Implementing the Circular Economy in Regional South Australia: Identifying Targets and Developing Partnerships

# Acknowledgements

# Acknowledgement of Country

The researchers wish to acknowledge that this work spans country traditionally owned by the Kaurna people, the Ngarrindjeri and Booandik people, and the Erawirung (Yirawirung, Jirawirung) people, also known as Yirau, Juju and other names. We recognise this land was stolen from them and that sovereignty has never been ceded.

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This report has been prepared by a cross-disciplinary research team of 7 researchers from STEM, Business and Creative academic units at the University of South Australia supported by 5 advisory team members.

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# Funding and sponsorship

This report was funded through financial contributions made by UniSA and Green Industries SA and in-kind sponsorship from The Legatus Group and Good Design Australia.

ISBN 978-1-922046-35-2









# Preface

The circular economy can be understood as a series of linked pathways to a less resource intensive world. It spans everything from service-based consumption to different ways of extending product lifespans in use, encouraging reuse and repair, remanufacturing and recycling. The circular economy is both technological and social in its scope, including, for instance, using digital systems to measure, monitor, repair, recycle and reform products and materials at their end of life, and all the social and economic changes required for these ends.

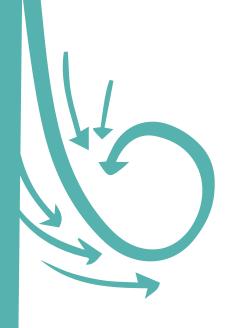
The circular economy's main goal is thus to shift us from a 'make, use and trash' linear economy of vast material throughputs to one of increasing material 'circularity', where slower and more 'circular' material flows replace the 'linear' flows of the present. This greater circularity can also help regenerate and replenish the natural environment and its diminishing resources. It is thus a secret weapon against climate change, but one which focussing our attention on the 70% of emissions now linked to our materials use.

This report is the outcome of an interdisciplinary research project aiming to better understand and map out the potential journey regional South Australia can take towards greater circularity. In this report, we have tried to take a snapshot of what is already being undertaken in the circular economy space in regional South Australia, and to focus on what more could be done to further its progress. It should be noted here that our research project was modified in response to COVID-19. We replaced face-to-face focus groups, for instance, with interviews by zoom, a method we also used for communication and analysis. We also had to abandon plans for workshops and public meetings at regional centres. Nevertheless, we are confident that the original aims of this project have been met.

The researchers would like to acknowledge that the project was generously funded by Green Industries SA in partnership with UniSA, and supported inkind by the Legatus Group and Good Design Australia. We would like to thank these organisations for their support, patient assistance, and also the 22 expert participants we interviewed as part of this project.







This report is the outcome of a research project led by a team from the University of South Australia, funded by Green Industries SA, with in-kind support from the Legatus Group and Good Design Australia. A preliminary scoping exercise, the project was conducted in three phases between mid 2020 and mid 2021: a literature review on global progress towards the circular economy with a particular focus on regional implementation cases, a data collection stage involving 22 interviews with local practitioners contributing to this field, and an analysis phase, where emergent themes from both the literature and interviews were examined and mapped, conclusions drawn, and recommendations made.

From the literature reviewed, it became clear that the circular economy embodies a wide range of 'resource value retention' strategies, beyond recycling and more efficient waste management. More broadly, the literature tried to identify the circular economy's major barriers and enablers, the characteristics and needs of 'circular' business models able to implement it, the links between

these and supporting design strategies, and the various technologies and data available to further its goals, along with the policy changes required. While there was some interest in case studies of firms, cities and regions engaging in the circular economy, there were noticeable gaps in this literature, especially in the area of communication and education, in modifying consumer behaviour to successful adapt to the circular economy, and in issues associated with its implementation in regional settings.

the circular economy is an 'umbrella concept,' embodying a wide range of 'resource value retention' strategies to reduce the environmental and social impacts of the current 'linear economy'

The findings derived from our interviews complimented this literature, but provided a more detailed South Australian perspective, elucidating what seems to be lacking and what still needs to be accomplished. Twelve themes dominated these interviews, including the importance of circular business models and interfirm collaboration, of the advantages of material flow perspectives, the deployment of enabling technologies, the important role of design, education and communication in advancing the circular economy, the negative impact of logistics and locality on its implementation, and the importance of effective leadership, along with considerable discussion of the significant barrier of consumer attitudes and behaviour.

Analysing these findings, the concluding section of the report makes a series of interdependent recommendations summarised here:

# Short Term (1-2 years)

- Establish Regional Circular Economy Coordinators to implement the report's recommendations.
- Align regional waste management strategies with the goals of the circular economy
- Measure regional resource flows and map these to the circular capabilities of all economic actors
- Develop a toolkit to make the resulting capabilities transparent and accessible
- Incentivise the local processing and reuse of wastes, especially of organics
- Establish circular economy education programs for schools, industries, businesses and communities
- Encourage circular material use through procurement policy changes

# Medium Term (1-3 years)

- Establish circular economy hubs in major regional centres
- Encourage businesses and other organisations to co-locate to these hubs
- Create and implement circular communication and education packages based in these hubs
- Embed regenerative agricultural and conservation solutions into the regional circular economy
- Adapt GISA's 'global leadership program' to build leadership capacity in the regions
- Develop circular economy content for professional university programs

# Longer Term (1-5 years)

- Develop a digital and technology circular economy strategy to build capacity and measure progress towards the circular economy.
- Build a circular economy marketing and branding strategy to engage consumers and businesses.
- Establish a design incubator program to support circular business and technology innovation
- Develop a circular economy policy and funding strategy to incentivise adoption of the circular economy
- Expand the proposed 'Centre of Excellence' to encourage design, research and innovation in support of the above.



# The origins of the Circular Economy

The origin of the concept of the circular economy is often traced back to the idea of a 'Spaceship Earth,' in the 1960s a striking metaphor for a world of limited resources requiring more careful conservation and management. This was popularised by the inventor Buckminster Fuller (1963) and the economists Kenneth Boulding (1966) and Barbara Ward (1966) at a time when the Cold War 'space race' was frequently in the news (Crocker 2018a; and see Meadows et al. 1972). The new fields of Industrial Ecology and Ecological Economics, growing out of this earlier concern with resource overconsumption and pollution, were the first to use the term 'circular economy' in academic discourse. This approach was defined in deliberate opposition to the dominant 'linear economy' of 'make, use and waste' (Pearce & Turner 1989; Frosch & Gallopoulos 1989).

Another important pioneer in the development of the circular economy concept was the architect and economist, Walter Stahel, whose early work with Genevieve Reday-Mulvey (1976, 1981) for the European Commission drew attention to the potential social and economic benefits to be gained from economic activities that encouraged extended product use, repair, material reuse and recycling. This represented a policy breakthrough since it highlighted real social and economic benefits to be derived from implementing various strategies of 'resource value retention' (Reike et al. 2018), at a time of considerable economic problems in Europe. Stahel was also the first to use the popular phrase, 'cradle to cradle', which summarises the circular economy's emphasis on maintaining the utility and value of materials and products for as long as possible, and reusing them after their end of life (Stahel 2016). This term was later taken up and popularised by McDonough and Braungart in their book of the same name (2002).



# Recent Policy Initiatives and Scholarship

More recent scholarly interest in the circular economy, much of it appearing since 2010, has been inspired by China's move towards environmental reform, and ambition to build 'an ecological civilization'. A central component of this has been the adoption of the circular economy, often described in China as the '3R model' (Winans et al. 2017; McDowall et al. 2017). This has led to the circular economy becoming a 'national priority' in 2007 (Yuan 2006; Zhijun & Nailing 2007; Zhao 2018), with a dedicated regulatory framework developed over the following two years (Yu et al. 2015; Zeng et al. 2017). This Chinese 'top-down' approach has focused to a great extent on macro- and mesolevel inter-firm collaborative initiatives, what is sometimes called 'industrial symbiosis'. This is where one producer's wastes might be utilised by a neighbouring firm, often at a local or regional scale. This development was supported by increasingly tighter environmental regulation and legislative encouragement towards the use of recycled materials in industrial production. The European Union's (EU) move towards the circular economy during the same period was driven by similar environmental concerns, with its member states struggling to manage a growing waste crisis, as well as meeting their obligations under increasingly stringent Climate Change agreements (McDowall et al. 2017). While their response has been more 'bottom up' than China's, it is significant that both are struggling to manage similar crises, of waste, resource depletion, environmental degradation and climbing GHG emissions, all linked to the dominant 'growth' or 'linear' economy model.

Over the last decade the British circular economy charity, the Ellen Macarthur Foundation, has made an especially significant contribution to the development of a global discourse around the circular economy in the business community. Its landmark McKinsey-authored report, Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition (EMF 2013a & 2013b; Webster 2013), revived Stahel and Reday-Mulvey's early ideas, and drew attention to the social and economic benefits likely to flow from a circular economy. This was followed by a report from the British charity, WRAP, Employment and the circular economy: job creation in a more resource efficient Britain (2015), which again emphasised the circular economy's potential economic and social benefits at a national level. This led the Ellen Macarthur Foundation, along with the World Economic Forum, UNEP and some of the world's leading corporations, to develop a Platform for Accelerating the Circular Economy (PACE 2018). These interventions managed to reframe a growing global environmental crisis into a sustainable business opportunity. In Australia, most recently, a Price Waterhouse Coopers (PwC) report, claims that going circular in this country will add \$1.9 trillion in economic benefits over the next 20 years (PwC 2021).

However, despite these advances, as the most recent Circularity Gap report (2021) makes clear, very little substantial progress on implementing the circular economy at a global scale has been made. In other words, while many governments have committed to developing a circular economy within their own jurisdictions, and there are now an increasing number of research-based discussions on various aspects of the circular economy, implementation in practice has progressed slowly, remaining largely experimental in scope and insufficient in scale, with the majority of businesses still committed to the dominant 'make, use and trash' linear economy of the past seventy years. As the Circularity Gap report (2021) shows, around 70% of emissions now derive from materials handling and use, much of this for consumption. As the report argues, even doubling the global circularity average of 8.6% to 17% could close the emissions gap by 2035, a gain far in excess of that projected to occur by the implementation of the Paris Agreement. Clearly, the circular economy is worth implementing.

# Approach

The research project whose outcomes are reported here was an interdisciplinary, qualitative scoping exercise, conducted by an interdisciplinary team of researchers from the University of South Australia. Its aim was to seek to define and map the most effective strategies available to engage regional communities and businesses in the development and implementation of a circular economy in regional SA. This involved an investigative process outlined below to identify 'partners, stages and targets' for this process, in the context of regional South Australia. Being limited to one year in time, with a limited budget, and somewhat delayed and reshaped by the COVID emergency in its methods, the project resulted in a deepening appreciation of the regions' capacity to grow a circular economy in South Australia and to develop strategies to harvest its many potential benefits.

# Research method

Beginning with a review of the circular economy literature and of local and national case studies, this report also presents findings from 22 semi-structured interviews conducted with representatives from government, industry and broader community networks (see Table 1). These were selected on the basis of the continuing and effective engagement in circular economy initiatives, and their voices became important contributors to the project's understand of the circular economy from a South Australian and regional perspective.

Code	Interviewee	Sector	Organisation
IP01	Industry Participant 1	Resource recovery	Peats Soil
IP02	Industry Participant 2	Manufacturing	BioBag World Australia
IP03	Industry Participant 3	Resource Recovery	Rawtec
IP04	Industry Participant 4	Resource Recovery	Veolia
IP05	Industry Participant 5	Resource Recovery	Veolia
IP06	Industry Participant 6	Manufacturing	APR - Advanced Plastic Recycling
IP07	Industry Participant 7	Food & Beverage/Entrepreneur	Watervale Hotel
IP08	Industry Participant 8	Retail	Echunga Hair & Beauty
AP01	Agency Participant 1	State Government	GISA
AP02	Agency Participant 2	State Government	GISA
AP03	Agency Participant 3	State Government	GISA
AP04	Agency Participant 4	Local Government	RDA Yorke and Mid North
AP05	Agency Participant 5	Local Government	RDA Murraylands & Riverland
AP06	Agency Participant 6	Local Government	Limestone Coast LGA
AP07	Agency Participant 7	Local Government	Legatus Group
AP08	Agency Participant 8	Local Government	Legatus Group
NP01	Network Participant 1	Design	Australian Design Council
NP02	Network Participant 2	Academia	UNSW, SMaRT Centre
NP03	Network Participant 3	Design	Good Design Australia
NP04	Network Participant 4	Resource Recovery and Design	E-Waste Watch and DIA
NP05	Network Participant 5	Repair	Clare Repair Café
NP06	Network Participant 6	Food & Beverage	Clare Valley Wine & Grape Association

Table 1: Interview Participants

# Participant recruitment

Participants were recruited based on their lived experience and high-level expertise in different aspects of the circular economy and they participated in the research on a voluntary basis. The findings from these interviews provided cross-sectoral insights into the most effective strategies for the regional implementation of the circular economy, with their knowledge and experience spanning different domains and multiple perspectives.

