National Environmental Science Program

Sustainable Communities and Waste Hub research plan 2025 – Attachment B project plans-IP2

Contents

Project type: Hub research project	
Project status: Existing project seeking amendment and new project submitted for approval	
Cross-cutting initiative:	Yes
Project start date: 01/07/2022 For New project IP2.05.03- 01/07/2025	**Project end date**: 31/12/2026
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Pathway to impact

Outcomes
The ultimate outcome of this research over the course of the NESP program will be an increase in materials circularity in Indigenous, remote, regional and urban Australian communities. **Informing policy and frameworks** This outcome will contribute to the delivery of the “National Waste Policy 2018" and the "National Waste Policy Action Plan”, particularly the goals of "Helping to reduce total waste generated by 10% per person by 2030" and "Significantly increase the use of recycled content by governments, consumers and industry". This new knowledge is expected to inform future policy discussion and considerations at all levels of government in addressing fit-for-purpose waste management in regional and remote communities and reducing the impact of micro/nano plastics. **Community benefits** The research projects will identify ways in which local communities can benefit from regional technological solutions to transform waste materials into new products. The benefits may include local jobs, improved environment (understanding microplastics and waste solar panels), and local education. **Economic Benefits** The project's outcomes will catalyse supply chains and create new markets. This work will lead to opportunities for Australian Indigenous, remote, regional and urban communities to embrace circular economy solutions to drive social and economic benefits. **Environmental Benefits** The project will advance recycling and plastic related policies, providing a framework to develop and promote new and sustainable national supply chains, reducing the impacts of waste materials subject to the export ban as well as the effects of microplastics on the environment. It will inform the Department's policy design and decision making via community co-designed solutions and on-ground success. The research will also provide innovative recycling solutions for waste streams, including plastics, tyres, textiles, end-of-life solar panels and glass. **Partnerships & Collaboration** Building partnerships between small to medium size enterprises (SMEs), all levels of government and local Indigenous and non-Indigenous community groups through co-design and partner projects to reduce the impact of waste materials. **New Capability Development** The increased funding available for RP25 and RP26 will enable the IP2.02.01 project to increase the number of microplastic interception points, with resourcing going to technical

staff time and an increase in the number of samples analysed. Additionally, this new funding will allow us to train young researchers and engineers as part of this project. The project will also investigate the plastic waste challenges, regulatory framework of managing the complex plastic waste and their challenges in the Indian Ocean Territories (IOT) and assess the circular economy potential of this waste. For IP2.02.02, the increased funding will enable an extra case studies to be undertaken, with resourcing also going to technical staff time. This will enable us to increase the number of councils who can provide feedback on the Technology Framework (Circular Economy Technology). The extra case studies exploring potential for decentralised resource recovery in Queensland Regional Councils will include case study with the Far North Queensland Regional Organisation of Councils (FNQROC) that will enable collaboration with 12 regional councils; case study with the Wide Bay Burnett (WBB) Regional includes the six local governments and case study with Central Queensland Region Organisation of Councils (CQROC) which represents 06 councils. These case studies will be helpful to understand the current gaps in waste management in regional and remote communities and also explore how fit-for-purpose technology can impact these communities given their unique waste challenges and contexts.

New subproject IP02.05.03 aims to deliver a transformative roadmap for creating value from metal recycling of end-of-life solar panels, enabling high-purity recovery of valuable metals and alloys such as silver, aluminium, copper, and silicon.

Research-user	Engagement and communication	Impact on management action	Outputs
IP2.02.01: Understanding Microplastics **(2022-2026)** Key partners are being identified through the RP2 process. Primary Research Users Include: Plastics, packaging and marine debris section, Circular Economy Division, Waste and Resource Recovery Branch, Environment Protection Division, Waste Policy and	Research-users have been engaged in the development and design of project and outputs through regular co-design workshops. Findings and outputs to be communicated via project workshops, project update emails and presentations. Key stakeholders, including EPD, will continue to be engaged through regular briefings to ensure alignment of workplans and outputs to ensure mutual benefits. Research outcomes will continue to be communicated through	Initial Research completed during RP2 will be used to direct operations including fundamental analyses of microplastics and their threat, as well as in-depth investigation into the impacts of tyre dust, synthetic grass, and the risks of microplastics toward EPBC listed species.	A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution. A final report on microplastic fundamentals. A preliminary report on tyre dust and recommendations for interception pilots. Factsheets and other communication tools about the project. As part of this project, we will generate comprehensive reports on the effects of thermal, microwave, and UV treatments on the degradation of various types of plastics. These

Research-user	Engagement and communication	Impact on management action	Outputs
Planning Branch, Domestic Plastics Policy Section, Local Councils Ocean Protect, Sea Shepherd, EPA NSW,	industry media, the SCaW Hub website, via social media and workshops and events. Researchers will continue to work closely with industry, scientific and regulatory bodies to meet the aims of the sub-projects. The researchers will work closely with the Knowledge Broker, Industry and Impact Manager, Data Wrangler, Senior Indigenous Facilitator and Communications and Media Manager of the SCaW Hub for capturing and transferring the knowledge created in this project.		reports will link the degradation processes to the formation of microplastics, providing valuable insights into how different environmental factors contribute to microplastic pollution. This research will help us better understand the lifecycle of plastics and develop strategies to mitigate their impact on the environment. Additionally, by understanding the nature of plastic waste in the Indian Ocean Territories (IOT), the major policy question to be addressed is: *How can elements of the plastic waste in the IOT be integrated into their respective circular economies?* Currently, detailed information on the types of plastics present and how they could best be incorporated into the supply chain is entirely missing. This project will help identify that valuable information.
IP2.02.02 Finding Fit for Purpose Technological Recycling Solutions for Regional and Remote Communities Across Australia **(2022 to 2026)** Key partners have been confirmed. List includes:	Co-design activities will continue and partnerships with local communities established to undertake demonstration case studies. Regular engagement will occur as a part of this process with partners. Regular update (monthly) engagements will occur with stakeholders involved in each demonstration case study to build trust and rapport. Monthly update calls to the Department to report progress.	Results of early research will be used to conduct: Evaluation of technology Design of a local council "one stop shop" portal Identification and commencement of demonstration case studies Annual Technology Forecast	Yearly progress report: Criteria (metrics) to evaluate technologies A synthesis of existing waste demographic frameworks and metrics Evaluation of technologies User requirements for a *one-stop-shop* for local governments Co-design outcomes Demonstration of case study 1 - Remote

Research-user	Engagement and communication	Impact on management action	Outputs
the Department - EPD, Parks Australia Representative local governments from regional and remote locations: Salamander Bay Council Shoalhaven City Council Forbes Shire Council Far North Queensland Regional Organisation of Councils (FNQROC) The Central Queensland Region Organisation of Councils (CQROC) The Wide Bay Burnett Regional (WBB) State and territory governments Regional Development Agencies Industry sectors (including manufacturing, agricultural and aquaculture) Business and private sector Investors Local communities (including Indigenous), Remote Communities of	The researchers will work closely with the Knowledge Broker, Industry and Impact Manager, Data Wrangler, Senior Indigenous Facilitator and Communications and Media Manager of the SCaW Hub for capturing and transferring the knowledge created in this project.		Community Project Progress Report Annual Technology forecast. Fact Sheets and other communication tools about on fit for purpose technologies for different waste demographic settings. Research product will be communicated with the Indigenous people or prepared as suitable for the same community to understand.

Research-user	Engagement and communication	Impact on management action	Outputs
Santa Teresa, Hermannsburg and Titjikala.			
IP02.05.03			
UNSW SMaRT Centre	Coordination of academic-industry collaboration, with regular progress reports and access to UNSW's Microfactorie™ facilities for pilot-scale trials. Support for research, development, and training activities.	UNSW SMaRT will use the data to improve dismantling processes and develop more easily recyclable solar panels in the future, promoting continuous innovation.	Research reports, new recycling technologies, and educational content to support student and researcher involvement in the project.
Local Governments (NSW Councils)	Collaborative meetings to address local waste management challenges.	Local governments will integrate findings into waste management programs, reducing the volume of solar panels sent to landfills and cutting associated costs. The recycling plant will divert 810 tonnes of waste annually.	Reports on pilot plant operations, data on waste diverted from landfills, and economic assessments of the recycling processes.

Project description

Project summary

The research from IP2 is seeking to reduce the impact of plastics, end-of-life (EoL) solar panels and other waste materials by:

a) Understanding Microplastics (IP2.02.01); and
b) Finding fit-for-purpose technological recycling solutions for regional and remote communities across Australia (IP2.02.02).
c) Establish a roadmap for value extraction from metals in EoL solar panels, which present challenges due to their complex composition (IP2.05.03).

In RP2025 researchers will continue the co-implementation stages of the project with the Department of Climate Change, Energy, the Environment and Water (DCCEEW), with industry partners and with community groups, including both Indigenous and government. The work will build on the foundational work in RP2022, RP2023 and RP2024. This will include:

- The finalisation of a national protocol for measuring and monitoring microplastics, providing deeper insights for policy
- Understanding the sources and generators of microplastics
- Developing a national framework for identification and evaluation of fit for purpose technological recycling solutions for regional and remote communities
- Commencement of a demonstration case study with a remote Indigenous community that will provide the ground-truthing for solutions and provide lessons learned and stories to build the capacity of other communities.

IP2 researchers are guided by national priorities "The National Waste Policy 2018" and the "2019 National Waste Policy Action Plan" and supported by further plans including modernisation of recycling and manufacturing capability; and sustainable protection of national materials supply (critical materials).

Project description

In RP2021, RP2022, RP2023 and beyond, researchers in IP2 worked with research-users to co-design a series of impactful research projects under the 'Reduced impact of plastics and other materials" research theme for the SCaW Hub. These stakeholders and partners included DCCEEW and other research-users such as state environment departments, local government, NGOs, Indigenous groups, private sector, industry groups and other NESP hubs. In RP2022, two themes of focus emerged for researchers:

1. Understanding the impact of materials contributing to microplastics (plastics and tyres) and identifying potential solutions for management and control to reduce impact.
2. Finding "fit for purpose" technological solutions for regional and remote communities.

To address these issues, IP2 proposed two multi-year sub-projects in RP2022. In RP2025 the projects remain largely unchanged and are still following the plans outlined in RP2022 and updated in RP2023 and RP2024.

IP2.02

Schematic diagram for IP2.02.01 and IP2.02.02 activities

Project	RP2022	RP2023	RP2024	RP2025	RP2026
IP2.02.01 Understanding Microplastics (2022-2026)	Protocol and risk framework methodology development Ongoing co-design of RP2023	Fundamental analysis of Microplastics Impact of Tyre Dust Ongoing co-design of RP2024	Guidelines to recycle individual microplastic-producing precursor materials Interception pilots will be initiated to combat tyre dust and microplastic problems A study on synthetic grass-based microplastic waste's composition, prevalence, and impact	Understanding plastic waste problems (i.e. scale, types, priority areas) of IOT Interception pilots will be designed to target the selected materials' recycling rates Interception pilots be reported and used to develop interception strategies based on whether strategy goals were met Pilots for synthetic grass waste and recycling rate improvement interception	Results of the improved or pivoted RP2025 interception pilots will be used to inform policy at various levels of jurisdiction RP5 Interception pilots will be reported and assessed. Based on this result, they may be enhanced, expanded, or pivoted to capture the optimal data applicable to the findings of investigations previous
	1) A progress report of findings to predict microplastic risk for EPBC Act-listed threatened species 2) A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution 3) A "live" list of additives in plastics and types of plastics leads to harmful emissions, including micro/nano plastics	1) A preliminary report of findings to predict microplastic risk for EPBC Act-listed threatened species 2) A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution 3) A final report on microplastic fundamentals 4) A preliminary report on tyre dust and recommendations for interception pilots 5) Factsheets and other communication tools about the project	1) Tyre dust interception pilot 2) Interception pilot plan for synthetic grass 3) A final report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution 4) Preliminary guidelines for recycling individual microplastic-producing precursor materials	1) Synthetic grass interception pilot 2) A final report on tyre dust including finding from the interception pilot 3) Interception pilot plan for microplastic-producing precursor materials 4) Updated research plan for RP2026	1) A synthesis report will be developed based on the previous year's work, outlining next steps 2) Factsheets and other communication tools about the project
IP2.02.02 Finding fit for purpose technological recycling solutions for regional and remote communities across Australia	Co-design phase	Evaluation of technology Local council "one stop shop" portal Identification of demonstration case studies Demonstration of case study 1 Demonstration case studies 2 and 3 Annual Technology Forecast			Explore future opportunities for circular economy within polymer supply chain of IOT National symposium
	1) Yearly progress report for DCCEEW 2) Communication tools about the project	1) Yearly progress report for DCCEEW 2) Local governments portal 3) Demonstration of case study 1 (Progress Report) 4) Annual Technology forecast 5) Communication tools	1) Yearly progress report for DCCEEW 2) Demonstration of case study 1, 2 & 3 (Progress Report) 3) Annual Technology forecast 4) Communication tools	1) Yearly progress report for DCCEEW 2) Demonstration of case study 1, 2 & 3 (Progress Report) 3) Annual Technology forecast 4) Communication tools	1) Final report for DCCEEW 2) Demonstration of case study 1, 2 & 3 (Final Report) 3) Annual Technology forecast 4) Communication tools 5) Handbook for local governments 6) Policy guidance document for the Department and State and Territory Governments National Symposium

