10 April 2025

A/Prof Joanne Chong and Dr Alison Roberts
Commissioners
Opportunities in the Circular Economy Productivity Commission
E: circular.economy@pc.gov.au

To: Productivity Commission, Australian Government

Dear Commissioners Chong and Roberts,

Re: Inquiry on Circular Economy Opportunities

The Productivity Commission's Inquiry is very timely and offers opportunities to discuss the issues beyond the historically limited view of circular economy as mainly waste management. The Interim report provides a solid basis to progress Australia's research, policy and enabling tools to world-level standards and beyond. **This submission makes the case for public digital infrastructure to empower Australia's circular economy.**

In December 2024, the Western Australia Circular Observatory—a research consortium led by Curtin University, the University of Western Australia and the Open Corridor Foundation—conducted the first comprehensive assessment of the circularity of the Western Australian economy examining material flows, waste outflows, greenhouse gas emissions flows and the built stock at the State, Greater Perth, and local government-level.

The report (see attachments for the Main and Summary Reports) provides critical insights into the state of circularity, and highlights the need for improved understanding and monitoring of circularity—including deploying a science-based circular observatory, as well as the availability public digital goods for governments, businesses and communities to identify and track progress on circular opportunities. A major finding of the report is that the challenges of the WA economy also offer vast opportunities for improvement. Below are some key messages from this report as they relate to the work of the Productivity Commission and embracing the circular economy in Australia.

Towards a science-based circular observatory

Addressing Information Request 10.6 Expanding the set of circular economy indicators, and 10.2 Supporting coordination, facilitation or brokering services

Having access to timely, relevant and evidence-based information is essential in building the multi-sector capacity required to effectively navigate the transition to a circular economy. However, during ongoing research and consultation with governments, businesses, and communities across Australia, we have identified several recurring challenges that state and non-state actors face in this transition:

1. Data fragmentation and lack of interoperability across systems, actors and scales;
2. Misalignment in objectives, with information gaps in policy, science and culture; and
3. Lack of data-driven tools, limiting the capacity for evidence-based action in line with circular outcomes.

To address these challenges, the Western Australia Circular Observatory (WACO) proposed WATCH (Western Australian Tool for Circular Horizons), a science-based circular observatory offering governments, industries and communities critical insight to support circular planning, monitor and report on enhanced material flows, and promote data-driven decision-making (Hopkins et al., 2024). By providing a comprehensive view of circularity at multiple geographical scales, this digital public good aims to enhance cross-sector collaboration and strengthen WA's capacity for interdisciplinary research and effective circular applications.

We emphasise the potential impact of Digital Public Goods (United Nations, 2021) in the context of enabling tools and technologies for circular economies and urge governments to prioritise the development and maintenance of solutions that adopt open-source-first principles (Augspurger et al., 2022). Open source software, open data, and open artificial intelligence models provide not only essential transparency and traceability but also promote circular strategies, such as reusability and product lifetime extension, presenting new opportunities to accelerate digital and circular transformation. The Open Source Software Guideline, published by the Queensland Government (Queensland, 2022), highlights the expected benefits of using and developing open-source software within the government and provides information for agencies considering adopting a similar approach. Industry and open-source community leaders have also published recommendations for stakeholders developing and supporting open-source for environmental sustainability (The Linux Foundation., 2023).

Given these distinct design choices, enabling tools and technologies, such as WATCH can be adapted to other regions and jurisdictions, integrating local information and knowledge while ensuring alignment with national priorities. We encourage governments to consider the impact of this approach—and Digital Public Goods more broadly—when adopting or developing solutions for circular economy monitoring.

Adopt a consistent system-wide circular monitoring framework

Addressing Information Request 10.6 — Expanding the set of circular economy indicators

A consistent systemic monitoring framework is critical to inform progress and enable data-driven decision-making. However, efforts to validate indicators for assessing the biophysical basis of a circular economy are fragmented across different scales: micro (individuals, products, companies), meso (value chains and sectors), and macro (administrative-political boundaries at city, regional, or national scales). As recent circular economy efforts have focused on specific products, industries or value chains, they often lack coherence across scales, making it difficult to interpret the data systematically or generate comprehensive, systems-level insights. This fragmentation is detrimental to effectively evaluating the contributions of each scale (mico, meso, or maco) to the overarching goal of a circular economy.