#### Data collection

Interview data was collected through 1-2 hour semi-structured interviews with participants, and these were guided by an ethics protocol approved by the UniSA Human Research Ethics Committee. All collected interview data was then stored in a secure digital environment with full encryption and password protection. Where permissible, participants' names have been included in this report, mostly as pull out quotes.

## Data Analysis

Data analysis was conducted collaboratively by the researchers through digitally facilitated workshops, using Zoom for video conferencing and Miro as a shared digital 'whiteboard' space. Collected data was loaded into Miro and data analysis was conducted through three co-research half day workshops where researchers worked collaboratively to map and analyse the data deriving from the interviews (see Figure 1).

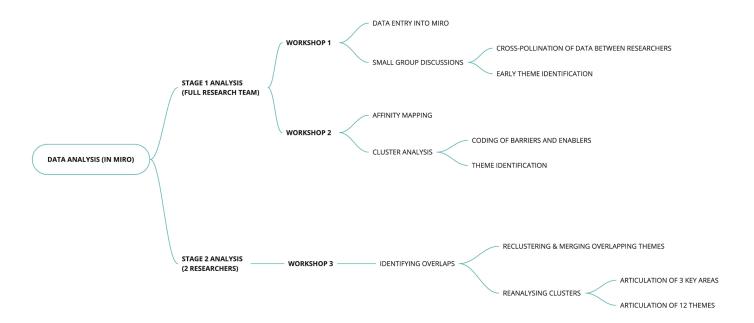
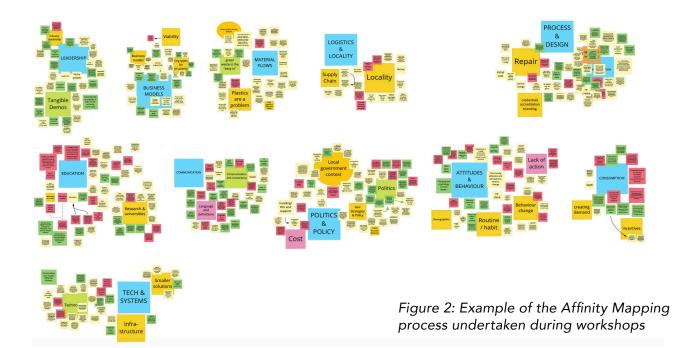


Figure 1: Data Analysis

Collected data was de-identified prior to analysis and was colour coded during the visual mapping process. Affinity mapping and cluster analysis processes (see Figure 2) were used to identify three main areas or domains of interest or concern amongst the participants—the technical, the 'bridging', and the social. Four key themes define each area of these themes, and in turn they form the structure of the Findings section in this report (see Figure 3). The Discussion section which follows this summary analysis of the interview data presents a synthesis of the literature review, case studies review and interview-based data analysis.



The aim of this process was to distil the voices, knowledge and experience of these most engaged individuals into some accessible but critical themes that could then be used to help develop a set of recommendations going forward. These capture the most effective strategies identified here to to develop partnerships, targets, and pragmatic stages to enable the implementation of the circular economy in regional South Australia.

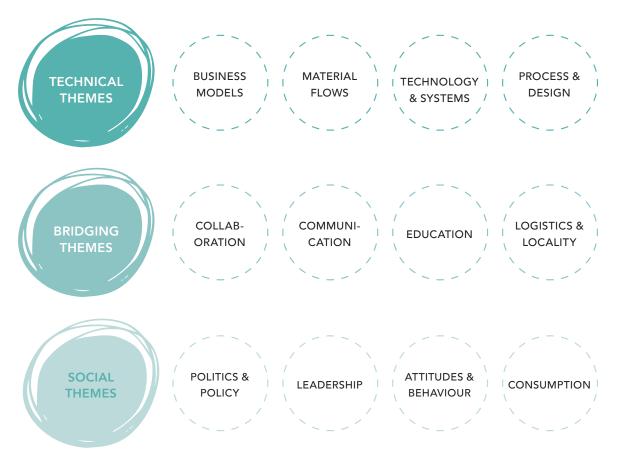


Figure 3: The 3 domains and their themes



The literature reviewed here surveys a growing body of research, most of it produced since 2015, on the circular economy. Every week numerous journal articles are produced, some based on the most recent research, with literally hundreds produced each year. While this literature review was unable to include some of this very recent material, it covers most of the most significant publications identified between 2015 and 2020.

In this literature, a number of key themes were identified which seem particularly relevant to the aims of this report, including

- The way the circular economy concept is now understood and defined;
- The circular economy's impact on policy development and economic strategy;
- The barriers that have been identified to its realisation;
- The challenge of developing more circular business models (CBM) and supply chains;
- The challenge of developing circular product design and product service systems;
- The challenge of aligning consumer behaviour within a circular economy as it develops; and
- The role of technological innovation in supporting the development of a circular economy.

Having listed these important topics it seems germane to point out that this literature, vast as it now is, was noticeably thin on certain important topics, and this relative absence is discussed further in the Preface, Discussion and Conclusion. For instance, there were relatively few articles available that discussed the economic policy changes that will be required to implement the circular economy on a national scale, this subject being picked up, as it were, in various EU and consultant reports, most recently the PwC (2021) report which has only just been released and is not included in this review. There was also a surprising dearth of literature, noted below, on education – at all levels – to progress the circular economy. Similarly, there was very few publications on ways to transform consumption to align this with the goals of the circular economy, for example ensuring advertising, marketing, and related policies do not directly conflict with the goals of the circular economy as they appear to do at the moment. Amongst other topics noticeable by their absence was the critical issue of toxics, and how to deal effectively with toxic materials and chemicals from a circular economy perspective. It appears these important topics are increasingly on the agenda in the European Union following their landmark circular economy 'package' (EU 2020) and in China also. However, we were unable to reference these since there were so few available articles at the time of composing this review (mostly in the second half of 2020).

After an initial, more global overview on the topics listed above, this literature review turns to state and regional reports and case studies (mainly from recent European publications and websites), before examining Australia's initiatives to date, with a particular focus on South Australia's pioneering role in this domain.



# Literature review

# 1. The Concept and its Development

The Chinese 'Circular Economy promotion law' of 2009 (Zhao 2018) and the EU's 'circular economy package' of 2015 (EU 2015), were both key milestones in the development of the circular economy and its take-up by governments and corporations. In one recent estimate (Homrich et al. 2019), around 80% of all peer-reviewed academic studies on various aspects of the circular economy published since 1950 have been produced since 2015, with a majority of these originating in China. Many of these Chinese studies focus on meso-level industrial symbiosis and eco-industrial parks, innovations based on adapting the model provided by Denmark's pioneering Kalundborg eco-industrial park (Ehrenfeld & Gertler 1997).

This eco-industrial park model has enabled a localised circular reuse of resources on site, a development fundamental to the goals of both industrial ecology and the circular economy (Zeng et al. 2017). In this 'industrial symbiosis' approach, businesses are encouraged to co-locate and cooperate, to create partnerships across particular domains within an area or region to reuse, where possible, waste products or energy from their neighbouring businesses as feedstock for their own production (Zeng et al. 2017). An important pioneer of this symbiotic model of the circular economy was the US chemist, Paul Palmer (now president of the Zero Waste Institute), who developed the closely related concept of 'zero waste' in the 1970s, based upon the recycling of chemicals in California, an important avenue for increasing circularity in the economy that has been largely overlooked in the current circular economy literature (Palmer 2005).

Since its adoption as policy 'packages' in both China and the EU, the concept of the circular economy has undergone considerable scrutiny by researchers, with a number of systematic literature reviews being published, with Homrich et al. (2019) amongst the most comprehensive. Since most of these reviews have been conceived from an engineering perspective, they differ mainly over the degree, feasibility, extent and management of the 'resource value retention options' investigated (Reike et al. 2018). This leads them to downplay the circular economy's social and environmental dimensions that nevertheless informed the concept's original development. This becomes relevant when examining the implementation process adopted by the EU, where the social and economic impacts of circular policies and business models have taken on increasing importance, in part in response to the problems faced by many 'post-industrial' societies within the global economy (Dodick & Kauffman 2020).

As Homrich et al. (2019) explain, many earlier studies' backgrounds in waste management, resource conservation and industrial ecology led their authors to ignore the circular economy's legislative, institutional and social dimensions, even though these have remained central to the EU's approach (Dodick et al. 2020; Schroder 2020), and also that of China (Zeng et al. 2019). This perspective is confirmed by Geissdoerfer et al. (2017), who point out that the circular economy's recent embrace by waste management

and environmental engineering has led to a relative neglect of its social and economic dimensions, and also their significant links to the Sustainable Development Goals, and not only to SDG 12 ('responsible consumption and production') (Amsterdam 2020). A good example of this is the challenge to the environment and to global development presented by 'fast fashion' (Goldsworthy 2017) that is growing at 4% a year and now accounting for over 3% of the world's GHG emissions; better recycling alone cannot 'fix' this problem. Here, the solution necessarily depends on legislation, circular design, and circular business models (CBM), many of which already exist, even if at the moment only amongst niche players (Khusainova 2018). In this case, as in the case of plastic pollution, 'slowing' the loop is more critical than only 'closing' it, which in itself would be insufficient to limit the environmental damage this sector is causing.

As this example suggests, one problem in defining the circular economy is scale – many 'fast' industries operate at a massive scale, with rapid product development, manufacture and distribution, and low margins per unit sold, and this presents a challenge to anyone trying to define the circular economy in a 'cross-scale' manner. In their review of the circular economy as an emerging field of scholarship, Merli et al. (2018) try to solve this problem by dividing the literature on the circular economy into three 'scales': macro-level studies of the social and economic dynamics required to implement the circular economy, micro-level case studies of firms attempting to implement circular reforms in their own organisations, and meso-level studies on industrial symbiosis, supply chains and the relationship between firms in a particular city or region. As in the case of fast fashion, most present studies fit within the last two categories (Henninger et al. 2017).

Merli et al. (2018) also draw attention to attempts to conceptualise and simplify the circular economy through frameworks such as the 'Resolve framework' developed by the Ellen Macarthur Foundation ('Regenerate, Share, Optimize, Loops, Virtualise and Exchange' - EMF 2015). Rizos et al. (2018), Homrich et al. (2018), and Merli et al. (2018), all emphasise the present lack of an agreed universal definition of the 'circular economy', apart from it being an attractive resource-based 'pathway' to sustainable development (Geissdoerfer et al. 2017; CGRI 2020; Gregson et al. 2015). Its broad aim, 'to close, narrow or slow' 'material flows' and reduce energy needs, and to transform today's 'linear' economy, unites what are often quite diverse definitions of the circular economy as a broadly pragmatic pathway to greater resource efficiency and conservation, an 'umbrella' concept (Rizos et al. 2018; Reike et al. 2018).

An imprecision in defining the circular economy is also emphasised in the few studies critical of the circular economy's 'loop' model of 'green growth'. Korhonen et al. (2018), for example, draw attention to six observed 'limitations' to the circular economy concept that need to be addressed before true 'circularity' can be attempted, and a more useful definition developed. These include:

- 'Thermodynamic' limits, especially the need for additional energy and materials to produce goods from recycled materials;
- System boundary limits, of the kind suggested by cases like that of 'fast fashion';
- Limits posed by scale and rebound effects, where the economic activity generated by circular economy businesses can outweigh the environmental gains made by greater resource efficiencies (Franco 2019, Zink & Geyer 2017);
- Limits posed by various forms of path-dependency and 'lock-in' (as in fast fashion);
- Limits posed by existing, often complex, linear supply chains (as in fast fashion), and
- Limits posed by social and cultural norms, for example, where experiencing the 'new' is central to today's consumer culture (see Crocker 2018b).

Looking beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits.

Another serious limit is the lack of depth and accuracy in much of the waste data available to policymakers and practitioners, with many potentially reusable wastes 'blended' with others at discard, or largely unrecyclable because of their composition, as with many plastics and hybrid packaging materials (Offenhuber 2017; Esbensen & Velis 2016).

These are all significant limitations, and these are noted below, and in the discussion that follows this review.

Despite these somewhat inevitable limitations in a concept now expected to carry so much weight, the Ellen Macarthur's definition of the circular economy is the most widely used in business and governments across the world (EMF 2020). More recently, it has been taken up in Australia, its '3 principles' adopted by the federal government funded 'Australian Circular Economy Hub' (Acircular economy 2020). This is therefore used as a working definition in what follows (EMF 2020):

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

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems

# 2. Policy and Regulatory Change

Outside China, the EU is now a world-leader in its implementation of the circular economy. However, out of all nations, only the Netherlands has achieved a substantial degree of circularity, at around 25% (see Amsterdam 2020), with most other member states sitting closer to the rather dismal global average of about 8-9 % (CG report 2021), a failure that runs in close parallel to the global failure to implement the SDGs (Sustainable Development Goals – see CGRI 2020). This failure has massive consequences, as the recent Circularity Gap report makes clear (CGRI 2020). The material flows of the linear economy (100 billion tonnes per annum) are now responsible for up to 70% of global emissions. Slowing and reducing these material flows through implementing the circular economy, even by doubling the very weak global average of 'circularity' (8-9%), according to this report could do more for reducing global emissions than the changes promised under the Paris Agreement (CGRI 2021).

