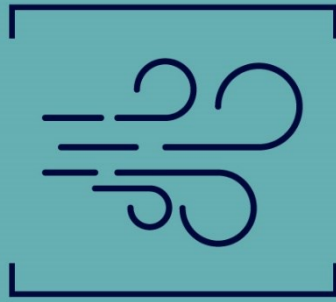




IDEAL

INDOOR AIR QUALITY
HEALTH

IDEAL CLUSTER POLICY BRIEF I

IDEAL Cluster Working Group 1:
Science translation for policy and
practice

Version 1.0
29 February 2024



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1. EXECUTIVE SUMMARY

Cluster details

Cluster title	Indoor Air Quality and Health
Cluster acronym	IDEA/IDEAL
Dates and duration	September 1 st 2022 – August 31 st 2026 (48 months)
Horizon Europe call	HORIZON-HLTH-2021-ENVHLTH-02-02 Indoor air quality and health
Number of projects	7

IDEAL's projects

PROJECT	TITLE	GA NUMBER
K-HEALTHinAIR	Knowledge for improving indoor air quality and health	101057693
SynAir-G	Disrupting Noxious Synergies of Indoor Air Pollutants and their Impact on Childhood Health and Wellbeing	101057271
LEARN	Evaluation on indoor air quality for children around Europe	101057510
TwinAIR	Indoor air quality for healthy living	101057779
InChildHealth	Identifying determinants for indoor air quality and their health impact in environments for children: measures to improve indoor air quality and reduce disease burdens	101056883
Inquire	Identification of chemical and biological determinants, their sources, and strategies to promote healthier homes in Europe	101057499
EDIAQI	Evidence Driven Indoor Air Quality Improvement	101057497

Cluster's aim

In order to optimise synergies, avoid overlaps and increase the impact of the projects selected for funding under the call HORIZON-HLTH-2021-ENVHLTH-02-02 Indoor air quality and health, the projects have formed a cluster. Common cluster activities include the following:

1. Common cluster kick-off meeting of the six projects
2. Annual cluster meetings and periodic report of joint activities
3. Common dissemination and communication activities
4. Thematic workshops/trainings on issues of common interest
5. Working groups on topics of common interest
6. Advisory board



Document details

Deliverable Type	Report
Deliverable Title	Policy Brief
Name of Lead Partners for this deliverable	SynAir-G
Version	1.0
Contractual delivery date	29/02/2024
Actual delivery date	29/02/2024
Dissemination Level	Public
Purpose	Focused on science for policy communication/translation. Report on how the results of the cluster could contribute to policy strategies and initiatives .

Revision history

The following table describes the main changes done in the document since it was created.

REVISION	DATE	DESCRIPTION	AUTHOR (PROJECT)
V.0.1	15/12/2023	First Policy Brief template draft	SynAir-G
V.0.2	12/01/2024	Contribution from WG1 members	IDEAL Cluster WG1 members
V.0.3	1/02/2024	Final round of review	IDEAL Cluster WG1 members
V.0.4	29/02/2024	Final Policy Brief	SynAir-G

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2. IDEAL CLUSTER POLICY BRIEF

Introduction

Clean air, despite being a cornerstone of life, continues to be imperilled by contemporary human-driven activities. Processes such as industrial production, energy generation and use, transport, agriculture and livestock, and waste treatment, are typically associated with the emission of pollutants in the air we breathe. Whether it is in an outdoor or an indoor environment, polluted air inflicts a severe impact on human health, as well as the environment.

Indeed, air pollution is now recognised as the single biggest environmental threat to human life within the European Union¹. It is responsible for more than 327,000 premature deaths, among which about 1,200 people under 18 years of age, as well as about 3,9 million disability-adjusted life years (DALYs)^{2,3,4}. Beyond the toll on human health, air pollution is projected to cost the EU a staggering €330 billion annually⁵. This financial burden encompasses diseases exacerbated by air pollution, along with associated losses in productivity and escalated healthcare expenses.

Even today, most of the public debates and policy attention globally is directed towards the risks posed by outdoor air pollution. However, multiple studies have illustrated that **indoor environments can harbour pollution levels that often exceed those found outdoors**^{6,7}. This becomes even more urgent following the experience of the COVID-19 pandemic (and the subsequent restrictive measures), which has led to a growing recognition of the interconnectedness between indoor and outdoor air quality and the need for broader policy considerations.

