EPA United States Environmental Protection Agency

Indoor Chemistry Research Priorities Presentation to the Clean Air Act Advisory Committee June 15, 2022

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Outline

- Introduction by Jonathan Edwards, Director, Office of Radiation and Indoor Air
- Brief overview of EPA's Indoor Air Quality Program and Indoor Chemistry
- Overview of National Academies of Sciences, Engineering, and Medicine (NASEM) Indoor Chemistry Consensus Study
- Review Charge
- Discussion and Next Steps

Office of Radiation and Indoor Air
Indoor Environments Division

Poor indoor air quality is among the top 5 environmental public health risks; associated with significant economic burden

Addresses top public health risks

- Radon
- Asthma
- PM (indoors)
- IAQ in Homes & Schools
- Emerging & Emergency issues, e.g., hurricanes, wildfires, COVID-19, by-products of indoor chemistry

Non-regulatory program

- Develop, synthesize and translate IAQ science to inform policy/programs
- Technical guidance and assistance; public information and education
- Partnerships with industry, NGOs, feds, states, tribes, communities
- Grants to states, tribes and NGOs (e.g., State Indoor Radon Grants)

Primary authorizing statutes: SARA Title IV – Radon and Indoor Air Quality Research Act; TSCA Title III – Indoor Radon Abatement Act

Indoor air quality and chemicals

Everyone is impacted by indoor air quality (IAQ).

- People in the US spend about 90% of their time indoors.

Indoor air can contain a wide variety of chemical pollutants that originate from both indoor and outdoor sources.

Most exposure to chemicals from outdoor sources occurs indoors.

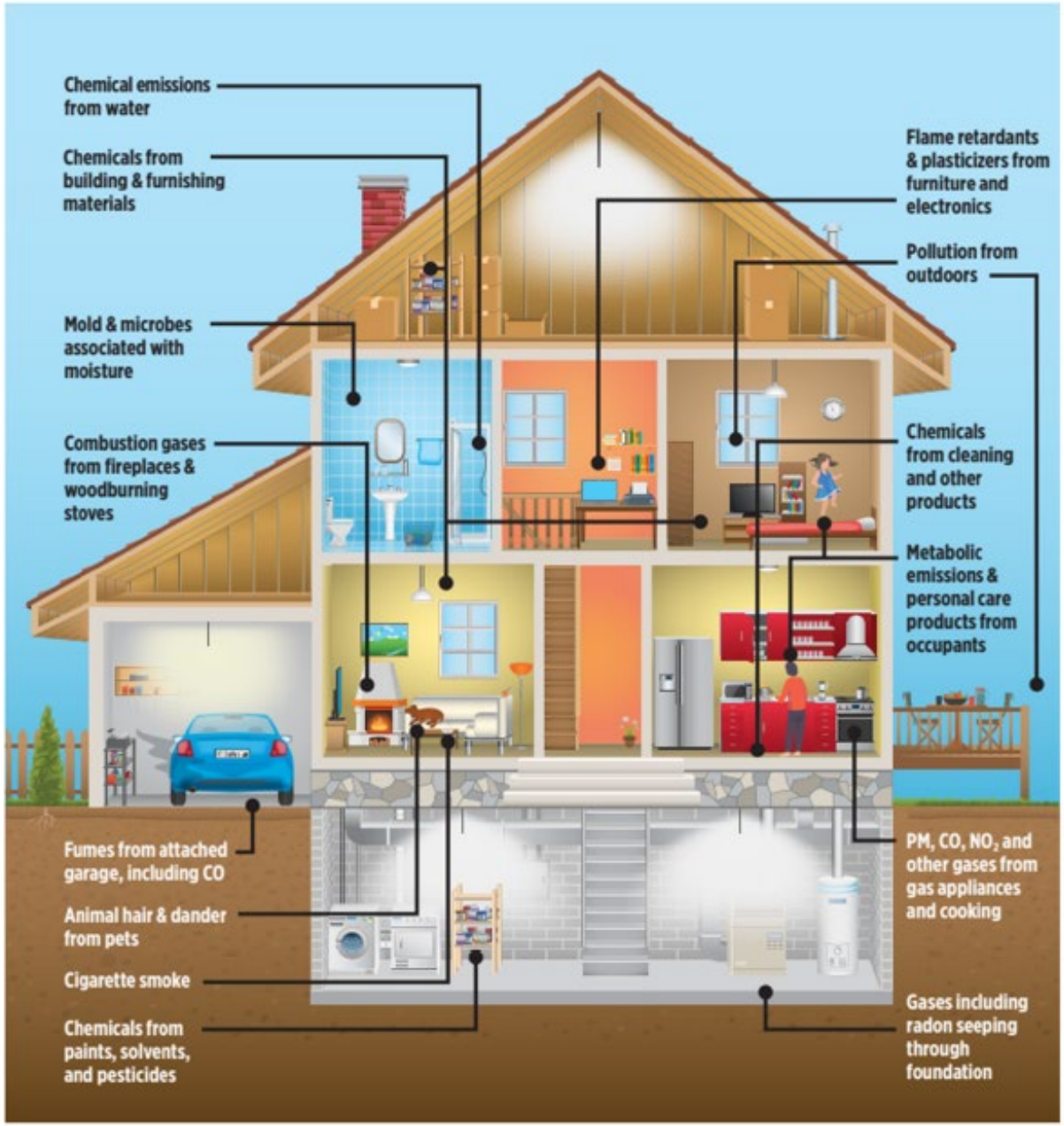
Indoor chemistry can transform some contaminants into new chemicals.

