

Circular economy in South Australia's built environment

Discussion paper
September 2022

Uniting Communities - U City
6 Star Green Star — Design & As Built v1.1
5 Star Green Star — Performance v1.2
Climate Active Carbon Neutral Certified Building



Acknowledgement of country

The project team wish to acknowledge Aboriginal peoples of all country throughout Australia, and their cultural, spiritual, physical, and emotional connection with their land, waters, and community. We pay our respects to all Elders past, present, and emerging.

We also acknowledge that ecologically sustainable development and circularity are not standalone concepts but intrinsic to Aboriginal peoples and that the built environment can incorporate these concepts by embedding a Connection to Country in the design process and as part of operations.

Acknowledgements



Established in 2002, Green Building Council of Australia (GBCA) is the nation's authority on sustainable buildings, communities and cities. Our vision is for healthy, resilient and positive places for people. Our purpose is to lead the sustainable transformation of the built environment. GBCA represents more than 550 individual companies with a combined annual turnover of more than \$46 billion.

Funding partner



Green Industries SA (GISA) is an enabler and driver of change, and aims to transform how South Australians use and value resources. The transition to a more circular economy is a priority outlined in South Australia's Waste Strategy 2020-2025, and GISA is an advocate for the benefits this transition will provide for South Australia and has a focus on developing a robust evidence base to support it.

Technical partner



dsquared Consulting has been engaged to undertake the technical research for this discussion paper. dsquared is a specialist Environmentally Sustainable Design (ESD) consultancy firm delivering innovative and independent sustainable solutions in the built environment. dsquared are Ambassadors of the Carbon Neutral Adelaide program and have been a Climate Active Certified Carbon Neutral Organisation since 2017.

Engagement partner



The Adelaide Sustainable Building Network (ASBN) advocates the uptake of sustainable and ecologically beneficial practices within all industries linked to the built environment. We actively promote, educate, connect, collaborate, facilitate and aim to be a catalyst in sparking dialogues and positive action towards sustainable built environments in South Australia.

With thanks to Angus Mitchell, Department for Trade and Investment (DTI), and Andrew Bishop, Renewal SA, for valuable contributions to the discussion paper and project.

Table of contents

Acknowledgement of country

Acknowledgements

Executive Summary

1

Introduction

4

Purpose

4

Context

4

Circular economy definition

4

Feedback

4

Partners

6

Circular economy context

7

Introduction

7

Policies, legislation, and strategies

7

Case studies

14

SA Government direction

14

Green Industries SA approach

17

Circular economy in rating tools

19

Global circular economy movement

22

Built environment opportunities

26

Background

26

Net zero emissions

26

Accelerating CE pathways

30

Barriers, opportunities & risks

33

Introduction	33
Stakeholders	33
Barriers	34
Opportunities	36
Risks	38
Summary	40
Appendix A Case Studies	43
Appendix B Example products and materials	54
Glossary	58

Executive Summary

The purpose of this report is to summarise the circular economy opportunities for South Australia, based on a national and international review of current policies, approaches and case studies. The South Australian context has then been considered to demonstrate outcomes that are already being achieved and that can be used as a nucleus to drive continued innovation.

The key existing circular economy outcomes identified include:

- South Australia's past and current waste and resource management strategies and programs are driving leading outcomes in resource management by providing high quality materials for reuse, remanufacturing, and recycling.
- South Australia is uniquely placed to take advantage of circular economy opportunities as it is already well progressed in developing and implementing circular economy driven materials and products. This is an opportunity to continue to demonstrate national leadership in resource management and circular economy.
- World leading renewable energy generation in South Australia is driving reduced emissions which is supporting circular economy outcomes by increasing competitiveness, reducing wholesale electricity costs, and supporting low emission manufacturing and industrial processes.
- South Australia's continued support for renewable industries including green hydrogen, solar, wind power and electrification are considered vital to continue supporting manufacturing, remanufacturing and the circular economy.
- There are multiple examples of circular economy principles being applied in the built environment which is driving emission reduction outcomes. However, quantifying these outcomes is challenging and some stakeholders are unsure on the impact their project is having.

There are many circular economy models and principles which can be applied to the built environment, with the below diagram outlining the key opportunities identified in this report.

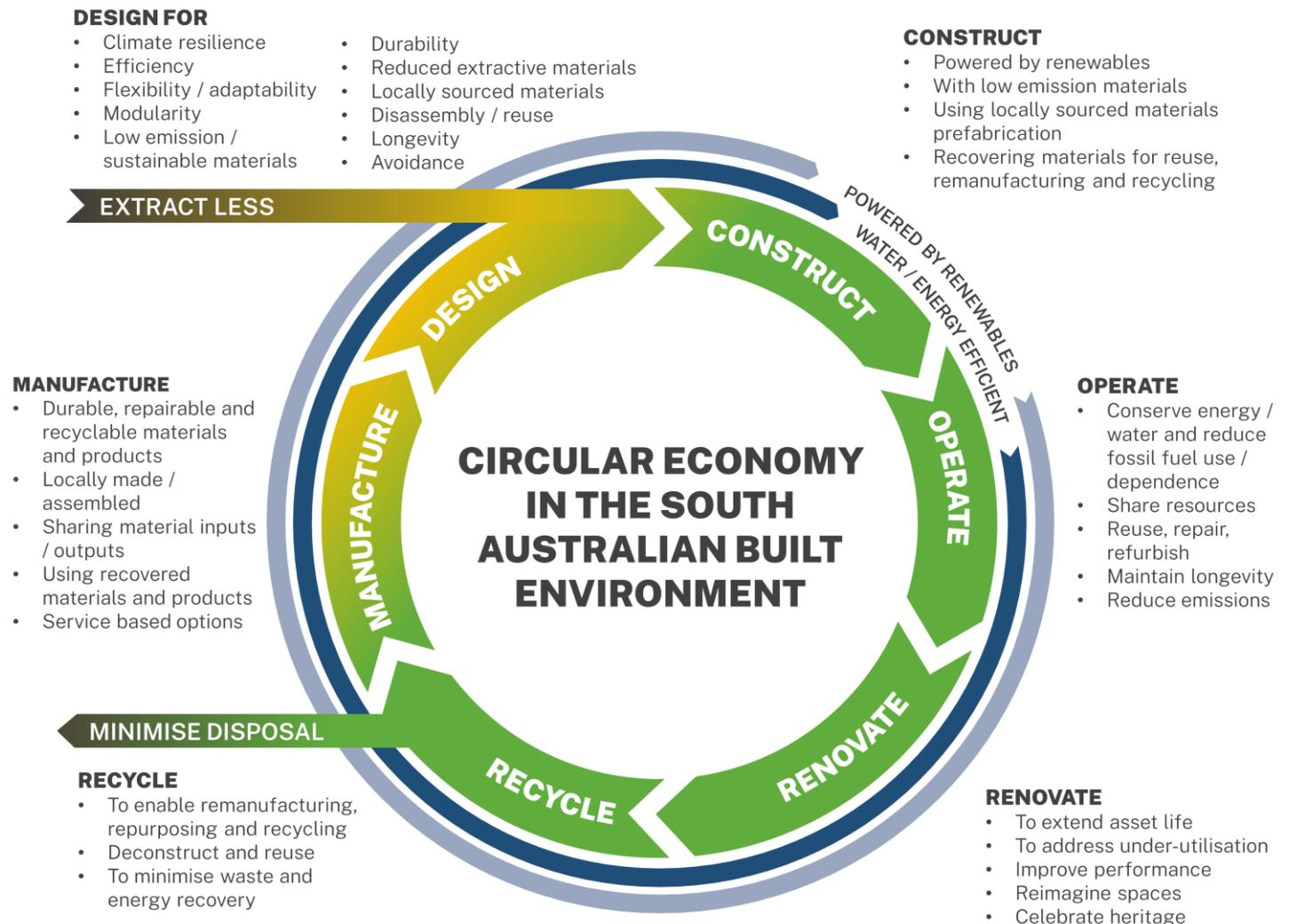


Figure 1: Circular economy in the built environment summary - Source: dsquared

Some of these opportunities are already being implemented across South Australia with tangible and quantifiable outcomes being achieved in the built environment, including in infrastructure, buildings and in products and materials. The image below outlines some of the case studies and outcomes identified in this report however there are many more which should continue to be recognised and celebrated as part of the circular economy transition.

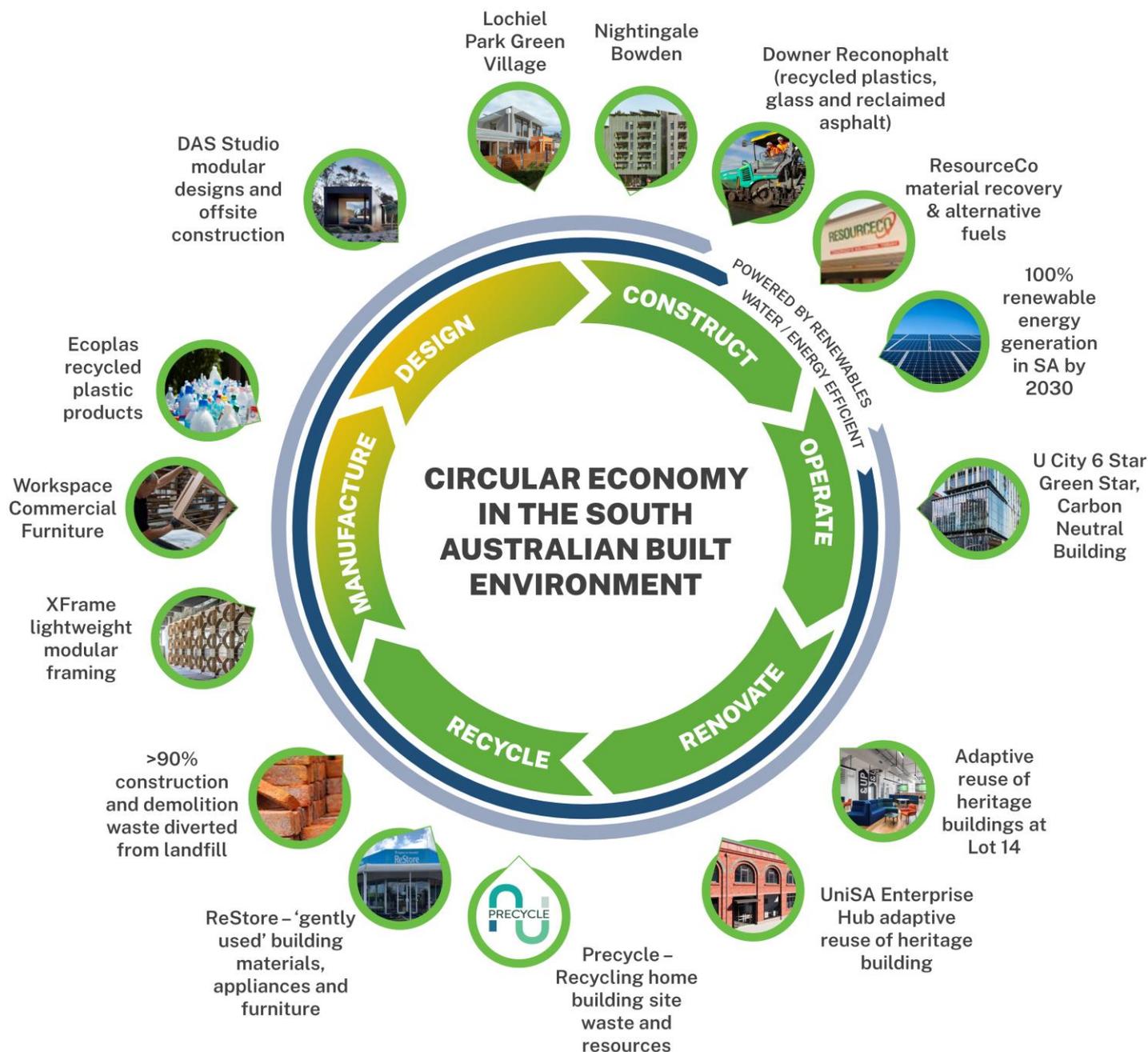


Figure 2: Examples of circular economy projects in South Australia – Source: dsquared

These projects and outcomes have been made possible due to strategic planning at a state level, including climate change mitigation and adaptation planning; emission reduction legislation, targets and goals; and waste and resource strategies and programs. This has then been supported by private industry and organisations that have taken advantage of South Australia’s net zero emissions transition. The state is now well placed to capitalise on circular economy opportunities.

In addition, there are also several current and future initiatives that are expected to continue to drive circular economy outcomes, including:

- 100% renewable energy generation is expected to be achieved by 2030, resulting in significantly lower GHG emissions for manufacturing, and remanufacturing, in South Australia.
- Renewable energy is driving green hydrogen opportunities which can be used to power industries that are difficult to decarbonise with current available technology, such as steel and cement, key materials in the built environment.

- Certification schemes such as Green Star and Climate Active are placing a stronger emphasis on embodied emissions which will increase over time, increasing demand for materials and products sourced as part of a circular economy model.
- Multiple organisations, including the South Australian Government and major development corporations, are incorporating, or planning to incorporate Scope 3 emissions in their net zero emission targets, which is expected to drive emission reduction outcomes, including reducing embodied carbon in capital works projects.

It is expected that the existing and future outcomes and initiatives identified will continue to support circular economy outcomes, however there are a number of barriers, opportunities and risks that will need to be addressed to maximise opportunities. These include:

- Implementing consistent metrics and KPI's to track performance over time, starting at state government level and then applied across industry.
- Implementing effective across government and industry governance structures to drive collaboration and share knowledge and resources.
- Continuing to highlight South Australia as a renewable energy and circular economy leader, which will in turn enable organisations to market their own sustainability credentials.
- Mandating circular economy requirements as part of infrastructure and capital works programs delivered by the state government to kick-start CE opportunities and drive demand.
- Providing funding, grants, and incentives to overcome the initial short-term investment required to kick-start CE opportunities across the state and facilitate new, longer-term relationships and new models of operation such as product as a service.
- Providing training and support knowledge sharing across the built environment industry to highlight CE opportunities and reduce misinformation.
- Highlighting the financial, climate change and competition risks to business of not transitioning to a circular economy model for the built environment.
- Highlighting opportunities for collaboration between all stakeholders from government, the private sector and the community sector and Aboriginal and Torres Strait Islander peoples. New partnerships will be essential for seizing new opportunities.

It is recommended that the barriers, opportunities, and risks identified in this report are discussed with key stakeholders as part of the planned workshops and stakeholder consultation, to identify additional built environment outcomes which can be supported through a South Australian Circular Economy Roadmap.

Introduction

Purpose

The purpose of this discussion paper is to summarise the circular economy opportunities for South Australia, based on a national and international review of approaches and case studies.

Context

According to the recent 'A Circular Economy Discussion Paper' commissioned by the GBCA, *'The age of the circular economy is coming, and the built environment has a substantive opportunity to contribute to its development in Australia.'*

Multiple sectors can be considered as part of the built environment, including civil infrastructure, non-residential or commercial construction and residential construction. The construction sectors comprise both new building and refurbishment activities. According to a recent report by Lifecycles, infrastructure consumes the most materials (4,088,000 tonnes), followed by residential construction (3,386,000 tonnes) and commercial construction (2,712,000 tonnes). For this reason, our reporting will focus on all three sectors, acknowledging that key initiatives could provide opportunities to each sector.

Circular economy definition

The Ellen McArthur Foundation describes a circular economy as:

"Looking beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles:

- design out waste and pollution;
- keep products and materials in use (there is no waste – all materials are resources that can be re-used); and
- regenerate natural systems.

Transitioning to a circular economy does not only amount to adjustments aimed at reducing the negative impacts of the linear economy. Rather, it represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits."

<https://www.ellenmacarthurfoundation.org/circular-economy/concept>

For the purposes of this paper, the World Economic Forum's definition of a circular economy has been adopted as it provides a broader summary which can be applied to the built environment:

"An industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems, and business models."

The circular economy is an economic model that aims to retain the value of the circulating resources, products, parts, and materials. It aims to create innovative business models that promote long life, maximise reuse, encourage refurbishment, and boost the use of renewable materials.

Feedback

This discussion paper has been developed to inform workshops, stakeholder engagement and the development of a circular economy roadmap for the built environment in South Australia which will be released in early 2023.

If you have any feedback on the discussion paper which may assist with the development of the roadmap, please send your comments to Katherine Featherstone at the GBCA: katherine.featherstone@gbca.org.au

PRINCIPLE

1

Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows
ReSOLVE levers: regenerate, virtualise, exchange



Regenerate Substitute materials Virtualise Restore

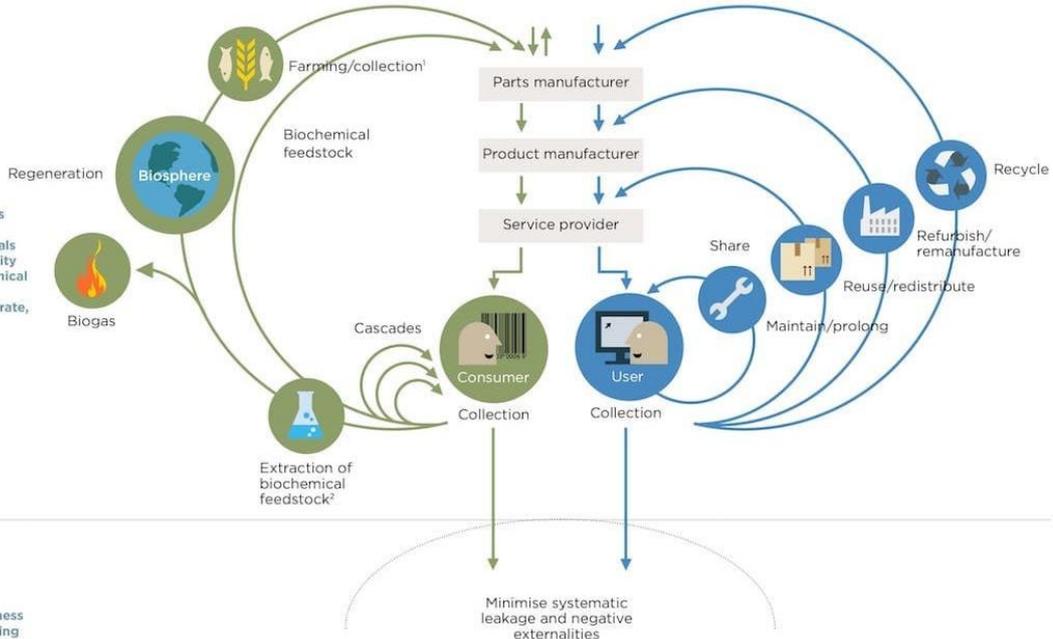
Renewables flow management

Stock management

PRINCIPLE

2

Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles
ReSOLVE levers: regenerate, share, optimise, loop



PRINCIPLE

3

Foster system effectiveness by revealing and designing out negative externalities
All ReSOLVE levers

Minimise systematic leakage and negative externalities

1. Hunting and fishing
2. Can take both post-harvest and post-consumer waste as an input

Figure 3: Ellen MacArthur Foundation – Circular Economy Concept

A circular economy model can change a linear system to a closed loop or circular system which maximises resource efficiencies, reduces waste, and saves money. Creating a circular economy can provide benefits from an environmental, economic, and social perspective, with increased efficiencies providing greater return on investment for industry, retained value of resources in the system, and reduced resource consumption decreasing environmental impact.

