



Australia's circular economy: Unlocking the opportunities

Interim report

This is an interim report prepared for further public consultation and input. The Commission will finalise its report after these processes have taken place.

The Productivity Commission acknowledges the Traditional Owners of Country throughout Australia and their continuing connection to land, waters and community. We pay our respects to their Cultures, Country and Elders past and present.

The Productivity Commission

The Productivity Commission (PC) is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed most simply, is to help governments make better policies, in the long-term interest of the Australian community.

The PC's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

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Opportunity for comment

The PC thanks all participants for their contribution to the inquiry and now seeks additional input for the final report.

You are invited to examine this interim report and comment on it by written submission/brief comment to the PC, preferably in electronic format.

Further information on how to provide a submission/brief comment (and the submissions close date) is included on the inquiry website: pc.gov.au/inquiries/current/circular-economy.

The PC will prepare the final report after further submissions have been received and further discussions with participants have been held.

For the purposes of this inquiry and interim report, in accordance with section 40 of the *Productivity Commission Act 1998* the powers of the PC have been exercised by:

Joanne Chong Presiding Commissioner

Alison Roberts Commissioner

Terms of reference

I, the Hon Jim Chalmers MP, pursuant to Parts 2 and 3 of the *Productivity Commission Act 1998*, hereby request that the Productivity Commission undertake an inquiry into Australia's opportunities in the circular economy to improve materials productivity and efficiency in ways that benefit the economy and the environment.

Background

A circular economy is an economic strategy that maintains the value of materials for as long as possible and ensures materials are used efficiently across all phases of their life cycle. In October 2022, Australia's Environment Ministers committed to accelerate the transition to a circular economy by 2030.

International studies suggest that a more circular economy supports higher economic growth and productivity, including by increasing materials productivity (how much output is produced per unit of raw input). Australia currently has the fourth lowest rate of materials productivity in the OECD. We generate US\$1.20 of economic output for every kg of materials consumed, which is under half the OECD benchmark of US\$2.50.

The Minister for the Environment and Water's Circular Economy Advisory Group has also identified commercial, regulatory, information and other barriers to achieving a more circular economy, and opportunities for Australia to improve economic and environmental outcomes through greater materials productivity and efficiency.

However, there is currently limited analysis of these matters, including the relative importance of these opportunities and how they should be measured and realised.

Scope of the inquiry

In this inquiry, the Productivity Commission is to investigate and report on:

- The potential scope to lift Australia's materials productivity and efficiency, and the best metrics to measure this opportunity and improvements made.
- Priority circular economy opportunities for Australia, including identification of the sectors, products or supply chain segments:
 - where Australia has the greatest potential to improve materials productivity/efficiency in ways that can strengthen economic outcomes, such as productivity, economic growth, economic diversity and capability
 - where other countries have made the greatest progress towards circularity, and the risks and opportunities associated with these developments in international markets for Australia
 - where cost-efficient emissions reduction could be achieved by improving materials productivity and reducing waste.
- Barriers to enhanced materials productivity and prospective approaches to addressing them, including but not limited to:
 - place based circular economy activities (e.g. industrial precincts and others enabled by urban planning and development)

- regulatory frameworks, and other mechanisms that influence businesses' and consumers' decisions on materials purchasing, use and replacement or the competitiveness of circular economy initiatives
- policy actions that are achievable over the near and medium term
- policy actions that could be progressed by Commonwealth, state and territory, and local governments, including improvements to existing national policy frameworks.

The Commission's findings will inform policymaking regarding strengthening Australian circular economy. Accordingly, recommendations made by the Commission should, where relevant and appropriate, include an assessment of implementation feasibility and risk.

Process

The Commission should engage with relevant stakeholders and experts, including the state and territory governments, to identify opportunities and constraints in this area.

The Commission should provide a final report to government within 12 months of the receipt of this Terms of Reference.

The Hon Jim Chalmers MP

Treasurer

[Received 23 August 2024]

Disclosure of interests

The *Productivity Commission Act 1998* specifies that where Commissioners have or acquire interests, pecuniary or otherwise, that could conflict with the proper performance of their functions they must disclose those interests.

Commissioner Joanne Chong holds an honorary position at the University of Technology Sydney.

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Overview

Key points

- * A circular economy aims to use materials and products more sustainably and efficiently, with economic, environmental and social benefits.**
 - Circular activities include designing products to use less materials, extending product lifespans via reuse and repair, and recycling and recovering materials to reduce waste.
 - The benefits of circularity include more efficient use of the planet's finite stock of natural capital to support economic and productivity growth; reduced harms to the environment, climate and biodiversity; and improved social outcomes such as health, amenity and intergenerational equity.
 - Some circular activities reduce materials use in ways that simultaneously benefit the economy, the environment and society. Others have trade-offs, such as lowering materials use but increasing carbon emissions (for example, if recycling requires transporting waste long distances).

- * Despite some uptake of circular economy opportunities in Australia, progress has been slow.**
 - Australia's materials productivity, circularity rate and waste recovery rate have increased slightly over the past decade.
 - Barriers to adopting circular economy opportunities include high costs; prescriptive, outdated or inconsistent regulations; coordination challenges and difficulties diffusing circular innovations; and limited practical information on circular opportunities.

- * Updating regulations to level the playing field for newer or less widespread technologies and capabilities would support the uptake of circular activities. Harmonising inconsistent regulations between jurisdictions would lower administrative costs and burdens for businesses undertaking circular activities across Australia.**

- * Governments can facilitate coordination and innovation diffusion by supporting information exchange platforms, adopting challenge-based innovation funding models, brokering businesses' engagement with regulatory processes, and leveraging sustainable procurement policies and place-based initiatives. The Australian Government's current leadership and coordination of product stewardship schemes could be expanded to products with higher-risk and/or higher-value waste streams.**

- * More information would enable better decisions about circular opportunities. For example, at the consumer level, product labelling schemes on reparability and durability would help people to make more informed purchases of sustainable products. At a higher level, monitoring the outcomes associated with materials use and circular activities would help governments and businesses identify opportunities and measure improvements.**

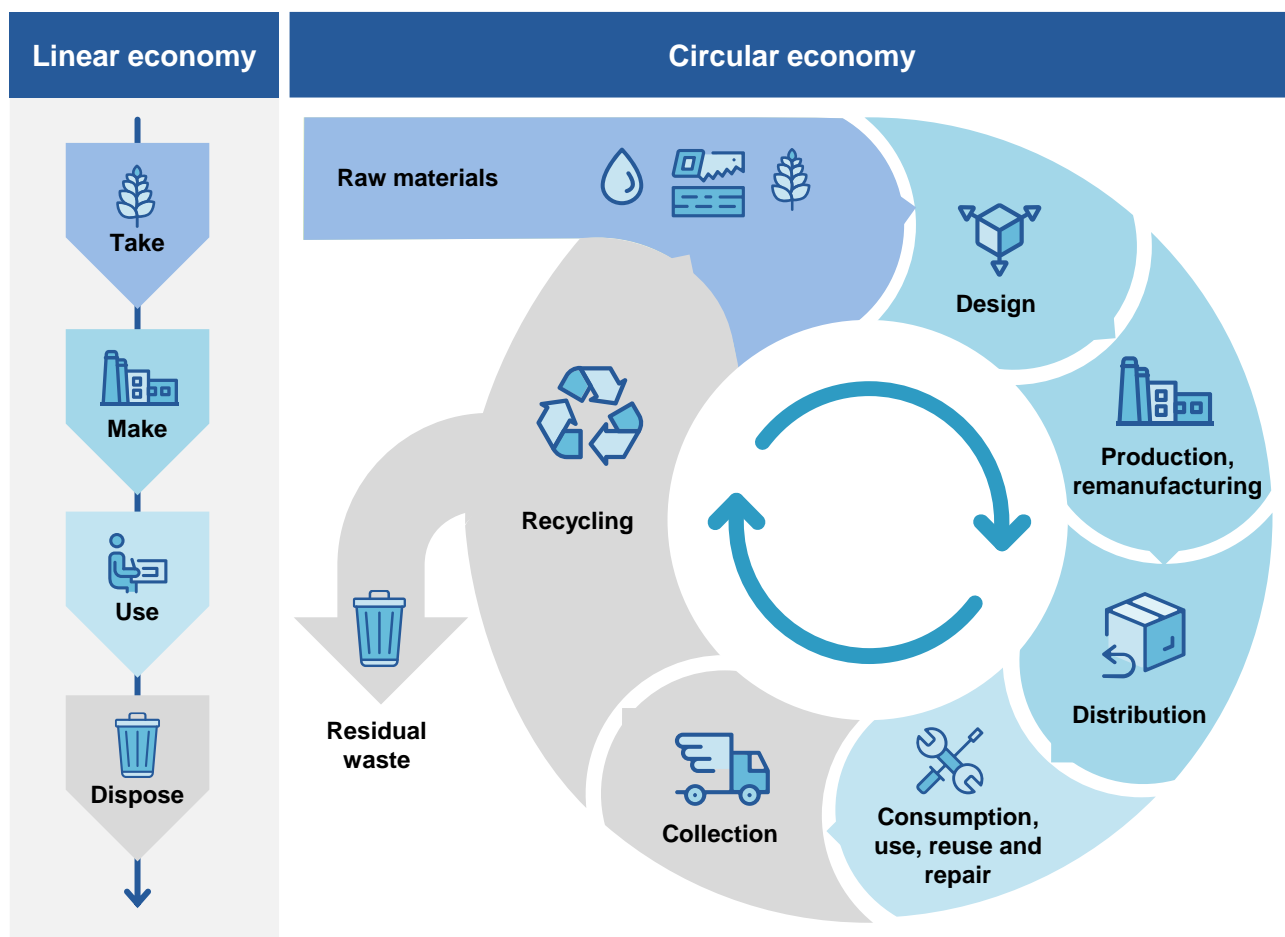
A circular economy uses materials in more sustainable and efficient ways. Traditionally, economic activity has followed a linear 'take, make, use, dispose' model: raw materials are extracted, transformed into products, consumed, then disposed of as waste. By contrast, a circular economy aims to meet human needs with fewer materials, reducing the environmental impacts and costs of economic activity.

Circular economy activities span the entire product life cycle and include designing products to use less materials ('narrowing material loops'); extending the time that products are consumed via reuse and repair ('slowing material loops'); and recycling and recovering materials ('closing material loops') (figure 1).

Increased circularity has economic and productivity benefits by more efficiently using the planet’s finite stock of natural capital (materials) to support our growing population and economy. And it reduces the harms to the environment, the climate and biodiversity associated with producing and consuming things. These in turn contribute to social benefits, such as better health and amenity, more sustainable development and fairer outcomes between generations.

Circular economy practices are not new in Australia. For more than 60,000 years, Aboriginal and Torres Strait Islander people have held deep cultural, social, environmental, spiritual and economic connections to Country, and their knowledges and practices have sustained the health of Country. These holistic, place-based understandings that emphasise connections and relationships are a powerful contribution to concepts such as a circular economy. Some governments have policies that promote the application of Aboriginal and Torres Strait Islander knowledges, and support their participation in circular economy opportunities in ways that benefit communities and respect cultural and intellectual property rights. However, in practice, governments have some way to go on enabling true partnerships to achieve these aims.

Figure 1 – Comparing the circular and linear economies



Despite some uptake, Australia's circular economy progress has been slow

Some households and businesses are already seeking opportunities to reduce their materials use, motivated by financial or commercial reasons. For example, households can save money by slowing material loops, and repairing or reusing objects until the end of their life rather than replacing them prematurely. And businesses that narrow material loops by designing and manufacturing products that use less materials can reduce input and waste disposal costs. However, these savings need to be weighed against the cost of adopting more circular approaches, such as repair costs or the time and investment required to implement new production processes or business models.

Household and business behaviours are also shifting to incorporate sustainable practices due to concern for the environment and future generations, or other sustainability reasons. A 2024 consumer survey found that 96% of respondents engaged in at least one sustainable practice in the last three months, though price and quality continue to be the top drivers of purchases. And businesses are increasingly adopting and reporting on environmental, social and governance principles. Almost all (98%) ASX100 companies published sustainability reports in 2023, and as of January 2025 climate-related reporting is mandatory for large companies. These shifts towards sustainability reflect changing societal expectations, emerging evidence from academic studies on the benefits and costs of sustainable practices, and government policies that seek to limit environmental harms.

All levels of government have policies in place that support the circular economy.¹ In general, the Australian Government is responsible for national legislation, strategies and policy frameworks, and provides national leadership for initiatives that span across jurisdictions or industries (such as product stewardship schemes). State and territory governments focus on waste management and resource recovery, and play an important enforcement role for environmental regulations. Local governments typically provide waste management services and manage infrastructure, and promote awareness among local residents. And all levels of governments provide financial incentives for circular activities that narrow, slow and close material loops, including direct funding for adopting innovative practices and via sustainable procurement policies.

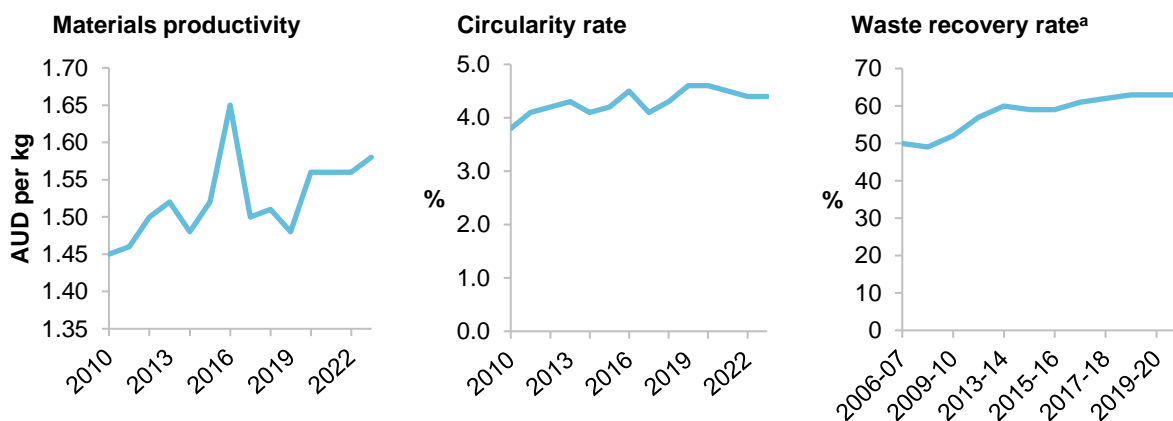
Until recently, government policies have tended to centre on recycling and waste management. But across all levels of government, there has been an increasing shift to incorporate earlier parts of the product life cycle. The Australian Government released a national circular economy framework in December 2024, which broadens thinking on Australia's circular economy beyond an end-of-product life focus. The framework notes that governments have an important role to set the direction and provide supporting foundations in Australia's transition to greater circularity.

But progress on a circular economy in Australia has been slow, despite the increasing focus on sustainability and government policy initiatives. Measuring the circular economy is challenging because of the range of activities and impacts covered. Existing indicators tend to focus on the total weight of materials used and

¹ Some policies directly target materials use and waste, such as waste levies on landfill. Others are aimed at reducing environmental impacts more generally and encourage greater circularity where objectives are complementary, including climate change policies (such as the Renewable Energy Target, Safeguard Mechanism, Australian Carbon Credit Unit Scheme, Capacity Investment Scheme and New Vehicle Efficiency Standard), water policy (such as the National Water Initiative) and sector-specific policies (such as in construction and mining). Several of these policies aim to put a price on the environmental costs associated with waste or, more generally, on emissions and other impacts. This seeks to address the issue that producers and consumers have not typically fully paid for these environmental costs in the past under more linear supply chains and models of materials use.

consumed. These indicators suggest that there have been small increases in Australia's materials productivity, circularity rate and waste recovery rate over the past decade (figure 2).² Australia's materials productivity of US\$1.10 lags the OECD average of US\$2.50, though this is largely explained by the dominance of materials-intensive sectors in the Australian economy. Materials productivity within sectors in Australia is on par with other OECD countries such as Japan, the Netherlands and Canada.

Figure 2 – Circular economy indicators in Australia



a. Waste recovered for recycling, reuse or energy; data unavailable for 2007-08, 2011-12 and 2012-13.

There are opportunities for governments to address barriers to circularity

Households and businesses can face barriers to circularity. Some circular practices are costly to adopt, as they may require investing in new technology, paying for different inputs or transport, operating at a certain scale, or accessing more expensive finance to fund projects perceived as high risk. In addition, prescriptive, outdated or inconsistent regulations sometimes prevent businesses from implementing more circular practices. Lack of information can also make it hard for households and businesses that are interested in circularity to make sustainable choices. And as many circular economy activities require coordination across businesses, governments and/or households, difficulties building connections between relevant stakeholders and sharing knowledge about best practice standards present barriers to greater circularity.

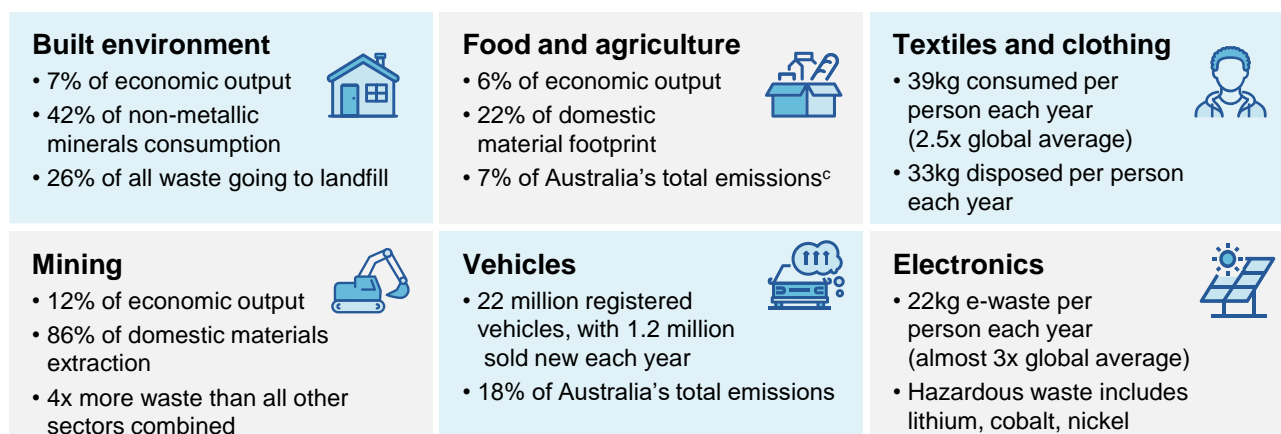
Governments can improve their policy settings to address some of these barriers. In doing so, their aim is not to achieve 100% circularity – there are trade-offs to circular activities, and a system where all materials are circulated indefinitely would not be economically, environmentally or socially optimal. And even with the right government policies in place, some circular opportunities may still be too costly for businesses and households to take up. But governments can support progress by reducing unnecessary regulatory frictions or burdens, while still maintaining policy settings with appropriate safeguards and pricing of environmental costs. Governments also have a role in facilitating coordination and improving information provision, to enable businesses and households to use materials in ways that maximise net benefits to the community.

² Materials productivity is the amount of economic value (measured by GDP) generated from a unit of materials used (measured by the weight of domestic materials consumption). The circularity rate is the proportion of non-virgin or recycled materials used against overall materials used. The waste recovery rate is the proportion of waste that is diverted from landfill and reused, recycled or used in waste-to-energy activities.

The PC has been asked to examine priority opportunities to improve materials productivity in ways that benefit the economy and environment, and policies to address barriers to achieving them. We have identified priorities in particular sectors, products and supply chain segments based on three broad considerations: environmental and economic significance of the materials used, applicability of opportunities to Australia (including behaviours and practices that Australian governments can more readily influence), and whether there are viable policies to reduce barriers to taking up opportunities. This interim report explores opportunities and potential policy reforms in six priority areas identified using this framework (figure 3).

- The **built environment**, comprised of buildings and infrastructure, involves large amounts of materials, waste and emissions in its construction. Priority opportunities for circularity focus on modern construction methods and using recycled materials, which could significantly reduce materials use and have scope for increased adoption.
- **Food and agriculture** represent a large share of Australia's economic output and exports. The sector is one of the largest users of materials for domestic production, generating significant emissions and affecting biodiversity, water and land health. Food waste and disposal occurs at all stages of the product life cycle, so priority opportunities are aimed at recovery and higher-value uses of food waste.
- **Textiles and clothing** production, consumption and disposal have a range of negative environmental impacts including on emissions, biodiversity, soil health and water quality. Australians are the biggest per-capita consumers of clothing in the world. However, because most of these products are imported, priority opportunities focus on consumption rather than production.
- **Mining** is one of the Australian economy's largest sectors by output. It accounts for the majority of domestic materials extraction and produces more waste than all other sectors combined. Mining companies have widely adopted circular activities in minerals exploration, extraction and processing, so priority opportunities relate to mining waste and alternative post-mining land uses.
- **Vehicles** are a sizeable contributor to emissions and materials use, with nearly as many vehicles as people in Australia. However, Australia has a very small domestic vehicle manufacturing industry and does not have significant influence on global manufacturers' decisions due to our small market size. As such, priority opportunities focus on reuse and recycling of vehicle components such as tyres and electric vehicle batteries.
- **Electronics** generate large waste streams with highly valuable and/or hazardous materials that pose environmental and safety risks. The volume of e-waste generated from lithium-ion batteries and solar photovoltaic (PV) systems is expected to increase significantly. Priority opportunities are aimed at improving recovery and recycling of materials in these products.

Figure 3 – Six priority areas explored in this interim report^a



a. Statistics show contribution and impacts in Australia. b. Built environment statistics are for the construction sector. c. Emissions statistics are for direct (scope 1) emissions.

Reducing regulatory barriers would encourage circular activities

Circular economy opportunities are diverse and exist across many sectors, locations and processes. As such, businesses pursuing these opportunities are affected by numerous regulations (such as health, environmental and planning regulations).

Some existing regulations and policies favour more linear processes or limit the adoption of circular practices, and updating these would level the playing field for newer or less widespread technologies and capabilities that improve materials productivity. Regulations are necessary to reduce or mitigate against the risks of adverse outcomes and engender community trust. However, they should be set and enforced in a way that minimises unnecessary burdens on businesses demonstrating compliance, and without disadvantaging those seeking to adopt innovative circular practices. These innovations contribute to economic growth and diversity by enabling new and more sustainable production processes and business models, beyond traditional linear practices. This interim report identifies several opportunities to update existing regulations and policies.

- Prescriptive standards governing construction can limit the narrowing of material loops by constraining adoption of more sustainable design and material-efficient technologies, such as prefabrication. Prescriptive building standards can also limit the use of recycled materials in public infrastructure projects, such as roads, reducing businesses' ability to close material loops. Governments could work with industry and stakeholders such as Standards Australia to update standards for using recycled materials in construction, and target standards around performance rather than prescription to avoid unnecessarily limiting the use of modern construction methods.
- Regulations on using anaerobic digestion to convert food and other organic waste into energy (such as biogas) limit the adoption of this technology. Governments could develop certifications and/or update carbon reporting methodologies for biogas derived from anaerobic digestion and drawn from shared infrastructure so that the environmental benefits of this energy source are better priced. Improving other regulatory settings, such as waste classifications and zoning, could also facilitate uptake.
- Approval requirements and regulations in mining can discourage companies from closing material loops by extracting residual minerals from their waste via tailings valorisation, or repurposing old mine sites for higher-value uses with broader regional benefits. A national assessment of state-based mining regulations could identify and reduce barriers to reprocessing mining waste and repurposing mine sites.

Any regulatory changes would need to balance environmental and economic risks and benefits, and consider potential impacts on the compliance load for businesses and enforcement burden for different levels of government. Changing regulations to enable the pursuit of circular opportunities in a way that has unintended negative outcomes could lower community support and wellbeing.

Further, **inconsistent regulations across different jurisdictions create additional costs** for businesses operating across state and territory borders. Different settings for different jurisdictions can be justified where local environments, activities and preferences differ. But in other cases, jurisdictional regulations could be harmonised – particularly where the differences between states and territories are definitional or administrative, rather than substantive or relating to outcomes. Streamlining these administrative inconsistencies would reduce the regulatory burden on businesses with national operations, and reduce frictions for businesses deciding where or whether to operate, therefore lowering barriers to productivity growth. This interim report identifies several opportunities for improving consistency, some of which Australian, state and territory governments are already considering.

- There are inconsistent bans on lithium-ion battery disposal, recycling and classification, even though these batteries' hazardous nature and fire risk in landfill are similar throughout jurisdictions across Australia.
- Different states and territories have different specifications on allowable content for recycled materials in infrastructure construction projects, but settings can be based on the same data and industry standards.
- Inconsistent waste classifications, including on organics and e-waste, present challenges for businesses with recycling activities across state and territory borders. Moreover, products made using recycled waste as inputs can be classified as waste in some jurisdictions, further increasing costs and limiting market access for businesses selling these circular products. The Heads of Environment Protection Authorities (EPA) Strategic Plan includes an action to align waste classifications, as far as practicable.
- Kerbside recycling requirements vary across and within jurisdictions, contributing to increased contamination of recycling streams and lowering the value of recycled materials. Governments are working together on harmonising requirements under the National Kerbside Collections Roadmap, following in-principle agreement from the Environment Ministers' Meeting.

Intergovernmental coordination is required to work out the detail on what settings regulations should be harmonised to, and how. This could leverage existing coordination mechanisms such as Environment Ministers' Meetings, the Heads of EPA alliance of environmental regulators, and/or departmental officer-level communities of practice. Different forums could be relevant in contributing to different aspects of the harmonisation process. For example, regulators could provide technical expertise, while government decision makers would be required to make policy decisions. Alternatively, if existing arrangements are not enough, governments could create a new interjurisdictional body dedicated to circular economy harmonisation efforts – as was suggested in the Circular Economy Ministerial Advisory Group's final report.

Coordination between industry and by governments could be improved

Many circular economy opportunities are enabled by coordination and collaboration between stakeholders. For example, circular practices can rely on businesses creating new supply chains or linkages with other businesses to exchange materials and learnings. But an individual business may face difficulties building these connections due to lack of knowledge, time or funds. And navigating complex regulatory processes can require coordination and information provision across several levels and departments of government.

Government-facilitated coordination supports greater uptake of circular activities and innovations by lowering coordination costs for an individual business. This not only improves circularity and materials productivity, but also creates opportunities for businesses to diversify their production processes and build capability in sustainable practices, generating both economic and environmental benefits. While some circular technologies and practices are eligible for existing grant funding, this interim report suggests that governments could encourage collaboration across the supply chain using challenge-based innovation funding models. Governments could also explore other avenues for coordination and innovation diffusion, such as building on trials of digital platforms that enable connections between waste producers and users to close material loops, and addressing coordination issues between food donors and charities (such as transport and storage) that are currently limiting food waste rescue.

Initiatives could involve governments partnering with other stakeholders, including local community organisations, research bodies or industry associations. For example, governments can facilitate connections between academia and industry that provide new opportunities to commercialise research. Some partnerships are already exploring circular opportunities, such as the Collaborate to Thrive program

between Hume City Council, Victoria University and Circular Economy Victoria, and Shoalhaven City Council partnering with the UNSW SMaRT Centre to improve recycling infrastructure.

In addition, governments can help businesses to navigate regulatory complexity by supporting coordination or 'brokering' services. Some businesses seeking to pursue circular opportunities have used private consultants to assist with regulatory approvals across multiple departments and levels of government, with positive results, but not all businesses are aware of or can access private services. Governments can work directly with businesses seeking regulatory approvals to make the process as efficient as possible. For example, Container Exchange Queensland worked closely with the Queensland Government to overcome regulatory constraints and align with evolving state and national regulations. This interim report suggests that there could be productivity gains from governments supporting businesses to navigate regulations, either by directly engaging with businesses or leveraging existing brokering services or industry partnerships.

Government procurement provides another channel for facilitating coordination between businesses and with government, particularly where the government is a large purchaser of a product or service, such as public infrastructure. Several governments have sustainable procurement policies that cover circular practices. But relying solely on procurement has limitations: it takes time for suppliers to adopt and demonstrate changes, government decision makers need to build understanding of new requirements, and the broad range of procurement objectives creates additional administrative burden and potentially increases the costs of goods and services purchased by governments.

Programs that support and build on sustainable procurement policies enhance the impact of these policies and promote connections between and within government and industry. For example, in Victoria, the ecologiQ program accompanying the Recycled First Policy facilitates connections between infrastructure projects, businesses producing recycled materials and government decision makers. It promotes information sharing between government and businesses, builds confidence in innovative approaches to using recycled materials and closing material loops, and is highly regarded by industry stakeholders. This interim report identifies an opportunity for similar initiatives to be rolled out by other state and territory governments.

Place-based initiatives help to enable coordination, address distance challenges and support businesses to develop and share new ideas. Businesses can use their neighbours' byproducts as material inputs for their own production ('industrial symbiosis') and learn from each other about innovative circular practices or how to efficiently navigate government approval processes. Often there are commercial benefits to using local waste streams as inputs, such as lower transport and other costs, as in WA's Kwinana Industrial Area. Co-location also has broader benefits such as local jobs creation, economic growth, social engagement and community cohesion, as evident at the Cherbourg Materials Recovery Facility on Wakka Wakka Country in Queensland and in Bega Valley in New South Wales.

Productive connections between businesses in these precincts and communities can arise in the course of business as usual, or by chance. But many businesses do not have the time or knowledge to identify circular opportunities with their neighbouring businesses, and innovation can be challenging to grow and scale. This interim report suggests that governments can help reduce barriers to local coordination by integrating circularity into precincts with related objectives (such as net zero), building on existing service delivery and infrastructure (such as recycling and waste management), and reducing regulatory barriers to encourage place-based experimentation and circular activities. Governments contemplating support for place-based initiatives should consider whether businesses already have motivations for co-location and local coordination, and how to design programs to enable local activities to grow sustainably so they do not require ongoing government support.

A particular policy area where **the Australian Government has a significant role in providing national leadership and coordination is product stewardship schemes.** Product stewardship schemes make

businesses responsible for managing the environmental impacts of products and materials over their life cycle, through activities to close, narrow and slow material loops.³ Making the businesses that create or sell products responsible for these impacts is more likely to lead to meaningful change across the life cycle, as businesses earlier in the supply chain have more direct control over design and production decisions than end consumers. It is challenging for state and territory governments to implement and enforce these schemes, as much of their activities require coordination at a national level, such as sharing information, aligning on best practice standards or involving international supply chains and trade flows.

Product stewardship schemes are typically sector- or product-specific with varying degrees of government involvement, ranging from voluntary industry-led schemes accredited by the government, to co-regulatory and mandatory schemes. Implementing a mandatory scheme has higher setup costs and requires more compliance monitoring and enforcement, and moving too fast to mandatory arrangements can reduce opportunities for businesses to join and 'buy-in' to the scheme. This interim report suggests that there is scope for the Australian Government to more actively coordinate stewardship for products with higher-risk and/or higher-value waste streams, and where arrangements are currently underdeveloped, ineffective or inconsistent across different jurisdictions.

- Electric vehicle (EV) batteries pose significant environmental and safety hazards if not properly disposed of. Growing demand for EVs is expected to significantly increase EV battery waste, and high-value materials could be recovered from this waste. A co-regulatory product stewardship scheme for EV batteries could include government compliance and enforcement activities to support traceability and information sharing, and standards on safe transport, storage and processing methods. Such standards have been developed in the US and Canada, while the EU has introduced digital passports to provide information about EV batteries across their life cycle.
- Solar panels are another emerging waste stream featuring materials that are relatively hazardous in landfill and relatively high value if recovered. Similar to EV batteries, setting up an appropriate co-regulatory product stewardship scheme for solar panels now will provide the foundations for higher resource recovery and lower environmental impact in coming years as volumes of hazardous waste increase. The Australian Government intends to develop such a scheme for small-scale PV systems, though its design and implementation are yet to be finalised. There has been international progress on addressing solar PV system waste and stewardship in the EU, China, Japan and some US states.
- Small electronic products are not included in the existing National Television and Computer Recycling Scheme (NTCRS).⁴ Many of these products have embedded lithium-ion batteries, which present significant safety risks upon disposal. Some state governments are separately proceeding on addressing these risks, but a national co-regulatory product stewardship scheme for small electronics would improve consistency and efficiency. The Australian Government intends to develop such a scheme, but its design and implementation are yet to be finalised.
- Plastics and packaging are covered by a co-regulatory product stewardship scheme, but the existing scheme is ineffective. The Australian Government is currently considering potential reforms, including transitioning towards mandatory product stewardship arrangements, which is broadly supported by many

³ These include resource recovery and recycling, improving sustainability in product design and extending product lifespans. Product stewardship schemes can also involve levies paid on new products sold.

⁴ The NTCRS is a co-regulatory product stewardship scheme that covers televisions and computers, including printers, computer parts and peripherals. It focuses on recycling e-waste, resulting in some otherwise functional or repairable products being dismantled or destroyed. As such, this interim report reiterates the recommendation from the PC's 2021 Right to Repair inquiry that the NTCRS should include reuse and repair within annual targets.

stakeholders. A detailed understanding of the benefits and costs of a mandatory approach, and the extent to which the benefits outweigh costs, should underpin any shift towards heavier government intervention.

Addressing information gaps would support decision making

Poor information quality and availability limits the ability of households and businesses to adopt more circular practices, as even if they wish to change behaviours, they may lack the information to make sustainable choices. And limited system-wide data on circular economy progress and impacts means that governments and other stakeholders are less able to make well-informed decisions about circular activities and policies.

From a consumer perspective, **better visibility on product repairability and durability would enable more informed purchase choices** and greater confidence regarding which products are easier to repair or have longer lives. This can shift behaviours towards these products, which slows material loops. For example, France's repairability index (which reports on the ease of repairing various consumer electronics) has led to retailers selling more repairable products in greater proportions than less repairable ones, and manufacturers introducing new product models that are increasingly repairable. This interim report reiterates the recommendation from the PC's 2021 Right to Repair inquiry that the Australian Government should introduce a product labelling scheme that provides consumers with repairability and durability information for appliances and electronics. It also suggests that improving labelling on textiles and clothing products to provide information on design, material composition, repairability and durability could support consumers and businesses to adopt circular practices.

At a system level, **existing indicators measuring Australia's circular economy are highly aggregated and weight based**, and do not specifically reflect the environmental, economic and social outcomes associated with different types of materials use and circular activities. An expanded set of indicators would enable governments and businesses to identify circular opportunities that could lift Australia's materials productivity and have positive environmental, economic and/or social impacts, and to measure the improvements made. This supports national efforts to achieve the targets in Australia's Circular Economy Framework on improving resource recovery, reducing material footprint and lifting materials productivity. It can also inform policy decisions around industry and regional development, and the contribution that circular opportunities could make to economic and productivity growth.

To achieve these aims, this interim report proposes an expanded set of circular economy indicators that could be measured in Australia, relating to the environmental and economic outcomes from circular activities.⁵ The proposed indicators are based on outcomes measured in more developed international monitoring frameworks and the level of granularity required for opportunity identification and progress tracking in the Australian context.

These benefits need to be weighed against the costs associated with collecting more data when determining the role for government in circular economy measurement. Data on several indicators is already collected and reported elsewhere (such as the National Waste Report and National Greenhouse Accounts), and some broader environmental data initiatives are also underway (such as the newly established Environment Information Australia and the ABS considering including environmental impacts on the economy in the

⁵ Proposed indicators relating to environmental outcomes include waste generated by material type and sector, recovery rates by material type and sector, and greenhouse gas emissions from production activities by sector. Those relating to economic outcomes include gross value added of circular economy activities by sector, jobs in circular economy activities by sector, business investment in circular economy activities by sector, and research and development expenditure on circular economy technologies by sector.

System of National Accounts). Where there is existing reporting or activity underway, data may be able to be added to a suite of indicators for monitoring Australia's circular economy at relatively low cost. The feasibility of other indicators could be limited by the potentially large costs associated with attributing outcomes to circular economy activities and disaggregating data by sector.

The PC is seeking further information about its proposed reform directions

Throughout this interim report, the PC has proposed reform directions on which it is seeking further information as an input to developing its final recommendations for this inquiry. The PC is also requesting information about other issues and policy areas that could feature in recommendations in its final report. Requests for information include questions about:

- the current and potential uptake of circular economy opportunities in specific sectors and materials
- the nature and size of the expected benefits of circular opportunities, and how policy reform directions enabling opportunities could be implemented to maximise these benefits
- the costs and implementation options associated with reform directions, including which are achievable over the short to medium term and which levels of government are best placed to progress them.

Recommendations, reform directions and information requests

In this interim report, the PC has identified circular economy opportunities where policy changes could result in net benefits to the community. 'Recommendations' are relevant policy changes that the PC has included as final recommendations in past inquiries, which governments have not yet fully implemented. 'Reform directions' are potential policy changes that the PC is currently considering. The PC is also seeking further input via 'information requests' as part of developing this inquiry's final recommendations.

Chapter 4: The built environment



Reform direction 4.1

Enabling fit-for-purpose use of recycled materials in public projects

The PC is considering ways governments can reduce unnecessary regulatory barriers to using fit-for-purpose recycled inputs in public infrastructure projects (such as roads). Options could include modifying or harmonising existing standards and specifications and developing new standards.



Information request 4.1

Enabling fit-for-purpose use of recycled materials in public projects

The PC is seeking information on:

- prescriptive versus performance-based standards:
 - specific examples where prescriptive standards or specifications for infrastructure construction significantly inhibit the use of recycled materials
 - what other benefits or objectives these prescriptive standards are intended to achieve (for example, public safety, or to enable clarity for smaller businesses)
 - ways that various levels of governments could facilitate greater use of performance-based standards
 - challenges, costs and benefits, and implementation issues that need to be considered if moving from prescriptive to performance-based standards (for example, monitoring and enforcement)
- harmonisation of standards:
 - key areas where there is scope to harmonise standards and specifications across states or territories and increase the use of recycled materials
 - specific implications (costs, benefits, risks) of harmonisation (for example, due to lack of flexibility to reflect local conditions), and whether or how they could be overcome.



Reform direction 4.2

Coordination mechanisms to enhance the benefits of sustainable procurement policies

The PC is exploring the potential for governments to introduce or expand delivery mechanisms around sustainable public procurement policies to facilitate coordination between suppliers, contractors and government agencies. This could include publishing information or connecting suppliers and users of recycled materials, as in Victoria's ecologiQ program.



Information request 4.2

Coordination mechanisms to enhance the benefits of sustainable procurement policies

The PC is seeking information on:

- the benefits and costs associated with introducing or expanding government-led coordination initiatives to support public procurement policies in different jurisdictions
- how further government efforts to facilitate coordination between suppliers, contractors and government agencies could be implemented to maximise net benefits to the community
- specific ways that coordination could assist suppliers of recycled materials to navigate sustainable procurement policy requirements and help government procurement agencies and suppliers identify win-win opportunities.



Reform direction 4.3

Reducing unnecessary regulatory barriers to prefabricated construction

The PC is considering a reform direction to further address regulatory barriers to prefabricated construction (noting that governments are currently implementing several initiatives to address these barriers). This may relate to:

- addressing planning requirements and design codes that stymie prefabricated construction
- establishing fit-for-purpose compliance pathways in the national compliance framework
- establishing new processes and schemes for national building product conformity.



Information request 4.3

Reducing unnecessary regulatory barriers to prefabricated construction

The PC is seeking further information on the regulatory barriers to prefabricated construction, including:

- the extent to which recently announced measures by the Australian Government (the Australian Productivity Fund and the Voluntary Certification Scheme) will address key barriers to prefabricated and modular construction
 - how these initiatives could be implemented to maximise the net benefits to the community
- specific regulatory changes (including recommendations from previous reviews that remain relevant) that would have the largest effect on uptake of prefabricated and modular construction, and:
 - the magnitude of the environmental, economic and social benefits associated with these changes, and measures and metrics that may quantify this
 - costs associated with the changes, including resources required for implementation, compliance and enforcement, and potential impacts on the environment associated with different regulations
 - how regulatory changes could be implemented to maximise the net benefits to the community.



Information request 4.4

Other circular economy opportunities in the built environment

The PC is seeking the following information on government assessment of public infrastructure projects, and integrated planning:

- any examples of infrastructure investment decisions proceeding without adequate integrated planning or assessment, which have led to significant unnecessary materials use and waste that may otherwise have been avoided
- the extent to which and ways in which improving assessment of public infrastructure projects could reduce materials use and waste, including quantitative analysis of costs and benefits (where available)
- barriers preventing further adoption of integrated urban planning, which governments could address.

The PC is seeking the following information on designing for disassembly in the built environment:

- expected growth in design for disassembly for different types of structures in Australia, in the absence of any further government activity
- barriers preventing further adoption of design for disassembly in Australia, which governments could address.

Chapter 5: Food and agriculture



Reform direction 5.1

Reducing food waste through food relief and donation to charity

The PC is considering how governments could facilitate greater donation of edible foods to the food relief sector. Supporting measures could include governments assisting food donors and charities to deal with transport and storage constraints, which currently prevent the diversion of edible food from disposal to food relief organisations.



Information request 5.1

Reducing food waste through food relief and donation to charity

The PC is interested in further information on the following matters:

- specific regions or stages of food donation (collection, storage, distribution) where barriers and challenges arise
- the most significant kind of barriers faced by the food relief sector, including (but not limited to) coordination issues and infrastructure capacity constraints, and how these might be overcome
- ways, and quantitative assessments of the costs and benefits (where available), governments can make food collection and distribution easier for small and/or geographically dispersed food businesses and charities, including incentivising the use of private storage and transport infrastructure
- examples of governments successfully playing a coordination role between food donors and food relief organisations in Australia or other countries.



Reform direction 5.2

Recognising the benefits of biogas in carbon reporting

The PC is considering how the emissions reduction benefits of anaerobic digestion projects that produce biogas from organic waste could be better accounted for, reported and valued. Options include developing certifications and/or other ways of accurately reporting biogas energy use, similar to those applicable to users of liquid biofuels under the National Greenhouse and Energy Reporting (NGER) legislation.

**Information request 5.2****Recognising the benefits of biogas in carbon reporting**

The PC is seeking further information (including data, where available) on the following matters:

- the extent to which modified carbon reporting methodologies for biogas use, similar to those for liquid biofuels use under NGER legislation, could materially increase uptake of anaerobic digestion projects in Australia
- the extent to which a nationally recognised certificate for biogas is necessary to accurately value the environmental benefits of using biogas drawn from shared infrastructure
- the benefits, costs and risks associated with adopting certifications or modified reporting methodologies for biogas.

**Information request 5.3****Reforming regulations to support the recovery of value from organic waste**

The PC is seeking further information on regulatory barriers to projects that recover value from organic waste. Specifically, the PC is interested in further information on the following matters:

- specific regulations or regulatory inconsistencies that create disincentives to invest in projects that recover the value of organic waste (and estimates of associated compliance costs, where available)
- examples of projects not proceeding because of restrictive regulations or regulatory inconsistencies
- opportunities for reducing these barriers without compromising objectives such as protecting human health, the natural environment or local amenity (e.g. odour), including examples of best practice.

Chapter 6: Textiles and clothing

**Information request 6.1****Protections for consumers of textiles and clothing**

The PC is seeking the following information on protections for consumers of textiles and clothing:

- the extent to which consumers of textiles and clothing products consider certification trademarks when choosing between different products and what product qualities those certifications cover (for example, ethical production, sustainable inputs, product functionality)
 - which certification trademarks are considered most trusted in the textiles industry and by consumers, and what makes them stand out compared to others
- the extent to which textiles and clothing manufacturers and retailers engage in misleading behaviours (for example, misleading logos, terminology, or accreditation; providing insufficient information to support claims) that fall outside of existing general consumer protection laws (such as the Unfair Trading Practices prohibition) and associated compliance activities (guidelines)



Information request 6.1 **Protections for consumers of textiles and clothing**

- what, if any, harms to consumers arise from these misleading claims
- actions that governments or product stewardship schemes could take to promote the availability of reliable and relevant information about whether clothing and textiles products' claims related to circularity and sustainability are accurate and credible.



Reform direction 6.1 **Product labelling for textiles and clothing**

The PC is considering the role for governments in product labelling to improve the availability of information about textiles and clothing products (such as their design, material composition, reparability and durability) and enable consumers and businesses to adopt circular practices. Options could include amending existing regulatory frameworks or standards governing existing textile and clothing labelling schemes, and/or designing and developing a new product labelling scheme with industry.



Information request 6.2 **Product labelling for textiles and clothing**

The PC is seeking the following information on product labelling for textiles and clothing:

- the types of information on product qualities (such as sustainable inputs, reparability, durability and recyclability) that would be usefully included on product labels for:
 - consumers, to support their ability to buy circular textiles and clothing products
 - textiles recycling and upcycling businesses, to support their ability to adopt circular opportunities
- what would be required for businesses and retailers in Australia to access accurate and consistent information for product label details
- the extent a product labelling scheme could build on existing information systems, standards and regulations or would require new ones to be set up, and associated costs and implementation issues
- whether other forms of labelling or information (business to business, or end of system) could facilitate greater circularity across the textiles product life cycle.

**Information request 6.3****Textiles and clothing product stewardship schemes**

The PC is seeking further information on:

- the impacts of changing from a voluntary industry-led scheme to a voluntary accredited, co-regulatory or mandatory scheme, such as:
 - the value of potential environmental, economic and/or social benefits from greater government involvement in textiles and clothing product stewardship schemes
 - the size and nature of potential costs associated with this increase in government involvement
- reasons for businesses and retailers to join or not join the Seamless and ABSC schemes, and what additional incentives or changes would encourage greater participation
- businesses' and retailers' experiences of participating in textiles and clothing product stewardship schemes, including challenges faced and benefits gained
- limitations in current government accreditation arrangements and how they can be improved to implement effective voluntary schemes.

Chapter 7: Mining

**Reform direction 7.1****Reducing regulatory barriers to circular economy opportunities for mining waste and alternative post-mining land uses**

The PC is considering whether there is scope to reduce regulatory barriers related to circular economy opportunities in mining waste and repurposing land post-mining. An assessment of these barriers across state, territory and Australian government policies could consider:

- processes and permissions required to re-mine or re-purpose mining tailings
- regulations and practices that make it difficult for multiple operators to co-exist on a mine site
- restrictions on transporting mining waste
- regulation and practices that maximise net environmental, economic and social benefits from mine transitions, including repurposing infrastructure associated with mine sites
- regulations limiting the ability of new operators to take on mine sites for alternative higher-value uses, such as liabilities for legacy environmental impacts.



Information request 7.1

Reducing regulatory barriers to circular economy opportunities for mining waste and alternative post-mining land uses

The PC is seeking further information on:

- specific examples of regulations that have impeded circular economy opportunities for mining waste or alternative uses for closed mine sites, and the expected benefits, costs and risks of reducing regulatory barriers (including quantitative analysis, where available)
- potential solutions to regulatory barriers, such as new regulatory frameworks or legislative changes
- specific areas of investigation or questions for an assessment of regulatory barriers related to mining waste materials recovery and repurposing closed mine sites
- the extent to which addressing regulatory barriers would increase the uptake of circular economy opportunities for mining waste and alternative post-mining land uses (including quantitative estimates, if available), or if other barriers would still prevent meaningful uptake.



Information request 7.2

Ways governments could facilitate circular economy opportunities for mining waste and alternative post-mining land uses

The PC is seeking further information on:

- ways that governments could better facilitate circular economy opportunities for mining waste and alternative post-mining land uses, such as improvements to regional planning and development, applying stricter standards on the production and storage of mining waste, or introducing disincentives for producing mining waste, such as mining waste levies
- the benefits, costs and risks associated with these options (including quantitative analysis, where available).

Chapter 8: Vehicles



Recommendation 8.1

Evaluating the Motor Vehicle Service and Repair Information Sharing Scheme

The PC recommends the Australian Government's evaluation of the Motor Vehicle Service and Repair Information Sharing Scheme in 2025-26 assess the following:

- the costs and benefits for various stakeholders and whether the scheme is delivering net benefits
- whether the scheme is achieving its objectives to improve competition and choice in the market and how the scheme could be potentially improved
- the costs and benefits for various stakeholders if the scheme were to be expanded to include a greater scope of products (such as agricultural machinery) or to provide fair access to more repair market participants (such as spare parts suppliers and marketplaces).

**Information request 8.1****Targeted measures to improve the collection and recovery of off-the-road tyres**

The PC is seeking input on appropriate policy actions to improve collection and recovery rates of off-the-road (OTR) tyres, and the extent to which policies could lead to net benefits to the community.

- What are the environmental, economic and social impacts of unrecovered OTR tyres? What are the size of these impacts (including any data, if possible)?
- Which policy actions would be most effective in improving collection and recovery rates? What are the benefits to the community associated with these policies (including any data, if possible)?
- What are the costs and benefits of implementing and enforcing these policies (including quantitative analysis, where available)?
- What are the roles for different levels of government in implementing these measures?
- What are the ways in which governments can partner with Aboriginal and Torres Strait Islander communities on collection and recovery opportunities?
- What are the current levels of demand for products that can be produced from OTR tyres (including any data, if possible)? Are there any technical or regulatory barriers inhibiting their production or use?

**Reform direction 8.2****Establish the foundations of a robust end-of-life electric vehicle battery industry**

The PC is considering the role for the Australian Government in improving end-of-life electric vehicle (EV) battery management and supporting the establishment of a circular industry for EV batteries. This could involve implementing a co-regulated product stewardship scheme to oversee the end-of-life management of EV batteries, featuring:

- improved traceability of EV batteries, such as through a digital passport
- regulations on second-use battery quality and performance for consumer use
- standards for the transport, storage and end-of-life processing of EV batteries.



Information request 8.2

Establish the foundations of a robust end-of-life electric vehicle battery industry

The PC is seeking further information about government measures that could appropriately facilitate support for and overcome barriers to the development of a robust end-of-life electric vehicle (EV) battery industry. Measures could address supply of end-of-life EV batteries, or demand for second-life batteries and battery products. The following questions can help inform responses:

- Are there technological or regulatory barriers inhibiting reuse, repurpose and recycle activities?
- What are current levels of market demand for second-life EV battery products in Australia (including any supporting data)? Are there barriers to connecting supply of these products with demand?
- What costs would the measures place on businesses and consumers, and (for regulation) on government implementation and enforcement (including quantitative analysis, where available)?
- What activities could be undertaken by state, territory and local governments to support any overarching scheme implemented by the Australian Government?
- What additional measures are needed to address environmental and safety concerns related to EV battery handling and processing?
- What are the costs and benefits (including estimates, where possible) of developing further processing capability of black mass in Australia?

Chapter 9: Household, consumer and emerging electronics



Recommendation 9.1

Introduce a product labelling scheme for household appliances and consumer electronics

To better inform consumer purchasing decisions, the Australian Government should develop a product labelling scheme that provides consumer information about durability and repairability for household appliances and consumer electronics, as recommended in the PC's Right to Repair inquiry (2021).



Recommendation 9.2

Include reuse and repair targets in the NTCRS and increase the use of tracking devices

The Australian Government should amend the NTCRS to include reuse and repair within annual targets, as previously recommended in the PC's Right to Repair inquiry (2021). The NTCRS should also increase its use of e-waste tracking devices to better monitor co-regulatory bodies and their downstream recyclers.



Information request 9.1 **Barriers to greater reuse and repair**

The PC is seeking further information on barriers to greater reuse and repair in the electronics sector and how widespread the issues are, including:

- whether there is unmet demand (including any data, if possible) for reuse and repair services, and if so, which electronic products and consumers are most affected
- what might be preventing the supply of these services
- what governments' role might be to address any barriers to these services, including relating to:
 - skills and accreditation for the repair of electronic products
 - coordination of and information provision about access to electronic repair services, including where this may assist recipients of social benefits and services.



Reform direction 9.3 **Product stewardship for small electronics, including embedded lithium-ion batteries**

The PC supports the Australian Government's intention to establish a co-regulatory product stewardship scheme for small electronics and is seeking further information on how the scheme could be designed and implemented to support materials productivity and economic outcomes.

Given the immediate risks of battery fires and the inefficiency and complexity of creating multiple state- and territory-based stewardship systems, the Australian Government should prioritise establishing co-regulatory stewardship arrangements for electronic products with embedded lithium-ion batteries.

Harmonising regulations for lithium-ion batteries will support the success of this scheme.



Information request 9.2

Product stewardship for small electronics, including embedded lithium-ion batteries

The PC is seeking further information on:

- what barriers (such as public awareness or infrastructure) currently limit the collection and recycling of different types of small electronics, and how these barriers differ by product
- how including different types of small electronics in a product stewardship scheme would result in environmental, economic and/or social benefits and costs (including estimates, where possible)
- the costs and benefits of expanding existing product stewardship schemes – such as the co-regulatory NTCRS or the voluntary B-cycle scheme – to include (other) small electronics, rather than establishing an entirely new scheme
- whether and how a staged approach (e.g. by product or location) could be a cost-effective way to sequence the addition of small electronics into a product stewardship scheme, whether new or existing
 - if staged by product, which products should be addressed first and why
- what the costs and benefits would be (including estimates, where possible) of introducing a minimum threshold for the value of small electronics to be included in a product stewardship scheme
- what compliance and enforcement arrangements would be necessary under a co-regulatory scheme to encourage adoption and address 'free rider' behaviour
- how else the scheme could support circularity earlier in a small electronic product's life cycle, including sustainable design and reuse and repair activities.



Reform direction 9.4

Product stewardship for small-scale PV systems

The PC supports the Australian Government's intention to establish a co-regulatory product stewardship scheme for small-scale PV systems, including legacy waste, and is seeking further information on how the scheme could be designed and implemented to support materials productivity and economic outcomes.



Information request 9.3 Product stewardship for small-scale PV systems

The PC is seeking further information on:

- whether large-format or energy storage batteries should be included or excluded in the scheme (including estimates of the costs and benefits, if possible)
- whether compensation should be provided for PV systems returned in good condition (including any estimate for this compensation and cost-benefit considerations)
- how best to establish a system of collection points for PV waste, including local government involvement, especially in regional and remote areas, and whether existing collection points such as those under the NTCRS could be leveraged
- which specific industries or markets in Australia, if any, could benefit from the recovered materials of PV waste (including the size of these benefits, if possible)
- how else the scheme could support circularity earlier in the solar PV system life cycle, including sustainable design and reuse and repair activities.

Chapter 10: System-wide arrangements



Reform direction 10.1 Governance arrangements to harmonise regulations that pose barriers to circularity

The PC is proposing that the Australian Government facilitates coordination between state and territory governments to harmonise inconsistent regulations across jurisdictions. The PC is considering how existing coordination mechanisms in Environment portfolios can be made more effective, what the role for the Australian Government should be in driving change (such as chairing, providing secretariat and/or resourcing, setting the agenda, leading the development of an intergovernmental agreement), and whether a new interjurisdictional body dedicated to circular economy harmonisation efforts is both practical and warranted.

Coordination would enable governments to agree on what settings regulations should be harmonised to, and how. A preliminary set of state and territory regulations for consideration might include:

- waste classifications (building on the strategic direction outlined by the Heads of EPA Australia and New Zealand)
- specifications for using recycled materials in infrastructure projects (chapter 4)
- lithium-ion battery waste management regulations (chapter 9).

Intergovernmental coordination would also support the identification of other harmonisation opportunities. These may include specific inconsistencies in planning, zoning and health regulations that relate to environmental impacts and are presenting barriers to circular economy growth.



Information request 10.1

Governance arrangements to harmonise regulations that pose barriers to circularity

The PC is interested in further information on the following questions:

- How could existing intergovernmental coordination mechanisms in Environment portfolios – such as the Environment Ministers' Meetings, Heads of EPA forums and/or officer level communities of practice – be improved to more effectively and quickly harmonise inconsistent regulations that are limiting uptake of circular opportunities? What would be the costs of these changes?
- What would be the benefits of setting up a new institutional body to oversee harmonisation efforts? How would such a body need to be structured to improve on current arrangements, and what would be the costs of setting up and running it?
- Apart from those identified in reform direction 10.1, what other inconsistent regulations (such as planning, zoning and health regulations) are presenting barriers to circular opportunities? How well do existing intergovernmental coordination mechanisms in other portfolios take into account the impact of these regulations on circular opportunities?



Reform direction 10.2

Supporting coordination, facilitation or brokering services

The PC is considering a reform direction on government support for services to assist businesses in finding circular opportunities and partners, and navigating the complex regulatory environment. This could include through governments facilitating access to coordination services through trials or raising awareness of relevant initiatives. Governments may, in some cases, choose to collaborate or partner with businesses and other stakeholders on circular opportunities.

