

## COMMENTARY

# FEDERAL AND STATE POLICY OPPORTUNITIES TO IMPROVE INDOOR AIR QUALITY

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The United States has significant opportunities to ensure buildings have clean indoor air. Federal and state governments can promote health-based indoor air quality (IAQ) targets, provide guidance and technical assistance, fund ventilation improvements, incentivize or require IAQ standards in public buildings, and work alongside industry and state and local partners to promote best IAQ practices. Despite the demonstrated health, economic, and national security benefits of improved IAQ, there has been limited progress in advancing clean indoor air across buildings in the United States. There is no comprehensive roadmap for federal and state policy actions. In this commentary, we offer a suite of policy options to improve IAQ that focus on establishing health-based IAQ targets, supporting state and local actions to adopt IAQ standards and policies, implementing sector-specific guidelines, and expanding IAQ research and development. This paper presents a spectrum of policy approaches, recognizing that different jurisdictions and sectors will have unique needs and constraints.

**Keywords:** Infectious diseases, Public health preparedness/response, National strategy/policy, Indoor air quality, Biosecurity

## INTRODUCTION

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### *Why Clean Indoor Air Matters*

CLEAN INDOOR AIR IS CRITICAL for human health and wellbeing; it influences how we feel, how we think, and whether we get sick. People spend 90% of their time indoors, yet many buildings do not have adequate ventilation and filtration to provide clean indoor air.<sup>1,2</sup> While major public initiatives to improve health and safety have led to clean water, the elimination of indoor smoking, and

increased fire safety in buildings, there has not been an equivalent initiative for clean indoor air. Experts have called for implementing indoor air quality (IAQ) standards in public buildings to support childhood learning, reduce asthma rates, improve workplace productivity, and prevent the spread of respiratory diseases.<sup>1</sup>

Improving outdoor air quality is not sufficient to provide clean indoor air. Regulations on outdoor air quality fail to account for the fact that many outdoor air pollutants end up indoors—in the schools, homes, and workplaces where people spend most of their time. Indoor exposure to

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PM<sub>2.5</sub> of outdoor origin is estimated to account for roughly half of the total mortality caused by PM<sub>2.5</sub> exposure.<sup>3</sup> Outdoor air regulations also do not account for the fact that there are many indoor sources of pollutants, and concentrations of certain air pollutants can be 2 to 5 times higher indoors.<sup>4</sup> Additionally, outdoor regulations do not focus on a major concern related to IAQ: the spread of respiratory pathogens. Wang et al suggest that airborne transmission may be the dominant form of transmission for several respiratory pathogens, including COVID-19, influenza, and respiratory syncytial virus (RSV).<sup>5</sup>

Indoor air pollution is recognized as 1 of the top 5 major environmental risks to public health.<sup>6</sup> High levels of particulate matter are associated with asthma and cardiovascular disease, and poor ventilation and high carbon dioxide levels can lead to decreased cognitive performance.<sup>7,8</sup> Volatile organic compounds have a range of negative health effects, and some, such as formaldehyde and benzene, can be toxic and carcinogenic.<sup>9,10</sup> In addition to harm from particulate matter and gaseous pollutants, biological contaminants in the air can pose a serious threat to human health. Global excess mortality between January 2020 to December 2021 due to the COVID-19 pandemic is estimated to be 18.2 million deaths, and the dominant route of COVID-19 transmission occurs through airborne aerosols.<sup>11,12</sup> Cleaner indoor air—through filtration, ventilation, and disinfection—can eliminate or minimize many of these harms.

Clean indoor air also boosts economic productivity and growth. Increased ventilation in buildings is associated with reduced sick days and worker absenteeism.<sup>13</sup> Lower concentrations of indoor pollutants improve workplace performance and productivity.<sup>14,15</sup> The resulting benefit to businesses that improve IAQ has been estimated to be a 10% gain in bottom-line performance.<sup>16</sup> One study estimates the US economy could gain \$23 billion annually with improved air quality due to a 35% decrease in sick leave.<sup>17</sup>

Lastly, IAQ safeguards the United States's national security and critical infrastructure. Poor IAQ in military installations can compromise force readiness by impacting the health and performance of military personnel and reducing operational effectiveness. Critical infrastructure—including hospitals, transportation, and emergency services—depends on clean air to remain operational, especially during crises.

### *US Indoor Air Policy Background*

Most air quality policies and financing in the United States focus on outdoor air. In 1970, Congress amended the Clean Air Act (42 USC §7401 et seq),<sup>18</sup> authorizing the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS). NAAQS sets standards for 6 criteria pollutants and requires states to take action to meet these standards. Federal agencies do not regulate indoor air outside of occupational settings and have limited abilities to support clean indoor air implementation at

the state and local levels. However, federal buildings are required to meet minimum ventilation standards under Federal Management Regulations (41 CFR §102–74.195).<sup>19</sup>

In most settings, state and local governments have jurisdiction over IAQ for public buildings, including schools, nursing homes, and transportation hubs. Additionally, most building codes are adopted and enforced at the local level.<sup>20</sup> This results in significant variation in standards and resources across states. For example, California, Connecticut, and Minnesota have some IAQ guidelines and standards, primarily for schools and other specific buildings. California requires minimum efficiency reporting value (MERV)–13 filters in schools and recommends that schools achieve 5 air changes per hour (ACH).<sup>21</sup> The California Air Resources Board (CARB) publishes IAQ guidance and regulates air cleaning devices.<sup>22,23</sup> CARB is also developing nitrogen dioxide (NO<sub>2</sub>) guidelines. Connecticut requires annual school IAQ inspections and HVAC inspections every 5 years.<sup>24</sup> Minnesota requires schools to have health and safety programs that comply with IAQ management best practices.<sup>25</sup>