In addition, processes which historically would have aimed to minimise impact on the environment can be redesigned to regenerate or improve natural ecosystems. This could be enhanced through engagement with Aboriginal and Torres Strait Islander peoples for knowledge sharing and understanding traditional land management practices.

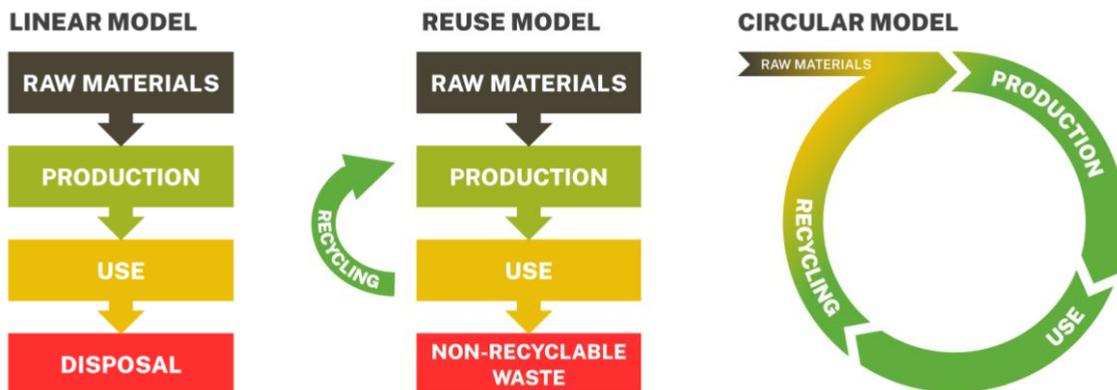


Figure 4: Linear to circular economy pathway – Source: dsquared

A report by Price Waterhouse Coopers (PWC) in early 2021 estimates that the circular economy could contribute two trillion dollars over the next 20 years to the Australian economy and could abate 165 million tonnes of carbon pollution year on year in Australia.

Partners

The following organisations have partnered to develop this discussion paper.

Green Building Council of Australia

Green Building Council of Australia's (GBCA) purpose is to lead the sustainable transformation of the built environment. We do this through our core functions:

- We rate: We rate the sustainability of buildings, fitouts and communities through Australia's largest national, voluntary, holistic rating system – Green Star.
- We educate: We educate industry, government practitioners and decision-makers, and promote green building programs, technologies, design practices and operations.
- We advocate: We advocate for policies and programs that support our vision and purpose.
- We collaborate: We work with our members and other stakeholders to achieve our mission and strategic objectives.

Established in 2002, GBCA has more than 600 members from small businesses to companies listed on the ASX200 with a collective annual turnover of more than \$46 billion.

We know that the building materials sector accounts for 8% of Australia's total emissions and construction and demolition waste accounts for over 40% of total waste to landfill. The built environment needs responsible products and practices that are part of a circular economy and GBCA is committed to working with our stakeholders to transform the supply chain.

Green Industries SA

Green Industries SA (GISA) is an enabler and driver of change, supporting the development of the circular economy through diverse collaborations which improve productivity, resilience, resource efficiency and the environment. It aims to transform how South Australians use and value resources.

Its objectives under the Green Industries SA Act 2004 are to:

- promote waste management practices that, as far as possible, eliminate waste or its consignment to landfill
- promote innovation and business activity in the waste management, resource recovery and green industry sectors, recognising these areas present valuable opportunities to contribute to the state's economic growth.

GISA is advocating for the benefits of a circular economy for South Australia – the opportunities for recycling, repair, reuse and remanufacturing, through circular solutions, can result in better economic, social and environmental outcomes. A transition to the circular economy is a priority in South Australia's Waste Strategy 2020-2025, and GISA's focus is on developing a robust evidence base to support measures for a circular economy in South Australia.

dsquared Consulting

dsquared Consulting has been engaged to undertake the technical research for this discussion paper.

dsquared is a specialist Environmentally Sustainable Design (ESD) consultancy firm delivering innovative and independent sustainable solutions in the built environment. dsquared are Ambassadors of the Carbon Neutral Adelaide program and have been a Climate Active Certified Carbon Neutral Organisation since 2017.

Circular economy context

Introduction

The following section outlines the current circular context including the leading policies, strategies and legislation, the approach in South Australia, and examples of a circular economy approach being applied in the built environment.

Policies, legislation, and strategies

To ensure all circular economy opportunities are identified, it is important to consider the opportunities for South Australia in the context of international, national, and state strategies and programs. The following section summarises the key plans on which this discussion paper is based.

International

Reference

THE PARIS AGREEMENT



United Nations
Framework Convention on
Climate Change

Summary

Paris Agreement

As part of the Paris Agreement, Australia committed to an emissions reduction target of 26-28% on 2005 levels by 2030. Australia officially enforced the Paris Agreement in December 2016 and at the Conference of the Parties (COP26) in 2021, the Australian Government updated this target to include net zero emissions by 2050. In August 2022, the Labor Government introduced legislation to strengthen Australia's commitment to reducing emissions by 43% by 2030.

SUSTAINABLE DEVELOPMENT GOALS



UN Sustainable Development Goals

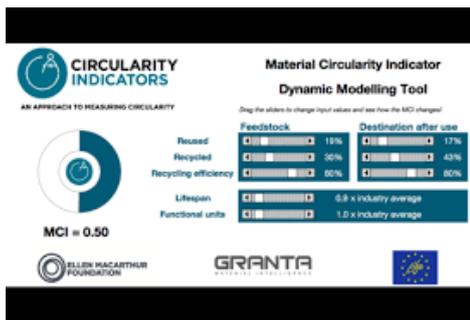
The SDGs are a global roadmap for building a stable and prosperous world and include 17 goals, 169 targets and 232 indicators.

Australia voluntarily reports on progress against the SDGs.



Level(s)

European Calculation and Assessment Tool created to support the design and construction of circular buildings. Designed for residential and office buildings, the tool uses core sustainability indicators to measure carbon, materials, water use, health, comfort and climate change impacts throughout a building's full life cycle



Material Circularity Indicator

The Material Circularity Indicator (MCI) tool, which is part of a broader ‘Circular Indicators Project’ developed by The Ellen MacArthur Foundation and Granta Design, allows companies to identify additional, circular value from their products and materials, and mitigate risks from material price volatility and material supply.

Repair Design Tool

REPAiR is an interactive online application that maps resource flows of construction & demolition waste, biowaste, post-consumer plastic waste, electrical waste and electronic equipment, and municipal solid waste. Funded by the European Union’s Horizon 2020 research and innovation program, the tool shows how waste streams could be usefully redirected, identifying significant opportunities in peri-urban areas.

www.h2020repair.eu

Circular Buildings Toolkit (ARUP)

Platform developed from collaboration between ARUP and the Ellen MacArthur Foundation to encourage adoption of circular economy principles in building design across all design stages by providing a framework to guide impactful decision-making. The online toolkit includes a collection of practical, implementable actions with a library of case studies to inspire teams, in addition to a calculator for circular assessment and benchmarking. Indicators in the toolkit align with the EU level(s) framework.

www.ce-toolkit.dhub.arup.com

Circular Construction in Regenerative Cities (CIRCUIt)

Collaborative project running from 2019-2023, involving 31 ambitious partners across the built environment chain in Copenhagen, Hamburg, the Helsinki Region and Greater London. Funded by the European Commission’s Horizon 2020 programme, the project aims to bridge the gap between theory, practice and policy by delivering a series of demonstrations, case studies, events and other dissemination activities that showcase how circular construction approaches can be scaled and replicated across Europe.

www.circuit-project.eu





restado

Online German marketplace for circular building materials, from deconstruction, oversupply, or are left over building supplies.

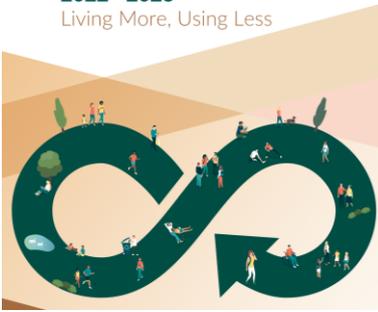
www.restado.de



Madaster

Online registry for materials and products used in construction to generate a building material passport. Documenting, registering and archiving of the materials applied in buildings makes their reuse easier, encourages smart design and eliminates waste.

Whole of Government
Circular Economy Strategy
2022 - 2023
Living More, Using Less



Whole of Government Circular Economy Strategy 2022-2023 (Ireland)

National strategy that follows Ireland's roadmap for waste planning and management, 'A Waste Action Plan for a Circular Economy: Ireland's National Waste Policy 2020-2025'. The Strategy is a key to Government's drive to achieve a 51% reduction in greenhouse gas emissions by 2030 and net-zero emissions by no later than 2050. Initiatives include Innovation Grants Scheme, Advisory Group and Green Public Procurement. Construction and demolition waste will be a focus in later iterations.

A circular economy in
the Netherlands by 2050

Summary



A Circular Economy in the Netherlands by 2050

The Dutch government is working with other public authorities, knowledge institutions and environmental organisations, industry, trade unions, financial institutions and other civil-society organisations to find smarter and more efficient ways of using raw materials. The goal is for the Dutch economy to be completely circular by 2050. By 2030 the consumption of primary raw materials should have been reduced by half.



ReLondon

A partnership of the Mayor of London and London's boroughs to improve waste and resource management in the capital, ReLondon work with government, business and communities through engagement, local case studies, consultancy and provision of information and resources.

Reference



Summary

The European Green Deal: Circular Economy Action Plan (CEAP)

The European Commission adopted the new CEAP in March 2020, a main element of the European Green Deal. It introduces legislative and non-legislative measures including sustainable product regulation and pollution mitigation measures.



Future Peterborough

Peterborough in the UK aims to be operating as a truly circular city by 2050. The programme includes the Circular Peterborough Commitment enabling individuals, communities and business to sign the pledge in support, and Circular City Champions Scheme where organisations champion each of the 7 Rs. The city is currently working towards a Circular City maturity Model to measure progress.

National

Reference



Summary

National Waste Policy Action Plan

The action plan aims to reduce waste to landfill through a number of mechanisms including implementing a circular economy approach and increasing procurement of products containing recycled content to help build market demand.



Sustainable Procurement Guide – A practical guide for Commonwealth entities (2021)

This guide provides steps on how to consider sustainability in the procurement process, including identifying business need, contracts, review and reporting. Guidance includes a focus on circular economy and encourages the use of the MCI calculator in decision making, as well as procurement of products with recycled content. Government procurement is a powerful lever for changing supply chains.



CEFC Timber Building Program

The Australian government launched a \$300M program in February 2022 through the Clean Energy Finance Corporation to encourage mass timber construction for medium and large-scale buildings. This follows international precedents such as ‘The Green Construction through Wood Program’ in Canada that funded projects for 4 years from 2017 and the ‘Green Deal Timber Construction’ in Amsterdam that commits 20% of all new housing projects to be constructed from wood or other biobased materials by 2025.



ASPIRE

An online matchmaking tool and mobile application for material resource exchange that would otherwise be discarded, by bringing different parties together to exchange value. Developed by CSIRO and Data61, the platform allows businesses and councils to list resources on a marketplace, purchase, monitor resource flows and track environmental impact.

(Advisory System for Processing Innovation & Resource Exchange)

www.aspiresme.com

NSW Circular
Economy Policy
Statement
Too Good To Waste
February 2019



NSW Circular Economy Policy Statement – Too Good To Waste

In line with the National Waste Policy Action Plan, the NSW Government have implemented a circular economy approach to reducing waste to landfill.



Yarrabilba

A progressive master planned community in QLD developed by Lendlease that launched a Circular Economy Strategy in 2019. Awarded a 6 Star Green Star Communities rating in 2017, initiatives include planting 40,000 Pongomia trees to offset diesel used in construction, free fast EV chargers, electric public transport, enhancing biodiversity through native planting, stormwater harvesting, phasing out gas connections to homes, smart meters, demonstration house, leasing appliances and reusing resources on site during construction.

Reference



Summary

A Circular Economy Discussion Paper

GBCA prepared this paper to start a conversation about its role, and that of its members, on creating the conditions for a circular economy in the built environment.



Driving responsible products in the built environment

GBCA prepared this paper to outline the strategy behind, and future trajectory for, the evolution of the Responsible Products Framework, Green Star Buildings and Green Star Fitouts.



Waste Management and Resource Recovery Strategy

Queensland released this strategy in 2019, providing three strategic priorities to guide the state's transition to a more circular economy. Strategic priority 2 proposes to transition to circular economy for waste.



Recycling Victoria: A New Economy

Victoria's 10-year policy and action plan for waste and recycling with a focus on transition to circular economy and a target to divert 80% waste from landfill by 2030. In addition to reforming kerbside recycling and introducing a container deposit system, the plan proposes growing the advanced manufacturing sector to make products from recycled materials.

State

Reference



Summary

Green Industries SA

The South Australia's Waste Strategy 2020-2025 forms a framework of policies, strategies and plans meeting South Australia's priorities for economic growth.

A key priority identified in this strategy is a transition to a circular economy.

Implementing the Circular Economy in South Australia (2020-2021)

The outcome of a research project led by the University of South Australia, funded by Green Industries SA, encompassing a literature review of global progress towards circular economy and interviews with local practitioners. The project identified barriers including policy changes, education and enabling technologies to name a few and supported the importance of circular business models. Recommendations include the establishment of Regional Circular Economy Coordinators, programs and hubs, measurement and mapping of resource flows and procurement policy changes.

Creating Value: The potential benefits of a circular economy in South Australia (2017)

First study into what circular economy could mean for SA and evaluation of the employment and economic opportunities that it could create. It was estimated that a shift towards a circular economy could create 25,700 full time equivalent jobs and reduce SA's greenhouse gas emissions by 27% by 2030 compared to business as usual.

South Australia's Waste and Resource Recovery Infrastructure Plan (2018)

Provides a vision for how waste is managed as a resource and a guide for future waste and infrastructure needs to support a resource efficient economy.

South Australia's circular economy and climate change mitigation opportunities (Draft July 2022)

Provides a roadmap for key circular economy priorities to drive emission reduction and climate change mitigation measures in South Australia.

Case studies

The case studies describe existing projects and businesses working in the built environment, to showcase and inform circular economy opportunities in South Australia. These have been integrated throughout this report (refer to Appendix A for expanded detail on each case study):

- **Lot 14:** Adaptive reuse of former hospital campus with heritage buildings.
- **XFrame:** A set of premium carbon sequestering light-weight flexible framing parts designed to enable circular commercial fit-out solutions and modular construction framing.
- **ResourceCo:** A global leader in the recovery and re-manufacturing of primary resources, extracting maximum value from materials otherwise destined for landfill.
- **U City:** Innovative mixed-use vertical village, inclusive of aged care accommodation, and the first certified Climate Active Carbon Neutral building in SA.
- **Green Ceramics – The Smart Centre at UNSW:** The UNSW Green Ceramics MICROfactorie™ developed ceramics made from waste glass and textiles that traditionally are not subject to recycling.
- **NeXTimber by Timberlink:** Manufactures Australian made Engineered Wood Products (EWP) and provides mass timber building solutions.
- **Circl Amsterdam:** Pavilion designed on circular principles, minimising raw materials and utilising urban mining to supply second hand building materials, mass timber framing, 'digital twin' material and component catalogue and fundamentally designed to be capable of disassembly.
- **DAS Studio:** Emerging architecture and design practice at the forefront of modular and off-site construction, delivering prefabricated education solutions for the Department of Education Major Capital Works Program.
- **ReStore by Habitat for Humanity:** Social enterprise that sells 'gently used' building materials, appliances and furniture, donated by businesses and the public instead of sending to landfill.
- **Signify Lighting:** World leading lighting supplier committed to responsible consumption and production with products that can be reprinted, refurbished, reused or recycled and offering innovative Light-as-a-Service (LaaS).

SA Government direction

The South Australian Government has developed an agenda for a Climate Smart South Australia, which includes policy directions and targets for of a more liveable and resilient state, low emissions jobs and growth, and net zero emissions by 2050.

To enable this transition, the government released the [South Australian Government Climate Change Action Plan 2021–2025](#), which includes a target of 50% emissions reduction by 2030, and a number of practical actions for government, including several related to reducing emissions from government infrastructure, buildings and operations to provide a climate resilient built and urban environment.

Directions for a Climate Smart South Australia

Unlock innovation and economic opportunity

The state government will support the development of low emissions and climate smart industries and services in South Australia.

Reduce net emissions

The state government will lead an orderly and socially responsible transition to a low emissions economy.

Build resilience and adapt

The state government will support South Australian communities, industries, businesses and the environment to manage risk, harness opportunities, adapt and build resilience to climate change.

Provide accessible information

The state government will provide high quality, accessible information and build capacity for South Australians to respond to climate related risk and opportunity.

Government leading by example

The state government will embed climate risk and opportunity into government decision making and investment, and seek to achieve net zero emissions in government.

Outcomes

- More liveable and resilient, climate smart state
- Low emissions jobs and growth
- Net zero emissions by 2050

Figure 5: Directions for a Climate Smart South Australia

In addition, the Department for Environment and Water (DEW) is currently developing a net zero program for SA Government agencies, which is expected to start driving emission reduction initiatives for Scope 1, 2 and 3 emissions. Due to DEW incorporating Scope 3 emissions in the SA Government's emissions inventory, it is expected that government projects will increasingly focus on emissions associated with capital works projects (embodied carbon) and the built environment, as well as goods and services used in buildings and facilities.

