



Report

# REGIONAL CIRCULAR ECONOMY HORIZON SCAN

Eastern Metropolitan Regional Council | September 2022



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**Table 1.1** *Summary of abbreviations*

| Abbreviation | Definition                            |
|--------------|---------------------------------------|
| AUD          | Australian dollar                     |
| EMRC         | Eastern Metropolitan Regional Council |
| GHD          | GHD Pty Ltd                           |
| GHG          | Greenhouse gasses                     |
| GSP          | Gross State Product                   |
| OPEX         | Operational expenditure               |
| TBC          | To be confirmed                       |
| USD          | United States dollar                  |
| WA           | Western Australia                     |

# 1. Message from the CEO

The Eastern Metropolitan Regional Council (EMRC), in partnership with consultancy group GHD, recently completed a 'Scan of the Circular Economy Horizon in WA' to gain a clearer picture of where we are at in WA, and in Perth's Eastern Region, and what we need to do in industry, business, and government to catalyse the adoption of circularity.

The Horizon Scan will support the EMRC to make circular economy focused strategic and operational decisions based on economic, regulatory and policy trends including working toward achieving net zero and continuing diversion from landfill, as well as waste market forecasts and shifting circular economy drivers.

It will also help to determine the facilitation role the EMRC may play in supporting a broader transition to a circular economy within WA. This includes creating a local vision, building a case for change through collaboration, promoting greater education and awareness campaigns and enabling a connected ecosystem, the required infrastructure and a transition to a circular economy, which in turn will lead to Net Zero and eco-resilience through a balance of natural capital, produced capital and human capital.

We all need to work together to move from a linear – 'take-make-use-dispose' consumption type approach to a circular approach where the value of resources is captured and retained in circulation for continued use, for as long as possible. The world's resources and natural systems are coming under increasing pressure from growing urban populations, growing consumption, and demand for resources, making it really important for us to get the balance right in terms of small, medium and global solutions and to communicate to businesses, industry, governments and the community that circularity can start, in fact needs to start small, but to think big.

The Circular Economy Horizon Scan will assist the EMRC to plan, promote and advance circularity in Perth's Eastern Region and across wider WA. The Scan will act as a guiding document to reduce environmental impacts, drive circular economy-based initiatives, future proof the business for market changes and increase awareness of the Circular Economy benefits.

The EMRC continues to lead the journey towards decarbonisation and Net Zero, through excellent work with its newly adopted EMRC's Sustainability Strategy which was developed in collaboration with our member councils, and now with this Eastern Region Circular Economy Horizon Scan.

Circularity is the key to achieving Net Zero and this Horizon Scan will help us understand our current position, regionally, and where we need to head in order to achieve our target of 'below zero carbon emissions by 2040'. This will be made possible through industry wide collaboration, cross industry mapping bases on needs assessment, ecological symbiosis and co-location, and creating industry and materials focused roadmaps to enable a circular economy, regionally and wider.

I am pleased to be able to share this important Horizon Scan and trust that together we can take the journey towards Net Zero and circularity through innovation and collaboration.

**Marcus Geisler**

**EMRC CEO**

## 2. Purpose of this scan

The Eastern Metropolitan Regional Council (EMRC) has recently undertaken an in-depth strategic review of their organisation and operations. This assessment included a preliminary assessment of the circular economy landscape. Through the review process, the EMRC has continued to explore the circular economy opportunity to understand how this new focus can deliver tangible benefits to their five member councils, communities, and the wider region.

There are numerous opportunities and benefits associated with accelerating the development of the regions circular economy including achieving Western Australian Government national targets of net zero carbon emissions by 2050, Waste Avoidance and Resource Recovery Strategy targets and economic growth targets.

Through an analysis of key data sources, a national, state, and regional macroeconomic assessment will show the largest influencing industries in terms of revenue generation. The data evaluated will also highlight industries that have high greenhouse gas emissions and/or difficult to abate waste generation. Each of these factors will be considered in terms of future markets, job creation and investment opportunities to help drive the shift to a circular economy. This could include investing in

new technologies to create more economic opportunities in response to future changes in waste generation, providing leadership in driving industry collaboration and establishing a baseline of data for innovative circular economy solutions.

This horizon scan will allow the EMRC to make circular economy focused strategic and operational decisions based on economic, regulatory and policy trends (i.e. net zero and diversion for landfill) as well as regional waste market forecast and shifting circular economy drivers. It will also help to determine the facilitation role that the EMRC may play in supporting a broader transition to a circular economy within Western Australia.

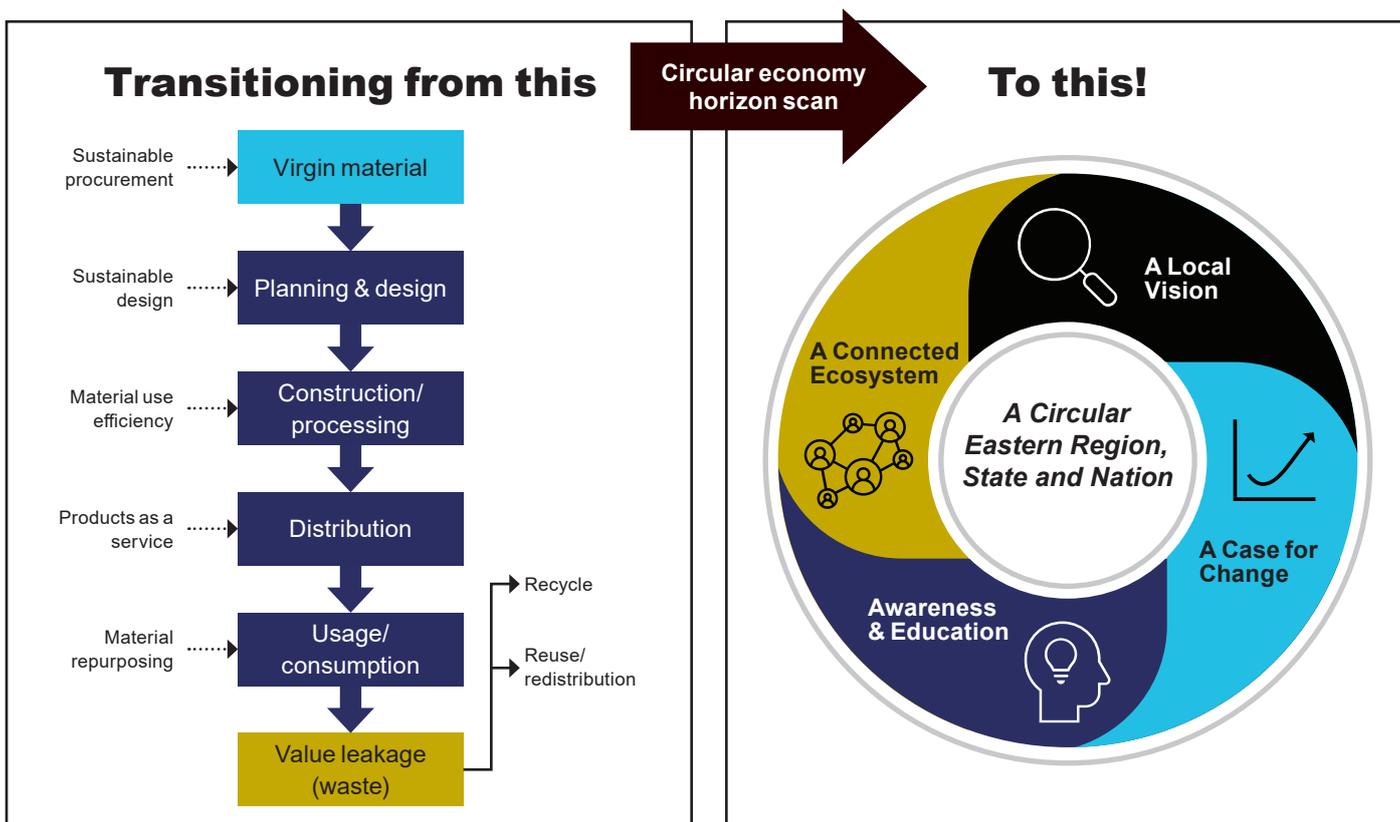


Figure 2.1 Purpose of this horizon scan - to support the transition to a circular economy

## 2.1 Disclaimers

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### 3. The Circular Opportunity

#### 3.1 Principles of a Circular Economy

The world's resources and natural systems are under increasing pressure from growing urban population, consumption and demand for resources, making the sustainable use of resources more critical by the day. Each year over 90 billion tonnes of primary materials are extracted globally with only nine per cent of these raw materials being reused after their first use.<sup>1</sup>

Traditionally Australia has followed a linear economy model where materials follow a simple process of *take – make – use – dispose*. The circular economy is about retaining the value of resources within a system such as an individual asset, an organisation, a supply chain, or a geographical region. The circular economy aims to change the way we plan, design and operate, removing waste before it exists, recognising the value of resources and retaining them in our economy, and creating a net environmental and social benefit from our economic activity.

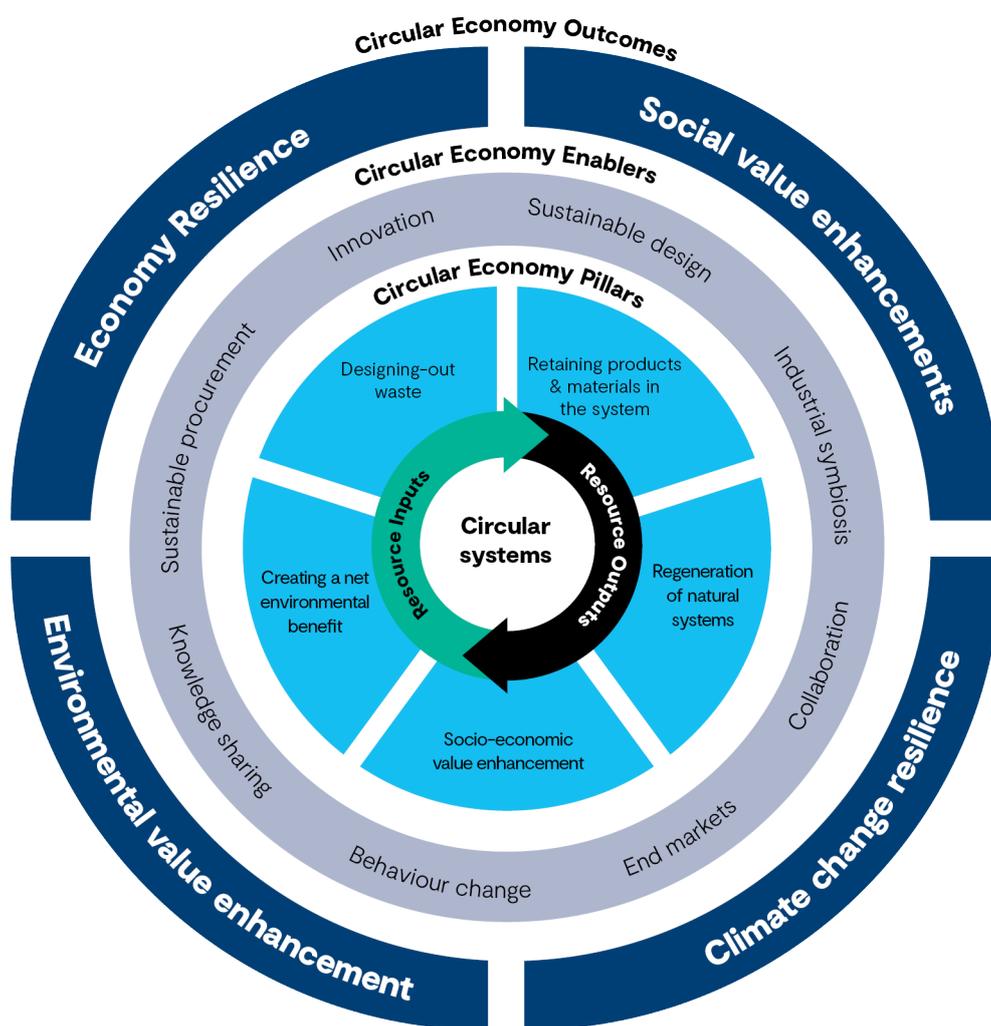


Figure 3.1 Circular economy model at a glance

<sup>1</sup> Circularity Gap Reporting Initiative, 2020

The aim of a circular economy shift away from a linear model of consumption to one in which value is captured and retained for continued use. A circular economy balances the ecological, social and economic needs of the present with the needs of the future by considering the following key principles of circular economy:

- Eliminating and designing out waste: targets the design phase of a material to eliminate waste generation before operation occurs. This encourages a design philosophy of reducing the dependency of sourcing virgin materials during operation but instead, looking for alternative options.
- Retaining products and materials in the system at their highest value: This principle encourages businesses to seek ways of retaining products and materials within their system and reduce the need to send waste to landfill. This can also be enabled influenced by extending the responsibility of a producer by providing goods as a service rather than product
- Creating a new environmental benefit & regeneration of natural systems: A truly circular economy aims to go beyond minimising the impact of industrial processes and seek to enhance the natural environment. This benefit and regeneration of the natural systems are achieved through healthier soils, unpolluted air and water, and increased biodiversity.
- Socio-economic value enhancement: A circular economy can provide benefits to multiple socio-economic areas including:
  - Business benefits: new business opportunities, cost-savings, increased supply chain resilience, simplified supply chains and improved corporate brand.
  - Benefits to Government: improved ecological service values, reduced human health risks, increased self-sufficiency and reduced climate change liability.
  - Community benefits: increased job opportunities, reduced health risk, lower household costs, job security, more disposal income

By adapting to circular economy principles, there will be a net benefit to the global ecosystem which will drive the change required to tackle climate change, decrease biodiversity loss and reduce net environmental impact.

## 3.2 Measuring Circularity

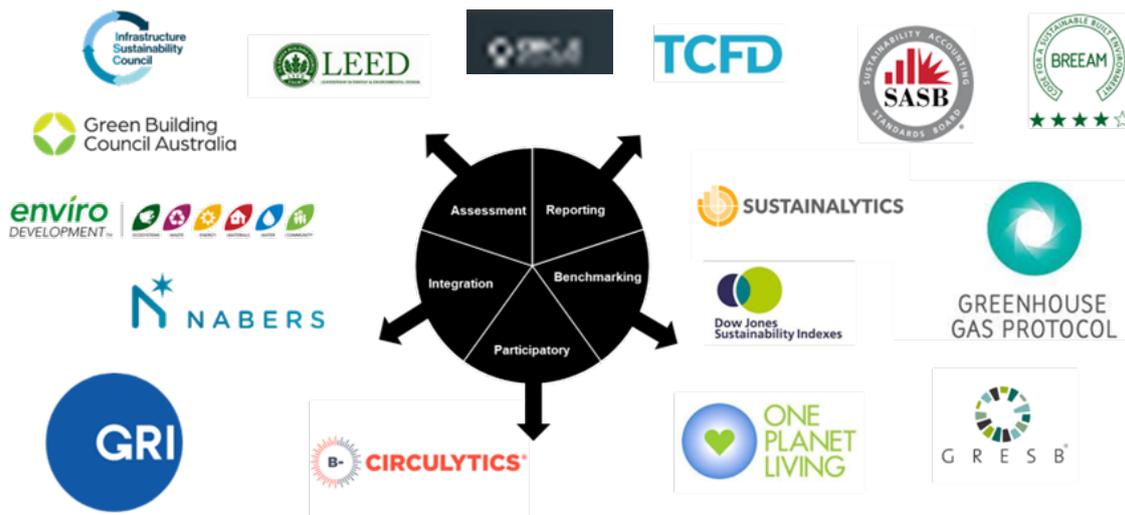
The measurement of the circular economy and its benefits is still developing across the world. The limited availability of tools for measuring circularity reflects both the complexity of measuring systemic change and the lack of available meaningful data. Additionally, each individual, organisation or government measuring circularity will require a different approach based on their overall objectives and the intended audience.