Whether it is private homes, workplaces, means of transportation and publicly accessible closed spaces, such as schools, hospitals and the food establishments, people spend about 90% of their time indoors⁸. Comprehending fully the issue of IAQ and devising strategies to enhance air quality in indoor spaces is paramount to avert the harmful impacts of indoor air pollution on our health.

This is exactly the aim of the policy briefing at hand: enhance understanding on indoor air quality in Europe, by outlining its key aspects from a health perspective but also through a brief analysis of the policy context and the existing gaps. It culminates to a set of policy recommendations that pave the way forward.

¹ European Environment Agency, "Air pollution", 2024 <https://www.eea.europa.eu/en/topics/in-depth/air-pollution>

² European Environment Agency, "Harm to human health from air pollution in Europe: burden of disease 2023", 2023 <https://www.eea.europa.eu/publications/harm-to-human-health-from-air-pollution/>

³ European Environment Agency, "Air pollution and children's health", 2023

<https://www.eea.europa.eu/publications/air-pollution-and-childrens-health>

⁴ OECD and European Union, "Air pollution and its impact on health in Europe: Why it matters and how the health sector can reduce its burden", *Health at a Glance: Europe 2020*, 2020 <https://www.oecd-ilibrary.org/docserver/5286cd4d-en.pdf?expires=1708705075&id=id&accname=guest&checksum=6CFC1E0DFDCCA18CA569E94F869E4A51>

⁵ European Commission, "Air", 2023 https://environment.ec.europa.eu/topics/air_en

⁶ P. Hunter 'The health toll of air pollution: Despite global efforts to clean up the air, outdoor and indoor air pollution still have a drastic negative effect on public health', EMBO report, 2020 <https://www.embopress.org/doi/full/10.15252/embr.202051183#sec-2>

⁷ A. Sekar et al, "Analysis of benzene air quality standards, monitoring methods and concentrations in indoor and outdoor environment," *Heliyon*, 2019 <https://pubmed.ncbi.nlm.nih.gov/31844766/>

⁸ S. Vardoulakis et al. Indoor Exposure to Selected Air Pollutants in the Home Environment: A Systematic Review, *Int. J. Environ. Res. Public Health* 2020 <https://www.mdpi.com/1660-4601/17/23/8972>

Overarching issues linked to Indoor Air Quality: Key components of the public discourse

Indoor Air Quality (hereafter IAQ) encompasses the air within and surrounding buildings, focusing on the comfort, well-being, and health of occupants. It can be compromised by elements like smoke, mould, emissions from heating/cooking, as well as chemicals such as Volatile Organic Compounds (VOCs), present in paints, furnishings, and cleaning products.

Understanding IAQ requires acknowledging **the intricate interplay between outdoor and indoor air pollution**. While the common belief is that opening a window refreshes indoor air, outdoor air may carry significant pollutants. Mechanisms such as **ventilation and infiltration**⁹ facilitate the exchange of outdoor and indoor air, impacting IAQ. However, badly designed or dysfunctional ventilation and an excessive infiltration can lead to the accumulation of outdoor air pollutants inside. Therefore, **a well-functional ventilation and adequate insulation** play a pivotal role. Finally, household air pollution also contributes to ambient air pollution, and therefore a reduction in indoor pollution will translate to a decreased outdoor pollution in the immediate environment of the building.

Moreover, indoor air pollution can have a **significantly impact on health**. It is linked to life-threatening chronic conditions such as asthma, chronic obstructive pulmonary disease (COPD), cardiovascular disorders, strokes, and lung cancer. As per WHO data from 2020, indoor air pollution was responsible for about 3,2 million premature deaths per year globally. Lower respiratory infections impacting children contribute to 21% of these fatalities, while COPD and lung cancer account for 19% and 6%, respectively. In addition, 32% of this mortality results from ischemic heart disease, and 23% from stroke due to pollutants from indoor solid fuels and kerosene¹⁰.

Moreover, **allergens, endotoxin, and mould** present in indoor air are associated with compromised health and performance in both children and adults¹¹. Typical short-term symptoms from exposure to indoor air pollution are eye irritation, headaches, and fatigue.

Population groups particularly vulnerable to indoor air pollution include children, pregnant women, the elderly, people with pre-existing respiratory and cardiovascular diseases, and socioeconomically disadvantaged households. Children, for instance, face higher risks as their immune and respiratory systems are still under development, while those with lung problems have greater sensitivity to pollutants or less reserve to cope with ill effects¹². Meanwhile, low-income households are more likely to live in inadequately ventilated buildings with higher concentrations of pollutants, due to lack of access to clean energy sources for heating¹³.