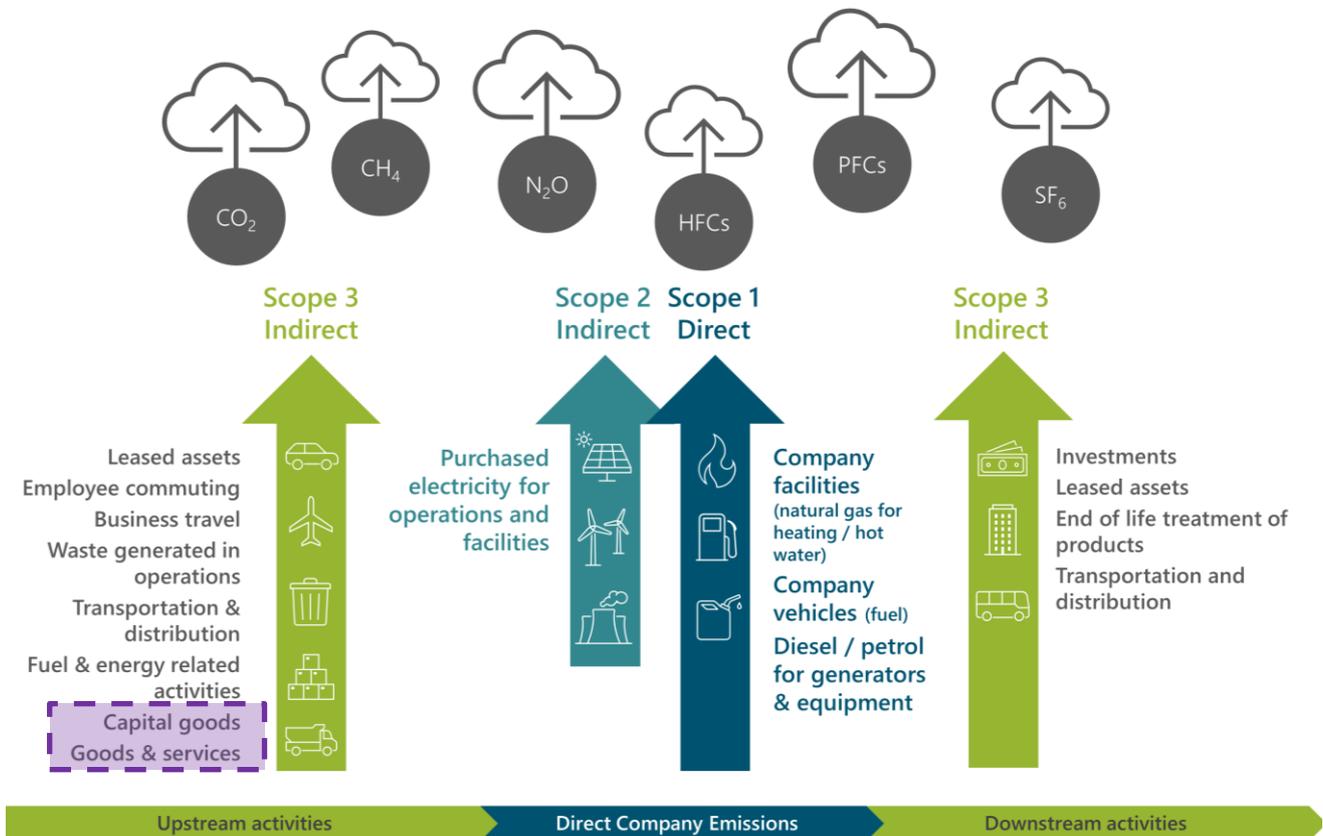


Figure 6: Scope 1,2 & 3 Emission sources

As part of this transition to net zero emissions, SA Government buildings will have to meet new building design standards (currently in draft) with the following agencies expected to play a significant role due to their infrastructure delivery oversight and capital works programs:

- **Infrastructure SA:** Infrastructure SA is an independent advisory which provides advice to government to enable informed and evidence-based decisions on infrastructure planning, investment, delivery and optimisation.
- **Department for Infrastructure and Transport (DIT):** DIT manage and deliver infrastructure and capital works programs across South Australia with approximately \$2.2b of infrastructure investments funded in 2022/23.
- **Department for Health and Wellbeing (SA Health):** SA Health has the largest building assets in SA Government with almost \$550m in capital works and maintenance programs funded in 2022/23. SA Health is the highest energy consuming government agency.
- **Department for Education (DfE):** The Department for Education delivers education services across over 1,000 sites with almost \$300m in capital works and maintenance programs funded in 2022/23. Education is the second largest energy consuming agency.

A key challenge for embedding circular economy outcomes in the above infrastructure and capital works programs will be balancing government priorities, such as providing health and education facilities, against initial upfront costs and timing for project delivery. An example where a circular economy approach has been implemented successfully are the modular buildings being delivered as part of the Department for Education’s capital works programs, and ResourceCo’s recycled asphalt products which has been used in infrastructure projects (further detail in Appendix A).

Case Study – DAS Studio

www.das-studio.com.au



An emerging Adelaide based architecture and design practice at the forefront of modular and off-site construction. Prefabricated construction techniques deliver high quality outcomes and increased construction precision, alongside reduced construction waste, as a result of off-site manufacturing in controlled factory environments. In collaboration with ESCA, DAS Studio created ‘Escapod’ in McLaren Vale - a movable, off grid-capable, luxury hotel suite, set amongst vineyards.

DAS Studio went on to deliver multiple school buildings with Sensus SA as part of the Department for Education Modular Capital Works Program, reducing construction timeframes and minimising disruption to schools.

Case Study – ResourceCo

www.resourceco.com.au



Carbon neutral certified company for resource recovery and alternative fuels, operating across Australia and South-East Asia. The cornerstone of the business is the processing of Construction and Demolition (C&D) waste material into a range of recycled aggregates and asphalt products, including Bitumix™ and Bitumate™ products. ResourceCo operate Tyrecycle that collects tyres to re-manufacture into high quality rubber materials, such as sporting and playground surfaces. Tyres are also used alongside wood-based non-recyclable material to manufacturing Process Engineered Fuel (PEF) and Tyre Derived Fuel (TDF), which is energy for use in high energy manufacturing environments, such as power plants and kilns.

Green Industries SA approach

The GISA 'South Australia's Waste Strategy 2020-2025' focuses on creating circularity throughout the value chain.

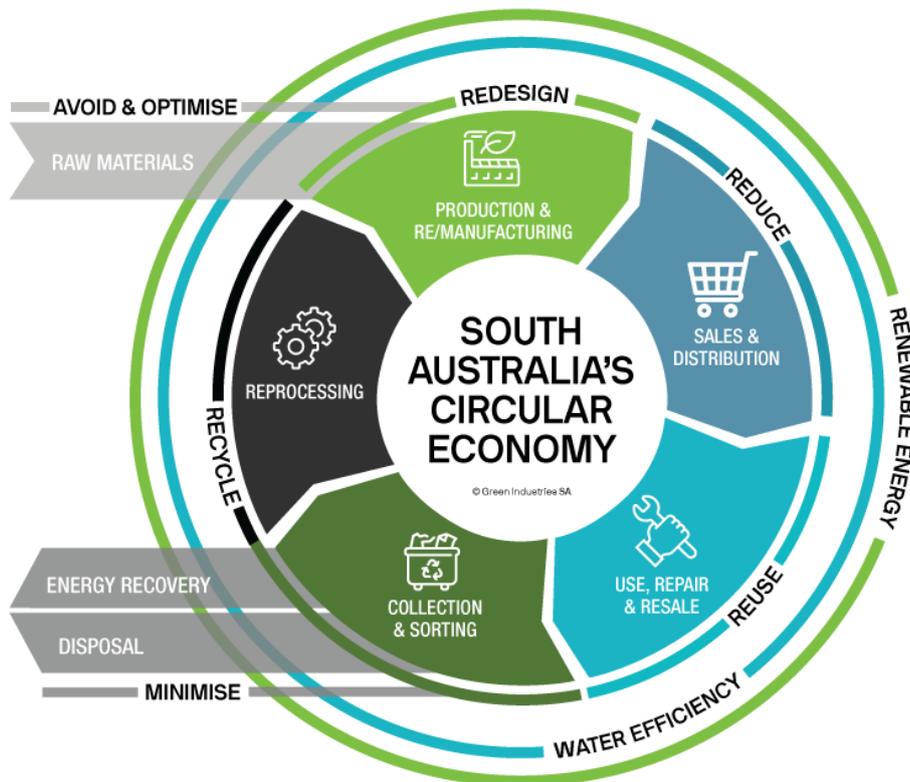


Figure 7: GISA circular economy value chain

GISA has identified the following key actions in transitioning to a circular economy.

1. Avoid waste:

- Encourage businesses and start-ups to adopt business models that support waste avoidance and a transition to the circular economy, for example in sharing, hire and leasing, product as a service, and incentivised return asset management.
- Promote design of products and components to increase reparability, durability, upgradability and recyclability to design out waste.
- Support reuse and repair for further waste avoidance.
- Advocate for product labelling standards to enable better dismantling, reuse and recycling of products and information relating to recycled content.

2. Improve resource recovery:

- Invest in infrastructure that supports circular economy material flows, either as: organic material, designed to re-enter and regenerate the environment safely (such as compost)
- Materials (such as metals, paper and plastic) that are designed to circulate for as long as possible through repair, reuse and, as a last resort, recycling, without entering the environment for disposal.
- Increase use of recycled material, design for recycled materials to be easily recycled again, and build demand and markets for recycled products.
- Promote manufacturing of products and components that replace virgin materials with sustainably produced materials.
- Better manage material flows to benefit human health and wellbeing, the environment and the economy.
- Advocate for extended producer responsibility schemes that deliver recycling outcomes and achieve higher outcomes on the waste hierarchy (such as through better product design).
- Improve information to support innovation, guide investment and enable informed consumer decisions.
- Encourage research and development, commercialisation and innovation in new technologies, including big data analytics, social media, trace and return systems, 3D printing and modular design technologies.

- Identify key sectors, materials and regions to benefit from the circular economy and seek to support practical consideration and actions.
- Support knowledge management and metrics for waste and resource recovery in a circular economy.

An example of GISA's support of transitioning to a circular economy approach is their co-funding of Innovzy's commercialisation of innovation program, which supported the development of XFrame. An additional example of avoiding waste to landfill as part of alternative business models is ReStore by Habitat for Humanity (refer Appendix A for further detail).

Case Study – ReStore

www.habitat.org.au/restoresa



Habitat for Humanity opened their first ReStore shop in Alberton, South Australia in May 2022, which sells new and second-hand furniture and donated building materials, including hardware, appliances, lighting and landscaping supplies, at a discounted price. Many items are new and sent direct from builders and suppliers, including overstocked or discontinued lines, salvaging items that may otherwise be sent to landfill. Funds generated by ReStore go towards Habitat for Humanity's home building and improvement programs. ReStore retail initiative started in Canada in 1991 and has grown to more than 1000 store locations across six countries.

Case Study – XFrame

www.xframe.com.au



Set of light-weight flexible framing parts designed to enable circular commercial fit-out solutions and modular construction framing. The system comprises 12 standard parts forming a modular braced structural matrix from precision milled engineered pine plywood components. Designed around a unique diagonal grid geometry of triangulated panels, the structure is designed for end-of-life deconstruction, reconfiguration, and reuse. XFrame's ambition is to aid the building industry to transition to a circular economy by establishing XFrame as a 'platform technology' in which supplementary technologies and systems can be developed, facilitating the recovery and reuse of almost all building layers.

Refer to the below summary of circular economy achievements in South Australia to date:

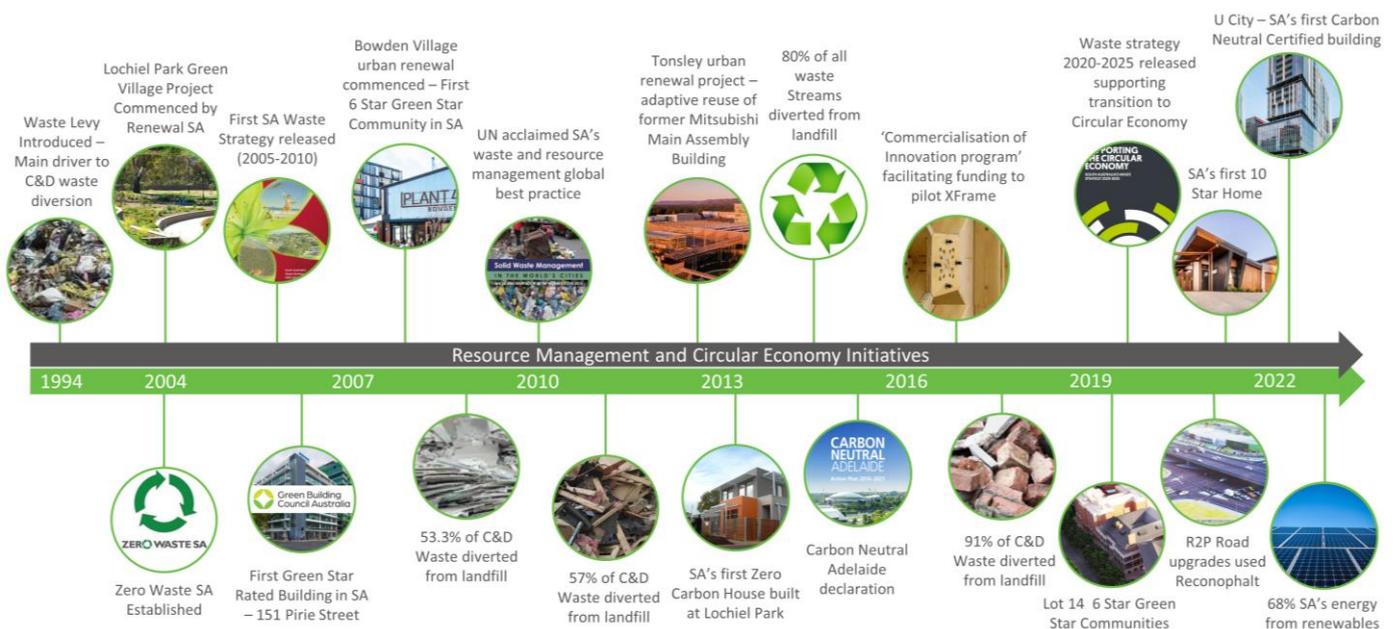


Figure 8: Circular economy achievements summary

Circular economy in rating tools

There are a number of sustainability rating tools and frameworks that include reference to circular economy approaches to design. Increasingly these tools are required to address materials, embodied carbon and circular economy approaches. The following table summarises these sustainable design tools.

Certification tool

Summary

CE Approach



Green Star Buildings

The Green Star Buildings tool assesses the design and construction of buildings and incorporates 8 categories which aim to improve the sustainability outcomes for buildings and health and wellbeing of occupants. The tool has a strong focus on transitioning to renewable energy powered buildings with zero fossil fuels, lifecycle impacts of the building, and the health and wellbeing of building occupants.

Minimum 20% reduction in embodied energy required in all new rated buildings. Extensive sustainable materials reviews required. Focus on reducing materials and resource requirements. The rating tool includes a circular economy Leadership Challenge.

Green Star Communities v1.1



Green Star Communities

The Green Star Communities tool assesses the sustainability of precincts and public realm developments against a set of categories and credits.

Focus on reducing materials and resource requirements. A new precinct tool is currently under development which aligns with the circular economy credits in the new Green Star Buildings tool above.

Green Star Performance v1.2



Green Star Performance

Green Star Performance assesses the operational performance of existing buildings.

Green Star Performance v2, currently under development, aligns with Green Star Buildings above and includes three credits targeting waste and encouraging circularity, including a credit for tenancy waste.

Certification tool



Summary

Living Building Challenge

The Living Building Challenge focuses on creating a net positive impact as a result of the build environment.

CE Approach

Extensive sustainable materials reviews required.
Focus on reducing materials and resource requirements.



Climate Active Carbon Neutral

Although there are a number of options to gain carbon neutral certification or recognition, the Climate Active Carbon Neutral certification is the official pathway managed by the Australian Government Department of Climate Change, Energy, the Environment and Water. The Climate Active standards provide a verifiable pathway to achieving carbon neutrality which is recognised by industry.

The Climate Active Buildings Standard currently focuses on operational carbon however a draft upfront carbon emissions standard was released for consultation in 2022 and is being used to certify buildings.



Embodied emissions

NABERS Embodied Emissions

A NABERS Embodied Emissions rating is currently being developed and is out for technical consultation with industry.

The NABERS Embodied Emissions rating is expected to be piloted in 2023 and will focus on embodied emissions in the built environment.



Infrastructure Sustainability (IS) Council

The IS Rating Scheme assesses the planning, design and construction of infrastructure projects and includes lifecycle impacts, operations and decommissioning.

The IS Design/As-Built provides the most comprehensive approach to embedding sustainability into infrastructure projects, with the IS Essentials rating also providing an option to identify, measure and deliver economic, social and environmental sustainability outcomes in the design and construction phases.

Focus on reducing materials and resource requirements.

Two local projects which have achieved strong circular economy outcomes recognised in sustainability ratings are the U City building developed by Uniting Communities and the adaptive reuse of heritage buildings at Lot 14 (refer Appendix A for further detail).

Case Study – Lot 14

www.lotfourteen.com.au



The re-development of the former Royal Adelaide Hospital Campus, to create a new mixed-use innovation and arts precinct. The project includes the adaptive re-use of heritage buildings, including detailed Life Cycle Assessments (LCA's), and the construction of new buildings to create over 40,000sqm of built form, and the immersion of the site into the adjacent botanic gardens to create a new urban green canopy.

Lot Fourteen is a 6 Star Green Star Communities certified precinct, and the first precinct in Australia to be Precertified as a WELL Community. Each building within the precinct must obtain a 6 Star Green Star rating and the Entrepreneur and Innovation Centre (EIC) will obtain a WELL building rating.

Case Study – U City

www.ucity.com.au

Uniting Communities has developed new vertical village in the Adelaide CBD, including retail, community use, commercial office, supported care accommodation, and retirement living apartments. Uniting Communities is a carbon neutral certified organisation under Climate Active. To showcase their commitment to sustainability and circularity, the facility has obtained a 6 Star Green Star Design & As Built rating, 5 Star Green Star Performance rating and is Adelaide's first Climate Active carbon neutral certified building.

The sustainability of this building allows its function to be future proofed against climate change and adaptable to the changing needs of the community over time.



Global circular economy movement

The circular economy movement is growing around the world, with many jurisdictions making advances in this model and sharing ideas on a global scale.

Circular economy discussions across the globe

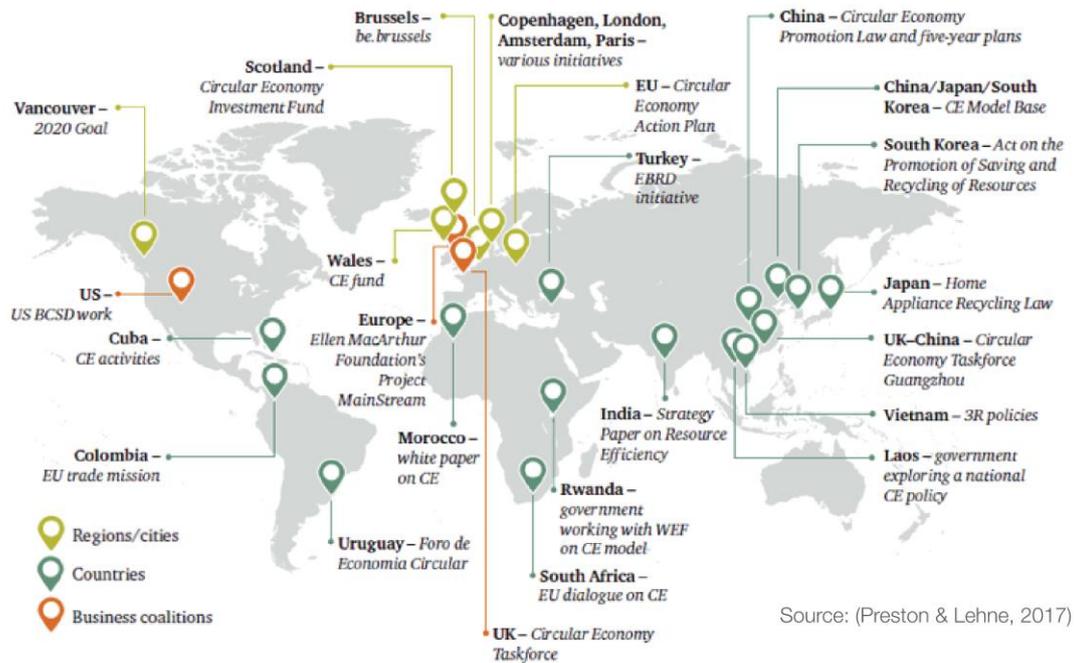


Figure 9: Circular economy at a global scale

These projects and initiatives are resulting in real-world examples of circular economy outcomes being created across the globe. Examples include Circl Amsterdam, Signify Lighting, and NexTimber which are embedding circular economy into the built environment as part of new buildings and product service models (refer below case study summaries and Appendix A for further detail).

