ACCELERATING THE CIRCULAR ECONOMY:

A *CITY SCAN* FOR THE HUNTER AND CENTRAL COAST

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Prepared for





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Executive summary

OVERVIEW

A window of opportunity exists for the Hunter and Central Coast region to establish national leadership and develop a vibrant, regional circular economy through strategic decisions grounded in a **sound evidence base**.

Accelerating development of the region's circular economy can accelerate progress towards reaching the New South Wales government's target of **net zero carbon emissions by 2050**.[1] Local environmental concerns can be addressed and economic development boosted through the efficient design, use, reuse and recovery of steel, food, concrete, plastic and other materials.

Ambitious scenarios for accelerating the circular economy assessed in modelling of other countries and regions point to a rise in **employment** and contributions to gross domestic product of up to 3 to 4 per cent in coming decades above a business as usual scenario. Greenhouse gas emissions could decline by up to 76 per cent.[2]

To achieve such benefits, local governments need to choose the right path for operations, procurement, waste management, business attraction, asset management, planning and development approvals. To do this, they need data on how much of a range of different materials is involved in the goods and services provided by the region's industry sectors, where these materials end up, and the level of greenhouse gas emissions that these processes generate.

KEY FINDINGS

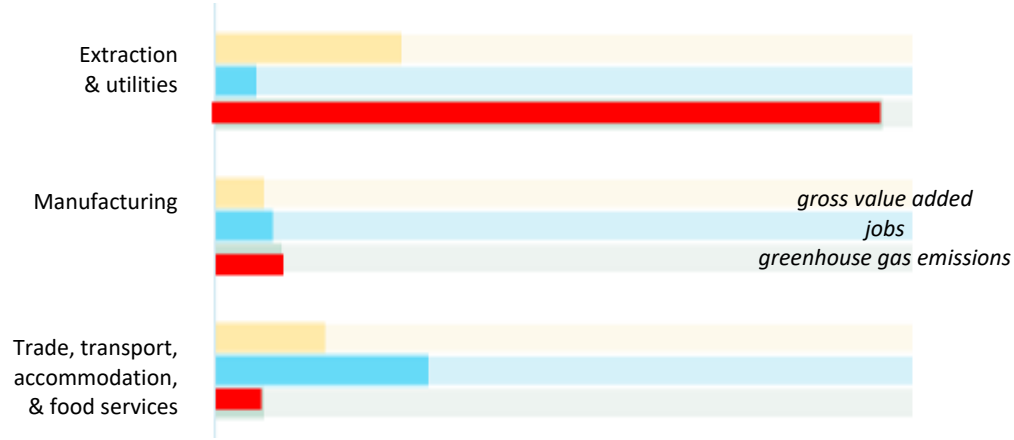
An assessment of the **region's circular economy potential** using phase 1 of the *City Scan* protocol is documented in this report. The four-phase *City Scan* was developed by a leading consultancy, the Netherlands-based, Circle Economy. The *City Scan* input and results provide an evidence base for discussion of which industry sectors, which materials and which environmental impacts should be the focus of attention.

Data gathered for this analysis identifies **power generation**, **mining**, **manufacturing** and **commerce** as the industry sectors with the highest emissions of greenhouse gases, but also with central roles in the region's economy. This is shown in the following figure.

[1] New South Wales government (2020). *Fact Sheet: Achieving Net Zero Emissions by 2050*, Office of Environment and Heritage, Sydney, https://www.environment.nsw.gov.au/–/media/OEH/Corporate–Site/Documents/Climate–change/achieving–net–zero–emissions–by–2050–fact–sheet–160604.pdf – accessed 1 August 2021.

[2] Aguilar–Hernandez, G., Dias Rodriguez, J. & Tukker, A. (2021). Macroeconomic, social and environmental impacts of a circular economy up to 2050: A meta–analysis of prospective studies, *Journal of Cleaner Production*, vol. 278, 123421.

Figure 1.0: Relative impacts of the region's three industry sectors with the highest GHG emissions.[3]



The *City Scan* tool for this phase 1 analysis provides general recommendations that these three sectors engage in greater reuse, repurposing and recycling of key materials within the respective sectors, greater collaboration, energy recovery from waste, energy efficiency and use of renewables, and designing out waste. These recommendations are to be confirmed and refined by subsequent analysis (e.g. in *City Scan* phases 2, 3 and 4) that engage industry and government stakeholders and involve more detailed, more accurate data with a narrower focus on selected industries.

Assembling input data for the *City Scan* analysis presented challenges, from an array of different ways of categorising materials to **significant gaps in accessible data**. Until these issues with data on material consumption and greenhouse gas emissions are resolved, benchmarking circular economy initiatives and assessing their progress from year to year remains highly problematic. To enable more accurate and more public reporting of such data, interviews with experts and company leaders identified the importance for local and state governments to engage with willing industry representatives to develop, refine and embed suitable frameworks and protocols. This needs to include estimates for greenhouse gas emissions, material consumption (meaning the amount purchased) and the composition of waste streams.

In documenting this analysis, this report provides:

1. An overview of the growing importance of the circular economy
2. A description of the four phases of a City Scan analysis for setting priorities and identifying circular economy strategies
3. An analysis of data available and description of data that is still needed
4. An initial set of recommendations as a springboard for discussion of which industry sectors can yield the greatest 'wins' from implementing circular economy strategies
5. Potential economic benefits, as suggested by studies overseas and in Australia
6. Recommendations for next steps.

NEXT STEPS TO A VIBRANT CIRCULAR ECONOMY

1. **Engage more with industry**. The circular economy is a market-based phenomenon with a distinctive regional scope. The local governments in the Hunter and Central Coast region should engage with industry to build literacy about the circular economy and its potential. That engagement will build relationships that lead to local companies providing much needed

[3] Circle Economy, *City Scan* tool input data https://www.circle–economy.com/digital/circle–city–scan–tool accessed 1 August 2021. Horizontal scale is percentage of the Hunter and Central Coast region's total for each figure.

data on material use and greenhouse gas emissions, particularly in the target sectors and their supply chains.

2. **Obtain consistent quality data at the right level of granularity**. More extensive, more accurate and more compatible data can be collected from industry by local, state and federal government departments, such as through the engagement recommended above.
3. **Characterise what is at risk**. An economic assessment is required to establish a sense of urgency related to jobs and gross regional product that could be at risk if development of the circular economy is delayed. Appropriate modelling could explore how many jobs could be generated if the circular economy is implemented sooner, rather than later. That is, identify the 'first mover' advantage for the Hunter and Central Coast region. Such modelling could be funded by state or federal government and undertaken by organisations which have insight into the region's economic base.
4. **Collaborate across the region**. Circular economy initiatives or prospects should be aligned with other regional initiatives, such as those related to business attraction and economic diversification. The circular economy needs a coordinated regional and state approach rather than being undertaken by individual local governments.
5. **Address supply chains**. Consider supply chains as opposed to single industry sectors or subsectors. Treat the region's economy as a complex system through which materials, energy and water flow.
6. **Select indicators**. Identify credible and salient indicators to enable benchmarking against other regions and cities as well as tracking progress over time.[4] Assure credibility for the indicators by consulting with key stakeholders in government as well as in the region. Such indicators can provide the credible evidence of progress that is essential for sustaining such significant initiatives.
7. **Boost circular economy 'literacy'**. Use analysis and make the data public (e.g. through dashboards) to raise 'circular literacy' in the business sector and in the community. Public data suggests transparency, which can build trust and credibility, which in turn are crucial for progressing significant changes in a region. Greater circular economy literacy can result in greater engagement in the marketplace for used materials and products, as buyers and sellers will be more informed and more confident. That will stimulate and grow the 'circularity' of the region's economy.
8. **Augment the *City Scan* phase 1 analysis**. For example, consider factors not yet included in the *City Scan* tool, such as adding waste stream volumes and information on available facilities, infrastructure, and land that can be repurposed. These considerations are particularly important in the *City Scan* phases 2-4, where industry subsectors and individual initiatives become the focus. The reuse, repurposing or sharing of infrastructure and land can result in significant cost savings for the businesses involved, which can add to the economic viability of newly launched enterprises.

- This report is intended for leaders, managers and specialist staff in local governments who are directly addressing economic development and business attraction, sustainability, and waste management.
- It has implications for local government functions of operations, procurement, waste management, asset management, planning and development approvals.
- The report should interest leaders in business who see opportunities in reducing waste and improving profitability, employment and sustainability through accelerated growth of the circular economy in the Hunter and Central Coast region.

[4] Uhlmann, V., Rifkin, W., Everingham, J. A., Head, B., & May, K. (2014). Prioritising indicators of cumulative socio–economic impacts to characterise rapid development of onshore gas resources. *The Extractive Industries and Society*, *1*(2), 189–199.

1. Background to this Project

1.1. OVERVIEW

- Circular economy presents an opportunity at a regional level, due to the cost of transporting materials
- Circular economy can create jobs, while some jobs become obsolete
- Economic diversification is on offer through 'smart specialisation'
- It has already started; local government has leverage opportunities
- Setting priorities for next steps in accelerating the circular economy is paramount
- Opportunity for the region to establish a leadership position in circular economy.

1.2. THE CIRCULAR ECONOMY OPPORTUNITY

Circular economy activity in the Lake Macquarie City Council area, and in the Hunter and Central Coast region more generally, has the potential to accelerate. That would benefit the environment and the economy and put the region in a leadership position as part of a national and international shift toward a more circular global economy.

Importantly, the circular economy is a regional economic opportunity. It has to do with the use, reuse and recycling of goods and the materials that they are made of, and such reuse requires the movement of things, for example, collecting old mattresses for recycling. With freight costing about 10 cents per kilometre per tonne[5], 10 tonnes of old mattresses could be more economically recycled here than 1,000 kilometres away in Melbourne.

Circular economy activity … has the potential to accelerate. That would benefit the environment and economy and put the region in a leadership position…

Additionally, reuse and recycling means importing a smaller volume of manufactured goods made from virgin materials. Keeping a table or desk in use longer reduces imports from other countries and from other regions within Australia. So, a shift toward a circular economy can eliminate some existing jobs in manufacturing because products remain in use, rather than being disposed of and replaced. Those jobs can either evaporate or be transformed. In fact, international and domestic economic modelling predicts a net increase in employment and a net increase in contributions to gross domestic product in forecasting for regions where circular economy strategies are adopted. Employment opportunities would arise in providing the technology and labour to extend the use of materials, such as in recycling and remanufacturing.

New industry options for this region are timely, given increased attention to economic diversification. Many in the region will recall closure of BHP's steel mills twenty years ago, and the news currently carries forecasts about changes in demand for the region's coal. Aspirations for 'smart specialisation' in the regional economy range from healthcare to high technologies for defence and an emerging hydrogen economy. The circular economy adds options including recycling, reuse, redesign, and remanufacturing, which involve building new business capabilities in existing firms or attracting new businesses.

Circular economy opportunities can be supported by shifting policies, procurement patterns and other local government strategies. Many these economic options require coordination across multiple organisations, i.e., local government, business, the non-profit sector, education and health, etc. Quarry Mining are shredding cardboard boxes to use in place of bubble wrap when

[5] Bureau of Infrastructure, Transport and Regional Economics (2017). *Freight Rates in Australia*, BITRE, Canberra.

shipping the components that they manufacture for underground mining equipment. Orica's byproduct stream of carbon dioxide from the manufacture of ammonium nitrate satisfies 50 per cent of the market in New South Wales for the carbonation of beverages. Net Modular has for years been disassembling and rehabilitating modular classrooms, as sole supplier of demountables for the NSW Department of Education.

These types of circular economy opportunities promise to reduce reliance on landfill, cut down on plastic particles and other chemicals entering the environment, pare back water use, reduce greenhouse gas emissions, and generate jobs in the region. In this context, which of thousands of opportunities should be the top priorities for those trying to grow the region's circular economy and for individual businesses? Consider that even an ordinary supermarket carries 40,000 different products.[6] Which one product should be an initial focus in an effort to decrease its environmental impacts, to set an example and to build momentum? Should you even begin with fast moving consumer goods?

1.3. THE *CITY SCAN*

There is growing interest and a widening array of circular economy initiatives being undertaken by Lake Macquarie City Council, the Hunter Joint Organisation of Councils, the City of Newcastle, Central Coast Council, the non-profit Go Circular, and others. These initiatives include establishment of a regional group of circular economy facilitators representing local government, state government and the University of Newcastle.

Lake Macquarie City Council and the Hunter Joint Organisation have identified the value in, and enlisted additional support for, completing a '*City Scan* '. This is a form of audit and analysis developed by Circle Economy, a non–profit consultancy launched several years ago in the Netherlands. The *City Scan* combines material flow analysis (MFA), which typically covers how much 'stuff' is being bought and thrown away and data on greenhouse gas emissions in each industry sector with economic analysis at the scale of major international cities.

The analysis undertaken for this project is phase 1 of a four-phase process recommended by Circle Economy, which is described in Appendix C. Phase 1 provides analysis that points to a general area of focus, up to three of the ten industry sectors that Circle Economy uses to define a city or region's economy. Phases 2 and 3 involve narrowing the focus further, into industry subsectors that have the greatest greenhouse gas emissions or greatest water use, for example, or sectors where innovation is prominent. Criteria for prioritising, Circle Economy suggests, should be developed through engagement with key stakeholders in industry, government and the community. Phase 4 is where action plans are developed, strategies that local government, state government, and businesses can engage in collectively.

Data for phase 1 of this process is gathered[7] and uploaded to the online *City Scan* tool, which then provides automated analysis based on a proprietary algorithm for matching circular economy opportunities with the region's economic activity, its consumption of various materials (the purchase of plastic, concrete, water, etc.), and its estimated greenhouse gas emissions.

[6] FMI (2021). Supermarket Facts, http://www.fmi.org/research–resources/supermarket–facts – accessed 1 August 2021.

[7] Data spreadsheets employed in this *City Scan* phase 1 analysis are too extensive to include in this report. However, overviews of the data are provided. The spreadsheets are now being hosted by the Hunter Joint Organisation, who can also facilitate online access to generate results from the *City Scan* tool.

The *City Scan* method is essentially about setting priorities. It enables local government policymakers to set priorities for developing the circular economy. It helps businesses and other organisations to identify circular economy opportunities. Across its four phases, which all involve data gathering, analysis, and engagement, the *City Scan* process is designed to identify the more promising circular economy opportunities. For example, in this region, are the bigger wins in waste reduction and greenhouse gas savings to be gained from addressing organic waste from leftover and surplus food at restaurants or in recovering legacy fly ash deposited around coal-fired electricity generation stations?

The *City Scan* method is essentially about setting priorities.

The availability of high quality, credible data for this analysis is recognised among international experts as a challenge. Characterising those gaps and highlighting the value in capturing higher quality data has been a key element of this project. Better data are needed to identify the volume of materials being used, from wood to metal to plastic, in each industry sector in the region. Similarly, each sector's greenhouse gas emissions need to be assessed more accurately, as a way to help track progress toward the goal of the New South Wales government of net zero emissions by 2050.

The availability of high quality, credible data for this analysis is recognised among international experts as a challenge.

1.4. STEPS IN THE *CITY SCAN* PROJECT

The plan for this *City Scan* project involved the following steps:

1. Data scoping – Identifying sources, granularity, and compatibility with the *City Scan* tools of materials flow data, greenhouse gas emissions data, and social and economic data for the Australian Bureau of Statistics SA4 regions covering the Hunter and Central Coast regions. Establish how much of the data needed for the initial analysis in the *City Scan* process can be gathered readily and at what granularity (*i.e.*, local government area [LGA], regional, postcode, industry sector). Employ this overview to determine where to focus for an initial tranche of data for the *City Scan*. Assess and determine how to adjust for differences between the nature of data gathered in the European Union, where *City Scan* was developed, and that in Australia. Liaise with data providers as needed, e.g. government departments and businesses.

2. Data gathering & transfer – Complete collation for a first tranche of data sets at the regional level (statistical area 4 [SA4], equivalent in size to the European NUTS3), which are sent to Circle Economy for addition to their data base for the *City Scan* analysis. Collate multiple years of data (to help identify trends over time) where feasible with the resources available, including updating the Hunter region materials flow analysis (MFA) completed in 2019 to the extent possible.

3. Data 'sense-checking' – Assess the quality and relevance of samples of data by checking with experts in the target industries and government departments. For example, is the volume of paper recycling really climbing to the extent indicated in the data?

4. Scenario modelling – Scenario modelling by UON (to the extent possible with the data available), with support from the Commonwealth government's Australian Postgraduate Research Intern program. Explore possible effects of acceleration of the circular economy on employment and gross regional product (the region's contribution to gross domestic product).

5. Presentation/s – Assemble and deliver presentations of work in progress and a report on final results for audiences that can include staff and stakeholders for Lake Macquarie City Council, the Hunter Joint Organisation of Councils, the City of Newcastle, Go Circular, the Hunter and Central Coast Circular Economy facilitators group, and other relevant stakeholder groups. That has included contributing to design and delivery of a 'think tank' event at the Hunter Innovation Festival in May 2021.

These steps have also provided a vehicle for engagement. Working relationships have been strengthened, plans formulated, submissions and proposals drafted and initiatives progressed. One example would be progress on common strategies across the region's councils for 'circular procurement', establishment of guidelines shared by councils for purchasing goods and services that have a lower environment impact.

1.5. SUMMARY

The *City Scan* effort can be seen as more than a process of collation of data and analysis to set priorities and establish benchmarks against which to measure progress in accelerating the region's circular economy. It has also provided a scaffold for activity along the lines of what is known as 'collective impact'. Collective impact is a process that has grown in use in different arenas to strengthen alignment of multiple parties who share common goals and aspirations. For example, it can be used to align efforts of corporations, nonprofits and government.

The project identifies sources of data and gaps that need to be filled. It uses the *City Scan* tool to provide an initial assessment identifying 'low hanging fruit' i.e. circular economy strategies that are suitable for the Hunter and Central Coast region given the data currently available. The project also serves as a vehicle to establish and strengthen working relationships among key actors needed to accelerate development of the region's circular economy. The reason that these efforts are needed is outlined in the following section, which covers the basic principles, players and outcomes of the circular economy.

2. Circular economy

2.1. OVERVIEW

- Circular economy needs to replace a 'linear economy' of take-make-waste
- The concept and stakeholders has evolved rapidly over the past few years
- Circular economy is crucial to reducing greenhouse gas emissions
- There is an opportunity for regional economic diversification in light of an 'energy transition'.

2.2. PRINCIPLES, PLAYERS AND OUTCOMES

Key principles of a circular economy relate to a reduction in waste through a wise use of materials. The aim is to shift from a 'take-make-waste' linear economy to one that keeps materials and resources in use at their highest and best value, designs out waste, and regenerates natural systems.[8] These central principles in defining a circular economy are important for determining whether the right things are being measured in order to identify important opportunities i.e. either low hanging fruit where it will be easiest to make headway or situations that can result in big wins.

The circular economy has become a rapidly evolving arena.[9] As such, it is useful to know who the key players are. This section provides an overview of the organisations that are doing leading work in advocacy, in regulation, in analysis and in consultancy.

The growing support for the circular economy emerges from a couple of key motivations of relevance to the Hunter and Central Coast region. One is a reduction in greenhouse gas emissions, aligned with the NSW government's aspirational target of net zero carbon emissions by 2050.[10] The other is economic development, particularly diversification in light of forecasts for a decline in major contributions made by coal mining and coal-fired, electric power generation to the gross regional product (the region's contribution to the nation's gross domestic product).[11]

This section gives an introduction to principles of the circular economy and names key organisations involved in the circular economy nationally and internationally, from the Ellen MacArthur Foundation to CSIRO. It also describes important outcomes from accelerating development of the region's circular economy i.e. reduced emission of greenhouse gases and increased economic diversification with accompanying job creation.

2.3. PRINCIPLES OF THE CIRCULAR ECONOMY

Principles central to a circular economy include using less material, energy and water and extending the life of materials, whether that material is derived from iron ore or from processing petroleum. That is, once these materials are created, use them judiciously through careful design, and keep the materials that are in use in use for a longer period of time. The circular

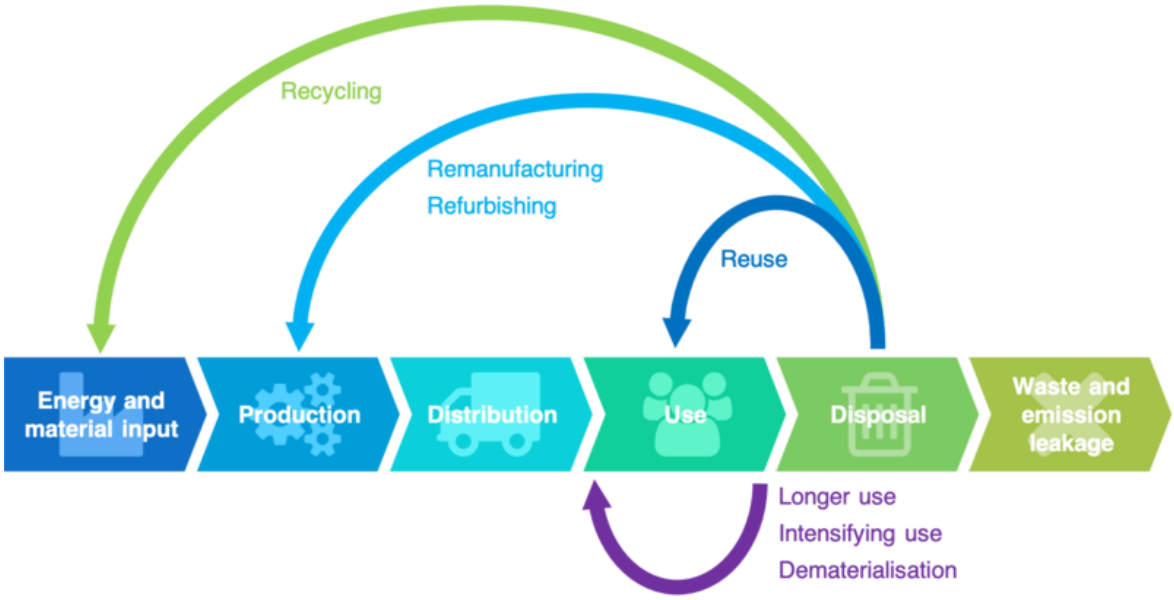
[8] Ellen MacArthur Foundation (2021). Concept. https://www.ellenmacarthurfoundation.org/circular–economy/concept – accessed 1 August 2021.
[9] Paul Klymenko, CEO of Planet Ark, Keynote presentation, Circular Economy Strategic Roadmap Workshop, Hunter Joint Organisation, 13 April 2021, Newcastle, NSW.
[10] New South Wales government (2020). *Fact Sheet: Achieving Net Zero Emissions by 2050*, Office of Environment and Heritage, Sydney, https://www.environment.nsw.gov.au/–/media/OEH/Corporate–Site/Documents/Climate–change/achieving–net–zero–emissions–by–2050–fact–sheet–160604.pdf – accessed 1 August 2021.
[11] See for example, recent publications: Hunter Jobs Alliance (2021). *Building for the Future: A 'Hunter Valley Authority' to Secure our Region's Prosperity*, Hunter Jobs Alliance, Newcastle; and McCarthy, P. (2021). *Transitioning communities dependent on coal mining in NSW*, Briefing Paper No. 1, NSW Parliamentary Research Service, Sydney.

economy is also about organic materials like food and fibre, assuring that their production is more sustainable. These materials can be productively used for longer, e.g. reusing window glass or office furniture.

To implement these principles, the circular economy encompasses business models that might be new to a particular sector.[12] Those models include giving up purchasing something, such as a motor vehicle, and instead using the vehicle temporarily and then returning it for others to use, such as in car sharing. Circular economy principles would also encompass familiar alternatives, such as taking public transport, a taxi or a ride-sharing service, such as Uber or Lyft.

The concept of a circular economy can be seen to have some historical roots decades ago in a field called 'industrial ecology'[13], which looked at how one industry's waste could be another's feedstock. Circular economy efforts pick up on themes in sustainability, with aligning with achieving certain of the UN's Sustainable Development Goals (SDGs).[14] There are also resonances with notions of the 'doughnut economy'[15] which focuses on the trade-offs in the SDGs between living within environmental limits (the outer face of the doughnut) and achieving basic social justice goals for those in need (the inner face of the doughnut).

Figure 2.1: Conceptual diagram for the circular economy[16]



The resonances with doughnut economics underline the social justice elements often cited in discussion of the circular economy.[17] However, the circular economy can also be seen as where environmental concerns can be addressed within a capitalist framework. That is because the circular economy relies on certain market mechanisms, such as buying and selling materials or

[12] OECD (2018), *Business Models for the Circular Economy: Opportunities and Challenges from a Policy Perspective*, OECD Publishing, Paris. https://www.oecd.org/environment/waste/policy–highlights–business–models–for–the–circular–economy.pdf – accessed 16 August 2021.
[13] Kapur, A. and Graedel, T. (2004). Industrial Ecology, *Encyclopedia of Energy*, C. Cleveland, editor, Elsevier Science, Edinburgh.
[14] Department of Economic and Social Affairs (2015). *The 17 Goals*. United Nations, New York. https://sdgs.un.org/goals – accessed 1 August 2021.
[15] Raworth, K. (2017). *Doughnut Economics: Seven ways to think like a 21st–centure economist*, Random House Business, North Sydney.
[16] Geissdoerfer, M., Pieroni, M.P., Pigosso, D.C. and Soufani, K., 2020. Circular business models: A review. *Journal of Cleaner Production*, p.123741. Creative Commons license.
[17] Morris, Ashley, Principal: Coreo circular economy consultancy, *personal communication*, 4 May 2021.

purchasing use of something rather than purchasing the 'tool' outright i.e. the new business models mentioned above.