Special arrangements may be required to assist businesses and other organisations to find partners for circular projects in regional and remote areas, and for small and medium businesses.

**Information request 10.2****Supporting coordination, facilitation or brokering services**

The PC is interested in further information on **supporting businesses and communities to identify circular opportunities and develop partnerships**:

- What government initiatives could most effectively support businesses' coordination?
 - How could governments use or build on existing platforms for information sharing or collaboration?
 - Are there examples of governments partnering with intermediaries, such as industry associations or other network bodies, to support collaboration? How might this be further strengthened?
 - What would be the benefits and costs associated with these initiatives, in terms of economic, environmental and/or social outcomes?
 - What lessons could be learned from successful government initiatives supporting facilitation or coordination in other industries?
- Are there special considerations for how governments might support businesses to identify partners in regional and remote Australia?
- How could governments support Aboriginal and Torres Strait Islander businesses and communities to identify opportunities and partnerships? What current or new initiatives could be adopted or extended?
- How do the needs of small and medium businesses or organisations differ from larger businesses or organisations in relation to adopting circular practices, and how might governments best support this cohort?

The PC is interested in further information on **navigating regulatory complexity**:

- What are the barriers to knowledge (or transition) brokers, project officers, community development officers and the like effectively assisting organisations to navigate regulatory complexity?
- To what extent is there a need for government to provide services, given that there are already private consultant services that can support businesses to navigate regulations?
- What kind of regulations do businesses most need help navigating to pursue circular opportunities? Are these at Commonwealth, state and territory, or local government level?

**Reform direction 10.3****Supporting greater adoption and diffusion of circular innovations**

The PC is considering a reform direction on government support for businesses to adopt and diffuse innovative circular practices and technologies. This could involve working with intermediaries that have existing connections between industry, government, researchers and markets, such as industry associations and other network bodies. The PC is considering:

- challenge-based funding models to encourage innovation across supply chains
- how governments can connect researchers and industry to commercialise innovative research.



Information request 10.3

Supporting greater adoption and diffusion of circular innovations

The PC is interested in further information on **challenge-based funding for innovation**:

- Are there examples of circular economy innovations that have been successfully funded through challenges (in Australia or internationally) and what determined their success?
- What might be the benefits and limitations to this approach? What are the likely costs?

The PC is interested in further information on **connecting industry and research**:

- What are useful models for how government can connect industry and researchers? When is this best done at the industry level, and when by location (such as a region or local government area)?
- Are there examples of successfully adopting or diffusing circular innovations across supply chains?
- What are additional examples of Australian, state, territory and local governments successfully fostering these connections?

The PC is interested in further information on **Aboriginal and Torres Strait Islander knowledges** and circular innovations:

- What actions could governments take to value Aboriginal and Torres Strait Islander knowledges, in ways that protect Indigenous cultural and intellectual property, in the adoption and diffusion of circular innovations?



Information request 10.4

Improving investor confidence in the circular economy

The PC is interested in further information on the following questions:

- Will the proposed Australian sustainable finance taxonomy and enhanced ESG reporting provide sufficient information for investors to make informed decisions about circular economy projects? Or are further initiatives, required to improve investor confidence in the circular economy?
- What are examples of sectors or circular activities being impacted by the cost and availability of insurance? What factors or risks currently determine insurance availability (or lack thereof)?



Reform direction 10.4

Government support for place-based circular initiatives

The PC is considering how governments at all levels could consider whether there are opportunities to enable place-based circular initiatives within their jurisdictions. As a first step, governments could consider:

- how existing precincts with related objectives (such as net zero) might integrate greater circularity
- setting up or expanding materials recovery facilities as a basis for place-based circular activities
- whether there are opportunities to reduce regulatory barriers to place-based circular activities (such as expediting approvals or planning processes).

**Information request 10.5****Government support for place-based circular initiatives**

The PC is interested in further information on the following questions:

- To what extent are existing precincts (such as those set up for net zero, advanced manufacturing, or Special Activation Precincts) already engaged in circular activities? What are some of the ways to encourage further circular activities in these precincts?
- What are the barriers (and possible solutions) to expanding or setting up materials recovery facilities? How might facilities provide a basis for place-based circular opportunities? Are there examples of this?
- What service provision and funding models would best support place-based circular activities, including reuse, repair, waste collection and recycling activities in remote and very remote areas?
- What are the main regulatory barriers that communities or businesses face in establishing place-based circular initiatives?
- What other kinds of government assistance or support do communities or businesses need to enable successful place-based circular precincts (such as coordination or facilitation, as in information request 10.2)?
- What actions could governments take to facilitate Aboriginal and Torres Strait Islander roles in progressing place-based circular initiatives?
- What actions could governments take to value Aboriginal and Torres Strait Islander knowledges, in ways that protect Indigenous cultural and intellectual property, to identify and develop place-based circular opportunities?

**Reform direction 10.5****Expanding the set of circular economy indicators**

The PC is considering a reform direction that proposes an expanded set of indicators to monitor Australia's circular economy progress. The outcomes captured in the proposed set are based on indicators used in more developed international monitoring frameworks. Outcomes would need to be tracked at reasonably granular level in order for the data to be used by governments and businesses to identify and track progress on circular opportunities. The proposed indicators include:

- Indicators relating to environmental outcomes from circular activities:
 - Waste generated by material type and sector
 - Recovery rates by material type and sector
 - Greenhouse gas emissions from production activities by sector
- Indicators relating to economic outcomes from circular activities:
 - Gross value added of circular economy activities by sector
 - Jobs in circular economy activities by sector
 - Business investment in circular economy activities by sector
 - Research and development expenditure on circular economy technologies by sector

Data on some indicators is already being collected and reported elsewhere. The PC notes that the feasibility of monitoring some of these indicators could be limited by the potentially large costs associated with attributing outcomes to circular economy activities, and disaggregating data by sector.



Information request 10.6
Expanding the set of circular economy indicators

The PC is interested in further information on the following questions:

- What are specific examples of how governments (at all levels) and businesses would use the proposed circular economy indicators to identify and track progress of circular opportunities?
- What would be the costs associated with gathering data on the proposed circular economy indicators?
- Which agencies would collect or estimate the data?
- How consistent across states and territories is the data needed for circular economy indicators? Does it allow comparison across industries or sectors?
- Are there alternative indicators that would better measure the progress of Australia's circular economy? What would be the benefits and costs associated with these alternatives?
- What reporting format would be most valuable and accessible to stakeholders using the monitoring data (e.g. including in the Measuring What Matters framework, or a separate dedicated dashboard)?
- Over what timeframe could the proposed expanded set of indicators be rolled out? How frequently should the set of indicators be reviewed and updated, so that they can remain fit for purpose to inform government and business decisions about the circular economy?

1. What is a circular economy?

Key points

- ✳ **The circular economy is about using materials, resources and products in ways that create sustainable and efficient outcomes for society.**
 - Australian businesses, households and communities are actively pursuing circular opportunities. They are innovating and forming new partnerships to deliver higher value from materials use.
 - Shifting to a circular product life cycle can reduce the negative environmental and economic impacts of the linear model.
- ✳ **While the circular economy is being increasingly recognised in policy, circular practices are not new.**
 - Aboriginal and Torres Strait Islander people have cared for Country for tens of thousands of years, and their knowledges can provide a powerful contribution to circular economy practices and policies. The Australian Government has noted the potential to better value these knowledges, and to facilitate equitable access to circular economy opportunities and benefits.
- ✳ **A circular economy can improve social, environmental and economic outcomes through decoupling materials use and wellbeing.**
 - There are win-win-win opportunities across these three dimensions. However, some circular economy activities require trade-offs – for example, reducing materials use may increase energy use.
- ✳ **Despite some uptake of circular economy opportunities in Australia, overall progress has been slow. The Australian Government has committed to doubling circularity by 2035.**
 - The slow progress is reflected in small increases in materials productivity, circularity and waste recovery rates over the last decade.
 - To achieve the goal of doubling circularity, the Australian Government has set targets to reduce material footprint per capita by 10%, increase materials productivity by 30% and achieve an 80% waste recovery rate.
- ✳ **Indicators measuring the circular economy should be interpreted with care. Considering a range of indicators provides a better overview of progress.**
 - While Australia's materials productivity is lower than the Organisation for Economic Co-operation and Development (OECD) average, this reflects its materials-intensive economy. Australia's materials productivity within each sector examined in this interim report is on par with other OECD countries.

1.1 Motivations for a circular economy

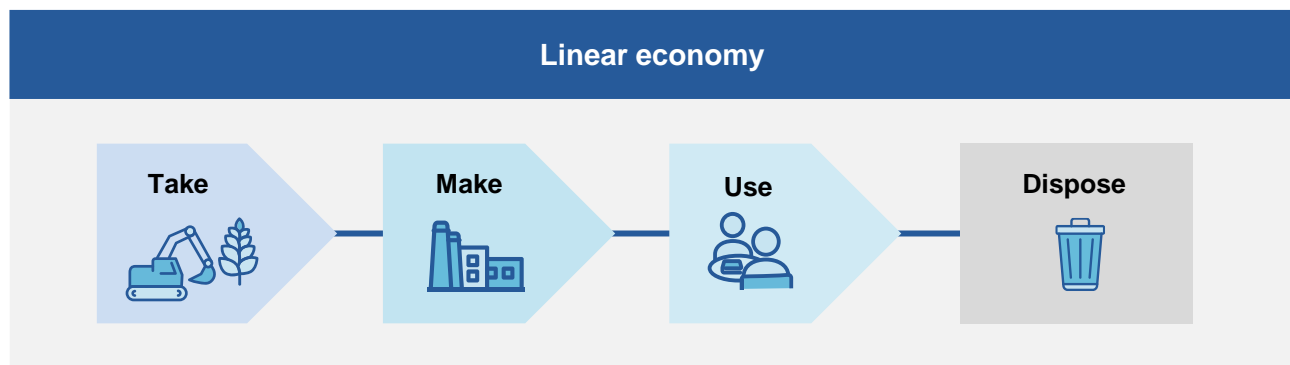
The product life cycle – linear to circular

The product life cycle describes the various stages in which a product is designed, manufactured, used and disposed of, or collected and recycled.

In a linear economy, goods are discarded into landfill, preventing further use of the products or their materials, representing a one-way flow.⁶ The linear economy is characterised by the take-make-use-dispose model (figure 1.1).⁷

- **Take** involves extracting raw materials from the environment. These materials generally replenish at a slow rate or do not replenish at all.
- **Make** involves manufacturing goods using the extracted raw materials.
- **Use** involves consuming goods until they are no longer deemed useful or are used up.
- **Dispose** involves discarding goods – generally in landfill.

Figure 1.1 – The linear economy model



Environmental and economic drawbacks of the linear economy

Throughout the 20th century, product life cycles predominantly followed the linear path. However, growing concerns over the environmental impacts of the linear economy have prompted a rethink. Many of these environmental impacts are domestic as well as global issues. Australian production and consumption decisions may have implications for the natural environment locally as well as in other countries. Conversely, the environmental impacts of production and consumption decisions overseas may also be borne by Australia.

These environmental impacts begin at the 'take' stage of the product life cycle. Globally, around 55% of greenhouse gas emissions result from extracting and processing material resources, making these activities the main drivers of climate change (UNEP 2024a, p. xiv). Additionally, biomass extraction and production are responsible for over 90% of land use-related biodiversity loss and water stress, posing a major risk to species extinction (UNEP 2024a, p. xiv).

⁶ Despite the term 'economy', this model relates only to the flow of physical materials. In a sense, the economy is anything but linear considering the decisions, relationships and transactions that feed into its complexity. Note that the term 'circular economy' (to be discussed later) also relates strictly to the physical flow of materials.

⁷ Some literature describes the model as 'take-make-dispose'.

Environmental impacts also occur at the 'make' stage. In 2021, greenhouse gas emissions from manufacturing and construction activities made up 13% of total global emissions (based on Ritchie et al. 2024). If unregulated, waste from these activities can also pollute surrounding waterways and land.

At the 'dispose' stage, products are generally discarded into landfill with no further use. However, the availability of sites for new landfills is an ongoing concern for Australian communities and local governments, as well as globally, with countries increasingly imposing restrictions on waste imports (Donovan and Pickin 2021, p. 10). Estimates suggest that the landfills servicing Greater Sydney will reach capacity by around 2030, with no suitable options currently available for new landfill sites (NSW EPA 2024f; Veolia Australia and New Zealand, sub. 8, p. 5).⁸ This poses a significant concern to the future security of Sydney's waste management system.

Even if suitable land is found to increase landfill availability, major environmental concerns remain with the disposal of waste into landfill (DCCEEW 2024d, p. 19). Landfill has negative impacts on the environment, including on biodiversity and air quality. For instance, leachate⁹ from landfills can contaminate groundwater and pose a risk to the biodiversity and regenerative capacity of surrounding ecosystems. Additionally, landfill gas (predominantly carbon dioxide and methane) poses a risk to air quality. If not properly managed, it can create odours and worsen climate change (EPA Victoria 2020).

Questions around the sustainability of the linear model have predominantly been driven by environmental concerns. Increased circularity can also have economic and productivity benefits, including intergenerationally, by more efficiently using the planet's finite stocks of natural capital (materials) to support our growing population and economy. These environmental and economic benefits also contribute to social outcomes such as better health and amenity and more sustainable development.

Full circle on the product life cycle

Shifting to a circular product life cycle reduces the negative environmental and economic impacts of the linear model. It involves activities throughout the product life cycle to reduce how much raw material is extracted to make the product, repairing and reusing the product as much as possible, and lowering the amount of waste sent to landfill by collecting and recycling materials (figure 1.2).

Early descriptions of the circular economy concept had a focus limited to recycling activities that sought to use component materials from goods destined for landfill as inputs to new, but not necessarily the same, products (Friant, Vermeulen and Salomone 2020, p. 7). These recycling activities created a link between the disposal and production of products, thereby introducing circularity to product life cycles. They also addressed environmental concerns by using recycled content, reducing demand for raw materials and the amount of waste sent to landfill.

Later iterations of the concept have incorporated activities throughout the product life cycle that can be categorised into closing, slowing or narrowing resource loops, a framework which has been adopted broadly (Bocken et al. 2016, p. 309; DCCEEW 2024d, p. 49). Interconnected loops encompass flows of resources beyond a single product.

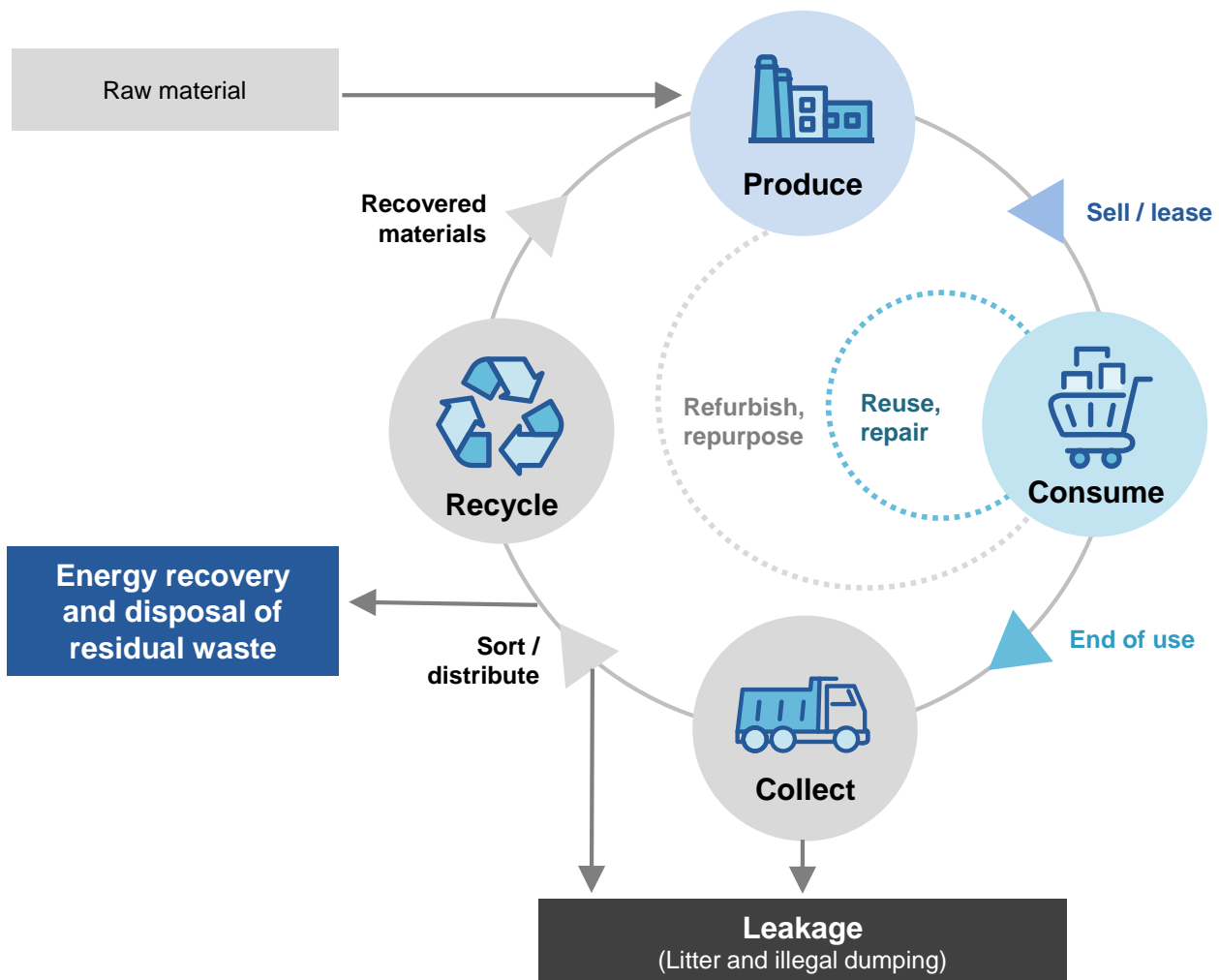
- **Closing resource loops:** These activities link the production and disposal stages, allowing for circularity in resource flow. Recycling activities, such as extracting and reusing materials from old batteries, close resource loops (BSC, sub. 140, p. 13).

⁸ Approvals for new landfill sites involve a lengthy process due to suitability checks and community consultation.

⁹ Leachate is a liquid contaminant prevalent in landfills. It is produced when rainwater and other moisture accumulates substances of concern that are released from the decomposition of waste.

- **Slowing resource loops:** These activities aim to increase the use of the product by either extending the product's life, increasing the intensity with which the product is used, or both. Activities that slow resource loops include designing products for durability, reusing products and repairing products. Retreading to extend the useful life of tyres is one example of this activity (TSA, sub. 148, p. 26).
- **Narrowing resource loops:** These activities aim to improve materials efficiency by minimising the amount of materials that go into a product. At scale, these activities reduce the aggregate demand for raw materials. An example includes the use of prefabrication in housing construction, which can lead to less materials use than onsite construction (BCSDA, sub. 175, pp. 10–11).

Figure 1.2 – A model of the circular economy



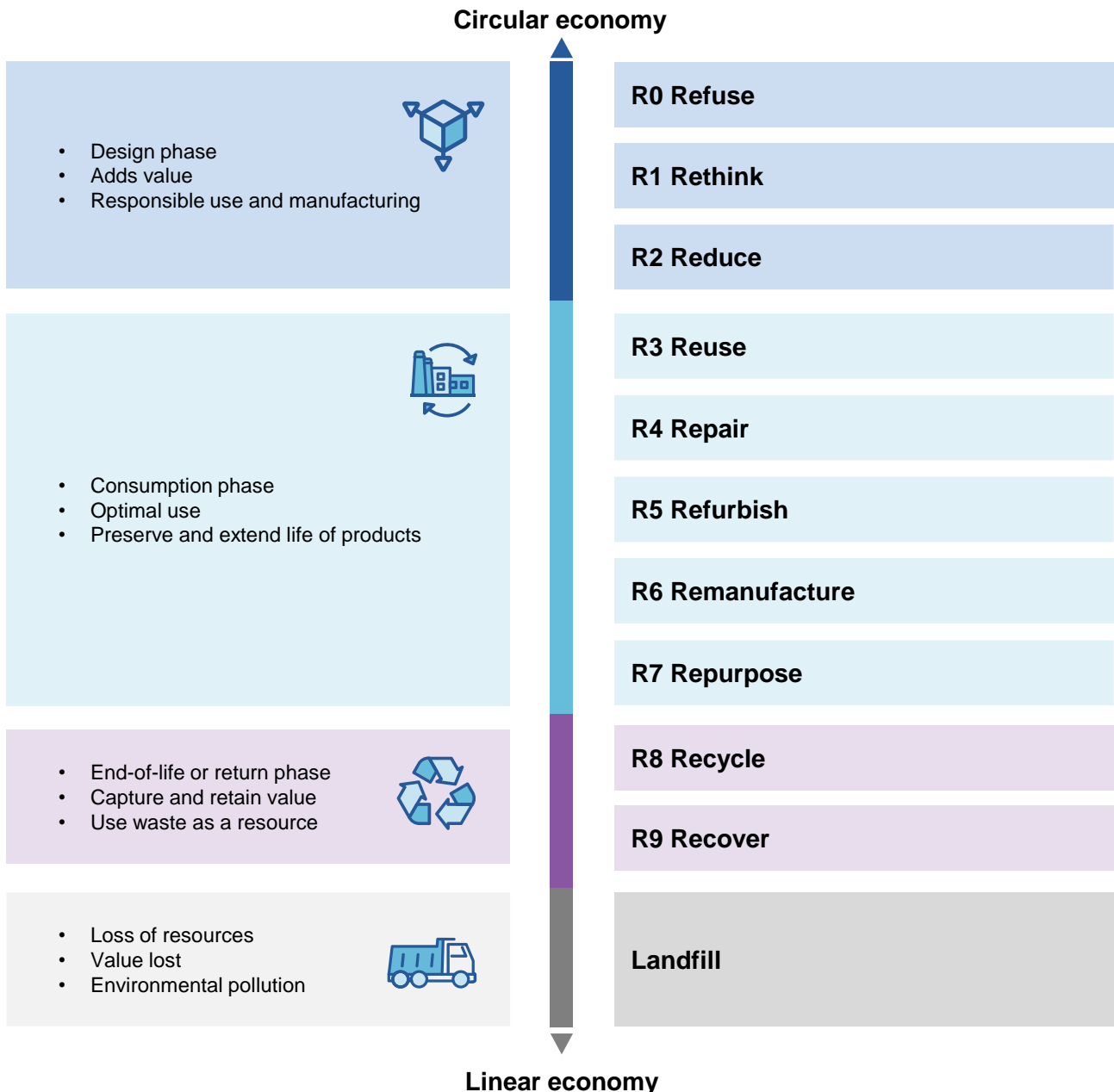
Source: Adapted from NSW DPIE (2021b).

The 10Rs is a widely used framework to articulate opportunities to increase circularity (figure 1.3) (Potting et al. 2017, p. 5). This framework categorises circular activities in a hierarchy, with 'higher-order Rs' focused on activities earlier in the product life cycle.

The terms of reference for this inquiry have directed the Productivity Commission to examine circular activities and opportunities focused on materials use and efficiency. Improving materials circularity has important implications for water and energy use and efficiency (DCCEEW 2024d, pp. 17, 101), and in identifying circular economy opportunities we have recognised these linked outcomes. However, broader

water or energy policy reform, or the much wider suite of policy levers that primarily aim to improve water or energy efficiency, are outside the scope of this inquiry.

Figure 1.3 – The 10Rs framework



Source: Malooly and Daphne (2023) adapted from Potting et al. (2017, p. 5).

Circular economy practices are not new

Aboriginal and Torres Strait Islander people hold deep cultural, social, environmental, spiritual and economic connections to Country. For more than 60,000 years, Aboriginal and Torres Strait Islander knowledges and practices have sustained the health of Country. These are holistic, place-based understandings that emphasise connections and relationships which provide a powerful contribution to concepts such as a circular economy (Poelina et al. 2020, p. 7).

There are various Aboriginal and Torres Strait Islander-led initiatives that undertake circular activities. These include activities undertaken by the Bega Local Aboriginal Land Council, such as providing circularity education and training, and delivering cultural land management programs (box 1.1). Additionally, the Cherbourg Aboriginal Shire Council operates the Cherbourg Materials Recovery Facility, which processes and recycles materials from waste collections around the Cherbourg region, supporting circular activities and providing work opportunities to the local community.

Box 1.1 – Bega Local Aboriginal Land Council

The Bega Local Aboriginal Land Council is involved in the circular economy primarily through delivering cultural land management programs, and providing education and training in circularity.

Aboriginal people have been in the circularity space for thousands of years. Caring for Country and circularity are interconnected, if you are caring for country you are participating in the circular economy. Cultural land management is very much about circularity, ensuring that things are replaced if they've been removed, to enable circular activity in the environment. For example, cultural fire practitioners ensure circularity in ecosystems during cultural burning, including collecting seeds and returning species to the natural environment.

Education and training in circularity is another piece of work we are involved in. We have established a mobile café, which provides hospitality training and employment opportunities for young Aboriginal people. This is a circular project, as it is interlinked with our horticulture venture – plants from the horticulture venture are used at the café and food waste is brought back to the horticulture venture to be used in the garden. A lot of young Aboriginal people haven't had opportunities to learn about caring for Country. This is one way for them to experience this while they are still at school, setting them up to work in this space in the future if they are interested. (Bega LALC, sub. 185, p. 1)

The Australian Government has made a commitment in its *Circular Economy Framework* to honour and integrate the deep knowledge systems of Aboriginal and Torres Strait Islander people, and include genuine partnerships with Aboriginal and Torres Strait Islander communities in further developing Australia's circular economy (DCCEEW 2024b, p. 5).

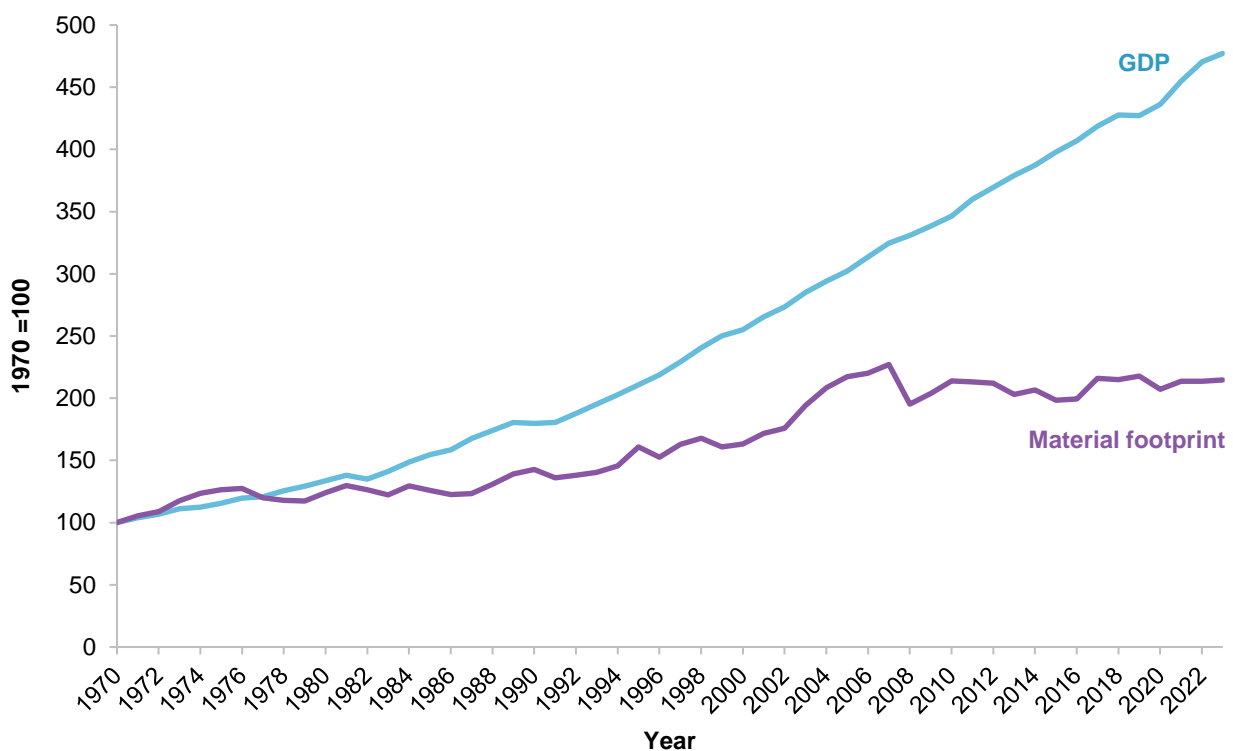
Governments, however, have some way to go on implementing the National Agreement on Closing the Gap priority reforms to enable true partnership (Priority Reform 1) (PC 2023b, p. 6). Aboriginal and Torres Strait Islander knowledges, practices and expertise need to be included in circular economy policies in ways that benefit communities and respect and protect cultural and intellectual property rights. Such ways include Aboriginal and Torres Strait Islander-led initiatives in resource management, agriculture and environmental stewardship, learning from Aboriginal and Torres Strait Islander practices in policy design, and partnering with communities in decision-making processes and circular precincts (Ford et al. 2020, p. 107; Planet Ark, sub. 147, p. 16; RMIT University Circular Economy Hub, sub. 31, p. 14).

Why does moving to a circular economy matter?

The economy can be strengthened while lowering materials use

Using less materials does not necessarily mean slower economic growth. In the last 40 years, the Australian economy has grown substantially while materials use has increased at a much slower rate (sometimes called 'decoupling' economic activity from materials – figure 1.4). Though many factors are likely to have driven this decoupling, it is in large part due to a shift towards services, which use significantly less materials than goods production. In the five decades between 1970 and 2020, the share of Australian economic activity generated by services has increased from 66% to 81% (PC 2021a, p. 6).

Figure 1.4 – Australia's material usage has grown more slowly than GDP since 1980
Materials decoupling in Australia, 1970–2023^{a,b}



a. Economic activity, measured through GDP, is used as it is not possible to quantify total welfare. While not a perfect proxy for societal welfare, economic activity is considered a significant contributor to it. **b.** Materials use is represented by material footprint. Material footprint measures the amount of materials needed to meet domestic consumption (by weight), incorporating all raw materials used across the global supply chain (section 1.2).

Source: OECD (nd).

Shifting to a circular economy is another way to achieve materials decoupling. It can reduce environmental harm and improve economic productivity by allowing the economy to grow while using fewer materials.

There are also other economic benefits to a circular economy. The shift could generate economic growth by creating new markets, products and job opportunities (DCCEE 2024d, p. 66). Circular economy opportunities can also improve economic diversity and capability as businesses adopt innovative business models that can lead to new production processes and products that are focused on sustainable design, reuse and recycling.

Circular activities can also achieve social benefits

While the environmental and economic aspects of the circular economy are relatively well established, social outcomes are often overlooked. An analysis of 114 definitions of the circular economy found that only 13% considered all three domains in their stated objectives of the circular economy (Kirchherr, Reike and Hekkert 2017, p. 227).

Social benefits of circular activities include improvements in health and safety, amenity, social inclusion and supporting Australians in need. For example, social enterprises engage in circular activities by conducting food rescue and distribution to those experiencing food insecurity, providing affordable repair services, and facilitating sharing models to increase accessibility to products such as toys (BCSDA, sub. 175, p. 8; OzHarvest, sub. 81, p. 9; Toy Libraries Australia, sub. 130, p. 2).

Many circular activities will have environmental, economic and social benefits. For example, selling imperfect fruit and vegetables at a lower price rather than disposing of the produce has economic, environmental and social benefits. Economically, producers benefit by generating revenue on produce that would otherwise be landfilled. Environmentally, selling this produce reduces the amount of waste going to landfill. Socially, lower produce prices improves equity and health as it enables access to affordable and healthy food for low-income households.

By improving environmental, social and economic outcomes, the circular economy has the potential to support the wellbeing of future generations. The global population is currently exceeding the planetary boundaries for climate change and biodiversity loss, meaning that there is a heightened risk for irreversible damage to the environment (Richardson et al. 2023, p. 5). Reducing materials extraction to lower biodiversity loss, avoiding pollutants, and mitigating greenhouse gas emissions will allow future populations to enjoy the same, if not better, level of wellbeing as current populations.

However, not all circular activities are win-win-win

While many circular economy activities will result in win-win-win situations (have environmental, economic and social benefits), other activities trade off one benefit at the expense of another. For example, prolonging the life of motor vehicles provides environmental and economic benefits through delaying their disposal and purchase of a new vehicle. However, this product life extension might reduce social welfare if a larger proportion of older cars, which lack the latest safety features and are less fuel efficient, continue to be driven.

There may also be trade-offs *within* each dimension – for example, where one environmental benefit (recycling) requires transporting materials by truck to a facility elsewhere, generating greenhouse gas emissions. In the example of prolonging the life of motor vehicles, there is an environmental trade-off between fuel efficiency and delaying disposal.

Ultimately, the goal of the circular economy is to improve public welfare. If the primary aim were circularity itself, it might reduce overall welfare due to the above trade-offs.

Shifting perspectives and behaviour

Policymakers are increasingly considering welfare across environmental, social and economic dimensions, driven by emerging evidence that planetary boundaries are being exceeded (DCCEEW 2024b, p. 10; OECD 2024, p. 12).

Consumer and business behaviours are also shifting to incorporate sustainable practices, as they become more conscious of the environmental impacts of their decisions (ACCC, sub. 178, p. 4).¹⁰ A recent survey by Australian Consumer Retail Studies found that 96% of the retail shoppers surveyed had engaged in at least one sustainable practice in the past three months (Zoppos 2024). But while sustainability has begun to influence consumer behaviour, price and quality are still the top drivers of purchases (ACRS 2024, p. 4).

Another recent study found that a relatively strong repair and maintenance culture for household goods exists in Australia. Reasons for undertaking repair activity varied by demographic, for example with younger and lower-income households motivated by cost, and women motivated by environmental reasons (Lane et al. 2024, p. 17).

Businesses have increasingly engaged with environmental, social and governance (ESG) principles in their operations (ACCI, sub. 76, p. 2). For large companies, ESG-related disclosures are typically discussed in sustainability reporting, with the vast majority (98%) of the ASX100 reporting on the sustainability of their operations in December 2023 (KPMG 2024). In 2024-25, this will extend to all large Australian companies following the introduction of mandatory sustainability reporting and standards. As part of this, companies will be required to report on scope 3 emissions; that is, emissions generated upstream and downstream of their own operations (The Treasury 2024c, p. 3). By increasing accountability and transparency of greenhouse gas emissions generated throughout a company's supply chain, this may provide an additional driver for businesses to take up circular opportunities.

As ESG reporting by businesses is becoming increasingly widespread due to compliance and market drivers, there is growing concern by consumers that many are 'greenwashing' and overstating the sustainability of their operations and products (ACCC, sub. 178, p. 4). An investigation of Australian company websites found that 57% of the businesses investigated had made concerning environmental claims (ACCC 2023a, p. 1).¹¹ The increasing development of ESG strategies and reporting indicates a mindset shift in the business community, and can be an important driver of behaviour change. However, social licence to operate will be damaged if this is matched by increasing instances of sustainability claims being overstated.

1.2 How is Australia progressing on a circular economy?

Targets to further circularity in Australia

The Australian Government has committed to doubling Australia's circularity by 2035.¹² To achieve this, targets for three metrics have been set across the product life cycle (DCCEE 2024b, p. 9). These include reducing material footprint per capita by 10%, increasing materials productivity by 30% and achieving a resource recovery rate of 80%. Recent modelling suggests that these are ambitious but achievable targets if

¹⁰ This shift in behaviour is part of a larger shift to consider sustainability, which is influenced by other environmental movements such as the shift to net zero emissions.

¹¹ To be classified as concerning, the business did at least one of the following: made vague/unclear environmental claims; did not provide evidence for their claims; set environmental goals without disclosing a course of action to achieve them; or used third-party certifications and symbols in a confusing way.

¹² This builds upon the Australian, state and territory governments jointly agreeing to national targets to increase Australia's circularity rate and reduce pollution (DCCEE 2024g, p. 1).

significant policy attention is given to increasing the level of circular economy activity in efficient ways (Miatto et al. 2024b, p. 25). There are four target indicators.

- **Circularity rate:** This indicator describes the extent to which secondary materials are used in an economy. It is defined by the proportion of non-virgin materials use against overall materials use, where materials use is measured by domestic materials consumption.
- **Material footprint:** This indicator measures materials needed to meet domestic consumption (by weight), incorporating all raw materials used across the global supply chain. It aggregates all materials use up to end consumption, regardless of where the materials have been extracted from.
- **Materials productivity:** This indicator assesses the amount of economic value generated from a unit of materials used (by weight). GDP at constant prices is used to measure economic value and materials use is measured by domestic materials consumption.
- **Waste recovered from landfill for reuse, recycling or energy (resource recovery rate):** This measure is indicative of resource recovery rates in an economy. It represents the proportion of waste that is diverted from landfill and reused, recycled or used in waste-to-energy activities. Over time, it could be used to assess the extent of closing resource loops.

Additional indicators can help measure progress on shifting to a circular economy. Developed by the Australian Government Treasury,¹³ the *Measuring What Matters* framework identifies and reports on a set of indicators that monitors the progress made towards a circular economy in Australia. Along with the target indicators above, there are two additional indicators.

- **Domestic materials consumption:**¹⁴ This indicator measures materials consumed in a domestic economy by weight. It measures the amount (weight) of materials extracted or harvested in the country, *plus* materials and products imported, *minus* materials and products exported.
- **Waste generation:** This indicator measures the amount (weight) of waste generated by an economy. If the indicator is assessed on a per capita basis, it could provide some insight into the uptake of activities that slow and narrow resource loops.

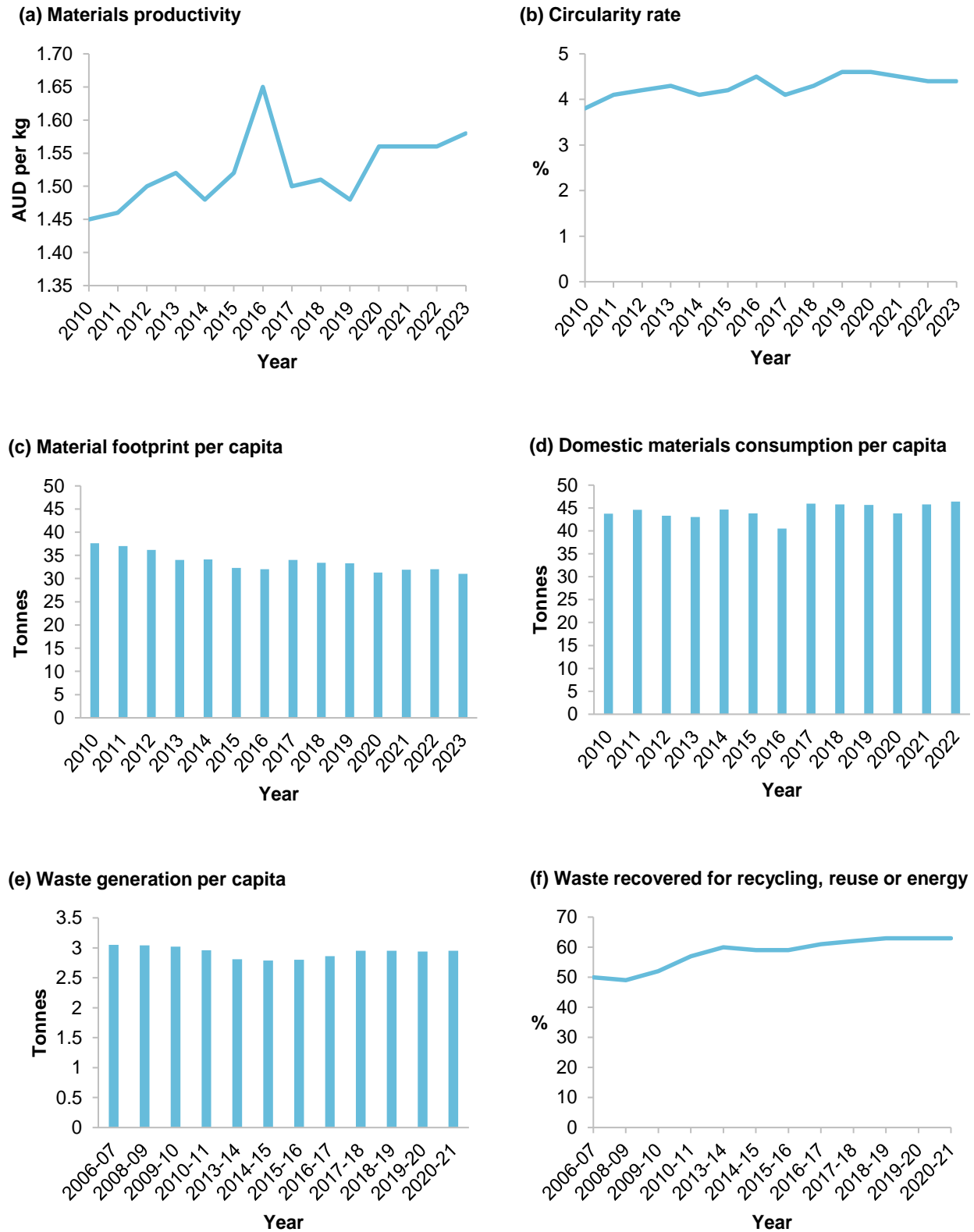
Trends in these indicators provide insights into the uptake of circular economy opportunities. In Australia, progress toward a circular economy has been slow (figure 1.5). Over the past decade, small increases in materials productivity may indicate that there has been some decoupling of economic welfare and materials use. Moreover, small increases in the circularity rate and waste recovery rate could reflect increases in the uptake of activities such as recycling.

The per capita domestic materials consumption and waste generation has remained relatively unchanged since 2010. This may reflect a similarly stagnant level of uptake of higher order activities, such as reuse and repair, each year. Increased uptake of higher order activities would be reflected by decreases in these indicators (Miatto et al. 2024a, p. 37).

¹³ Reporting on indicators in the *Measuring What Matters* framework is now a responsibility of the Australian Bureau of Statistics.

¹⁴ Domestic materials consumption is not an indicator that is separately identified in the *Measuring What Matters* framework. However, it is used to calculate materials productivity and the circularity rate, which are both measured in the framework.

Figure 1.5 – Circular economy progress indicators in Australia^a



a. Waste generation and recovery data was unavailable for the years 2007-08, 2011-12 and 2012-13.

Source: ABS (2024e); OECD (nd).

Indicators must be interpreted with care

Assessing progress on a circular economy requires a range of indicators – relying on a single indicator gives only a partial view. For example, the global circularity rate has recently declined (Fraser, Conde and Haigh 2024, p. 8), partly due to increasing materials complexity. This increasing complexity can result in materials becoming stronger and more durable¹⁵ – a benefit not captured by the circularity rate alone over shorter time frames. This may skew the picture of uptake of 'higher-order Rs' and longer-term progress towards a circular economy. Additionally, the single indicators that reflect materials use and waste generation provide insight into these activities in isolation. They do not provide insight into how these activities contribute to the cumulative effects on the environment, such as those caused by interactions between different environmental impacts over time (Cresswell, Janke and Johnston 2021, p. 124).

Moreover, many indicators rely on weight to measure materials use and waste, which does not necessarily reflect environmental impacts. Relying solely on weight-based measures to track the circular economy and implement circular initiatives can have unintended consequences, such as uptake of activities that do not address the environmental, economic or social objectives of the circular economy. For example, substituting plastic for other heavier materials in packaging may result in a decrease in domestic materials consumption and a subsequent increase in materials productivity. However, greater plastics use could have more negative environmental impacts than using heavier, but more inert, materials.

These limitations aside, the above indicators are a useful tool to measure circular economy progress. Considered together, they provide a better picture of the objectives of a circular economy than relying solely on aggregated economic variables such as GDP. However, they do not capture details about the circular economy's impacts across the environmental, economic and social dimensions. An additional suite of indicators would be required to monitor the uptake and outcomes of circular economy activities (chapter 10).

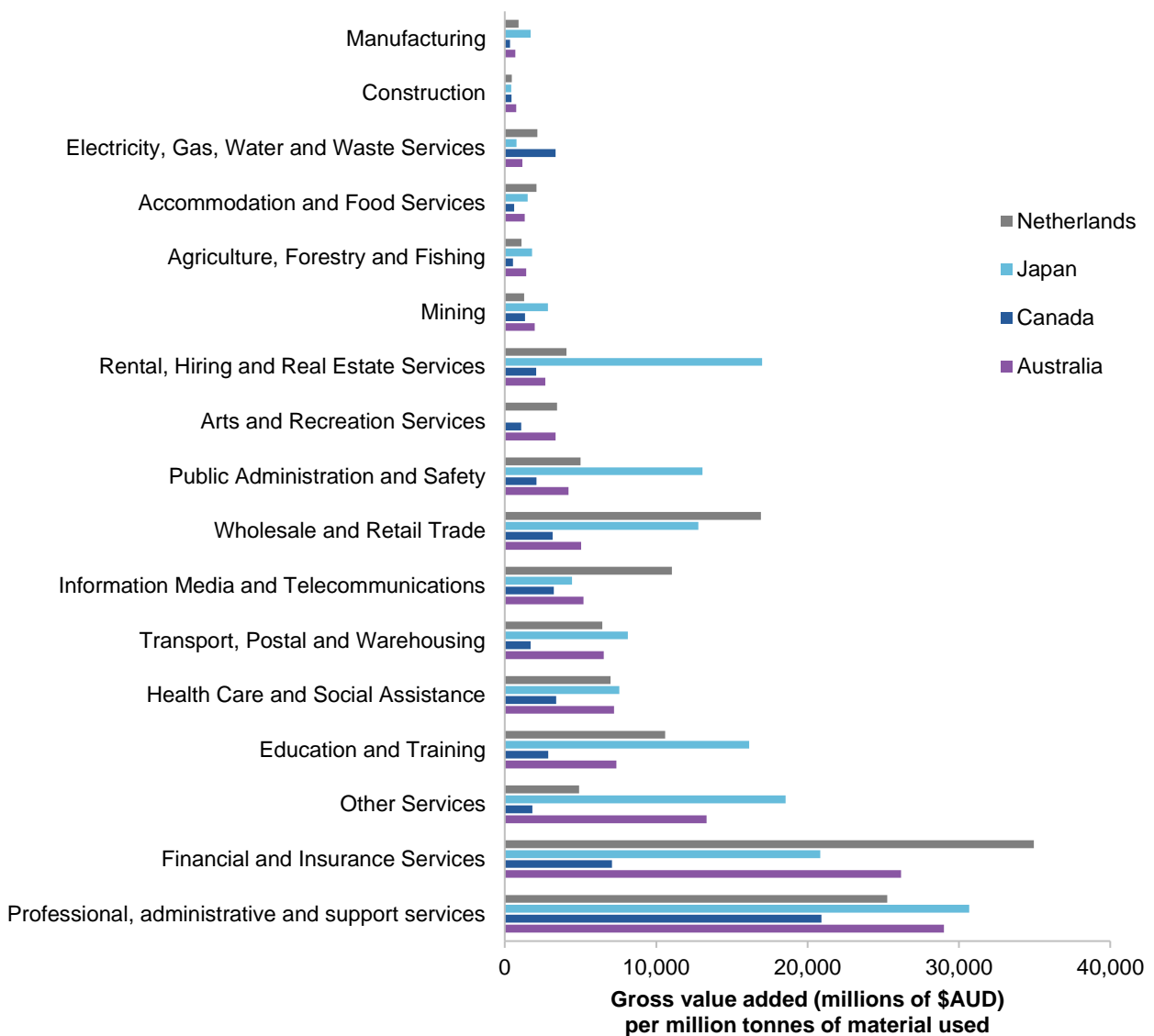
Comparing these indicators across countries can lead to misleading conclusions. Each country has its own unique industry structure, geography and demographics, which can impact progress on a circular economy. Regarding industry structure, different sectors have varying needs for materials use, with heavy industry sectors such as mining having greater materials use than service sectors such as professional services. This influences results for countries that have larger materials-intensive sectors, such as Australia.

Australia's materials productivity is largely explained by its industry structure

Sectoral comparisons across countries can be more useful, as they control for some of the variation in industry structure, geography and demographics. Compared to other Organisation for Economic Co-operation and Development (OECD) countries such as the Netherlands, Japan and Canada, Australia's materials productivity within each sector is on par with other countries (figure 1.6). This suggests that Australia's materials productivity of US\$1.10, which lags the OECD average of US\$2.50 (OECD nd), is explained in large part by the dominance of materials-intensive sectors in the Australian economy.

¹⁵ Carbon fibre is an example of a complex material. It can be used to substitute for steel in some applications and offers an improvement on strength when considered on a strength to weight basis. However, carbon fibre is technically difficult and costly to recycle compared to steel (Isa et al. 2022, pp. 3–4).

Figure 1.6 – Materials productivity by sector^{a,b,c,d}
Australia, Netherlands, Japan and Canada



a. Due to data availability, the reference period for the Netherlands, Japan and Canada is 2022, and for Australia it is 2020. **b.** Data was unavailable for gross value added of ‘Arts and Recreation Services’ in Japan. **c.** Sectors are organised by Australian and New Zealand Standard Industrial Classification divisions. ‘Professional, Scientific and Technical Services’ has been combined with ‘Administrative and Support Services’, and ‘Wholesale Trade’ has been combined with ‘Retail Trade’ due to the granularity of data available. **d.** International data was converted into Australian dollars using a point-in-time exchange rate on 27 September 2024.

Source: ABS (2024c); ADB (2023); Statistics Canada (2024); Statistics Netherlands (2023); UNEP (2024d).

2. The role of government in fostering a circular economy

Key points

- * **People and organisations are motivated by financial, environmental and other reasons to adopt circular practices, but sometimes face barriers.**
 - Barriers to adopting circular economy approaches include high upfront costs for changing production processes or new business models, outdated or prescriptive regulation, limited practical information on circular economy opportunities, and coordination failures.
- * **Historically, governments focused largely on the 'end' of the product life cycle through waste management and recycling.**
- * **All levels of government now have policies and programs in place to support Australia's transition to a circular economy. The responsibilities and activities of different levels of government reflect the division of powers in the Constitution.**
 - The Australian Government's *Circular Economy Framework* has set national targets for circularity, and a range of Commonwealth legislation and agencies play a role in environmental and other policy areas that impact circular economy activities.
 - State and territory governments enable the circular economy through policies and programs including regulating and managing waste, bans on single-use plastics and public procurement of recycled content.
 - Local governments deliver waste management services, educate and raise awareness. In some cases, they also support innovative circular practices.
 - Coordination across jurisdictions (such as Ministers' meetings, heads of government agency forums, senior official and officer-level working informal and formal groups) supports policy alignment.

2.1 What drives and what impedes circularity?

Businesses and individuals are motivated by a range of reasons to pursue circular opportunities ...

Businesses and individuals pursue circular opportunities for a range of reasons including where it makes financial sense, and out of their concern for the environment. Government policy settings also influence actions, such as through environmental protection regulation and enforcement, waste levies, sustainability

requirements in grants, procurement specifications, and a range of other legislated penalties or mechanisms (e.g. the Safeguard Mechanism).

Individuals can often save money by repairing objects or using them until the end of their life, rather than replacing them prematurely. For businesses, production processes that require fewer materials can reduce input costs whilst also minimising waste. Businesses may also adopt circular approaches in response to preferences by consumers and/or shareholders for environmentally positive products, as this may create brand reputation and loyalty, increasing demand and market share (ResiLoop, sub. 84, p. 5).

Businesses and individuals may also be motivated to take up circular economy activities by concern for future generations, societal expectations, altruism or other sustainability reasons. People who are motivated by a sense of responsibility to minimise their impact on the environment might choose to purchase sustainably produced goods and services, or use goods for longer before replacing them. And, as discussed in chapter 1, businesses are increasingly adopting environmental, social and governance (ESG) principles in their practices. The proportion of ASX200 companies with 'detailed' and 'comprehensive' ESG disclosures increased from 55% in 2019 to 71% in 2021 (ACSI 2022, p. 8). Besides private for-profit businesses, there are also community organisations and social enterprises which aim to increase circularity (for example, The Reconnect Project (sub. 134, p. 2) repairs and refurbishes old electronic devices to provide to disadvantaged and at-risk groups).

... but can also face barriers to adopting circular practices

Regulations sometimes make it hard for businesses to adopt circular economy activities. While regulations reduce or mitigate the risks of adverse outcomes, regulations that are too prescriptive, outdated or complicated can hinder the uptake of more circular practices. For example, businesses wanting to develop and market innovative waste-derived products rely on regulatory arrangements to ensure consumer and public confidence about the safety and environmental credentials of their products. Enforcement of regulations (such as to protect the environment, from waste dumping/pollution) are also critical to their business, as they underpin incentives for suppliers. However, where these businesses are creating 'new' products they may find some environmental and regulatory licensing schemes complex and time-consuming to navigate. Inconsistent regulations across jurisdictions can also pose barriers to businesses (chapter 10).

Specific ways in which regulation hinders adoption are explored in more detail in the sector-specific chapters 4 to 9. Examples raised by participants in this inquiry include:

- Australian standards can limit the use of recycled materials (Vinyl Council of Australia, sub. 32, p. 4)
- current waste classifications (for example, anaerobic digestate) limit the ability to recover waste (Centre of Decommissioning Australia, sub. 46, p. 14; RGA, sub. 50, p. 8), including transporting materials made from waste products (raised by inquiry participants in consultations)
- restrictions on locations where the thermal treatment of waste to energy can be undertaken (Dubbo Regional Council, sub 68, p. 2).

Businesses also face costs when changing existing production processes and business models. For example, finance may be more expensive and difficult to access, including because circular technologies may be relatively new and expensive to implement; or lenders might perceive them as higher risk or challenging to value. The price businesses need to pay for feedstock, or that they can command in the markets for their products, may reflect that negative externalities from using virgin materials are not accounted for.

A report by the International Chamber of Commerce and Ernst & Young (2024, pp. 13–14) detailed four financial barriers to the adoption of more circular approaches:

- additional insurance premiums associated with circular materials due to high costs of reprocessing and limited supply in a predominantly linear economy
- upfront investment required for research and development and upscaling circular approaches
- current accounting and financial practices unable to accurately value the financial benefits from circular approaches
- impact on near-term bottom line means that it is harder for products produced with circular approaches to compete with those that follow a linear path.

Imperfect information can also hinder adoption. Households and businesses may not have clear information on the recyclability of different items. As a result, they may dispose of these items through landfill, or recycle incorrectly and contaminate waste streams.¹⁶

Businesses can also experience barriers to coordination, which is essential for facilitating many circular opportunities. For example, they may lack information and knowledge about where to source feedstock or find buyers for their waste products, or be unaware of government programs that might provide financial support or assistance in navigating regulatory processes.¹⁷

2.2 Rationale for a government role in the circular economy

Government policy levers are important to improve overall wellbeing when the decisions of private actors, such as individuals and businesses, fail to deliver outcomes that maximise net benefits to the community. As noted in this inquiry's terms of reference, 'regulatory frameworks and policy actions influence businesses' and households' decisions on materials purchasing, use and replacement or the competitiveness of circular economy initiatives'.

Several reasons justify targeted government intervention to address barriers to improving materials productivity and support opportunities in the circular economy.

- **Externalities** arise when costs or benefits from purchasing goods or services are not reflected in their price. For example, environmental damage from resource extraction is a negative externality that may not be included in prices.
- A **public good** is something that anyone can use, such as clean air and biodiversity. Without government intervention, the value of these goods are often not protected sufficiently because no one is excluded from using or prevented from harming them. Shared or freely available environmental resources can also be overused.
- **Information asymmetry** is when different parties have different amounts of information. This can make it hard to make decisions that benefit the community. For example, people who want to make sustainable choices might not have enough information about the impact of their purchases (section 2.1).
- **Equality of opportunity** means a fair distribution of resources across society and over time. Governments may try to address inequalities, such as the environmental impacts on future generations due to the current use of materials.

¹⁶ Veolia Australia and New Zealand, sub. 8, p. 3; Boomerang Alliance, sub. 2; Chad, sub. 19, p. 3; Infrastructure Victoria, sub. 28, p. 7.

¹⁷ For example, Wannon Water (sub. 88, p. 2); CODA (sub. 46, p. 15); Vejnovic, Schepis, Purchase and Tarabashkina (sub. 24, p. 2); COREO (sub. 104, p. 12); Circular Australia (sub. 126, p. 13); Business Chamber Queensland (sub. 136, p. 10); TSA (sub. 148, p. 92); GlobalPSC (sub. 149, p. 44); CIPS Australia and New Zealand (sub. 161, p. 5).

