An **indoor environment** refers to the physical space inside a building or structure designed to support specific function (living, working, learning…), with controlled environment.

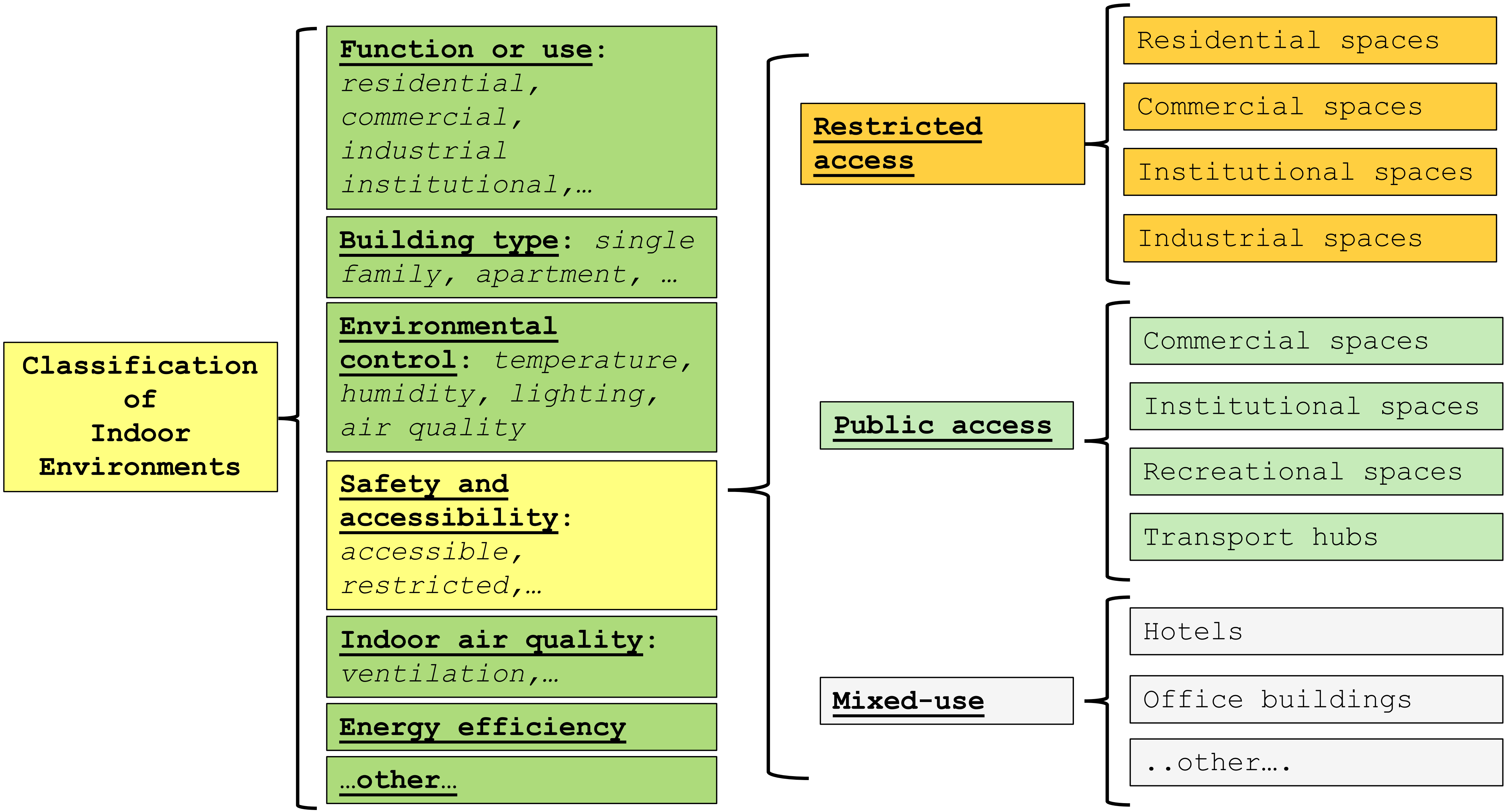
- *Buildings*
- *Car cabin*
- *Trains*
- *Airplanes*
- *Buses*
- *….*

