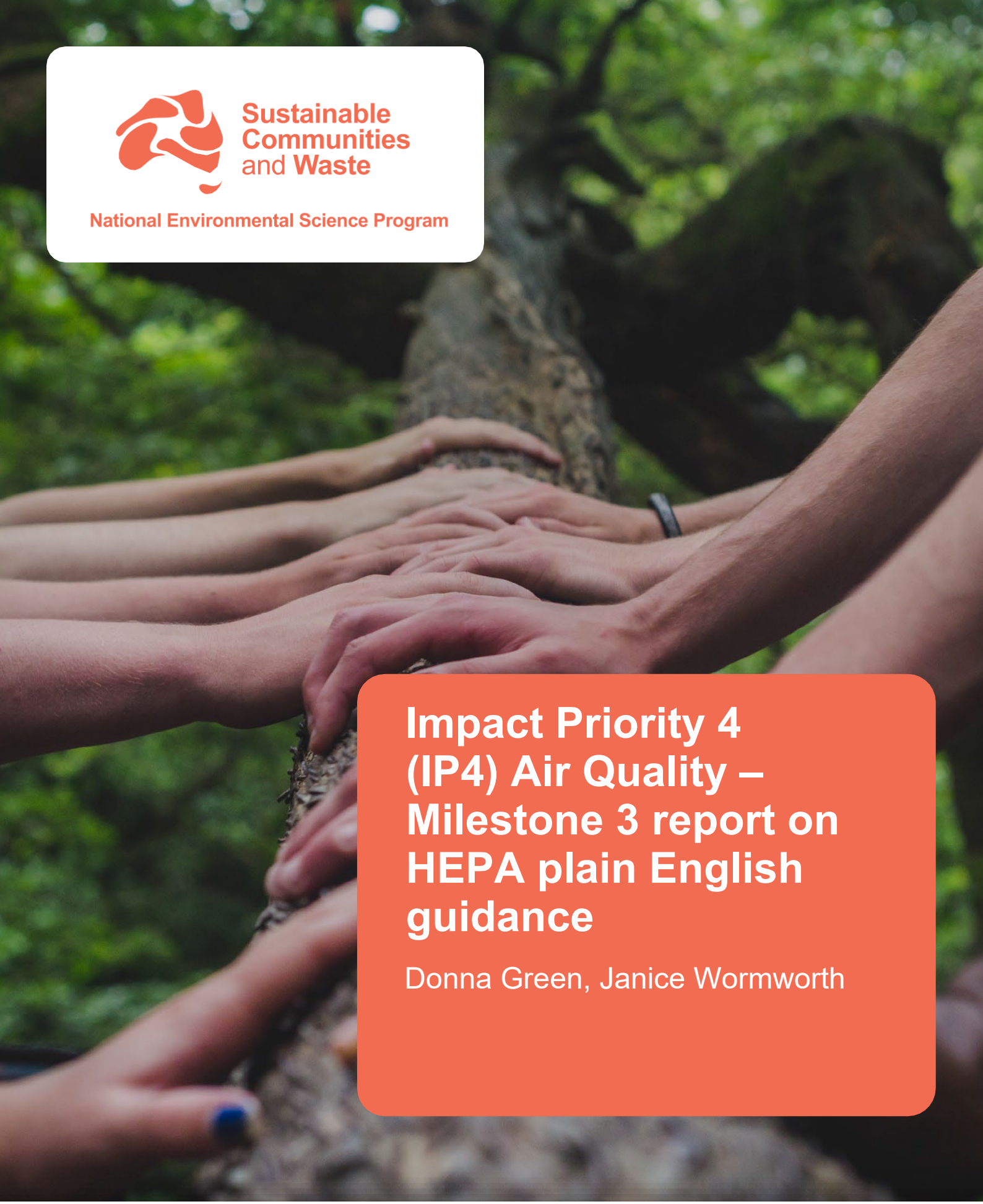

Sustainable Communities and Waste

National Environmental Science Program

Impact Priority 4 (IP4) Air Quality – Milestone 3 report on HEPA plain English guidance

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Milestone 3 Report on Sustainable Communities and Waste Hub project:

Low-cost sensor networks and interventions to improve awareness and reduce exposure to air pollution (IP4.02.04).

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November 2024

HEPA plain English guidance report

DOI: https://doi.org/10.26190/unsworks/31283

Acknowledgements

The Sustainable Communities and Waste Hub acknowledges all Aboriginal and Torres Strait Islander Traditional Custodians of Country and recognises their continuing connection to land, sea, culture, and community. We pay our respects to Elders past, present, and emerging.

This project is supported with funding from the Australian Government under the National Environmental Science Program.

Table of Contents

Executive Summary

This report summarises outcomes of work on high-efficiency particulate air (HEPA) plain English guidance under the NESP Sustainable Communities and Waste Hub project (IP4.02.04).

The 2019-20 summer fires prompted calls for interventions to reduce air pollution exposure, with HEPA filter systems identified as a key solution. The project team assessed available resources for Australians to make informed decisions when purchasing HEPA filter units and produced guidance on HEPA filters, ventilation, and air quality.