The way circular economy policy is developed in Europe within different states and then applied across regions following policy and funding leadership from the EU's central government, provides a useful laboratory for observing the development of, and attempts to implement, relevant circular economy policy and legislation, and especially in smaller nations. This seems especially relevant to Australia, where state-based resource governance and policy arrangements tend to loosely follow federal leadership. Similar to this arrangement, in the EU the circular economy is expressed and implemented through regional policies that are aligned through a central EU 'Cohesion'

Policy' (Silvestri et al. 2020), an interesting parallel to the relations between state and federal governments in Australia. This has become particularly relevant following the ban on Australia exporting many classes of wastes to China following the China Sword initiative (Levitzke 2020). For this reason, we give the EU, and reported cases from EU nations, a preeminent role in this review.

The EU's landmark embrace of the circular economy formally commenced in 2015, with its publication Closing the loop, which covered production, consumption, secondary raw materials, innovation and investment, and monitoring (EU 2015). The EU's 2020 follow up, the Circular Economy Action Plan took this goal much further into the pragmatics of a series of pathways towards greater circularity (Dodick & Kauffman 2020). This focussed on improving product durability, reusability, upgradability and reparability, addressing the presence of hazardous chemicals in products, and ensuring their greater energy and resource efficiency (Dodick & Kauffman 2020). Among the existing rules mentioned in the EU's increasingly comprehensive plan were the Product Environmental Footprint (COM/2013/0196 final), the Ecodesign Directive, the EU Ecolabel which identifies products with a reduced environmental impact, the EU Cohesion Policy noted above, the Bioeconomy Action Plan; the EU Environmental Technology Verification scheme as an EU certification mark, and the new Directive on Single Use Plastic Products and fishing gear, which addresses the problem of plastic pollution, the development of a Recycled in the EU label, created to prevent the shipment of waste overseas and illegal recycling, and a Green Public Procurement (GPP) plan, which included provision for life cycle assessment in public procurement, and its integration within the EU's sustainable finance framework (EU circular economy Plan 2020). It should also be noted that the EU has long engaged in policies and legislation aiming to curb the irresponsible disposal of e-wastes (EU WEEE 2020). While the technical discussion of these topics continues within the EU policy making apparatus, and also in a specialised literature, as yet much of this has not been explicitly aligned to the goals of the circular economy, as we noted in the introduction to this literature review above.

However, what has been taken up by both within the EU and by researchers interested in the development of the circular economy in Europe is the urgent need to foster circular business model (CBM) creation, generate associated employment, encourage circular economy-led entrepreneurship among SMEs, and more sustainable, 'circular', and transparent, supply chains. In Europe this movement for business change is being led by training and advice under the flag of the Enterprise Europe Network, and knowledge transfer through the European Resource Efficiency Knowledge Centre (Rizos et al. 2019). Circular start-ups, business models and supply chains are central to Europe's developing circular economy initiative, and this to a great extent echoes China's experience, although there 'institutional pressures' from above have tended to push some firms into eco-industrial parks, and towards adopting the principles of sustainable supply chain management (Zeng et al. 2017; Zhao 2018). To encourage investment in these initiatives the EU has developed a Circular Economy Finance Support Platform, with InvestEU now committed to prioritising the circular economy, while the European Institute of Innovation and Technology together with an Intellectual Property Strategy are expected to assist in growing the circular economy within Europe (Invest EU 2020).

Economic instruments are also being enacted, such as pro-environmental taxation, including increased landfill levies and incineration taxes (EU circular economy Plan 2020). The EU has also encouraged member states to use value added tax (VAT) rates to promote circular economy activities that target consumption, even if only weakly so. This is not really reflected in the literature and is a somewhat neglected theme in what appears to be an increasingly vast academic industry. One interesting initiative, noted by some social scientists (Coooper & Salvia 2018), is an attempt to revive repair services. These have declined precipitously over the last three decades, in response to a trend of

lower product prices and the design of increasingly evident technical barriers to repair and product longevity, for instance in 'sealing' in the parts of many electronic products and ensuring that only the manufacturer can gain access (Cooper & Salvia 2018; Rivera & Lallmahomed 2016). The 'right to repair' is an increasingly significant issue in this domain, and incentives (and some disincentives) are being introduced in the EU to differentiate the financial contribution paid by producers under extended producer responsibility schemes on the basis of the end-of-life costs of their products.

## 3. Barriers to Implementing the Circular Economy

Evident from both the European and Chinese experience (as well as that of Japan and South Korea) is the significance of existing barriers to the circular economy's implementation, and these have been widely discussed in the literature to date (Lahane et al. 2020; Govindan & Hasanagic, 2018; Ranta et al. 2018; Tura et al. 2019; Vermunt et al. 2019). Unsustainable 'linear' business models, some of these long adopted by the world's largest companies, complex, lengthy, opaque and ethically sub-optimal supply chains (Tura et al. 2019), and a range of internal and external factors preventing a company's adoption of circular practices, are all discussed in this literature (Govindan & Hasanagic 2018; Vence & Periera 2019). In one of the most detailed analyses of barriers to implementing the circular economy, Govindan & Hasanagic (2018) identify 39 separate barriers, usefully classifying them under several headings, including:

- Governance and policy, with many governments failing to legislate to support more sustainable supply chains;
- Organisational and supply issues, including an absence of product design to support repair, refurbishment or recycling, and a lack of skill to realise this;
- A general ignorance amongst consumers of the benefits of a circular economy, even in pilot cities like Tianjin in China which have prioritised the circular economy's implementation;
- From a consumer perspective, the still often negative view of refurbished products, a barrier noted by many researchers.

Indeed, in this review (2018), 'consumer perception towards remanufactured products' was the most significant barrier identified (n=7), followed by a 'lack of public awareness of the circular economy,' and 'technology limitations by the enterprises to make products that can be easily remanufactured'. These suggest the central importance of consumer engagement, and its absence in recent attempts to implement the circular economy, along with the critical role of enabling technologies. Govindan & Hasanagic (2018) emphasise in their review that government policy changes could have a positive impact on implementing the circular economy by promoting supportive laws, policies, risk reduction strategies (e.g. tax levies) and stricter governance including monitoring. All these points are also targeted in the EU's circular economy package referred to above (EU circular economy Plan 2020).

From a Chinese perspective, a related study by Zhang et al. (2019) investigated barriers to the implementation of smart or 'circular' waste management systems. While narrower in its scope, the 12 barriers identified in this study echo Govindan's and Hasanagic's findings. These include:

- 1. A lack of knowledge of smart waste management;
- 2. A lack of consistent regulatory pressure;
- 3. A lack of innovation capacity;
- 4. Difficulties with existing technologies and their applications;
- 5. A lack of market pressure and demand;

- 6. Cost and financial challenges;
- A lack of environmental education and a culture of environmental protection;
- A lack of stakeholder cooperation, including service provider co-operation;
- The pursuit of short-term profitability instead of long-term sustainability;
- 10. A lack of cluster effects:
- 11. A lack of leadership commitment; and
- 12. A lack of effective standards in waste management.

This last echoes Esbensen and Velis (2016) study, which also identified significant gaps in data in the waste management and resource sector.

These barriers are consistent with barriers identified by others, including Ritzen & Sandstrom (2017), and Vermunt et al. (2019) in two other overviews of the barriers confronting the implementation of the circular economy. The linear economy encourages the use of 'planned obsolescence' and the upgrading of less efficient to more efficient products, and this necessarily obscures what is of continuing utility and value within existing waste streams (Rivera & Lallmahomed 2016). This reliance on obsolescence in many existing business models will need to be 'reversed' in a circular economy, a point emphasised by Bocken et al. (2014) and also by Bakker et al. (2014) in their textbook on product design for 'circular' business models (CBM). In a linear economy the content, identification and separate treatment of waste streams seems unnecessary, since most of this is destined for landfill or incineration. There are few economic or social incentives in the linear economy to encourage more effective and efficient waste management processing and information management (Esbensen & Velis 2016).

#### 4. Circular Business Model Development

Moving from a linear business model to a circular one is perhaps the most significant systemic barrier to implementing the circular economy from a business perspective. Ritzen & Sandstrom (2017) focus their study of this problem on firms' 'internal' barriers to implementing the circular economy, emphasizing the disruptive nature of transitioning to the circular economy that businesses must face, particularly their need to discover and capture value in new, innovative, more circular, and often very different ways (see also Whalen 2019). They emphasise financial, structural, operational, attitudinal and technological barriers within firms that attempt to transition towards circularity. This internal emphasis is echoed by Vermunt et al. (2019), who identified a list of barriers to implementing circular business models (CBMs) through analysing 43 cases based on in-depth interviews with 31 Dutch firms, a nation well in advance of most other European countries in this regard (CGRI 2020). Business model innovation necessarily plays a central role in the growing body of literature on the circular economy, since attaining circularity requires sometimes radical changes within firms, in their supply chains and network relationships, and also in the supporting structural, policy and sometimes legislative changes

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value-capture may not be determined by their own activities in isolation and competition with others as it might be in the linear economy, but rather through cooperative alliances with other firms and groups in their network

required (Nussholz 2017). Consequently, mapping and analysing CBMs, especially in start-ups, has become an important focus of this literature (Baldassare et al. 2017).

A key distinction uncovered in this literature on CBMs is the centrality of networks and longterm business relationships to stimulate and nurture the innovation that can contribute to the circular economy, and how, in a circular economy business eco-system, companies are often pushed to shift from a 'firm-centric' to a 'network-centric' operational logic. This is because value-capture may not be determined by their own activities in isolation and competition with others as it might be in the linear economy, but rather through cooperative alliances with other firms and groups in their network (Pieroni et al. 2019). This is echoed in discussions from China, where the 'eco-industrial park' has become a formal model for this type of networked collaboration, consciously building upon the 'industrial symbiosis' pioneered in Kalundborg, Denmark (Zeng et al. 2017, Ehrenfeld & Gertler 1997).

While there are a number of ways to classify CBMs, Pieroni et al. (2019), defines them as either 'downstream circular' (such as pay per use models), 'upstream circular' (such as using reverse logistics), or 'fully circular', which combines both upstream and downstream, while Whalen (2019) takes a similar tripartite analysis, but emphasises the firms' type of relationship to the product(s) where value capture takes place. In her analysis, these firms act either as 'facilitators', 'redistributors' or 'doers'. Similarly, Bakker et al. (2014), from the perspective of industrial design, distinguish between 'Classic long life' CBMs (making long-lived products such as a Rolex watch), 'Hybrid' (where a long-lived product, such as coffee machine, is paired with a high-turnover item such a recyclable capsule), 'Gap-Exploiter' (repair businesses and the like), 'Access' (companies leasing long-lived products) and 'Performance' (where businesses might 'sell' services such as photocopying) - the last two are often found in some sort of combination in circular 'product-service systems'.

These discussions necessarily return to the problem of how and where value capture occurs in the CBM. In another different approach, by Henry et al. (2020), circular startups were classified as design-based, waste-based, platform-based, service-based, or nature-based, with these mapped against three typical material flow strategies, reduce/ reuse; recycle/recover; and regenerate (Henry et al. 2020, p.11). A key insight in this study is that CBMs tend to drive the development of more circular supply chains within a network, and this can encourage a closer integration between technological and social innovation, between the provider, its suppliers and its users (see also Geissdoerfer et al. 2018a).

While many start-ups focus on 'narrowing', 'closing', 'intensifying' or 'dematerializing' the 'loops' of material flows in their provision of goods or services (Geissdoerfer et al. 2018b), a few outstanding examples suggest how 'slowing' loops – that is, retaining products in use for longer (what Whalen calls 'obsolescent products') - also becomes possible. As noted above, this is critical in sectors such as fashion and textile products. In Pedersen et al.'s (2019) interesting hypothetical case study of a 'service shirt', designed in collaboration with consumers and producers to last for fifty years (the expected lifespan of the material of a shirt), a greatly extended and ongoing relationship between the consumer and manufacturer(s) was explored. In their hypothetical case, the

consumer would have to periodically surrender the shirt back to the company so that it could be transformed into a series of predesigned stages, from shirt, to jacket lining, and eventually to cloth jewellery, a hypothetical case emphasising how this type of CBM involves ongoing, long-term dependent relationship between the provider and user. This suggests the importance of more directly engaging consumers in the development and implementation of the circular economy to extend the useful life of products. This may involve, as Pedersen et al.'s study emphasises, a deeper and much longer relationship between consumers and their possessions than that which is encouraged in the linear economy. Similar conclusions are reached in a number of experimental qualitative design-led case studies, such as that of Cherrier et al. (2018) and Mate (2018): consumers will need to be 'retrained' to value their products over longer periods of time, and suppliers will need to learn to engage more directly with consumers to facilitate this longer, and deeper, relationship.