However, one needs to keep in mind that the **complete scope of health effects stemming from indoor air pollution remains largely unknown**, characterised by numerous **gaps in knowledge**. This is mainly due to the **multitude of pollutants, often present in synergy**, as well as **the influencing factors from both indoor and outdoor sources**. Human activities like smoking, burning solid fuels, and cleaning, along with emissions from building materials and biological contaminants are often happening simultaneously, leading to a harmful mix. Moreover, age and maintenance of sources, ventilation patterns, and malfunctions in appliances further complicate it. Thus despite strides in understanding, substantial knowledge gaps persist, hindering a comprehensive grasp of sources, factors, contaminants, and pollutants influencing IAQ.

⁹ Infiltration refers to a process where outdoor air flows into buildings through openings, joints, and cracks in walls, floors, and ceilings, and around windows and doors.

¹⁰ World Health Organisation, "Household air pollution", 2023 <https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health>

¹¹ The NIEHS-funded Center, Indoor Air Quality, 2021 <https://www.niehs.nih.gov/health/topics/agents/indoor-air>

¹² J. Environ. Res. Public Health 2022, 19(14), 8752; <https://doi.org/10.3390/ijerph19148752>

¹³ OECD/European Union (2020), Health at a Glance: Europe 2020: State of Health in the EU Cycle, OECD Publishing, Paris, <https://doi.org/10.1787/82129230-en>.

Current situation on IAQ in Europe and beyond: Guidelines, policies, best practices

IAQ is recognised by WHO as a critical health determinant of health. Through a series of publications over the last 35 years, WHO has offered guidelines and recommendations on indoor air pollution both from a general and more specific perspectives. Although not legally binding, they equip WHO member states with evidence-driven tools to shape legislation and policies.

The **WHO Air Quality Guidelines**, initially released in 1987 and updated in 2000, 2005 and 2021 are globally applicable, setting standards in the form of evidence-based quantitative recommendations for air quality management, looking at six key air pollutants: PM_{2.5} and PM₁₀, ozone (O₃), nitrogen dioxide (NO₂), carbon monoxide (CO) and sulphur dioxide (SO₂). While the earlier versions focused on outdoor pollutants, the 2021 revision encompasses both outdoor and indoor environments¹⁴.

From an indoor viewpoint, in 2009 the WHO addressed the health effects of **dampness and mould**, offering recommendations to tackle building moisture and microbial growth¹⁵. In 2010, the WHO looked at **selected indoor air pollutants**. Rigorously evaluated by multidisciplinary experts, the guidelines addressed specific pollutants including benzene, NO₂, formaldehyde, PAHs, CO and radon¹⁶. Finally, in 2014 WHO examined the effects of **household fuel combustion**, with the first-ever health-based guidelines on clean cooking, heating and lighting¹⁷.

The guidelines and recommendations are typically targeted to building designers, authorities overseeing indoor environments, healthcare professionals, but also the wider public.

Governing IAQ at the national level in the European Union

Several **EU Member States**, including France, Portugal, Finland, Austria, Belgium, Germany, the Netherlands, and Lithuania, have taken varied approaches to address IAQ. These include adopted guide values, reference concentrations, and action values, aligning with WHO guidelines. Such measures typically form part of national IAQ plans and dedicated legislative acts for indoor environments. Additionally, there are initiatives for mandatory indoor air monitoring, alongside training programmes targeting technical offices, managers, and staff. Some EU Member States have also introduced specific legislations and reference ISO standards for individual pollutants.

This **mosaic of efforts** reflects a concerted push to enhance IAQ standards and protection across different Member States at a national level¹⁸. However, a prevailing challenge in this process has been the absence of dedicated IAQ sampling and analysis standards.

At EU level, while there is a comprehensive legal framework for ambient air quality, there is no specific directive addressing IAQ. Pre-legislative initiatives, research, standards, and guidelines have been introduced, but a unified EU-wide policy on IAQ is yet to be established¹⁹. Therefore, the current IAQ policy landscape in the EU remains a patchwork of measures with largely diverse scopes and levels of enforcement, and often applying to different pollutants and indoor environments.