Currently, most jurisdictions have a waste generation centred measurement approach with the focus being on tonnes of municipal solid waste, construction/ demolition waste and hazardous waste. There is a range of different data sets available however they are not consistent across all businesses, sectors or jurisdictions which limits the ability to quantify impact.

Current data sets focus on volumes of waste to landfill, percentage recycled and specifically designed disposal facilities (i.e. class V materials) than an assessment of higher order R strategies, broader economic or environmental benefits. While data for extraction, processing, import and export of materials exists, environmental, societal impacts and financial exchange across sectors there remain unaccounted for. This includes data gaps across the supply chain, scales and jurisdictions.

Measurement of capacity for reuse and the cyclical potential of products/ materials is a key area for improvement. New datasets should be supplemented and supported by rates of reduction in other areas – for example: the reliance for virgin materials and finite resources.

At the organisational level, a range of circular economy measurements tools have emerged including:



A unified measurement tool will enable useful data collection, identification of key indicators, efficient analysis and productive sharing of information across industries. Currently, there is not a single well-established measurement tool that allows a true understanding of what circularity means and provide context for smart decision making. This limits current decision making and its subsequent impact on desired goals.

Any unified measurement tool will need to ensure that results can be used broadly to encourage faster change across industries and provide value to business and government. The seven considerations that should be made when developing a framework for measuring circularity at the company level are<sup>2</sup>:

1. Driving circular business performance
2. Targeting specific audiences pending on company objectives
3. Covering a comprehensive sustainability scope
4. Ensuring flexibility and inclusion
5. Adapting a phased approach
6. Building upon the framework and standards
7. Driving cultural change and provide guidance

### 3.3 Key Global and National Players

While the circular economy paradigm is developing rapidly, it is not a new, and is based on a collection of concepts including biomimicry, industrial ecology and cradle to cradle thinking. Recognised as a global leader, Dame Ellen Macarthur has elevated the paradigm to where it is now, a recognized part of mainstream discourse. Through global leadership and collaboration, the Ellen Macarthur Foundation (EMF) works with strategic partners to promote and facilitate the global transition to a circular economy.

According to the World Economic Forum<sup>3</sup>, a transition to a circular economy has potential material cost savings greater than USD \$1 trillion and global economic benefits could reach USD \$4.5. Trillion. The European Commission adopted the new circular economy action plan (CEAP) in March 2020. It is one of the main building blocks of the European Green Deal, designed to achieve carbon neutrality, halt biodiversity loss and ensure Europe stays competitive in the marketplace. The World Bank and OECD have also recognised the circular economy as a key vehicle to facilitate more efficient use of resources, and more sustainable consumption and production patterns as well as developing regenerative, resilient projects and initiatives to facilitate solutions that reduce poverty and build prosperity in developing countries.<sup>4</sup>

<sup>2</sup> <https://www.wbcsd.org/Programs/Circular-Economy/Metrics-Measurement/Resources/Landscape-analysis>

<sup>3</sup> <https://www.weforum.org/communities/circular-economy-and-value-chains>

<sup>4</sup> *Circular Economy: An Opportunity to Transform Urban Water Services* (worldbank.org)

The adoption of the Circular Economy Promotion Law in 2008<sup>5</sup> marked China as a frontrunner in circular economy policy and was proposed as a new model to help China make better use of resources and energy. Many European countries including Finland, Netherlands, France, Slovenia and others are committing to circular roadmaps noting the economic advantage in such a transition. The benefits of a circular economy to Australia have been reported on by KPMG<sup>6</sup> highlighting a potential GDP uplift of \$210 billion and the creation of 17,000 new jobs by 2048. PWC<sup>7</sup> have stated that a reduction of 165m tonnes of CO<sub>2</sub> emissions could be achieved by a circular transition.

As a result of the national waste reduction targets to reduce waste to landfill by 80% by 2030 and the ban on waste exports, the CSIRO was tasked with developing a National Circular Economy Roadmap which highlighted the potential to triple job creation from resource recovery in Australia, where the recycling sector currently generates 9.2 jobs per 10,000 tonnes of waste, compared with only

2.8 jobs for the same amount of waste sent to landfill. In addition, increasing Australia's recovery rate by just 5 per cent would add an estimated \$1 billion to GDP. The Australian Government has also provided \$1.6M in funding to Planet Ark to establish the Australian Circular Economy hub to facilitate collaboration and knowledge sharing.

State based initiatives including NSW Circular, funded by the NSW Government, Recycling Victoria, establishing the Circular Economy Business Innovation Centre (CEBIC) and the South Australian Government's Green Industries SA have all identified the value within a circular economy. Recent years has seen the development of a range of not-for-profit groups evolving across each state to assist in local knowledge sharing, network creation and education.

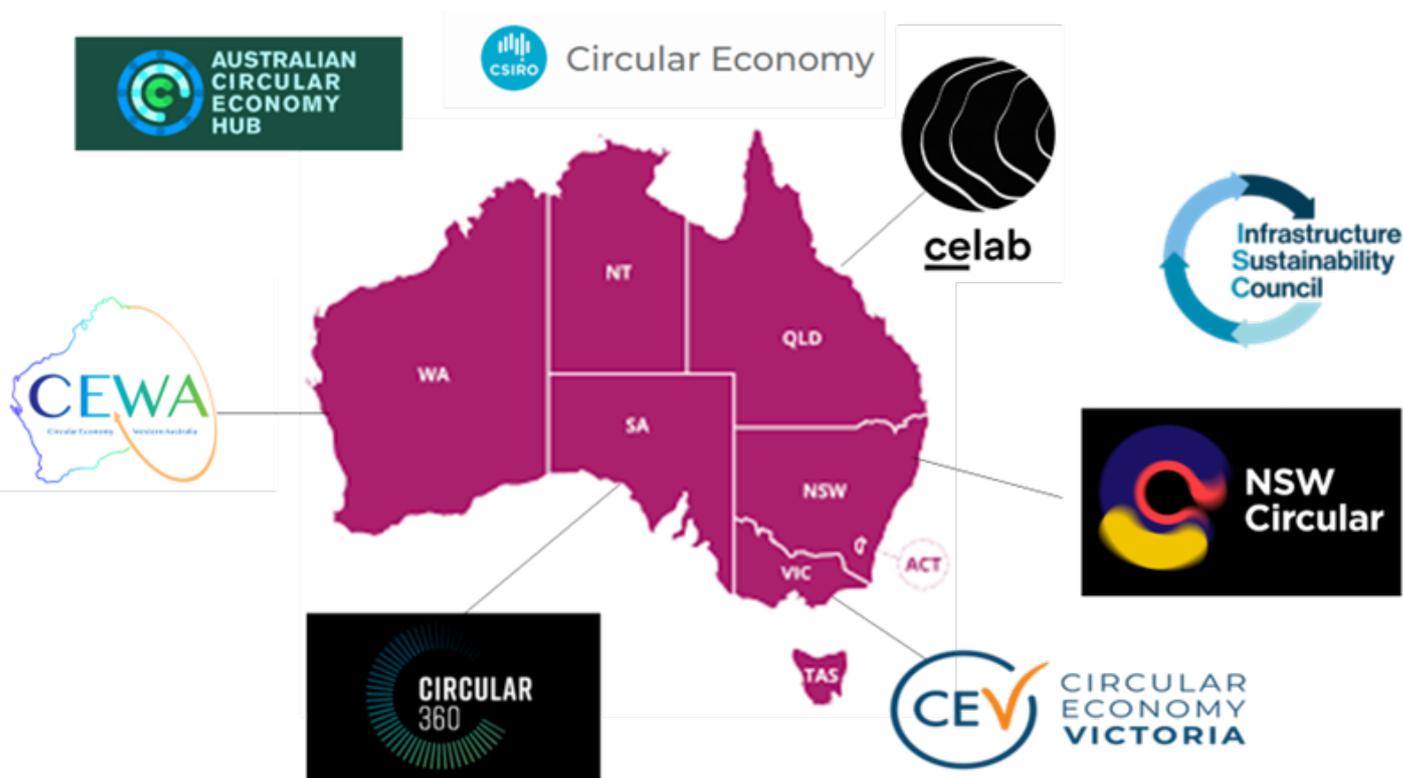


Figure 3.2 The shift towards a circular economy in Australia

<sup>5</sup> Circular Economy Promotion Law of the People's Republic of China, Congressional – Executive Commission on China Circular Economy Promotion Law of the People's Republic of China (Chinese and English Text) | Congressional-Executive Commission on China (cecc.gov)

<sup>6</sup> Potential Economic Payoff of a circular economy, 2020

<sup>7</sup> Building a more circular Australia, 2021

### 3.4 The Circular Economy and Greenhouse Gas Emissions

The world is currently focused on decarbonisation with clear directives from the IPCC reporting and 2022 United Nations Climate Change summit pushing the setting of net zero targets for 2050. However, the transition to a Net Zero could stall if there isn't a shift from our current relationship with the extraction of non-renewable resources.

Decoupling our economic prosperity from the extraction of virgin materials is a key premise of the circular economy. According to the EMF, almost half of the total reductions in greenhouse gas (GHG) emissions needed to limit global warming to 1.5°C above pre-industrial levels will have to be achieved by adopting a circular economy. In Western Australia, the highest contributor to GHG emissions is the energy sector with over 84,000 mega tonnes of CO<sub>2</sub>eq emissions in 2020. This estimate does not account for the embodied carbon associated with product use as shown in Figure 2.3.

In addition the global finance sector is seeing major shifts in investment in solution providers responding to the major challenges facing society. According to research from Opimas and the Global Sustainable Investment Alliance, 'Green' investment increased by over USD 17 Trillion in 2020. Deutsche Bank estimates that 95% of assets under management, or USD 130 trillion, will be governed by an ESG mandate by 2030. The circular economy can help to translate climate ambition into action.

Another key factor to note is that currently in Western Australia Greenhouse Gas Emissions the WA Environmental Protection Authority will require proponents

to develop a Greenhouse Gas Management Plan as part of the proposal assessment process that demonstrates their contribution towards the aspiration of net zero emissions by 2050. New proposal assessments predominately only include large developments with anticipated scope 1 emission levels over 100,000t of CO<sub>2</sub> equivalent however suppliers to these large industries or projects may well be required to report on emissions in the future as part of the wider supply chain supplying these projects. There is also a move to report on scope 2 & 3 emissions which will significantly impact the reporting required across supply chains.

The EMRC have been working closely with industry to help track and abate the regions greenhouse gas emissions. The re-energising Perth's Eastern Region<sup>9</sup> project has undertaken numerous audits focusing on lighting, pool maintenance and air-conditioning in Bassendean, Bayswater and Mundaring. Through energy efficiency initiatives such as improved technologies, better circulation devices and building upgrades, these audits found energy consumption was reduced by over 40% across each of the trial facilities. One of the initiatives included replacing street lighting in Bassendean with LED's which increase the life of the lighting system when compared to previous alternatives, reducing the impact of embodied carbon from regular replacement and increased energy efficiency. Reducing embodied carbon emissions through elongating the life of materials is a key principle of a circular economy.

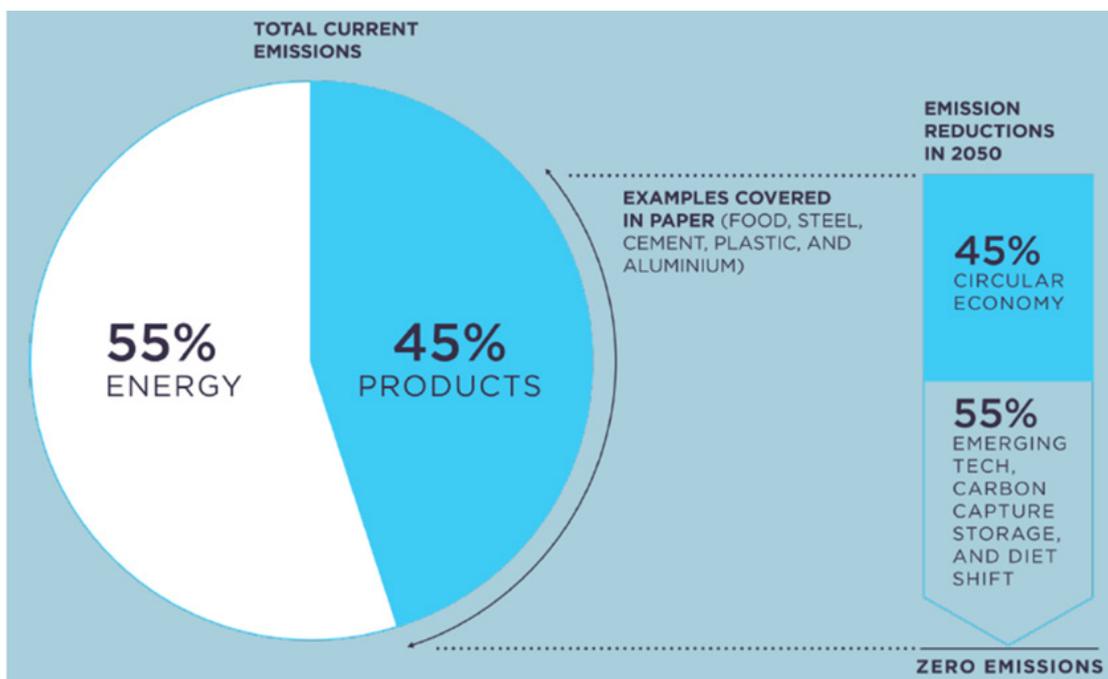


Figure 3.3 Embodied carbon contribution on the global emissions profile<sup>8</sup>

<sup>8</sup> Ellen McCarthy Foundation

<sup>9</sup> <https://www.emrc.org.au/sustainability/environmental-services/environmental-projects/re-energising-perth-s-eastern-region.aspx>

## 3.5 Circular Economy and economic growth

### 3.5.1 Global

Global events such as the COVID-19 pandemic, the Russian invasion of the Ukraine and the economic downturn has led to a significant impact on supply chains. These are due to logistics barriers such as travel restrictions, reduced availability of fuel sources and under resourced service providers. The circular economy offers better more resilient economic growth whilst addressing the pressing global challenges that we face.

The desire for circular practices was highlighted during the COVID-19 pandemic where there was a growing appetite for local suppliers to reduce the impact of supply chain logistics. With business as usual becoming more stable in 2022, there has been a demand for solutions to reduce waste generation and to reduce the carbon footprint of carbon intense industries such as concrete manufacturing, aluminium smelting and mining extraction.

With Australia and Western Australia being heavily reliant on import and export opportunities for economic growth, global events such as the COVID-19 pandemic have a notable impact on supply chains. This also impacts the ability to enable sustainable circular economy initiatives such as closed-loop materials and product as a service initiatives.

### 3.5.2 State and National

The WA Government released a Diversify WA during 2019, a new economic development framework which focused on developing a robust economy through job creation and industry diversification. This document acknowledges that while the Mining sector is a key part of the WA economy, reliance on this sector over the past 30 years has left the state exposed to global fluctuations in commodity prices and placed a risk on local jobs whilst also limiting the support and development of other sectors<sup>10</sup>.

The National Circular Economy Roadmap<sup>11</sup> developed by CSIRO highlights that diversification and innovation within our manufacturing industries will drive significant economic gains. In addition, Australia's ban on the export of waste materials has created an opportunity for value creation from waste. Identifying circular opportunities across the whole supply chain can also avoid waste being created in the first place and instead focus on the value that products and materials have with continued use. With

a new focus on value, new technologies, services, and industries can emerge that generate long-term economic opportunity and job creation within our State.

In Western Australia, while Covid-19 may have been muted by comparison, supply chain issues, unemployment and pressure on businesses have highlighted a need to consolidate a diversified and resilient economy that also respond to global challenges.

For Western Australia, currently the value of natural resources is defined as unprocessed overseas exports, limiting the economic opportunity of controlling all stages of the supply chain including manufacturing. By maximising resource use and incorporating the principles of circularity during extraction, production and consumption, the circular economy can help boost and diversify our economic profile.

