



National Environmental Science Program

Low-cost sensor networks and interventions to improve awareness, and reduce exposure to air pollution

(IP4.02.04)

1 Low-cost sensor (LCS) guidance

Rationale:

- Low-cost sensor (LCS) devices to measure air quality are undergoing rapid growth.
- They offer an opportunity to identify air pollution sources and raise awareness about air quality.
- But... choosing a monitor that's fit-for-purpose can be confusing and time-consuming.

LCS guidance: What we've done

LCS resource compilation

Scientific articles, grey literature, and online resources including product evaluations.

LCS product matrix

Survey of ~50 low-cost sensor devices; narrowed selection to ~30 sensors meeting 'low-cost' price criteria (<10K) and available to Australia.

Cross referenced each device with key user concerns, eg price, type of pollutants measured.

Online LCS decision tool

Used matrix to produce an online decision tool that helps non-expert users find low-cost sensors to suit their needs.

Info Sheets

Plain English guidance for key user groups on how to select LCS.

LCS guidance: Online decision tool

Monitor type

Indoor (18)

Outdoor (20)

Indoor & outdoor (8)

Portable (5)

Indicative price*

\$ - \$

Monitors these particle sizes

PM1 (20)

PM2.5 (31)

PM10 (24)

Monitors these gases

NO2 (12)

O3 (11)

CO (9)

SO2 (9)

H2S (5)

CH4 (2)

















NH3 (4)

CH2O (2)

NO (7)

Monitors volatile organic compounds (VOCs)

(9)

			
<u>PURPLEAIR TOUCH INDOOR</u>	<u>ECOSMART</u>	<u>AIRLY PM+GAS</u>	<u>AIRLY PM</u>
\$300	\$7986	\$1600	\$1600
			
<u>PURPLE AIR CLASSIC</u>	<u>AEROQUAL S-500 PM</u>	<u>OUDOOR AIRQINO</u>	<u>AIRTHINX IAQ</u>
\$380	\$2800	\$5700	\$850
			
<u>DYLOS DC1100 PRO</u>	<u>DYLOS 1700PM</u>	<u>AIR QUALITY EGG</u>	<u>HABITAT MAP AIRBEAM3</u>
\$450	\$700	\$2000	\$370
			
<u>IQAIR AIRVISUAL PRO (INDOOR)</u>	<u>IQAIR AIRVISUAL OUTDOOR</u>	<u>KUNAK AIR PRO</u>	<u>KUNAK AIR LITE</u>
\$550	\$430	\$7290	\$4860

Simple, accessible tool helps users quickly refine their search for a low-cost sensor based on:

- Type of monitoring (indoor, outdoor, portable)
- Price (under 10K)
- Target pollutants (PM, gases, VOCs)

<https://monitors.cleanairstars.com>

LCS guidance: Online decision tool

Monitor type

- Indoor (18)
- Outdoor (20)
- Indoor & outdoor (8)
- Portable (5)

Indicative price*

150 \$ - 7896 \$

Monitors these particle sizes

















- PM1 (20)
- PM2.5 (31)
- PM10 (24)

Monitors these gases


- NO2 (12)
- O3 (11)
- CO (9)
- SO2 (9)
- H2S (5)
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- NH3 (4)
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PURPLEAIR TOUCH INDOOR	ECOMESURE ECOSMART	AIRLY PM+GAS	AIRLY PM
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IQAir AirVisual Pro (Indoor)
\$550



Category: Indoor
Monitors these particle sizes: PM2.5
Data transmission: Wi-Fi
Data display: On-device display, app, web, API
Data storage: Local
Calibration: Factory calibrated
Size: 82 x 184 x 100mm
Power options: Plug-in, battery
Product page: <https://www.iqair.com/au/air-quality-monitors>
Sensor accuracy: PM2.5: 0.79 – 0.81

Detailed information on products, including power, and data transmission and handling; direct links to seller web pages.