Case Study – Circl Amsterdam

www.circl.nl/themakingof/en



Pavilion commissioned by ABN Ambro bank in Amsterdam's Zuidas district, as a meeting place for clients and the community whilst serving as a living lab for circular and sustainable thinking and exemplar project for Netherlands 2050 circular economy target. The project was committed to designing for future disassembly, using only mechanical connections and mass timber framing. Urban mining by local company New Horizon provided second hand building materials such as cable ducts, cladding and hardwood flooring, harvested from existing buildings due for demolition. The lift is leased and all materials and components that make up the building are recorded in a 'digital twin' or building passport, to facilitate future reuse.

Case Study – Signify Lighting

www.signify.com/global



Signify Lighting are carbon neutral in operations and offer serviceable luminaires, circular components and managed lighting or Light-as-a-Service (LaaS). Signify provide modular 3D printed customised designs, made locally on demand, reducing waste, transport, and large stock storage.

Components can also be replaced so the lifespan of the luminaire can be extended beyond the lifespan of its parts. Light-as-a-Service (LaaS) provides design, financing, installation, maintenance, and end-of-life management as a single service to customers, which means Signify own the equipment, maintain and repair during operation, and then recover for reuse or recycling at the end of the contract.



Circular Dutch Economy by 2050

The Dutch government published an ambitious target for circular economy in 2016, announcing the intention to achieve full circularity in the Netherlands by 2050. A focus has been placed on the building and construction industry as a key sector in reaching their goals.

Professor Dr Jacqueline Cramer is a member of the Amsterdam Economic Board in charge of the Circular Economy and Chair of the Supervisory Board of the Holland Circular Hotspot and a clear driving force behind circular activities in the Netherlands. As a professor of Sustainable innovation at Utrecht University and a previous Minister for Housing, Spatial Planning and the Environment for the Labour party (2007-2010), Dr Cramer wrote a book based on the Dutch experiences, – ‘How Network Governance Powers the Circular Economy’ – which outlines the 10 Guiding Principles for Circular Economy, summarised below:

Sparking the transition

- 1 The circular initiative starts with a shared sense of urgency.
- 2 The implementation of circular initiatives occurs in four sequential yet cyclic phases.
- 3 Tasks to be performed for each circular initiative are roughly the same, but the focus is case-specific.
- 4 Building a circular economy is a journey with a clear destination but no predetermined path.

Context is key

- 5 Focus on the most promising and disrupting innovations.
- 6 Map the key drivers and preconditions for successful implementation.
- 7 Identify the relevant actors and assess their willingness to join forces.

Successful implementation

- 8 New circular business models should benefit all network partners.
- 9 Transition brokers can accelerate circular initiatives.
- 10 A transparent division of labour among the relevant actors is indispensable.

Furthermore, the book emphasises the importance of focusing on approaches higher on the circularity ladder, addressing systems and product design (refuse, reduce, redesign and reuse) before materials recovery and recycling. Buildings are to be designed to last as long as possible, be functionally adaptive for new uses and be maintained to a high standard to reduce value destruction. This hierarchy is illustrated in the Dutch Construction Value Model overleaf.

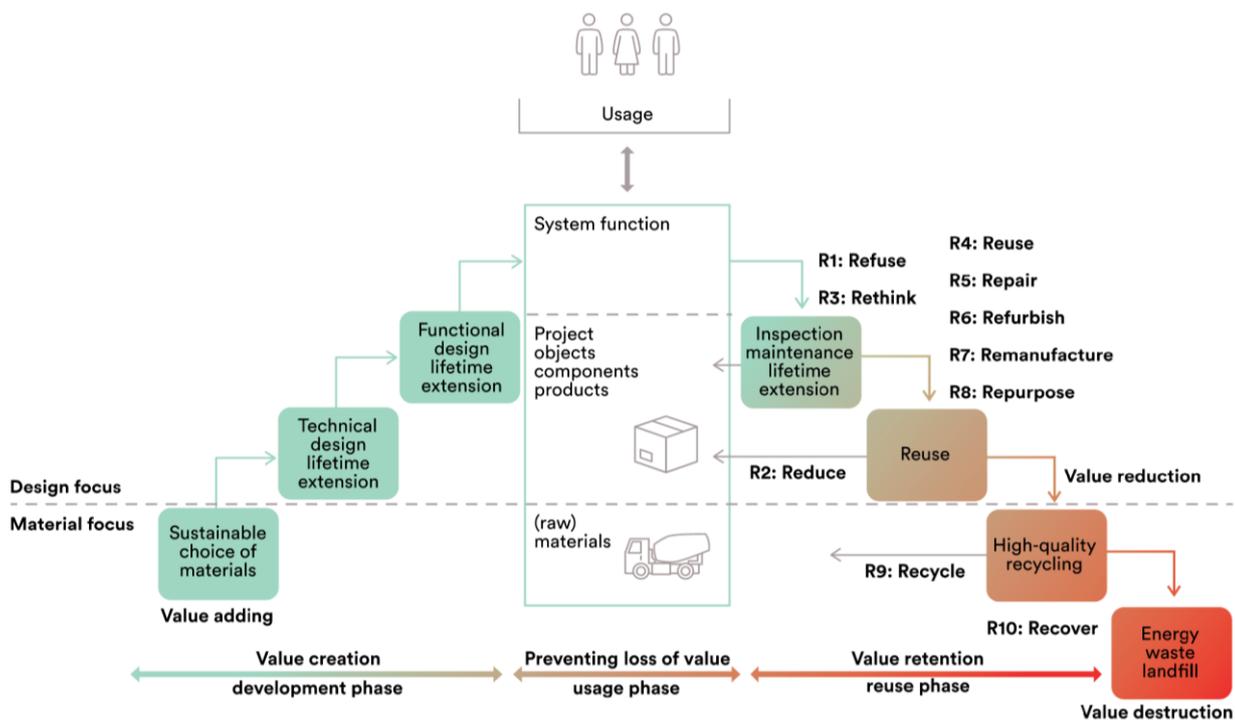


Figure 10: Dutch Construction Value Model based on the ladder of circularity
 Source: How Network Governance Powers the Circular Economy, Dr Cramer.

Key to the Dutch approach is the triple helix of collaboration among the public and private sectors, alongside academia for innovation. Dr Cramer explains that major circular change is not achieved by any one company, industry sector or government in isolation. Powerful collaboration, often activated by an intermediary or ‘transition broker’, with clear goals, agreements and division of roles, brings success.

In the Netherlands, examples of this include the Concrete Agreement formed by the commitment of 82 industry and government parties in 2018 to produce climate neutral concrete by 2030. Following the initial agreement, signatories divided into eight working groups to implement solutions and associated guidance and roadmaps for industry. The success of these actions instigated a further Steel Agreement in 2021, with a commitment to reduce CO2 in steel production and procurement by 60% (Compared to 1990) by 2030. This agreement was formed by 30 stakeholders within a record timeframe of four months, utilising the framework of the Concrete Agreement.

Further initiatives in the Netherlands include the Holland Circular Hotspot which is a private/public platform in which companies, knowledge institutes and (local) authorities collaborate to promote and support international collaboration and knowledge exchange on Dutch circular economy. Circular marketplaces have established for sharing construction equipment and reusing or reprocessing second hand building materials. In addition, the CB’23 Platform has developed a core method for measuring circularity that can be used as an incentive mechanism to drive circular procurement.

Built environment opportunities

Background

The built environment is a major contributor to climate change and resource consumption, accounting for around 40% of energy-related global carbon emissions and approximately 50% of all materials consumed. These two issues are inextricably linked, with around a quarter of all building emissions related to material production and construction.

Overall, the built environment is responsible for:

- One-third of global resource consumption
- 40% of solid waste being construction and demolition waste
- 30% of global energy consumption
- 42.4bn tonnes of materials consumed annually.

Net zero emissions

Net zero emissions is a key component of the Paris Agreement, with signatories committing to short and long-term targets to mitigate the impacts of climate change and to reduce GHG emissions in line with either a 1.5°C or well-below 2°C temperature increase pathway.

The South Australian Government has set a goal to "...reduce South Australia's greenhouse gas emissions by more than 50% below 2005 levels by 2030, and to achieve net zero emissions by 2050." Although this goal is currently set based on operational GHG emissions based on the following sources, circularity will play an increasing role as emissions reduce from energy and transport industries to manufacturing and industrial processes.

A key component of the net zero emissions goals is South Australia's world leading share of renewable energy generation, which is driving reduced energy emissions, facilitating a zero-emission transport transition by powering electric vehicles (EVs) and supporting green hydrogen and ammonia industries. In 2021 renewable energy generation in South Australia reached 63% and is estimated to have reached 68% in 2021/22 which is one of the highest renewable energy shares in a gigawatt scale electricity network in the world.

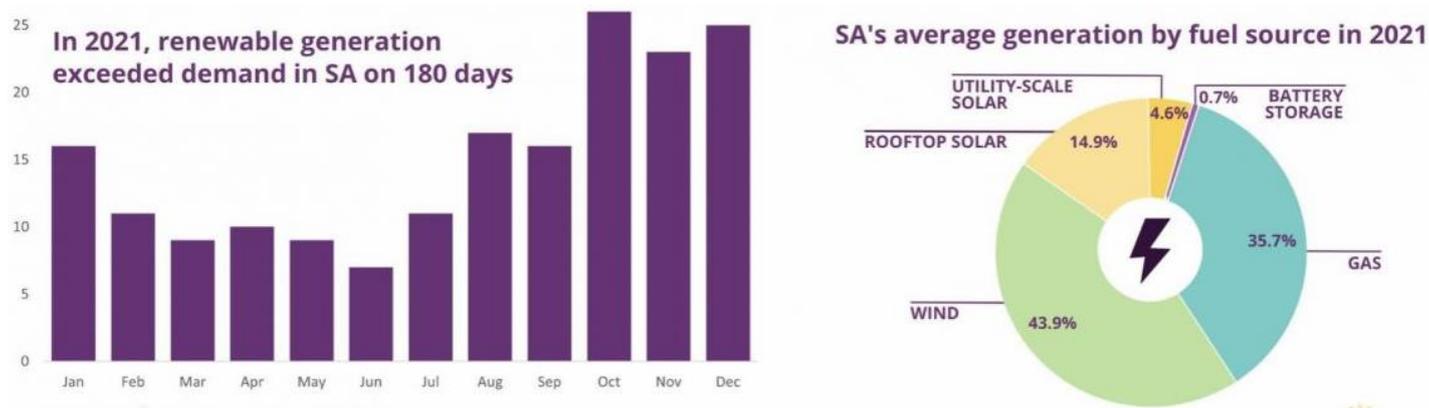


Figure 11: Renewable energy South Australia (AEMO)

Based on projections by the Australian Energy Market Operator (AEMO), renewable energy generation is projected to reach 85% by 2025, with recent projections estimating that renewables in South Australia may reach this milestone earlier, with projects such as the Goyder Renewables Zone which is planning to construct 1,200MW of wind, 600MW of solar and 900MW of battery storage, with construction of a 412MW wind farm beginning in mid-2022. This is a key opportunity for South Australia, with renewable energy powered manufacturing and transport expected to increase competitiveness and reduce costs.

In addition to the above state government goals, the private sector is increasingly setting targets for net zero emissions and are beginning to incorporate embodied emissions associated with capital works. This includes working towards or achieving Climate Active Certified Carbon Neutral certification, which can incorporate Scope 3 embodied emissions from capital works projects if in the organisations operational control.

Some examples of development organisations in the built environment that have committed to net zero emissions are outlined below and may provide an opportunity to be collaborated with to maximise circular economy opportunities in South Australia.

Organisation

Summary



Cbus Property has set ambitious targets as part of its Sustainability Strategy including Net Zero Embodied Carbon buildings on all projects by 2025, 6 Star NABERS Energy ratings, 6 Star Green Star Performance ratings, as well as a range of health and wellbeing commitments. The recently completed 83 Pirie St is a key example of a project working towards these targets.



Charter Hall's sustainability targets are reducing emissions across its portfolio including clean energy, energy and water efficiency, climate resilience and waste targets. Carbon emissions are a key priority with projects such as 60 King William Street reducing its embodied emissions through the use of Holcim ECOPact concrete.



GPT Group's carbon neutral commitments and sustainability initiatives are driving emission reduction outcomes across their portfolio, with recent projects such as Foundation Road achieving certification under the Upfront Carbon Emissions Standard and Queen & Collins reusing over 90% of the facade and structure from the existing asset as part of its redevelopment.



DEXUS has committed to achieving net zero emissions by 2030, is embedding sustainability requirements across its portfolio and has achieved Climate Active Carbon Neutral Certification. A key example in the DEXUS portfolio is the Australian Bragg Centre (SAMRI 2) which is aiming for a LEED Gold rating.



Lendlease has committed to achieving net zero emissions for Scope 1 & 2 by 2025 and absolute net zero (incl. Scope 3) by 2040. This is a key opportunity for working with Scope 3 emissions in the construction sector. Key projects in South Australia include Adelaide Oval Redevelopment, Adelaide Convention Centre Redevelopment, Flinders University at Tonsley and Adelaide Botanic High School. Adelaide Botanic High School is a key example of adaptive reuse with the existing Reid Building seamlessly integrated into the first vertical school in South Australia.



Mirvac's Planet Positive plan includes an aim to achieve net positive emissions by 2050 while also including social outcomes to create a positive impact. Mirvac's zero waste strategy is also fully embedded within a circular economy approach.



The Walker Corporation is working on a number of developments in South Australia including Adelaide Festival Square (6 Star Green Star + WELL Building ratings) and the Port Wakefield intersection upgrade which has a strong focus on local business participation.

Other organisations in South Australia that are driving sustainability and emission reduction outcomes in the built environment include the Kambitsis Group which is currently redeveloping 150 Grenfell Street as a significant adaptive reuse project and Palumbo with the Princes Terrace Adelaide achieving a 6 Star Green Rating and multiple sustainability awards.

Net zero emissions vs circular economy approaches

Much of the work on sustainable buildings in Australia to date has focussed on reducing environmental harm and operational GHG emissions, in line with the net zero emission transition, to mitigate the impacts of climate change. A circular economy approach deals more directly with resource scarcity and the finite resources of our planet, while also reducing emissions to mitigate the impacts of climate change.

The two concepts are not conflicting, and are generally complemented, i.e. using less materials in a circular economy approach also results in lower whole of life GHG emissions (embodied and ongoing) for buildings. In addition, many net zero initiatives, such as improving energy and water efficiency and resource recovery during the operation of buildings, will support circular economy outcomes by increasing the availability of resources.

Below is an example of the levels of circularity and carbon management hierarchy which follows a similar approach. In both examples, a measure stage has been added to enable resource use and emission reduction outcomes to be tracked over time which is a key stage to enable opportunities to be identified and maximised.

Carbon management hierarchy

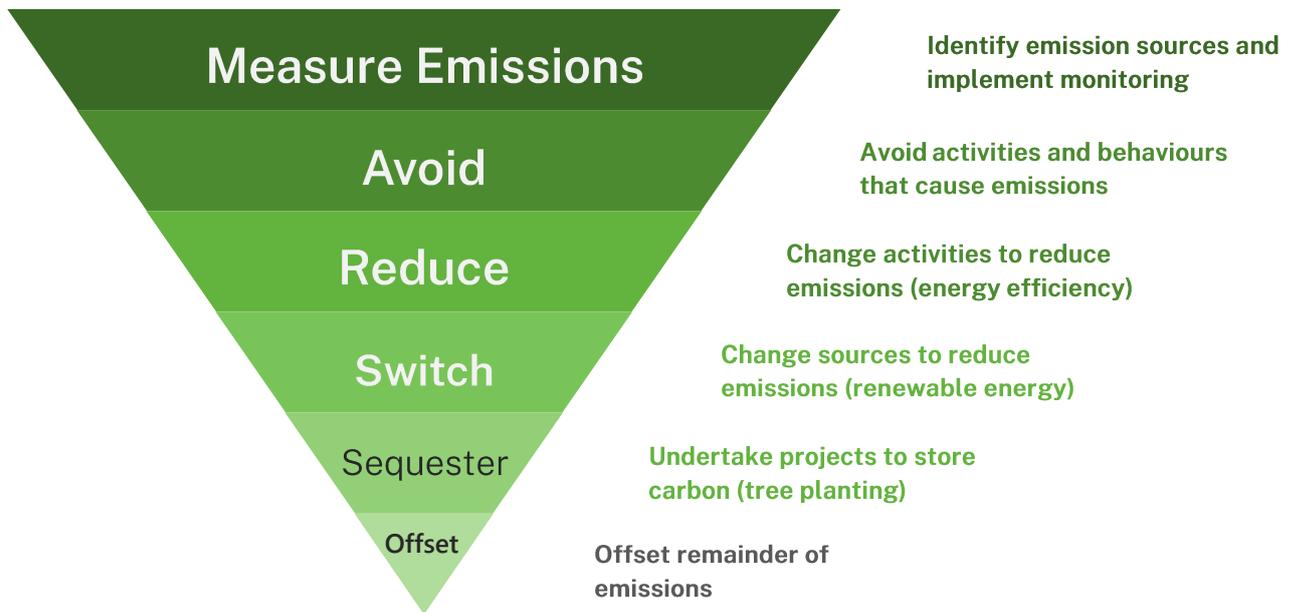


Figure 12: Carbon management hierarchy

Levels of circularity

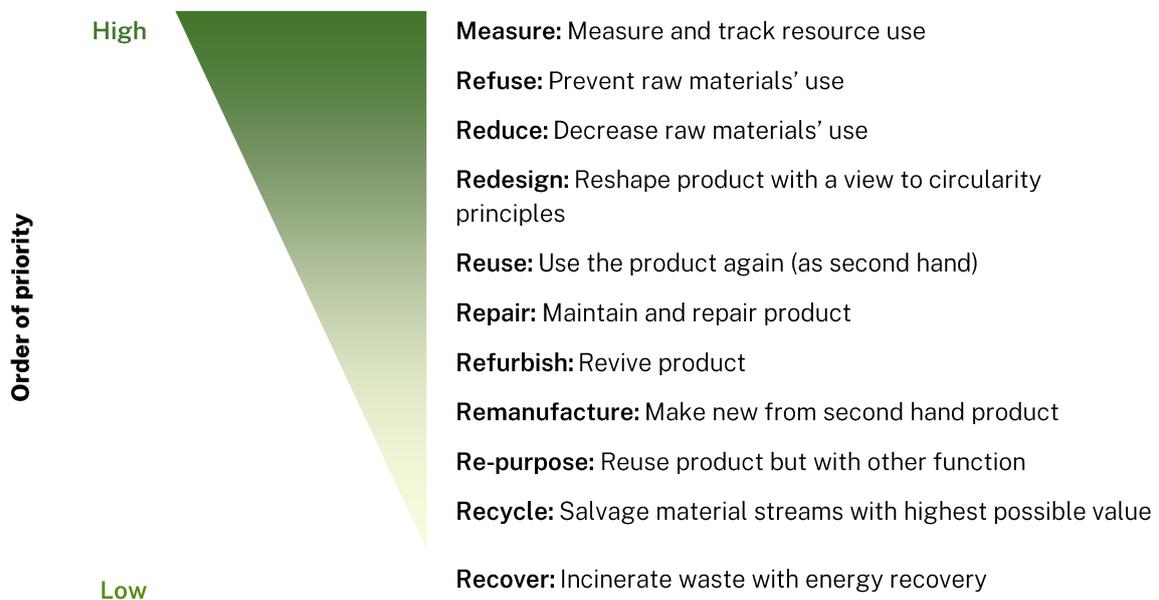


Figure 13: Levels of circularity and 10 R's adapted from J. Cramer 2015

To achieve truly sustainable outcomes, the two concepts should be considered together to realise shared benefits with both approaches complementing each other.