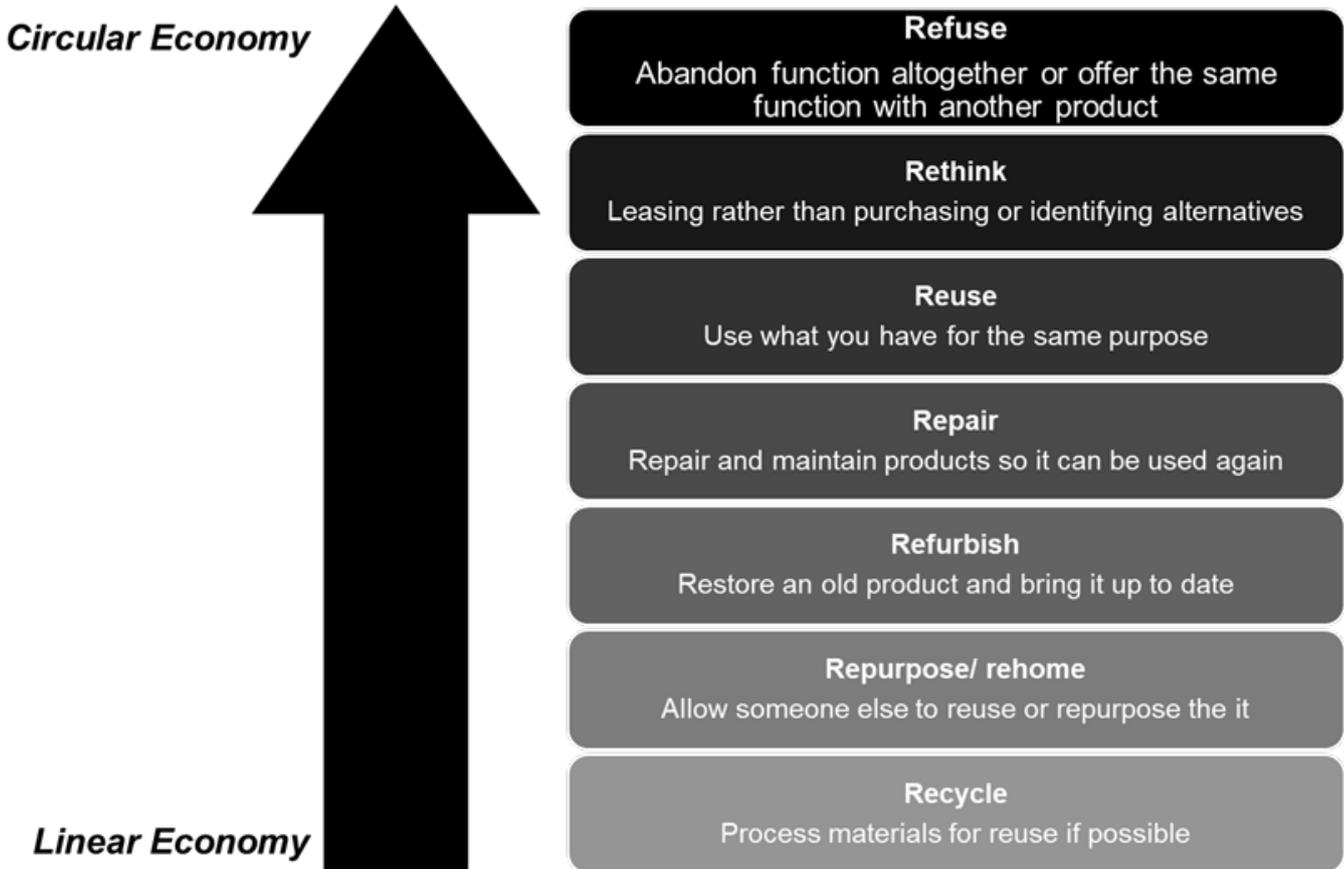
### 3.5.3 Regional

The key to the circular economy is diversifying and developing capacity across local supply chains offering closed-loop economic wins less impacted upon by global fluctuations. Creating a regionally focused circular system can help reduce waste and minimise resource inputs, thus eliminating the pressure on supply chains to maintain stability during unforeseen circumstances (like the pandemic). On top of creating a more resilient supply chain, circular systems are also a needed solution to help work towards a net-zero impact on the planet.

Circular economy participants can be divided into three categories of community, government and organisational (i.e. business, industry, commercial). Collaboration across these participants can be an effective solution to issues surrounding insufficient material volumes to make a circular solution economically viable. Co-ventures also provide financial capacity to address problematic materials and products whilst providing new regional job markets. Regional collaboration is enabled by community support and education programs where application of the 7 R's act as a simple way to support businesses to make more circular – less linear decisions.

<sup>10</sup> <https://www.ipcc.ch/reports/>

<sup>11</sup> <https://www.un.org/en/climate-sdgs-conference-2022>

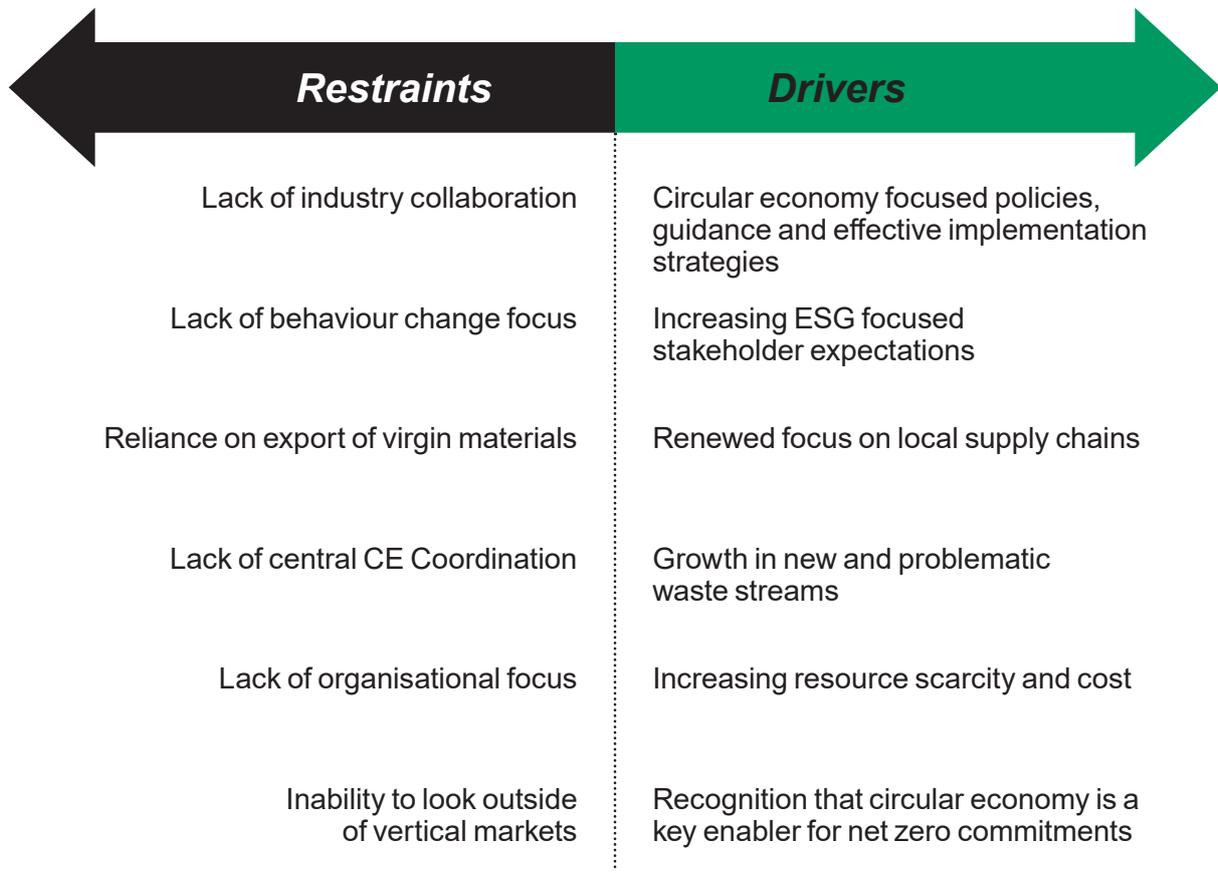


**Figure 3.4** 7 R's and associated opportunities for the transition to a circular economy

When establishing a circular economy at a regional level, it is important to create a balance between small, medium and global solutions. This is usually driven by the financial viability of aggregating specific materials or social complexity of the area providing alternative options. For example, refusing packaging materials may not be a viable alternative in smaller regional areas where established transport and logistics providers are available.

## 4. Circular economy drivers & restraints

The following sections discuss the key circular economy drivers & restraints including:



### 4.1 Key Circular Economy Market Drivers

#### 4.1.1 Circular economy focused policies, guidance, and effective implementation strategies

Legislation and government policies have historically been the key driver for the circular economy change globally, creating the all-important 'fiscal-carrot and punitive-stick' to rapidly change behaviour. For example, when the European Union (EU) banned electronics from landfill with the Waste Electrical and Electronic Equipment (WEEE) Directive and subsequent Regulations, it created an immediate business opportunity for electronic equipment recycling businesses. This also led to a new business of

mining landfills to extract finite resources for reinjection into the manufacturing industry.

In 2015, Western Australia significantly increased its landfill levy from \$28 to \$55 a tonne for putrescible waste and \$8 to \$40 a tonne for inert waste. This was then increased in 2018 for both waste types to \$70 per tonne<sup>12</sup> which is between a 60-88% increase.

<sup>12</sup> <https://www.mediastatements.wa.gov.au/Pages/McGowan/2019/03/Waste-levy-capped-for-2019-20.aspx>

Furthermore, the release of the Waste Avoidance and Resource Recovery Strategy 2030 (WARR) in 2019 explicitly states the purpose of the Strategy being to introduce “significant transformations aimed at Western Australia (WA) becoming a circular economy”. The effect of the WARR strategy has quickly cascaded into strategic thinking in Western Australia with numerous largely private and public sector organisations developing circular economy focused strategy. Other key legislative drivers for circular economy change include:

## National

- National decarbonisation targets – net zero by 2050
- National Environmental Economic Accounting (EEA) Strategy and Action Plan (2018)<sup>13</sup>
- Budget Strategy and Outlook (2022)<sup>14</sup>
- General Funding Strategy and Investment Plan 2021-2024 (2021)<sup>15</sup>
- Digital Economy Strategy 2030 (2021)<sup>16</sup>
- National Waste Policy Action Plan (2019)<sup>17</sup>
- Action Plan for Sustainable Procurement (2020)<sup>18</sup>
- Australian Government Waste and Recycling Reduction Bill (2020)<sup>19</sup>
- COAG Export Bans – Response strategy (2020)<sup>20</sup>
- CSIRO National Circular Economy Roadmap for plastics, glass, paper, and tyres (2021)<sup>21</sup>
- National Plastics Plan (2021)<sup>22</sup>
- National Soil Strategy Australia (2021)<sup>23</sup>
- Australia’s Modern Manufacturing Strategy (2021)<sup>24</sup>
- THRIVE 2030: Strategy Action Plan (2021)<sup>25</sup>

## Western Australia

- Diversify WA - Supply Chain Development Plan 2021-22 (2021)<sup>26</sup>
- State Planning Strategy 2050 (2021)<sup>27</sup>
- Net Zero Emission Mining (2022)<sup>28</sup>
- Energy transformation strategy (2021)<sup>29</sup>
- Western Australian Soil Health Strategy 2021 - 2031<sup>30</sup>

<sup>13</sup> <https://eea.environment.gov.au/about/national-strategy-and-action-plan>

<sup>14</sup> [https://budget.gov.au/2022-23/content/bp1/download/bp1\\_2022-23.pdf](https://budget.gov.au/2022-23/content/bp1/download/bp1_2022-23.pdf)

<sup>15</sup> <https://arena.gov.au/about/publications/funding-investment-plan/>

<sup>16</sup> <https://digitaleconomy.pmc.gov.au/>

<sup>17</sup> <https://www.environment.gov.au/protection/waste/publications/national-waste-policy-action-plan>

<sup>18</sup> <https://www.environment.gov.au/protection/waste/publications/sustainable-procurement-guide-2020>

<sup>19</sup> [https://www.aph.gov.au/Parliamentary\\_Business/Bills\\_Legislation/Bills\\_Search\\_Results/Result?bld=r6573](https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bld=r6573)

<sup>20</sup> <https://www.coag.gov.au/sites/default/files/communique/phasing-out-waste-exports-response-strategy.pdf>

<sup>21</sup> <https://www.csiro.au/en/research/natural-environment/circular-economy>

<sup>22</sup> <https://www.environment.gov.au/system/files/resources/a327406c-79f5-47f1-b71b-7388407c35a0/files/national-plastics-plan-2021.pdf>

<sup>23</sup> <https://www.agriculture.gov.au/ag-farm-food/natural-resources/soils>

<sup>24</sup> <https://www.industry.gov.au/data-and-publications/make-it-happen-the-australian-governments-modern-manufacturing-strategy/our-modern-manufacturing-strategy>

<sup>25</sup> <https://www.austrade.gov.au/news/publications/thrive-2030-strategy>

<sup>26</sup> [https://www.wa.gov.au/system/files/2021-10/2109-095\\_DWA-Supply%20Chain%20Development%20Plan-Web.pdf](https://www.wa.gov.au/system/files/2021-10/2109-095_DWA-Supply%20Chain%20Development%20Plan-Web.pdf)

<sup>27</sup> <https://www.wa.gov.au/government/publications/state-planning-strategy-2050>

<sup>28</sup> <https://www.mriwa.wa.gov.au/challenges/net-zero-emission-mining/>

<sup>29</sup> <https://www.wa.gov.au/organisation/energy-policy-wa/energy-transformation-strategy>

<sup>30</sup> <https://www.agric.wa.gov.au/wa-soil-health-strategy>

#### 4.1.2 Increasing ESG focused stakeholder expectations

Momentum for change is driven by an increasing societal understanding of climate change risk and demand for action to decarbonise our society. Sustainability and circular economy principles are cascading down to national, State and local government policy.

Despite the Australian Government's slow response to climate risk, communities are mobilising, shareholder expectations are increasing, and young professionals are choosing employers whose company values and actions align with their personal sustainability values. These shifting dynamics are impacting corporate and government policy. Companies and organisations that are not actively reducing their waste and carbon emissions and minimising their impact on the environment and communities in which they operate, risk the 'real cost' of doing business increasing, as shareholders and investors demand tangible action and the 'social licence to operate' is put at risk.

This has been further highlighted by global investment decision making (such as BlackRock Fund) shifting away from companies that are not incorporating ESG targets and actions and toward those that have clear plans at board level and are contributing to the advancement of circular economy<sup>31</sup>. Additionally, Intesa Sanpaolo is an Italian international banking group that has set circular economy as a strategic priority with the bank stating "the risks of continuing to operate in a linear, extractive economic model are becoming more evident by the day"<sup>32</sup>

#### 4.1.3 Renewed focus on local supply chains

With global supply chains growing annually (excluding during the COVID 19 pandemic), the logistics surrounding reuse, repair, refurbishments, repurpose and recycling of materials is often not economically viable. In instances where specialised equipment has been designed in a specific area such as electronics in China, car manufacturing in the USA and processing equipment in Europe, the circular economy logistics around keeping a material within its original life cycle becomes increasingly more difficult. Global supply chains are complicated through differing governance structures, transport logistics (import and export) and fast evolving markets.

The COVID-19 pandemic and conflict in the Ukraine have highlighted the vulnerability of complex, global supply chains, which have an over-reliance on foreign-sourced goods, services and markets. Instead, we are witnessing a clear shift in focus towards a need to develop more resilient local supply options. This is a significant driver for the uptake of circular economy principles in Western

Australia, which, as a remote and geographically isolated society has much to gain from a circular approach.