LCS guidance: Plain English info sheets

Guidance on key concerns for selecting a low-cost sensor product.

This guidance was tailored for, and peer reviewed by, five key user groups:

1. Researchers
2. Local government
3. Schools
4. Community & environment groups
5. Households

<https://monitors.cleanairstars.com>

Selecting low-cost sensors for air quality monitoring
Sustainable Communities and Waste
National Environmental Science Program

Guidance for local governments

About this fact sheet
Low-cost sensors (LCS) to monitor air quality are a rapidly developing area of technology. Dozens of models with widely varying costs and capabilities are now available to the Australian market. For local governments, selecting a model that's fit-for-purpose can be time-consuming.

This fact sheet provides guidance for local governments seeking to acquire LCS devices for their air quality monitoring projects. It describes key attributes or concerns to consider when selecting a device.

This advice complements our online LCS selection tool: monitors.cleanairstars.com

This guidance covers LCS that measure particulate matter (PM), polluting gases and VOCs. It does not cover carbon dioxide (CO₂) monitors, such as the Aranet4, commonly used to check whether indoor ventilation is adequate.

Low-cost sensor guidance for local government

Pollutants Measured	Data Storage and Transmission	Sensor Housing for Different Weather Conditions
PM _{2.5} , NO ₂	Wifi, Card, Cloud	Rain, Cold, Heat
Data Visualisation	Power	Data Privacy
On the sensor, Web, App	Plug, Battery, Solar	Open access, Closed access

Key user concerns for LCS selection

The following are some key concerns or attributes to consider when selecting an LCS device for your project.

- mounting station and installation costs
- power-related costs (for example, solar panels)
- subscriber services for data transmission, storage, or visualisation
- technical support
- maintenance, including repairing or replacing sensor components
- calibration services.

Understand device costs & related expenses

The purchase price of LCS devices varies. For purposes of this fact sheet and associated online tool, LCS are defined as devices costing less than AUD\$10,000.

Device costs generally increase with the number of pollutants measured and the degree of sensor accuracy and sensitivity.

Most LCS manufacturers offer units for a one-off purchase price, but some are available on a subscriber basis. Some manufacturers offer discounts on purchases of multiple units.

When costing a device for your project, consider the total cost of ownership. This includes not only purchase costs or subscriber fees for the device, but also any ancillary costs and long-term operating costs, especially for more expensive models, such as:

- Buy
- Maintain
- Data Services
- Supplies

Study duration is an important aspect of cost, especially for solutions with high maintenance requirements. 'Plug and play' models afford the option to easily replace individual sensors on the device, an option that might suit longer-term monitoring projects.

Low-cost sensor guidance for local government

2

2. HEPA guidance: What we've done

Interventions paper

Addresses knowledge gaps regarding ventilation and HEPA filtration in school settings.

Stakeholder workshop

“How to Protect Schoolchildren from Air Pollution”

Healthy Classroom FAQs

Answers to frequently-asked questions on indoor air quality.

HEPA guidance: interventions research paper

Rationale: to address the following dilemma, which many school decision-makers face:



Should you **open windows** to lower CO₂ levels, promote good air flow, and reduce indoor air pollution, or **close them** to prevent outdoor air pollution from entering?

HEPA guidance: Interventions research paper

ENVIRONMENTAL RESEARCH
HEALTH


LETTER • OPEN ACCESS

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

Donna Green^{4,1} , Nathan Cooper¹ , Charitha de Silva² , Prateek Bahl² ,
Shovon Bhattacharjee³ , Mohamed Mahmoud Abdelkareem Mahmoud² , Con Doolan²  and
C Raina Macintyre³ 

Published 23 August 2023 • © 2023 The Author(s). Published by IOP Publishing Ltd
[Environmental Research: Health, Volume 1, Number 4](#)

Citation Donna Green et al 2023 *Environ. Res.: Health* 1 041001
DOI 10.1088/2752-5309/ace5c9

 Article PDF

- Compares effectiveness of HEPA filters vs. natural & mechanical ventilation
- Examines how natural ventilation affects classroom HEPA performance.
- See: Donna Green et al 2023 *Environ. Res.: Health* 1 041001



Figure 4. Set up of classroom with tables set up for volunteers (looking away from windows).