IP2.02.01: Understanding microplastics

The problem

Research on microplastics and their potential threats to ecosystems and humans is in its infancy and is complex - a lot remains uncertain. However, growing scientific evidence on the hazards of the uncontrolled, irreversible, and long-term ecological risks due to microplastics do exist for some coastal waters and sediments. Scientists predict that if emissions to the environment continue at the current rate or increase, ecological risks could be widespread within a century. A key issue highlighted by the Department and other research-users through the co-design activities in 2021 was the need for an improved understanding of the impacts of microplastics in Australia on the environment and species to guide policy and best practice management responses. In particular, the following priorities were identified:

- **Developing a national monitoring protocol** - Currently, no standards exist for sampling and testing microplastics. A nationally consistent monitoring system and national database for microplastic pollution are required to improve knowledge of the prevalence and impact.
- **Understanding best practice management for tyre dust and use of rubber crumb** – Improved understanding is required about the composition, occurrence, and fate of tyre particles in the environment, including the impact of factors such as tyre quality and road characteristics on tyre wear, particle generation and microplastic pollution from recycled rubber crumb. Research on these areas will help inform how to reduce microplastic emissions from tyres in Australia. This includes identifying best practices for the reuse and recycling of tyres considering the risk of microplastic pollution—for example, the use of rubber crumb in artificial sports turf.
- **Understanding microplastic risk for Environment Protection and Biodiversity Conservation (EPBC) Act listed threatened species** – Greater knowledge is needed about plastic waste characteristics (e.g. toxicity, colour, ability to fragment, density, format, composition, size) that increase the likelihood of negative impacts on marine vertebrates when ingested or entangled. A risk framework is required to build understanding related to plastic and microplastic pollution and be able to make predictions on microplastic risk for EPBC Act-listed threatened species. After further co-design in RP2022 this work is being progressed by CSIRO outside of this project.

Our response

The project seeks to address the concerns raised by councils, industry, governments, and communities over microplastics and component materials to directly address gaps on the prevalence and impact of microplastic pollution. Over a five-year project, IP2 will undertake research to answer the specific questions raised by the Department and others regarding microplastics.

In the first year (2022), the focus was on developing a monitoring protocol for the systematic sampling, identification, and analysis of microplastics in a variety of environmental matrices (i.e. different environments, such as sand, soil and water), which was undertaken through a co-design process and refined through RP2022 and was being finalised in RP2023. A broad set of stakeholders, including from peak bodies, local council associations and state governments were engaged in the co-design process. The protocol encompassed primary (direct release) and secondary (fragmented from larger items) microplastics.

In 2024, the protocol saw further development with a methodology that included pre-processing steps, inorganic separation, physical characterisation and polymer identification techniques. Three reports were published on the SCaW Hub website providing an initial look at road and tyre dust, plastic additives and the current understanding of microplastics.

The remaining time (2024-2026) will tackle specific areas of concern for secondary microplastics raised by research-users, such as waste tyres and road markings, synthetic grass, stormwater / wastewater outlets, plastics recycling and manufacturing facilities and marine debris. This list will be refined over time through co-design. Key focus points will include materials analysis, identification of control and management options and solutions to reduce risk. For example, through re-manufacturing of materials or through providing alternatives, the focus will be to inform improved understanding of how to minimise impacts. Data will be populated into a national database being developed by the Department.

Given the significance of microplastics being found in coastal and marine environments, engaging with Indigenous Ranger groups and their communities will be undertaken over the life of this project. Where opportunity arises, working with Indigenous researchers to undertake aspects of the project will also be sought.

Data relevant for impact and measuring success will be shared in consultation with the Data Wrangler and Knowledge Broker.

Methodology

RP2022 Activities and methods

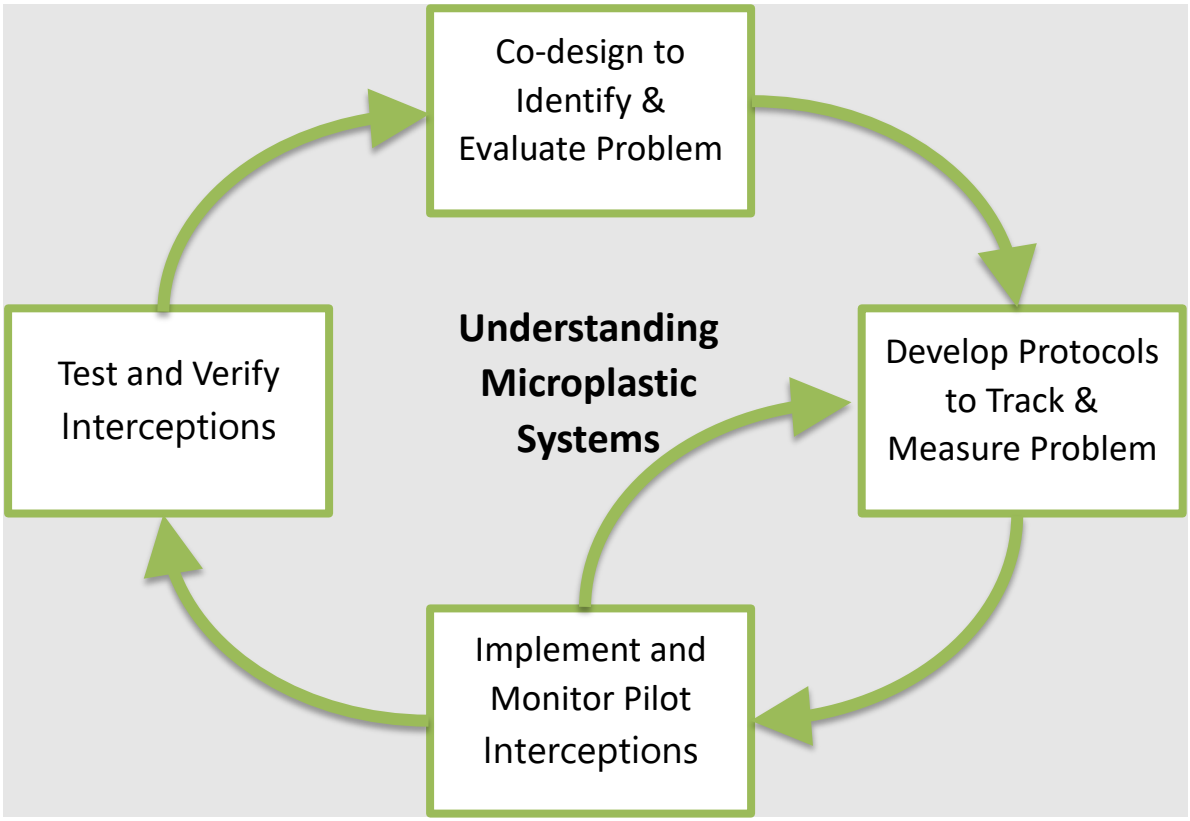
The first year of this project was divided into two target areas, namely sampling protocol development and further co-design to refine the project plan for the proceeding years.

Protocol and Framework Methodology Development - Researchers have conducted a literature survey, identifying gaps, and developing a national protocol to build a better understanding of the qualities of plastics and plastic items (e.g. toxicity, colour, ability to fragment, density, format, composition, size) that increase the likelihood of negative impacts. The literature survey was completed in RP3 and will inform activities in 2023 and beyond.

RP2021, through the co-design process found there is no standardised protocol for sampling, extraction, and purification, qualitative and quantitative analysis of microplastics, with specific gaps on nano-plastics (NPs) smaller than 1um. Researchers were investigating current best practices for detecting and quantifying micro/nano plastics in selected environmental matrices. The environmental matrices were identified through the literature survey. Solutions were ideated for investigation in RP2023 and beyond.

To develop the protocol, researchers identified sources (things that generate microplastics) and sinks (places where microplastics collect) of microplastics through literature survey and co-design with community and industry leaders impacted by microplastics. The identified sources included tyre dust, and synthetic turf. The identified sinks, or hotspots, may include beaches, rivers/stormwater, agricultural land, playgrounds, landfill sites and waste storage areas.

The protocol was built from current practices from around the world, adapted and updated to the Australian context. The protocol included representative sample designs, especially when sampling at beaches, also working with Indigenous communities to ensure sensitivities around land were accounted for.



Outputs

1) A progress report of findings to predict microplastic risk for EPBC Act-listed threatened species
2) A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution
3) A "live" list of additives in plastics and types of plastics leads to harmful emissions, including micro/nano plastics. This list will be provided in a report format and hosted on the NESP SCaW Hub website for community consultation. (Live in this context refers to the continual update, refinement and revaluation of the materials listed through the duration of this multi-year project)

Outcomes and Impact

- The start of a national protocol for measuring and monitoring microplastics, providing deeper insights for policy

RP2023 Activities and methods

RP2023 built upon the co-designed research plan developed in RP2022. RP2023 addressed the need for understanding tyre dust and the compositions of microplastics through a literature review and materials analysis. From the learnings in RP2022 metrics such as a “Risk rating” and ranking tools based on parameters such as prevalence were added to the live list of material additives.

Fundamental analysis of microplastics - The literature survey started in RP2 was concluded to identify the current understanding of microplastic presence and impacts in Australian contexts. From this study, intervention points were determined to study and then affect the

impacts of these materials firstly. This survey's critical areas of understanding included the relative contributions of primary (whole particles) and secondary (fragmented materials) to microplastic contaminations. Further investigation determined the changes in physical properties associated with virgin and waste plastics and their degradation in environmental conditions, be that by bio- or photo-degradational means.

Supporting this literature review and desk-top analysis, using materials samples collected from across a broad geographic scope nationally and from a cross-section of industries/ organisations that use plastics, textiles and tyres, this project undertook materials characterisation using fit for purpose technology. Fundamental analytical techniques, such as Raman and Fourier transform infrared (FTIR) Spectroscopy, were utilised, alongside thermogravimetric methods.

These experiments identified the origin of microplastics in Australian environments and the environmental impacts of their characteristics, including additive profiles, colour, fragmentation pattern, density, format, composition, and size. This study explored the relative contribution of different plastic species to the broader microplastic issue. Finally, prominent microplastic precursors' waste life cycles were modelled to determine critical points for hazardous material release and interception methods.

Impact of tyre dust - Research was undertaken to understand the composition, occurrence and fate of tyre particles in the environment, particle generation and on microplastic pollution from recycled rubber crumb. This study will inform manufacturers and regulators of best practices for the reuse and recycling of tyres, considering the risk of microplastic pollution, such as the incorporation of rubber crumbs in artificial sports turf. Researchers worked collaboratively with IP3 linking research on harmful additives and materials with microplastics.

Unlike many simple microplastics, tyres, composed of vulcanised rubber and synthetic substitutes, incorporated large quantities of sulphurous and other additive compounds whose degradation was toxic toward many segments of Australian ecosystems. However, the single application of these materials makes them a strong candidate for nuanced recycling techniques, unlike microplastics which come from more diverse sources. Much like the above microplastics study, this research was conducted through an initial literature survey of individual tyre components, an assessment of their cradle-to-grave life cycles, and the impact of the whole and fragmented waste materials on host ecosystems.

This study identified common automotive tyres' wear resistance and fragmenting tendencies and characterised the tyre dust particles released throughout their product lifespans. Various materials testing techniques investigated the rates and impacts of these patterns to identify steps toward mitigating microplastic release through engineering, substitutional, or regulatory means.