Organisations such as the Global Distribution Alliance could be leveraged to provide a global transition to circular supply chains through their extensive logistics and transportation partnerships. With a mission to strengthen the global distribution network through comprehensive tracking and the integration of modern digital technologies. These existing systems could be leveraged to also track and provide transport services for end of life materials and reinjection into the cycle.

With its strong economy and geographic isolation, WA is well-placed to invest in local manufacturing, local employment creation and value retention. This has been highlighted as a key focus in the Diversify WA Economic Framework.<sup>33</sup>

#### 4.1.4 Growth in new and problematic material streams

In addition to regulatory driven shifts in the WA waste market, we can also expect to see changes to the WA waste dynamic from the rapidly evolving industrial landscape. This includes significant future waste streams from the renewable energy sector, with numerous gigawatt scale wind and solar farms being planned in response to the emerging hydrogen fuel demand. This will lead to an inevitable future disposal requirement for solar panels and wind turbines along with large- and small-scale lithium batteries.

With the success of the container deposit scheme (CDS) it is evident that consumer driven source separation is possible with the right incentive model. Although this stream is being collected at high recovery rates, Western Australia is currently limited by a lack of manufacturing facilities resulting in streams such as glass bottles being transported to South Australia.

Some of the other growth areas in waste generation including (but not exclusive to):

- Electronics and ICT from organisational digitisation
- Batteries and E-vehicles from electrification and decarbonisation of industry fleets
- End of life solar panels from domestic and industrial initiatives
- Food Organics Green Organics processing from source separation initiatives associated with the national and State waste strategies

<sup>31</sup> <https://www.blackrock.com/americas-offshore/en/products/310165/blackrock-circular-economy>

<sup>32</sup> <https://ellenmacarthurfoundation.org/financing-the-circular-economy-capturing-the-opportunity>

<sup>33</sup> <https://www.wa.gov.au/organisation/department-of-the-premier-and-cabinet/diversify-wa-economic-development-framework>

- Packaging, plastics and paper from source separation initiatives associated with the COAG ban
- Construction and building materials from an increase in state-wide infrastructure projects
- Tyre processing associated with the COAG ban
- Fly ash processing / value adding from waste to energy facilities

#### 4.1.5 Increasing resource scarcity and cost

The world's resources and natural systems are under increasing pressure from growing urban population, consumption and demand for resources, making the sustainable use of resources more critical by the day. On current projections, the footprint of cities is predicted to grow 150% by 2030<sup>34</sup>, global consumption of resources is expected to double in the next forty years<sup>35</sup> and annual waste generation is projected to increase 70% by 2050<sup>36</sup>.

While the urgency to respond is primarily driven by the threat of climate change, we are also faced with the irrefutable fact that we are consuming finite resources at an alarming and unsustainable rate. Some examples of a resources of growing scarcity include rubber (impacting the motor vehicle & processing industry), potash (impacting food prices) and rare earth metals (impacting electronics and electrification technologies).

The cost of a resource is directly proportional to its relative abundance and availability. By identifying material production responsibilities across the complete supply chain, the identification of alternative, circular pathways can increase the resilience of an economic system.

#### 4.1.6 Recognition that circular economy is a key enabler for net zero commitments

In November 2020, Western Australia formalised its emissions reduction target in the State Climate Policy, which included actions to transition to net zero emissions by 2050, this is cascading throughout Western Australia with every Government agency, department required to develop a plan to achieve net zero carbon by 2050. The private sector is also setting ambitious net zero targets in an effort to de-risk their business ensure future investment and respond to changing global expectations.

While the focus is currently strongly on the decarbonisation of our energy systems, the circular

discourse highlights that without a fundamental change in our reliance on the extraction of virgin materials to fuel our production and consumption patterns, we will not achieve our net-zero aspirations<sup>37</sup>. Circular economy principles and tools have been identified as key enablers for net zero strategies globally as well as creating new opportunities for markets in Products as a Service, maintenance and remanufacture and recycling and logistics.

## 4.2 CE Market Restraints

### 4.2.1 Lack of industry collaboration

Complexity surrounding designing waste out of a system is often a difficult concept for organisations to understand. This is worsened by a lack of collaboration between customers and suppliers and overall collaboration to allow for sustainable solutions to be developed. The Australian market is currently limited to open loop reuse (i.e. road surfacing with construction material, glass, plastic and end of life tyres) and basic recycling.

Industries are now looking for more sustainable solutions however often this is limited by what is communicated by vendors, what is currently available in the market and current regulations. An example of upstream design creating significant waste generation is tyres. As tyre products have been developed over decades, the design has evolved to make the product as safe and physically hard as possible by high temperature treating the material to increase resilience. Although this provides a longer operational life, changing the natural chemical structure of the native material makes it difficult to re-inject back into the system. This has resulted in open-loop repurposing solutions such as road surfacing which is energy intensive and simply prolonging the materials end-of-life. This example highlights how a lack of industry collaboration has resulted in the creation of a product that is linear by nature, inhibiting the implementation of truly circular solutions.

Circular solutions require a collaborative approach and shared goals to leverage a long term closed loop solution. These solutions often require industry collaboration and innovation to succeed. An example of this collaboration can be seen in the outcomes of Circular Plastics Australia who have developed a local Australia based closed loop solution to PET packaging.<sup>38</sup>

34 <https://www.un.org/en/observances/biological-diversity-day/convention>

35 <https://www.oecd.org/environment/raw-materials-use-to-double-by-2060-with-severe-environmental-consequences.htm#:~:text=22%2F10%2F2018%20-%20The%20world%E2%80%99s%20consumption%20of%20raw%20materials,seeing%20today%2C%20according%20to%20a%20new%20OECD%20report.>

36 <https://www.worldbank.org/en/news/press-release/2018/09/20/global-waste-to-grow-by-70-percent-by-2050-unless-urgent-action-is-taken-world-bank-report#:~:text=Global%20Waste%20to%20Grow%20by%2070%20Percent%20by,rapid%20urbanization%20and%20growing%20populations%2C%2C%20the%20report%20finds.>

37 Reference

38 <https://circularplasticsaustralia.com/>

A lack of industry collaboration can also be driven by hesitation surrounding shared intellectual property between competing organisations. This can be alleviated through government incentive programs and industry supported stewardship programs where information can be aggregated and de-identified. Shared services such as processing and manufacturing of recycled content can also be enabled by government incentive programs but are only successful with the appropriate industry support.

#### **4.2.2 Reliance on export of virgin materials**

The Australian and Western Australian economy are both significantly influenced by mining with a growth margin of 11.5% in 2021. Materials such as bauxite (aluminium ore), iron ore, lithium, gold, lead, uranium, zinc and rare earth metals are all currently being mined in Australia with varying market demand. With a global shift to sustainable decision making, high commodity materials such as rare earth minerals have resulted in a peak in mining. Due to the “electrification” of traditionally hydrocarbon rich operations, there has been an increased focus on mineral rich countries such as Australia.

As one of Australia’s more mature industries dating back to more simplistic extraction techniques such as gold panning during the goldrush, there is a strong economic reliance on extracting virgin materials for use across all industries. If Australia wants to shift to a circular economy this business model would need to be re-evaluated to acknowledge issues surrounding finite resources reaching end of life/ supply. A potential lever to enable better material tracking and decreasing reliance on the extraction of virgin materials are government incentive programs of levies. With an appropriate financial mechanism, tracking, recovery and leasing of extracted materials would be more appealing, catalysing circular economies.

According to the World Business Council for Sustainable Development (WBCSD), “the total demand for resources is expected to reach 130 billion tons by 2050,” an overuse of the Earth’s total capacity by more than 400%<sup>39</sup>. This highlights a prevalent risk to the Australian economy with an over reliance on virgin material extraction and distribution.

#### **4.2.3 Lack of behaviour change focus**

Shifting away from a linear economy is riddled with challenges which are exemplified by a reliance on human behaviour change. The more simplistic model of take – make – dispose is the natural pathway with current systems and design practices focusing on the cheapest and most efficient solutions. For example, when single use

plastics were introduced, the purpose was to reduce the time required to safely package and store supplies such as food whilst reducing effort and cost.

Successful behaviour change can notionally be described as altering the actions of an individual, an organisation or a community, even when the target is agnostic to an emotional driver or a particular ideology. For instance, circular economy focussed behaviour should be exhibited by all, not just by people who are motivated to act by a passion for circular economy thinking.

While legislation and associated financial penalties (e.g. landfill levies) are critical behaviour change drivers, creating business opportunities for circular alternatives; behaviour change is accelerated when coupled with education and support programs, effectively penalising the linear behaviour but supporting community to minimise the risk of incurring this penalty.

With current designs, there is a heavy reliance on source separation to make the reuse, repair, refurbishments, repurpose and recycling of materials economically viable. As shown by the current 2 and 3 bin systems nationally, this is often a significant challenge due to lack of education, ease of application and misalignment between industries (i.e. confusing marketing). The key to addressing this issue is through smart education strategies and national/ preferably international standards for waste management. This will enable higher volumes of resource recovery and drive the perception of “waste” from being a problem to a valued commodity. A successful example of a behaviour change program that has been successful in Australia is the container deposit scheme where specific materials were given a value that both increased household source separation and encouraged investment in processing infrastructure of these materials.

By strengthening and streamlining circular education programs, a shift in behaviour change can be achieved. As exhibited by the national program War on Waste released in 2017. This well-known program highlighted the impacts of waste generation such as single use plastics which resulted in increased user alternatives and source separation. This was later supported by government initiatives such as the COAG ban of 2019, where plastics were identified alongside glass, tyres, paper and cardboard to enable a shift in specific material consumption.

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<sup>39</sup> <https://www.wbcd.org/>

#### 4.2.4 Lack of prioritisation and coordination

One of the key barriers to applying circular thinking across government and business is simply time and focus. Core tasks, services or products are often valued based purely on short-term/ immediate payback or job related KPI's. Opportunities are often not realised because it is simply not anybody's job to look for circular opportunities. In addition, hoping for circular outcomes from adapting inherently linear systems will only marginally improve circumstances. Systemic change invariably requires prioritisation and coordination to develop a set of shared goals and pathways to successful implementation.

Centralised coordination for circular economy leadership is essential to enable a connected WA circular economy. It is the key to leading practice, acting as the hub and driver for circular economy knowledge sharing across community, whilst fostering leading practice, innovation and thought leadership and providing the platform for cross industry collaboration and exchange.

Another key barrier is how rarely government and business look outside of the vertical markets and supply chains that organisations inhabit. The solution is more than likely going to be business-as-usual in another sector. It has been observed that bringing organisations together from different industries (often geographical neighbours) often leads to win-win synergies. Collaboration across sectors and with our geographical neighbours is key to circular solutions and is the premise for many successful industrial ecologies that are developing around the world.<sup>40</sup>

#### 4.2.5 Lack of Funding

Transitioning from a linear to a circular economic model will require substantial structural, technological, and behavioural change within society. To enable change and growth, in new circular economic business models, direct investment in minimising waste and pollution as well as supporting business to shift towards designing and manufacturing products and services that use and reuse resources efficiently and reduce the need for the constant injection of virgin materials will be required.

While the evolution of circular economy across other parts of Australia has seen funding contributions from both the Federal Government and some State governments, there is yet to be a consolidated approach to the transition to a circular economy in Western Australia.

At the National level we have seen the emergence of the Planet Ark Australian Circular Economy Hub, a foundation that is partially funded by the Australian Federal Government along with other partners. We have seen the State based NSW Circular (now Circular Australia), Circular Economy Victoria (CEV) and Circular 360 in South Australia develop standing relationships with State Government Agencies to ensure they can act as State circular economy hubs. Circular Economy WA<sup>41</sup> has also launched however is yet to become a funded body which could limit the capacity for impact.

While there are some examples of sustainability programs being funded (for examples: Waste Sorted Grants: Waste Authority, Sustainable Business Fund), these funding sources are often tied to predetermined outcomes that do not include a specific circular economy focus and can in fact limit the capacity for innovation.

Examples in other States include funding from Sustainability Victoria<sup>42</sup> that highlights opportunities for funding and investment in a circular, net-zero emissions economy including support for developing new circular business cases, research, development and demonstration funds as well as commercialisation support. Specific material stream funding is also available for examples: textiles, organics and others.

The lack of targeted direct funding for circular economy projects will slow the transition through a lack of focus on priority areas, lack of market development and funding to support businesses who wish to transition.

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<sup>40</sup> [http://www.symbiosis.dk/en/https://wwf.panda.org/wwf\\_news/?204431/Kalundborg-industrial-symbiosis#:~:text=The%20Danish%20municipality%20of%20Kalundborg%20is%20widely%20considered,closed-loop%20flows%20of%20energy%2C%20water%2C%20materials%2C%20wastes%2C%20etc](http://www.symbiosis.dk/en/https://wwf.panda.org/wwf_news/?204431/Kalundborg-industrial-symbiosis#:~:text=The%20Danish%20municipality%20of%20Kalundborg%20is%20widely%20considered,closed-loop%20flows%20of%20energy%2C%20water%2C%20materials%2C%20wastes%2C%20etc)

<sup>41</sup> [www.cewa.com.au](http://www.cewa.com.au)

<sup>42</sup> [www.sustainability.vic.gov.au](http://www.sustainability.vic.gov.au)

## 5. Regional analysis

### 5.1 Overview

There are numerous global, national, and state drivers that are pushing for circular economy change. Several strategic documents have been released as a catalyst for change in the circular economy space including:



43

Each of these documents highlight different gaps in baseline data, circularity measurement and the economic growth potential associated with the circular economy opportunity. The following outlines the key baseline data that has fed into these documents and economic opportunity at a national, state, and regional level.

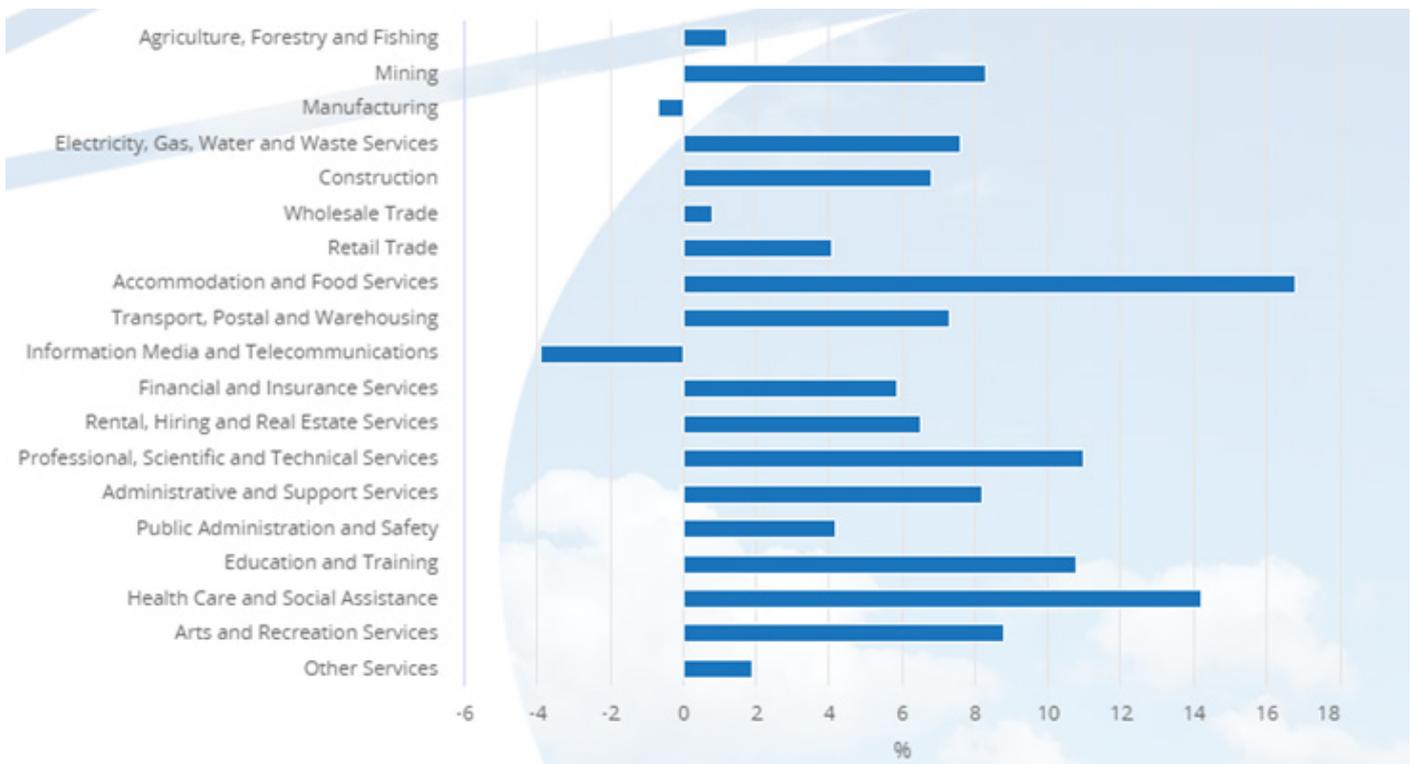
### 5.2 Australian Context

In financial year 2020/21 Australia showed a Gross Value Added (GVA) index increase of 1.3% across all industries. This was predominantly influenced by the following top three areas of growth (Australian Industry and Skills Committee, 2022)<sup>44</sup> Mining at 11.5% growth, Health care

and social assistance at 8.1% growth and Financial and insurance services at 8% growth. This is also reflected in employment growth projection for each of these industries between 2020 and 2025 as shown in Figure 4.1.