In addition to state actions, the federal government has recently made progress on IAQ. The COVID-19 pandemic highlighted the importance of IAQ to policymakers, and in 2022, the Biden administration launched the Summit on Indoor Air Quality and the Clean Air in Buildings Challenge.<sup>26</sup> In 2023, the Centers for Disease Control and Prevention (CDC) released new building ventilation guidance aimed at reducing disease transmission.<sup>27</sup> Congressmen Paul D. Tonko (D-NY) and Brian Fitzpatrick (R-PA) introduced bipartisan legislation in July 2024 that would direct the EPA to set voluntary guidelines and certifications for IAQ, assess IAQ in schools nationally, and offer assistance and guidance to schools (as of December 2025, the bill has not moved forward).<sup>28</sup>

The private and nongovernmental sectors also play a crucial role in advancing clean air in buildings. In 2023, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), a standard-setting body for heating, ventilation, and air conditioning systems, released a first-of-its-kind health-based standard for IAQ. ASHRAE Standard 241 establishes minimum ventilation requirements for reducing airborne disease transmission in buildings, building upon the past evolution of their ventilation standards.<sup>29,30</sup> Additionally, the Model Clean Indoor Air Act was developed by Johns Hopkins University in 2023 as a model for states to advance clean indoor air.<sup>31</sup> Green and healthy building certifications, including LEED, WELL, Fitwel, and UL, have expanded the market for indoor air and incentivized coinvestments in building efficiency and IAQ.<sup>32–34</sup>

Despite increased awareness of the importance of IAQ, there is minimal coordinated action at the state and federal levels to make buildings healthy and improve public health, and there is no roadmap to guide these efforts. To address this, we present a menu of policy options that we believe

can serve as a roadmap for federal and state leaders. Recognizing the changing landscape of federal action, we also provide recommendations for states and the private and public sectors. While federal policy actions and resources are often essential for long-lasting impact, there are a number of important steps that can be taken at the federal, state, and local levels to successfully drive adoption of measures to provide cleaner indoor air.

In our recommendations, we mention IAQ guidelines, standards, and targets. Guidelines are voluntary, public recommendations, sometimes serving as starting points for future regulation. In contrast, standards are written to be enforceable (for example, in the case of building standards that can be adopted into code). Targets are metrics or thresholds for desired performance outcomes, such as pollutant concentrations or ventilation rates.

## RECOMMENDATIONS

We present policy recommendations for Congress, federal agencies, and state and local partners across 4 broad categories (Table 1): (1) Develop health-based IAQ targets for adoption at the state and local levels, (2) support states and local communities in adopting IAQ building standards and provide financing for their implementation, (3) implement sector-specific IAQ standards or guidelines, and (4) expand IAQ research and development. These recommendations have been formulated from engagement with dozens of leaders and experts across industry, academia, government, and nonprofits.

1. **Health-Based IAQ Targets:** Consistently, leaders and practitioners have emphasized the importance of IAQ targets (such as thresholds or metrics) that account for health, wellbeing, productivity, and infectious disease (which we will term “health-based IAQ targets”).<sup>1</sup> IAQ targets could include carbon dioxide (CO<sub>2</sub>) and particulate matter (PM<sub>2.5</sub>), 2 easy-to-measure indicators of air quality and ventilation. Without simple targets that building owners and the broader public can coalesce behind, there is no clear goal to drive toward. Federal, state, and local policymakers have declared a need for IAQ targets to point to in legislation or guidance. Recently proposed metrics by Morawska et al and Health Canada can serve as models for future action.<sup>1,35</sup>
2. **State and Local IAQ Standards:** States and local entities need to adopt and implement IAQ and ventilation building standards. Building codes are adopted and enforced at the state and local levels, and many do not have the latest ventilation standards, leading to a patchwork of requirements. Similar to national model energy codes, a national model IAQ code can provide clear consensus around design and operation standards in buildings and promote easier adoption

nationwide.<sup>36</sup> Additionally, states can incentivize or require clean indoor air through legislation, voluntary guidelines, tax incentives, regulations, and technical assistance programs. Nongovernmental organizations (NGOs) could catalyze this process by developing a state playbook with model policies, guidelines, building codes, and regulations.

3. **Sector-Specific IAQ Standards and Guidelines:** There are opportunities to improve IAQ in schools, nursing homes, defense buildings, federal and state-owned buildings, workplace settings, and public transportation. Importantly, IAQ monitoring and maintenance should be incorporated into all IAQ implementation efforts, ensuring that buildings meet performance standards, not just design standards.
4. **IAQ research and development:** There is a need for coordinated research and development related to improving IAQ and reducing airborne disease transmission. Many federal entities—particularly the CDC, Department of Energy (DOE), EPA, and the National Institutes of Health (NIH)—play a role in advancing our understanding of indoor air contaminants, respiratory disease transmission, and air mitigation strategies, but there is no coordinated research agenda to address major knowledge gaps and technology needs. The federal government can support this by establishing a center for preventing airborne disease, with an emphasis on translational research. The federal government can also uplift the Federal Interagency Committee on Indoor Air Quality to improve coordination and support the market for safe and effective air purifiers.

