# National Environmental Science Program

## Sustainable Communities and Waste Hub research plan 2023 – Attachment B project plans – IP4

# Project IP4.03 – Improved Air Quality, Forecasting and Assessment

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|---|---|
| **Project type:** Hub research project | |
| **Project status:** Existing project seeking amendment to scope and budget | |
| **Cross-cutting initiative:** | No |
| **Project start date:** 01/03/2023 | **Project end date**: 30/06/2024 |
| | |
| **Project leader details:** | Name: Amanda Wheeler<br>Organisation: CSIRO Environment<br>**IP4.02.01**<br>Name: Erin Dunne<br>Organisation: CSIRO Environment<br>**IP4.02.02**<br>Name: Dr Kathryn Emmerson<br>Organisation: CSIRO Environment<br>**IP4.02.03**<br>Name: Prof Fay Johnston<br>Organisation: University of Tasmania<br>**IP4.02.04**<br>Name: Donna Green<br>Organisation: UNSW |
| **Cross-hub contact details:**<br>(If applicable) | Name: Amelia Tandy (IP4.02.01)<br>Organisation: Climate Systems Hub<br>Name: Marcus Thatcher (IP4.02.02)<br>Organisation: Climate Systems Hub |

# Project description

## Project summary

Research in IP4 explores how air quality in Australia, while generally good, continues to cause significant health impacts from bushfire smoke, planned burns, wood-heaters, and local industrial pollution. Australia faces great challenges with a changing climate. Questions have been identified around how a changing climate will impact air pollution. A range of stakeholder engagement activities identified four air quality priorities that form the basis of four multiyear research projects:

1) engagement with Indigenous communities around smoke exposures and management of planned burns

2) modelling experiments based on a range of climate scenarios

3) evaluation of interventions to reduce population exposures to wood heater smoke and

4) effective use of low-cost sensors to quantify changes in air quality resulting from air quality interventions to create safer air quality havens.

## Project description

During RP2021, researchers in IP4 worked with stakeholders and partners to co-design a series of impactful research projects under the 'improved air quality, forecasting and assessment' research theme. These stakeholders and partners included the Department of Climate Change, Energy, the Environment and Water, (the Department) and other research-users such as state environment departments, local government, NGOs, Indigenous groups and other NESP hubs. This engagement included virtual meetings, a survey (completed by 80 participants), an interactive workshop involving 45 participants, and presentations to national bodies including the Healthy Environment and Lives Network (HEAL), the Australia New Zealand Aerosol Symposium and the Climate Adaptation cross-cutting program of the Climate Systems NESP Hub.

In addition, two standalone documents were generated in RP2021. These were a synthesis review of 'Public health messaging during smoke events' and a 'Survey of current guidance for low-cost sensor air quality monitors' both of which will be used to inform the Sustainable Communities and Waste (SCaW) Hub moving forward.

RP2022 activities have commenced but are not completed yet. Most projects are conducting further engagement with stakeholders to better target research activities. IP4.02.01 have commenced conversations with relevant stakeholders and researchers to develop a roadmap and will leverage other projects that are engaging with Indigenous communities around air quality. IP4.02.02 will evaluate a range of climate change scenarios and potential emission reduction policies to determine which ones will be carried forward for full modelling. IP4.02.03 will engage with stakeholders to develop a roadmap of novel interventions / actions that could be trialled to reduce wood heater emissions. IP4.02.04 will evaluate the efficacy of a range of HEPA cleaners, how they can best be used and generate a guidance document on their use to improve air quality in public spaces. The report developed in RP2021 on low-cost sensors will be used to generate a guidance document on their use in the management of local air quality problems.

### *IP4.02.01 Lets Yarn about Smoke*

This project is an amendment to extend Project IP4.02.01 – Let's talk about smoke, for 12 months into RP2023. We have reassessed the time required to carry out the deep listening and conversations required to undertake the project with communities and recognise that it cannot be constrained to 12 months. The work planned for RP2022, which has only recently commenced will determine the next

steps and the planning for additional work and deliverables in this project for RP2023. This includes the identification and inclusion of Indigenous researchers to design and lead the project.

Aboriginal and Torres Strait Islander people are likely to experience greater exposures to smoke and such exposures are known to exacerbate poor health and wellbeing in those with already high burdens of risk factors and disease. Accessible, culturally appropriate tools and resources are required to help reduce Aboriginal and Torres Strait Islander peoples' exposure to harmful smoke. Furthermore, Indigenous fire management is playing an increasing role in fuel reduction and carbon farming initiatives. Co-designed air quality research, resources and tools are required to assist Indigenous land managers in the planning and conduct of burns to achieve the desired environmental, economic and socio-cultural outcomes while managing the impacts of smoke on communities.

***The problem***

In RP2021, an IP4 co-design workshop found that planned and unplanned fire smoke was among the most important areas of concern for many stakeholder groups, however Aboriginal and Torres Strait Islander stakeholders were not explicitly consulted as part of this process. The disproportionate impact of bushfire smoke on Aboriginal peoples' health and the relative absence of first nations voices in natural hazard risk management have been highlighted in recent reviews prepared for the Lowitja Institute and Centre for Aboriginal Economic Policy Research [3][8]. The SCaW Hub recognises and values the experiences, perspectives and cultures of Indigenous Australians and the NESP hub provides an opportunity for redress and empowerment of First Nations communities to strengthen their adaptive capacity to mitigate and manage air quality impacts in a changing climate.

From a purely Western health science perspective smoke is a known cause of adverse health outcomes. To date, air quality research, management, and communication initiatives on the impact of smoke has largely focused on the negative health impacts on urban populations. Conversely, Aboriginal and Torres Strait Islander perspectives and experiences of smoke are unique. There are complex interactions between historical, social, cultural, and environmental factors which influence Indigenous peoples' attitude to smoke. Accessible, culturally appropriate tools and resources are required to help reduce Aboriginal and Torres Strait Islander peoples' exposure to harmful smoke. Likewise, co-designed air quality research, resources and tools are required to assist Indigenous land managers in the planning and conduct of burns to achieve the desired environmental, economic and socio-cultural outcomes while managing the impacts of smoke on communities.