# 5. Consumer Engagement in the Circular Economy

The importance of engaging consumers in the implementation of the circular economy should not be underestimated (Govindan & Hasanagic 2018). This becomes especially clear once the related literatures on circular design and business models are considered together (Camacho-Otero et al. 2018). While 'circular forms of consumption' might seem eclipsed by discussions of CBMs and circular supply chains in the literature reviewed above, a more coherent set of pro-circular economy consumption policies and related legislation is starting to emerge as a critical issue in every nation's attempts to implement the circular economy, as the legal scholars Maitre-Ekern & Dalhammar (2019) argue. In terms of consumption, they propose a hierarchy of preferable consumption behaviours to be nurtured through policy interventions (and presumably supported by marketing), a hierarchy in many respects similar to the widely-used waste hierarchy, adapted by Green Industries SA for South Australia (GISA). This would prioritise the elimination of single-use and low quality products from the market, and would extend from the most preferable, that of avoidance of consumption and waste itself, through to encouraging maintenance and repair, to engaging in circular economy-type share and lease arrangements, to buying second-hand products rather than new ones, to buying quality and longer-lasting goods rather than cheap ones, and finally, as a last resort, to 'recirculating', which is their least preferable consumer behaviour, that is, disposal and recycling.

Maitre-Ekern & Dalhammar (2019) also identify four areas of focus in consumer-oriented policy-making to encourage this type of more 'circular' consumer behaviour in the circular economy. These include: 1. the provision of environmental impact information, such as universal labelling, which calls for more consistent and deeper levels of product or service transparency and less dependence on advertising and promotional media for product information; 2. economic incentives to keep and repair goods rather than dispose of them, which again may challenge some existing large-scale linear business models; 3. more robust consumer protection legislation, such as guarantees relating directly to product lifespans; and 4. More opportunities for shared consumption, such as localised product service systems (Cooper 2010). The 'right to repair' is increasingly discussed amongst policy-makers as a potential means of leveraging change in fast-changing resource-demanding domains like ITC and fast fashion (Grove 2020; Goldsworthy 2017).

In addition to this preliminary discussion, as Singh and Ordonez (2016) emphasise, more effective take-back rules, or 'extended producer responsibility' (EPR) legislation, could assist manufacturers and designers to develop responses in keeping within the limits provided by pro-circular economy policies. They could address present consumer uncertainties about product quality, lifespan and maintenance, to help both slow and

close the loop of material and resource flows more effectively. Extending both the lifespan of the product and the consumer's attachment to the product, would need to reinforce each other (Mugge 2017; Cooper 2010). This will require greater confidence on the user's part that the product is fit for purpose, can continue to be useful, can be repaired, and can be used again after repair, and that this is itself a desirable activity to engage in (Lindahl 2018; Cooper & Salvia 2018).

# 6. Circular Product Design and Product Service Systems

The potential role of design in providing repairability, for example, and in helping develop a circular economy out of the existing linear economy, has been a concern in the literature for some time, including design education (Bakker et al. 2014; Mestre & Cooper 2017). Design's important role is evident in the Ellen Macarthur Foundation's recent partnership with the leading US design group, IDEO, and the instructive case studies they have assembled, as well as their 'Circular Design Toolkit' (EMF 2017b), and more recent report on design in the circular economy (EMF 2021). Three of the earlier IDEO-Ellen Macarthur cases were examined by Wastling et al. (2018) in terms of 'Design for Circular Behaviour', emphasising the value of considering more closely the interactions that occur between users, products and business strategies, with an 'extended life cycle perspective' to help develop a circular economy-framed design process and outcome (Lindahl 2018). The critical role of CBM development and its link to circular design strategies is also evident in the work of Bocken et al. (2019), who present a framework for linking circular product design to CBM. The three main product design strategies they emphasise would aim to slow resource loops (extending product lifespans in use), close resource loops (reusing, remanufacturing, and recycling products and materials), and increase resource efficiency, through narrowing resource loops.

The value of the first and second of these strategies is the focus of a paper by den Hollander et al. (2017), which defines their approach as 'design for product integrity'. This speaks of circular design as founded on a 'reversal of obsolescence', and an extension of the life of products in use (Bakker et al. 2019, Bakker et al. 2014, Cooper 2010). However, since obsolescence is now so fully integrated into the linear economy (Rivera & Lallmahomed 2018; Park 2010), extending the life of

evident in design and manufacturing at this present time (Whalen 2019; Wieser 2016), a global task of some magnitude. As de los Rios and Charnley (2017) emphasise, new skills and capabilities will be required for designing this type of product for the circular economy under such radically different obligations. This will require a deeper knowledge of material composition and consumer behaviour, to ensure the user's continuing engagement and satisfaction with the product. This is because the designer's responsibility will not

design textbook, Products that last (2014).

end with the purchase and warrantee period

as it does in many cases now, but continue

for much longer, over the notional lifespan of the product. Education for 'design for product integrity', for 'longer lasting products', is also a thread running through Bakker et al.'s circular product

a product must reverse the 'linear' economic priorities

the object to be designed might no longer be a product or even a service, but an extended relationship between producer or supplier and consumer, to be potentially valued by both

In a revealing study on the potential role of 'circular' product service systems (PSS) in consumer electronics, Hankammer et al. (2019) note that currently only 50% of consumer needs are being met through the readily available 'linear' electronic products they examined. They call for design innovation to be driven by an awareness of the direct links between fulfilling individual consumer needs and the larger societal and environmental requirements of a circular economy (see also Bakker et al. 2014). This argument – that satisfying the consumer's real needs should be prioritised in all circular design (see also Mate 2018; Cherrier et al. 2018) - could be used to support the concept of designed 'value' that Lindahl refers to when describing 'circular economy solution' design (Lindahl 2018). This emphasis on an integrated consumer-centred approach to design for the circular economy echoes the call of others to more explicitly link the circular

economy to the UN's development goals

(SDGs) which do address the majority of consumers' needs (CGRI 2020; Geissdoerfer

2017).

Servitization and various product service systems (PSS), like product design, must be reconceptualised and redesigned to ensure that the circular economy is their goal

What is actually being designed for the circular economy, or what is 'circular design', is another question addressed in this literature. The question must be asked, since the object to be designed might no longer be a product or even a service, but an extended relationship between producer or supplier and consumer, to be potentially valued by both. This may involve a product or a service, or even both of these in some innovative combination (see Whalen & Whalen 2020). The designed result should yield a 'performative' value for the user, which can 'fit' the user's needs more directly, effectively and efficiently than occurs in shorter-lived linear products today, where the obligations of the maker and seller largely end with the purchase. From this literature, it becomes increasingly apparent that product design, product service systems, and business models require designing together for a circular economy solution, as European Environment Agency (EEA) report, Circular by Design (2017) and den Hollander et al. (2017) both emphasise.

In an interesting afterword to this re-evaluation of the role of design in the circular economy, Franco (2019) uses a system dynamics approach to determine the potential benefits of combining certain 'circular' product designs or Product Service System (PSS) designs and CBM strategies, but alerts the reader to the changed landscape of duration that 'circularity' or 'long-life' design might involve (see Zink & Geyer 2017). Extending the life cycle of a product and intending this product to stay useful for so much longer brings into play quite different priorities for the designer, the maker and the seller or service provider (Bakker et al. 2014), including digitization to track material flows (McGinley 2018; Elmualim 2018), and 'design for disassembly' (Crowther 2018), or at least easier dismantling for recycling or reformation (Maroufi et al. 2018). Circular design thus challenges the short-term, linear focus of advertising, marketing and most product design today, suggesting that policy and legislation needs to be calibrated to support not only circular design, but also circular marketing and advertising, topics largely absent from the literature.

Servitization and various product service systems (PSS), like product design, must be reconceptualised and redesigned to ensure that the circular economy is their goal (Pieroni et al. 2019). Studies on product service systems (PSS) predate the circular economy, and their potential environmental benefits have long been recognised (Tukker 2015; Michelini et al. 2017). In all PSS models, value comes from the sale of 'units of service' (Stahl 2016), rather than from the sale of products, but again this is not necessarily the same as the performative, long-term 'value' that comes into play in a PSS designed for the circular economy, or a 'circular PSS.' Michelini et al. (2017) note that while the literature on the PSS model is large and growing, there is still limited discussion in this literature around using PSS as a model for implementing the circular economy, even if there is a growing awareness that PSS may have to be redesigned within a circular economy and could be useful for attaining its aims (Gnoni 2017).

# 7. Technology and Innovation in the Circular Economy

From a technological perspective, the circular economy is about identifying, generating and improving more 'resource value retention options', and these may be embodied as water, materials or energy in a product or a service or both (Reike et al. 2018). The implementation of the circular economy therefore can be understood also in terms of the iterative development of specific technological solutions better able to close, narrow and slow resource flows across all economic sectors, a potentially vast, complex and long-term task. This has led initially to the realisation that technologies for improving the prospects of reuse, of remanufacturing and recycling need to be substantially improved, whilst those technologies shaping the front end of the lifecycle of most goods also need changing. Technology and its appropriate application is thus fundamental to addressing the central problem the circular economy tries to address, but this tends to reflect the priorities of those using it, which again emphasises the importance of a collaborative approach to developing and implementing the circular economy.

In terms of scale, research on the circular economy that includes addressing technology at present tends to focus on the macro scale of cities, states and nations (Momente 2020) drawing on existing data, and sometimes developing 'indicators' able to measure progress towards the circular economy (Moraga et al. 2019), or on the micro-scale of the design, use and recycling of

on the micro-scale of the design, use and recycling of various materials such as metals (Lane 2014) or

Industry 4.0 needs a more prominent environmental, social and ethical framing, such as that which can provided by both the circular economy and the SDGs

plastics (Singh et al. 2017), and more recently, the reformation of certain waste materials for reuse in manufacturing (Maroufi et al. 2018). The meso-scale of buildings or precincts, on the other hand, is still under-researched, even if there are a number of designers and engineers actively engaged in transferring ideas from the circular economy into this field (Baker-Brown 2019, Pomponi & Moncaster 2017). Baker-Brown (2019), a British architect active in this field, draws attention to the potential role of buildings as 'resource banks', able to store materials and energy for more lengthy periods. Such 'circular buildings' and precincts will also have to generate more comprehensive and accurate data – using relevant technology – to manage the retention and reuse of the resources they contain (see McGinley 2018).

Current discussions of the role of technology to support the implementation of the circular economy tend to fall into two broad categories that are slowly being integrated (e.g. ATSE 2020): the first looks at technologies dedicated to facilitate the sharing of services or products, remanufacturing or reusing products or materials, and recycling and improving resource use (e.g. Goh et al. 2018; Maroufi et al. 2018; Taito-Matamua et al. 2018), while the second discuss technologies required to access data, and measure or determine the environmental, economic and social value to be obtained from particular materials or products considered from a more circular or sustainable vantage point (Esbensen & Velis 2016; Offenhuber 2017; Elmualim et al. 2018). This literature tends to reinforce the view that the goals of the circular

economy and Industry 4.0 have much in common, an integration increasingly apparent in the literature (ATSE 2020; Antikainen et al.

2018).

The circular economy will require a more systematic approach to recognising, assigning and trading this value currently lost at end of life

Industry 4.0 may be defined as the ongoing automation of industry and manufacturing using existing and emerging smart technologies, and this neatly dovetails into the kinds of technological needs apparent in the circular economy (Dev et al. 2020, Rosa et al. 2020, Halse & Jaeger 2019, Antikainen et al. 2018, De Man & Strandhagen 2017). Typical Industry 4.0 approaches include the use of additive manufacturing (AM – or 3D printing), big data analytics (BDA), internet of things (IoT) and cyber physical systems (CPS), all potentially useful technologies for consideration in implementing the circular economy (ATSE 2020). For example, digitization and the use of big data enables more efficient resource and lifecycle management, greater transparency and security of provenance in supply chains, and further supports digitally enabled CBMs (McGinley 2018). In Italy this technology is increasingly being used to respond to the problems of underdevelopment, marginalisation and economic decline in 'marginal' rural areas, in this way suggesting further possible synergies between the circular economy and the Sustainable Development Goals (SDGs) through the tools and methods provided by these technologies (Salvia et al. 2018).

This use of these new technological approaches can have local advantages to assist the shift to a circular economy in a particular 'territory' (Salvia et al. 2018). The small scale use of additive manufacturing to make tourist mementos out of waste plastics on a Pacific island, for example, an island where there are few cost-effective alternatives to deal with this plastic waste, provides a useful illustration of this point (Taito-Matamua et al. 2018). Other advanced networked technologies are already making an appearance in some circular economy start-ups. However, it should be emphasised here that Industry 4.0 needs a more prominent environmental, social and ethical framing, such as that which can provided by both the circular economy and the SDGs, since the footprint of many advanced technological products, including that of smartphones, continues to grow unabated within the linear economy (Belkhir & Elmeligi 2018). Indeed, without 'slowing' the output of those industries with the heaviest footprints, such as ITC and fashion textiles (Grove 2020), Industry 4.0 technologies can be used to substantially add to humanity's environmental impacts rather than help alleviate them.

One central issue here, as elsewhere, is how value is conceived and integrated into the circular economy. In the present linear economy it is assigned according to the transactional, traded price of resources and goods, and then – often heavily discounted – determined to be 'waste' at the end of a conventionally predetermined life (see Offenhuber 2017; Esbensen & Velis 2016). This linear process – exemplified by the 'make, use, discard' business models behind most technological products – reflects a 'market failure' that discounts the larger environmental and social impacts of the making, use and disposal of these goods, and the potential value of what has been lost as material resources at their end of life (Shanahan 2018, Belkhir & Elmeligi 2018, Lane 2014). The circular economy will require a more systematic approach to recognising, assigning and trading this value currently lost at end of life, and especially in technological goods, where change is so rapid, and rapid obsolescence a standard business strategy.