Enclosed space

Functionality

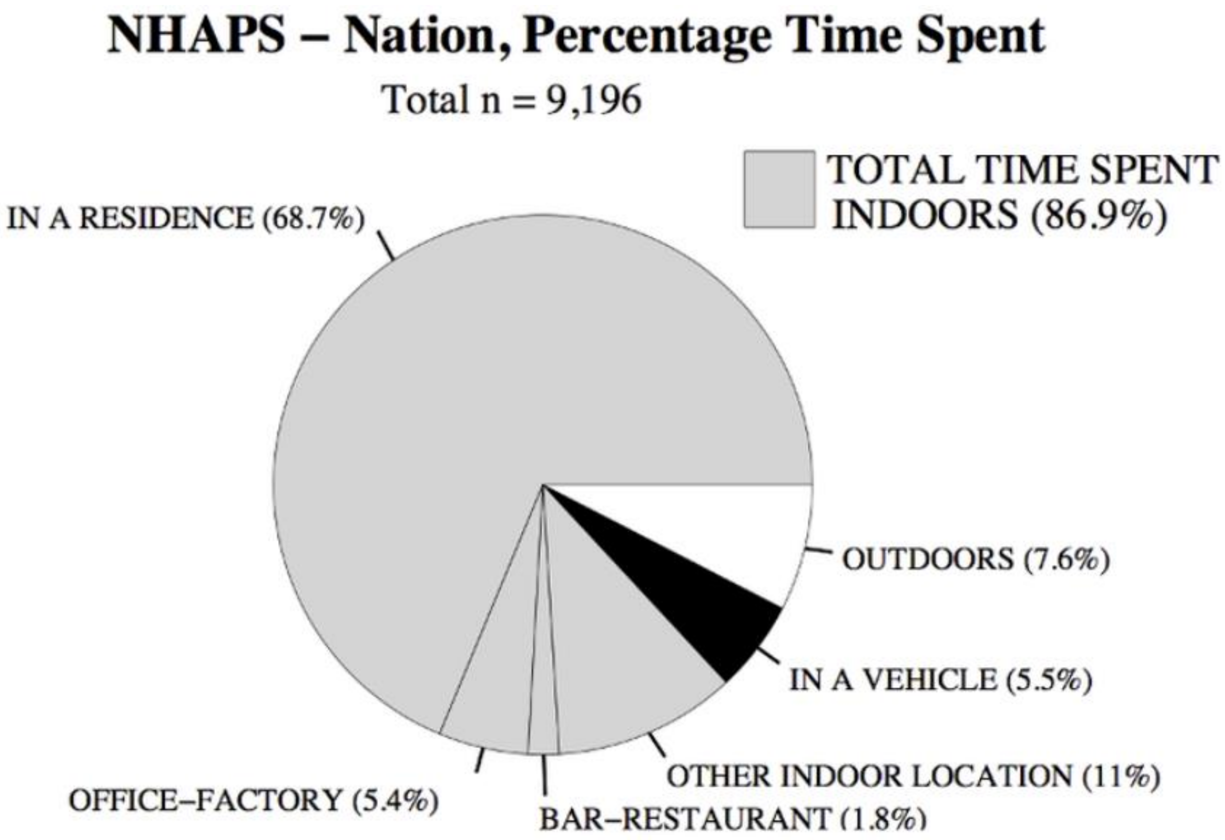
Environmental control

Accessibility, safety and comfort

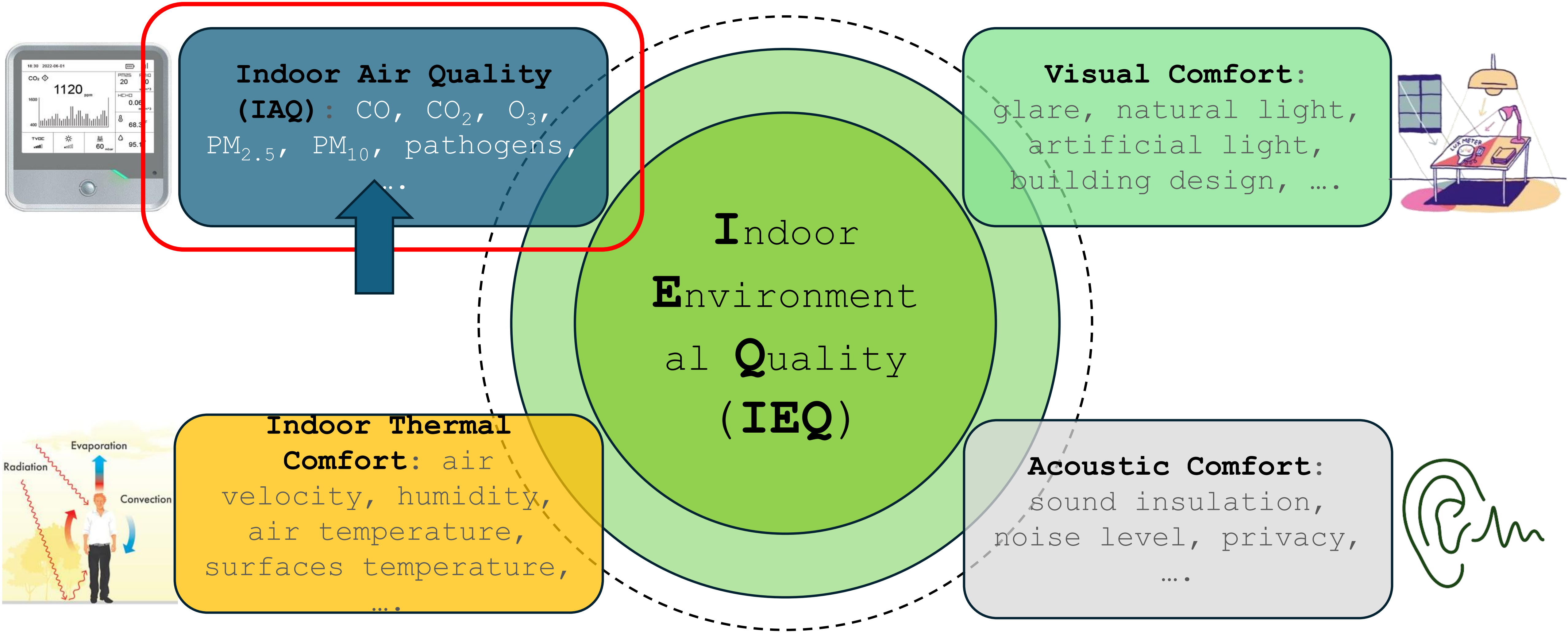

Classification of Indoor Environments
Function or use: residential, commercial, industrial institutional,…
Building type: single family, apartment, …
Environmental control: temperature, humidity, lighting, air quality
Safety and accessibility: accessible, restricted,…
Indoor air quality: ventilation,…
Energy efficiency
…other…
Restricted access
Residential spaces
Commercial spaces
Institutional spaces
Industrial spaces
Public access
Commercial spaces
Institutional spaces
Recreational spaces
Transport hubs
Mixed-use
Hotels
Office buildings
..other….

The National Human Activity Pattern Survey (NHAPS): “**A Resource for Assessing Exposure to Environmental Pollutants”**, by Neil E. Klepeis and others, and published by the Lawrence Berkeley National Laboratory in 2001.

A 2016 survey entitled “**Our lives inside our cars**” conducted by Citroen in collaboration with CSA Research revealed that, on average, Europeans spend inside cars 4 years and 1 month during their life.



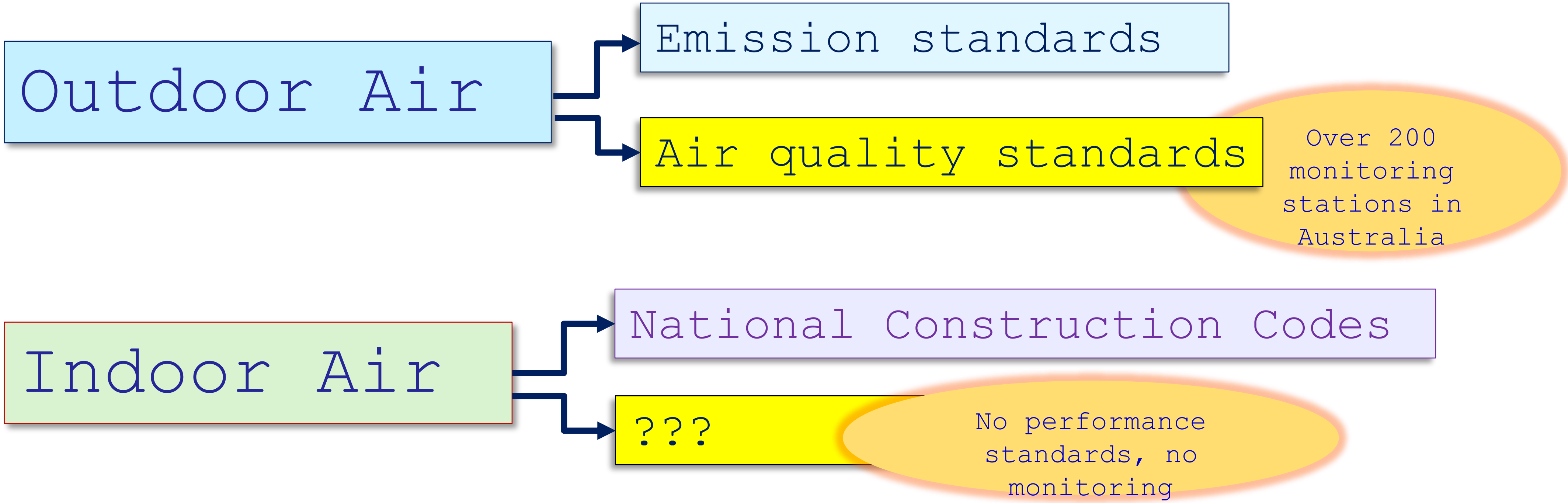
Indoor environment control is crucial because the quality of the indoor environment directly impacts the health, comfort, productivity, and overall well-being of the occupants.



Indoor Air Quality (IAQ): CO, CO_2, O_3, $PM_{2.5}$, PM_{10}, pathogens, ….
Visual Comfort: glare, natural light, artificial light, building design, ….
Indoor Environmental Quality (IEQ)
Indoor Thermal Comfort: air velocity, humidity, air temperature, surfaces temperature, ….
Acoustic Comfort: sound insulation, noise level, privacy, ….
Evaporation
Radiation
Convection
1120
LUX METER

From Science to Policy: mandating *indoor air quality* for public buildings

Air quality: standards



Difference between guidelines and standards

A reality check!