### *Develop Health-Based IAQ Targets for Adoption at the State and Local Levels*

IAQ targets include pollutant thresholds and clean air delivery rates that promote health and wellbeing of building occupants. Similar to how EPA sets National Ambient Air Quality Standards (NAAQS) for outdoor air pollutants, EPA could publish voluntary health-based targets for indoor air that aim to reduce disease transmission and exposure to harmful pollutants. The bipartisan legislation Indoor Air Quality and Healthy Schools Act of 2024 outlines a framework for EPA voluntary target development.<sup>28</sup>

To complement or precede any national standards, a nongovernmental coalition could create a consensus and health-based guideline for IAQ that state and local entities can voluntarily adopt. This guideline could present metrics or thresholds for easy-to-measure indoor air pollutants (such as CO<sub>2</sub> and PM<sub>2.5</sub>). Entities positioned to publish guidelines may include the World Health Organization; ASHRAE; National Academies of Sciences, Engineering, and Medicine; or a commissioned task force. A US state

Table 1. Federal and State Policy Recommendations

	<i>Federal Entities</i>	<i>State Entities</i>	<i>Recommendation</i>
Develop IAQ targets	EPA	State health departments	Publish voluntary health-based IAQ targets for indoor air pollutants
Support state and local governments in adopting IAQ building standards	DOE	State health and energy departments	Develop a national model IAQ code
	–	State and local jurisdictions	Adopt the latest building ventilation codes
	DOE	State energy departments	Provide technical assistance for IAQ code development, adoption, and compliance, and support IAQ improvements alongside building energy updates
	Congress	State legislatures	Provide tax incentives for IAQ improvements in commercial buildings
	–	State agencies (with support from NGOs)	Develop a playbook for state IAQ policies, regulations, and guidelines
Implement sector-specific standards and guidelines	–	State legislatures, health and education departments	Set standards and guidelines for IAQ in schools
	DOD	–	Develop and codify IAQ standards for defense buildings
	CMS	State legislatures	Set IAQ standards or guidelines for nursing homes. Incorporate IAQ into infection prevention and control programs
	GSA	State general services and administration departments	Ensure federal and state-owned buildings meet existing ventilation standards and improve HVAC operations and maintenance
	OSHA	State OSHA plans and labor departments	Update IAQ exposure limits for occupational settings
	DOT	State transportation departments	Publish guidelines for IAQ and mitigating airborne disease transmission in public transportation. Support implementation through state and local grant programs
	Expand R&D	HHS	–
EPA		–	Publish a protocol for the testing and certification of air purifiers and monitors
CIAQ, Congress		–	Clarify the roles and responsibilities of the CIAQ and allocate funds to enhance its effectiveness as a coordinating body

Abbreviations: CIAQ, Federal Interagency Committee on Indoor Air Quality; CMS, Centers for Medicare and Medicaid Services; DOD, Department of Defense; DOE, Department of Energy; DOT, Department of Transportation; EPA, Environmental Protection Agency; GSA, General Services Administration; HHS, Department of Health and Human Services; IAQ, indoor air quality; NGO, nongovernmental organization; OSHA, Occupational Safety and Health Administration; R&D, research and development.

could also publish guidelines in partnership with the state health department or an advisory council, providing a model for other states and localities to adopt.

***Support States and Local Communities With the Adoption of IAQ Building Standards and Financing for Their Implementation***

**Develop a National Model IAQ Code**

A national coalition including state health and energy departments, industry, academia, and other nongovernmental

partners could call for and facilitate the development of a national model IAQ code, which could then be adopted at the state and local levels. Similar to how DOE participates in the development of voluntary building energy codes, DOE could help facilitate the development of a national model IAQ code. The code should include building *design* standards as well as building *performance* standards. The publication of this code is an opportunity to elevate how IAQ improvements (and ongoing monitoring and verification) can align with energy efficiency investments and support buildings that are healthy and sustainable while saving costs

(building tune-ups can achieve upwards of 15% energy savings while improving IAQ).<sup>37,38</sup>

Additionally, ASHRAE could develop an IAQ standard as a future evolution of Standard 62.1 and Standard 241.<sup>29,39</sup> Standard 62.1 for Ventilation and Acceptable Indoor Air Quality sets *minimum* ventilation standards and Standard 241 sets IAQ standards during periods of high airborne infection transmission risk (“Infection Risk Management Mode”), such as during a pandemic, that can be achieved through a combination of ventilation, filtration, and air cleaning. Neither standard is intended to mitigate disease transmission and provide health-based IAQ during routine operations. ASHRAE and other entities could also promote the full adoption of ASHRAE 62.1, including the *design* and *performance* components.

### **Adopt IAQ Building Codes and Provide Technical Assistance**

State and local jurisdictions could update building codes to meet minimum ventilation standards (such as ASHRAE 62.1 and 62.2) and work towards adopting more comprehensive health-based standards. Congress could establish a federal grant program administered by the DOE Building Technologies Office to support jurisdictions in this process and provide technical assistance for code development, adoption, and compliance. Similarly, states can establish technical assistance programs to support local implementation of IAQ building codes. DOE and states could incentivize the adoption of IAQ standards alongside grant programs that fund the adoption of the latest building energy codes.