Key accomplishments and findings include:

1. Creation of a comprehensive Zotero literature database with over 200 HEPA-related items, including scientific articles, grey literature, media pieces and digital resources.

2. Identification of existing HEPA decision tools and resources.

3. Conducting a HEPA intervention study in a classroom setting, which demonstrated the effectiveness of HEPA filters in quickly clearing particulate matter and emphasized the importance of natural ventilation supplemented with HEPA filtration.

4. Development of plain English HEPA guidance based on a review of existing advice, stakeholder consultation, and insights from intervention research. The resulting guidance addresses about 30 frequently-asked questions on HEPA filters and related topics.

The project's findings highlight the importance of combining natural ventilation with HEPA filtration in classrooms to address both particulate matter and carbon dioxide levels. The intervention study showed that HEPA units of varying clean air delivery rates effectively cleared particulate matter from classrooms within five minutes, while cross ventilation and natural ventilation reduced levels of particulate matter and carbon dioxide very effectively during low levels of outside particulate matter.

The research team identified a gap in Australian public-facing HEPA-specific guidance suitable for school occupants, particularly for scenarios involving bushfires or other serious air pollution incidents. To address this gap, the project team produced the Healthy Classroom Air FAQ, hosted on the Clean Air Schools website. This plain English guidance provides accessible information on HEPA filters, natural ventilation, air quality monitoring, and carbon dioxide monitoring. While focusing on school environments, this resource is also broadly applicable to the general public.

The original research plan proposed to develop a HEPA comparison tool, however, recent new and comprehensive sources of guidance (hardware laboratory tests, comparison tools, and pros-and-cons lists) by other researchers rendered this work

redundant. Instead, we redirected these project resources to the next tranche of work on Safe Havens. Also known as community clean air shelters, safe havens are existing buildings where filtration can be used to reduce airborne particulate matter below outdoor air levels. This work will be reported in detail in the next, Milestone 4 report.

In conclusion, this project contributed to understanding and improving indoor air quality, particularly in school settings. By providing comprehensive, plain English guidance and conducting intervention studies, the research team helped address gaps in knowledge and resources related to HEPA filters and air quality management. The findings and resources developed through this project can help Australians make informed decisions about air quality interventions and contribute to healthier indoor environments, especially in schools facing air pollution challenges.

Introduction

The 2019-20 summer fires and other smoke pollution episodes have triggered calls for interventions to reduce exposure to air pollution. Widespread roll out of HEPA (High-Efficiency Particulate Air) filter systems was cited as a key intervention by government and other NESP stakeholders.

In this tranche of work, we assessed resources available to Australians that enable them to make informed decisions when purchasing HEPA filter units. We produced guidance on HEPA filters, ventilation and air quality. This guidance was informed by available literature, stakeholder consultation, and insights garnered from an intervention study.

HEPA literature compilation

To facilitate our work on HEPA guidance we compiled more than 200 HEPA-related items in a Zotero literature database. This database comprises scientific journal articles, 'grey' literature and other online guidance, and high-impact media and social media pieces. This resource was shared and used by other air pollution researchers; online access is available on request.

HEPA decision tools & refining research direction

Our original research plan proposed to compare HEPA hardware currently available in Australia and develop an online HEPA comparison tool because, at that time of our proposal, this type of advice was lacking. However, when work on this priority commenced, our literature survey revealed that several sources of comprehensive guidance had become available to meet this need. Specifically, the following types of analysis have been recently completed by other researchers:

- laboratory test comparison of hardware currently available on the Australian market
- decisions tools, with pros and cons list of currently available HEPA in Australia.

The key pieces of work in this area are summarised further below (see: Existing HEPA Decision Tools section).

Redirection of resources to safe havens research

Rather than duplicate work in these areas, we redirected project resources to the next tranche of work, on Safe Havens. Also called community clean air shelters, these are existing publicly-accessible buildings or structures (such as libraries, shopping malls and community centres) where indoor air quality can be improved using filtration systems to reduce airborne particulate matter below that of the corresponding outdoor air levels. This permitted us to produce a public-facing opinion piece on Safe Havens for Croakey Health Media's online magazine,

contribute to a peer-reviewed journal article on the topic, and present our proposed Safe Havens work at the 2024 AIRAH Indoor Air Quality conference.

This work, in addition to a comprehensive literature survey and extensive stakeholder consultation, led us to focus our safe havens work on major shopping centres. These buildings are large in capacity and already designated as public refuges from smoke pollution events in government advice. However, shopping centres' protective role in terms of reducing harmful particulate matter relative to outdoor levels is unstudied.

The details of this ongoing Safe Havens work will be covered comprehensively in our Milestone 4 report (due November 2025).

Existing HEPA Decision Tools

In recent years several HEPA comparison tools and sources of advice have become available to help Australian consumers make informed decisions about the type of HEPA filter units they need, and to compare them to other products based on key features. Key resources are summarised below.