Australia's Circular Economy Framework noted that governments 'can create the conditions that allow circular systems to thrive by implementing supportive policies, providing financial incentives, and encouraging collaboration and behaviour change across sectors' (DCCEEW 2024b, p. 30).

Governments should only intervene where the benefits to community wellbeing from doing so exceed the costs. But assessing benefits and costs, and valuing policy outcomes, is difficult – particularly when outcomes span interconnected economic, environmental and social dimensions as in the case of the circular economy (chapter 1). Governments also need to select and design policy mechanisms to appropriately target the activities (of producers or consumers) or points in the supply chain most effective for achieving the desired outcome. Government policies and regulations may also have unintended consequences and costs. The reform directions considered in this interim report cover existing policies and regulations that could be unnecessarily hindering adoption, as well as new opportunities for government to act on circularity.

The three level of governments in Australia have different roles and responsibilities in the circular economy. Australian Government and state and territory governments' roles and responsibilities are shaped by the division of powers in the Constitution. In the Constitution, both the Australian Government and state and territory governments have concurrent powers with respect to the environment (PEO nd). For example, waste management is primarily the responsibility of state and territory governments, delivered through legislation, policies and programs. The Australian Government is responsible for national legislation, strategies and policy frameworks, including obligations under international agreements, and recently launched *Australia's Circular Economy Framework* to support Australia's circular economy transition (DCCEEW 2024b). Local governments are responsible for waste, as laid down by the regulatory framework of each state or territory.

2.3 Australia's circular economy policy landscape

Current circular economy policies

Circular economy policies have evolved over time and predate the more widespread use of the term 'circular economy'. Australian governments have long managed waste, initially focusing on disposal. This changed during the 1990s, with a growing appreciation that 'the current high levels of consumption without the efficient use of resources and waste minimisation are not ecologically sustainable' (Senate Standing Committee on Environment, Recreation and the Arts 1994, p. 1). Policies shifted to also incorporate waste minimisation, with the National Kerbside Recycling Strategy and National Waste Minimisation Strategy introduced in 1992 (Senate Standing Committee on Environment, Recreation and the Arts 1994, p. 11). More recently, governments have considered environmental impacts along all parts of the product life cycle.

In Australia, governments at all levels have policies and programs in place to support circular economy activities (table 2.1). Many policies directly relate to circular economy practices by targeting materials use and waste, while others that are aimed at reducing negative environmental impacts more generally may also encourage greater circularity and can be sector-specific. Circular practices are also influenced by a wide range of other policies and interventions (table 2.1).

Table 2.1 – Circular economy policies and interventions by level of government

Level of government	Type	Circular economy, materials use and waste	Other
Federal	<ul style="list-style-type: none"> Frameworks and strategies Laws and regulation Financial incentives Product stewardship Public procurement Foreign policy Education and awareness 	<ul style="list-style-type: none"> Australia's Circular Economy Framework National Waste Policy National Waste Policy Action Plan National Plastics Plan National Food Waste Strategy <i>Recycling and Waste Reduction Act 2020</i> (Cth) <i>Hazardous Waste (Regulation of Exports and Imports) Act 1989</i> (Cth) Australia's Ending Plastic Waste Mission Recycling Modernisation Fund Food Waste for Healthy Soils Fund Product stewardship schemes National standard for data and reporting on waste and resource recovery (WRR) National Framework for Recycled Content Traceability Environmentally Sustainable Procurement Policy and Reporting Framework Water and Energy Efficiency Labelling schemes 	<ul style="list-style-type: none"> Climate change policies^a Water policies – legislation and regulation Environment conservation protection laws Consumer protection laws Regional development programs Precinct programs including Regional Precincts and Partnerships Program and Urban Precincts and Partnerships Program Financial regulation Insurance law National Reconstruction Fund Clean Energy Finance Corporation Future Made in Australia Northern Australia Infrastructure Facility Construction code Nature Repair Market Critical Minerals Strategy National Agreement on Closing the Gap
State and territory	<ul style="list-style-type: none"> Frameworks and strategies Laws and regulation Financial incentives Service delivery Public procurement Education and awareness 	<ul style="list-style-type: none"> Circular economy plans or strategies (all states and territories to some extent^b) Waste management regulation Waste levies (all states and territories, except the NT, with different rates^c) Container deposit schemes (all states and territories^d) Single-use plastic bans (all states and territories^e) E-waste to landfill bans (only Vic, SA and WA have bans on e-waste to landfill^f) Waste to energy approaches (all states and territories except NT and Tas) Plastics strategy Sustainable procurement (all states and territories to some extent^g) 	<ul style="list-style-type: none"> Environment conservation and protection laws and agencies (all states and territories) Net Zero and energy strategies (all states and territories) Construction codes (all state and territories) Regional development strategies, plans, blueprints, and frameworks (all states and territories) Infrastructure planning, funding and policies Precinct plans (all states and territories)

Level of government	Type	Circular economy, materials use and waste	Other
		<ul style="list-style-type: none"> Waste strategies/programs for Aboriginal and Torres Strait Islander communities (Qld and NSW) 	<ul style="list-style-type: none"> Business concierge services (NSW and SA) Land use planning and zoning Critical minerals strategies and roadmaps (Qld, NSW, WA, Tas)
Local	Financial incentives Education and awareness Service delivery Public procurement	<ul style="list-style-type: none"> Waste, recycling and food organics and garden organics (FOGO) collection Community education programs Repair programs 	

a. Climate change policies at the Commonwealth level include the Renewable Energy Target, Safeguard Mechanism, Australian Carbon Credit Unit Scheme, Capacity Investment Scheme and New Vehicle Efficiency Standard. The Australian Government intends to release a Net Zero Plan in 2025, supported by six sectoral emissions reduction plans. b. The comprehensiveness of circular economy plans or strategies varies widely across states and territories. Some states and territories incorporate their circular economy plans within their waste management strategies. c. The Northern Territory is considering introducing a waste levy. d. Tasmania’s container deposit scheme (called Recycled Rewards) is scheduled to commence in mid-2025 (Tasmanian NRE 2024a). e. The Northern Territory has announced an intent to phase out single-use plastics by 2025. Tasmania has a ban on lightweight shopping bags and has a commitment to phase out certain single-use plastics and materials in 2025 f. The Australian Government has committed to introducing a mandatory product stewardship scheme to reduce waste from small electronic products (DCCEEW 2024n). g. Some states and territories have a dedicated sustainable procurement policy/guideline whereas others incorporate sustainable principles in their procurement policy/guidelines.

Source: Productivity Commission research.

In 2022, all Australian Environment Ministers agreed to work with the private sector to design out waste and pollution, keep materials in use, and foster markets to achieve a circular economy by 2030 (DCCEEW 2022a), and in 2024 agreed to increase Australia’s circularity rate (DCCEEW 2024g).

The **Australian Government** is responsible for national legislation, strategies and policy frameworks, including measures that give effect to obligations under international agreements (such as meeting Australia’s obligations under the Basel Convention through the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*). Frameworks and strategies include Australia’s Circular Economy Framework, National Waste Policy, National Waste Action Plan, National Plastics Plan and National Food Waste Strategy. The Australian Government also plays a role in some product stewardship schemes (discussed below). And it applies tax and other financial incentive levers, such as through the Recycling Modernisation Fund, which is provided jointly with states and territories, and Future Made in Australia. The Australian Government also includes or incentivises uptake of sustainable products and services through its Environmentally Sustainable Procurement Policy and Reporting Framework. These levers are discussed in further detail, where relevant, in sector chapters.

The Circular Economy Ministerial Advisory Group (CEMAG) final report was released by the Australian Government in December 2024. One of the report’s key recommendations was to establish the abovementioned National Circular Economy Framework. This framework was also released in December 2024 and sets three targets to support the goal of doubling Australia’s circularity by 2035:

- reducing material footprint by 10% on a per capita basis compared to 2024 levels
- lifting materials productivity by 30% on a per capita basis compared to 2024 levels
- safely recovering 80% of resources by 2030 (as reflected in the National Waste Policy Action Plan) (DCCEEW 2024b, p. 9).

It sets out short-to-medium term priorities in four sectors (industry, built environment, food and agriculture, and resources) (DCCEE 2024b, p. 16) and includes enablers and crosscutting objectives to pursue these priorities. The role of governments to support Australia's transition to a circular economy, according to the Framework, will be to 'set the direction and provide the foundation ... by implementing supportive policies, providing financial incentives and encouraging collaboration, and behaviour change across sectors' (DCCEE 2024b, p. 30). The enablers are focused on better design, higher quality and verifiable recycled materials and embedding circularity in frameworks and standards.

The Australian Government also has an important forward-looking role to identify and manage emerging issues, such as those posed by hazardous chemicals. For example, a Senate Committee is currently inquiring into the regulation and management of per and polyfluoroalkyl substances (PFAS), including the effectiveness of current and proposed federal and state and territory regulatory frameworks to control the risks of PFAS to human health and the environment (Parliament of Australia nd).

State and territory governments' circular economy policies predominantly focus on waste management and resource recovery. They have various legislation, regulations and programs in place to govern what happens to materials at the end of the product life cycle, such as plastics bans and waste levies (discussed further below). State and territory governments also play an essential role in enforcing environmental protection regulations.

State and territory governments provide financial incentives such as grants and funding to support circular economy approaches – both jointly with the Commonwealth through the Recycling Modernisation Fund, and through their own programs such as Queensland's Resource Recovery Industry Development Program and Victoria's Recycling Victoria Infrastructure Fund (QLD Department of the State Development, Infrastructure and Infrastructure 2024; Victorian Government 2022). Many state and territory governments also support the circular economy through sustainable procurement. For example, the SA Government has the Green Procurement Guideline and the WA Government has the Environmental Procurement Guide.

Some state and territory governments have initiatives aimed at earlier parts of the product life cycle such as:

- Victoria's Circular Economy Business Innovation Centre, which supports organisations to adopt circular economy practices such as through improving resource use, adopting innovative approaches to sustainability and developing future-proof models to design out waste (CEBIC 2023)
- NSW's Circular Materials Fund, which provided a financial incentive for producers to design out or replace carbon emissions-intensive virgin plastic with lower carbon-intensity recycled materials (NSW DPIE 2021b).

Within a circular economy, **local governments** generally provide services and manage infrastructure.

Local governments are responsible for waste management within their local areas as laid down by the regulatory framework within their state or territory. Local governments collect household waste and recyclables, manage and operate landfill sites, deliver education and awareness programs, and provide and maintain litter infrastructure. For example, many councils implement waste sorting behaviour campaigns and promote reusable products (e.g. nappies) to local residents.

Local government contexts differ considerably, such as from urban to regional to remote; and across population densities and different communities, environments and local economies. This is reflected in the range of ways that they support circular economy, through such activities as:

- introducing or increasing the use of recycled materials in their operations and procurement (such as in local road construction)
- reusing materials in the refurbishment of community facilities
- using artificial intelligence to sort waste

- partnering with charities to reuse and repair goods (Bower Reuse & Repair Centres nd; Australian Local Government Association, sub. 21, p.4; CASC 2021).

Australian Government involvement in product stewardship schemes varies

Product stewardship puts responsibility on industry, manufacturers and/or importers to manage the environmental impacts of products and materials over their life cycle. A product stewardship scheme aims to encourage changes in all parts of a product’s life cycle, from design to disposal, to minimise materials use and waste. Requiring businesses that make or sell products – rather than end consumers – to be responsible for environmental impacts can lead to greater change across the life cycle, as businesses have more direct control over design and production decisions earlier in the supply chain. At the same time, these businesses can choose to pass the costs of product stewardship obligations onto consumers through higher prices.

The Australian Government has an important role in providing national leadership for product stewardship schemes, as it is challenging for state and territory governments to lead implementation and enforcement, since much of these schemes’ activities require coordination at a national level across businesses in a given industry. The *Recycling and Waste Reduction Act 2020* (Cth) provides for three categories of product stewardship schemes in Australia:

- industry-led voluntary schemes – these can operate independently of or be accredited by the Australian Government
- co-regulatory arrangements between industry and government – a combination of industry action and supporting government regulation to achieve specified outcomes, such as improving product design or increasing recycling
- mandatory schemes – these are set under law and used when other types of product stewardship schemes are unsuitable or when mandatory arrangements deliver a greater net benefit to the community (DCCEEW 2024w; Product Stewardship Centre of Excellence nd).

There are already a number of product stewardship schemes in place in Australia (table 2.2), though most industry-led schemes are individual businesses with recycling or returns programs for their own (or related) products, rather than industry-wide initiatives. Each year the Environment Minister lists priority products for action. When there is insufficient progress of stewardship schemes for products identified on the Minister’s priority list, the government may consider implementing a mandatory scheme (DCCEEW 2024w).

Table 2.2 – Current product stewardship schemes in Australia

Mandatory	Co-regulatory ^a	Government accredited industry-led voluntary
Oil	TVs and computers	Mobile phones
	Plastics and packaging ^b	Tyres
	Cash for Containers – NT	Large plastic bags
	Container Deposit Scheme – ACT	Batteries
	Container Deposit Scheme – SA	Aluminium cladding
	Container Deposit Scheme – QLD	Plastics and packaging ^b
	Container Deposit Scheme – VIC ^c	Plastic paint pails
	Container Deposit Scheme – WA	Newspapers and magazines ^d
	Return & Earn – NSW	

Mandatory	Co-regulatory ^a	Government accredited industry-led voluntary
Industry-led schemes^a		
<p>Aldi Battery Recycling, Apple product stewardship initiatives, Australian Food Pact, Australia Post product stewardship initiative, Back to MAC product stewardship initiative, Bata PVC gumboot recycling program, Bedding Stewardship Scheme, BIC Writing Instrument Free Recycling Program, Big W Toys for Joy, Boral product stewardship initiatives, Brickworks Carbon Offset Program, Canon Oceania product stewardship initiatives, Cartridges for Planet Ark, ChemClear, Chemists' Own Blister Pack Free Recycling Program, Compose Connect, Comsol packaging stewardship initiative, Conscious Koala product stewardship initiative, Construction Plastics Recycling Scheme, David Jones BeautyCycle, drumMUSTER, EDMI product stewardship initiatives, Fluorocycle, Fronius product stewardship initiative, FujiFilm product stewardship initiative, Furniture 360, Game On Recycling, Good Citizens product stewardship initiatives, Green Caffein product stewardship initiative, Havianas Free Recycling Program, HP product stewardship initiatives, IKEA buy-back product stewardship initiative, Kathmandu product stewardship initiatives, Kitx product stewardship initiative, Maybelline Greener Together Free Recycling Program, MECCA Beauty Product Free Recycling Program, National Clothing Product Stewardship Scheme (Seamless), Nespresso Coffee Pod Recycling, Nude Jeans repair initiative, Officeworks product stewardship initiatives, Paintback, Patagonia Worn Wear Program, Plastics Stewardship Australia, Plumbing Industry Plastic Recycling Scheme, PP5 Recycling, PVC Recycling in Hospitals Program, PVC Stewardship Program, Responsible Care, ResiLoop – Stewardship for resilient flooring^c, ResponsibleSteel, Rip Curl wetsuit takeback and recycling program, Schiavello product stewardship initiative, Schulz Organic Dairy Milk in Glass, ShawContract product stewardship initiatives, Simply Cups, Sustainable Living Fabrics, Sustainable Salon Recycling Service, SVC product stewardship initiatives, Tarkett product stewardship initiatives, Telstra product stewardship initiatives, The ICONIC product stewardship initiatives, Tip Top product stewardship initiative, TreadLightly, UCI product stewardship initiatives, Woven Image EchoPanel initiative, YUMEFoods product stewardship initiative</p>		

a. There are also a number of product stewardship schemes in development which include: A circular economy for silage wrap, Container Refund Scheme – TAS, Cosmetics Product Stewardship Program, End-of-life vehicle waste management solutions, Fit for Office, National non-packaging agricultural initiative, National Plastics Recycling Scheme, PODcycle, Project Divert, Recycling Used Oil Containers, SeatCare and TexBack: PVC polyester textiles stewardship scheme. **b.** There is both a government accredited industry-led voluntary scheme and co-regulatory arrangements for plastics and packaging. **c.** These product stewardship schemes are in operation but at the time of writing this report they were still listed as in development on the Product Stewardship Centre of Excellence's Product Stewardship Gateway. The most recent update of the Product Stewardship Gateway was completed in May 2024 and was updated based on published financial year 2022 and financial year 2023 annual performance data that was collated between late 2023 to April 2024 (Product Stewardship Centre of Excellence, pers. comm., 8 January 2025). The next update of the Gateway is scheduled for the first half of 2025 (Product Stewardship Centre of Excellence, pers. comm., 8 January 2025). **d.** The newspapers and magazines product stewardship scheme ThinkNewsBrands is listed as a government accredited scheme on the DCCEE website but not on the Product Stewardship Centre of Excellence's Product Stewardship Gateway.

Source: Department of Climate Change, Energy, the Environment and Water (2024w); Product Stewardship Centre of Excellence (2025); Engage Victoria (nd) and ResiLoop Limited, sub. 84, p. 1.

Many participants submitted to this inquiry that product stewardship schemes could have significant benefits. For example, WWF Australia (sub. 44, p. 4) suggested that effective product stewardship schemes help Australia avoid being the dumping ground for manufactured goods, including white goods, that have inbuilt obsolescence. Planet Ark (sub. 147, p. 5) raised that holding producers accountable for the products they place on the market will encourage designs that prioritise durability, repairability and recyclability. Wannon Water (sub. 88, p. 3) put forward the need for 'strengthening of product stewardship regulation to make purchasing easier and create and strengthen regional markets for secondary materials'. Some participants also raised the need for greater national oversight on product stewardship to level the playing field so there are no free riders.

However, implementing mandatory product stewardship schemes has costs, both upfront in setting up the scheme and in the ongoing monitoring and enforcement of businesses' compliance with the scheme's requirements. And moving too fast to mandatory arrangements can reduce opportunities for businesses to join and 'buy-in' to the scheme. Heavier government intervention should only occur where the benefits to

community wellbeing arising from a mandatory scheme exceed these costs. DCCEEW are currently completing a statutory review of the *Recycling and Waste Reduction Act 2020* (Cth), which will consider 'the limitations of the current approaches to product stewardship, including concerns around the viability, integrity and impact of stewardship schemes supported by the Act' (DCCEEW nd).

As stewardship schemes are typically product or industry-specific, they are explored in more detail in the sector-specific chapters 4 to 9, where such schemes exist or have been suggested for a relevant sector.

Some states and territory policies are similar but not aligned

Almost all states and territories collect waste levies from waste operators, which in turn pass on the costs to businesses and households disposing waste at their facilities.¹⁸ By putting a price on landfill, levies provide an incentive for businesses and households to reduce or recycle waste. Waste levy rates and approaches differ between jurisdictions, with some adopting a flat rate across the state, and others varying rates depending on location and/or type of waste (table 2.3). These introduce, in effect, different prices for unpriced externalities associated with waste (such as air, water and soil pollution). Unnecessary inconsistencies in levies or regulations across jurisdictions can lead to inefficiency and barriers to circularity (chapter 10).

Table 2.3 – Waste levies vary across jurisdictions

State/ Territory	Rate in 2024-25	Year of introduction
NSW	\$170.10 per tonne in the Metropolitan Levy Area and \$97.90 per tonne in the Regional Levy Area	1971
Vic	Prescribed municipal (metro) premises: municipal waste \$132.76; industrial waste \$132.76. Non-prescribed municipal (rural) premises: municipal \$66.30; industrial \$116.76	1992
Qld	General levy rate metro \$115 per tonne; regional \$94 per tonne	2019
WA	\$85 per tonne; \$129 per cubic metre	1998
SA	Metropolitan solid waste \$161 per tonne; non-metro \$80.50 per tonne	1994
Tas	\$44.88 per tonne	2022
ACT	\$113.40 per tonne	1993
NT	Under consideration	

Source: NSW EPA (2024g); Environment Protection Authority Victoria (2024d); Queensland Government (2024c) Government of Western Australia (2023); EPA SA (2024c); Department of Natural Resources and Environment Tasmania (2024b); TCCS (nd) and Northern Territory Government (2022, p. 12).

Container deposit schemes have been introduced in most states and territories. These schemes aim to reduce littering and waste in landfill and increase recycling by putting a value on eligible empty containers. South Australia was the first government to introduce such a scheme in 1977 (EPA SA 2024a), with most remaining state and territory governments following over the last 12 years.¹⁹ While the refund rate for eligible empty containers is consistent across all jurisdictions, there are small differences in the containers that are eligible to be

¹⁸ New South Wales was the first jurisdiction to introduce a waste levy in 1971 (NSW EPA 2024e, p. 1) with others following from 1990, though the Northern Territory is still considering the introduction of a levy (NT DEPWS 2022, p. 13).

¹⁹ Tasmania's container deposit scheme is scheduled to commence in mid-2025 (Tasmanian NRE 2024a).

returned.²⁰ In 2021, Environment Ministers agreed to harmonise container sizes and products, refund amounts, standards for labelling, and community education across jurisdictions by the end of 2025 (DCCEEW 2021a, p. 1).

All states and territories have also banned or are planning to ban single-use plastic items. The negative environmental impacts of plastics include harming wildlife and public amenity, and greenhouse gas emissions at each stage of the life cycle of most plastics (NSW DPIE 2021a, p. 4). While all jurisdictions have banned single-use lightweight plastic bags, some jurisdictions have taken a stronger stance (for example, Western Australia and the Australian Capital Territory have banned all plastic shopping bags with handles, regardless of thickness, and South Australia banned all plastic shopping bags except for those that are certified as compostable). All states and territories have banned or are planning to ban single-use plastic drinking straws and stirrers, cutlery and plates. Inconsistent circular economy and waste policy settings across jurisdictions are discussed in chapter 10.

A wide range of other policies also affect the circular economy

In addition to government policies that are directly focused on shifting towards a circular economy, there are also policies, including those aimed at reducing environmental impacts more generally, that can encourage more efficient materials use.

For example, the Australian Government's existing climate change policies – including the Renewable Energy Target, Safeguard Mechanism, Australian Carbon Credit Unit Scheme, Capacity Investment Scheme and New Vehicle Efficiency Standard – act to address the emissions-related negative externalities including those associated with materials use and waste. Circular economy opportunities that reduce greenhouse gas emissions by lowering materials extraction and use could be covered under these policies, to the extent that the circular emission reduction methods are eligible under relevant schemes. However, as emissions policies do not directly address other negative externalities – such as other types of air and water pollution, biodiversity loss, and adverse impacts on human health and safety – they only partially account for the environmental impacts arising from materials use and waste.

Water policy, such as the National Water Initiative, aims to improve the sustainable management of Australia's water resources and increase water security for communities, agriculture and the environment. While circular activities that predominantly relate to water use efficiency are outside the scope of this materials-focused inquiry, it is important to note that some circular economy opportunities could also lower demand for water use. For example, the Water Efficiency Labelling Scheme is estimated to have saved 172 GL of water in 2024 by supporting better quality products (DCCEEW 2024b, p. 10), and sustainably developed precincts (urban and agricultural) with efficient water managements systems can recycle greywater and/or harvest rainwater, reducing freshwater consumption.

Finally, other government policies and regulations can play a significant role in guiding how businesses use materials and recycle waste, although not always labelled 'circular' policies. These are often in sector-specific contexts, such as standards on how recycled materials can be used for building in the National Construction Code, regional planning and transformation strategies²¹ or requirements about processing mining waste in state-based mining regulations. Such policies and regulations are discussed further in the sector-specific chapters 4 to 9. Other policies and regulations, such as Australian Consumer Law, cut across multiple policy dimensions including circular economy.

²⁰ In Queensland, the containers accepted for recycling were expanded in 2023 to include glass wine and pure spirit bottles (Queensland Government 2024a). The WA and SA Governments have both released discussion papers and consulted on expanding eligible containers (EPA SA 2024b; Government of Western Australia 2022). The Victorian container deposit scheme explicitly states it accepts fermented milk product containers whereas other jurisdictions' schemes do not (*Circular Economy (Waste Reduction and Recycling) (Container Deposit Scheme) Regulations 2022*, S.R. No. 94/2022).

²¹ For example, Greater Whitsunday's *Regional Transformation Strategy* (Queensland Government 2024b).

3. Prioritisation framework

Key points

- * **The Productivity Commission is identifying priority circular economy opportunities to improve materials productivity (and associated policy interventions) using three broad considerations:**
 - the environmental and economic significance of the materials use addressed by circular economy opportunities
 - the applicability of circular economy opportunities to Australia
 - the viability of policy intervention to reduce barriers to circular economy opportunities.
- * **The PC is using comparable quantitative indicators (where data is available), qualitative information from engagement with inquiry participants and desktop research to inform prioritisation.**
- * **This interim report explores potential circular economy opportunities in six priority sectors – the built environment, food and agriculture, textiles and clothing, mining, vehicles, and electronics. It also examines several system-wide changes that would facilitate circularity across sectors.**

3.1 Considerations for prioritisation




The terms of reference ask the Productivity Commission to identify priority circular economy opportunities for Australia and ways governments can address barriers to their adoption.

The PC is identifying priority circular economy opportunities to improve materials productivity (and associated policy interventions) using three broad considerations:

- the environmental and economic significance of the material use addressed by circular economy opportunities
- the applicability of circular economy opportunities to Australia
- the viability of policy intervention to reduce barriers to circular economy opportunities.

The rest of this section outlines the reasoning behind these considerations and guiding questions for assessing circular economy opportunities against them. Figure 3.1 summarises the PC's approach.

Figure 3.1 – Summary of the PC's approach to prioritising circular economy opportunities and associated policy interventions

Consideration	Guiding questions	Rationale
Environmental and economic significance of the materials use addressed 	<ul style="list-style-type: none"> How large is the current and projected materials use? How environmentally harmful is the materials use and to what extent can the opportunity reduce these harms? To what extent are there economic or strategic reasons for improving materials productivity? 	The benefits of increased materials productivity are correlated with the size of material use and its impacts
Applicability of circular economy opportunities to Australia 	<ul style="list-style-type: none"> To what extent can Australia influence the part of the product life cycle an opportunity relates to? How will the Australian context, such as geography or population, affect an opportunity's feasibility? What is the scope for improvement, given current adoption of circular practices? 	The applicability of circular economy opportunities will depend on Australia's context and economic structure
Viability of policy intervention to reduce barriers to circular economy opportunities 	<ul style="list-style-type: none"> What market or regulatory failures act as barriers? What existing regulations, data collection, and monitoring arrangements could be built on? What is the evidence that an intervention would be cost-effective? Are there lessons to be learnt from elsewhere? What is the public support for the intervention? 	Intervention is more likely to have net benefits when market or regulatory failures exist or the policy builds on current arrangements, public support and evidence

Environmental and economic significance of the materials use

Circular economy opportunities that relate to larger amounts of materials use, or more hazardous materials, are likely to have greater economic and environmental benefits. For example, a circular economy opportunity that increases materials efficiency in:

- a sector that uses comparatively large quantities of materials will tend to result in greater economic and environmental benefits because the materials efficiency improvement is multiplied across a large consumption base
- a production process that results in particularly harmful by-products or waste streams will tend to have larger environmental benefits because the avoided negative impact will be greater for each percentage increase in materials efficiency.

When assessing potential economic and environmental benefits of a circular economy opportunity, the significance of current and projected materials use are both relevant. Even if some materials or waste streams do not have major environmental impacts now, it is prudent to prioritise circular economy opportunities that will address likely future impacts if strong growth is projected.

Circular economy opportunities can have a variety of economic benefits. Business practices that reduce the amount of materials needed to produce goods and services can improve overall productivity. Circular economy opportunities may also enhance economic diversity and capability, by shifting away from traditional linear business practices and enabling innovative business models and production processes centred around circular practices such as sustainable design, repair and recycling. Furthermore, a circular economy opportunity could generate economic growth by creating new markets and job opportunities. For example, a report commissioned by Green Industries South Australia found that South Australia's circular economy has the potential to generate 25,700 jobs by 2030 (Lifecycles et al. 2017, p. 2).

The economic and environmental benefits of circular economy opportunities may also vary depending on their contribution to other strategic policy agendas. For example, some circular economy opportunities may reduce risks to Australia in international markets where other countries have made greater progress towards circularity. Circular economy opportunities may also contribute to strategic agendas such as critical mineral and food security or achieving sustainable development goals.

Where possible, the PC is using quantitative data to assess the significance of materials use (table 3.1).²² However, as highlighted by many participants, there are gaps and insufficient granularity in publicly available quantitative data.²³ As such, these indicators alone cannot tell nor predict the full story of materials use, impacts, or environmental or economic potential. For example, tonnes of materials used is a pragmatic but imprecise proxy indicator of environmental impact. It also offers limited insights into the social and economic impacts of materials use and wastes. Therefore, the PC is supplementing materials use indicators with other available data sources, such as those on specific environmental impacts, and lifecycle analyses to understand the lifecycle impacts of certain products and materials. The PC is also applying qualitative forms of evidence to guide prioritisation.

Guiding questions for assessment and prioritisation: significance of materials use

- **How large is the materials use** that the circular economy opportunity relates to? Is materials use projected to grow substantially? Does the circular economy opportunity improve materials efficiency and/or productivity across a range of sectors, products, supply segments or materials, or a small subset of these?
- **How environmentally harmful is the materials use** that the circular economy opportunity relates to? What are its global effects (for example, greenhouse gas emissions) and localised effects (for example, contaminants)? To what extent could the circular economy opportunity reduce these harmful effects?
- **Is improving materials efficiency and/or productivity important for other economic or strategic reasons?** To what extent does the circular economy opportunity improve economic outcomes (such as productivity, capability, growth, diversity)? To what extent does the circular economy opportunity contribute to other strategic policy agendas (such as critical mineral or food security, achieving sustainable development goals, facilitating industry adjustment to international circular economy trends)?

²² While quantitative measures have been examined, the PC has not formally modelled potential impacts of circular economy opportunities in this interim report.

²³ For example, Coreo (sub. 104, p. 14), Engineers Australia (sub. 108, p. 3), Mathur (sub. 10, p. 1), NSW Government (sub. 139, p. 1), ResiLoop Limited (sub. 84, p. 4), Swedish Australian Chamber of Commerce Sustainability Committee (sub. 94, p. 2), WALGA (sub. 167, p. 2) and WARRRL (sub. 87, pp. 6-7).

Table 3.2 – Indicators for prioritising circular economy opportunities: significance of materials use

	What does it measure?	Role in prioritising circular economy opportunities?	Limitations and caveats
Consumption indicators	Tonnes of materials extracted ^a domestically or internationally, to meet final domestic consumption (for example housing, food) (figure 1.5).	Higher consumption footprint means greater potential for consumption-related circular economy opportunities to result in environmental benefits.	Tonnes of materials is an imprecise measure of environmental impacts ^b and there is limited data availability for sectors and products of interest (including lacking granularity).
Production indicators	Tonnes of materials extracted domestically to meet final consumption domestically or internationally (such as exports).	Higher production footprint means greater potential for production-related circular economy opportunities to result in environmental benefits.	<i>As above</i>
Waste indicators	Tonnes of waste produced and disposed of domestically (by sector or material type where possible) (figure 1.5).	More waste means greater potential for circular economy opportunities that affect waste storage and disposal to result in environmental benefits.	<i>As above</i>

a. Raw materials include biomass, fossil fuels, metal ores and non-metallic minerals. **b.** The environmental impact associated with producing one unit (for example, one tonne) of a material varies significantly, but measuring by weight treats them equally (European Commission nd).

Applicability of circular economy opportunities to Australia

Some circular economy opportunities lend themselves more readily to Australia than others due to the characteristics of the Australian economy (including its size, structure and trade orientation).

For example, Australia imports significantly more textiles and clothing than it produces (based on ABS 2024c). Consequently, opportunities that change how Australians consume and dispose of textiles and clothing will likely affect a larger volume of materials than those that change how local businesses manufacture these products (chapter 6). Australian governments could seek to influence how overseas businesses design and manufacture imported goods, but this influence may be limited where Australia represents a relatively small share of the global market (such as for vehicles, chapter 8). Circular economy opportunities in production are more applicable to products that are predominantly manufactured in Australia, such as packaging (based on APCO 2024, pp. 43, 66, 88, 117, 134).

Owing to the geographic dispersion of Australia's population, some circular economy opportunities may be limited to certain parts of the country. These include opportunities that rely on economies of scale, co-location (for example, some place-based initiatives), and access to specific technical skills or infrastructure.

The extent to which Australian businesses and households are leaders or laggards in circular economy best practice varies across sectors, products, product life cycle segments, materials and locations. In some cases, adoption rates are relatively high, such as motor vehicle repair, which makes up the largest share of repair and maintenance activity in Australia (PC 2021b, p. 67). As such, some of the available benefits from this opportunity are already being realised (chapter 6). In other cases, adoption of circular practices remains persistently low (such as modular housing design), such that there may be greater scope for change. Low

uptake of certain circular business models, technologies or behaviours may also indicate barriers to adoption that governments could potentially help address.

The PC assessed the applicability of circular economy opportunities to Australia using comparable quantitative indicators where possible, complemented by data sources on specific sectors or opportunities, and qualitative research (table 3.2). The PC intends to engage further with stakeholders after its interim report is released to fill some of the data gaps encountered and improve its assessment.

Guiding questions for assessment and prioritisation: applicability to Australia

- To what extent **can Australia influence the part of the product life cycle** that the circular economy opportunity relates to?
- How will the **Australian context** (for example geography, population, infrastructure) affect the feasibility of this circular economy opportunity?
- **What is the scope for improvement** in the management of materials, given current adoption of circular practices?

Table 3.3 – Indicators for prioritising circular economy opportunities: applicability to Australia

	What does it measure?	Role in prioritising circular economy opportunities	Limitations and caveats
Size of product life cycle segment in Australia	The amount of materials used in Australian production (including waste) or consumption, in the supply chain segment that a circular economy opportunity applies to.	Greater activity in Australia means greater potential for circular practices to be adopted by Australian businesses and/or households.	Lack of data related to specific supply chain segments. Size is not a complete indicator, as full adoption of a circular economy opportunity may not be possible or desirable.
Circular adoption rates	The extent businesses or households in Australia undertake circular practices (for example, percentage of new build using recycled inputs).	Lower current levels of adoption may suggest scope for improvement.	Lack of data on adoption (particularly by materials). Low levels of adoption may be due to barriers in Australia’s context (for example, geography) or technical constraints.
International comparison	Domestic consumption or waste per capita relative to international comparators.	If Australia has relatively high levels of consumption or waste per capita, this may suggest greater scope for improvement.	Lack of data on domestic consumption and waste related to specific supply chain segments. Differences may be due to Australia’s context (for example, economic structure).

Viability of policy intervention to reduce barriers to circular economy practices

Businesses and households are motivated by various reasons to pursue circular economy opportunities (section 2.1), and there are government programs and regulations to manage some of the negative impacts associated with materials use (section 2.2). However, existing policies, programs or regulations may have gaps (for example for new and emerging products), outdated standards or rules, or poor design or implementation that act as barriers to adoption. This could result in, for example, relatively lower cost abatement opportunities from newer circular processes and technologies going unrealised. Market failures, such as where the price of products does not reflect the full costs to society of extracting and processing virgin material inputs, can also limit adoption of circular economy practices. For example, businesses may avoid using recycled inputs for production if they have access to relatively inexpensive virgin materials.

If there are regulatory or market failures, there may be a case for government to intervene to address them, depending on the likely costs, benefits and risks of different policy options. There may also be scope for governments to help businesses overcome barriers to adopting circular economy practices that require coordination across different sectors or parts of the supply chain.

Intervention to reduce barriers to uptake of circular economy opportunities is more likely to have net benefits where:

- a market or regulatory failure is associated with the production, consumption or disposal of materials, resulting in limited adoption of circular economy practices
- there is scope to build on existing policies, regulations or strategies and avoid the costs associated with setting up, administering and adapting to new ones
- there are lessons to be learned from other jurisdictions
- business and community support and readiness for government intervention is high, as this can reduce costs associated with implementing the intervention, and build on existing knowledge about what works
- there is evidence the proposed policy intervention would be a cost-effective way to achieve environmental and socio-economic outcomes, including implementation, monitoring and enforcement requirements.²⁴

Guiding questions for assessment and prioritisation: viability of policy intervention

- What **market or regulatory failures** act as barriers to the uptake of circular economy opportunities?
- What existing **regulations, data collection and monitoring arrangements** could be built on?
- What is the **evidence** that a circular economy opportunity would be a cost-effective way of addressing environmental or socioeconomic objectives?
- What are the **lessons from other jurisdictions** in which a particular opportunity has been pursued?
- How **willing and ready are businesses and the community** to support the intervention, including whether they are already coordinating or advancing effort in this space? Are the right enablers in place to support this change?

²⁴ A dynamic approach to assessment is necessary as intervention details are developed.

3.2 Applying the prioritisation framework

A staged approach to prioritising opportunities

In this inquiry, the PC is undertaking the following steps to prioritise and analyse circular economy opportunities, and propose policy recommendations relating to these opportunities:

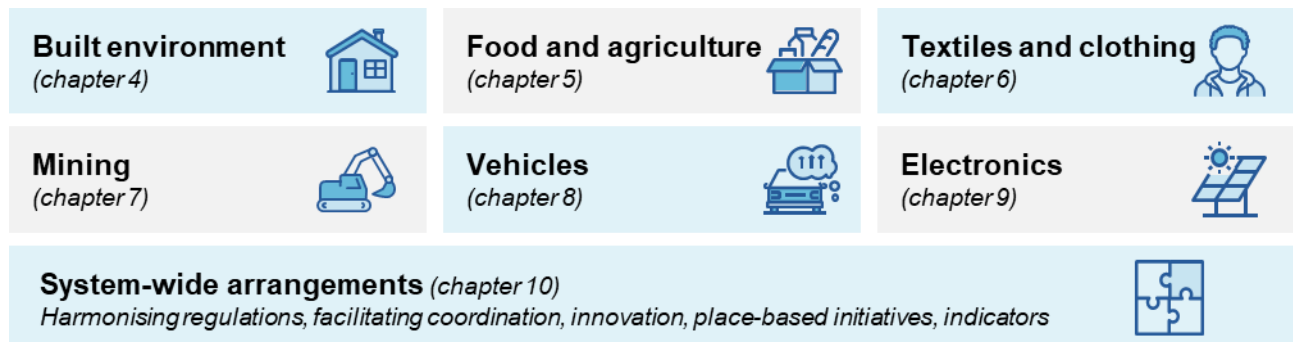
1. **Gather potential circular economy opportunities:** Review the relevant literature, policy documents and inquiry submissions, and engage with variety of industry, community and government participants to identify potential circular economy opportunities in Australia, and current and planned government policy and programmes.
2. **Assess circular economy opportunities and policies to address barriers to adoption:** Apply the prioritisation considerations to understand the extent to which circular economy opportunities could result in environmental or economic benefits (for example based on amount and types of materials currently used), the applicability of the circular economy opportunity to Australia and the viability of policy interventions to address relevant barriers.
3. **Prioritise circular economy opportunities and outline policy reform directions in this interim report:** Identify circular economy opportunities that perform well against the prioritisation criteria and outline potential directions for policy reform that address the barriers to their realisation (for example market and regulatory failures).
4. **Seek feedback and refine policy analysis for the final report:** Engage with inquiry participants following this interim report's release to test the identified circular economy opportunities, barriers and reform directions, and seek additional information to inform policy design, including implementation feasibility and risks.
5. **Develop final policy recommendations:** Finalise the identification of priority circular economy opportunities and develop a series of priority recommendations for government action, including implementation details, for the inquiry's final report.

Selected priority areas for circular economy opportunities

In this interim report, the PC examines circular economy opportunities in six priority sectors identified using the above framework (chapters 4 to 9) and several system-wide changes that would facilitate circular economy opportunities across sectors (chapter 10) (figure 3.2). There is some cross-over between the sectors identified by the PC and the sectors selected for deep dives in the Circular Economy Ministerial Advisory Group's final report: built environment, food and agriculture, resources and water (DCCEEW 2024v).

While the PC did not undertake a detailed examination of all circular economy opportunities in all the sectors suggested by stakeholders, the PC has identified cross-sectoral opportunities to improve circularity (chapter 10), with broader applicability than the six priority sectors. For example, the PC considers if and how inconsistent regulations, standards and specifications across Australia should be addressed, and this may include settings that apply to other sectors.

Figure 3.2 – Priority areas for circular economy opportunities and system-wide changes



Throughout this interim report, the PC has identified specific issues on which it is seeking further information to help inform its final recommendations, including the:

- current and potential uptake of circular economy opportunities in specific sectors and for certain materials
- nature and size of the expected benefits of circular opportunities, and how policy reform directions enabling opportunities could be implemented to maximise these benefits
- costs and implementation issues associated with reform directions, including which reforms are achievable over the short to medium term and which levels of government are best placed to progress them.

4. The built environment

Key points

- * Constructing buildings (such as houses and offices) and civil infrastructure (such as roads, rail and utilities) involves large amounts of materials, waste and emissions.**

 - Australia's construction sector accounts for 42% of Australia's non-metallic minerals consumption, 25% of metallic minerals consumption, and 7% of biomass consumption.
 - Manufacturing these materials accounts for 2.2%, 6.4% and 0.3% of Australia's emissions, respectively. Direct emissions from construction (such as fuel combustion) accounts for 2.6% of emissions.
 - Construction and demolition waste contributes a quarter of all waste that goes to landfill in Australia.
- * Circular practices with potential for greater uptake in Australia include using recycled materials to build civil infrastructure, and using prefabricated building techniques to construct buildings.**

 - Using recycled materials or by-products instead of virgin materials for construction can reduce emissions and environmental impacts from manufacturing and extracting virgin materials (such as contaminating water or soil).
 - Prefabricated building techniques can reduce materials use and waste, build times and emissions.
- * Some prescriptive aspects of current specifications and standards for public infrastructure procurement, and coordination challenges between suppliers, contractors and government agencies, are limiting the use of recycled materials in civil construction.**

 - The Productivity Commission is considering policy measures to enable fit-for-purpose use of recycled materials in public projects. It is seeking further information on which building specifications are unnecessarily impeding the use of recycled materials in public projects and ways to address these barriers.
 - The PC is also exploring whether supporting federal and state procurement policies by introducing coordination mechanisms, such as Victoria's ecologiQ program, could lead to net benefits.
- * Barriers to prefabricated techniques include high production costs and burdens when complying with regulations that were developed with conventional building techniques in mind.**

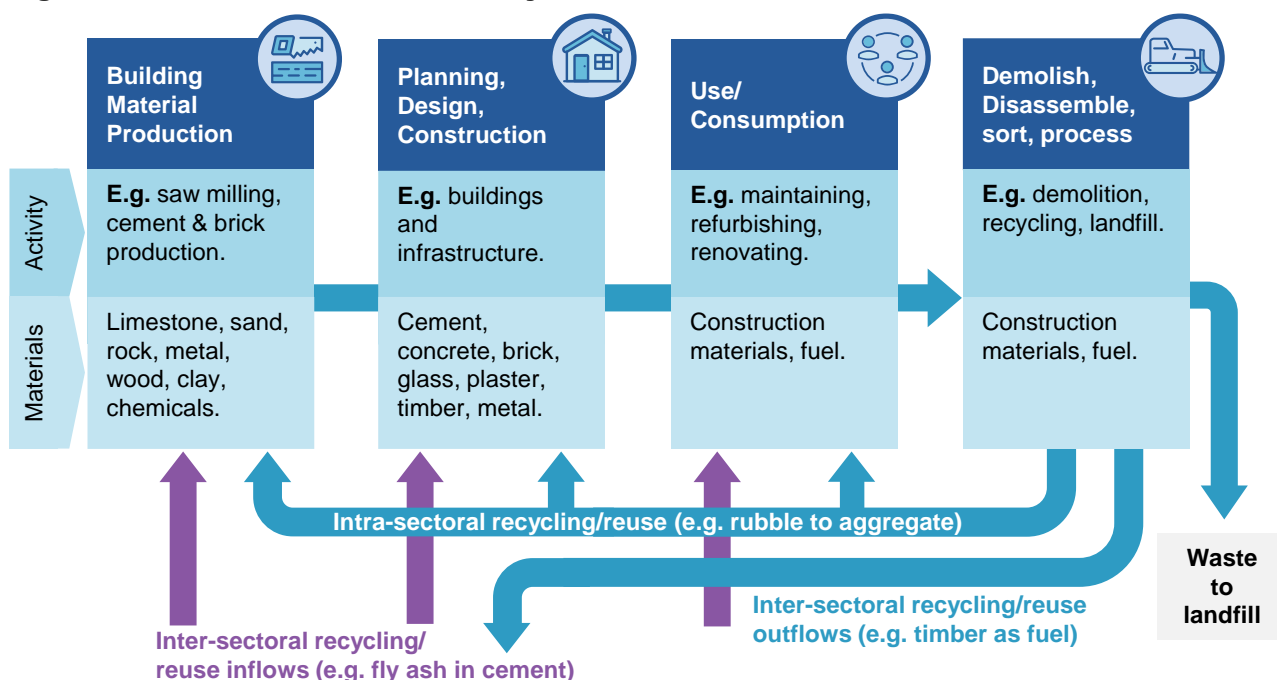
 - The PC is considering a reform direction on how governments can reduce unnecessary regulatory barriers to prefabricated construction, recognising that some regulations may be required to limit undesirable outcomes.

4.1 Overview of the built environment sector

The built environment relates to the structures that people live in, work in and use each day. These structures include residential buildings (houses and apartments), non-residential buildings (offices, warehouses, schools and stores), civil infrastructure (bridges, roads and railways) and service infrastructure (energy and water). The life cycle of structures in the built environment consists of six phases.

- **Infrastructure planning, urban planning and zoning** (including at region/city scales): planners determine where to locate different types of land uses and structures (residential, business, industrial, mixed) and the need for different types of service infrastructure (for example, water, transport, energy).
- **Planning and design**: engineers, and architects develop a structure's look, feel and functions.
- **Construction**: builders or construction companies use various materials, such as ceramics, glass, steel, timbers and concrete, to make and assemble the structure.
- **Use**: households and organisations occupy or use the building or infrastructure, which uses resources such as energy and water. Owners or occupiers of the structure may periodically undertake repairs, maintenance or refurbishment to extend the structure's life, which also use materials and other resources.
- **Demolition or disassembly**: demolition companies take down the structure and send materials to landfill or to other businesses to reuse or recycle.
- **Sorting and processing**: waste and recyclables are sent for sorting and processing, to be diverted or sent to landfill (figure 4.1).

Figure 4.1 – Built environment life cycle and material-use



Profile of the Australian construction sector

Australia's construction sector accounted for about \$175 billion (or 7%) of Australia's total economic output in 2023-24 (based on ABS 2024a). The construction sector directly employed about 1.2 million people in September 2024, which represented 8.3% of Australia's total workforce (based on ABS 2024g).

Master Builders Australia has forecast that the total value of residential, non-residential and civil construction work carried out in Australia from 2024 to 2028 will be \$1.38 trillion – 16.4% higher than the value from 2019 to 2023. Their forecast assumes strong growth in residential housing construction spurred on by the National Housing Accord and continued projected growth in infrastructure construction (Master Builders Australia 2024, p. 4). This would likely mean growth in associated materials use and waste production.

Australia's construction sector sources most material inputs from domestic suppliers. Master Builders Australia states that over 80% of construction inputs were estimated to come from domestic suppliers in 2018-19 (Master Builders Australia 2021, p. 20).

Environmental impacts associated with construction materials

Australia's construction sector uses a large amount of emissions-intensive virgin materials. The construction sector accounts for 42% of Australia's consumption of non-metallic minerals (such as concrete, glass, plaster and ceramics), 25% of Australia's consumption of metallic minerals (such as structural steel, fittings, aluminium, and copper pipes), and 7% of Australia's consumption of biomass (such as wood products) (based on UNEP 2024d). The manufacturing of products using these materials in Australia accounted for 2.2%, 6.4% and 0.3% of total emissions respectively in 2022.²⁵ Construction also has direct emissions (for example, from fuel combustion when operating machinery), which accounted for 2.6% of Australia's emissions in 2022 (based on DCCEEW 2022b).

Construction and demolition (C&D) waste recycling rates are relatively high. Nationally, the C&D waste recycling rate was around 81% in 2022-23 (DCCEEW 2025b, p. 39). However, Australia's construction sector produces a large amount of waste by weight. C&D waste represents approximately 26% of all waste that goes to landfill in Australia (based on DCCEEW 2025b, p. 82).²⁶ Volumes of construction waste to landfill are considerable when compared to other waste streams, with the amount of landfilled construction waste roughly similar to that of total municipal solid waste landfill (around 5.5 and 6.5 megatonnes respectively in 2022-23) (DCCEEW 2025b, p. 82).

Landfilled construction waste can negatively affect human health and natural ecosystems by contributing to global emissions and contaminants entering nearby water resources and soil (Molla et al. 2021, pp. 7–8). Most waste types by weight (such as concrete rubble, asphalt, bricks) do not disintegrate naturally and typically do not create harmful leachate (EPA SA 2019, pp. 3, 5; Molla et al. 2021, p. 4). However, some waste streams from construction, such as asbestos, contaminated soil, chemicals and heavy metals, are hazardous to human health and the environment (DAWE 2021, p. 14; Molla et al. 2021, pp. 7–8). Hazardous waste accounted for about 13% of all construction waste in 2018-19, and is dominated by contaminated soils excavated during infrastructure construction and asbestos (based on ABS 2020; DAWE 2021, pp. 14, 132, 140). Governments typically have legislated processes for safe end-of-life waste management of these materials (EPA Victoria 2024a, 2024b; NSW EPA 2019; Victorian Government 2024).

²⁵ Using 2022 emissions, these estimates are calculated by dividing 20 Non-Metallic Mineral Product Manufacturing, 21 Primary Metal and Metal Product Manufacturing+ 22 Fabricated Metal Product Manufacturing, and 14-16 Wood, Pulp, Paper and Printing by Total of all Economic (ANZSIC) Sectors.

²⁶ Calculated using core waste figures (excludes ash).

4.2 Opportunities for greater circularity in the built environment

Circular economy opportunities associated with the built environment arise at various stages of a construction project's life cycle. To understand the applicability of these opportunities in Australia, the Productivity Commission has considered the current and projected size of the relevant market sectors to which each opportunity relates (such as residential builds) and the current levels of adoption, using the considerations outlined in chapter 3.

Robust assessment of public infrastructure and integrated planning

Government processes that ensure public investment in new infrastructure is both economically efficient and environmentally sustainable help to avoid investment of taxpayer funds in projects for which the costs to society outweigh their benefits.

Robust public investment processes are an important circular economy strategy, because choosing not to proceed on projects that do not have sufficient net benefits to the community also avoids the associated materials usage, waste flows and localised impacts on the environment and country (Arup 2024; SIRM, sub. 1, p. 3). Past and present Australian, state and territory governments have issued various policies and guidelines to promote economically efficient and environmentally sustainable infrastructure investment, including requirements for agencies to consider alternatives to building new infrastructure (such as demand management strategies) (for example, DCCEEW (2024u, p. 13), WA DoT (2024a, p. 4), Infrastructure Australia (2021), Infrastructure NSW (2024, p. 7)).

However, government decision makers sometimes do not rigorously apply these principles. In its 5-year productivity review, the PC observed that:

In some instances, best practice procurement is not to procure at all because the dollars could be spent elsewhere on better outcomes for the public. The oft-repeated admonition to apply genuine, disinterested, rigorous cost-benefit analysis (CBA) of major projects suffers from its forgettability. Everyone says it is a good idea. ... But compliance with best practice is piecemeal, and the outcomes of the analysis may not have any effect on project choice (PC 2022, p. 72).

Integrated urban planning is an important aspect of city design and management to facilitate efficient and sustainable government investment, improve materials productivity, and reduce environmental impacts associated with the built environment (UNEP 2024c). It incorporates place-making, transport, housing, health and biodiversity in the same planning processes (UNEP 2024b), across decisions about land use, service delivery and civil infrastructure development.

Many state and territory governments have stated objectives around integrated planning, including in infrastructure and transport (Infrastructure NSW 2022; SA DHUD 2019; VIC DTP 2024b), and urban water planning (DELWP 2017; NSW DPIE 2022). However, challenges still remain. For example, in 2020, the PC identified barriers to integrated water management relating to a lack of clear objectives, clarity of roles and responsibilities, and formal process for communication between the urban planning and water sectors (PC 2020a, p. 40). The Water Services Association of Australia (2024, p. 8) also noted that integrating urban water and land use planning needed to be pursued as part of an updated National Water Reform agenda.

Designing structures for disassembly

Designing the built environment for circularity aims to reduce materials use and wastage by making it easier to prolong the life of buildings through repair or refurbishment and/or to recover materials when a building reaches the end of its useful life (EU 2019). A key principle of designing for circularity is designing structures so they are easy to disassemble,²⁷ which enables circular practices later in the structure's life cycle. For example, designing for disassembly can make it easier for property owners to refurbish and repair buildings during the use phase by allowing them to detach and replace specific parts. It can also allow demolition and recycling companies to recover materials for reuse because it is easier to separate materials and avoid damage during demolition or disassembly (NSW Treasury 2023, p. 20; APCC, sub. 74, p. 3; ACOR, sub. 75, p. 12). These activities in turn have environmental benefits, such as reduced emissions.

While designing for disassembly is relatively uncommon in Australia, there is growing interest in this area. For instance, there are consultants dedicated to helping construction companies adopt circular built environment design solutions (Zero Waste Victoria sub. 169, p. 10). A survey undertaken by the World Green Building Council in 2018 attributed increased green building practices in Australia to market and client demands, and to a lesser extent, environmental regulations and altruism (WGBC 2018, pp. 46–47).

Designing for disassembly appears to have a wide range of applications across most forms of construction. For example, Bradfield City Centre's 'First Building' in New South Wales was designed with disassembly and whole-of-life cycle waste minimisation in mind (NSW Treasury 2023, p. 20). Another example is the Northshore Pavilion in Queensland, which was designed as a temporary public structure for future disassembly and relocation (Wood Solutions 2024b). Internationally, there are examples of design for disassembly in a wide array of uses, including temporary housing (for example, British Columbia temporary affordable housing), non-residential buildings (offices in the Netherlands), bridges and viaducts (Dutch transport agency Rijkswaterstaat, TU Delft, Vaylavirasto Circular Bridges in Finland) (Arup, sub. 52, p. 4; CMHC 2021; Fast Company 2019).

Using recycled materials in civil construction

In a variety of cases, builders can use by-products and recycled materials (such as recycled glass, tyres and fly ash) for construction instead of virgin materials, without compromising safety. Many submissions and industry reports that identify the opportunity for greater use of by-products and recycled materials in construction relate to civil infrastructure construction (such as building roads).²⁸

In Australia, the degree of industry usage and acceptance of recycled construction materials varies by material type (table 4.1). Recycled concrete aggregate, bricks, asphalt and fly ash all generally have well-developed markets and are re-used in civil construction, particularly as road base, aggregates, hardstand areas and asphalt. Other materials such as recycled glass, crumb rubber and recycled plastic have less developed markets and are not as commonplace in industry but are emerging as inputs for substitution or addition into road and rail infrastructure. For example, the Victorian Government has used recycled plastic in constructing noise walls for the Mordialloc freeway, and recycled glass has been increasingly used in road construction and pavement (CCAA, sub. 55, p. 10; SSROC, sub. 26, p. 3).

²⁷ For example, APCC (sub. 74, p. 3); Arup (2024; sub. 52, p. 4); Engineers Australia (sub. 108, p. 3); WWF (sub. 44, p. 5).

²⁸ For example, ALGA (sub. 21, p. 4); Arup (sub. 52, pp. 4, 6); Australasian Railway Association (sub. 97, pp. 2-4); CCAA (sub. 55, pp. 8, 10); CCF (sub. 42, p. 4); Infrastructure Victoria (sub. 28, p. 4); Pact Group (sub. 77, p. 10); Polar Enviro (sub. 29, pp. 6-7); SSROC (sub. 26, p. 3).