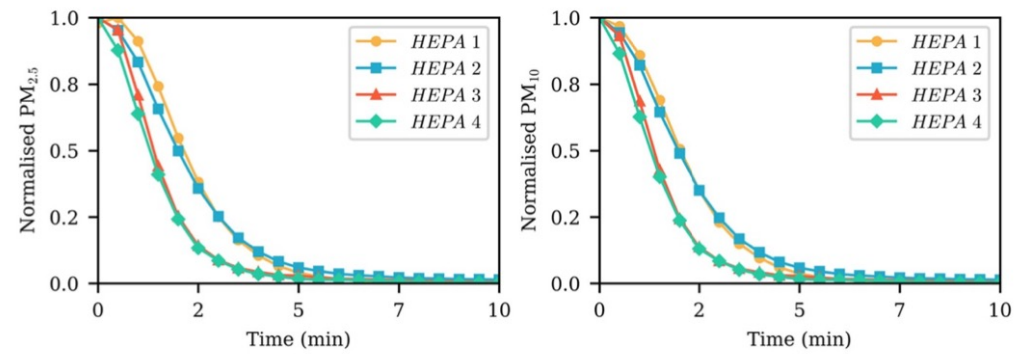


Figure 5. (a), (b) Comparison of PM_{2.5} and PM₁₀ removal by four different HEPA filters in a chamber.