Clean Air Stars calculator & product comparison tool

Developed by Dr Pieter Peach in collaboration with US and UK researchers, the Clean Air Stars website provides comprehensive guidance on choosing HEPA filters. Its online tool and calculator help users determine the required number of HEPA units based on the room size or number of occupants, and the fan speed to run. Users can access detailed information on the range suitable products available in Australia to compare before they purchase a HEPA filter unit.

See: cleanairstars.com/filters

University of Melbourne HEPA guidance

Developed by Dr Robin Schofield and available on the University of Melbourne website, this guidance includes research on product comparisons based on cost efficiency, air quality and noise output of all the safe air cleaner products currently in the Australian market. It also provides a product comparison tool that helps consumers decide which air clean is right for them.

See: sgeas.unimelb.edu.au/engage/air-cleaner-guide/australian-product-comparisons

Clean Air Crew buying guide

Additional HEPA comparison advice on the Clean Air Crew website by air quality expert Martwa Zaatari provides a buying guide. This guide compares HEPA filters

based on clean air delivery rate, cost and noise level. (This information, however, is not specific to the Australian market.)

- cleanaircrew.org/air-cleaners

Plain English HEPA guidance

Before developing plain our English guidance, we carried out a comprehensive review of HEPA guidance published in the past three years. This review encompassed advice from Australia and abroad that is geared to a wide range of users. Notable sources of advice are summarised in the section below.

To develop our own guidance, we also consulted stakeholders, drew on insights from our intervention research and direct experience with Clean Air Schools, and performed a gap analysis, as outlined further below.

Key existing sources of Australian HEPA guidance

To develop our guidance, we reviewed ~100 pieces of domestic and international advice.

This section lists notable sources of HEPA advice that informed our own HEPA guidance and our gap analysis.

University of Melbourne has produced online guidance about air cleaners for the general public that includes answers to technical questions “what is clearance time?” as well as common concerns “Do they work to remove COVID-19?” This guidance also includes product comparison advice mentioned above.

Please see: Frequently asked questions about air cleaners

Ozsage, an independent public health advocacy group, provides a guidance document on how to achieve safe indoor air for schools and business post-COVID.

Please see: Safe indoor air (ventilation) recommendations

Victoria’s Department of Education has produced guidance to inform schools how to use and maintain HEPA filters, as well as ventilation.

Please see: Ventilation and air purification guidance

Key existing sources of international HEPA guidance

Some notable international sources of advice include:

- U.S. National Academy of Sciences
- Lancet COVID-19 Task Force
- California Department of Public Health
- Health and Safety Authority (Ireland)
- Harvard TH Chan School of Public Health - Schools for Health (USA)
- Schools Air Quality Monitoring for Health and Education (United Kingdom) - (informative due to focus on naturally ventilated classrooms)
- Joey Fox blog (Canada-based air quality expert)
- Clean Air Crew fact sheets

Stakeholder Consultation

In 2023 we held a workshop themed: How to Protect Schoolchildren from Air Pollution. This allowed us to consult 23 stakeholders from the education, government, research and non-profit sectors on their views regarding gaps in current HEPA guidance, and how to address them.

Participants called for HEPA-specific advice, with updates reflecting new knowledge, including on use, placement and maintenance. They urged us to keep the message positive and use an easily digestible format to describe what to do, and what not to do. Key issues and topics identified at the workshop were:

- information to help staff to change behaviour
- advice on filter cleaning regimes, including how to change filters
- advice to teachers to open windows and turn HEPAs on if found turned off.
- whether to switch filters off at the end of school day to reduce filter replacement rates
- how to choose the best locations for HEPA in rooms within a school
- how to deal with long extension cords
- whether to use HEPA units with windows open
- how to use HEPAs and natural ventilation
- how to use HEPAs and natural ventilation during smoke events.
- clear install instructions – e.g. the need, often overlooked, to remove plastic around filters
- information on the benefits of good indoor air quality
- how to improve air quality, with a focus on natural ventilation.

HEPA intervention study insights

Our guidance also incorporated key insights from our HEPA intervention study.

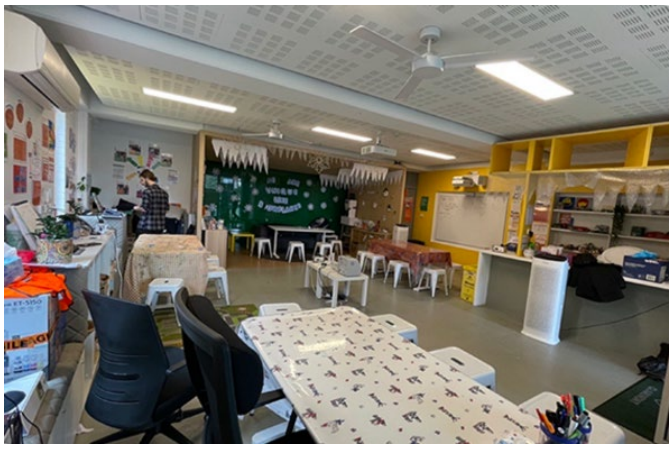

Figure 1: Intervention study set up of classroom with tables for volunteers (looking away from the room's windows; with permission from Green et al. 2023).