Thus, Hopkinson et al.'s (2020) four 'building blocks' of the circular economy – circular design, circular business models, a networked approach to managing material flows and energy, and systemic (including economic and policy) enablers – becomes increasingly important in planning a way forward towards transition to the circular economy (Hopkinson et al. 2020). It is also useful here to insert a temporal dimension into these principles, for all four building blocks require close attention to the speed at which resources are consumed, goods purchased and discarded, and reuse or recycling takes place. 'Reversing obsolescence' could almost be added to these four as an additional, or fifth, building block (Bakker et al. 2014).

One central issue here, as elsewhere, is how value is conceived and integrated into the circular economy

To a great extent Hopkinson et al.'s (2020) building blocks summarise the more essential global principles covered so far in this literature review: the importance and centrality of design and consumer engagement in building a circular economy, this circular design's (and consumption's) interdependent relationship with circular business models (CBM), the vital importance of a networked, digitized approach to providing goods, services and distributing energy - whether this is through 'sharing' or product service systems or through buying and using a more long-lived product – and the essential supporting presence of policy and economic changes. These building blocks are worth emphasising here as we turn to the literature more directly relevant to a regional circular economy implementation strategy.

# Regional Case Studies on Implementing the Circular Economy

Because of its reliance on networked cooperation, the circular economy is well suited to localized regional and city-based implementation strategies. Some recent research, and a number of policy documents, mostly from the EU, have focused on cooperative development of circular economy-implementation strategies in linked regions, cities and local government areas (Silvestri et al. 2020; BIOREGIO 2020; URBACT 2020). Cooperation is a critical principle in this regional development of the circular economy, since each initiative depends upon sometimes complex webs of multi-stakeholder engagement and their ongoing involvement.

Since regions, states and cities have sometimes quite different, even unique physical characteristics and needs, most studies on the regional implementation of the circular economy have fallen into two broad but complementary approaches, which are sometimes combined into the one document or on the one website (e.g. BIOREGIO 2020; URBACT 2020, ZW Scotland). In the first category are comparative studies that attempt to draw conclusions from particular regional experiences in implementation programs, and these sometimes aim to develop indicators, frameworks, or 'toolkits', to delineate the most effective pathways to develop the circular economy in regions or cities (e.g. Silvestri et al. 2020; Avdiushchenko 2018). The second category contain more specific case studies that explore the implementation experience on the ground, typically from the vantage point of particular industrial or agricultural sectors attempting to go 'circular' in a particular region (e.g. DeLorenzo et al. 2019; Salvia et al. 2018).

Reflecting the depth of the EU's commitment to an urban and regional implementation of the circular economy, there are a number of EU-funded cross-regional web platforms and alliances aimed at encouraging the implementation of the circular economy at this local level. Many of these contain summary principles and frameworks, and also include specific cases to help the reader think through the implications of trying to go circular in their city or region. URBACT (2020), for example, is aimed more generally at making cities and regions more sustainable, but provides a number of regional circular economy cases. These emphasise both the 'diversity of territorial contexts' within the EU, and how this fact 'translates into different needs and opportunities'. Often the goal of this implementation is consciously matched to specific SDGs, and is then applied with this in mind to 'territories' that for various reasons have been left behind in social and economic terms. As this suggests, the circular economy can be used as a pathway to sustainable development (most obviously, but not solely through SDG 12: sustainable or 'responsible' consumption and production). The large umbrella URBACT project, for example, funds cross-European regional groupings, each featuring a lead city or region to implement a particular collaborative innovation. The advantage of this approach

is also in co-learning: different regions or cities in different states, some technically 'behind' others in economic and social terms, are encouraged to collaborate in the development of the circular economy and learn from each other, sometimes in very different geographical areas of Europe.

BIOREGIO Interreg Europe (2020), to take another example, is a substantial web-based platform aimed at improving knowledge of reuse in the European regional bioeconomy, from food wastes and agricultural residues to municipal and industrial sludges. With partner organisations across Slovakia, Greece, France, Finland, Macedonia and Spain, this website offers some insights into how the EU is now trying to shape policy, legislation and implementation of the circular economy in the 'bio-economy' at a regional and city level, guided by the principles established by the EU government in Brussels. Its 'Project Good Practices' is instructive, being a series of small regional case study projects undertaken as funded collaborations between local governments, local businesses and experts at local universities. This has considerable relevance to South Australia, where similar initiatives have been, and are continuing to be, developed.

Two cases within Europe – Alelyckan Recycling Park, Gothenburg, Sweden, and Amsterdam Circular Strategy 2020-2025 – and one in Canada, an agricultural case study from Guelph, Canada, seem especially relevant to the regional SA context. The Alelyckan Recycling Park (2020) is a general reuse centre created by the City of Gothenburg to process most solid waste streams, including construction and building materials and waste furniture. Where this is possible, items from these streams are cleaned, recycled or repaired for reuse, and then sold on to second-hand shops in the region. The council-run park is co-located with other NGOs and private companies in the same line of work, so that the public can come to the site to find what they need.

Although operating for over 15 years, it is now part of a

Europe-wide network of projects aiming to implement similar waste-reduction strategies called 'Urban Wins' (2020). Its success reflects an increasing

shift amongst consumers, especially in the EU and Britain, towards buying and using second-hand products and materials where these are available (Appelgren & Bohm 2015a, 2015b). Its relevance to SA lies in its integration of a waste sorting facility, repair and reclamation centres and retail, and its use of co-location to create opportunities for consumers and retailers that are typically spread across cities. In Australia these facilities are now often divided between charities, resource businesses and demolition yards. This localised concentration of facilities has potential economic synergies and benefits which are noted on the

concentration of facilities has potential econom synergies and benefits which are noted on the relevant websites. Job-creation and transport reduction are also calculated on these sites to enable visitors to see their environmental, economic and social benefits.

this localised concentration of facilities has potential economic synergies and benefits

The Amsterdam Circular Strategy 2020-2025 (2020) is another interesting European example. Officially the first of four linked policy documents outlining the advanced implementation plans developed by the city, it includes three main groups of 'ambitions' linked to the EU's and Dutch government's overarching circular policy and circular business strategies. These focus on food and agriculture (shortening food chains, high-quality processing of waste streams, etc), consumer

goods (setting an example through city procurement, reuse of discarded products, and reducing consumption), and the built environment (circular approaches to planning, development and construction). This circular city-wide grand plan is supported by three other complementary policy documents, the first an 'innovation and implementation' plan, the second a 'waste and raw materials implementation program' and the third, significantly, a 'monitoring' and benchmarking program. These are linked to a framing 'doughnut economic' plan, which positions the circular economy symmetrically within the sustainable development goals and the EU's overarching sustainability ambitions (Doughnut Economic Lab 2020). The approach developed by the Oxford economist, Kate Raworth (j2017), encourages a collaborative, co-creative, iterative approach linking circular economy type initiatives explicitly to the sustainable development goals, in a manner similar to that used by some 'Living Labs', user-centred, typically localised, iterative and cooperative 'open-innovation eco-systems' (ENoLL 2020; Boffey 2020).

In another useful regional example, this time from Canada, in Cities and Circular Economy for Food, Guelph, Canada (2019), the Ellen Macarthur Foundation developed a case study based upon a series of policy and legislative initiatives developed by the state government (Ontario, where Toronto is also located). The project aimed to develop Canada's 'first technology-enabled circular food economy by 2025' (DeLorenzo et al. 2019; Salvia et al. 2018), leveraging the regional co-location of large-scale farming, established agri-businesses, strong residential green waste collection and reuse schemes, and prominent agricultural research institutions. Its 'ambitions' were to shift food production towards regenerative systems, to 'make the most of food' (reduce waste, reuse, etc), and to 'design and market healthier food products'. Its economic benefits the EMF calculated to be US \$39 million. This case has considerable relevance to regional SA, particularly because of Guelph's not dissimilar assemblage of

number of common themes with GISA's, the circular business initiatives they have helped develop and promote seem particularly valuable to regional SA, in part because few

with relevant experience and skill. Another valuable resource for practical regional case studies that reflect a similar relationship between government, industry and communities to be found in South Australia through Green Industries SA is that of Zero Waste Scotland (ZW Scotland). This organisation has been an important leader, enabler and promoter of responsible and circular production and consumption at a regional level for a number of years, and there are some parallels between their present role as a 'lighthouse' of the circular economy in the UK and that of Green Industries SA (formerly Zero Waste SA) in South Australia (see ZWScotland: 'who we are', and 'our corporate plan'). The cases listed on their website, the research projects they have funded and made use of, and the new business ventures they have co-funded or promoted have a number of parallels to similar efforts pursued in SA by GISA. While their food waste, recycling and waste reduction programs share a

directly overlap with the exemplars in SA (ZW Scotland).

large-scale technologically efficient farms, established agri-businesses, businesses

processing 'green' agricultural and food

wastes, and advanced research institutes

the new business ventures Zero
Waste Scotland have co-funded
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# Australia's turn towards the Circular Economy

Australia's turn to the circular economy has been a relatively slow one, the result of many prior, often state-based waste reduction and resource efficiency initiatives, led informally by South Australia as a policy and legislative pioneer. The introduction of the 'National Sword' policy which banned the importation of wastes for recycling and processing into China in January 2018, helped stimulate a waste reduction agenda across the nation, joining up a number of state-based initiatives under the intent of a federal umbrella. While many resource and recycling companies lost money at this time, finding nowhere else to export their stockpiled wastes, China's decision was largely positive for the advancement of the circular economy agenda in this country, encouraging each state government to revisit and revise their waste policies and legislation, and to develop more comprehensive and longer term circular economy-based perspectives of waste, with policy development to match them. Since the states are generally responsible for waste collection and processing under Australia's constitution, state governments around the country soon moved to financially help their own resource

businesses to encourage more efficient local recycling, and to start looking more closely at their resource efficiency, capacity, and the policy and legislative frameworks responsible for managing the sector (Levitzke 2020; and see Fry et al. 2018).

in Australia a number of policy and legislative changes over the last five years have contributed positively to the nation's increasing embrace of the circular economy

The Federal Government also updated its 5 year waste strategy at this time and related legislation (Commonwealth of Australia 2020), bringing to the fore five circular economy-influenced principles: prioritising waste avoidance, improving resource recovery systems for recycling, increasing the use of recycled materials in products and packaging, improving the efficiency and safety of material flows, and improving waste-related information and data collection systems (Levitzke 2020, pp.33-34). It is therefore not surprising that most knowledge of the circular economy and its principles in Australia at present tends to derive from, or through, the resource and waste management sector. It should be emphasised here that Australia is not alone in this (e.g. SITRA 2020),

and this tendency to see the circular economy as an 'end of pipe' resource-sector driven 'solution' to a growing waste crisis is sometimes explained by the weakness of the concept itself (Korhonen et al. 2018), and its early embrace by engineers

and businesses in the resource and recycling sector (Reike et al. 2018).

However, beyond the crisis triggered by the China Sword policy, in Australia a number of policy and legislative changes over the last five years have contributed positively to the nation's increasing embrace of the circular economy. One important step towards a more national circular economyshaped waste strategy in Australia was the national food waste strategy announced in 2017 (GISA 2020b), and a series of product stewardship interventions (from 2000), including the collection and recycling of TVs and e-waste (NTCR 2020). Important also was the development and accreditation of a number of 'co-regulated' industry organisations to more effectively collect and recycle specific problem wastes, such as mobile phones (Mobilemuster 2020), mercury-containing lighting products (Fluorocycle 2020), vehicle tyres (Tyre Stewardship Australia 2020), household paints (Paintback 2020), and product stewardship for waste oil scheme (PSO),

the goals of the circular economy are explicitly linked to Industry 4.0 developments in the resource sector, even if its recommendations go beyond better recovery and recycling rates for achieving a more systemic circularity in Australia's economy.

one of the earliest and most successful of these take back and reuse schemes. These organisations are 'guided' by relevant legislation towards some measurable, collaboratively funded industry-wide remedial action. The Australian Packaging Covenant (APCO 2020) is one example of this approach (1999 onwards). By 2025, they aim to make 100% of all Australian packaging reusable, recyclable or compostable, and the organisation recently developed an 'Australasian Recycling Label' (ARL 2020) based on a successful 'circular' packaging design guide, PREP (PREP 2020), a significant innovation in this area (PREP 2020; APCO 2020; Levitzke 2020, pp.35-37).

More recently, the federal government and Planet Ark founded the 'Australian Circular Economy Hub' (Acircular economy 2020a), which is to become the national leader in the adoption and implementation of the circular economy. One of the first publications made by this organisation, Circularity in Australian Business: Where Australian business leaders are at in the transition to a circular economy (Acircular economy 2020b), emphasises once more that the circular economy is still widely perceived by business leaders across the nation in end-of-pipe terms, as largely a matter of better recycling and waste reduction. Few of the leaders surveyed for the production of this document understood what the circular economy really means, and most confused the circular economy's implementation with improving waste reduction and recycling strategies, with many believing that their companies had 'already' embraced and started to implement circular economy principles (Acircular economy 2020b). This short report concludes that there is a need for an Australian 'knowledge hub' for business, which this organisation hopes to embody into the future.