Table 4.1 – Types and uses of by-products and recycled materials in civil construction

Material	Industry uptake	Use
Reclaimed asphalt pavement	More accepted	Direct use in new pavements, granular pavement
Fly ash (by-product from coal-fired power plants)	More accepted	Supplementary cementitious material, Portland cement replacement, asphalt filler
Crushed recycled concrete and brick	More accepted	Subbase, basecourse, alternative to quarried aggregate, sand, and limestone
Crumb rubber (tyres)	More accepted	Sprayed seal, performance enhancing additive to asphalt
Recycled plastic	Developing	Plastic ancillary components (e.g. sound barriers), bitumen binder, concrete additive
Recycled glass (predominantly from bottles)	Developing	Natural sand replacement for embankments (developed), road pavement and concrete additive (developing)

Sources: adapted from Standards Australia, ACOR and Infrastructure Australia (2022; 2023).

Environmental benefits from substituting by-products and recycled materials for virgin materials include reducing emissions from manufacturing virgin materials and localised impacts associated with extracting and disposing of the materials (ARRB 2022, p. 14; Chen et al. 2024, pp. 9–10). In addition, some materials and applications have performance benefits compared to virgin counterparts, which contributes to larger end-user markets for these materials. For instance, crumb rubber increases the resistance of road surfaces, and crushed recycled concrete can have superior performance compared to virgin alternatives used in hardstand applications (Infrastructure Australia 2022, p. 52; Sustainability Victoria 2014, p. 3). Fly ash is used as a supplementary cementitious material,²⁹ and improves the performance and quality of concrete while also reducing water demand (Cement Australia 2024).

Low-carbon materials in building construction

Substituting highly emissions-intensive construction materials with low-carbon alternatives could help reduce overall carbon emissions associated with the built environment. For example, the production of wood for construction generally results in lower emissions than the production of steel framing or concrete (Hawkins et al. 2021, pp. 93–96; Huang, Xing and Rameezdeen 2023, p. 9). Inquiry participants identified the use of low-carbon materials like cross-laminated timber – a type of engineered strong wood product – as an emerging opportunity in the built environment (Australian Institute of Architects, sub. 117, p. 12; Circular Australia, sub. 126, p. 9).

Use of less emissions-intensive materials such as wood is widespread in Australia's construction sector. In most states builders predominantly use structural timber framing in walls for detached residential housing rather than structural steel, concrete or double brick (Kempton, Boehme and Amirghasemi 2024, p. 4).

For non-residential and multi-unit residential construction, structural steel and reinforced concrete has traditionally been used. However, there has been growing innovation and interest in the use of mass (or cross-laminated) timber in high-rise multi-residential and commercial construction as a substitute for structural steel and concrete (Karacabeyli and Gagnon 2019, p. 8; Kremer and Symmons 2015). The Australian Institute of Architects noted that low-carbon materials like cross-laminated timber are 'commonly

²⁹ 'Supplementary cementitious materials' are substances that are added to concrete to partially supplement cement, are typically certain waste or by-products and are often used due to desirable properties.

used for clients seeking to lower their portfolio GHG emissions and achieve high Green Star as-built ratings' (sub. 117, p. 12). There are multiple instances in Australia of the use of mass timber in newer high-rise apartments and office buildings, namely the 15-storey 'T3' office building by Hines Australia and the 10-storey residential 'Forte Living' building by Lendlease (Hines 2023; Wood Solutions 2024a).

Prefabrication for residential and non-residential buildings

Prefabricated construction involves manufacturing standardised components in a factory and then transporting them to construction sites for assembly. In some cases, manufacturers preassemble components within-factory, and transport completed units for installation. These can range from two-dimensional systems, such as wall panels, to three-dimensional (also known as 'modular') systems, such as bathroom pods, whole rooms or whole houses (HIA and AMGC 2022, p. 4; McKinsey & Company 2019, pp. 7–10).

Prefabricated construction techniques can significantly reduce the build time compared to standard building techniques (albeit sometimes at a cost premium, discussed in section 4.3). For example, Xian Li et al. noted that developers delivered Australia's tallest prefabricated tower at the time – the La Trobe Tower in Melbourne – around 30% faster than comparable projects using standard methods (2017, p. 7). Other reports estimate that prefabricated construction techniques can result in 20–50% quicker completion times compared to traditional onsite construction (McKinsey & Company 2019, p. 10; Modscape 2024). This was corroborated by some inquiry participants (APCC, sub. 74, p. 3; Coreo, sub. 104, p. 5).

Environmental benefits of prefabricated construction techniques include reduced material use and waste (DCCEEW 2024b, p. 20; Ai Group, sub. 160, pp. 3-4; BCSDA, sub. 175, p. 10). One study found that prefabrication can lower waste (by weight) by up to 83% compared to conventional building methods (Loizou et al. 2021, p. 17). In addition, using prefabricated and modular construction techniques has a lower emissions profile than using traditional building techniques, as prefabrication typically uses less concrete and other carbon-intensive materials. One review of existing studies estimated a 15.6% embodied emissions reduction on average from using prefabricated construction techniques (Teng et al. 2018, p. 8). However, the extent of carbon benefits vary by a variety of factors, including building size, materials used, and level of prefabrication (Chen et al. 2022).

Modular construction techniques are also promoted due to their ability to facilitate other circular practices such as disassembly and reuse, where modular systems and panels can be reused as rooms, walls and floors (Yan et al. 2022, p. 2), or repaired and replaced, without requiring full demolition. The Housing Industry Association noted that prefabricated and modular construction can enhance builders' ability to manage waste because the waste materials generated in factory tend to be cleaner and easier to monitor and control than onsite waste materials. They also noted that prefabricated and modular construction can foster innovation in design and construction techniques, and in recent years, have made it easier for builders to comply with energy efficiency regulations (pers. comm., 5 February 2025).

Prefabricated construction techniques – particularly three-dimensional systems – are not commonly used in Australia. Around 5% of new houses in Australia are constructed using prefabrication practices (prefabAUS 2024, p. 24). While this figure is similar to the percentage of new dwellings that use prefabricated construction practices in the United States of America and the United Kingdom (about 3–7%), it is below the two largest adopters in the world, Japan (14%) and Sweden (80%³⁰) (JPCSMA 2018; Steinhardt and Manley 2016, pp. 128–130). One study suggested that higher uptake in these countries is

³⁰ The Swedish rate is the share of detached residential houses that use prefabrication techniques. This does not include multi-residential housing.

partly because costs to onsite construction are larger in Sweden due to short daylight hours and cold weather, and in Japan prefabricated construction is partly demanded for earthquake resilience (McKinsey & Company 2019, pp. 17–18). However, there has been increased use of prefabricated and modular construction in Australia for disaster relief housing, public and affordable housing, as well as regional and remote housing (DCMC 2024; Miles, Dick and Scanlon 2024; Minns, Jackson and Scully 2024; NSWPW 2022).

Refurbishing and repairing instead of demolishing buildings

Refurbishing and repairing built structures (such as apartments) rather than demolishing them delays the need to extract materials for new structures (GBCA and GISA 2023, p. 28). Reduced material use can, in turn, lower emissions associated with processing material and waste.

Renovation and repair of existing buildings is an established practice in Australia. In 2023-24, renovations accounted for 40% of all spending on residential construction (KPMG Australia 2024). About \$13.2 billion was spent on alterations and additions to residential housing (including conversions) in 2023-24 (based on ABS 2024b). While over 100,000 residential buildings were approved to be demolished in Australia from 2016–2021 (ABS 2021b), only some of these may be suitable for repair or refurbishment. Demolition often occurs when the quality of the building is too costly to repair or refurbish compared to the cost and value of a redevelopment, or there is genuine hazard to human health (Baker, Moncaster and Al-Tabbaa 2017, p. 145). The total stock of buildings demolished each year therefore likely overestimates what can be refurbished.

4.3 Policy interventions to address barriers to circularity

Existing government measures to encourage circularity in the built environment

The Australian, state and territory, and local governments have already introduced several types of measures to encourage circularity in the built environment. These include sustainable procurement policies for public infrastructure projects,³¹ education and guidance on circular design, and funding research on circular opportunities (table 4.2).

Adjacent policies and regulations, such as regulated waste levies, also provide incentives for circular activities. Landfill levies in all states and territories are weight-based, meaning builders and construction companies have an incentive to reduce the amount of heavy construction materials they create. The NSW EPA observed that levies have encouraged a high recycling rate for C&D waste materials and have generally been responsive to increases in levy costs, driving growth in alternative destinations to landfill such as use in recycled products (2024e, p. 7).

³¹ While these policies can improve sustainability, some participants noted in consultations that additional requirements in government procurement processes leads to increased administrative burden and complexity as suppliers have to adopt and demonstrate changes, and potentially increases the costs of goods and services purchased by governments.

Table 4.2 – Government measures to support circularity

Measure	Description	Examples
Sustainable procurement policies for public infrastructure	Directly incentivise sustainable building practices (such as use of recycled materials) through preferential treatment in public tenders. Increase broader industry and consumer confidence in sustainable building practices.	<ul style="list-style-type: none"> • Australian Government’s sustainable public procurement policy • Victorian Government’s ‘Recycled First’ policy (recycled materials for major state infrastructure projects) • Western Australia’s Roads to Reuse plan, and Transport Sustainable Infrastructure Policy • Southern Sydney Regional Organisation of Councils ‘Paving the Way’ (procuring recycled crushed glass for use in road asphalt) • NSW Decarbonising Infrastructure Delivery Policy, and Protection of the Environment Policy (reducing upfront emissions in infrastructure delivery).
Education and guidance on circular design	Information to help builders, developers, communities and local governments understand opportunities and navigate regulatory issues related to circular designs and prefabricated construction.	<ul style="list-style-type: none"> • Australian Building Codes Board handbook for prefabricated, modular and offsite construction • NSW Treasury circular design guidelines (provides a high-level overview of circular design considerations and case studies in-use) • Victorian Government Prefabricated Construction Directory • Green Industries South Australia circular procurement knowledge hub (tools, guides, case studies, training).
Funding research on circular opportunities	Funding for research into more sustainable design and construction practices and new building processes.	<ul style="list-style-type: none"> • Australian Government co-funded Building 4.0 Cooperative Research Centre in 2020

Sources: ABCB (2024); Building 4.0 CRC (2020); DCCEEW (2024h); Department of Transport (2024b); Hutchins (2024); NSW Treasury (2023); SSROC, sub. 26, p. 3; Victorian Government (2020); Waste Authority WA (2019).

Barriers to circularity and potential areas for government action

In Australia, greater use of recycled materials in infrastructure construction and prefabricated construction techniques are priority circular economy opportunities in the built environment. Both of these circular economy opportunities have scope for greater uptake and the potential to significantly reduce the amount of virgin materials used during construction (section 4.2). As outlined below, there are also potentially unnecessary regulatory and other barriers to their adoption that could be addressed with government action.

Standards and specifications for public infrastructure projects

In Australia, businesses providing goods or services for public infrastructure projects (such as roads) must meet certain standards and specifications set out by the procuring government agency (such as a state road authority). Some of these specifications reflect mandatory standards from the National Construction Code (NCC) or voluntary Australian standards. Government procurement agencies may also set additional specifications around types, uses and amounts of allowable recycled content for public infrastructure applications.

Participants have suggested that some standards and specifications for infrastructure projects unnecessarily restrict the use of recycled materials.³² The Business Council for Sustainable Development Australia suggested that some state road authorities apply 'conservative specifications that limit the use of recycled aggregates and plastics in road construction' (sub. 175, p. 24). Polar Enviro, which manufactures low carbon and recycled products for roads, noted that prescriptive Australian standards and state specifications inhibit uptake of circular alternatives (sub. 29, p. 14). In particular, the CCAA noted that the Australian standard related to general purpose and blended cements (AS3972-2010) needed to be updated to support greater use of supplementary cementitious materials in concrete (sub. 55, p. 16).

Different specifications and standards across states increases compliance costs for companies with national operations that use recycled materials. This was also noted by various inquiry participants.³³ The Cement Industry Federation recommended that steps be taken to 'identify, remove and avoid regulatory duplication' across all levels of government (sub. 103, p. 13). Similarly, the Australasian Procurement and Construction Council noted inconsistent regulations across governments pose challenges to using recycled materials in construction (sub. 74, p. 3). Infrastructure Australia has also said more action should be taken to develop, update and harmonise performance-based specifications, standards and guidance for use of recycled materials in roads (2022, p. 48).

Standards Australia, in collaboration with the Australian Council of Recycling (ACOR), has previously identified substantial inconsistencies in recycled content specifications set by state government agencies when commissioning road projects. They noted instances where states referred to the same Australian standards but still arrived at notably different recycled content limits in their procurement specifications. For example, New South Wales's specification for allowable recycled crush glass as granular base and subbase in road pavement is 10%, whereas in Victoria it is 5-10% for granular base and 15-50% for granular subbase (Standards Australia and ACOR 2023, p. 25; TfNSW 2020, p. 17; VIC DTP 2023b, p. 6). This is despite both referring to the same Australian standard (AS1289) in their respective documentation. Standards Australia and ACOR recommended that the Australian Government and industry experts collaborate to modify and/or create new performance-based standards that harmonise inconsistencies and reduce uncertainty (Standards Australia and ACOR 2023, p. 27). To the PC's knowledge, while there has been some reform targeting these objectives there is still more scope to progress these recommendations.

Before removing prescriptive standards and increasing consistency across jurisdictions, it is important to understand the reasons for current settings. Performance-based standards and/or greater harmonisation may have drawbacks that warrant consideration for policy makers.

- Moving to performance-based standards from prescriptive standards could make it more difficult for some smaller contractors to follow specifications and shift perceived risks from the public agency to the contractor (Thomson 2014, p. 447). Strong quality control and assurance procedures must also be in place to ensure safety and adherence (Hooton and Bickley 2012, p. 1101). However, performance-based standards may have longer-term dynamic benefits by enabling innovative suppliers to meet requirements in flexible and new ways, leading to the development of improved methods that can then be diffused across the market (Hooton and Bickley 2012, p. 1097).
- Greater regulatory harmonisation could limit jurisdictions' ability to have different settings based on local characteristics and preferences, such as to account for differences in climatic conditions. Additional targeted policy tools could help to overcome this drawback, such as the adoption of optional or

³² For example, see APCC (sub. 74, p. 3); BCSDA (sub. 175, p. 24); CCAA (sub. 55, p. 16); Infrastructure Victoria (sub. 28, p. 3,6); Polar Enviro (sub. 29, p. 14).

³³ For example, see ACOR (sub. 75, p. 28); Australasian Railway Association (sub. 97, p. 6); APCC (sub. 74, p. 3); CCAA (sub. 55, p. 1,15); CIF (sub. 103, p. 13); Engineers Australia (sub. 108, p. 3).

location-specific clauses for when certain jurisdictions have localised requirements (Austroads 2021), that still allow for more consistency in areas without specific requirements.

The PC is seeking further information to better understand where there is scope to replace prescriptive specifications with performance-based standards and/or harmonise standards across jurisdictions. The PC is also interested in the extent to which these changes would affect demand for recycled materials and result in net benefits to the community, economic growth and productivity.



Reform direction 4.1

Enabling fit-for-purpose use of recycled materials in public projects

The PC is considering ways governments can reduce unnecessary regulatory barriers to using fit-for-purpose recycled inputs in public infrastructure projects (such as roads). Options could include modifying or harmonising existing standards and specifications and developing new standards.



Information request 4.1

Enabling fit-for-purpose use of recycled materials in public projects

The PC is seeking information on:

- prescriptive versus performance-based standards:
 - specific examples where prescriptive standards or specifications for infrastructure construction significantly inhibit the use of recycled materials
 - what other benefits or objectives these prescriptive standards are intended to achieve (for example, public safety, or to enable clarity for smaller businesses)
 - ways that various levels of governments could facilitate greater use of performance-based standards
 - challenges, costs and benefits, and implementation issues that need to be considered if moving from prescriptive to performance-based standards (for example, monitoring and enforcement)
- harmonisation of standards:
 - key areas where there is scope to harmonise standards and specifications across states or territories and increase the use of recycled materials
 - specific implications (costs, benefits, risks) of harmonisation (for example, due to lack of flexibility to reflect local conditions), and whether or how they could be overcome.

Coordination issues in public procurement

In some cases, opportunities to use recycled material in public infrastructure projects go unrealised because recycled material suppliers, builders, and government procurement agencies are unable to coordinate with each other.

One obstacle to coordination appears to be that recycled material suppliers, builders or procurement agencies lack reliable information or awareness about fit-for-purpose applications for recycled materials in infrastructure projects. Consequently, procurement agencies or builders may perceive using recycled materials as too risky, or recycled material suppliers may not tender their services. ACOR noted that ‘despite

some procurement policies that prioritise recycled materials, there remain persistent and significant barriers to uptake, including ... willingness within the supply chain to embrace change' (sub. 75, p. 27).

Another potential obstacle is the time and costs that builders and suppliers of recycled materials incur in navigating procurement policy requirements. One inquiry participant noted that national businesses must contend with a patchwork of different procurement policies for each state and the Australian Government.

Some inquiry participants suggested that government-funded delivery initiatives could help both suppliers of recycled materials and public infrastructure contractors to navigate sustainable procurement policy requirements and identify win-win opportunities. In particular, participants noted Victoria's ecologiQ program – a delivery mechanism for the state's 'Recycled First' procurement policy – which promotes engagement and information sharing between government and industry, and builds decision makers' confidence in using recycled materials (VIC DTP 2023a) (box 4.1).³⁴ The Circular Economy Ministerial Advisory Group's final report also highlighted that ecologiQ helps to 'coordinate efforts between industry and government' for sustainable procurement, and provides 'guidance, support and resources' to project teams and suppliers (DCCEEW 2024d, p. 41).

Box 4.1 – Victoria's ecologiQ program

In 2020, the Victorian Government initiated the Recycled First Policy, a public procurement policy mandating the use of recycled and reused materials in major transport projects. It requires bidders to demonstrate how they will optimise usage of recycled materials within allowable specifications and standards (VIC DTP 2024c). As part of this, ecologiQ was developed to support this policy. ecologiQ is a program designed to connect infrastructure projects to recycled materials, encourage innovation in use of recycled materials for construction and support markets for recycled materials. Under the ecologiQ program, over 3.4 million tonnes of recycled materials have been delivered.

In doing so, ecologiQ states that it works to:

- change the approach to technical standards and specifications
- optimise the use of recycled materials
- pursue market development opportunities for emerging materials (VIC DTP 2023a).

ecologiQ also provides publicly available information such as recycled materials reference guides, intended to be used by designers and contractors during the planning, pre-tender, and construction stages for infrastructure (VIC DTP 2024a; CCAA, sub. 55, p. 11).

Participants to the inquiry predominantly noted that ecologiQ plays a coordination role, connecting suppliers of recycled materials to companies working on major infrastructure, and supporting companies to use these materials (WWF, sub. 44, p. 4; Australasian Railway Association, sub. 97, p. 5; ACOR, sub. 75, p. 29). Participants also noted that ecologiQ effectively considers fit-for-purpose use of recycled materials. That is, ecologiQ considers which recycled materials make economic sense in which location, and for what purpose. This consideration is particularly important for recycled materials in construction

³⁴ ACOR (sub. 75, p. 27); Arup (sub. 52 p. 6); Australasian Railway Association (sub. 97, p. 5-6); CCAA (sub. 55, p. 6); ICLEI (sub. 45, p. 3); WWF (sub. 44, p. 4).

Box 4.1 – Victoria’s ecologiQ program

due to transport costs and distance of materials to market affecting the viability of certain materials by geographical area (CCAA, sub. 55, pp. 6,16).

In general, inquiry participants indicated that ecologiQ is an effective delivery agent for recycled materials procurement policies, acting to support coordination, temper industry concerns and provide information to government and industry. For example, the Australasian Railway Society noted that ecologiQ has been ‘immeasurably helpful’ in supporting suppliers and users of recycled materials and ‘helps overcome some of the hurdles associated with unknown demand levels’ (sub. 97, p. 5). Similarly, the Australian Council of Recycling noted that the ecologiQ program has been ‘critical to building capability and confidence in procurement of sustainable and recycled materials’ (sub. 75, p. 29).

Setting up delivery mechanisms such as ecologiQ also involves costs to governments. During consultations, one participant from a state government noted that while these initiatives are effective, they can require substantial funding despite their relatively narrow remit.

The PC is considering the extent to which introducing or expanding delivery mechanisms around public procurement policies to facilitate coordination between suppliers, contractors and government agencies would lead to net benefits for the community and improve productivity. The PC is seeking further information to better understand the feasibility, benefits and costs of government-funded public procurement coordination initiatives.

For example, a coordination initiative may help:

- connect suppliers of recycled materials (for example, recyclers) with users of recycled materials (for example, contractors engaging in the public procurement process)
- provide general guidance, support and industry showcases on how to use recycled materials, and for what purpose
- provide specific guidance on what recycled materials are most fit-for-purpose for a specific project, keeping in mind cost and logistical considerations (such as geographical location and availability).



Reform direction 4.2

Coordination mechanisms to enhance the benefits of sustainable procurement policies

The PC is exploring the potential for governments to introduce or expand delivery mechanisms around sustainable public procurement policies to facilitate coordination between suppliers, contractors and government agencies. This could include publishing information or connecting suppliers and users of recycled materials, as in Victoria’s ecologiQ program.



Information request 4.2

Coordination mechanisms to enhance the benefits of sustainable procurement policies

The PC is seeking information on:

- the benefits and costs associated with introducing or expanding government-led coordination initiatives to support public procurement policies in different jurisdictions
- how further government efforts to facilitate coordination between suppliers, contractors and government agencies could be implemented to maximise net benefits to the community
- specific ways that coordination could assist suppliers of recycled materials to navigate sustainable procurement policy requirements and help government procurement agencies and suppliers identify win-win opportunities.

Regulatory barriers to prefabricated construction

Several factors discourage construction companies, builders and their clients from choosing prefabricated and modular construction techniques.

- **High production costs** can make prefabricated housing uncompetitive relative to conventional builds. Inquiry participants noted in consultations that prefabricated techniques have large, fixed costs, so manufacturers require large, guaranteed orders for per unit costs to be economically viable.
- **Additional regulatory burdens** associated with working around building regulations that were developed with conventional building techniques in mind. Under national building codes, standards and approval processes, builders using modular construction techniques need to demonstrate compliance in a case-by-case manner, using performance-based tests. And building product conformity regulations require proponents to test each individual component rather than testing the assembled product. Consequently, a single modular product can require multiple tests (HIA and AMGC 2022, pp. 35–43).
- **Difficulties securing finance and insurance** for both construction companies and customers purchasing a modular home. Lending arrangements are suited to traditional onsite construction where payments to the builder occur when stages of progress are met (HIA and AMGC 2022, pp. 27, 47). More circular alternative construction methods – including modular design or reusing materials – are seen to have a different risk profile by business lenders and insurers, posing difficulties for construction businesses or assessors in accessing finance or professional indemnity insurance (Engineers Australia, sub. 108, p. 3).

In 2022, the Housing Industry Association recommended a suite of measures to make regulatory arrangements more suitable for prefabricated and modular construction. These included:

- addressing local government planning requirements and design codes that stymie prefabricated construction
- establishing pathways for easier national regulatory compliance
- reviewing national construction product conformity frameworks
- establishing a certification scheme for prefabricated and modular construction (HIA and AMGC 2022, p. iv).

Recent government commitments are positioned to partially address these recommendations. In March 2024, the Building Ministers Meeting committed to improving regulatory certainty in the construction sector. As part of this, the Australian Building Codes Board (ABCB) released guidance clarifying pathways for prefabricated and modular construction to attain NCC compliance (ABCB 2024). They also stated that the ABCB will be conducting a review of regulatory improvements for prefabricated and modular construction (DISR 2024b).

In November 2024, the Australian Government announced that states and territories will be eligible for funding from the \$900 million Australian Productivity Fund in return for 'levelling the regulatory playing field for modern methods of construction and simplifying the certification process' (Chalmers 2024). Separately, in November, the Australian Government announced that it would fund a 'Voluntary Certification Scheme' to simplify the process for approving prefabricating housing under the NCC, and that banks, superannuation funds and other institutional investors would work with industry to address barriers to financing prefabricated housing at scale (Chalmers and Husic 2024).

These initiatives indicate that some of the existing regulatory barriers to prefabricated construction will be addressed. Despite this, the Housing Industry Association (pers. comm., 5 February 2025), noted that while there has been increasing government interest in identifying and seeking to address barriers to prefabricated construction, more progress is needed to support increased industry activity.

In this context, the PC is seeking further information on the extent the announced measures will address key barriers to prefabricated and modular construction, and specific regulatory changes (including recommendations from previous reviews that remain relevant) that would have the largest effect on uptake, economic capability and productivity. The PC is interested in the benefits and costs to the community associated with any proposed changes, recognising that while regulatory arrangements can act as barriers to certain activities, they can also be necessary for public safety and to prevent undesirable outcomes.



Reform direction 4.3

Reducing unnecessary regulatory barriers to prefabricated construction

The PC is considering a reform direction to further address regulatory barriers to prefabricated construction (noting that governments are currently implementing several initiatives to address these barriers). This may relate to:

- addressing planning requirements and design codes that stymie prefabricated construction
- establishing fit-for-purpose compliance pathways in the national compliance framework
- establishing new processes and schemes for national building product conformity.



Information request 4.3

Reducing unnecessary regulatory barriers to prefabricated construction

The PC is seeking further information on the regulatory barriers to prefabricated construction, including:

- the extent to which recently announced measures by the Australian Government (the Australian Productivity Fund and the Voluntary Certification Scheme) will address key barriers to prefabricated and modular construction
 - how these initiatives could be implemented to maximise the net benefits to the community
- specific regulatory changes (including recommendations from previous reviews that remain relevant) that would have the largest effect on uptake of prefabricated and modular construction, and:
 - the magnitude of the environmental, economic and social benefits associated with these changes, and measures and metrics that may quantify this
 - costs associated with the changes, including resources required for implementation, compliance and enforcement, and potential impacts on the environment associated with different regulations
 - how regulatory changes could be implemented to maximise the net benefits to the community.

Other potential circular opportunities in the built environment

While the PC has identified greater use of recycled materials in infrastructure construction, and prefabricated construction techniques, as the priority opportunities for circularity in the built environment (discussed above), it is also seeking further information to better understand the potential importance of other built environment opportunities. These include the scope for greater adoption of designing for disassembly, best practice infrastructure investment, and integrated urban planning in ways that increase materials efficiency and result in improved productivity, economic growth, and environmental benefits to the community.



Information request 4.4

Other circular economy opportunities in the built environment

The PC is seeking the following information on government assessment of public infrastructure projects, and integrated planning:

- any examples of infrastructure investment decisions proceeding without adequate integrated planning or assessment, which have led to significant unnecessary materials use and waste that may otherwise have been avoided
- the extent to which – and ways in which – improving assessment of public infrastructure projects could reduce materials use and waste, including quantitative analysis of costs and benefits (where available)
- barriers preventing further adoption of integrated urban planning, which governments could address.

The PC is seeking the following information on designing for disassembly in the built environment:

- expected growth in design for disassembly for different types of structures in Australia, in the absence of any further government activity
- barriers preventing further adoption of design for disassembly in Australia, which governments could address.

5. Food and agriculture

Key points

- ✳ **Producing, manufacturing, distributing and consuming food involves large amounts of materials and generates waste.**
 - Food production, packaging and distribution in Australia uses 215 million tonnes of raw materials annually.
 - Australian businesses and households produce about 7.6 million tonnes of food waste each year.
- ✳ **Circular economy opportunities exist at all stages of the food life cycle.**
 - Sustainable agricultural practices can reduce materials use, alleviate pressures of food production on land and water resources, and support long-term land productivity.
 - Sustainable packaging for food manufacturing reduces emissions and pollutants entering the environment.
 - Food relief, alternative markets for surplus food, and enhanced logistics and storage can help reduce emissions from food waste. Food relief can also help to address aspects of food insecurity.
 - Higher-value uses of food and agriculture waste streams (such as bioenergy, biochar and natural fertilisers) can reduce emissions and improve soil health.
- ✳ **Several initiatives are already underway to reduce food waste throughout the food life cycle.**
 - Recent government measures targeting household consumption habits, supermarket demand forecasting and fresh produce standards suggest limited benefits from further policy intervention in these areas.
- ✳ **The Productivity Commission is considering policy reform and seeking further information about overcoming barriers to food donation and relief.**
 - Farmers and retailers produce 2.2 million tonnes of food waste each year, a large portion of which could be diverted to people in need to address aspects of food insecurity.
 - Transport costs and capacity constraints are strong barriers to primary producers donating edible food to food relief charities, as these costs can be avoided by disposing of food on farms.
- ✳ **The PC is considering reform directions and seeking further information about higher-value uses of organic waste (for example, bioenergy, biochar or natural fertiliser).**
 - Converting food and agricultural waste streams into products such as bioenergy, biochar and natural fertiliser can reduce emissions and contamination of aquatic ecosystems, and generate income.
 - Some regulations may be impeding the productive use of organic waste streams, such as waste classification regulations and carbon reporting methodologies.

5.1 Overview of the food and agriculture sector

Food production and consumption in Australia

The food product life cycle spans primary production, manufacturing, distribution and retail, consumption and disposal. Primary production of food includes broadacre cropping, horticulture, fisheries and aquaculture, livestock grazing, and intensive livestock farming (and excludes forestry). Primary production occurs in different types of systems, such as irrigated agriculture, rainfed or dryland systems, and can be operated by commercial operations or small land holders. Food manufacturing refers to processing and packaging foods such as into meat, bakery, dairy, confectionary, processed fruit and vegetable, and seafood products.

Food is an important part of the Australian economy. In the 2022-23 financial year, Australia's primary and manufactured food sectors³⁵ produced about \$280 billion in output, or about 3% of GDP (ABS 2023a, 2024d), and exported goods worth about \$49 billion, or 12% of total exports (Observatory of Economic Complexity 2022). This represented just under half of total food sector economic output, which accounts for approximately 6% of GDP (ABS 2023a, 2024d).³⁶ In the same time period, about 662,000 people, or 5% of the Australian workforce, were employed in the primary and manufactured food sectors (ABS 2023a, 2024g). In 2022, 98% of Australian food and agribusinesses were small or medium enterprises (with fewer than 200 employees), and 70% were non-employing operations including many family businesses (FIAL 2024, p. 13).

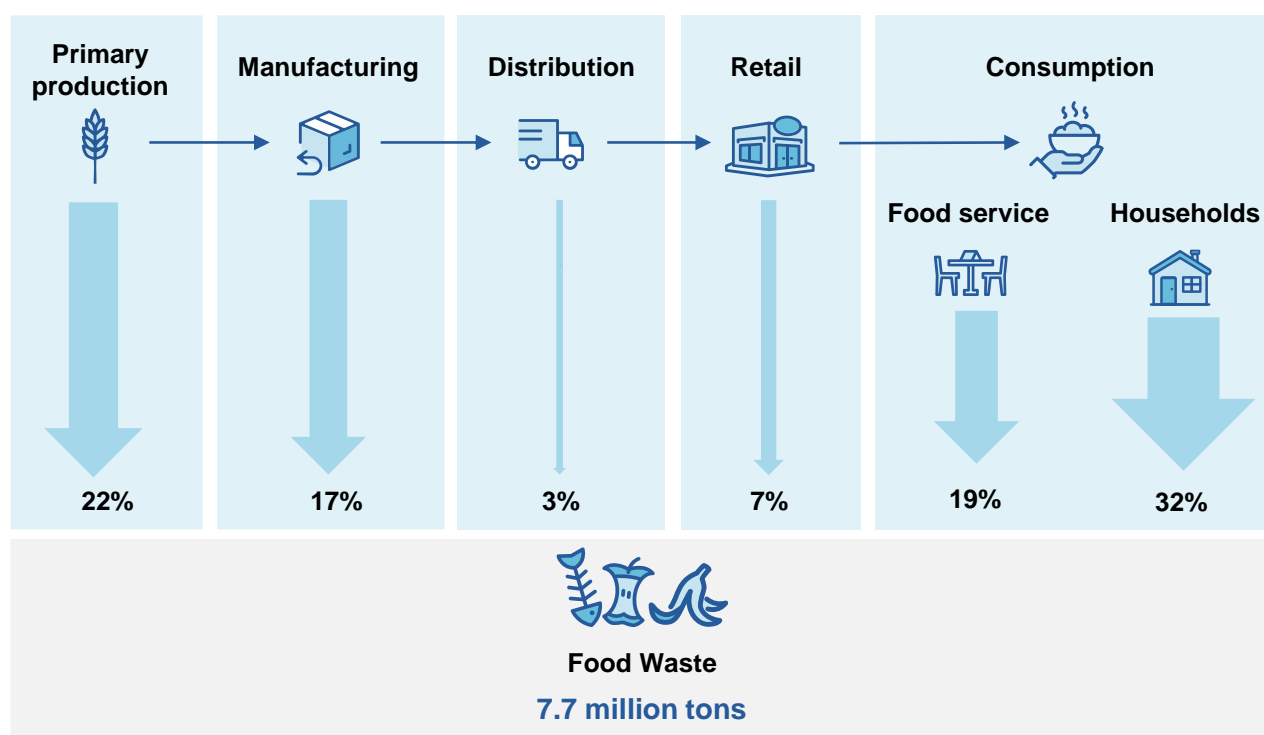
Food distribution involves collecting produce from farms and food processors, storing them in warehouses, and then transporting them to retail and wholesale customers, including supermarkets, chain restaurants, and food service providers. In Australia, large food retailers have their own distribution systems with significant warehouses, technology and inventory in most states and territories (ACCC 2024, p. 179). In 2022, food retail sales in Australia were worth about \$160 billion (ABS 2024i).

Food consumed can be home-made or prepared by food service providers (for example, restaurants or caterers for hospitals, schools, prisons). About a third of household food expenditure in Australia each year is spent on food service providers (Cameron et al. 2022, p. 77). 85% of household food expenditure is on food produced in Australia (Hogan 2018, p. 8).

Food waste and disposal occurs at all stages of the food product life cycle, including production, distribution, retail and consumption (figure 5.1). Food waste includes both edible waste (food produced for human consumption but disposed of without consumption) and inedible food waste (such as seeds, bones, skins and peels) (DEE 2017, p. 8). Food Innovation Australia Limited (2021, p. 18) estimated Australians waste 7.6 million tonnes of food each year across the food supply chain, costing the economy \$37 billion annually. The biggest contributor to food waste is households (32% or 2.5 million tonnes), who account for more food waste than primary producers (22%), manufacturers (17%), food distributors (3%), retailers (7%), hospitality services (16%) and institutions (3%) (based on FIAL 2021, p. 12). Approximately 70% of Australia's food waste is edible food (FIAL 2021, p. 14).

³⁵ The primary and manufactured food sector is comprised of the agriculture, aquaculture, fishing, hunting and trapping, agriculture, forestry, fishing and support services, food manufacturing, and beverage and tobacco manufacturing subsectors.

³⁶ The food sector is comprised of primary and manufactured food sector and the grocery, liquor and tobacco product wholesaling, food retailing and food and beverage services subsectors.

Figure 5.1 – Food waste in the food product life cycle^a

a. Food service includes hospitality venues, such as restaurants and cafes, and institutions, such as schools and prisons. Source: Productivity Commission estimates, based on FIAL (2021, p. 12).

Supplying food to Australians requires a significant volume of materials, particularly biomass (organic materials from plants and animals such as seeds, fertilisers and timber). The CSIRO estimates that the Australian food provision system uses 215 megatonnes of materials each year, with biomass as the leading material type. This makes the food provision system the third largest materials user by weight behind only housing and mobility, accounting for 22% of materials used in Australia (Miatto et al. 2024a, p. 19).³⁷

Environmental impacts of food production and waste

Besides using a range of materials, food production also relies on natural resources, including land and water. Approximately half of Australia's land area is used for agricultural production (Williams et al. 2021, p. 72), and the agriculture, forestry and fishing industry accounts for the majority of Australia's water consumption (ABS 2023b).

Farmers have adopted practices that better manage the environmental quality and productive capacity of agricultural landscapes, including a systems approach through Natural Resource Management championed by the national Landcare movement. This has been supported by other agricultural industry and government initiatives, such as investment in research and innovation (table 5.1) (DCCEEW 2025d; EY 2021, p. 15). Agricultural industries, governments and researchers are also increasingly interested in how the quality of on-farm and landscape-scale natural capital impacts economic productivity, and the potential benefits for farmers from protecting the land's natural capital and biodiversity. This is evident in the results of innovative

³⁷ The International Resource Panel's Sustainable Consumption and Production Hotspot Analysis Tool estimates materials use for food to be approximately 178 megatonnes (UNEP 2023a), but incorporates different subsectors into the 'Nutrition' and 'Agriculture' sectors.

projects such as Farming for the Future (Ogilvy et al. 2024, p. 85) and biodiversity stewardship pilot programs (Lansdell et al. 2023, p. 32).

However, Australian landscapes have been significantly modified since colonisation, and environmental quality and agricultural land productivity continues to decline in some areas (Williams et al. 2021, p. 107). Agricultural practices vary considerably and some continue to result in negative environmental impacts, such as overgrazing leading to biodiversity loss and affecting soil structure, water infiltration and nutrient cycling (Murphy and van Leeuwen 2021, p. 85). Prolonged fertiliser and pesticide use, where not well managed, can increase soil acidity, reduce the availability of plant nutrients and harm soil organisms and useful bacteria (Agriculture Victoria 2024). Runoff from fields treated with fertilisers and pesticides can also pollute nearby water rivers, leading to eutrophication, which threatens human health (Juncal et al. 2023, p. 3).

Some types of food production, such as dairy, cattle and crop production, are emissions intensive. Agriculture contributes more than half of Australia's total methane emissions each year (DCCEEW 2024o), with methane burped by cattle accounting for more than half of these agricultural emissions (CCA 2023a, p. 9). The food sector³⁸ collectively contributed 7% of Australia's direct (scope 1) emissions in 2022 (DCCEEW 2022c). Separately, food waste contributes to emissions as it decomposes, with production and disposal of wasted food emitting about 17.5 million tonnes of carbon dioxide equivalent emissions annually in Australia, or approximately 4% of Australia's total direct (scope 1) emissions (FIAL 2021, p. 18).

Food and beverage manufacturing (including packaging) can use chemicals and plastics, which can pollute land and waterways and negatively affect human health and ecosystems. For example, food packaging often contains microplastics (plastic fragments less than five millimetres) that can enter the environment during manufacturing, use, recycling or disposal (Jadhav et al. 2021, pp. 2, 3; Ncube et al. 2020, p. 2; Suzuki et al. 2022, p. 8). Microplastics can pollute oceans, and cause adverse health effects in sea life and humans when consumed (Issac and Kandasubramanian 2021, p. 2).

5.2 Opportunities for greater circularity in food and agriculture

To understand the applicability of specific circular economy opportunities in food and agriculture to Australia, the Productivity Commission considered the current uptake of circular economy activities, and the current and projected size of the relevant market sectors (chapter 3). The PC identified several areas where Australia could adopt further circular economy activities that either reduce food waste, reduce the negative effects of materials use (such as packaging), or realise higher value uses for food and agriculture waste.

Primary production

Greater adoption of agriculture practices that reduce materials inputs

Sustainable agriculture and food sourcing is not a new practice. Aboriginal and Torres Strait Islander people have drawn on knowledges, laws and customs to sustain the health of Country for more than 60,000 years.

³⁸ This includes direct emissions from the agriculture, aquaculture, fishing, hunting and trapping, agriculture forestry and fishing support services, and food, beverage and tobacco manufacturing subsectors. In addition, emissions also arise from the distribution of food: globally, 19% of all food system emissions are from transporting food products by road, rail, air and sea. However, Australia's emissions from transporting food is lower than other large landmass countries, such as Brazil, China, Russia, Canada and the United States of America (Li et al. 2022, pp. 449, 450).

Cultural rules and practices relating to, for example, regenerative fish life cycles, sourcing food according to seasonal calendars, and using fire to enhance the health of land, ecosystems and people have been maintained for generations (AIATSIS 2022; Atkinson et al. 2020, p. 63; FISH 2024; Prober et al. 2013, p. 39).

Sustainable agriculture is a holistic approach to balancing financial, environmental and social goals while considering the burdens imposed on future generations (Clune 2020, p. 495). Sustainable agriculture approaches integrate agricultural production and ecosystem management to improve environmental health, conserve water, promote animal well-being and biodiversity, and maintain farm resilience (Velten et al. 2015, p. 7838).³⁹ More recent regenerative agriculture approaches emphasise restoring and enhancing ecosystem function through practices designed to work with the landscape, climate, people and livestock (Orgill and Dougherty 2021, p. 3).

Integrated management of productive and environmental values, such as fencing waterways and improving groundcover to reduce erosion, supports land health in ways that require less materials like fertilisers or pesticides (WA DWER 2023, p. 3). Other practices directly relate to the use of materials, such as organic fertilisers (for example manure, garden organics or food waste), which improve soil health and reduce the need for additional synthetic materials (Culas et al. 2025, pp. 6, 8). Another is precision agriculture, which involves using spatially distributed experimentation and advanced technologies to tailor land management techniques to the characteristics of the area. Correctly applied, precision agriculture techniques can reduce the environmental impacts of agriculture, and increase agricultural output (CSIRO 2021a).

Australia has over 53 million hectares of farmland under organic management, more than 55% of the global total (Willer et al. 2024, p. 257). Some sustainable agricultural techniques can help meet the challenges of food security, environmental sustainability and socioeconomic wellbeing; however, the costs of these activities can reduce their economic feasibility in the short term, limiting their uptake (Francis 2020, p. 9).

Using biotechnology to develop more sustainable protein sources

Emerging biotechnologies (such as precision fermentation) are enabling the production of alternative proteins, bio-based materials and sustainable food ingredients (DCCEEW 2024d, p. 91). In addition to providing economic opportunities for recovering value from food waste (discussed below) and addressing social objectives such as food security, these technologies could also help alleviate pressures on materials use and reduce emissions associated with farming traditional protein sources.

While these technologies are relatively new, the CSIRO (2024, p. 12) has suggested Australia's climatic conditions, high volumes of organic waste and investment levels in biotechnology position Australia to lead these innovations. The alternative proteins market is relatively small, accounting for only 2% of the global protein market in 2020, but is expected to grow to between 10% and 22% by 2035 (Witte et al. 2021, p. 26).

Enhancing the reliability of food demand forecasts for farmers

Producing food in the quantities and qualities needed to meet demand is challenging because various environmental and market factors cause domestic food supply and demand to vary from year to year. These factors include seasonal rainfall, temperatures, natural disasters, pest and disease outbreaks, the availability

³⁹ Sustainable practices range in technological complexity from maintenance of surface coverage, low (or no) till farming (Kirkegaard et al. 2013, p. 133), windbreaks (Brunton and Badgery-Parker 2012, p. 1) and fencing waterways (WA DWER 2023, p. 3) to agroecology, sustainable intensification, precision farming, climate-smart agriculture (Muhie 2022, pp. 2, 5), recirculating aquaculture (ACWA, sub. 65, p. 1), and alternative livestock feed ingredients such as seaweed (Kinley et al. 2020, p. 8). For example, farmers in the Bega Valley region are adopting seaweed and shellfish farming practices that improve water quality and provide habitats for other marine species (Croft et al. 2024, p. 14).

and price of imported foods, and export demand. In years of domestic food oversupply, farmers may resort to disposing of crops such as fresh fruit and vegetables. In 2022-23, for example, a survey of farmers found at least 20% of almost all fruit and vegetable crops planted went to waste. Furthermore, 5% of farms reported that excess production was a primary reason for crop waste (Slatter 2024, pp. 5, 6).

To reduce the risks of under or oversupply, farmers often use forecasts of weather and market conditions when planning production. These include informal and non-binding demand forecasts supplied by large supermarkets (Coles Group 2024b, p. 15; The Treasury 2024b, p. 68; Woolworths Group 2024a, p. 46), which are influential in primary producers' production decisions.

Some primary producers have suggested there is scope to improve the reliability of supermarket food demand forecasts to reduce oversupply (and associated food waste). They argued that supermarkets almost always forecast higher demand than they order (NFF Horticulture Council 2024, p. 12) because surplus food production lowers prices (Queensland Fruit & Vegetable Growers 2024, pp. 8, 9). An Independent Review lent some support to these claims, concluding that not all supermarket forecasts may currently be conducted with due diligence and in good faith (The Treasury 2024b, p. 68).

Food manufacturing and packaging

Sustainable food packaging

Food packaging uses a significant volume of materials, particularly plastics. Circular design makes packaging easier to recycle, by limiting the use of adhesives, inks and lacquers (Veolia Australia and New Zealand, sub. 8, p. 2). It also reduces virgin materials use by using recycled content and eliminating unnecessary packaging, thereby reducing carbon emissions, as recycled plastics have a lower carbon footprint (Ganesan et al. 2022, p. 6722). The benefits of designing food packaging for recyclability can only be realised if households have, and use, opportunities to recycle that packaging, and producers are able to use recycled packaging in place of virgin materials. As a result, the benefits of this opportunity depend on product design, household behaviour and convenient access to recycling bins and recycling infrastructure.

The uptake of these opportunities is varied. The Australian Packaging Covenant Organisation estimates that 41% of plastic packaging is currently designed to be recycled, but only 6% of inputs manufacturers use to make plastic packaging are recycled materials (APCO 2024, p. 92). In 2022, almost 1.3 million tonnes of plastic packaging was placed on the Australian market, 63% of which was produced domestically (APCO 2024, p. 88). Though the exact proportion of plastic packaging for food in Australia is unknown, food packaging is a common use of many types of plastics (Schandl et al. 2020, p. 16). Barriers and potential policy responses to enable circularity in packaging are discussed in chapter 10.

Food distribution and retailing

Finding alternative uses and markets for surplus food

Food waste during primary production and retail collectively account for 2.2 million tonnes (or 29% of total food waste) each year (based on FIAL 2021, p. 12). Some of this relates to commercial arrangements between food producers and retailers, such as the quality standards farmers must meet to sell to supermarkets. The Farm to Supermarket Waste Report (2023, pp. 5, 6) noted one of the major causes of food waste during food production and retail is the disposal of fruit, vegetable and cereal crops because they are rejected by supermarkets for non-compliance with appearance or size standards. Up to 25% of all vegetable crops grown never leave the farm (DEE 2017, p. 6), at a net cost to primary producers of more than \$150 million per year (Rogers, Ekman and Titley 2013, p. 128).

One strategy for reducing this type of waste is for retailers to work with producers to market aesthetically imperfect produce as a discounted product for budget or environmentally conscious households. This provides income for farmers and eases cost pressures on households. Examples include Harris Farm Market's 'Imperfect Picks' discounted selection (Harris Farm Markets 2022; Wheeler 2021), Woolworths Group's 'Odd Bunch' campaign (Woolworths Group 2024b, p. 53), and Coles Group's 'I'm Perfect' campaign (Coles Group 2024a, p. 22). Uptake is contingent on household preferences and a willingness to purchase produce with unexpected size or shape. While a lack of familiarity with misshapen produce has traditionally stifled demand, increased sharing of positive beliefs in online communities has been shown to increase household acceptance of visually imperfect produce (Young et al. 2024, p. 14). Evidence from New Zealand also shows that children are more accepting of mildly misshapen or discoloured produce (Makhal et al. 2020, p. 6), which could be a foundation for changing household purchasing norms in the future.

Another strategy to reduce food waste (both fresh and processed) is for retailers and producers to donate, or sell at heavily discounted prices, to charities or food relief organisations. This has environmental, economic and social benefits. Producers can recover compensation (either through a discounted price or, in some cases, tax deductible donation) for products that would otherwise have incurred disposal cost and released emissions while decomposing. Food relief also helps to address aspects of food insecurity, which has broader social benefits such as lower healthcare costs (Tarasuk et al. 2015, p. 432), improved community relationships (Miroso et al. 2016, p. 3052) and improved quality of life (Russell et al. 2016, p. 54).

While these strategies have become more common, there is room for further uptake. For example, about 90% of wholesale-retail food waste, or 500,000 tonnes, is edible (FIAL 2021, p. 14). And while all major Australian supermarkets have a charity partner to whom they donate edible waste (Lewis et al. 2017, p. 70), only 6% of retail food waste is recovered for food relief (based on FIAL 2021, p. 12).

Technologies that reduce food spoilage during distribution

Some stakeholders highlighted opportunities to reduce food waste during distribution, which can arise because of inadequate temperature control, damage to packaging and inefficient inventory management of food in transit (DCCEEW 2024b, p. 23; DEE 2017, p. 25). These opportunities focused on adopting emerging technology such as more efficient logistics management using blockchain technology (CSIRO 2021c), and 2-D barcode labelling (to alert distributors when food is expiring and provide storage information) (GS1 Australia, sub. 114, p. 3). More efficient food distribution using these techniques can also bring about emissions benefits through reduced energy use for refrigeration and transport.

Adoption of these technologies to reduce waste in distribution is growing. For example, 2-D barcode labelling is used by Woolworths for the majority of its meat products (GS1 Australia, sub. 114, p. 3), and the technology is becoming increasingly prevalent for fruit and vegetables (Dingley 2023).

The volume of food waste currently lost in transit is relatively low. In 2021, only 3% of total food waste occurred at the distribution phase, and only 34% of that waste was sent to landfill, with the remainder sent to commercial composting (based on FIAL 2021, p. 12). Consequently, even widespread uptake of these distribution technologies would be unlikely to lead to significant reductions in total food waste.

Food consumption

More sustainable and less wasteful food consumption habits

Encouraging and enabling households to reduce food waste through better meal planning and awareness of when food expires (OzHarvest, sub. 81, p. 7) could save households between \$2,200 and \$3,800 per year (DEE 2017, p. 6), in addition to the environmental benefits of reduced food waste.

In Australia, there is considerable scope for households to improve their food waste behaviours. While 75% of households reported they were fairly or very motivated to reduce household food waste (Fight Food Waste CRC 2020, p. 23), approximately two-thirds of household food waste is edible (FIAL 2021, p. 14), comparable to the United Kingdom, where 74% of household food waste is edible (Torode et al. 2023, p. 4). The Australian Government has set a goal to halve the country's food waste by 2030, per United Nations Sustainable Development Goal 12.3 (DEE 2017, p. 3).

Higher value uses for food and agriculture waste streams

Australia produces a substantial volume of organic waste annually. In 2023, organic waste accounted for 19% (15 megatonnes) of all waste generated, and was the second most common type of waste (DCCEEW 2025b, p. 15). Various technologies exist to convert organic waste into valuable products, which can save disposal costs, generate income and reduce materials use.

Converting organic waste to bioenergy

Food and agricultural wastes, such as vegetable oils and tallow, can be used to produce liquid biofuels (CEFC and ARENA 2019, p. 17). Some advanced biofuels can readily replace conventional fossil-derived fuels used in transport, reducing emissions by as much as 60–100% (CSIRO 2023b, pp. 12, 23). Australia's current biofuel production is low, representing one-tenth of domestic ethanol fuel production (DAFF 2022, p. 2). In 2024, Australia accounted for only 0.1% of global biofuel production (EI 2024, p. 64). However, the CSIRO (2023b, p. 40) estimates that if 40% of applicable wastes were diverted to biofuel production, biofuels could satisfy 9% of all Australian fuel demand.

Inedible food waste and other agricultural or organic wastes can also be transformed into biogas by anaerobic digestion. Anaerobic digestion describes the breakdown of organic matter into gases ('biogas') in the absence of oxygen (Tait, Harris and McCabe 2021, p. 2). The breakdown can occur in large 'digester' facilities, such as the Richgro Waste to Energy Plant (box 5.1). Biogases such as biomethane can replace fossil-fuel intensive alternatives for energy production (Marconi and Rosa 2023, p. 1), which saves the carbon emissions from both decomposing organic waste and burning fossil fuels (Mahmudul et al. 2022, p. 5).

Box 5.1 – Richgro's anaerobic digestion plant

Richgro's anaerobic digestion plant, located in Jandakot, Western Australia, began operation in September 2015 as the first anaerobic digester in Australia (Richgro 2016; Waste Management Review 2016). The plant was established for \$6.6 million, including a \$2.2 million loan from the Clean Energy Finance Corporation, and a combined \$1.6 million of grants from the Australian and WA Governments (CEFC 2016; Waste Management Review 2016).

The plant draws on solid and liquid food waste from food processors, breweries and fruit and vegetable producers to generate energy. As diversion of organic waste to anaerobic digestion is not subject to landfill levies, many waste service contractors are drawn to the plant as a cheaper way to dispose of organic materials and reduce environmental impacts (City of Cockburn 2022; Waste Management Review 2016). The plant does not rely on household organic waste from food organics and garden organics (FOGO) bins, and many inquiry participants^a noted that organic processing of FOGO waste was difficult due to contamination by plastics and other toxins like perfluoroalkyl and polyfluoroalkyl substances (PFAS) or asbestos.

Box 5.1 – Richgro’s anaerobic digestion plant

The facility can process more than 35,000 tonnes of organic materials annually, which enables electricity production of two megawatts per year. This is enough to power the plant’s operation and, as the plant is connected to the energy grid, provide electricity to 3,000 homes. By powering its own operation, the plant saves an estimated \$600,000–\$800,000 per year on energy costs, and generates income from sales of surplus electricity and biofertiliser (Waste Management Review 2016).

a. Participants include: ACOR, sub. 75, p. 19; Cleanaway, sub. 112, p. 9; Hunter Joint Organisation, sub. 172, p. 13; NSW Government, sub. 139, p. 10; Swedish Australian Chamber of Commerce Sustainability Committee, sub. 94, att. 2, p. 2.

Australia’s biogas production is in the early stages of development, so currently has relatively low uptake. Australia has approximately 250 anaerobic digestion plants (McCabe 2022, p. 5), with a biogas output that accounts for about 0.5% of national energy production (based on DISR 2022, p. 12). Germany is a world leader with more than 10,000 anaerobic digestion plants (Kornatz et al. 2021, p. 5).

Australia’s volumes of organic waste (both food and agricultural) mean the industry has significant growth potential (Tait et al. 2021, p. 13). Agricultural waste could account for nearly 90% of all biogas production by 2050, and biogas could account for more than 6% of Australia’s total energy consumption (Kaparaju et al. 2023, pp. 19, 121). However, it is likely that at least some agricultural waste will be diverted for the production of liquid biofuels such as biodiesel and sustainable aviation fuel (as outlined above), so these theoretical maximums are unlikely to be achieved.

The potential for place-based hubs, including shared infrastructure, to advance opportunities to recover value from organic waste was also highlighted in *Australia’s Circular Economy Framework* (DCCEEW 2024b, p. 23). Place-based strategies to enable circularity are discussed in chapter 10.

Converting organic waste to biochar

Inquiry participants⁴⁰ raised the potential to convert organic waste (agricultural, crop and sewerage) into biochar via pyrolysis or gasification. Agricultural waste, crop residues, animal waste, and digestate (a solid by-product from anaerobic digestion) can all be transformed into biochar (Amalina et al. 2022, p. 1). Biochar is a carbon-rich solid that can be used as a feed supplement or alternative fertiliser, and has been associated with improved agricultural outcomes (Man et al. 2021, pp. 191, 208). Substituting chemical fertilisers for biochar has similar environmental benefits to replacing chemical fertilisers with organic compost (discussed below). Biochar also stores the carbon of its organic inputs, avoiding the emissions that would otherwise arise as the organic waste decomposes (Singh et al. 2014, p. 739).

Although Aboriginal and Torres Strait Islander people have used biochar for thousands of years to promote soil health and crop growth, total Australian biochar production is relatively low. As of 2020, only between 10,000 and 20,000 tonnes of biochar was produced per year in Australia (ANZBIG 2023, p. 8), compared to more than 150,000 tonnes in North America (Gray et al. 2023, p. 7).

⁴⁰ ANZBIG, sub. 173, p. 25; AWA, sub. 23, p. 1; Engineers Australia, sub. 108, p. 5; GlobalPSC, sub. 149, p. 24; Logan City Council, sub. 61, p. 2; qldWater, sub. 51, p. 5; RAI, sub. 100, p. 5; Tasmanian Government, sub. 180, p. 11; Water and Catchments Group, Victorian Department of Energy, Environment and Climate Action sub. 72, p. 2; WSAA, sub. 150, p. 5.

Converting organic waste into other products

Organic waste can be used for a range of other products, including natural fertilisers and household or commercial composting, which returns organic matter to soil and reduces the need for chemical fertilisers (Blanchard et al. 2023, p. 2). Replacing chemical fertilisers with composted organic waste lowers harms to aquatic plants and animals by reducing the run-off of nitrogen (Wei et al. 2021, p. 7), and increased use of composted organic waste has been associated with greater microbial biomass and respiration (Larsen et al. 2022, p. 8).