¹⁴ World Health Organisation, “WHO global air quality guidelines: particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide”, 2021

<https://www.who.int/publications/i/item/9789240034228>

¹⁵ World Health Organisation, “WHO guidelines for indoor air quality: dampness and mould”, 2009,

<https://www.who.int/publications/i/item/9789289041683>

¹⁶ World Health Organisation, “WHO guidelines for indoor air quality: selected pollutants”, 2010

<https://www.who.int/publications/i/item/9789289002134>

¹⁷ World Health Organisation, “WHO Guidelines for indoor air quality: Household fuel combustion”, 2014

<https://www.who.int/publications/i/item/9789241548885>

¹⁸ Gaetano Settimo et al, ‘Indoor Air Quality: A Focus on the European Legislation and State-of-the-Art Research in Italy’ MDPI, 2020 <https://www.mdpi.com/2073-4433/11/4/370>

¹⁹ Ibid

Recognising the necessity for a more holistic approach to IAQ, there is a growing consensus for coherent and mutually reinforcing policies at the European level. This entails ensuring effective alignment between health, safety, chemical, and building regulations to form a unified strategy.^[46]

Ambient Air Quality Directives: Governing Outdoor Air and the Zero Pollution Action Plan

Implemented since the 1980s, the EU Ambient Air Quality Directives set air quality standards for key pollutants that are harmful for human health and the environment, including PM_{2.5}, PM₁₀, O₃, SO₂, NO₂, CO, benzene, lead, arsenic, cadmium and nickel²⁰. Since October 2022, as part of the **European Green Deal**, the legislative framework is under revision, with the aim to align more closely with WHO recommendations, and achieve zero air pollution by 2050²¹. The revisions foresee stricter limit values, regular legislative reviews, access to justice, and better public information on air quality, alongside strengthening air quality monitoring and modelling. However, like their name shows, the EU directives only address outdoor air pollution, excluding indoor environments and workplaces.

In May 2021, the European Commission presented the '**Zero-Pollution Action Plan**' (ZPAP)²². The ZPAP constitutes a cornerstone initiative aimed at comprehensively addressing pollution across different domains. This plan identifies a range of key objectives to tackle water, air, and soil pollution, to contribute to the EU Green Deal goal of a pollution-free environment by 2050. While the action plan is broad in scope, it explicitly underscores the significance of tackling air pollution. Among its main objectives, the plan seeks to reduce health impacts caused by air pollution by more than 55%, resulting in a considerable decrease in premature deaths attributed to particulate matter by 2030²³.

The European Indoor Air Quality Legislative Framework: A Vague Patchwork

On multiple occasions, the European Commission has recognised the complex web of factors affecting IAQ. Existing EU policies regulate various determinants, including ambient air, construction materials, tobacco control, consumer products, as well as occupational health and safety regulations. Yet a comprehensive and integrated approach addressing IAQ is absent within the EU legislative framework. References to it remain largely implicit and secondary at best, bearing resemblance to a policy patchwork.

- The **1989 European Council Directive** concerning the minimum safety and health requirements for the workplace mandated fresh air to accommodate the working conditions and physical demands placed on workers²⁴. It emphasised the need to maintain ventilation systems, and addressed issues related to air conditioning or mechanical ventilation installations to ensure workers' comfort and health.
- Similarly, **Regulation EU No 305/2011** outlined conditions for marketing of construction products, including aspects related to hygiene, health, and the environment²⁵. While this

²⁰ Official Journal of the European Union, 2008, "DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe" <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050>

²¹ European Commission, "Revision of the Ambient Air Quality Directives", 2022m

https://environment.ec.europa.eu/topics/air/air-quality/revision-ambient-air-quality-directives_en

²² European Commission, "Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil', 2022, https://eur-lex.europa.eu/resource.html?uri=cellar:a1c34a56-b314-11eb-8aca-01aa75ed71a1.0001.02/DOC_1&format=PDF

²³ European Commission, "Zero pollution targets", 2022, https://environment.ec.europa.eu/strategy/zero-pollution-action-plan/zero-pollution-targets_en

²⁴ European Agency for Safety and Health at Work, "Directive 89/654/EEC - workplace requirements", 2021, <https://osha.europa.eu/en/legislation/directives/2>

²⁵ Eur-Lex, "Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC Text with EEA relevance", 2021, <https://eur-lex.europa.eu/eli/reg/2011/305/oj>

regulation touches on the release of toxic gases, emissions of dangerous substances, and particles into indoor and outdoor air, it does not provide comprehensive standards for IAQ.

While these directives set a foundation for addressing related concerns, they did not offer comprehensive nor focused guidance vis-a-vis IAQ. However, with the onset of the **COVID-19 pandemic**, the importance of healthy indoor environments took on a renewed emphasis owing to containment measures and the virus's biological characteristics.

