

# Low-cost sensor networks

**Interventions to improve awareness & reduce exposure to air pollution**

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**Sustainable  
Communities  
and Waste**

**National Environmental Science Program**



# Project overview



Low-cost sensors



HEPA filters



Clean air centres



## Impact example: Low-cost sensors

Problem: Lack of guidance



Low-cost sensors



# Impact example: Low-cost sensor Solution: online guidance tool

### Online selection 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)

### Fact sheets

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

**Key things to consider**

The sections below cover some key features to consider before you buy a low-cost sensor device.

**Indoor, outdoor or portable?**

If you're only concerned about air quality inside your home, consider buying one of the many affordable models specifically geared to monitor indoor air.

If understanding more about air pollution outside your home is your goal, look for one of the more weather-proof monitors designed for outdoor use. Be aware that if a monitor is specified only for outdoor use, it's not a good idea to use it for indoor air monitoring too. Instead, look for one of the models labelled for **both** indoor and outdoor use.

A growing number of portable monitors also makes it possible to monitor air in a variety of locations, such as inside and outside your home during bushfire season, or along roads children use to walk to school.

**Costs**

Different models of air quality sensor devices vary greatly in price. This guidance and our online tool cover devices less than AU\$10,000. Many households will likely opt for the growing number of models under \$500. Cost generally increases with the number of pollutants a device measures, and accuracy and sensitivity of its sensors.

**Buy** **Maintain**

**Data Services** **Supplies**

Most manufacturers offer devices for a one-off purchase price, but some offer units on a subscription basis. Before you buy, consider the total cost of ownership. This includes not only the purchase or subscription price for the unit, but any additional and long-term operating costs as well, such as:

- installation costs
- subscriber services for viewing the air quality information
- technical support
- maintenance, including repairs.

Low-cost sensor guidance for households

## 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

Guidance to select suitable monitors,  
building awareness of air pollution



# Impact example: Low-cost sensor

## Solution: fact sheets for stakeholders

### Selecting low-cost sensors for air quality monitoring

Guidance for primary and secondary schools



**About this fact sheet**

Low-cost sensors to monitor air quality are developing rapidly. Dozens of models with wide-ranging costs and capabilities are now available to the Australian market. This can make it time-consuming to select a model that's fit-for-purpose.

This fact sheet provides guidance for those in primary and secondary schools who wish to buy low-cost sensor devices for air quality monitoring projects. It describes key features or concerns to consider, and complements our online low-cost sensor selection tool: [monitors.cleanairstars.com](http://monitors.cleanairstars.com)

This guidance covers low-cost sensors that measure particulate matter (PM), polluting gases, and volatile organic compounds (VOCs). It does not cover carbon dioxide (CO<sub>2</sub>) monitors, such as the [Aranet4](#), commonly used to check whether indoor ventilation is adequate.

**Match the device with your monitoring goals**

It's important to choose a low-cost sensor that suits the goals of your air quality monitoring project. For example, at your school you may wish to:

- educate students and others about air quality
- raise awareness about air pollution
- monitor exposure to determine health risks
- facilitate action to reduce exposure to unhealthy air and maintain a clean breathing environment.

If your goals are educational, such as a student project to study local air quality, you may wish to select a device that's intuitive and easy-to-use, and has features to sustain engagement, like a readily viewable display screen, or the option to send automatic notifications.



<b>Pollutants Measured</b>  <small>PM<sub>2.5</sub> NO<sub>2</sub></small>	<b>Data Storage and Transmission</b>  <small>Wi-Fi Card Cloud</small>	<b>Sensor Housing for Different Weather Conditions</b>  <small>Rain Cold Heat</small>
<b>Data Visualisation</b>  <small>On the sensor Web App</small>	<b>Power</b>  <small>Plug Battery Solar</small>	<b>Data Privacy</b>  <small>Open access Closed access</small>

**Key user concerns for selecting low-cost sensors**

The following are some key things to consider when selecting a sensor model for your air quality monitoring project.

**Indoor, outdoor or portable?**

If your school's project is only concerned with indoor air quality, consider buying one of the many affordable models specifically geared for indoor monitoring.

If monitoring air pollution outside the school is your project's goal, look for one of the more weather-proof monitors designed for outdoor use. Be aware that if a monitor is specified solely for outdoor use, it's not a good idea to use it for indoor monitoring as well. Instead, look for one of the models labelled as suitable for **both** indoor and outdoor use.