Over recent decades, the introduction of food organics and garden organics (FOGO) bins has increased the potential for recovering municipal organic waste. However, kerbside collection is limited to specific parts of Australia. Only 44% of local governments in Australia offered FOGO services in 2023 (based on Nestor 2023), servicing 53% of the Australian population (DCCEEW 2025b, p. 59). In 2023, 87% of South Australians had access to kerbside organic waste collection, compared to less than 20% of Queenslanders and no services offered at all to residents of the Northern Territory (based on DCCEEW 2025b, p. 87). Inquiry participants⁴¹ also noted there was greater potential to use waste from food production (such as manure) or manufacturing as materials to produce other products (such as fertilisers).

Several inquiry participants⁴² noted contamination of organic waste (and the cost of avoiding or removing contaminants) reduces the attractiveness of developing circular products that using organic waste. *Australia's Circular Economy Framework* notes that better household waste sorting could improve the safety and quality of household organic waste for use in value recovery processes like anaerobic digestion (DCCEEW 2024b, p. 23). Inconsistent kerbside bin collection requirements, which could be contributing to contamination of waste streams, are discussed in chapter 10.

5.3 Policy interventions to address barriers to circularity

Existing government measures to encourage circularity in food and agriculture

All levels of government in Australia have policies that either directly or indirectly promote circular activities relating to food and agriculture. Types of government policies that encourage or support circular practices are discussed below.

- **Direct financial incentives:** providing grants to make circular economy activities (such as sustainable farming practices and organic resource recovery) more economically attractive.
- **Laws and regulations:** restrictions on the types and amounts of materials (such as fertilisers) that people may use to grow or manufacture foods, as well restrictions on the types and amount of waste they may send to landfill.
- **Funding for research and innovation:** government investment in research and development aimed at increasing the profitability, productivity, competitiveness and sustainability of Australia's agricultural industry (which may include circular economy activities), through bodies such as Research and Development Corporations and the CSIRO.

⁴¹ ACMF, sub. 111, p. 7; Australian Pork Ltd, sub. 69, p. 3; Hetherington, sub. 9, p. 2; Planet Ark, sub. 147, p. 9.

⁴² ACOR, sub. 75, p. 19; Hunter Joint Organisation, sub. 172, p. 13; NSW Government, sub. 139, p. 10; Swedish Australian Chamber of Commerce Sustainability Committee, sub. 94, att. 2, p. 2.

- **Funding for education programs:** programs about how households and businesses can adopt circular activities, such as recycling organics, reducing food waste, more sustainable agriculture practices or opportunities to turn food and agriculture waste streams into resources (table 5.1).

Governments are also taking steps to address the environmental impacts of food and agriculture production in adjacent policy areas, including water, land management, energy efficiency and net zero emissions. For example, over the past three decades, the Australian and state and territory governments have invested in environmental protection and sustainable agriculture through the national heritage trust (DCCEEW 2025d).

The Australian Government also facilitates the Safeguard Mechanism and Australian Carbon Credit Unit (ACCU) scheme, which requires large emitters to reduce their emissions or purchase carbon credits, and incentivises emissions reduction through recognised methods. Currently, businesses can claim ACCUs for separating organic waste at the point of generation (CER 2024c), capturing and combusting gas emitted from decomposing organic waste in landfill (CER 2024b) or using an anaerobic digester to capture methane (CER 2024a), though the latter two of these methods are under review and due to expire at the end of March 2025 (DCCEEW 2024m). State and territory governments are also consulting with industry to develop new policies for biomethane. These policies include the New South Wales renewable fuel strategy, which is expected in 2025 (NSW DCCEEW 2024, p. 5), and Victoria's industrial renewable gas guarantee directions paper (DEECA 2024, p. 2).

Table 5.1 – Government measures that support circularity in food and agriculture

Measure	Description	Examples
Direct financial incentives	Directly funding projects that incorporate circular economy activities such as reducing food waste, or recovering value from organics waste.	<p>Food Waste for Healthy Soils Program: multimillion-dollar investments in projects that increase composting capacity of food waste, including household FOGO.</p> <p>Funding for food relief organisations: all levels of government have donation arrangements with food relief organisations.</p>
Laws and regulations	Creation and enforcement of laws and regulations to encourage sustainable practices in food and agriculture sectors, including reducing materials use and food waste.	<p>Food and grocery code of conduct^a: imposes strict penalties for supermarkets who unreasonably reject fresh produce or negligently over-forecast requirements.</p> <p>Recognition of the value of anaerobic digestion in energy from waste regulations^b: some state and territory energy from waste policies explicitly recognise the higher value of anaerobic digestion of organic waste as opposed to other energy from waste methods, and exempt anaerobic digestion from some production caps and licensing restrictions.</p>
Funding for research and innovation	Targeted research and development aimed at increasing the profitability, productivity, competitiveness and sustainability of the agricultural industry.	<p>Supporting the CSIRO: the Australian Government provides funding for the CSIRO to assist small businesses advance circular economy initiatives, including in the food sector, through programs such as Kick-Start.</p> <p>Research and Development Corporations: the Australian Government matches industry investment in research and development activities of selected agricultural and fishing industry projects.</p>

Measure	Description	Examples
Funding for research and education programs	Direct provision of information to change household behaviours, funding for research programs and facilitating diffusion of knowledge.	<p>State, territory and local government waste sorting campaigns: initiatives that aim to reduce the contamination of organic waste in household kerbside bins, such as the 'Which Bin' campaign in South Australia.</p> <p>End Food Waste Australia Cooperative Research Centre: an Australian Government-funded research centre that partners with industry to research and implement new methods to reduce food waste, such as 'The Great Unwaste' behaviour change campaign to reduce household food waste.</p>

a. The Australian Government endorsed a recommendation to require supermarkets to forecast required volumes of fresh produce with due care and to have reasonable fresh produce standards (The Treasury 2024b, p. 70, 2024a, p. 10), which are currently being implemented. b. Energy from waste regulations recognise the value of producing biogas from organic waste as higher than other energy from waste processes in Victoria, Queensland, South Australia, New South Wales and the Australian Capital Territory (DELWP 2021, p. 2; EPA SA 2020, p. 4; NSW EPA 2021b, p. 2; ORR 2021, p. 9; TCCS 2020, p. 8).

Source: DCCEE (2024j); DSS (2024); EPA (2024b); City of Sydney (2023); Treasury (2024b, p. 70, 2024a, p. 10); DELWP (2021, p. 2); EPA (2021b, p. 2); EPA (2020, p. 4); ORR (2021, p. 9); TCCS (2020, p. 8); CSIRO (2021c); DAFF (2025); GISA (2021), End Food Waste Australia (2025).

Priority opportunities for further government intervention

Food relief emerges as a priority circular economy opportunity in food and agriculture. Farmers and retailers collectively dispose of 2.2 million tonnes of food each year (based on FIAL 2021, p. 12), a large portion of which could be diverted to people in need to address aspects of food insecurity (section 5.2). As discussed below, policy interventions could help small and dispersed organisations overcome barriers to the collection and distribution of food donations, with broader benefits to the community.

Higher-value uses of organic waste also emerge as a priority circular economy opportunity given the potential for significant economic and environmental benefits (section 5.2). Existing regulatory frameworks may be unnecessarily impeding the adoption of this opportunity, as discussed below.

Policy measures to reduce food waste by changing household consumption habits, supermarket demand forecasting and fresh produce standards are already planned or underway. In 2024, the End Food Waste Cooperative Research Centre, funded by the Australian Government, established 'The Great Unwaste': a behaviour change campaign seeking to reduce household food waste (End Food Waste Australia 2024, 2025). The Australian Government also agreed to recommendations made by the Independent Review of the Food and Grocery Code of Conduct, requiring supermarkets to forecast required volumes of fresh produce with due care and have reasonable fresh produce standards (The Treasury 2024a, p. 10). Whilst these policies have been enacted too recently to assess their impacts, successful implementation should contribute to substantially reducing food waste.

The PC considers policy issues relating to packaging (including food packaging) in chapter 10.

Food donation to charity

In Australia, not-for-profit food relief organisations are feeding millions of Australians in need, while helping reduce food waste by collecting and distributing surplus food from farms, retailers and households. However, food relief organisations have insufficient food donations to meet the needs of the 32% of Australians who suffer from food insecurity (Guerrero et al. 2024, p. 8).

OzHarvest (sub. 81, p. 14) suggested that offering tax offsets to businesses that provide food donation services, including transport and storage, could increase donations. However, a Senate Committee recently chose not to support a bill proposing tax offsets. Despite overwhelming support from inquiry participants, the committee was concerned that tax offsets would result in a greater amount of fresh produce going to waste, as producers could recover some compensation for food not sold to retailers (Walsh et al. 2024, p. 21).

Primary producers and food retailers have also highlighted high transport and storage costs as prohibitive barriers to food donation, exacerbated in regional and remote areas (AFGC 2024, p. 3; AUSVEG 2024, p. 6; Flinders University Centre for Social Impact 2024, p. 3; Food & Fibre Gippsland Inc. 2024, p. 1; KPMG 2023, p. 13; NFF 2024, p. 3; Salvation Army 2024, p. 3; WACOSS 2024, p. 3). These costs are a disincentive to food donation, as producers can avoid them by disposing of surplus food on farms. Inquiry participants suggested governments could assist food donors and charities to deal with transport and storage constraints by helping to establish shared infrastructure (Woolworths Group, sub. 162, p. 11). This could include negotiating or incentivising access to private infrastructure to store donations (such as storage facilities at regional supermarkets), or supporting digital platforms for retailers and producers to coordinate transport of larger quantities of surplus food.

Considering the broader community benefits associated with food relief, and barriers that food relief organisations and donors can face in coordinating access to distribution and storage infrastructure, the PC is interested in further information on possible policy interventions.



Reform direction 5.1

Reducing food waste through food relief and donation to charity

The PC is considering how governments could facilitate greater donation of edible foods to the food relief sector. Supporting measures could include governments assisting food donors and charities to deal with transport and storage constraints, which currently prevent the diversion of edible food from disposal to food relief organisations.



Information request 5.1

Reducing food waste through food relief and donation to charity

The PC is interested in further information on the following matters:

- specific regions or stages of food donation (collection, storage, distribution) where barriers and challenges arise
- the most significant kind of barriers faced by the food relief sector, including (but not limited to) coordination issues and infrastructure capacity constraints, and how these might be overcome
- ways, and quantitative assessments of the costs and benefits (where available), governments can make food collection and distribution easier for small and/or geographically dispersed food businesses and charities, including incentivising the use of private storage and transport infrastructure
- examples of governments successfully playing a coordination role between food donors and food relief organisations in Australia or other countries.

Recognising the benefits of biogas in carbon reporting

Inquiry participants cited several barriers to wider uptake of anaerobic digestion of organic waste to produce biogas in Australia. Barriers to production included insufficient high quality feedstock (DCCEEW 2024b, p. 23), high upfront costs of establishing anaerobic digestion plants (Dubbo Regional Council, sub. 68, p. 3; Jemena, sub. 106, p. 4) and inconsistent and stringent state and territory environmental regulations (Australian Pork Ltd, sub. 69, p. 4; Infrastructure Victoria, sub. 28, p. 4; Jemena, sub. 106, p. 5; RGA, sub. 50, p. 8). Barriers to increased demand included a lack of recognition of the full benefits of biogas use in carbon reporting methods, which gives businesses less incentive to purchase biogas to meet their emissions reductions obligations (BCA, sub. 99, p. 3; Jemena, sub. 106, p. 6; RGA, sub. 50, p. 8).

The lack of recognition of the benefits of biogas is a barrier the Australian Government could address within regulatory frameworks. Currently, all facilities covered by the National Greenhouse and Energy Reporting (NGER) legislation can report avoided emissions associated with generating energy from biogas (rather than fossil fuels) if the biogas was produced on-site. For facilities with Safeguard Mechanism obligations, reporting these avoided emissions lowers the costs of meeting their emissions reduction benchmarks.

However, facilities cannot claim avoided emissions if they purchase biogas from shared infrastructure (gas networks that convey both biogas and non-renewable gas) (CCA 2023b, p. 50). This restriction exists because, under available reporting and accounting approaches, users cannot accurately calculate the amount of energy generated from biogas compared to fossil fuel-derived gas drawn from shared infrastructure. The inability to claim avoided emissions associated with biogas purchased from shared infrastructure reduces incentives for businesses covered by the Safeguard Mechanism, or those who have adopted voluntary emissions targets, to use biogas, and may weaken the economic feasibility of anaerobic digestion projects. As noted by Jemena (sub. 106, p. 6), 'this has held back investment, and is stymieing the environmental, social and economic benefits a robust biomethane industry can provide'.

A 2023 review of the NGER legislation recommended the creation of a nationally recognised certificate for renewable gas, which would enable carbon benefits to be appropriately valued under the Safeguard Mechanism (CCA 2023b, p. 53). The Australian Government has agreed in principle to implement the review's recommendation (DCCEEW 2024a, p. 7), and GreenPower has established a pilot certification (GreenPower 2024, p. 1). The Australian Government has indicated that the Guarantee of Origin scheme⁴³, which does not include biogas, could be expanded to include biomethane in the future (DCCEEW 2024k, p. 29).

Elements of the approach for recognising the emissions benefits of low-carbon liquid fuels, including biofuels, could be applied to biogas where relevant. For example, the Australian Government has amended the NGER scheme legislation to allow facilities to claim reduced emissions from using biofuel drawn from shared fossil-derived and renewable fuel infrastructure (DCCEEW 2024i, pp. 7–9). To claim these emissions reductions, a reporting facility needs to demonstrate, among other things, that they have purchased the amount of renewable fuel they are reporting.

The PC is considering whether a nationally recognised certificate for biogas, or other approaches to accurately measure and recognise the benefits of biogas, would materially increase uptake of biotechnology such as anaerobic digestion in Australia.

⁴³ The Guarantee of Origin scheme is an Australian Government-backed emissions accounting framework. It will provide businesses with certificates that detail when, where and how renewable energy was produced (DCCEEW 2025a).

**Reform direction 5.2****Recognising the benefits of biogas in carbon reporting**

The PC is considering how the emissions reduction benefits of anaerobic digestion projects that produce biogas from organic waste could be better accounted for, reported and valued. Options include developing certifications and/or other ways of accurately reporting biogas energy use, similar to those applicable to users of liquid biofuels under the National Greenhouse and Energy Reporting (NGER) legislation.

**Information request 5.2****Recognising the benefits of biogas in carbon reporting**

The PC is seeking further information (including data, where available) on the following matters:

- the extent to which modified carbon reporting methodologies for biogas use, similar to those for liquid biofuels use under NGER legislation, could materially increase uptake of anaerobic digestion projects in Australia
- the extent to which a nationally recognised certificate for biogas is necessary to accurately value the environmental benefits of using biogas drawn from shared infrastructure
- the benefits, costs and risks associated with adopting certifications or modified reporting methodologies for biogas.

Reforming regulations to support the recovery of value from organic waste

In addition to the lack of recognition for the benefits of biogas in carbon reporting, inquiry participants cited a range of regulatory barriers to recovering value from organic waste. These barriers are described below.

- Restrictive and complex environmental protection and planning regulations that prevent use of some organic wastes as an input for production, or create large regulatory burdens that reduce incentives to invest in such projects.⁴⁴ For example, in Victoria, animal manure is classified as an industrial waste (EPA Victoria 2021), which imposes additional reporting and licensing requirements for any business seeking to reuse the manure as a fertiliser input (ACMF, sub. 111, p. 7). And in New South Wales, environmental regulations require producers to obtain exemptions to reprocess marine waste (such as oyster shells) into soil conditioners (NSW EPA 2021a; RAI, sub. 100, att. 1, p. 30).
- Barriers specific to producing and using biochar, such as a disproportionate regulatory burden for biochar production and the fact that it is not recognised in the ACCU scheme.⁴⁵
- Variable environmental protection and planning regulations across states and territories, which can increase administrative costs of scaling businesses across state or territory borders, and introduce regulatory burden to importers of materials from other states or territories.⁴⁶

⁴⁴ ACMF, sub. 111, p. 7; BCA, sub. 99, p. 3; Infrastructure Victoria, sub. 28, pp. 4, 5; Jemena, sub. 106, p. 5; RGA, sub. 50, p. 8; Urban Utilities, sub. 71, p. 4.

⁴⁵ ANZBIG, sub. 173, p. 40; GlobalPSC, sub. 149, p. 38; Logan City Council, sub. 61, p. 2; qldWater, sub. 51, p. 5; SEATA Group, sub. 145, p. 11; WSAA, sub. 150, p. 10.

⁴⁶ ACOR, sub. 75, p. 19; CCEP, sub. 170, p. 11; Jemena, sub. 106, p. 4; Veolia Australia New Zealand, sub. 8, p. 6.

Reducing the restrictiveness or inconsistency of regulations across states and territories would support the recovery of value from organic waste. For example, many jurisdictions now explicitly recognise anaerobic digestion of organic waste as more valuable than other waste to energy processes and exempt anaerobic digestion from some production caps and licensing restrictions (table 5.1).

However, there are limits to how much governments can relax or harmonise regulations and planning laws without compromising other objectives, such as protecting human health and local amenity and the integrity of emissions reduction efforts. Changing regulations to enable the adoption of circular practices in ways that have unintended negative outcomes could lower community support and wellbeing. And simplified regulatory processes may be inappropriate, or ineffective, for resource recovery technologies (such as biochar) where production outputs are highly variable from project to project, or where project risks are highly dependent on geography. A better understanding of opportunities to reduce regulatory burdens will develop as industry and governments build and share knowledge of the risks of using organic wastes, such as the Australia New Zealand Biochar Industry Group's recently released guide to the production, uses and applications of biochar (Joseph and Taylor 2024).

As many participants referred to regulatory barriers to the adoption of biochar, anaerobic digestion and projects using organic waste in broad terms, the PC is seeking further information on whether and where government intervention is likely to have net benefits. It is also seeking input on the regulations or regulatory inconsistencies that create the biggest disincentive to invest in projects. The PC is interested in near-term roles for government action outside the ACCU scheme, noting for example the Australian Government Department of Climate Change, Energy, the Environment and Water (DCCEEW) only recently elected to not prioritise an expression of interest to establish a biochar ACCU method using the triage criteria (DCCEEW 2024I).⁴⁷



Information request 5.3

Reforming regulations to support the recovery of value from organic waste

The PC is seeking further information on regulatory barriers to projects that recover value from organic waste. Specifically, the PC is interested in further information on the following matters:

- specific regulations or regulatory inconsistencies that create disincentives to invest in projects that recover the value of organic waste (and estimates of associated compliance costs, where available)
- examples of projects not proceeding because of restrictive regulations or regulatory inconsistencies
- opportunities for reducing these barriers without compromising objectives such as protecting human health, the natural environment or local amenity (e.g. odour), including examples of best practice.

⁴⁷ DCCEEW is implementing a new proponent-led process for developing and modifying ACCU methods, which was recommended by a 2022 Independent Review of the ACCU scheme (Chubb et al. 2022, p. 10). While the government progresses legislative reforms to implement the Review's recommendations, there is an interim process whereby proponents put forward method expressions of interest to the Emissions Reduction Assurance Committee (ERAC) within DCCEEW for inclusion in the scheme. The ERAC then uses triage criteria (including scale, complexity, innovation, co-benefits and adverse impacts) to inform their recommendations to the Minister about which expressions of interest should be prioritised.

6. Textiles and clothing

Key points

- * **The production, processing and disposal of materials for textiles and clothing products have negative effects on the environment and human health, if not well managed.**
 - Textiles accounts for up to 8% of global emissions each year (with manufacturing contributing 40% of these emissions) and about 9% of global microfibre pollution in oceans.
- * **Australia is the biggest per-capita consumer of clothing in the world.**
 - Australian households and organisations consume an average of 39kg of new textiles and clothing per person each year, two and a half times the global average, and dispose of 33kg each year.
 - Australia's recycling rate for textiles is 5%, compared to 12% in France and 15% in the United States.
 - One-third of discarded clothing in Australia (100,000 tonnes each year) goes to landfill.
- * **As Australians consume 38 times more textiles products each year than are made in Australia, there is a wider scope to directly influence consumption rather than production.**
 - Renting, reusing, repairing and refurbishing clothes extend product lives, therefore lowering textiles waste and its associated environmental impacts (which include emissions, water pollution and biodiversity loss).
 - Making it easier for households to donate clothes can reduce waste and provide clothing to those in need.
- * **Commonly cited barriers to circular practices in textiles relate to purchasing and consumption behaviours, and low participation in product stewardship schemes.**
 - Households and businesses lack reliable and relevant information about products' sustainability and reparability and may also be influenced by social norms around purchasing behaviour ('fast fashion'), and low reuse and recycling rates ('throw away' culture).
 - Existing textiles product stewardship schemes in Australia are voluntary industry schemes that have only been recently implemented.
- * **The Productivity Commission is seeking further information on potential areas for further government action: enhancing product labelling and increasing participation in product stewardship schemes.**
 - Enhanced labelling about the design, material content, reparability or durability of textiles and clothing products could help consumers select products and help businesses identify opportunities for recycling.
 - The PC is considering the appropriateness of different models for textiles and clothing product stewardship schemes. For example, government accreditation of existing voluntary schemes could improve participation, while avoiding the additional costs of a co-regulatory or mandatory scheme.

6.1 Overview of the textiles and clothing sector

Materials used in the textiles product life cycle

Textiles and clothing businesses make a variety of products with a range of industrial and household applications. Industrial applications include tents, life vests, ropes, packaging and seats and upholstery in automotive vehicles. Household applications include clothing apparel, blankets, carpets, mattresses and curtains.

The textiles product life cycle comprises six phases.

- **Textiles design:** determining the functional, structural and aesthetic features of fabrics and textiles products.
- **Fibre production:** sourcing agricultural materials and processing them to extract fibres or producing synthetic fibres from crude oil extraction and chemical manufacturing.
- **Manufacturing textiles products:** producing yarn (spinning fibres into yarn), fabric (knitting, weaving or bonding the yarn into fabric) or textiles production (chemical and/or mechanical processes to produce finished textiles), and assembly (cutting and sewing of fabric into a final product).
- **Distribution and retail:** transporting textiles products to retail stores or directly to consumers.
- **Use:** washing, ironing and other forms of garment care.
- **Disposal:** disposing discarded textiles to landfills or exporting to other countries.

Textiles and clothing businesses use a range of natural and synthetic materials as inputs to production. Common materials used in textiles products include crop-based fibres such as cotton, hemp and linen; animal-based fibres such as silk, wool and leather; and synthetic materials such as polyester, nylon and elastane. More than 60% of clothing sold in the Australian market is made from synthetic fibres and about 40% is made from cellulosic fibre sources, primarily cotton (AFC 2022; Gbor and Chollet 2024). Most garments are blends of different fibre types. Apparel accounts for about 60% of global demand for fibres, while industrial textiles and other household textiles account for about 20% each (UNEP 2020, p. 11).

Key environmental impacts associated with material use in textiles

Producing, processing and disposing materials for textiles and clothing products can have negative effects on the environment and human health. Commonly cited issues include impact on biodiversity and soil health, greenhouse gas emissions and water pollution.

- **Biodiversity and soil health impacts from fibre production:** Natural fibres, such as cotton, can require extensive amounts of water, pesticides and fertilisers, which can result in soil degradation and biodiversity loss.⁴⁸ The Ellen MacArthur Foundation (2017) estimates that cotton cultivation accounts for 16% of pesticide use and 4% of fertiliser use globally. In Australia, the environmental impacts of fibre production vary depending on fibre type and other location-specific factors such as climate and water availability (Lockrey et al. 2022).
- **Greenhouse gas emissions and waste from textiles manufacturing:** Textiles manufacturing is energy intensive, which contributes to greenhouse gas emissions. The United Nations Environment Programme (UNEP) (2023b, p. 26) estimates the textiles value chain accounts for 2 to 8% of global emissions and textiles manufacturing accounts for over 40% of these emissions. Textiles manufacturing also requires heavy chemical use, many of which are hazardous if they enter the environment or people encounter

⁴⁸ However, natural cellulose fibres are renewable and can offer a more readily biodegradable, lower pollution impact alternative to synthetic materials for various applications including textiles and packaging (El Bourakadi et al. 2024).

them. The Ellen MacArthur Foundation (2017) estimates that producing 1kg of textiles requires about 0.58kg of chemicals.

- **Greenhouse gas emissions associated with transporting textiles and textiles waste:** Along with many other countries, Australia imports the majority of its textiles products that have been manufactured overseas. International shipping is energy intensive, contributing to carbon emissions.
- **Environmental impacts from textiles use:** Washing, drying and ironing textiles uses energy. As with textiles manufacturing, this energy use can contribute to greenhouse gas emissions. The UNEP (2023b, p. 26) estimates washing, drying and ironing textiles accounts for 25% of textiles emissions. Washing textiles also results in the release of microfibres to wastewater systems and eventually to the environment.
- **Impacts of disposed textiles on landfill and the environment:** When businesses and households dispose of textiles products, such as clothing, the fibres enter landfill and potentially the environment. UNEP (2023b) estimates the textiles sector accounts for about 9% of global microfibre pollution in oceans. In Australia, research has shown that microfibre pollution can negatively affect iconic environmental assets. For example, researchers found that pollutants on the Great Barrier Reef include synthetic and naturally-derived fibres (Kroon et al. 2018). While natural cellulose fibres biodegrade relatively quickly, synthetic fibres such as polyester and nylon do not readily biodegrade in natural environments (Collie et al. 2024).

Profile of textiles production, consumption and waste in Australia

Australia consumes more textiles products than it makes. Australian households and organisations consume an average of 39kg of textiles and clothing per person each year (ACTA 2021),⁴⁹ two and a half times the global average of 15.5kg per person (Textile Exchange 2024). In 2018-19, Australians consumed 383,000 tonnes of new clothing, with imported products accounting for about 97% of this consumption. Australian-based textiles businesses produce about 10,000 tonnes of clothing products annually (AFC 2022). Most domestic textiles production (including wool fabrics and home textiles such as bed linens) is designed in Australia (ECCP 2024; Mordor Intelligence 2025).

The Australia Institute reports that Australia is the biggest per-capita consumer of clothing in the world, with the average Australian purchasing 56 items of new clothing annually, compared to 53 items in the United States and 33 in the United Kingdom (Gbor and Chollet 2024).⁵⁰ Between 2018 and 2023, however, the number of clothing items purchased per capita in Australia decreased by 12%, while the number of second-hand clothes purchased increased by 18% (Seamless 2025).

Australian households and organisations dispose an average of about 33kg of textiles and clothing per person each year. In 2020-21, about 860,000 tonnes of textiles, leather and rubber waste was generated in Australia. Clothing is the major component of textiles waste. About 300,000 tonnes of clothing is discarded each year, of which about 100,000 tonnes go to landfill, with 200,000 tonnes given to clothing donation or collection services. About 60% of donated clothing is exported to developing countries (DCCEEW 2022d), and an unknown proportion of this ends up in landfill.

⁴⁹ This estimate by the Australasian Circular Textile Association is based on extrapolating data on textiles consumption in New South Wales to the rest of Australia; as such, it assumes that textiles consumption trends are similar across jurisdictions.

⁵⁰ These figures are illustrative as they relate to different years, with data from 2018 for Australia and 2017 for the United States and the United Kingdom.

6.2 Opportunities for greater circularity in textiles and clothing

Circular economy opportunities exist throughout the textiles product life cycle, offering environmental and socioeconomic benefits. To understand the applicability of these opportunities in Australia, the PC considered the current and projected size of the relevant market sector to which each opportunity related and the current levels of adoption (chapter 3).

Types of circular opportunities in textiles and clothing

Circular opportunities at the textiles production and retail stages include designing and making textiles more durable or repairable (Zero Waste Victoria, sub. 169, p. 17), using recycled fibres instead of virgin materials to make textiles (ACOR, sub. 75, p. 91; Turnbull, sub. 5, p. 1), using logistics and warehousing systems that reduce overstocking of textiles that can lead to waste (UNEP 2023b) and producing textiles and clothing from materials that have less impacts on natural resources (regenerative textiles) (Schandl et al. 2024) or use less hazardous chemicals (CTWG, sub. 22, p. 2). Some brands such as Patagonia (Stanley 2023) and Kathmandu (2025) have taken steps to reduce microfibre release from clothing by improving design and encouraging customers to wash in cold water, less often and on a gentle cycle.

At the use stage, opportunities include reusing, repairing, refurbishing, repurposing, renting, and sharing to maximise the useful life of materials (AFCC 2023a; Boulton, McCallion and Dechrai 2022; UNEP 2023b). Some brands have programs that encourage customers to return items for repair promoting the extension of product life. For example, Nudie Jeans offer a free repair service at their retail outlets and provide a 20% discount on new purchases when customers return used jeans (Recovery Tas Pty Ltd, sub. 90, attachment, p. 46).

At the post-consumption phases, opportunities include processing discarded textiles products to recover fibres, so they can be reused as raw materials for new products (TOMRA, sub. 118, p. 6). Some retailers (such as Upparel and Textile Recyclers Australia) facilitate this process through product takeback and collection schemes that reduce the collection and sorting costs incurred by consumers (PlanetArk 2025).

A key benefit of these circular practices is reducing carbon emissions. A report undertaken for the Global Fashion Agenda estimated that circular business models such as rentals, reuse, repair and refurbish could enable the fashion industry to cut around 143 million tonnes of greenhouse gas emissions in 2030. They found that each 1% increase in market share of circular business models is likely to reduce CO₂ equivalent emissions by 13 million tonnes (McKinsey & Company 2020, p. 14). Circular practices can also reduce emissions associated with transporting textiles waste to other countries (Boulton, McCallion and Dechrai 2022).

Reuse can also support broader socio-economic goals. Business donations of excess stock to charities can divert products to people in need at lower cost, while maximising the value of materials in existing products (Boulton, McCallion and Dechrai 2022; Charitable Reuse Australia, sub. 18, p.5; The Salvation Army, sub. 53, p.6).

Circular opportunities applicable in Australia

Circular design techniques (such as manufacturing textiles products and packaging from recycled content) are relatively uncommon for textiles produced or sold in Australia, though some businesses have adopted these practices (for example, Fairtrade Organic Cotton, and Repreve recycled polyester) (Product Stewardship Centre of Excellence 2025; Turnbull, sub. 5, p. 1). Samsara Eco, an organisation that has developed technology that can recycle plastics and textiles in collaboration with the Australian National University, has partnered with companies like clothing brand Lululemon to create new clothing products from recycled polyester (Tink MP, sub. 142, p. 2).

There also appears scope for greater adoption of circular practices among consumers (such as reusing or repairing textiles, choosing textiles that are more durable, repairable or sustainable, or reducing the number of clothes they buy). A 2024 national survey by Lane et al. (2024) found that more than 30% respondents had never repaired clothing items. Recent surveys of Australian consumers found:

- about 14% of respondents indicated that they repair most or all damaged items (just over 30% of respondents said they never do) (Statista 2024)
- the proportion of respondents who had purchased 'sustainable fashion products' was lower among men (35%) than women (47%), and lower among Baby Boomers (aged 59 to 77) (28%) than Gen Z (aged 18 to 28) (55%) (Statista 2024)
- in making fashion purchase decisions, 47% of respondents prioritise the use of natural fibres, 38% prioritise durable garments, and 30% prioritise garments made from sustainable fibres (Baptist World Aid Australia 2023).

While clothing reuse is relatively widespread,⁵¹ Australia's recycling rate for textiles is 5% compared to 12% in France and 15% in the United States (Girling 2024). Businesses such as BlockTexx and Upparel are pioneering efforts in textiles recycling, focusing on recovering polyester and cotton from discarded clothing and bedlinen (BlockTexx 2024; UPPAREL 2024).

Based on the scale of materials involved, opportunities that focus on local textiles consumption have much greater potential to affect materials use than those focusing on domestic production. Australian businesses and households consume 38 times more clothing products each year than Australian businesses make (section 6.1). However, some opportunities relating to post-consumption activities (such as recycling) may be limited by technical constraints, as noted in chapter 3. For example, the high costs and absence of technologies to recycle some textiles materials mean that 100% recycling rates will not be a realistic goal.

6.3 Policy interventions to address barriers to circularity

Existing government measures to encourage circularity

The Australian Government is encouraging greater circularity in the textiles sector by supporting product stewardship schemes and through the Environmentally Sustainable Procurement Policy. The Minister added clothing to the priority list for stewardship scheme action in 2021-22, and mattresses in 2022-23 (section 2.2).

The product stewardship scheme for clothing, Seamless, is an industry-led voluntary scheme that is not currently accredited by the government (types of schemes are discussed further below). Seamless, which commenced in July 2024, aims to foster circular business models, expand collection and recycling points, encourage sustainable design and production, and introduce education campaigns on responsible acquisition, care, repair, and disposal (AFCC 2023b). The Australian Government provided a \$1 million grant through the National Product Stewardship Fund to develop the scheme, and will provide a further \$1 million to support Seamless over two years from 2024-25 (Australian Government 2024b, p. 218). In early 2024, the Minister for the Environment stated that if the voluntary stewardship scheme is not sufficiently adopted by industry, it will be formally regulated by the Australian Government (DCCEE 2024t).

⁵¹ Charities including Vinnies, Salvos Stores, Good Sammy and the Red Cross handle an estimated 200,000 tonnes of clothing annually (or 52% of annual consumption), with about 17% of these donated clothing resold domestically (Lockrey et al. 2022). A 2024 survey by the Australia Institute found that 64% of respondents donated their last unwanted clothing item (Gbor and Chollet 2024, p. 4).

Product stewardship schemes also exist for textiles products other than clothes. The Australian Bedding Stewardship Council (ABSC) Scheme, which is also an industry-led non-accredited voluntary scheme, was introduced in 2023, provides national recycling solutions for mattresses (including in regional communities). The Scheme is funded through a product stewardship fee of \$10 per mattress, approved by the Australian Competition and Consumer Commission (ACCC).

Commencing in July 2025, the second phase of the Australian Government's Environmentally Sustainable Procurement Policy (which aims to reduce the environmental impacts of Australian Government procurements) will target textiles. The Policy includes products such as uniforms (including footwear and hats) and textiles for home and industrial use (for example, carpets and bedding) and will apply to procurement contracts over \$1 million.

The Australian Government has also developed a national framework for recycled content traceability in November 2023. The framework aims to improve trust in recycled materials by setting clear and consistent traceability rules for recycled content and guiding businesses to collect and share information about recycled materials. The Government's 'ReMade in Australia' program is working to create product labelling to encourage consumers to buy products made with recycled materials. The scheme aims to develop a recognisable logo for certified 'remade' products and is expected to help consumers identify Australian made products with recycled content.

State and territory governments have initiatives to encourage circularity in textiles through funding, infrastructure development and strategic programs. For example, the Queensland Government is investing \$4.97 million in project Boomerang, a textiles recycling hub in Brisbane operated by Salvos Stores to implement automated sorting and decontamination technologies that enable recycling and reuse of textiles. The government also supported BlockTexx, a textiles recycling business, with \$600,000 from the Resource Recovery Industry Program.

Local government actions for supporting circularity in textiles include providing household collection services and drop-off points to make reuse more convenient. For example, Mitchell Shire Council, Randwick City Council and City of Sydney Council offer intake of used clothing.

Barriers to increased circularity

During consultations conducted for this inquiry, commonly cited barriers to circular practices in textiles related to household and business purchasing and consumption behaviours. These barriers include high costs of repair relative to new products (CTWG, sub. 22, p. 1), lack of information about products⁵² and societal attitudes and norms (i.e. throw away culture, fast fashion) (Good Sammy, sub. 25, p. 2).

There are also barriers related to collection, reuse and recovery. These barriers include the lack of collection and sorting infrastructure, limited space for infrastructure development,⁵³ and consumers donating unwearable items to charities (Charitable Reuse Australia, sub. 18, p. 4; Good Sammy, sub. 25, p. 2).

⁵² For example, Circular Australia (sub. 126, p.8); CPRC (sub. 141, p. 4); eBay Australia and New Zealand (sub. 151, p.6); Monash University (sub. 138, p. 11).

⁵³ For example, Australian Retailers Association (sub. 165, p. 2); Circular Australia (sub. 126, p. 8); Good Sammy (sub. 25, p. 5); Millicer (sub. 82, p. 4); SSROC (sub. 26, p. 9); Vejnovic et al. (sub. 24, p. 3).

The barriers related to material recovery and recycling include complex textiles recycling processes,⁵⁴ lack of technology,⁵⁵ insufficient funding,⁵⁶ lack of information on product recyclability (Circular Australia, sub. 126, p. 8) and lack of markets for recycled materials (SSROC, sub. 26, p. 9). Some participants (for example, Zero Waste Victoria, sub. 169, p. 6) highlighted that textiles and clothing products made from a combination of synthetic and natural fibres, or those incorporating various components like buttons, zippers, and mixed fabrics, complicate material recovery. A few participants during consultation for this inquiry suggested improved product design such as using single fibre types and compatible materials could enhance material recovery and recycling processes.

Several participants noted challenges associated with the voluntary nature of textiles product stewardship schemes including free riding,⁵⁷ low participation and insufficient funding to support sector-led initiatives to manage waste streams in textiles and clothing (Resource Work Cooperative, sub. 30, p. 6; SSROC, sub. 26, p. 9).

The barriers identified at the textiles production phase related to circular design and using recycled inputs. It was noted that there is a lack of resources for small business designers and manufacturers (Vejnovic et al., sub. 24, p. 3) and that using recycled materials to produce clothes can be more expensive than using virgin materials (ACOR, sub. 75, p. 91). In consultations conducted for this inquiry, a few participants suggested that there is limited ability to influence the design, fibre choice and labelling of imported textiles.

Potential areas for further government action

Improving information about textiles and clothing products through labelling is a priority for further investigation. First, there appears scope for encouraging greater adoption of circular practices among Australian consumers (such as choosing products that are durable, repairable or sustainable) (section 6.2). Second, it has the potential to influence consumption behaviours and therefore a large volume of materials in Australia, compared with opportunities that focus on production (section 6.1). Third, empowering consumers to choose circular products through information and education would avoid some of the adverse impacts (such as negative distributional effects) of heavier interventions, such as consumption taxes, which could disproportionately affect low-income households.

Another potential area for further government action explored in this section is improving the effectiveness of existing product stewardship schemes in textiles. This would have the advantage of leveraging existing mechanisms, partnerships and infrastructure, compared to developing entirely new policies.

Improving information availability on circular textiles and clothing products

Growing environmental concerns among consumers and increasing demand for sustainably and ethically produced products are shaping purchasing preferences for textiles and clothing products (Lockrey et al. 2022). In a survey conducted among Australian consumers in 2021, Statista found that around 84% of respondents were willing to pay more for sustainable clothing products in comparison to regular products (Statista 2021). According

⁵⁴ For example, Global PSC (sub. 149, p. 12); Millicer (sub. 82 attachment; Chamberlin, sub. 73, p. 6).

⁵⁵ For example, Good Sammy (sub. 25, p. 5); Infrastructure Victoria (sub. 28, p. 5); Kylea Tink MP (sub. 142, p. 2); Now and Future (sub. 123, p. 3); Resource Work Cooperative (sub. 30, p. 6).

⁵⁶ For example, ACOR (sub. 75, p.5); Zero Waste Victoria (sub. 169, p. 4).

⁵⁷ Free riding occurs when a business benefits from the actions of another without paying for or sharing the costs. In the context of voluntary PSS, non-participating businesses can benefit from the collection and recycling infrastructure funded by the schemes.

to a 2023 YouGov survey, about 46% of Australian consumers said seeing a fashion item marked as 'sustainably-made' or similar makes them more likely to purchase it (Tan and Iacono 2023).

Providing consumers with reliable and relevant information about circular textiles products assists them in choosing products that align with their values and preferences. Around two-thirds (69%) of consumers who do not consider environmental sustainability when buying clothes said they 'find it difficult to identify whether a fashion item/brand is sustainable or not', and 66% said they are 'sceptical when a fashion brand makes claims about sustainable/ethical practices or products' (Tan and Iacono 2023).

Improved consumer information may in turn enhance incentives for manufacturers or retailers to produce or stock these products (CTWG, sub. 22, p. 2). And consumers may be more inclined to participate in takeback schemes if they are confident that the manufacturer or retailer will recycle or reuse the returned products, rather than throw them away.

Measures to mitigate the risk of greenwashing for textiles and clothing products

Consumer groups (CPRC, sub. 141, p. 9; CTWG, sub. 22, p. 2) argued that businesses are responding to rising consumer demand for environmentally friendly products, including textiles and clothing, by marketing their products as sustainable. In the absence of adequate regulations, there is a risk that businesses may make such sustainability claims without evidence. The Consumer Policy Research Centre (CPRC) (sub. 141, p. 4) noted the absence of clear standards about what constitutes circular textiles or clothing products provides scope for greenwashing,⁵⁸ as terms such as 'eco-friendly', 'sustainable', 'good for the planet' and 'efficient' are confusing. According to a survey on ethical consumer decisions conducted in Australia in 2023, 34% of respondents said a leading barrier was that they were unsure which fashion brands were ethical (Baptist World Aid Australia 2023).

Citing the findings of the ACCC's internet sweep of environmental claims for selected products, consumer groups raised specific concerns about:

- the large number of certification trademarks for the same product class (such as textiles, garments and shoes) makes it difficult for consumers to understand what every certification trademark means or to assess how robust the scheme is. The ACCC found seven different textiles certification schemes
- the use of logos or symbols on websites and packaging (such as nature-based imagery like leaves and the planet, and the colour green) that appear to be trustmarks but are not associated with a certification scheme. The CPRC cited research found that 69% of people said they were likely to trust a green claim that had a trustmark (CPRC, sub. 141, p. 9)
- businesses creating their own certification schemes for their products, rendering certification trademarks meaningless in helping consumers to distinguish between different products (ACCC 2023a, p. 7)
- businesses not providing sufficient evidence for their claims.

The ACCC did not provide examples from the textiles, garments and shoes sector for the last three concerns. However, it found 18 out of the 27 (or 67%) textiles businesses reviewed made concerning claims, compared to an average of 57% across all sectors.

There are initiatives in place to address these issues. In December 2023, the ACCC issued guidance for businesses making environmental claims (ACCC 2023c). The Australian Senate Standing Committee on Environment and Communications has been conducting an inquiry (report due by March 2025) into 'greenwashing' across various sectors, including clothing and footwear, to assess the impact of misleading environmental and sustainability claims on consumers and explore further legislative options to protect

⁵⁸ Greenwashing refers to a situation where businesses make false or misleading claims about the environmental benefits of a product or service.

consumers. And the Treasury is currently consulting on amending the Australian Consumer Law to address unfair trading practices, which could make it harder for businesses to make vague 'green' claims about products and services (The Treasury 2024d).

General consumer protection measures and compliance activities, and initiatives underway to improve these, appear to be addressing greenwashing concerns in the textiles and clothing sector. But to the extent that there are specific greenwashing issues that fall out of scope of existing protections and proposed improvements, there may be a case to increase compliance activities and education in this sector. As such, the PC is seeking further information on the adequacy of protections for textiles consumers and further actions that may have net benefits to the community.



Information request 6.1 Protections for consumers of textiles and clothing

The PC is seeking the following information on protections for consumers of textiles and clothing:

- the extent to which consumers of textiles and clothing products consider certification trademarks when choosing between different products and what product qualities those certifications cover (for example, ethical production, sustainable inputs, product functionality)
 - which certification trademarks are considered most trusted in the textiles industry and by consumers, and what makes them stand out compared to others
- the extent to which textiles and clothing manufacturers and retailers engage in misleading behaviours (for example, misleading logos, terminology, or accreditation; providing insufficient information to support claims) that fall outside of existing general consumer protection laws (such as the Unfair Trading Practices prohibition) and associated compliance activities (guidelines)
 - what, if any, harms to consumers arise from these misleading claims
- actions that governments or product stewardship schemes could take to promote the availability of reliable and relevant information about whether clothing and textiles products' claims related to circularity and sustainability are accurate and credible.

Product labelling to help consumers select circular textiles and clothing products

Textiles and clothing products currently include mandatory care labelling. Several participants suggested that improving labelling could help consumers choose genuinely circular or sustainable products.⁵⁹ There is evidence that consumers value information about sustainability when purchasing textiles products (Lockrey et al. 2022). A United Kingdom survey found that there is a receptive market for eco-labels for home textiles that provide information on durability, recyclability and repairability (WRAP 2023). And a 2023 survey of Australian consumers found that about 1 in 5 respondents claimed environmental sustainability and brand ethics was among their top three considerations when shopping for fashion items (Tan and Iacono 2023).

There is also evidence that consumers can find it difficult to access repairability and durability information. The CPRC (sub. 141, p. 4) observed that it is difficult for Australian consumers to identify whether products will last for a long time or can be easily repaired when they make a purchase. In an Organisation for

⁵⁹ For example, Circular Australia (sub. 126, p. 8); CPRC (sub. 141, p. 4); eBay Australia and New Zealand (sub. 151, p. 5); Monash University (sub. 138, p. 11).

Economic Cooperation and Development (OECD) working paper, Laubinger and Börkey (2021, p. 11) noted (about products in general) that 'consumer-oriented information and labels that encourage consumers to opt for longer-lived products or to repair and use them for longer timeframes currently remain niche and their uptake is low. Only few consumer-oriented labels include product lifespan criteria'.

Repairability and durability labelling schemes exist in other countries for other products (such as France's repairability index for electronics, see chapter 9). However, these other scheme designs may not have the same effectiveness if applied directly to textiles. Even when consumers of textiles and clothing products have access to reliable information, they may not act on that information if it is not relevant to their purchase decision. For some products, characteristics such as reparability and durability may not be as influential in buying decisions as whether the process for making the textiles was sustainable or ethical. These concerns may be better addressed by other eco-labelling schemes, such as the global organic textile standard or the 'fair mined' gold certificate, which provides information on materials origin. Consumers may also be more interested in repairability and durability information to inform an expensive, infrequent electronics purchase (where they have limited ability to assess quality by inspection), than they would for clothing.

The feasibility of implementing a labelling scheme will depend on whether businesses are able to access the information required (such as material composition, recycling options, and sustainability practices) to be included on their product labels, and whether this information is accurate and consistent to enable consumers to have confidence in the labels. Some of this information may be in the control of businesses, while other aspects may require external research, adding costs. Circular Australia (sub. 126, p. 8) highlighted the need for standardisation and traceability, with a national approach on material and product passports, and eco-labelling for textiles products.

Product labelling to help textiles businesses adopt circular opportunities

Product labelling can also provide information to businesses at other stages of the product life cycle, enabling feedback loops between repair services, materials recovery and recycling companies, and designers and manufacturers.

- Labels can provide essential details for resale and upcycling businesses (such as Loop Upcycling), helping assess textiles value and durability, and facilitating transparency in the second-hand market.
- Labels with materials composition (such as cotton, polyester) and care instructions can help textiles repairers choose the right repairing techniques.
- Labels about materials composition and recyclability can streamline sorting, reduce contamination and minimise materials loss at collection and sorting facilities.
- Labels about fibre and material types (such as in buttons and zippers) can enable materials recovery and recycling businesses (such as Upparel and BlockTexx) to extract fibres more efficiently, improving materials recovery rates and reducing waste.

The PC is seeking further information to better understand the potential benefits and costs of additional policy measures to improve the availability of information about textiles and clothing products (such as their design, material composition, repairability and durability) through product labelling. These policy measures could involve amending existing regulatory frameworks or standards governing existing textiles and clothing labelling schemes, and/or designing and developing a new product labelling scheme with industry.



Reform direction 6.1 Product labelling for textiles and clothing

The PC is considering the role for governments in product labelling to improve the availability of information about textiles and clothing products (such as their design, material composition, repairability and durability) and enable consumers and businesses to adopt circular practices. Options could include amending existing regulatory frameworks or standards governing existing textile and clothing labelling schemes, and/or designing and developing a new product labelling scheme with industry.



Information request 6.2 Product labelling for textiles and clothing

The PC is seeking the following information on product labelling for textiles and clothing:

- the types of information on product qualities (such as sustainable inputs, reparability, durability and recyclability) that would be usefully included on product labels for:
 - consumers, to support their ability to buy circular textiles and clothing products
 - textiles recycling and upcycling businesses, to support their ability to adopt circular opportunities
- what would be required for businesses and retailers in Australia to access accurate and consistent information for product label details
- the extent a product labelling scheme could build on existing information systems, standards and regulations or would require new ones to be set up, and associated costs and implementation issues
- whether other forms of labelling or information (business to business, or end of system) could facilitate greater circularity across the textiles product life cycle.

Enhancing the effectiveness of product stewardship schemes

In Australia, government involvement in product stewardship varies across a spectrum of accredited voluntary, co-regulatory or mandatory schemes (section 2.2). During consultation, some organisations noted that voluntary product stewardship schemes face difficulties in compelling businesses to participate, with some businesses and retailers not engaging unless the scheme is regulated. Seamless highlighted the importance of establishing partnerships between stewardship schemes and governments to achieve circularity in the clothing industry (AFCC 2023b). The Product Stewardship Centre of Excellence noted ‘regulation is the best solution for ensuring high levels of industry investment and participation’ (sub. 159, p. 6).

Several participants to this inquiry argued that product stewardship schemes in the textiles and clothing sector, such as Seamless and the ABSC Scheme, should be mandatory so that:

- sufficient revenue is generated (ACOR sub. 75, p. 91; Resource Work Cooperative sub. 30, p. 6)
- all apparel products are covered (Chamberlin, sub. 73, p. 10)
- textiles collection, sorting, reuse and recycling infrastructure can be scaled up (TOMRA, sub. 118, p. 12)
- manufacturers and brands share the costs of end-of-life product recovery (SSROC, sub. 26, p. 8).

The Southern Sydney Regional Organisation of Councils noted voluntary schemes often fail to secure sufficient market share, leaving local governments and ratepayers to bear the burden of managing waste:

Councils in Sydney recovered close to 160 000 mattresses in 2023-24, costing approximately \$50 per unit for collection and recovery. Despite efforts by the Australian Bedding Stewardship Council to establish a voluntary scheme requiring a \$10 per unit contribution from manufacturers, this initiative has not provided adequate funding to councils, leading to increased financial strain. (SSROC, sub. 26, p. 8)

The Seamless Consortium noted several benefits of a co-regulated scheme over a voluntary one, including that it would:

- make it easier for stakeholders to progress change
- alleviate participants' concerns that their contributions are supporting free riders
- make it easier to forecast income, expenditure and level of contribution required (AFCC 2023b, p. 21).

During consultations for this inquiry, some participants suggested a staged approach to enhancing the effectiveness of existing voluntary product stewardship schemes for textiles and clothing, which could involve voluntary schemes seeking government accreditation in the immediate term and then moving to co-regulation and mandatory regulation, if necessary.

Under the *Recycling and Waste Reduction Act 2020* (Cth), voluntary product stewardship schemes can apply for government accreditation. The Australian Government assesses applications based on how the scheme promotes circularity, maximises the continued use of products and materials over their life cycle, and reduces harms to the environment and human health. The Minister for the Environment has the power to decide whether to accredit a voluntary scheme and if any further conditions are needed to ensure the arrangement complies with the Act, such as targets on scheme outcomes, reporting and performance evaluation requirements (DCCEEW 2025c).

Accreditation permits schemes to use the Australian Government product stewardship logo. One of the purported benefits to businesses of the logo is that it provides a competitive advantage by letting the public know that the industry has worked to reduce the negative impacts from its products. Such benefits might encourage greater scheme participation (DCCEEW 2025c). While the 2020 review of the *Product Stewardship Act 2011* noted the schemes regulated and accredited under the Act have reduced the impacts of covered products on the environment and human health (DAWE 2020), the specific impacts of accreditation on industry participation rates and schemes outcomes in Australia have not been evaluated.

In other countries, co-regulatory and mandatory schemes have had some effect on textiles circularity. France introduced a mandatory extended producer responsibility scheme for textiles products in 2008 and the Netherlands introduced a similar mandatory scheme in 2023 (box 6.1). In comparison to Seamless, the French and Dutch schemes have a specific target for reuse and recycling and also mandate that producers submit regular compliance reports. In France, collection rates have improved since the scheme's introduction, however there are concerns around underdeveloped recycling operations, eco-contributions providing minimal incentives for circular design, and reliance on exports for reuse and recycling (Wilson 2021). In 2019, the collection rate of textiles waste was 38% in France, 45% in the Netherlands, 19% in Sweden, and 43% in Denmark (Global Observatory of Climate Action 2022, p. 139).

Box 6.1 – Mandatory textiles product stewardship schemes in other countries

In European Union (EU) countries, extended producer responsibility (EPR) legislation will be mandatory from 2025. The Netherlands has had a mandatory EPR scheme for textiles since July 2023. The government's targets include that 50% of the textiles released on the Dutch market must be recycled or reused in 2025, gradually increasing to 75% in 2030. The scheme requires producers and importers to make it possible for consumers to give back their old textiles at any time and at no charge. Textiles producers must ensure that consumers know how to dispose of their old textiles and understand what happens to these items. Producers also have to report the volume of textiles they sell, reuse and recycle in the Netherlands.

In France, the textiles EPR legislation has been in place since 2008. It sets collection and recycling targets for textiles including clothing, linens, curtains and footwear. By 2028, it aims to achieve a minimum of 60% annual collection of textiles waste, and to recycle 90% of the synthetic waste that comes from textiles each year. Producers, importers and distributors operating on the French market, including online retailers, are required to either enrol in a certified collection organisation or establish their own officially accredited collection and recycling program.

While several other countries (such as Sweden, Spain, Italy, Norway, United Kingdom and Chile) are in the process of introducing textiles EPR schemes, the effectiveness of such schemes remain unclear. In France, the scheme has contributed to a threefold increase in textiles collection and recycling rates, with recovery rates reaching up to 90%. But while consumers are buying fewer clothes since the scheme began, the volume of clothes placed on the market has increased. Additionally, 80% of the textiles collected are exported to developing countries, many of which lack adequate waste management systems (Girling 2024).

In Australia, co-regulatory and mandatory schemes in other sectors (such as the National Television and Computer Recycling Scheme (discussed in chapter 9) and Used Oil Product Stewardship Scheme) have been associated with increased private investment, reduced waste to landfill and increased materials recovery (DAWE 2020; Product Stewardship Centre of Excellence, sub. 159, p. 6). But heavier regulation of product stewardship schemes entails costs, including administrative costs for governments establishing, monitoring and enforcing the scheme. Under a mandatory scheme, as all businesses incur compliance costs to meet regulatory requirements, this may result in costs being passed onto consumers. And moving too fast to mandatory arrangements can reduce opportunities for businesses to join and 'buy-in' to a voluntary or co-regulatory scheme.

As such, mandatory schemes have to date been established for products with particularly problematic waste streams, such as oil and e-waste. Textiles and clothing waste does not have as hazardous properties as these more problematic streams. More time is also needed to determine whether the recent voluntary approaches to product stewardship for textiles will be effective in motivating industry change (without mandatory regulations).

Clothing Stewardship Australia (CSA) commenced the operation of Seamless as a voluntary industry-led scheme without government accreditation in 2024, and the ABSC Scheme commenced in 2023, and there is limited information on progress towards objectives and impacts on businesses and consumers. CSA is working with the Department of Climate Change, Energy, the Environment and Water (DCCEEW) to seek government accreditation of the voluntary scheme, as this is the next step in the current regulatory pathway,

which may help encourage sector participation by demonstrating to businesses and consumers that the arrangement has the Australian Government's stamp of approval (DCCEEW 2025c).

To better understand the costs and benefits of regulation in textiles product stewardship schemes, the PC is seeking further information on the motivations of textiles businesses and retailers to join or not join existing schemes, experiences participating in these schemes, and suggestions for improving governance and transparency (information request 6.3). The PC invites further information on the extent government accreditation of existing voluntary schemes could help address concerns about lack of scheme participation (including experiences from other product stewardship schemes that have gained accreditation).



Information request 6.3

Textiles and clothing product stewardship schemes

The PC is seeking further information on:

- the impacts of changing from a voluntary industry-led scheme to a voluntary accredited, co-regulatory or mandatory scheme, such as:
 - the value of potential environmental, economic and/or social benefits from greater government involvement in textiles and clothing product stewardship schemes
 - the size and nature of potential costs associated with this increase in government involvement
- reasons for businesses and retailers to join or not join the Seamless and ABSC schemes, and what additional incentives or changes would encourage greater participation
- businesses' and retailers' experiences of participating in textiles and clothing product stewardship schemes, including challenges faced and benefits gained
- limitations in current government accreditation arrangements and how they can be improved to implement effective voluntary schemes.