Aboriginal and Torres Strait Islander people are likely to experience greater exposures to smoke than the non-Indigenous population as a result of higher rates of smoking [1]; the use of open fires for cooking and heating [2]; higher representation in remote and regional areas that are more frequently impacted by smoke from planned burns and bushfires [3,4] and their important and growing role in land and fire management [3]; and carbon abatement [5]. Exposure to smoke results in comparatively worse health and wellbeing outcomes among Aboriginal and Torres Strait Islander peoples with already high burdens of risk factors and disease.

Indigenous fire management is playing an increasing role in fuel reduction and carbon farming initiatives. In Northern Australia, savanna burning projects have contributed 10% of the total national avoided emissions reported in the Emissions Reduction Fund to date, mostly through projects on Aboriginal land. The Aboriginal carbon industry generates an estimated $20 million per year in carbon credits and has provided nearly $100 million in total revenue. Indigenous savanna burning carbon credits attract a premium due to their significant economic, social, and cultural co-benefits for the Indigenous communities engaged in these projects [5]. However, as with any form of planned burning there is a potential to cause significant impacts on local and regional air quality [6]. For instance, a recent study has indicated that smoke from fires on Aboriginal land may be contributing to a

deterioration of dry season air quality in Darwin [7] and it is likely savanna burning projects were a significant source of smoke from these areas.

***Our response***

While there is growing recognition of the value of Indigenous-led land and fire management, and community health initiatives, there has been very little involvement of Aboriginal and Torres Strait Islander peoples in air quality research and management activities in Australia. The SCaW Hub provides a timely opportunity for Aboriginal and Torres Strait Islanders' needs and priorities to be better represented in the Australian air quality research and management landscape. By bringing together practitioners from air quality, Indigenous health, and fire and land management domains with government and community stakeholders, this project aims to:

- learn from, and where possible, support existing Indigenous-led actions towards improving air quality and health; and
- identify opportunities to co-design air quality research, resources and tools that address Indigenous identified priorities for managing the impact of landscape smoke on the health of communities.

The goal of this multi-year project will be to build new partnerships among Indigenous researchers and communities and the air quality research community to develop:

- greater Indigenous engagement and leadership of activities in IP4;
- a network of stakeholders with an interest in air quality, smoke and health;
- a shared understanding of different attitudes to smoke from ecosystem burning, and perceptions of the impact of smoke on the health of Country and communities;
- opportunities to learn from, and where possible, enhance existing Indigenous led actions towards improving air quality and health;
- opportunities for new activities that address Indigenous identified research priorities; and
- enhanced capability and capacity in the non-Indigenous air quality research community to appropriately engage with Indigenous peoples in mutually beneficial relationships.

*Methodology*

Year 1 and 2 (RP2022 and RP2023) focus on building partnerships that support sharing knowledge about smoke. The IP4 team will:

1. Review the existing research landscape and liaise with the SCaW Indigenous Advisory Committee, the Healthy Environment and Lives (HEAL) Network and the NESP Climate Systems Indigenous Reference Group to develop these connections and identify Indigenous researcher /teams/ organisations to lead/co-lead the project.
2. Support Indigenous leadership/co-leadership through contributing to co-design of a broad scope of Indigenous identified research priorities and frameworks for knowledge sharing.
3. Develop and support opportunities to connect project leaders with stakeholders through meetings, workshops and hub communications and networks.
4. With guidance from the SCaW Indigenous Advisory Group develop a plan for appropriate training programs for the IP4 Team to undertake.
5. Governance, community participation and Indigenous knowledge underpin our co-design approach. We aim to produce actionable knowledge, methods, tools and data for transitions towards circular economies and more sustainable communities.

***Linkages***

Several SCaW Hub partner organisations and researchers are also among the 100 investigators and 30 institutions involved in the National Health and Medical Research Council (NHMRC) funded HEAL Network, whose broad aim is to "bridge the gap between knowledge and action" to address the impact of environmental change on health (https://heal2021.com.au/). An opportunity exists for the SCaW Hub to support a current HEAL project with Asthma Australia's National Research Program. The aim of this project is to translate current scientific evidence and findings from consumer group engagement into a suite of advice materials tailored for use by people of Aboriginal, and Arabic backgrounds, health professionals and policy makers to take practical actions to reduce exposure to air pollution. The focus of the proposed project will be communities in NSW and ACT that were impacted by the 2019/20 Black Summer bushfires. Given the clear alignment between objectives of IP4, HEAL and Asthma Australia initiatives, collaboration in this project represents a clear opportunity to value add on effort and resources, and improve co-ordination at the national level.

**Is this a cross-hub project?** Possibly - linkages with the NESP Climate Systems Hub are likely to evolve over the course of RP2022 and RP 2023.

**Does this project contribute to a cross-cutting initiative?** No

## IP4.02.02 How will a changing climate and emissions reduction measures impact sources of air pollution and secondary pollutant formation?

The project is a modelling study that will provide a lens on how altered we can expect air quality to be under future emission scenarios in Australia. It will be guided by RP2022 literature review results investigating a range of climate change scenarios and emission reduction policies. This is a logical extension of RP2022 and this project seeks to expand the scope of the initial application. It will leverage modelling capability in the Climate Systems Hub and will potentially contribute to cross hub Initiative activities. The research outcomes will be used by government agencies for managing future changes to air quality and health.

***The problem***

Australia is committed to emission reduction measures that will help combat future climate change. These measures will impact the sources, types and strengths of anthropogenic emissions to the air and thus change the levels of air pollution and secondary pollutant formation in our cities. A warmer climate will also impact the strength of natural emissions and change the levels of chemical processing that occurs in the atmosphere. Whilst we expect reducing emissions to lead to less air pollution, the impact of increasing temperatures and drought on natural emissions and chemical processing could increase air pollution.

This project is a priority because it will provide a lens on which of the various measures will have the greatest impact on air quality in 2050, giving us time to adapt and/or find solutions. The RP2021 stakeholder workshop recommended that there needed to be a range of model scenarios and their potential economic benefits conducted as these are key to targeting appropriate activities.

***Our response***

This multiyear project that commenced in RP2022 seeks to address the key research question: How will a changing climate and proposed emissions reduction measures impact sources of air pollution and secondary pollutant formation?