- A report by the **European Parliament** epitomised this renewed emphasis, acknowledging the fragmented nature of existing legislation covering IAQ²⁶. This recognition underlined the need for a more comprehensive EU approach to air pollution, ensuring coherence between ambient air quality, health and safety at workplaces, chemical regulations, and building legislation. The report also stressed knowledge and policy gaps around IAQ. The report also highlighted the socio-economic implications of this pollution, emphasising that marginalised groups experience heightened exposure due to proximity to pollution sources both outdoors, such as traffic and industrial areas, and indoors, like inefficient heating methods. It concluded calling the European Commission to consider regulating IAQ independently.
- The **communication from the European Commission on ZPAP** also underlined policy and knowledge gaps vis-à-vis IAQ and highlighted actions the European Commission has undertaken, such as the Horizon Europe Mission for Climate Neutral and Smart Cities, the Covenant of Mayors, and the New European Bauhaus initiative. Within this context, the Commission committed to *'assess pathways and policy options to improve indoor air quality, focusing on key determinants and pollution sources and exploring ways to raise greater public awareness and reduce risks'*.

Standards as supporting tool to create policies and EU regulations

Standards are generally considered as supporting tool to create policies, by establishing techniques, methods and systems developed and agreed by all stakeholders, to guarantee and improve the IAQ across Europe.

Beyond the EU level, a number of standards have been agreed at international level within the International Organization for Standardization (ISO), as regards indoor air. Most of these standards deal with standardized sampling methodologies and measurement techniques for different pollutants. Some of them have been adopted at European level in the frame of the European Committee for Standardization (CEN).

However, other standards are not adopted by CEN, for instance, a large part of the series ISO 16000 on "Indoor Air" or the complete series ISO 12219 "Interior air of road vehicles"^{27,28}. In this sense, there are no standards specifically dedicated to indoor air in vehicles published by CEN.

Regarding indoor air quality management in particular, two relevant standards have been published by ISO: the standard ISO 16000-40:2019 "Indoor air — Part 40: Indoor air quality management system" and, recently, the standard ISO 16000-41:2023 "Indoor air — Part 41: Assessment and classification"^{29,30}. These standards have not been adopted at European level, and no other standards

²⁶ European Parliament, "on the implementation of the Ambient Air Quality Directives: Directive 2004/107/EC and Directive 2008/50/EC (2020/2091(INI))", 2021 https://www.europarl.europa.eu/doceo/document/A-9-2021-0037_EN.pdf

²⁷ ISO, "Indoor air | Part 1: General aspects of sampling strategy", 2004-07 <https://www.iso.org/standard/39844.html>

²⁸ ISO, "Interior air of road vehicles | Part 1: Whole vehicle test chamber", 2021 -08 <https://www.iso.org/standard/72410.html>

²⁹ ISO, "Indoor air | Part 4: Indoor air quality management system", 2019-07 <https://www.iso.org/standard/70424.html>

³⁰ ISO, "Indoor air | Part 41: Assessment and classification" 2023-08 <https://www.iso.org/standard/76519.html>

have been published dealing with indoor air quality and assessment. This circumstance allows that each country in Europe can decide to adopt the ISO standards as national standards, or to develop its own standard related to IAQ management and assessment.