### **Provide Tax Incentives for IAQ Improvements in Commercial Buildings**

State and local governments could expand tax deductions, grants, and other financial incentives for commercial buildings that meet IAQ standards, similar to existing federal, state, and local energy-efficiency tax deductions. For example, states such as Maryland, Nevada, and Ohio offer tax abatements and credits for buildings with LEED certification.<sup>32,40</sup> Similarly, Congress could amend the Internal Revenue Code of 1986 to provide tax credits for IAQ assessments and improvements in commercial buildings, as introduced in the Airborne Act of 2024.<sup>41</sup> As businesses invest in energy efficiency, there are opportunities to conduct IAQ improvements alongside energy-efficiency improvements.

Although buildings are designed to meet certain standards when first constructed, building performance often declines over time, worsening IAQ in older buildings.<sup>42</sup> States and local jurisdictions can incentivize the adoption of third-party building certification programs with IAQ components and provide financial incentives for routine operations and maintenance to address existing buildings.

### **Develop a Playbook for State IAQ Policies, Regulations, and Guidelines**

NGOs, in partnership with state governments and agencies, could develop an IAQ playbook for state legislatures; state departments of health, education, energy, and housing; and state and local building code councils. This state playbook would offer template language for guidelines, regulations, building codes, and draft law, and provide a menu of options for state IAQ actions. Since the development of this commentary, such a resource has been advanced through the Brown University Pandemic Center’s 2025 state guide for clean indoor air, published in partnership with other NGOs.<sup>43</sup> The playbook complements existing resources like the Johns Hopkins Center for Health Security’s Model Clean Indoor Air Act.<sup>31</sup>

### **Implement Sector-Specific IAQ Standards or Guidelines**

#### **Set Standards and Guidelines for IAQ in Schools**

State legislatures and health and education departments can require or incentivize schools to install IAQ monitors, regularly inspect and maintain HVAC systems, install higher-rated MERV filters, or install classroom-level air cleaning, as recommended by ASHRAE’s Design Guidance for Schools.<sup>44</sup> State health and education departments can publish guidelines and best practices to support school districts, building upon existing resources like EPA’s Tools for Schools.<sup>45</sup> Most schools in the United States have poor IAQ. A 2020 Government Accountability Office report found that 41 percent of school districts need to update or replace HVAC systems in at least half of their schools.<sup>46</sup> Improving IAQ can help keep children safe and healthy, improve learning, and reduce absenteeism.

IAQ monitoring provides helpful information on building performance, as ventilation performance decreases over time, and outdoor conditions, such as high concentrations of wildfire smoke, change IAQ. Measuring indoor air metrics (eg, as done by the Boston Public School District) can turn the invisible visible, allowing school facilities managers to see real-time IAQ and intervene when necessary.<sup>47</sup> Monitoring should be considered for all buildings, including the buildings referenced below, and should be integrated into IAQ management plans and standards.

#### **Develop and Codify IAQ Standards for Defense Buildings**

The Department of Defense (DOD) could develop and codify IAQ standards to maintain US military readiness and ensure the health and safety of military personnel. In doing so, DOD could update the Unified Facilities Criteria to require health-based IAQ standards and regular operations and maintenance for defense buildings.<sup>48</sup> The DOD oversees one of the world’s largest building portfolios, with over

280,000 buildings and structures. Aligning with the Resilient and Healthy Defense Communities Strategy and subsequent Implementation Plan, improving IAQ through better ventilation, filtration, and disinfection would reduce the risk of disease transmission and improve resiliency to biological threats.<sup>49,50</sup>

#### **Set Minimum IAQ Standards or Guidelines for Nursing Homes**

The Centers for Medicare and Medicaid Services (CMS) could set IAQ standards as a condition of participation for nursing homes. While hospitals must meet ventilation requirements as a condition for participation, nursing homes do not. Infections are a major concern, and cleaner indoor air can reduce infections in nursing centers.<sup>51</sup> CMS could require nursing homes to meet minimum IAQ standards and achieve the CDC's recommended 5 air changes per hour. It could also amend federal regulations 42 CFR §483.80 to require nursing homes to include IAQ in their infection prevention and control programs and in the training for infection preventionists.<sup>52</sup> A good start would be to incorporate IAQ into annual inspections and the Five-Star Quality Rating system.<sup>53</sup>

States could adopt IAQ standards for nursing homes for design and ongoing performance standards. For new buildings, states could adopt design standards such as ASHRAE 170 Ventilation of Healthcare Facilities (also included in the facilities guidance institute guidelines).<sup>54,55</sup> While there are no performance requirements specifically for nursing homes, states could incorporate CDC hospital ventilation requirements and require IAQ inspections as part of routine assessments.<sup>56,57</sup>

#### **Ensure Federal and State Buildings Meet Health-Based IAQ Standards**

Government agencies that oversee and set standards for federal- and state-owned buildings could ensure these buildings provide clean indoor air. State administration and general services departments, such as the Texas Facilities Commission or California Department of General Services, could ensure the latest building ventilation codes are adopted for their buildings and establish ventilation verification programs.