To a great extent this end-of-pipe view of the circular economy remains important, since there is still a lot to do in waste recovery and treatment across Australia to reach a point where implementing the circular economy becomes possible at scale (Commonwealth of Australia 2020; Fry et al. 2018). In a recent report from the Australian Academy of Technology and Engineering, Towards a Waste Free Future: Technology readiness in waste and resource recovery (ATSE 2020), the goals of the circular economy are explicitly

linked to Industry 4.0 developments in the resource sector, even if its recommendations go beyond better recovery and recycling rates for achieving a more systemic circularity in Australia's economy. These recommendations echo the implicit goals of Hopkinson et al.'s four building blocks listed above (2020). They include the following (ATSE 2020):

- 1. A paradigm shift to design for waste avoidance,
- 2. A systems approach to increase resource productivity and recovery,
- 3. Big data and analytics to inform decision making by policy makers, businesses and consumers, and
- 4. Targeted government investment, regulatory reform and policy certainty.

After surveying the major waste streams across Australia, including building and construction wastes, organics, paper and card, plastics, glass, tyres and 'emerging waste streams' (including e-wastes), this report emphasised the importance of design within the circular economy, before discussing improved product stewardship standards, advanced resource recovery and recycling initiatives and standards, and the various

'enabling technologies' to be used to achieve these aims. These include a wide range of new digital, physical, biological, and chemical technologies, echoing some of the work included above in this literature review. The

ATSE report reflects a new awareness amongst some leaders in Australia for continuous technological improvement to be linked to, and shaped by, circular economy principles, with design highlighted repeatedly as being critical to a more substantial systemic shift to the circular economy. The report also emphasised the importance of improvements not only in the application of relevant technologies, but also in the training and skills needed to make better use of these still relatively new technologies (ATSE 2020). The conclusions of this report largely mirror te findings of this literature review, with the

the findings of this literature review, with the exception of the importance of shifting consumers towards both accepting and engaging with the aims of the circular economy, something that still seems to be absent in much of the relevant literature.

Turning to the implementation of the circular economy on the ground, there are as yet few academic studies of circular economy implementation initiatives across Australia, though it is apparent from the materials cited above that regional implementation is critical to the success of implementing a circular economy. This is because of the social, economic and technical advantages to be gained from localising resource collection, separation, processing and reuse, and engaging local communities, and consumers, to this end. However, as Fleischmann's (2017) solitary case study from regional Queensland suggests, initiatives that try to involve local businesses in collaborative circular economy initiatives that are not supported by sufficient investment, infrastructure, local government policy and state government legislation are unlikely to succeed, at least beyond the sometimes heroic efforts of the individuals involved. Fleischmann's study makes clear that not only local economic viability and government policy are critical to the success of regional circular economy implementation, but also business and consumer education. Her study is suggestive of the modest, local, and

shifting consumers towards both accepting and engaging with the aims of the circular economy... still seems to be absent in much of the relevant literature rather ad hoc advances of the circular economy so far in Australia, and the need to develop coherent, linked policies, legislation and information campaigns that support such initiatives, and to recruit larger players like the universities, corporations and government departments to trial initiatives that might result in 'best practice' showcases (see also Waller et al. 2018).

# South Australia's developing Circular Economy

Despite its small population, South Australia has long been the nation's leader in resource recovery and recycling, and various related waste reduction initiatives. SA was the second state in the world and first in the nation to adopt a container deposit scheme (1977), the first state in Australia to ban plastic bags (2009) and the first to adopt a circular economy strategy (2017). South Australia now diverts over 83% of its waste from landfill, far above the national average of about 60% (GISA 2020a, Fleischmann 2017). The state recovers and recycles over 90% of construction and demolition waste, while refuse-derived fuel has replaced natural gas in cement kilns, and water from sewage plants is widely used in horticulture (GISA 2020b,c,d). Stormwater is being harvested and used to recharge aquifers for use in manufacturing, while the state leads Australia in its increasing reliance on renewable energy – principally solar and wind. These now account for 60% of the state's power needs, and this is continuously growing, now being supported by the largest battery in Australia (Levitzke 2020; GISA 2020a).

South Australia's leadership in waste management and resource efficiency has been extraordinary and exceptional, and is largely unrecognised beyond the state's borders, even if many Asian nations are aware of this. For example, SA's leadership in this space is widely recognised across the Asia-Pacific region, even if much less so in the more parochial and conservative national pond. For example, it was GISA that hosted the successful UNCRD's Seventh Regional 3R Forum in Asia and the Pacific in November 2016, and at this forum a resolution sponsored by their Australian, GISA-led hosts recognised the 'multiple benefits of pursuing a circular economic development approach through effective 3R policies, programmes and institutions,' which was a adopted by the member states. This was the 'Adelaide 3R Declaration towards the Promotion of Circular Economy in Achieving Resource Efficient Societies in Asia and the Pacific under the 2030 Agenda for Sustainable

Development' (UNCRD 2017). GISA's 'Global Leadership Program on the Circular Economy' (GISA 2020b) is also unique in attracting a range of professionals from across the Asia-Pacific region and Australia to learn from SA's experience as one of the world's significant leaders in resource management and recovery.

From the above, it is clear that South
Australia is uniquely placed to develop a
regional circular economy strategy, and
under GISA's leadership has developed
many initiatives towards this goal, with
some even commenced under Zero
Waste SA, GISA's previous incarnation. For
example, Zero Waste SA's successful banning
of plastic bags in 2009 was a first in the nation
and the region, and this is now being extended
to include other single use plastics, including plastic
straws and polystyrene cups and trays (see GISA 2020c),

South Australia is uniquely placed to develop a regional circular economy strategy, and under GISA's leadership has developed many initiatives towards this goal

a move only belatedly taken up by the larger eastern states. Indeed, a report on the potential development of industrial symbiosis in northern Adelaide was commissioned as early as 2013 by Zero Waste SA, so GISA has been working towards developing a broad circular economy strategy for some time, based upon many years of hard work. The group's commissioned report, Creating Value: the Potential Benefits of a Circular Economy in South Australia (2017), was the first clear economic argument for integrating circular economy objectives into waste strategies in the nation, and was soon duplicated by other state governments, with GISA's leadership advising them on how to develop their own circular economy policies and strategies (Levitzke 2020). Since the launch of this report, GISA has introduced a series of ground-breaking initiatives aimed at reducing waste and increasing the state's circularity, including most recently the ban on single-use plastics. Their just released Strategic Plan 2021-2025 lists five priorities, which are reflected in the findings and recommendations contained in this report:

- 1. Circular Products and Services: 'designing out waste to keep resources circulating in the economy and enabling sustainable procurement'
- 2. Circular Consumption: 'reducing wasteful consumption by sustaining products through repair and reuse, avoiding waste and improving recycling and recovery'
- 3. Circular Resource Recovery: 'Investing in state-of-the-art infrastructure to unlock the value of materials that would otherwise go to landfill'
- 4. Circular Sectors: 'Creating economic growth and job opportunities by making targeted industry sectors resource efficient and carbon-neutral'
- 5. Circular Capacity: 'Capacity building through investment in training, education, innovation and research and development to nurture the next generation'.

#### Literature Review Conclusion

From an economic and business point of view the circular economy may be a somewhat confusing and misunderstood concept, for it requires all economic actors to place a 'whole of life' value on the products they make, use or sell, a radical departure from today's 'linear economy'. As an 'umbrella' concept developed in opposition to the dominant 'linear' economy, the circular

position to the dominant 'linear' economy, the circular economy's specific social, economic and technological dimensions are still under development and an

Consumers, and most businesses, remain unaware of the substantial impacts of their own consumption

occasion for debate, in part because few nations around the world have managed to transition more than 8.6% of their economic activities towards measurable 'circularity' (the global average - CG Report 2021), and in part because most current business models are still decidedly linear, isolated and firmcentric, and often dependent on lengthy, sometimes opaque and environmentally sub-optimal supply chains. While the potential environmental and social benefits of 'going circular' have been identified many times, most businesses, and most consumers, are still not aware of these benefits. This lack of awareness, of the damage the linear economy presently wreaks on the environment, and the promised benefits of the circular economy itself, are two of the more significant barriers to the circular economy's

implementation identified in the literature above. The legacy of products designed within a 'linear' economy, being as it were 'designed for disposal', also represent a powerful obstacle to the development of greater circularity. Consumers, and most businesses, remain unaware of the substantial impacts of their own consumption, for example of buying new mobile phones every year.

The development of more circular designs and circular business models (CBMs) is highlighted in the literature as an essential strategy for rebuilding the economy on a more circular basis. A need for stakeholder collaboration supporting CBMs is also repeatedly emphasised, since the circular economy requires a very different 'network-based' approach to value creation, where product value and utility are retained and extended for as long as possible, as opposed to the linear economy's simple firm-centric approach to business. Thus a collaborative, long-term reset of relationships in the circular economy has radical implications not only for business, but also for design, marketing and consumption. For the circular economy requires designs that can satisfy users for longer periods of time, marketers and advertisers able to sell the benefits of these products or services, and consumers able to understand and engage with such an extended user experience. Similarly, while there is considerable alignment between technologies able to measure and manage a circular economy and those associated with Industry 4.0, most existing circular economy businesses are not dependent on these novel technologies and their

application, a noticeable gap highlighted in the literature on technologies for the circular economy in both Europe and

Australia. The potential may be there, but this has not yet been developed.

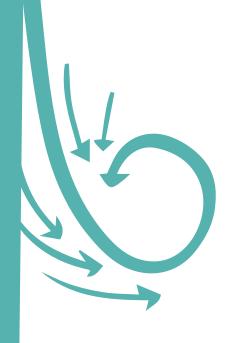
South Australia has long taken a leadership role in Australia in developing and implementing strategies for waste reduction, resource efficiency and the development of the circular economy

The circular economy in principle benefits from prioritising and localizing an ongoing exchange of resources between economic actors, sometimes termed 'industrial symbiosis', and this can be supported and facilitated by policy and legislative interventions, as shown by the widespread interest in the implementation of the circular economy in regional settings in both the EU and China. In Australia the circular economy has been nominally embraced by most state jurisdictions, in part as a way of dealing with waste and landfill following the recent ban on exporting waste plastics and other materials to China for processing. However, most of this has occurred amongst larger businesses already engaged in the resource sector, familiar names now collecting and sorting urban wastes, but now introducing more sophisticated sorting and processing systems, and claiming, often on slender evidence, that they have 'gone circular'.

South Australia has long taken a leadership role in Australia in developing and implementing strategies for waste reduction, resource efficiency and the development of the circular economy. However, 'joining the dots' between more efficient resource and waste management and the more radical and far-reaching transition required by a full adoption of the circular economy may be more challenging. Trialling this in regions, as is now occurring in Europe, will have multiple benefits in South Australia, including the possibility of reviving local economies suffering long years of neglect, marginalisation and inconsistent development policies.



These findings are drawn from our analysis of collected data and are presented through three main areas or domains, classified here as technical themes, 'bridging' themes and social themes.





#### Circular Business Models

As indicated in the literature review, circular business models play a significant role in the transition from a linear to a circular economy. A number of topics relating to the development of circular business models and their benefits were discussed in the interviews, including the importance of having an awareness of the circular economy, opportunities associated with circular business models, benefits arising from circular business models, and various drivers and barriers encountered when enterprises begin to move towards a circular economy.

Many of the participants emphasised the need for a greater awareness of the concept of the circular economy and its benefits, and also the damage the linear economy presently wreaks on the environment in its absence. This awareness, it became clear, was shaped by stakeholders' beliefs, knowledge, background of experience and education, and varied considerably in emphasis amongst participants. This confirms that the circular economy is best understood as a multidimensional 'umbrella concept', driving social, economic and environmental improvements throughout the economy.

Ways of seeing the circular economy amongst participants bear this observation out. Participant NP01, for example, understood the circular economy in terms of a 'core business process' for value capture in new environmentally and socially beneficial ways, largely through the deployment of design for extended use and reuse in business. However, as he acknowledged, the concept is still poorly understood in the business world, for many, just another 'shiny new thing'. On the other hand, participant AP03 saw the circular economy in terms of a 'regenerative economy' that allowed for a more conscious compromise between human and environmental needs. Like NP01, he understood the circular economy as a proposition that businesses could embrace, in contrast to previous sustainability concepts.

All participants emphasised the opportunities and benefits to be gained from implementing the circular economy. Participant NP02, for instance, drew on examples from her experience in the development of 'green steel', where the hydrogen she found to be locked in waste tyres led to beneficial changes in steel making, and a reduction in its requirement for coke. This challenged perceptions in an otherwise well-established conservative manufacturing process. However, as in NP02's work, understanding the content and capabilities of particular waste streams was widely acknowledged to be critical to the development of many circular business models. Participant AP07 emphasised the value of better resource data, and the opportunities these could provide for new kinds of circular economy-led investment. This could result in more jobs, and sometimes new kinds of jobs, as well as the development of new skills. From a regional perspective, he also emphasised the importance of reducing costs in waste management through localizing processing. This could result in more sustainable outcomes for the community, and the added benefits flowing from the creation of new businesses. Similarly, government participants generally emphasised the employment opportunities to be gained from job creation and circular business models across the state, with one (APO2) drawing attention to how even current recycling businesses generate up to six times as many jobs as work in landfill does.