The goal of this project will be to complete the activities necessary to design and implement a set of future modelling experiments based on a range of climate scenarios.

*Methodology*

The literature review being undertaken in RP2022 (yet to be completed) will guide activities for RP2023. In particular, it will inform the need for, and design of, a series of modelling experiments to address the research question being asked in RP2023. The literature search will include a focus on how greenhouse gas emission mitigation also has an air quality benefit.

We will use a Chemical Transport Model (CTM) to run simulations under a range of future climate scenarios, provided by the Climate Systems Hub. These will be compared to a baseline run which will tell us the level of changes we might expect by 2050.

The model inputs needed to assess air quality in a future climate will be generated by IP4 and include:

1. Decide on a model baseline run.
2. Produce downscaled meteorology from a range of predicted climate futures.
3. Run simulations based on expected emission inventories for 2050.
4. Develop an urban street canyon simulation to calculate street level exposure.

1. Decide on a baseline run:

All changes in air quality need to be compared to a baseline set of conditions across an 'average' year. A long-term average in criteria air pollutants spanning at least 15 years will be calculated. We have experience and can create this dataset using observations from fixed term air quality monitoring stations, in combination with the spatially varying concentrations output from the chemical transport model.

2. Produce downscaled meteorology:

Within the CSIRO drought resilience program, we built the system for providing the CTM with downscaled meteorology from stored outputs from the decadal prediction project. The model was run in forecast mode with 6 ensemble members up until June 2023, and predicted the current wetter conditions brought about by La Nina in the south-eastern states.

Using the experience gained from that program, we will use the Conformal Cubic Atmospheric Model (CCAM) to provide the projected 2050 meteorology for the modelling. This work is being done within the Climate Systems Hub with whom we are collaborating as a cross-hub exercise. Prediction of the future is challenging; an ensemble of climate outcomes is more likely to provide a reasonable estimate. Ensemble projections will be chosen that accurately project historical data, as they are 'more likely' to represent future climate scenarios more efficiently. Overall, the ensemble average is expected to perform better than individual model runs. To best represent the mean spread, our experience recommends that more ensemble projections are better than less, and the number of ensemble projections will be determined as part of this project.

We will investigate the impacts of how short periods of extreme heatwaves will impact on air quality. These heatwave periods will be identified by the Climate Systems Hub and downscaled accordingly for use in the CTM.

3. Emission inventories:

Australia has a target for a 43% reduction on 2005 greenhouse gas emissions by 2030 to reduce the impacts of climate change. This reduction will also provide benefits for air quality. We will produce a range of simulations for the year 2050 which include cleaner emissions from transport, industry and domestic appliances, prioritised based on RP2022 outcomes. Examples of scenarios being investigated include:

- No petrol/diesel fuelled motor vehicles
- No domestic solid fuel / wood heaters
- No coal fired power station emissions
- No nitrogen oxides from commercial domestic operations
- Increased by-products from production of hydrogen, e.g. ammonia.
- Increased biogenic emissions from urban greening activities

We will also look at some of the unintended by-products of cleaner technologies – i.e., the ammonia used in the production of hydrogen fuel – and the potential increase in biogenic emissions from vegetation in a warmer world.

This work will build on and utilise our expertise gained from when we developed the CTM to provide the capability to separate out the different emission types in the model. Initial work looked at the impacts of global warming on biogenic emissions from *Eucalyptus* and how this led to an increase of up to 20 ppb ozone (a secondary pollutant) in Sydney during a 2050 simulated summer [9].

4. Develop an urban street canyon simulation:

Human exposure to air pollutants within the street canyons of city centres is a major concern as urban areas become more densely populated. Air flow is restricted within streets that have tall buildings along them, resulting in traffic-related air pollution becoming trapped. We propose to build a system to investigate the atmospheric chemical processes occurring within these street canyons, by combining elements of CCAM and the CTM, including use of a machine learned chemical mechanism to speed up processing times. We can then re-run the proposed emission inventory scenarios within this new system to assess how different the outcomes are when compared to a 1km horizontal grid simulation. A street canyon model environment would also be a good test bed to investigate the impact of proposed solutions such as green walls for improving air quality.

***Linkages***

The research cuts across a number of themes within SCaW. IP1.02.01 looking at nature connection, including urban greening aspects will directly inform the extent of urban vegetation in the biogenic model simulation. Cities such as Sydney are aiming for 30-40% vegetation coverage and are predominantly favouring native species which could emit more volatile organic compounds. However, there is a trade-off between choosing drought tolerant plants able to survive heatwaves in future and their emission potential. We aim to explore this trade-off in the model and see what the impacts on urban air quality could be.

**Is this a cross-hub project?** Yes

The Climate Systems Hub will generate the Conformal Cubic Atmospheric Model (CCAM) to provide the projected 2050 meteorology for the modelling being proposed.

This project in its second year, is a multi-year project that directly addresses the question “how will a changing climate and emissions reduction measures impact sources of air pollution and secondary pollutant formation”. This question lays in the remit of the Climate Adaptation Initiative and the project will involve significant collaboration with researchers in the Climate Systems Hub.

**Does this project contribute to a cross-cutting initiative?** No.

## Project IP4.02.03 – Woodheaters: developing and testing novel solutions to a persistent problem

### *The problem*

Wood heaters are one of the most important sources of anthropogenic air pollution in Australia. The listed estimates for deaths attributable to wood heater smoke by state, and the associated health costs, are derived from the CSIRO national air pollution model (AQFx), using the most recent wood heater inventory data available (table). The economic costs to Australia are estimated at $3.3 billion each year, thus forming a large proportion of the annual $6.2 billion attributable to air pollution from all anthropogenic sources combined, including wood heaters. It is the single most important source of anthropogenic particulate pollution in both Sydney and Melbourne, Australia's two largest cities.

| State/Territory | Estimated deaths (mid scenario) | Percentage of daily $PM_{2.5}$ attributable to WHS | Cost in $millions |
|---|---|---|---|
| New South Wales | 385 | 20.8% | 1,730 |
| Victoria | 167 | 11.6% | 749 |
| South Australia | 74 | 16.5% | 334 |
| Queensland | 63 | 7.2% | 285 |
| Western Australia | 24 | 4.0% | 107 |
| Tasmania | 21 | 19.2% | 95 |
| Australian Capital Territory | 8 | 11.1% | 36 |
| Northern Territory | 0 | 0.1% | 0 |
| **TOTAL** | **743** | | **$3,336** |