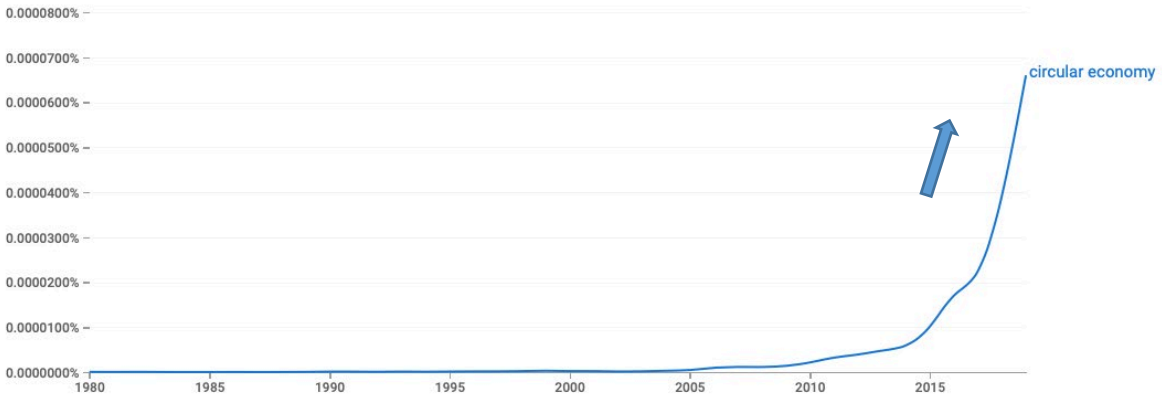
In fact, that market mechanism has historical roots stretching back centuries, in the buying and selling of used goods. That is manifested today in very active markets for 'used' houses and apartments, used cars, antiques, and temporary accommodation (housing as a service). These historical examples resonate with the quote, 'The future is already here. It is just not very evenly distributed,' by the noted science fiction writer, William Gibson.[18]

'The future is already here. It is just not very evenly distributed.'

The circular economy is gaining increasing currency in relation to large corporations achieving the sustainability goals that have been nominated by investors or governments.[19] There are arguments in academia and the non-profit sector that the circular economy needs to be seen as an ecosystem, hosting interactions involving businesses, government and consumers.[20] The term 'circular economy' seems to appeal to managers of small to medium sized enterprises, at least according to the interviews conducted for this project, and some of them would not identify themselves as 'greenies'. They state that they are seeking to reduce waste based on personal values, doing they feel is the right thing to do, as well as for business efficiency.

The prevalence in use of the term 'circular economy' in books has risen dramatically since 2015. This is shown in Figure 2.2.

Figure 2.2: Use of 'circular economy' in books 1980-2019[21]



So, the circular economy, in principle, is not an entirely new concept. It is recognised as being about materials and sustainability, but also about reducing waste. There are sentiments inherent in the circular economy that resonate strongly with the green left, which is evident at circular economy events and in discussion with consultants. However, as the interviews for this project indicate, there are also sentiments that align with more traditional corporate drivers and operational requirements. This alignment with existing values could be one explanation for the rapid uptake of the circular economy concept suggested by the steeply sloped curve in Figure 2.2.

[18] Quoted in an interview in *The Economist*, 4 December 2003.

[19] Note, for example, the actions of Australia's mining giant, BHP – 'BHP launches $10m tailings circular economy challenge in Chile', 16 March 2020: https://www.austrade.gov.au/australian/education/news/opportunities/bhp–launches–10m–tailings–circular–economy–challenge–in–chile – accessed 1 August 2021.

[20] See, for example, Konietzko, J., Bocken, N., and Jultink, E. (2020). Circular ecosystem innovation: An initial set of principles, *Journal of Cleaner Production*, vol. 253, 119942.

[21] *Google Books Ngram* – *https://books.google.com/ngrams*. The vertical scale represents the frequency with which a term is mentioned in the books scanned in a given year across English, simplified Chinese, French, German, Hebrew, Italian, Russian and Spanish. That percentage figure is very small for nearly any word or phrase analysed due to the size of the vocabulary across these languages. That makes the shape of the curve more important than the raw figure, *i.e.*, the curve shows whether the term is being used more frequently or less frequently over time.

That notion is consistent with studies of innovations generally, where such 'compatibility' with existing values enhances the rate of adoption.[22]

2.4. PLAYERS PROMOTING THE CIRCULAR ECONOMY

The principles and practices of the circular economy have been disseminated and promoted by the Ellen MacArthur Foundation (EMF). It is based in the UK and is seen as a leader internationally.[23]

Also recognised internationally are Circle Economy, creators of the *City Scan*.[24] For the last few years, they have provided an annual report to assess how economies in different countries, and now in different cities, are becoming more circular and what gaps remain. For example, they assess 'global circularity' to be 8.6 per cent, with a figure of 17 per cent being necessary to keep the world 'liveable and thriving'.[25] They can be seen as one leader in these regionally focused metrics. Their awareness of how accurate or inaccurate local estimations are for use of materials and for greenhouse gas emissions has been evident in liaison with them over the past six months for this project. Circle Economy, the Ellen MacArthur Foundation, an international organisation of cities – ICLEI[26], and a Netherlands-based, sustainability consultancy – Metabolic, are collaborating on development of digital tools for the circular economy.

The circular economy is also addressed by international economic organisations, such as the Organisation for Economic Cooperation and Development (OECD). The OECD has been providing various types of analysis (e.g. *Labor market consequences of a transition to a circular economy: a review paper*, published in May 2020) developed by researchers in their member countries. It has recently compiled a tally of 474 circular economy indicators derived by review of a range of studies of cities and regions (OECD, 2021).[27] Work on developing useful metrics is also supported by the European Union, such as in the CityLoops network.[28] That involves seven cities assessing their progress across an array of circular economy initiatives.

Benefits of a circular economy to Australia have been reported in recently by the consultancies KPMG (*Potential Economic Payoff of a Circular Economy* published in April 2020) and PricewaterhouseCoopers (*Building a more circular Australia* published in March 2021). CSIRO published their *National Circular economy roadmap for plastics, glass, paper and tyres* in January 2021. NSW Circular, an initiative funded by the New South government, has published figures on economic benefits to the state and national economy in November 2020 – *The circular economy opportunity in NSW*.[29] Assessment of benefits of a circular economy to individual businesses is an area of active consultancy work, with tools developed by the World Business Council for Sustainable Development[30] and the Ellen MacArthur Foundation's *Circulytics*[31], to name two salient examples.

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[22] Rogers, E. (2010). *Diffusion of Innovations*, 5th edition. Simon and Schuster, New York.
[23] Ellen MacArthur Foundation (2021). *Our story*: Milestones. https://www.ellenmacarthurfoundation.org/our–story/milestones – accessed 1 August 2021.
[24] Circle Economy (2021). *About the CGRi*. https://www.circularity–gap.world/about – accessed 1 August 2021.
[25] Circle Economy (2021). *The Circularity Gap Report 2021*. https://www.circularity–gap.world/2021 – accessed 1 August 2021.
[26] ICLEI stands for the International Council for Local Environmental Initiatives, a network of over 2,500 local and regional governments supporting sustainable urban development.
[27] OECD (2021). *The OECD Inventory of Circular Economy Indicators*, OECD Publishing, Paris.
[28] CityLoops (2021). *CityLoops Project*. https://cityloops.eu/about/cityloops–project – 1 August 2021.
[29] NSW Circular (2020). *The circular economy opportunity in NSW*. NSW Government, Sydney.
[30] World Business Council for Sustainable Development (2021). *Circular Economy*. https://www.wbcsd.org/Programs/Circular–Economy – accessed 1 August 2021.
[31] Ellen MacArthur Foundation (2021). Circulytics – measuring circularity. https://www.ellenmacarthurfoundation.org/resources/apply/circulytics–measuring–circularity – accessed 1 August 2021.

National initiatives in the circular economy have been seen in Asia and Europe, with the English speaking world seeming to lag behind. Enabling legislation in Japan dates back to 1970, with a resource efficiency law in 1996. Germany instituted recycling legislation in 1991, and China's circular economy law is cited as being in 2009.[32] The China Sword policy in 2018 stopped Australia's export of recyclables to that country, which the previous year had been 1.25 million tonnes.[33]

Analysis of opportunities at a state level has been commission by the South Australian government's Green Industries SA – Creating value: The potential benefits of a circular economy in South Australia (May 2017).[34] The Victorian state government has adopted a 10-year plan, *Recycling Victoria: a new economy*, and established the Circular Economy Business Innovation Centre (CEBIC).[35] In July 2021, CEBIC provided $6.3 million across 23 projects in its first funding round. They are also having analyses completed by Circle Economy. The NSW government funded NSW Circular in 2020, and they used the term 'circular economy' over 100 times in their recently released *NSW Waste and Sustainable Materials Strategy 2041: Stage 1 2021-2027*.[36] The Australian government in November 2020 provided $1.6 million for the Australian Circular Economy hub to be run by the environmental organisation, Planet Ark.[37] The Commonwealth Parliament published the outcomes from its inquiry into the circular economy, *From Rubbish to Resources: Building a Circular Economy*, in December 2020.[38]

… the past few years could be seen as an inflection point in the Australian context.

This high level overview shows that attention to the circular economy has been growing over the last few years internationally, nationally and in the NSW government as well as within large domestic and multi-national corporations. That is, the past few years could be seen as an inflection point in the Australian context. This recent rise is evident in the increasing use by government, industry and the media of the term 'circular economy', in development of state government initiatives with that focus, *i.e.,* NSW Circular, and in reports by major consultancy firms on the topic.

This attention is focused in part on advocating for more circular strategies to be implemented by companies and supported by government. Importantly, it is also addressing the need for more accurate metrics of material use, greenhouse gas emissions and to assess progress toward greater circularity of the economy.

2.5. REDUCING GREENHOUSE GAS EMISSIONS

The circular economy is cited as important for a range of reasons, from pollution caused by landfills and the effects on sea life of plastics in the ocean to environmental impacts attributed to

[32] Ogunmakinde, O. (2019). A Review of Circular Economy Development Models in China, Germany and Japan, *recycling*, 4, 27,; doi: 10.3390/recycling4030027.
[33] NSW EPA (2018). Response to enforcement of the China National Sword Policy. NSW government. https://www.epa.nsw.gov.au/your–environment/recycling–and–reuse/response–to–china–national–sword – accessed 1 August 2021.
[34] Lifecycles (2017). *Creating value: The potential benefits of a circular economy for South Australia*, Green Industries SA, Adelaide.
[35] Circular Economy Business Innovation Centre (2021). *Accelerating a circular and climate–resilient economy*. https://www.cebic.vic.gov.au – accessed 1 August 2021.
[36] Department of Planning, Industry and Environment (2021). *NSW Waste and Sustainable Materials Strategy 2041: Stage 1 2021–2027*. New South Wales government, Sydney. https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0006/385683/NSW–Waste–and–Sustainable–Materials–Strategy–2041.pdf – accessed 1 August 2021.
[37] Planet Ark (2021). *Australian Circular Economy Hub*. https://planetark.org/programs/australian–circular–economy–hub – accessed 1 August 2021.
[38] Parliament of the Commonwealth of Australia (2020). *From Rubbish to Resources: Building a Circular Economy*. House of Representatives Standing Committee on Industry, Innovation, Science and Resources, Canberra.

mining and land use conflicts related to farmland being turned over to suburban development. Severe weather, wildfires, drought and flooding are now focusing public, government and corporate attention on greenhouse gas emissions.

> … 55 per cent of greenhouse gas emissions are due to energy generation and transportation, while 45 per cent are due to use of materials ...

The Ellen MacArthur Foundation suggests that 55 per cent of greenhouse gas emissions are due to energy generation and transportation, while 45 per cent are due to use of materials.[39] In other words, to reach net zero emissions by 2050, solar panels and electric cars are examples of important technologies to reduce about half of greenhouse gas emissions. However, the other half requires reducing emissions in the production and use of materials. The material whose manufacture creates the single largest contribution to greenhouse gas emissions from the industry sector is cement, which accounts for 8 per cent of all greenhouse gas emissions.[40] These figures suggest that anything substantial that the Hunter and Central Coast region can do to reduce the energy expended in production of concrete can be seen as a positive contribution.

In seeking to reduce greenhouse gas emissions, it is important to know how they are tracked and tallied. Greenhouse gas emissions are not measured simply with instruments, in the way that pollutants like particulate matter are measured in smoke (e.g. looking at laser light reflected from the particles). Rather, greenhouse gas tonnage is estimated by assessing emissions generated in different aspects of a product's production and life. Estimates can involve use of chemical equations or known figures for the amount of heat needed for a given industrial process and how efficiently it is generated by electricity or natural gas.

The international *Greenhouse Gas Protocol Corporate Accounting and Reporting Standard* offers a widely recognised taxonomy of scope 1, scope 2, and scope 3 emissions.[41] Scope 1 emissions cover a company's emissions on their site of operations. That could include carbon dioxide from natural gas burned in a boiler for a food processing plant. Scope 2 emissions come from energy purchased from other parties, such as electricity, steam, heating or cooling (the purchase of the steam, heating and cooling occurs at a district scale in urban settings in Europe, for example). Scope 3 emissions arise elsewhere in the company's supply chain. That could include emissions from a coal-fired power station whose electricity runs a water heater, whose water is used to clean an aluminium part manufactured by a supplier 500 km away from the ultimate manufacturer. Scope 3 also includes the transport, consumption and disposal of products.

The standard categories and methods of estimation have been developed to enable consistent reporting of greenhouse gas emissions by large corporations. A corporation might hire a consultant to assess their operations and the material inputs that they employ to estimate greenhouse gas emissions for each unit of output. For example, how many kilograms of CO_2 or other greenhouse gases are emitted for each lithium ion battery that the company ships to a customer? This type of reporting is done in Australia through the National Greenhouse and Energy Reporting Scheme (NGERS). Estimated emissions for large corporations are listed publicly on its web site.[42]

These methods for estimating greenhouse gas emissions are important for several reasons. First, they are still being refined. Second, the larger companies in the Hunter and Central Coast region will be estimating and reporting their greenhouse gas emissions, but the smaller ones will not

[39] The Ellen MacArthur Foundation (2021). https://climate.ellenmacarthurfoundation.org – accessed 1 August 2021.
[40] Robertson–Fall, T. (2021). Building a world free from waste and pollution: Redesigning how we make and use buildings to reach net–zero emissions, *Circulate* (4 May), https://medium.com/circulatenews/building–a–world–free–from–waste–and–pollution–575efb9a6a47 – accessed 1 August 2021.
[41] World Business Council for Sustainable Development & World Resources Institute (2021). *The Greenhouse Gas Protocol: A corporate accounting and reporting standard*, Revised edition. WBCSD, Geneva and WRI, Washington, DC. –
[42] National Greenhouse and Energy Reporting Scheme – (http://www.cleanenergyregulator.gov.au/NGER.

unless they are requested to as a result of supplying the larger companies. On the positive side, the large companies will be reporting their emissions publicly to the Australian government, often to shareholders in the corporation's annual report and frequently to international financing organisations. However, the publicly reported figures may be reported by company, not by site. So, the greenhouse gas emission figures reported by an international company like Glencore will be tallied internationally, but they will also report just the Australian operations to the Australian government. The reporting of separate figures for their operations in the Hunter Valley might become more likely with some sort of incentive or a reporting requirement, such as a regional version of NGERS.

Despite such challenges, studies in various parts of the world do suggest how much scope 1 (local) greenhouse gas emissions a mining operation will generate for each tonne of ore or coal produced.[43] These estimates, though, may be tailored to certain types of operations in certain countries, and they are likely to be less accurate in other settings. For example, estimates for greenhouse gas emissions from coal mines in Poland would not necessarily apply in the Hunter Valley.

So, the aspiration for locally assessed greenhouse gas emissions remains. Approximations that can be arrived at by scaling or adapting from detailed estimations of emissions for other locations are useful for very rough rankings of one industry relative to another. For example, the estimates used here for greenhouse gas emissions overall and per employee in the mining sector in the Hunter and Central Coast region indicate that they are far higher than greenhouse gas emissions in the health and social services sector.

2.6. FUELING ECONOMIC DEVELOPMENT – SMART SPECIALISATION

The regional nature of a circular economy has also aligned it in Europe with strategies for regional development, particularly smart specialisation.[44] Smart specialisation refers to having each region identify its competitive strengths. That is, what infrastructure does it have (from specific machinery to built infrastructure, like a port or airport), what commercial economic strength and what skills sets in its workforce.

Smart specialisation tends to be more popular in the European Union than in Australia[45], and the circular economy seems to have a stronger foothold in the EU, as well.[46] Smart specialisation is being explored in Gippsland with the support of the Latrobe Valley Authority[47], an organisation formed to respond to the closure of the nearby power stations and coal mines. Elements of smart specialisation are also evident in the NSW government's designation of special activation precincts (SAPs) in the regional areas of Parkes and Wagga Wagga.[48]

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[43] For a tally of these estimates across mining operations, see Norgate, T. and Hope, N. (2010). Energy and greenhouse gas impacts of mining and mineral processing operations, *Journal of Cleaner Production*, vol. 18, issue 3, pp. 266–274.

[44] Vanhamaki, S., Rinkinen, S. & Manskinen, K. (2021). Adapting a Circular Economy in Regional Strategies of the European Union, *Sustainability*, *13*, 1518. https://doi.org/10.3390/ su13031518.

[45] This conclusion, that Australia is lagging behind in adoption of smart specialisation strategies, is evident in the number of case studies on the topic in the Australian academic literature and in regional development discussions in the Hunter region. It is also alluded to in a panel discussion summarised in: KPMG (2015). *Future state: Australian manufacturing and smart specialisation*, KPMG, Sydney – https://assets.kpmg/content/dam/kpmg/pdf/2015/07/australian–manufacturing–smart–specialisation–june–2015.pdf – accessed 16 August 2021.

[46] Otter, C. (2018). *The Circular Economy: An explainer*. Research Note No. 10, Department of Parliamentary Services, Parliament of Victoria. https://www.parliament.vic.gov.au/publications/research–papers/send/36–research–papers/13880–the–circular–economy–an–explainer – accessed 1 August 2021.

[47] https://sustainable.unimelb.edu.au/research/research–projects/gippsland–smart–specialisation–strategy – accessed 1 August 2021.

[48] Department of Planning, Industry & Environment (2021). *Special Activation Precincts*. NSW government. https://www.planning.nsw.gov.au/Plans–for–your–area/Special–Activation–Precincts – accessed 20 August 2021.

The approach has also been explored for the Hunter region, under the auspices of the federal agency, the Regional Development Authority Hunter. That study identified seven areas of competitive advantage for the region:

1. Food and agriculture
2. Mining equipment, technology and services
3. Medical technologies and pharmaceuticals
4. Oil, gas and energy resources
5. Advanced manufacturing
6. Defence
7. Creative industries.[49]

These industry sectors have been highlighted in recent years in numerous public forums and discussions on economic development opportunities and business attraction for the Hunter region. The *Greater Newcastle Metropolitan Plan* notes many of these areas as sources of growth in the Lower Hunter.[50] The medical technologies and pharmaceuticals area could see a boost from the $700 million redevelopment of the John Hunter Hospital being expanded with an additional $1 billion investment in a health and innovation precinct. There is also the medical precinct development on the Central Coast in Gosford, near the University of Newcastle's new medical education and research campus and the local health district headquarters. The defence focus is supported by the declaration of a special activation precinct near the Williamtown airbase, which encompasses the aerospace companies providing maintenance of the Joint Strike Fighters.

The region's strengths in these areas are evident in general economic data in terms of gross value added by each industry sector, its contributions to the country's gross domestic product (GDP). However, missing from the list is the healthcare and social services sector, the region's sector with the largest employment. Also missing are tourism along with real estate services and associated home construction, which provide a substantial contribution to the local economy due to dramatic rises in house prices over the long term.

There is a high correlation between economic output … and greenhouse gas emissions …

This notion of industry strength has two implications for building the region's circular economy. First, it suggests which industries will use the most materials and likely dispose of the most. Knowing the economic strength of industries can also help to characterise the level of greenhouse gas emissions created. There is a high correlation between economic output, as measured by gross domestic product per capita, and greenhouse gas emissions according to World Bank data (see, for example, the brief discussion by Archer in the online publication, *Medium*)[51] and various other sources. A tension between output and emissions heightens as industries seek to decarbonise and to decarbonise their supply chains in response to pressure from government, funding institutions and shareholders. In response, an industry strength suggests that the region has workers with skill sets that can be applied to circular economy areas, such as remanufacturing goods or reusing waste materials in industrial processes.

[49] Regional Development Australia (2016). Identifying the Hunter's Strengths for the Future, https://rdahunter.org.au/initiatives/smart–specialisation/ – accessed 1 August 2021.

[50] State of New South Wales (2018). *The Greater Newcastle Metropolitan Plan 2036*. NSW Department of Planning and Environment, Sydney. https://www.planning.nsw.gov.au/–/media/Files/DPE/Plans–and–policies/greater–newcastle–metropolitan–plan–2036/greater–newcastle–metropolitan–plan–2036–2018–09–17–part–1.pdf

[51] Archer, H. (2018). The Environment and the Economy: Correlation between CO_2 Emissions and GDP, *Medium*, https://medium.com/@xsm918/the–environment–and–the–economy–correlation–between–co2–emissions–and–gdp–fd4484e157e1 – 3 Aug 2021.

2.7. SUMMARY

The concept of the circular economy encompasses principles related to use and reuse of materials but also economic elements, such as identifying which array of existing and new industries might work best together. Complementary industries that are essential for a circular economy could be assembled through a smart specialisation strategy. Importantly, the notion of a circular economy seems to be gaining broader attention in the past two years. These gains are seen in the growing number of initiatives funded by federal and state governments as well as reports on the circular economy from the CSIRO and from consulting companies. This surge in activity provides a window of opportunity for the Hunter and Central Coast region to make steps toward gaining a position of national prominence so as to attract businesses with products and services that are especially attuned to the circular economy.

This surge in activity provides a window of opportunity for the … region to … attract businesses … attuned to the circular economy.

Potential economic gains from the circular economy*

International studies

Journal of Cleaner Production – 'Macroeconomic, social and environmental impacts of a circular economy up to 2050'

- Analysis of 27 academic studies
- Median figures from 300 circular economy scenarios in various parts of the world
- Reductions in greenhouse gas emissions by 2030 of 25%
- Rise in employment of 1.6%
- Rise in GDP of 2%

National studies

KPMG & CSIRO – *Potential Economic Payoff of a Circular Economy*

- $96 billion gain by 2048 from improved building energy efficiency
- $30 billion from reduced water leakage

South Australia – *Creating Value*

- 4,700 jobs by 2030 through efficient and renewable energy
- 21,000 jobs through material efficiency
- Half in professional, scientific and technical services
- Half in construction, personal and other services

New South Wales – *The circular economy opportunity in NSW*

- $210 billion added to Australia's GDP by 2048
- Up to 50,000 jobs in NSW by 2025
- 3.3 times more jobs in recycling for every job in landfill

Hunter and Central Coast region

Beyond Zero Emissions – *Million Jobs Plan*

- 10,000+ jobs in Hunter region by 2030
- Building zero emissions buses, use of fly ash in construction, mine rehabilitation, carbon farming, land care, housing energy retrofits

Grattan Institute – *Start with Steel*

- 10,000 jobs in the Hunter manufacturing green steel, replacing jobs in coal mining

Hunter Community Environment Centre – *Jobs and Growth*

- Fly ash from power stations creating 3,000 jobs state–wide and $1b contribution to GDP

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**These studies are reviewed and full citations are provided in Appendix B.*
Where possible, outcomes for the Hunter and Central Coast region are estimated.

3. Economic baseline

3.1. OVERVIEW

- A table of the economic strengths of each of the 10 local government areas in the Hunter and Central Coast region puts *City Scan* results in context
- This data enables comparing local government areas to determine which ones are contributing more to employment or economic output or greenhouse gas emissions
- This comparison highlights issues related to how greenhouse gas emissions are allocated (scope 1, scope 2 and scope 3), with emissions due to the electric power generation in this region allocated across the regions who use that electricity in some emissions accounting protocols.

3.2. ECONOMIC AND EMISSIONS DATA ON THE REGION'S LOCAL GOVERNMENT AREAS

Important input into the phase 1 analysis for *City Scan* is data on the region's contribution to the country's gross domestic product, specifically industry sector by industry sector. Additional data is needed on employment by sector and greenhouse gas emissions by sector, as already noted. The figures are tallied for the Hunter and Central Coast region as a whole, as that is the scale at which the *City Scan* analysis works. It is also the scale of a circular economy i.e. regional.

This data at the level of local government area was requested as an output for this project. In other words, the LGA level data has not been used in the City Scan tool, but it can have value for local governments in the Hunter and Central Coast region. This data is in Table 3.1 (*see the next page*).

Industry sectors that are top greenhouse gas emitters
For greenhouse gas emissions, across the 19 sectors in Australia's ANZSIC classification system, three rank at the top in the Hunter and Central Coast region. Those industry sectors are mining and utilities, manufacturing, and wholesale and retail trade, which includes motor vehicle repair.

The next four in the emissions rankings are agriculture, construction, professional & support services, and social services (with education included in this group). The lowest sectors in terms of emissions are recreational & other services, finance/insurance/real estate, and information and communication.

Evident in these rankings is that local government, included in the public administration and defence sector, is <u>not</u> among the higher direct emitters. That said, local government may rely on industry sectors, e.g. as contractors or vendors, who are in high emitting sectors, such as construction or wholesale.

Idiosyncrasies in the data
It is important to note the assumptions, methods and estimations inherent in these figures. These issues are not necessarily paramount in assessing which industry sector in a given locality offers greater employment or is responsible for higher greenhouse gas emissions (identified in the table in the column labelled 'eCO_2'). However, these issues with data and how it is assembled and how it is categorised can play a role in more detailed considerations, such as tracking changes from year to year or analysing one LGA in depth separately from the others. These issues with the data are itemised and discussed in more depth in section 4 of this report, while assumptions underlying the estimations used are described in Appendix D.