<sup>43</sup> National Waste Policy Action Plan, 2019, Sustainable Procurement Guide, 2020, Recycling and Waste Reduction Bill 2020, COAG Export Bans – Response strategy 2020, A circular economy roadmap for plastics, tyres, glass and paper in Australia, 2021, National Plastics Plan, 2021 National Soil Strategy, 2021, Make it Happen: The Australian Governments Modern Manufacturing Strategy 2021, Australian Circular Economy Hub Strategic action plan for 2020-2023, Diplomatic Courier Ana Rold 2021 Report, Ellen Macarthur Foundation 2022, CSIRO Circular Economy and Waste Management Plan, KPMG Potential economic pay-off of a circular economy for Australia, United Nations Environment Programme Driving The Shift To Circular Economies: New Report On Role Of Finance Industry

<sup>44</sup> Note that these values can vary as per what has been displayed in REMPLAN Economy database 2021 (<https://app.remplan.com.au/easternmetro/economy/industries/value-added/>)



**Figure 5.1** Projected employment growth from 2020 to 2025 (Australian Industry and Skills Committee, 2022)

Figure 4.1 also reflects a decline in manufacturing and information media and telecommunications employment nationally which is likely a reflection of factors such as manufacturing moving offshore due to labour costs and automation.

As expected, there was a notable spike in health care and social assistance employment in 2019 as reflected by the COVID-19 pandemic which influenced this growth. Health care and social assistance was one of the few divisions that recorded a positive employment increase during the pandemic with an increase of 54,000 people (4.1%). This is not surprising with an increase in healthcare services

including pathology, diagnostic imagery, and primary care. Although there is a significant projected growth in employment in this area, this is unlikely to be sustained in the long-term unless another unforeseen global health crisis occurs.

Each of these industries have only been compared in relation to their financial impact (GVP) and social impact (employment rates) but lack granularity around the environmental impact of each industry (i.e. material consumption, overall footprint, emissions profile, reliance on finite resources). This highlights a gap in current national reporting mechanisms such as the data collated by the Australian Bureau of Statistics (ABS).

### 5.3 Western Australian Context

The Western Australian (WA) economy has been characterised by a combination of historically cheap fossil fuels, landfill, an abundance of space and the private resource sector. Due to WA's resource rich environment, sustainability and circular economy initiatives have been overshadowed by a perceived threat to production and return on investments.

Currently majority of electricity in Western Australia is generated using coal and gas, with smaller amounts coming from diesel and renewable sources (wind, solar, hydro and landfill gas). With national decarbonisation targets to be net zero by 2050, there has been a shift in this industry to convert fossil fuel-based power stations to renewable energy. With the newly elected Labour government reigniting the conversation on climate action, it is likely that more centralised action will be seen at the national government level.

Western Australia accounted for 52% of Australia's goods exports in 2021. This was due to a rise in iron ore (31.6% rise to 152.2 billion) and other mineral exports (22.0% rise to 87.4 billion). With minerals and petroleum accounting for 96% of Western Australia's goods exports in 2021. It is evident that front-end virgin material management is the most influential area for Western Australia to enable circular economy initiatives.

New data released by the Commonwealth shows Western Australia's carbon emissions are up, sparking fresh debate over whether the state should join the others in setting its own emissions targets, with environmental groups saying WA is now "ground zero" in Australia's climate war. This is no-doubt due to an increase in mining operations and global demand for virgin materials such as iron-ore.

The blooming battery manufacturing industry represents one area for expansion and innovation where the WA State Government recently announced the establishment of a Future Batteries Industry Cooperative Research Centre (CRC) devoted to industry growth. This presents an excellent opportunity for the manufacturing industry within

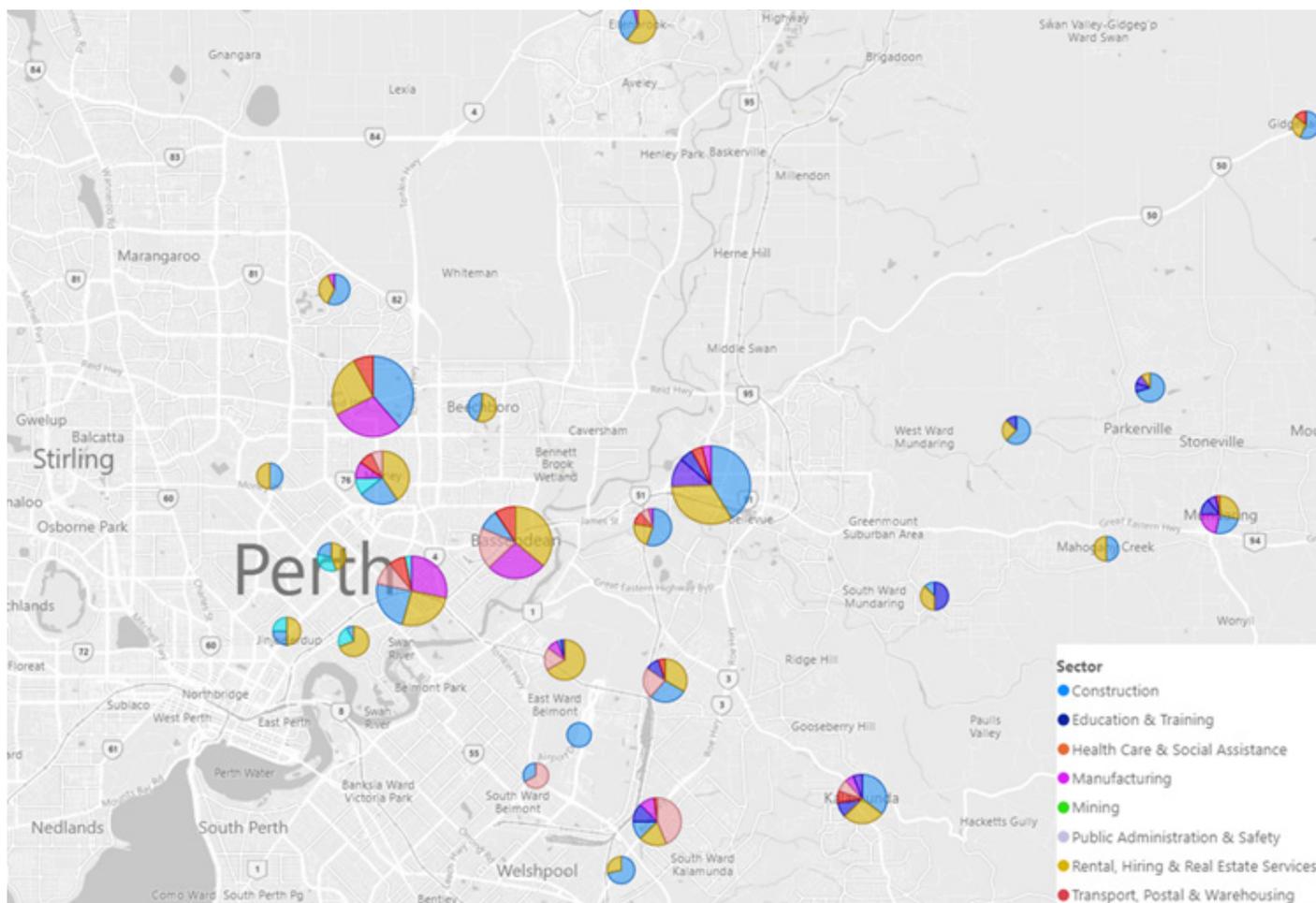
WA, a state that produces around half the globe's supply for lithium within seven mines.

With manufacturing up 8.7%, this made the largest contribution to Western Australia's real GSP growth in 2020-21, followed by Agriculture, forestry and fishing (up 23.1%). This growth is reflected by Western Australia's manufacturing industry increasing production of minerals and chemical products and machinery and transport equipment. With a shift towards front end processing and manufacturing, there is a distinct opportunity for regional areas to leverage off this stage in the supply chain to enable a shift towards a circular economy.

## 5.4 The Eastern Metropolitan Region Context

The Eastern Metropolitan Region generates an estimated \$63.387 billion in revenue. This represents approximately 9% of Western Australia's revenue and 1.5% of Australia's revenue. At an estimated \$4.4 billion, the mining sector is the largest contributor to the Eastern Metropolitan Region through direct and indirect services. The largest industries contributing to annual economic output in the Eastern Metropolitan Region are transport (including Perth International Airport), postal, warehouse and manufacturing.

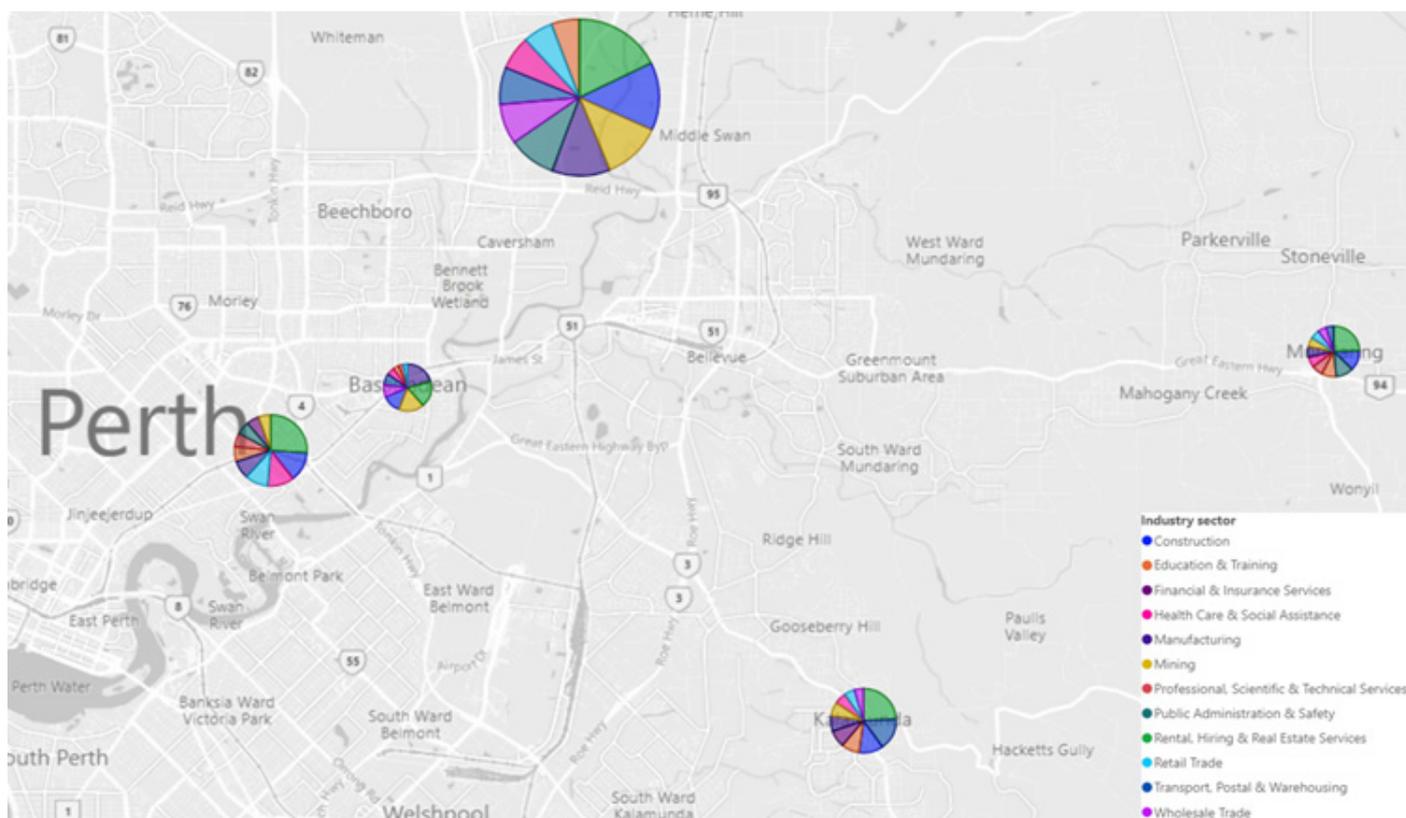
Figure 4.2 represents both the number and type distribution of the top 5 industries in the Eastern Metropolitan region. This figure shows that City of Swan has the greatest amount of industrial activity attributed to construction, manufacturing, rental, hiring and real estate services.



**Figure 5.2** Distribution of top industry sectors in the EMRC Region<sup>45</sup>

<sup>45</sup> The economic contribution has not been captured in this figure as the size of the pie graph doesn't represent the actual productivity or value added to the region but the number of registered businesses associated with each category

Figure 4.3 shows the economic distribution of each of the member councils with the City of Swan clearly contributing the greatest gross value added.



**Figure 5.3 Gross value added (million\$) by each industry sector (top 10) for EMRC Region**

Perth’s Eastern Region’s export value is continuously growing with a demand for mining, manufacturing, transport, postal, and warehousing industries. These industrial precincts contribute to a \$360+ billion gross state product (GSP) for Western Australia. EMRC Region supports over 120 thousand jobs and contributes a Gross Regional Product (GRP) is estimated at \$30.232 billion. Due to the locality of Perth international airport, Transport, Postal & Warehousing is the EMRC largest employment sector, supporting an estimated 14,360 jobs.

The distribution of industry sectors across the eastern region shows its diverse nature with great opportunity to enable industry collaboration and closed-loop regional solutions. The Eastern Region includes Perth’s primary international airport with direct flights to over 50 destinations including economic hubs such as London, Heathrow, Hong Kong, Kuala Lumpur, Bangkok and Jakarta. Due to the advantageous freight opportunities in the Eastern region, a cluster of mining and professional service industries are evolving including Rio Tinto’s and Roy Hill’s operational centres. The area also includes distribution centres for Woolworths, Coles and Amazon alongside freight and logistics providers such as Toll, FedEx and Australia Post.

Another industrial precinct in the region includes South Bullsbrook Industrial Precinct (SBIP) which is a developing area in the City of Swan that has significant potential for manufacturing and processing activities. Through a \$15 million Federal grant to develop roads and infrastructure connecting SBIP to National Highway, Great Northern Highway and the State Government planned intermodal terminal.

The Region also had numerous food processing and agriculture activities produced from areas such as the Swan and Bickley Valleys. With both of these areas becoming famous for their local wineries, there is increased potential to reinject end of life materials back into front-end manufacturing (i.e. glass bottles and packaging). The area is also home to several large food processing firms such as Golden Eggs and Sanitarium acting as a primary storage and passage point for commodities and agricultural produce for local, interstate and international export.