- The health impacts of many of these new chemical are not well understood.

Indoor sources of chemicals

- building materials
- biological sources (e.g., people, plants, pets, microorganisms)
- paints, pesticides
- personal care products
- stoves
- cleaning products
- furnishings
- electronics

Chemical emission sources and reservoirs



NASEM. 2022. Why Indoor Chemistry Matters. Figure 2-1.

Indoor air vs outdoor air

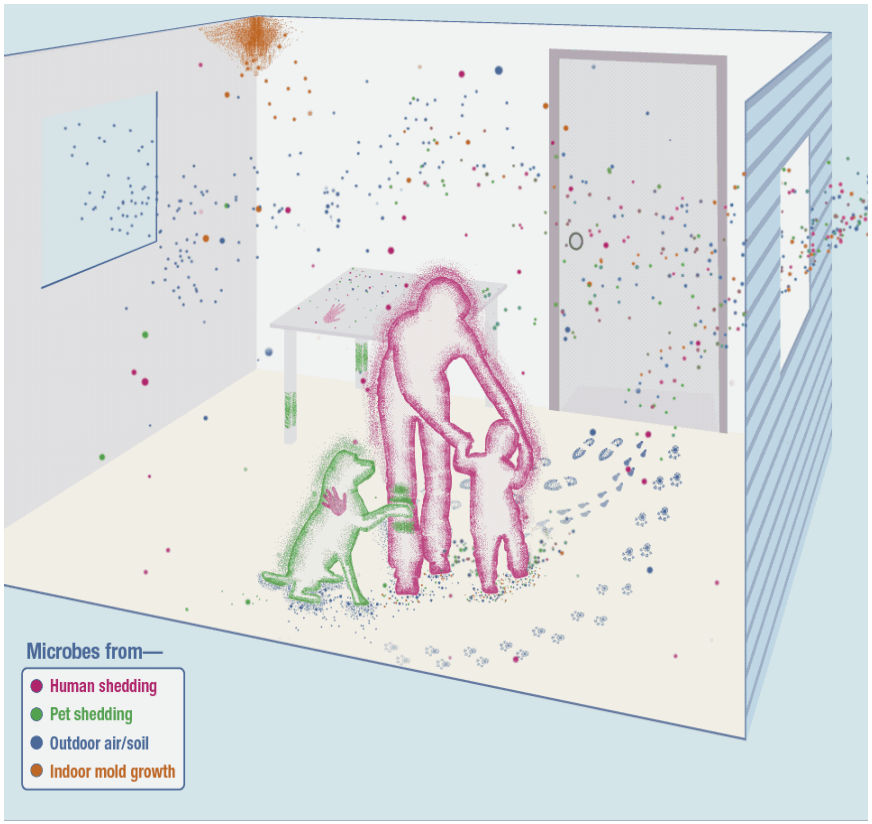
Indoor Air chemistry is more complex than outdoor air chemistry

- Indoors, there are more sources and more surfaces.