Air quality guidelines

…are any kind of recommendations or guidelines on the protection of *human populations* or receptors in the environment from the adverse effects of air pollution

Exclusively based on exposure-response relationships found in:

- Epidemiological studies
- Toxicological studies
- Environment-related studies

Air quality standards

An air quality standard is a level of air pollution (concentration, deposition, etc) which **is promulgated** by a regulatory authority and adopted as **enforceable**

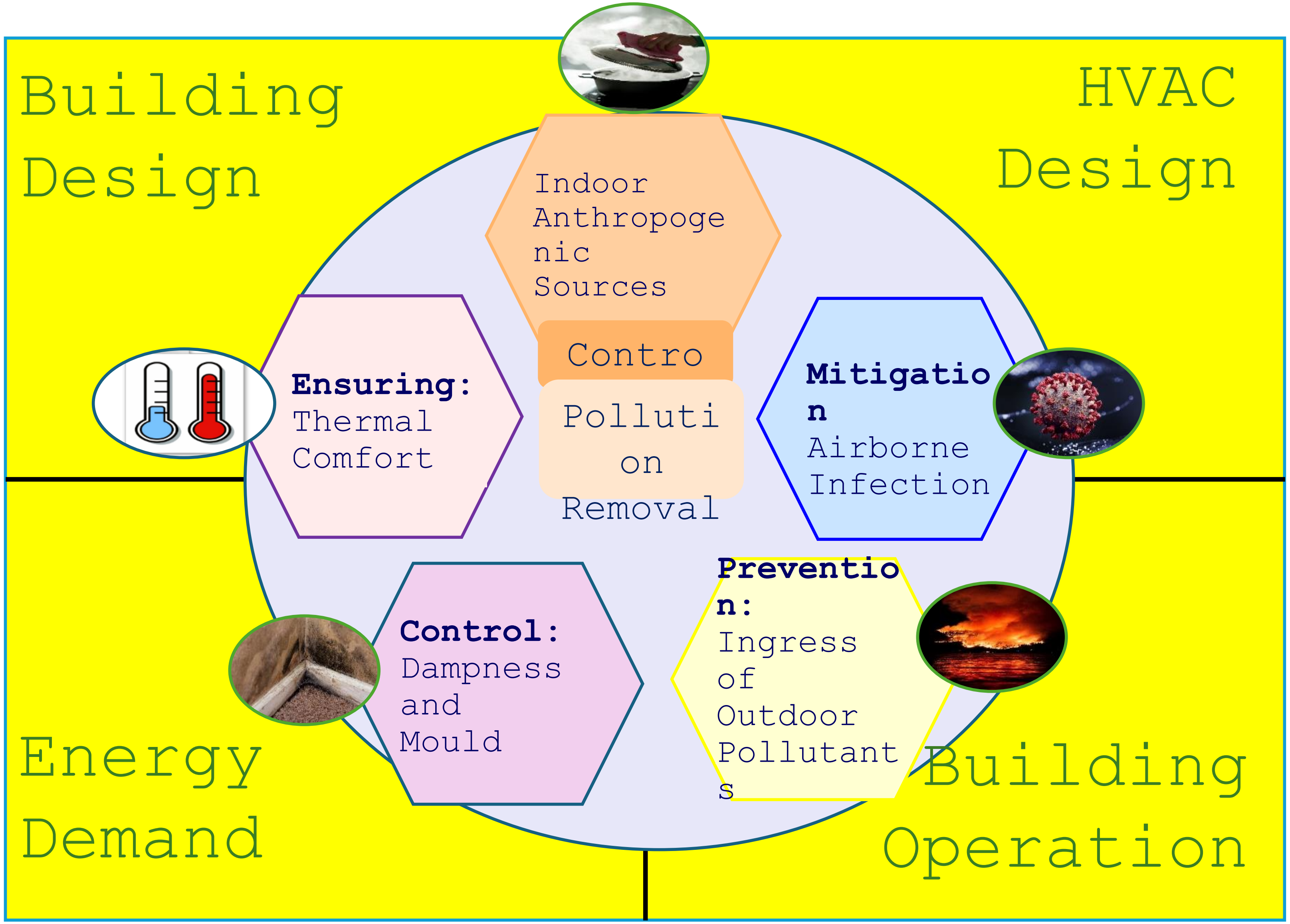
Elements in formulation of a standard:

- Effect-based level
- Averaging time
- Measurement procedure
- Definition of compliance parameters corresponding to the averaging times
- Permitted number of exceeding

A reality check!

Proposed IAQ Regulations

Air Risks indoors



POLICY FORUM

Science

INFECTIOUS DISEASE

A paradigm shift to combat indoor respiratory infection

Building ventilation systems must get much better

By Lidia Morawska, Joseph Allen, William Bahnfleth, Philomena M. Bluyssen, Atze Boerstra, Giorgio Buonanno, Junji Cao, Stephanie J. Dancer, Andres Floto, Francesco Franchimon, Trisha Greenhalgh, Charles Haworth, Jaap Hogeling, Christina Isaxon, Jose L. Jimenez, Jarek Kurnitski, Yuguo Li, Marcel Loomans, Guy Marks, Linsey C. Marr, Livio Mazzarella, Arsen Krikor Melikov, Shelly Miller, Donald K. Milton, William Nazaroff, Peter V. Nielsen, Catherine Noakes, Jordan Peccia, Kim Prather, Xavier Querol, Chandra Sekhar, Olli Seppänen, Shin-ichi Tanabe, Julian W. Tang, Raymond Tellier, Kwok Wai Tham, Pawel Wargocki, Aneta Wierzbicka, Maosheng Yao

Two factors in particular may contribute to our relatively weak approach to fighting airborne transmission of infectious diseases compared to waterborne and foodborne transmission.

First, **it is much harder to trace airborne infections**. Food and water contamination nearly always come from an easily identifiable point source with a discrete reservoir, such as a pipe, well, or package of food. Its impact on human health is early if not immediate in terms of characteristic signs and symptoms.

1. Over the years, this has led to the current public health structures in well-resourced countries.
2. Standards have been enacted for all aspects of food and water processing, as well as wastewater and sewage.
3. Public health officials, environmental health officers, and local councils are trained in surveillance, sampling, and investigation of clusters of potential food and waterborne outbreaks, often alerted by local microbiology laboratories.

By contrast, airborne studies are much more difficult to conduct because air as a contagion medium is nebulous, widespread, not owned by anybody, and uncontained. Buildings and their airflows are complicated, and measurement methods for such studies are complex and not generally standardized.

Second, **a long-standing misunderstanding and lack of research into airborne transmission of pathogens has negatively affected recognition of the importance of this route.**

Most modern building construction has occurred subsequent to a decline in the belief that airborne pathogens are important. Therefore, the design and construction of modern buildings make few if any modifications for this airborne risk.

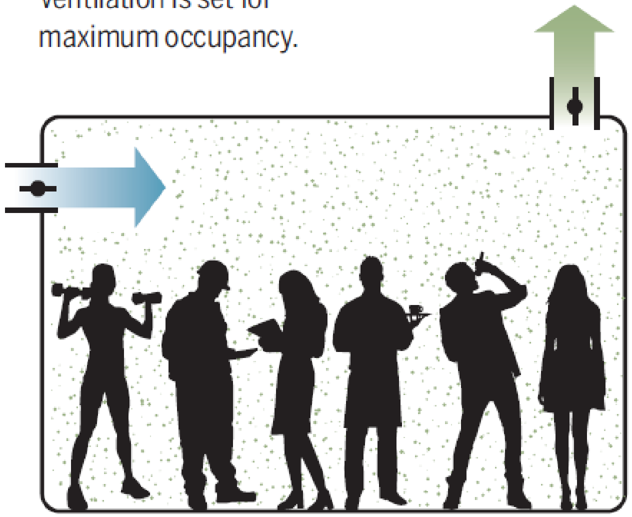
Respiratory outbreaks have been repeatedly “explained away” by invoking droplet transmission or inadequate hand hygiene.

For decades, the focus of architects and building engineers was on thermal comfort, odor control, perceived air quality, initial investment cost, energy use, and other performance issues, whereas infection control was neglected.

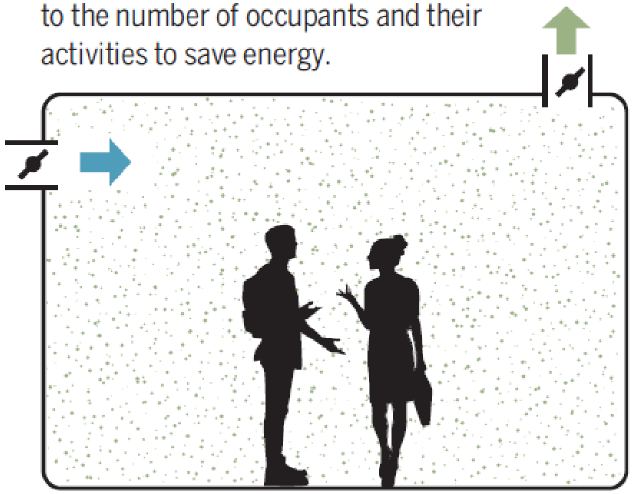
Flexible ventilation systems, dependent on the building's purpose

Ventilation airflow rates must be controlled by the number of occupants in the space and their activity.