Table 3.1: Economic strengths for each local government area.[52]

Local Govt Area	Employment (top 3 sectors)	Value added (top 3 sectors)	Gross regional product (% of regional total)	Number of workers (% of regional total)	eCO_2 emissions (ktonnes CO_2 eq) (% of regional total)
Lake Macquarie	Health & social services Wholesale/retail Construction	Real estate Mining Health & social services	$11 billion 14%	61,601 16%	2,576 16%
Newcastle	Health & social services Wholesale/retail Education	Financial & insurance Real estate Health & social work	$18 billion 23%	102,800 26%	2,988 18%
Central Coast	Health & social services Wholesale/retail Construction	Health & social services Construction Wholesale/retail	$16 billion 21%	121,746 31%	4,192 25%
Cessnock	Accommodation & food services Wholesale/retail Health & social services	Real estate Mining Health & social services	$2.8 billion 4%	15,494 4%	659 4%
Maitland	Health & social services Wholesale/retails Construction	Real estate Mining Construction	$1.5 billion 2%	28,318 7%	1,218 7%
Port Stephens	Public admin/defence Wholesale/retail Manufacturing	Public admin/defence Real estate Construction	$4.9 billion 6%	27,346 7%	1,442 9%
Singleton	Mining Wholesale/retail Public admin. & defence	Mining Public admin/defence Real estate	$13 billion 17%	16,325 4%	1,695 10%
Muswellbrook	Mining Wholesale/retail Electricity generation	Mining Electricity generation Real estate	$7.3 billion 9%	10,017 2.5%	1,194 7%
Upper Hunter	Agriculture Wholesale/retail Education	Agriculture Real estate Education	$1.7 billion 2%	5,260 1%	445 3%

[52] Figures for employment, gross value added, gross regional product, and number of workers are from the Australian Bureau of Statistics (ABS). That data is aggregated on the REMPLAN websites for each local government area in the Hunter region, while data on the Central Coast is aggregated and put on the web by .ID. Data on emissions of greenhouse gases, represented are here given by 'eCO_2' – tonnes of different gases in terms of how much carbon dioxide they are equivalent to in contributing to global warming. These figures are from the *Snapshot Climate* website of Ironbark Sustainability – https://snapshotclimate.com.au – accessed 1 August 2021.

Local Govt Area	Employment (top 3 sectors)	Value added (top 3 sectors)	Gross regional product (% of regional total)	Number of workers (% of regional total)	eCO_2 emissions (ktonnes CO_2 eq) (% of regional total)
Dungog	Agriculture Education Construction	Real estate Agriculture Construction	$0.4 billion 1%	2,202 0.5%	187 1%
Total for region	Health & social services Wholesale/retail Construction	Mining Real estate Health & social services	$77 billion 5% of national total	391,109 3% of national total	16,596 3% of national total

The employment figures from the ABS tend to identify where workers in a given sector live or where they work. The tradition in this sort of analysis is for workers in the mining sector who live in Cessnock but who are employed in Singleton or Muswellbrook to be counted toward the Cessnock total. That enables each council to identify how many of their own residents work in a given sector.

The greenhouse gas emission figures in the table above are taken from the *Snapshot* website of emissions by LGA assembled by Ironbark Sustainability.[53] These figures are used because they enable comparisons across different regions. Their estimation process follows recognised international protocols, and these figures have come to be seen as a touchstone. The estimates are based on formulas derived from modelling communities in the State of Victoria. In doing their modelling and estimation, Ironbark Sustainability has decided to allocate the very significant emissions from large power generation stations to the localities where they see that the electricity is consumed.[54] That means that the emissions for the large power stations in Muswellbrook and Lake Macquarie are not counted in the tallies shown in this table, even though the power stations provide up to 40 per cent of the state's electricity.

As a result, the greenhouse gas emission figures from *Snapshot* were not employed in the data for the Hunter and Central Coast LGAs that were uploaded to the *City Scan* website. This decision, to instead include the power station emissions for Muswellbrook and Lake Macquarie, was made in order to assess the circular economy potential of the utility sector, as it is economically important in these LGAs and contributes significantly to the scope 2 and 3 greenhouse gas emissions for industries around the state. That is consistent with the aims of the *City Scan* analysis, which is a prioritising process, identifying which industry sectors can offer the greatest gains.

In other words, the *Snapshot* figures are reported above to enable comparisons that are consistent across LGAs within the region and comparisons with LGAs outside the region. This potentially confusing choice was made following internal review of this report, where it was noted that the figures in this table disagreed with state government estimates of greenhouse gas emissions for each LGA.

For further discussion of these issues and challenges, see section 4 of this report on data quality, data gaps and data needs. Additional data, including estimates of greenhouse gas emissions by industry sector within each local government area and very rough figures for material consumption across a dozen different types of materials for each sector in each local government area, are in a soft copy spreadsheet to be made available via the Hunter Joint Organisation.

[53] *Snapshot* (2021). Ironbark Sustainability, Melbourne. https://snapshotclimate.com.au – accessed 1 August 2021.
[54] Methods employed in estimating greenhouse gas emissions are described in this report: Sullivan–Kilgour, M. (2020). *Snapshot Municipal Carbon Emissions: Calculation Methods*, Snapshot Community Climate Tool, Ironbark Sustainability, Melbourne.

Alignment between economic output and emissions, in general

Note that some, though not all, of the sectors with the greatest employment in the region and with the greatest contributions to the economy are also the ones with the greatest greenhouse gas emissions. Some of these sectors are more prominent in certain local government areas. For example, agriculture is economically prominent in Upper Hunter Shire and in Dungog Shire, though not in the other local government areas.

Certain economically prominent industry sectors in the region do not rank highly in terms of greenhouse gas emissions, specifically, the real estate industry and the finance and insurance industries.

Real estate ranks highly in terms of gross value added in all local government areas. That can be attributed to the high prices for real estate resulting from a market that keeps rising. Real estate, finance and insurance industries are contributing to employment and the economy but not so much to direct emissions of greenhouse gases.

That said, these sectors may be procuring services from or working in concert with sectors that do make significant contributions to greenhouse gas emissions. For example, the real estate sector and financial services sector can be seen as elements in the supply chain of the construction sector in relation to financing, building and selling homes.

These supply chain issues are highlighted by a recent report by the World Economic Forum.[55] In greenhouse gas emissions nomenclature, these supply chain issues fall under scope 2 (for energy generation) and scope 3. There promises to be a greater focus on scope 2 and scope 3 emissions in the future, as suggested by a call NSW Circular in August 2021 for examination of the current state of the art internationally in 'life cycle assessment' as a way of characterising in a credible and consistent way progress toward reaching net zero emissions.[56]

3.3. SUMMARY

The data provided here on the economic strengths of each of the 10 local government areas considered in this study would not be news to those in local government focused on economic wellbeing and development in their own council area. However, this data can add an economic development lens to current discussions of emissions and recycling, which might otherwise focus mainly on waste management and sustainability.

Additionally, the comparative data provides a useful foundation for looking beyond a single local government when considering a regional approach, as is needed in development of the circular economy. Juxtaposing the economic data with data on emissions helps to highlight trade-offs that might occur between the two, such as jobs that might be at risk if activity in industry sectors with higher emissions are curtailed in coming years and decades.

[55] World Economic Forum (2021). *Net–Zero Challenge: the supply chain opportunity*, Insight Report. World Economic Forum with Boston Consulting Group, Geneva.
[56] NSW Circular (2021). *Rapid Review Research Funding: NSW Government Challenge*. https://www.nswcircular.org/wp–content/uploads/2021/08/NSW–Government–Challenge–Statement.pdf – accessed 23 August 2021.

4. Data quality, data gaps and data needs

4.1. OVERVIEW

- The *City Scan* process involves existing data sets and newly emerging ones
- Estimates, including very rough estimates, are important input data for *City Scan* phase 1
- Data currently available at a regional or council level is not sufficiently granular or publicly available to focus circular economy strategies and track their progress
- Data on greenhouse gas emissions and material consumption is especially key but has issues
- A regional data strategy is needed
- There is evidence of a willingness in the region's industries to start sharing some information.

4.2. PRIORITIES, ESTIMATES, MARKET INFORMATION

The *City Scan* analysis underlines the importance of having data on the consumption of materials and generation of greenhouse gas emissions at the level of local government area, industry sector and type of material. This data enables setting priorities. For example, are the greatest 'wins' in accelerating development of the region's the circular economy to be gained in the information technology sector or in the construction sector? Which focus should local government have?

The *City Scan* analysis underlines the importance of … data on … materials and … greenhouse gas emissions at the level of local government area, industry sector and type of material.

These sorts of early decisions about priorities can be guided by data that is estimated rather than an exact measurement, the *City Scan* analysis suggests. If estimates of greenhouse gas emissions generated by the IT sector in the region are off by 50 per cent, it will still be evident that those figures are far below the emissions generated by the construction sector. However, data with this much uncertainty is less useful in tracking progress from year to year. That tracking is critical for a number of reasons. First, it indicates which efforts to boost the circular economy, and reduce greenhouse gas emissions, are actually having a significant effect. Second, it is necessary to gauge whether overall progress is quick enough to reach a goal of net zero carbon emissions by the year 2050.

Aside from setting priorities and tracking progress, a third use of data on material consumption, and materials going to recycling or landfill, is to inform the marketplace. Business operators who are buying and selling goods of any sort in significant volume can be understood to need a lot of information given the expenditures involved and the effects of material quality and availability on their business. For example, an initiative to extend the life of office furniture needs gross figures on volumes of furniture being surrendered or thrown away in a given locality. It also helps to know the qualities of each lot of material i.e. how many desks, how many chairs, how many file cabinets, and made of what materials, steel, wood, plastic, etc. Assembling this information is well beyond the scope of the *City Scan* guidelines that have been provided. However, insights into what is needed, and potential barriers to collecting that information, can be gained. This

area can also benefit from modelling that draws inferences from careful sampling that is then extrapolated to new settings based on demographic and market factors.[57]

This section outlines which of the data that has been input into the *City Scan* can be viewed with a high level of confidence and which data is more of a rough approximation. This section also relays input on data quality or credibility and data needs from interviews of 16 executives, sustainability specialists, and government staff in the region. These interviews point to elements required for a regional data strategy to support development of the circular economy. There are more general implications for data sharing to spur economic development and support of wellbeing in the region.

Discussions below support a contention that, despite the uncertainties, the *City Scan* does enable identifying which sectors might offer 'big wins' in the circular economy. However, the data on offer has a sufficient number of gaps, particularly in relation to tracking material consumption, to make assessing progress from year to year and benchmarking against other regions a problematic exercise.

4.3. *CITY SCAN* INDICATORS

The *City Scan* tool takes as input four general categories of data for the Hunter and Central Coast region, as a whole, as noted earlier. This data is broken down into a figure for each of 10 industry sectors: employment by sector, the 'gross value added' (contributions to the GDP) by sector, greenhouse gas emissions, and what is called 'domestic material consumption' by industry sector. These categories of data represent figures which could be estimated, least roughly, for cities around the world. That is an attraction of the *City Scan* tool, it enables international benchmarking.

Guidelines for the *City Scan* process point to international protocols to follow in collating data for input, such as use of ICLEI data on cities around the world. ICLEI is an international consortium of cities aimed at sharing data to help track and ultimately reduce negative environmental impacts; the data sharing is facilitated by adoption of common protocols and common categories for estimating or recording that data.

Such international benchmarking is enabled by having a relatively small number of datasets involved. That is because the purposes and traditions for gathering data differ from country to country, despite attempts to make data gathering methods more consistent. For example, it would be unreasonable to expect the same quality of data from Slovenia, Eritrea and Canada as these countries have different capabilities and resources to commit to data gathering. So, for these international data sets, figures where the quality of data gathered is likely to be reasonably consistent are required. The figures employed for such comparison (selecting a small number of figures that are suggestive of broader trends) are 'indicators', and an industry has grown around generating them.

An example of an indicator is the use of the 'Big Mac Index' by the weekly publication, *The Economist*.[58] The index, which is the cost of a Big Mac sandwich at a McDonald's outlet in a given city, enables coming to a very rough estimate of the relative cost of living in various cities around the world. The cost of a Big Mac reflects a range of factors, from the price of real estate for the McDonald's store itself to the wages for labour to assemble the sandwich to the cost of two all-beef patties, special sauce, lettuce, cheese, pickles, onions and the sesame seed bun.

Perhaps, a Big Mac represents the sort of widely available product that could be characterised by an index or indicator to suggest its cost to the environment. Such figures are being assembled by

[57] See, for example, iNex Circular, described by Lebleu, T. (2019). iNex Circular, the first circular economy platform for companies, *1000 Solutions*. https://solarimpulse.com/news/inex–circular–the–first–circular–economy–platform–for–companies# – 20 August 2021.
[58] *The Economist* (2021). The Big Mac Index. https://www.economist.com/big–mac–index – accessed 1 August 2021.

the company, Planet Price. They can potentially serve as a gauge of the circularity of a region's economy.

The *City Scan* is an international tool that must deal with variations in data quality. Circle Economy advise that it is not overly sensitive to modest changes in input data. That is, it is not making predictions; rather, it is helping to set priorities, such as guiding decisions about where a local government could have a worthwhile influence in accelerating development of the region's circular economy. From this perspective, the data fed into the *City Scan* could be understood to be more like a set of indicators and less like an accurate set of measurements. With that goal in mind, the following section characterises areas where there is confidence in the data while providing caveats about where data gaps exist.

4.4. ESTIMATES AND APPROXIMATIONS

In general, the employment and economic data can be viewed with confidence. They are derived from survey results and estimates assembled as part of Australia's 'national accounts' by the Australian Bureau of Statistics.[59] This data is highly trusted, and it has been relied on for years.

The figures on employment and economic output provided by the ABS tend to lose accuracy at the local government level as cost constraints for this national assessment mean that few employees and firms are being surveyed in each locality. Accuracy is enhanced by the head counting that occurs every five years during the Australian national census. Furthermore, electronic means of tracking employment are becoming more prevalent. That said, uncertainties will remain, such as considering how to categorise someone who works in two different jobs in a single day. These individuals tend to be allocated in the tallies to one job, not two. Despite such questions, the confidence in economic data is not yet close to being matched by the confidence in data on greenhouse gas emissions, material consumption, or waste volumes. The latter areas still require years of effort to boost their accuracy.

Greenhouse gas emissions data could be seen as growing in consistency, but it is still represents a rough approximation.

The greenhouse gas emissions data could be seen as growing in consistency, but it still represents a rough approximation. Key issues relate to estimates of emissions, which are based on the amount of fuel, electricity or heat required for various types of manufacturing or commerce. These emissions are not generally measured directly; that is, there is no equipment that is sampling exhaust stacks that relays digital information that is reported to Canberra.

4.5. WHICH LOCALITY IS CREDITED WITH EMISSIONS AND WHY

Once estimates of emissions from any one type of business or enterprise are arrived at, decisions need to be made about which company or which locality gets attribution for those emissions *i.e.*, scope 1 direct emissions versus scope 2 emissions from purchasing energy (e.g. electricity), versus scope 3 indirect emissions of other sorts from elsewhere in the supply chain. For example, a car dealer's emissions in scope 1 include emissions from the test driving of new vehicles by prospective buyers and the gas-fired water heater for the staff washroom. The emissions in scope 2 are for the lights in the showroom and the power tools in the repair shop, as the electricity is generated by the utility, not on site at the dealership.

The emissions in scope 3 would be for the manufacturing and transport of the cars. The emissions involved in manufacturing a car can be substantial, compared to the energy required to heat water for the staff washroom. So, scope 3 emissions represent a significant consideration.

[59] National Accounts (2021). 5216.0 – *Australian System of National Accounts: Concepts, Sources and Methods, 2020–2021*. Australian Bureau of Statistics, Canberra. https://www.abs.gov.au/ausstats/abs@.nsf/mf/5216.0 – 1 August 2021.

Should these scope 3 emissions be a concern of a local government in the Hunter and Central Coast region, and, if so, what strategies can be implemented here to reduce them?

An example of how rough the estimations are for greenhouse gas emissions arises when comparing two tallies for annual emissions from the Central Coast Council area. Using a set of formulas applied nationally by Ironbark Sustainability[60], this LGA is credited with generating 4,700 kilotonnes per year of CO_2-equivalent greenhouse gas emissions. When Ironbark Sustainability was employed to do a more detailed analysis of the Central Coast Council area, the analysis arrived at 3,700 kilotonnes per year, a figure that is about 27% lower.[61] That difference could be attributed to more detailed analysis of activities in the council area as well as the client's preferences for which scope 2 and scope 3 emissions to include in the tally. This notion of where to draw the boundary around including or excluding scope 2 and scope 3 emissions can be seen to be behind the recent initiatives, mentioned earlier, to take a supply chain perspective on materials, products and their destinations.

4.6. ESTIMATING MATERIAL CONSUMPTION

Data on 'domestic material consumption' e.g. how many tonnes of steel are used each year by the mining industry in Singleton Shire, is challenging to collect. Useful data on how much material goes into a given product are often available from manufacturers, as they have records of what materials they have purchased. For example, a manufacturer interviewed for this study sent us some of their records. However, such data are not currently aggregated at an industry level or for a locality.

In other words, manufacturing companies would often have reasonably precise figures on their use of steel or wood or glass based on their purchasing records. However, those figures are not generally reported publicly so that they can be added up for a local government area.

Furthermore, companies that sell products made up of varied materials, such as a lawnmower or an office chair or a Big Mac, would know how many items they sell, but they are unlikely to itemise individual materials by weight, such as how many kilograms of aluminium in the lawnmower. Plus, these companies are not reporting or publishing that data, again, to enable adding up figures across the region or local government area.
Despite a general lack of data on material consumption, estimates can be made by looking at examples of careful analyses and then extrapolating or scaling the data. For example, sometimes a government department, consultancy or research group has retrieved figures for an industry sector or a locality with a known mix of industries. There is a growing body of academic publications and grey literature (consultancy and government reports) that include such assessments.[62]

There are also efforts to aggregate these findings to derive formulas that can be used to create estimates of material use in cities, regions, countries and globally. A scan of such studies suggests that they tend to focus on an industry sector or certain types of material at a national or international level. An example would be the research associated with CSIRO's *National Circular economy roadmap for plastics, glass, paper and tyres*.[63]

[60] Sullivan–Kilgour, M. (2020). *Snapshot Municipal Carbon Emissions: Calculation Methods*, Snapshot Community Climate Tool. Ironbark Sustainability, Melbourne.
[61] Armstead, R. & Snape, H. (2019). *Central Coast Council: Community Emissions Profile Report*. Ironbark Sustainability, Melbourne.
[62] Such studies would include the phase 2 and phase 3 City Scan efforts by Circle Economy, such as for Prague – Circle Economy (2019). *Circular Prague*. Technology Agency of the Czech Republic.
[63] Schandl, H., King, S., Walton, A., Kaksonen, A., Tapsuwan, S. and Baynes, T. (2020). *National circular economy roadmap for plastics, glass, paper and tyres*. CSIRO, Australia.

Studies of material use suggest that the volume climbs very roughly in proportion to how much economic activity rises.[64] So, a rise of 10 per cent in gross value added for an industry sector in a given region will see a rise, more or less, of a similar amount in the tonnage of wood or steel that that sector uses. In some of the more sophisticated modelling, the relationship involves material prices, employment, specifics of the industry and gross value added (GVA), as well as other factors, which are combined increasingly sophisticated computer models.

However, rough scaling can be gained by using GVA to compare the size of one sector's use of materials with the volume used by another sector. That is, does the construction sector in the Hunter and Central Coast use 50 times the volume of material of the public administration sector? This example, though, illustrates a form of interconnection among sectors, what if the public administration sector commissions construction of a building or roadway? Which sector gets 'credit' for the material use? Which sector has the greater leverage to reduce the level of material use and increase the level of recycling?

4.7. MATERIAL FLOW OVERALL

The *City Scan* tool currently accepts input data on material consumption for the region, but it does not yet have the capability to accept and assess data on materials in the waste stream. Circle Economy states that this capability is being developed. It is not merely a process of implementing the technical capability to accept the uploaded data. It also involves determining what taxonomy to use to categorise the materials in the waste stream and how best to assess volumes that are being recycled. Additionally, the *City Scan* tool needs modelling to determine how the volume of a material in the waste stream or in recycling, such as aluminium, should affect its recommendations for how a given industry sector can become more 'circular'.

An array of data on the materials in waste streams is currently collected in Australia. Trends over time are captured at a national level by the *National Waste Report*, which is commissioned by the Australian government's Department of Agriculture, Water and the Environment.[65] The New South Wales Environmental Protection Authority (NSW EPA) collects information via its Waste Information Unit. That information is reported annually by councils through the Waste and Resource Reporting Portal. Data provided by the NSW EPA is covered by confidentiality provisions requested by the waste management companies, given the level of competition for providing waste management services. That limits the extent to which this data can be revealed for analysis and limits publication of any figures. Despite these restrictions on the NSW EPA, local governments can provide this data, with samples offered for this project by Lake Macquarie City Council, the City of Newcastle and Central Coast Council.

To assess the volume and array of materials in the waste stream, the Hunter Joint Organisation and the New South Wales government's Sustainability Advantage commissioned a material flow analysis for the Hunter and Central Coast region by the engineering firm, Ricardo.[66] This analysis captures just the waste flow side of a full material flow analysis. A full analysis would cover materials entering or mined and refined in the region, materials in use, and materials in the waste stream or being recycled. Though Ricardo's assessment only focuses on the waste stream (and recycling), their report usefully combines information from a range of sources. However, it still

> However, it still categorises about 40 per cent of the waste stream…as 'general, mixed waste'.

[64] See for example: Weisz, H., Krausmann, F., Amann, C., Eisenmenger, N., Erb, K. H., Hubacek, K., & Fischer–Kowalski, M. (2006). The physical economy of the European Union: Cross–country comparison and determinants of material consumption. *Ecological Economics*, *58*(4), 676–698.

[65] Blue Environment Pty Ltd (2020). *National Waste Report 2020*, Department of Agriculture, Water and the Environment, Canberra.

[66] Hull, G. (2019). *Hunter and Central Coast Materials Flow Analysis: Project Report*. Ricardo Energy & Environment, Chatswood.

categorises about 40 per cent of the waste stream by weight as 'general, mixed waste'. This stream of general, mixed waste is subject to an audit every other year by local councils.[67]

The pursuit of this data for this project revealed a wide array of data on waste streams. The data is gathered by waste management firms to assess their own operations. Some data is collected for audits by local councils, and some data is gained in the operations of waste sites and recycling facilities. Certain data is available from companies that generate waste (to help keep track of costs or for sustainability reporting). Some data is reported to the New South Wales government, and some data is collated at a national level. There are also estimates of waste flows done for modelling exercises and for development of national strategic plans.[68]

Challenges include gaining access to the waste data, preferably on an ongoing basis. Other challenges are getting data or assembling data from different sources to build a picture of a region or local government area. There is also the challenge of reconciling the different ways that materials are classified in different data sets. Are four general categories used, a dozen types of materials used, or are waste types identified, e.g. listing mattresses separate from tyres, where multiple materials are in a single product. Then, this needs to be repeated for material consumption data, with a different array of organisations as potential sources of data. A more extensive collation of data and greater reconciliation among ways of counting and categorising materials will then enable tracking these materials as they enter a region, identifying where they end up being used, and assessing what happens at their end of use.

4.8. COPING WITH GAPS FOR THIS ANALYSIS

The *City Scan* team in the Netherlands has made estimates of material consumption for individual cities and regions, such as Bilbao, Spain or Amsterdam, based on other studies of material use by industries.[69] The proportions from these results (how much of one material an industry sector uses versus how much of another material) have been employed in this analysis. These proportions enable estimating very rough figures for the volume of each different category of material used by each industry sector for the Hunter and Central Coast region.

With this estimation technique, some results are particularly informative, such as the high reliance on animal fodder by the health and social services sector. That relates to how much of the activity in hospitals and aged care homes involves serving food that includes meat and dairy. The importance of meal production in this sector may not be surprising to the food service managers and senior executives in the sector, but it could be informative to those analysing consumption across diverse industry sectors.

However, this estimation technique, scaling from European examples, also suggests that crops are a major input for the region's manufacturing industry. There is a significant food industry on the Central Coast and a certain amount of dairy and beef in the Hunter region. However, the high values for crop inputs suggests that the dairy and meat industries could be a more significant proportion of the manufacturing sector in the European cities which were used as models than they are in the Hunter and Central Coast region. A more detailed comparison is needed.

[67] Hal Dobbins, Waste Strategy Coordinator, Lake Macquarie City Council, *personal communication*, 29 July 2021.
[68] See for example – Schandl, H., King, S., Walton, A., Kaksonen, A. Tasuwan, S. and Baynes, T. (2020). *National circular economy roadmap for plastics, glass, paper and tyres*. CSIRO, Australia.
[69] These results are accessible on the *City Scan* website – https://cities.circle–lab.com – accessed 1 August 2021.

Large differences between industry sectors in use of materials should be noted. However, a deeper analysis sector by sector is warranted.

One conclusion here is that modelling or scaling of data based on European examples is providing results that lack credibility. This data regime can be seen to benefit from being more carefully tailored to the Australian context.

These sorts of concessions to gaps in the data on material consumption make the *City Scan* phase 1 results suggestive but not definitive. Large differences between industry sectors in use of certain materials should be noted. However, a deeper analysis sector by sector is warranted.

The level of uncertainty is such that it is not possible to tally for a given year how much wood enters the region, how much is residing in the region in the form of furniture, fenceposts and wooden pallets and what percentage of that stockpile is going to recycling or landfill i.e. there is no accurate mass balance across the range of materials and array of industry sectors.

More accurate assessment of a mass balance could be approached through a more narrow focus, such as counting mattresses sold and those going to recycling versus those going to landfill or something similar in relation to tyres. Note that these instances are for particular products rather than particular materials. Mattresses are made of foam, fabric and often steel. Tyres are rubber, carbon, other additives, and fabric or steel. An attempt to balance estimated figures for material consumption with data on materials in the waste stream and figures for how much is recycled is provided in Appendix E.

4.9. GAPS TO CLOSE FOR THE NEXT STEPS

The challenges outlined here indicate that very rough figures for material consumption seem sufficiently credible for phase 1 of a *City Scan* analysis i.e. deciding which industry sectors to focus on. The conclusions are similar for greenhouse gas emissions, though a bit more confidence in that data seems warranted. An important consideration with greenhouse gas emissions data is how large emitters in the Hunter and Central Coast region are handled, specifically, is the region seen as 'responsible' for the emissions of power stations that light up Sydney or coal mines that fuel steel mills in China and Korea and power stations in Japan?

More detailed data that can be seen to be more accurate is needed for subsequent steps in analysing industry sub-sectors and deciding where local governments can make a difference. To inform advice on improving data in this domain, experienced business leaders and government staff were interviewed.