Exposure Rule of 1,000*

- A pollutant released indoors is about 1,000 times more likely to reach someone's lungs than if released outdoors.

Biological sources



*Nazaroff, W. 2008. **Inhalation intake fraction of pollutants from episodic indoor emissions**. *Building and Environment*, *43*(3), 269-277)

NASEM report highlights

"Chemicals found indoors are a significant risk factor that can modify or degrade the indoor environment. "

"…understanding complex chemistry matters for three prime reasons:

(1) indoor chemistry is complex and may lead to the creation of new chemicals of concern,

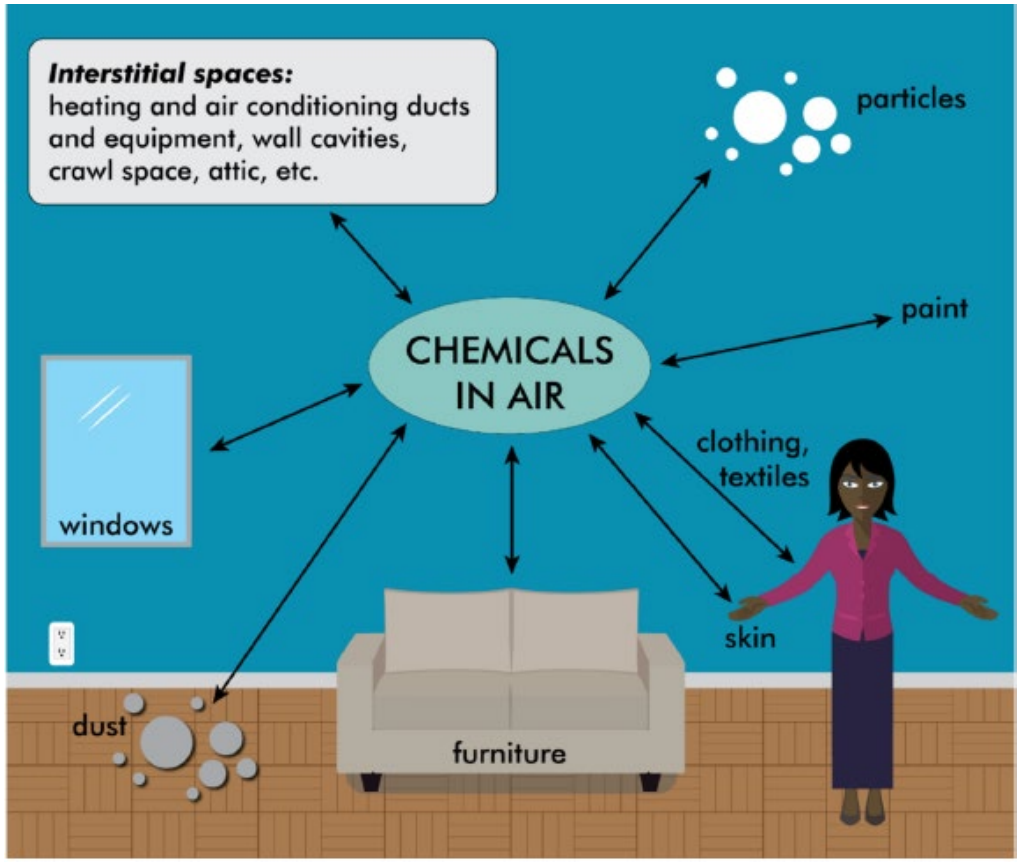
(2) indoor chemicals can adversely impact indoor air quality and the indoor environment, and

(3) indoor chemicals are an important source of human exposure that may result in adverse health effects."