Other developing economic hubs in the region including:

- Tonkin Highway and Bassendean industrial estate<sup>46</sup>
- Malaga Industrial Center<sup>47</sup>

<sup>46</sup> <https://www.tonkinindustrial.com.au/#home>

<sup>47</sup> <https://www.swan.wa.gov.au/Your-Council/About-us/Local-Area-Planning/Malaga>

- Arts and culture prominent venues such as Belvoir Amphitheatre, Mundaring and Swan Art centres and Kalamunda performing arts centre
- Numerous tertiary and vocational education institutions with training areas in technological development, health and education
- Hazelmere Resource Recovery Park
- Belmont Business Precinct<sup>48</sup>
- Forrestfield/High Wycombe Industrial Area<sup>49</sup>
- Engineering and Manufacturing Industry Cooperative Limited (Emicol)<sup>50</sup>
- Kewdale Rail and Freight Terminal<sup>51</sup>
- Midvale And South Guildford warehousing areas

## 5.5 Material consumption and waste generation

Current reporting frameworks and regulations in Australia provide good visibility over materials that are processed by licensed waste facilities, generally including residual waste treatment facilities, sorting and recycling facilities above an annual tonnage threshold. Having a wholistic understanding of material consumption and waste generation data, problematic material streams can be identified for designing waste out of the cycle in a transition to a circular economy.

Western Australians currently send over a million tonnes of household waste per annum to landfill, however data integrity is limited by the ability to accurately measure tonnages. Less than half (49%) of Perth metropolitan landfills have weighbridges, with the proportion of regional landfills with weighbridges unknown.

Although improved data capture is a stated priority of Waste Avoidance and Resource Recovery (WARR) the installation of new weighbridges at landfill sites is still a

significant impediment to accurate reporting of landfilling tonnages. According to the National Waste Report 2018 (the most recent data), 1.45 million tonnes of municipal waste was generated in WA in 2016, of which 485,000 was recycled and 962,000 tonnes landfilled (GHD 2021a).

Historically, the volume of waste flows in the Perth metro waste market have been directly correlated with changes in population and economic activity. Municipal Solid Waste (MSW) volumes had been steadily increasing year on year with population as illustrated in Figure 4.4, but were noted to have contracted by around 1% in 2017 to an estimated 920 kilo tonnes (kt), and continuing to post modest annual decreases in 2018 and 2019.

Figure 4.4 illustrates the correlation between waste volumes and population growth in the Perth metropolitan area. Note that the end of the mining boom in 2016 coinciding with a fall in Perth's domestic waste generation rates as unemployed people tend to generate less waste.

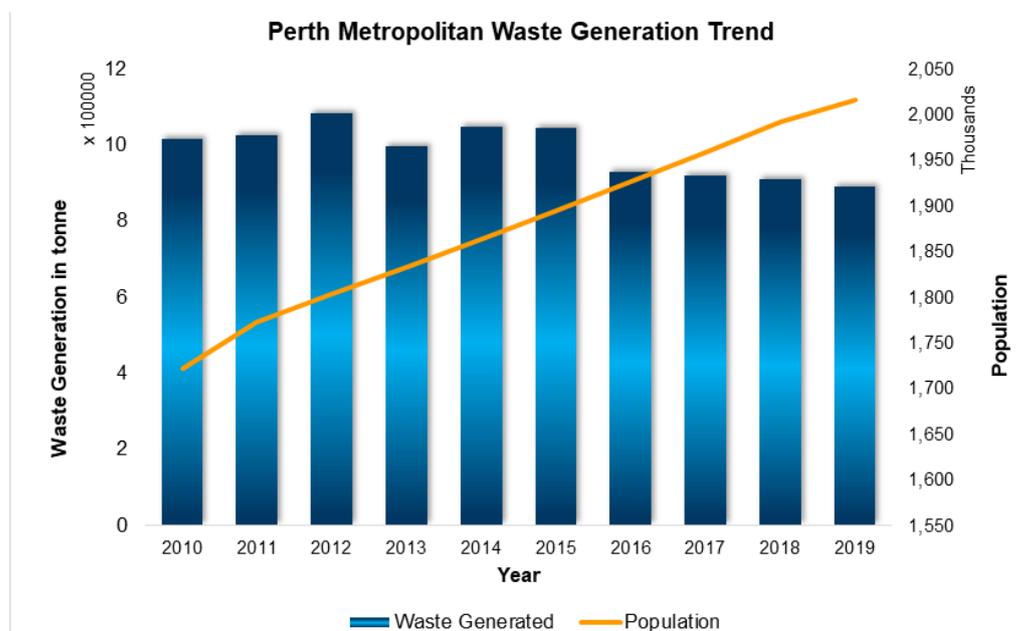


Figure 5.4 Perth metro waste generation and population trends

<sup>48</sup> <https://belmontbusinesspark.com/>

<sup>49</sup> <https://www.kalamunda.wa.gov.au/building-development/planning/projects/forrestfield-high-wycombe-industrial-area>

<sup>50</sup> <https://emicol.com.au/>

<sup>51</sup> <https://www.kewdalecentral.com.au/>

## 6. Creating a regional circular economy

### 6.1 Overview

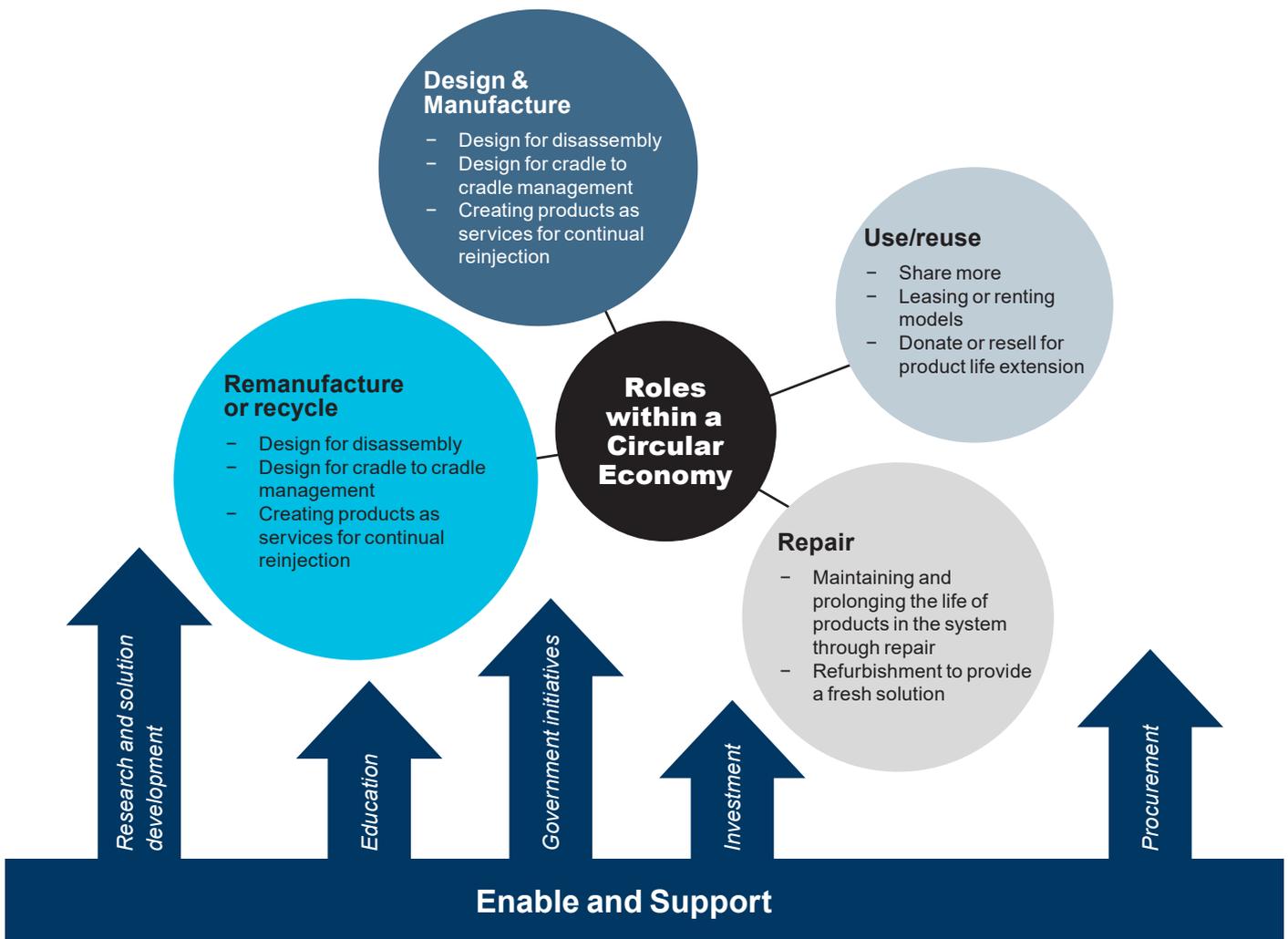
As discussed throughout this report, there are government, market and community drivers which are leading a global transition to a circular economy. Responding to this transition requires a systemic transition at all levels.

Many countries around the world have seen the opportunity that a circular economy can provide in the United Kingdom and Europe. Through clear policy and financial drivers, new circular opportunities can be identified and developed promoting new markets and job opportunities as well as reductions in virgin material use and carbon intensity.

To transition to a circular economy, it is important to understand the key roles that stakeholders need to play within a circular ecosystem. Each of these roles are important to close the loop on biological and technical resource cycles to ensure value is retained within the system. There is also a suite of enabling and supporting factors that facilitate the closing of value loops by providing

a set of enabling circumstances. These key roles and enablers are highlighted below. By understanding each of these roles and enablers, and ensuring they are included within supply chain solutions, regionally specific opportunities can be identified and maximised.

In the Eastern Metropolitan Region and across the State, there are specific opportunities for circular innovation across: specific current and future material streams, opportunities to utilise waste as a resource and develop solutions to ensure supply chains can be localised and closed. For these opportunities to be realised, local education and collaboration will need to be prioritised to ensure an understanding of the circular concept and the local ecosystem developing. Local, national, and global case studies can be used as a baseline model for duplication and/or future thinking about other possible solutions.



## 6.2 Regional specific opportunities

### 6.2.1 Resources and their circular potential

According to the World Business Council for Sustainable Development (WBCSD), ‘the total demand for resources is expected to reach 130 billion tons by 2050, ...an overuse of the Earth’s total capacity by more than 400%<sup>52</sup>. By transitioning to a more circular material use model, there are significant environmental, financial and intergenerational benefits<sup>53</sup>.

To circularise our resources, we need to ensure that we close the loop. For the region to move away from a linear take – make – use – dispose model, each aspect of Figure 5.1 below needs to be available for all resources. When considering the basic stages of a material’s circular life cycle, it is evident that investment needs to be made into the transformation and reuse parts of the cycle to allow for small circle solutions that keep value in the system.

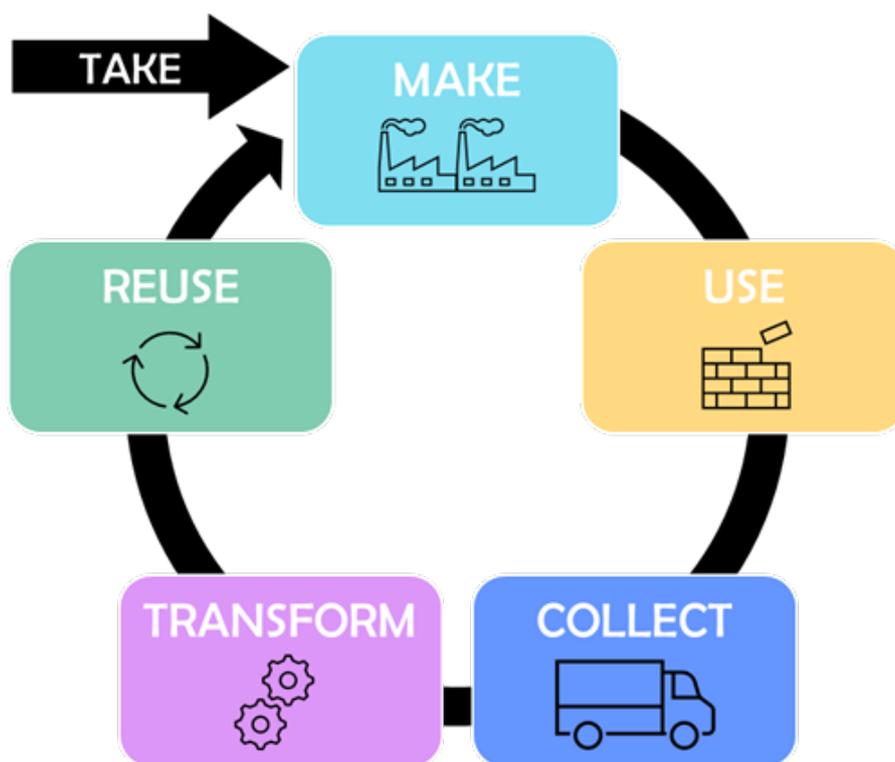
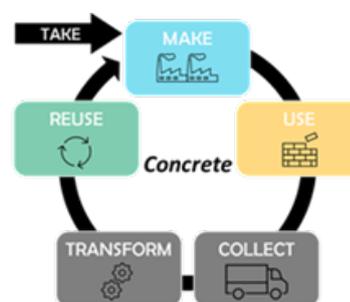


Figure 6.1 Ideal resource and material lifecycle<sup>54</sup>

As shown below, small circle solutions for commonly used materials such as concrete, plastics packaging, steel/ metal and technology products are inhibited by a lack of transformation and reuse potential. By controlling front end manufacturing, reuse potential of different materials could be endless, creating a more stable economy through new market development and more sustainable material design. The following provides three example of material streams which are limited by specific links in their circular lifecycle.

In Western Australia there are numerous concrete manufacturing groups such as Cockburn Cement which use virgin materials to produce aggregates for cement. This can then be applied throughout the region in roads, infrastructure and alike. Once the material reaches end of life, there are limited collection and transformation options with most projects leading to disposal to landfill. To close this loop, a focus should be drawn to identifying innovative solutions for concrete reuse/ repurposing/ recycling.



<sup>52</sup> World Business Council for Sustainable Development, 2017

<sup>53</sup> Journal of Cleaner Production – ‘Macroeconomic, Social and environmental impacts of a circular economy up to 2050’

<sup>54</sup> Note, greyed out boxes indicate areas in a specific products’ circular life cycle where the eastern region currently has no notable influence of infrastructure.

Like concrete, the main inhibiting factor to circular packaging solutions in Western Australia is limited infrastructure and options. This is often due to front-end design limiting the re-use potential of plastics packaging and the high energy demand reuse solutions. With groups such as Redcycle helping close the loop in collecting and aggregating this material, the next focus should be on economically viable reuse solutions.



Technology such as phones, computers and other devices are a perfect example of how circular solutions are limited in the region. With limited to no visibility of the manufacturing process, the transform and reuse potential is also constrained. With this said, there are several repair options such as screen replacement and tech service providers which can be used to elongate the life of these products. The materials themselves are often sent to landfill due to lack of disassembly and redistribution potential.

The concept of a product or material leasing model has been proven to be effective with a greater focus on maintaining products in their natural life cycle and designing them for maintenance and reuse. By retaining ownership, materials can be sold an endless number of times to new customers adding value to the business as a continued revenue stream.

While this concept has been embraced across some industries (eg Kennards, Other hire/leasing services) others at the beginning of the value chain such as Australian mining and manufacturing organisations could investigate the full ecology of their system including retaining ownership of their mineral/metal product and cycling it back through their business to create an additional value add when it is resold to the next user. This will be particularly important for the critical minerals sector who are only at the beginning of a substantial need for resources as the world decarbonises. Additional value streams can also be found in tailings and waste streams. For example, other valuable metals and minerals often found with copper such as uranium, silver and gold which is produced by BHP’s Olympic Dam Metal Mine could be valorised<sup>55</sup>.