*(Source. CAR seed funding grant 2022. Publication in preparation).*

Despite being the most important single source of particulate air pollution there is no national approach to mitigating the environmental and health impacts, regulation of wood heaters, enforcement of environmental regulations, and mitigation of health impacts falling across multiple agencies across local, state and national levels of government. Investment in this offers the opportunity for highly cost-effective improvements in environmental, health and economic outcomes. The most effective interventions evaluated have been at the level of local area initiatives that reduce wood heater numbers such as the initiatives implemented in Launceston from 2000 using funding from the National Heritage Fund. While local councils recognise the problem, resource limitations are the primary reason cited for lack of progress in the area. However, if national investment is provided for initiatives throughout Australia, it is crucial that the investment is targeted towards practical and effective interventions. This project aims to identify which interventions will provide the best return on investment for national policy and investment in mitigation strategies.

In RP2021, an IP4 co-design workshop found that wood heater smoke was a priority concern for many stakeholder groups. This multi-year project responds to the high level of interest identified via the NESP survey and co-design workshop in RP2021. The IP4 team understands that there are a range of challenges related to reducing woodheater emissions. These include barriers to healthy heating choices for homeowners and safer heater operation, practical difficulties with managing chimney emissions and limitations to current Australian heater manufacturing standards and their enforcement.

### *Our response*

This amended multi-year program (IP3.02.03) aims to implement and evaluate novel solutions to wood heater emissions to (a) directly inform policy and (b) support the scaling up of successful interventions.

The program proposed for RP2023-RP2026 builds on co-design work currently underway with government, industry and community partners to identify intervention options.

The outcomes will provide practical guidance and solutions for decision makers across Australia. It is highly relevant to research-users, being identified as a high priority by stakeholders in the IP4 Air Quality RP2021 workshop.

IP4.02.03 project seeks to address key evidence and capability gaps by supporting and evaluating novel wood heater interventions. In RP2022, six regions are being identified that experience wood smoke pollution, and that have air quality monitoring in place. Three regions will trial interventions, and three will act as controls. Current NESP partners have already been approached.

We have met with the Environmental Protection Agency Tasmania, Asthma Australia, ACT Health and researchers from Curtin University and Australian National University, amongst other stakeholders, and will hold a workshop in November 2022 to share ideas and refine plans for wood heater interventions. In addition, in RP2022 we will conduct Discrete Choice Experiments (DCE) to gather information on what drives individual decision making on wood heater use. Based on the workshop, stakeholder meetings and the DCE, we will identify three interventions to be trialled from RP2023 onwards. The project is a multi-year project to ensure interventions can be rigorously evaluated, including with respect to health benefits and economic costs, over multiple seasons and in multiple contexts nationally. Partners will identify suitable locations where wood heater emissions are a known problem. Pre and post intervention evaluations will be conducted to ensure that impacts are quantified. All interventions will be suitable for local governments to manage going forward.

Based on the workshop findings and the DCE, we will work with partners in our identified regions to develop a roadmap of interventions to be implemented and evaluated via the multi-year research plan.

*Methodology*

IP4.02.03 is a multi-year plan, spanning RP2022 to RP2026 that seeks to:

1. Implement the roadmap developed via RP2022. Key steps will include:
    a. Establish or augment existing air quality monitoring in the six target regions to ensure air quality data are captured at sufficient resolution.
    b. Support our partners to roll-out the interventions with appropriate data collection mechanisms in place.
    c. Gather air quality and other relevant data (e.g., health symptom data, public and stakeholder perceptions/experiences) over wood heater smoke seasons.
2. Evaluate the effectiveness of the interventions with respect to:
    a. Wood smoke exposure reduction.
    b. Health impacts.
    c. Economic impacts.

    A PhD candidate will evaluate one or more of the interventions.
3. Model the health and economic impacts of the interventions at regional and national scales.
4. Based on our results, produce a comprehensive assessment of the interventions trialled, together with a guidance package for local and state governments to support best practice wood heater policy, regulation and management. In addition, we will produce other outputs (e.g. resource packs, social media products etc) as determined via ongoing conversations with our partners.

The interventions to be trialled will be determined via the RP2022 consultation currently underway. However, evidence-based options we are exploring include:

- Subsidies for replacing wood heaters with reverse cycle air conditioner units

Currently, the Australian Capital Territory (ACT) and Victorian governments both offer subsidies to replace household wood heaters. Previously, rebates of up to $1,250 were available to replace wood heaters with reverse cycle air conditioning. However, uptake of this scheme was low, with the payment failing to act as an incentive to change, rather a reward for those who could already afford to make the switch. A new trial program is being undertaken where the upfront costs of replacing a wood heater with a reverse cycle air conditioner are covered by the ACT Government. This aims to remove the financial burden that has restricted many households from being able to make the change.

In Victoria, low income and vulnerable households may be eligible to receive a base rebate of $1,000 towards the cost of purchasing and installing a high-efficiency heating and cooling system. Replacing wood heaters with reverse cycle air conditioning also tackles the growing issue of cooling during the summer months, increasing the human health benefits of such initiatives.

- Subsidies for Ultra Low Emission Burners (ULEBs)

While a complete phase-out of all wood heaters would be ideal, the persistence of wood heater use in Australia despite woodsmoke pollution and educational campaigns indicates that this may not be a pragmatic approach. ULEBs are wood burners that, under real-life operating conditions meet an emissions and efficiency standard of 38 milligrams per megajoule, emit less than 0.5 grams of total suspended particulate per kilogram of fuel burned and have a thermal efficiency of 65% or greater. ULEBs are much less polluting than standard wood heaters, and the emission standards that they are required to meet are modelled off real-life operation conditions. Offering a subsidy for the installation (when replacing a traditional woodfire heater) of ULEBs that meet the current New Zealand National Environmental Standards for Air Quality may be a practical harm-reduction strategy. Such standards do not currently exist for the Australian context, hence the recommendation to use existing ones from New Zealand. ULEBs retail in Australia for approximately $5,000.