Quotes from NASEM. 2022. *Why Indoor Chemistry Matters*

NASEM report highlights

Indoor chemistry is complex, involving partitioning and chemical transformation of a multitude of chemical species present in the gas phase and on airborne particles, indoor surfaces, dust, water, and other reservoirs.



NASEM. 2022. Why Indoor Chemistry Matters, Figure 3-2

NASEM report highlights

The NASEM report emphasizes the intersection of indoor chemistry with several priorities identified in EPA's Strategic Plan, including:

- environmental justice,
- climate change, and
- the importance of partnerships among indoor air scientists, engineers, regulators and others.

THE NASEM committee has indicated that "Effective management of chemicals in the indoor environment is critical to human health."

Key issue to address: There are many research needs. The committee did not prioritize these.

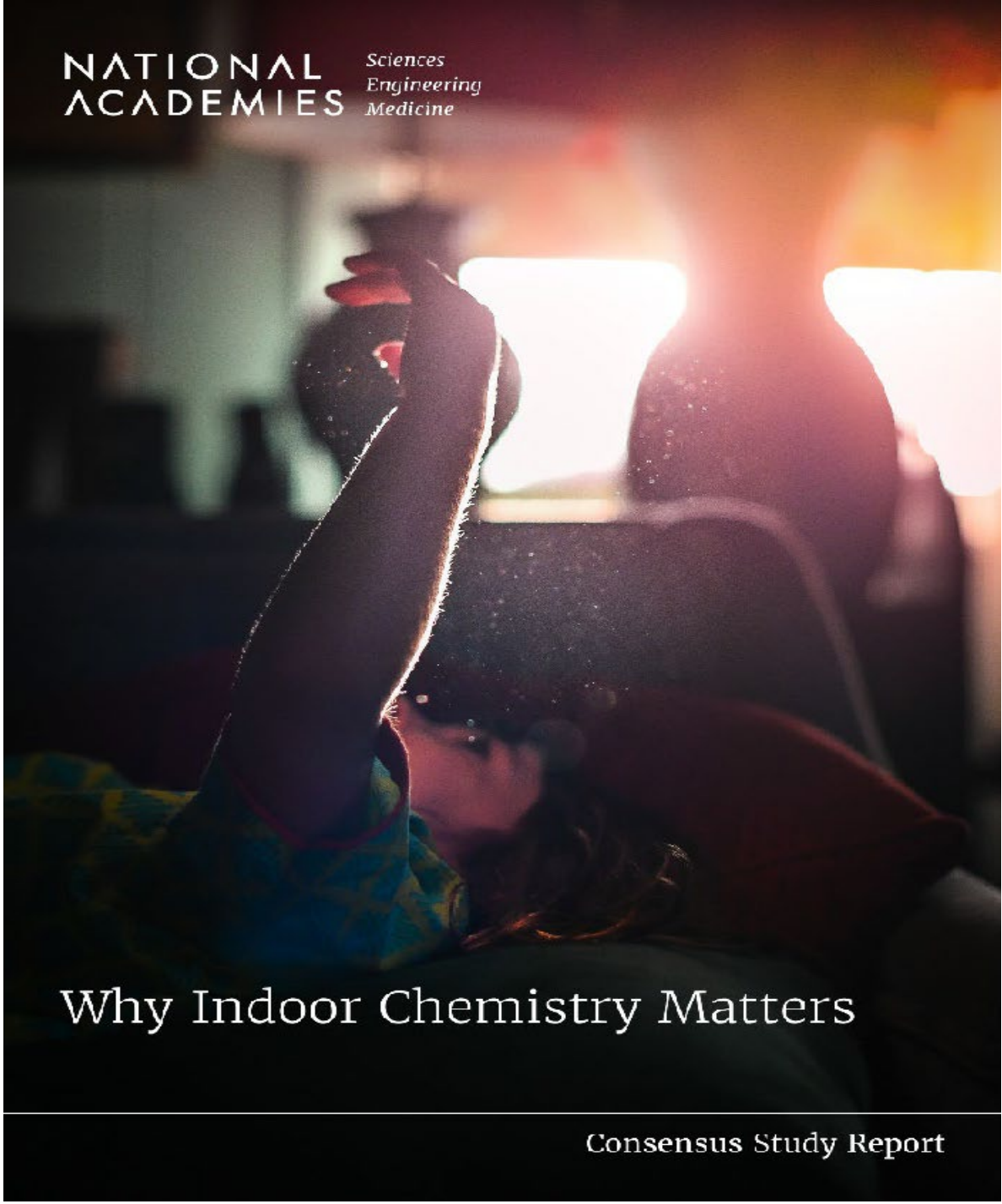
OAR/Indoor Environments Division (IED) response to NASEM report