With Western Australia still heavily reliant on global supply chains, small circle solutions may seem unattainable however due to vast land utilisation opportunities and an increasingly skilled workforce population a transition is possible. Accessibility to high commodity resources such as natural gas, critical minerals and metals, the eastern region is well-positioned to shorten current product supply chains by increasing process manufacturing and remanufacturing. This opportunity is further enhanced by the region’s locality to logistics and transport hubs, further supporting the business case for small circle distribution and collection of goods.

Transitioning to a circular economy also requires the reuse and reprocessing of materials. Current state and national drivers lead to the following material streams being identified as the most opportunistic business propositions for regional manufacturing and reprocessing facilities. Some of these opportunities include:

- **Tyre processing, repurposing, and repair:** Due to the COAG Ban on exporting whole tyres, processing in Australia is more economically viable than before. This is due to the high energy consumption/ cost associated with chipping the material for export. Although rethreading for elongated life and repurposing as open-loop solutions such as road surfacing is lower in level of circularity than reuse, opportunities are currently limited by the high temperature treatment of the rubber-based material.

Circular strategies can be applied to tyres including elongating the life of the product through retreading, repurposing as road or other surfacing, conversion to an alternative fuel source with lower emissions profiles, metal reuse, lower-order recycling of nylon-based fabrics in manufacturing of tyres. Companies such as **Circularind** and **Shaw Contract** provide innovative circular remanufacturing solutions while organisations such as UNSW are researching alternative solutions to difficult to abate materials through **Micro Factories**.

<sup>55</sup> BHP, 2021

- **Renewable energy infrastructure repair and reuse:** The industrial movement to decarbonise has introduced new technologies that are heavily reliant on batteries. With lithium refining currently being invested in WA there is an opportunity to remanufacture these products. By aggregating renewable infrastructure in excess warehousing precincts in the region, reuse options could be achieved. Renewable energy sources and energy efficiency should be considered as a service with the intent to design out waste and recycle.
- **Reuse of materials and encapsulating embodied carbon:** All material streams such as glass, furniture, processing equipment and building supplies have an associated carbon footprint. By re-using these materials as a continuous, circular solution there is potential to reduce to carbon emissions and footprint associated with the formation of these products from virgin materials.

By designing for disassembly and reconstruction embodied carbon can remain in the system and prevent the introduction of new products. This system is exhibited by the Container Deposit Scheme which encourages collection of easy to retain materials for reinjection into the cycle. Other examples include **Greencrete - Redicrete** Quality Ready-Mixed Concrete and **BAMB** - increase the value of building materials in the building industry

- **Paper and cardboard, single use plastics refusal and reprocessing:** The COAG ban has also driven, government co-investment to design single use plastics out of the supply chain (i.e. plastic straws and plastic shopping bags) as well as reprocessing of paper and cardboard. There are also other options for the remaining non-renewable and oil derived (industrial) reprocessing such as what is being implemented at the Bayswater trial. Another example is Redcycle who is working with organisations such as **iQRenew - Intelligent Australian Recycling** to create alternate fuel sources for industrial process such as kilns.
- **Substitution of organic fertilisers for industrial fertilisers:** With the release of the national waste strategy and national soil strategy there is a push for a transition to organic fertilisers in agricultural applications. With the cost of conventional fertilisers are increasing creating an opportunity for greater uptake of recycled/ organic products or fertiliser. Fossil derived fertilisers could be phased out with if currently acting as the 4th largest commodity globally. A transition to organic based fertilisers exhibits circular repurposing and acts as a decarbonisation solution by providing a natural carbon cycle solution for agricultural demand. Organic waste solutions have been provided by organisation such as and Donut waste – coffee grounds.
- **Offshore oil and gas decommissioning infrastructure:** With over \$50 billion of decommissioning work estimated to be required for Australia's offshore oil and gas infrastructure there is a growing market for metal cleaning and recycling services (National Energy Resources Australia, 2021). With the current regulatory preference being full removal, there will be a significant increase of material streams such as stainless steel, hydrocarbon waste, naturally occurring radioactive material/ muck (solid waste), biological marine matter from cleaning, plastic coatings and other miscellaneous streams. Industry collaboration and shared strategies is integral in servicing this growing industry.

## 6.2.2 Regional hubs and industrial ecology

Regional hubs can provide an opportunity to collaborate across multiple materials streams and sectors to identify local value chains and facilitate close looped, circular economies. As discussed in section 4.3, WA accounts for 52% of Australia's goods exports in 2021 with over 200 billion dollars of revenue generated from virgin materials. From this, the Eastern Metropolitan Region generates an estimated \$63.387 billion in revenue from transport (including Perth International Airport), postal, warehousing, construction, and manufacturing. Each of these industries pose their own unique circular economy opportunities.

The concept of industrial symbiosis is not new, with a heavy reliance on understanding all aspects of an area's needs, inputs, and outputs. The Kwinana Industrial Precinct is a great example of an industrial hub where chemical processing manufacturers such as CSBP provide inputs to metal refining processing in the area and

shared infrastructure. Provisions such as the Precinct's shared noise and emissions environmental approvals force industry collaboration and operational optimisation. With the Eastern Region starting to develop industrial hubs in Hazelmere, South Bullsbrook, Malaga and alike, there is a unique opportunity to co-develop these area's as industrial innovation hubs with a core focus on attracting symbiotic industries and appropriate solutions

Another key economic region with unique potential is the Swan and Bickley Valleys. With land availability, proximity to a trained workforce and a well-established tourism market, these two regional hubs have the potential to grow into locally focused circular economies. Current service offerings including hobby farming, wineries, distilleries, temporary accommodation and more, result in notable consumption of materials such as organics and packaging which could remain within the regional area through closed-loop solutions.

The global exemplar, Kalundborg in Denmark, has developed as an industrial ecology through its use of energy integration and closed-loop materials cycling among to yield the greatest net benefit. With less pollution, more efficient use of resources, and less need for environmental regulatory supervision through joint approvals, Kalundborg provides the perfect example of how a large land area, agricultural and tourism focused regional area can close the loop. From bioplant processing feeding yeast into live-stock feed which provides high quality sludge for cropping and energy production, the options for upscaling the area through key industrial services makes the Swan and Bickley Valleys prime regional hubs.

Another key regional hub opportunity is present near Perth Airport. Situated on the Great Eastern Highway and home to numerous logistics service providers (i.e. Australia post, FedEx, Toll), Perth Airport is in a prime position to capitalise on circular change. With each of these service providers emitting high levels of greenhouse gas emissions through traditional fossil fuel-based vehicles, there is a need for regional innovation to provide carbon neutral alternatives to current operational practices. Each of the businesses in this logistics hub has highly complex state and national services which often also rely on high amounts of disposable packaging and transport materials (i.e. timber pallets, shrink wrap, packing boxes). By working with organisations such as Opal<sup>56</sup>, Perth Airports logistics hub could transition to more circular packaging solutions, closing the loop on one of their major material consumption and generation streams. Due to the regions locality to large open land areas, there is also potential of integrating fully renewable shared energy generation infrastructure which could help enable high energy intensive alternate fuel source production processes (i.e. hydrogen, tyre derived fuels, refuse derived fuels). In addition, these underutilised land and warehousing areas could become critical transfer stations for disassembled products and materials awaiting reuse by others across a whole range of sectors. An assessment of core product and material flows will be needed to inform this kind of outcome.

Focus could be given to looking at developing a suite of business types and skillsets to facilitate more circular outcomes. Support the shift of businesses from a point-of-sale business approach to offering their product as a service. Within regional hub there is also merit in considering an attraction strategy for businesses that may complement each other. A logistics operation close to a resource recovery facility for backhauling purposes or developing a suite of businesses co-located that can utilise each other's waste products as priority inputs

Existing regional hubs can also be seen as potentially rich in reusable resources. Aging industrial warehousing and storage can be seen as an opportunity for new business leases with a more circular supply chain focus. In addition, no longer needed materials could be harvested and moved on to other uses prolonging their life.

### 6.2.3 Education, Upskilling and Collaboration

Research undertaken by the Australian Circular Economy Hub identified that while '88% of business leaders believe that the circular economy will be important to their business in the future more than a third of leaders were unable to define what the circular economy was or how to implement circular principles'<sup>57</sup>. Education and upskilling will be critical to taking advantage of the circular economy opportunities within the region and across the State.

Through education on the importance of elongating the life of a resource, new regional services can be identified. This opportunity has been realised through numerous services such as Gumtree and Facebook Market Place where products are diverted from landfill by creating a local economy around the resale of products. Currently limited by digital platforms, these services could be expanded into regional innovation hubs where products are matched with those in need. This process can also reduce the need for new products to be bought in to the region by encouraging and facilitating the reuse and introduction of new embodied carbon into the region through new product creation, transport and disposal.

By encouraging community and industry collaboration, a more holistic supply and demand picture can be established. Through broader industry engagement, networks can be created to better optimise current industry practices and close the loop. For example, organisation such as Fixable act as a social enterprise with a goal to "make money" while creating a sustainable business<sup>58</sup>. The organisations objectives are to:

- Have a defined primary social, cultural or environmental purpose consistent with a public or community benefit,
- Derive a substantial portion of our income from trade,
- Invest efforts and resources into our purpose such that public/community benefit outweighs private benefit.

Fixable's digital presence has successfully diverted waste from landfill by linking individuals' skills and services to customers in need of repairs. This business model could be applied across industry for the sharing of equipment, learnings and resources for a mutually beneficial outcome.

<sup>56</sup> <https://acehub.org.au/knowledge-hub/case-studies/opal>

<sup>57</sup> [http://assets.ctfassets.net/fqjwh0badmlx/6fpGTK8JOTzAMktVSSfN2/c0a64829525f670d472bb0b94504e445/ACEHUB\\_CIRCULARITY\\_IN\\_AUSTRALIAN\\_BUSINESS\\_2020\\_REPORT.pdf](http://assets.ctfassets.net/fqjwh0badmlx/6fpGTK8JOTzAMktVSSfN2/c0a64829525f670d472bb0b94504e445/ACEHUB_CIRCULARITY_IN_AUSTRALIAN_BUSINESS_2020_REPORT.pdf)

<sup>58</sup> <https://fixable.co/>

Collaboration around shared themes and challenges can have wide ranging impacts. Cardiff Metropolitan University, Celsa Steel UK, One Planet Cardiff and Cardiff Commitment (Curriculum Development) have co-funded a pilot project working with businesses, schools and colleges to network and develop a broader understanding of Circular Economy principles<sup>59</sup>. In Australia, collaborations between research centres, industry and Government has paved the way for innovative new sustainable materials and processes research and technology focused on solving the global problem of waste generation. Professor Veena Sahajwalla and her team have transformed many waste products into useful resources<sup>60</sup>. Regional hubs can act as the catalyst for stakeholder collaborations identify key challenges requiring solutions.

Programs like this could be considered in the Eastern Region to help link different community groups, industries and government bodies in identifying shared challenges and developing shared solutions. These types of programs can also help address high priority areas of concern such as state-wide decarbonisation, net environmental impact, and economic diversification as well as sharing the cost and risk generally associated with innovative solution development.

Providing an environment of active engagement and open collaboration is a key enabler for change. As highlighted in section 3.1, fostering innovative idea generation can help eliminate reliance on virgin materials and reduce leakage from the system. By including basic circular economy theory into all levels of the regional education system, untapped solutions and community behaviour change can be achieved. For example, Involvement and promotion of Circular Economy WA (CEWA) and others can be a vehicle to educate and promote the value of a circular economy as well as support the development of a broader circular ecosystem which is an imperative to closing the loop. There are many examples of successful initiatives shifting the conversation from new to repair such as community-based repair cafes and Buy Nothing websites.

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<sup>59</sup> <https://www.walescirculareconomy.com/>

<sup>60</sup> <https://www.smart.unsw.edu.au/>

## 7. Recommendations and next steps

### 7.1 Overview

Dictated by a reliance on material export and commodity prices, WA has traditionally been a boom-and-bust economy. Implementing regional circular economy opportunities can create a more stable baseline for the future. With and increased focus on accountability, cradle to grave pathways can be avoided with higher reinjection rates of materials. Additionally, robust, historical databases can inform future demand and maximise the use of existing circular business within the region. By turning material flows into clear economic opportunities for industry and communities, the business case for circular solutions becomes a logical next step to going beyond recycling and source separation.

Considering the state and regional climate, it is important to acknowledge both immediate and medium to long-term strategic next steps. These two layers can kick-start a circular economy across the region.

### 7.2 Immediate opportunities and needs

Select a few key areas of focus based on further engaging with key stakeholder groups. Engage with specific groups or supply chains initially in an effort to achieve effective outcomes. This outcomes and success stories can be built on.

Telling the circular story is a key part of educating community, industry and government bodies. By identifying upcoming local projects which can design out waste and use recycled products, greater awareness in the region can be achieved through real-life examples. Once these projects are identified, servicing groups can provide support in design specifications, procurement optimisation, waste minimisation and recycled product integration recommendations.

As enabled by national and state policies, recycling, remanufacturing, and reuse infrastructure that is planned or already in operation should be highlighted across all industries. This will help support the recovery of priority material streams such as single use plastics, organic waste, tyres, paper, and cardboard. This will ultimately support key circular economy solutions to flourish and expand.

Data will be a key requirement to build a clear picture of the opportunities available and how best to access them. More accurate data at the right level of granularity will be required to make these in-depth assessments. Engaging

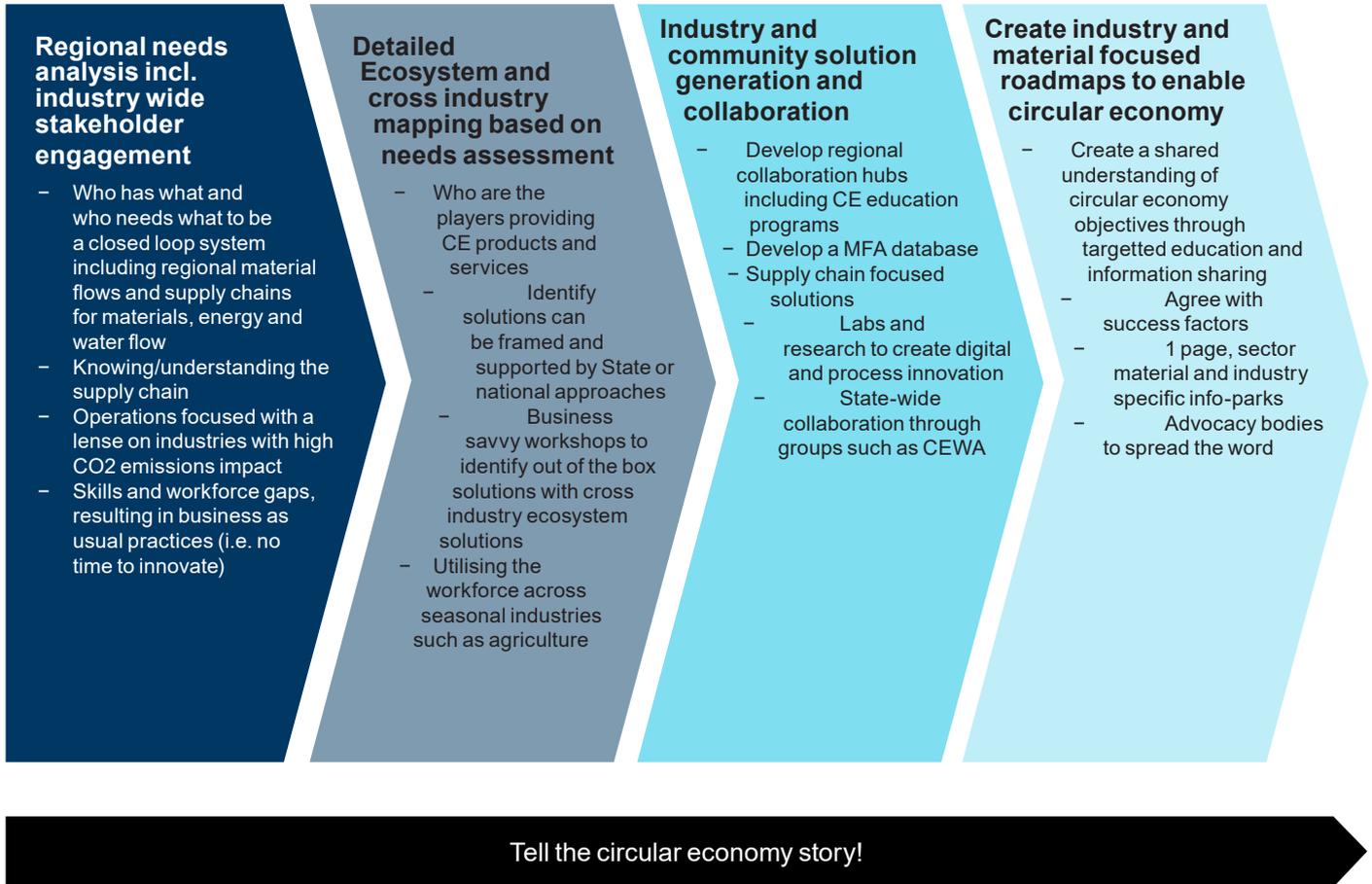
with Industry will be essential to help them understand the imperative and how it could benefit them to provide this level of data. Additional policy may be required to assist this process.