Lack of sufficient ventilation inside school classrooms, as indicated by high CO_2 levels, often compounds indoor air quality problems. Many school decision-makers face a dilemma. They can ask staff to open windows to lower carbon dioxide levels, promote good air flow and circulation, and reduce indoor sources of air pollution. However, increasing natural ventilation in this manner can also allow outdoor particulate matter and other outdoor air pollutants to enter buildings.

Appropriate use of HEPA filters and related hardware in classrooms and other public spaces was the impetus for our HEPA intervention study. It addressed the lack of Australian-based studies required for more informed decision-making to improve indoor air quality in schools.

The research examined how well HEPA filters remove particulate matter in a classroom setting. We found that units of varying clean air deliver rates (CADRs) effectively cleared the classroom of $PM_{2.5}$ within five minutes; higher-CADR units did this even more quickly, in two minutes.

The study confirmed outdoor air is needed to reduce CO_2 levels in classrooms. Without purging with outdoor air, CO_2 level rose to greater than 1000ppm in just 12 minutes, which is internationally understood as crossing the threshold to unhealthy levels. Cross ventilation and natural ventilation reduced levels of $PM_{2.5}$ and carbon dioxide very effectively — in under 5 and 10 min respectively, during low levels of outside $PM_{2.5}$.

Importantly for our guidance, the results emphasise the vital role of natural ventilation supplemented with HEPA filtration in classrooms. They also demonstrate the valuable role of monitoring CO_2 and pollution using low-cost sensors.

More information on the HEPA intervention study is available in our Milestone 2 report.

See Appendix A for the research abstract or visit Environmental Research: Health to view the full research article by Green et al. (2023), *Demonstrating the most effective interventions to improve classroom air quality. What novel in situ tests of real-world conditions show is still missing in our guidance.*

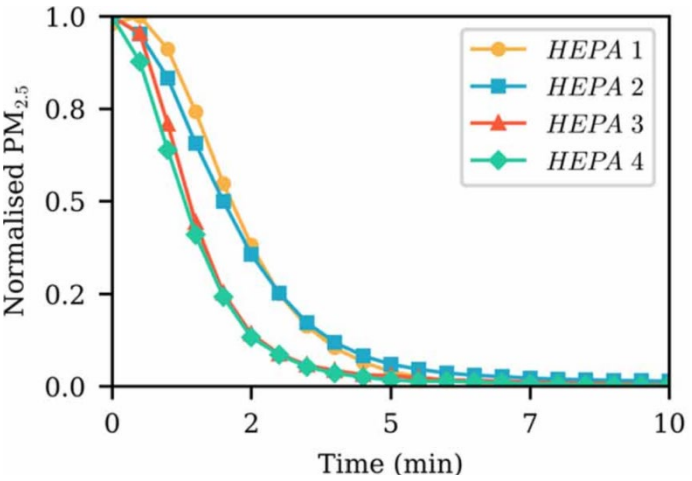

Figure 2: Both lower (HEPA 1 and 2) and higher (HEPA 3 and 4) CADR HEPA filter units efficiently clear PM2.5 from classroom air within five minutes. (With permission from Green et al. 2023).

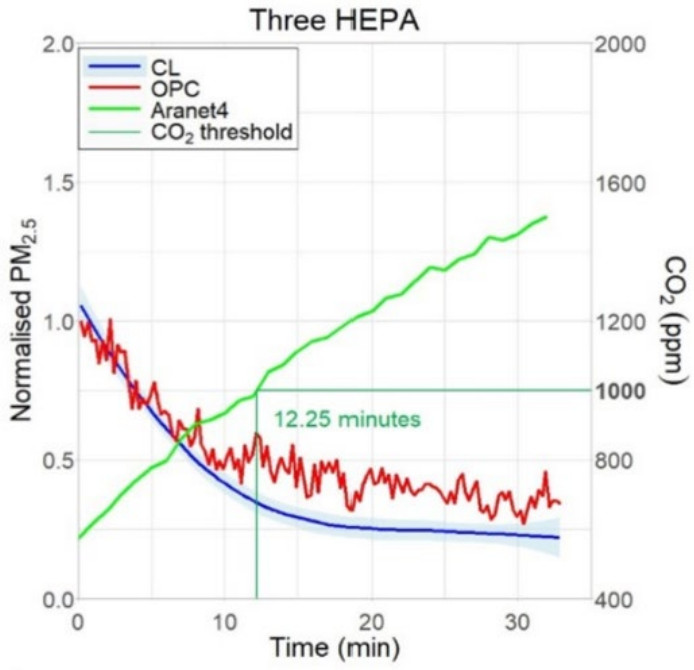

Figure 3: Without ventilation and with HEPA filters running to reduce $PM_{2.5}$ (red line), classroom CO_2 levels (green line), rise rapidly to exceed guideline levels reaching 1000 ppm in just over 12 minutes. (With permission from Green et al. 2023).

GAP analysis

We used the existing expertise around air quality in NSW schools to perform a gap analysis, which indicated a lack of Australian public-facing HEPA-specific guidance that is basic, engaging and suitable for occupants (e.g. teachers and students) of schools.