The following design actions are likely to result in both low carbon and positive circular economy impacts:

- Avoid demolition in favour of retention
- Avoid finite virgin resource extraction
- Build less, reuse existing buildings where possible
- Reuse materials
- Use low carbon systems, components and materials that are durable and low maintenance
- Use systems, components and materials with high recycled content
- Use natural materials (biophilic design)
- Use local materials to reduce transport emissions and support local economy
- Specify certain suppliers and/ or systems, components and materials that have systems in place to decarbonise, reprocess and re-manufacture materials
- Designing to optimise passive design outcomes
- Designing for energy efficiency and water conservation.

Designing for circularity

Consideration should also be given to all aspects of the building or infrastructure design and all project stages. The ARUP Circular Economies Toolkit breaks buildings into the following layers to allow the consideration of approaches that best suit the lifecycle of the built elements and it is recommended that projects consider this approach:

- **Systems:** Including the structure and services of the whole element
- **Site:** The location of the building
- **Structure:** The building skeleton
- **Skin:** The façade and exterior
- **Services:** The pipes and wires of the building
- **Space:** The internal fitout
- **Stuff:** The equipment within the building

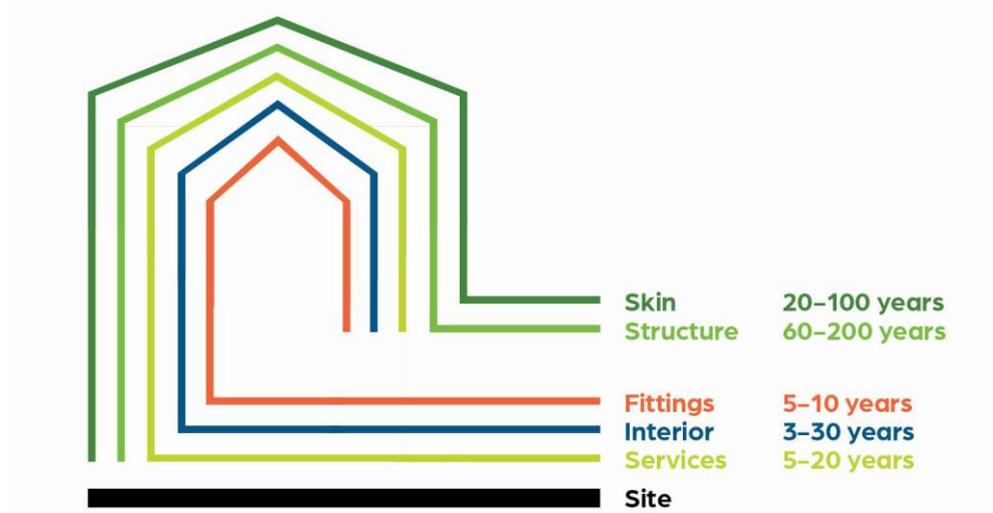


Figure 14: Building components and opportunities for CE

Accelerating CE pathways

GISA is focussed on exploring potential areas which accelerate the circular economy and make significant reductions in scope 3 emissions, to support the pathway to a net zero carbon future.

Relating to the built environment, potential areas include:

1. Investments in green manufacturing for modular construction, prefabrication, and green steel and cement.
2. Optimisation and longevity of existing buildings and spaces through reusing, renovating, retrofitting and adaptive reuse and sharing models.
3. Research and innovation for enabling design and systems that enable flexible use, designing out waste, and planning for future resource recovery.
4. Enabling strategies for material banks and 'urban mining' in deconstruction and disassembly and supporting tracking and tracing opportunities for building stocks
5. Adapting building codes and regulations to be world-leading and embracing net zero carbon and optimising resource recovery and circularity.
6. Committing to independent certification with Green Star or the IS rating tool for large developments which encourage and verify significant circularity.
7. Consider government commitment to Green Star Performance v2 for its existing assets which includes circular economy pathways.

Whilst the focus of this report is on investment stream 1, there are opportunities to support and the other investment streams through investment in buildings and infrastructure. An example of research and innovation is the Green Ceramics material developed by UNSW and NeXTimber Cross Laminated Timber (CLT) being manufactured in SA (refer case study summary overleaf and further detail in Appendix A).

Case Study – Green Ceramics – The Smart Centre at UNSW

www.smart.unsw.edu.au



The Sustainable Materials Research and Technology (SMaRT) Centre developed a Green Ceramics MICROfactorie™ at UNSW. The green ceramics are manufactured using types of waste glass and textiles that are traditionally not subject to recycling, due to issues such as contamination and material complexity. Other waste streams that can be used to create these ceramics, include waste wood and plastics. The ceramics can be used as kitchen benchtops, tabletops, floor tiles and furnishings, including light fixtures and were showcased in Mirvac's Pavilions project.

Case Study – NeXTimber by Timberlink

www.smart.unsw.edu.au



NeXTimber will manufacture Cross Laminated Timber (CLT) and Glue Laminated Timber (GLT) at Timberlink's Tarpeena facility in SA, from locally grown and certified (FSC and PEFC) sustainability managed plantation pine. CLT comprises alternating layers of timber laid perpendicular to each other, finger jointed with adhesive and cured under pressure. It is a highly accurate building product that can be used as roof, floor and wall structures, including lintels, in place of structural steel or concrete. Substituting these materials for a timber alternative reduces a project's embodied carbon, whilst also reducing emissions associated with overseas procurement.

CE construction opportunities in South Australia

The draft *South Australia's Circular Economy and Climate Change Mitigation Opportunities* report has identified a number of priorities for the construction and housing sector which will assist in transitioning from a linear to circular model. These are outlined below, with South Australia's renewable energy resources driving many of the initiatives and the circular economy transition.

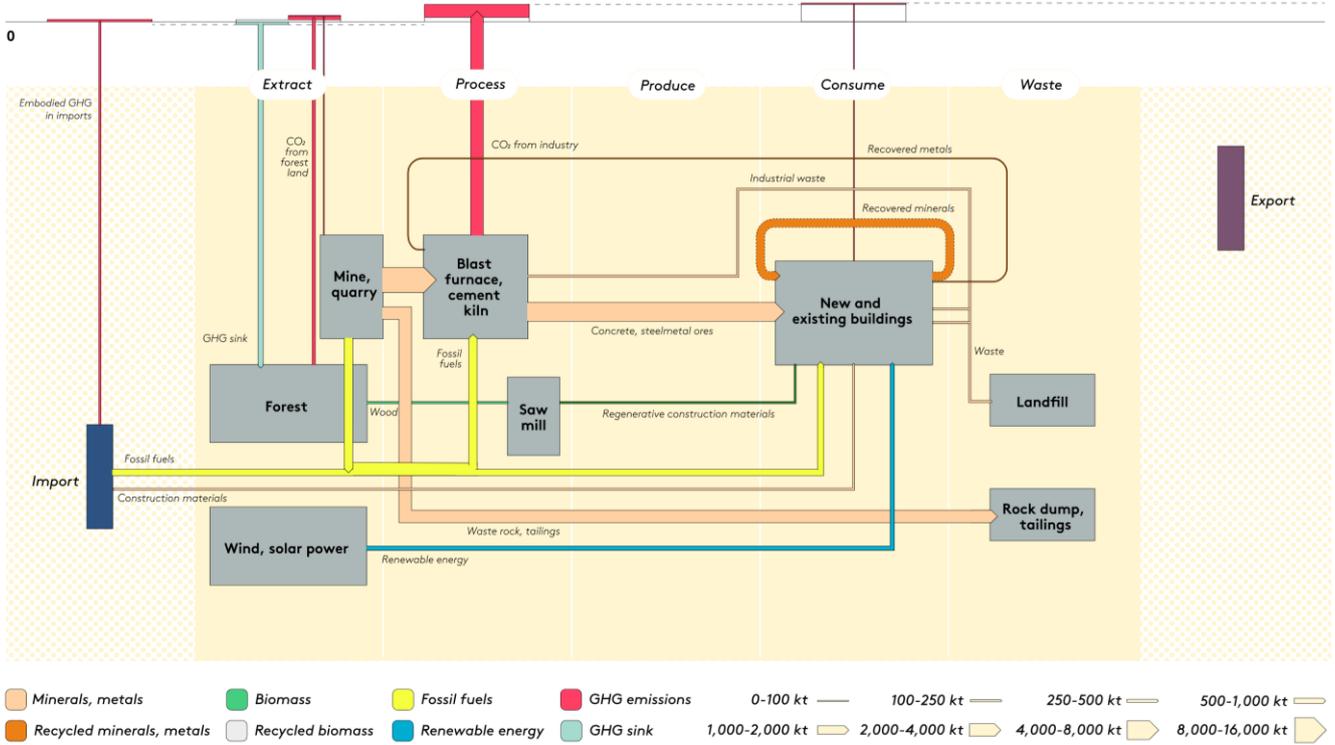


Figure 15: Existing GHG emissions in construction and housing

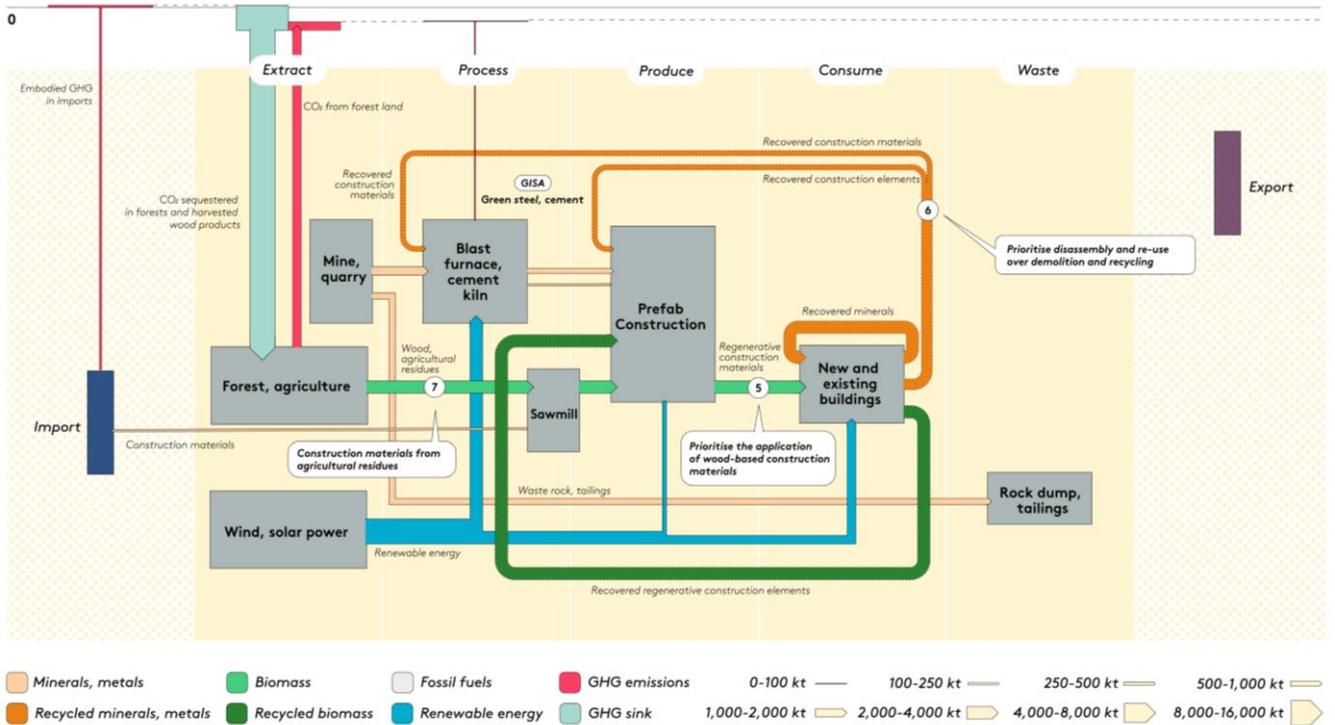


Figure 16: Circular economy opportunities in construction and housing

Material flows in the built environment

Material flows in the South Australian built environment have also been identified in the LifeCycles material flow report (refer Figure 17) with residential and non-residential buildings incorporating a large portion of concrete and sand, and roads and bridges incorporating concrete, aggregates, and sand.

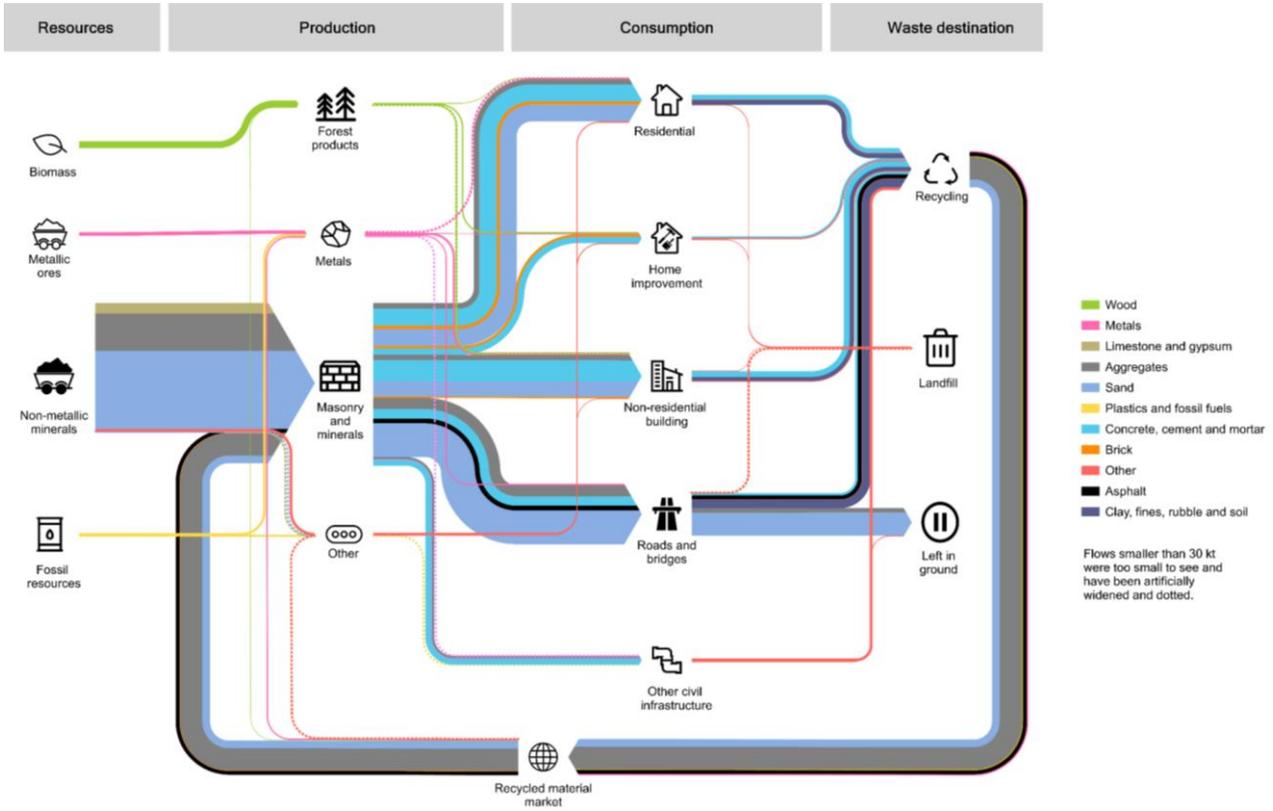


Figure 17: Material flows in the built environment - Source: LifeCycles

The report also identified that steel and concrete are significant sources of embodied emissions and therefore should be a priority for the transition to a circular economy model for the built environment and as part of manufacturing and industrial processes.

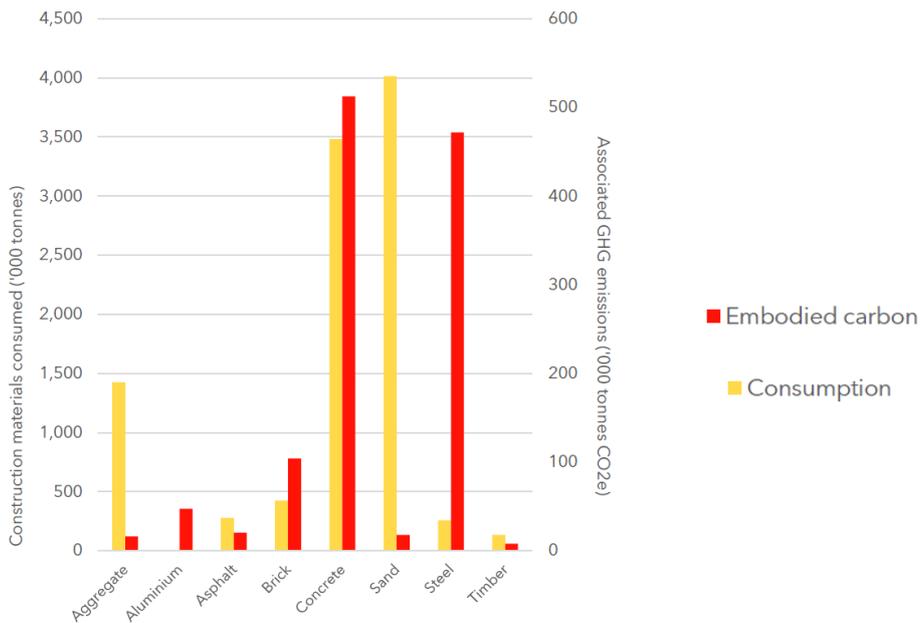


Figure 18: Embodied emissions - Source: Lifecycles

Barriers, opportunities & risks

Introduction

The built environment presents a number of barriers, opportunities and risks that will need to be addressed across all sectors for circular economy outcomes to be achieved.