7. Mining

Key points

- ✳ **Resource extraction and mining waste can have significant negative effects on the environment.**
 - Mining accounts for 86% of materials extraction in Australia and is Australia's second largest producer of direct (scope 1) emissions. It produces more than four times the waste of all other sectors combined.
 - Mining waste can contain valuable materials, such as critical minerals and strategic materials.
- ✳ **Companies adopt circular opportunities in exploration, extraction and processing for commercial reasons, once technologies reach sufficient readiness. However, there is lower uptake of circular opportunities that capture value from mining waste or repurposing mine sites.**
 - Mining companies have limited private incentives to repurpose mining waste for uses such as carbon capture or transform post-mining land for higher-value uses.
- ✳ **Governments currently support the mining sector to adopt circular practices in various ways.**
 - Governments fund mining research and development.
 - Some governments also offer direct financial incentives for reprocessing mining waste.
- ✳ **The Productivity Commission is seeking views on how governments could facilitate greater uptake of circular economy opportunities for mining waste and alternative post-mining land uses.**
 - There are regulatory barriers affecting some of these opportunities, such as administrative burdens associated with obtaining permits for materials recovery and restrictions on transporting mining waste.
 - The PC is considering a reform direction to undertake a national assessment of mining regulations to identify and reduce barriers relating to opportunities for mining waste and repurposing closed mine sites.
 - The PC is also seeking information on other ways governments could enable circular economy opportunities for mining waste and alternative post-mining land uses, such as targeted regional planning and development.

7.1 Overview of the mining sector

The mining sector extracts naturally occurring resources such as metal ores, coal, and natural gas, which it then supplies to the manufacturing sector for further processing into products and services such as steel and energy (ABS 2013). Mining involves exploration and planning, extraction, and sorting and basic processing (such as grinding and washing). This chapter does not examine opportunities in more advanced mineral processing. Mining activities produce various wastes such as overburden (soil and rock removed to access the desired commodity), waste rock, and tailings (fine particle residue left after the desired materials are removed during processing).

Environmental impacts associated with materials mining

If not well managed, mining can have significant negative impacts on the natural environment, human health and wellbeing. Resource extraction, sorting and processing and the associated waste generated (such as mining tailings) can have local impacts. Developing and operating mine sites can significantly disturb local lands and waterways, resulting in air and water pollution, biodiversity loss, and soil erosion, which can in turn negatively affect human health, and social and cultural connections to the land (Leyton-Flor and Sangha 2024, p. 2).

Mining's impact on local land and waterways can remain long after a mine closes. Australia has over 50,000 abandoned mines (Salmi, Bekele and Schmid 2022, p. 6). Many of these pose contamination risks because they operated before regulators introduced modern environmental and safety practices (Abraham, Dowling and Florentine 2018, p. 123). Issues include various types of water pollution, such as acid mine drainage and cyanide leaching, and geotechnical instability caused by underground cavities (Salmi, Bekele and Schmid 2022, p. 11). Even modern mines that were subject to stricter environmental management can continue to have long-term impacts on the landscape. For example, a 2017 research paper found fewer than 30 examples of fully rehabilitated and relinquished mines across Australia (Campbell et al. 2017, p. 10).

Both the volume and types of waste produced during mining have raised environmental concerns. In 2020-21, the mining sector produced 620 megatonnes (Mt) of waste, which was more than four times the waste of all other sectors combined. Mining companies deposited an estimated 96% of this waste in tailings dams and used most of the remainder to fill mine voids (DCCEEW 2022d, p. 17). Tailings and other mining waste contain significant amounts of contaminants. If mining companies do not properly manage tailings and other wastes, or if there is a failure in tailings storage facilities (TSFs), the waste can negatively affect water quality, surrounding soils, and the air (Salmi, Bekele and Schmid 2022, p. 11; University of Melbourne, sub 36, p. 8).

Mining processes are emissions-intensive and make a sizeable contribution to Australia's total emissions. Mining is the second largest producer of direct (scope 1) greenhouse gas emissions in Australia, producing 101 Mt CO₂e in 2021-22. Mining also produced 24 Mt CO₂e in scope 2 emissions during 2021-22. Scope 1 and scope 2 emissions from mining have grown considerably, by 64% and 94% respectively, since 2004-05 (DCCEEW 2022c).

Mining is one of Australia's largest sectors

The mining sector is the largest producer of materials in Australia and one of the largest sectors in terms of output value (figure 7.1). Given mining accounts for 86% of domestic materials extraction, even small efficiency improvements or reductions in waste generation should have a significant impact (DCCEEW 2024d, p. 96; based on Miatto et al. 2024a, pp. 10–14).⁶⁰

Figure 7.1 – Mining in the Australian economy



a. % of Gross Value Added (GVA) at basic prices, at current prices as of June 2024. **b.** Proportion of exports by value
Source: ABS (2024a); DISR (2024c, p. 5); Jobs and Skills Australia (2024).

⁶⁰ The mining sector accounts for domestic extraction of all material categories except biomass.

The Organisation for Economic Co-operation and Development (OECD) Global Materials Resource Outlook projects that global demand for primary materials will double between 2019 and 2060, in response to population and per capita income growth (OECD 2019). However, studies have noted that there will be a change in the composition of demand as global mineral requirements for the clean energy transition increase. For example, CSIRO noted the transition toward clean energy technologies and electric vehicles has doubled the demand for critical minerals in the past five years (CSIRO 2024, p. 1).

Shifts towards net zero and circularity in major export markets for Australian mining commodities, such as China and Japan, are expected to directly impact Australia by reducing demand for certain materials, such as coal (DISR 2024c, pp. 11, 134; Ogunmakinde 2019, p. 1). The recycling of some materials, such as metals, has the potential to reduce demand for other virgin materials but it is unlikely that recycled materials will fully meet demand in the near to medium term (AMEC, sub. 143, p. 1; Australian Aluminium Council, sub. 86, p. 1; Dominish, Florin and Wakefield-Rann 2021, p. iv; West, Ford and Meyers 2021, pp. i–iii). For example, CSIRO modelled global demand for metals used to make electric vehicles (EVs) from 2020 to 2060 under a range of scenarios (including various rates of metal recycling, technology change, and EV uptake). In all scenarios there was demand for virgin metals up to 2035 and, in most cases, demand continued up to 2050 (West, Ford and Meyers 2021, pp. i–iii).

7.2 Opportunities for greater circularity in mining

Circular economy opportunities associated with the mining sector arise during exploration, extraction and processing and in mining waste and post-mining land use. To understand the applicability of these opportunities in Australia, the Productivity Commission considered the current and projected size of the sector and current levels of adoption of circular economy practices (chapter 3).

Exploration, extraction and processing phases

Lower-impact and precision mining techniques

Lower-impact and precision mining techniques enhance the precision of exploration and selectivity of extraction, thereby minimising waste volumes (CSIRO 2017, pp. 39–40, 47–48, 2023a, pp. 12–13). These techniques are used in the first three stages of the mining life cycle.

- **Exploration and planning:** Digitally enhanced geological surveying techniques, advanced sensing and drilling technologies enable more precise ore body characterisation (identifying properties of an ore deposit, such as its mineralogy, size and shape).
- **Extraction:** Advanced extraction techniques enable more selective extraction of ores (for example, in-situ recovery extracts metals from ore using a chemical solution, leaving the surrounding rock in place) and can help optimise blasting to better prepare ores for processing.
- **Sorting and processing:** Processing waste closer to the mining site and using advanced ore sorting technologies to separate out waste earlier in the process reduce the need to transport large amounts of waste materials.

These technologies can have environmental and economic benefits by:

- **Reducing mining waste** and its treatment costs, and lowering hazards to human health and biodiversity associated with TSFs and contaminants potentially entering the environment (CSIRO 2023a, pp. 12–13).
- **Reducing land disturbance**, including by enabling the processing of lower-grade ores in brownfield sites, rather than starting greenfield projects (Vernon 2020).

- **Reducing haulage** and associated transport costs and emissions (CSIRO 2017, pp. 47–48).

While these techniques have environmental and safety advantages, they may also introduce other environmental risks; for example, the chemicals used during in-situ recovery have groundwater contamination risks (Taylor et al. 2004, p. 11).

Because of their transformative nature, many of these technologies are well-suited for implementation to new projects, although some solutions can be implemented in operational mine sites (such as advanced ore sorting) (CSIRO 2023a, p. 12). Currently Australia has over 100 prospective mining projects, some of which could employ these technologies (MCA 2024). Given the cost reduction benefits, mining companies tend to adopt new techniques quickly once they reach sufficient maturity, as it is often in their commercial interests. Lower-impact and precision mining techniques and technologies are continually advancing. For example, advanced sensors and high-resolution scanning technologies are now commonplace in exploration and planning (Hodkiewicz 2024). In-situ recovery is commercially mature in uranium mining but still at the pilot-scale for other materials (CSIRO 2023a, p. 13).

While there may be some gaps in technology readiness for newer processes that are yet to be deployed at commercial scale (CSIRO 2023a, p. 13), mining and mining equipment, technology and services companies are already investing heavily in research and development to remediate these gaps (MCA 2022, pp. 16, 20, 22). Governments also fund mining research and development, including into technologies that underpin circular economy opportunities (MCA 2022, pp. 22–23).

Life extension and re-use of mining equipment

Keeping mining equipment in use for longer through maintenance, refurbishment and re-use can reduce material consumption, on-site waste and potentially upstream emissions in the mining machinery sector by avoiding or delaying the purchase of new equipment. 7% of mining machines globally are in Australia, creating a large potential re-use market (Tunncliffe 2024).

In Australia, adoption of these opportunities is already widespread. Repair is more likely for expensive machinery, such as mining equipment, as it is not cost-effective to replace when it could be repaired (PC 2021b, p. 29; Wiseman, sub. 40, p. 2). Mining companies often have internal repair and maintenance capacity and Australia has a robust mining equipment repair industry, with demand for mining machinery repair and maintenance increasing in recent years (IBISWorld 2025). An inquiry participant observed that companies are already offering 'products designed for repair and refurbishment, with a strong emphasis on preventative maintenance' as well as some offering product-as-a-service models (Greater Whitsunday Alliance, sub. 109, p. 11).

Mining waste and post-mining land uses

Recovering mineral resources from mining waste

Valuable materials, such as critical minerals, can be recovered from some mining waste (DISR 2024a). Traditionally, mining operations only focused on one or two primary commodities, ignoring co-occurring metals that were not valuable at the time (AMEC, sub. 143, p. 4). As a result, a large number of TSFs and waste stockpiles may contain minerals that have since become highly valuable or strategically critical, such as cobalt and tungsten (AMEC, sub. 143, p. 4; CSIRO 2023a, p. 16; Greater Whitsunday Alliance, sub. 109, p. 10; University of Melbourne, sub. 36, p. 8). A 2022 study identified 1090 TSFs in Australia (331 active and 759 inactive) (Sarker et al. 2022, p. 1), which could potentially be mined for critical minerals.

Uptake of this opportunity will depend on the economic viability of recovering materials. This is influenced by factors such as the value of the materials being recovered, concentration in tailings, ease of extraction and availability from other sources. For example, cobalt is in high demand from Australia's strategic international partners, as it is essential to modern technologies (DISR 2024a; SACES 2024, p. 56). Therefore the balance between extraction costs and market prices is shifting to favour recovery (SACES 2024, p. 56). Extracting valuable materials from mining tailings increases economic value per tonne of materials used, thereby enhancing materials productivity (DCCEEW 2024d, p. 96).

Recovering mineral resources from mining waste can also have environmental benefits. For example, reprocessing tailings can reduce the amount of toxic materials entering the surrounding environment. However, these processes are sometimes very energy-intensive (and hence emissions-intensive) (Adrianto et al. 2023, p. 11).

Recovering minerals from waste is still an emerging practice in Australia (Kinnunen and Kaksonen 2019, p. 157). In Mt Morgan in Queensland, Heritage Minerals has set up a project to recover gold from its tailings legacy mine, which has significant waste and tailings stockpiles that are contaminating the nearby waterways (Heritage Minerals nd). The Northern Australia Infrastructure Facility reports that the project will result in \$849 million in economic benefits to northern Australia (NAIF 2022).

Recycling mineral wastes

Some types of mining waste, such as mine waste rocks and tailings, can be an input for other sectors such as construction (AMEC, sub. 143, p. 5; Hunter Joint Organisation, sub. 172, p. 5). Potential options include recycling into higher-value silica-sand products (ore-sand), low-carbon geopolymers concrete, and mineral fertilisers, or downcycling for backfilling and road construction (Golev et al. 2022, p. 4; MRIWA 2024a). In addition to revenue from selling this material, recycling mine waste rocks and tailings also helps mining companies reduce onsite risks associated with large waste and tailing stockpiles, such as acidic and metalliferous drainage (CSIRO 2023a, p. 14). It can also reduce environmental impacts associated with extracting virgin materials (Golev et al. 2022, p. 3).

Recycling rates for mineral wastes are generally low but vary by material and recycling methodology. For example, there are multiple Australian examples of recycling waste rock for construction (AMEC, sub. 143, p. 5). Other opportunities, such as producing ore-sand from tailings, have limited adoption as they are still in the research and development phase (Australia's Economic Accelerator 2024; Golev et al. 2022, pp. 88–89).

Repurposing mining tailings for carbon capture

In the mining sector, there are emerging carbon capture techniques that have the added benefit of making tailings easier to recycle for other uses, such as building materials (MCi Carbon, sub. 119, p. 3). These benefits arise from mineral carbonation, a natural process whereby CO₂ binds to minerals in the earth's crust and is captured permanently. In a mining context, mineral carbonation can occur passively (for example on the surface of mine tailings) or in an accelerated manner using specialised technology (Srinivasan et al. 2021, pp. 46–48), either on the mine site (in-situ) or offsite (ex-situ). Onsite mineral carbonation involves injecting carbon into target rocks or tailings. Offsite mineral carbonation involves transporting the tailings to a dedicated facility where the reactions take place via a controlled industrial process (Fitch, Battaglia and Lenton 2022, p. 181).

CSIRO researchers have estimated that ex-situ mineral carbonation could sequester as much as 36 Mt of carbon per year by 2050, which is equivalent to about one third of the mining sector's scope 1 emissions in 2021–22 (based on DCCEEW 2022c; Fitch, Battaglia and Lenton 2022, p. 183). Technology to accelerate mineral carbonation is currently only available at demonstration-scale, with commercial-scale applications

expected in the next decade (MCi Carbon, sub. 119, p. 4). Passive mineral carbonation has been demonstrated in tailings at the BHP Mount Keith Mine in Western Australia. In November 2023, BHP started a project with Canadian company Arca to pilot their accelerated mineral carbonation technology (Austrade 2024).

Reducing and recycling non-mineral waste

Mining operations and support services also generate non-mineral waste. These can range from plastic packaging, to decommissioning waste, to tyre and conveyor belt waste (tyres are discussed in chapter 8). The non-mineral waste generated by mining appears less significant than mineral mining waste, both in volume and nature.

There is limited data on the extent to which non-mineral waste is recycled. CSIRO indicates that commercial uptake of recycling solutions is limited and that 'depending on the economics of the mine location and the volume of these materials, they may be disposed of in a landfill or buried onsite' (CSIRO 2023a, p. 20). However, there are some examples of mining companies adopting strategies to avoid or recycle non-mineral waste. For example, Fortescue has implemented several initiatives including working with suppliers to avoid single-use packaging; processes for recycling metals, hydrocarbons and plastics; and establishing a container deposit scheme across mine sites (AMEC, sub. 143, p. 9).

Alternative post-mining land uses

While mines operate at specific locations for a limited time, their effects on the local environment and economy can persist long after the site has closed (Beer et al. 2022, p. 9). Traditionally, when a mine closes, the goal of site rehabilitation is to return it to a safe, stable and non-polluting landform suitable for its pre-mining use (such as agriculture) (EnviroMETS QLD 2023, p. 5). However, there are opportunities for alternative uses that re-purpose elements of mining infrastructure for social, economic and environmental benefit, such as clean energy projects, recreational, educational or scientific facilities (AMEC, sub. 143, p. 6; Beer et al. 2022, p. 21). These alternatives make use of the unique characteristics of existing mine infrastructure to create economic opportunities, while also reducing risks to humans and the local environment (Salmi, Bekele and Schmid 2022, p. 9,11), and supporting broader regional development objectives for communities in economic transition (box 7.1).

There are only a handful of Australian examples of mining companies or third parties re-purposing closed mine sites for alternative social or economic uses (AMEC, sub. 143, p. 6; Beer et al. 2022, p. 21; CSIRO 2023a, p. 38). One such example is the Stawell Underground Physics Laboratory, which was built in an unused portion of an operational gold mine in Victoria. The existing mine facilities enabled the laboratory to be located 1km underground, creating optimal conditions for research into dark matter, neutrinos and geoscience (CSIRO 2023a, p. 38).

Based on the number of mine sites in Australia, the potential for repurposing closed mine sites for alternative social or economic uses appears significant. As of 2020, Australia had over 50,000 closed and abandoned mines and almost 240 existing Australian mines are expected to close by 2040 (CSIRO 2023a, p. 2; Salmi, Bekele and Schmid 2022, p. 9). CSIRO estimates that expenditure on mine rehabilitation and closure activities could exceed \$4 billion each year (CSIRO 2023a, p. 2).

Box 7.1 – Post-mining land uses in the context of regional development

Many regional areas in Australia are highly reliant on mines for employment and local business activity (such as food, accommodation and healthcare services), which in turn support the local economy and enhance the quality of life for residents. Mine closures can therefore have major economic and social impacts on the surrounding communities and broader regions (CRC TiME 2025). Job losses can affect those working on mines, and workers providing essential services for remote populations (Blackwell, McFarlane and Fischer 2017, p. 3). Mine closures also can significantly reduce economic activity in the broader region, creating a social and economic imperative to repurpose mine sites to sustain the local economy (Beer et al. 2022, pp. 10–11) and increase economic diversity in the region.

Community and government involvement in decisions about mine closure helps facilitate a successful transition (ICMM 2019, p. 5). While mining companies have some incentives to re-purpose mines through reduced rehabilitation costs and reputational benefits, broader community involvement facilitates future land uses that align with the strengths and aspirations of people remaining in, or with a connection to, the region. For example, Aboriginal and Torres Strait Islander people, local communities, and economic development agencies may all have significant interest in using the mine's land or infrastructure (Beer et al. 2022, p. 10).

Latrobe Valley: a case study of post-mining land uses forming part of regional planning

In Victoria's Latrobe Valley, state and local governments and the local community are helping guide post-mining land use planning, as part of broader regional development planning and investment. All three large open-cut brown coal mines in the Latrobe Valley will cease operations for the purpose of electricity generation by 2035. When they are rehabilitated, this will make around 130 km² of land available for repurposing (CRC TiME 2024a; Haque, Reeves and Foran 2024).

These closures are occurring in the context of the Latrobe Valley needing a broader regional transformation away from coal mining and coal-fired power generation, towards other economic opportunities, including those created by the available post-mining land. The Cooperative Research Centre for Transformations in Mining Economies (CRC TiME) is supporting a collaborative planning project that proposes future land use options for post-mining lands that are supported by key stakeholders and address a range of community benefits, including Aboriginal and Torres Strait Islander people's aspirations. The project incorporates existing regional strategies and plans, aiming to support broader regional economic development (CRC TiME 2024a; Haque, Reeves and Foran 2024).

7.3 Policy interventions to address barriers to circularity

Existing government measures to encourage circularity in mining

There are already various government policies that encourage circular activities in mining. Several governments provide financial incentives for projects that involve reprocessing mining waste.

- The Tasmanian Government is developing a fixed term royalty rebate scheme, the Minerals Royalty Rebate Scheme, to incentivise the reprocessing of historic mine tailings and the re-commencement of mining operations at brownfield sites, where project proponents can demonstrate environmental benefits (Premier of Tasmania 2024).

- The Australian and NSW Governments provide incentives for critical minerals production, which indirectly encourage circular practices insofar as most projects that recover minerals from mining tailings focus on critical minerals. These are the national Critical Minerals Production Tax Incentive and the NSW Government's deferred royalty scheme for critical minerals projects (King 2024; NSW DPIRD 2024, p. 27).

The Australian, state and territory governments also fund mining research and development, including into technologies that underpin circular economy opportunities. Key mining research bodies such as the Minerals Research Institute of Western Australia (MRIWA) and Sustainable Minerals Institute (SMI) conduct research into circular mining practices such as alternative uses of tailings and waste (MRIWA 2024a; SMI 2024a). For example, the Mine Waste Transformation through Characterisation research stream at SMI has discovered sources of cobalt, indium, antimony and rare earth elements in Australia's mining waste (SMI 2024b). CSIRO also makes significant contributions to mining research and innovation in the circular economy space. For example, they developed NextOre, a precision mining technology that uses magnetic resonance imaging for advanced sorting of mineral ores (MCA 2022, pp. 22–23). CSIRO has also provided skills and capability support to new precision mining companies (CSIRO 2021b).

Some studies have identified information and technology gaps as barriers to opportunities for mining waste, such as recovering minerals from tailings (Araujo et al. 2022, p. 12; Kinnunen and Kaksonen 2019, p. 155). However, significant investment in research and development in these opportunities through several Australian research institutes, reduces the likelihood that additional intervention would maximise benefits (Copp 2022; MRIWA 2024a; SMI 2024a). The Australian Government also financially supports both pilot and commercial scale projects for circular economy activities in mining. For example, MCi Carbon secured a \$14.5m Carbon Capture Technology Grant in 2024 for a mineral carbonation demonstration plant (MCi Carbon, sub. 119, p. 3). Heritage Minerals was awarded a NAIF loan of up to \$66m to build a tailings processing plant and associated infrastructure at the legacy Mount Morgan mine (NAIF 2022).

Barriers to circular opportunities in mining

Distance, costs and regulation are barriers to circular economy opportunities for mining waste

The tyranny of distance is a disincentive to mining waste recovery and reprocessing (DCCEEW 2024d, p. 97). Most mines are located in remote areas, far from potential end markets for reused or recycled mining waste, leading to significant transport and logistics costs when selling waste.⁶¹ The geographic dispersion of mines and low concentrations of recoverable elements can also prevent mining companies from achieving sufficient economies of scale in waste processing capacity to make these operations profitable (Centre of Decommissioning Australia, sub. 46, p. 10; Kinnunen and Kaksonen 2019, p. 157).

The low economic value of some mining waste materials can also make recovery and reprocessing uneconomic (Kinnunen and Kaksonen 2019, p. 157). For example, the commercial viability of selling recycled tailings for use in construction materials is limited by the availability of cheaper alternatives made from virgin materials (Araujo et al. 2022, p. 11). Demand is also limited for recycled non-mineral mine waste, for example, there is little demand for recycled plastics (Anderson and Gbor 2024, p. 1).

These economic barriers do not affect all materials to the same extent. For example, the projected increase in demand for critical minerals is making recovery projects for these minerals more economically attractive to mining companies despite the costs (DISR 2024c, p. 11). Growing global demand for sand has prompted

⁶¹ Greenhouse gas emissions associated with bulk, long-distance transportation may also limit the environmental benefits of such operations and could attract additional costs through carbon pricing mechanisms.

universities and mining companies to start developing techniques for producing ore-sand from mine tailings (Australia's Economic Accelerator 2024; Golev et al. 2022, p. 3). As highlighted by an inquiry participant, 'the challenge is to find the right mix of policy and technology solutions to make recovery [of valuable minerals] economic' (University of Melbourne, sub. 36, p. 8).

There are also economic barriers to investment in research and uptake of carbon capture through mineral carbonation. The Australian Carbon Credit Unit (ACCU) Scheme (chapter 5) does not include an approved method for awarding carbon credits for carbon capture through mineral carbonation. The MRIWA has argued the inability to claim carbon credits for carbon capture through mineral carbonation can limit the financial viability of this opportunity (2024b, p. 49). The Climate Change Authority noted a range of measures would be needed to reduce the cost of engineered removal technologies (such as mineral carbonation) to make them financially viable, and that adding methods under the ACCU Scheme could support their development (Climate Change Authority 2023, p. 70).⁶²

The cost of navigating regulation can also affect the viability of projects recovering and processing materials from mining waste (Greater Whitsunday Alliance, sub. 109, p. 13). For example, Australian industry representatives have indicated that the administrative burden associated with obtaining permits for materials recovery can be similar to the burden of obtaining permits when establishing a new mine (Kinnunen and Kaksonen 2019, p. 156). A report for the WA Government observed:

... using mine waste materials for any application, other than that outlined in the mine closure plan, will require not only an update and review of the mine closure plan, but the mine waste materials removed from the tenement will also be subject to the payment of royalties... This additional administrative and financial burden on mining tenement holders may hamper the use of mine waste materials (LeGrand 2023, p. 11).

The Greater Whitsunday Alliance (sub. 109, p. 13) noted that regulations regarding mining waste can prevent mining companies from returning materials back to suppliers (for example pallets, protective film).

Mining regulations limit circular economy opportunities in alternative post-mining land uses

There are regulatory barriers to reusing or repurposing closed mines and their infrastructure. Traditionally, governments and regulators have preferred mining companies return land to its pre-mining state following mine closure, usually requiring rehabilitation of mined land and removal of mine assets such as infrastructure (CRC TiME 2024b, p. 4). When a mine closes, the mine operators must comply with state or territory (and in some cases Commonwealth) standards and criteria for site rehabilitation (Allens 2020, p. 11).⁶³ These are typically set out in the approved rehabilitation plan during the first environmental impact assessment, which

⁶² Similarly, under the Safeguard Mechanism, eligible facilities cannot accumulate and sell Safeguard Mechanism Credits (SMCs) associated with capturing carbon through mineral carbonation. The Safeguard Mechanism is the Australian Government's policy for reducing emissions at Australia's largest industrial facilities (DCCEEW 2024s). It offers SMCs to facilities that fall below an emissions baseline, which can be sold to other Safeguard facilities (DCCEEW 2024s). Carbon capture for permanent storage can be deducted from a facility's estimation of emissions, so could theoretically be used to bring them below their baseline to accrue SMCs. However, carbon captured via mineral carbonation is not included in the current definition of permanent storage in Division 1.2.3 of the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*.

⁶³ State and territory governments usually require security bonds, or annual levies to a pooled fund, to be provided in advance of mine construction, to guarantee the company meets its rehabilitation obligations (Kerrigan and Leary 2022).

is prepared before the mine is constructed. Some jurisdictions, such as Queensland, have introduced legislation to require the progressive rehabilitation of mined land (QLD DETSI 2022).

Current regulatory approaches to mine closure often focus on managing liabilities from post-mining land and infrastructure rather than viewing them as potential assets (EnviroMETS QLD 2023, p. 7). The preference for returning post-mining land to its pre-mining state is generally driven by legitimate concerns about risks (safety, environmental and otherwise) that arise when a mine is not closed properly. In jurisdictions where mine operators can update mine closure plans to facilitate an alternate post-mining land use, additional regulatory approvals are required (Department of Regional NSW 2023, pp. 13–14).

However, the focus on returning land to its pre-mining state creates barriers to economic and environmental opportunities from alternative uses of post-mining land and infrastructure (CRC TiME 2023, p. 2). For example, a 2023 study found that despite Queensland Government officials helping industry navigate existing regulatory frameworks, the Queensland Environmental Protection Act 1994 (EP Act) 'appears unable to consider the net environmental benefit of a PMLU [post-mining land use], or secondary mining activity, and as a result potential net environmentally positive PMLU projects fail to proceed' (EnviroMETS QLD 2023, p. 9). But regulatory changes to facilitate more alternative post-mining land uses would also have associated enforcement costs, which would have to be assessed relative to benefits.

While mining companies and third parties can propose alternative higher-value uses for mine sites, existing operators typically do not have a commercial reason to invest in these alternative uses, and the associated risks act as major obstacles (EnviroMETS QLD 2023, p. 8; Kragt and Manero 2021, p. 4). Mine operators may also risk their security bonds if they are unable to meet appropriate environmental standards through the alternative land use. New operators wishing to repurpose the site must engage with a variety of regulatory agencies, which may have competing ideas and interests for the post-mining activity. They may also risk taking on legacy environmental liabilities from previous operators (EnviroMETS QLD 2023, p. 9; PC 2020b, p. 230).

Policy reform directions

The priority circular opportunities for mining relate to mining waste and post-mining land uses. The adoption of circular economy opportunities in the exploration, extraction and processing phases of the mining life cycle is already relatively widespread in Australia. In contrast, circular economy opportunities in mining waste and post-mining land uses appear to have significant potential to increase materials efficiency, with scope to grow due to their lower rates of adoption. As discussed below, there are also potentially unnecessary impediments to adopting these activities arising from current regulations, which governments could address.

Despite the potential benefits of repurposing mining waste for carbon capture through mineral carbonation, the PC is not suggesting a policy reform direction in this area. This in part reflects the recency of the government's decision to transition towards a proponent-led ACCU method development process, in response to a recommendation from the Independent Review of ACCUs (Chubb et al. 2022, p. 10). This change was made to 'streamline method development and encourage greater uptake of bespoke method activities' (Chubb et al. 2022, p. 11). The Australian Government also supports the development of emerging technologies for carbon abatement through investment in research, such as through CSIRO's CarbonLock Future Science Platform, and through grant programs, such as the Carbon Capture Technologies Program (CSIRO nd; DCCEE 2024c).

Reducing regulatory barriers to circular economy opportunities for mining waste and alternative post-mining land uses

Environmental regulation, planning and approval processes are necessary to keep mining companies accountable for managing mining waste, mine rehabilitation and closure in an environmentally responsible and safe manner. However, they can add unnecessary compliance burden if they are overly restrictive (for example, not risk-based) or do not evolve with changing circumstances. This can discourage mining companies from pursuing circular economy opportunities in mining waste and post-mining land uses.

Past studies and inquiry participants have suggested various regulatory barriers, often without details on the specific regulations (nor on other impacts of removing the regulatory barriers). These suggested impediments include some states applying:

- **regulatory processes that result in mining operators removing potentially valuable mine assets**, such as infrastructure, as part of the mine closure process (CRC TIME 2024b, p. 4)
- **regulations that mean existing mining operators take on new risks when accommodating alternative uses** of mine sites after closure (EnviroMETS QLD 2023, p. 8; Kragt and Manero 2021, p. 4), which reduce incentives for mines to consider these options
- **regulations that can shift legacy environmental liabilities from previous operators onto new operators** when taking over a site to enable circular opportunities, such as reprocessing waste or implementing an alternative post-mining land use (EnviroMETS QLD 2023, p. 8; PC 2020b, p. 230)
- **responsibilities established under both environmental and safety legislation can, in combination, make it difficult for multiple operators to coexist on a mine site**, creating barriers for circular economy opportunities such as having a secondary operator recovering resources from mining waste⁶⁴ (Queensland Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development, pers. comm., 29 January 2025)
- **restrictions on transporting mining waste**, including non-hazardous wastes such as pallets (Greater Whitsunday Alliance, sub. 109, p. 13), which prevent reuse opportunities
- **mining royalties on the recovery and recycling** of mining waste (LeGrand 2023), at levels affecting the cost-effectiveness of these activities.

Given the significance of opportunities related to mining waste and repurposing closed mine sites, the PC is considering a reform direction around assessing whether there is scope to reduce regulatory barriers to adoption without compromising environmental value and safety.

The PC is not undertaking a wide-reaching review of the extensive state, territory and Australian government policies and regulations affecting these circular economy opportunities, but is seeking information on specific areas of investigation or questions for the assessment. The PC intends to engage with state and territory governments to better understand the jurisdiction-specific elements of these issues. Some governments are already exploring options that may better facilitate circular economy opportunities in mining. For example, the Queensland government is conducting a review of its regulatory framework to facilitate secondary

⁶⁴ In Queensland, relevant safety and environmental regulations are based on a traditional single operator model, which can make coexistence on a mine site difficult. The *Mining and Quarrying Safety and Health Act 1999* (Qld) requires one Site Senior Executive to have ultimate responsibility for the health and safety of all persons on the mine site, adding complexity if there are multiple operators. Companies must be granted an environmental authority before carrying out activities relating to a mining lease (Queensland Law Reform Commission 2023, p. 13). The regulator's preference is to have one company accountable per mine site, to reduce uncertainty around responsibilities and the risk that environmental obligations are not met (Queensland Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development, pers. comm., 28 January 2025).

prospectivity for critical minerals (Queensland Government 2023, p. 15). In New South Wales, there is an ongoing parliamentary inquiry into beneficial and productive post-mining land use (Parliament of New South Wales 2024). In Western Australia, the Land and Public Works Amendment Act 2023 introduced a new land tenure option called a diversification lease. This lease enables multiple activities to co-exist on the same land, which may facilitate circular opportunities such as re-using mining infrastructure for renewable energy projects (Government of Western Australia 2024).

The PC is also seeking to understand whether reducing regulatory burdens would be sufficient to meaningfully increase the uptake of these opportunities, or whether other government interventions could support (such as improved regional planning and development, stricter standards on the production and storage of mining waste or financial disincentives, such as a mining waste levy).



Reform direction 7.1

Reducing regulatory barriers to circular economy opportunities for mining waste and alternative post-mining land uses

The PC is considering whether there is scope to reduce regulatory barriers related to circular economy opportunities in mining waste and repurposing land post-mining. An assessment of these barriers across state, territory and Australian government policies could consider:

- processes and permissions required to re-mine or re-purpose mining tailings
- regulations and practices that make it difficult for multiple operators to co-exist on a mine site
- restrictions on transporting mining waste
- regulation and practices that maximise net environmental, economic and social benefits from mine transitions, including repurposing infrastructure associated with mine sites
- regulations limiting the ability of new operators to take on mine sites for alternative higher-value uses, such as liabilities for legacy environmental impacts.



Information request 7.1

Reducing regulatory barriers to circular economy opportunities for mining waste and alternative post-mining land uses

The PC is seeking further information on:

- specific examples of regulations that have impeded circular economy opportunities for mining waste or alternative uses for closed mine sites, and the expected benefits, costs and risks of reducing regulatory barriers (including quantitative analysis, where available)
- potential solutions to regulatory barriers, such as new regulatory frameworks or legislative changes
- specific areas of investigation or questions for an assessment of regulatory barriers related to mining waste materials recovery and repurposing closed mine sites
- the extent to which addressing regulatory barriers would increase the uptake of circular economy opportunities for mining waste and alternative post-mining land uses (including quantitative estimates, if available), or if other barriers would still prevent meaningful uptake.

**Information request 7.2****Ways governments could facilitate circular economy opportunities for mining waste and alternative post-mining land uses**

The PC is seeking further information on:

- ways that governments could better facilitate circular economy opportunities for mining waste and alternative post-mining land uses, such as improvements to regional planning and development, applying stricter standards on the production and storage of mining waste, or introducing disincentives for producing mining waste, such as mining waste levies
- the benefits, costs and risks associated with these options (including quantitative analysis, where available).

8. Vehicles

Key points

- ✳ **Vehicles make a sizeable contribution to Australia's materials use. There are 22 million vehicles in Australia and circular opportunities relating to vehicle bodies, tyres and electric vehicle (EV) batteries.**
 - Vehicles are a significant source of direct (scope 1) emissions, with cars, light commercial vehicles, trucks and buses accounting for 18% of Australia's total emissions.
 - Tyres, EV batteries and, to a lesser extent, vehicle bodies, pose environmental, health and safety risks related to their disposal.
- ✳ **Australia's very small domestic vehicle manufacturing industry and small share of the global market for vehicles has meant that circular initiatives have mainly targeted the end of the product life cycle.**
 - Australian, state and territory government legislation addresses aspects of waste tyre storage, reuse, disposal and export.
 - Industry initiatives such as the National Tyre Product Stewardship Scheme, accredited by the Australian Government, also promote the development of viable markets for end-of-life tyres in Australia. Despite this, recovery rates of off-the-road tyres remain low at 13%. Increasing recovery of these tyres would provide a higher quality feedstock and improve the range and quality of recycled tyre products.
- ✳ **There is an opportunity to establish a robust end-of-life EV battery industry in Australia based on a reuse-repurpose-recycle model.**
 - Barriers to overcome include inconsistent EV battery design, current lack of feedstock, safety risks and technological challenges.
 - Given the projected growth in the volume of end-of-life EV batteries, a co-regulatory product stewardship scheme with both industry and government involvement could have net benefits to the community. Such a scheme could include a digital passport to improve traceability, regulations on second-use battery quality and standards for transporting, storing and processing end-of-life EV batteries.

8.1 Overview of the vehicles sector

This chapter examines the opportunity to improve materials productivity and efficiency in vehicles through circular economy activities relating to tyres, vehicle bodies and electric vehicle (EV) batteries.

Efficient, low-emission transport assists circular transformation

The transport sector is an important enabler of the shift to a circular economy, as it facilitates flows of materials and workers. For example, prefabricated materials are transported to site to be constructed into

homes (chapter 4) and food donations are transported to charities for distribution (chapter 5). In addition to its role in facilitating circular activities in other sectors, there are also opportunities to further circularity in transport itself, for passenger and freight transport modes, and fuels.

Significantly increasing the uptake of passenger transport modes such as public transport, vehicle-sharing and ridesharing can improve sustainability outcomes. However, uptake depends on broader factors such as population and urban density. While governments do have policy levers to influence these factors, the implications of changes extend far beyond circularity and materials use.

For logistics and freight services, circularity could be improved by minimising fuel usage and increasing vehicle use through optimising transport routes. However, individual firms are already incentivised to minimise operating costs by optimising the use of their fleets and minimising fuel usage and transport-related emissions. As such, there is relatively limited opportunity to directly improve circularity in freight and service operations. However, transport infrastructure and land use planning (chapter 4) fundamentally influence system-wide logistics and freight activity. Place-based approaches (chapter 10) also create potential opportunities for logistics-related circular outcomes.

Across all levels of government, significant policy attention has been given to fuel efficiency and sustainability, due to their importance in reaching emissions reduction targets. Fuels are also a relatively significant contributor to materials consumption in Australia (Miatto et al. 2024a, p. 11). For some modes of transport, such as passenger vehicles, reduced fuel consumption can be achieved through fuel efficiency and electrification. For other, larger, modes of transport, such as those used in freight and logistics, circular opportunities exist in adopting renewable fuels such as biodiesel and sustainable aviation fuel, using waste products as feedstocks (CSIRO 2023b, p. 40; SAFAANZ and CFA, sub. 115, p. 2). The adoption of renewable fuels is being supported by the establishment of the Jet Zero Council, the publication of the Aviation White Paper, and consultations on the Transport and Infrastructure Net Zero Roadmap and Low Carbon Liquid Fuels Standards.

To improve the uptake of EVs, the Australian Government is currently working on the Transport and Infrastructure Net Zero Roadmap and Action Plan and has released the New Vehicle Efficiency Standard and National Electric Vehicle Strategy. State and territory governments have also provided businesses and households with incentives to support the uptake of EVs (NSW Treasury 2024; QRIDA 2024). Local governments have supported the installation of EV charging stations, procured EVs for council fleets and committed to designing disincentives to reduce the use of high-emitting vehicles (Cities Power Partnership nd; Electric Vehicle Council 2020, p. 30).

Focusing on specific circular opportunities for vehicles

Some aspects of transforming the transport sector are already underway and are being addressed by current policies (or those in development). In this interim report, the Productivity Commission is examining opportunities to further the circular economy specifically in the production, consumption and disposal of vehicles. Circular opportunities in constructing road infrastructure are discussed in chapter 4, using organic waste as feedstock for biofuels is discussed in chapter 5 and transport's role in place-based precincts and hubs is discussed in chapter 10.

In addition to providing circular economy opportunities, vehicles are also economically significant (chapter 3). By providing mobility, vehicles play a major role in the day-to-day lives of Australians contributing to the economy through work, study or recreation. In 2023, 1.2 million new passenger and commercial vehicles were sold, and in January 2024, there were 21.7 million registered motor vehicles (BITRE 2024, p. 5; FCAI 2024, p. 9). This equates to nearly as many motor vehicles as people in Australia. Vehicle upkeep also plays a

prominent role in the economy. In 2018, the motor vehicle repair industry generated around \$22 billion in business revenue, making up approximately two-thirds of total repair industry revenue (PC 2021b, pp. 64, 67).

Environmental impacts and materials footprint

The main environmental impact of vehicles is their greenhouse gas emissions during use. In 2022, the transport sector was responsible for 21% of Australia's emissions (CCA 2024, p. 45). Of this, cars, light commercial vehicles, trucks and buses contributed 85%, and accounted for 18% of Australia's total emissions (based on CCA 2024, pp. 45, 207).

With the expected increase of EVs on Australian roads, the disposal of EV batteries at the end of their life is becoming an emerging environmental and policy issue. EV batteries are large lithium-ion batteries and pose a significant risk to safety and the environment at the end of their useful life (Christensen et al. 2021, p. 6). While there is currently a low volume of EV batteries reaching their end of life, the way in which smaller lithium-ion batteries are currently managed at end-of-life (discussed further in chapter 9) gives an insight into the risk that bigger EV batteries pose. In Australia, there is currently little capacity for the end-of-life processing of lithium batteries, resulting in stockpiling in warehouses, disposal into landfill or exportation (Lithium Australia, sub. 17, p. 2). This poses a significant fire risk, particularly if the battery is damaged.⁶⁵ In addition, the landfilling of EV batteries can contaminate the surrounding environment through toxic chemicals leaching into the soil and groundwater (Zhao et al. 2021, p. 8).

Similar risks are associated with the end-of-life management of tyres. Tyres have caused large-scale fires that produce hazardous smoke, are hard to extinguish and costly to clean up (TSA 2024c, p. 12). In 2016, a large fire involving 150,000 tyres broke out at a recycling facility in metropolitan Melbourne, which significantly diminished air quality in neighbouring areas over the course of 24 hours (EPA Victoria 2016, p. 1). Additionally, stockpiled tyres provide a suitable environment for vermin to breed, negatively impacting the local biodiversity and putting human health at risk (TSA 2024c, p. 10).

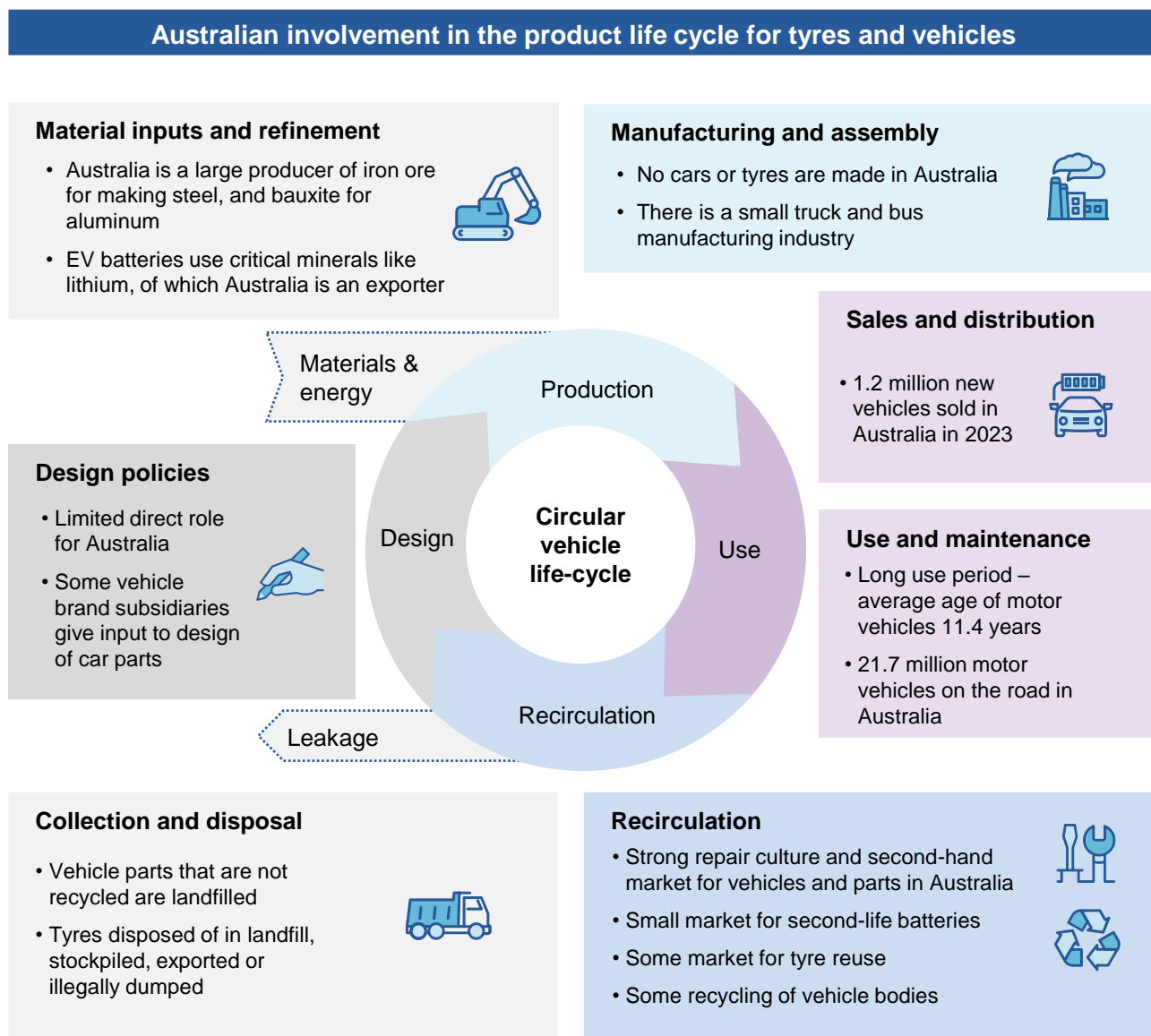
8.2 Opportunities for greater circularity in vehicles

Circular economy opportunities within the vehicles sector vary at each stage of the product life cycle. Australia has a very small vehicle manufacturing industry and no tyre manufacturing industry. Therefore, opportunities to improve materials productivity and efficiency for vehicles and tyres are concentrated in the use and end-of-life phases of the product life cycle (figure 8.1). To understand the applicability of these opportunities in Australia, the PC considered the current and projected size of the relevant market sector to which each opportunity related and the current levels of adoption (chapter 3).

At the design stage, there is limited scope for Australian consumers or producers to influence activities that can fulfil circular objectives. This is partly due to the absence of a domestic manufacturing industry for both cars and tyres (FCAI, sub. 85, p. 13; TSA, sub. 148, p. 1). In addition, Australia is a relatively small share of the global market for vehicles, and hence has limited influence on global vehicle makers' design decisions.

⁶⁵ The fire risk is largely associated with lithium nickel manganese cobalt (NMC) batteries. This risk is reduced with lithium iron phosphate (LFP) batteries. It is likely that both types of batteries will be used in future due to their varying features. While LFP batteries are more cost-effective and safer, NMC batteries offer greater power and range (Perdana et al. 2025, p. 1).

Figure 8.1 – Australian activity in the vehicle life cycle is concentrated in the use and end-of-life phases



Source: BITRE (2024); FCAI (2024).

In the use phase, consumer incentives are well-aligned with circular goals – owners of vehicles generally want their vehicles to last longer, and so look after them. This is supported by a widely-accessible vehicle repair industry (PC 2021b, p. 67). Consumers regularly service their vehicles and usually choose to repair when functionality is impeded. This is driven by the need for reliability, safety and prevention of costly future repairs, as well as the cost-effectiveness of repair compared to replacement. Some vehicle retailers are competing based on the repair and maintenance services associated with the vehicles they sell, for example by offering extended warranties and capped price (or free) servicing for new car purchases (ACCC 2017, p. 39).

The relative costs of disposal and recovery options significantly influence decision-making by consumers and retailers in relation to vehicle end of life. Factors such as landfill levies and the value of recovered materials and products impact these decisions (FCAI and MTAA 2024, p. 12). In addition, regulations such as Victoria's landfill ban on whole tyres and environmental concerns influence decisions on disposal and materials recovery (FCAI, sub. 85, p. 5).

With limited Australian involvement in vehicle design and manufacturing, and well-aligned incentives in consumption, the end-of-life stage provides the greatest opportunity to further circular economy objectives in Australia. These opportunities particularly relate to collection and disposal of end-of-life tyres, vehicles and EV batteries.

Tyre collection and recycling opportunities

Inquiry participants noted opportunities to use product stewardship schemes to improve circular outcomes for end-of-life tyres, vehicle bodies and EV batteries (FCAI, sub. 85, p. 4; Product Stewardship Centre of Excellence, sub. 159, p. 4; RMIT University Circular Economy Hub, sub. 31, p. 11; TSA, sub. 148, p. 3).

Of these products, a product stewardship scheme exists for tyres only – a voluntary scheme managed by Tyre Stewardship Australia and accredited by the Australian Government (section 2.3 outlines the different scheme arrangements more generally). To participate in this scheme, passenger vehicle and truck tyre manufacturers and importers pay a levy of \$0.25 for each passenger tyre sold, while off-the-road (OTR) tyre manufacturers and importers face a variable levy based on tyre size (TSA, sub. 148, p. 8). The levy contributes to the scheme's objective of generating and supporting demand markets for end-of-life tyre products. Currently, 57% of tyre importers (by market share) participate in the scheme (TSA 2024a, p. 26).

Two-thirds of end-of-life tyres were collected and recovered in 2023-24 (TSA 2024b, p. 2).⁶⁶ Of the tyres recovered, 13% were reused, 25% were recycled and 62% were used in energy recovery (tyre-derived fuel) (based on TSA 2024b, p. 2).

There is a stark difference between the recovery rates of passenger and truck tyres compared to OTR tyres. In 2023-24, 155,000 tonnes of used OTR tyres were generated and only 13% of this was recovered. In comparison, 382,000 tonnes of used passenger vehicle and truck tyres were generated and over 85% of this was recovered (TSA 2024b, pp. 1, 3). Low recovery rates are most pronounced for OTR tyres used in mine sites, with only 2% of these tyres recovered annually (TSA, sub. 148, p. 39). With the recycling technology in existence, there is scope to improve the OTR tyre recovery rate and reduce the risks associated with stockpiling (outlined above). While recycling challenges remain due to the varying sizes of OTR tyres, they have a high natural rubber content, making them a high quality feedstock that can result in a higher value recycled product and greater improvements in materials productivity (O'Farrell 2019, p. 3).

EV battery circular opportunities

A key circular opportunity noted by inquiry participants and government bodies is the end-of-life management, recycling and reuse of EV batteries (AADA, sub. 91, p. 1; DCCEEW 2024b, p. 25; RMIT University Circular Economy Hub, sub. 31, p. 1). The importance of this opportunity stems from the environmental and safety hazards that EV batteries pose if not disposed or handled properly (discussed above). Uptake of passenger EVs has occurred only recently in Australia, and most batteries have not yet reached the point where they need replacing. However, the future proliferation⁶⁷ of EV batteries due to the importance of EVs to net zero objectives will make end-of-life management increasingly important. Establishing the foundations for a well-functioning end-of-life battery industry will help meet circular and net zero objectives, improve economic diversity and capability, and manage the future environmental burden of end-of-life batteries.

⁶⁶ 66% of end-of-life tyres, by weight. The remaining 34% of tyres were either disposed of (30%) or were still 'in flow' (4%). Disposal options included landfilling, burying on-site and burning with no energy recovery. 'In flow' tyres were either being stockpiled, illegally dumped or remained onsite and were yet to be officially disposed of or recovered.

⁶⁷ Estimates suggest that 40% of new batteries will be EV batteries by 2050 (BSC 2024a, p. 4).

A reuse-repurpose-recycle model has been suggested for managing end-of-life EV batteries (RMIT University Circular Economy Hub, sub. 31, p. 6), with activities across several stages of the 10Rs framework (chapter 1).

- Reuse involves using a second-life battery to power another EV. Reuse would be most applicable where an EV has prematurely reached its end-of-life due to a mechanical fault or damage to its exterior, and its battery quality remains relatively high.
- Repurpose involves using the EV battery for an alternative application. While end-of-life EV batteries may be unable to fulfil the energy needs for a vehicle, they retain a significant part of their charging capacity, making them suitable for energy storage for other purposes (Xu et al. 2023, p. 1). In Australia, there are currently a small number of commercial operators offering repurposing services for commercial and industrial clients, such as Infinitev and Relectrify.
- Recycling involves crushing EV batteries to form a powder known as black mass. This is then refined to extract critical minerals for use in the production of new batteries or other products. There is currently limited uptake of the refinement and extraction process in Australia as most black mass is exported (FCAI, sub. 85, p. 6), which may indicate potential to improve materials productivity.

Vehicle body collection and recovery opportunities

Inquiry participants identified an opportunity to establish a co-regulated product stewardship scheme for end-of-life vehicle bodies to improve their recovery rates (FCAI, sub. 85, p. 4; Toyota Motor Corporation Australia, sub. 33, p. 2). Current estimates of recovery rates indicate that approximately 70% of a vehicle (by weight) is recovered on average (FCAI and MTAA 2024, p. 4). Most metal is recycled during the shredding process, while the remaining 30% consists of plastics, glass and textiles (referred to as automotive shredder residue) and is landfilled.

With some countries⁶⁸ achieving recovery rates of over 90%, there may be an opportunity to improve the recovery rate in Australia (FCAI, sub. 85, p. 7). However, there are significant challenges for both supply and demand of recycled automotive shredder residue. On the supply side, Australia lacks the capability to recycle high volumes, and there are challenges in creating sufficient demand due to the lack of a sizeable domestic vehicle manufacturing industry (FCAI and MTAA 2024, p. 4).

While recovery rates may have scope to improve from the current level of 70%, automotive shredder residue has proven challenging to recycle, with a significant technology investment required (Soo et al. 2017, p. 274). This challenge is amplified by the very small size of the vehicle manufacturing industry in Australia, meaning that generating sufficient demand for the recycled products will be difficult. The costs associated with further government intervention are therefore likely to exceed the benefits. As such, the PC does not consider this a priority opportunity for governments to pursue in Australia.

Maintaining a strong motor vehicle repair market

The already strong repair culture for vehicles means that there are fewer opportunities to increase circularity in the consumption phase of the vehicle life cycle. The Motor Vehicle Service and Repair Information Sharing Scheme (MVIS) aims to support productivity and competition in the repair market by ensuring that vehicle repairers are able to access relevant information from vehicle manufacturers at a fair price (ACCC 2023d). The PC's Right to Repair inquiry recommended that the MVIS be evaluated three years into its operation to assess its success in improving competition and choice, whether it provides a net benefit, and the possibility of expanding the scheme (PC 2021b, p. 294). With the Australian Government announcing an evaluation of the scheme in 2025-26 (Australian Government 2024b, p. 300), the PC recommends that it assesses

⁶⁸ The Netherlands, Belgium, France, Ireland, the United Kingdom, Japan and South Korea.

whether the scheme is meeting its competition objectives, is delivering net benefits and whether there is scope to broaden the scheme to additional products such as agricultural machinery.⁶⁹



Recommendation 8.1

Evaluating the Motor Vehicle Service and Repair Information Sharing Scheme

The PC recommends the Australian Government's evaluation of the Motor Vehicle Service and Repair Information Sharing Scheme in 2025-26 assess the following:

- the costs and benefits for various stakeholders and whether the scheme is delivering net benefits
- whether the scheme is achieving its objectives to improve competition and choice in the market and how the scheme could be potentially improved
- the costs and benefits for various stakeholders if the scheme were to be expanded to include a greater scope of products (such as agricultural machinery) or to provide fair access to more repair market participants (such as spare parts suppliers and marketplaces).

Retreading tyres

While most circular opportunities for vehicles arise in the later stages of the product life cycle, retreaded tyres represent an early-stage opportunity. Retreading prolongs the life of tyres by replacing the tread and reusing tyre casings. Tyres from trucks and buses are most suited to retreading due to the durability of their casings compared to standard passenger vehicles. Retreading has environmental benefits – retreading a tyre produces 74% less emissions and uses 54%⁷⁰ less materials (by weight) compared to manufacturing a new tyre (Valentini and Pegoretti 2022, p. 211).

In the past, retreaded tyres offered a cost-effective alternative to new tyres. However, increased competition in the new tyre market has decreased the market share of retreaded tyres, which now represent around 33% of sales of new truck tyres, down from 50% in the past (TSA 2019, p. 2).

Increasing the uptake of retreaded tyres may provide some environmental benefits, mainly overseas, by displacing new tyre production. However, the environmental benefits are limited by the narrow range of vehicles (predominantly trucks and buses) that use retreaded tyres (TSA 2019, p. 2). Trucks and buses account for less than 4% of vehicles in Australia (based on ABS 2021a). As such, the PC does not consider this a priority opportunity in line with the prioritisation framework (chapter 3).