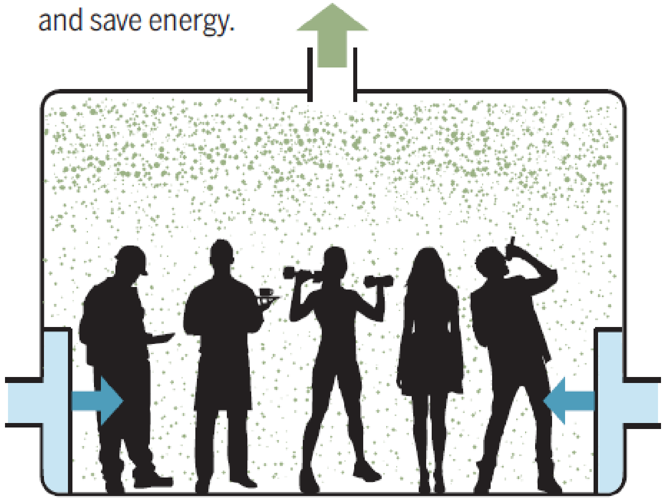
Design occupancy
Ventilation is set for maximum occupancy.



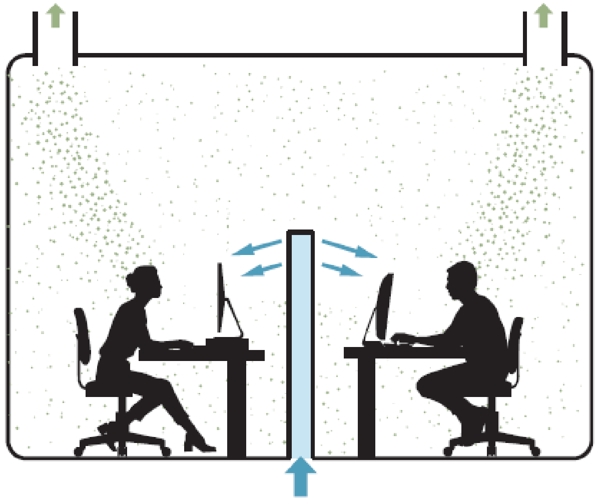
Demand controlled
Ventilation is adjusted according to the number of occupants and their activities to save energy.



Improved air distribution
Different system designs can decrease exposure and save energy.



Personalized ventilation
Clean air is supplied where needed to further reduce exposure and energy use.



A PATH FORWARD

We encourage several critical steps. **First and foremost, the continuous global hazard of airborne respiratory infection must be recognized so the risk can be controlled**.

Global WHO IAQ guidelines must be extended to include airborne pathogens and to recognize the need to control the hazard of airborne transmission of respiratory infections.

National comprehensive IAQ standards must be developed, promulgated, and enforced by all countries. Some countries have IAQ standards, but none are comprehensive enough to include airborne pathogens. In most countries that have IAQ standards, there are no enforcement procedures. Most countries do not have any IAQ standards.

New approaches must be developed to encourage implementation of standards (e.g., "**ventilation certificates**" similar to those that exist for food hygiene certification for restaurants).

Wide use of monitors displaying the state of IAQ must be mandated. At present, members of the general public are not well aware of the importance of IAQ and have no means of knowing the condition of the indoor spaces that they occupy and share with others.

POLICY FORUM

Science

PUBLIC HEALTH

Mandating indoor air quality for public buildings

If some countries lead by example, standards may increasingly become normalized

By **Lidia Morawska, Joseph Allen, William Bahnfleth, Belinda Bennett, Philomena M. Bluyssen, Atze Boerstra, Giorgio Buonanno, Junji Cao, Stephanie J. Dancer, Andres Floto, Francesco Franchimon, Trish Greenhalgh, Charles Haworth, Jaap Hogeling, Christina Isaxon, Jose L. Jimenez, Amanda Kennedy, Prashant Kumar, Jarek Kurnitski, Yuguo Li, Marcel Loomans, Guy Marks, Linsey C. Marr, Livio Mazzarella, Arsen Krikor Melikov, Shelly L. Miller, Donald K. Milton, Jason Monty, Peter V. Nielsen, Catherine Noakes, Jordan Peccia, Kimberly A. Prather, Xavier Querol, Tunga Salthammer, Chandra Sekhar, Olli Seppänen, Shin-ichi Tanabe, Julian W. Tang, Raymond Tellier, Kwok Wai Tham, Pawel Wargocki, Aneta Wierzbicka, Maosheng Yao**

People living in urban and industrialized societies, which are expanding globally, spend more than 90% of their time in the indoor environment, breathing indoor air (IA).

Despite decades of research and advocacy, most countries do not have legislated indoor air quality (IAQ) performance standards for public spaces that address concentration levels of IA pollutants.

Few building codes address operation, maintenance, and retrofitting, and most do not focus on airborne disease transmission. But the COVID-19 pandemic has made all levels of society, from community members to decision-makers, realize the importance of IAQ for human health, well-being, productivity, and learning.

We propose that IAQ standards be mandatory for public spaces. Although enforcement of IAQ performance standards in homes is not possible, homes must be designed and equipped so that they could meet the standards.

For the past two decades, scientists have called for national IAQ standards and laws to be established, but so far, little action has been taken.

The approach to IA contrasts sharply with outdoor air, for which quality is regulated and monitored and compliance with regulations is enforced.

The World Health Organization (WHO) Global Air Quality Guidelines (AQG) published in 2021 provide recommendations for concentration levels of six pollutants and their averaging times (PM2.5, PM10, NO2, SO2, CO, and O3) and apply to both outdoor air and IA.

In cases for which IAQ standard and guideline values were established by national or association working groups, the outcomes were inconsistent; often the criteria for the same parameter differed by orders of magnitude.

The reasons cited for limited progress include different criteria in the selection of the critical study, in the starting point, and in the derivation procedure; the complex political, social, and legislative situation regarding IAQ; the lack of an open, systematic, and harmonized approach; and that establishing an IAQ standard is always the result of a compromise between scientific knowledge and political will.

Because of the heterogenous landscape of approaches needed, such barriers remain intact despite the considerable IAQ research and evidence base developed over the past decades.

CHALLENGES

Source contributions

IA pollution originates from sources indoors (including humans) and outdoors and from chemical reactions between pollutants in IA.

Compliance with IAQ standards (that refer to the concentrations of indoor pollutants) would require controlling indoor emission sources (such as combustion, building products, and cleaning products) and minimizing the entry of outdoor pollutants indoors (for example, by filtering or treating outdoor air to remove particles and chemical compounds and reducing penetration of pollutants through the building envelope).

During respiration, **humans emit** (in addition to CO2) **particles that contain viruses and bacteria**. Most respiratory infections are acquired indoors, through inhalation of virus-laden airborne particles.

However, **there are no exposure-response relationships for respiratory pathogen concentrations in IA, nor are there technologies available to routinely monitor such pathogens in buildings in real time.** We cannot control human respiratory emissions in the same way that we control emissions from other sources.

CHALLENGES

Monitoring

We cannot use the well-established approach that is used to measure outdoor air quality to monitor IAQ. We cannot rely on a monitoring network (in only selected indoor public spaces) because every space is different and is used differently, and we cannot use modeling to predict pollution concentration in one space by using the concentrations measured in other spaces.

Compliance monitors are too costly and complex to deploy in all indoor spaces to monitor for all six pollutants included in the WHO AQG. However, there are environmental parameters that can already be monitored in each room of each building, such as temperature and relative humidity.

The feasibility of monitoring IAQ parameters in buildings depends on the size, cost, robustness, and silent operation of the sensor or monitor; calibration; and ease of interpreting data. But routine, real-time monitoring of indoor pathogens is currently infeasible.