Outline of the IDEAL Cluster projects' objectives

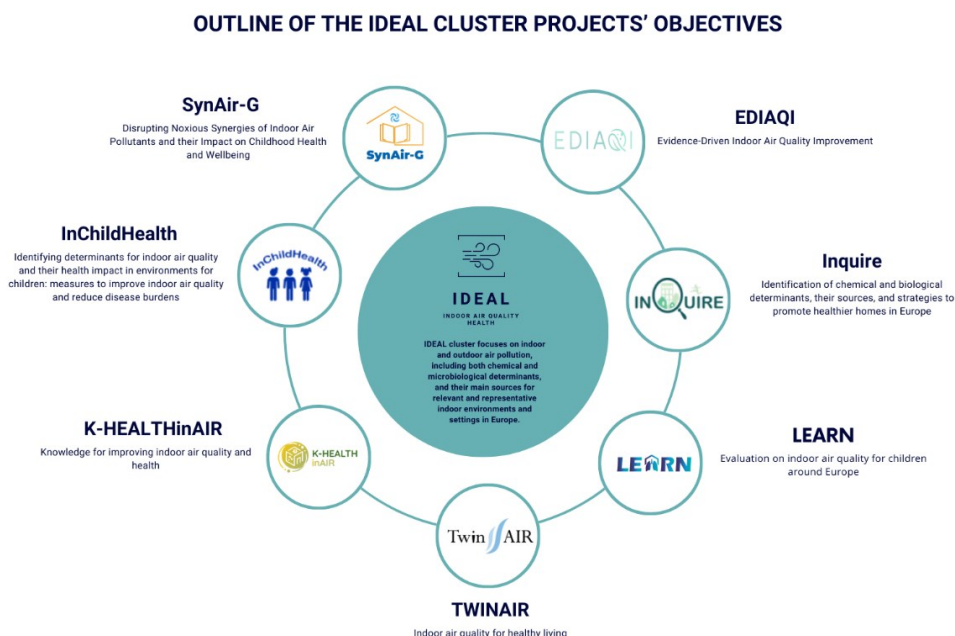


Figure 1 - Outline of the IDEAL Cluster projects' objectives

Key policy questions in addressing indoor air pollution

In view of the overarching issues and the current state-of-play outlined above, there is a set of key questions that arise as the EU seeks to develop a more consistent policy approach to address indoor air pollution and the risks associated with it. For policymakers, working closely with relevant stakeholders such as technical specialists, scientists, civil society organisations and public health experts at both the EU and the national level, is essential to resolve these questions in an effective and inclusive way.

As with all EU initiatives, it is fundamental that the action to address indoor air pollution be grounded on a **solid and appropriate legal basis** that respects the subsidiarity principle, while giving the freedom to the EU to take measures for the protection of public health and facilitating a cross-border exchange of best practices and learning process.

Tackling indoor air pollution means taking advantage of multiple potential interconnections and synergies among different policies via both legislative and non-legislative measures. The **EU One Health agenda**, for example, emphasises the links among all living environments, including buildings. Settings such as schools and hospitals are of particular interest, as they are largely frequented by vulnerable groups. To be effective, initiatives on IAQ must be **aligned with policies currently in place**, such as the rules on construction products, the zero-pollution target by 2050 and the relevant climate goals, to name just a few.

Another key aspect to reflect on is the interplay between **individual measures and systemic approaches**. What would be a commonly acceptable legal definition for indoor air pollution, one that would integrate person-level activities and external factors? Given that indoor air pollution is the result of multiple factors at different levels, where should we set the limits between individual-level behaviour

and the systemic level that sets the example and defines legal limits? Even more importantly, how do the two levels influence each other?

Moreover, the diverse landscape of national measures and policies has revealed a variety of approaches and tools for technical matters around IAQ in different EU countries. For instance, methods for the **measurement, exposure assessment and analysis** are not equally advanced across the region, or do not even exist in some cases. Furthermore, combining contextual information with technical methods e.g. measuring or sampling.

In order to design and evaluate the success of specific policy actions to improve IAQ, it is essential to have established standardized criteria bases for the classification of IAQ in spaces, using a range of quality classes or levels.

Finally, following the experience of the COVID-19 pandemic and the lockdowns that came with it, it is absolutely relevant to **re-assess the social perception of indoor spaces**, whether public or private, and their impact on human health. How far or how near are we, indeed, from the emergence of an IAQ culture?

Policy recommendations

- 1) Establish a **sound legal basis for EU action against indoor air pollution**. Article 168 of the Treaty for the Functioning of the EU (TFEU) would be most suitable in this respect, serving as the glue linking the heterogeneous and multifaceted challenges posed by indoor air pollution.
- 2) Present a **cohesive strategic plan for IAQ**, connecting the numerous policies relating to indoor air pollution, aligning it with existing policy objectives, and integrating it in the unfolding EU One Health Agenda.
- 3) Adopt a **common definition for IAQ** that takes into account the complex interplays among the individual level and the external factors involved.
- 4) Reinforce the **links between existing standards relevant to IAQ** in the framework of the European Committee of Standardisation (CEN) and the EU regulations, while developing **new standards on IAQ management, exposure assessment and analysis**, to ensure a harmonised landscape across the EU. Promote the development of standards that establish EU standardized criteria basis for the classification of IAQ in rooms and buildings using quality classes.
- 5) Conduct a **survey on the public perception of indoor spaces** and the **health impact of indoor air pollution**, in view of the COVID-19 experience and the potential emergence of an IAQ culture.

Next steps

The design of this report will be readapted for dissemination purposes after the document content approval by the European Commission.

