

Novel Air Treatment Solutions

Towards practical, scalable technologies for indoor air quality improvement

Understanding the scope of this work

This deliverable presents the first version of a technical assessment of novel air treatment solutions aimed at improving indoor air quality (IAQ). Developed under the K-HEALTHinAIR project, it focuses on evaluating and comparing multiple technologies in terms of:

- Efficiency in reducing indoor pollutants,
- Compatibility with naturally ventilated and HVAC-equipped buildings,
- including homes, schools and healthcare facilities in various countries such as Spain, the Netherlands, Germany, Poland, Austria, and Norway.

The report outlines current innovations, implementation strategies, and the preliminary version of a decision matrix to guide future selection and deployment of these systems.

It sets the ground for upcoming validations in real environments across selected pilots in Germany, Austria, and Poland.

1. Introduction and objectives

Indoor air quality (IAQ) is increasingly recognised as a key factor affecting health and wellbeing across residential, commercial, and public buildings. Although ventilation plays a major role in pollutant removal, additional air treatment technologies are often needed to ensure sufficient protection, particularly in buildings with limited natural ventilation or specific pollutant sources.

This report reviews and assesses a range of novel indoor air treatment solutions with the goal of supporting their deployment in real-world environments. The aim is to identify technologies that:

- Are effective in reducing key IAQ pollutants such as PM, VOCs, and CO₂
- Can operate alongside natural or mechanical ventilation systems
- Are suitable for use in diverse indoor settings
- Offer practical and scalable installation options for long-term use

These findings will contribute to the definition of a decision-support framework for selecting appropriate technologies depending on building type, ventilation characteristics, and dominant pollutants.

2. Types of indoor air treatment solutions

The primary strategies for IAQ improvement can be categorized into three main groups: source control, ventilation, and air purification:

- Source Control

This includes eliminating or reducing indoor sources of pollution, such as emissions from building materials, cleaning products, or combustion appliances. It is considered the first and most effective line of defence.

- Ventilation

Ensuring adequate air exchange through natural or mechanical systems is fundamental. However, outdoor air quality and energy consumption can limit its effectiveness.

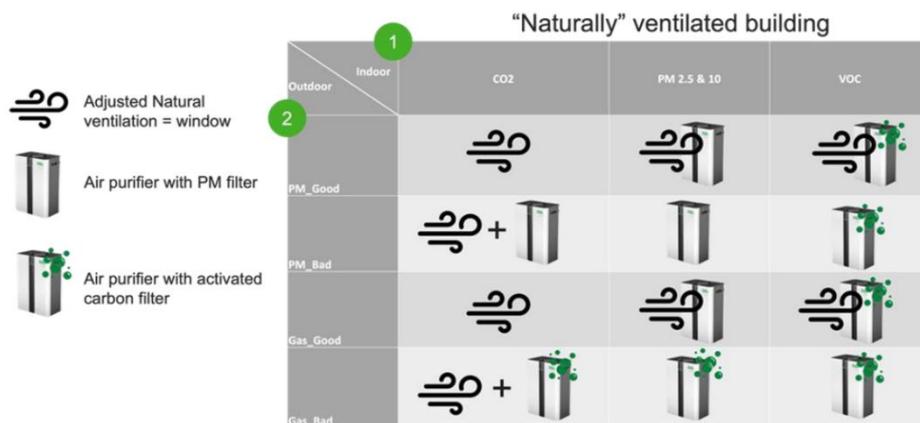


Figure 1. Decision matrix on measures for improving air quality for "naturally" ventilated building.

- Air Filtration and Purification

In this report, both terms are considered closely related, as most air purifiers primarily filter the air. Filters remove particles and, in some cases, gases from the air. High-efficiency filters like HEPA are effective at capturing fine particulate matter (PM), while activated carbon filters target certain VOCs and odours.

Some advanced air purification technologies, such as photocatalytic oxidation (PCO), electrostatic precipitation, UV disinfection, or plasma-based systems, go beyond filtration by chemically or physically neutralising certain pollutants. Each category

plays a complementary role and must be evaluated based on pollutant type, building characteristics, operational constraints, and health impact.

3. Technology review and selection criteria

A detailed review of indoor air treatment technologies was carried out based on their technical performance, safety, scalability, and compatibility with various building types. Technologies were grouped according to their operational principles and evaluated using a set of predefined selection criteria.

Technologies reviewed include:

- Combined filter systems (typically integrating HEPA and/or activated carbon layers)
- Photocatalytic oxidation (PCO) units
- Electrostatic precipitators
- UV-C germicidal systems
- Ionisation and plasma-based air cleaners
- Photocatalytic paints and coatings
- Hybrid solutions combining multiple mechanisms

Each solution was assessed on parameters such as:

- Efficiency in reducing PM, VOCs, and biological agents
- Energy consumption and maintenance requirements
- Ease of installation and integration
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- Potential side effects, including by-product formation

This review provides a comparative basis to support technology selection tailored to specific indoor environments and ventilation configurations.

4. Ongoing pilot activities

To evaluate the real-world applicability of selected air treatment solutions, pilot installations are being conducted across three countries: Germany, Austria, and Poland. These pilots aim to test the effectiveness, feasibility, and user acceptance of different technologies in diverse indoor environments.

The pilots involve both naturally ventilated buildings and those with mechanical ventilation (HVAC) systems. The technologies being trialled include:

- Combined filter units (HEPA and/or activated carbon)

- Photocatalytic oxidation (PCO) devices
- UV-C systems
- Hybrid treatment units
- Photocatalytic paints developed by UiA

In each site, key indoor pollutants such as PM1, PM2.5, PM10, CO₂, and VOCs are being monitored before and after installation, using validated measurement protocols.

The pilots are also assessing:

- Ease of integration with existing infrastructure
- Maintenance needs and operational stability
- Suitability for different building types and occupancy levels

These studies will provide evidence-based insights to refine and enhance the decision matrix, aimed at optimizing indoor air quality.

5. Decision matrix for technology selection

A technical decision matrix was developed to guide the selection of air treatment technologies based on a building's characteristics, ventilation type, and dominant indoor pollutants. The matrix supports decision-making in both natural ventilation and HVAC contexts.

It considers several critical factors:

- Target pollutants (e.g. particulate matter, VOCs, CO₂, biological contaminants)
- Building type and usage (e.g. residential, commercial, public facilities)
- Optimization strategies for HVAC systems emphasize the importance of controlling pressure and temperature setpoints and selecting appropriate filters
- Potential health impacts and by-product generation
- Integration with existing ventilation systems

Each cell in the matrix provides recommendations on the most suitable technologies, balancing effectiveness, safety, and feasibility for each scenario.

The decision matrix provides a structured approach for selecting the most appropriate air quality improvement measures based on the specific conditions identified in each scenario.

6. Conclusions and next steps

The review conducted confirms that a range of air treatment technologies—particularly HEPA filters, activated carbon systems, and photocatalytic oxidation (PCO)—show strong potential for enhancing indoor air quality in various settings.

These solutions offer complementary benefits when combined with existing ventilation systems and can be adapted for both new and retrofit applications. However, their effectiveness depends on correct selection, installation, and maintenance, as well as alignment with building-specific needs.

The decision matrix developed through this work provides a practical framework for identifying suitable technologies according to the type of building, prevailing pollutants, and operational constraints.

Ongoing pilot activities in Germany, Austria, and Poland will supply further insights regarding real-world performance, user acceptance, and long-term viability. These findings will inform future refinements of the decision tool and contribute to wider deployment strategies across the built environment sector.

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