Synthetic grass - Planning and consultation commenced for intercepting an unresearched source of microplastic release. At the time of writing, synthetic grasses had been identified by the Department as a potential target material. Planning, including co-design and research identified the typical components and diversity of these materials, the spread of their use nationally, and current trends in their waste disposal or recycling methods.

Outputs

1) A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution

2) A final report on microplastic fundamentals
3) A preliminary report on tyre dust and recommendations for interception pilots
4) Factsheets and other communication tools about the project.

Outcomes and Impact

- The development of a national protocol for measuring and monitoring microplastics, providing deeper insights for policy
- Understanding of the sources and generators of microplastics.

RP2024 Activities and methods

A detailed study has been undertaken on synthetic grass-based microplastic waste composition, prevalence, and impact. At completion, suggestions identified through co-design for interception points were given, from which pilot studies are being designed.

An interception pilot with Ocean Protect has been designed and will be initiated to combat tyre dust and microplastic problems analysed previously. The goal of these studies will be to increase plastic recycling rates and prevent microplastic release into the environment.

Cross-hub collaborations have been co-designed and developed with the Marine and Coastal Hub project 2.4 Ecological outcomes of wastewater discharges in contrasting receiving environments. This included the exchange of samples and integration of research findings to provide a better understanding of the impact of micro and nano-plastics. Analysis of these samples will continue into RP2025.

A systematic literature review will be conducted to create a set of guidelines for reducing the impact of microplastic precursor materials using solutions in the Technosphere.

Outputs

1) A fact sheet will be produced by the researchers to illustrate the methodology for identifying locations for case studies.
2) Implementation of a pilot project to intercept tyre dust
3) A detailed study will be produced on synthetic grass-based microplastic waste composition, prevalence, and impact. This will be used to provide the scientific foundation for the findings from the pilot interventions for synthetic grass based microplastics.
4) A final report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution
5) Preliminary guidelines in the Technosphere for reducing the impact of individual microplastic-producing precursor materials.

Flexible Outputs

The research plan will include a set of flexible outputs, as suggested by the primary research users, for 2024.

1) Important scientific contributions of national significance will be communicated to various audiences via targeted short and accessible communication pieces, with support from the SCaW Hub Knowledge brokering team, such as short articles in industry journals and generally accessible media.

2) Targeted short presentations for industry partners, communities and the government sector as well as the public.
3) Research findings will be peer-reviewed through scholarly publication.
4) On-demand policy and business briefs to inform planning and decision making as part of the ongoing engagement with research users and other interested parties.

Outcomes and Impact

- The development of a national protocol for measuring and monitoring microplastics, providing deeper insights for policy
- Understanding of the sources and generators of microplastics, with domain knowledge of tyre dust.

RP2025 Activities and methods

Interception pilots for microplastics and tyre dust implemented in RP2024 will be reported and used to develop either enhanced or pivoted interception strategies based on whether strategy goals were met.

Pilots for synthetic grass waste and recycling rate improvement interception will be initiated based on the guidelines laid out in RP2024.

On-going co-design activities will inform the next trial. This will be co-designed with the other hubs and the Department to identify priorities.

From guidelines developed in RP4, interception pilots will be designed to target the selected materials' recycling rates.

In RP2025 IP2 team will investigate policies and procedures to reduce the impact of Microplastic leakage from recycling and remanufacturing operations. Learning from existing programs targeting the reduction in loss of pellets, e.g. Operation Clean Sweep Australia, will be captured through a literature review and incorporated into any guidance or recommendations.

A new project will be incorporated from 2025 which aims to open pathways for the characterisation and analysis of plastics from marine waste and electronic waste (e-waste) in the Indian Ocean Territories (IOT) of Australia. Currently, there is no detailed breakdown of specific plastic types, their properties, or the coexistence of other materials within the waste. These plastics, which are otherwise destined for landfill, incineration, or contribute to land and ocean pollution, will be analysed to inform future recycling, resource recovery, and waste management strategies. The goal is to repurpose this waste as a valuable resource within the supply chain for remanufacturing. Specifically, the project seeks to assess the scale of plastics trade, production, consumption, and disposal by adopting a holistic supply chain perspective. It will encompass all types of plastics in the IOT and key sectors that utilise polymers. Additionally, the project will identify feasible solutions for creating a circular plastics supply chain by analysing the types of waste plastics and their characteristics.

RP2025 activity for the IOT will involve reviewing the literature on prior research and publications related to plastics waste at IOT (including waste collection, conversion products, material flow, and reuse), an evidence-based approach will be developed to identify industry gaps, relevant technologies, and research opportunities. This process will include a systematic review of peer-reviewed articles, government reports, patents, industry white papers, and consultations with industry peak bodies. It will also investigate the behavioural barriers to circularity in the plastic value chain at each stage -1. product or service design, 2. production process, 3. access and use, 4. dispose or reuse/recycle (including segregation, collection transportation, treatment). While an understanding of the types of plastics embedded in the plastic waste of IOT will be developed, the project will also identify the regulatory and other challenges associated with plastics management in IOT. The scope of the incoming plastics problem on the islands is not yet fully understood and requires attention, particularly in relation to domestic plastics management. The project will explore opportunities that could be adopted by similar regions, benefiting both the community and the environment.

A desktop study will be conducted to complement the laboratory study. The research will outline the challenges inherent in managing plastic waste within IOT from various sources,

particularly marine waste. It will address the regulatory and other waste-related challenges associated with plastic waste management and recycling. The study will serve as a tool for IOT to assess the viability of different plastic management options and develop tailored plastic waste management strategies.

This study could be expanded to similar islands, e.g. Norfolk Island, to ensure scalability of the findings.

In RP 2025–2026, we will also include research on used **vaping devices** as part of our plastic characterisation studies. Used vaping devices are a growing source of plastic pollution, yet it is still unclear what types of plastics and other materials they contain. Their mixed plastic and metal design makes recycling very difficult, increasing the risk of pollution. Through this project, we will collect used vaping devices from the community and conduct plastic characterisation studies to identify the types of plastics and other materials present, track their degradation behaviour, and provide new insights into their environmental risks.

Outputs

1) Synthetic grass interception pilot based on the guidelines laid out in RP2024.
2) A final report on tyre dust including finding from the interception pilot
3) Interception pilot plan for microplastic-producing precursor materials
4) A report on the effects of thermal, microwave, and UV treatments on plastic degradation, linking these processes to microplastic formation and providing insights for strategies to mitigate environmental impact.
5) A comprehensive report on the plastic consumption, waste generation and plastic waste management challenges (regulatory and others); identification of polymer types, sources, and recyclates' application sectors in IOT.
6) Experiment will be conducted to characterise the types of plastics in used vaping devices collected from community.

Outcomes and Impact

- The development of a national protocol for measuring and monitoring microplastics, providing deeper insights for policy
- Understanding of the sources and generators of microplastics, with domain knowledge of tyre dust.
- A crucialinsights will be provided into plastic degradation and microplastic formation, helping to develop sustainable solutions for reducing plastic pollution and enhancing waste management.
- Understand the plastic waste management system of IOT to assess challenges and opportunities in moving towards a circular economy.

<u>RP2026 Activities and methods</u>

Results of the improved or pivoted RP2025 interception pilots will be used to inform policy at various levels of jurisdiction and, if successful, could be expanded to nationwide programs.

RP5 Interception pilots will be reported and assessed as to their efficacy. Based on this result, they may be enhanced, expanded, or pivoted to capture the optimal data applicable to the findings of investigations previous.

The research activity will involve developing a technology scan that evaluates and ranks treatment options (recycling or transforming) for different polymer waste streams of IOT identified in RP 2025. It will capture information on standards and guidelines, types of the existing recyclates and recycled products and define visible gaps and circularity opportunities to understand viable and non-viable technologies while carrying out the field survey/scanning of the plastic wastes. The project will assess the understanding knowledge, attitudes and practice of plastic stakeholders to identify opportunities for interventions to facilitate a circular economy transition for IOT.

Outputs

1) A synthesis report will be developed based on the previous year's work, outlining next steps.
2) Factsheets and other communication tools about the project.
3) A Report on constructing the evaluation and ranking approach for technological options and understanding the barriers to facilitate a circular economy transition for IOT.
4) Experiment will be conducted to characterise the types of plastics in used vaping devices collected from community.

Outcomes and Impact

- The development of a national protocol for measuring and monitoring microplastics, providing deeper insights for policy
- Understanding of the sources and generators of microplastics, with domain knowledge of tyre dust.
- Achieve viable recommendation and understanding for the complete transformation of plastic waste from the IOT into remanufactured products.

Linkages

Linkages to IP3 and IP5 have been outlined in the plan in previous sections.

This sub-project will work with the Marine and Coastal Hub to understand the risk that microplastics poses to the environment. Preliminary discussions have been held and work will continue under RP2024.

The following are relevant excerpts from RP2022 and RP2021 of the MaC Hub.

2.2	Advancing national standards and best practice to monitor key marine values and pressures	This project aims to advance the establishment and use of national standards and best practices to monitor the condition status of priority values and pressures of Australia's marine estate. We will achieve this by building on the national standards and best practice process developed in the previous NESP Marine Biodiversity Hub to produce three new national standards for monitoring (drop cameras, socioeconomic surveys of marine users, **marine microplastics**). We will also develop a practical implementation plan to embed the application of standards, with particular attention to inclusive and diverse approaches (e.g. engagement of community groups and Indigenous partnerships). The plan will set out a future path to develop, maintain and make available national standards; increase their uptake; and assess effectiveness and impact as related to the delivery of priority monitoring activities.
2.4	Ecological outcomes of wastewater discharges in contrasting receiving environments	With about 85% of Australians living near a coast, the chemicals we use on land can pollute our estuaries and oceans. Household wastewater is cleaned by wastewater treatment plants before being discharged to the ocean. No treatment system is perfect, however, and residual chemicals can persist in discharged water. Depending on the prevailing ocean currents and water residence time, they may accumulate and reach concentrations that can reduce water quality and affect the health of the marine ecosystem. Currently, we have little understanding about which contaminants are entering our oceans, what concentrations they are found in, and what effects they have on marine plants and animals. This project aims to determine the concentration of emerging pollutants in different wastewater outfall settings and assess where environmental impacts are greatest. It follows a Marine and Coastal Hub scoping study (Project 1.16) that engaged stakeholders from around Australia in identifying and prioritising concerns about threats to water quality, including chemicals of emerging concern. The study identified a need for data on environmental concentrations of emerging contaminants and an assessment of their impact on ecological communities.

IP2.02.02: Finding fit for purpose technological recycling solutions for regional and remote communities across Australia

The problem

As defined using the Australian Statistical Geography Standard (ASGS) categorisation[1], regional and remote communities struggle with finding *fit for purpose* solutions to address fundamental waste problems. Regional and remote locations present several unique challenges in managing waste, dealing with seasonal weather-driven isolation, and a lack of connection to major roads or towns. In many cases, regional and remote areas often lack kerbside waste collection and access to recycling and re-manufacturing centres[2]. There has been significant work undertaken previously by several organisations to understand the complexities of the challenges and make recommendations for how best to address them[3].

The Department identified trialling regional and remote waste management solutions as a priority for the SCaW Hub to address. Parks Australia noted the impacts unmanaged waste was having in Commonwealth Managed National Parks, including the socio-economic challenges it created for resident Indigenous communities and the resulting effects on well-being and the environment and the challenges in remote islands.