8.3 Policy interventions to address barriers to circularity

Tyre collection and recycling

Some inquiry participants have suggested that there is a need to shift from a voluntary to regulated (co-regulated or mandatory) product stewardship scheme for all tyres, while other participants have noted that such a scheme is not required for all tyre types (Elan Energy Matrix, sub. 116, p. 3; TSA, sub. 148, p. 3).

⁶⁹ The PC has recommended that a repair supplies obligation on agricultural machinery be introduced which would require manufacturers to provide access to repair information. An assessment should be made about whether the obligation should be implemented through an extension of the MVIS or through a separate scheme (PC 2021b, p. 301).

⁷⁰ This is based on a scenario where a tyre is retreaded twice.

This shift would involve the Australian Government setting regulation, and impose compliance costs on passenger and truck tyre businesses. Given relatively high recovery rates for passenger and truck tyres, the overall costs to the community of such a change would likely exceed the benefits.

Barriers to recovering OTR tyres include high collection costs due to distance, variability in OTR tyre sizes, feedstock quality and the legality of tyre burial in mine sites (O'Farrell 2019, p. 3; TSA, sub. 148, p. 42). The main barrier is the higher cost of collecting and transporting tyres from regional and remote areas (DCCEEW 2024d, p. 76). As a result, tyre stockpiling and illegal dumping are more pronounced in regional and remote areas. This poses health and safety risks for remote communities, including for Aboriginal and Torres Strait Islander communities in remote areas. The PC is seeking further information on the potential role for government in overcoming this barrier and whether policy intervention would have net benefits.



Information request 8.1

Targeted measures to improve the collection and recovery of off-the-road tyres

The PC is seeking input on appropriate policy actions to improve collection and recovery rates of off-the-road (OTR) tyres, and the extent to which policies could lead to net benefits to the community.

- What are the environmental, economic and social impacts of unrecovered OTR tyres? What are the size of these impacts (including any data, if possible)?
- Which policy actions would be most effective in improving collection and recovery rates? What are the benefits to the community associated with these policies (including any data, if possible)?
- What are the costs and benefits of implementing and enforcing these policies (including quantitative analysis, where available)?
- What are the roles for different levels of government in implementing these measures?
- What are the ways in which governments can partner with Aboriginal and Torres Strait Islander communities on collection and recovery opportunities?
- What are the current levels of demand for products that can be produced from OTR tyres (including any data, if possible)? Are there any technical or regulatory barriers inhibiting their production or use?

EV battery circular opportunities

Inquiry participants and other stakeholders have identified a variety of barriers that impede reuse, repurpose and recycling activities for end-of-life EV batteries (BSC 2024a, p. 8; Rizos and Urban 2024a, p. 6; RMIT University Circular Economy Hub, sub. 31, p. 6). Key barriers include:

- a lack of information about EV batteries at end-of-life
- safety concerns in collection, handling and second-use applications
- insufficient volume of feedstock
- variability in battery design.

Greater oversight of EV batteries throughout their life cycle would help to address these barriers and mitigate environmental and safety risks. An EV battery product stewardship scheme could facilitate greater oversight, and Australian Government regulatory involvement could reduce barriers to trade by aligning national standards with overseas EV markets. Additionally, the variability in battery design and complexity involved in handling and processing gives merit to a scheme under which EV manufacturers are responsible for end-of-life EV batteries. The costs associated with this responsibility may be borne by manufacturers or passed onto consumers.

Initial work on designing a scheme has begun. The Battery Stewardship Council, with funding from the Australian Government, has proposed a staggered approach to EV battery stewardship that aligns with projections of the volume of end-of-life EV batteries (BSC 2024a, p. 5). More broadly, the Australian Government is currently investigating opportunities to expand EV battery recycling, disposal and safety (Parliament of Australia 2024).

Given the significant fire and environmental contamination risks from improper disposal of EV batteries at end of life, the PC considers that a co-regulatory product stewardship scheme could be warranted.⁷¹ This would involve greater government compliance and enforcement activities to support traceability and information sharing for EV batteries, as compared to a voluntary scheme. It could be implemented through a feature such as a digital passport, which is due to be implemented in the European Union in 2027 (box 8.1).

Maintaining the safety of EV battery handlers and users of second-use batteries is of paramount importance, and designing a set of Australian standards that sets out specifications, procedures and guidelines would support safe use and processing of EV batteries. Such standards have been introduced in the United States and Canada (box 8.1) and requested by Australian industry participants (BSC 2024a, p. 9). Once developed, the Australian Government could monitor and enforce these standards as part of a co-regulatory stewardship scheme.

Box 8.1 – EV battery reuse applications and policies in other countries

International car manufacturers are already pursuing circular initiatives for EV battery reuse and repurposing. In Japan, Nissan EV batteries and solar panels have been used to provide street lighting and outdoor lighting in areas without power infrastructure (Nissan 2018). In Germany, car manufacturer Audi and electricity generation firm RWE used 60 decommissioned Audi EV batteries to build an energy storage system for an industrial power plant (Audi 2022).

While these initiatives indicate that there are reuse applications for EV batteries, the market is currently small, reflecting a limited feedstock of batteries and the technological and economic hurdles of preparing a battery for reuse (Tankou, Bieker and Hall 2023, p. 10). Governments have considered various policy levers to promote circularity in EV batteries.

- In the United States, the Californian Government has introduced durability standards for EV batteries. EVs produced from 2026 will have to be able to retain at least 70% of their battery storage capacity for 10 years of use or up until the vehicle's mileage reaches 150,000 miles (241,000 kilometres). This requirement will increase to 80% in 2030 (California Air Resources Board 2022, p. 10).
- In the United States and Canada, standards have been developed for processing decommissioned EV batteries. These standards provide guidance on processes including sorting and grading batteries to be used for repurposing (Johnson 2022).
- In the European Union, digital passports will be a requirement for EV batteries from 2027 (Rizos and Urban 2024b, p. 1). They will provide manufacturers, users, repairers, remanufacturers and recyclers with key information about the battery across its life cycle.

⁷¹ The Australian Government already has a co-regulatory product stewardship scheme for some electronic products – the National Television and Computer Recycling Scheme – and the PC is considering policy options for product stewardship of other types of consumer electronics (chapter 9). However, collection methods, handling and processing standards, and end markets would be very different for EV batteries compared to other consumer electronics and a separate scheme would be more appropriate.



Reform direction 8.2

Establish the foundations of a robust end-of-life electric vehicle battery industry

The PC is considering the role for the Australian Government in improving end-of-life electric vehicle (EV) battery management and supporting the establishment of a circular industry for EV batteries. This could involve implementing a co-regulated product stewardship scheme to oversee the end-of-life management of EV batteries, featuring:

- improved traceability of EV batteries, such as through a digital passport
- regulations on second-use battery quality and performance for consumer use
- standards for the transport, storage and end-of-life processing of EV batteries.



Information request 8.2

Establish the foundations of a robust end-of-life electric vehicle battery industry

The PC is seeking further information about government measures that could appropriately facilitate support for and overcome barriers to the development of a robust end-of-life electric vehicle (EV) battery industry. Measures could address supply of end-of-life EV batteries, or demand for second-life batteries and battery products. The following questions can help inform responses:

- Are there technological or regulatory barriers inhibiting reuse, repurpose and recycle activities?
- What are current levels of market demand for second-life EV battery products in Australia (including any supporting data)? Are there barriers to connecting supply of these products with demand?
- What costs would the measures place on businesses and consumers, and (for regulation) on government implementation and enforcement (including quantitative analysis, where available)?
- What activities could be undertaken by state, territory and local governments to support any overarching scheme implemented by the Australian Government?
- What additional measures are needed to address environmental and safety concerns related to EV battery handling and processing?
- What are the costs and benefits (including estimates, where possible) of developing further processing capability of black mass in Australia?

9. Household, consumer and emerging electronics

Key points

- ✳ **E-waste is a small but rapidly growing waste stream in Australia, with highly valuable and/or hazardous recovered materials including lithium, cobalt and nickel.**
 - Australians generate 22 kg of e-waste per person each year, almost three times the global average.
 - Australia's e-waste collection and recycling rate is lower than North America and Western Europe.
- ✳ **Government and private sector e-waste management focuses largely on collection and recycling activities. There are opportunities to address barriers that may be inhibiting reuse and repair.**
 - Providing consumers with information about the extent to which electronic products are durable and/or repairable would facilitate more sustainable purchasing behaviours. The Productivity Commission's Right to Repair inquiry recommended that the Australian Government should develop a product labelling scheme on the durability and repairability of household appliances and consumer electronics.
 - The National Television and Computer Recycling Scheme has had success as a co-regulatory product stewardship scheme, but is focused on collection and recycling. As recommended in the PC's Right to Repair inquiry, the scheme should be amended to include reuse and repair within annual targets.
- ✳ **The volume of e-waste generated from lithium-ion batteries and solar photovoltaic (PV) systems is expected to increase significantly over the coming years. The PC supports the Australian Government's intentions to establish product stewardship arrangements for small electronics (including products with embedded lithium-ion batteries) and solar PV systems.**
 - There are significant and immediate risks of battery fires arising from the improper disposal of small electronics. While some state and territory governments have introduced measures to address these risks, multiple jurisdiction-specific arrangements creates inefficiency and complexity.
 - Solar PV systems are installed extensively across Australian households but there is a lack of infrastructure and end-of-life markets for recycling, especially in regional areas. Improperly managed solar PV system waste has large environmental consequences including leachate and fires.
 - The Australian Government is in the early stages of establishing co-regulatory stewardship schemes for these products. The PC is seeking further information on how these schemes could be best designed, implemented and operationalised.

9.1 Overview of the electronics sector

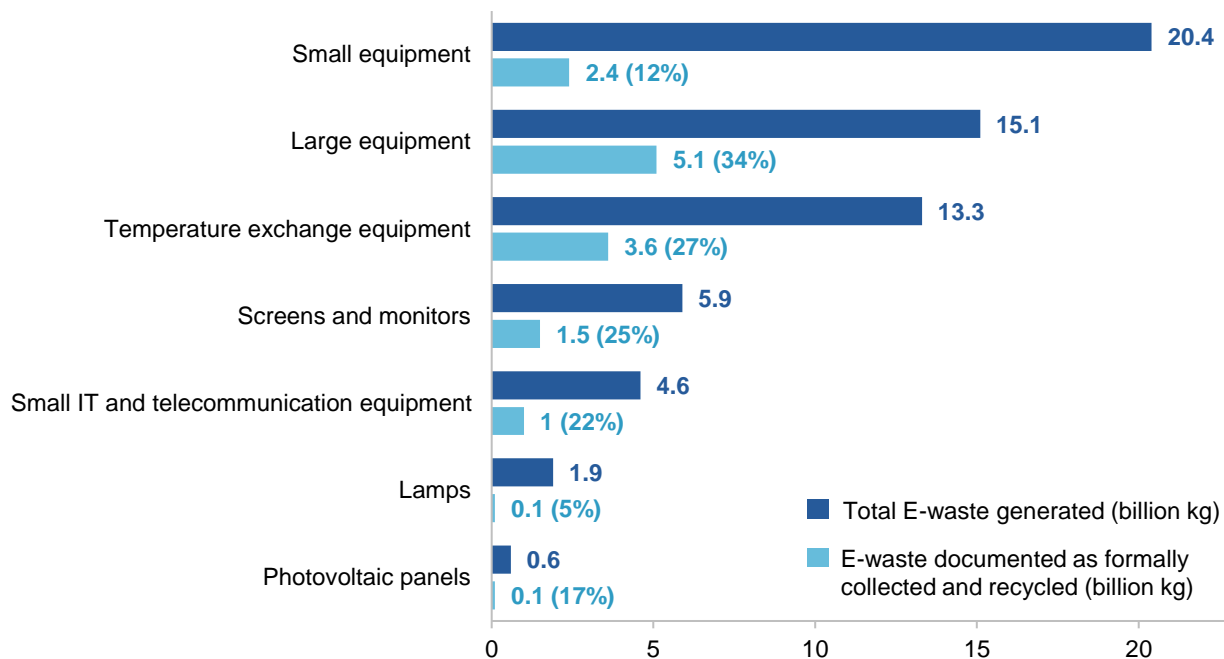
E-waste is one of the fastest growing waste streams

The electronics sector is a rapidly growing industry that underpins much of the modern global economy and our everyday lives. It encompasses a wide array of products, ranging from household appliances and consumer devices to emerging electronics including solar photovoltaic (PV) systems. Many of these products are responsible for large productivity increases and improvements in quality of life. However, as electronics become cheaper and more advanced, their increased use, along with designs that are less durable or recyclable, are turning e-waste into a growing concern.

E-waste is one of the fastest growing waste streams in the world and is outpacing the capacity of the collection and recycling sector by almost a factor of five (UNITAR 2024, p. 10; WHO 2024). If mishandled, e-waste can have serious consequences for human health and the environment, including fires and the leaching of toxic substances and persistent organic pollutants. In 2022, US\$78 billion in externalised costs to the global population and environment arose from e-waste mismanagement (UNITAR 2024, p. 14).

While the largest e-waste category by mass, small equipment (toys, vacuum cleaners, microwave ovens)⁷² has a low collection and recycling rate of 12% (figure 9.1). In contrast, large equipment (washing machines, dishwashers) and temperature exchange equipment (refrigerators, air conditioners) feature the highest collection and recycling rates at 34% and 27% respectively, partly due to supplier collection during delivery, and because their weight and size make them inconvenient for consumers to store (UNITAR 2024, p. 32).

Figure 9.1 – Small equipment produces the most e-waste but has low recycling rates
Global e-waste by electrical and electronic equipment category, 2022



Source: UNITAR (2024, p. 28).

⁷² UNITAR includes phones, computers, and their batteries and chargers in 'small IT and telecommunication equipment'.

Global e-waste volumes are projected to increase by more than 30% from 2022 to 2030 (UNITAR 2024, pp. 10, 16), with solar PV system waste expected to quadruple during this period (UNITAR 2024, p. 15). E-waste contains valuable metals like copper, gold and iron, with an estimated total value exceeding US\$90 billion in 2022, emphasising the significant opportunity for resource recovery (UNITAR 2024, p. 14).

Australians generate more e-waste per person than most other countries

Australians generate 22.4 kg of e-waste per person per year, almost three times the global average of 7.8 kg per person and ranking equal fourth in the world (UNITAR 2024, pp. 10, 120–135). This reflects contributions from both households and businesses, driven by factors including increasing consumer demand for the latest technology and a heavy reliance on imported electronics, which limits governments' visibility of and ability to directly regulate product safety, quality or design (beyond import standards) (Lockrey et al. 2022, pp. 13–14). It is estimated that e-waste will continue to increase to 23.4 kg per person in 2030 (DCCEEW 2021b, p. 7).

In 2019, embodied greenhouse gas emissions from Australian e-waste totalled 5.6 million tonnes of CO₂e, and are projected to reach 6.8 million tonnes by 2030 (DCCEEW 2021b, p. 10). Notably, emissions from landfill and recycling are minimal compared to those from manufacturing (DCCEEW 2021b, p. 35), which often occurs overseas. This underscores the need for strategies that extend the active product lifetime of existing electronics, including improved design and reuse and repair activities.

There is a notable overlap between recyclable and hazardous e-waste materials (figure 9.2). In Australia, these hazardous materials can present health risks to workers involved in the repair and recycling sectors and in cases of illegal dumping (DCCEEW 2021b, p. 10). The Victorian, SA, WA and ACT Governments have banned the disposal of e-waste to landfill in efforts to address these risks.

Figure 9.2 – There is a large overlap between recoverable and dangerous e-waste
Examples of recyclable and hazardous e-waste materials



Source: Productivity Commission (2021b, p. 253).

The e-product life cycle in Australia

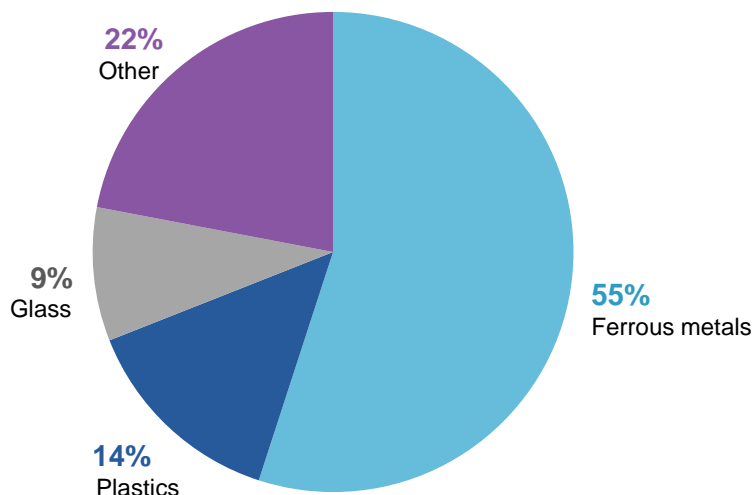
The linear product life cycle of an electronic product encompasses extracting raw materials (including large Australian exports such as iron, gold, lithium and copper), design and manufacturing (mostly occurring overseas), sale and distribution (between retailers, online retailers and installers), use and maintenance (including reuse and repair) and finally disposal, collection and processing.

In Australia, electronics typically reach the end of their active product life either because they are broken and repair is too expensive or inaccessible (often due to a limited availability of skilled repairers, spare parts or time), or because they are replaced by newer models while still functional (CHOICE 2021a). Product replacement is driven not only by high consumer demand for electronics, but also planned obsolescence in product design and a lack of strong policies supporting reparability or extended producer responsibility (EPR), given Australia’s reliance on imports (Lockrey et al. 2022, p. 14).

E-waste typically follows three main pathways: landfill (managed by local governments and private waste operators), metal scrapping (carried out by low-efficiency processors to recover metals) or high-efficiency recycling (where specialised recyclers dismantle e-waste for full material recovery) (DCCEEW 2021b, p. 7). All levels of governments influence these pathways by setting waste management policies, regulating the handling of hazardous materials including during collection and transfer, and supporting infrastructure and programs, such as e-waste drop-off points, landfill facilities and partnerships with private recyclers (Parliament of Australia 2018, p. 7). It is estimated that approximately 54% of all e-waste is collected in Australia, with 80% of this sent to low-efficiency recycling processes (DCCEEW 2021b, p. 8).

The majority of the material composition of e-waste in Australia is easy-to-recycle ferrous metals (figure 9.3). However, because of the presence of more costly and difficult-to-recycle materials such as plastics, the financial viability of recycling e-waste is low. Recycling systems must either remove substances such as harmful chemicals from plastics during sorting, treat them or find safe applications for the recycled materials if harmful traces cannot be removed (DCCEEW 2021b, p. 10).

Figure 9.3 – Plastic is a small component of e-waste but costly and difficult to recycle
Material composition of e-waste as a share of total weight, 2019, Australia



Source: DCCEEW (2021b, p. 10).

There is significant room to improve Australia’s e-waste collection and recycling rates. The collection and recycling rate of e-waste in the combined Australia and New Zealand region is 42.8%, which compares favourably to many other countries, but is lower than North America (52.1%) and Western Europe (58.4%) (UNITAR 2024, pp. 117–118). In 2019, the value of recovered material from Australian e-waste was estimated at \$145 million, only 18% of the potential \$820 million if all material was successfully recovered

(DCCEE 2021b, p. 10). This underscores missed opportunities for resource recovery, and the environmental and economic benefits of reducing reliance on virgin material extraction.

There is variability in end-of-life processing across different electronic products.

- Consumers discard the vast majority of solar PV systems in landfill due to limited recycling options.
- Large household appliances and temperature exchange equipment are typically processed by scrap metal recyclers who carry out low-efficiency recycling to recover valuable metals.
- Approximately 50% of televisions and computers are recycled through high-efficiency processes under the National Television and Computer Recycling Scheme (NCRS), while the other 50% are discarded by consumers and end up in landfill.
- Most obsolete or broken phones are stored in homes (DCCEE 2021b, p. 8).

9.2 Opportunities for greater circularity in electronics

Circular economy opportunities associated with the electronics sector arise during the design, reuse and repair, and collection and recycling stages. To understand the applicability of these opportunities in Australia, the Productivity Commission considered the current and projected size of the relevant market sectors to which each opportunity related and the current levels of adoption (chapter 3).

Designing for repairability and durability

Australia relies heavily on imported consumer electronics and has little influence on their design. While Australia manufactures some specialised electronics, such as mining equipment, medical devices and defence technology, it plays a minimal role in designing mass-market products like smartphones, laptops or home appliances, which are primarily developed in the United States, South Korea and Japan. Though Australia lacks a comprehensive framework for design standards, like the European Union's Restriction of Hazardous Substances or Ecodesign Directives, many existing standards in Australia draw from successful international examples. These are either mandated⁷³ or available for voluntary industry adoption⁷⁴.

Several submissions noted the importance of sustainable design principles in slowing loops, diverting e-waste from landfill and minimising leachate and resource depletion (ACT NoWaste, sub. 16, p. 3; WRAP, sub. 56, pp. 2–3; Product Stewardship Centre of Excellence, sub. 159, pp. 12–13). Benefits also extend to lowering waste management costs and the frequency of product replacements, and stimulating the domestic market for reuse and repair services (NSW EPA 2024c, p. 17). Longer product lifespans also lower carbon emissions, as the majority of lifetime emissions are embedded in the manufacturing phase of electronics (TCO Certified, sub. 63, p. 2).

The PC's Right to Repair inquiry (2021) found that, for certain types of products including household appliances and consumer electronics, some consumers find it difficult to access relevant information about product durability and repairability (PC 2021b, p. 234). Such information gaps could prevent consumers from selecting more durable and repairable products based on their preferences, and thereby reduce

⁷³ For example, the International Electrotechnical Commission (IEC) sets international design standards for electronic products, such as IEC 62087, which specifies how to determine the power consumption of television sets and AV equipment. Australia's Greenhouse and Energy Minimum Standards (GEMS) Act 2012, which regulates the energy efficiency and performance of electronic products, has adopted the IEC 62087 standard as AS/NZS 62087 under the GEMS (Television) Determination 2013.

⁷⁴ For example, IEC 62430 (Environmentally Conscious Design for Electrical and Electronic Products and Systems) is included on the Standards Australia search directory for reference and voluntary industry adoption.

manufacturers' incentives to develop these products (DCCEEW 2024d, p. 32). In 2021, CHOICE survey data also revealed a gap between consumer values and purchasing behaviour in Australia: while most Australians consider product durability (85%) and reparability (73%) important, only a smaller proportion actively choose items that last longer (39%) or can be repaired (46%) (CHOICE 2021b, p. 24).

There has been momentum towards reparability labels internationally (PC 2021b, p. 235), including the French Repairability Index, which has had a positive effect on the sale and availability of more repairable products both in store and online (BIT 2024). While impacts cannot entirely be attributed to the index, there has been a clear improvement in product reparability scores and a growing share of repairable products offered in the market since the index's introduction, reflecting a shift towards sustainable consumer choices and product design. Belgium will also implement its own Repairability Index for certain household appliances, including the cost of spare parts, from 2026 (Right to Repair Europe 2024).

A product labelling scheme can shift consumer bias away from price such that purchasing decisions are informed by sustainability data, and the Australian Government can draw on learnings from these countries and from schemes in other sectors. Notably, labelling schemes for energy, fuel and water efficiency already exist in Australia, including the Energy Rating Label, Green Vehicle Guide and Water Efficiency Labelling and Standards scheme. In this context, the PC renews its recommendation for the Australian Government to develop a product labelling scheme that provides durability and reparability information to consumers on electronic products, due to its importance in promoting circular activity.



Recommendation 9.1

Introduce a product labelling scheme for household appliances and consumer electronics

To better inform consumer purchasing decisions, the Australian Government should develop a product labelling scheme that provides consumer information about durability and reparability for household appliances and consumer electronics, as recommended in the PC's Right to Repair inquiry (2021).

Reuse and repair

Supporting reuse and repair activities seeks to shift consumption towards greater circularity, where electronic products and their components are kept in use for longer periods of time. Several submissions noted the importance of strengthening the reuse and repair sector, as listed below.

- Promoting reuse and repair in national frameworks and schemes and increasing focus on activities early in the product life cycle can encourage sustainable consumer behaviours (Resource Work Cooperative, sub. 30, p. 3; Wiseman, sub. 40, p. 2; Blueprint Institute, sub. 70, p. 3; SERI, sub. 92, p. 6).
- Improving coordination efforts, including greater representation of reuse and repair activities and clear opportunities for funding, can support the sector's impacts and capacity for growth (Mischkulnig, sub. 12, p. 16; Charitable Reuse Australia, sub. 18, p. 4; Australian Library of Things Network, sub. 59, p. 2).
- Developing an electronic repair market with the appropriate skills, spare parts and accreditation pathways can provide accessible alternatives to replacement and address planned obsolescence (Wiseman, sub. 40, p. 6; WRAP, sub. 56, p. 4; WorkVentures, sub. 89, p. 4).
- Supporting data collection of reuse and repair activities, including building on existing state-level reuse studies in New South Wales and Tasmania and conducting a national audit of e-waste streams, can help identify growth opportunities and guide policy and target setting for the sector (Mischkulnig, sub. 12, p. 16; Charitable Reuse Australia, sub. 18, p. 6; Product Stewardship Centre of Excellence, sub. 159, p. 9).

- Improving identification of product condition at disposal, such as crate changes at disposal sites that sort by condition and minor fault categorisation, can help to identify functional versus broken items and reduce the probability of destroying products that could be reused or repaired (Mischkulnig, sub. 12, p. 13).
- Supporting intermediaries in the resale of used and repaired products, especially with regard to liability risks and insurance challenges, builds trust in second-hand electronics and supports circularity (Smith, sub. 14, p. 2; ACCC, sub. 178, p. 8).
- Addressing barriers to repair, including unfair competition in repair markets, increases the accessibility of repair services and protects consumers from unlawfully void warranties (Wiseman, sub. 40, pp. 4, 6; ACCC, sub. 178, p. 6).

Many of these opportunities are being embraced in Australia, with various reuse and repair efforts coordinated by peak bodies including Charitable Reuse Australia, the Australian Repair Network, the Australian Library of Things Network and the Australian Men's Shed Association. At the end of the 2023-24 financial year, approximately 6,100 repair and maintenance businesses for appliances and electronics operated in Australia (ABS 2024f). Repair cafés, many of which are supported by local governments, also provide spaces for people to gather and repair everyday objects, including electronics.⁷⁵

Reuse platforms such as eBay, Gumtree and Facebook marketplace also support circularity by enabling the resale of electronic products. And innovative business models such as product-as-a-service systems, including Philips Lighting, offer electronics as a service rather than a one-time sale. In this model, consumers lease the service and the company retains ownership of the hardware, ensuring that products are maintained, upgraded and eventually recycled in a controlled manner.

To the extent that existing government policies focus too heavily on recycling and unduly exclude reuse and repair activities, policy changes could result in a more level playing field. For example, the NTCRS – Australia's product stewardship scheme for televisions and computers – is recycling-centric. The scheme provides minimal incentives for options beyond recycling for e-waste, resulting in some otherwise functional or repairable products being dismantled or destroyed (WorkVentures, sub. 89, p. 3; ANZRP, sub. 176, p. 4). As a result, valuable electronics are often reduced to their component materials rather than being repurposed for higher value uses, undermining the potential to maximise resource efficiency and reduce waste (ANZRP 2020, p. 38).

As previously recommended in the PC's Right to Repair inquiry, the Australian Government should amend the NTCRS to include reuse and repair within its annual targets. Incorporating these targets would allow for the identification of recovery opportunities for still functioning electronic products, and facilitate the development of evidence-based policies and targets in the reuse and repair sector. It would not only expand the impact of the NTCRS but also set a precedent for other product stewardship schemes, fostering a cultural shift towards sustainable consumption and production practices. The Right to Repair inquiry also recommended the use of electronic tracking devices within e-waste products to determine their final destination, including whether any recyclers unlawfully export them. This would improve the accountability of product stewardship schemes, including the NTCRS, by providing a supplementary data source for monitoring and compliance of co-regulatory bodies and their downstream recyclers.

⁷⁵ Repair cafés have grown to more than 110 stores across Australia since the first establishment in 2015 (Griffith University n.d.), including inquiry participants such as the Bega Valley Repair Café and the Bower Reuse and Repair Centre in Sydney. Many repair cafés and similar groups are also deeply embedded in their communities. Good Sammy Enterprises, which collects used items from over 200,000 households across regional and metropolitan Western Australia each year, employs more than 50% of staff with a disability (Good Sammy, sub. 25, p. 1).



Recommendation 9.2

Include reuse and repair targets in the NTCRS and increase the use of tracking devices

The Australian Government should amend the NTCRS to include reuse and repair within annual targets, as previously recommended in the PC's Right to Repair inquiry (2021). The NTCRS should also increase its use of e-waste tracking devices to better monitor co-regulatory bodies and their downstream recyclers.

The PC is interested in understanding any barriers to the supply of, and demand for, reuse and repair services. For example, a potential barrier for resale intermediaries is that only fully qualified technicians or those pursuing a trade are able to obtain micro-credentials to service or test for the safety of an electronic product for reuse purposes. Many of these intermediaries are social enterprises or charities (such as the Bower Reuse and Repair Centre in Sydney) that provide social benefits and services to local communities by offering affordable second-hand products to lower income or at-risk groups. Addressing the issue of accreditation may also reduce the liability risks and insurance challenges faced by resale intermediaries.



Information request 9.1

Barriers to greater reuse and repair

The PC is seeking further information on barriers to greater reuse and repair in the electronics sector and how widespread the issues are, including:

- whether there is unmet demand (including any data, if possible) for reuse and repair services, and if so, which electronic products and consumers are most affected
- what might be preventing the supply of these services
- what governments' role might be to address any barriers to these services, including relating to:
 - skills and accreditation for the repair of electronic products
 - coordination of and information provision about access to electronic repair services, including where this may assist recipients of social benefits and services.

Collection and recycling

There are various private sector initiatives for collecting and recycling e-waste. Major retailer schemes offer consumers convenient and rewarding ways to return their used electronics. Officeworks, JB Hi-Fi and Apple have well-established take-back programs that allow customers to exchange old devices for store-credit or responsibly recycle them. Private waste management companies such as Cleanaway, Veolia and Greenbox also play an important role in collecting, sorting and recycling valuable materials from discarded electronics, diverting from landfill and promoting resource recovery. However, there is still a pressing need for improving public awareness and education on safely disposing e-waste, especially for products with embedded lithium-ion batteries, due to the risk of fires and injuries (ACCC 2023b, p. 32).

Under the National Waste Policy Action Plan, state and territory governments are responsible for managing e-waste in their jurisdictions and regulating hazardous materials, and local governments play a significant role in organising these processes and informing the community about their collection and recycling options (DCCEEW 2024q, p. 14). Together, they collaborate to provide drop-off points, enforce landfill bans, and invest in waste collection and recycling facilities (DCCEEW 2023, p. 20). One of the primary nationwide

initiatives relating to e-waste recycling is the NTCRS, a co-regulatory product stewardship arrangement under the *Recycling and Waste Reduction Act 2020* (Cth) (refer to section 2.2 for details) which requires collaboration between governments (DCCEEW n.d.). With more than 1,800 drop-off points, the scheme provides Australian households and small businesses with free access to industry-funded collection and recycling services for television sets, computers and printers (NSW EPA 2016, p. 5).

Two government-accredited, industry-led, voluntary e-waste stewardship schemes also operate in Australia.

- Mobile Muster, administered on behalf of the Australian Mobile Telecommunications Association, is a recycling programme that diverts nearly 90% of the mobile phones and accessories collected from landfill and maintains 96% industry participation across mobile phone manufacturers and 85% across mobile network carriers operating in Australia (AMTA, sub. 155, pp. 2, 5).
- B-cycle is the national battery collection scheme run by the Battery Stewardship Council (BSC), which places a levy on imported loose and handheld batteries that is used to fund rebates for accredited collectors, sorters and recyclers (BSC, sub. 140, p. 7, 8).

Opportunities to improve e-waste collection and recycling are discussed further in section 9.3.

The PC's Right to Repair inquiry also reviewed general waste management and its effect on the health of Aboriginal and Torres Strait Islander people in regional and remote communities. It found that service irregularity, limited landfill maintenance and inadequate management of hazardous wastes was placing community health and the local environment at risk (PC 2021b, p. 260). There is an opportunity to develop more targeted approaches to collection and recycling in regional and remote communities to support e-waste management, especially for solar PV systems and lithium-ion batteries, factoring in the unique characteristics of these areas such as dispersed populations, infrastructure capability and transport costs (Mathur, sub. 10, pp. 1–2; ABRI, sub. 27, p. 3; WA Solar Recycling, sub. 34, p. 2).

9.3 Policy interventions to address barriers to circularity

Extending the range of electronics that are currently covered in product stewardship schemes has significant potential to lift Australia's materials productivity and efficiency, due to the growing consumption of these products. Most small electronics are not covered by any existing schemes (mobile phones, televisions and computers being the exceptions), giving rise to an opportunity to recover valuable materials, build industry capability in high-efficiency recycling (and hence economic diversity) and avoid environmental damage and safety risks from leachate and lithium-ion battery fires. There is also an opportunity to improve productivity by establishing product stewardship arrangements for emerging streams of solar PV system waste.

Product stewardship for small electronics

A number of small electronics are not covered by existing product stewardship schemes in Australia, including but not limited to:

- appliances (toasters, blenders, kettles and coffee machines)
- personal care electronics (hairdryers, straighteners, curlers, and electric toothbrushes and razors)
- household gadgets (alarm clocks, remote controls, radios, cameras, small electric fans, hand-held vacuum cleaners, power tools and e-cigarettes)
- entertainment devices and accessories (speakers, headphones, game consoles and DVD players)
- wearables (smartwatches and fitness trackers)
- lighting products (small lamps, reading lights, LED light strips and decorative lights)
- electronic toys (such as remote-controlled cars).

High-efficiency recycling of these products is limited due to the costs of sorting, transporting and processing the waste, which outweigh the value of the recovered materials (CIE 2023a, p. 3). As these products are small, they are also typically easy to store or throw away in household bins. The absence of a consistent regulatory framework or incentives to recycle small electronics exacerbates the problem, and low public awareness and engagement limit the accessibility and effectiveness of existing collection systems (Morris and Metternicht 2016). This is becoming an increasingly important issue, as the total volume of waste arising from small electronics in Australia is expected to exceed 400,000 tonnes per year by 2040, with those products not currently covered by existing product stewardship schemes comprising the majority of that waste (CIE 2023a, pp. 3–4).

The Australian Government has announced its intention to establish a co-regulatory product stewardship scheme for small electronics, including those already covered by the NTCRS and Mobile Muster (DCCEEW 2023, p. 35). Its objective is to divert e-waste and harmful materials from landfill, increase resource recovery and provide accessible avenues for high-efficiency recycling, improving economic diversity. Addressing small electronic waste with stewardship solutions is supported by inquiry participants (Good Sammy, sub. 25, p. 6; Resource Work Cooperative, sub. 30, p. 5; SERI, sub. 92, p. 3; ANZRP, sub. 176, p. 4) and could contribute to job creation and recycling sector growth. This includes industry investment in new recycling facilities or upgrades to existing ones, and the employment of disabled and disadvantaged workers (ANZRP 2020, pp. 12, 26).

The Australian Government's intended stewardship scheme would place a fee on importers and manufacturers of small electronics to cover the costs of collection, transport and recycling, including free disposal services or drop-off collection points across the country for households and small businesses (DCCEEW 2023, pp. 28–30). These costs would ultimately be passed on to consumers through higher product prices (DCCEEW 2023, p. 7). The scheme would also require mechanisms for reuse and repair at collection sites, when requested by a reuse or repair organisation, and involve public education and awareness campaigns on reuse and repair options and safe disposal practices (DCCEEW 2023, p. 39). Cost-benefit analysis has found that the costs associated with processing, administration and network operations would ultimately be borne by the consumer, but are outweighed by the environmental benefits, with an estimated net economic benefit in present value terms of \$32 billion⁷⁶ (CIE 2023a, p. 8).

Lithium-ion batteries are embedded in almost all small electronics including laptops, smart watches, power banks, mobile phones, cordless vacuum cleaners, power tools, e-cigarettes, video games and toys (ACCC 2023b, p. 23).⁷⁷ They are difficult to remove without specialised tools and therefore pose challenges for product disassembly. If damaged or improperly disposed of, these batteries can present significant fire risks in households and trucks, during waste collection, transport and recycling. These fires release toxic gases and are difficult to extinguish (ACCC 2023b, p. 17).

The Australian Government's proposed product stewardship scheme for small electronics would improve lithium-ion battery waste management by facilitating responsible collection and recycling of many at-risk products. The harmonisation of broader regulations for lithium-ion batteries would support the success of this scheme and drive productivity benefits (box 9.1).

⁷⁶ This estimate is largely driven by non-market benefits – consumers' willingness to pay for environmental damage avoided by the scheme of roughly \$150 per adult per year (CIE 2023a, p. 81).

⁷⁷ Embedded batteries are excluded from the B-cycle scheme, which focuses on loose batteries, leaving a gap in recycling options for many small electronics (B-cycle n.d.; DCCEEW 2023, p. 35). The BSC has proposed expanding B-cycle to include these products under 'Scenario 5' (BSC 2024b, p. 8), though they would still be covered under a voluntary rather than co-regulatory scheme. BSC estimates that 75% of 'small electronics and electrical equipment with batteries' in Australia weigh under 3 kg and can be diverted immediately through the B-cycle network (BSC 2024b, p. 12).

In parallel to the Australian Government's intentions to address lithium-ion battery waste within this product stewardship scheme, state governments are already taking measures to address the urgent risks posed by battery fires.⁷⁸ However, inquiry participants, including some state and territory governments, raised the limitations of 'patchwork' schemes across Australia and stated their preferences for a nationally led approach. These limitations included inevitable inconsistencies between jurisdictions, industry reluctance to comply across state borders and important supply levers that can only be dealt with at the national level, including working with a large number and diversity of imported consumer electronics.

Box 9.1 – Harmonising regulations for lithium-ion batteries

Lithium-ion batteries are the fastest growing fire risk in New South Wales (Fire and Rescue NSW 2024) and, according to survey results from state and territory fire services, were responsible for more than 1,000 fires across Australia in 2023 (Baker 2024). Despite this, inconsistent regulations, including material classifications, landfill regulations and those that govern the collection, storage and transport of lithium-ion batteries across jurisdictions, still allow for landfill disposal in New South Wales, Queensland, the Northern Territory and Tasmania. Inquiry participants have said these inconsistencies are increasing safety hazards and transport costs, limiting resource recovery and creating complications for storing, moving and processing end-of-life batteries (Lithium Australia, sub. 17, p. 2; ABRI, sub. 27, p. 4, 6). Discrepancies create confusion for waste handlers and processors, limit operational efficiency and restrict opportunities for reuse (DCCEE 2024d, p. 44).

Harmonising regulations for lithium-ion battery waste would support the Australian Government's proposed product stewardship scheme for small electronics by establishing consistent standards for handling, transport and recycling. Given the prevalence of these batteries embedded in small electronics, harmonising regulations would reduce compliance complexities, improve safety and productivity, and support the recovery of valuable materials including lithium, cobalt and nickel, supporting the scheme's overall success. Harmonising regulations would also enhance the clarity and effectiveness of associated education campaigns, making them simpler to understand. The overarching governance arrangements through which harmonisation could take place are discussed in chapter 10.

The PC supports the Australian Government's intention to establish a co-regulatory product stewardship scheme for small electronics not currently covered by stewardship schemes. The PC is considering the relative costs and benefits to the community of the design elements of the proposed scheme, including the increased complexity in managing a wide range of items, and various regulatory and compliance hurdles associated with investment in infrastructure and implementation across jurisdictions. While state and territory governments are addressing the urgent concern of fires caused by lithium-ion batteries, a product stewardship scheme for small electronics, including electronics with embedded lithium-ion batteries, at the

⁷⁸ The June and December 2024 Environment Ministers' Meetings addressed joint efforts by New South Wales, Victoria and Queensland towards stewardship arrangements for batteries due to the escalating issue of fires, including discussing the findings of a draft Regulatory Impact Statement (DCCEE 2024f, p. 1, 2024g, p. 2). The NSW Government intends to introduce legislation for mandatory battery product stewardship in 2025 (NSW EPA 2024d) and, in partnership with local governments, has also begun a two-year trial at select Community Recycling Centres to accept some products with embedded batteries that are not covered by existing stewardship schemes (NSW EPA 2024a).

national level would be a more efficient response. It could also provide a platform for improving public education on lithium-ion battery safety, as recommended by the ACCC (2023b, p. 42).



Reform direction 9.3

Product stewardship for small electronics, including embedded lithium-ion batteries

The PC supports the Australian Government's intention to establish a co-regulatory product stewardship scheme for small electronics and is seeking further information on how the scheme could be designed and implemented to support materials productivity and economic outcomes.

Given the immediate risks of battery fires and the inefficiency and complexity of creating multiple state- and territory-based stewardship systems, the Australian Government should prioritise establishing co-regulatory stewardship arrangements for electronic products with embedded lithium-ion batteries.

Harmonising regulations for lithium-ion batteries will support the success of this scheme.



Information request 9.2

Product stewardship for small electronics, including embedded lithium-ion batteries

The PC is seeking further information on:

- what barriers (such as public awareness or infrastructure) currently limit the collection and recycling of different types of small electronics, and how these barriers differ by product
- how including different types of small electronics in a product stewardship scheme would result in environmental, economic and/or social benefits and costs (including estimates, where possible)
- the costs and benefits of expanding existing product stewardship schemes – such as the co-regulatory NTCRS or the voluntary B-cycle scheme – to include (other) small electronics, rather than establishing an entirely new scheme
- whether and how a staged approach (e.g. by product or location) could be a cost-effective way to sequence the addition of small electronics into a product stewardship scheme, whether new or existing
 - if staged by product, which products should be addressed first and why
- what the costs and benefits would be (including estimates, where possible) of introducing a minimum threshold for the value of small electronics to be included in a product stewardship scheme
- what compliance and enforcement arrangements would be necessary under a co-regulatory scheme to encourage adoption and address 'free rider' behaviour
- how else the scheme could support circularity earlier in a small electronic product's life cycle, including sustainable design and reuse and repair activities.

Product stewardship for solar PV systems

Solar PV systems, including battery storage equipment, contain potentially hazardous substances such as cadmium and lead, and valuable materials including silicon and metals (US EPA n.d.). In Australia, the majority of end-of-life PV systems are sent to landfill or discarded in shredder floc, with some illegally dumped on roadsides or bushland. This can lead to toxic materials leaching into soil and water, air pollution

from fires caused by embedded lithium-ion batteries in storage equipment and the depletion of finite resources, including glass, used to manufacture new systems (CIE 2023b, p. 3). By 2030, glass as a material component of e-waste is projected to increase by more than 170%, driven by the projected 18-fold growth in the weight of solar PV system waste in Australia from 2019 (DCCEEW 2021b, pp. 7, 10).⁷⁹

Despite being the world's largest installer of solar PV systems per person (IEA 2024, p. 12), Australian infrastructure is not currently capable of recycling these systems effectively and there is limited development of an end-of-life market for their components (WA Solar Recycling, sub. 34, p. 2; Gell, sub. 60, p. 2; BCA, sub. 99, pp. 2–3). Regional and remote areas, particularly in the Northern Territory and Western Australia, face specific barriers due to limited recycling infrastructure and high transport costs (Mathur, sub. 10, p. 3; WA Solar Recycling, sub. 34, p. 2).

The early decommissioning of still well-functioning solar panels is accelerating this waste. Contributing factors include rebate incentives⁸⁰, preferences for newer models and renovations that require solar panel removal (WA Solar Recycling, sub. 34, p. 2; RMIT University Circular Economy Hub, sub. 31, p. 3; CPVA, sub. 62, p. 3). There is also no consistent approach across Australia to divert solar panels from landfill or close loops such that component materials (many of which are large Australian exports) are kept in circulation in the country (Gell, sub. 60, p. 1; CPVA, sub. 62, p. 3).

The Australian Government has announced its intention to develop a co-regulatory product stewardship scheme for small-scale⁸¹ solar PV systems to address many of these barriers.⁸² As with the proposed scheme for small electronics, organisations that import or manufacture PV systems above a certain threshold would fund the scheme by paying fees to a central administering body (appointed and overseen by the government) to provide drop-off points, undertake recycling activities and manage contracts and payments with network operators (DCCEEW 2023, pp. 28–30).

Cost-benefit analysis has found that scheme costs are likely to be outweighed by the environmental benefits of greater uptake of high-efficiency recycling, with an estimated net economic benefit in present value terms of \$7.2 billion (CIE 2023b, p. 8). Specifically, though scheme costs would ultimately be passed on to consumers in the form of higher upfront prices for solar PV systems, they are expected to be offset by the reduced price in charging for the decommissioning of these systems at the end of their life (CIE 2023b, p. 81). Inquiry participants also supported a national product stewardship scheme for PV systems (Resource Work Cooperative, sub. 30, p. 5; CPVA, sub. 62, p. 4; BCA, sub. 99, p. 2).

International approaches to managing solar PV waste (box 9.2) have tended toward bespoke schemes, with manufacturers responsible for end-of-life systems through EPR. However, Australia imports the vast majority of its PV systems, mainly from China (IEA 2022, p. 43), making it challenging to implement an EPR model that relies on manufacturer take-back (Lockrey et al. 2022, p. 14). The European Union, for example, though

⁷⁹ This includes both small household PV systems and those at large utility-scale sites, the collection for which is different but the breakdown of material the same, with potentially similar material recovery pathways (DCCEEW 2021b, p. 18).

⁸⁰ Under the Australian Government Small-scale Renewable Energy Scheme, Small-scale Technology Certificate rebates offer credit for installing and upgrading solar PV systems.

⁸¹ By 2030, more than 80% of decommissioned solar panels are expected to come from small-scale (household) distributed PV systems due to the early development of Australia's residential solar PV market, with waste panels from large-scale systems expected to grow faster after 2030 (ACAP 2024, p. 5).

⁸² Small-scale PV systems would be systems of up to 100kW capacity. The Australian Government proposes to include all solar panels, inverters, attached cabling, racking and potentially household energy storage batteries in the legislated scheme (DCCEEW 2023, p. 10). The scheme would cover legacy waste (small-scale PV systems installed before the scheme commences) including over three million small-scale PV systems already in use, 90% of which are on domestic rooftops (DCCEEW 2023, p. 41).

also a major importer of PV systems, relies on large multinational corporations with established compliance systems to meet EPR obligations. Australia also has more rooftop solar PV systems than other countries (Climate Council 2024, p. 4), with a significant proportion of these systems already approaching the end of their life (ACAP 2024, p. 5). This creates a need to also address legacy PV system waste, which is not typically covered under stewardship schemes that rely on manufacturer take-back.

A co-regulatory scheme that shifts the cost of recycling to consumers could support sustainable management of PV system waste given Australia's unique challenges, and encompass both new and legacy systems. Moreover, Australia is largely an importer of solar PV systems, and a national scheme led by the Australian Government would enable greater coordination where international supply chains and trade flows are involved. The PC therefore supports the Australian Government's intention to establish a co-regulatory product stewardship scheme to manage this waste.

Box 9.2 – International approaches to managing solar PV system waste

The **European Union's** Waste Electrical and Electronic Equipment (WEEE) Directive is a regulatory framework designed to manage the end-of-life treatment of e-waste. Under this directive, solar PV systems are classified as e-waste and manufacturers are required to assume extended producer responsibility (EPR) for the collection, recycling and disposal of their products (Ndalloka et al. 2024, p. 4). Of the collected waste, the directive sets targets at 85% recovery and 80% preparation for reuse and recycling, and industry-led programs such as PV CYCLE have established collection points, logistics systems and partnerships with specialised recyclers to facilitate efficient processing (EU 2012, p. 23; PV Cycle 2023a).

In 2023, PV CYCLE issued a position paper arguing that PV systems differ significantly from typical e-waste covered by the WEEE directive, as they have different and longer product life cycles, generate electricity rather than consume it and are influenced by energy policies and subsidy mechanisms. PV CYCLE suggested that a tailored EPR framework would improve the end-of-life management of renewable energy products like PV systems, and invited the European Commission to conduct an impact assessment of EPR legislation specific to renewable energy equipment (PV Cycle 2023b).

Other movements towards product stewardship are taking place internationally.

- **China** is beginning to address PV system waste through guidelines issued by the National Development and Reform Commission in 2023, which outline requirements for manufacturers to develop collection and recycling systems (Ndalloka et al. 2024, p. 4).
- In the **United States**, state-level initiatives are emerging in the absence of federal regulation addressing PV system waste. As of 1 July 2025, PV systems cannot be sold in Washington State unless the manufacturer has an approved stewardship plan (Ndalloka et al. 2024, p. 4).
- Proposed legislation in **Japan** aims to mandate the collection and recycling by manufacturers of solar PV systems reaching their end-of-life (The Japan Times 2024). Industry commitment to developing recycling solutions for these systems has expanded in recent years (AGC 2023).



Reform direction 9.4 **Product stewardship for small-scale PV systems**

The PC supports the Australian Government's intention to establish a co-regulatory product stewardship scheme for small-scale PV systems, including legacy waste, and is seeking further information on how the scheme could be designed and implemented to support materials productivity and economic outcomes.



Information request 9.3 **Product stewardship for small-scale PV systems**

The PC is seeking further information on:

- whether large-format or energy storage batteries should be included or excluded in the scheme (including estimates of the costs and benefits, if possible)
- whether compensation should be provided for PV systems returned in good condition (including any estimate for this compensation and cost-benefit considerations)
- how best to establish a system of collection points for PV waste, including local government involvement, especially in regional and remote areas, and whether existing collection points such as those under the NTCRS could be leveraged
- which specific industries or markets in Australia, if any, could benefit from the recovered materials of PV waste (including the size of these benefits, if possible)
- how else the scheme could support circularity earlier in the solar PV system life cycle, including sustainable design and reuse and repair activities.

10. System-wide arrangements

Key points

- * Harmonising policies and regulations that affect uptake of circular opportunities – but that unnecessarily vary across states and territories – would have net benefits to the community.**

 - The Australian Government could lead on harmonising waste classifications, kerbside recycling requirements, recycled content specifications for infrastructure, and lithium-ion battery waste management regulations, either through improved interjurisdictional arrangements or a new body.
- * Facilitation and coordination services can assist businesses to find circular opportunities, develop partnerships, and navigate complex regulatory arrangements.**

 - The PC is considering how governments could work with industry associations, research bodies and/or community organisations on coordination initiatives. This could include offering information on existing services, trialling new platforms, or facilitating connections between businesses for circular opportunities.
- * Governments can foster innovation in circular practices and technologies, and help connect researchers and industry to commercialise research.**

 - The PC is considering challenge-based funding models to encourage collaboration across supply chains.
- * Place-based circular initiatives involve businesses co-locating to innovate and share knowledge, reduce costs (e.g. on inputs and transport), and share infrastructure.**

 - The PC is seeking further input on how governments can use place-based circular policies to support economic, social and/or environmental objectives – such as by reducing regulatory burdens, linking circular objectives to precincts or regions with related objectives (such as net zero) or service delivery (such as waste management and recovery).
- * Monitoring the circular economy will be necessary to measure Australia’s progress and inform government and business decisions, but the current set of circular economy indicators included in the *Measuring What Matters* framework is limited.**

 - The PC is proposing that an expanded set of indicators could include environmental and economic outcomes from circular activities, so that the data can be used to identify opportunities and measure improvements made. But feasibility could be limited by high data collection costs for some indicators.

Across all sectors, there is evidence that some businesses are improving materials efficiency, employing a variety of innovative circular techniques and technologies, and developing market opportunities. Businesses and households are responding to a variety of signals and motivations, ranging from financial considerations

(higher profits through lower costs or higher revenues) to environmental and social concerns. While there are barriers unique to each sector, there are also institutional and system-wide reasons why businesses and individuals do not pursue circular activities. This chapter explores these cross-cutting issues.

Important context is the emergence of a national policy framework to support circularity. Until recently, circular policy in Australia focused primarily on the end of the product life cycle (waste and recycling). Reflecting the locus of this policy responsibility, the main actors have been state and territory governments.

The recent Circular Economy Ministerial Advisory Group (CEMAG) final report (DCCEEW 2024d) brought forward a number of cross-cutting policy recommendations, including a stronger policy role for the Australian Government. A key recommendation was to introduce a Circular Economy Act, with this legislation to provide an 'overarching, integrated regulatory framework for the Circular Economy [and] equip the Australian Government with a streamlined, agile and proactive tool to regulate the environmental performance of materials and products' (DCCEEW 2024d, p. 35). The recommendation suggests the Act should provide a framework for issues such as eco-design, information disclosure, product stewardship and labelling.

The PC has previously noted that best practice regulatory and legislative reform involves taking a stepped approach to emerging issues. This involves three stages: assess existing regulation and legislation to see if it is fit-for-purpose to address emerging issues; if not, clarify or amend them to address gaps; and if this is not possible, then introduce new regulation or legislation that appropriately balances benefits and costs.⁸³ In proposing reform directions for this inquiry for both specific sectors (chapters 4–9) and system-wide (this chapter), the PC has generally been able to identify existing regulations that could be amended or improved in how they are applied. Where new regulation or legislation is required, this is likely to be more appropriately introduced as a standalone piece, rather than an overarching Act.

10.1 System-wide policies to support a circular economy

A key theme cutting across sectors was the need for governments to reduce regulatory barriers to greater circularity – particularly inconsistency of regulations across Australia – and help businesses navigate complex and time-consuming regulations. Governments can also support innovation and investor confidence in circular initiatives. And governments can bring parties together, including with place-based approaches.

Harmonising regulations across states and territories

Circular economy opportunities are diverse, and often involve more than one sector, location or process. As such, businesses pursuing circular economy activities – larger businesses operating nationally, or smaller businesses operating in one location and seeking to grow – can be affected by numerous policies and regulations. Where regulations differ across states and territories, this can impose additional costs on circular activities.

Inquiry participants identified a range of regulations that are inconsistent across jurisdictions, including:

- waste management and resource recovery⁸⁴
- environmental approvals (ABRI, sub. 27, p. 6)
- allowable content for recycled materials in infrastructure construction (chapter 4)
- bans on lithium-ion battery disposal, recycling and classification (chapter 9)

⁸³ See, for example, the PC's submission on regulating the use of artificial intelligence in health care (2024, pp. 4–5).

⁸⁴ For example, ACCI (sub. 76, p. 3); AFGC (sub. 105, p. 7); Vinyl Council of Australia (sub. 32, p. 2); Arup (sub. 52, p. 5); RAI (sub. 100, p. 7); CIF (sub. 103, p. 13); Hunter Joint Organisation (sub. 172, p. 14). This issue was also raised in the PC's consultations with industry participants.

- planning and zoning (Xseed Solutions, sub. 7, p. 14; Australian Pork Limited, sub. 69, p. 2; PC consultations with industry participants)
- health regulations (ACOR, sub. 75, p. 37; CIPS Australia and New Zealand, sub. 161, p. 6).

Different settings for different jurisdictions can be justified where local environments and activities differ. But there are also examples where the inconsistency can lead to missed opportunities, such as businesses expanding into new regions or utilising waste products. In such cases, jurisdictional regulations could be harmonised to reduce the regulatory burden on businesses – particularly where the differences between regulations are definitional or administrative, rather than substantive or relating to outcomes.

For example, inconsistent waste classifications at the state and territory level can prevent gains in materials efficiency (box 10.1). The Heads of EPA Australia and New Zealand (HEPA) Strategic Plan 2022–2025 includes a direct action to ‘align, as far as practicable, waste classifications, including e-waste and organics’ (HEPA 2021, p. 5) and provide advice and guidance to ‘develop nationally consistent regulatory guidance on management of agreed high priority wastes’ (HEPA 2021, p. 5).

Box 10.1 – Inconsistent waste classifications can be a barrier to materials efficiency

Waste is classified and regulated to manage risks of harm to human health and the environment. However, inconsistent waste classifications and regulations across states and territories create additional costs and burdens for businesses that operate in multiple jurisdictions. Differing waste classifications also impact businesses’ decisions on where to locate or expand. Fragmented regulations may pose significant administrative barriers to businesses trying to expand into new regions (DCCEEW 2024d, p. 44).

Digestate⁸⁵ is an example of a material that is classified as a reportable priority waste residue in some jurisdictions (Infrastructure Victoria, sub. 28, p. 4). ‘This inconsistency is an impediment to investment and cross-border trade’ (Jemena, sub. 106, p. 4), such that circular opportunities involving digestate are not realised. The benefits of digestate include improving plant growth and soil quality, reducing the need for fertilisers (EPA Victoria 2024c) and as a substitute for synthetic fertilisers.