4.10. PERSPECTIVES ON DATA FROM INDUSTRY AND GOVERNMENT

Insights on data quality, data gaps and data needs were offered by leaders, consultants and staff across more than a dozen organisations in the private sector and government (see Appendix G). Those interviewed could be categorised as having a keen interest in the circular economy, specifically, or in corporate reporting and strategies for boosting sustainability, more generally.

They suggested sources of data. For example, some noted that large companies report on sustainability indicators, such as greenhouse gas emissions, to the Australian government and sometimes to shareholders and international investment organisations. This data is often publicly available, such as in a corporation's annual report. However, the public version may not have data reported by location.

Large companies report on sustainability indicators, such as greenhouse gas emissions, to the Australian government… shareholders and international investment organisations.

So, a large mining company may report its estimated greenhouse gas emissions as a total summed across all of its operations internationally. Data would be available for its Hunter Valley operations, but permission would be needed to gain access.

Material consumption data is evident in purchasing records for most companies. Though that data is not generally not made public, it was provided and volunteered for public consumption by two of the CEOs interviewed. It is important to note, though, that purchasing records do not normally specify what percentage of a product is made of what material. That is, if you purchase windows for a commercial building, the purchase order will not state '40% aluminium frame and 60% glass by weight'.

Data on waste materials is available from various sources with varying levels of resolution in distinguishing tonnage of different types of materials. Local governments report figures annually to the New South Wales government. They also tend to conduct an audit of materials in the recycling and waste streams, typically every other year. These figures are shared with the companies collecting the waste or recycling. Figures from the New South Wales government and data held by waste collection companies is not generally shared publicly due to commercial competition in the waste management sector.

Across these interviews, there is evidence of interest in the circular economy, awareness of a need for a wide array of data, an eagerness to share data that is already being collected, and barriers to making more publicly available. Restrictions on the sharing of data can be seen to affect decision making across local governments in the region and development of reuse and recycling markets by the private sector.

Nine key points emerged from the interviews:

1. **Aims for gathering data** – Be clear on stories or messages to be conveyed and who the target audiences are; work backward from there to identify what data achieves these aims.
2. **Qualities of data** – Provide confidence and transparency, triangulate among sources, determine an appropriate frequency of measurement, cover a regional scope, identify relevant baseline figures to help assess changes over time.
3. **What is measured** – Identify the location of materials to be repurposed in the circular economy and what time of year they are available (if they are seasonal). Characterise the sustainability of the resource (how long will stocks last) and the expected lifetime of materials/products when they are in use; measure the volume of these materials diverted from landfill. Measure water use, greenhouse gas emissions, energy use, renewable energy generated, and kilometres travelled. Identify the market values of materials, the volumes of material imported and material exported from the region and from the country (that is, assess the volume consumed as well as the finished products or waste exported). Also, assess the economic output of industry sectors that are involved in the circular economy, chart the sectors in terms of the 'complexity' and 'connectedness' of the products that they offer (see https://www.aumanufacturing.com.au/astralias–low–economic–complexity–infographic).
4. **Other information is needed aside from data** – Case studies of circular economy strategies used by individual companies. Identify large users of materials and sources of materials. Describe infrastructure that is related to material use or generation (such as fly ash from the power stations) and indicate how many people that infrastructure employs (related to what economists call 'flow on effects').
5. **Sources of data** – Identify key contacts and organisations who can provide relevant data and specify who in each such organisation needs to approve for release of that data.
6. **Protocols for organisations who receive this data and make it public** – Align these protocols with client/investor/audience concerns and requirements. Give the data sharing protocols time to ramp-up/be implemented. Establish a governance framework, designate

responsibilities for stewardship of data, for updating, quality control, analysis, storage, and visualisation. Provide example dashboards to enable refining presentation of relevant data and assess its usefulness in generating impact by guiding decisions and generating outcomes.

7. **Economic options in the circular economy** – Characterise the cost of additional capacity in technology to enable using a material (for example, using pieces of scrap steel instead of virgin material), cost of reused material, labour cost differences in using existing material versus virgin material. Assess economies/cost savings from employing a circular economy strategy and the costs of alternatives to a circular economy strategy. Identify sources of capital to fund a company's implementation of a circular economy strategy.
8. **Assess the viability of various circular economy options** – Has government approved uses of certain materials (in a reuse or redesign option). Provide a technology readiness rating for certain options, e.g. how reliable and how expensive are tyre or mattress shredders?
9. **How the region rates in its development of a circular economy** – Assess progress in the circular economy in this region compared to other regions in Australia and to regions in Europe or China. Identify 'indicator species', that is, materials that can be tracked to enable assessing regional or industry progress; for example, is reuse of glass, paper or plastic the better indicator of an advanced circular economy? Contextualise the circular economy assessment with general indicators on the region, such as population, housing prices, job market, air/water quality, weather.

Figure 4.1. shows the considerable focus on 'data' by participants.

Figure 4.1: Concerns and insights related to data – word cloud *(worditout.com)*.

4.11. SUMMARY

The high level challenges with data that need to be addressed include:

1. **Economic data** relevant to development of the region's circular economy exists, and there is reasonable confidence in it at the level of local government area and 2-digit industry sector (broken down into 19 industry sectors, rather than 100 or 1,000 sub-sectors; e.g. construction as a sector versus road construction or commercial construction as subsectors). The 2021

Australian national census will provide good resolution at a fine level to supplement the data input into the *City Scan* analysis. The main concern about economic data concerns the level of uncertainty that annual updates have at the local government level due to sampling.

2. **Greenhouse gas emissions data** is estimated, and estimates vary depending on the methods involved. Industry specialists interviewed for this study suggest that larger companies report on greenhouse gas emissions each year, to shareholders, investment providers and governments. It would be useful to organise to receive those estimates broken down by site, *i.e.,* for facilities in the Hunter and Central Coast region. Incentives might be required to build trust, and to have each organisation commit staff time, to assure that such data will be well used for local analysis and initiatives.

3. **Material consumption data** – to supplement waste flow data emerged as a major area of need. Such data is available on a firm by firm basis, but commercial competition among firms may inhibit some from reporting. Such data is not comprehensive nor necessarily broken down with sufficient granularity (e.g. differentiating one type of ferrous metal from another). However, establishing a tradition and protocols for reporting material consumption would be a big step forward. Staff in local government involved in this *City Scan* project, have discussed whether such reporting can be made a requirement in procurement contracts with local governments. For example, Officeworks would need to bid to provide stationery supplies with a promise to report on how much paper, steel and glass are in the products that they deliver to a given council each year.

For example, Officeworks would need to bid to provide stationery supplies with a promise to report on how much paper, steel and glass are in the products that they deliver to a given council each year.

4. **Data collection**, in general, can be time consuming and expensive, as can formulation of estimates of material consumption, for example, when data is not available. Given this level of effort, the adoption of data requirements ought to be phased in according to criteria on which data is going to make the most difference for the cost invested in collecting it.

More specific challenges in gathering data for analysis at the level of local government area and the region are presented in Table 4.1.

Table 4.1: Data gaps and how to remedy them.

Type of gap	Prevents	Example	Remedy – option
1. Too little	Tracking effectiveness of circular economy strategies	Little data on material consumption; cannot balance with data on tonnage of materials in waste stream	Start small – collect data from a few committed businesses
2. Too much	Collating data to fill gaps (see 1)	Large companies estimate and report greenhouse gas emissions, material use; need to collect it from each one.	Start small – collect data from a few committed businesses
3. Inaccurate	Tracking progress in reducing GHGs	Greenhouse gas emissions (GHG) are estimated depending on the industrial processes used & the amount of economic activity. Not measured.	Improve models for assessing GHGs

Type of gap	Prevents	Example	Remedy – option
4. Too complex	Identifying which companies can make the biggest difference in reducing consumption, reusing, recycling	GHGs in scope 3 are generated by vendors outside a given region, but the company in the region might have some influence to shift those processes or practices	Improve international protocols for assessing and allocating responsibility for GHGs, material consumption
5. Commercial in confidence	Big picture view on the region, developing a marketplace to exchange materials	Waste audit data is kept confidential due to competition in the waste management arena	Build trust with small experiments in sharing data publicly
6. Different set of categories	Readily getting consistent figures on material consumption (inflows) to assess in relation to info from waste audits (outflows)	Virgin material categories can be different from waste stream categories, e.g. aluminium becomes categorised as 'non-ferrous metal'; high percentage of 'mixed waste'	Assemble relevant peak bodies from upstream (mfg) and downstream (waste) to work toward common categories (or simpler mapping from one set to another)
7. Not Australian	Accurate estimates based on examples elsewhere when detailed data is missing in this region	Material consumption data is hard to assemble, and estimates from Europe, with more manufacturing, seem inaccurate in Australia, with less mfg.	Analyse examples in an Australian context, rather than extrapolating from European examples
8. Not interested	Businesses taking advantage of opportunities to redesign/reuse/ repurpose materials	Even the most interested business leaders had little knowledge of the scale of the challenges and opportunities for the circular economy	Start small with committed businesses

5. *City Scan* findings – Opportunities

5.1. OVERVIEW

- The *City Scan* data input provides a comparison of an industry sector's greenhouse gas emissions and consumption of various materials with its economic importance in the Hunter and Central Coast region across a wide range of industries
- The *City Scan* tool draws on a list of 25 general strategies to recommend a small set that could contribute the greatest to reduce waste and greenhouse gas emissions in each of ten broad industry sectors in this region
- The *City Scan* outputs for this phase 1 analysis should be seen as conversation starters, suggesting priorities rather than providing definitive answers
- Circle Economy recommends that the *City Scan* website https://cities.circle–lab.com be made available to stakeholders in the Hunter and Central Coast region to boost engagement and their understanding of trade-offs and circular economy opportunities.

5.2. CITY SCAN RESULTS AND HOW TO EXPLORE THEM

The *City Scan* analysis draws on data on the Hunter and Central Coast region to rate the potential for various strategies to enhance the region's circular economy. Across 25 types of strategies, the *City Scan* tool's analysis of the region offers high ratings for strategies of recycling within the industry sector, industry collaboration, energy efficiency and use of renewables, energy recovery from waste, designing out waste and recycling waste via other industries.

This section … rank[s] the economic and environmental impacts of each industry sector at the regional level … [and] at the local government level …

This section gives an overview of these results by ranking the economic and environmental impacts of each industry sector at a regional level. At the local government level, there is information on which industry sectors have the greatest economic and environmental impacts. The regional view enables formulating regional strategies, while the local government level data helps councils to assess potential impacts in their respective council areas.

This section describes how to explore these *City Scan* results with the help of the tool's tick boxes for input and the 'opportunities radar' output, which is accessible online at https://cities.circle–lab.com. This description is provided as the *City Scan* output at this point does not give the ultimate answers. Rather, it represents an important stepping stone toward identifying strategies that will enable the region's circular economy to 'take off'. The *City Scan* input and results provide an evidence base for discussion of which industry sectors, which materials, and which environmental impacts should be the focus of attention. These efforts to accelerate the region's circular economy could, for example, be by local government focusing on sustainability and economic development or by individual companies that are looking for a market niche in the circular economy.

A brief description of the *City Scan*'s opportunities radar to help in further exploration of the results on the *City Scan* website. That is how Circular Economy recommends employing the tool by uploading data to enable interested parties to assess the status of the region's circular economy and potential opportunities in broadly defined industry sectors.

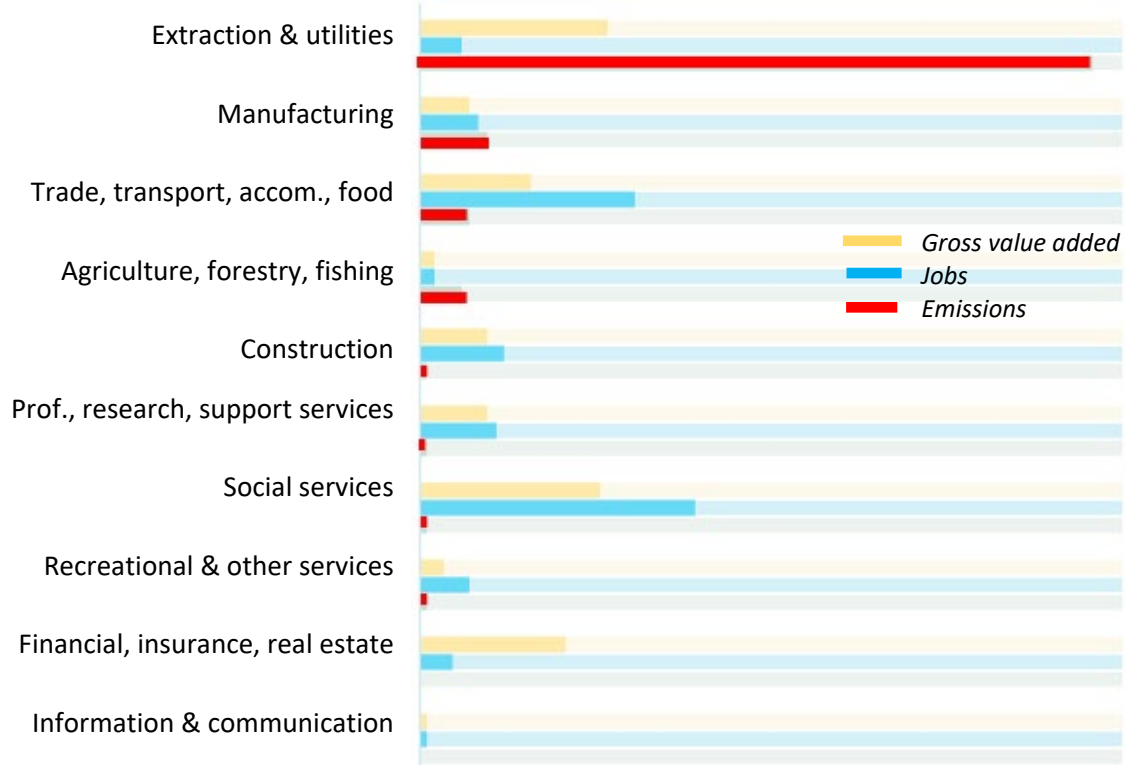
5.3. A REGIONAL VIEW

The total contributions of each of *City Scan*'s 10 industry sectors to the region's gross regional product, employment and greenhouse gas emissions are charted in Figure 5.1.

This chart shows that the region's extraction and utilities sector, mainly mining and electricity generation, produces a significantly greater volume of greenhouse gas emissions than all other sectors combined. The other big contributors are: manufacturing; trade, transportation, accommodation and food services; and agriculture. The higher volumes of emissions are from the nature of the technologies that are currently used, such as many diesel powered vehicles in mining and agriculture or heat sources in power generation and food services. These emissions would be expected to decline as decarbonisation strategies are taken up more broadly, such as through electrification of mining vehicles.[70]

There are smaller volumes of emission but significant contributions to the gross domestic product from social services sector and the financial, insurance and real estate. That can be attributed to high levels of commercial activity and consequently high employment in the social services sector. The real estate sector is dealing with high value goods, homes and apartments, while banks and insurance companies handle large volumes of money, as well, though with fewer staff in this region.

Figure 5.1: Economic and greenhouse gas impacts of the region's industry sectors.[71]



[70] See, for example, EVSE (2021). *Electrification of the Australian Mining Industry is beginning with Electric Land Cruiser, Dump trucks and Excavators*. https://evse.com.au/blog/electrification–of–the–australian–mining–industry–is–beginning–with–electrific–land–cruisers–dump–trucks–and–excavators/ – accessed 20 August 2021.

[71] This chart is generated by the *City Scan* website – https://cities.circle–lab.com – for the region identified as 'Newcastle, Lake Macquarie, the Hunter and Central Coast'. The bars in the chart are the percentage of the region's total that that factor represents. For example, the extraction and utilities sector emits over 90 per cent of the region's greenhouse gases while providing about 25 per cent of economic output and less than 10 per cent of employment.

These figures can help in prioritising targets for circular economy policies, practices and strategies undertaken by local governments. The *City Scan* process juxtaposes figures that are usually the focus of local government departments for economic development with figures that would be the focus of departments for waste management and sustainability. This juxtaposition can help to engender the cross-departmental discussions that are essential to support development of the circular economy.

Any decisions that result about which companies or industry subsectors should become targets for circular economy initiatives, programs or policies ought to reflect a range of factors, from how much environmental impact these organisations could prevent to how much influence local government initiatives might have on them. For example, can local government influence activities that generate greenhouse gas emissions in the mining sector? Sorting through the criteria for local governments to employ in deciding where to invest their energies is part of phases 2 and 3 of the whole *City Scan* approach, as described in Appendix C.

Table 5.1 presents another version of this data, to rank where each industry sector sits relative to the others. The table lists the industry sectors in order of their contributions to greenhouse gas emissions for the Hunter and Central Coast region. It then lists how each sector ranks relative to the others in terms of those emissions as well as in how many jobs it offers and how much it contributes to the gross regional product (which is the regional equivalent of the national figure, gross domestic product; the approximate equivalent for one industry is gross value added). Examples of companies in each sector are provided to help describe what the sector label refers to.

… how many jobs are on the line … if industries with high levels of greenhouse gas emissions are shut down.

Table 5.1: Relative environmental and economic impacts by industry sector in this region.[72]

Sector	Example companies	Emissions rank	Jobs rank	Value added rank
Extraction & utilities	Glencore, AGL, Hunter Water	**1**	7	**1**
Manufacturing	Ampcontrol Quarry Mining	**2**	5	7
Trade, transport, accommodation, food service	Coles Port of Newcastle Wests	**3**	**2**	4
Agriculture	McGuigan Hunter Belle	4	9	9
Construction	McDonald Jones Downer	5	**3**	5
Professional & support services	U of Newcastle Forsythes	6	4	6
Social services	HNE Health NDIS	7	**1**	**2**
Recreational & other services	Surf Life Saving Port Stephens Koala Sanctuary	8	6	8

[72] This table was assembled by UON based on economic data from the Australian Bureau of Statistics that was aggregated in websites for each council by either REMPLAN or .ID. The greenhouse gas emissions data was estimated based on data derived from a range of sources described in Appendix D.

Sector	Example companies	Emissions rank	Jobs rank	Value added rank
Financial, insurance, real estate	Newcastle Perm nib Walkom	9	8	**3**
Info tech & comms.	NBN Telstra	10	10	10

This table can be read with a lens that considers how many jobs might be lost, and how much of the region's economic output, if industries with high levels of greenhouse gas emissions are asked to reduce operations or shut down. Such reductions could occur if pressure to take further action on climate change continues to mount, and if governments see no other viable way to drive down those greenhouse gas emissions.

The table shows that the great proportions of employment are in the health and social services sector; trade, transport, accommodation and food services; and construction. The greatest dollar values generated are by the sectors extraction and utilities; social services; and financial, insurance, and real estate.

These charts illustrate how the Circle Economy team has identified a small set of key economic and environmental indicators that should influence how a local government sets broad priorities on where to focus to accelerate the local circular economy. In other words, the *City Scan* tool and methods lead to assembly of an evidence base to inform and speed the priority setting.

The explanations that follow are meant to enable understanding the nature of the output provided by *City Scan*'s online tool and the choices that stakeholders, decision-makers and analysts have in generating that output.

5.4. SPECIFIC CIRCULAR ECONOMY STRATEGIES FOR SPECIFIC SECTORS

The *City Scan* tool employed the data summarised in the table and charts above to recommend a suite of circular economy strategies for each industry sector. These recommendations need to be treated as a focus for discussion and further investigation, given the high levels of uncertainty in some of the data, e.g. on material consumption, and the diversity of types of businesses in the 10 amalgamated industry sectors that *City Scan* uses. Addressing these recommendations here suggests what further investigation can find. In addition, reviewing these recommendations can contribute to building 'circular literacy', a sense of what strategies tend to keep materials in use and/or contribute to restoring natural systems.

The circular economy strategies named by *City Scan* are presented as 25 general headings. Circle Economy has identified a set of what they refer to as 'core' strategies. Core strategies fall in three general domains: (1) use waste as a resource; (2) stretch the lifetime; and (3) prioritise regenerative resources. There are also 'enabling' strategies under another five headings: (4) strengthen and advance knowledge; (5) rethink the business model; (6) design for the future; (7) incorporate digital technology; and (8) team up to create joint value. Under each of these headings are 2, 3, or 4 sub–headings, which results in 25 specific types of strategies.

The specific 25 headings include titles, such as 'valorise waste streams – closed–loop', which means recycling waste materials within the industry sector. The recycling recommendation does not identify which material to recycle or explain why it is opportune to recycle it. However, each recommendation on the website has links to a set of 'case studies' which are examples of initiatives or companies elsewhere in the world that are taking similar steps. There are also links

to companies in the Hunter and Central Coast region involved in a related area, such as metal recyclers.[73]

These general results are summarised in Table 5.2. The recommended strategies are compiled from the *City Scan*'s 'opportunities radar' output for each of the ten industry sectors. The sectors here are listed from highest greenhouse gas emitters in the region to the lowest. The strategies that prove successful and widespread for sectors listed near the top of table would likely have a higher impact on the region's greenhouse gas emissions than strategies that are successful only for those sectors listed toward the bottom of the table.

For example, 'industry collaboration' adopted by the extraction and utilities sector, if successful, could create far greater reductions in materials consumed and greenhouse gas emissions than 'recycling within the industry' would create in the information technology and communications sector, which sits at the bottom of the table.

Table 5.2: Circular economy (CE) strategies ranked highly by *City Scan* for this region.[74]

Sector	Materials consumed most[75]	CE Strategy 1	CE Strategy 2	CE Strategy 3
Extraction & utilities	Coal Motor fuel Concrete, sand, gravel	Recycle within industry sector	Industry collaboration	Energy recovery from waste
Manufacturing	Nonferrous metals Concrete, sand, gravel Natural gas	Recycle within industry sector	Energy recovery from waste	Energy efficiency & renewables
Trade, transport, accommodation, food service	Motor fuel (insufficient data)	Recycle within industry sector	Energy efficiency & renewables	Design out waste Energy recovery from waste
Agriculture	Crops Crop residues Construction materials	Recycle within industry sector	Energy recovery from waste	Recycle waste via other industries
Construction	Concrete, sand, gravel Nonferrous metals Diesel	Recycle within industry sector	Recycle waste via other industries	Energy recovery from waste Energy efficiency & renewables
Professional & support services	Natural gas & motor fuel Wood (insufficient data)	Recycle within industry sector	Industry collaboration	Recycle waste via other industries
Social services	Crop residues Concrete, sand, gravel Nonferrous metals	Recycle within industry sector	Energy recovery from waste	Recycle waste via other industries Energy efficiency & renewables Design out waste

[73] This local data was uploaded to the *City Scan* website as part of this project. It draws on organisations listed in the website on the Hunter and Central Coast Circular Economy Ecosystem. That website was produced by the Hunter Joint Organisation – https://www.huntercircular.com.au – accessed 1 August 2021.

[74] This table was created by UON based on output from the *City Scan* website for the region – 'Newcastle, Lake Macquarie, Hunter and the Central Coast' – https://cities.circle–lab.com – accessed 5 July 2021. The three sectors highlighted by **bold face type** are addressed in the subsections following the table.

[75] Estimations of tonnes of materials consumed by each sector in this region are based on patterns of material use by industry sectors in Europe, where data at the scale of cities and regions are more plentiful. However, this estimation method has led to some results lacking credibility in certain sectors, noted in this table by the entry, 'insufficient data'. Further explanation is available in Appendix D.

Sector	Materials consumed most[75]	CE Strategy 1	CE Strategy 2	CE Strategy 3
Recreational & other services	Motor fuel Concrete, sand, gravel Crop residues	Recycle within industry sector	Design out waste	Recycle waste via other industries
Financial, insurance, real estate	Concrete, sand, gravel Motor fuel Wood	Energy efficiency & renewables	Recycle within industry sector	Energy recovery from waste
Info tech & comms.	Concrete, sand, gravel Motor fuel Wood	Recycle within industry sector	Energy efficiency & renewables	Energy recovery from waste Design out waste

5.5. EXTRACTION AND UTILITIES

For the mining/extraction and utilities/power generation sector, initial analysis with the *City Scan* tool looked at 'all material inputs', with coal and steel being the inputs with the highest tonnage. All types of impacts were analysed on greenhouse gas emissions, material consumption, waste tonnage and water use. The resulting opportunities radar diagram is shown below in Figure 5.2, with diagrams for other sectors on the succeeding pages. For this sector, the diagram illustrates that eight circular economy strategies received a rating above the threshold of 50 (on a scale of 50 to 100), whereas a greater number of strategies receive high ratings for the other industry sectors. A rating over 50 sees these strategies ranked as 'recommended' based on the economic, material and environmental factors considered by Circle Economy's proprietary algorithms. The results are described below, while the diagram is more legible when viewed on the *City Scan* website. How to interpret the *City Scan* output is described in Appendix F.

Figure 5.2: Opportunities radar for the region's extraction and utilities sector.[76]

[76] This 'opportunities radar' diagram was generated by the *City Scan* website – https://cities.circle–lab.com – using data provided by UON from the sources described previously and in Appendix D, e.g. the Australian Bureau of Statistics.

The strategy that ranks highest, with a score of 67/100, is 'valorise waste streams – closed loop'. That is defined by *City Scan* as 'reuse, repurpose, and recycle waste streams in the same industry'. 'Valorise' refers to giving value to something, and 'closed loop' implies in this instance to use in the same industry where a waste steam has been generated. In the utilities sector, waste streams could include anything from steel generator casings to warmed cooling water to fly ash that results from the burning of coal. The steel can be recycled into grinding media for the mining industry, the warmed cooling water could be used in food processing, and the fly ash can play a role in the construction industry.

The *City Scan* analysis points to, for the mining and power generation sector, a second-ranked opportunity. With a score of 61/100, this opportunity is an 'enabling strategy' identified as 'industry collaboration'. An example of collaboration might be the power generation sector joining with the concrete casting industry to fund laboratory tests to assess the strength and safety of aggregate made from fly ash (see Appendix B for more specifics). Both parties could benefit, with the power generation sector finding a market for its fly ash, which presents and environmental challenge, and the construction materials sector gaining a novel product.