From the co-design process undertaken with other stakeholders in 2021, the following challenges were also identified concerning regional and remote communities and waste management:

- Economies of scale and lack of existing infrastructure (lack of current recycling infrastructure as well as lack of transport and logistics) in regional and remote locations
- Lack of markets locally for waste materials
- Lack of incentives for recycling to reduce landfill
- Links between socio-economic problems experienced by some communities and the volume of waste in the community
- Lack of engineering or technical capability/jobs in communities, particularly for youth
- The complexity of different waste materials, e.g., solar panels, treated pine and agricultural waste, tyres, old batteries, metals, plastics, glass, and textiles

Our response

Building on the findings and using the recommendations from previous studies on how to address waste in regional and remote settings, this project seeks to identify and trial fit for purpose

[1] Refer https://www.abs.gov.au/ausstats/abs@.nsf/mf/1270.0.55.005 for definition of regional and remote

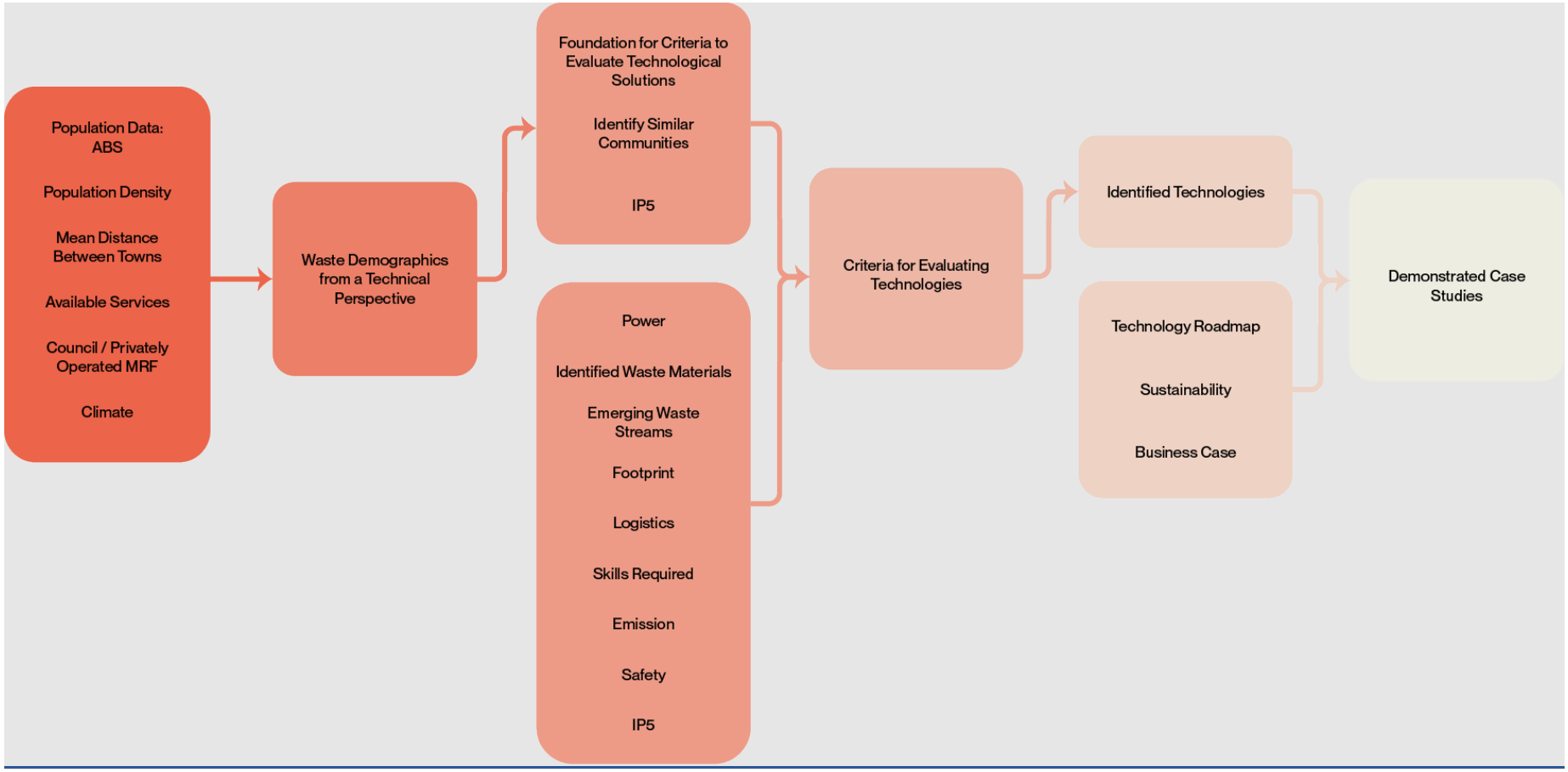
[2] Refer https://www.awe.gov.au/environment/protection/waste/how-we-manage-waste/recycling-modernisation-fund/supporting-waste-infrastructure-regional-remote

[3] Previous work includes Australian Local Government Association (2018) Submission to the Department of the Environment and Energy: In response to the review of the Product Stewardship Act. August 2018; Infrastructure Australia (2021) 2021 Australian Infrastructure Plan; Local Government Association of Queensland (LGAQ) (2021); Queensland Indigenous Waste Strategy: Respecting Country - A sustainable waste strategy for First Nations communities; NACCHO (2020) Submission to House of Representatives Standing committee on Industry, Innovation, Science and Resources into Australia's waste management and recycling industries. Submission Number 223. Downloaded 19 October 2021. Pp1-8; North Queensland Regional Organisation of Councils (NQROC) (2020); North Queensland Waste and Resource Recovery Strategy 2020-2030. October 22, 2020; Northern Territory Environment Protection Australia (NTEPA) (2015) Waste Management Strategy for the Northern Territory 2015-2022.; Productivity Commission (2021) Right to Repair – Draft Report; RDATN feasibility study: https://www.rdatropicalnorth.org.au/about/initiatives/fnq-plastics-industry-proposal/.

technological recycling solutions, utilising ‘hub and spoke’ models for remote/very remote, inner and outer regional communities across Australia.

We will evaluate and investigate suitable technologies available for regional and remote communities to cost effectively address waste management. A framework for the Circular Economy will be designed to create the foundation for how different technologies will impact a community at different stages of the circular framework. A set of criteria will be co-designed with representative regional and remote communities, states, territories and federal government, and business and industry stakeholders to account for waste demographics (how waste relates to populations, densities, and distributions in different geographic settings). The technologies will then be benchmarked against the agreed criteria. Three demonstration case studies over the life of the project will be undertaken, working with local communities (including Indigenous) in regional and remote settings with different waste demographics to identify and trial fit for purpose solutions. These case studies will include identification of materials supply networks to create sustainable businesses and technologies that provide local jobs and sovereign capability. Lessons learned, key findings and stories will be captured and shared on the Hub Portal (to be confirmed) or alternative. A 'one-stop-shop' solution will be provided for local communities through that portal to be able to provide guidance on available fit for purpose solutions that address their context and waste stream problems. Data relevant for impact and measuring success will be shared in consultation with the Data Wrangler and Knowledge Broker. Broad engagement across the SCaW Hub will be undertaken to consider findings, working closely over the life of the project with researchers in IP5 as they develop socio-economic metrics for sustainable solutions for regional and remote communities (IP5.02.03).

Methodology



RP2022 Activities and methods

A comprehensive co-design process was undertaken with key stakeholders to **develop and define a waste demographics framework for regional and remote communities.** This process included using interactive data interrogation tools to inform the development of a waste demographic framework and a series of workshops with key stakeholders from government, industry and regional and remote communities to understand priorities and challenges. An initial information primer was prepared in advance of the co-design workshop. The findings were summarised in a report to inform the metrics identified for undertaking a technology solutions evaluation.

Outputs

1) Yearly progress report for the Department and other research-users summarising progress and results. For 2022, this included the waste demographic framework for regional and remote communities using the Australian Statistical Geography Standard (ASGS) categorisation. A summary of key findings from the co-design workshops with regional and remote communities was included. Account for networked governance in Indigenous communities.
2) Factsheets and other communication tools about the project.

Outcomes and Impact

- Identification of the needs of regional and remote communities and a framework to categorise similar communities in terms of demographics and needs/priorities.

RP2023 Activities and methods

Evaluation of technology - The co-design process continued with key stakeholders to develop and define criteria (metrics) to evaluate available and emerging fit for purpose technologies. This was informed by a literature review (looking at the academic- and industry- published expert reports) and stakeholder co-design workshops.

Design of a local council "one stop shop" portal - This included a follow-up workshop with key stakeholders to present the result of the technology evaluation and identify how and what information should be presented that will be of most use (user requirements) in a public facing portal. In addition, through creating a regional and remote 'community of practice', project stakeholders involved in the co-design process were encouraged to share their solutions and technology they have identified for particular waste streams. This will also feed into the Annual Technology Forecast (below) and ongoing updates to the technology evaluation over the coming years.

Identification and commencement of demonstration case studies - Coming out of the co-design process from 2021 as well as in 2022, it is expected that 3 demonstration case studies will be identified, targeting firstly remote/very remote, then inner regional and outer regional communities, using the Australian Statistical Geography Standard (ASGS) categorisation.

Ongoing technical support will be provided to each group to assist in understanding the needs of the community to ensure that the solutions sought will be fit for their purposes and to support them through their implementation journey. At this early stage, lessons learned and stories relating to planning will be captured and included in consultation with the Data Wrangler. Demonstration case study 1 will commence in 2024 (location to be determined),

with a focus on planning and enabling activities. Demonstration case studies 2 and 3 will be identified and preliminary co-design commence with communities.

Annual Technology Forecast – A technical survey for the Annual Technology Forecast was prepared to summarise current and emerging technologies for the solutions being identified for the demonstration case studies and of relevance to other communities with similar waste demographics. The final forecast will also identify emerging waste streams that may become problematic.

Outputs

1) Yearly progress report for the Department and other research users summarising progress and results of the multi-year project. For 2023, this will include findings relating to:
    - Criteria (metrics) to evaluate technologies.
    - A synthesis of existing waste demographic frameworks and metrics
    - Evaluation of technologies
    - User requirements for a *one-stop-shop* for local governments
    - Co-design outcomes
2) Demonstration of case study 1 - Remote Community Project Progress Report (to be submitted as a separate document)
    - Summary of the results from the first demonstration case study
    - Identification of challenges and potential solutions going forward
    - Analysis of potential locations for demonstration case studies 2 and 3
    - One page Impact summary on the current progress for case study 1
3) Annual Technology forecast for evaluated technologies.
4) Fact Sheets and other communication tools about fit for purpose technologies for different waste demographic settings.

Outcomes and Impact

- A national framework for identification and evaluation of fit for purpose technological recycling solutions for regional and remote communities
- Provision of information for local governments to inform decision making around waste management in regional and remote communities
- Commencement of demonstration case study with a remote Indigenous community that will provide the *ground-truthing* for solutions and provide lessons learned and stories to build the capacity of other communities.

<u>RP2024 Activities and methods</u>

An update of the evaluation of technology was undertaken and reviewed by stakeholders.

Demonstration case study 1- remote implementation - Working with Indigenous community partners, support will be provided to implement the first demonstration case study. This could include assistance in business case development, feasibility studies,

proposal preparation to access grants, and technical support and training to implement solutions. Lessons learned and stories will be captured and may be incorporated into the ACE Hub Portal or disseminated into a summary report for stakeholders. Materials supply networks will also be mapped for demonstration case study 1 to understand sources of materials and markets to sell products produced. A life-cycle assessment (LCA) of the carbon benefit/impact will be undertaken.

A co-design process to plan demonstration case studies 2 – inner regional, and 3 – outer regional will continue this year, with commencement of both projects towards the end of this year. The materials supply network mapping and a life-cycle assessment for demonstration projects 2 and 3 will also be undertaken.

Annual technology forecast - The Annual Technology Forecast was refined and updated to reflect changes to current and emerging technologies for the solutions being identified for the demonstration case studies. A Circular Economy Technology framework was developed to form part of the foundation for how these technologies were categorised. Workshops were held with industry, council and researcher representatives from regional NSW to discuss the shift from linear to circular economies from a remote and regional context. This will be further developed with future workshops following feedback from the workshop. The forecast also identified emerging waste streams that may become problematic for other regional and remote communities.

In addition to the broader research goals, the research outputs for RP4 were designed to support the Recycling Modernisation Fund (RMF) priorities. For example, an increase in focus on facilitating Technosphere solutions in regional and remote communities where kerbside recycling does not exist for mainstream waste material i.e. focus on materials that would normally be managed via kerbside collection in urban areas such as plastics, paper and cardboard, glass.

Prioritise remote communities where waste disposal by pit burning was the primary end-of-life outcome.

Outputs

1) Yearly progress report for the Department and other research users summarising progress and results.
2) Produce a factsheet to illustrate methodology to identify locations.
3) To identify stakeholders and providers willing to partner with government to invest in recycling infrastructure in these communities.
4) Identify number of relevant skilled work force available in remote communities, number of jobs that could be created and cost to upskill if required.
5) Demonstration case study 1 - Remote Community Project Progress Report
6) Demonstration case study 2 – Inner Regional Community Project Progress Report
7) Demonstration case study 3 – Outer Regional Community Project Progress Report
8) Annual Technology forecast for evaluated technologies.
9) Fact Sheets and other communication tools about on fit for purpose technologies for different waste demographic settings.