With numerous small circle services such as repair cafes, second-hand marketplaces, community advocacy groups and equipment leasing there are pockets of innovation appearing throughout the region. It is important to identify these sector and community leaders as first movers to help encourage others to make the transition. Published success stories can help foster innovative idea generation by highlighting logistics and strategic solutions which challenge business as usual models.

As major industry groups are grappling with internal decarbonisation targets and increased focus on ESG, investment in emerging technologies and unique ideas are increasing. Supporting funding distribution across all aspects of the supply chain will help generate innovative solutions to decarbonisation whilst taking the burden off a specific organisation by sharing the load. Initiatives related to economic development and diversification can help identify strategic investment opportunities. Strategies that leverage off multiple sectors can influence regional development perspectives and attract funding. This will likely require input from Government to achieve.

## 7.3 A four-stage circular economy enabling strategy

As mentioned in section 5 innovation and collaboration is a key opportunity for growth in the shift towards circularity. To enable more effective industry collaboration and ideation, a circular economy strategy for the region should be established. By applying the following four-stage approach, the region will be in the best position to achieve circularity across all aspects of its economy.



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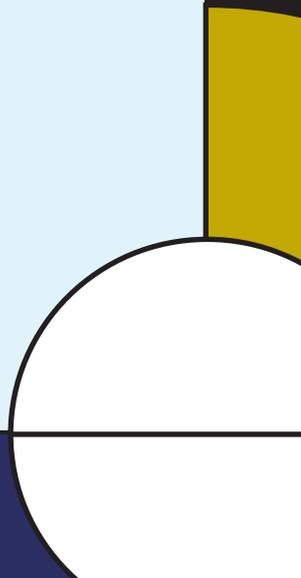
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# **Appendix A**

**Detailed WA project list**



- Mining (47% or \$169.6 billion). Some of the key projects includes:
  - Boddington Gold Mine in Boddington (Peel region) is one of the biggest gold mines in western Australia with 696,000 troy ounces production per year
  - Gorgon LNG in Barrow Island with 10,000 plus workers produces 15.6 million tonnes of LNG per annum
  - Whaleback mine in Newman (Pilbara region)
  - Greater Tom Price Mine in Tom Price (Pilbara)
  - Warrawoona Gold Project and Marble Bar Lithium Project in Marble Bar (Pilbara)
  - Robe Valley Mine and Mesa J mine in Pannawonica (Pilbara)
  - Paraburdoo Iron Ore Mine and Mt Maguire Gold Project in Paraburdoo (Pilbara)
  - South Flank and Iron Bridge magnetite mine in Port Hedland (Pilbara)
  - The Super Pit and Kalgoorlie Operation in Kalgoorlie (Goldfields)
  - Gwalia mine in Leonora (Goldfields)
  - Southern Cross Operation in Southern Cross (Goldfields)
  - Coolgardie Gold Project in Coolgardie (Goldfields)
  - Norseman Gold Project in Norseman (Goldfields/Esperance)
  - Karara Mining in Geraldton
  - Argyle Diamond Mine and Mt Gibson Iron, in Kimberley region
- Construction (5% or \$18.2 billion). Some of the major Construction in WA includes:
  - METRONET: \$1.84 Billion
  - Outback Way Project: 1.008 billion of which \$476+ million is allocated to WA)
  - Mount Holland Lithium Project: \$1,400m
  - Elizabeth Quay Lot V and Lot VI Mixed-Use Complex: \$841 million
  - Bunbury Outer Ring Road Project: \$560 Million
  - Tonkin Gap works as part of the \$1.39 billion Tonkin Corridor Upgrades
  - Port Augusta to Perth Corridor: \$62.5 Million
- Manufacturing (4% or \$15.3 billion). Top manufacturing companies in Western Australia with annual sales revenue above \$5m includes:
  - Australian Underwriting Holdings Limited (Perth)
  - Wesfarmers Bengalla Pty Ltd (Perth)
  - Ucone Pty Ltd (Perth)
  - Wesfarmers/CSBP Limited (Kwinana)
  - Cuming Smith And Company Limited (Perth)

- Pailou Pty. Ltd (Perth)
- Bluescope Building And Construction Limited (Welshpool)
- Bluescope Water Australia Pty Ltd (Bellevue)
- Envirocoat (Wa) Pty Ltd (Perth)
- Woodside Energy Group Ltd (Perth)
- Hamersley Iron - Yandi Pty Limited (Perth)
- Shell Energy Holdings Australia Limited (Perth)
- Samsung Heavy Industries Co., Ltd. (Perth)
- Goldcorp Australia (East Perth)
- Agriculture, Forestry And Fishing (2% Or \$6.4 Billion)
  - Agriculture
    - Northern Agricultural Region (NAR)- The NAR covers 7.5 million hectares which runs from Gingin in the South to Kalbarri in the north, east to Mullewa, Perenjori and Kalannie along the Local Government Area (LGA) boundaries
    - Southwest agricultural region- The SWAR covers area across Wheatbelt, Mid-West, Great Southern and Goldfields-Esperance (Esperance Port Zone) regions
    - WA produces on average 13 million tonnes of grains (cereals, oilseeds and pulses) each year. The state's grain production area, known as the 'wheatbelt', covers seven million hectares across the south-west corner of the state.
  - Forestry
    - Jarrah and Karri Forest in the south-west of the Australia
    - Remnant areas of rainforest in the Kimberley
    - Great Western Woodlands
  - Fishing
    - West Coast Bioregion
    - South Coast Bioregion
    - Gascoyne Coast Bioregion
    - North Coast Bioregion
    - Northern Inland Bioregion

# **Appendix B**

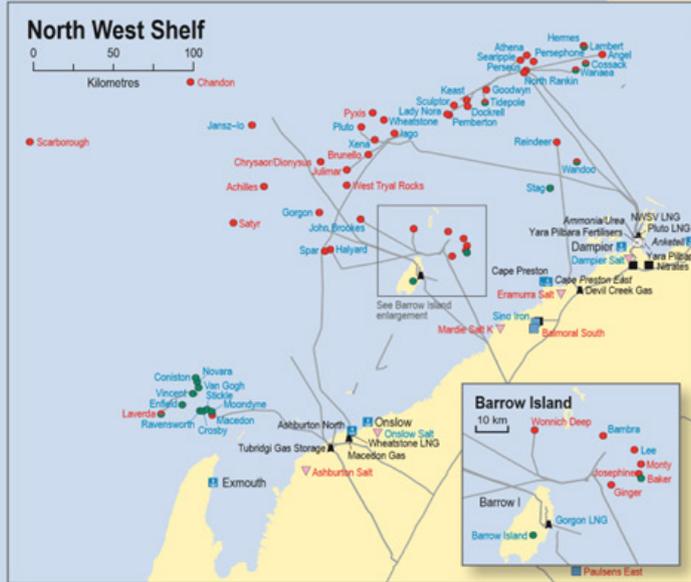
**Major Mining and Resource in WA  
(2021)**

# Major Resource Projects

## March 2021

### Project labels:

- Principal resource projects operating with sales >\$5 million in 2019-20 are in blue text
- Resource projects currently under construction are in green text
- Planned mining and petroleum projects with at least a pre-feasibility study (or equivalent) completed are in red text
- Principal resource projects recently placed on care and maintenance, or shut are in purple text



- ### Commodities
- Ag. Silver
  - Al. Alumina
  - Au. Gold
  - Cu. Copper
  - Dmd. Diamond
  - Fe. Iron
  - Gr. Graphite
  - Grt. Garnet
  - K. Potassium
  - Kln. Kaolin
  - Li. Lithium
  - LNG. Liquefied natural gas
  - Mag. Magnetite
  - Mn. Manganese
  - Ni. Nickel
  - Pb. Lead
  - Pd. Palladium
  - Pt. Platinum
  - REE. Rare earth elements
  - Ta. Tantalum
  - Ti. Titanium
  - V. Vanadium
  - W. Tungsten
  - Zn. Zinc
  - Zr. Zirconium

- ### Mineral symbols
- Precious mineral (Dmd)
  - Precious metal (Au (or as shown))
  - Steel alloy metal (Ni (or as shown))
  - Speciality metal (Ti-Zr (or as shown))
  - Base metal
  - Iron
  - Bauxite
  - Coal and lignite
  - Uranium
  - Industrial mineral
  - Mineral Processing plant

- ### Petroleum symbols
- Gas
  - Oil
  - Oil and gas
  - Petroleum Processing plant
  - Oil / gas pipeline, operating
  - Oil / gas pipeline, proposed

- ### Infrastructure
- Power plant
  - Port
- ### Infrastructure status
- Operating or under development
  - Proposed

Enquiries for latest information for Commonwealth-controlled waters is available from the National Offshore Petroleum Titles Administrator (NOPATA) at <info@nopata.gov.au>

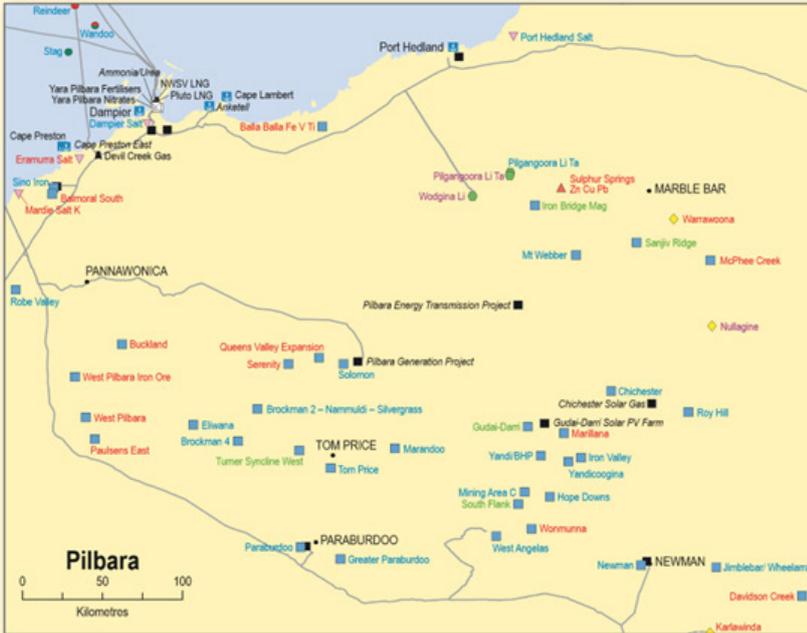


Government of Western Australia  
Department of Mines, Industry Regulation and Safety



# Major Resource Projects

## March 2021



| Commodities                      | Mineral symbols            |
|----------------------------------|----------------------------|
| Ag..... Silver                   | ◆ Precious metal           |
| Al..... Alumina                  | ◆ Au (or as shown)         |
| Au..... Gold                     | ◆ Steel alloy metal        |
| Cs..... Cesium                   | ◆ Ni (or as shown)         |
| Cu..... Copper                   | ◆ Speciality metal         |
| Fe..... Iron                     | ◆ Ti-Zr (or as shown)      |
| HPA..... High purity alumina     | ▲ Base metal               |
| K..... Potassium                 | ■ Iron                     |
| Kln..... Kaolin                  | ■ Bauxite                  |
| Li..... Lithium                  | ■ Coal and lignite         |
| LNG..... Liquefied natural gas   | ◆ Industrial mineral       |
| LPG..... Liquefied petroleum gas | □ Mineral Processing plant |
| Mag..... Magnetite               |                            |
| Ni..... Nickel                   |                            |
| Pb..... Lead                     |                            |
| REE..... Rare earth elements     |                            |
| Sisd..... Silica sand            |                            |
| Sn..... Tin                      |                            |
| Ta..... Tantalum                 |                            |
| Ti..... Titanium                 |                            |
| Tlc..... Talc                    |                            |
| V..... Vanadium                  |                            |
| W..... Tungsten                  |                            |
| Zn..... Zinc                     |                            |
| Zr..... Zirconium                |                            |

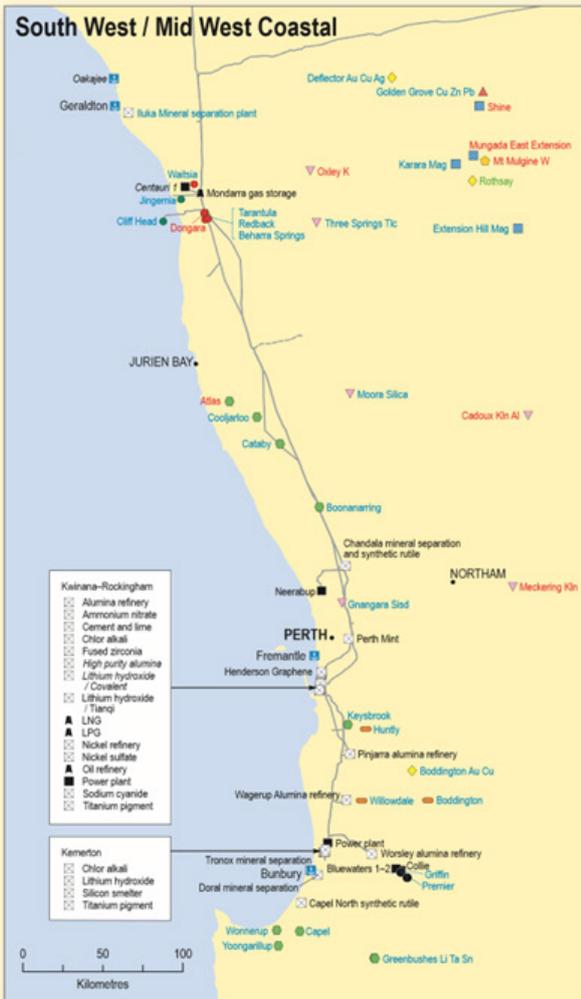
| Petroleum symbols                      | Infrastructure |
|--|----------------|
| ● Gas                                  | ■ Power plant  |
| ● Oil                                  | ■ Port         |
| ● Oil and gas                          |                |
| ▲ Petroleum Processing plant           |                |
| — Oil / gas pipeline, operating        |                |
| - - - - - Oil / gas pipeline, proposed |                |

| Infrastructure status          |
|--------------------------------|
| Operating or under development |
| Proposed                       |

Enquiries for latest information for Commonwealth controlled waters is available from the National Offshore Petroleum Titles Administrator (NOPTA) at <info@noppta.gov.au>

### South West / Mid West Coastal



### Project labels:

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Principal resource projects recently placed on care and maintenance, or shut are in purple text