The WACO report has outlined several essential requirements for building a system-wide circular monitoring framework from an extensive literature review (see section 1.4. Circular economy monitoring: a system-wide perspective, Hopkins et al., 2024). We proposed a consistent multi-level and multi-actor framework, allowing it to be applied cumulatively across different scales—from products to industries, to cities and regions, to nations and the global level. For example, data from individual Australian States and Territories can be reliably aggregated to reflect the total state of circularity in Australia. Based on an extended economy-wide Material Flow Analysis (ew-MFA), this framework is critical for informing policymaking, setting targets across various administrative-political and organisational levels, and monitoring progress over time. Furthermore, a nested approach enables actors to consistently assess their contributions and evaluate potential responses towards a sustainable circular economy as the indicators are coherent across levels.

As it stands, the WATCH indicator framework consists of 62 circular economy indicators, including many of those proposed under “Expanding the set of circular economy indicators” (Reform direction 10.5). See Table 1.

Table 1: Expanding the set of circular economy indicators cross reference

Proposed under Reform Direction 10.5	**Supported in WATCH**
Indicators relating to environmental outcomes from circular activities	
Waste generated by material type and sector	Yes
Recovery rates by material type and sector	Yes
Greenhouse gas emissions from production activities by sector	Yes
Indicators relating to economic outcomes from circular activities	
Gross value added of circular economy activities by sector	Yes (initial estimates)

Jobs in circular economy activities by sector	Yes (initial estimates)
Business investment in circular economy activities by sector	Planned, given data availabilities
Research and development expenditure on circular economy technologies by sector	Planned, given data availabilities

Our research demonstrates the feasibility of implementing a comprehensive and consistent circular economy indicator framework at multiple scales, offering a robust foundation for further advancements within WA and beyond.

Moving forward, we recommend that the Commission consider circular economy indicators frameworks in the context of multi-level and multi-actor applications, with identifiable links to real-world use cases. In particular, consideration should be given to indicators that allow for an in-depth analysis of the main strategies for a circular economy. As recommended by the OECD (2024), the selection of indicators should consider relevance, analytical soundness and measurability, following a taxonomy based on "core-", "complementary-" and "contextual indicators", with a number that remains manageable and facilitates analysis. Last but not least, we encourage the commission to explore the social dimension of a circular economy when expanding measurement approaches. So far, the lack of metrics and indicators to measure the social outcomes of circular activities has been little explored both in the literature and practice.

Enable circular value chains through data-driven approaches

Addressing Information Request 10.3 — Supporting greater adoption and diffusion of circular innovations

Digitisation enhances value chain visibility and coordination, allowing actors to track and trace the flow of materials and goods, understand their movement from point to point, and measure and report on their impact. For instance, product passports linked to QR codes and RFID systems allow companies and consumers to track a product throughout its lifespan, improving transparency for a wide range of resources – from consumables to construction materials (Vahidi et al., 2024). These tools can provide information on the state of a product at any given point in its life cycle, such as when a plastic container arrives at a recycling facility, or information about a building component currently in use. More detailed traceability can be achieved by generating a "digital twin" of a product, including information about its material composition, disassembly instructions, and labour practices. To create circular and efficient supply chains, such visibility is essential. Open standards such as the circularity.ID are pointing in the right direction. However, there is a lack of digital infrastructure optimised for modern circular economy use cases. The convergence of accounting frameworks and resource exchange protocols, such as the System of Environmental-Economic Accounting (SEEA), Resource-Event-Agent (REA), and other industrial ecology approaches (e.g., life cycle assessment), together with distributed

messaging protocols, show promise in linking actors and resources in a privacy-preserving and secure manner (Roio et al., 2021).

We encourage the adoption of open standards and technologies to enable the level of interoperability and traceability necessary to ensure value chains are efficient, ethical and sustainable, in line with circular economy principles. At the same time, value chain actors require proof for such circular claims with minimal compliance and reporting burden. Governments play a key role in promoting market intelligence and protecting consumers through innovative technologies, policy instruments, standards and protocols. The success of Open Banking and Consumer Data Rights (CDR) legislation provides some insight into the role of government in facilitating innovation through the lens of openness and collaboration.