IED is reviewing and carefully considering the NASEM report and priority actions we could pursue to further protect the public from exposures to chemicals in the indoor environment.

IED has ongoing work to effectively communicate the known risks associated with indoor chemical exposures and will update this work as appropriate.

IED works to support priority research on indoor chemistry internally and externally and will update this work based on the NASEM report & CAAAC recommendations.

Why Indoor Chemistry Matters



Sponsors

Alfred P. Sloan Foundation

U.S. Centers for Disease Control and Prevention

U.S. Environmental Protection Agency

U.S. National Institute of Environmental Health Sciences

Statement of Task

The National Academies of Sciences, Engineering, and Medicine will convene an ad hoc committee of scientific experts and leaders to consider the state-of-the science regarding chemicals in indoor air.

Specifically, the committee will focus on:

- new findings about previously under-reported chemical species, chemical reactions, and sources of chemicals, as well as the distribution of chemicals; and

- how indoor chemistry findings fit into context of what is already known about the link between chemical exposure, air quality, and human health.

Statement of Task

The committee's consideration of this information will lead to a report with findings and recommendations regarding:

1) key implications of the scientific research, including potential near-term opportunities for incorporating what is known into practice; and

2) where additional chemistry research will be most critical for understanding the chemical composition of indoor air and adverse exposures.

As appropriate, opportunities for advancing such research by addressing methodological or technological barriers or enhancing coordination or collaboration will be noted.

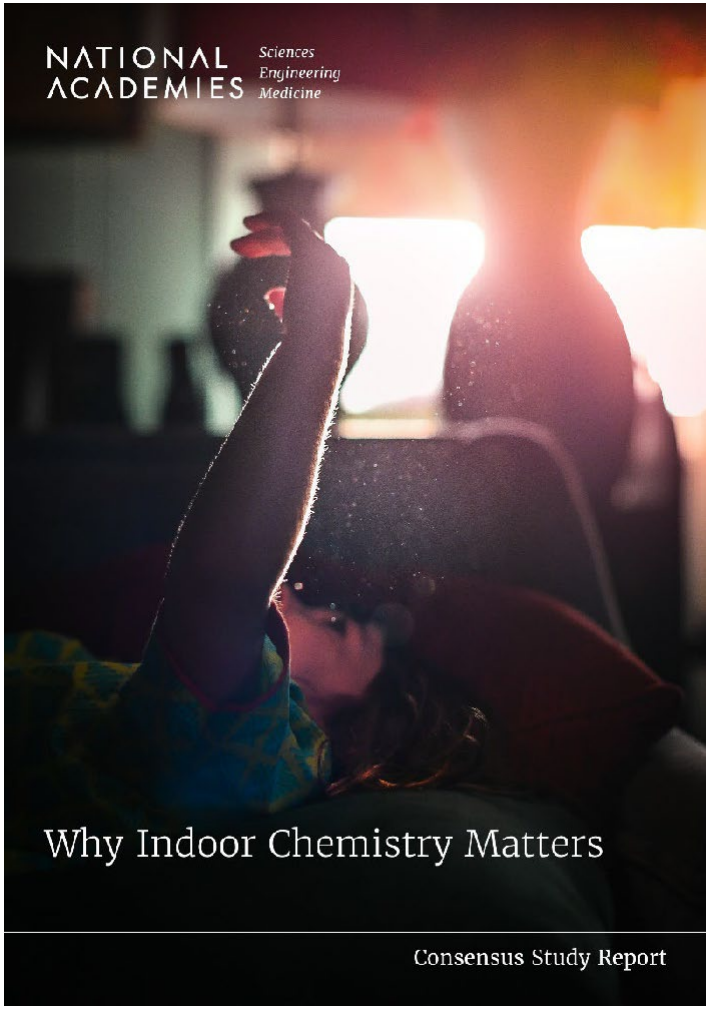
The committee will also provide recommendations for communicating its findings to affected stakeholders. The indoor environments focused on in this study will be limited to non-industrial exposure within buildings.