- Subsidies for healthy heating for landlords

Any interventions will require structural changes to the home itself, which excludes the 31% of Australians living in rental accommodation from being able to participate. Offering subsidies to landlords who install healthy heating options (only new and certified appliances with high energy efficiency and installed using certified electricians) in their rentals may provide a shift from the reliance of wood heaters.

- Registration and licencing/certification of wood heaters

Currently, data on wood heater use in Australia is based on estimations. The establishment of a central register for domestic wood heaters would be able to provide valuable information on the number of wood heaters, their age, including what standard they had been certified to operate under, and their location. This would allow for insight into the statistics of wood heaters for an area that has poor air quality. It could also provide necessary insight into the costs associated with interventions targeting wood heaters of a certain age. For example, Nelson City Council, New Zealand, by-laws that requires ULEB appliances meet ‘authorisation’ and ‘certification’ requirements prior to installation. There is an authorised appliance list, and ULEBs must receive an authorisation number and a ‘Burner Allocation Certificate’ from the Council, and all ULEBs are recorded on a database maintained by the Council.

- Creative arts schemes and education campaigns

While it has been shown that education campaigns are not effective drivers of long-term change in relation to wood smoke emissions, innovative schemes running alongside the above interventions may increase their uptake and increase the level of community engagement. For example, social media posts, competitions, segments on sustainability programs may reach members of the community who are able to implement change but are not aware of the extent of the problem of wood smoke pollution.

- Engaging with industry partners to provide air cleaners for use in households

If wood smoke emissions are not able to be adequately lowered in the environment, a practical solution that can greatly benefit the health of vulnerable members of society is the use of HEPA cleaners in the home. Industry partners, such as Dyson, have indicated their willingness to contribute HEPA filters as part of a study looking at their effectiveness. Additional data could be gathered during this intervention by having participants track any symptoms they experience. This could be done using AirRater. This would allow insight into the how the use of HEPA cleaners affects the health of individuals during different levels of measured air quality.

Overall, this research will allow local governments across Australia to gain an insight into cost-effective and practical interventions that are available when attempting to reduce wood heater smoke pollution. The most suitable option will depend on the local social, economic and environmental considerations, and so guidance will be context specific. By evaluating a range of interventions, it will provide local governments and policy makers a few options at different cost categories to use going forward.

***Linkages***

No linkages with other IPs.

**Is this a cross-hub project?** No

**Does this project contribute to a cross-cutting initiative?** No.

## Project IP4.02.04 – Evaluation of interventions to reduce air pollution in safe havens and use of Low-Cost Sensors to identify areas of concern

***The problem***

The last few years has seen several air pollution episodes that have triggered the call for interventions to reduce exposure to air pollution. The RP2021 stakeholder workshop identified this as one of the key priorities to be addressed. This was identified by stakeholders and the Department as an area of priority given the paucity of research existing in this space. Examples that were highlighted included design/designation of community clean air shelters and widespread roll out of HEPA (High-Efficiency Particulate Air) filter systems. Many of these interventions are currently being implemented with limited understanding of best practice for their use. This is especially important for vulnerable people such as those in aged care, schools or health settings.

We have also seen the rise of several low-cost sensor (LCS) tools and networks to measure air pollutants in a largely *ad hoc* fashion. Overseas experience has demonstrated that when implemented and integrated with reference station data, these low-cost data networks have the capacity to provide finer grained insight into local air pollution levels. There is the opportunity to use these systems and networks to provide a cost-effective opportunity to assess the effectiveness of any air pollution mitigation interventions, such as HEPA filtrations and building changes.

This research is of huge importance due to the recent public awareness of the negative impacts of air pollution on human health, but the general lack of awareness about how best to monitor and measure local air pollution, and how to reduce it indoors if it is present. Ensuring the project is driven by stakeholder concerns, the needs, concerns, and deliverables will meet the national priorities of applied research that delivers useful guidance for a range of stakeholders.

***Our response***

IP4.02.04 is a multi-year project focused on working with stakeholders such as ACT Health (see IP4.02.03), Victoria EPA, Department of Health Victoria and NSW DPE to apply the knowledge identified in RP2022 to intervention case studies. This will include further comparative evaluation of HEPA filters themselves (in a laboratory setting) to their use in real world interventions studies, in for example, clean air shelters to reduce risk from air pollution, with a focus on vulnerable populations.

This project aims to provide up to date guidance on the choice and use of LCS and HEPA filters in the Australian context. Part of this project will include working with manufacturers to develop plain English education material and programs to ensure research-users understand the capacities and limitations of these technologies. The outcome of this multi-year project would be that research-users are more informed and able to make better choices over the selection and use of LCS and HEPA and, consequently, reduce the impacts of air pollution on health.

This project builds on the identified needs raised during RP2021 and RP2022 co-design workshop discussions and review of low-cost sensor availability and useability.

The previous consultations will guide intervention work including the appropriate use of HEPA filters and related hardware use in public spaces, schools and other buildings that could serve as safer air refuges / environments to identify how best to use HEPA filters to reduce the health impacts associated with bushfire smoke and traffic emissions.

IP4.02.04 seeks to address the following questions:

- How best to provide safer air spaces during times of high air pollution events.
- How to address the national priorities of the NESP by providing applied research that is translated into tangible guidance for stakeholders to improve environmental conditions.

*Methodology*

The research will be delivered via:

- literature reviews of current international best practice for the choice and use of LCS and HEPA;
- a laboratory test comparison of hardware currently available on the Australian market;
- intervention studies to explore how effective these technologies are in the Australian context; and
- production of plain English selection, guidance and use materials developed with the manufacturers, relevant stakeholders from local, state and federal government as well as non-government organisations.

There are limited guidance documents available internationally on how to select and manage public buildings for use as safer havens during poor air quality events. Health Canada have created a document that we propose to evaluate and use to develop Australian relevant guidance. Suggested interventions include changing the building ventilation and / or installing HEPA filters. The use of low-cost sensors is recommended to evaluate the efficacy of such interventions.

The team will co-design a range of interventions with stakeholders to ensure that the outcomes are relevant to their needs and can be broadly applicable for a range of building designs.

