmergingTech@ComEd.com).

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<sup>1</sup> Illinois Institute of Technology (IIT), Chicago, IL

<sup>2</sup> Elevate Energy, Chicago, IL

<sup>3</sup> Harvard T.H. Chan School of Public Health, Boston, MA

## **I.0 EXECUTIVE SUMMARY**

Human exposure to indoor air pollutants is an important risk factor for asthma and the exacerbation of asthma symptoms. The goal of the Breathe Easy Project is to evaluate the ability of three common types of residential mechanical ventilation systems to (1) reduce indoor pollutants of both indoor and outdoor origin, (2) maintain adequate environmental conditions and ventilation rates, (3) improve asthma-related health outcomes in adults with self-reported asthma and (4) evaluate the impacts of each system type on building energy use and life cycle costs, including an analysis of a subset of homes that received air handler motor replacements, from permanent split capacitor (PSC) motors to electronically commutated motors (ECMs).

This study provides a holistic understanding of the costs and benefits of mechanical ventilation systems designed to provide minimum flow rates specified by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 62.2. The three types of systems investigated are 1) continuous exhaust-only ventilation systems, 2) intermittent central-fan-integrated-supply (CFIS) ventilation systems with automatic fan-cycler timers integrated into the existing air handling units (i.e., with the air handler operating 20 minutes out of every 60 minutes to meet 62.2 requirements) and 3) continuous balanced supply and exhaust ventilation systems with energy recovery ventilator (ERV) units. The study utilized a pseudo-randomized crossover study with quarterly periods of week-long data collection for one-year pre-installation and one-year post-installation, as well as monthly asthma symptom questionnaires throughout the two-year study period. The findings will provide guidance on cost-effective ventilation upgrades for healthy homes, the benefits of ECMs for mitigating energy use increases from mechanical ventilation systems and the non-energy benefits of ventilation in homes with asthmatic residents.

### **Key Findings**

- **Better indoor air quality (IAQ) is associated with improved asthma control, particularly reduced nitrogen dioxide (NO<sub>2</sub>).** Based on the data analysis of the pre-intervention period, higher NO<sub>2</sub> concentrations were statistically associated with increased odds of poorly controlled asthma. This highlights the health risk of gas appliances that can be a source of NO<sub>2</sub> pollution, such as a gas stove.
- **Asthma severity is worse among black and low or moderate income participants.** Race and annual income were statistically associated with asthma control. The odds of having poorly controlled asthma are 470%

higher in Black/African American participants than White/Caucasian participants and a one-level decrease in annual income category leads to a 94% increase in the odds of having poorly controlled asthma. This is consistent with previous research demonstrating race- and income-based inequity in asthma severity.

- **Mechanical ventilation improves asthma control.** There was a small but significant improvement in asthma control across the entire study population after the interventions were implemented. However, when it comes to three ventilation system types, only the CFIS system was statistically significant.
- **Mechanical ventilation improves IAQ.** The interventions were found to reduce indoor concentrations of formaldehyde (HCHO), carbon dioxide (CO<sub>2</sub>), ozone (O<sub>3</sub>) and size-resolved particulate matter (PM<sub>1.0</sub>, PM<sub>2.5</sub>, and PM<sub>10</sub>) with statistical significance.
- **ECM upgrades mitigate the additional energy used by CFIS ventilation systems.** The PSC fan motor change outs with ECMs could be used to negate the additional energy penalty introduced by increased ventilation in intermittent CFIS systems, allowing for achieving better IAQ and potentially better health outcomes with a negligible change in operating costs.
- **Homeowner education, contractor training and post-install quality control are important to ensure customer satisfaction.** It is important for installation contractors to provide high quality customer service, including educating homeowners on the basics of their ventilation systems, answering questions about how ventilation will affect temperature and drafts and working with homeowners to adjust the systems as needed for comfort and satisfaction.

## Recommendations

- **Combined efficiency and healthy homes/ventilation programs:** Energy efficiency and weatherization programs should consider including ventilation to help mitigate air pollutants from indoor sources and improve IAQ in weatherized homes. The non-energy benefits of ventilation can be substantial, especially for residents with health vulnerabilities such as asthma, while a combined program could facilitate energy efficiency improvements like ECMs that may not be widely adopted in existing programs.

- **Workforce development:** In addition to the technical skills that contractors need to install ventilation systems correctly, they also need strong customer service and organizational skills for scheduling, homeowner education and reassurance, as well as related needs.
- **Homeowner education:** As COVID-19 has highlighted the importance of IAQ and healthy homes, this has become an ideal time to educate homeowners and building owners about the health benefits of ventilation, especially when combined with weatherization and furnaces with ECMs. Homeowner education could drive interest in both ventilation and energy efficiency upgrades and expand the reach of existing programs.