Committee roster and NASEM staff

- **David Dorman** (Chair) North Carolina State University
- **Jonathan Abbatt** University of Toronto
- **William Bahnfleth** Pennsylvania State University
- **Ellison Carter** Colorado State University
- **Delphine Farmer** Colorado State University
- **Allen Goldstein** University of California, Berkeley
- **Vicki Grassian** University of California, San Diego
- **Rima Habre** University of Southern California
- **Gillian Mittelstaedt** Partnership for Air Matters/Tribal Healthy Homes Network
- **Glenn Morrison** University of North Carolina
- **Jordan Peccia** Yale University
- **Dustin Poppendieck** National Institute of Standards and Technology
- **Kim Prather** (NAS/NAE) University of California, San Diego
- **Manabu Shiraiwa** University of California, Irvine
- **Heather Stapleton** Duke University
- **Meredith Williams** California Department of Toxic Substances and Control

- **Megan Harries** NASEM

Report Structure and Main Messages



Report structure

The main body of the report focuses on:

- Primary sources and reservoirs of chemicals indoors;
- Partitioning of chemicals in indoor environments;
- Chemical transformations;
- Management of chemicals in indoor environments;
- Indoor chemistry and exposure;
- **A path forward for indoor chemistry.**

Each chapter provides an overview of current state of the science and research needs

Main messages

- Environmental conditions and indoor chemistry vary between buildings based on their purpose and use.

- Researchers know very little about how humans are exposed to multiple indoor chemicals across phases and pathways, how these joint exposures interact across timescales, and the cumulative and long-term impacts of the indoor chemical environment on human health.

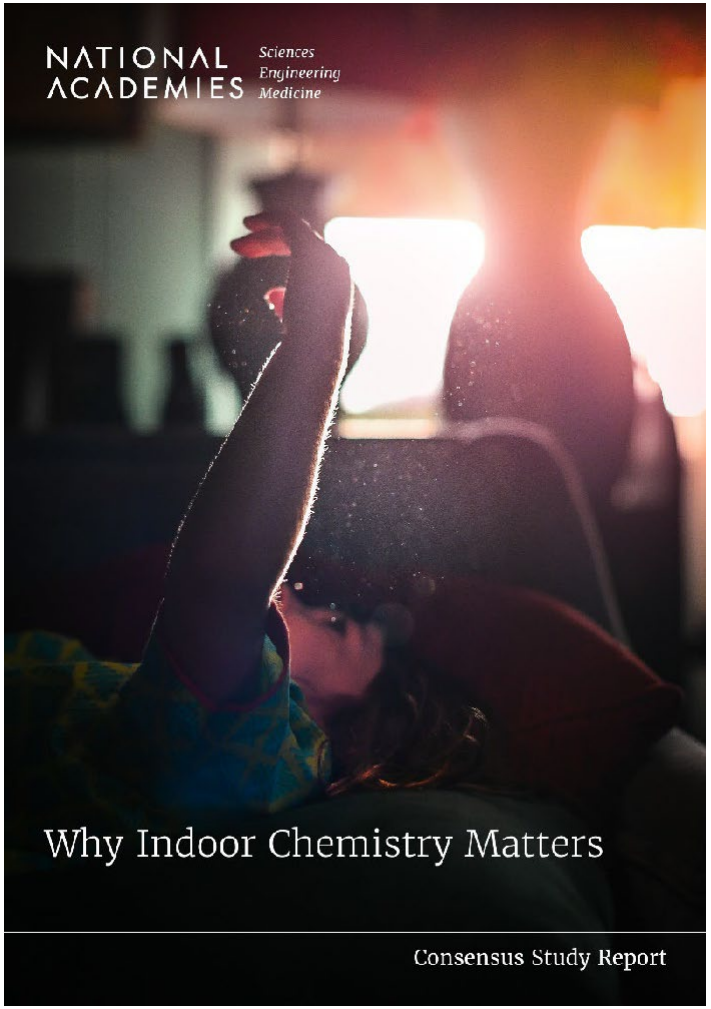
- Changes in the outdoor environment owing to climate change, wildfires, and urbanization have significant impacts on indoor environments.