We need to identify how and where to provide safer air spaces for high air pollution days. IP4.02.04 will provide insights into how and where to do this via intervention studies which will be broadly replicable nationwide. The research will be conducted via desktop assessments and *in situ* intervention experiments in existing buildings via a case study approach. It will be informed by the earlier pilot intervention work being conducted in RP2022 with HEPA cleaners and LCS in schools. This will work in concert with IP4.02.03 looking at woodsmoke pollution (crossing over for $PM_{2.5}$) so we hope we may be able to share some resources and findings. This research will inform decision-making and on-ground action in relation to where we can best provide clear guidance for vulnerable communities about where to go during high air pollution events.

**Is this a cross-hub project?** No.

**Does this project contribute to a cross-cutting initiative?** No.

# Pathway to impact

**Outcomes**

This multi-year project proposes to build upon activities yet to be undertaken in the current RP2022 project in IP4.

The outputs from IP4.02.01 – 'Let's Yarn About Smoke', a foundational project, are intended to be a roadmap forward for cooperation and engagement in a broad scope of Indigenous identified research priorities, stakeholders and potential opportunities to undertake activities that will contribute to better management of the impacts of smoke from planned and unplanned fires on First Nations people and the broader Australian community.

As these formative RP2022 outputs are yet to be developed, the outcomes and impact from subsequent RP2023 projects cannot be defined. We do anticipate that outcomes will generate key findings to support public guidance, policy development and roadmaps to improve Australian air quality and reduce population exposures.

The following proposed activities and outputs represent potential opportunities within existing activities that IP4 researchers are presently engaged. The following are anticipated outcomes for RP2023 activities:

*Informing policy and frameworks*

IP4.02.04 will contribute to the improved guidance on the use of HEPA filters for air quality in public spaces, guidelines on the selection and use of low-cost sensor networks for the management of local air quality problems and a roadmap for interventions to reduce exposure on high air pollution days.

IP4.02.02 will provide a lens on how altered we can expect air quality to be under future emission scenarios in Australia. The research outcomes will be used by government agencies for managing future changes to air quality and health.

*Community benefits*

IP4.02.04 will deliver plain English guidance for the use of HEPA cleaners and outcomes of the comparison testing and intervention studies, the public and stakeholders will be able to make more informed decisions on purchasing cleaners to reduce their exposure to air pollution.

*Economic Benefits*

Both IP04.02.03 and IP4.02.04 will incorporate Discrete Choice Experiments to gather information on what drives individual decision making on wood heater use, HEPA cleaner purchases and low-cost sensor network installations. These can be used to understand potential economic choices.

*Environmental Benefits*

The environmental value of project IP4.02.03 will be two-fold. Through the implementation of wood heater interventions and the assessment of their impact, this project aims to assess which interventions result in not only increased human health outcomes but also environmental health. The result of successful interventions should see an increase in ambient air quality, with a reduction in the pollutants being emitted from wood heaters – not only from the combustion of standard wood but from people burning other fuel sources, such as rubbish and treated wood. In addition to this, reducing the number of people who use wood heaters will reduce the environmental costs of sourcing wood to use as fuel. Currently it is estimated in Tasmania one third of wood burned in residential wood heaters is sourced from a 'sustainable' producer, with the majority being illegally

taken from bush land. Dead wood plays a major role in the ecosystem of the Australian bush and its removal has ramifications far beyond releasing its stored carbon into the atmosphere.

Changes in ambient air quality will be measured in this project using EPA monitoring stations and low-cost air quality sensors.

*Partnerships & Collaboration*

IP4.03.01 will identify current and planned air quality activities through consultation and discussion with relevant partners. This will lead to a roadmap that can be used to progress future smoke-related research activities.

IP4.02.03 will engage a broad range of stakeholders, including the LGA's responsible for air quality complaints related to wood heater emissions. This will ensure that suitable educational material can be developed to support actions.

Long-term outcomes:

The ultimate outcome of this research over the course of the NESP program will be the reduction of exposure of Australian communities to poor air quality in future. This outcome contributes to Goals 3 and Goal 11 of the UN Sustainable Development Goals by reducing mean annual levels of particulate matter in cities and reducing mortality rates attributed to household and ambient air pollution.

The research will provide the tools and knowledge that will empower all scales of government to undertake a co-ordinated approach to interventions that will reduce exposure to air pollution and save lives. Outputs from this project that will contribute to this outcome will enable government to plan for the impacts of a warming climate on future air quality and to maximise the co-benefits of reducing emissions and improving air quality.

| **Research-user** | **Engagement and communication** | **Impact on management action** | **Outputs** |
|---|---|---|---|
| Department of Climate Change, Energy, Environment and Water (DCCEEW) (Environment Protection Branch, NESP Program)<br><br>Community groups and national networks as well as industry partners | The needs of researchers and research-users will be identified through conversations and consultation during RP2022.<br>Continual engagement is embedded in the workplan which will include workshops and regular virtual meetings.<br>Research findings and project updates will be provided at quarterly meetings with the Department.<br>IP4 project leads will meet quarterly with the Hub Knowledge Broker to identify opportunities for communications and knowledge translation. IP4 meets every other Monday, the Knowledge Broker will be invited to attend quarterly. | The research outcomes will:<br>• Be used to assist the 2027 State of the Environment report to include an Indigenous co-author for the Air Quality Chapter.<br>• Work towards the NESP goal of finding ways to strengthen Indigenous knowledge, build strong partnerships and explore ways we might share and weave Indigenous and non-Indigenous knowledge that can be applied to improve the health of our environment and urban and regional communities.<br>• (IP4.02.02) inform the direction of future emissions and planning policy. | IP4.02.01 –<br>A roadmap forward for further conversations and if appropriate, the development of project ideas to carry out in further years of this project.<br>IP4.02.02 -<br>Journal paper on 2050 air quality outcomes from anthropogenic emissions<br>Journal paper on 2050 air quality outcomes from biogenic emissions<br>Journal paper on street canyon model<br>Discussion paper reflecting on the model outcomes to assist policy decisions<br>Presentation of emission scenarios for the year 2050 and their impact on urban air quality at |