The General Services Administration (GSA) oversees federal buildings that house approximately 1 million federal employees. Federal regulation 41 CFR §102-74.195 requires agencies to meet ventilation rates under ASHRAE Standard 62.1.<sup>19</sup> However, a recent audit of federal buildings found that the majority did not meet the standard or could not be assessed due to incomplete data.<sup>42</sup> This points to a major challenge with implementing these standards: operation and maintenance requirements are not incorporated or enforced, and building ventilation performance typically decreases with time when ventilation systems are not adequately maintained. GSA could

establish a ventilation verification program to ensure all federal buildings meet IAQ standards. GSA could also improve building operations and maintenance, establish a routine ventilation assessment for buildings, and publish a best practices guide to ensure federal buildings meet existing standards. As federal workers return to in-person work full time, improving ventilation is key to reducing sick days and employee absences.<sup>13</sup>

#### **Update IAQ Exposure Limits for Occupational Settings**

The Occupational Safety and Health Administration (OSHA) could update its permissible exposure limits (PELs) to be more comprehensive and consistent with recent evidence. OSHA regulates exposure to specific airborne contaminants (such as benzene and asbestos) in occupational settings via PELs and provides voluntary guidance.<sup>58,59</sup> OSHA "recognizes that many of its [PELs] are outdated and inadequate for ensuring protection of worker health," as most were developed in the 1970s, and points to more updated exposure limits from California OSHA, the National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH).<sup>60</sup> In addition to updating the PELs, OSHA could include sector-specific guidance for occupational settings with high exposure to airborne pollutants or pathogens. For example, restaurant ventilation guidelines could address fine particulate matter and volatile organic compounds, which often accumulate in commercial kitchens. State labor or occupational safety and health departments could adopt the regularly updated California OSHA or ACGIH exposure limits or publish voluntary guidelines.

#### **Set IAQ Guidelines for Public Transportation**

State transportation departments and the US Department of Transportation (DOT) could publish guidelines for improving IAQ and mitigating airborne disease transmission in public transportation. DOT could incentivize IAQ improvements through its grant programs. Just as airplanes have IAQ standards, other forms of public transportation can as well.<sup>61</sup>

### ***Expand IAQ Research and Development***

#### **Establish a National Center for Research and Development to Improve IAQ and Reduce Disease Transmission**

The Department of Health and Human Services (HHS) could establish a center for preventing airborne disease to lead the federal government's research efforts. Similar to recommendations from experts, this center could fund basic and translational research, including randomized controlled trials, to strengthen the evidence around IAQ and airborne disease transmission.<sup>62</sup> Research is currently distributed across multiple government agencies, and no

entity drives progress on critical research needs. For example, the federal government has limited infrastructure to quickly deploy research efforts to assess how new pathogens spread through the air and what interventions can best reduce the spread. The research center could additionally study the safety, efficacy, and deployment of technologies such as far-UVC (ultraviolet C). The center could include a shared research facility between EPA, HHS, and the Department of Homeland Security and help accelerate response to future biological threats.

#### Establish a Protocol for the Testing and Certification of Air Purifiers and Monitors

In coordination with the National Institute of Standards and Technology (NIST) and the Food and Drug Administration (FDA), EPA could publish a protocol for testing and certifying air purifiers. FDA regulations are limited to devices that are intended for medical use. Although EPA regulates nonmedical devices, its regulations primarily cover the mislabeling of devices.<sup>63</sup> There is no federal certification guaranteeing the safety and efficacy of non-medical devices, including air purifiers, and the federal government defers to industry bodies such as the Association of Home Appliance Manufacturers in verifying the efficacy of air purifiers in removing particulate matter.<sup>64,65</sup> Industry certification, however, is voluntary and does not test for other criteria, such as byproduct formation or chemical and gas removal efficiency. For example, the use of some bipolar ionization in air purifiers has the potential to generate harmful byproducts, and air purifiers that claim to reduce levels of volatile organic compounds may increase them.<sup>66,67</sup> EPA, FDA, and NIST could play a role in supporting a safe and efficient market for air cleaners by developing a comprehensive protocol for testing and certification.

Similarly, EPA, FDA, and NIST could publish a protocol for testing and certifying IAQ monitors, which can vary widely in accuracy. One analysis of 14 low-cost devices

available to consumers found that while all devices met reported accuracy ranges for temperature, relative humidity, and CO<sub>2</sub>, only 1 device met the accuracy range for PM<sub>2.5</sub>.<sup>68</sup> Federal agencies could also point to existing third-party accreditations, such as RESET Accredited Monitors or UL 2905 Environmental Claim Validation Procedure.<sup>69,70</sup>

#### Elevate the Role of the Federal Interagency Committee on Indoor Air Quality

The Federal Interagency Committee on Indoor Air Quality (CIAQ) was established by Congress in 1983 to coordinate federal IAQ research and facilitate information sharing.<sup>71</sup> Leadership from CIAQ cochairs (the Consumer Product Safety Commission, DOE, EPA, NIOSH, and OSHA) or Congress could elevate the committee by clarifying its roles and responsibilities and allocating funds to enhance its effectiveness as a coordinating body. Additionally, CIAQ could conduct a landscape analysis and publish a research agenda for federal IAQ research and development.

#### FUTURE ACTION

New authorities, funding, or requirements may be needed to achieve the policy options outlined above. Vehicles to achieve these changes may include congressional or state legislation, appropriations, agency actions, and grant programs (Table 2). Importantly, partners from the private sector, including NGOs, industry, and academia, are essential to advancing these recommendations. External advocates and experts need to make the case to policymakers for the health, economic, and security benefits of IAQ. Partnerships are essential between ventilation experts, health experts, and federal, state, and local staff to develop scientifically sound guidelines tailored to the needs of local communities.