- New analytical tools have been instrumental in improving understanding of indoor chemistry; however, key challenges remain that will require strategic investments.

Main messages

- There is an ongoing need to effectively translate scientific knowledge about indoor chemistry into practice and policy.
- Many chemicals found indoors have little to no information regarding their toxicity, either as individual agents or in combination with other chemicals present in the environment.
- Mitigating chemical hazards will require efforts in changing building design and operation, altering the use and contents of products and materials, and addressing the impact of human activity on indoor chemistry.

Committee Recommendations



Chemical complexity in the indoor environment

Recommendation 1: Researchers should further investigate the chemical composition of complex mixtures present indoors in a wide range of residential and nonresidential settings and how these mixtures impact chemical exposure and health.

Recommendation 2: Researchers should focus on understanding chemical transformations that occur indoors, using advanced analytical techniques to decipher the underlying fundamental reaction kinetics and mechanisms both in the laboratory and in indoor environments.

Recommendation 3: Researchers should prioritize understanding the phase distribution of indoor chemicals between all indoor reservoirs and incorporate these findings into exposure models.

Recommendation 4: All stakeholders should proactively engage across disciplines to further the development of knowledge on the fundamental aspects of complex indoor chemistry and its impact on indoor environmental quality, exposure assessment, and human health.

Indoor chemistry in a changing world

Recommendation 5: Researchers who study toxicology and epidemiology and their funders should prioritize resources toward understanding indoor exposures to contaminants, including those of outdoor origin that undergo subsequent transformations indoors.

Recommendation 6: Researchers and their funders should devote resources to creating emissions inventories specific to building types and to identifying indoor transformations that impact outdoor air quality.

Recommendation 7: Researchers and engineers should integrate indoor chemistry considerations into their building system design and mitigation approaches. This can be accomplished in different ways, including by consulting with indoor air scientists.

Future investments in research

Recommendation 8: Given the challenges, complexity, knowledge gaps, and importance of indoor chemistry, federal agencies and others that fund research should make the study of indoor chemistry and its impact on indoor air quality and public health a national priority.

Recommendation 9: Researchers and their funders should invest in developing novel methods and chemoinformatic resources that increase our ability to identify and quantify the abundances of wide classes of indoor chemicals, both primary emissions and secondary chemical reaction products.

Recommendation 10: Researchers measuring indoor environments should apply and develop new analytical tools that can probe the chemical complexity of gases, aerosols, and surfaces.

Recommendation 11: Federal agencies should design and regularly implement an updated National Human Activity Patterns Survey. Federal and state agencies should add survey questions in existing surveys that capture people's activities in indoor environments as they relate to indoor chemistry and indoor chemical exposures.

Communicating science and risks

Recommendation 12: Researchers should proactively engage in links that connect research to application throughout the indoor chemistry research process—for example, at the dissemination stage, by engaging with technical and standard-writing committees, presenting at conferences attended by practitioners, and disseminating the significance of research findings in social and mass media.

Recommendation 13: Researchers and practitioners should include environmental justice communities in the wide range of indoor environments they study and engage these communities in formulating research priorities and recommendations for future indoor air quality standards.

Recommendation 14: Funding agencies should support interdisciplinary research to investigate the impact of products and services on indoor chemistry, especially under realistic conditions. There is also a need to determine how occupant access to air quality data leads to behavior that influences indoor chemistry.