One of the ten international examples provided is Birmingham Industrial Symbiosis. This city council strategy, a description on the website explains, was enacted in 2002 and has resulted in a number of initiatives, including creation of the Tyseley Environmental Enterprise District (TEED).[77] Within that district, a local development order (LDO) enables 'certain changes of use without the need for specific planning permission.' An LDO sounds like it shares certain features with a special activation precinct in NSW.

Industry collaboration in the mining and power generation sector has already been identified in the Hunter and Central Coast as a focus of attention. These opportunities for industry collaboration include schemes to repurpose power generation stations slated for closure as renewable energy or 'biocircular hubs'. Industry collaboration would also cover employing recently accumulated fly ash or legacy fly ash from the power stations as a medium to fill mining voids, to cap tailings dams, as a substitute for Portland cement in concrete and as a feedstock for creating lightweight aggregate for precasting for the construction industry.[78] In this instance, the *City Scan* result can be seen as an endorsement for initiatives and opportunities that are already being discussed or undertaken in this region.

The third-ranked opportunity for this sector highlighted by the *City Scan*, with a score of 58/100, is 'energy recovery from waste'. That is defined on the *City Scan* website as 'Recover waste energy or generate fuels and energy from waste streams'. However, in the case of the mining and power generation sectors, it is hard to see what in their waste streams could be burned, aside from old oil-based lubricants from mining trucks or perhaps wooden delivery pallets for certain equipment and supplies.

A stronger possibility could be recovering 'waste energy' from the power generation industry. There is about 1.5 GWh of waste heat exhausted for every 1 GWh of electricity generated by a large coal-fired power station. That is a vast amount of heat that is currently released into the atmosphere directly or into cooling ponds. This heat can be made available at somewhere above room temperature but below the boiling point of water (100 degrees C). That could make it suitable for food processing, dry cleaning or laundering, certain chemical processes, or heating

[77] Tyseley Environmental Enterprise District – https://www.birmingham.gov.uk/info/20054/local_plan_documents/70/local_development_orders/3 – accessed 1 August 2021.

[78] Schraner, I. (2021). *Jobs and Growth: The economic impact of a manufacturing approach to reusing coal ash in NSW*, Hunter Community Environment Centre, Newcastle.

and air conditioning for offices and residences. This sort of use of waste heat is done on a district scale in European cities.[79]

So, for the mining and power generation sector, the *City Scan*'s opportunities radar with the input provided and consideration of all materials and all impacts appears to provide a mix of inspiration, endorsement and fodder for discussion.

> The *City Scan*'s opportunities radar … provides a mix of inspiration, endorsement and fodder for discussion.

5.6. MANUFACTURING AND TRADE, TRANSPORT, ACCOMMODATION AND FOOD SERVICE

Opportunities radar charts were generated for the other two industry sectors in the Hunter and Central Coast region with the highest economic output – (2) manufacturing and (3) trade, transport, accommodation, and food service. For these sectors, Figures 5.3 and 5.4 (illustrate the number and spread of recommended strategies, those strategies that achieve a score of 50 out of 100 or above. For both the manufacturing sector and for trade, transport, accommodation and food services, there are 11 such strategies. Table 5.2 lists each of the three most highly rated recommendations in these two sectors, as well as in all ten industry sectors.

The highest ratings in the manufacturing sector are for recycling within the sector, energy recovery from waste, 'regenerative energy' (energy efficiency and low impact sources of energy), designing out waste, designing for durability, and industry collaboration.

For the trade, transport, accommodation and food services sector, the highest ratings are earned by recycling within the industry, 'regenerative energy', designing out waste, energy recovery from waste, designing for 'cyclability' (multiple uses and lifecycles of a product and its materials), and government collaboration.

Figure 5.3: Opportunities radar for the region's manufacturing sector.[80]

[79] Ostergaard, P. and Lund, H. (2010). Chapter 14 – Climate Change Mitigation from a Bottom–up Community Approach, pp. 247–265. In *Sustainable Communities Design Handbook*, ed., W. Clark, Elsevier: Amsterdam,.

[80] This 'opportunities radar' diagram was generated by the *City Scan* website – https://cities.circle–lab.com – using data provided by UON from the sources described previously and in Appendix D, e.g. the Australian Bureau of Statistics.

Figure 5.4: Opportunities radar for the trade, transport, accommodation & food sector.[81]

5.7. *CITY SCAN* POINTS TO AREAS FOR FURTHER INVESTIGATION

The *City Scan* gave a relatively high rating to a general approach of industry collaboration, within which there can be seen an array of specific options for this one sector in the Hunter and Central Coast region, extraction and utilities. Thus, the opportunities radar does not provide simple answers in this phase 1 stage of the four-phase *City Scan* analysis. However, it does identify or endorse certain directions that would benefit from further investigation.

Interpreting the *City Scan* results requires knowing something about the industry sector to help to identify which opportunities seem realistic and which ones are less so. This process of sorting the best opportunities from ones that are less promising can be instigated by local governments, who can involve business managers and consultants from a given sector. If certain sectors and opportunities arise across a range of different regions, then state and federal involvement could be needed, as well. Within a given region, this sort of expert input from key industry stakeholders can stimulate further engagement about the circular economy and its promise generally.

Those engaged in such analysis can learn about the breadth of activities in the circular economy as well as business opportunities that they might not have considered, suggests Circle Economy.[82] That could help to build the community of practice of 'circular' business leaders. Working relationships developed within sectors or across sectors could lead to selling and buying of materials, further boosting the circular economy.

[81] This 'opportunities radar' diagram was generated by the *City Scan* website – https://cities.circle–lab.com – using data provided by UON from the sources described previously and in Appendix D, e.g. the Australian Bureau of Statistics.
[82] Marijana Novak, Circle Economy – *personal communication*, July 2021.

In this way, analysis supported by the *City Scan* protocol can be seen not just to provide 'answers', as indeed it does not provide simple, tightly defined answers. However, it can direct attention, highlight potential opportunities, boost interest and build working relationships, which also support development of the region's circular economy.

5.8. SUMMARY – INSPIRATION, ENDORSEMENT, DISCUSSION

Next steps … include engaging with stakeholders from industry, government and community in discussing which sectors to focus on …

These recommendations, as noted just above, are to be viewed as a mixture of inspiration, endorsement and topics for discussion.

Next steps, according to the *City Scan* methodology, include engaging stakeholders from industry, government and community in discussing which sectors to focus on, based on the input indicators and local knowledge.

Then, within those sectors, discuss these recommendations and identify sub-sectors to which they might be applied in an effective way. Then, to summarise what is covered in Appendix C on the *City Scan* methodology, dig for more specific data on the target sectors and sub-sectors to narrow the focus to a handful of strategies. Finally, develop detailed action plans for implementing those strategies.

6. Conclusion – Next steps

6.1. OVERVIEW

- *City Scan* phase 1 analysis provides data for setting priorities about which industry sectors and what types of circular economy strategies should be the focus for local government
- These results should inform a more narrow focus on a selected set of industry sectors and exploration of subsectors within those sectors, eventually leading to development of action plans for boosting the region's circular economy
- The increased attention given to the circular economy in recent years, as an avenue to reduce greenhouse gas emissions, suggests that there is a window of opportunity for the Hunter and Central Coast region to provide leadership, which could result in business growth and employment growth.
- Accelerating the circular economy in the Hunter and Central Coast region requires better data on the consumption, use, waste and recycling of materials and on greenhouse gas emissions
- Better data can be gained by engagement with the local business sector and pursuit of a carefully planned, regional data strategy.

6.2. INTERNATIONAL ATTENTION TO THE CIRCULAR ECONOMY POINTS TO LOCAL STEPS

The analysis provided in this report suggests many options for accelerating development of the circular economy in the Hunter and Central Coast region. Key steps include establishing criteria for identifying priority sectors and addressing gaps in data on those selected sectors to assure that eventual action plans are arrived at based on a solid base of evidence.

This report provides context by describing the concept of the circular economy and highlighting the rising attention that it is receiving in the past few years while identifying the key actors internationally, such as the Ellen MacArthur Foundation, and within Australia, such as the CSIRO and large consultancy firms. This view of the current context suggests that there is a window of opportunity today for the region to establish national leadership in progressing Australia's circular economy, which can attract a suite of businesses to establish or expand operations here.

Accelerated development of the circular economy can help the region and the state to reach net zero carbon emissions by 2050, according to studies cited here. Some of these studies characterise modest boosts in employment and in GDP that can result from accelerating development of the circular economy in any one of a range of regions. That sort of boost could help to counter job losses forecast to accompany a decline in markets for the Hunter region's coal, though transferability of skills from one sector to the another remain an open question. Locally focused studies (highlighted in Appendix B) point to economic benefits from technological changes, such as production of renewable energy, development of a 'green steel' industry, or initiating production of building materials derived from the region's legacy fly ash.

The *City Scan* approach has involved collecting not just economic data but juxtaposing that data with data identifying which of the Hunter and Central Coast region's this industry sectors contribute the most to greenhouse gas emissions – mining and power generation, manufacturing and trade, transport, accommodation and food services. 'Extraction and utilities' emits far more greenhouse gas emissions than manufacturing. Manufacturing is followed by a similar volume of emissions estimated to come from 'trade, transportation, accommodation and food services'. A slightly smaller but similar volume of emissions is from 'agriculture, forestry and fishing'. Small contributions to greenhouse gases are from construction and a range of professional areas and

services. Criteria are needed to select which of these overarching sectors local governments should focus on. Such criteria would need to include consideration of where local governments can have influence, e.g. in relation to large national or multi-national corporations.

Once priority sectors are identified, the *City Scan* protocol (described in detail in Appendix C) involves a phase 2, which narrows the focus further to sub-sectors. Analysis of sub-sectors requires its own investigation to collate data to undergird recommendations for specific circular economy strategies to pursue. Some types or strategies are recommended by the *City Scan* tool using the data on the 10 overarching sectors. These categories of circular economy strategies include areas, such as recycling and increasing energy efficiency.

Overcoming limitations and undertaking next steps, related to gathering and analysing data as well as engaging with industry, are summarised in the subsections that follow.

6.3. LIMITATIONS – DATA CHALLENGES

This project was established to provide analytical insight into what local governments in the Hunter and Central Coast region can do to accelerate development of the region's circular economy and what economic benefits they could aspire to. That insight, it was hoped, would emerge from entering existing data into Circle Economy's *City Scan* tool. The search for that data has identified foundations for an evidence base, but it has also highlighted challenges and gaps.

Use of the *City Scan* tool, and consultation with the Circle Economy team, have underlined the importance of prioritising which industries to focus on and which materials. All materials for all industry sectors may be something that the circular economy will encompass in coming years or decades, but that breadth of focus would overwhelm the capacity, and likely the appetites, of local governments in the near term.

For example, data for each LGA on greenhouse gas emissions by industry sector is just a set of estimates, which are a bit rough. There are uncertainties and disagreements about how best to calculate carbon emissions and which emissions in a supply chain to credit to which locality. For example, are emissions of the Eraring power station the 'responsibility' of Lake Macquarie (scope 1) or that of Sydney, where much of the power is used (scope 2)?

… Are emissions of the Eraring power station the 'responsibility' of Lake Macquarie (scope 1) or that of Sydney, where much of the power is used (scope 2)?

Even more rough, and potentially contestable, are estimates of consumption of materials. It is not currently possible to assess how much aluminium, for example, enters the region each year, how much is installed as window frames or aerospace components and remains in the region or is exported, and how much is discarded, either into recycling or into the landfill. Even if there are year on year trends in data gathered, the causes of a rise or fall in material consumed or discarded would need to be determined by analysing changes in the population and shifts in the local, national and international markets. An argument can be made that data on material consumption and greenhouse gas emissions should have the level of attention in the national accounts (figures assembled and estimated by the ABS) that economic data has.

So, key challenges include identifying criteria for deciding where to focus and criteria for how to categorise emissions and materials. To track progress over time, a better understanding is needed of factors affecting material use in the region, from technologies used to economic pressures to international markets.

6.4. NEXT STEPS – WHERE TO FOCUS

According to Circle Economy, next steps for local governments to undertake to accelerate development of the region's circular economy should include selecting and prioritising certain industry sectors and then certain subsectors. That requires obtaining data on those specific sectors and subsectors.

Finding more detailed data on industry sectors can sound daunting given the gaps in data highlighted here. However, the task is made a bit more feasible by taking small bites, such as, addressing individual industry sectors and then subsectors. Where the *City Scan* data for this phase 1 analysis is meant to cover thousands of businesses in each local government area, the subsequent steps, phases 2-4, would encompass hundreds or tens of businesses. Even with these figures, the number of large users of materials and energy, and large emitters of greenhouse gases, is likely to be small.

A decision on where to focus also needs to consider where local government can have the greatest influence – from land use planning to procurement policies

The key is to use evidence to establish a focus. A decision on where to focus also needs to consider where local government can have the greatest influence – from land use planning to procurement policies.

Which sectors should each local government area focus on?

The industry sectors that each local government area in the Hunter and Central Coast region can consider for an initial focus are listed in Table 6.1. This recommendation is based on simple criteria. The sectors listed are among the top three employers in the LGA or one of the top three in contributing to the gross regional product. Additionally, each industry sector recommended is ranked among the top greenhouse gas emitters.

These criteria are all orientated around scale – where can the biggest impacts be gained in terms of reducing greenhouse gas emissions. The sectors that are larger emitters are likely to be the ones most affected in coming years by government regulations to restrict emissions. Such restrictions could also result from international protocols to reduce emissions imposed on multinational corporations or on financial institutions. So, these sectors could be seen as either the ones offering the greatest wins or the ones being most at risk.

Local governments could individually, or collectively, also decide to employ alternative criteria for determining which industry sectors on which to focus circular economy initiatives. These criteria could involve consideration of which industry sectors have proven to be more innovative, which sectors play a key role in supply chains for other industry sectors, which ones create the largest waste tonnages, or which ones will provide the greatest visibility for circular economy initiatives. A more sophisticated method of prioritising where to direct circular economy initiatives may well encompass multiple such criteria.

Additionally, economic benefits could be gained by pursuit of development of a suite of business areas that build on the region's current strengths, such as specialty manufacturers for the mining sector diversifying into machinery for sorting waste materials. Business attraction strategies should seek areas that complement one another. For example, one sector's output or waste can be another's feedstock. Using such considerations to establish multiple sets of criteria is recommended by Circle Economy for use in phases 2 and 3 of the full *City Scan* approach.

Table 6.1: Industry sectors for each local government to focus on initially.[83]

Local Government Area	Economically important Industry sectors with high emissions
Lake Macquarie	Wholesale/retail Mining
Newcastle	Wholesale/retail
Central Coast	Wholesale/retail
Cessnock	Accommodation & food services Wholesale/retail Mining
Maitland	Wholesale/retail Mining
Port Stephens	Wholesale/retail Manufacturing
Singleton	Mining Wholesale/retail
Muswellbrook	Mining Wholesale/retail Electricity generation
Upper Hunter	Agriculture Wholesale/retail
Dungog	Agriculture

Economic development considerations & reuse of infrastructure

Strategies that attempt to gain synergistic effects across multiple industry sectors are often employed in smart specialisation approaches to regional development and in precinct-level strategies. Synergies are sought across industrial processes as well as in the use of skill sets that are common and well developed in the region's workforce, in order to gain what are called 'agglomeration economies'. In simple terms, that means that a concentration of talent in a given industry attracts employers, and this collection of employers subsequently attracts more talent. The cycle becomes self-reinforcing. It is central to regions like metropolitan Sydney seeing such dynamic economic growth.

A precinct–level approach and smart specialisation strategies were described in interviews (and they have been discussed more broadly for the past few years) in relation to repurposing the region's power generation stations. The coal-fired Liddell power station in Muswellbrook is due to close in a few years, with the neighbouring Bayswater power station and Eraring and Vales Point power stations on Lake Macquarie facing closure in the coming 10-15 years.[84] The electric power line infrastructure, land and water can be repurposed, such as being used for battery storage of electricity generated by solar and wind.

The power stations can be seen as promising locations for a precinct-driven approach. The accumulated fly ash can be harvested to make building products, as discussed in Appendix B . One interviewee suggested employing the nearby lakes for cooling data centres (server farms) . Additional activities recommended for the site include green waste processing to generate methane or hydrogen for gas turbines to provide electricity during periods of peak demand.

[83] UON recommendations based on data from the ABS and other sources described in Appendix D.
[84] Australian Energy Market Operator (2021). *General Information: Expected closure years*. https://aemo.com.au/en/energy–systems/electricity/national–electricity–market–nem/nem–forecasting–and–planning/forecasting–and–planning–data/generation–information – accessed 1 August 2021.

Peak demand could also be served by utility scale batteries positioned at the site. There is also the potential by locating multiple industries in such a precinct to use the large volumes of waste heat from the existing power stations in areas such as food processing, as discussed in one of the interviews.

Data on precinct development or repurposing infrastructure was not an input in this phase 1 *City Scan* analysis. However, the availability of suitable infrastructure and state economic development regimes seems important to deciding on which circular economy avenues to promote.

6.5. NEXT STEPS – WHAT NEEDS TO CHANGE

The *City Scan* guidelines, as well as academic and practical insights on regional development, point to the need for the following changes.

Engagement and collaboration

1. **Engage more with industry** – The circular economy is a market-based phenomenon with a distinctive regional scope. The local governments in the region should engage with industry to build literacy about the circular economy and its potential. That engagement can also be about local companies providing much needed data on material use and greenhouse gas emissions, particularly in the target sectors and their supply chains.
2. **Obtain consistent, high quality data at the right level of granularity** – More extensive, more accurate and more compatible data can be collected from industry, as just noted, by local, state and federal government departments. Eliciting that data could well require implementing new policies and incentive systems.
3. **Characterise what is at risk** – An economic assessment is required to establish a sense of urgency related to jobs and gross regional product that could be at risk if development of the circular economy is delayed. Appropriate modelling could explore how many jobs could be generated if the circular economy is implemented sooner, rather than later. That is, identify the 'first mover' advantage for the Hunter and Central Coast region. Such modelling could be funded by state or federal government and undertaken by consultants and research institutions who have access to knowledge of the region's economic base.
4. **Collaborate across the region** – Circular economy initiatives or prospects should be aligned with other regional initiatives, such as those related to business attraction and economic diversification. The circular economy is not an effort for a single council but rather a regional and state consideration.

Methods

5. **Address supply chains** – Consider supply chains as opposed to single industry sectors or subsectors. Treat the region's economy as a complex system through which materials, energy and water flow.
6. **Select indicators** – Identify credible and salient indicators[85] to enable benchmarking against other regions and cities as well as tracking progress over time. Assure credibility for the indicators by consulting with key stakeholders in government as well as in the region. Significant initiatives are hard to sustain without credible evidence of success.
7. **Boost circular economy 'literacy'** – Use analysis and make the data public (e.g. through dashboards) to raise 'circular literacy' in the business sector and in the community. Public data suggests transparency, which can build trust and credibility, which in turn are crucial for

[85] Uhlmann, V., Rifkin, W., Everingham, J. A., Head, B., & May, K. (2014). Prioritising indicators of cumulative socio–economic impacts to characterise rapid development of onshore gas resources. *The Extractive Industries and Society*, *1*(2), 189-199.

progressing significant changes in a region. Greater circular economy literacy can result in greater engagement in the marketplace for used materials and products, as buyers and sellers will be more informed and more confident. That will stimulate and grow the circular elements of the region's economy.

8. **Augment the *City Scan* phase 1 analysis** – For example, consider factors not yet included in *City Scan* tool, such as adding waste stream volumes and information on available facilities/infrastructure/land that can be repurposed. These considerations are particularly important in the City Scan phases 2–4, where industry subsectors and individual initiatives become the focus. The reuse, repurposing or sharing of infrastructure and land can result in significant cost savings for the businesses involved, which can add to the economic viability of newly launched enterprises.

6.6. ENABLERS FOR CHANGE

The Hunter and Central Coast region can develop a vibrant circular economy – and maintain the health of its current economy – if local governments can collectively:

- **Determine what counts as a 'win'** – Develop criteria for selecting strategies that balance environmental benefits (such as reducing greenhouse gas emissions) with economic benefits (business attraction and jobs) but also with political benefits (e.g. visibly effective changes to policies and practices). To establish these multi–dimensional criteria, local government should gather input and commitment from businesses and other stakeholders.
- **Select key areas of focus** – Engage with specific industry sectors, or industry supply chains, to achieve the most efficient outcomes from accelerating the region's transition to a more circular economy.
- **Close data gaps** – Fill gaps in the data on use of materials and energy/greenhouse gas emissions, improve its accuracy and make it more publicly available by working with the key industry sectors. This focus on data enables local and state governments to build the circular economy in conjunction with building the region's knowledge economy. This effort benefits from having a regional data strategy and a central data repository implemented by local governments working with local research institutions. Support by state and national governments could speed development and enable sufficient refinement and documentation to make the Hunter and Central Coast implementation a model for other regions.
- **Provide national leadership** – Establish a position of national leadership by starting these initiatives now to take advantage of rising interest in the circular economy that is evident at the state and federal level alongside growing regional aspirations for business attraction and economic diversification. The leadership role provides visibility to attract businesses with suitable smart specialisation capabilities, thereby developing in the region's circular economy the advantages 'agglomeration', which will further speed growth.
- **Regional taskforce to build the circular economy** – These changes require a suite of activities that benefit from alignment among various actors in local government, state government and business. This sort of alignment can be built and strengthened through ongoing liaison among existing initiatives and departments with agreement on shared agendas and common ways of assessing progress. That argues for a central role and expanded capability for the Hunter and Central Coast circular economy facilitators group.
- **Government policy change** – Needed changes in government policy and funding can be identified and promoted by this coordinated regional taskforce. Such policies can relate to initiatives such as the sharing of data gathered by government and addressing opportunities that are significant at a state or national level, such as reuse of fly ash from the power stations.

Appendix A: Scope of work

The scope for the *City Scan* project included:

1. **First tranche of data to Circle Economy** – Pilot aggregation of socioeconomic and materials flow data that corresponds with items needed by the *City Scan* assessment – volume or mass of 6–10 key materials or categories of materials and their use by up to 20 industry sectors along with use of energy and water, as well as sectoral employment, economic value added, and carbon dioxide emissions. Collation of these data (meaning the collection of existing data) to the extent available with the time, staff resources and degree of access available, *i.e.*, recognising that some data are not gathered or are not necessarily publicly available. Delivery is in terms of uploading this data to Circle Economy's *City Scan* web–based tool for including in their database through which their tools can help to identify opportunities for circular economy initiatives. Include not a comprehensive update or extension of the existing MFA for the region; rather identify and prioritise significant material sources and flows where suitable data is found to be available (e.g. glass, plastic, organics). Add to the MFA data that are available for reasonable effort on water and energy use and volumes of biomass and fly ash. From these data, a short list of indicators (about 6) suggesting the status/extent of the region's circular economy employing input from stakeholders in the region will be agreed on.
   – *Data assembled on each LGA is available in a spreadsheet from the Hunter Joint Organisation. Data on material flows into council waste sites in the region was garnered from the NSW EPA, ready for categorization to enable updating the materials flow analysis. However, NSW EPA requested that this data not be made public. The waste data, specifically from Ricardo's material flow analysis, has been compared with material consumption data to illustrate the nature of data gaps in the latter. Waste data are addressed in this report, but they were not employed extensively in analysis as the City Scan tool is not yet able to use it*.
2. **Engagement with stakeholders** – Provide insight from up to 15 representatives of industry types with key sources of usable and re–usable materials; prioritise engagement with the 'low hanging fruit', early adopters or potential early adopters of circular economy strategies. Provide regular updates (e.g. monthly) as desired to the Hunter and Central Coast circular economy facilitators group, and other audiences. The updates are to consist of a list of bullet points and short explanations totaling up to one page along with opportunities for 15 minutes of verbal explanation and Q and A.
   – *Engagement with stakeholders in business and government was undertaken, with 13 interviews and presentations to Hunter Joint Organisation's circular economy committee, a state circular economy working group on the built environment, the Hunter and Central Coast circular economy facilitators group, and a circular economy 'think tank' attended by 120 individuals at the Hunter Innovation Festival*. *Project clients received regular weekly or fortnightly updates.*
3. **Benchmark report** & **presentation**– Compare and contrast Hunter and Central Coast region data with that of other *City Scan* localities. Highlight and explain in the report between 6 and 10 circular economy opportunities identified by the automated, online *City Scan* analysis. Written report will total up to 25 pages, with a companion presentation of up to 15 PPTs, which will be designed to take about 20 minutes. The report and presentation provide an overview of methods and their limitations, data and recommended indicators, stakeholder input, *City Scan* recommendations and their implications for next steps.
   – *This report constitutes the 'benchmark report'. A 20–minute presentation of methods and findings was provided to the clients in a meeting of the Hunter and Central Coast facilitators group.*

4. **Hackathon guide/elements** – Contribute to the design and delivery of an engagement event for the Hunter Innovation Festival scheduled for May 2021. The event is expected to last from one to four hours and involve up to 30 participants. The contribution will consist of key elements drawn from the above deliverables along with input on facilitation of this sort of engagement, e.g. 5–10 pages of detailed facilitation notes covering every 10 minutes of workshop activity.
   – *The project team presented at the Hunter Innovation Festival on 10 May. The workshop element of the presentation was postponed due to time constraints on the day (which was facilitated by an external consultancy, Coreo) and delays in gaining permission to upload regional data to the* City Scan *website. Engagement with project findings is planned as part of an upcoming workshop (possibly in September 2021) on developing a regional data strategy, which has been delayed due to COVID lockdown restrictions.*
5. **Framework for next steps in the *City Scan* analysis for this region** – Identify a series of 5–10 further steps of data collation, analysis and planning to progress development of the circular economy for the Hunter and Central Coast region economies. For example, the first round may identify construction materials and construction waste as a key area in terms of the volume, cost and employment – deliverable 1 above. So, next steps could involve looking more closely at what types of construction are the 'low hanging fruit' in this region (e.g. homes, offices or roads) and the areas showing the most promise for redesign (e.g. by changing council's construction requirements) or recycling. The framework will be delivered as a 5–page section of the report described above.