While the recommendations above are important for advancing IAQ, we recognize that only a subset may be

Table 2. Vehicles for Action

<i>Vehicle</i>	<i>Action</i>
Congressional legislation	Incorporate IAQ legislation into new stand-alone bills or forthcoming legislative vehicles such as the National Defense Authorization Act (annually) or the Pandemic and All-Hazards Preparedness Act
State legislation	Require or incentivize IAQ standards, guidelines, monitoring, and improvements; establish new state and local IAQ programs
Congressional and state appropriations	Allocate funding for federal and state IAQ programs
Federal and state agency actions	Catalyze new agency actions, including new guidelines, regulations, programs, or communications
Federal and state grant programs	Incentivize IAQ improvements by directly funding IAQ programs at the state and local levels or attaching funding conditions to existing grant programs
Building codes	Update local building codes to incorporate IAQ and ventilation standards (such as ASHRAE 62.1) and consider integration of IAQ performance metrics

Abbreviation: IAQ, indoor air quality.

pursued in the short term. Based on conversations with experts inside and outside of government, we have presented recommendations in roughly descending priority order, emphasizing that recommendations 1 (for health-based IAQ targets) and 2 (for state adoption of IAQ building standards) will unlock bottlenecks to advance widespread progress.

## CONCLUSION

Clean indoor air is essential for health, productivity, economic growth, and national security. Federal, state, and local governments can play a critical role in advancing IAQ, and we present a menu of policy options to accomplish this. First, we recommend developing health-based IAQ targets for broad adoption. Second, federal and state governments could support adopting and implementing IAQ standards by developing model codes, establishing or expanding grant programs, and providing tax incentives and technical assistance. Third, federal and state agencies could implement sector-specific guidelines for schools, nursing homes, defense buildings, and public transportation, and require clean indoor air in federal- and state-owned buildings. Lastly, the federal government could expand research and development to reduce disease transmission, improve interagency coordination, and support a credible market for air purifiers and monitors. Cleaner indoor air is an overlooked public health issue, and we have the opportunity to transform where we live, learn, eat, and work into healthier, safer, and more productive spaces.

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## REFERENCES

- Morawska L, Allen J, Bahnfleth W, et al. Mandating indoor air quality for public buildings. *Science*. 2024;383(6690):1418-1420.
- Allen JG. Recommitting to ventilation standards for healthy indoor air quality. *Am J Public Health*. 2024;114(10):991-993.
- Azimi P, Stephens B. A framework for estimating the US mortality burden of fine particulate matter exposure attributable to indoor and outdoor microenvironments. *J Expo Sci Environ Epidemiol*. 2020;30(2):271-284.
- United States Environmental Protection Agency. Indoor air quality. Updated June 17, 2025. Accessed December 10, 2025. <https://www.epa.gov/report-environment/indoor-air-quality>
- Wang CC, Prather KA, Sznitman J, et al. Airborne transmission of respiratory viruses. *Science*. 2021;373(6558):eabd9149.
- United States Environmental Protection Agency. Why indoor air quality is important to schools. Updated September 24, 2025. Accessed December 10, 2025. <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>
- Anderson JO, Thundiyil JG, Stolbach A. Clearing the air: A review of the effects of particulate matter air pollution on human health. *J Med Toxicol*. 2012;8(2):166-175.
- Allen JG, MacNaughton P, Satish U, Santanam S, Vallarino J, Spengler JD. Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: A controlled exposure study of green and conventional office environments. *Environ Health Perspect*. 2016;124(6):805-812.
- World Health Organization (WHO) Regional Office for Europe (EURO). *WHO Guidelines for Indoor Air Quality: Selected Pollutants*. Copenhagen: WHO EURO; 2010.
- Chiavarini M, Rosignoli P, Sorbara B, Giacchetta I, Fabiani R. Benzene exposure and lung cancer risk: a systematic review and meta-analysis of human studies. *Int J Environ Res Public Health*. 2024;21(2):205.
- Wang H, Paulson KR, Pease SA, et al. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020–21. *Lancet*. 2022;399(10334):1513-1536.
- Zhang R, Li Y, Zhang AL, Wang Y, Molina MJ. Identifying airborne transmission as the dominant route for the spread of COVID-19. *Proc Natl Acad Sci U S A*. 2020;117(26):14857-14863.
- Lawrence Berkeley National Laboratory Indoor Air Quality (IAQ) Scientific Findings Resource Bank. Ventilation rates and absences in offices and schools. Accessed January 30, 2025. <https://iaqscience.lbl.gov/ventilation-rates-and-absences-offices-and-schools>
- Fisk WJ, Black D, Brunner G. Benefits and costs of improved IEQ in U.S. offices. *Indoor Air*. 2011;21(5):357-367.
- Cedeño Laurent JG, MacNaughton P, Jones E, et al. Associations between acute exposures to PM2.5 and carbon dioxide indoors and cognitive function in office workers: a multi-country longitudinal prospective observational study. *Environ Res Lett*. 2021;16(9):094047.
- Allen JG, Macomber JD. *Healthy Buildings: How Indoor Spaces Can Make You Sick—or Keep You Well*. Cambridge, MA: Harvard University Press; 2022.
- Milton DK, Glencross PM, Walters MD. Risk of sick leave associated with outdoor air supply rate, humidification, and occupant complaints. *Indoor Air*. 2000;10(4):212-221.
- Clean Air Act. 42 USC §7401 et seq. <https://www.govinfo.gov/content/pkg/USCODE-2011-title42/html/USCODE-2011-title42-chap85.htm>
- What ventilation policy must Federal agencies follow? 41 CFR §102-74.195. <https://www.ecfr.gov/current/title-41/section-102-74.195>