Most existing advice was too complex (e.g. written for facility managers), COVID-specific, out-of-date, contains information gaps, or is geared for jurisdictions where HVAC systems are the norm. Natural ventilation is the norm in the majority Australian public schools in New South Wales and Victoria.

This gap in guidance extends to advice for bushfire scenarios (or other serious air pollution incidents).

Output: HEPA & Healthy Classroom Air FAQ

Based on our literature compilation, stakeholder consultation and informed by insights from the above HEPA intervention study and other work, we developed the Healthy Classroom Air FAQ (see Appendix B for FAQ content).

This online FAQ emphasises the importance of clean, healthy indoor air for optimal learning and teaching. It provides Plain English guidance on approximately 30 frequently asked questions on:

- HEPA filters and their use
- natural ventilation
- what to do when bushfire/hazard reduction smoke affects local air quality
- air quality monitoring
- CO_2 monitoring

The main intended audience is users of HEPAs in schools; however, the content is broadly applicable to any member of the general public seeking to use HEPAs.

The Clean Air Schools website was deemed a suitable platform for this FAQ because the site is devoted to the topic of indoor air quality in schools. As an added advantage, the authors (Green and Wormworth) have administrative access to the site, facilitating revisions to the guidance as new research deems appropriate.

The FAQ includes links to the above-mentioned Clean Air Stars calculator and HEPA comparison tool, to allow users to easily access these in-depth resources.

View the online FAQ: www.cleanairschools.com.au/what-is-hepa/

Appendices

Appendix A – Intervention study abstract

For the full article see: Donna Green *et al.* 2023 *Environ. Res.: Health* **1** 041001

Over 20 years ago a report commissioned by the European Commission identified air quality in schools as a public health priority. Despite this concern, little action was taken in the following two decades. Over the last two years as classrooms were increasingly recognised as hotspots for the transmission of SARS-CoV-2, renewed interest and resources have been made available in response to this issue. Questions remain, however, over how best to achieve safer classroom air. Our analysis assessed a range of in situ interventions to remove particulate matter ($PM_{2.5}$) and carbon dioxide from inside a populated classroom. Our approach used saline spray and volunteers' exhalations as our source of $PM_{2.5}$ and carbon dioxide to explore the ability of high efficiency particulate air (HEPA) filters, natural ventilation and a recirculating A/C unit to remove these air pollutants which collectively provided a novel set of data. For a total window opening of 1.86 m^2 for a 181.7 m^3 classroom with a HEPA filter with a 703m^3/hr clean air delivery rate, our results confirmed that outdoor air was needed to purge the room to reduce carbon dioxide levels that otherwise rose to >1000 ppm in 12 min. Cross and natural ventilation reduced levels of $PM_{2.5}$ and carbon dioxide very effectively—in under 5 and 10 min respectively during low levels of outside $PM_{2.5}$. We conclude that natural ventilation supplemented with the use of HEPA filters is the most effective way to reliably improve indoor air quality year-round, balancing the need to have easy to enact approaches to reduce the buildup of $PM_{2.5}$, airborne viruses and carbon dioxide. These results highlight an important knowledge gap. Without having localised real-time outdoor air pollution sensing, evidence-based decisions cannot be made about how often, and for how long, windows can safely remain open to purge classrooms in times of poor quality outdoor air.

Appendix B - HEPA & Healthy Classroom Air FAQ

About this FAQ

Air pollution is the greatest environmental health risk we face today. Good air quality supports children's healthy development and contributes to staff wellbeing.
This FAQ aims to support good indoor air quality by answering frequently asked questions. Below you'll find information on air pollution, guidance on choosing, using and maintaining HEPA air filters, and an explanation of importance of ventilation and air quality monitoring.

This FAQ is for schools or other buildings with **natural ventilation or hybrid** (natural combined with mechanical ventilation) systems. It's **not** intended for schools that use **only** mechanical ventilation or have HVAC systems.

Indoor air quality: Overview

Why is clean, healthy indoor air so important for children?
ANSWER
Children are more vulnerable to air pollution than adults. Clean indoor air helps prevent allergies, asthma and damage to children's lungs caused by pollution. It can limit the spread of infections and viruses. Good air quality supports children's healthy development, leading to improved alertness, concentration, mood and overall academic performance. Finally, improving indoor air quality can reduce the number of sick days taken by students.

Why is good indoor air quality so important for staff wellbeing?
ANSWER
Clean, healthy indoor air is as important for staff as for students. Poor indoor air quality can contribute to development of asthma, bronchitis and other lung disease, and can worsen existing respiratory and cardiac conditions. Good indoor air quality reduces the risk of infectious disease transmission. This is important for teachers and other staff in routine contact with large groups of children and young adults. Finally, clean, healthy indoor air enhances cognitive function, productivity and comfort.