Appendix B: Employment and GDP generated by a circular economy: scenarios

B.1. OVERVIEW

International studies suggest that employment growth can be expected from 'ambitious' development of the circular economy. Employment growth is also characterised by a growing number of national studies, such as by KPMG with CSIRO, and a few studies of opportunities this region, such as the Grattan Institute's 'green steel' report and recent analysis of economic benefits from processing legacy fly ash from the region's four power stations. These studies are described below.

They suggest that new opportunities will emerge from improved product design, enhanced recycling and sorting, reuse and remanufacturing, and development and implementation of renewable energy technologies. The gains in employment foreseen in other parts of the world are expected to at least offset jobs lost as the volume of manufactured goods decreases because the life of the goods already being used is extended. For example, if automobiles are kept on the road for 40 years instead of for 20 years, then only half as many automobiles need to be manufactured. In this example, though, the jobs would be lost where the automobiles are manufactured, such as in Thailand, China, or Belgium. However, jobs would be gained where the automobiles are used and maintained, such as in Australia.

Precisely what will happen in coming decades in the Hunter and Central Coast region appears to depend on a couple of key factors. The region's largest economic contributor – mining and electricity generation – is expected by many to face significant changes in response to concerns about climate change. Secondly, interest in the circular economy within Australia has been growing in the past three years. That has opened a small window of opportunity for the region to gain a 'first mover advantage' by developing physical capacity and workforce expertise in growth areas of the circular economy.

This section provides a brief overview of selected international, national and locally focused studies that suggest employment outcomes for accelerating development of the region's circular economy.

B.2. INTERNATIONAL STUDIES

Studies to assess economic, social and environmental effects of 'business as usual' as opposed to accelerating development of the circular economy have been undertaken for various countries and regions around the world. An overview that is particularly useful for this report has been provided in the form of analysis of results of 300 circular economy scenarios for the period 2020 to 2050.[86] The article analyses the outcomes predicted by these various forecasts in terms of their impact on gross domestic product, employment and the percentage reductions in greenhouse gas emissions.

Each study addressed the promise of implementing a particular set of policies (e.g. a carbon tax) or a particular technological goal (e.g. extending product lifetimes) for a particular country or set of regions. The authors started with a set of 595 articles to filter through and ended up focusing on 27 relevant articles covering 324 circular economy scenarios. This narrower set had the desired big–picture focus – primarily being a quantitative analysis covering multiple economic sectors. Authors of these studies came from organisations ranging from the United Nations

[86] Aguilar-Hernandez, G., Dias Rodriguez, J., and Tukker, A. (2021). Macroeconomic, social and environmental impacts of a circular economy up to 2050: A meta-analysis of prospective studies, *Journal of Cleaner Production*, vol. 278, 123421.

Environmental Program, the European Environmental Agency, and the Ellen MacArthur Foundation to Australia's CSIRO.

Looking across the ambitious circular economy scenarios modelled in these studies shows predictions of a median rise in gross domestic product by 2030 of 2 per cent (where 'median' means that half of the studies predicted a bigger figure and half predicted a smaller figure). The median rise in employment by 2030 was seen by the authors to be 1.6 per cent, while the reduction of greenhouse gas emissions by 2030 came in at a median of 25 per cent (measured in terms of carbon dioxide equivalent). So, the big wins to 2030 were in reducing emissions with modest benefits for jobs and gross domestic product.

The modelled predictions for 2050, which is the target year for reaching net zero greenhouse gas emissions, are more significant. The gains in gross domestic product had a median of just under 4 per cent. In employment at 2050, the median gain was just over 4 per cent. For greenhouse gas emissions in 2050, the median result was a reduction of 55 per cent.

So, the ambitious circular economy scenarios have impressive results in reducing greenhouse gas emission by 2050. Gross domestic product and employment are seen to rise 4 percent compared to business as usual. The moderate scenarios for circular economy development to 2050 were predicted, generally, to boost gross domestic product by less than 1 per cent. Job creation was well below 1 per cent. Greenhouse gas emissions declined by 2050 by a minimum of 20 percent. Again, the moderate scenarios across 27 studies show that the big wins are in reduced emissions, with marginal gains in gross domestic product and employment.

The results summarised in this international meta study suggest substantial impacts in reducing greenhouse gas emissions from either ambitious or moderate implementation of circular economy policies and practices. However, benefits to employment are generally only seen with the more ambitious circular economy strategies. A more ambitious acceleration of the circular economy for the Hunter and Central Coast region could create jobs to help counterbalance losses expected in coming decades in the mining and power generation sectors.

> … acceleration of the circular economy … could create jobs to … counterbalance losses … in mining and power generation.

B.3. NATIONAL STUDIES

KPMG Australia report[87]

KPMG and CSIRO identified eight circular opportunities for the nation to undertake: nutrient recovery and recycling, biogas from organic waste, water use efficiency, food waste reduction, electrification of transport, car sharing, compact dwellings, and energy efficient buildings. The criteria for the focus on this particular set were not provided, but these estimates are useful, nonetheless, for identifying the scale of benefits possible for the Hunter and Central Region based on their estimates at the national level.

The recommendation of producing biogas from organic waste comes from the fact that 22 per cent of Australia's organic waste is disposed of in landfill, which equates to roughly 3.1 million tonnes of organic material going to waste. KPMG proposes that constructing biogas plants to process about 70 per cent of this landfilled organic waste, roughly 2.1 million tonnes per year, will result in electricity generation of 55 million kilowatt-hours per plant, at a cost of only 7-10 cents per kilowatt–hour. KPMG estimates that implementing these biogas plants will result in a net gain for Australia's GDP of 0.02 per cent while creating 823 full–time jobs.

[87] KPMG Economics (2020). *Potential Economic Pay-off of a Circular Economy*, Commissioned by CSIRO, KPMG, Sydney.

For the Hunter and Central Coast region, the material flow analysis by Ricardo[88], commissioned by the Hunter Joint Organisation and NSW Sustainability Advantage, estimated that, of organic waste (listed as 'food waste' and 'other organic waste') produced in the region, roughly 16.2 per cent is disposed of in landfill. This figure equates to about 270 thousand tonnes of organic matter. The estimates from KPMG enable an assessment of the energy generation capability of this volume of organic matter.

KPMG estimates that 15 biogas plants handle the nation's landfilled organic matter, each processing 150 thousand tonnes annually. Assuming that this proportion scales down linearly, two biogas plants would be able to handle the total landfilled organic matter of the Hunter and Central Coast region each year. That would generate about 110 million kilowatt–hours of electricity per year for the region. That is nearly the electricity consumption of all of Lake Macquarie's small to medium, non–residential energy customers (~119,000 megawatt–hours).

These figures should be reconciled with the estimates produced by Ricardo in their analysis of the biovalley plans for the Hunter Joint Organisation and with estimates undertaken by Resilience Brokers for Hunter Water.[89] More specifically, Ricardo's analysis applied to part of the function of the biovalley being biogas production via anaerobic digestion, and Resilience Brokers were exploring, among other things, uses for biosolids from sewage. Estimates of economic benefit – in terms of the value of the electricity generated and the jobs created – can help to determine the optimal proportion of organic waste to be allocated to biogas production in the biovalley scheme, versus sending the same waste to a composting facility.

The other seven opportunities that KPMG explores all promise modest to large benefits for the nation's $4 trillion economy by the year 2048. For example, there is a $5.1 billion boost in GDP via car sharing. There is also a $29.9 billion boost in GDP forecast for a reduction in water leakage and a substantial $96.6 billion GDP gain from implementing greater energy efficiency in building designs.

Estimating the benefits of these opportunities for the Hunter and Central Coast region will take some work in gathering relevant data. For example, the benefits to this region of increasing the sales of electric cars would need to be assessed. That would require scaling figures on the benefits from national estimates. That scaling would require data on car sales within the region, as well as data on kilometres travelled in this region and typical fuel mileage (an indicator of how much stop–start driving is done).

For another example, the energy star ratings of new dwellings[90] being built, supplied by the CSIRO's Australian housing data[91], can be used to scale the economic benefits that KPMG estimates will come from the nationwide improvement in energy efficiency. As it stands, several regions in the Hunter have large proportions of new dwellings being built with a less than 6-star rating (e.g. Lake Macquarie at 52 per cent, Central Coast at 51 per cent, and Newcastle at 48 per cent). That contrasts with the national proportion across all LGAs, where just 28 per cent of all new dwellings have a rating below 6 stars.

From these percentages, it can be inferred that setting a minimum standard of 6 stars (already being implemented by the Nationwide House Energy Rating Scheme, or NatHERS[92]) will result in an improvement in energy efficiency for these LGAs of much greater than the 22 per cent estimated by KPMG, which is based on a lower rate of compliance.

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[88] Hull, G. (2019). *Hunter and Central Coast Materials Flow Analysis*: Report for Hunter Joint Organisation and Sustainability Advantage. Ricardo Australia Pty Ltd, Chatswood.

[89] Neither of these reports has been made publicly available.

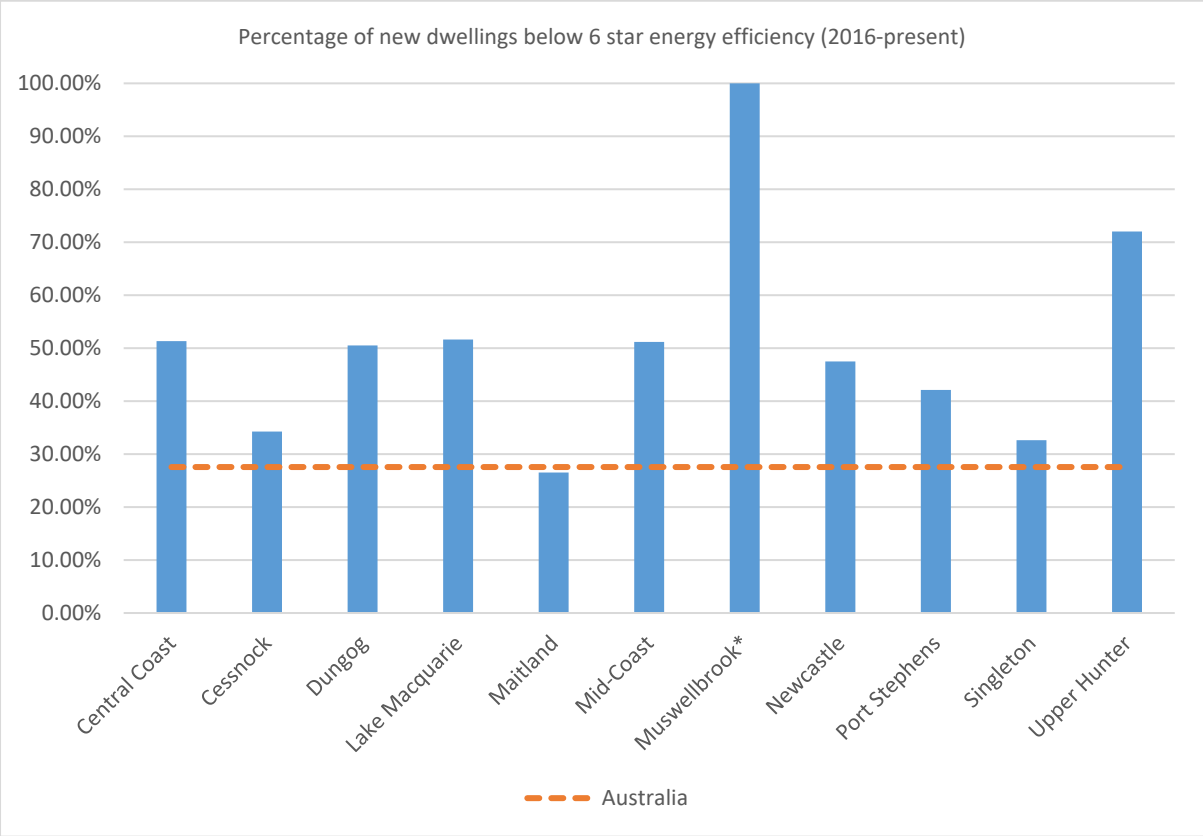
[90] The term 'dwelling' refers to houses, townhouses, villas, apartments, etc. So, in comparing regions, the relative number of free standing houses versus apartments and so on needs to be assessed. Also, recognise that state and national averages are swayed by the major capital cities, Sydney, Melbourne and Brisbane, where 40 per cent of the population resides.

[91] https://ahd.csiro.au/dashboards/energy–rating/lga/ – accessed 1 August 2021.

[92] https://www.nathers.gov.au/owners–and–builders/home–energy–star–ratings – accessed 1 August 2021.

The gain in national GDP from a 22 per cent increase in energy efficiency is estimated to be around 0.2 per cent. For LGAs with large numbers of new dwellings with low energy efficiency ratings, the gains in energy efficiency stand to be much higher than 22 per cent, representing potential gains in gross regional product that are higher than 0.2 per cent. That means a bigger economic boost in the Hunter and Central Coast area, where the average level of energy efficiency in new dwellings has so much room to improve. Such assessment can also apply to existing dwellings to estimate improvements in gross regional product to be expected from adding insulation and weather stripping.

Figure B.1: Proportion of new dwellings in the region that could have higher energy efficiency.[93]



The KPMG study provides useful examples of benefits from a select group of strategies that fall under the umbrella of the circular economy. It illustrates the opportunity to estimate the promise of these circular economy strategies from national studies. Then, use that potential as impetus for more detailed analysis at the scale of Hunter and Central Coast region, with locally commissioned studies, such as those by Ricardo and Resilience Brokers.

In a similar way, the KPMG study can be seen to complement the scope of *City Scan* in its phase 2 or 3 stage, by giving national figures that should be followed by regional estimates. The KPMG effort differs from *City Scan*, though, in that it has more of a focus on strategies that affect the residential sector, such as car sharing and residential energy use. In contrast, the *City Scan* has more emphasis on industry and commercial activity.

[93] Chart created by UON from data assembled by CSIRO – [93] https://ahd.csiro.au/dashboards/energy–rating/lga/ – accessed 1 August 2021.

Lifecycles South Australia report[94]

The team of consultancy organisations involved in creating the Lifecycles report for South Australia takes a different approach to KPMG in their modelling. Rather than considering specific circular opportunities, KPMG consider the effect on South Australia's economy of implementing a suite of circular economy strategies to achieve goals for reducing greenhouse gas emissions to a particular target by 2030. For example, KPMG assess a scenario that has 84 per cent of electricity generated in 2030 by renewable sources and 33-50 per cent of petroleum-based fuels replaced by electricity.

The report also covers a scenario where material efficiency is improved across the board by 35 per cent, with 50 per cent of virgin materials being replaced by secondary materials. Additionally, 30 per cent of natural gas used is replaced by biogas. These figures and additional specifics are offered as 'stretch targets' conceived by South Australia's Low Carbon Economy Experts Panel for decarbonised scenario modelling.

When the needed measures are implemented, Lifecycles estimates that the total emissions of the state of South Australia would reduce from 43 million tonnes of equivalent CO_2 in 2030 in a business as usual scenario to 28 million tonnes of equivalent CO_2, a decrease of about one–third (34 per cent). That decrease would be despite their assumption of growth in the state economy that causes energy use to rise by 30 per cent during this period.

The scenario of efficient and renewable energy results in this analysis in a figure of 4,700 jobs (0.6 per cent) being added by 2030 compared to the business as usual scenario. The material efficiency scenario adds another 21,000 jobs (2.6 per cent). A more ambitious circular economy scenario, combining these two elements, includes a total of 25,700 more jobs (3.1 per cent).

These figures fall within the range found in such analyses done in other countries.[95] Lifecycles foresees half of these additional jobs occurring in professional, scientific and technical services, with the other half spread across construction services, personal and other services, and waste management services. They cite a UK study that suggests that additional jobs would be across recycling, services, remanufacturing, reuse and biorefining. About half of the positions, the UK study estimates, would be in skilled jobs, about one third in low-skilled jobs, and the smallest portion in professional roles.[96]

It is difficult to assess the size of impact of implementing a similarly ambitious set of decarbonisation strategies to achieve these targets in the Hunter and Central Coast region as the array of industries and other essential factors here are different. Additionally, the stretch targets provided by the expert panel in South Australia would need to be assessed to see if they are seen as reasonably achievable by an expert panel on this region.

Currently, there is already a lack of data on material consumption for the Hunter and Central Coast region (no such database exists, and data that could inform it is not yet publicly available). So, the effects that replacing virgin materials with secondary materials would have on greenhouse gas emissions, or employment, would be difficult to estimate in a credible way.

Two conclusions can be drawn from this South Australian scenario analysis. First, applying insights gained to this region is hindered by a lack of data. Second, this modelling provides estimates of additional employment that are roughly aligned with results from certain international studies.

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[94] Lifecycles, EconSearch, Colby Industries, University of Queensland (2017). *Creating Value: The potential benefits of a circular economy in South Australia*, Green Industries South Australia, Adelaide.

[95] Aguilar–Hernandez, G., Dias Rodriguez, J., and Tukker, A. (2021). Macroeconomic, social and environmental impacts of a circular economy up to 2050: A meta–analysis of prospective studies, *Journal of Cleaner Production*, vol. 278, 123421.

[96] Morgan, J. & Mitchell, P. (2015). *Employment and the circular economy job creation in a more resource efficient Britain*, Green Alliance and WRAP, London.

B.4. LOCALLY FOCUSED STUDIES

BZE *The Million Jobs Plan*[97]

One million jobs in Australia's regional areas are forecast to be created by fostering elements of the circular economy, according to *The Million Jobs Plan* published by the environmental advocacy organisation, Beyond Zero Emissions (BZE), in 2020. Specifically, BZE describes adding 200,000 jobs in renewable energy generation and transmission, 940,000 jobs in retrofits and new buildings, 140,000 jobs in electric buses and new green transport, 230,000 jobs in clean manufacturing and mining, 200,000 jobs in land regeneration and 80,000 jobs in waste recycling.

The BZE plan is meant to boost wages, in real terms, by 2 per cent and to increase gross domestic product by 1 per cent by 2030. These figures are reasonably consistent with the scenario modelling in international studies, which was summarised above.

The BZE plan also see benefits for women in the workforce and for Indigenous development. Implementing the plan would require billions of dollars in private investment as well as a reorientation of government policies and investments. BZE cites the current pipeline of renewable energy projects in Australia as totalling over $100 billion.

The report contains case studies on the Hunter region and description of the two-year Hunter Diversification Project, a study of economic opportunities that BZE is undertaking with Hunter communities, businesses, government and investors. For the Hunter region, the BZE plan includes creation of 10,000 additional jobs for the span of 2021 to 2025 to undertake housing retrofits.

Additional jobs are foreseen in development of the clean steel industry (see the discussion below of the Grattan Institute's study of this topic), with the total reaching just over 10,000 jobs by 2030. Smaller increments of jobs to be added by 2030 are meant to come from: building zero emissions buses; use in construction of fly ash from the region's four, large, coal-fired power stations; mine rehabilitation; reforestation; carbon farming; and more rangers involved in land care.

The BZE figures for 2030 total about 12,000 jobs, which compares with around 11,000 persons currently employed in mining in the Hunter region.[98] The BZE study can be seen as aspirational by design. Nonetheless, it usefully identifies job types and job numbers in areas related to the circular economy. That suggests that growth of the circular economy could feasibly create a suitable number of jobs to replace coal mining jobs, though the precise match up in job skills is yet to be assessed.

Grattan Institute – *Start with Steel*[99]

The Grattan Institute describes opportunities for employment in Australia, and in the Hunter region specifically, in a steel industry powered by hydrogen and renewable energy rather than by coal. A central focus of the study was finding alternative employment for thousands of workers in the next few decades in light of what the authors characterise as great uncertainty in the nation's coal mining industry.

The report is positioned in the discussion of how to reduce greenhouse gas emissions and how measures to create that reduction can affect the Australian economy, negatively or positively. It is not framed as a 'circular economy' study, but it addresses a range of factors that are central to a circular economy.

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[97] BZE (2020). *The Million Jobs Plan: A unique opportunity to demonstrate the growth and employment potential of investing in a low-carbon economy*. Beyond Zero Emissions, Melbourne.
[98] Coal Services (2021). Statistics. https://www.coalservices.com.au/mining/statistics–2/ – accessed 1 August 2021.
[99] Wood, T. and Dundas, G. (2020). *Start with Steel: A practical plan to support carbon workers and cut emissions.* Grattan Institute, Melbourne.

The analysis in the Grattan report addresses alternative industries that could employ renewable energy. The analysis covered cement production, refining of alternative fuels for aviation and shipping, aluminium processing, and manufacture of ammonia. The assessment concludes that steel production is the largest clean manufacturing opportunity that Australia has. The Grattan report specifically cites the promise of using hydrogen and renewably generated electricity in a rejuvenated steel industry that services export markets that would demand 'greener' steel.

The Grattan Institute's analysis of the elements needed to manufacture green steel and the size of its possible markets feeds their estimates of employment. They foresee the green steel industry offering alternative jobs to coal mining in the Hunter region, 10,000 jobs, and in Central Queensland, 15,000 jobs. They also calculate that a biofuels industry could generate thousands of jobs nationally as could production of 'green ammonia', created from hydrogen generated by renewable energy rather than from natural gas.

So, the Grattan Institute's green steel study joins the BZE *Million Jobs Plan* in identifying the number of jobs and types of jobs that could result from accelerating development of the circular economy. The figures presented – thousands of jobs in this region in each case – would be significant, and they are still within the envelope suggested by the international studies. Importantly, both studies point to the need for specific policies by government to support these types of economic diversification as well as significant private investment.

Hunter Community Environment Centre – *Jobs and Growth*[100]

The use of legacy fly ash from coal–fired power stations in the construction industry promises to create up to 3,000 jobs and a $1 billion annual contribution to the NSW economy. That is according to a report for the Hunter Community Environment Centre that is scheduled to be launched in August 2021, *Jobs and Growth: The economic impact of a manufacturing approach to reusing coal ash in NSW*.

The fly ash dams at the four power stations in the Hunter and Central Coast house 185 million of the 216 million tonnes of legacy fly ash in the state.[101] The legacy fly ash is the portion accumulated from years of operation of the power stations, as these four power stations generate about 150 kilograms each year for every resident of Australia. These volumes make it easy to see that fly ash is the largest single source of waste in the country. Less than half of the amount currently generated is being re-employed in making concrete (where it can replace 30 per cent of Portland cement and potentially more) or road pavement. As a result, none of the volume of legacy fly ash is being reduced.

This report focuses on the use of the legacy fly ash in making 'structural lightweight aggregates', rather than on its use in place of Portland cement in concrete mix. The Portland cement option is noted here because the manufacture of cement is the single largest source of greenhouse gas emissions in industry, with an 8 per cent share of total global emissions across all sectors.[102] Though the use of fly ash as a replacement for Portland cement has environmental appeal, the concentration of power with a few big players in the cement industry has been characterised as a barrier during assessment of this opportunity.[103] This potential 'barrier to entry' makes the use of fly ash in aggregate, rather than cement, the focus of this report.

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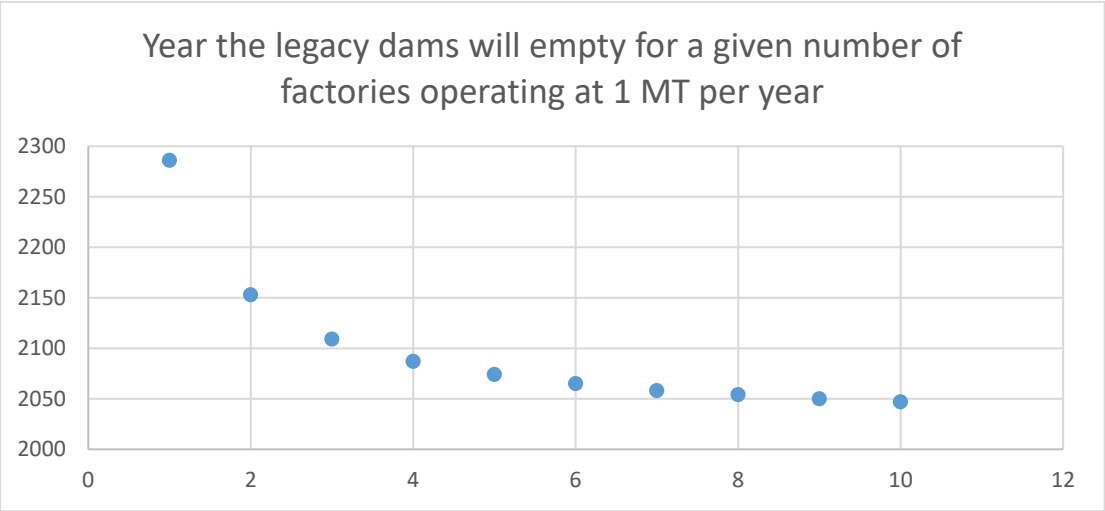
[100] Schraner, I. (2021). *Jobs and Growth: The economic impact of a manufacturing approach to reusing coal ash in NSW.* Hunter Community Environment Centre, Newcastle.
[101] Winn, P. (2020). *Out of the Ashes II: NSW water pollution and our aging coal-fired power stations*. Hunter Community Environment Centre, Newcastle.
[102] According to Chatham House, cited in Garrison, C. (2021). Concrete makers face heavy lift on climate pledges, *Sustainable Business*, Reuters – https://www.reuters.com/business/sustainable–business/concrete–makers–face–heavy–lift–climate–pledges–2021–07–01/ – accessed 16 August 2021.
[103] Dr Ingrid Schraner, Lilli Pilli Consulting, *personal communication*, 10 May 2021.

The *Jobs and Growth* report indicates that a 3–year, $34 million investment is needed in the required equipment. The benefits that result under full operation would be seen particularly for localities where the five facilities are located – the Central Coast, Lake Macquarie, Lithgow, Muswellbrook and Singleton.

The current 216 million tonnes of legacy fly ash is sufficient to support this new industry for decades. The length of this period depends on how much fly ash is removed each year balanced against how much fly ash is added until each power station is scheduled to close. A higher annual use of fly ash would suggest a need for more processing facilities and more employment. Figure B.2, based on UON modelling, shows that investing in 10 plants would use 10 million tonnes per year of legacy fly ash resulting in the current stocks being used up by about 2040. Once the fly ash is gone, the needed equipment could be shipped to another location, or alternative materials that are locally available could be employed, the report states.