Outcomes and Impact

- Provision of information for local governments to inform decision making around waste management and circular economy in regional and remote communities.
- Practical demonstration case studies (communities) that will provide the *ground-truthing* for solutions and provide lessons learned and stories to build the capacity of other communities.

RP2025 Activities and methods

An update of the technology evaluation will be undertaken for review by stakeholders.

Demonstration case studies 1, 2 and 3 implementation - Learnings and feedback from demonstration case study 1 will continue to be captured. Working with community partners, support will be provided to implement the second and third demonstration case studies targeting different waste demographics, for inner and outer remote communities. This work could include assistance in business case development, feasibility studies, proposal preparation to access grants, and technical support and training to implement solutions. Lessons learned and stories will be captured and may be incorporated into the ACE Hub Portal or disseminated into a summary report for stakeholders.

Annual technology forecast – The Annual Technology Forecast will be refined and updated to reflect changes to current and emerging technologies for the solutions identified for the demonstration case studies. The Circular Economy Technology framework will continue to be developed through co-design and workshopping with relevant stakeholders. Workshops will be run that will build upon the co-design work from RP2024 around circular economies and the regional context. It will also identify emerging waste streams that may become problematic for other regional and remote communities. The technology forecast will be presented through a “one-stop-shop” web portal that will enable councils to view technologies, share their experiences and interact with the technology framework.

Outputs

1) Yearly progress report for the Department and other research users summarising progress and results.
2) Demonstration case study 1 - Remote Community Project Progress Report
3) Demonstration case study 2 – Inner Regional Community Project Progress Report
4) Demonstration case study 3 – Outer Regional Community Project Progress Report
5) Annual Technology forecast for evaluated technologies
6) Fact Sheets and other communication tools about on fit for purpose technologies for different waste demographic settings

Outcomes and Impact

- Provision of information for local governments to inform decision making around waste management and circular economy in regional and remote communities.
- Practical demonstration case studies (communities) that will provide the ground truthing for solutions as well as provide lessons learned and stories to build the capacity of other communities.

RP2026 Activities and methods

Ongoing support will be provided to all three demonstration case studies with learnings and feedback captured.

An update of the technology evaluation will be undertaken for review by stakeholders.

The Annual Technology Forecast will be refined and updated to reflect changes to current and emerging technologies for the solutions identified for the demonstration case studies. It will also identify emerging waste streams that may become problematic for other regional and remote communities.

A national symposium will be undertaken for local governments and other stakeholders to share the findings of the projects, experiences, and lessons learned.

Outputs

1) Final report for the Department and other research users summarising progress and results.
2) Demonstration case study 1 - Remote Community Project Final Report
3) Demonstration case study 2 – Inner Regional Community Project Final Report
4) Demonstration case study 3 – Outer Regional Community Project Final Report
5) Annual Technology forecast for evaluated technologies
6) Fact Sheets and other communication tools about on fit for purpose technologies for different waste demographic settings
7) Handbook for local governments on implementing fit for solutions for various waste streams identified
8) Policy guidance document for the Department and State and Territory Governments on addressing regional and remote waste management across Australia (developed in collaboration with IP5.02.03)
9) National Symposium.

Outcomes and Impact

- Provision of information for local governments to inform decision making around waste management and circular economy in regional and remote communities.
- Demonstration case studies (communities) that will provide the *ground-truthing* for solutions and provide lessons learned and stories to build the capacity of other communities
- Improved information to inform national and state, and territory policy responses.

Linkages

This project aligns with IP5.02.03, "*Governing Regional Community Based Resource Recovery and Circular Economy Initiatives*", due to the focus on local-scale community-based initiatives.. IP2 will work across the SCaW Hub with IP Leaders to ensure coordination and maximise opportunities where activities and budgets allow, particularly given its community-driven approach.

IP2.05.03 Creating value from metals and alloys of waste solar panels: Technological roadmap to capture economic benefits and lower carbon emissions

Overview

This project aims to develop a sustainable and economically viable roadmap, for recycling end-of-life (EoL) solar panels aligning with principles of circular economy. The roadmap guides the likely commercialisation of current lab-scale waste photovoltaics (PV) recycling technologies, focusing on identifying scalable technologies over the next 5-10 years and analysing how the commercialisation of these technologies may impact costs, revenues, output quality, and overall sustainability in the recycling of metals from end-of-life solar panels. The project focuses on advanced recycling techniques of metals to address the challenges posed by their complex material composition. These methods aim to identify the technologies and strategies for selectively recovering high-value materials such as silver, copper, aluminium, silicon, and glass while enabling the creation of value-added products, including silicon carbide, ferrosilicon and other alloys and high-purity silver powder. By prioritising efficient and cost-effective recovery processes that help realise the highest value of materials, the project seeks to contribute to a resilient circular economy.

The five-phase roadmap integrates technical, environmental, and economic considerations, ensuring adaptability for both short-term (less than five years) and long-term (more than five years) implementation. It emphasises selective material recovery, maintaining high standards for reclaimed materials, and tailoring processes to meet the needs of diverse contexts, including emerging technologies in urban and regional areas. By evaluating the cost and efficiency of advanced recycling methods, the project evaluates scalability for commercial adoption and alignment with Australia’s sustainability goals. Two key objectives of this project include: (1) developing and validating advanced technologies to reduce reliance on virgin materials, and (b) promoting economic growth through green job creation and sustainable industrial practices.

The outcomes of this project will directly address the growing solar panel waste challenge in Australia by providing scalable recycling solutions, resulting in high-purity of recovered materials. These innovative approaches will enable the use of recovered materials in high-demand sectors such as additive manufacturing, electronics, and steelmaking. Ultimately, this initiative will robustly assess the lasting impacts of these recycling approaches on sustainable waste management, enhancing Australia’s transition to a low-carbon, circular economy and supporting efforts to achieve net-zero emissions by 2050.

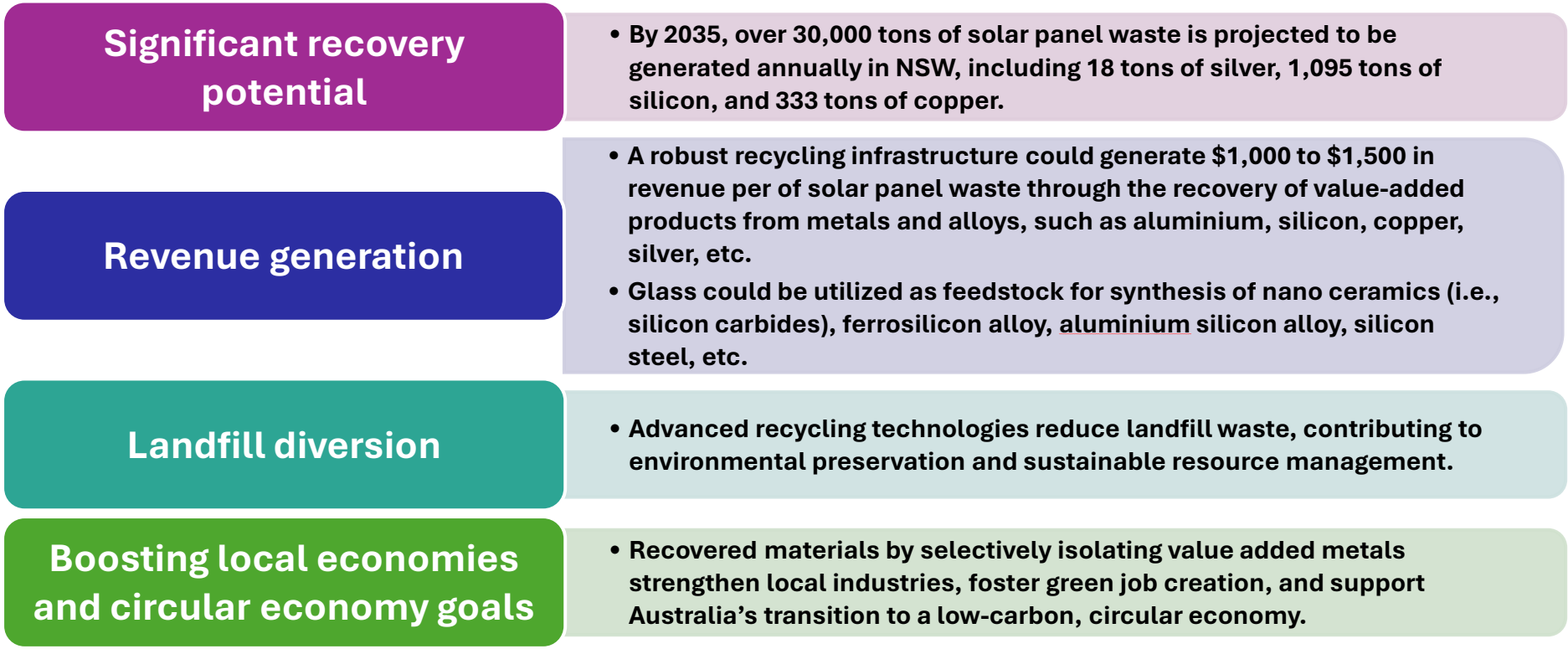


Figure. Technical, economic and environmental benefits of advanced metal recycling from waste solar cells.

Challenges

Recycling EoL solar panels aiming high value added material recovery involves several interconnected technical and regulatory challenges, which must be addressed to establish a sustainable and efficient recycling roadmap.

***Complex material composition**:* Solar panels contain a mix of valuable metals and alloys, such as silver, copper, aluminium, and silicon, embedded within complex layers. Efficiently recovering these materials while maintaining their quality is critical to sustainable recycling. However, achieving high recovery rates is challenging due to the tight integration of these metals with other components and their dispersion in small quantities. This complexity underscores the need for advanced separation and processing technologies.

Extracting trace metals: Trace metals, particularly silver, account for a significant portion of the economic value of solar panels despite their minimal weight. For instance, silver comprises only 0.06% of a panel's mass but contributes to 47% of its economic value. Conventional recycling processes struggle to efficiently isolate such valuable trace metals without contamination. To overcome this, the project will investigate advanced processes that enable selective recovery of metals to achieve high purity, while minimising energy consumption and environmental impact in general. These innovative approaches will enhance the reuse of recovered metals in high-value applications such as additive manufacturing and electronics.

Ensuring quality and preventing downcycling: Maintaining the quality of recovered materials is essential to their reintegration into high-value manufacturing. Metals extracted from EoL solar panels must meet strict industry standards to avoid downcycling, where recycled materials are relegated to lower-grade applications. This project will incorporate robust quality control measures throughout the recycling process to ensure that recovered metals, alloys, ceramics and glass retain their original mechanical and chemical properties, enabling their reuse in high-demand sectors such as additive manufacturing, electronics, and steelmaking.

Scalability and adaptability: Developing scalable solutions that are adaptable to diverse geographic contexts is critical. While this project focuses on advanced technologies for material recovery, it acknowledges the need to tailor recycling strategies to meet the needs of both urban and regional areas. Scalable recycling models must account for varying technological, economic, and operational requirements, ensuring equitable access to recycling infrastructure across Australia.

By addressing these challenges, this project will establish a scalable and adaptable roadmap for solar panel recycling. The outcomes will promote efficient recovery of high-value materials, and contribute to both economic growth and environmental sustainability, supporting Australia's transition to a circular economy.

Figure. Challenges and opportunities in creation value from metals of PV waste.

Aims and objectives

(a) Prioritising technologies for efficient recovery of high-value metals and alloys and approaches for mobilisation

This project aims to develop a roadmap providing specific inputs on types of effective and suitable technologies and models for scalability for recovering high-value metals and alloys from EoL solar panels. With the growing volume of solar panel waste, the project focuses on advanced methods for transforming materials such as silver, copper, aluminium, and silicon into valuable resources. Emphasis will be placed on processes that ensure high-purity recovery, enabling their reintegration into high-performance industries like additive manufacturing, electronics, and steelmaking.