| Research-user | Engagement and communication | Impact on management action | Outputs |
|---|---|---|---|
| | | • (IP4.02.03) will test and compare different management options developed in collaboration with stakeholders<br>• This will have a direct pathway to influencing management – both through the process of establishing the research interventions and through the results that come from their evaluation<br>• (IP4.02.04) Outcomes of the interventions using HEPA filtration will be vital to guide decisions relating the rapid retrofitting of public buildings as well as for new building regulations to reduce the ingress of air pollutants.<br>• The low-cost sensor network assessment will be used to evaluate the efficacy of interventions to reduce exposures to air pollutants. | workshops and conferences<br>Fact Sheets summarising main project outcomes in plain English<br><br>IP4.02.03 –<br>RP2023<br>Appropriate monitoring network established and data integration systems in place.<br>Pre-intervention data captured and assessed.<br>Production of fact-sheets aimed at non-scientific readers.<br>RP2024 & RP2025<br>Interim data and evaluation reports on implementation trial results<br>RP2026<br>Comprehensive evaluation report, including national and regional scale cost-benefit modelling, and recommendations for wood heater policy and strategy.<br>Resource packages and other translation outputs produced as agreed with partners.<br><br>IP4.02.04<br>Discussion paper including the results of the lab test on comparative HEPA filters available in Australia. Online tool to facilitate choice of low-cost sensors and HEPA filters for end users<br>Education materials about how best to use HEPA filters in different settings and how to respond to increased indoor air pollution identified by low-cost monitors.<br>How and when to use LCS/ HEPA in concert with existing HVAC systems to improve air quality in public spaces.<br>Significant effort will be made to translate research findings into |

| Research-user | Engagement and communication | Impact on management action | Outputs |
|---|---|---|---|
| | | | plain English and communicated through social media (infographics/fact sheets) as well as traditional peer reviewed papers and workshops/presentations. |
| **Additional outputs**<br>N/A | | | |

# Indigenous consultation and engagement

Indigenous consultation and engagement form the crux of project IP4.02.01, with an aim to involve Indigenous researchers/knowledge holders at all stages and provide a platform for Indigenous-led dialogues. The IP4 team have much to learn in this space so will be guided by consultation with the SCaW Indigenous Advisory Committee, the NESP Indigenous Facilitation Network, the Senior Indigenous Facilitator and the SCaW Indigenous Partnerships Strategy.

This project aims to map-out through conversations any Indigenous identified priorities for managing the impact of landscape smoke on the health of communities. These conversations will be carried out according to the SCaW Indigenous Partnerships Strategy goals. In particular:

- Respect and Mutual Benefit – as noted in the SCaW Indigenous Partnerships Strategy, relationships are built over time and with on-going communication. We envisage this project will be the start of these ongoing conversations over the course of the Hub lifetime. In these conversations we will ensure that knowledge held by Indigenous collaborators is valued and protected through the partnership by ensuring all legal obligations are understood before discussions commence. All SCaW air quality researchers involved in this project will be encouraged to read True Tracks (Jenkins 2021)® and when available, undertake True Track® training.
- Right to Indigenous cultural and intellectual property – in addition to the above, the project will involve Ethics approval, primarily through CSIRO.
- Co-created research – this project represents the second year of an ongoing project to co-design research activities with Indigenous researchers and stakeholders around air quality. All air quality researchers involved in this project will be encouraged to read Our knowledge our way in caring for Country' and undertake 'Your Mob' training.

It is recognised that there was low participation of Indigenous researchers in the RP2021 process of IP4. This led us to propose the question, how can we increase engagement of Indigenous researchers and stakeholders in air quality discussions and research. As such, all IP4 projects sit in the **Scoping and Building wedge** of the Partnering Cycle (Figure 1 of the Indigenous Partnerships Strategy). We are starting with *scoping needs and options* and hope to progress through *identifying potential partners* (particularly Indigenous researchers and stakeholders to lead and participate in these discussions). We anticipate that we may reach the *building relationships* phase and that *mapping and planning* will be a bonus but likely will occur in RP2022 and RP2023.

Ultimately IP4 falls into **Category 1 of the NESP Three Category Approach** in that the goal is to carry out an air quality research project relevant to Indigenous stakeholders. The RP2022 and RP2023 component of the project will focus on the co-design aspect of the Category 1 Approach.

IP4 will include capacity-building for all researchers, training and co-authorship. Indigenous cultural and intellectual property (ICIP) and traditional knowledge will be managed according to the Indigenous Strategy and will be incorporated into the project design.

| Which Three-category approach the project meets | **Co-design** | **Collaborate** | **Communicate** |
|---|---|---|---|
| | ☒ | ☐ | ☐ |

(with aspirations to include Collaborate and Co-design)

# Project milestones

| Milestones | Due date | Responsible person |
|---|---|---|
| Signing of contract between Hub lead and research organisations | 1 February 2023 | Amanda Wheeler |
| **IP4.02.01** | | |
| Milestone 4 – IP4.02.01 Progress report for RP2022 (amendment to proposal) | 1 March 2023 | Erin Dunne |
| Milestone 1 - Progress report for RP2023 | 1 March 2024 | Erin Dunne |
| Milestone 2 - A document detailing a Roadmap forward for further conversations and if appropriate, the development of project ideas to carry out in further years of this project. Summaries of any meetings and workshops throughout RP2023 will be provided. | 15 May 2024 | Erin Dunne |
| **IP4.02.02** | | |
| | | |
| Milestone 0. Presentation and discussion of Literature Review | 15 July 2023 | |
| Milestone 1. Gathering model input data | 15 October 2023 | Kathryn Emmerson |
| Milestone 2. Decide and run baseline conditions | 15 December 2023 | Kathryn Emmerson |
| Milestone 3. Acquire CCAM downscaled data ensemble package for 2050 | 15 March 2024 | Kathryn Emmerson |
| Milestone 4. Progress report for RP2023 | 15 March 2024 | Kathryn Emmerson |
| *Anthropogenic Emissions* | | |
| Milestone 5. Run at least 5 sets of anthropogenic emission scenarios.<br>Milestone 6. Journal paper on 2050 air quality outcomes from anthropogenic emissions | 15 December 2024<br>15 April 2025 | Kathryn Emmerson<br>Kathryn Emmerson |
| Milestone 7. Progress report for RP2024 | 15 March 2025 | Kathryn Emmerson |
| *Biogenic Emissions* | | |
| Milestone 8. Run biogenic emission scenarios | 15 September 2025 | Kathryn Emmerson |