Stakeholders

A key component to ensuring that a circular economy approach in the built environment is successful is identifying stakeholders that have a role to play in facilitating, connecting, and driving circular economy outcomes. In addition, key stakeholders and industries should be identified that could be used as a nexus to kickstart circular economy opportunities.

The adjacent diagram outlines the main stakeholders and industry opportunities identified in South Australia that are expected to be key to kickstarting a circular economy in the built environment. The summary is based on Dr Cramer's "Relation between public governance and network governance" diagram.

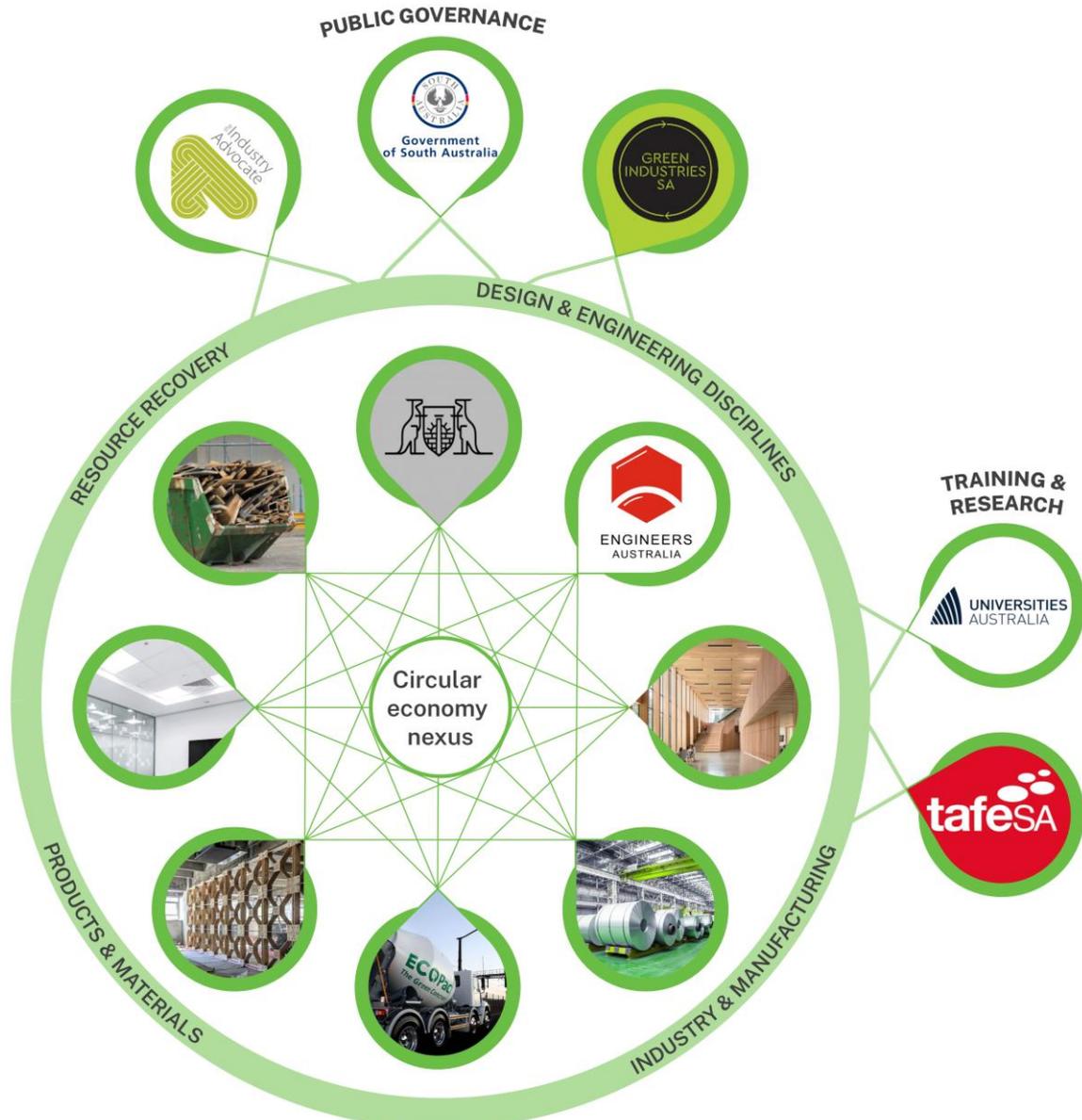


Figure 19: Key stakeholders and governance structure

The following section outlines key topics and potential actions to maximise circular economy outcomes based on the following categories:

- **Government:** Predominantly focusses on state government actions however also considers national and local government opportunities.
- **Non-government:** Focusses on private sector and industry in the built environment and actions that can be implemented to improve awareness and reduce barriers. This includes non-government organisations, research and education institutions, community organisations, and Traditional Land Owners.

Barriers

The following barriers and actions have been identified for CE in the built environment.

Topic	Summary	Action/s
 <p>Governance (Australia wide)</p>	<p>Strategic vision and support from government, starting at a federal level, is disjointed approach across state and local governments resulting in the duplication of strategies, plans and actions.</p> <p>Example: Each state government develops state specific strategies, plans and projects which do not integrate opportunities and consider Australia wide CE outcomes.</p>	<p>Government: State governments implement a cross border approach to CE, with material flows assessed at a local, regional, and state level to assist in identifying cross border opportunities. The aim is to increase opportunities for materials to be shared.</p> <p>Non-government: Work with government to identify cross-border opportunities to improve business cases.</p>
 <p>Governance (South Australia)</p>	<p>Each state government agency with a role in the circular economy targets different priorities and investment opportunities, without considering potential duplication or conflict with other agency programs and strategies.</p>	<p>Government: Implement an across government circular economy working group which targets priority sectors and opportunities in the built environment.</p>
 <p>Local planning / regulations</p>	<p>Local planning rules and regulations do not support flexibility and experimentation of CE materials and opportunities.</p> <p>Example: Local planning rules for the built environment and standardised engineering approaches reduces opportunities for innovative designs and materials to be tested.</p>	<p>Government: Ensure planning rules incorporate flexibility to trial different materials and approached that maximise CE outcomes while supporting other sustainability outcomes (e.g. climate resilience change).</p> <p>Non-government: Showcase how local materials can meet local design requirements and improve CE outcomes.</p>
 <p>Knowledge and perception</p>	<p>Understanding and awareness of the latest materials and products, as well as out of date costings or specifications, results in materials being excluded before being fully investigated.</p> <p>Example: Locally manufactured low emission concrete is identified as an opportunity but is excluded as there are concerns on structural strength, curing time and longevity based on out-of-date information.</p>	<p>Government: Showcase CE outcomes and latest material information in a single location e.g. on the GISA or Industry Advocate website. Include technical information on how the materials meet and exceed performance requirements if known (e.g. if the low emission concrete met the structural and construction program requirements this should be highlighted).</p> <p>Non-government: Showcase how local materials can meet and potentially exceed design requirements and improve performance outcomes.</p>

Topic

Summary

Action/s



Technical feasibility

Lack of consistent technical feasibility assessments (e.g. as part of Life Cycle Assessments or in the development of Environmental Product Declarations) results in an inability to accurately compare materials with reduced transparency and an inability to demonstrate outcomes.

Example: Two low emission materials (e.g. concrete) incorporate different assumptions in their Environmental Product Declaration (EPD) which makes it difficult to compare without sourcing material data for further assessment.

Government: Provide a template and consistent approach to material reporting for the built environment as part of the CE website and material information above. Includes alignment with standardising metrics and monitoring outlined below.

Non-government: Provide increased information on what has been incorporated in LCAs/EPDs to enable a comparison between materials to be more readily undertaken.



Technical knowledge and expertise

A lack of inhouse technical knowledge and expertise on the benefits, opportunities, and costs of CE in the built environment results in the opportunities not being pursued.

Example: Architects, engineers, and builders are not aware of current materials, costs and benefits and therefore do not specify or investigate CE opportunities.

Government: Provide tailored training and information to design and construction industry to maximise CE opportunities early in the design stage while ensuring construction contractors maximise opportunities as they arise during construction.

Non-government: Showcase how local materials can meet local design requirements and improve CE outcomes.



Financial feasibility (project based)

Increasing costs associated with locally manufactured lower emission materials results in value management (VM) assessments removing local materials from scope. In addition, CE and embodied emissions initiatives may not provide a return on investment for the project owner (e.g. using recycled or local low emission materials may have a cost premium for the owner however the tenant/occupier may

Example: Increasing construction and material costs create budget pressures with CE material opportunities removed due to lack of budget.

Government: Provide grants and incentives for projects to incorporate CE materials where there is a cost premium e.g. projects demonstrate the baseline cost vs. local/CE material cost and emission reduction outcome, and a grant is provided to an agree value (50% grant on completion). This will also enable increased data and monitoring with outcomes shared on CE website.

Non-government: Collate baseline vs. CE material costs for internal use and to inform future projects, while enabling grant applications if available.



Financial feasibility (sector wide)

Although a CE model is expected to result in improved financial and environmental outcomes, increased costs associated with transitioning the built environment to a CE model and implementing CE technologies restricts opportunities and outcomes.

Example: Large investment and subsidies required from government to kick-start CE opportunities, including local manufacturing, material recovery and performance monitoring to track outcomes.

Government:

Increase investment and grants into CE opportunities including local manufacturing, materials, and waste recovery to increase the CE transition. Includes marketing and increasing awareness of existing and new grants/incentives.

Mandate local content / CE assessments as part of government major capital works and infrastructure projects to increase uptake and demonstrate leadership.

Priorities: Large infrastructure projects (>\$20m) and agencies with large capital works budgets or control over government projects (Department of Infrastructure and Transport, Department for Health and Wellbeing, Department for Education).

Non-government: Take advantage of existing and future grants and incentives.



Circular economy opportunities are considered as a post tender or value-add opportunity as part of procurement processes.

Example: Tender specifications include a preference for recycled or CE materials with

Government: Incorporate minimum mandatory CE/ recycled / local manufacturing requirements in government tenders to drive uptake and competitiveness between tenderers. This should be

Topic

Summary

Action/s

Tendering and procurement

responses provided as a value-add in tender responses.

an above the line (in budget) requirement, not optional extra.

Non-government: Showcase CE materials and approach as part of tender responses.



Metrics and monitoring

A lack of consistent metrics for monitoring CE outcomes reduces the ability for achievements to be shared in a transparent and meaningful way and reduces the ability to identify further opportunities.

Example: Multiple CE outcomes are achieved across the built environment sector however inconsistent metrics and lack of monitoring results in more general outcomes being identified and specific priorities that have the largest opportunities being overlooked.

Government: Implement standardised metrics, monitoring systems and performance indicators to track CE outcomes. For example:

Waste diverted from landfill (tonnes per year / %)

CO₂ emissions saved (tonnes per year / %)

Reduced virgin materials / use of recovered materials (tonnes per year / %)

No. of new CE related businesses / employees / jobs created

Economic benefits - increased revenue and reduced costs (\$ / yr)

Government procurement (# of government contracts with CE integrated)

Non-government: Adopt standardised metrics and performance indicators to integrate with sector monitoring and highlight achievements.

Opportunities

The following opportunities and actions have been identified for CE in the built environment.

Topic

Summary

Action/s



Material tracking and metrics

Consistent material tracking, metrics, and reporting mechanism to monitor uptake of circular economy and low emission materials will enable outcomes to be demonstrated, achievements celebrated and additional opportunities to be identified for resource sharing.

Government: Implement a standardised reporting platform for government led infrastructure and capital works projects, focussing on the highest emission sources and circularity opportunities first. Expand over time to capture further material sources.

Non-government: Report as part of voluntary schemes to increase data availability and awareness of CE outcomes.



South Australia Net zero emissions

The SA Government has committed to achieving a 50% reduction in GHG emissions by 2030 and net zero emissions by 2050. This target is similar to other states and jurisdictions and there is an opportunity to accelerate the net zero transition by driving circular economy initiatives and focussing on emissions in hard to abate sectors such as manufacturing, industrial processes and agriculture which provide feedstock, products and materials for the built environment.

Government: Focus circular economy initiatives on hard to abate sectors that require an across government and industry approach to drive the net zero transition.

Non-government: Take advantage of decarbonisation opportunities and work with government to achieve emission reduction targets.

Topic

Summary

Action/s



SA Government Net zero emissions

The Department for Environment and Water (DEW) is currently developing a net zero program for SA Government which will include targets and actions to achieve the above targets for SA Government. There is an opportunity to integrate further circular economy actions into the program, including targeting Scope 3 capital works and asset maintenance program emissions.

Government: Work with DEW to integrate circular economy targets into the SA Government net zero program to drive investment from government programs. Utilise current SA Government emissions inventory to identify key Scope 3 emission sources for targeting as part of government programs.



Renewable energy

Reaching net 100% renewable energy generation, while reducing electricity imported from other states with higher percentages of fossil fuel-based energy generation, should continue to be a high priority to: Increase the competitiveness of companies manufacturing materials and products in South Australia. This will enable companies to market their materials as having lower embodied emissions, while taking advantage of lower transport emissions across the while lifecycle. Enable green hydrogen production to integrate into green steel manufacturing and gas dependent processes, therefore increasing the availability of local low emission materials and products.

Government: Continue to promote and support renewable energy investment in South Australia, as well as energy storage provisions (e.g. battery, thermal, and pumped hydro), to support lower emission and reliable manufacturing.

Non-government: Invest in onsite renewable energy as a competitive advantage e.g. powering local manufacturing with renewables can be used as a marketing tool to attract like-minded businesses and demonstrate decarbonisation initiatives to clients. Demonstrate that local products and materials have been manufactured or assembled with 100% renewable energy as part of competitive marketing.



Renewable energy remanufacturing / recycling

South Australia's significant renewable energy generation systems are driving emission reduction outcomes across the state. There is an opportunity for the materials in the infrastructure, solar panels, wind turbines and energy storage to be captured and remanufactured or recycled at end of life.

Government: Investigate the feasibility of implementing a renewable energy remanufacturing hub to capture end of life materials from solar PV and wind farms and energy storage systems across the state.



Green Hydrogen

Investigate opportunities for green hydrogen as an energy source to decarbonise industrial processes with high heating requirements such as steel production and other manufacturing and remanufacturing.

Government: Support "Green Gas" certification schemes currently in development to help support green hydrogen / gas being used in manufacturing. This will enable businesses to market SA products and materials as "Green Gas" powered in line with how businesses market being powered by Green Power.

Non-government: Work with government and certification schemes to recognise Green Gas (when powered by 100% renewable energy).



Infrastructure investment

The SA Government infrastructure and capital works investment portfolio provides an opportunity for circular economy requirements to be integrated into major infrastructure and capital works projects which could be used to kickstart investment in circular economy industries.

Government: Mandate minimum circular economy requirements in infrastructure and major capital works projects, with additional budget allocated to accelerate circular economy outcomes in the built environment.

Non-government: Highlight opportunities as part of government tenders as a value-add.

Topic

Summary

Action/s



Reduced likelihood of supply disruptions

Increasing circular economy outcomes within South Australia will reduce exposure to global markets disruptions and price impacts. In particular, for major construction materials such as steel and aluminium and energy intensive manufacturing which can be powered by renewables and green gas in the future.

Government: Review CE and material flow opportunities to identify key risks to supply interruptions and opportunities for SA manufacturing to increase resilience.

Non-government: As per above with a focus on materials that would cause a major disruption or that could be a future opportunity for diversifying products and materials.



Circular economy network

Create, expand, and integrate with existing sustainability and circular economy networks through events, training, and networking events to share CE outcomes and increase awareness.

Government: Implement a regular South Australian based CE networking event that builds upon this piece of work and initial engagement with industry.

Risks

The following risks have been identified for not driving circular economy outcomes in the built environment:

Topic

Summary

Action/s



Reduced competitiveness

Other states and jurisdictions leverage increased investment from investors by marketing circular economy outcomes. For example, the NSW Clean Manufacturing Precincts and Special Activation Precincts have a strong focus on attracting and working with businesses that support circular economy outcomes and the NSW Renewable Energy Zones are expected to increase renewable energy generation significantly, reducing South Australia's marketability.

Government: Continue to market and drive renewable energy and circular economy outcomes in South Australia.

Non-government: Support and take advantage of CE opportunities to maximise competitiveness.



Increased operating costs

Products and materials sourced from recycled content and using circular economy principles are expected to reduce in cost over time, resulting in businesses not participating in the market paying increased costs for virgin and extractive materials.

Government: Demonstrate outcomes where reduced costs have been achieved and provide information and training to businesses on how to reduce their exposure to high emission products and materials.

Non-government: Request a financial comparison is undertaken of virgin vs. recycled material as part of product and material specifications in projects.



Negative environmental impacts

Continued negative environmental impacts associated with a linear economy and extractive industries.

Government: Continue to drive CE priorities and integrate with the SA Government net zero program.

Non-government: Demonstrate leadership by going beyond minimum compliance to improve environmental performance and reduce emission and use this as a competitive marketing tool.

Topic

Summary

Action/s



Increased climate change impacts

Climate change unable to be mitigated due to short-term thinking and hard to abate sectors not pursuing net zero and circular economy pathway.

Government: Develop CE specific short-term and long-term targets as part of the net zero transition and incorporate in legislation to drive outcomes.

Non-government: Undertake a climate change risk assessment to identify potential risks and quantify the dollar cost if mitigation measures are not implemented.



Social Licence to Operate

Lack of credibility and social licence to operate by continuing to use virgin and fossil fuel powered products and materials, with no plan to transition as part of a circular economy.

Government: Continue to market South Australia's sustainability and CE credentials and demonstrate how the economy is decoupling from emissions.

Non-government: Ensure CE claims are credible and backed by robust testing and certification schemes to increase market confidence.

Summary

This report has assessed circular economy opportunities at an international, national, and state level, while focussing on the South Australian context to demonstrate outcomes that are already being achieved and that can be used as a nucleus to drive continued innovation.

The key existing circular economy outcomes identified include:

- South Australia’s past and current waste and resource management strategies and programs are driving leading outcomes in resource management by providing high quality materials for reuse, remanufacturing, and recycling.
- South Australia is uniquely placed to take advantage of circular economy opportunities as it is already well progressed in developing and implementing circular economy driven materials and products. This is an opportunity to continue to demonstrate national leadership in resource management and circular economy.
- World leading renewable energy generation in South Australia is driving reduced emissions which is supporting circular economy outcomes by increasing competitiveness, reducing wholesale electricity costs, and supporting low emission manufacturing and industrial processes.
- South Australia's continued support for renewable industries including green hydrogen, solar, wind power and electrification are considered vital to continue supporting manufacturing, remanufacturing and the circular economy.
- There are multiple examples of circular economy principles being applied in the built environment which is driving emission reduction outcomes. However, quantifying these outcomes is challenging and some stakeholders are unsure on the impact their project is having.