(b) Encouraging material recovery focusing on value creation

A key aim of the project is to ensure that recovered materials meet stringent industry standards for use in high-value applications. Maintaining the quality and mechanical properties of these materials is essential to prevent downcycling, where recycled materials are restricted to lower-grade uses. In certain instances, reuse can be a viable alternative. Quality control measures will be introduced throughout the recycling process, ensuring that reclaimed materials, such as silicon carbide, ferrosilicon, and high-purity silver powder, retain their original value for applications in additive manufacturing, 3D printing, electronics, and steelmaking (as ferrosilicon alloys).

(c) Proposing emerging approaches for urban and regional recycling

This project explores emerging approaches to address the unique challenges of recycling solar panels in both urban and regional contexts. It focuses on identifying adaptable and scalable technologies that can be implemented effectively across diverse geographic settings. The aim is to ensure solar panel recycling solutions are inclusive and economically viable, promoting advanced recovery practices that integrate seamlessly into the circular economy. By tailoring approaches to the specific conditions of urban and regional areas, this project seeks to deliver sustainable outcomes for all communities.

(d) Developing an integrated roadmap for advanced material recovery

The aim of this project is to create a roadmap that connects advanced technologies, recovered materials, and their market value to enable large-scale recycling and remanufacturing in Australia. This roadmap will focus on the viability of both lab-scale and commercial technologies (for the short-term (less than 5 years) and long-term (more than 5 years), ensuring alignment with environmental, economic, and quality goals. Principles of circular economy will underpin the roadmap, enabling the regeneration of materials for reuse across diverse supply chains and markets.
By developing a roadmap that integrates advanced recycling technologies and focuses on creating high-value materials from complex waste, this project will reduce environmental impacts, decrease reliance on virgin materials, and foster economic growth through green jobs and sustainable practices. A proof of concept will demonstrate recycling solutions for end-of-life (EoL) solar panels, highlighting the value of recovered materials such as silicon, glass, and metals, and the emissions reductions achieved through these processes. This comprehensive approach will encourage the adoption of sustainable, technological solutions which are readily adoptable in markets, supporting Australia's transition to a circular economy.

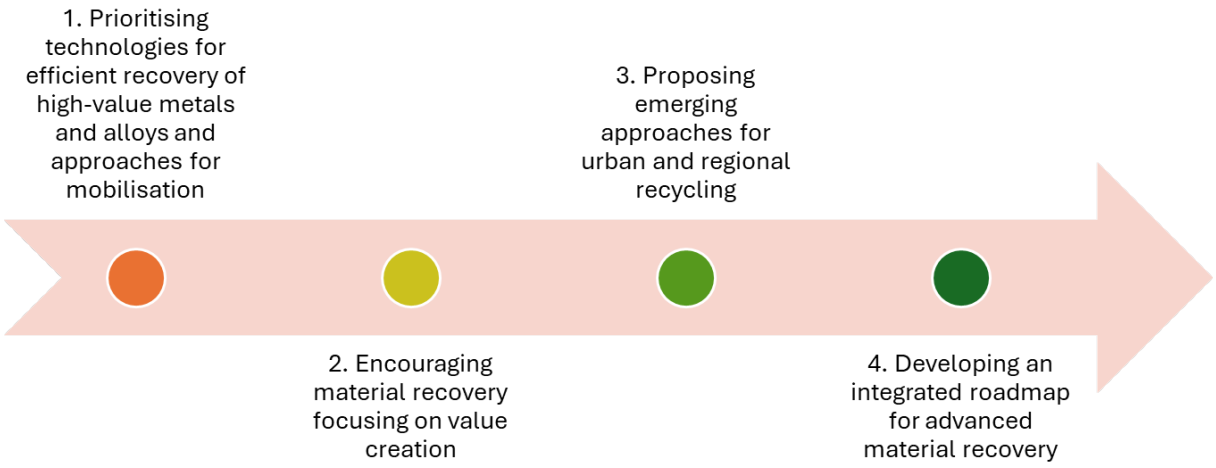


Figure. Ultimate aims in value creation from waste PV.

Throughout the project, we will engage with various communities and organisations through workshops and other engagements with the support of stakeholders across Australia, including Aboriginal and Indigenous groups, as well as communities involved in different aspects of solar panel management. Our aim is to seek their feedback on the project outcomes and to ensure they are informed about the findings of this research. We have already identified several key communities and organisations for engagement, including: (a) FNQ Regional Organisation of Councils (FNQROC), Cairns, QLD; (b) Agency Projects, Melbourne, VIC; (c) New England Renewable Energy Zone, NSW. Additionally, we will continue to expand our outreach by engaging with other relevant stakeholders and exploring potential collaboration with the recommended networks. This approach ensures that Indigenous and regional communities remain actively involved in discussions around solar panel waste management and that they receive relevant project updates and findings in a meaningful and accessible way.

Background

The rapid expansion of the solar energy industry has significantly increased the demand for solar panels, resulting in a corresponding rise in solar panel waste. According to projections, solar panel waste in Australia will grow from 17,000 tonnes in 2020 to approximately 145,000 tonnes by 2030 and could reach 450,000 tonnes by 2040. This surge in EoL solar panels presents both a challenge and an opportunity for sustainable resource management. Currently, less than 5% of solar panel waste in NSW is being recycled, with most waste either exported or sent to landfills despite containing valuable materials like silver, aluminium, and silicon.

A typical solar panel comprises around 70% glass, 18% aluminium (primarily in the frame), 6.6% polymers, 3.6% silicon, 1% copper, and 0.6% other metals, including valuable elements such as silver and tin. These panels contain approximately 5-6% metals by weight, contributing to over 65% of the economic value of the panel's components. Although these metals are embedded in small quantities, their recovery is economically viable. For example, silver, which makes up only 0.06% of the panel's mass, accounts for nearly half (47%) of its economic value. Other critical materials such as copper, aluminium, and silicon also provide significant revenue potential.

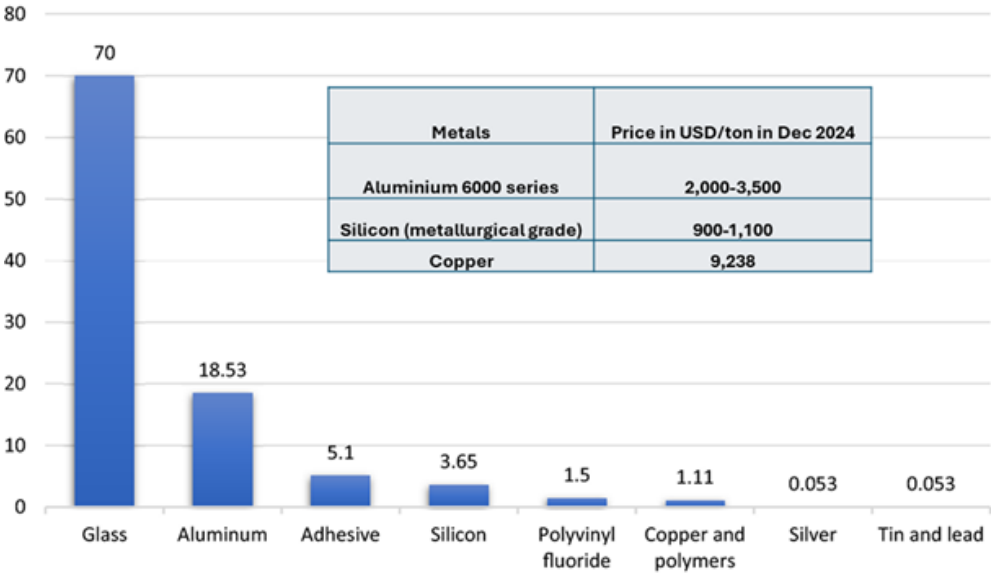


Figure. Typical weight percent of components of photovoltaic module

Australia's existing recycling infrastructure faces several challenges in processing EoL solar panels effectively. Current systems often focus on recovering glass and aluminium frame and junction box, leaving valuable metals underutilised. Moreover, the absence of well-established recycling guidelines and economic incentives limits the development of advanced metal recovery processes. As solar panels near the end of their operational life, new strategies for reclaiming these valuable materials are urgently required to align with Australia's circular economy goals.

This project aims to bridge these gaps by robustly assessing innovative metal and glass recovery processes to selectively extract metals like silver, aluminium, copper, and silicon from solar panel waste, along with advanced methods for recovering glass. Reusing can serve as a viable alternative. These processes will enable the recovery of high-purity materials that can be reintroduced into manufacturing industries, such as additive

manufacturing, 3D printing, iron and steelmaking (ferrosilicon production), energy storage applications, and electronics. By developing a road map for advanced recycling techniques in the short and long term, the project seeks to maximise economic returns while reducing environmental impacts by minimising the need for virgin material extraction and safely isolating hazardous materials for reuse.

The economic benefits of advanced metal recycling are substantial. By 2035, it is estimated that over 30,000 tonnes of solar panel waste will be generated annually in NSW. Recovered materials from these panels, including an estimated 32 tonnes of silver, 1,967 tonnes of silicon, and 247 tonnes of copper, offer significant potential for economic growth. Market projections suggest that a robust recycling infrastructure could generate $1,000 to $1,500 in revenue per tonne of solar panel waste, driven by the recovery of valuable metals and alloys. This recycling process not only reduces landfill use but also creates economic opportunities by supporting local industries and green job creation, fostering economic growth across Australia. Aligning with the NSW Waste and Sustainable Materials Strategy 2041, the project will demonstrate the value of integrating advanced and/or emerging recycling technologies into Australia's waste management practices. By considering the broader opportunities for material recovery, this initiative aims to drive the adoption of sustainable practices, support local economies, and contribute to Australia’s transition to a circular economy.

Research approach/plan

Conceptual/Theoretical Framework

The core conceptual framework of this project is centred around the principles of circular economy that leads to sustainable resource management practices, with a focus on investigating advanced and economically viable methods for recovering high-value metals and developing value-added materials from EoL solar panels. Unlike conventional recycling methods that prioritise bulk recovery of all elements together, this project emphasises selective material recovery to maximise economic and environmental benefits. The approach promotes the reuse of secondary raw materials, reducing reliance on virgin resources and preventing valuable materials from entering landfills.

The main innovation outcomes that contribute to this project comes from advanced material separation techniques (in both commercial and lab-scale stages) that enable the selective isolation of high-purity silicon, copper, silver, aluminium, and glass. By integrating concepts from industrial ecology, the project ensures that recovered materials meet stringent quality standards and can be reintegrated into high-value industries such as additive manufacturing, electronics, and steelmaking. These methods provide a pathway to develop innovative materials, including silicon carbide, ferrosilicon, and high-purity silver powder, supporting high-performance applications and enhancing market readiness.

This project also explores the applicability of emerging technologies to recycling challenges across diverse regions. While the focus remains on advanced recovery techniques, it acknowledges the need to adapt technologies to suit the varying conditions of urban and regional settings. By leveraging scalable solutions, the project aims to ensure inclusivity and adaptability for recycling practices nationwide.

The framework seeks to establish a robust roadmap for achieving sustainable recycling outcomes by:

- Exploring the methods to extract the highest-value materials from waste solar panels.

- Investigating the advanced remanufacturing processes that result in low greenhouse gas (GHG) emissions
- Integrating circular economy principles for the recovery of materials like silicon, silver, copper, aluminium and glass, with a focus on high-demand markets
- Supporting a circular economy for materials like silicon, silver, copper, aluminium, and glass, with a focus on integration into high-demand markets
- Offering the most efficient short-term (less than 5 years) and long-term approaches (more than 5 years) for recycling of end-of-life solar panels

The outcomes will serve as a foundation for reducing environmental impacts, fostering economic resilience, and advancing the technological capabilities needed to address the growing volume of EoL solar panels.

Design and Methods

This project adopts a comprehensive, five-phase approach to develop a structured roadmap for the sustainable recycling of EoL solar panels, and resuing in certain cases. The focus is on investigating advanced and economically viable methods for recovering high-value metals and developing value-added materials, aligned with the principles of circular economy. All phases contribute to creating a practical roadmap with guidelines for technical, economic, and environmental aspects, ensuring scalability and adaptability for large-scale implementation.