20. Congressional Research Service. Building codes, standards, and regulations: Frequently asked questions. Published April 23, 2025.
21. California Department of Public Health. Improving indoor air quality in schools. Published November 6, 2024. Accessed January 31, 2025. <https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/COVID-19-and-Improving-Indoor-Air-Quality-in-Schools.aspx>
22. California Air Resources Board. Fact sheets and other resources. Accessed January 31, 2025. <https://ww2.arb.ca.gov/our-work/programs/indoor-air-quality/fact-sheets-and-other-resources>
23. California Air Resources Board. California's air cleaner regulation (AB 2276). Accessed January 31, 2025. <https://ww2.arb.ca.gov/about-indoor-air-cleaning-devices-regulation>
24. Connecticut State Government Department of Administrative Services. Indoor air quality requirements for school districts. Accessed May 12, 2025. <https://portal.ct.gov/das/grants/hvac-grants/iaq-requirements-for-school-districts>
25. Minnesota Department of Health. Indoor air quality (IAQ) in schools. Accessed January 31, 2025. <https://www.health.state.mn.us/communities/environment/air/schools/index.html>
26. The White House. Clean Air in Buildings Challenge. Published March 2022. Accessed May 15, 2025. <https://bidenwhitehouse.archives.gov/cleanindoorair/>
27. US Centers for Disease Control and Prevention. How much ventilation is enough? Published October 3, 2024. Accessed January 31, 2025. <https://www.cdc.gov/niosh/ventilation/prevention/Aim-for-5.html>
28. Indoor Air Quality and Healthy Schools Act, HR 9131, 118th Cong (2024). <https://www.congress.gov/bill/118th-congress/house-bill/9131>
29. ASHRAE. *ASHRAE Standard 241-2023, Control of Infectious Aerosols*. Peachtree Corners, GA: ASHRAE; 2023.
30. Persily A. Challenges in developing ventilation and indoor air quality standards: the story of ASHRAE Standard 62. *Build Environ*. 2015;91:61-69.
31. Johns Hopkins Center for Health Security. *Model Clean Indoor Air Act*. Baltimore, MD: Johns Hopkins Center for Health Security; 2023. Accessed December 10, 2025. <https://centerforhealthsecurity.org/sites/default/files/2024-07/240710-mciaa.pdf>
32. US Green Building Council (USGBC). LEED rating system. Accessed February 3, 2025. <https://www.usgbc.org/leed>
33. International WELL Being Institute (IWBI). Accessed February 3, 2025. <https://www.wellcertified.com/>
34. Fitwel. Accessed February 3, 2025. <https://www.fitwel.org>
35. Government of Canada. Indoor air quality resources for professionals. Updated September 19, 2025. Accessed December 10, 2025. <https://www.canada.ca/en/health-canada/services/air-quality/residential-indoor-air-quality-guidelines.html>
36. US Department of Energy. Commercial and residential building energy codes. Accessed February 4, 2025. <https://www.energycodes.gov/commercial-and-residential-building-energy-codes>
37. Allen JG. Designing buildings that are both well-ventilated and green. *Harv Bus Rev*. Published January 9, 2023. Accessed February 4, 2025. <https://hbr.org/2023/01/designing-buildings-that-are-both-well-ventilated-and-green>
38. Mills E. Building commissioning: a golden opportunity for reducing energy costs and greenhouse gas emissions in the United States. *Energy Effic*. 2011;4(2):145-173.
39. ASHRAE. *ANSI/ASHRAE Standard 62.1-2022: Ventilation and Acceptable Indoor Air Quality*. Peachtree Corners, GA: ASHRAE; 2022.
40. Holowka T. Engaging with state and local governments on LEED. U.S. Green Building Council. Published February 8, 2021. Accessed January 31, 2025. <https://www.usgbc.org/articles/engaging-state-and-local-governments-leed>
41. Airborne Act of 2024, HR 9000, 118th Cong (2024). <https://www.congress.gov/bill/118th-congress/house-bill/9000/titles>
42. US General Services Administration (GSA) Office of Inspector General. *Audit of GSA's Response to COVID-19: PBS Faces Challenges to Meet the Ventilation and Acceptable Indoor Air Quality Standard in GSA-Owned Buildings*. Washington, DC: GSA; 2023. Accessed December 10, 2025. <https://www.gsaig.gov/content/audit-gsas-response-covid-19-pbs-faces-challenges-meet-ventilation-and-acceptable-indoor>
43. Chwalek S, Lagoudas GK, Bhanger S, et al. *Clean Indoor Air: A Guide for State Leaders to Improve Indoor Air Quality*. Providence, RI: Brown University Digital Publications; 2025. Accessed February 12, 2026. doi: 10.26300/b64s-yn69
44. ASHRAE Technical Committee 9.7, Educational Facilities. *Design Guidance for Education Facilities: Prioritization for Advanced Indoor Air Quality*. Peachtree Corners, GA: ASHRAE; 2023. Accessed May 12, 2025. <https://www.ashrae.org/file%20library/technical%20resources/free%20resources/design-guidance-for-education-facilities.pdf>
45. United States Environmental Protection Agency. IAQ tools for schools resources. Updated May 21, 2025. Accessed December 10, 2025. <https://www.epa.gov/iaq-schools/iaq-tools-schools-resources>
46. US Government Accountability Office (GAO). *K-12 Education: School Districts Frequently Identified Multiple Building Systems Needing Updates or Replacement*. Washington, DC: GAO; 2020. Accessed December 10, 2025. <https://www.gao.gov/assets/gao-20-494.pdf>
47. Boston Public Schools. Indoor Air Quality Sensor Dashboard. Accessed February 4, 2025. <https://www.bostonpublicschools.org/students-families/respiratory-illness-protocols/air-quality/indoor-air-quality-sensor-dashboard>
48. Whole Building Design Guide. Unified Facilities Criteria (UFC). Accessed January 31, 2025. <https://www.wbdg.org/dod/ufc>
49. US Department of Defense (DOD). *Strategy for Resilient and Healthy Defense Communities*. Washington, DC: DOD; 2024. Accessed December 10, 2025. [https://media.defense.gov/2024/Feb/15/2003394891/-1/-1/1/RESILIENT\\_AND\\_HEALTHY\\_DEFENSE\\_COMMUNITIES\\_OSD008028\\_23\\_RES\\_FINAL%20.PDF](https://media.defense.gov/2024/Feb/15/2003394891/-1/-1/1/RESILIENT_AND_HEALTHY_DEFENSE_COMMUNITIES_OSD008028_23_RES_FINAL%20.PDF)
50. US Department of Defense (DOD). *Resilient and Healthy Defense Communities Implementation Plan*. Washington, DC: DOD; 2024. Accessed December 10, 2025. <https://media.defense.gov/2024/Nov/21/2003592153/-1/-1/1/SIGNED-RESILIENT-AND-HEALTHY-DEFENSE-COMMUNITIES-IMPLEMENTATION-PLAN.PDF>