From the assessment there are many circular economy models and principles which can be applied to the built environment, with the below diagram outlining the key opportunities identified in this report.

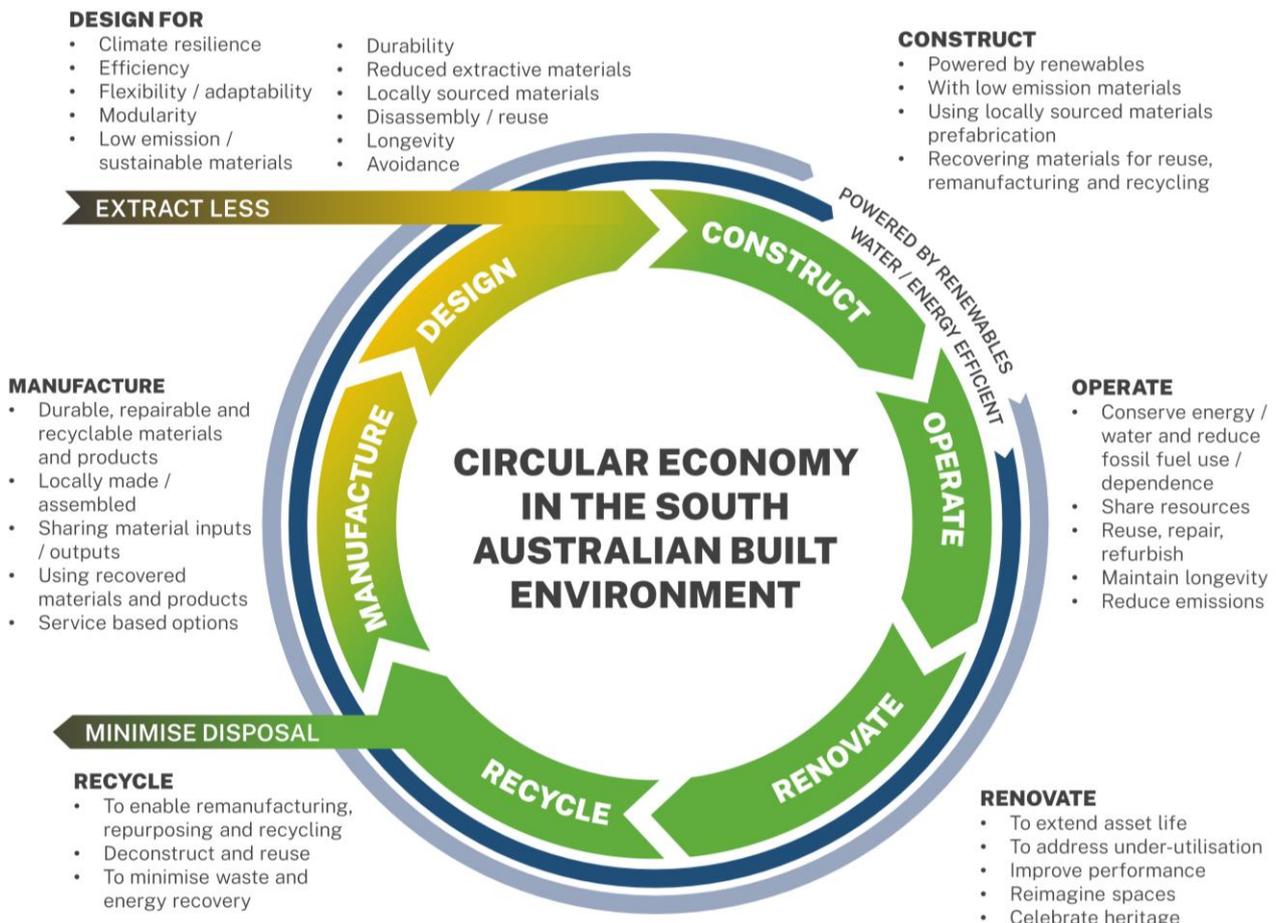


Figure 20: Circular Economy in the Built Environment Summary

Some of these opportunities are already being implemented across South Australia with tangible and quantifiable outcomes being achieved in the built environment, including in infrastructure, buildings and in products and materials. The image below outlines some of the case studies and outcomes identified in this report however there are many more which should continue to be recognised and celebrated as part of the circular economy transition.

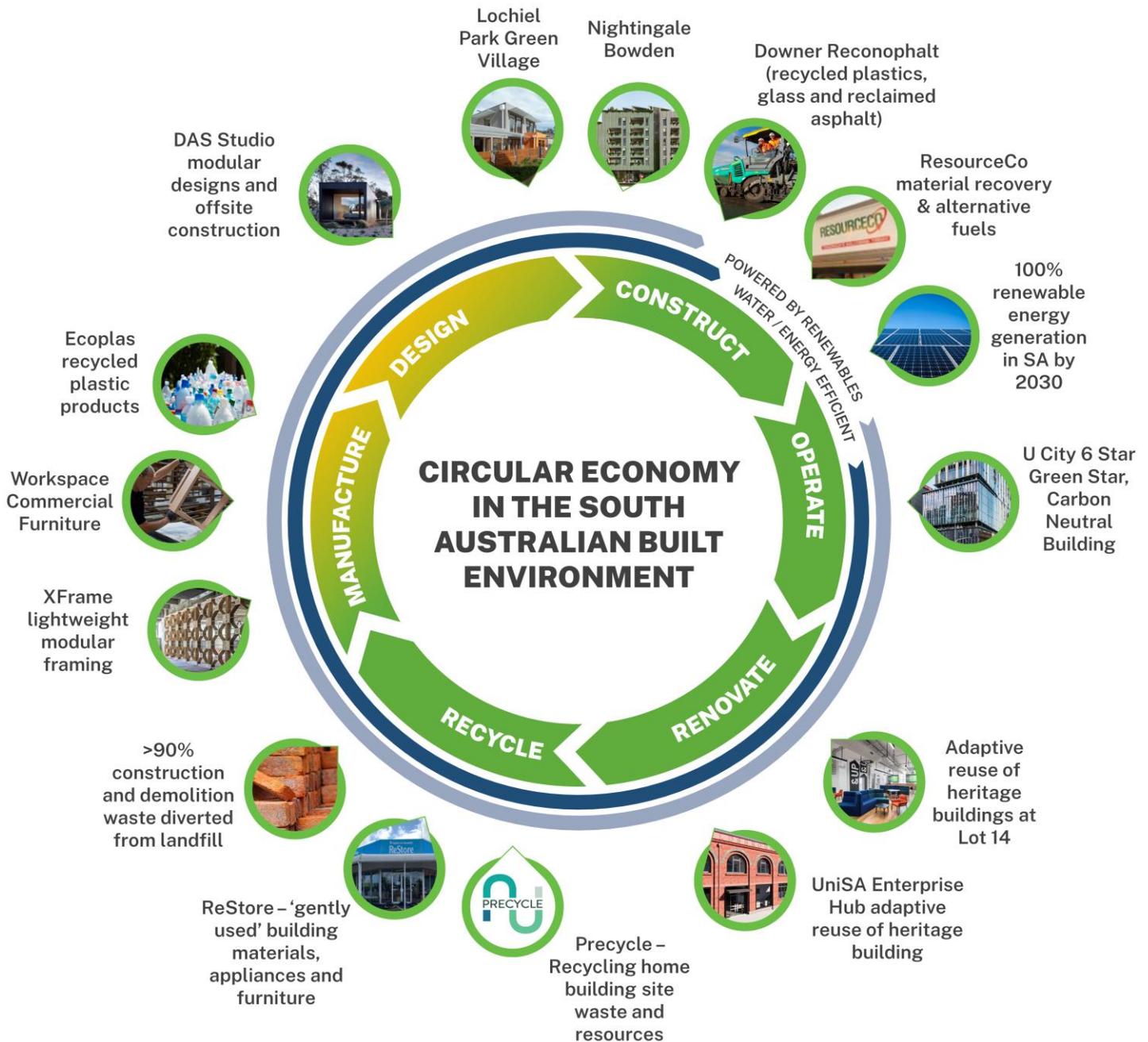


Figure 21: Examples of circular economy projects in South Australia

These projects and outcomes have been made possible due to strategic planning at a state level, including climate change mitigation and adaptation planning, emission reduction legislation, targets and goals, and waste and resource strategies and programs. This has then been supported by private industry and organisations that have taken advantage of South Australia's net zero emissions transition. The state is now well placed to capitalise on CE opportunities.

In addition, there are also several current and future initiatives that are expected to continue to drive CE outcomes, including:

- 100% renewable energy generation is expected to be achieved by 2030, resulting in significantly lower GHG emissions for manufacturing, and remanufacturing, in South Australia.
- Renewable energy is driving green hydrogen opportunities which can be used to power industries that are difficult to decarbonise with current available technology, such as steel and cement, key materials in the built environment.
- Certification schemes such as Green Star and Climate Active are placing a stronger emphasis on embodied emissions which will increase over time, increasing demand for materials and products sourced as part of a circular economy model.
- Multiple organisations, including the South Australian Government and major development corporations, are incorporating, or planning to incorporate Scope 3 emissions in their net zero emission targets, which is expected to drive emission reduction outcomes, including reducing embodied carbon in capital works projects.

It is expected that the existing and future outcomes and initiatives identified will continue to support circular economy outcomes, however there are a number of barriers, opportunities and risks that will need to be addressed to maximise opportunities. These include:

- Implementing consistent metrics and KPI's to track performance over time, starting at state government level and then applied across industry.
- Implementing effective across government and industry governance structures to drive collaboration and share knowledge and resources.
- Continuing to highlight South Australia as a renewable energy and circular economy leader, which will in turn enable organisations to market their own sustainability credentials.
- Mandating circular economy requirements as part of infrastructure and capital works programs delivered by the state government to kick-start CE opportunities and drive demand.
- Providing funding, grants, and incentives to overcome the initial short-term investment required to kick-start CE opportunities across the state and facilitate new, longer-term relationships and new models of operation such as product as a service.
- Providing training and support knowledge sharing across the built environment industry to highlight CE opportunities and reduce misinformation.
- Highlighting the financial, climate change and competition risks to business of not transitioning to a circular economy model for the built environment.
- Highlighting opportunities for collaboration between all stakeholders from government, the private sector and the community sector and Aboriginal and Torres Strait Islander peoples. New partnerships will be essential for seizing new opportunities.

It is recommended that the barriers, opportunities, and risks identified in this report are discussed with key stakeholders as part of the planned workshops and stakeholder consultation, to identify additional built environment outcomes which can be supported through a South Australian Circular Economy Roadmap.

Appendix A Case Studies

Lot 14

Adaptive reuse of former hospital campus with heritage buildings.

Location	Value Chain	Materials	Application
Adelaide, Australia	Adaptive Reuse	Various construction	Buildings



The re-development of the former Royal Adelaide Hospital Campus, to create a new mixed-use innovation and arts precinct. The project includes the adaptive re-use of heritage buildings, and the construction of new buildings to create over 40,000sqm of built form, and the immersion of the site into the adjacent botanic gardens to create a new urban green canopy.

Lot Fourteen is a 6 Star Green Star Communities certified precinct, and the first precinct in Australia to be Precertified as a WELL Community. Each building within the precinct must obtain a 6 Star Green Star rating and at least one will obtain a WELL rating.

The reuse of the existing buildings along North Terrace is an excellent example of how the adaptive reuse of existing buildings can be revitalised into new, sustainable office accommodation. The buildings are now home to innovative technology companies and start-up tech incubators, including the Space Discovery Centre, and 'Stone and Chalk', a carbon neutral innovation hub.

The buildings have been subject to extensive life cycle analysis to understand the embodied energy saved in the reuse of buildings. Where former hospital buildings were not suitable for reuse, demolition was planned to reclaim reusable materials for use within the site where possible. New buildings are being designed with lower embodied energy, and highly efficient building services and façade design, to allow the precinct to work towards a carbon neutral future.

XFrame

A set of premium carbon sequestering light-weight flexible framing parts designed to enable circular commercial fit-out solutions and modular construction framing.

Location	Value Chain	Materials	Application
Australia, New Zealand + US	Circular Construction	Engineered Radiata Pine Plywood	Fit-out walling and residential framing



XFrame construction system was first developed through an Architectural Thesis research project at the University of Wellington in 2017, supported by The New Zealand Institute of Building's Charitable Trust to enable a full-scale demonstration. Prototyping activities were undertaken during 2018 and 2019 and XFrame Australia was established in 2019, with the company's commercial growth supported by KiwiNet and Green Industries SA (GISA).

The framing system comprises 12 standard parts forming a modular braced structural matrix from precision milled engineered radiata pine plywood components. Designed around a unique diagonal grid geometry, triangulated panels are laterally resilient, always square and materially efficient, creating a reliable and stable panel design that allows linings, claddings and glazing systems to be secured with reversible fixing systems. Milling and manufacturing has been optimised to make the most of the available materials, leaving minimal waste or offcuts.

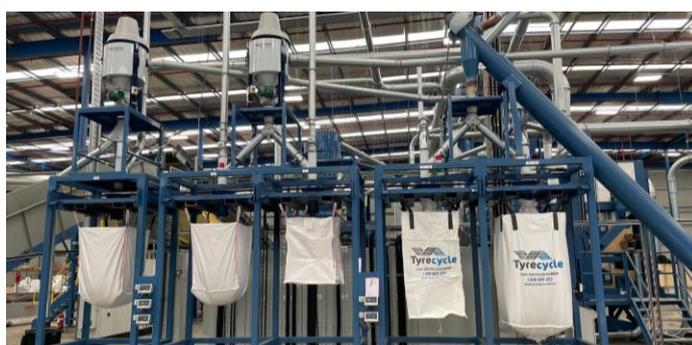
The modular structure is designed for end-of-life deconstruction, reconfiguration and reuse, with the first original prototype from 2017 still in circulation, repurposed as functional walls around New Zealand.

XFrame's ambition is to aid the building industry to transition to a circular economy by establishing XFrame as a 'platform technology' in which supplementary technologies and systems can be developed, facilitating the recovery and reuse of almost all building layers.

ResourceCo

Global leader in the recovery and re-manufacturing of primary resources, extracting maximum value from materials otherwise destined for landfill.

Location	Value Chain	Materials	Application
Australia Wide	Recycling	C&D Waste, C&I waste and Tyres	Roads, energy and rubber products



ResourceCo commenced operations as a concrete crushing company in 1992 and became a global leader in resource recovery and alternative fuels with operations spanning Australia and South-East Asia. Working closely with clients to audit waste streams to recapture embodied energy in materials and assisting with the development of comprehensive environmental management plans.

The cornerstone of the business is the processing of Construction and Demolition (C&D) and Commercial and Industrial (C&I) waste materials, consisting of asphalt, concrete, bricks and rubble to manufacture a range of recycled aggregates and recycled asphalt products, including Bitumix™ and Bitumate™ products.

ResourceCo acquired national tyre recycler Tyrecycle in 2012 and collect over 20 million tyres per annum to re-manufacture into high quality rubber materials, such as sporting and playground surfaces, brake pads, tile adhesives, building insulation, roads and drainage aggregates for civil engineering projects. The recycling rate for tyres is 99% with seven dedicated facilities around Australia.

In 2019, ResourceCo Energy commenced as a dedicated energy service business, manufacturing Process Engineered Fuel (PEF) from dry, wood-based non-recyclable material and Tyre Derived Fuel (TDF) from tyres and conveyor belts, for use in high energy manufacturing environments, power plants and cement kilns. Under long term agreements, ResourceCo partners with large energy users to provide alternative fuels or to install and manage onsite alternative energy infrastructure as a service.

ResourceCo achieved the company's first Carbon Neutral Certification in 2009/2010 FY.

U City

Innovative mixed-use vertical village, inclusive of aged care accommodation.

Location	Value Chain	Materials	Application
Adelaide, Australia	Multi use, green star & carbon neutral	Construction materials	New building



Uniting Communities have developed new vertical village in the Adelaide CBD, including retail, community use, commercial office, supported care accommodation, and retirement living apartments.

Uniting Communities are a carbon neutral certified organisation under Climate Active. To showcase their commitment to environmental conservation, sustainable operations and the health and wellbeing of their staff and clients, Uniting Communities sought to develop the new building in the most sustainable way possible. The building has obtained a 6 Star Green Star rating for its design and construction.

Sustainability is an ongoing journey for Uniting Communities, and in 2022 they sought to achieve sustainability ratings for their ongoing sustainability initiatives, including a transition to 100% renewable energy for the facility. The building is now Adelaide's first Climate Active Carbon Neutral certified building and has also achieved a 5 Star Green Star Performance rating for its operational commitments.

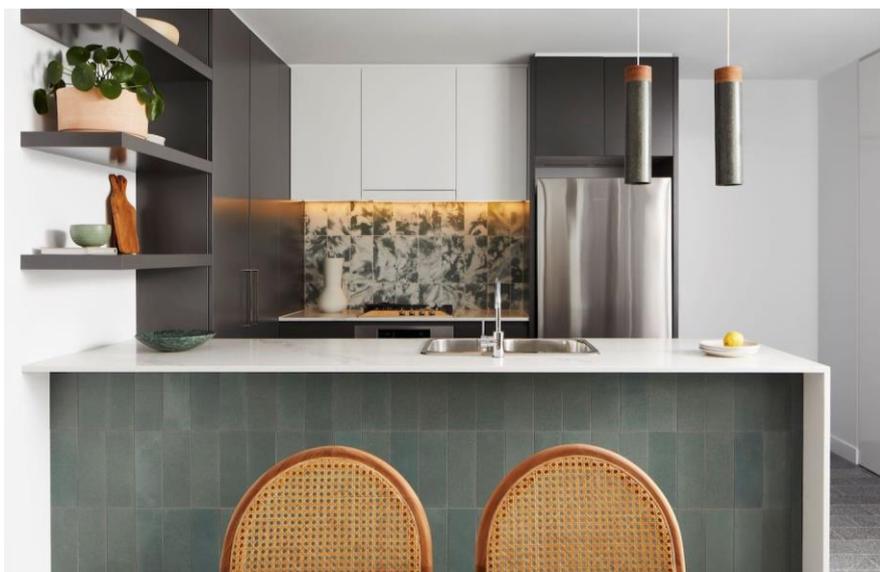
Some of the key initiatives of this building include:

- The building façade was designed to minimise heat gain, allowing the air conditioning plant to be optimised.
- Rainwater is captured for reuse on the landscaped terraces.
- Materials were reused from the former church to recognise the history of the site.
- The mixed-use nature of the building also allows sharing of services, co-locating Uniting Communities offices with the services that they provide. This greatly reduces transport emissions, time and resources in providing valuable care to the community.
- The function centre is used widely by the CBD community, and carbon neutral events can be booked.

Green Ceramics – The Smart Centre at UNSW

The UNSW Green Ceramics MICROfactorie™ developed ceramics made from waste glass and textiles that traditionally are not subject to recycling.