Why is healthy air important for children with asthma?
ANSWER
In Australia, about one in 10 children suffer with asthma. Healthy air is crucial for these children, whose airways are more sensitive to pollution. Breathing in polluted air can trigger asthma attacks, causing airways to become inflamed and narrow, and making it difficult to breathe. Exposure to air pollution, including bushfire smoke, can worsen a child's asthma symptoms over time, and increase a child's risk of developing asthma in the first place.

What are other benefits of good indoor air quality?
ANSWER
Healthy indoor air can save schools money by reducing absenteeism for both staff and students. Clean, healthy indoor air also promotes a better sense of comfort, health and well-being.

A California study found that increasing ventilation rates of 4L /p/s (litres per second per person) to meet that state's standards for schools would decrease absence due to illness by 3.4%. The economic benefits of this measure would outweigh its costs by a factor of eight to one.
Another study from the U.S. found that every 1L /p/s increase in ventilation rate was associated with a 5.6 decrease in days with absences per year at the classroom level.

What are some common air pollutants?
ANSWER
Air pollution can take many forms. Particulate matter (PM) includes tiny particles that we can breathe in. It includes pollutants from traffic exhaust and bushfire smoke, as well as allergens like pollen and dust. Nitrogen dioxide (NO_2), from burning fuels, is a gas that irrigates the lungs. Volatile organic compounds (VOCs) are indoor airborne pollutants that off-gas from paint, cleaning products, furniture and adhesives.

What about bacteria and viruses – are they types of airborne pollution?
ANSWER
Yes, airborne bacteria and viruses, including COVID-19, are biological pollutants. Viruses and bacteria are extremely small. They may move through the air as individual particles, but can also travel on larger particles, such as airborne droplets that form when people exhale, cough or sneeze.

How does outdoor air pollution get into schools and other buildings (for example, from outdoor areas with heavy traffic, or on days with bushfire smoke)?
ANSWER
When present, outdoor air pollution can get into rooms through windows, doors and mechanical or natural ventilation systems. It can pass through small gaps or cracks around door or window frames, even if windows and doors are closed. Schools near busy roads or industrial plants face bigger challenges from polluted outdoor air.

What about carbon dioxide (CO_2)? Why is it a problem for students and staff?
ANSWER
Carbon dioxide (CO_2), the waste gas we exhale when we breathe out, can have negative effects if it builds up in rooms. The recommended level for carbon dioxide is less than 850 parts per million (ppm). This compares to the background level of

carbon dioxide which is around 415ppm. Levels higher than 1000ppm can negatively affect learning. It's harder for students to stay alert, concentrate and make decisions when carbon dioxide levels are high. Elevated carbon dioxide levels can cause headaches, dizziness, tiredness, trouble breathing, and make asthma worse. These physical problems may correlate with emotional, mood and behavioural issues.

About HEPA filtration

What are HEPA units?
ANSWER
The air filtering appliances commonly called HEPA (**H**igh **E**fficiency **P**articulate **A**ir) filters or HEPA units look like large rounded or square boxes with lots of small holes on their sides. Inside a typical unit you'll find a motor and a fan that draws air through a pre-filter, and behind that, the HEPA filter itself.

Each HEPA filter consists of a mat of dense fibres, arranged in pleats to increase its surface area. Air — along with any pollutants it contains — is drawn through the filter, which traps pollution particles across a wide range of sizes. The unit vents clean air back into the room and the pollutants stay trapped inside the filter.
HEPA filters need to be replaced when they fill with dirt and dust.

How do HEPA filters work?
ANSWER
As air flows through a HEPA filter, most airborne particles collide or get stuck to the filter's fibres. Technically speaking, HEPA filters work through a combination of interception (trapping by fibres), impaction (colliding with fibres) and diffusion (erratically colliding with gas molecules before colliding with fibres).
Here's a useful video overview of how HEPA filters work.

What do the ratings used for HEPA filters mean?
ANSWER
Australia doesn't have a standard for HEPA. Global standards for HEPA filters differ slightly between regions. The main U.S. standard requires HEPA filters to remove at least 99.97% of particles sized 0.3 microns or larger (0.3 microns is about 300 times smaller than the diameter of a human hair). Europe's standard is based on the size of particle most likely to get through, known as the most penetrating particle size. By this standard, most HEPA filters are rated H13, which means they should be 99.95% efficient for the most penetrating particle size. The good news is they're even more efficient at filtering larger or smaller particles.

If a product's marketing material says HEPA, can I assume it really is?
ANSWER
Watch out for fake products or appliances claiming to be 'HEPA-like'. These filters may be constructed in a similar way, but do not meet HEPA's high standards. They

may not remove particles as small in size or to such high percentages as HEPA filters can. Make sure your product contains a HEPA filter rated to a grade of at least H13 (not lower).

Buy your HEPA unit and its replacement filters from reputable brands and retailers to ensure they are genuine. If buying online, read reviews and check a seller's reputation to avoid fakes.

What can HEPA filters do?
ANSWER
HEPA filters can remove airborne particles from smoke and other air pollution, as well as pollen, mould, dust and bacteria. They also capture tiny droplets released as people breathe, called aerosols, that contain bacteria and viruses. This makes HEPAs an important tool for preventing the spread of airborne bacteria and viruses, including COVID-19, RSV and influenza.