Communicating science and risks

Conclusion 1: Standardized consensus test methods could enable potential certification programs for air- cleaning products and services. Such test methods could help regulators determine whether action on these products and services is warranted.

Recommendation 15: Researchers and their funders should prioritize understanding the health impacts from exposure to specific classes and mixtures of chemicals in a wide range of indoor settings. Such understanding is needed to inform any future standards, guidelines, or regulatory efforts.

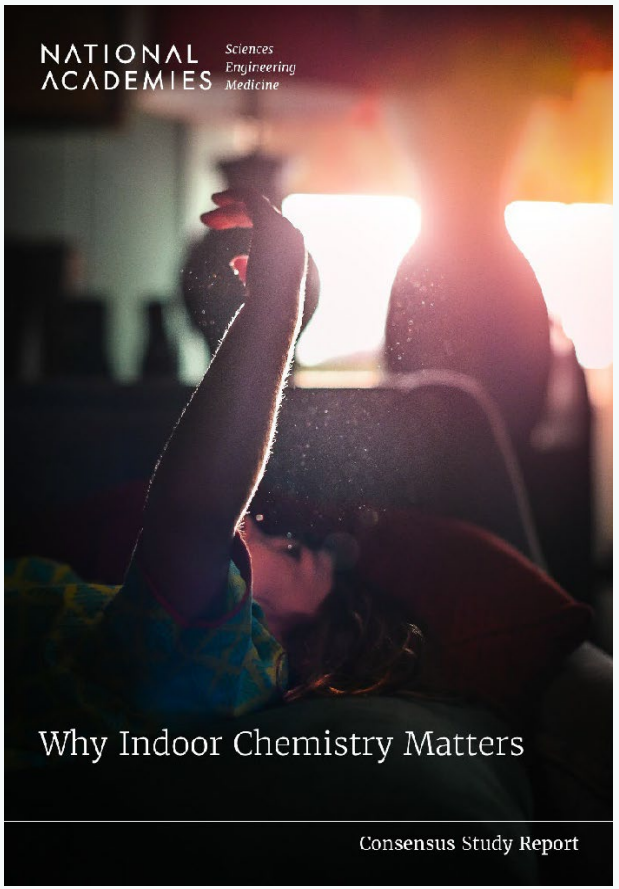
Charge to CAAAC

Provide recommendations on prioritizing the research needs identified by the NASEM in their consensus report: *Why Indoor Chemistry Matters.* Focus on priorities for short term research (1-3 years) that could inform public health guidance and building practices for improving Indoor Air Quality (IAQ) in homes, schools, and commercial and office buildings.

- Full CAAAC or workgroup
- Short term written response (3 to 6 months -- flexible)
- Lead office: ORIA
  - Contact: Laura Kolb at kolb.laura@epa.gov

Discussion

- Questions
- Identify chair, workgroup members
- Timeline
- Next steps



Resources

NASEM Report: Why Indoor Chemistry Matters
https://nap.nationalacademies.org/catalog/26228/why-indoor-chemistry-matters

NASEM Report Highlights: Why Indoor Chemistry Matters
https://nap.nationalacademies.org/resource/26228/Indoor_Chemistry_Report_Highlights.pdf

NASEM Emerging Science on Indoor Chemistry Project Information
https://www.nationalacademies.org/our-work/emerging-science-on-indoor-chemistry

Resources

EPA Indoor Environments Division webpages

Indoor Air Quality Science and Technology
https://www.epa.gov/indoor-air-quality-iaq/indoor-air-quality-science-and-technology

Volatile Organic Compounds' Impact on Indoor Air Quality
https://www.epa.gov/indoor-air-quality-iaq/volatile-organic-compounds-impact-indoor-air-quality

“IndoorChem” website

IndoorChem is a project funded by the Alfred P. Sloan Foundation. We aim to support and cultivate a community of researchers, business professionals, students, academic institutions, and individuals who are interested in the chemistry of the indoor environment. This website is the hub for our community. https://indoorchem.org/

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