51. Khadar BTSA, Sim J, McDonald VM, McDonagh J, Clapham M, Mitchell BG. Air purifiers and acute respiratory infections in residential aged care: a randomized clinical trial. *JAMA Netw Open*. 2024;7(11):e2443769.
52. Infection Control. 42 CFR §483.80. <https://www.ecfr.gov/current/title-42/chapter-IV/subchapter-G/part-483/subpart-B/section-483.80>
53. US Centers for Medicare and Medicaid Services. Five-Star Quality Rating System. Updated December 10, 2025. Accessed January 31, 2025. <https://www.cms.gov/medicare/health-safety-standards/certification-compliance/five-star-quality-rating-system>
54. ASHRAE. *ANSI/ASHRAE/ASH Standard 170-2017, Ventilation of Health Care Facilities*. Peachtree Corners, GA: ASHRAE; 2017.
55. Facility Guidelines Institute. FGI guidelines for design and construction. Accessed December 10, 2025. <https://www.fgiguidelines.org/>
56. Schulster LM, Chinn RYW, Arduino MJ, et al. *Guidelines for Environmental Infection Control in Health-Care Facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)*. Chicago; American Society for Healthcare Engineering/American Hospital Association; 2004. Accessed December 10, 2025. <https://www.cdc.gov/infection-control/media/pdfs/Guideline-Environmental-H.pdf>
57. US Centers for Disease Control and Prevention. Appendix B. Air. Published January 11, 2024. Accessed January 30, 2025. <https://www.cdc.gov/infection-control/hcp/environmental-control/appendix-b-air.html>
58. Air Contaminants. 29 CFR §1910.1000. <https://www.ecfr.gov/current/title-29/section-1910.1000>
59. Occupational Safety and Health Administration. Indoor air quality. Accessed January 31, 2025. <https://www.osha.gov/indoor-air-quality>
60. Occupational Safety and Health Administration. Permissible exposure limits—annotated tables. Accessed February 4, 2025. <https://www.osha.gov/annotated-pels>
61. Federal Aviation Administration. Cabin air quality. Published September 4, 2025. Accessed December 10, 2025. <https://www.faa.gov/newsroom/cabin-air-quality-0>
62. Rockefeller Foundation. *Getting to and Sustaining the Next Normal: A Roadmap for Living With COVID*. New York: Rockefeller Foundation; 2022.
63. United States Environmental Protection Agency. Pesticide devices: a guide for consumers. Updated October 6, 2025. Accessed December 11, 2025. <https://www.epa.gov/pesticides/pesticide-devices-guide-consumers>
64. United States Environmental Protection Agency (EPA). Does EPA certify/register or provide lists of acceptable air cleaners or manufacturers/sellers? Updated March 11, 2025. Accessed December 11, 2025. <https://www.epa.gov/indoor-air-quality-iaq/does-epa-certifyregister-or-provide-lists-acceptable-air-cleaners-or>
65. AHAM Verifide. Facts about clean air. Accessed January 31, 2025. <https://ahamverifide.org/>
66. Zeng Y, Manwatkar P, Laguerre A, et al. Evaluating a commercially available in-duct bipolar ionization device for pollutant removal and potential byproduct formation. *Build Environ*. 2021;195:107750.
67. Ye Q, Krechmer JE, Shutter JD, et al. Real-time laboratory measurements of VOC emissions, removal rates, and byproduct formation from consumer-grade oxidation-based air cleaners. *Environ Sci Technol Lett*. 2021;8(12):1020-1025.
68. Peters T, Zhen C. Evaluating indoor air quality monitoring devices for healthy homes. *Buildings*. 2024; 14(1):102.
69. RESET. RESET air accredited monitor process. Accessed May 9, 2025. <https://www.reset.build/programs/monitors/process-air>
70. ARM Environments. UL 2905 environmental claim validation procedure. Accessed May 9, 2025. <https://www.arm-environments.com/resources/ul-2905-environmental-claim-validation-procedure>
71. United States Environmental Protection Agency. Federal Interagency Committee on Indoor Air Quality. Updated August 13, 2025. Accessed December 11, 2025. <https://www.epa.gov/indoor-air-quality-iaq/federal-interagency-committee-indoor-air-quality>

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