Other materials raised by participants that present opportunities for recycling or reuse, but for which the waste classification is currently a barrier, include biosolids (ANZBIG, sub. 173, p. 47; GlobalPSC, sub. 149, p. 45), fly ash (BCSDA, sub. 175, p. 23), scrap steel (CODA, sub. 46, p. 16) and concrete (CCAA, sub. 55, p. 15).

Households can also benefit from more harmonised regulations, such as for kerbside collection (box 10.2). By making it easier for households to segregate waste streams, harmonised kerbside collection improves the quality of the materials that can be recovered from waste. The December 2024 Environment Ministers’ Meeting (EMM) agreed to progress a roadmap to harmonise kerbside collection services (DCCEEW 2024f, p. 1).

⁸⁵ Digestate is a by-product of anaerobic digestion, an organic recovery process that generates biogas. Chapter 5 discusses anaerobic digestion in further detail.

Box 10.2 – Harmonising kerbside collection supports recovery of valuable materials

The majority (approximately 90%) of Australians have access to kerbside municipal waste collection and recycling services (DCCEEW 2024p, p. 5). However, what can and cannot be included in kerbside recycling bins and food organics and garden organics bins differs across local governments. This can make it hard for households to understand what can be put into their different bins, which contributes to contamination of kerbside recycling (DCCEEW 2024p, pp. 7–8).

Contamination of kerbside recycling increases collection and recycling costs, and lowers the value of recycled materials. For example, when co-mingled recycling is contaminated by soft plastics, items in plastic bags and clothing, these items get caught in sorting machinery and need to be manually removed before sorting can recommence (Sustainability Victoria 2023). Contamination can also lead to otherwise recyclable items being sent to landfill (Queensland Government 2024d).

While harmonising regulations across jurisdictions would make it easier for organisations to pursue circular innovations, changes to regulations need to balance environmental and economic risks and benefits, and consider the cost of change, as well as any new enforcement requirements for governments. The broader objective for governments is to ensure that new and existing regulations are appropriate, effective and efficient, and that regulatory reform efforts are both coordinated and cost-effective. Governments also need to design and implement regulations that are adaptable and responsive to emerging risks, such as issues with hazardous materials in waste streams.⁸⁶

The Australian Government could coordinate harmonisation efforts

Coordination between state and territory governments takes time and direction, and effective regulatory changes require political will and buy-in from key stakeholders. The Australian Government would need to play a leadership role in facilitating harmonisation across jurisdictions. Appropriate governance arrangements around the coordination mechanism would enable jurisdictions to more effectively agree on how regulations should be harmonised (for example, alignment to which settings), identify other potential inconsistencies that may benefit from harmonisation, and agree where exclusions or location-specific settings may still be required (for example, to accommodate for unique geography).

The Environment Ministers' Meeting (EMM) already provides a mechanism for communicating the high-level agreements it reaches across Commonwealth, state and territory governments. This supports the authorising environment for Environment portfolios to work together alongside channels such as HEPA and officer-level working groups and communities of practice. Some of these bodies are already progressing harmonisation initiatives relevant to the circular economy. For example, Australian governments are working together on the National Kerbside Collections Roadmap under in-principle agreement from EMM (DCCEEW 2024p), and HEPA's Strategic Plan includes an action to align waste classifications (discussed above).

There may be ways to increase the effectiveness of existing mechanisms for coordination. For example, the Australian Government could play a more active role in driving change, such as by chairing and agenda setting, providing secretariat and/or other resourcing. In addition, an intergovernmental agreement could

⁸⁶ For example, in December 2024 Environment Ministers agreed to publish an updated PFAS National Environmental Management Plan, complementing the standards established under the Industrial Chemicals Environmental Management Standard which addressed the environmental impacts of PFAS (per- and polyfluoroalkyl) and related substances from 1 July 2025 (DCCEEW 2024f).

formalise a commitment by Australian and state and territory governments to work together to harmonise regulations, and set out timeframes for achieving harmonisation on specific areas. Although not legally binding, intergovernmental agreements can be effective at motivating progress, particularly when supported with Australian Government funding.

Alternatively, a new interjurisdictional body could be set up to coordinate harmonisation of regulations across states and territories. CEMAG's final report (DCCEEW 2024d, p. 44) suggested that existing governance mechanisms (e.g. Environment Ministers' or senior officials' meetings), have not resolved longstanding regulatory inconsistencies and recommended creating a dedicated body to facilitate harmonisation. The proposed body would be similar to the Australian Building Codes Board, with a mandate to address inconsistent regulatory barriers to circular opportunities, and would allow input from industry and experts to identify key areas for harmonisation (DCCEEW 2024d, p. 44). The effectiveness of such a body would depend on a range of factors such as its structure, remit, resourcing and level of support from jurisdictions.

The PC is considering a reform direction that would have the Australian Government take a coordination role in harmonising regulations across jurisdictions to enable greater circularity. The PC is seeking feedback on the appropriate governance mechanism, including any benefits and drawbacks.



Reform direction 10.1

Governance arrangements to harmonise regulations that pose barriers to circularity

The PC is proposing that the Australian Government facilitates coordination between state and territory governments to harmonise inconsistent regulations across jurisdictions. The PC is considering how existing coordination mechanisms in Environment portfolios can be made more effective, what the role for the Australian Government should be in driving change (such as chairing, providing secretariat and/or resourcing, setting the agenda, leading the development of an intergovernmental agreement), and whether a new interjurisdictional body dedicated to circular economy harmonisation efforts is both practical and warranted.

Coordination would enable governments to agree on what settings regulations should be harmonised to, and how. A preliminary set of state and territory regulations for consideration might include:

- waste classifications (building on the strategic direction outlined by the Heads of EPA Australia and New Zealand)
- specifications for using recycled materials in infrastructure projects (chapter 4)
- lithium-ion battery waste management regulations (chapter 9).

Intergovernmental coordination would also support the identification of other harmonisation opportunities. These may include specific inconsistencies in planning, zoning and health regulations that relate to environmental impacts and are presenting barriers to circular economy growth.



Information request 10.1

Governance arrangements to harmonise regulations that pose barriers to circularity

The PC is interested in further information on the following questions:

- How could existing intergovernmental coordination mechanisms in Environment portfolios – such as the Environment Ministers' Meetings, Heads of EPA forums and/or officer-level communities of practice – be improved to more effectively and quickly harmonise inconsistent regulations that are limiting uptake of circular opportunities? What would be the costs of these changes?
- What would be the benefits of setting up a new institutional body to oversee harmonisation efforts? How would such a body need to be structured to improve on current arrangements, and what would be the costs of setting up and running it?
- Apart from those identified in reform direction 10.1, what other inconsistent regulations (such as planning, zoning and health regulations) are presenting barriers to circular opportunities? How well do existing intergovernmental coordination mechanisms in other portfolios take into account the impact of these regulations on circular opportunities?

Assisting businesses to navigate regulations and develop partnerships

Businesses may have to navigate many regulations across different departments or levels of government to take up circular opportunities. Harmonising inconsistent regulations where possible (discussed above) will reduce regulatory complexity, but such efforts take time. Reflecting the difficulties that businesses can have in gaining all required approvals under the current system, participants raised the need to streamline regulations to make it easier to realise circular opportunities (Veolia Australia and New Zealand, sub. 8, p. 6; Xseed Solutions, sub. 7, p. 6; Shelley, sub. 72, p. 4).

Coordination and facilitation services can help businesses to deal with regulatory complexity. Some inquiry participants have sought private consultants to assist with navigating regulations across multiple departments and levels of government, with positive results. And in communities and precincts where place-based circular hubs have developed (discussed below), there is often a local organisation or business leader acting as 'transition broker' to enable shifts towards circularity, including support to navigate regulatory and funding approval processes (DCCEEW 2024d, p. 75). However, not all businesses seeking to pursue circular opportunities are aware of, eligible for, or able to afford these services. There may also be a limited number of people with the appropriate knowledge to provide these services.

In this context, governments can also play a role in helping organisations to navigate complex regulations. For example, Container Exchange Queensland (sub. 83, p. 7) worked closely with the Queensland Government to overcome regulatory constraints and align with evolving state and national regulations. And CEMAG's final report recommended that the Australian Government should support transition brokers in circular precincts, such as by connecting those in different regions to share transferrable learnings (DCCEEW 2024d, p. 74).

Businesses also benefit from connecting with each other on circular opportunities, such as to adopt circular processes along the supply chain or to diffuse innovative circular approaches. But they may not have the time or knowledge to identify opportunities that could have both economic and environmental benefits. And some businesses may avoid collaborating for competitive reasons, or to ward off perceptions of anti-competitive behaviour (Nous Group 2019, p. 19). CEMAG noted that clear, accessible guidance on regulatory requirements, legal considerations and best practices for collaboration would reduce uncertainty for businesses looking to collaborate (DCCEEW 2024d, p. 64).

Governments can play a coordinating role by offering information or facilitating connections between businesses looking to take up circular economy technologies or find partners for circular activities (such as markets for waste streams via a materials information exchange platform). Finding the right partners for circular projects can catalyse success, but can be difficult, particularly in regional and remote areas. According to the Bega Local Aboriginal Land Council:

We would be interested in government helping connect us with partners, such as universities or other like-minded organisations. There could be a role for an organisation like a university that's interested in building circular economy partnerships. There's a lack of recognition that in rural and regional areas there aren't many big players to partner with. (Bega LALC, sub. 185, p. 2)

Small businesses may also experience greater challenges finding partners due to a lack of time, knowledge and resources. In its final report, CEMAG recommended that governments support businesses to collaborate up and down supply chains, with small to medium enterprises requiring different support services to larger organisations (DCCEEW 2024d, p. 60).

Coordination initiatives can stretch across several locations and stakeholders. For example, the Hunter Joint Organisation (sub. 172, p. 7) is a collaboration amongst Hunter Councils that engages stakeholders from diverse sectors to collaborate on innovative circular solutions. And Hume City Council is working with Victoria University and Circular Economy Victoria to explore circular economy opportunities across business, social enterprise, industry, residents and interest groups through its Collaborate to Thrive program (Hume City Council nd, p. 63). Another collaboration with the university sector is UNSW's SMaRT Centre (sub. 4, p. 3) partnership with Shoalhaven City Council and Kandui Technologies, using new technology to transform problematic glass and textiles waste streams into materials for use in the built environment.

Governments can use existing tools and platforms to support coordination between businesses. For example, ASPIRE⁸⁷ is an online brokering platform that facilitates materials exchange, matching waste producers with potential users of that waste. Several local governments, including Logan City Council (sub. 61, p. 1) and some in northern Tasmania (Tasmanian Times 2020), have trialled ASPIRE to encourage businesses to exchange materials that would otherwise have been discarded. However, there has been low uptake in some areas, potentially reflecting that the circular economy is still a relatively new concept and awareness of the benefits to businesses is currently low.

⁸⁷ ASPIRE was developed by CSIRO and Data61 in response to Australian businesses and local councils who were seeking a solution to waste disposal costs. It was transitioned to a commercial operation in 2019 (ASPIRE nd).



Reform direction 10.2

Supporting coordination, facilitation or brokering services

The PC is considering a reform direction on government support for services to assist businesses in finding circular opportunities and partners, and navigating the complex regulatory environment. This could include governments facilitating access to coordination services through trials or raising awareness of relevant initiatives. Governments may, in some cases, choose to collaborate or partner with businesses and other stakeholders on circular opportunities.

Special arrangements may be required to assist businesses and other organisations to find partners for circular projects in regional and remote areas, and for small and medium businesses.



Information request 10.2

Supporting coordination, facilitation or brokering services

The PC is interested in further information on **supporting businesses and communities to identify circular opportunities and develop partnerships**:

- What government initiatives could most effectively support businesses' coordination?
 - How could governments use or build on existing platforms for information sharing or collaboration?
 - Are there examples of governments partnering with intermediaries, such as industry associations or other network bodies, to support collaboration? How might this be further strengthened?
 - What would be the benefits and costs associated with these initiatives, in terms of economic, environmental and/or social outcomes?
 - What lessons could be learned from successful government initiatives supporting facilitation or coordination in other industries?
- Are there special considerations for how governments might support businesses to identify partners in regional and remote Australia?
- How could governments support Aboriginal and Torres Strait Islander businesses and communities to identify opportunities and partnerships? What current or new initiatives could be adopted or extended?
- How do the needs of small and medium businesses or organisations differ from larger businesses or organisations in relation to adopting circular practices, and how might governments best support this cohort?

The PC is interested in further information on **navigating regulatory complexity**:

- What are the barriers to knowledge (or transition) brokers, project officers, community development officers and the like effectively assisting organisations to navigate regulatory complexity?
- To what extent is there a need for government to provide services, given that there are already private consultant services that can support businesses to navigate regulations?
- What kind of regulations do businesses most need help navigating to pursue circular opportunities? Are these at Commonwealth, state and territory, or local government level?

Supporting the adoption and diffusion of circular innovations

Innovation is core to achieving a more circular economy, and governments can assist businesses to adopt new technologies and processes with funding and other support. Existing Commonwealth programs that do or could support circular innovations include:

- the National Reconstruction Fund, which provides debt, equity and guarantees ‘to support Australian projects that drive high-value industry transformation’ (National Reconstruction Fund Corporation nd). Renewable and low-emission technologies is one of seven priority areas, which can include commercial opportunities for manufacturing products related to recycling and waste reduction or resource recovery (National Reconstruction Fund Corporation 2023)
- A Future Made in Australia, with five industries supported in the 2024-25 Budget (renewable hydrogen, critical minerals processing, green metals, low carbon liquid fuels and clean energy manufacturing including battery and solar panel supply chains) (Australian Government 2024a, p. 2)
- public research funding, including to the CSIRO and universities
- Cooperative Research Centres grants and Cooperative Research Centres Projects grants, which provide funding for industry-led research collaborations (Commonwealth of Australia 2024a, 2024b)
- sector-based initiatives, such as Research and Development Corporations
- Green Bonds (discussed below).

There are barriers to accessing and using government programs and grants for circular economy innovations (ACOR, sub. 75; RAI, sub. 100; consultations with inquiry participants). Some businesses are unaware of available programs or face high application costs. Grants may provide financial support over shorter time periods than projects need, and applying for some grants precludes applicants from applying for others. Some grant programs (such as the National Reconstruction Fund) are not available to circular economy projects in all sectors or supply chains or have restrictive conditions that do not align with local needs.

And innovation goes beyond any one business – diffusing knowledge and collaborating across supply chains is integral to harnessing the full benefits of circularity. *Australia’s Circular Economy Framework* identifies business-to-business collaboration as essential for circular economy innovations (DCCEEW 2024b, p. 27), and governments can play a role in supporting this. As an alternative to grants, governments can fund innovation through challenges or missions that reward collaboration across the supply chain.⁸⁸ Governments can also provide shared infrastructure for innovation, including as part of place-based initiatives (discussed below). And they can support greater collaboration between industry and academia so that innovative research that improves circularity can be commercialised.

Several inquiry participants suggested governments could do more to provide subsidies and tax incentives to encourage investment in circular opportunities, such as tax credits or accelerated depreciation (ANZBIG, sub. 173, p. 45; Civil Contractors Federation, sub. 42, p. 5; Monash University, sub. 138, p. 16). Tax policy settings have implications for business investment and productivity beyond the circular economy and therefore need to be assessed in a broader context.

The PC is interested in exploring how governments can specifically support circular economy-related business innovation, and how governments can strengthen collaborative networks to help diffuse innovation and support economic diversity and capability. The PC (2023a, p. 49) has previously suggested that working

⁸⁸ Unlike traditional approaches to innovation, mission-oriented or challenge-based innovation is designed to align research, innovation and policy around clear, ambitious goals and encourage cross-disciplinary collaboration (Monash University, sub. 138, p. 5; AAS and ARC Centre of Excellence in Synthetic Biology, sub. 144).

with intermediaries that have existing connections between industry, government, researchers and markets, such as industry associations and other network bodies, would support diffusion.



Reform direction 10.3

Supporting greater adoption and diffusion of circular innovations

The PC is considering a reform direction on government support for businesses to adopt and diffuse innovative circular practices and technologies. This could involve working with intermediaries that have existing connections between industry, government, researchers and markets, such as industry associations and other network bodies. The PC is considering:

- challenge-based funding models to encourage innovation across supply chains
- how governments can connect researchers and industry to commercialise innovative research.



Information request 10.3

Supporting greater adoption and diffusion of circular innovations

The PC is interested in further information on **challenge-based funding for innovation**:

- Are there examples of circular economy innovations that have been successfully funded through challenges (in Australia or internationally) and what determined their success?
- What might be the benefits and limitations to this approach? What are the likely costs?

The PC is interested in further information on **connecting industry and research**:

- What are useful models for how government can connect industry and researchers? When is this best done at the industry level, and when by location (such as a region or local government area)?
- Are there examples of successfully adopting or diffusing circular innovations across supply chains?
- What are additional examples of Australian, state, territory and local governments successfully fostering these connections?

The PC is interested in further information on **Aboriginal and Torres Strait Islander knowledges** and circular innovations:

- What actions could governments take to value Aboriginal and Torres Strait Islander knowledges, in ways that protect Indigenous cultural and intellectual property, in the adoption and diffusion of circular innovations?

Improving investor confidence in circular opportunities

The Responsible Investment Association Australasia found 36% of surveyed Australian investment managers incorporated waste management, zero waste or circular economy-related investments into their strategies (Dandarvanchig et al. 2024, p. 32). However, investors can be reluctant to invest in circular economy opportunities due to a lack of credible information about businesses' circularity performance, regulatory and policy uncertainty and fragmentation, and access to insurance.

While some participants noted uncertainty about the veracity of businesses' circularity claims (Circular Australia, sub. 126, p. 5), a broader issue is the lack of widespread reporting and disclosure about circularity.

Environment, social and governance (ESG) reporting can provide investors with information about a company's environmental performance but has a way to go before circular activities are embedded and codified. Mandatory climate-related financial disclosures (which includes scope 1, 2 and 3 emission metrics and targets) commenced on 1 January 2025 (ASIC 2024a, 2024b) and will start to provide transparency for investors on emissions-related circular activities by large companies.

The Australian Sustainable Finance Institute (ASFI) is, in partnership with the Australian Government, developing an Australian sustainable finance taxonomy to support sustainable finance markets in Australia (ASFI nd).⁸⁹ The framework will provide a set of classifications that defines what qualifies as a circular activity, supporting investors to identify and finance these opportunities. ASFI proposes the taxonomy include, among other things: designing out waste and pollution; shifting to renewable and long-lived materials; implementing more materials-efficient production processes and circular business models; circulating materials and products at their highest value; and regenerating nature (ASFI 2024, p. 21).

The Australian Government supports investment in circular economy activities through its Green Bond program. The first Green Treasury Bond was issued in June 2024 with the aim to 'enable investors to back public projects that drive Australia's net zero transformation and support environmental objectives' (The Treasury nd). Green Bond proceeds can be used to finance government programs that improve environmental outcomes, including circular objectives about reducing and recovering waste (AOFM 2023, p. 16).

Inquiry participants also stated that investor confidence can be undermined by the complex and fragmented regulatory environment (discussed above), particularly for resource recovery and recycling (ACOR, sub. 75, p. 6). Participants noted that establishing a consistent national policy framework would provide certainty and encourage investment in circular economy initiatives (Veolia Australia and New Zealand, sub. 8, p. 6).

A lack of access to insurance was raised as another challenge for investment in some parts of the recycling sector (ACOR, sub. 75, p. 24; BSC, sub. 140) and for some repair, resale and reuse activities (Toy Libraries Australia, sub. 130; Smith, sub. 14). However, the extent to which insurance represents a widespread barrier to investment and growth in circular activities is unclear, and the insurance sector covers a complex and broad range of risks and operations. As such, further information is required to identify which parts of the circular economy are most impacted by limited access to insurance and determine whether government action is warranted in this space.



Information request 10.4

Improving investor confidence in the circular economy

The PC is interested in further information on the following questions:

- Will the proposed Australian sustainable finance taxonomy and enhanced ESG reporting provide sufficient information for investors to make informed decisions about circular economy projects? Or are further initiatives, required to improve investor confidence in the circular economy?
- What are examples of sectors or circular activities being impacted by the cost and availability of insurance? What factors or risks currently determine insurance availability (or lack thereof)?

⁸⁹ The 2024-25 Budget provided funding to extend Australia's sustainable finance taxonomy to the agriculture sector and develop an investment product labelling regime for financial products marketed as sustainable (Australian Government 2024a, p. 4).

Facilitating place-based circular initiatives

Place-based approaches to developing the circular economy target the specific needs of a location and its community across economic, social and/or environmental dimensions (DCCEEW 2024d, p. 71). Place-based approaches that draw on the unique strengths and resources of each region can improve coordination in a circular economy and reduce duplication and unnecessary expenditure. Place-based initiatives:

- foster economies of agglomeration so that innovation occurs amongst organisations with similar objectives (for example, lowering environmental impacts from materials use)
- reduce the distance and therefore transport costs (including time and emissions savings) between organisations along the supply chain, such as downstream customers and upstream suppliers and inputs
- enable co-located organisations to make use of co-located infrastructure.

Place-based circular economy hubs or precincts can emerge from private commercial motivations. For example, in WA's Kwinana Industrial Area, multi-dimensional interrelationships within the industrial ecology allow for materials exchange, sourcing skilled workers and specialist contractors, and collaboration with government on infrastructure, land-use planning, environmental regulation and other aspects of the precinct (Oughton et al. 2022, p. 1321).

Commercial, community and environmental motivations can also be linked. In the Bega Valley in New South Wales, local business partnerships support circular economy outcomes – such as utilising waste streams,⁹⁰ synergistic agricultural practices such as 'enterprise stacking', and regenerating nature – as well as regional economic development objectives.

Place-based connectivity also has broader benefits such as local jobs creation, social engagement and cohesion, as evident at the Cherbourg Materials Recovery Facility, on Wakka Wakka Country in Queensland. And in establishing place-based circular initiatives, there is opportunity to integrate caring for Country principles and Aboriginal and Torres Strait Islander knowledge systems so that these resource management and regenerative practices can be undertaken (Bega LALC, sub. 185, p. 1; DCCEEW 2024d, p. 29).

Governments' roles in place-based initiatives will vary

Governments may be able to address coordination issues or other barriers to place-based initiatives that businesses or the community identify. However, place-based approaches require a holistic understanding of the context, readiness, strengths and constraints of a community and location.

Successfully developing a circular precinct relies on understanding the context of the place and its people, exploring how it will fit into the broader system, considering existing policy, industry and environmental opportunities and constraints. This ... involves building a connection to people and the land, mapping current needs and conditions and responsively, co-designing precinct scale, vision and objectives with stakeholders. (Circular Australia 2024, p. 7)

Place-based initiatives can emerge from government service delivery or infrastructure. For example, some local, state and territory governments have commissioned or are in the process of commissioning materials

⁹⁰ For example, The Bega Group's dairy factory boiler runs on wood waste and fly ash residue used as a lime replacement on pastures, and extracts milk minerals from whey waste using a new evaporator (Courtney 2024).

recovery facilities as place-based solutions to waste management services.⁹¹ The Queensland Government's *Recycling Enterprise Precinct Location Strategy* provides 'guidance on potential locations for the establishment of a network of Recycling Enterprise Precincts across Queensland' (E3 Advisory 2022, p. 5).

Governments can also enable place-based initiatives by streamlining regulation and expediting approvals, such as environmental approvals and planning and zoning processes. For example, to facilitate innovation the NSW Government has established regional Special Activation Precincts, which have streamlined planning and approval processes (Regional Growth NSW Development Corporation nd). The precincts are intended to support circular economy principles and drive resource-efficient outcomes, while also achieving broader regional development objectives. And integrated planning processes (discussed in chapter 4) can improve environmental and economic outcomes by incorporating place-based considerations alongside governments' decisions about land use, service delivery and infrastructure investment.

Place-based circular opportunities are likely to be found in existing precincts set up with objectives similar to circular economy objectives. For instance, Barangaroo was Australia's first urban precinct to be awarded carbon neutral certification by the Australian Government (Infrastructure NSW 2019), and the precinct has a sustainability commitment to responsibly manage waste, divert waste from landfill and produce zero waste emissions (NSW Government nd). CEMAG's final report recommends that governments support precincts (such as net zero and advanced manufacturing precincts) to adopt circular economy principles into their design and operation (DCCEEW 2024d, p. 74).

All levels of government provide financial support for place-based circular initiatives. For example:

- Australian and state and territory government grants through the Regional and Remote stream of the Recycling Modernisation Fund support recycling infrastructure capacity in regional and remote Australia (DCCEEW nd)
- grant funding from the NSW Government supported the establishment of the National Centre for Circularity (Bega Valley Shire Council, sub. 166, p. 3)
- the Queensland Government and the Cairns Regional Council provided funding for the Cairns Regional Council Materials Recovery Facility (Cairns Regional Council 2022)
- the City of Melbourne funded businesses in the Kensington Circular Economy and North and West Melbourne Circular Economy Precincts to adopt circular solutions, such as reusable milk keg systems and a community-led compost network and repair hub (City of Melbourne nd, nd).

As the unique needs and strengths of each place differ, the PC has no 'one size fits all' recommendation to governments providing financial support for place-based circular initiatives. Governments should weigh up the expected net benefit from their spending on each project, noting that projects may have economic, environmental and social benefits and could take many years to reach success. Government support should be designed in such a way that it can be phased out over time by allowing local circular activities to grow and sustain themselves. Any government programs or measures need to allow for sufficient establishment time, whilst also making it clear upfront that funding will not be continued indefinitely for those projects that do not lead to the anticipated benefits or sustain success. The Victorian Government has identified indicators of community (and government) readiness that help make place-based approaches successful (Victorian Government nd, p. 28).

⁹¹ These include the Cairns Regional Council Materials Recovery Facility, funded by the Queensland Government and the Cairns Regional Council (Cairns Regional Council 2022), the West Nowra precinct set up by Shoalhaven City Council in partnership with the UNSW SMaRT Centre (Local Government NSW 2022), and the Cherbourg Materials Recovery Facility run by the Cherbourg Aboriginal Shire Council.

There may be regions or communities that can benefit more than others from financial support; for example, CEMAG recommended grant funding to support circularity in remote and very remote Australia, including for waste collection, recycling, reprocessing and remanufacturing (DCCEEW 2024d, p. 74). But grants are not necessarily the best model for supporting place-based approaches. One participant noted the difficulties inherent in relying on short-term grant funding to run long-term programs, and suggested a better approach is wrap-around support to build an organisation's capability, or a procurement model:

Instead of always having to rely on grant funding we would prefer a model where government procures our services ... [We are] working with a consultant to develop a cultural land management program and pricing matrix. This will then be presented to the federal government, to show a methodology for pricing and procuring parts of a land management program. (Bega LALC, sub. 185, p. 2)

Governments contemplating support for place-based circular initiatives should consider:

- if a place-based approach would be an appropriate response to local opportunities or challenges
- how current incentives motivate organisations to co-locate without government intervention
- how government intervention could be targeted to address any specific barriers (e.g. coordination) and what is the best delivery model
- whether the place-based initiative is able to sustain itself when government funding ends.



Reform direction 10.4

Government support for place-based circular initiatives

The PC is considering how governments at all levels could consider whether there are opportunities to enable place-based circular initiatives within their jurisdictions. As a first step, governments could consider:

- how existing precincts with related objectives (such as net zero) might integrate greater circularity
- setting up or expanding materials recovery facilities as a basis for place-based circular activities
- whether there are opportunities to reduce regulatory barriers to place-based circular activities (such as expediting approvals or planning processes).



Information request 10.5

Government support for place-based circular initiatives

The PC is interested in further information on the following questions:

- To what extent are existing precincts (such as those set up for net zero, advanced manufacturing, or Special Activation Precincts) already engaged in circular activities? What are some of the ways to encourage further circular activities in these precincts?
- What are the barriers (and possible solutions) to expanding or setting up materials recovery facilities? How might facilities provide a basis for place-based circular opportunities? Are there examples of this?
- What service provision and funding models would best support place-based circular activities, including reuse, repair, waste collection and recycling activities in remote and very remote areas?
- What are the main regulatory barriers that communities or businesses face in establishing place-based circular initiatives?
- What other kinds of government assistance or support do communities or businesses need to enable successful place-based circular precincts (such as coordination or facilitation, as in information request 10.2)?
- What actions could governments take to facilitate Aboriginal and Torres Strait Islander roles in progressing place-based circular initiatives?
- What actions could governments take to value Aboriginal and Torres Strait Islander knowledges, in ways that protect Indigenous cultural and intellectual property, to identify and develop place-based circular opportunities?

Reforming packaging regulation

Packaging is an example of a cross-cutting issue that affects materials productivity and efficiency. Packaging serves several important functions in the economy but can have negative environmental impacts (chapter 5). In Australia, packaging is regulated by a co-regulatory product stewardship scheme between industry and government (chapter 2), as established by the *National Environment Protection (Used Packaging Materials) Measure 2011* (Cth). The scheme creates obligations for brand owners to design more sustainable packaging to increase recycling and reduce litter. Packaging producers are required to either become a signatory to the Australian Packaging Covenant and fulfil the obligations of the covenant (set by industry), or be covered by relevant state or territory packaging regulations.

Inquiry participants stated that the current co-regulatory scheme is inconsistently enforced, resulting in free-riding and reduced business confidence (AFGC, sub. 105, p. 3; MP Consulting 2021, p. 4; Veolia Australia New Zealand, sub. 8, p. 1). The Australian Packaging Covenant Organisation reported that only 20% of plastic packaging was recovered for reuse in 2022, well behind the target of 70% (APCO 2024, pp. 5, 13).

Australian, state and territory Environment Ministers have agreed the need to reform packaging regulation (DCCEE 2022a, p. 2). The Australian Government consulted publicly on three reform options in late 2024: stronger compliance and enforcement of the existing scheme, introducing mandatory standards such as bans on concerning materials and minimum recyclability requirements, or introducing a mandatory product

stewardship scheme with eco-modulated fees. As of February 2025, the government is yet to publicly release its preferred model or underlying analysis.⁹²

Many inquiry participants supported a mandatory product stewardship scheme for packaging (Boomerang Alliance, sub. 2, p. 1; Pact Group, sub. 77, p. 2; TEC, sub. 79, p. 6; Tetra Pak, sub. 41, p. 3; Veolia ANZ, sub. 8, p. 1; WMRR, sub. 168, p. 6). They argued a mandatory scheme would facilitate more equitable cost sharing for collecting, sorting and recovering packaging across industry, and provide additional funding for measures such as improving recycling infrastructure or educating households on waste sorting behaviours.

There is limited public information with which to assess potential benefits and costs of a mandatory stewardship scheme for packaging. While there are international examples of such schemes, most have only operated for a limited time or are yet to commence, making it difficult to assess their effectiveness. For example, the Netherlands' scheme became mandatory in 2022 (Lewis et al. 2023, p. 9), and the United Kingdom made substantial changes to their mandatory scheme in 2024 (UK DEFRA 2024). Mandatory schemes impose added costs on packaging producers, which they may pass on to consumers through higher prices. Monitoring, enforcing and administering a mandatory scheme could also involve higher costs to the government than the current, or a strengthened, co-regulatory scheme. And a mandatory scheme for packaging could create internal inconsistencies with other product stewardship schemes; for example, products with arguably more problematic and hazardous waste than packaging, such as batteries, are currently subject to voluntary stewardship schemes (chapter 9).

Recently introduced or forthcoming measures in adjacent policy areas could also result in greater uptake of sustainable packaging design in the absence of further changes to packaging regulations. For example, mandatory public reporting of scope 3 emissions for large entities from July 2025 (The Treasury 2024c, p. 3), and enhanced scrutiny of environmental claims made by emissions-intensive businesses (ACCC 2023c, p. 25) both provide incentives for packaging producers to minimise emissions and adapt practices to align with consumers' increasing expectations for green packaging (Toluna 2021, p. 2).

The Australian Government is in the process of considering the current set of proposed packaging reforms to select a preferred model. When the packaging system was last reviewed in 2012, the Government undertook cost-benefit analysis as part of a regulatory impact statement (COAG SCEW 2011, p. 35), which included modelling on proposed reforms (PwC and WCS 2011, p. 100). A similarly rigorous evidence base should be required to inform any upcoming changes to packaging regulation. As part of the Policy Impact Analysis process for any mandatory stewardship scheme for packaging, the Australian Government should commission and publicly release a cost-benefit analysis of different options and scenarios.

10.2 Monitoring progress on Australia's circular economy

Measuring Australia's progress towards a circular economy supports 'setting direction, showing progress, identifying opportunities, and demonstrating impact' (Ellen MacArthur Foundation 2024). The indicators used to monitor circular economy development and impact should have policy relevance and utility for users, analytical soundness and measurability (OECD 2024, p. 27); and, aligning with the goals of the newly established Environment Information Australia, allow faster, clearer actions and national decision making.

⁹² The Australian Government is also in the process of reviewing the *Recycling and Waste Reduction Act 2020* (Cth), which will consider the limitations of current approaches to product stewardship (DCCEEW 2024r), and is consulting with industry on a new framework for the classification of packaging materials based on recyclability through kerbside collection (DCCEEW 2024e, p. 4).

Australia's *Measuring What Matters* framework includes circular economy indicators on waste generated and materials used, typically in aggregate and based on weight. *Measuring What Matters* also includes broader environment and sustainability indicators based on the themes of air quality, biological diversity, climate resilience, emissions reduction and protected areas (ABS 2024j). But existing indicators do not specifically reflect the environmental, economic and social outcomes associated with different types of materials use and circular activities (chapter 1).

An expanded set of indicators to monitor Australia's circular economy could have various benefits and use cases. It would enable governments and businesses to identify potential circular opportunities that could lift Australia's materials productivity and have positive environmental, economic or social impacts, and to measure the improvements made. For example:

- Understanding waste and resource recovery by materials type can assist governments at all levels to identify which materials have low recovery rates and assess the feasibility of improving uptake of circular activities to improve recovery and recycling of these materials. This would support national efforts to achieve the targets in *Australia's Circular Economy Framework* on improving resource recovery, reducing material footprint and lifting materials productivity (chapter 1). Moreover, measuring by material types would allow governments to better understand environmental impacts: materials that have low recovery rates (and therefore high disposal after use) are likely to have larger impacts.
- Understanding the sources of waste and how recovery rates vary by sector allows governments to assess which sector-specific interventions to increase circular activities could have the greatest impact. Additionally, it provides context when comparing waste production and recovery in Australia with other countries, as differences in sectoral composition will affect these metrics (chapter 1).
- More specific data on economic outcomes relating to circular activities (especially at the sector level) can support governments' policy decisions around industry and regional development, and the contribution that opportunities to develop the circular economy could make to economic and productivity growth. This could be particularly important for industries and regions that are in transition, such as high-emitting industries as part of the net zero transition.
- While businesses would be unable to use whole-of-economy or even whole-of-sector data to monitor the effects of their own circular activities, they would be able to use economy or sector-wide data as a benchmark for understanding their own operations and potential areas for improvement. For instance, a business could compare their resource recovery rates by materials type with rates for their sector as a whole, to identify where they are performing well or falling behind.

Participants in this inquiry supported an expanded set of indicators to reflect different motivations such as 'social and economic development, job creation, environmental protection and operational and cost efficiency gains for councils' (ALGA, sub. 21, p. 6). They also observed that consistent methodologies and indicators could assist in measuring progress both nationally and for individual jurisdictions, government agencies and organisations (ACT NoWaste, sub. 16, p. 3; Shelley, sub. 72, p. 3). CEMAG's final report noted that a common approach for data collection would assist regions transitioning to a circular economy (DCCEEW 2024d, p. 74). The absence of a set of appropriate indicators to measure progress could act as a barrier at a system level, holding Australia back from circular economy opportunities.

Internationally, circular economy monitoring frameworks are better developed and include a larger suite of indicators than Australia's current framework. The OECD has proposed about 100 indicators for measuring circular economy progress, noting that individual countries can adapt the set of indicators to suit their own needs and data availability (box 10.3). The EU's circular economy monitoring framework has 27 indicators, capturing waste by type (e.g. food, plastic packaging) and economic outcomes (e.g. investment, employment, gross value as they relate to circular economy) (EU nd). Australia's existing narrower set of

indicators in *Measuring What Matters* is broadly aligned with materials and waste indicators included in the OECD and EU frameworks.

Box 10.3 – Circular economy indicators proposed by the OECD

In *Monitoring Progress towards a Resource-Efficient and Circular Economy*, the OECD proposes a set of about 100 indicators spanning themes such as materials and waste, natural resource and environmental quality impacts, government responses to encourage circularity, and socio-economic outcomes and opportunities. Indicators are categorised as either core, complementary or contextual.

The proposed core indicators aim to capture key elements of a CE [circular economy], respond to main CE policy questions and point to developments or changes that may require further analysis and possible action. Complementary indicators accompany the message conveyed by 'core' indicators, provide additional detail, or cover additional aspects.

Contextual indicators provide background information on socio-economic and environmental variables and facilitate interpretation in the appropriate country context (OECD 2024, p. 10).

The OECD suggests that the size of the indicator set should remain manageable, with no more than 20–25 core indicators to facilitate monitoring of major trends. Indicators can be applied to different levels, sectors and geographies. The report acknowledges that measurement issues and data gaps exist for several proposed indicators, and have placeholders where indicators are yet to be identified and defined.

The OECD advocates for a coordinated research agenda and 'a pragmatic, step-wise approach to improving measurement in countries accompanied with statistical guidance and a regular exchange of good practices' (OECD 2024, p. 10). To fill data gaps, it suggests opportunities be explored through:

- strengthening the use and usefulness of official statistics and data sources from international organisations and national administrations
- exploiting alternative and novel data sources that go beyond official statistics, such as data from the private sector and trade associations
- making use of innovative data sourcing techniques and data collection tools (OECD 2024, p. 10).

The PC is exploring a reform direction on expanding the set of indicators used to monitor progress on Australia's circular economy. The environmental and economic outcomes captured in the proposed set are based on indicators in the more developed international monitoring frameworks, described above, which are both commonly used in other countries and relevant to the Australian context. The level of granularity suggested for some of the indicators (by material type and/or sector) is based on the intended use cases for Australian governments and businesses, discussed above. Outcomes would need to be tracked at this level of granularity for the data to be used to identify and track progress on circular opportunities. The proposed indicators include:

- Indicators relating to environmental outcomes from circular activities:
 - Waste generated by material type and sector (already partly reported elsewhere)
 - Recovery rates by material type and sector (already partly reported elsewhere)
 - Greenhouse gas emissions from production activities by sector (already reported elsewhere)

- Indicators relating to economic outcomes from circular activities:
 - Gross value added of circular economy activities by sector
 - Jobs in circular economy activities by sector
 - Business investment in circular economy activities by sector
 - Research and development expenditure on circular economy technologies by sector.

The benefits of collecting and reporting data on additional indicators needs to be balanced against the costs of this data collection. Data on some indicators is already collected and reported elsewhere, and could therefore be added to a suite of indicators for monitoring Australia’s circular economy at relatively low cost. For example, waste and recovery rates by material type for some waste source streams are currently published in the National Waste Report.⁹³ And greenhouse gas emissions from businesses’ production activities by sector are already reported in Australia’s National Greenhouse Accounts (DCCEEW 2022c).

But other indicators would require bespoke data collection and methodologies, and these would entail higher costs. For example, the gross value added of circular economy activities is not easily determined by current input–output table classifications and may require developing an estimation methodology based on existing data structures.⁹⁴ As part of this, in-scope circular economy activities would need to be defined, and could include not only recycling and waste recovery, but also activities earlier in the product life cycle such as reuse and repair. The costs associated with attributing outcomes to circular economy activities, and disaggregating data by sector, are likely to be large. Such costs could limit the feasibility of incorporating these indicators to an expanded circular economy monitoring framework in Australia.

The PC is also considering how an expanded set of indicators could be operationalised to support CEMAG’s call for clear metrics to drive and track progress (DCCEEW 2024v, p. 26). This includes features such as:

- reporting format. Adding to the existing *Measuring What Matters* publication would have lower reporting costs but could unduly skew the broader framework towards circular economy indicators. As an alternative, creating a dedicated circular economy monitoring publication or dashboard would have higher costs, but could have additional benefits in increasing awareness of the circular economy
- periodic reviews. Over time, better data may become available due to technological advances, or what needs to be measured to inform government and business decisions may change. Periodic updates of the indicator set, including to reflect international developments in measurement, would support its continued relevance and use in monitoring Australia’s circular economy.

⁹³ The National Waste Report is published every two years (DCCEEW 2025b). Material types reported for waste and recovery rates are ash, building and demolition materials, glass, hazardous wastes, metals, organics, paper and cardboard, plastics and textiles. The waste source streams captured in the report are municipal solid waste, commercial and industrial waste, and construction and demolition waste. Some sources of waste are not captured, such as most mining and agricultural wastes that are not managed by the waste and resource recovery sector.

⁹⁴ The ABS is considering updates to the System of National Accounts, which will potentially include some environmental impacts on the economy, such as how the depletion of natural resources can be captured (ABS 2024h). However, this is unlikely to address the specific indicators suggested for monitoring economic outcomes from circular activities.



Reform direction 10.5

Expanding the set of circular economy indicators

The PC is considering a reform direction that proposes an expanded set of indicators to monitor Australia's circular economy progress. The outcomes captured in the proposed set are based on indicators used in more developed international monitoring frameworks. Outcomes would need to be tracked at reasonably granular level for the data to be used by governments and businesses to identify and track progress on circular opportunities. The proposed indicators include:

- Indicators relating to environmental outcomes from circular activities:
 - Waste generated by material type and sector
 - Recovery rates by material type and sector
 - Greenhouse gas emissions from production activities by sector
- Indicators relating to economic outcomes from circular activities:
 - Gross value added of circular economy activities by sector
 - Jobs in circular economy activities by sector
 - Business investment in circular economy activities by sector
 - Research and development expenditure on circular economy technologies by sector.

Data on some indicators is already being collected and reported elsewhere. The PC notes that the feasibility of monitoring some of these indicators could be limited by the potentially large costs associated with attributing outcomes to circular economy activities, and disaggregating data by sector.



Information request 10.6

Expanding the set of circular economy indicators

The PC is interested in further information on the following questions:

- What are specific examples of how governments (at all levels) and businesses would use the proposed circular economy indicators to identify and track progress of circular opportunities?
- What would be the costs associated with gathering data on the proposed circular economy indicators?
- Which agencies would collect or estimate the data?
- How consistent across states and territories is the data needed for circular economy indicators? Does it allow comparison across industries or sectors?
- Are there alternative indicators that would better measure the progress of Australia's circular economy? What would be the benefits and costs associated with these alternatives?
- What reporting format would be most valuable and accessible to stakeholders using the monitoring data (e.g. including in the *Measuring What Matters* framework, or a separate dedicated dashboard)?
- Over what timeframe could the proposed expanded set of indicators be rolled out? How frequently should the set of indicators be reviewed and updated, so that they can remain fit for purpose to inform government and business decisions about the circular economy?

A. Public consultation

This appendix outlines the consultation process and lists the organisations and individuals who participated in the inquiry. The PC received the terms of reference for this inquiry on 23 August 2024. A call for submissions was released on 16 September 2024 inviting public submissions and brief comments. In total, 183 submissions (table A.1) and 22 brief comments were received. The submissions and brief comments are available at: pc.gov.au/inquiries/current/circular-economy. The PC consulted with 110 individual organisations (table A.2). The PC would like to thank everyone who participated in this inquiry.

Table A.1 – Submissions

Participants	Sub no.
ACT NoWaste	16
Apple	124
Aquaculture Council of Western Australia (ACWA)	65
Arup	52
Association for the Battery Recycling Industry (ABRI)	27
Association of Mining and Exploration Companies (AMEC)	143
AusKelp	163
Australasian Procurement and Construction Council (APCC)	74
Australasian Railway Association	97
Australia New Zealand Biochar Industry Group (ANZBIG)	173
Australian Academy of Science and ARC Centre of Excellence in Synthetic Biology	144
Australian Academy of Technological Sciences and Engineering (ATSE)	110
Australian Aluminium Council (AAC)	86
Australian and New Zealand Recycling Platform Ltd (ANZRP)	176
Australian Automotive Dealer Association (AADA)	91
Australian Beverages Council Ltd (ABCL)	174
Australian Chamber of Commerce and Industry (ACCI)	76
Australian Chicken Meat Federation (ACMF)	111
Australian Communications Consumer Action Network (ACCAN)	146
Australian Competition and Consumer Commission (ACCC)	178
Australian Council of Recycling (ACOR)	75
Australian Food and Grocery Council (AFGC)	105
Australian Gas Infrastructure Group (AGIG)	152
Australian Industry Group (Ai Group)	160
Australian Institute of Architects	117
Australian Library of Things Network	59
Australian Local Government Association (ALGA)	21
Australian Mobile Telecommunications Association (AMTA)	155

Participants	Sub no.
Australian Packaging Covenant Organisation (APCO)	157
Australian Pipelines and Gas Association (APGA)	49
Australian Pork Ltd	69
Australian Retailers Association (ARA)	165
Australian Science Communicators (ASC)	43
Australian Water Association (AWA)	23
Battery Stewardship Council (BSC)	140
Baxter Healthcare	64
Bega Local Aboriginal Land Council (Bega LALC)	185
Bega Valley Shire Council	166
Blueprint Institute	70
Boomerang Alliance	2
Business Chamber Queensland	136
Business Council for Sustainable Development Australia (BCSDA)	175
Business Council of Australia (BCA)	99
Cement Concrete & Aggregates Australia (CCAA)	55
Cement Industry Federation (CIF)	78
Centre for Smart Modern Construction	3
Centre of Decommissioning Australia (CODA)	46
Charitable Reuse Australia	18
Chartered Accountants Australia and New Zealand	129
Chartered Institute of Procurement and Supply (CIPS) Australia & New Zealand Pty Ltd	161
Christopher Wilson	102
Circular Australia	126
Circular Design Thinking	101
Circular Economy Asia Inc	158
Circular Economy Huon (CEH)	98
Circular Economy Villages Co-operative Ltd (CEVCO)	35
Circular PV Alliance (CPVA)	62
Circular Textile Working Group WA (CTWG)	22
City of Adelaide	107
Civil Contractors Federation (CCF)	42
Cleanaway	112
Closed Loop Environmental Solutions	137
Coca-Cola Europacific Partners Australia (CCEP)	170
COMFORTiD	177
Community Industry Group	93
Consumer Healthcare Products Australia (CHP)	122
Consumer Policy Research Centre (CPRC)	141
Container Exchange (QLD) Ltd	83
Coreo	104
CropLife Australia	95
CSIRO	57

Participants	Sub no.
DeCarbonate Energy	179
Department of Health and Aged Care (DOHAC)	182
Dr. Deepika Mathur	10
Dr. Guy Keulemans, Creative People, Products and Places Research Centre, University of South Australia	48
Dr. Paul Chad	19
Dubbo Regional Council	68
eBay Australia and New Zealand	151
Edward Khoury	13
Elan Energy Matrix	116
Ena Vejnovic, Professor Sharon Purchase, Dr Daniel Schepis and Dr Liudmila Tarabashkina	24
Engineers Australia	108
Federal Chamber of Automotive Industries (FCAI)	85
Gippsland Climate Change Network, Gippsland Circular Futures Initiative (GCCN)	11
Global Product Stewardship Council (GlobalPSC)	149
GoGet Carshare	38
Good Natured ESG	58
Good Sammy	25
Good360 Australia and Thread Together	96
Greater Whitsunday Alliance (GW3)	109
Green Industries South Australia (GISA)	181
GS1 Australia	114
Helen Millicer	82
Hume City Council	20
Hunter Joint Organisation	172
IKEA Australia	47
Infrastructure Victoria	28
Institute of Public Accountants (IPA)	131
International Council for Local Environmental Initiatives (ICLEI)	45
Jack B. Hetherington	9
Jack Davenport	127
Jemena	106
Kylea Tink MP	142
Lithium Australia	17
Local Government Association of the Northern Territory (LGANT)	132
Local Government Procurement (LGP)	67
Logan City Council	61
Lumicare Pty Ltd	66
MALVA Sustainable Tasmania & B-alternative	37
MCi Carbon Pty Ltd	119
Meriel Chamberlin	73
Michelle D. Smith	14
Monash University	138
Ms. Kathryn Mamone, Eden Marine High School	128

Participants	Sub no.
Northern Sydney Regional Organisation of Councils (NSROC)	154
Now + Future	123
NSW Government	139
NSW Health	183
NSW Small Business Commission	54
Orora Limited	184
OzHarvest	81
Pact Group	77
Penelope Turnbull	5
Peter Mulherin	121
Planet Ark	147
Polar Enviro	29
Product Stewardship Centre of Excellence	159
Prof. Leanne Wiseman	40
Queensland Water Directorate (qldWater)	51
Reconnect Project	134
Recovery Tasmania Pty Ltd	90
Recycling Technologies Group Pty Ltd (RTG)	164
Regional Australia Institute (RAI)	100
ReLoop	80
Renewable Gas Alliance (RGA)	50
Requis Australia Pty Ltd and Requis Inc (US)	15
ResiLoop Ltd	84
Resource Work Cooperative	30
Reverse Garbage	113
RMIT University Circular Economy Hub	31
Robert Gell	60
Ryan Mischkulnig	12
Salvation Army	53
SEATA Group	145
Sims Metal	171
Sircel Limited	153
Southern Sydney Regional Organisation of Councils (SSROC)	26
Sustainability Research Institute	125
Sustainable Aviation Fuel Alliance of Australia and New Zealand (SAFAANZ) and Cleaner Fuels Alliance (CFA)	115
Sustainable Electronics Recycling International (SERI)	92
Sustainable Infrastructure and Resource Management, University of South Australia (SIRM)	1
Swedish Australian Chamber of Commerce Sustainability Committee	94
Tasmanian Government	180
Taylor Granville	156
TCO Certified/TCO Development	63
Tetra Pak	41

Participants	Sub no.
TOMRA	118
Total Environment Centre (TEC)	79
Toy Libraries Australia	130
Toyota Motor Corporation Australia	33
Tyre Stewardship Australia (TSA)	148
University of Melbourne	36
University of Technology Sydney Institute for Sustainable Futures	120
UNSW SMaRT Centre	4
Urban Utilities	71
Veolia Australia and New Zealand	8
Victorian Bioenergy Network	39
Vinyl Council of Australia Pty Ltd	32
WA Solar Recycling	34
Wannon Water	88
Waste and Resources Action Programme (WRAP)	56
Waste Management and Resource Recovery Association of Australia (WMRR)	168
Water and Catchments Group, Victorian Department of Energy, Environment and Climate Action	72
Water Services Association of Australia (WSAA)	150
West Australian Local Government Association (WALGA)	167
Western Australia Return Recycle Renew Limited (WARRRL)	87
Woolworths Group	162
WorkbenchX	133
WorkVentures	89
WWF Australia (WWF)	44
XFrame Ltd	6
Xseed	7
Zero Waste Victoria	169

Table A.2 – Consultations

Participant
ACT NoWaste
Altogether Group
AusKelp
Australian Bedding Stewardship Council
Australian Capital Territory Directorate of the Chief Minister, Treasury and Economic Development
Australian Capital Territory Environmental Protection Authority (ACT EPA)
Australian Competition and Consumer Commission (ACCC)
Australian Government Department of the Treasury
Australian Industry Group (Ai Group)
Australian Local Government Association (ALGA)
Australian Packaging Covenant Organisation (APCO)

Participant

Australian Retailers Association (ARA)
Australian Sustainable Finance Institute (ASFI)
Battery Stewardship Council (BSC)
Bega Chamber of Commerce
Bega Community Workshop
Bega Group
Bega Regional Circularity Co-operative
Bega Repair Cafe
Bega Valley Data Collective
Bega Valley Eggs
Bega Valley Shire Council
Bega Village
BINGO Industries
BlockTexx
Bower Reuse and Repair Centre
Broadwater Oysters
Calibre Group
Centre for Regenerative Design & Collaboration (CRDC) Resin8
Cherbourg Aboriginal Shire Council
Cherbourg Material Recovery Facility
Clean Energy Regulator (CER)
Consumer Policy Research Centre (CPRC)
Cooperative Research Centre for Transformations in Mining Economies (CRC TiME)
Coreo
CSIRO
Department of Climate Change, Energy, the Environment and Water (DCCEEW)
Environment Protection Authority Victoria (EPA Victoria)
Essential Energy
Food Recycle
Forestry Corporation of NSW
Frogs Hollow Brewing
Green Industries South Australia (GISA)
Grow the Future Bega
Housing Industry Association (HIA)
Hydro Tasmania
Infrastructure Australia
Infrastructure Western Australia
Jodie Bricout
Kwinana Industries Council
Leser Build
Lisa McLean
Local Government Association of the Northern Territory (LGANT)
Loop Upcycling

Participant

Minerals Council of Australia (MCA)

Mint Innovation

Modscape

Ms. Kathryn Mamone, Eden Marine High School

New South Wales Department of Climate Change, Energy, the Environment and Water

New South Wales Department of Planning, Industry and Environment

New South Wales Environment Protection Authority (NSW EPA)

Northern Territory Department of Lands, Planning and Environment

Northern Territory Department of the Chief Minister and Cabinet

Northern Territory Department of Trade, Business and Asian Relations

Nous Group

Ocean2Earth

Officeworks

Pact Group

Pentarch Group

Product Stewardship Centre of Excellence

Prof. John Thwaites

Prof. Ralph Horne

Queensland Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development

Queensland Department of the Environment, Tourism, Science and Innovation

Recycling Technologies Group Pty Ltd (RTG)

Recycling Victoria

Regional Development Australia – Southern NSW and ACT

Renewable Cobargo

ResiLoop Ltd

Responsible Investment Association Australasia (RIAA)

Reverse Garbage

Richgro

Rino Recycling

Sapphire Community Pantry

Seamless

South Australian Department for Energy and Mining

South Australian Department for Infrastructure and Transport

South Australian Department for State Development

South Australian Department of Primary Industries and Regions

South Australian Department of the Premier and Cabinet

South Australian Department of Treasury and Finance

South Australian Environment Protection Authority (EPA SA)

South Coast Fish

Standards Australia

Sustainability Victoria

Tasmanian Department of Natural Resources and Environment

Tasmanian Department of Premier and Cabinet

Participant

Tasmanian Department of State Growth

TasWater

Toyota Motor Corporation Australia

Tyre Stewardship Australia (TSA)

United Nations Global Compact Network Australia

University of Technology Sydney Institute for Sustainable Futures

Victorian Department of Energy, Environment and Climate Action (VIC DEECA)

Victorian Infrastructure Delivery Authority

Waste Management and Resource Recovery Association of Australia (WMRR)

Western Australian Department of Finance

Western Australian Department of Jobs, Tourism, Science and Innovation

Western Australian Department of Transport

Western Australian Department of Water and Environmental Regulation

Abbreviations

ABCB	Australian Building Codes Board
ABS	Australian Bureau of Statistics
ABSC	Australian Bedding Stewardship Council
ACCU	Australian Carbon Credit Unit
APCO	Australian Packaging Covenant Organisation
ASFI	Australian Sustainable Finance Institute
C&D	Construction and demolition
CEMAG	Circular Economy Ministerial Advisory Group
CSA	Clothing Stewardship Australia
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Australian Government Department of Climate Change, Energy, the Environment and Water
EMM	Environment Ministers' Meeting
EPA	Environment Protection Authority
EPR	Extended Producer Responsibility
ESG	Environmental, social and governance
EV	Electric vehicle
FOGO	Food organics and garden organics
GDP	Gross domestic product
GEMS	Greenhouse and Energy Minimum Standards
GVA	Gross value added
HEPA	Heads of EPA Australia and New Zealand
IEC	International Electrotechnical Commission
LFP	Lithium iron phosphate
MRIWA	Minerals Research Institute of Western Australia
Mt	Megatonne
MVIS	Motor Vehicle Service and Repair Information Sharing Scheme
NAIF	Northern Australia Infrastructure Facility
NCC	National Construction Code
NGER	National Greenhouse and Energy Reporting
NMC	Nickel manganese cobalt
NTCRS	National Television and Computer Recycling Scheme

OECD	Organisation for Economic Co-operation and Development
OTR	Off-the-road
PC	Productivity Commission
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
PMLU	Post-mining land use
PV	Photovoltaic
SMC	Safeguard Mechanism Credit
SMI	Sustainable Minerals Institute
TSF	Tailings storage facility
UNEP	United Nations Environment Programme
UNITAR	United Nations Institute for Training and Research
WEEE	Waste electrical and electronic equipment

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