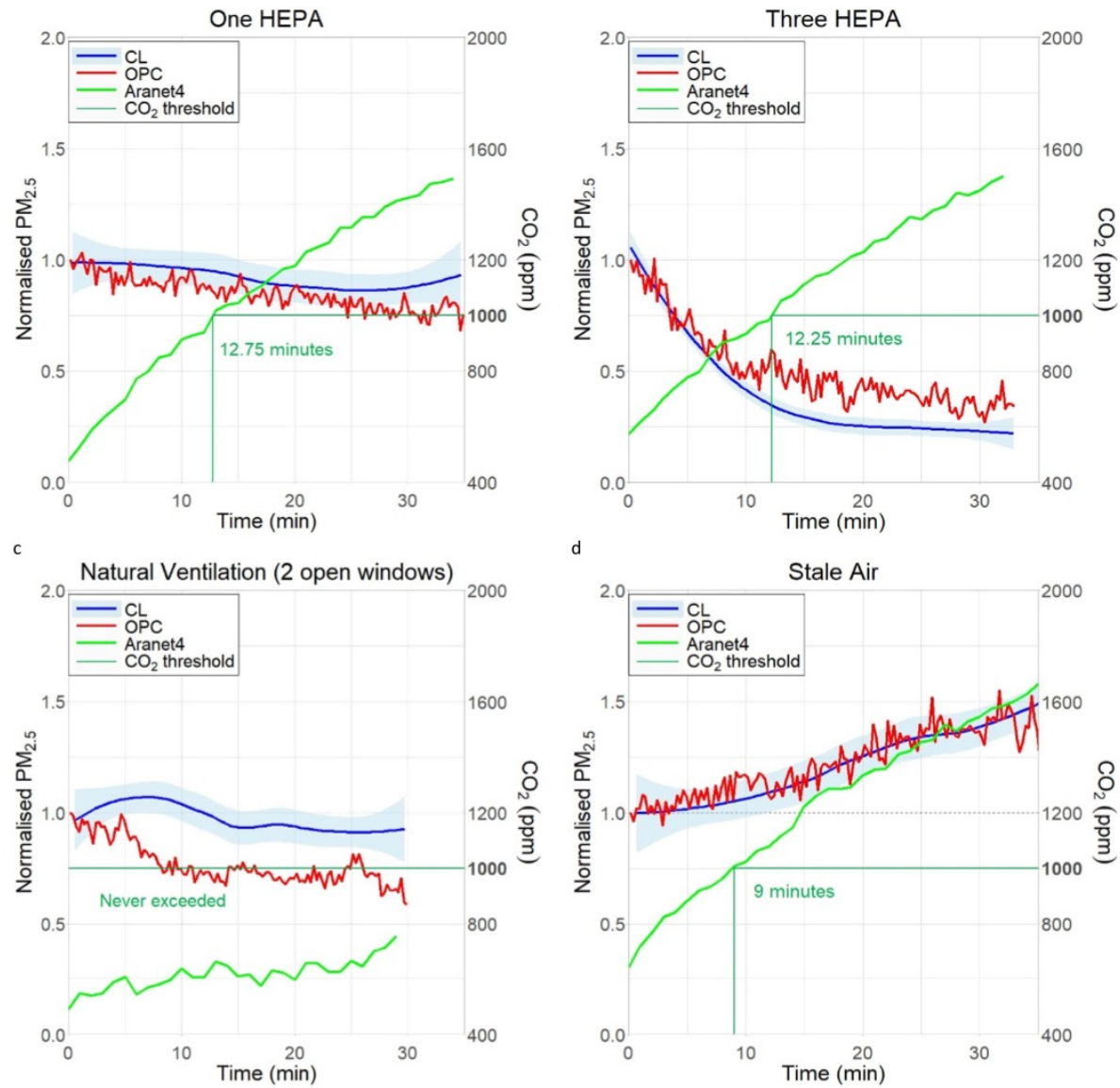


Figure 8. (a)–(d) Comparison of PM_{2.5} number concentration levels during the unmasked people tests normalised to the initial value.

HEPA guidance: Stakeholder workshop

Theme: How to Protect Schoolchildren from Air Pollution

- **Who:** 23 representatives from education, government, research and non-profit sectors.
- **Key outcome:** Participants called for HEPA-specific guidance for schools reflecting new knowledge and advice on use, placement and maintenance.

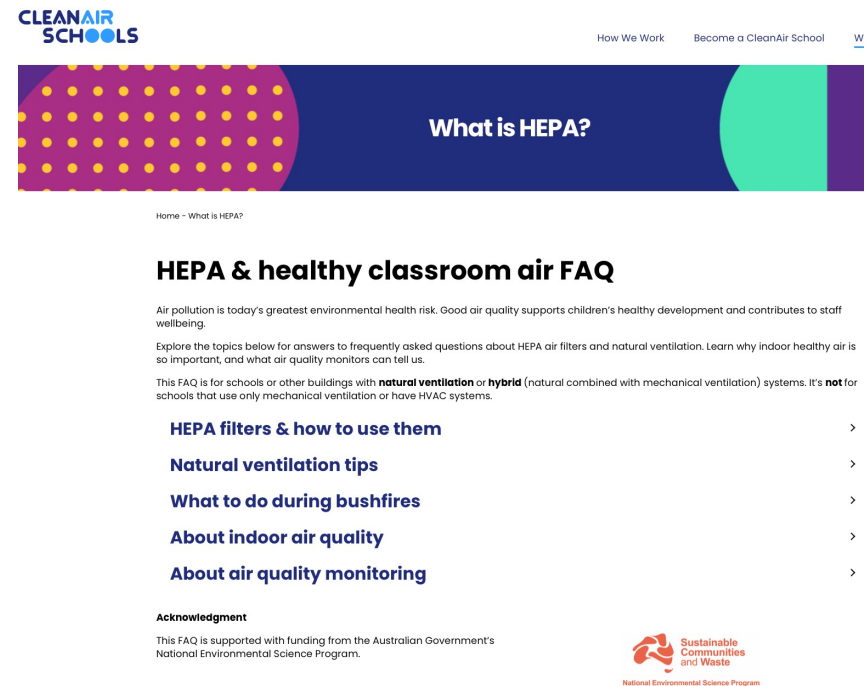
HEPA guidance: Healthy Classroom FAQs

Clean, healthy air in classrooms is crucial for optimal learning and teaching.