Inform circular life cycle planning in the built environment

Addressing Information Request 4.4 —Other circular economy opportunities in the built environment

In Australia's built environment, there is an urgent need for more rigorous, integrated planning and material assessment across the infrastructure life cycle. Too often, major construction projects proceed without adequately quantifying the embedded material stocks or considering end-of-life outcomes—leading to avoidable waste, inefficient use of high-value materials, and missed circular economy opportunities. WACO research has identified that integrated tools—such as life cycle assessment (LCA), digital twins, GIS, and BIM—can be deployed to better forecast material needs, inform low-carbon material selection, and optimise for reuse and disassembly. These tools can help identify high-demand or scarce materials early in the planning process, facilitating their recovery through urban mining and "building-as-material-bank" (BAMB) strategies. Two policy-relevant opportunities emerge. First, improving infrastructure assessment methods by embedding material traceability into the early stages of project development would allow governments to reduce materials use and waste. Second, a more consistent focus on integrating recycled materials across public projects could extend asset lifespan and lower whole-of-life costs. However, its uptake remains limited due to regulatory inertia, procurement models that disincentivise long-term value recovery, and a lack of national guidelines that reward modularity and recoverability.

To address these shortcomings, our research proposes that embedding integrated life cycle assessment and material sourcing in infrastructure planning would enable smarter material procurement, improve resilience to supply chain disruptions and support secondary material markets (see recommendation 4.6, Hopkins et al., 2024). These improvements require policy support to overcome current institutional silos, fragmented data governance, and the absence of mandatory requirements for circular design principles in procurement frameworks.

Demonstrating design for disassembly through an Australian case study to incentivise policy support

Addressing Information Request 4.4 — Additional information on designing for disassembly in the built environment, and *10.3 — Supporting greater adoption and diffusion of circular innovations*

Design for disassembly (DfD) has significant potential to reduce construction waste and material demand across infrastructure projects in Australia. Yet, without targeted government action, its uptake is expected to remain low and fragmented—limited to small-scale or one-off developments. Further, public infrastructure planning and procurement rarely consider end-of-life material recovery or design reversibility, leading to avoidable waste and higher embodied carbon. Field-tested prefabricated buildings such as the Legacy Living Lab (L3) (Minunno et al., 2020a) show that DfD can drastically cut emissions and support material reuse—yet these technologies remain niche (O'Grady et al., 2021). Key barriers to their adoption include the absence of performance standards, lack of secondary markets for reused components, and procurement models that undervalue life cycle benefits. Financing models also remain narrowly focused on upfront capital costs, with little recognition of long-term savings from avoided demolition, landfill, and material input. To enable growth in DfD, governments could embed disassemblability into construction assessment processes, adopt circularity metrics in procurement, and support demonstration projects. Adjusting financing frameworks to reward life cycle resource efficiency would further accelerate uptake. Without these shifts, disassemblable construction will remain underleveraged, and the economic and environmental potential of circular infrastructure unrealised. Also, problematically there is currently no national framework that embeds disassembly or material recovery considerations into public infrastructure planning or procurement. Research and field trials suggest that incorporating DfD principles—such as accessible connections, modular components, and non-destructive assembly—can drastically reduce end-of-life waste and enable reuse at scale. The WA-based L3 prototype applies these principles, leading to an 88% reduction in life cycle emissions compared to a conventional build, with less than 1% of materials lost in relocation (Minunno et al. 2020b). However, these outcomes remain rare due to market and regulatory barriers.

The key constraints preventing wider adoption of DfD include:

- Public procurement processes that do not assess or value material recoverability.
- Financing models prioritise low upfront costs, overlooking long-term savings from material recovery, reuse, and avoided end-of-life costs.
- A lack of recognised metrics or standards to evaluate disassemblability.
- Limited secondary markets for reusable structural and non-structural components.
- Perceived cost and design complexity, especially in the absence of volume demand.

To support the expected growth of DfD across building typologies—particularly in transport, civic and institutional infrastructure—governments could:

- Integrate DfD criteria into infrastructure assessment frameworks.
- Mandate circularity performance indicators in public procurement.

- Align financing frameworks with whole-of-life value by incentivising designs that reduce demolition, landfill, and virgin material costs.
- Fund the development guidelines for modular and disassemblable design.

Importantly, however, disassembly-ready construction will remain underutilised if disassembled building components are not discoverable through secondary marketplaces when their original building is disassembled. Digital technologies such as product traceability protocols, the Internet of Things (IoT), and satellite-aided geographical positioning systems should be implemented in disassemblable buildings to foster component reusability (see recommendation 4.6; Hopkins et al., 2024).