| Milestones | Due date | Responsible person |
|---|---|---|
| Milestone 9. Journal paper on 2050 air quality outcomes from biogenic emissions | 15 February 2026 | Kathryn Emmerson |
| Milestone 10. Progress report for RP2025 | 15 March 2026 | Kathryn Emmerson |
| *Street Canyon Model* | | |
| Milestone 11. Develop and test street canyon model | 15 September 2026 | Kathryn Emmerson |
| Milestone 12. Run urban greening strategies in street canyon model | 15 February 2027 | Kathryn Emmerson |
| Milestone 13. Journal paper on street canyon model | 15 May 2027 | Kathryn Emmerson |
| Milestone 14. Progress report for RP2026 | 15 March 2027 | Kathryn Emmerson |
| Milestone 15. Final report and draft discussion paper on model findings | 15 June 2027 | Kathryn Emmerson |
| **IP4.02.03** | | |
| Milestone 1 – Six regions and councils across Australia identified | 1 April 2023 | Fay Johnston and Project Officer |
| Milestone 2 – Data collection needs established | 1 July 2023 | Fay Johnston and Project Officer |
| Milestone 3 – Adequate air quality monitoring infrastructure in place | 1 July 2023 | Fay Johnston and Project Officer |
| Milestone 4 – Pre-intervention data captured | From 1 April 2023 to 31 December 2023 | Fay Johnston and Project Officer |
| Milestone 5 – Interventions deployed | 1 September 2025 | Fay Johnston and Project Officer |
| Milestone 6 – Health and economic cost-benefit analysis completed | 31 December 2026 | Fay Johnston and Project Officer |
| Milestone 7 – Comprehensive assessment reports and related translational outputs delivered | 31 December 2026 | Fay Johnston and Project Officer |
| **IP4.02.04** | | |
| Milestone 1 – LCS decision tool report | 1 March 2023 | Donna Green and researcher |
| Milestone 2 – HEPA comparison and intervention study report | 1 November 2023 | Donna Green and researcher |

| Milestones | Due date | Responsible person |
|---|---|---|
| Milestone 3 – HEPA decision tool report and plain English guidance pieces report | 1 November 2024 | Donna Green and researcher |
| Milestone 4 – LCS/HVAC/HEPA options for safer refuges report | 1 November 2025 | Donna Green and researcher |
| Milestone 5 – Workshop conducted for stakeholders to provide feedback | 1 November 2026 | Donna Green and researcher |
| Milestone 6 –Final compiled report integrating all separate results and provision of policy recommendations | 1 February 2027 | Donna Green and researcher |

# Data and information management

The co-design process will identify detailed knowledge products to be delivered through RP2023 and beyond. Detailed data and information management plans will be developed for each of these. It is expected that any knowledge products generated through the co-design phase will be made publicly available through the Hub website, and in accordance with the Hub Data Management Strategy and subject to ethics approvals and any relevant Indigenous Cultural and Intellectual Property (ICIP) arrangements. The Data Wrangler will play a key role in coordinating and facilitating this data management and sharing through the provision of expert advice.

| **Project output** | **Data management and accessibility** |
|---|---|
| Publications and Reports | Reports will include Indigenous Knowledge so the management and accessibility of the report will be subject to the conditions of the Ethics approvals and ICP arrangements entered. Where possible we will endeavour to make the reports publicly available via the SCaW website or other suitable platforms. |
| Data sets | The IP4 team will work with the Hub Data Wrangler to ensure that all the requirements of the SCAW Hub Data Management strategy are met. All data produced by this NESP co funded project will be subject to FAIR and CARE principles and Ethics) principles and any specific Indigenous Cultural and Intellectual Property (ICIP) arrangements developed with the communities involved. We will handle the data that emerges from these discussions according to Article 31 of the United Nations Declaration on the Rights of Indigenous Peoples.<br><br>Data will be stored in the Hub data repository upon finalisation of the databases. Project leads will be responsible for ensuring this is conducted in a timely manner.<br><br>All data sets will be accompanied by high-quality metadata records, will be assigned persistent identifiers and will be subject to rigorous quality assurance and quality control checks. |
| Workshop output | Slides and a summary of any workshops to be shared with attendees and made available through the SCaW website. |

# Location of research

The table below describes the scale at which the project will be working, and the location/s where the majority of the project research will be conducted.

| **At which spatial scale is the project working** | **National** ☒ | **Regional** ☒ | **Local** ☒ |
|---|---|---|---|
| **Location(s) – gazetted region /place name** | **IP4.02.01**<br>This research will initially occur virtually, engaging on a national scale. As the projects progress, we may focus discussions within relevant states. We may have a better idea of locations once RP2022 is completed.<br>Project management will occur from Aspendale, Victoria<br><br>**IP4.02.02**<br>Aspendale Victoria<br><br>**IP4.02.03**<br>The desktop component of this research will primarily be carried out in Hobart Tasmania.<br>Locations for field trials are being determined via ongoing consultation in RP2022.<br>However, approximately 6 locations/regions will be involved, potentially including City of Launceston, City of Ballarat, City of Yarra and the ACT.<br><br>**IP4.02.04**<br>Much of this research will initially occur virtually, engaging on a national scale. As the projects progress, we may focus discussions within relevant states.<br><br>UNSW Sydney - Gadigal on Eora Country for the desktop research, with the research output impact at a national level. | | |
| **Aboriginal or Torres Strait Islander nation or traditional place name(s)** | **IP4.02.01**<br>Bunurong country<br><br>**IP4.02.02**<br>Bunurong country<br>**IP4.02.03**<br>The desktop component will be carried out primarily in nipaluna, lutruwita.<br>The traditional owners and custodians of the land on which the City of Ballarat is built are the Wadawurrung People and the Dja Dja Wurrung People.<br>The area now known as the City of Yarra stands on the traditional lands of the Wurundjeri people.<br>The ACT is Ngunnawal country.<br><br>**IP4.02.04**<br>Gadigal on Eora Country | | |

# Project keywords

Air quality, Smoke, Indigenous knowledge, Emissions, Interventions