In the absence of information on the concentration of pathogens in IA, the question is which proxy parameter or pollutant should be the basis for legislation that targets airborne infection transmission.

CHALLENGES

Legislation

Legislation comprises the system of rules created and enforced by the government of a jurisdiction.

Guidelines, on the other hand, are less formal, not mandatory, and generally not enforceable unless adopted in legislation.

Standards, also generally unenforceable unless they are adopted in legislation, are typically voluntary in nature and can set out requirements with respect to design, operation, and performance. They may be adopted in legislation and thus made enforceable by law.

In terms of formal international law, there are global treaties on transboundary air pollution, but to date, no international treaty requires or encourages adoption of ambient air quality standards.

At a country level, IA legislation is hampered by the tremendous variability across jurisdictions and the particulars of each country's legal structure. "Air pollution" is not defined in air quality legislation in a substantial number of countries. This presents a challenge for the development of laws on IAQ. However, the United Nations (UN) Sustainable Development Goals provide an opportunity for global progress on IAQ.

Industry priorities

Many regulations reflect compromise between the needs for human protection and for industry opportunities, with the regulatory process involving balanced participation from groups with different priorities to reach consensus.

The industry most closely related to IAQ is the heating, ventilation, and air conditioning (HVAC) industry, which in response to market demand has evolved to focus primarily on thermal comfort and energy efficiency; the market has not yet demanded large-scale supply of technologies to improve IAQ.

Regulation could rapidly change this demand, which may or may not benefit the HVAC industry and many other building industries. There will always be some industries that do not benefit and/or will require strategic change owing to new regulations, so they would prefer the status quo.

There are groups who will be forced into capital costs by regulation change (such as property owners and their associations) that must be convinced of need and value. Thus, in the pursuit of new IAQ regulation, market forces may mean that industry support is not guaranteed.

The social and political dimension

Introducing standards is complex, not only because scientific parameters may be contested or technically difficult to achieve but also because **human stakeholders have different values, goals, and power, and standards may have cultural or political implications.**

A particular standard may be unfeasible in any given setting (for example, because it is unaffordable or blocked by powerful individuals or groups), so compromises must be made.

Organizations that choose (or are required) to implement standards must go through a complex and sometimes costly process to identify, assimilate, implement, and adapt them.

ADDRESSING THE CHALLENGES

The proposed approach is based on science, technology, and specific solutions that have existed for some time and can now serve as a basis for addressing a complex interdisciplinary problem.

Pollutants recommended by WHO

Low-cost sensors are a viable technology to measure some of the six pollutants included in the WHO AQG; however, not all six can be realistically monitored in buildings, nor do they all need to be monitored.

The two most relevant candidates for routine regulatory IAQ monitoring are PM2.5 and CO, for which low-cost advanced sensors have demonstrated stability, durability, and robustness.

Particulate matter in IA originates from indoor and outdoor sources, and exposure to PM2.5 is among the 10 leading risks.

CO arising from various natural processes is present in the atmosphere at very low concentrations, but it is incomplete combustion (indoor and outdoor) that can raise concentrations to levels harmful to humans. Indoor CO should be routinely measured in areas where outdoor CO concentrations exceed regulations and where indoor combustion takes place. In several countries, CO monitors are mandated in spaces where combustion takes place to alert to life-threatening levels of gas, but these monitors are typically not sufficiently sensitive to lower concentrations.

Carbon dioxide

Currently CO_2 concentration values are not included in the WHO AQG. However, regardless of the potential harm it causes, CO_2 can serve as a proxy for occupant-emitted contaminants and pathogens and as a means to assess the ventilation rate. CO_2 sensors are readily available, inexpensive, and robust and can be used in all interiors. **The advantage of using CO_2 as a proxy is that although both pathogens and CO_2 are emitted during human respiratory activities, it is much easier to link CO_2 concentrations to these activities than to model risk from the emissions of pathogens.**

Ventilation

Ventilation with clean air is a key control strategy for contaminants generated indoors.

The role of ventilation is to remove and dilute human respiratory effluents and body odors and other indoor-generated pollutants at a rate high enough relative to their production so that they do not accumulate in IA. IA is replaced (diluted) with outdoor air (assumed to be clean) or clean recirculated air. Outdoor air ventilation rates are almost always set according to criteria of hygiene and comfort (perceived air quality). Effective air distribution (ventilated air reaching the entire occupied zone and airflow not directed from one person to another) is a practical candidate for a standard. The measured ventilation rate can be used as a proxy of IAQ.

Suggested numerical levels

Below, we provide justification for proposed numerical levels and their averaging times for the pollutants and the parameters discussed above. Actual levels adopted by countries and jurisdictions will differ, reflecting local circumstances and competing priorities.

$PM_{2.5}$ concentration. It is proposed that the WHO AQG 24 hours, 15 µg/m^3 level be considered as the basis for IAQ standards, but with a 1-hour averaging time because 24 hours is much longer than people typically spend in public places or, for that matter, that public spaces are occupied. This is a compromise between the realistic occupancy of and exposure in public spaces and the need for rigor in the derivation of the health-based value. Using the WHO AQG value for 24-hour exposure for 1-hour exposure is a conservative approach that considers each environment as though it were the only one where people spend all their time.

CO_2 concentration. To decide on a level that would adequately control the risk of infection in public spaces, a scenario of exposure must be defined and then a risk assessment model be applied. We propose a scenario of a classroom with one infected student.

A ventilation rate of 14 liter/s per person, keeping CO_2 concentrations at or below the standard level proposed in the table, would ensure that the reproduction number $R_e < 1$ even for respiratory pathogens with high transmissibility, such as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) Delta and Omicron variants and measles. The recommended level of 800 parts per million is within an already relatively narrow range of values of the CO_2 levels recommended by different organizations and countries.

In indoor environments where the supplied ventilation air is a mixture of outdoor air and recirculated air, the CO_2 concentration can be high, but the risk of infection may be low provided that the supplied ventilation air is sufficient. This is because the recirculated air is often filtered, and most of the pathogens are removed before it reenters the space; however, gaseous pollutants, such as CO_2, are not removed by this process.

Ventilation rate. The recommended rate of 14 liters/s per person, based on (*12*), is higher than the WHO-recommended minimum ventilation rate for nonresidential settings of 10 liters/s per person (*3*), or the highest category I ventilation rate defined in the existing standard ISO 17772-1. However, it is in line with ventilation rate recommended by (*11*), based on an experimental exposure study of a cohort of school children.

Proposed parameter levels

Values may be adjusted to reflect local circumstances and priorities.

	LEVEL	AVERAGING TIME OR SETPOINT
$PM_{2.5}$, µg/m^3	15[i]	1-hour
CO_2, ppm	800 (absolute value)[ii]	threshold
	350(delta)[iii]	threshold
CO, mg/m^3	100[iv]	15 minutes[iv]
	35[iv]	1 hour[iv]
	10[iv]	8 hours[iv]
Ventilation, liters/s per person	14[v]	When the space is occupied

(i) 24-hour level from (*3*). (ii) When 100% of air delivered to the space is outdoor air, assuming outdoor CO_2 concentration is 450 ppm; based on classroom scenario (see SM). (iii) Delta is the difference between the actual CO_2 concentration and the CO_2 concentration in the supply air. (iv) 8-hour averaging time, from (*15*). (v) Clean air supply rate in the breathing zone; see (*12*). At 25°C and 1 atm for CO 1 ppb = 1.15 µg/m^3. Threshold is the concentration level of CO_2 that must not be exceeded.