A related topic was the drivers of circular business innovation, which included how to deal with existing wastes. Participant AP06 noted that the SA Waste Levy acts as a significant driver towards circularity in regional councils, since they must now pay to ship their non-recyclable wastes to landfill in the city, adding appreciably to the costs of doing things in the 'traditional' linear way. Paying metropolitan charges plus shipping costs thus incentivises regional councils to find local, more 'circular' solutions to their waste problems. Conversely, mistaken assumptions, such as one that emphasises the immediate 'costs' of recycling and waste processing, can become a barrier to the development of the circular economy and of circular business models.

Participants were also concerned to emphasise the value of understanding the most common barriers to the development of the circular economy. Participant AP07 noted that communities are typically left out in deliberations on developing a circular economy, despite its likely impacts on their community, and the opportunities it is likely to bring. Referring to the proposed development of regional recycling facilities, AP07 noted again the way mistaken cost assumptions, and decisions made behind closed doors away from the community, could shut down the potential development of a circular economy. To take another example of this kind of negative thinking, participant NP03 acknowledged that not only government but many businesses prefer to stick to what seems safest, and for this reason government needs to support the development of circular business models. NP03 was particularly critical of 'policy incrementalism' in moving to a circular economy, which could result in a significant delay in return on investment (ROI) for businesses, and this discouraged businesses from pursuing circular strategies or developing circular business models.

Enablers of the circular economy were also widely discussed, from business model innovation to the presence of local champions of the circular economy. For instance, participant AP05 noted that business model innovation is a 'rich area for us' with the majority of businesses in his region being SMEs and owner managed (62%). He also emphasised that his organisation, Regional Development Australia, was intent on growing 'the circular entrepreneur space'. Recognising the value of local 'circular champions', he pointed to a number of examples where companies had developed additional profitable businesses or strategies based on circular business models.

#### Material Flows

There was a considerable awareness amongst participants of the need to address the development of a regional circular economy from a material flows perspective. While the organics sector was widely understood to be truly circular, participants from the organics sector itself regarded green waste as a still undervalued part of the circular economy. They pointed out its true circularity as a waste stream and one that is easily managed, whose value is high, and that there could be no justification for exporting green waste out of the region where it originates. They noted that localizing this processing would immediately reduce transport impacts and associated costs. In a memorable quote, Participant IP01 described organics as 'an infinite process within the circular economy that is both the beginning and the end of the circle', a striking affirmation of the true circularity of organic material flows.

Taking up a material flow perspective, participant NP01 noted how waste reduction strategies commonly pursued in the circular economy were also to be found in Agriculture 4.0. NP01 emphasised that using existing technology it was now possible to better balance supply with demand in agricultural ventures, and in this way 'design out waste' from overproduction at the outset. By growing only what an enterprise can sell, no waste is generated. Picking up on this idea, a number of other participants emphasised the importance of design as a means of redirecting material flows towards circular outcomes, and design's potential creative role at the 'front end' of the cycle. A strategic deployment of design and existing technology could eliminate many problematic or toxic materials at their

Organics is an infinite process within the circular economy that is both the beginning and the end of the circle

Peter Wadewitz,
Peats Soil

origins, and create more value in products on the shelf. This led to a discussion of design's relation to whole of system thinking, including 'circular' design's potential contribution to the regeneration of natural systems.

However, to achieve this goal, it became clear that there is a need to better understand waste materials and their volumes in some detail. Participant NP03 pointed out that value could be discovered or added to the waste stream through not only redesigning a particular product, but also through levies that penalise the producer if their products pose genuine threats to the environment. NP03 and several other interviewees emphasised that there are now too many different types of plastic, and condemned the now common practice of blending these with other materials, leading to difficulties in separation, and failures, or added expenses, in recycling. NP03 and NP02 singled out fast-food packaging as an example of this problem, and they considered that this should be entirely redesigned.

Some were also concerned about the use of waste polymers in roadway and infrastructure projects. Participant IP02 was of the opinion that 'burying waste in a road or concrete is a lost opportunity and programs like Redcycle are just there to make us feel better'.

However, participant IP06 considered that councils should consume more of their own waste material through buying recycled products and that this could create a demand for more recycled materials within a particular area. IP06 also suggested ambitious infrastructure projects such as building sound walls on the highways could use recycled plastic instead of the current concrete/timber, a practice which might ensure an ongoing demand for recycled products. However, like IP02, participant AP06 considered that there was a need to look more closely at such projects' circularity, since once waste plastics are put into roadways the future of these now mixed

> materials had to be considered. In general, there was some consensus that the value of what is recycled or reused needed to become higher to ensure a demand for them. Higher quality and cleaner waste streams would enable the creation of higher quality recycled products, leading to increased demand over time.

Burying waste in a road or concrete is a lost opportunity and programs like Redcycle are just there to make us feel better

Scott Morton, BioBag World Australia

As well as pointing out the deficiencies in waste stream data, many participants noted that there is often insufficient information attached to what is 'in' the waste. A number emphasised the value of capability mapping so that the circular potential of certain materials in particular locations could be better understood and more effectively managed, and in this way moved towards a circular economy. Participant AP01, used the example of wastes produced by the smelter at Port Pirie, and its potential co-processing with e-waste. To process this locally would be better than exporting it overseas, as is done at the moment, and could provide an opportunity for more CE-led enterprises. However, material flows and related data need to be better understood and linked to a knowledge of the circular economy amongst practitioners, and these would then be able to see the potential for particular circular business models to develop in response (AP07).

The potential of the circular economy to reduce emissions and decouple material flows

from economic activity was also raised by several interviewees. Participant AP03, for example, emphasised the present gap between emissions reduction research and that which measures and enumerates the benefits of circular economy. Participant NP04 similarly emphasised the environmental value to be gained from decoupling material flows from economic activity in the circular economy, and how recycling alone, since it involves adding considerable energy and new materials, is insufficient on its

#### Technology & Systems

own to achieve this aim.

Most of the participants emphasised technology's critical role in developing circular solutions, through streamlining processes, increasing efficiencies, and scaling up activities, all points also made in the literature. In agriculture, particularly, technology was seen as extremely valuable in the development of the circular economy. Several referred to the ability to measure and monitor the weather and landscape using sensors and cyber-physical systems, and to provide temperature and rainfall information. In some areas of agriculture, technology was a 'game-changer'. There was also considerable interest in new but widely applicable technologies, such as drones and sensors. Drones are used in the agricultural sector, extending beyond farming and grape-

growing to other rural activities in bushland and forests.

I think technology is going to play an important role in the circular economy in the development of techniques that eliminate, for example, the environmental dangers presented by single use plastics.

> Paul Huxtable, Good Design Australia

Smart technology at smaller scales will play a key role in the success of regional implementation. Systems including items such as small glass crushers for bottles to become sand, and engagement with schools for composting and community gardens, could help close loops on particular waste streams locally. A factor that is missing is the ability to ascertain which technologies can succeed and be commercially viable. Councils and small businesses in regional SA do not have the capacity to identify which technologies could work for their needs. Therefore they do not know where to invest their money and time.

Participant NP01, referring to the overlap between Industry 4.0 and the circular economy, noted that machine learning technologies could bring about less waste and greater efficiencies to production processes, as big data can be used to analyse materials and waste streams. Technological developments in 3D printing could also result in more local production, with no need to import or export many types of goods. Locally sourced materials could be used to re-produce objects, either by companies on a larger-scale or by the local community at specialist 3D printing facilities.

However, technologies need to not only be successful but also commercially viable. At present, commercial applications of technologies tend to be less developed than domestic ones with a focus on households and household waste. As noted by participant IP04, conveyor belts which recycle the contents of bin collections are only designed to take domestic-sized bins, not commercial-sized bins, resulting in a lot of commercially produced recyclable materials going to landfill. Overall technology, in conjunction with Industry 4.0 initiatives, was seen, especially in agriculture, as a key enabler of the circular economy.

#### Design and process

One theme touched on by many participants was design and its potential to facilitate the move to a circular economy. A number of participants referred to the potential role of design to create new 'circular' products and processes, especially at the 'front end' of material flows. In this way it would become possible to design out waste, to design for disassembly to facilitate reuse, or to produce 'clean streams' for later recycling. At present, the general attitude is to make things cheaply and easily – where it becomes someone else's problem at the end-of-life of a product. For example, participant NP03 noted that the use of screws instead of glue makes it much easier to dismantle items at the end-of-life to reuse the materials again- including the screws. NP03 also noted that designers should approach the challenge of designing for the circular economy by extending the product's 'value chain' to improve social and economic outcomes, a view supported by NP01. Participant IP07 related the story of making pencils from sea-kelp and embedding tree seeds in them so that the pencils could be planted at end-of-life to grow trees—the reverse of cutting down trees

to make pencils. Further, they suggested designers should reduce the quantity of materials needed by perhaps reducing the thickness of materials or think up alternative solutions such as the example of producing seaweed-based sheep and cattle feed to reduce methane emissions.

The toolbox needed to achieve a circular economy is a very big tool box and product stewardship is one of the key tools when we're talking with product stewards, with manufacturers, with producers, with retailers.

John Gertsakis, e-Waste Watch and DIA

Participant NP03 noted that the design and process of making goods in a more circular way has the added benefit of resulting in green credentials, providing branding and advertising opportunities that could validate the maker and seller. Accreditation and certification is a tangible benefit that helps exports and sales - and circular economy certification would be a valuable addition to current credentialling regimes. However, standards and benchmarks would need to be established to make it a level playing field across markets and jurisdictions.

Many participants made the point that there is a need to rethink waste from the perspective of design and production. All agreed that waste should be viewed as a resource, not as a burden; attitudes should change to view waste as an input for other things. As participant IP07 noted, the circular economy is about what you leave behind, not the value that has been extracted. As he put it, the 'rape and pillage' of the planet may look good now providing profits and growth, but it diminishes asset values over time. And as NP04 added, the relationship between resources and growth needs to be re-examined from a longer-term perspective, questioning what will be left behind at the end of the production and consumption cycle.

Participant IP08 described the social enterprise Sustainable Salons, which collects waste from hair salons, including human hair, and creates sea-booms from that hair, to soak up oil spillages at sea, using the same chemical properties in hair that repels water but absorbs oil. Recreating and reusing waste and by-products is a key factor in circularity. As this example suggests, many processes involving reuse tend to be more readily aligned to the biological cycle of the circular economy, rather than the technical cycle. Thus, designers need to be more creative, even going down to the molecular level, as NP02 suggested, to reconstitute materials so that they can safely go back into the productive stream. And as participant NP01 noted, to be successful the recycled product value chain needs to create products whose values are higher than that of the original virgin materials used.

Repair was also of interest to the participants, and participant NP05 made the point that repair cafés should also be treated as co-learning spaces, where the community can learn why and how to repair items, and lengthen the life-cycle of their goods and products. While great things are being done in some areas such as water, energy and waste, there was concern amongst several participants that circular economy-led initiatives at present tend to be unconnected. Participant AP01 repeatedly called for 'joined up thinking' in response to this lack of connection. Ideas and initiatives need to be linked together holistically within a circular economy. As participant IP07 put it, the circular economy should be like ripples on a lake with millions of small, local initiatives sending out ripples and thus connecting the whole to what is happening in the society at large,

beyond these starting points.

We need to raise awareness of the negative legacy effects.

> Veena Sahajwalla, UNSW, SMaRT Centre



#### Logistics and Locality

Many of the participants referred to the importance of a local or regional perspective in developing and communicating an understanding of the circular economy. For many, the problem of waste in regional settings was an important starting point for discussing the implementation of the circular economy. For example, participant AP06 provided the following definition of circular economy for local government: the 'circular economy to me means that you are basically recycling your outputs back into inputs and you are keeping it within a regional location or within a system as such and that could be a town, a region, a state. It could even be national'.

There was a shared appreciation amongst participants of the potential benefits from implementing the circular economy at regional and local levels. This echoed the literature where regional circular economy development was seen as able to diversify revenue streams, reduce disposal costs and risks, attract and retain talent, and improve brand reputation. This was also emphasised by AP06, AP01, AP02, and AP03, who all acknowledged that the circular economy in regional areas could reduce costs, and create more sustainable outcomes for the community through circular initiatives and businesses. However, as AP07 emphasised, regional collaboration was an important aspect of this, since many SA councils lacked the resources to act on their own.

Having local champions to advocate for the circular economy in regional settings was also recognised as an important driver of the circular economy . According to participant AP05, local champions can play an important role, with local and state government organisations such as GISA facilitating collaboration in the community to draw out this more committed participation. Locality was another driver, with the 'local' having more resonance, and encouraging local people to join in. In the country, people like to support what is local, NP06 emphasised, and every location was understood to be different, with local nuances, a setting in which circular economy hubs could act as potentially important foundations for change (IP04, IP05).