Based on stakeholder, research, and extensive literature review, we produced plain English guidance to answer ~30 frequently asked questions on:

- HEPA use
- natural ventilation
- what to do when bushfire smoke affects local air quality
- air quality & carbon dioxide monitoring.

Audience: school users, but broadly applicable to members of the general public seeking to use HEPAs.



The screenshot shows the 'CLEANAIR SCHOOLS' logo in the top left corner. In the top right, there are navigation links: 'How We Work', 'Become a CleanAir School', and a partially visible 'W'. The main header area features a dark blue background with a purple circle containing yellow dots on the left and a green circle on the right. The text 'What is HEPA?' is centered in white. Below the header, the breadcrumb 'Home - What is HEPA?' is visible. The main heading is 'HEPA & healthy classroom air FAQ'. The introductory text states: 'Air pollution is today's greatest environmental health risk. Good air quality supports children's healthy development and contributes to staff wellbeing. Explore the topics below for answers to frequently asked questions about HEPA air filters and natural ventilation. Learn why indoor healthy air is so important, and what air quality monitors can tell us. This FAQ is for schools or other buildings with **natural ventilation** or **hybrid** (natural combined with mechanical ventilation) systems. It's **not** for schools that use only mechanical ventilation or have HVAC systems.' A list of five topics with right-pointing chevrons follows: 'HEPA filters & how to use them', 'Natural ventilation tips', 'What to do during bushfires', 'About indoor air quality', and 'About air quality monitoring'. At the bottom left, an 'Acknowledgment' section reads: 'This FAQ is supported with funding from the Australian Government's National Environmental Science Program.' At the bottom right is the logo for the 'Sustainable Communities and Waste' National Environmental Science Program.

<https://www.cleanairschools.com.au/what-is-hepa/>

HEPA & healthy classroom air FAQ

Air pollution is today's greatest environmental health risk. Good air quality supports children's healthy development and contributes to staff wellbeing.


Explore the topics below for answers to frequently asked questions about HEPA air filters and natural ventilation. Learn why indoor healthy air is so important, and what air quality monitors can tell us.

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

HEPA filters & how to use them



Find practical information on how to buy, use and maintain HEPA filters to clean indoor air.

What are HEPA units? 

The air filtering appliances commonly called HEPA (High Efficiency Particulate Air) 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 and 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? 


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).


What do HEPA filter ratings mean? 


If a product's marketing material says HEPA, can I assume it really is? 


What can HEPA filters do? 

What are things HEPA filters can't do? 

If virus particles are small enough to pass through HEPA filters, how can HEPA capture them? 

How do I choose the right HEPA unit? 

How do I know how many HEPA units I need for a room? 

Is it better to have one larger HEPA unit or two or more smaller HEPA units in a room? 

Building disaster resilience by empowering future innovators



A newly funded program led by UNSW Sydney's Professor Donna Green will soon enable NSW primary school teachers to equip their students with the knowledge and practical skills to face natural disasters.

Published on the 06 August 2024 by Melissa Lyne, UNSW Science

 Melissa Lyne, UNSW Science

The NSW Government has recently announced funding for a UNSW Sydney-led program for upper primary school students on bushfire and air quality management.

The Fresh AIR Innovators program combines technology, environmental awareness and entrepreneurial spirit to inspire the next generation of problem-solvers and innovators.

Project lead Professor Donna Green from the UNSW [School of Biological, Earth & Environmental Sciences](#) says the program is a re-think on how STEM and disaster resilience is taught in schools.

"The program is designed to address a critical need in our community—the need for increased awareness and preparedness in the face of natural hazards, particularly bushfires," Prof. Green says.

Thank you for listening, any questions?