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Proposed IAQ standards

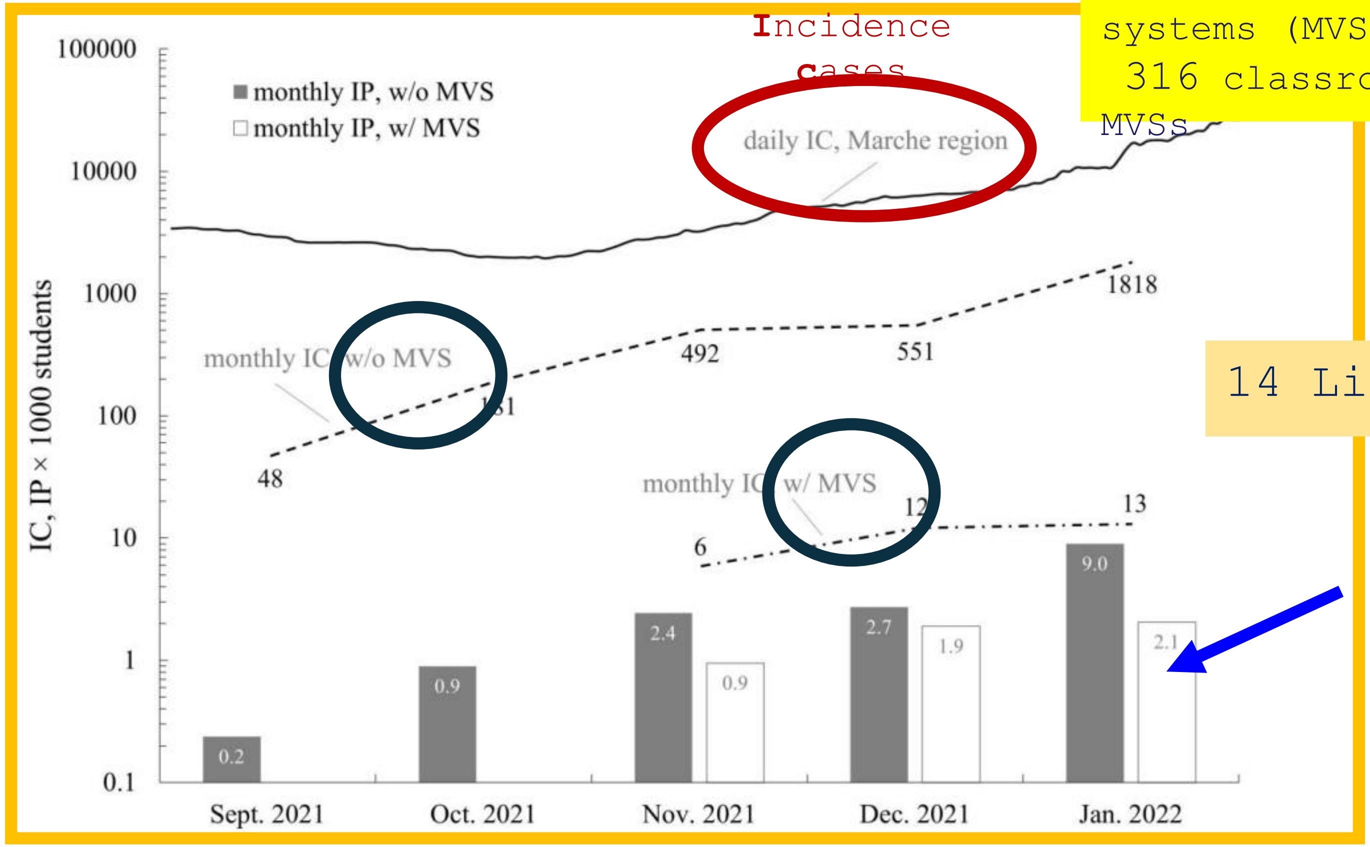
	Level	Averaging time or setpoint
$PM_{2.5}$, µg/m^3	15 (i)	1-hour
CO_2, ppm	800 (absolute value) (ii) 350 (delta) (iii)	threshold threshold
CO, mg/m^3	100 (iv) 35 (iv) 10 (iv)	15 minutes (iv) 1 hour (iv) 8 hours (iv)
Ventilation (L/s/person)	14 (v)	When the space is occupied

(i) 2021 AQG 24-h level; (ii) when 100% of air delivered to the space is outdoor air, assuming that outdoor CO_2 concentration is 450ppm. It is calculated based on a classroom scenario as described in the Supplement; (iii) Delta (Δ) is the difference between the actual CO_2 concentration and the CO_2 concentration in the supply air (iv) 2010 IAQG level; only including the 8h averaging time; (v) clean air supply rate in the breathing zone, where clean air is as defined earlier in section 3 (Allen et al. 2022). At 25°C and 1 atm (standard atmospheric pressure) for CO 1 ppb = 1.15 µg/m^3. Threshold is the concentration level of CO_2 that must not be exceeded.

Ventilation and COVID-19 in schools in the Marche region

10,441 classrooms without (w/o) mechanical ventilation systems (MVSs)
316 classrooms with (w/) MVSs

Incidence cases



14 Litres/s/person

Incidence proportion (IP, per 1000 students)

Ricolfi, L., Stabile, L., Morawska, L. and Buonanno, G., 2022. **Increasing ventilation reduces SARS-CoV-2 airborne transmission in schools: a retrospective cohort study in Italy's Marche region**. Frontiers in Public Health, section *Infectious Diseases: Epidemiology and Prevention*, 10: 1087087, 2022.

Low-cost sensors: the paradigm change

Environmental Science & Technology
Feature
pubs.acs.org/est

The Changing Paradigm of Air Pollution Monitoring

Emily G. Snyder,*,† Timothy H. Watkins,† Paul A. Solomon,‡ Eben D. Thoma,† Ronald W. Williams,† Gayle S. W. Hagler,† Da

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‡U.S. Environmental Protection
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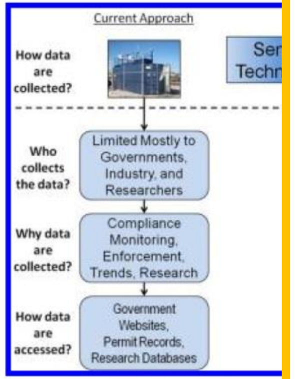


Historically, approaches generally use expensive ment,[1,2] which limits who colle

Science of the Total Environment 560–561 (2016) 150–159
Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv

Review

Real-time sensors for indoor air monitoring and challenges ahead in deploying them to urban buildings