A growing number of portable monitors also make it possible to monitor air in multiple locations. For example, students doing an air quality project could use these devices to explore air pollution sources inside and outside the school and along roadways.

**Consider device costs & related expenses**

Air quality sensor devices vary greatly in cost. This fact sheet and associated online tool define low-cost sensors as devices costing less than AUD\$10,000. Device cost generally increases with the number of pollutants measured and the degree of sensor accuracy and sensitivity.

 <small>Buy</small>	 <small>Maintain</small>
 <small>Data Services</small>	 <small>Supplies</small>

Most models are available for a one-off purchase price, but some manufacturers offer units on a subscriber basis. 'Plug and play' models offer the option to easily replace individual sensors on the device, an attractive option for longer-term monitoring projects.

UNOFFICIAL



# Impact example: Clean air centres

## Problem: lack of data

<p>Very poor</p>	<ul style="list-style-type: none"> <li>• STAY INDOORS as much as possible with windows and doors closed until outdoor air quality is better.</li> <li>• If you feel that the air in your home is uncomfortable, consider going to a place with cleaner air (such as an air-conditioned building like a library or shopping centre) if it is safe to do so.</li> <li>• Actively monitor symptoms and follow the treatment plan recommended by your doctor.</li> <li>• If you are concerned about symptoms call the 24-hour HealthDirect helpline on 1800 022 222 or see your doctor.</li> <li>• In a health emergency, call triple zero (000) for an ambulance.</li> </ul>
<p>Extremely poor</p>	<ul style="list-style-type: none"> <li>• STAY INDOORS with windows and doors closed until outdoor air quality is better and reduce indoor activity.</li> </ul>



Clean air centres (i.e., shopping malls, libraries, community centres)



## Impact example: Clean air centre

Solution: collect data, carry out filter intervention

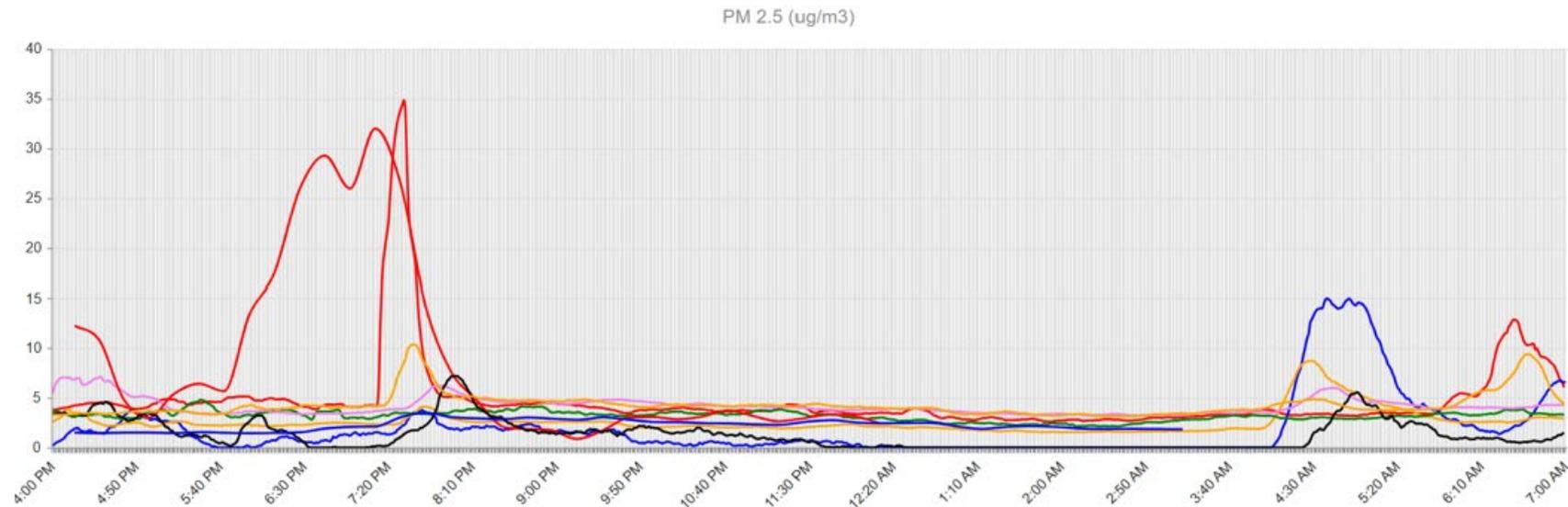
Shopping centre air quality monitoring project