What are things HEPA filters *can't* do?
ANSWER
HEPA filters aren't designed to remove gases from the air. This means they can't remove odours or gases like carbon dioxide or nitrogen dioxide. Activated carbon, sometimes included with a HEPA unit, can help remove some gases such as volatile organic compounds.

If virus particles are small enough to pass through HEPA filters, how can HEPAs capture them?
ANSWER
It's correct that individual virus particles are small enough to pass through a HEPA filter. But most respiratory viruses like COVID 19 are spread on aerosols emitted when people exhale, cough or sneeze. These suspended particles are large enough for HEPA filters to trap.

How do I choose the right HEPA unit?
ANSWER
Here are some web resources to help you choose:

- Clean Air Stars Air Filter Recommendation Tool
- Australian product comparisons

When buying, as well as the unit's cost, key factors to consider include:

- **Room size**: Your room's volume will help determine how many HEPA units you need to meet the World Health Organisation recommended rate of 6 air changes per hour or 10L/p/s.
- **Filter efficiency**: This affects how many units you'll need to achieve the filtration rate recommended above. A high clean air delivery rate (CADR) means the unit is more efficient. Powerful purifiers generally range from 500-

900 cubic metres per hour (m^3/hour). Larger units are generally more powerful. Clean air delivery rates refer to a unit's highest setting; depending on the model, this can be quite loud.

- **Noise level:** A noisy HEPA unit can distract and interfere with learning. Consider using two slightly smaller units, separated from each other, to reduce the noise level and allow for more uniform filtration across the room.
- **'Set and forget' function:** If possible, choose a model that allows users to program start/stop times. If that's not possible, purchase a programmable digital timer to plug into the room's power point, and plug the HEPA unit into that. Some models have smartphone apps to set start/stop times.
- **Filter replacement:** If you plan to use your HEPA unit for several years, consider the cost of filter replacement. Choose a reliable company that will make it easy for you to buy filter replacements over the next few years (or buy a supply at the time of buying the HEPA unit).

How do I know how many HEPAs I need for a room?
ANSWER
The number of HEPA units you'll need depends on room size. As a rough guide, a good choice for a typical Australian classroom size (~65 square meters) would be two medium-sized (roughly adult thigh-height) HEPA units, each with a clean air delivery rate of around 500 m^3/hour or greater.
This guide is an ideal scenario. It's important to remember that in the real world of budget constraints, some HEPA filtration is better than none at reducing risk.
This web tool can help you choose the right number of HEPA units:

- Clean Air Stars Air Filter Recommendation Tool

Is it better to have one larger HEPA unit or two or more smaller HEPA units in a room?
ANSWER
Smaller units tend to be less noisy than larger ones. Running two less powerful units may be quieter than one larger unit. As an added advantage, two or more units placed around a room clean the air more effectively than a single unit, because they provide more uniform filtration of airborne particles.

Should a room's windows be open when running the HEPA unit?
ANSWER:
Yes -- if air quality is good outdoors, it's best to keep windows open when running a HEPA unit. Be aware this may counter advice from the HEPA manufacturer. This is okay. Natural ventilation through windows and doors improves air quality by reducing carbon dioxide levels, and the HEPA unit cleans the air by removing polluting particles and airborne viruses.
But if air quality outside is poor, such as during bushfires, it may be best to close the windows and run the HEPA unit on full power. Then when people leave the room, for example during lunchtime, open the windows to purge carbon dioxide from the air.

Then close the windows again and run the HEPA unit at its highest filtering speed for 20 minutes or more to clear smoke particles from the room before people re-enter.

Where in the room should I put a HEPA unit?
ANSWER
For one HEPA unit:

- Place the HEPA unit on the floor, ideally in a central location where it can filter and catch airborne particles.
- Make sure the power cord doesn't create a trip hazard.
- Ensure the unit's in/out vents are not blocked by furniture or other objects.
- If placing near a wall, make sure the unit is far enough away from the wall to allow air flow.
- Avoid placing HEPA units near open windows or doors, where their clean, filtered air may get sucked straight out.
- Never place them near heat sources or flammable objects.
- If the HEPA units out-vent blows air in a sideways direction, make sure the vent side is at least 2m away from a person.

For multiple HEPA units: Follow the instructions above, but try to space the HEPA units around the room to provide uniform air filtering coverage.

What steps do I take to get my new HEPA unit running?
ANSWER

- Remove any plastic wrap on the outside of the unit. Open the unit and remove any plastic wrap from the filter inside.
- Make sure the HEPA filter (folded white filter) and pre-filter (thinner plastic sheet with tiny holes) are installed properly. The unit may also contain a black or dark-coloured filter layer of activated charcoal.
- Test the unit's different filtering speeds for the highest speed that's acceptable in terms of noise.
- Don't use automatic settings for filtering speed – they'll cause the unit to run too slowly to properly clean the air.
- Automate the HEPA unit's run times, so no one needs to manually turn it on and off each day if possible. If available, use the unit's 'set and forget' feature to program start/stop times. Alternatively, set up a programmable digital timer to do this. Some units can also be programmed using smartphone apps.
- Let others know about the unit, so they understand its health benefits.