Figure B.2: Year the legacy fly ash will be gone as a function of how many facilities use it.[104]



… The regulations on use of fly ash represent a current restriction, and these regulations differ from state to state.

The report expresses an expectation that a significant proportion of the aggregate produced would be employed in the Sydney construction market, with additional uses as fill in roadway embankments. Gaining 10 per cent of the Sydney market for structural lightweight precast products employing the legacy fly ash would add 570 direct jobs to the Lower Hunter region. Growth in these markets hinges on the material being officially certified as suitably safe and strong while being given preference in government and private tendering processes. The regulations on use of fly ash represent a current restriction, and these regulations differ from state to state.[105]

Thus, legacy fly ash from the region's power stations reflects not only the environmental aspirations of the circular economy. It offers economic benefits such as jobs and contributions to gross regional product which rely on technologies and markets that are, in the main, already familiar to the building construction industry.

[104] UON modelling based on data from the reports already cited: *Jobs and Growth* and *Out of the Ashes II*, as well as closure dates for the power stations published by the Australian Energy Market Operator – https://aemo.com.au/en/energy–systems/electricity/national–electricity–market–nem/nem–forecasting–and–planning/forecasting–and–planning–data/generation–information – accessed 1 August 2021.

[105] See for example – Ash Development Association of Australia (20). *Guide to the Use of Fly Ash in Concrete in Australia*, Fly Ash Reference Data Sheet No. 1. https://www.adaa.asn.au/uploads/default/files/adaa–ref_data_sheet_1.pdf – accessed 16 August 2021.

Circle Economy – Jobs analysis for the Hunter and Central Coast region

Circle Economy estimated the proportion of jobs in this region that are already engaged in, or could be engaged in, some element of the circular economy.[106] These estimates are useful in assessing the prospect jobs growth suggested by the studies summarised above.

The estimates are based on employment figures from the ABS which are broken down into more than 400 industry subsectors. Circle Economy then classified these jobs as 'core', 'enabling' and 'indirectly' involved in the circular economy. This assessment was based on their detailed analysis of these sectors in the reports and the cities that they have studied.

The Circle Economy calculations thus looked at how many people are employed in an industry subsector in this region as well as what proportion of the activity of that subsector could be classified as currently being in or exposed to the circular economy. This latter distinction is important because not every job that contributes to the environmental benefits of the circular economy would be classified as being 100 per cent focused on the circular economy. Similarly, jobs that emerge in the region as a result of demand created by the circular economy would not simply involve sorting recyclables or purchasing scrap steel.

Some newly emerging 'circular employment' would be partial, involving perhaps 90 per cent of a traditional job with 10 per cent dedicated to redesign, reuse, recycling, repurposing, etc. Jobs generated figures are generally expressed as 'full-time equivalents' for just this reason which means that part-time or casual employment as well as full-time jobs with partial responsibility for the newly emerging industry should be expected.

Circle Economy requested that their preliminary jobs analysis not be published in this report, as their methods are still going through academic peer review. That said, the concepts described here have importance for assessing how many jobs are 'generated' by the circular economy.

B.5. SUMMARY

The promise of the circular economy is increasingly being subjected to economic analysis, and the results suggest no net job losses and often gains in employment figures as well as prospects for gains in gross domestic product. That is despite a widely acknowledged link between economic growth and consumption, which seems in conflict with the aspiration for the circular economy of reducing that consumption.

These studies illustrate that the forecast economic gains could support investments in circular economy strategies given the environmental benefits on offer, from reduced greenhouse gas emissions and reduced material consumption. So, the studies cited can be seen to be making a case for the circular economy to be considered in development of new government policy that links emissions reductions with opportunities for economic development.

The number of jobs created remains speculative and subject to uncertainties inherent in any economic modelling. There are also the challenges with getting good data, see Section 4 of this report. Additionally, new businesses in these emerging industries have to decide where to locate, and the Hunter and Central Coast region can be seen to be in competition with the nearby Sydney region for business investment.

[106] The method of assessment was developed by Circle Economy and the United National Environment Program, and it is undergoing academic peer review at the time of publication of this report. Results on analysis of other regions will be available at – http://jobsmonitor.circle–economy.com/, including estimated figures for Australia as a whole.

A circular economy has strong regional elements, given the cost of transporting materials, as noted earlier. The cost of moving material by truck, the cited figure of 10 cents or more per tonne per kilometre, means that shipping bulky, low-value plastics, for example, to distant recycling facilities would not be economically viable unless exceptional value can be gained from the products that result.[107] Emerging businesses may seek not just materials and a market but also a workforce with the expertise in chemistry, physics and engineering needed to develop and operate the specialised technology required for the circular economy to accelerate.

Emerging businesses .. seek a workforce with the expertise in chemistry, physics and engineering needed to develop and operate the specialized technology required for the circular economy ...

[107] Long term, electrification of the motor vehicle fleet and increased automation may change the cost per tonne for sending freight by road. However, the figure referred to here of 10 cents per tonne per kilometre is a rough figure, with specific costs depending on a wide range of factors, including the type and capacity of vehicle.

Appendix C: Four phases of a full *City Scan*

C.1. OVERVIEW

The analysis provided in this report represents what Circle Economy refers to as phase 1 in a multi–step process of data collation, analysis and engagement need to complete a full City Scan. Phase 1 involves combining relevant data on the region from economic, environmental and manufacturing domains, as done in this report.

Phase 2 requires a detailed material flow analysis on a few target sectors to assess how much material local industries receive and how much tonnage of different types of materials end up in waste or recycling. This effort leads to a third phase, where specific circular economy strategies are identified and some are rated as high priorities due to their promise based on selection criteria agreed to within a region or city. That is followed by a fourth phase, where action plans to implement those strategies are developed.

Elements prescribed for these additional phases 2, 3, and 4, would enable local governments in the Hunter and Central Coast region to set priorities. Priorities would enable local governments to decide which manageable set of businesses and other organisations should be engaged and in relation to what materials, products and waste streams.

C.2. EMPHASIS OF A *CITY SCAN*

A *City Scan* emphasizes establishing priorities, but it also enables drawing analytical insight and inspiration from other cities or regions. The analytical tools draw on a catalogue of over three thousand circular economy initiatives to rate circular economy 'opportunities', from firms that recycle furniture to city-wide initiatives to reduce greenhouse gas emissions.

Importantly, a *City Scan* focuses on commercial and industrial use of materials and greenhouse gas emissions. It does not directly address residential use. Rather, it treats residential consumption and emissions as being a consequence of residents buying food from a supermarket, for example, which is counted in the retail sector, or using electricity, which is counted in the utilities sector. What is missed would be fuel consumed by people driving to work or for recreation, which would need to be assessed in a separate analysis of transportation modes, land use, etc.

Circle Economy have done a number of *City Scan* pilots over the past few years. Their consultancy portfolio includes extensive, multi-step analysis and engagement in Amsterdam, Bilbao and the surrounding region, and Almaty, Kazakhstan, to name a few. They are now seeking to roll out their methodology to a wider array of local governments through this automated online tool kit, which they are now piloting, and this project provides them with feedback to improve the tool kit.

The *City Scan* tool kit provides a scaffold for gathering data)carefully selected evidence on industry activity and its impacts) that is needed to engage with and inform key stakeholders. Circle Economy have been providing advice during the initial stage of analysis for this project, a modest measure of consultancy at no charge to support the pioneering nature of this region's efforts.

This first phase, feasibility analysis reveals what economic and environmental 'wins' are possible, but it also requires local knowledge and insight into state and federal policy and international financial considerations related to corporate social responsibility. The data and these political considerations play into choices of which sectors are more amenable to change and where progress may be more publicly visible and therefor more likely to generate flow on initiatives.

C.3. PHASE 1 – IDENTIFYING A STARTING POINT

Phase 1 of the *City Scan* process is about finding the strengths and weaknesses of the local economy. That suggests the skills and industry sectors that are at the core of the region's economy that could play a key role in the circular economy, specifically.

Economic activity in different industry sectors was gauged in terms of gross value added (GVA), contributions to the nation's gross domestic product (GDP), and employment figures.

A challenging element in Phase 1 has been identifying the tonnage of materials used in the economy within a dozen different categories in each of 10 different industry sectors. In addition, environmental impact was assessed in terms of tallies of greenhouse gas emissions.

Material use tonnage required estimating what is referred to as 'domestic material consumption' at the regional level. The regional level was employed because that is the level that is the most relevant for function of a circular economy *i.e*., where it is easiest to send or exchange materials in bulk. Estimations were made at the level of local government area (LGA), as well, but that those estimates could not be used in the *City Scan* tool. LGA figures were likely to be less accurate than estimates at the regional level, as well. The analysis has involved taking national or state level figures and then apportioning them to each LGA in the Hunter and Central Coast according to economic activity, rather than measuring them locally.

Accuracy of certain input data is an issue, as explained in section 4 of this report. That is because there is no readily available, public data on how much aluminium, for example, from ingots to bottle caps, is used in a given geographical area. Figures for consumption of certain materials can be found at the national level and in international studies, but they are estimates, not measured quantities. The methods used in this study to provide estimates for the regional level are described in Appendix C.

Figures were scaled from estimates made at the national level, drawing on aggregate figures for production, importing and exporting of raw materials employing estimation processes. These figures were scaled to the regional level based on factors such as the size of the sector in the region relative to its national presence, with 'size' represented by gross value added (though employment figures would be an alternative figure for scaling). For example, what is the GVA for the construction sector in this region compared its contribution to the GPD nationally?

In addition to estimating regional figures, the *City Scan* input requires an estimate the share of a given material used by each one of the 10 industry sectors that the tool analyses. The 10 sectors represent combinations of sectors from Australia's standard 19 general categories, referred to as Australian and New Zealand Standard Industry Classification (ANZSIC). Again, specifics are in Appendix D. The key point here is that the assessment of the Hunter and Central Coast region is based on national figures, with a breakdown of these estimates into 10 industry sectors and a dozen categories of materials for each sector. So, that is 120+ data points, all estimated at one regional level and at the level of 10 local government areas.

Estimates of greenhouse gas emissions for the region were also collated. They then needed to be divided up by industry sector, as well. Potential inaccuracies in this process are discussed in section 4 and Appendix D. They necessitated estimating greenhouse gas figures through a couple of different means, which involved scaling from national figures.

Despite issues with the accuracy of figures for domestic material consumption, as discussed in section 4 of this report, it is important to recognise that the *City Scan* tool just prioritises certain sectors. Its results suggest which industry sectors are significantly larger emitters of greenhouse gases or larger users of particular materials. When one industry sector, such as power generation and mining, can have 10 times the greenhouse gas emissions of the sector with the next largest emissions, then errors of 20 or 30 per cent are not significant.

Phase 1 is as far as the data collation and analysis went for this report. However, those figures should be seen in the context of the remaining three phases in the *City Scan* process. Analysis and further prioritising such as those in phases 2, 3, and 4 are needed to turn insight into the region's economy into action plans to accelerate the circular economy.

C.4. PHASE 2 – MATERIAL FLOW ANALYSIS

Phases 2 of the *City Scan* process involves a focus on the three industry sectors that the inputs and outputs of phase 1 suggest should be priorities. Criteria for prioritising are meant to reflect insights of an array of regional stakeholders engaged in the process. Keen interest in the Hunter and Central Coast region is on greenhouse gas emissions given the state government's aspiration to achieve net zero carbon emissions by 2050. If landfill were the top issue, then sectors with the highest domestic material consumption could be rated as needing attention, particularly if the consumption was matched by large tonnages going to landfill. If economic development is the greatest concern, then those sectors with the highest employment or greatest contribution to the GDP could be ranked as among the highest priorities.

The Circle Economy guidelines suggest that this prioritisation process is not only informed by data but is also participatory.

The Circle Economy guidelines suggest that this prioritisation process is not only informed by data but is also participatory. That is why the findings of this report are being shared publicly. Additionally, detailed data is being made available, via the Hunter Joint Organisation, on spreadsheets to enable an informed discussion among interested stakeholders.

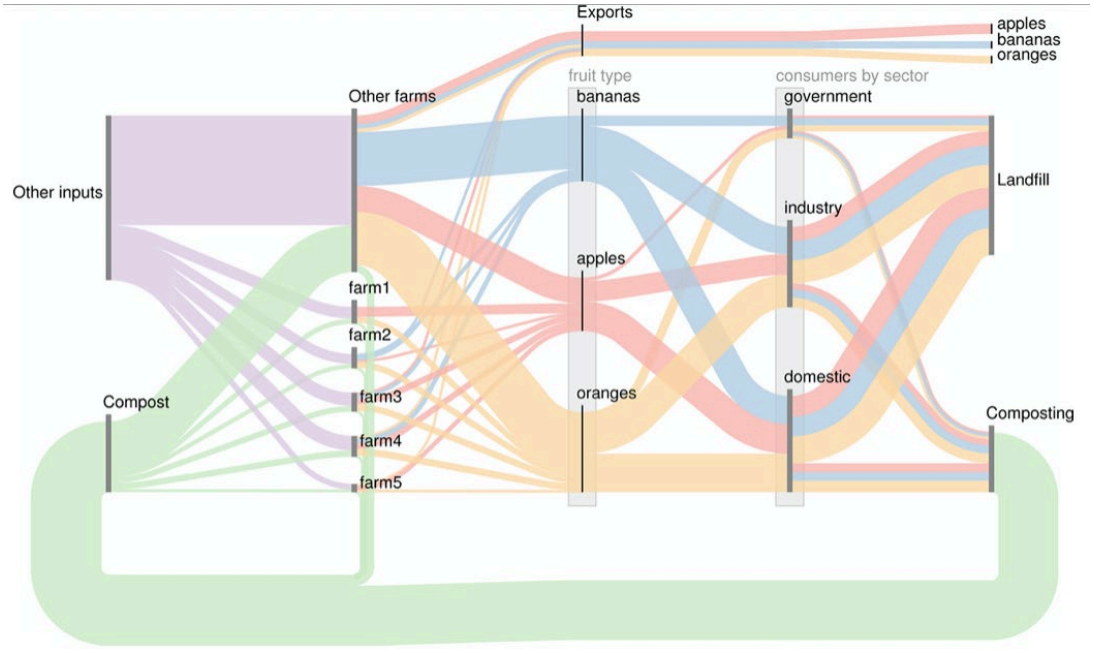
The phase 2 analysis involves a material flow analysis on the three industry sectors prioritised in phase 1. A material flow analysis ideally tracks material entering the region, provides an assessment of how much is in the region, and identifies what ends up in landfill and what is recycled. That would involve collecting some in depth data on specific sectors. So, rather than estimating the tonnage of steel used in the power generation and mining sectors based on national figures, it would be important to ask the big players and their suppliers how much steel they purchase or how many earth movers they purchase, then obtaining figures on how much steel each one contains.

One common output of a material flow analysis is what is called a Sankey diagram. A Sankey diagram shows as arrows the flows of materials and often energy or water into a region as well as the flows out of the region that result. An example of a Sankey diagram is provided in Figure C.1.

This data is meant to narrow the focus of efforts to stimulate the circular economy. That is, the 19 ANZSIC categories for industry sectors actually represent headings under which are categories for 150 or so more narrowly defined industry subsectors. For example, consider the mining and power generation sectors in the Hunter and Central Coast region. It can sound like one industry. However, there are firms that load railroad cars with coal to be sent to the Port of Newcastle. There are also companies that provide various kinds of services and equipment to the mining sector, from cleaning their washrooms to selling them drill bits.

Phase 2 enables using the material flow analysis to identify who is using the materials with the most value or greatest environmental impact. This analysis would then inform a discussion with stakeholders on which three subsectors to focus on in phase 3.

Figure C.1: Material flow analysis – example of a Sankey diagram.[108]



C.5. PHASE 3 – CIRCULAR STRATEGIES

Phase 3 of the *City Scan* process is where particular circular economy strategies are identified. That is, the focus in each of the three priority industry sectors may encompass only a handful of companies or a greater number of companies but in a well-defined area of activity, such as fast food franchises. The preceding phases would be looking across dozens of types of companies in any one of the 19 ANZSIC industry sectors.

So, phase 3 is meant to suggest for this narrow set of companies, what particular circular economy strategies might work, from facilitating greater recycling of cardboard cartons to use of surplus food from restaurants by social service agencies. Circle Economy recommends identifying 12 such strategies and working with stakeholders to prioritise 6. So, will the focus be on recycling food waste from fast food franchises specifically or on installation of solar panels on holiday accommodation?

The priority strategies will be arrived at based on environmental benefits, economic benefits, technical feasibility, financial feasibility and political benefits.

Circle Economy describes phase 3 as leading to a vision for the future, what the engaged stakeholders would like to see in place in the region.

C.6. PHASE 4 – ACTION PLAN

Phase 4 of the *City Scan* process involves creating an action plan for how to turn the vision arrived at in phase 3 into a reality. For example, how can fast food franchises and social service organisations coordinate to turn surplus food into meals for the needy? What organisational relationships are needed, and what new technologies might be needed? What business model is required – can fees be charged, are government grants required for start-up, what is competing in the marketplace with this circular strategy?

[108] Lupton, R. & Allwood, J. (2017). Hybrid Sankey diagrams: Visual analysis of multidimensional data for understanding resource use, *Resources, Conservation and Recycling*, vol. 124, pp. 141-151. Creative Commons license.

C.7. ENGAGEMENT – PHASE 1 TASKS UNDERTAKEN HAVE SPIN OFF BENEFITS

The efforts described above represent an initial round of data collation and stakeholder consultation. The data gathered and studies reviewed informed assessment by the UON to identify the potential benefits from growing various elements of the region's circular economy. That is, how many jobs might be generated and what dollar contributions to the gross regional product of the Hunter and Central Coast could be expected.

These tasks provided content for a presentation for the Hunter Innovation Festival at a circular economy 'think tank' occurring on 10 May 2021, which attracted 120 participants from government and industry. The project has also fed into various other engagement activities related to circular economy development undertaken by the Lake Macquarie City Council, the Hunter Joint Organisation and the NSW government's Sustainability Advantage program.

In addition, weekly meetings over four months involving the project team and the client group have been opportunities for frequent updates on activities and ongoing discussions about synergies and potential collaborative efforts. Working relationships have been strengthened, plans formulated, submissions and proposals drafted and initiatives progressed. One example would be progress on common strategies across region's councils for 'circular procurement', establishment of guidelines shared by councils for purchasing goods and services that have a lower environment impact.

The project meetings and spin off meetings have also been opportunities to review new circular economy tools being offered by consultancies, such as Planet Price and Inex. There has also been consideration of offers for national and international collaboration, such as with the Australian environmental organization, Planet Ark, the *City Scan* team in the Netherlands, and the City Loops initiative among seven municipalities in the European Union. City Loops is being coordinated by the ICLEI Local Governments for Sustainability network. ICLEI was founded in 1990, and it now involves more than 2,500 local governments across 126 countries with activities ranging from policy formulation to establishing common data protocols.

These experience illustrate how the elements in phase 1 of the *City Scan* process resulted in productive engagement of a range of stakeholders with aspects of development of the region's circular economy.

C.8. SUMMARY – RELEVANCE TO THE HUNTER AND CENTRAL COAST REGION

The four phases described above have been completed by Circle Economy for several cities. The reports are available on their website or that of their clients. See for example the report on the Circle Economy analysis of Bilbao and surrounding Bizkaia.[109] These reports look impressive, with charts representing data, how materials flow within given sectors, and diagrams illustrating factors to consider in prioritising alternatives.

More importantly, the phases described here illustrate essential steps of data gathering and estimation, prioritising, engagement with key stakeholders and assessment of feasibility across a number of dimensions. Recognising these elements, and challenges in undertaking them, is of relevance to getting use from this report on a phase 1 *City Scan* analysis on the Hunter and Central Coast region.

[109] Circle Economy & InnoBasque (2018). *Circular Bilbao & Bizkaia*. Bilbao Ekintza, Biskaia beaz, InnoBasque, and Circle Economy, Bilbao. – https://info.beaz.bizkaia.eus/wp–content/uploads/2018/04/circular_bilbao_bizkaia–5ac49c217e005.pdf – accessed 1 August 2021.

Appendix D: Details on formulating *City Scan* input data

Categories of data for *City Scan* (by industry sector):

- Economic (GVA, GRP)
    - Available at national, state and LGA levels (REMPLAN and .id both source from the ABS)

- Employment (by ANZSIC division, no info needed on subdivision, group or class)
    - Available at national, state and LGA levels (REMPLAN and .id both source from the ABS)
    - ANZSIC 4-digit code enables us to see exactly how industries are broken down
    - 4-digit employment data was provided to *City Scan*
        - collected via ABS table builder, which did not list ANZSIC codes in the table, just the occupation category?!
        - provided *City Scan* with 'translation' table: ANZSIC to ISIC (EU system); most categories are the same, but Australia has greater breakdown for mining, agriculture

- Emissions (scope 1 and 2 in equivalent kilotonnes of CO_2)
    - Available at national level from the ABS's national inventory
    - Sparingly available at state level also from the ABS
    - Estimates available at LGA level provided by Ironbark Sustainability at Snapshotclimate.com.au
        - Note that these appear to differ by quite a bit when an LGA commissions an in-depth emissions report
        - For example, the free online estimate of GHG emissions for the Central Coast is 4,700 kilotonnes; a detailed calculation for the Council by Ironbark Sustainability reports 3,700 kilotonnes
        - Ironbark's estimates are based on the correlations between factors such as industry economic output and employment and GHG emissions; correlations are derived from sample localities in Victoria; they are described in a 'methods' booklet published by Ironbark
    - ABS seems to disseminate direct emissions of each industry at a national level only. This aggregation leads to what appear to be quite different figures when studies publish emissions estimates (e.g. https://doi.org/10.1016/S2542–5196(17)30180–8 claiming roughly 35,000 ktonnes of eCO2 from the healthcare industry when the ABS's national inventory publishes a figure of less than 2,000 ktonnes)
    - Takeaway message – GHG emissions are estimates, not measurements; estimates for larger, closely tracked, point sources, such as electric power stations, are likely to be more accurate than estimates for individual industrial processes distributed across many smaller sites.

- ‘Material consumption’ (in kilotonnes, broken down by MFA13 material classification)
    - Available at national level, not broken down by industry, provided by CSIRO via resourcepanel.org
    - nothing found for state or LGA level beyond any commissioned MFAs
    - Can be easily confused with ‘material input’ (see: https://ec.europa.eu/eurostat/statistics–explained/index.php?title=Glossary:Material_flow_indicators or http://www.materialflows.net/methods/ for explanation of various MFA terms)
    - Only tells a part of the material flow story; it leaves out material outflow (waste + products + other categorisations)
    - Perhaps, data collection from all industries is not necessary; A-based estimations could perform well enough to capture broad trends in consumption (see INEX https://www.inex–circular.com); the level of accuracy needed depends on the use desired
    - There is an assumption that capability in tracking this sort of data on material consumption will grow over time, particularly for industries with a high level of material use; national reporting of sustainability related data tends to be required for large companies already (such as greenhouse gas emissions), but figures aggregated across multiple sites tend to be submitted.

Emergence of effect of gaps in relation to *City Scan* data collection

- **Emissions** – Due to the lack of data at the level required by the *City Scan* tool (equivalent CO_2 emissions by industry at the LGA level), the decision was made to use two different estimation methods to produce emissions figures:
    - The first relied on coarse-grained figures of LGA emissions provided by Ironbark Sustainability (published on https://snapshotclimate.com.au) which had a breakdown of emissions into broad categories: transport, waste, agriculture, electricity (split up by ‘residential’, ‘industrial’ and ‘commercial’) and gas (also split up by ‘residential’, ‘industrial’ and ‘commercial’).
        - The figures from Ironbark Sustainability were used as total emissions for each LGA. These were broken down using the same proportions for each of the 19 standard ANZSIC industry sectors as found in Australia’s national emissions profile. As Ironbark had classified whether emissions were residential, industrial or commercial sources, it was possible to categorise/aggregate the national figures along the same lines in order to fine tune the proportions.
        - As such, estimates of Lake Macquarie LGA’s emissions due to manufacturing using the above method are:
            1. Ironbark estimates that Lake Macquarie emitted a total of 2,576 kilotonnes of equivalent CO_2 in 2019, of which 41% (≈1,056

kilotonnes) is emitted from industrial sources, not including transportation, agriculture or waste and water

2. According to the national figures, manufacturing emissions make up 16% of the industrial emissions in Australia.

3. Assuming that Lake Macquarie behaves similarly to the national numbers, it is estimated that the manufacturing sector in Lake Macquarie emits 16% of the 1,056 kilotonnes, or 169 kilotonnes of equivalent CO_2.

- The major assumptions at play here are a) Ironbark's estimates are reliable and b) the LGAs have emissions profiles matching the national figures.

- The second form of estimation relied on purely economic figures, relating the gross value added of an industry sector to the emissions of that industry sector.
  - The coefficients were calculated using national figures, as both the national emissions by industry and the gross value added by industry are readily available at a national level. The GVA numbers by industry sector for each LGA were then used (supplied by either REMPLAN or .id) and multiplied by the coefficients to convert from dollars to tonnes of greenhouse gas emissions.
  - Again, estimates of Lake Macquarie's emissions due to the manufacturing sector using the above methods shows:
    1. The national emissions for the manufacturing industry total 53,740 kilotonnes of eCO_2 (2016-17); in the same period, the manufacturing industry contributed $102 billion of gross value added. Dividing the former by the latter gives a coefficient of 0.000000521936667 kilotonnes of eCO_2 per dollar of industry output.
    2. Lake Macquarie's manufacturing sector's contribution to GVA of $563 million AUD (2016-17) is then multiplied by the coefficient above, resulting in 294 kilotonnes of eCO_2.
  - Note that the major assumption here is that the relationship between emissions and value added are consistent when scaling down from the national to the LGA level. Note that this assumption differs from the one made in the previous emissions estimation. The answers differ, as well. Using Ironbark's figures, the manufacturing sector in Lake Macquarie seems to emit 169 kilotonnes of eCO_2 per year. Scaling national figures to the regional level using gross value added yields a figure of 294 kilotonnes per annum.
  - This 74 per cent difference seems substantial and, for example, comparing the manufacturing sector with the financial sector in Lake Macquarie shows that the former emits significantly more than latter and as such, manufacturing is a much bigger target than the financial services sector.