## Impact example: Clean air centre

Solution: collect data, carry out filter intervention



Baseline indoor air quality data for major Sydney shopping centre



# Impact example: HEPA guidance for classrooms

**Problem:** Lack of guidance on use of HEPA filters





# Impact example: HEPA guidance for classrooms





# Impact example: HEPA guidance for classrooms



Home - 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?

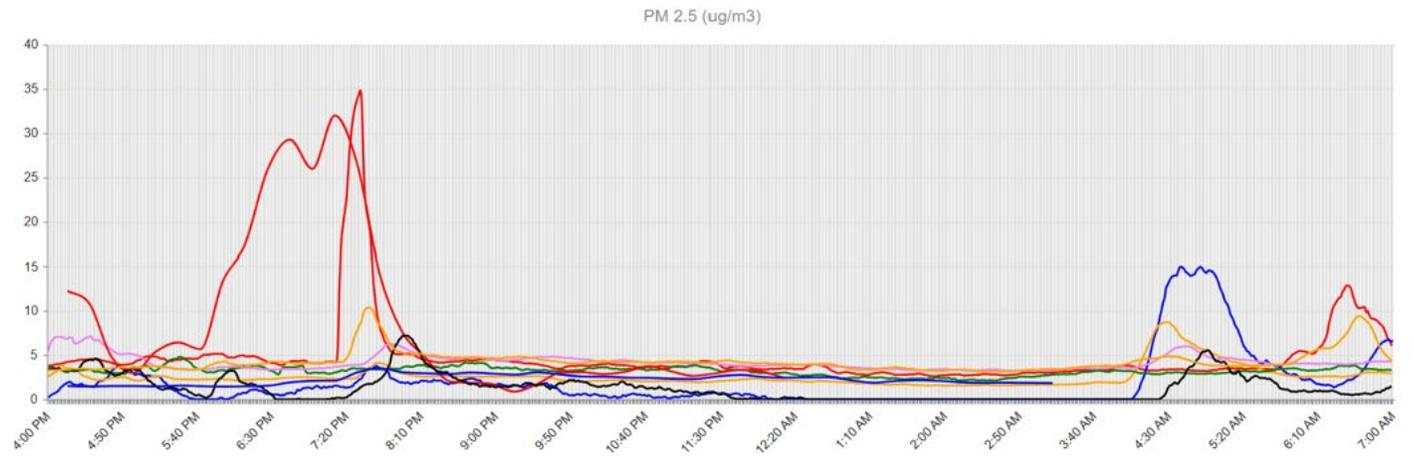
The air filtering appliances commonly called HEPA (High Efficiency Particulate Air) filters or HEPA units look like large rounded or square boxes with lots of small holes on their sides. Inside a typical unit you'll find a motor and a fan that draws air through a pre-filter, and behind that, the HEPA 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.



# What's next





# What's next





# What's next

**FRESH AIR INNOVATORS**

Fresh Air Innovators program. Submit your request via the Contact tab to secure a place.

## Explore the vital role clean air plays in human health and the environment.

Empowering students to tackle bushfire and air quality challenges through creativity, innovation, and real-world problem-solving.

[View Lessons](#)