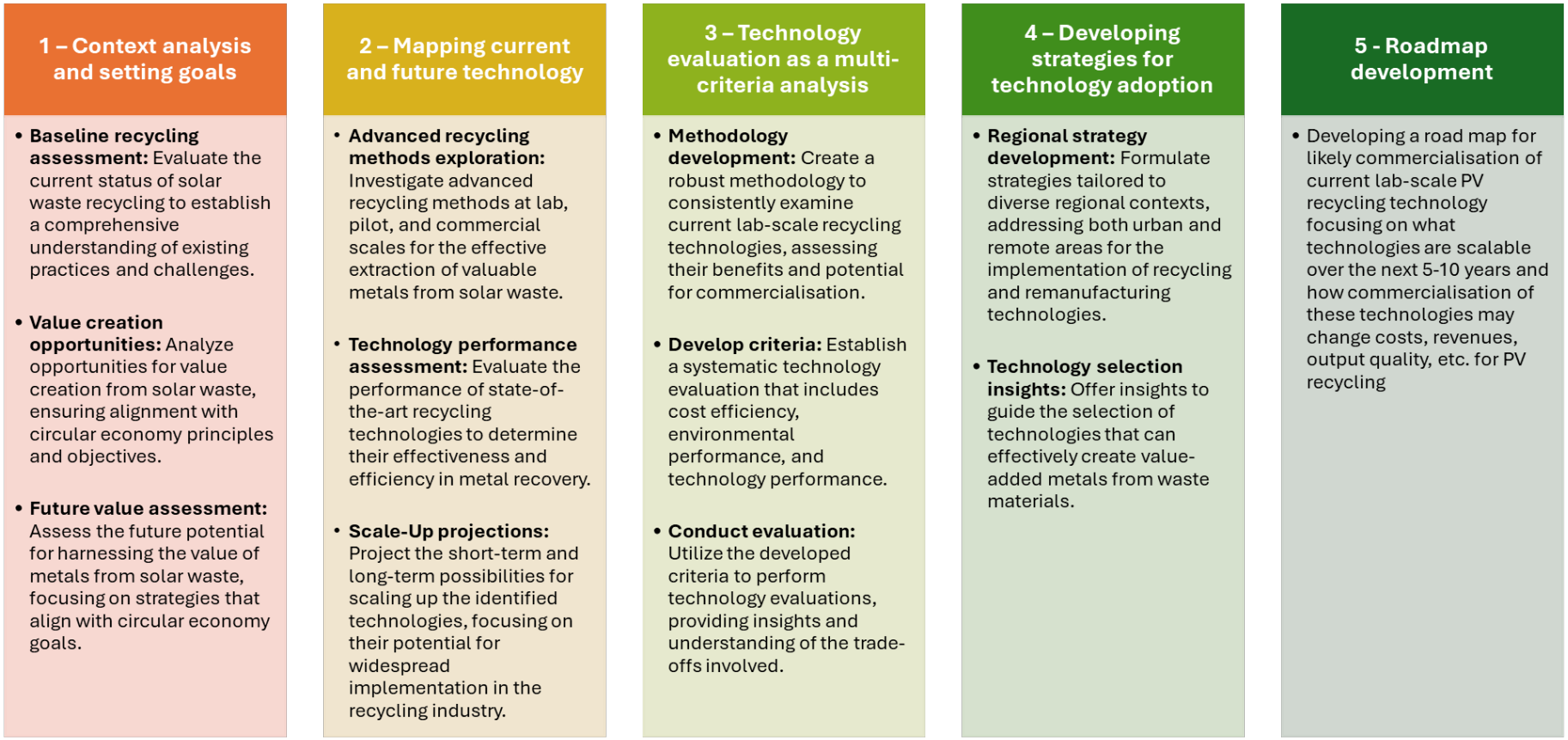


Figure. Phases and activities of the project to develop a roadmap.

Table. Output of each phase

Phases	**1 – Context analysis and setting goals**	**2 – Mapping current and future technology**	**3 – Technology evaluation as a multi-criteria analysis**	**4 – Developing strategies for technology adoption**	**5 - Road map development**
Outputs	Workshop for co-design of future pathways value-added metal recovery	Report on evaluation of advanced recycling and remanufacturing technologies (lab, pilot, and commercial scales) for value-added metals (metallurgical grade silicon, aluminium 6000 series, copper, silver, etc. and nano metals).	Co-design workshop with the stakeholders and experts to gather insights on criteria development for evaluation Report on robust evaluating technologies using multiple criteria on cost-competitiveness, environmental and technology performance	Workshop with the stakeholders and experts to gather insights on evaluating strategies for uptake and integration	A comprehensive report on the proposed roadmap and recommendations for technology implementation

This five-phase roadmap ensures the development of actionable solutions to address the technical, economic, and environmental challenges associated with solar panel recycling. The roadmap will guide stakeholders in maximising material recovery, minimizing environmental impacts, and advancing a circular.

Is this a cross-hub project?

IP2.02.01: Yes

Preliminary conversations have been held to discuss the direct links for this project to the Marine and Coastal Hub, primarily relating to IP2.02.01 on microplastics. There are strong linkages in working together to understand how materials such as plastics and tyres degrade over time and impact on ecosystems and threatened ecological communities and species. This research will contribute to delivering the *Threat Abatement Plan on the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans*.

Preliminary conversations have been held with the IP4 and the Climate Systems Hub and they have confirmed it will be of benefit through improved understanding of the additives and emissions associated with difficult to recycle materials as they degrade, and the emerging risks associated with air pollutants.

Other linkages relating to within the SCaW Hub are outlined above under the project description for each project.

IP2.02.02: No

IP2.05.03: No

Does this project contribute to a cross-cutting initiative?

IP2.02.01: No

IP2.02.02: No

IP2.05.03: No

Indigenous consultation and engagement

Australian Aboriginal and Torres Strait Islander peoples have integral physical and cultural connections with land and sea environments and their sustained protection and care. However, waste streams such as plastics, tyres, glass, metal, and textiles litter the landscape of regional and remote areas of Australia. Based on preliminary discussions during a 2-day workshop with Aboriginal businesses and communities in NSW and Western Australia in 2021, it was identified that these waste streams were growing concerns to the Traditional Owners at those workshops.

The project prioritises meaningful engagement with regional and remote communities, ensuring their active participation in research and decision-making. The project will foster collaboration by integrating traditional ecological knowledge, conducting culturally appropriate workshops, and strengthening communication through Indigenous storytelling (this style could be adopted in the reporting) and by creating factsheets of the reports in a simpler form. By working closely with the government organisation groups such as:

Northern Territory: Land council roles and contacts | NT.GOV.AU
New South Wales: Land Council - NSW Aboriginal Land Council
Queensland: Native title representative bodies | Aboriginal and Torres Strait Islander peoples | Queensland Government
Victoria: Victoria's Registered Aboriginal Parties | aboriginalheritagecouncil.vic.gov.au
Australian Capital Territory: Aboriginal and Torres Strait Islander peoples - ACT Government

We will identify the best approach to communicate about our research programs to different communities and providing appropriate knowledge to the regional and remote communities members on the technological options and recycling for tackling the plastic and solar panel waste. Our aim is to seek their feedback on the project outcomes and to ensure they are informed about the findings of this research. We have already identified several key communities and organisations for engagement, including: (a) FNQ Regional Organisation of Councils (FNQROC), Cairns, QLD; (b) Agency Projects, Melbourne, VIC.

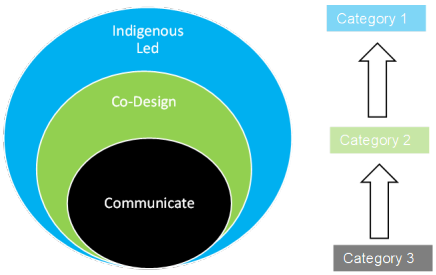
Targeted workshops, reports, and all research outcomes will be showcased on digital platforms, providing a structured way to share research findings and project updates in an accessible and culturally appropriate manner. Ongoing discussions will focus on how Indigenous/regional and remote community’s perspectives can be integrated into both current and future waste management research.

The project's research goals are aligned to the National Environmental Science Program Indigenous partnership principles and the Hub's Indigenous Partnership Strategy, which include respect and mutual benefit, a right to Indigenous cultural and intellectual property, co-created research, Indigenous lead governance, and relationships-focused and an individual approach.

The multi-year sub-projects described in this research plan align with the Communicate category. All projects have been designed in consultation with Indigenous stakeholders and have continued to workshop and communicate with key stakeholders as the project has progressed. This has included Indigenous knowledge leaders, businesses and communities. We plan to continue to progress towards a co-design category by developing governance structures that comply with the three-category approach.

In addition, all project team members are required to undertake the Our Mob cultural awareness training and Indigenous Cultural and Intellectual Property (ICIP) True Tracks training to ensure engagement with Aboriginal and Torres Strait Islander communities is appropriate. The project activities will be co-designed and built on respect and mutual benefit.

Which updated Three-category approach the project meets	**Communicate (3)** ☒	**Co-design (2)** ☐	**Indigenous led (1)** ☐



Project milestones

The following project milestones are specific to RP2025. Each subsequent research plan will elaborate on the annual milestones for multiyear projects.

IP2.02.01: Understanding Microplastics

RP2022

Milestones	Due date	Responsible person
Milestone 1 – IP2.02.02 inception meetings/discussions	30 Jul 2022	**Veena Sahajwalla** / Arthur Wilson
Milestone 2 – Plastic additives report	30 Sep 2022	**Veena Sahajwalla /** Anirban Ghose
Milestone 3 - A progress report of findings to predict microplastic risk for EPBC Act-listed threatened species	30 Oct 2022	**Veena Sahajwalla /**Anirban Ghose
Milestone 4 - A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution	30 Oct 2022	**Veena Sahajwalla /** Anirban Ghose
Milestone 5 – Preliminary RP3 Plan	23 Sep 2022	**Veena Sahajwalla /** Arthur Wilson
Milestone 6 – RP2 Draft report submission	30 Dec 2022	**Veena Sahajwalla /** Arthur Wilson

RP2023

Milestones	Due date	Responsible person
Milestone 1 – IP2.02.01 inception meetings/discussions	30 January 2023	**Veena Sahajwalla** / Anirban Ghose
Milestone 2 – A preliminary report on tyre dust and recommendations for interception pilots	30 June 2023 - Delayed to 30 September 2023	**Veena Sahajwalla** / Anirban Ghose
Milestone 3 – Updated RP4	30 September 2023	**Veena Sahajwalla** / Anirban Ghose
Milestone 4 – A progress report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution	30 October 2023	**Veena Sahajwalla** / Anirban Ghose
Milestone 5 – A final report on microplastic fundamentals	30 November 2023	**Veena Sahajwalla /** Anirban Ghose
Milestone 6 – RP2023 Draft report submissions	30 January 2024	**Veena Sahajwalla** / Anirban Ghose

RP2024

Milestones	Due date	Responsible person
Milestone 1 – IP2.02.01 RP4 review and planning meeting with Departmental Research Users	25 February 2024	Veena Sahajwalla / Anirban Ghose
Milestone 2 – Fact sheet illustrating methodology for identifying locations for case studies	31 March 2024 - Delayed to 31 August 2024	Veena Sahajwalla / Anirban Ghose
Milestone 3 – A report on tyre dust and recommendations for interception pilots	30 June 2024 - Delayed to 31 August 2024	Veena Sahajwalla / Anirban Ghose
Milestone 4 – Updated RP5 co-designed with research users, incorporating Identification and scoping of additional pilot intervention sites	30 July 2024	Veena Sahajwalla / Anirban Ghose
Milestone 5 – A final report on a nationally consistent monitoring system (protocol) and national database for microplastic pollution	30 October 2024	Veena Sahajwalla / Anirban Ghose
Milestone 6 – A plan for interception pilot for synthetic grass	30 November 2024	Veena Sahajwalla / Anirban Ghose
Milestone 7 – RP2024 Draft report submissions	30 January 2025	Veena Sahajwalla / Anirban Ghose

RP2025

Milestones	Due date	Responsible person
Milestone 1 – RP5 review and planning meeting with Departmental Research Users	25 February 2025	Veena Sahajwalla/Rumana Hossain
Milestone 2 – Co-design plan for interception pilot project for microplastic producing precursor materials.	30 June 2025	Veena Sahajwalla/Rumana Hossain
Milestone 3 – A Preliminary report on the plastic consumption and waste generation; identification of polymer types, sources, and recyclates' application sectors in IOT	15 October 2025	Rumana Hossain/Veena Sahajwalla
Milestone 4 – Draft report on synthetic grass interception pilot study	30 October 2025	Veena Sahajwalla/Rumana Hossain
Milestone 5 – Updated research plan for RP6	30 November 2025	Veena Sahajwalla/Rumana Hossain
Milestone 6 – Draft report on microplastics from tyres	15 November 2025	Veena Sahajwalla/Rumana Hossain