Location	Value Chain	Materials	Application
Sydney, Australia	Recycling	Glass and textiles	Kitchen Benches, floor tiles and furnishings



The Sustainable Materials Research and Technology (SMaRT) Centre developed a Green Ceramics MICROfactorie™ at UNSW in 2021 to conduct ongoing research and development on its ceramics technology and capability and to advance its collaboration with industry and the community as part of its continuing work. The MICROfactorie™ was supported through the NSW Government's Physical Science Fund and is located at the Mattress Recycle Australia Premises in Cootamundra in regional New South Wales and operated by Kandui Technology.

The green ceramics are manufactured using types of waste glass and textiles that are traditionally not subject to recycling, due to issues such as contamination and material complexity. Other waste streams that can be used to create these ceramics, include waste wood and plastics. The ceramics can be used as kitchen benchtops, tabletops, floor tiles and furnishings, including light fixtures.

In March 2021 UNSW SMaRT Centre partnered with Mirvac to reveal an industry-first apartment, made using waste materials that include the green ceramics used for the first time as a commercial construction material. Products developed and installed at the 'Pavilions' display apartment include the floor tiles, tiles for the kitchen splash back and island bench walls, ceramics used as light pendants and for a lamp stand, as well as for two ornamental feature walls and a large ceramic for a beautiful dining table.

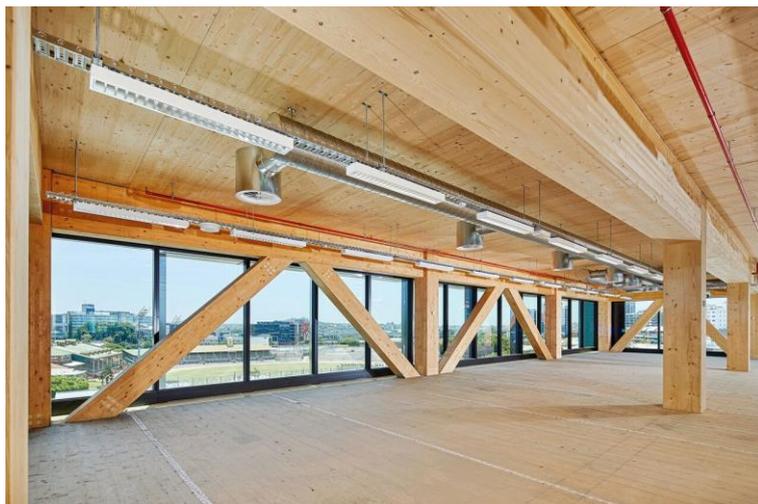
Hunters Hill Library collected old uniforms and the SMaRT Centre used these in the manufacture of ceramic tiles that were fitted to an island bench in 'The YARN' space. Furthermore, green ceramics have been made using waste coffee cups which were used to build rubbish bins in the city of Canberra.

Following the success of the products so far, a second MICROfactorie™ is under construction at West Nowra Recycling and Waste Depot with support of a government grant and anticipated to be completed by late 2022.

NeXTimber by Timberlink

Manufactures Australian made Engineered Wood Products (EWP) and provides mass timber building solutions.

Location	Value Chain	Materials	Application
Tarpeena, South Australia	Cross Laminated Timber (CLT) and Glue Laminated Timber (GLT)	Australian Certified Kiln-dried Radiata Pine	Commercial, residential and public projects



Timberlink Australia began operations in 2013 in Tasmania and currently operates two regional sawmills in Bell Bay (Tasmania) and Tarpeena in South Australia. In December 2021, Timberlink announced their new brand, NeXTimber that will manufacture Cross Laminated Timber (CLT) and Glue Laminated Timber (GLT) at the Tarpeena facility following a \$63M investment. Upgrades to the facility are underway to create Australia’s most advanced sawmill that is due to commence production capabilities in 2023.

NeXTimber is made from locally grown and sustainability managed plantation pine, certified by the Forest Stewardship Council (FSC) and Responsible Wood (PEFC). CLT comprises alternating layers of timber laid perpendicular to each other, finger jointed with adhesive applied along the faces and edges, then cured under pressure to form one solid rectangular billet up to 16m in length, 3.5m wide and 360mm thick. Individual elements are then digitally machined from the billet using Computer Numerically Controlled (CNC) technology. Kilns used in the process are fired using biomass energy generated from by-products such as sawdust, offcuts and shavings.

The cross-direction layup of the panels, combined with the digital fabrication, offer a strong, rigid, dimensionally stable, and highly accurate building product that can be used as roof, floor and wall structures, including lintels, in place of structural steel or concrete. Substituting these materials for a timber alternative reduces a project’s embodied carbon, whilst also reducing emissions associated with overseas procurement, given NeXTimber products will be sourced and manufactured entirely in Australia.

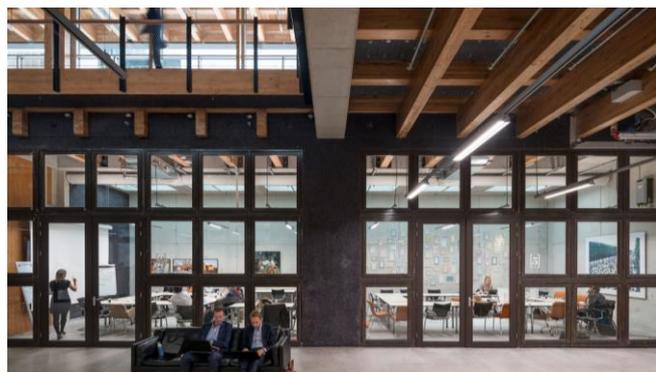
Timber manufacturing has been coined a ‘carbon-negative industry’. For every cubic metre of dry finished plantation softwood timber produced by NeXTimber, 699 kilograms of carbon dioxide is removed from the atmosphere and stored in the timber over its entire lifetime. Utilising timber as a construction material from sustainably managed forests means that carbon is continually captured from the atmosphere as the forests are replanted.

Timberlink also announced in 2021 a wood-plastic composite manufacturing plant for Bell Bay sawmill that will manufacture decking and screening products for the domestic market from saw dust and shavings combined with recycled HDPE plastic.

Circl Amsterdam

Pavilion designed on circular principles, minimising raw materials and utilising urban mining to supply second hand building materials, mass timber framing, 'digital twin' material and component catalogue and fundamentally designed to be capable of disassembly.

Location	Value Chain	Materials	Application
Amsterdam, Netherlands	Designing for Disassembly	BAMB – Buildings as material banks	Corporate and Community



Circl Amsterdam is a pavilion commissioned by ABN Ambro bank in Amsterdam's Zuidas district, as a meeting place for clients and the community. The journey to design a sustainable pavilion began in 2015, after the bank halted the construction of a conventional building. The design team began an ambitious process to remould the existing developed design using the principles of circular economy.

The project team was committed to designing for disassembly, therefore building elements were required to be screwed, bolted or clamped together, rather than using bonding agents like glue and polyurethane. The planned concrete structure was replaced with mass timber framing and beams were a fraction longer than required to better enable disassembly and reuse. Corten planter boxes as part of the landscaping are fixed together using hinges rather than welded corners. There are no fitted ceilings and pipes and cable ducts are exposed.

Amsterdam based business New Horizon provided Urban Mining services to the project, where valuable materials and items are recovered or 'harvested' from buildings at their end of life and reused in new construction. New Horizon 'dismantle' rather than demolish, viewing buildings as a material bank (BAMB), and supplied fire hose reels, cable ducts, cladding and paving stones to the project. In addition, hardwood from a former monastery was used to make up the flooring.

The lift is leased and all materials, components and parts that make up the building are recorded in a 'digital twin' or building passport, to facilitate later reuse.

The pavilion opened in 2017 and alongside functions of the bank, it serves as a living lab for circular and sustainable thinking and exemplar project for Netherlands 2050 circular economy target.

DAS Studio

Emerging architecture and design practice at the forefront of modular and off-site construction, delivering prefabricated education solutions for the Department for Education Major Capital Works Program.

Location	Value Chain	Materials	Application
Adelaide, South Australia	Modular and Prefabricated	2D and 3D prefab systems	Education, Residential, commercial, Industrial



DAS Studio is an emerging Adelaide based architecture and design practice at the forefront of modular and off-site construction. Director Dino Vrynios explored the concept of modular building design and prefabricated construction through a year long tour of Australia, Asia and Europe as part of the prestigious Jack Hobbs McConnell Travelling fellowship, awarded by the Australian Institute of Architecture.

Prefabricated construction techniques deliver high quality outcomes and increased construction precision, alongside reduced construction waste, as a result of off-site manufacturing in controlled factory environments. This practise increases efficiency, reducing project construction timeframes and time spent on site by up to half that of a traditional build.

There are two main families of prefab systems; 2D prefab systems involve the prefabrication of components that are assembled or installed on site, such as the building envelope, stair cores, partitions, or roof structures. 3D prefab systems are modular or unitised elements which are combined on site with other units and may also comprise an entire small building.

DAS studio's first modular project was the Escapod in McLaren Vale (pictured right) – a movable, off-grid capable, luxury hotel suite. In collaboration with modular construction and tourism experts ESCA, this self-sufficient retreat was designed and executed within the confined footprint required by transportation logistics and offsite construction.

Alongside Sensum SA, DAS studio were engaged to deliver the Modular Capital Works Program for the Department for Education in South Australia which commenced in October 2019. The initial pilot program provided fast-tracked modular solutions for 12 schools, including Mitcham Girls High School to meet an immediate need for teaching spaces for over 300 new students in just four months. The pilot's success quickly expanded the program to a further 16 schools, which includes SA's first two storey modular building for Greenwith Primary School (Pictured Left). This project comprised modular wall and floor methods and a roof panel system that was entirely fabricated offsite, minimising disruption to the school.

DAS Studio strive to change the industry's perception of modular buildings and demonstrate it as an idea of smarter design, construction, and procurement with higher-quality project outcomes.

ReStore by Habitat for Humanity

Social enterprise that sells new and 'gently used' building materials, appliances and furniture, donated by businesses and the general public instead of sending to landfill.

Location	Value Chain	Materials	Application
Alberton, South Australia	Re-Use, Social Enterprise	Building materials and furniture	Residential construction and renovation



Habitat for Humanity Australia is part of an international non-for-profit organisation originating in the United States in 1976, with a mission to provide vulnerable families with safe and decent housing. Alongside volunteers and corporate partners, Habitat for Humanity empower families through 'sweat equity' to build homes and transform communities.

In May 2022, Habitat for Humanity opened their first ReStore shop in Alberton, South Australia which sells new and second-hand furniture and donated building materials, including hardware, appliances, lighting and landscaping supplies, at a discounted price. Many items are new and sent direct from builders and suppliers who no longer require the materials or products, including overstocked or discontinued lines, salvaging items that may otherwise be sent to landfill.

This initiative is aimed at the residential market, offering families and homeowners an affordable solution to home construction and renovation. Funds generated by ReStore go towards Habitat for Humanity's home building and improvement programs within South Australia.

ReStore retail initiative started in Canada in 1991 and has grown to more than 1000 store locations across six countries. In Australia, the Alberton store joins two other outlets operating in Victoria.

Signify Lighting

World leading lighting supplier committed to responsible consumption and production with products that can be reprinted, refurbished, reused or recycled and offering innovative Light-as-a-Service (LaaS).

Location	Value Chain	Materials	Application
Global	Products as a Service, Print-On-Demand, Repair, Recycle	Polycarbonate	Residential, Commercial, Industrial and Public Realm



Signify was established in 2019, as a rebrand of Philips Lighting which was founded in the Netherlands and has been in operation for more than 127 years. Signify is a global company servicing more than 70 countries worldwide, committed to research and development and innovation.

Committed to increasing circularity, Signify aims to double revenues from circular products, systems and services to 32% by the end of 2025 through the Brighter Lives, Better World 2025 Sustainability program, by offering serviceable luminaires, circular components and managed lighting or Light-as-a-Service (LaaS).

Serviceable luminaires provide modular 3D printed customised designs, made locally on demand, reducing waste, transport, and large stock storage. These luminaires are manufactured from 100% recyclable polycarbonate which can be reused at the end of the products' lifetime. Consisting of fewer and less complex parts including paint and screws, the 3D printed luminaires weigh less than traditional aluminium luminaires and use less energy in the production process compared to traditional die casting methods. Coupled with circular components that can be easily replaced and are made of recyclable parts, such as drivers, controls, and LED boards, the lifespan of the luminaire can be extended beyond the lifespan of its parts.

Signify also offer Light-as-a-Service (LaaS), which provides design, financing, installation, maintenance, and end-of-life management as a single service, which means Signify own the equipment, maintain and repair during operation, and then recover for reuse or recycling at the end of the contract. This allows higher quality lighting to be installed with a longer lifespan, reducing the financial barrier and creating an improved user experience, whilst ensuring sound stewardship practices.

In addition, Signify has been carbon neutral in operations since September 2020, consuming 100% renewable energy, sent zero waste to landfill since in 2020 and has eliminated plastic from consumer packaging for its products.

Appendix B Example products and materials

Product + Supplier	Materials Recovery	Circularity	Application + Examples
Plastic Forests <i>Recycled Plastic Products</i>	<ul style="list-style-type: none"> _Redcycle soft plastics (post-consumer) _Agricultural Plastics, Silage film (hay bale wrapping) _Post Industrial Plastics 	100% recycled content	<ul style="list-style-type: none"> _underground electrical cable cover _Garden edging _water surrounds _fence posts _wheel stops (car parks)
The Green Pipe <i>Stormwater and Drainage Pipe</i>	<ul style="list-style-type: none"> _Kerbside recycling HDPE (post-consumer milk bottles etc) 	100% recycled content Reclaims offcuts and returns for reprocessing	<ul style="list-style-type: none"> _Irrigation _Stormwater drainage _Civil works _Forestry *Irrigation Bay Outlets St George, QLD *Echuca-Moama Bridge, VIC (Murray River crossing)
Holcim <i>Eco Pact Concrete</i>	Construction + Demolition Waste: <ul style="list-style-type: none"> _Rocks _Sand Industrial Waste: <ul style="list-style-type: none"> _Fly Ash (coal fired power stations) _Slag (steel industry) 	30-60% reduced carbon content Net Zero Pledge 2050	<ul style="list-style-type: none"> _Aggregates _Ready mix concrete _Pipes _Residential house _Infrastructure projects _Rail projects
Enviromesh/ Fibrecon <i>eMesh fibre reinforcement for concrete</i>	Polypropylene: <ul style="list-style-type: none"> bags, ropes, twine, tape, carpets, upholstery, clothing and camping equipment 	100% recycled content Can be recovered and reused at end of life.	<ul style="list-style-type: none"> _Roads _Rail projects _Artificial reef units (Stradbroke Island QLD)
Replas <i>Polyrok Aggregate</i>	<ul style="list-style-type: none"> _Redcycle soft plastics (post-consumer) 	98% recycled content	<ul style="list-style-type: none"> _Aggregates in concrete
Dunlop Flooring <i>Carpet and underlay</i>	<ul style="list-style-type: none"> _Polyurethane Foam _Furniture and bedding industry (offcuts and end of life) 	98% recycled content	<ul style="list-style-type: none"> *Opera House *Parliament house Canberra *Government House Brisbane

Product + Supplier	Materials Recovery	Circularity	Application + Examples
Winya Office Furniture	_Timber _Foams _Fabrics	Up to 100% recycled content Reclaims products for repurposing	_Office fitouts *Commonwealth Bank *Melbourne University
UCI <i>Workstation Screens + Acoustic Panels</i>	_PET plastic (post-consumer water bottles etc)	Up to 80-95% recycled content Stewardship program: Reclaims products for repurposing – products are fully recyclable	_Commercial office Furniture
APR <i>Composite Landscaping Products</i>	_Kerbside recycling HDPE (post-consumer milk bottles etc) _Sawdust (timber mill)	100% recycled content Fully recyclable into new products at end of life	_Boardwalks _Bollards _signage _Sound Wall _Furniture
Integrated Recycling <i>Duratrack Railway Sleeper</i>	PE polymers and polystyrene _Pipes _drums _tanks _agricultural silage film	90% recycled content Fully recyclable into new products at end of life	*QLD Rail *Metro Trains Melbourne *VLine
Nu-Rock <i>Construction Blocks and Bricks</i>	Industrial Waste: _Fly Ash (coal fired power stations) _Slag (steel industry) _Aluminium plants _Tyres _Glass	100% recycled content Fully recyclable into new products at end of life	_Road base _Building blocks _Civil works
Geofabrics <i>Bidim® Green + Megaflo Green</i>	_Kerbside recycling HDPE (post-consumer milk bottles etc) _PET plastic (post-consumer water bottles etc)	100% recycled content	_Roads _Rail Networks _Drainage _Filtration _Waste Containment _Protection

Product + Supplier	Materials Recovery	Circularity	Application + Examples
PACT Reuse <i>Noise Walls</i>	_Kerbside recycling HDPE (post-consumer milk bottles etc) _Recycle soft plastics	75% recycled content	_Infrastructure projects
Close the Loop <i>Tonerplas Asphalt Additive</i>	_Toner cartridges _Recycle soft plastics	Continuously recyclable	_Roads
Alex Fraser Group <i>Aggregates</i>	_Concrete _Tiles _Brick _Asphalt _Glass	Continuously recyclable	_Road base _Concrete _Asphalt
Fulton Hogan <i>Asphalt Products</i>	_Tyres (rubber) _Glass _Aggregates	Continuously recyclable	_Roads
Downer <i>Reconophalt – Road Surfacing</i>	_Toner cartridges (Tonerplas) _Asphalt _Glass	Up to 100% recycled content Continuously recyclable	_Footpaths _Recreational Areas _Highways _Airports *City of Adelaide - 100% recycled asphalt mix for Chatham Street (first in Australia)
Repurpose It <i>Construction Materials</i>	_Construction + Demolition Waste _Contaminated Soil _FOGO (organics)	Up to 99% resource recovery Continuously recyclable	_Road sub grade materials + capping _Concrete _Underground infrastructure _Rail projects _Compost _Organic fertilisers _Soil amendments _Bark _Coloured mulch

Examples compiled from the Department of Agriculture, Water, and the Environment (DAWE) *Enabling Design for Environmental Good* project and reference materials and videos.

Glossary

Term	Definition
C&D Waste	Construction and demolition waste
CE	Circular economy
CO ₂	Carbon dioxide as a proxy for GHG emissions
EPD	Environmental Product Declaration
GBCA	Green Building Council of Australia
GHG	Greenhouse Gas
GISA	Green Industries SA
Industrial Waste	Fly Ash from coal fired power stations and slag from steel industry
LCA	Life Cycle Assessment
PE polymers	Pipes, drums, tanks etc
PP	Polypropylene plastic including, bags, ropes, twine, tape, carpets, upholstery, clothing and camping equipment
Scope 1, 2 and 3 emissions	<p>Scope 1 emissions are direct GHG emissions that occur from sources that are controlled or owned by an organisation.</p> <p>Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling.</p> <p>Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting organization, but that the organisation indirectly impacts in its value chain, including embodied carbon.</p>