<p><b>LESSON 1</b> <b>Power up!</b></p> <p>In this lesson, students will explore how energy is transferred and transformed, including renewable...</p> <p><a href="#">Learn More</a></p>	<p><b>LESSON 2</b> <b>The first scientists</b></p> <p>In this lesson, students will explore Aboriginal and Torres Strait Islander Peoples' sustainable land...</p> <p><a href="#">Learn More</a></p>
<p><b>LESSON 3</b> <b>Know your backyard</b></p> <p>In this lesson, students will explore the connection between their local landscapes and natural hazard...</p> <p><a href="#">Learn More</a></p>	<p><b>LESSON 4</b> <b>Invisible invaders</b></p> <p>In this lesson, students will explore the sources and impacts of air pollution and learn how to monitor...</p> <p><a href="#">Learn More</a></p>
<p><b>LESSON 5</b> <b>Breathe easy</b></p> <p>In this lesson, students will learn about carbon dioxide (CO<sub>2</sub>) and its impact on both the environment and...</p> <p><a href="#">Learn More</a></p>	<p><b>LESSON 6</b> <b>Filter heroes</b></p> <p>In this lesson, students explore the properties and purpose of HEPA filters and investigate their...</p> <p><a href="#">Learn More</a></p>
<p><b>LESSON 7</b> <b>Fresh air action plan</b></p> <p>In this lesson, students will apply their scientific understanding and problem-solving skills to design a...</p> <p><a href="#">Learn More</a></p>	<p><b>LESSON 8</b> <b>Future innovators</b></p> <p>This lesson introduces students to the concept of entrepreneurship and its role in addressing...</p> <p><a href="#">Learn More</a></p>





# Impact of EMCRs on project

## Nathan Cooper

Air quality, data analysis, environmental health & environmental justice



## Janice Wormworth

Environmental policy, digital content & communications



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- installation costs
- subscriber services for viewing the air quality information
- technical support
- maintenance, including repairs.



# Impact example: Classroom study



## Air Quality Action Guide

Take these simple steps for healthier classrooms and better learning

### 1 Identify your school's ventilation system

**Look for the Cooler Classrooms panel.** Do your classrooms have a control panel that looks like the photo on the right? If yes, your school uses the Cooler Classrooms system.

**If no Cooler Classrooms panel is present.** Your school likely uses natural ventilation and may be equipped with split system air conditioning units.

Type	What this means
Cooler Classrooms	Retrofitting, ducted air conditioning system with fresh-air intake from outside fed into each classroom.
Naturally ventilated, possibly with split AC	Ventilated by operable windows. These rooms may also have split air conditioning systems that recirculate heated or cooled indoor air. (These systems do not access or bring in new outdoor air).



### 2 Check today's outdoor air quality

Here are 2 ways to check air quality in your area:

- Use Google Map's Air Quality Layer to find out about the air quality outside your school.
- Use the Air Quality NSW website: [airquality.nsw.gov.au](http://airquality.nsw.gov.au). You can also use this website to sign up for daily alerts for your region.



### 3 Take action

Classroom type	Good	Fair	Poor	Very Poor	Extremely Poor
<b>Cooler Classrooms</b> Run A/C systems as instructed by lights on panel	Open windows and doors	<ul style="list-style-type: none"> <li>• Close windows</li> <li>• Run HEPAs on high, if available</li> </ul>			
<b>Naturally ventilated/ Split A/C</b> Run split A/C system as normal	Open windows and doors	<ul style="list-style-type: none"> <li>• Close windows</li> <li>• Open windows when room is empty, such as during a break or lunchtime, to refresh air</li> <li>• Run HEPAs on high, if available</li> </ul>		<ul style="list-style-type: none"> <li>• Close windows</li> <li>• Run HEPAs on high, if available</li> </ul>	

## Meet the Friends



Controlled study of interventions to optimise air quality using a real-world classroom setting with volunteers.



# EMCR career impact

## Wider benefits due to this research:

- Enhanced expertise in air quality monitoring using LCS
- Deeper understanding of data analysis for air quality studies
- Expanded research networks through national and international presentations



### About Nathan

Nathan is an interdisciplinary environmental scientist at the school of Biological, Earth and Environmental Sciences in the University of New South Wales. He is interested in air quality, data analysis, environmental health and environmental justice. His current research focuses on air quality in schools, using networks of low-cost sensors to measure and analyse school children's exposure to air pollution and actions to minimise their exposure



See more IAQ24 speakers

[VIEW SPEAKERS](#)

Example: In 2024 I gave a presentation about our clean air centres project at Australia's main conference for HVAC&R industry stakeholders.



# Q&A

**Questions?**

**Web links:**

**Low-cost sensor guidance:** [monitors.cleanairstars.com](https://monitors.cleanairstars.com)

**HEPA guidance:** [cleanairschools.com.au/what-is-hepa](https://cleanairschools.com.au/what-is-hepa)

**Fresh Air Innovators:** [freshairinnovators.com.au](https://freshairinnovators.com.au)

**Fresh Air Friends (stickers):** [freshairfriends.com](https://freshairfriends.com)