Milestone 7 – Final report on microplastics from tyres Final report on synthetic grass interception pilot study	30 January 2026	Veena Sahajwalla/Rumana Hossain
Milestone 8-Final report on the plastic consumption and waste generation; identification of polymer types, sources, and recyclates' application sectors in IOT	30 February 2026	Veena Sahajwalla/Rumana Hossain

RP2026

Milestones	Due date	Responsible person
Milestone 1 – RP6 review and planning meeting with Departmental Research Users	25 February 2026	Veena Sahajwalla/Rumana Hossain
Milestone2 – Report on characterization of used vaping devices.	30 July 2026	Veena Sahajwalla/Rumana Hossain
Milestone 3 – Draft preliminary report on waste generation and plastic waste management challenges (regulatory and others) and circular economy of plastic waste for IOT.	30 August 2026	Veena Sahajwalla/Rumana Hossain
Milestone 4 – Draft synthesis report on IP2.02.01 detailing outcomes from pilot interventions and next steps	15 September 2026	Veena Sahajwalla/Rumana Hossain
Milestone 5 – Final synthesis report on IP2.02.01	30 November 2026	Veena Sahajwalla/Rumana Hossain
Milestone 6 – Final report on waste generation and plastic waste management challenges (regulatory and others) and circular economy of plastic waste for IOT	15 December 2026	Veena Sahajwalla/Rumana Hossain

IP2.02.02: Finding Fit for Purpose Technological Recycling Solutions for Regional and Remote Communities Across Australia

RP2022

Milestones	**Due date**	**Responsible person**
Milestone 1 – IP2.02.02 inception meetings/discussions	30 Jul 2022	Veena Sahajwalla / Arthur Wilson

Milestone 2 – Yearly progress report for the Department and other research users summarising progress and results	30 Oct 2022	Veena Sahajwalla / Arthur Wilson
Milestone 3 – Preliminary RP3 Plan	23 Sep 2022	Veena Sahajwalla / Arthur Wilson
Milestone 4 – RP2 Draft report submission	30 Dec 2022	Veena Sahajwalla / Arthur Wilson

RP2023

Milestones	Due date	Responsible person
Milestone 1 – IP2.02.02 inception meetings/discussions	30 January 2023	Veena Sahajwalla / Anirban Ghose
Milestone 2 – Demonstration of case study 1 – Remote Community Project Progress Report	30 July 2023	Veena Sahajwalla / Anirban Ghose
Milestone 3 – Annual Technology forecast for evaluated technologies	30 September 2023 - Delayed to 30 September 2023	Veena Sahajwalla / Anirban Ghose
Milestone 4 – Fact Sheets and other communication tools about fit for purpose technologies for different waste demographic settings	Ongoing (quarterly)	Veena Sahajwalla / Anirban Ghose
Milestone 5 – RP3 Draft report submission	30 January 2024	Veena Sahajwalla / Anirban Ghose

RP2024

Milestones	Due date	Responsible person
Milestone 1 – RP4 review and planning meeting with Departmental Research Users	30 January 2024	Veena Sahajwalla / Anirban Ghose
Milestone 2 – Demonstration of case study 2 – Remote Community Project Progress Report	30 July 2024	Veena Sahajwalla / Anirban Ghose
Milestone 3 – Annual Technology forecast for evaluated technologies	30 September 2024	Veena Sahajwalla / Anirban Ghose
Milestone 4 – RP4 Draft report submission	30 January 2025	**Veena Sahajwalla / Anirban Ghose**

RP2025

Milestones	Due date	Responsible person
Milestone 1 – RP5 review and planning meeting with Departmental Research Users	25 February 2025	Veena Sahajwalla/Rumana Hossain

Milestone 2 – Demonstration of case study 3 – Remote Community Project Progress Report	30 July 2025	Veena Sahajwalla/Rumana Hossain
Milestone 3 – Annual Technology forecast for evaluated technologies	30 September 2025	Veena Sahajwalla/Rumana Hossain
Milestone 4 – RP5 Draft report submission	30 January 2026	Veena Sahajwalla/Rumana Hossain

RP2026

Milestones	Due date	Responsible person
Milestone 1 – RP6 review and planning meeting with Departmental Research Users	25 February 2026	Veena Sahajwalla/Rumana Hossain
Milestone 2 – Draft synthesis report on IP2.02.02 detailing outcomes from demonstration case studies	15 September 2026	Veena Sahajwalla/Rumana Hossain
Milestone 3 – Final synthesis report on IP2.02.02	30 November 2026	Veena Sahajwalla/Rumana Hossain

IP2.05.03: Creating value from metals and alloys of waste solar panels: Technological roadmap to capture economic benefits and lower carbon emissions

RP2025		
Milestones	**Due date**	**Responsible person**
Milestone 1 -Workshop for co-design of future pathways value added metal recovery	15/09/2025	Veena Sahajwalla/Rasoul Nekouei/Rumana Hossain/Samane Maroufi
Milestone 2 Report on evaluation of advanced recycling and remanufacturing technologies (lab, pilot, and commercial scales) for value-added metals (metallurgical grade silicon, aluminium 6000 series, copper, silver, etc. and nano metals).	15/12/2025	Veena Sahajwalla/Rasoul Nekouei/Rumana Hossain/Samane Maroufi

RP2026		
Milestones	**Due date**	**Responsible person**

Milestone 3 Co-design workshop with stakeholders and experts to gather insights for developing evaluation criteria. Report on evaluation of technologies using multiple criteria on cost-competitiveness, environmental and technology performance.	15/12/2025	Veena Sahajwalla/Rasoul Nekouei/Rumana Hossain/Samane Maroufi
Milestone 4 -Workshop with the stakeholders and experts to gather the insights on evaluating strategies for uptake and integration	15/06/2026	Veena Sahajwalla/Rasoul Nekouei/Rumana Hossain/Samane Maroufi
Milestone 5 A comprehensive report on proposed roadmap for technology implementation strategies to create circular materials from waste and lower carbon emissions	15/12/2026	Veena Sahajwalla/Rasoul Nekouei/Rumana Hossain/Samane Maroufi

Data and information management

The information presented below is specific to RP2025. For each stage of a multiyear project, the table will be updated to reflect the specific outcomes.

Knowledge products, co-designed with stakeholders and the Hub knowledge broker, that are generated through the project phase may be made publicly available through the Hub website, and in accordance with the Hub data management and communications strategies, and subject to ethics approvals and any relevant Indigenous Cultural and Intellectual Property (ICIP) arrangements. The co-design process identified, and will continue to identify, detailed knowledge products to be delivered over the life of the projects and detailed data and information management plans will be developed for each of these. The data products developed through RP2025 and beyond will be co-designed with the Data Wrangler and Knowledge Broker to meet the FAIR and CARE guiding principles.

Project output	Data management and accessibility
Synthesis report/brief/outcomes reviewing the current state of knowledge on the multiple benefits arising from the project	According to the Hub's data management strategy, information will be made publicly available on website. • It is expected that these will be derived from publicly available information, and there should be limited sensitives
Reports and other written documentation	According to the Hub's data management strategy, information will be made publicly available on-website. • The report / document will be identified by a unique code for identification. Dates and other metadata should follow ISO standards. Key words should also be included in the title and included as 'tags' to improve findability. Metadata should also clearly define the type of document, such as whether it is a report, a fact sheet etc. • The metadata my include a preview picture to improve findability if appropriate. • Each type of document (report, fact sheet, etc) will follow relevant standards in terms of structure, identification, and format. This will streamline how the documents are presented and increase interoperability. • The reports should include publicly available information to prevent sensitive information from spreading and to maximise accessibility. A data usage license should be included on the website and referenced at the beginning of the document to clarify reusability. • Where data cannot be accessed without authorisation, a clearly defined procedure will be outlined to provide a methodology for requesting authorisation and providing the data securely. Specific safeguards will be implemented to protect privacy and data security. A data usage license should be included on the website and referenced at the beginning of the document to clarify reusability. • A separate spreadsheet will be included providing raw data in an organised and clearly defined format, following a selected standard in terms of data organisation and identification. • All documents will be communicated under the relevant sections on the website in consultation with the knowledge broker and communications manager. • A title page should be appended to the beginning of each document, providing detailed metadata including globally unique and persistent identifier, related data spreadsheet with its own

Project output	Data management and accessibility
	unique and persistent identifier, data usage license reference, domain-relevant community standards and detailed provenance. • Indigenous data gathered for regional and remote communities will be co-designed with the Indigenous facilitator to ensure compliance with CARE principles and ICIP.
Annual Technology forecast for evaluated technologies	To ensure proper identification, reusability, and referencing, the Annual Technology Forecast should be accompanied by well-structured metadata, similar to the approach used for data management and the accessibility of documentation such as reports and fact sheets. Whilst data may not be required to be included via a separate, uniquely identified spreadsheet, appropriate referencing must be included following the same standards as selected for all documentation on the website.

Location of research

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

The majority of work will be undertaken remotely using online facilities to conduct co-design workshops and meetings and desktop-based activities, either at UNSW, Sydney or Curtin University. Where safe to travel and COVID-19 measures are in place, face to face meetings will occur with Indigenous communities and other communities and stakeholders in regional and remote locations. Locations are yet to be determined for the 3 demonstration case studies.

Any prototyping and laboratory work relating to materials analysis will be undertaken at the UNSW Sydney Kensington Campus. Any remanufacturing sample products will occur at the UNSW MICROfactorie, Shoalhaven MICROfactorie and a separate Sydney MICROfactorie.

IP2.02.01 - Understanding Microplastics			
At which spatial scale is the project working	**National** ☐	**Regional** ☐	**Local** ☒
Location(s) – gazetted region /place name	Desktop Studies: UNSW Sydney, Kensington Lab Work: UNSW Sydney, Kensington Field Studies: Currently being codesigned with stakeholders under IP2 The research outputs from IP2.02.01 will be tested at a local and regional scale through pilot interceptions, however the outcomes will have national significance. Microplastics will be collected from various local government areas (LGAs) at NSW and locations across Australia, including UV- and marine-degraded plastics from Adelaide. The collected microplastics will be separated, characterised, and analysed at the SMaRT Centre and UNSW's state-of-the-art facilities. The developed standardised analytical and characterisation techniques, along with the associated protocols and outputs, may be applicable across Australia to enhance the understanding of microplastics.		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Desktop Studies: Eora Nation Lab Work: Eora Nation Field Studies: Currently being codesigned with stakeholders under IP2 The research outputs from IP2.02.01 will be tested at a local and regional scale through pilot interceptions, however the outcomes will have national significance.		

IP2.02.02 – Finding fit for purpose technological recycling solutions for regional and remote communities across Australia			
At which spatial scale is the project working	**National** ☐	**Regional** ☒	**Local** ☐
Location(s) – gazetted region /place name	Desktop Studies: UNSW Sydney Field Studies: Currently being co-designed with stakeholders under IP2. Potential sites include Huon Valley, TAS, and Murraylands and Riverlands, SA. The research outputs from IP2.02.02 will be tested at a local and regional scale through pilot demonstrations, however the outcomes will have national significance.		
Aboriginal or Torres Strait Islander nation or traditional place name(s)	Desktop Studies: Eora Nation Field Studies: Currently being codesigned with stakeholders under IP2. Potential locations include Nuenonne Country and Ngarrindjeri and Erawirung (Yirawirung, Jirawirung) Country. The research outputs from IP2.02.02 will be tested at a local and regional scale through pilot demonstrations, however the outcomes will have national significance.		

IP2.05.03 – Understanding value-added materials from metals and alloys of waste solar panels: Technological framework to capture economic benefits and lower carbon emissions			
At which spatial scale is the project working	**National** ☒	**Regional** ☐	**Local** ☐
Location(s) – gazetted region /place name	UNSW Sydney, Kensington		
Aboriginal or Torres Strait Islander nation or traditional place name(s)			

Project keywords

Microplastics; tyre wear particles; circular economy; waste; regional; remote; plastic waste; Indian Ocean Territories (IOT); re-manufacturing; Microfactories; end-of-life solar panels, metals and alloy; technology roadmap