What maintenance do I need to do for the HEPA unit, and how often?
ANSWER

- Wipe down the **air intake** on the outside of the unit (the area with holes where air enters). To do this, use a soft, soapy cloth once a month — or whenever you see dust build-up.

- If the unit has a **pre-filter**, clean it every six months — or whenever you see dust build-up. To do this, open the unit, take out the pre-filter, wash it with soapy water, then let it fully dry before you put it back.
- Replace the **HEPA filter** when the unit indicates you need to do so or, depending on use, every year. To do this, you'll need to open the unit, remove the used filter, and discard it inside a sealed plastic bag. Remove any plastic wrap from the new replacement filter, and insert the filter into the unit.

When should I turn my HEPA unit on or off?
ANSWER
Run the HEPA unit at the highest setting possible 30 mins before students arrive, all during the day, and 30 mins after classes end, to clear the room's air of pollutants.
When students or staff are present, run the HEPA unit at its highest setting possible given noise tolerance.
During lunch breaks, purge the room with as much outside air as possible. To do this, ideally open the windows fully, while the HEPA units keep running.
At night, and during weekends or holidays, the HEPA unit can be off if the room is empty.

What can I do about a HEPA unit that is too noisy to teach or hear the students' responses?
ANSWER
It's normal for a HEPA unit to make some noise. Quieter models run at about 40–50 dBA. For reference, 40dBA is the level of noise you'd expect to find in a quiet library.
Here are some things you can do if your HEPA unit is too noisy:
- **Temporarily** lower the filtering speed. Because HEPA units are quietest at lowest fan speeds, this will reduce noise but still provide the benefit of some filtration. But since lower speeds reduce the amount of air filtered, it's important to remember to turn it back up as soon as possible.
- Consider moving the HEPA unit to a position further from the conversation.

Should any of these types of air cleaners be used instead of HEPA?
- **Ozone generators**
- **Ionic air purifiers**
- **Plasma air cleaning technology**
- **Air disinfectants or air fresheners**

ANSWER
Avoid the above types of air cleaners due to their potential health and safety issues. Use safe and effective HEPA units instead.

Ventilation and its importance

Why should I open a room's windows and doors?

ANSWER

- **Better indoor air quality**: Natural ventilation refreshes the air we breathe. It exchanges indoor air, with contaminants like viruses and carbon dioxide, with air from outdoors. By improving indoor air quality, natural ventilation creates a healthier learning environment for students and staff.
- **Fewer illness-related absences:** Natural ventilation helps reduce the spread of airborne respiratory pathogens and improves indoor air quality, leading to fewer absences due to illness.
- **Improved academic performance**: Natural ventilation can help create a comfortable learning environment that can improve academic performance.

What are some tips to get the most out of natural ventilation?
ANSWER

- Between classes, refresh the air by opening doors and all windows and vents as much as possible. If conditions permit, keep windows open during class. Even having windows open just a few centimetres can improve air quality.
- Cross ventilation is the most effective way to refresh a room with clean outdoor air. Open windows, doors and vents to create more through-flow, especially if these openings are on different sides of the room.
- On warm days, open low and high windows to increase airflow between them, cooling the air and improving indoor air quality.

What to do during bushfires

When it's smoky outside, is it OK to close the windows?
ANSWER
During bushfires and hazard reduction burns, outdoor pollution may be so bad you need to close the windows. Here's what to do:

- Close the windows when people are present and run the HEPA unit on full power to keep cleaning pollution from the air.
- When people leave the room, open the windows to purge carbon dioxide from the room's air. Keep the HEPA units running.
- Close the windows again and run the HEPA unit at its highest filtering speed for 20 minutes or more, to clear smoke particles from the room before people re-enter.

About air quality monitoring

What can air pollution monitoring tell us about indoor air quality?
ANSWER
Air pollution varies from place to place and even from room to room. Air pollution monitoring can provide valuable insights to help schools create safer, healthier environments for students and staff. By monitoring air quality schools can:

- **Identify pollution** through the collection of real-time air quality data, so schools can act to cut air pollution at its source.
- **Optimise ventilation** by making the most of natural or mechanical ventilation systems to ensure schools have fresh clean air.
- **Educate students and staff** by raising awareness about air pollution's impact on health and the importance of good indoor air quality.

What can carbon dioxide monitoring tell us tell us about indoor air quality?
ANSWER

Monitoring carbon dioxide levels in rooms can help us understand some aspects of indoor air quality, as follows.

- **Safe levels of carbon dioxide:** Monitoring carbon dioxide can help ensure levels stay below the recommended value of 850 ppm.
- **Ventilation levels:** Carbon dioxide levels can help indicate the level of ventilation. A high carbon dioxide level may indicate the room is not properly ventilated with fresh outside air.

Monitoring carbon dioxide levels **does not**, however, indicate the effectiveness of air filtration or purification systems to remove indoor air pollutants or airborne viruses. These contaminants may still be present in a room with low carbon dioxide levels.