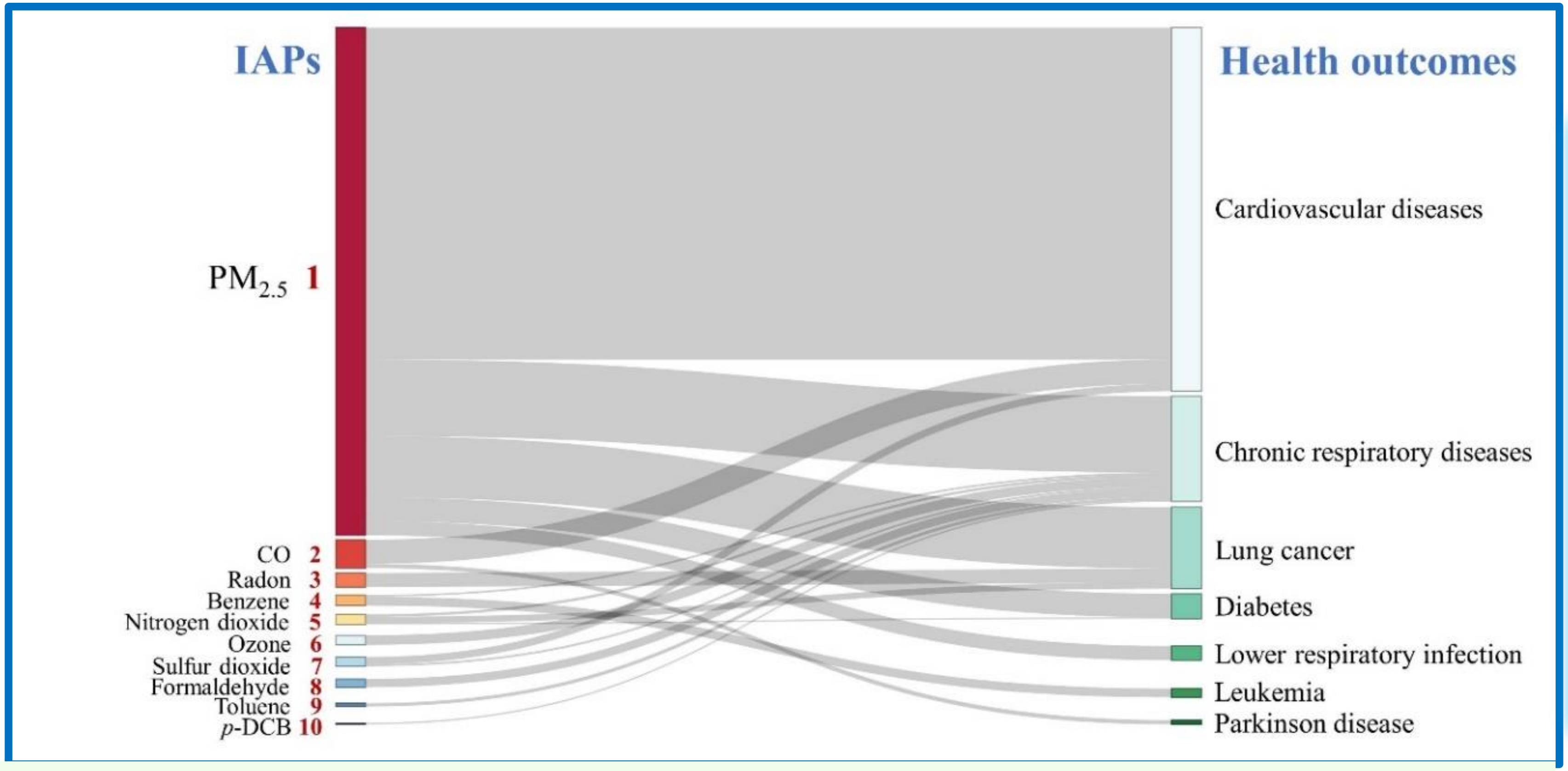
Prashant Kumar [a,b,*], Andreas N. Skouloudis [c], Margaret Bell [d], Mar Viana [e], M. Cristina Carotta [f], George Biskos [g,h], Lidia Morawska [i]

[a] Department of C
[b] Environmental
[c] Joint Research C
[d] Transport Oper
[e] Institute of Envi
[f] IMAMOTE - C.
[g] Faculty of Civil
[h] Energy Environ
[i] International La

*"In particular, we demonstrate that awareness of **IAQ risks** and availability of **appropriate regulation** are lagging behind the*

Focus on particles

Impacts of indoor air pollution: China



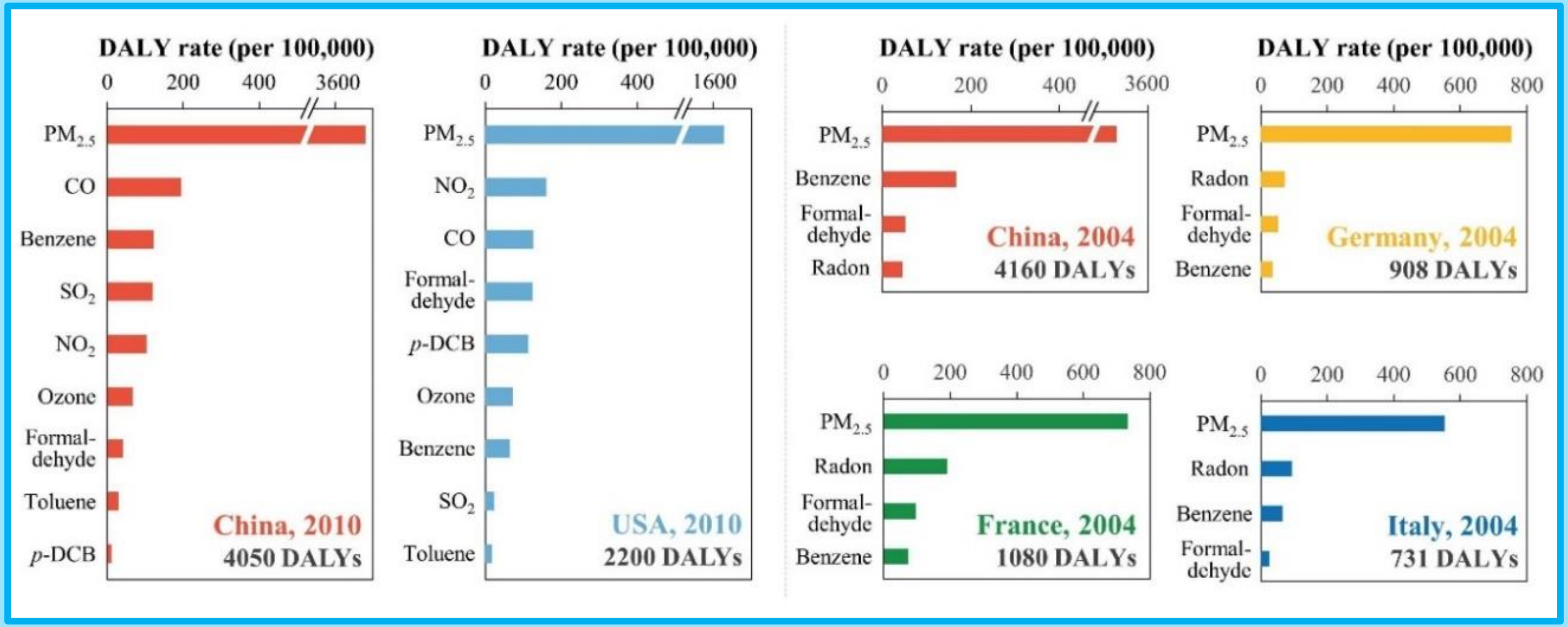
The corresponding financial costs due to exposure to IAPs reached 2880 billion CNY (~411 billion USD) in 2017 and accounted for 3.45% of China's gross domestic product.

Morawska, L. News & Views: The burden of disease due to indoor air pollution and why we need to know about it. *Science Bulletin,* 69(9): 1161-1164, 2024. https://doi.org/10.1016/j.scib.2024.02.031

Liu N, Liu W, Deng F, et al. **The burden of disease attributable to indoor air pollutants in China from 2000 to 2017.** The Lancet Planetary Health, 2023, 7: e900-e911