Implement a government-wide circular procurement framework

Addressing Information Request 4.2. Coordination mechanisms to enhance the benefits of sustainable procurement policies

Government-led coordination across jurisdictions offers significant potential to enhance the impact of sustainable procurement. Government can play a catalytic role by leveraging its purchasing power to stimulate demand for recycled and circular products, particularly through coordinated specifications and standards across agencies and local governments. By embedding recycled content clauses in public procurement, governments can accelerate market development, lower risk for suppliers, and indirectly spur innovation across construction and materials sectors. To maximise net benefits to the community, further coordination between suppliers, contractors, and procurement agencies should be institutionalised. This includes harmonising circular procurement frameworks across jurisdictions, aligned with the 2024 *Sustainable Procurement Guide* from DCCEEW (DCCEEW, 2023), and informed by life cycle-based methodologies that measure environmental impact per dollar spent across procurement categories. Such coordination can reduce compliance complexity for suppliers—especially SMEs and recycled material providers—by streamlining expectations, reporting formats, and assessment criteria. We suggest governments consider leveraging digital infrastructure and integrated assessment framework, such as that provided through WATCH, to accelerate efforts towards adopting science-based circular procurement benchmarking tools. In the short term, this could assist procurement officers in identifying high-impact material supply chains where recycled content uptake would yield the greatest environmental benefit. In the long term, coordination mechanisms could include product disclosure statements (PDS) which connect supplier- and product-level circularity performance, thereby creating a consistent and transparent basis for supplier engagement and contract evaluation (see Enable circular value chains through data-driven approaches).

Apply an “open source first” funding criterion for circular research and development

Addressing Information Request 10.3 — Supporting greater adoption and diffusion of circular innovations

Our findings show that open source can have a significant impact on sustainable choices and technology diffusion (Augspurger et al., 2023). However, when it comes to financing enabling technologies and circular economy-related research projects, open source is often not a decisive investment criterion. A fundamental rethink needs to take place here. In particular, the investment of public funds can help to reverse this trend and ensure that such investments directly benefit the general public in the long term. A policy that prioritises open source within research and development is crucial to ensuring publicly funded outputs, such as critical digital infrastructure for circular economies, do not end up constrained by intellectual property, but rather returned to the commons as public goods. Not doing this will indicate government failure as the market will not be in a position to deliver such public goods.

Drive economic benefits through digital innovation and circular strategies

Addressing Information Request 10.3 — Supporting greater adoption and diffusion of circular innovations

Governments at all levels can play a central role in building capacity for a circular economy by prioritising open source technologies when developing internal systems, within the procurement process, and when funding research and development where software and hardware are outputs. There are many direct and indirect benefits of taking this approach, which are highlighted throughout this submission. Importantly, building interdisciplinary and transdisciplinary capacity around open source information and technology has cascading effects across government, academia, industry and the community; stimulating GDP (Blind, K., et al 2021), labour productivity (Ghosh, et al. 2006), and the formation of start-ups (Wright et al., 2023). Increased economic complexity and resource efficiency gains are also evident (Ma et al., 2022). According to research from the European Commission, an increase in contributions to open source software (OSS) of 10% per year results in a GDP increase of 0.4% to 0.6%, as well as the creation of more than 600 new technology start-ups in the EU (European Commission, 2020). OSS presents clear environmental, economic, and social advantages, and should therefore be seen as a key component of effective digital innovation and circular strategies (Augspurger, 2022). With many governments acknowledging the Sustainable Development Goals within their internal operations, we encourage policy and decision-makers to assess their contribution towards these Global goals within the context of open source and public-purpose value, particularly concerning circular initiatives. New alliances, such as the Digital Public Goods Alliance, play an important role in generating a shared understanding of the benefits of supporting and fostering open source, together with governments at scale.

Going forward

Australia is well-positioned to take a leadership role in advancing the circular economy, supported by the insights and capabilities demonstrated through initiatives such as the Western Australian Circular Observatory. We welcome the opportunity to engage further and contribute to the important work of the Commission.

Annexes

1. State of Circularity in WA – Summary Report.pdf
2. Mapping the Circular Economy of Western Australia – Main report.pdf

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