- **Material Consumption** – The *City Scan* tool requires material consumption data broken down by both material type (MFA13 categories) and industry sector. As with the greenhouse gas emissions, two different estimation methods were used to come up with material consumption figures for each LGA. These figures, clearly, suggest where a locality can see big wins through efforts of companies to reduce material use and to recycle.

    - The materials are broken down into four major categories, which are further broken down into a total set of 13 subcategories: Biomass (crops, crop residues, grazed biomass and fodder crops, wild catch and harvest, and wood), fossil fuels (coal, natural gas, oil shale and tar sands, and petroleum), metal ores (ferrous ores and non-ferrous ores), non-metallic minerals (construction dominant, and industrial or agricultural dominant).

    - The two methods for estimating material use tonnage per year followed the same idea: scale down the national figures provided by the CSIRO (accessed on https://www.resourcepanel.org/global–material–flows–database) in order to get total material consumption for each industry sector. Then break down each industry's total consumption into the 13 subcategories. That breakdown was achieved through analysing material consumption data of multiple cities whose data were on the *City Scan* tool already. For example, for Bilbao, the proportion of biomass-crops, the proportion of fossil fuels-natural, and so on was identified for the manufacturing sector. Was biomass-crops tonnage double that of fossil fuels natural gas for that sector, for example? This was then averaged over the proportions of material types in a given sector across the multiple cities. So, if the ratio for Bilbao was 2x biomass-crops to 1x fossil fuels-natural gas in the manufacturing sector, we average that with a figure for this ratio in the manufacturing sector in Amsterdam and Almaty.

    - Before using these proportions, a figure was required for how much tonnage of materials were consumed for the locality.

    - For the first method of calculation employed, economic data, namely GDP and GRP, was used in order to scale down the national consumption figures.

        - First, the total domestic material consumption for Australia was divided by the GDP in AUD (matching years) to get a coefficient in tonnes/dollar.

        - The GVA contribution from each industry sector (taken from REMPLAN or .id) was then used to estimate their contribution to the GRP of their LGA. That provided an estimate of how many tonnes of material were consumed in a given year by that industry sector based on the presumption that material use tonnage scales with economic output. Double the GVA of the construction sector, and the tonnage of materials employed is likely to double.

        - The GRP contribution for an industry sector was multiplied by the calculated national coefficient for material consumption per dollar of GVA to obtain an estimated total material consumption for each industry sector in tonnes.

        - A problem with this method is that industries with very high economic impact and very little material usage (e.g. service sector industries like real estate, information, and administration) will have inflated estimates of material consumption. In other words, some figures for the real estate sector did not make sense; they seemed to be way too high. So, a second method was developed to attempt to correct this skewing through the use of a non-economic indicator to scale from national figures to local figures.

    - The second method is based on the premise that material consumption correlates highly with electricity consumption. Again, national figures for material consumption were used, this time, scaled down based on electricity consumption.
        - First, the total domestic material consumption for Australia was divided by the total electricity consumption in petajoules to get a coefficient (tonnes of material / petajoule of electricity).
        - Multiplying this coefficient by the total energy consumption of an LGA gives an estimate of the LGA's total material consumption in tonnes.
        - The proportion of material consumption for a given industry sector across Australia was determined as a fraction of the total national consumption across all industry sectors. This figure was arrived at by dividing a sector's estimated material consumption by the total material consumption. This coefficient is dimensionless: ((electricity consumption × material consumption per petajoule) / (total material consumption)).
        - These proportions were then used to arrive at a total material consumption for each LGA by industry sector.
        - As the 'commercial industries' were all lumped together in the national data on electricity consumption, they were split up the commercial industries according to GVA. That is, if retail generated one-fourth of the GVA nationally for the set of industries classified as commercial industries, then it would be allocated one-fourth of the material consumption for that set of industries.

    - For both methods, the material consumption of each industry sector was further divided into amounts of material from each of the 13 material subcategories.
        - That required information on the proportion of materials consumed by each industry, something that does not currently exist in Australia (at least, it does not seem to be publicly available).
        - The *City Scan* tool has pre-set data for many cities across the globe. These figures include estimated data from global input-output tables as well as data they have obtained on cities for whom they provided services.
        - Material consumption data was taken from multiple cities and, for each industry sector, the consumption of a given material (e.g. wood) was divided by that industry sector's total across all materials in order to get coefficients for the proportions. In other words, if wood constituted 10

per cent of the material used in the retail sector in Bilbao, this was averaged that with figures for wood consumption in the retail sector in the other target cities.

- The coefficient for each material for each industry sector was tallied to get a single set of average coefficients. These coefficients were then applied to the Hunter and Central Coast LGAs. So, if the retail sector in Lake Macquarie had a given GVA and an estimated electricity usage, then how much wood that sector would consume via the two avenues could be calculated.
- The key assumption is that industries consume materials in similar proportions in the developed world, regardless of location, whether in Western Europe or in Australia. A good example of this consistency would be transport, which could be expected (and it does) to have a high consumption of liquid fossil fuels (i.e., petrol and diesel). A bad example would be manufacturing, as the materials used in manufacturing will vary significantly depending on what goods are being produced. A region with a strong defence sector is likely to see greater use of aluminium parts for airplanes than a region with a strong dairy industry.

Data <u>not</u> asked for by *City Scan*:

- Material waste/output – the *City Scan* tool has data in the databases for waste flows for certain cities, but, as yet, there is no way to input such data for the Hunter and Central Coast region.
    - That is unfortunate as there exists more waste data available for this region than consumption data. Much of that data is controlled the EPA, and they have cautioned that it is not to be made public. However, some good data are available from collaborating local governments, such as the City of Newcastle, Lake Macquarie City Council, and Central Coast Council. There is also a snapshot of this data acquired by the consultancy, Ricardo, for a material flow analysis completed for the Hunter Joint Organisation and NSW Sustainability Advantage.
    - The waste data includes an extensive array of output pathways (e.g. products being sold, waste staying in the LGA and waste leaving the LGA, recycled materials, material emitted into the environment, such as smoke particles, and material stockpiled in the environment, such as fly ash).
    - The ABS has input-output tables for national accounts of supplies and products, specifically to generate dollar figures for things like gross value added, gross regional product and gross domestic product as well as to assess trade flows: https://www.abs.gov.au/statistics/economy/national–accounts/australian–national–accounts–input–output–tables/latest–release
        - That can be seen as a 'dollar flow analysis' rather than a 'material flow analysis', where the latter would provide all inputs, estimations of how much material stays in one place for a given product lifetime (e.g. how long do you keep your mattress), and then waste, reuse or recycling tallies.

- General national estimates of materials being consumed, processed and then outputted as resources are available, such as this source: https://www.sankey–diagrams.com/tag/australia/ (a collection of Sankey diagrams regarding various aspects of Australia's material, energy, water and other flows). However, the material flow data are not available at a finer granularity than the national level.
    - These figures suggest that CSIRO or other government departments have been able to estimate with relative confidence how much plastic is produced nationally, how much gets landfilled, how much gets recycled, how much gets exported, etc. However, figures to give a 'mass balance' (input, existing stock, and waste flows) cannot be sourced at the LGA level. A portion of these figures exists in that estimates of the volume of plastic in waste streams does seem to be tallied.

- **Water consumption**
    - Water use is another metric that would seem to be easily tracked (every property hooked up to the water supply has a water meter)
    - A breakdown by industry of supply and consumption is available from ABS https://www.abs.gov.au/statistics/environment/environmental–management/water–account–australia/latest–release#data–download
    - However, water use in a given industry can vary by location depending on the weather and scarcity of water in the region. The level of water consumed by industrial and commercial users is available from water utilities, to the extent that it is not protected by commercial confidentiality clauses.

- **Energy consumption**
    - Data on energy consumption by locality and by industry sector are not widely available for public view.
    - Some distribution companies, like Ausgrid, put out yearly stats on electricity usage. These figures are broken down by the LGAs that they service and by what type of usage the consumption falls under (e.g. residential, small or large-scale commercial, traffic lights). Some utilities even publish electricity usage by postal code. It is assumed that electric utilities have a wealth of this data but it is not yet publicly available.
    - Industrial or commercial organisations would have their own consumption figures. Some larger organisations could be providing such data in annual reporting on sustainability. However, it is not clear the extent to which such figures are provided publicly on a site by site basis, rather than aggregated across the whole company.

- **Some measurement of circularity**
    - The Ellen MacArthur Foundation has been investing in development of a material circularity indicator (https://www.ellenmacarthurfoundation.org/resources/apply/material–circularity–indicator). More on this factor below
    - The European Union has committed funding to a half-dozen cities to develop the *CityLoops* reporting mechanism, with somewhat parallel aims.
- **Landfill rates**
    - Ties in with material output/waste data, but it is specifically the material going to landfill within a city or LGA's domain.
        - For example, waste that has historically been shipped to China would not be covered under this figure.
    - Landfill figures are available from each council as well as from the NSW Environmental Protection Agency. Confidentiality requirements, due to competition in the waste handling sector, provide some constraints on this data.
    - Figures for the Hunter and Central Coast region were assembled by Ricardo in a material flow analysis completed in 2019.
    - National figures on waste, recycling and landfill are reported annually in the Australian government's *National Waste Report*. Lead author of that report acknowledges gaps in the data available.
- **Scope 3 greenhouse gas emissions** (difficult to quantify and put into a tool)
    - Not sure if any indicators even exist to measure this figure beyond an individual material basis (e.g. Planet Price methodology).
        - Note that emissions are labelled as 'scope 3' not because they are necessarily a smaller part of emissions. Rather, they may be a larger part of emissions than scope 1 or scope 2 emissions but they are occurring elsewhere.
    - The World Economic Forum addressed scope 3 emissions in a recent report on what they characterise as supply chain emissions (World Economic Forum in collaboration with Boston Consulting Group 2021). *Net-Zero Challenge: The supply chain opportunity*, Insight Report, Geneva, Switzerland.

Data limitations

The *City Scan* approach requires various kinds of data, with less accuracy needed in early, more general assessment of priorities. More accuracy would be needed for later phases of the *City Scan* approach, where a business case for certain programs needs to be made. Greater accuracy is also needed to track progress or to compare this region with efforts in other regions.

Materials and emissions data in Australia currently seem to be estimated rather than measured. That draws into question how accurate the figures are for tracking their change from year to year, that is, the level of uncertainty seems to remain fairly high. As noted above, a concern along these lines was voiced by the lead author of the Australian government's *National Waste Report 2021*, when presenting to members of Waste Management and Resource Recovery, a waste industry peak body. The concern that he raised along with the challenges faced in this project suggest the level of accuracy in material consumption and waste management data could be better. That would contribute to decisions that can made with greater confidence.

As analysis here suggests, the spatial resolution in the data that is required to assess the progress in a given industry sector in a given region is not yet available. Even with such resolution, it is important to also track what else is happening in the locality in terms of population growth, economic stresses, geopolitical tensions and opportunities making certain materials expensive/cheap, available/unavailable.

This complexity would be familiar to specialists in economic modelling and forecasting. That sort of expertise is being brought to bear in assessing materials flows, but further progress is needed.

Appendix E: Do material inflows balance waste flows?

Overview

This appendix provides figures which suggest that the currently available data on how much 'circularity' there is in the economy of the Hunter and Central Coast region is insufficient.

Key challenges are differences in how materials are categorised by the industries that need them compared to the industries that handle the waste. More importantly, good figures on how much material is consumed by different industries are just not yet available. The figures are estimates, and the regional figures are scaled from national estimates.

Additionally, the calculations shown here do not account for material embodied in goods exported to other regions or overseas. However, the figures do suggest that the region would have to be exporting as products 80 per cent or more of the materials than it is consuming across most categories. That seems to be true for coal and may be true for certain metals used in manufacturing. But is that true for tyres, windows and mattresses?

An assessment of the volume of materials being exported requires detailed economic investigation of the sort that has been undertaken for certain national and international studies. Those studies tend to employ what is called 'environmentally enhanced input-output modelling'.

In addition to such modelling, there are issues with the estimates of the make-up of the waste stream. Though good figures are available on the tonnage of types of material in the waste in the region, the recent estimate in the material flow analysis for the region conducted by the engineering consultancy firm, Ricardo, classifies over the 40 per cent of the waste tonnage going to landfill as 'general/mixed waste'. So, a glass wine bottle with an aluminium cap that goes into the waste stream heading toward landfill (rather than recycling) has been counted as neither glass nor aluminium.

The paragraphs and table below illustrate the discrepancies and challenges with this data on use of materials and what percentage goes to landfill.

Categories of materials

The material flow analysis by Ricardo shows 'outflows' of material, categorised by material type. *City Scan*, in contrast, currently requires estimating just 'inflows' (domestic material consumption) for the region by material type. This section provides a comparison. One challenge is assuring that the two methods, those assessing inflows of materials and those assessing outflows, are assessing similar categories of material and are capturing the vast majority of the material of that type. That is, is nearly all of the aluminium entering the region captured, from the ingots being smelted at Kurri Kurri to the caps of wine bottles?

A still greater challenge is how rough the estimates are for domestic material consumption, the inflows. That is, each distributor or retailer knows what they sell, but it is not necessarily broken down by material type, and the information is not shared publicly or aggregated at the local government level or regional level. Additionally, material that is exported to other regions and other countries is not typically accounted for in a way that can readily be tracked publicly.

Different methods of categorising

The categories of waste employed by Ricardo are more numerous and somewhat different to the categories of materials used by *City Scan*. That can reflect a different focus, on waste flows rather than inflow/consumption, or differences between categories employed in Australia versus in Europe.

Categories of waste employed by Ricardo (in alphabetical order):

Asphalt Batteries Concrete E-waste Food General/mixed waste Glass Green waste Hard plastics Mattresses Metals - ferrous	Metals non-ferrous Miscellaneous wood Other Other organic Paper & card Plasterboard Soil, sand & rocks Soft plastics Textiles & carpets Tyres and rubber Waste oil

Categories for domestic material consumption* used *by* City Scan*:

Biomass Wood Crop residues Crops Animal products Metal & ores Non-ferrous metals Ferrous metals	Minerals & chemicals Construction dominant Industrial/agricultural dominant Fossil carriers Coal and solids Liquids and gases.

Note that this *City Scan* list of materials does not distinguish mattresses, plasterboard, textiles and carpets or tyres and waste rubber. These items can clearly be seen as significant in the waste stream, but they have not yet earned a separate listing among materials consumed, in part because they represent combinations of materials.

In the waste stream for the Hunter and Central Coast, the volume categorised general / mixed waste is nearly 400,000 tonnes, according to Ricardo's tally. That is nearly four times the tonnage of the next largest category, which is food waste at just over 100,000 tonnes per year, with green waste just behind at just over 90,000 tonnes per year. Paper and card are about 74,000 tonnes per year, and hard plastics are 67,000 tonnes per year. Then, there is a large gap to soil, sand and rocks going to landfill, at 41,000 tonnes per year. General / mixed waste constitutes about 42 per cent of the total waste tonnage going to landfill each year.

Waste management experts suggested, in the interviews, that the general / mixed waste category is audited every other year by local governments. That information can usefully be aggregated and potentially made public. That would enable assessing the waste stream as a resource at the regional level, which would help to spur local businesses and others to invest in recycling and reuse.

Household or Commercial/Industrial?

In terms of categorising materials, note that the *City Scan* figures do not include household material consumption, as such, given the *City Scan* focus on commercial and industrial sectors only. On the other hand, the Ricardo waste figures do include residential waste. Residential waste accounts for about 20% of total waste, according to the *National Waste Report 2020*.[110]

Residential consumption of materials tends to occur through businesses in the region. For this reason, a plumbing supply shop would be counted in the material consumption figures for the *City Scan* inputs, but the homes where their materials are ultimately used would not be included. That enables the *City Scan* to avoid double counting material volumes.

Tonnage in, tonnage out

Correspondence between Ricardo's 'outflow' list and *City Scan*'s 'inflow' list can be seen in the following table. The table also provides tonnage for each material type. That is, it shows how many tonnes in the Hunter and Central Coast region are estimated to be consumed across all ten local government areas and all ten industry sectors (*City Scan*'s 10 sectors rather than ANZSIC's 19 sectors) for each material type.

It shows the tonnage going to landfill, by material type, as assessed in the Ricardo material flow analysis. Not available at this time are specific tonnages for materials exported or materials that remain in the region. Figures for the percentage recycled are available and are reflected in the far right hand column.

Table D.1: Comparison of material consumption with material waste figures

City Scan material consumption categories	Ricardo waste material categories	Material consumption (ktonnes)	Waste to landfill (ktonnes)	Difference multiplier*
Biomass	Food Green waste Miscellaneous wood Paper & card Other organic Tyres & rubber	10,876	231	47x Agric waste tends to be recycled on farm, says Ricardo
Wood				
Crop residues				
Crops				
Animal products				
Metals & ores		5,639	19	72x If sector recycles 76% (see Nat Waste Report 2020)
Non-ferrous metals	Metal - non-ferrous			
Ferrous metals	Metals - ferrous			
Minerals & chemicals				
Construction dominant	Asphalt Concrete Plasterboard Soil, sand & rocks	11,095	104	21x If recycling rate is 80% (see Nat Waste Report 2020, p.xii)
Industrial/agricultural dominant	Batteries E-waste Glass Mattresses Textiles & carpets	914	47	19x

[110] Blue Environment Pty Ltd (2020). *National Waste Report 2020.* Australian Department of Agriculture, Water and the Environment, Canberra.

City Scan material consumption categories	Ricardo waste material categories	Material consumption (ktonnes)	Waste to landfill (ktonnes)	Difference multiplier*
Fossil carriers				
Coals and solids Utilities only	(Fly ash) (Greenhouse gases)	19,695	10,000 8,610	1.05
Liquids and gases Summed across sectors except utilities	Waste oil Hard plastics Soft plastics (Greenhouse gases)	8,998	15,780	0.57 Note that some emissions may be H_2O
General mixed waste	Mixture of the above	—	389	
Total consumption/ waste		57,217	70,360	

**The multiplier in the far right hand column represents the ratio of the tonnage of material consumed in the region divided by the amount going into the waste stream, to either recycling or to landfill, or being burned.*

Rates of recycling employed in the calculations for two of the cells in the far right hand column are from the Australian Bureau of Statistics (2020).[111] Here are their figures on the rate of recycling across a range of familiar materials:

Plastics = 9%
Organics = 42%
Masonry = 81% (*used in chart above for construction materials*)
Metals = 76% (*used in chart above for metals*)
Paper & cardboard = 65%
Plastics = 19%
Textiles, leather & rubber = 26%
Hazardous waste = 27%.

Tonnage of materials recycled in the Hunter and Central Coast region, specifically, would be available on a council by council basis. From that, what percentage is recycled, versus how much goes to landfill, from the waste flow can be estimated. However, these are just early attempts to gauge the size of the gap in data on material consumption and where those materials end up.

The table suggests that there is a significantly greater tonnage entering the region than going to waste for most materials. These materials either remain in the region being used, e.g. concrete in a bridge or metal in a TV set, or they are exported again in manufactured form.

If the export of manufactured goods is ignored, then the multiplier in the far right-hand column, in its simplest terms, should be approximately the number of years that something remains in use in the region. For example, a metal sink in a restaurant kitchen might last for 20 years, which would correspond to a multiplier of 20x.

The multipliers calculated here look to be significantly higher, in general, might be expected. That can be attributed to the material consumption figures being very rough estimates. Additionally, firm figures are non-existent for how much material resides in the region such as desks, concrete

[111] Australian Bureau of Statistics (2020). *Waste Account, Australia, Experimental Estimates: Waste generation, management and economic response by industry and household in alignment with System of Environmental–Economic Accounts (SEEA)*, Reference period 2018–19 financial year. https://www.abs.gov.au/statistics/environment/environmental–management/waste–account–australia–experimental–estimates/latest–release – accessed 1 August 2021.

blocks, windows, etc. Finally, manufactured exports, where materials entering the region or originating within the region are sent elsewhere, need to be taken into account.

Assessing how circular the use of materials is in the Hunter and Central Coast region requires more sophisticated modelling. That modelling will still just provide estimates. Making the estimates suitably accurate to enable setting priorities, and more importantly to track progress toward greater circularity, requires better sources of data. Those sources could include tapping into material use already tracked by individual companies in the region.

Appendix F: The *City Scan* output

F.1. OPPORTUNITIES RADAR

The *City Scan* web tool 'opportunities radar' provides an overview of which strategies might provide the best outcomes for circular economy. A radar diagram is generated for each of ten industry sectors. An example is shown in Figure 5.2 in the main text of this report.

Any one opportunities radar diagram further reflects which material or materials are the focus, among 10 categories of materials, which range from fossil fuels to construction materials to biomass. There are additional options as a new opportunities radar diagram can be generated depending on which of four 'impact areas' are of interest: reducing emissions, reducing material consumption, minimising waste or saving water. The website also enables selecting some combination of those four, such as emissions and water or material consumption and minimising waste.

These options are described in the subsections below, which explain how to interpret the opportunities radar diagrams generated.

Many options for industry, material, impact area

A set of 10 industry sectors, 10 categories of material inputs, and 4 types of environmental impacts creates substantially more than 10 x 10 x 4 = 400 different opportunity radar diagrams that could be generated. That is because the boxes can be ticked in a wide array of combinations.

The *City Scan* website enables a quick assessment of which choices of inputs can make a difference in terms of which strategies the opportunities radar highlights. This helps to inform whether to just focus on reducing greenhouse gas emissions through the choice of construction materials across a range of economic sectors or consider water use, or only sectors with a combination of high employment and high 'value added' for the region's economy.

Exploring the entire range of 400+ opportunities radar diagrams that can be generated is beyond the scope of this project. However, as a starting point, the analysis looks at each of *City Scan* 's 10 industry sectors to identify recommended circular economy strategies that are related to all 10 of their categories of materials and all 4 of their types of environmental impacts i.e. a broad view.

This broad view can be seen as appropriate when the *City Scan* output is considered. The circular economy strategies that are identified on the opportunities radar are listed under headings that are general principles. Those on the left-hand part of the opportunities radar's circular diagram are categorised as 'core circular strategies', and those on the right are labelled as 'enabling circular strategies'.

Circle Economy has identified a set of what they refer to as 'core' strategies. Core strategies fall in three general domains: (1) use waste as a resource; (2) stretch the lifetime; and (3) prioritise regenerative resources. There are also 'enabling' strategies under another five headings:(4) strengthen and advance knowledge; (5) rethink the business model; (6) design for the future; (7) incorporate digital technology; and (8) team up to create joint value. Under each of these headings are 2, 3, or 4 sub-headings, which results in 25 specific types of strategies. The City Scan tool arrays these 25 types in a radial pattern on the diagram.

The rating given to a strategy in a run of the analysis reflects *City Scan* 's scoring criteria, which are proprietary. It is assumed the model considers European experiences found through consultancy experience and research and an assessment of which strategies tend to, or could be conceived to, have the greatest impacts in energy use, recycling, and reduction in water and material use in various industries. Those criteria are used to assess the region's input data, resulting in each of the 25 strategies receiving a score out of 100. If that score is above 50, then the strategy is rated as 'recommended' and placed closer to the diagram's centre.

The Output

The *City Scan* tool produces results fairly quickly and provides 5-10 strategies on a 'bulls-eye' chart with scores of between 50 and 70. The other 15-20 circular economy strategies that received lower ratings are also shown.

The definition of each strategy recommended on the opportunities radar is provided by clicking on the 'opportunity' on the diagram. A window opens that also contains a list of recycling organisations in the Hunter and Central Coast region. A set of more than 50 'case studies', documented by the Hunter Joint Organisation, were uploaded to the *City Scan* website. There are more such case examples of organisations engaged in various ways in the circular economy or the region, but they have not yet been documented in a central place. Increasing the number of case examples has been highlighted in the 'data gaps' section of this report.

F.2. THE NEED FOR MORE RELEVANT CASE STUDIES

There is a data gap since not enough case examples of 'circular' businesses in the Hunter and Central Coast region have been documented to provide sensible referrals in all cases. For example, the Salvation Army are listed by the *City Scan* tool as a recycling organisation that might help the mining and power generation industries to recycle their steel and other materials.

A set of 3,000 enterprises and programs around the world have previously been entered in the *City Scan* database. A subset of 10 of these international examples is offered for each strategy recommended by the website's algorithms.

These international examples, at present, are sometimes helpful and sometimes lacking in relevance. For instance, recycling measures undertaken by water utilities and for food waste were listed among the 10 on offer as being of relevance to the mining and power generation sector.

Circle Economy have acknowledged that they have not, as yet, developed a way to rank the relevance to a given region of these international case examples. Rather, the international examples just seem to be categorised, in this instance, as relevant to 'recycling within an industry sector', in a general sense. So, that is without much regard to which industry sector. On this basis, the international examples can be seen as a source of inspiration rather than necessarily as a specific target to replicate.

Appendix G: Stakeholder engagement

Interviews were conducted to assess how credible the data gathered for the *City Scan* is, to gain insight into how to gather more detailed or more credible data, and to ascertain interest in the circular economy.

Interviews ranged in length from a half hour to more than an hour. The most senior persons interviewed were a board chairperson and two chief executive officers. A number of those interviewed were technical staff in areas related to sustainability. Additional input was provided by email.

Some questions and comments were also received in response to four brief presentations of data collected for the *City Scan*. Audiences included the 120 people across 79 organisations attending the circular economy 'think tank' on 10 May 2021 as part of the Hunter Innovation Festival, the circular economy subcommittee of the Hunter Joint Organisation, a circular economy committee in state government addressing the built environment, and the Hunter and Central Coast circular economy facilitators group.

More input was gained from the interviews and emailed questions than in feedback from group meetings or the event. These responses were from people in organisations involved in manufacturing, logistics, the utility sector, consultancy, local government and research.

The responses provided are neither representative of the range of industry and government organisations in the region, nor are they comprehensive. However, they do suggest a wide range of concerns related to providing data to guide growth, or fuel growth, of the region's circular economy.

Interviews were conducted with one or more executives or staff with each of the following organisations:

- Advitech
- Ampcontrol
- CSIRO
- Dantia
- Hunter Water
- Kumalie Group
- Lake Macquarie City Council
- Net Modular
- Orica
- Port of Newcastle
- Quarry Mining.

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