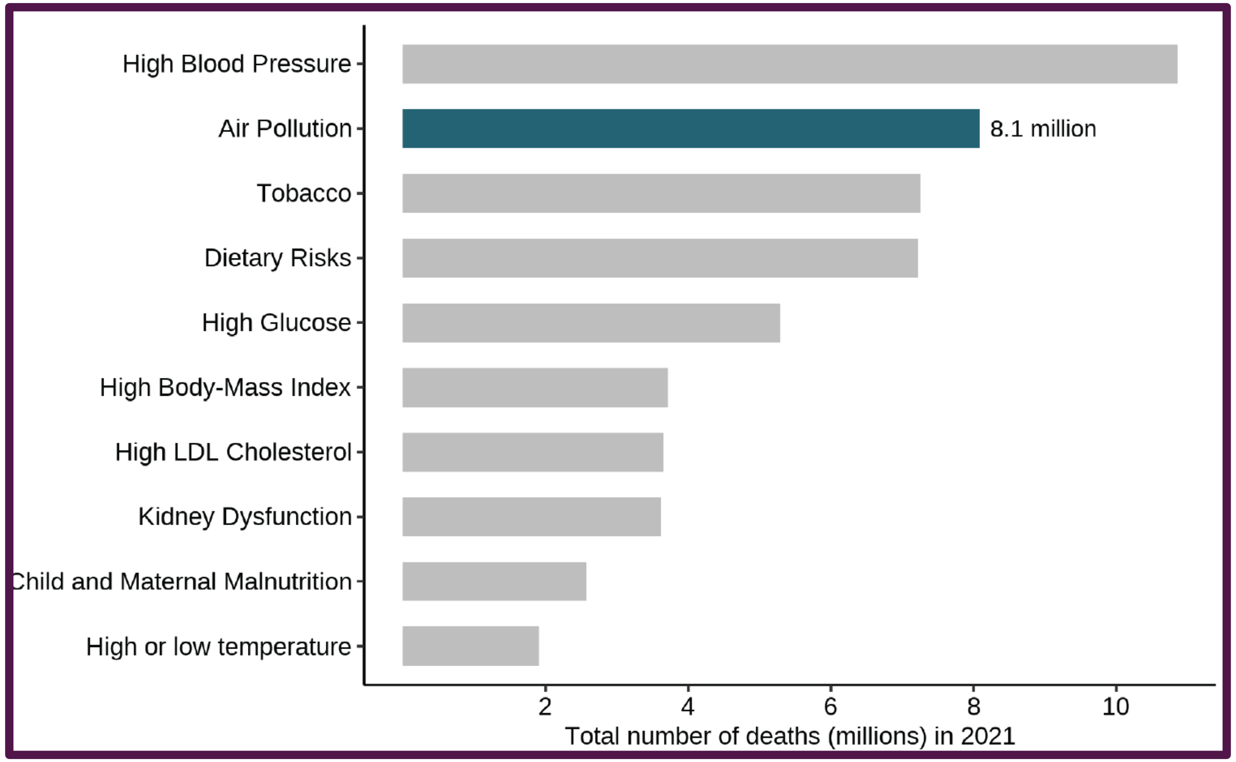
Impacts of indoor air pollution: the world

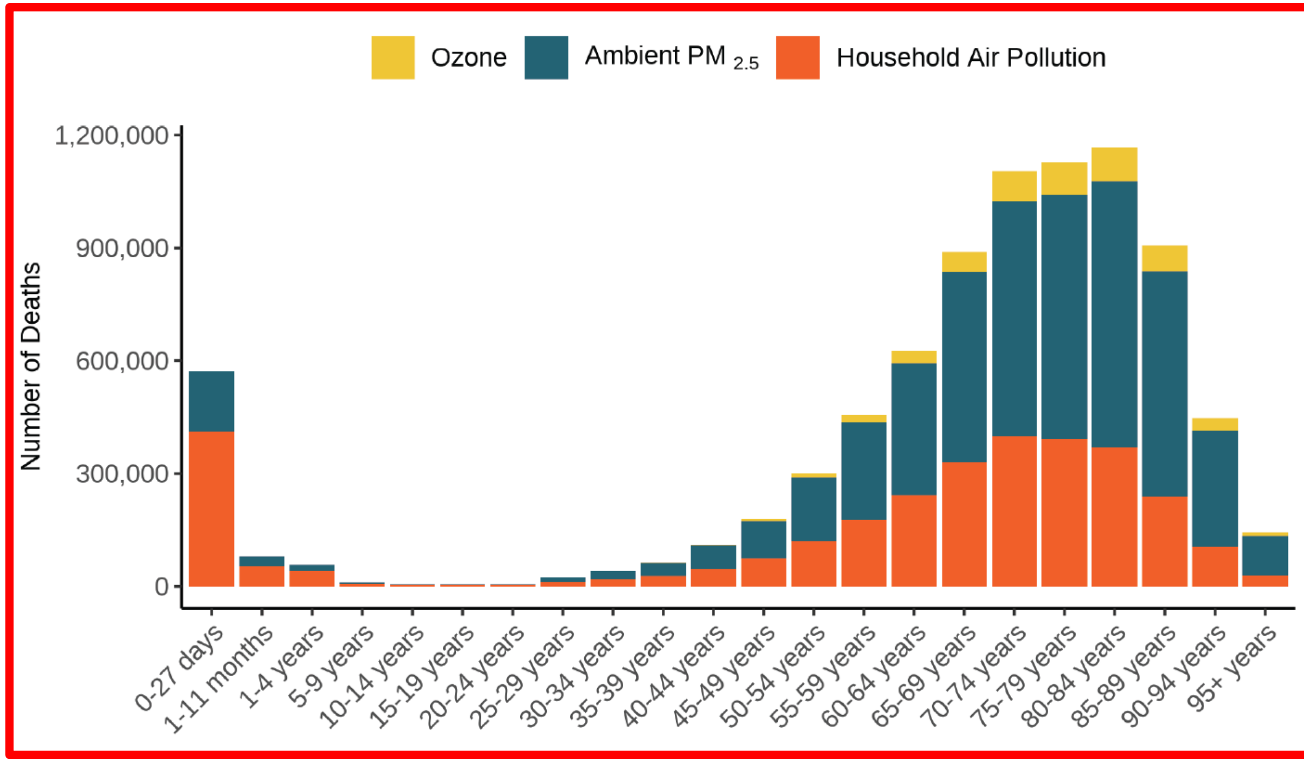
Attributable disability-adjusted life years (DALY)



Morawska, L. News & Views: The burden of disease due to indoor air pollution and why we need to know about it. *Science Bulletin,* 69(9): 1161-1164, 2024. https://doi.org/10.1016/j.scib.2024.02.031

Particles: a key *problem* and a key *challenge*





HEI, 2024. State of Global Air Report 2024. Health Effects Institute. Health Effects Institute (HEI). https://www.stateofglobalair.org/resources/report/state-global-air-report-2024:

Scientific challenges still to resolve: 1

The existing *health-based particle guidelines* (and national ambient air quality standards) are **mass-based**, while optical particle detection technologies are **number-based**.

It is ***unlikely studies will be conducted soon*** to link exposure to particles measured by number concentration (and in different size ranges) to health endpoints.

Therefore, ***a scientific bridge*** must be developed **between particle number concentrations** monitored by sensors **and particle gravimetric mass concentrations** to relate to the existing health guidelines.

Scientific challenges still to resolve: 2

In situ **indoor** calibration of low-cost particle sensors!

Calibration is a key requirement for compliance monitoring, but because of *the scale of monitoring* (every public indoor space), the **current costly and labour-intensive methods** used to calibrate existing regulatory monitors *will not be practical.*

Significant progress in "calibration" of outdoor $PM_{2.5}$ LCS

PurpleAir example:

- Each instrument contains two Plantower sensors
- Commercially available since 2015
- More than 30,000 are registered around the world (2021)
- Used also in support of government air monitoring

"The final PurpleAir correction reduces the root mean square error of the raw data from 8 to 3 µgm m^{-3}, with an average FRM or FEM concentration of 9 µgm m^{-3}. This correction equation, along with proposed data cleaning criteria, has been applied to PurpleAir $PM_{2.5}$ measurements across the US on the *AirNow Fire and Smoke Map*"

Barkjohn, K.K., et al., 2020. **Development and application of a United States wide correction for $PM_{2.5}$ data collected with the PurpleAir sensor**. *Atmos. Meas. Tech*, *2020*, pp.1-34

Tryner, J., et al., 2020**. Laboratory evaluation of low-cost PurpleAir PM monitors and in-field correction using co-located portable filter samplers**. *Atmospheric Environment*, *220*, p.117067

Ardon-Dryer, K., Dryer, Y., Williams, J.N. and Moghimi, N., 2020. **Measurements of PM 2.5 with PurpleAir under atmospheric conditions. *Atmospheric Measurement Techniques***, *13*(10), pp.5441-5458

Stavroulas, I., et al., 2020. **Field evaluation of low-cost PM sensors (Purple Air PA-II) under variable urban air quality conditions, in Greece**. *Atmosphere*, *11*(9), p.926

In summary

- Indoor air quality standards are essential to support public health.
- To be enforceable, they will be different from the outdoor air quality standards.
- A viable framework for regulating indoor air quality already exists.

Our goal: to make clean, healthy indoor AND outdoor air the norm…

The role of scientists: not only to investigate but to be a voice for the application of science!

Thank you!