A concern with barriers to the development of a circular economy at a local level was also evident in the interviews. Consistent with the literature, and mirroring the drivers identified above, anxieties around costs and an absence of government support, and a lack of collaboration, were foremost amongst the barriers identified. For instance, participant IPO3 observed that for many the cost of transport is one of the key barriers to the circular economy. For this reason, it is important to try to 'close the loop' locally and collaboratively, in this way overcoming this significant barrier. This could be an important advantage/enabler for regional SA since it is possible to have the producers and consumers of waste in the same place, with a number of participants pointing to processing organic wastes locally as essential.

Most participants recognised the importance of supporting the development of the circular economy in regional areas, but noted that this was often neglected by government and businesses. An example provided by NP03 seems instructive here: having mentored an oyster grower in Ceduna whose short-lived oyster baskets could not be recycled, NP03 designed him a more robust 10-year basket, but recycling this product proved to be very difficult in such a 'remote' region.

Developing local and regional circular solutions were of great interest to the participants, and most emphasised the importance of 'resource sharing' and 'mapping' local capabilities as a vital first step. For instance, AP07 identified 'resource sharing' and the identification of 'opportunities for collaboration' as amongst the most important strategies to help drive the circular economy in small towns or regional areas. These observations were supported by AP01, AP02 and AP03, although AP01 also made the point that opportunities in the region transcend most conceptions of 'region', since this

depended very much on the type of activity and its spread. Hence it was vital to map these activities, and their inputs and outputs, to be able to identify circular economy -type opportunities and capabilities. Further, there was a need for involving the community in this exercise. These views around strategies to identify capabilities and opportunities are consistent with the findings of the literature cited above.

#### Collaboration

Participants all emphasised the value of collaboration to help develop the circular economy in each region. Collaboration is also present in many of the success stories used to promote the circular economy in SA and appears to be lacking wherever barriers exist. In this sense, collaboration's presence acts as an enabler, while its absence becomes a barrier to implementation. Collaboration's potential enablement/disablement of the circular economy also points to the vital role played by universities in collaborative industry-based learning to produce 'jobs for the future', a point made by a number of participants.

The importance of collaboration was highlighted at a government level by participant AP02, who described it as 'essential between different government agencies and industry and community.' They emphasised that 'collaboration should be reciprocated across the board.' Participant AP07 similarly suggested that 'collaboration through engagement would flourish through a coalition of the willing', emphasising the central role of collaboration in locating regional champions of circularity. For AP07, collaborative engagement could help address some of the more difficult issues in the regional implementation of the circular economy in SA's small towns, which are different in scale, infrastructure, funding and needs compared to the other states' larger regional cities.

One standout suggestion from AP06 was to harness the collective power of local regional councils to catalyse collaborative engagement, which could then extend to industry, state and federal governments. This suggestion was echoed by AP07. At an industry level there was also clear agreement amongst participants on the need for collaborative approaches across sectors and between government, industry, business and education. NP03 oted that from his experience success through collaboration tended to come from the diversity of skills contributing to and influencing projects he had been involved with. This sentiment was echoed by another designer, participant NP04, who saw collaboration as essential in

Similarly, NP01 declared that the ideal starting point for such a collaboration was to focus on particular problems that could then be used as lenses to view implementation strategies for specific areas or regions. Such an approach could include considering consistency

bringing together critical skills around implementation goals.

I think that really at the heart of circular economy is local supply chains, and so I'm very much interested in how we can decentralise a lot of the services. particularly at the State level.

> lan Overton, Green Industries SA

Collaboration through engagement would flourish through a coalition of the willing

Simon Millcock, The Legatus Group of supply (of local 'waste' materials or resources) and an understanding of this in the context of their relationships within a supply chain, a point also supporting the importance of capability mapping.

Collaboration was framed as key to success but it was also made clear by a number of participants that without collaboration, an independent actor's agency in the circular economy space was limited. Several participants identified negative impacts for businesses who lacked the power to influence their supplier's packaging practices, meaning any upstream over-packaging or packaging using undesirable materials was felt further downstream where people were not empowered to affect change. This highlights the importance of seeing the circular economy' as a complex adaptive system with many interdependencies, and reveals the benefit of collaborative relationships in addressing blind spots or downstream consequences.

Some industry participants (IP04, IP05) recognised the need for a holistic systems approach that encompassed households, businesses, and industries working in collaboration with one another. The role of systems thinking as part of this collaborative effort was discussed by many participants, spanning industry and government, with circular economies being well described as 'adaptive systems' by AP05. He also identified the need for greater education and strategic experience to work within such an adaptive system. He suggested collaborative partnerships with GISA and the universities would be essential for such an undertaking.

Collaboration was also viewed as an important factor in the marketplace for remaking waste into useful 'circular' products. Early signals of such collaborative efforts were identified, for example, in the way that councils in Naracoorte and Lucindale are now recycling tyres into roadways, and a consortium of local councils are committed to a sustainable procurement policy that creates a market for other recycled products including office consumables, fixtures, construction materials and compost. Without such programs, the opportunities for using recycled materials remains limited. However, as IP06 suggested, such limitations could be overcome by mandating councils to buy back recycled products made from their waste through 'content buyback' initiatives. Though the same opportunities exist for corporates, their accountability to shareholders who have expectations of profit can hinder involvement in such programs, as currently most recycled products are relatively more expensive than alternatives. Councils' leadership in creating a market for recycled alternatives could therefore serve a dual purpose, by also influencing uptake in corporations.

It is clear that collaboration is a necessary aspect of the successful implementation of, and participation in, the development of the circular economy, however the benefits of this collaboration might also extend beyond it. Participant IPO3, for example, suggested that with wider collaboration, initiatives within the circular economy at a regional level could further support social needs through the generation of jobs, increase food security and even support improvements to mental health. But, as many participants also noted, the obverse of this emphasis is also true, that without real collaboration, the circular economy is unlikely to be successfully implemented.

#### Communication

Language concerns and the use of circular economy terminology were raised in multiple interviews, with some concerned with the ease with which the circular economy could become just another buzzword, used for instance to 'hijack recycling' or badge plastics as circular. Much like the theme of collaboration, effective communication was seen as an enabler of the circular economy, whilst alternatively, if done poorly or not at all, could create a most serious barrier to its implementation.

A common theme for those in the organics sector was the danger of rhetoric and the increasingly common misunderstanding of plastic as 'circular'. This was highlighted as an issue for education and communication, but also understood as a fundamental flaw in the way circular material flows were being understood by those participating in recycling programs. More effective communication of circular principles and processes was widely recognised as needed to overcome this misconception. This was described by IP01 as the need to go 'beyond spin' and to educate using plain English in an accessible way, and in different contexts. Though the current lack of clarity in the communication of circular economies is problematic, he suggested that knowledge about the circular economy should be embedded and integrated with economic and environmental learning in each discipline, from school onwards.

At a community and consumer level, many also referenced how a lack of transparency prevents most people from building an understanding of where their products come from. AsAP05 noted, despite considerable public awareness of solar power, water, and waste systems, even rudimentary knowledge of supply chains for most products was lacking. Others concurred, highlighting the value in transparently communicating the origins of products and their contents, suggesting that communicating the circular economy should involve focusing on the top half of the waste hierarchy, including consumption, rather than the bottom half as is common now. As NP03 emphasised, this could help

Cutting through the rhetoric and arguments around 'best' language will be key to a shared understanding, and IP01, described the clear benefit in focusing on points of agreement. He noted how debate over terminology could become a barrier, but simpler terms such as pollution became 'an argument everyone can engage with'. This provides some insight into the role language plays in inviting participation towards a shared vision or action, and in the specific role that effective communication can play in reaching a shared vision in the first instance.

mitigate the danger of the circular economy being rebadged as only a form of waste reduction.

Participant NP02 highlighted the need for communication to emphasise the holistic nature of the circular economy, as having social, environmental and economic benefits. She pointed out the circular economy's close relationship to the UN's Sustainable Development Goals, going beyond number 12, 'responsible consumption and production', the goal usually associated with the CE. Many participants offered suggestions for where such communication might be most impactful. In regional contexts, locally specific communication through a combination

I think being able to articulate the stories in this early adoption phase is really important, and that's where I think investment and traceability is so key.

> Kelly Anne Saffin, RDA, Yorke and Mid North

of social media and local newspapers seemed to be key. While some felt traditional media such as TV advertising could have a role to play, social media seemed especially important for its ability to capture attention through repeated exposure in newsfeeds, networks and amongst 'friends'.

Participant AP03 described successful public engagement as being 'all about the narrative; it's all about storytelling and communication; stories, supported by numbers (evidence) shifts others', whilst AP02 emphasised that 'seeing things in action could generate interest'. AP03 further emphasised the current lack of communication between researchers and business, describing how business often lacks the ability to see what researchers can offer business development. Participant NP06 suggested industry bodies had a significant role to play in communicating the circular economy and its goals, whilst AP05 suggested businesses needed to better understand the circular economy's purpose, that a circular economy is less about 'what you make' and more about 'why you make it'. AP05 referred to the case of electronic giant, Philips' communication of its provision of lighting as a service, as exemplary in communicating the circular economy with clarity of purpose to businesses.

There were many overlaps between participants' expressions of the need to communicate and the need to collaborate, and it is evident that effective communication was crucial for inviting participation in circular economy-directed collaborations. Participant AP06 emphasised the interdependency of collaboration and communication, noting that it is 'probably the key ingredient that's not there now.' Participant AP03 concurred, declaring that success for GISA would consist of people in regions recognising the value of the circular economy, embracing it and collaboratively working towards its goals.

It is thus clear that effective communication of the principles and processes of the circular economy must play a pivotal role in people's recognition of its value, and in their participation. This comes from increased transparency, shared goals and language, and the clarity with which core principles and practices are communicated, which can be spread through education,

learning and networking. South Australia has a significant opportunity to clearly define the circular economy and make it tangible in ways that invite participation.

Collaboration and communication are probably the key ingredients that are not there now.

Tony Wright, Limestone Coast LGA

#### Education

Education was highlighted by many participants as a crucial component of the transition to circularity. Education was discussed both in terms of barriers and enablers. Lack of education was identified as a significant barrier. As AP05 stated, 'it won't happen without education'. Businesses and the public need education about the circular economy and its benefits. Businesses seem to have a better understanding of the circular economy in general, but there is less understanding about the potential value that this can add to their activities.

On the other hand, businesses that are already embracing the circular economy and offer recycled products are facing the challenge of educating potential clients to sell their products. As IP06 stated, 'We refer to our salespeople as educators... I have to hire salespeople who have to first educate people about recycled products'.

Education was considered a key enabler to build capacities and skills associated with implementing the circular economy. It was discussed as something that should be embedded in schools and colleges rather than becoming only a specialist topic in universities and it could become part of learning across multiple subjects instead of being contained within older 'environmental' studies programs. While NP01 believed the circular economy should become a separate course in

success is legacy....and quite
often the legacy of that is a
destroyed piece of earth
Warrick Duthy,
Watervale Hotel.

The only real measure of

programs. While NP01 believed the circular economy should become a separate course in universities rather than diluted (and 'lost') across different courses, there was some unanimity in the belief that it should have a more central role in formal education at all levels, and that a 'learning by doing' approach would be the most effective. As IP07 put it, 'we need to educate through experiences- see, taste, feel and smell'.

It was also emphasised that there was a need for more capacity development opportunities, with practical elements, at the community level. NP05 suggested that initiatives such as Maker Space Adelaide and repair cafes in regional areas could be very useful to further this 'learning by doing'. In these co-learning spaces, make and repair activities can be amplified, and broken objects not just repaired, but the skills to repair them can be imparted from one community member to another.

Some aspects of the topic of education were closely aligned with that of collaboration. The need for workshops bringing together industry, researchers, policymakers, councils, NGOs, was canvassed, in order to better understand what each is doing and the education gaps and opportunities. Others highlighted the importance of collaboration so that research at universities would not be limited to producing 'research papers,' but rather focus more on tangible benefits, to educate businesses, government, policymakers and communities. Some further emphasized the role of universities in helping councils and businesses make decisions about which technologies and practices to adopt, given that these are presented with many options, and often do not have the capacity and time to test them.



#### Policy & Politics

Most participants agreed that legislation plays a critical role in driving change, as businesses would need to comply thus making policy crucial to implementing the circular economy. The SA Government's historic leadership in this area was mentioned as giving businesses confidence that there will be support in the form of policies and programs to promote the adoption of the circular economy in SA. Most agreed that policy, and supporting funding programs, will play a vital role as an enabler of the circular economy, but also understood that policy can become a barrier when there is a shift away from more pragmatic approaches. Participants also drew attention to the fact that businesses respond to value propositions, and these can be incentivised through taxation, and funding, to drive them towards circular policy goals.

Legislation was understood as a key guide for businesses, making clear what could and could not be done with materials and wastes, and to encourage them to find solutions to their waste problems. NP03 saw the value in government developing transition strategies and policies, to shift thinking and businesses towards the circular economy, beyond the incrementalism preoccupying most governments at present. Most of the participants were also concerned that waste and recycling has become the focus in circular economy discussions and emphasised the need to rethink CE policy in relationship to design. According to NP01 and NP03, this could include using levies to shift behaviour in areas such as a choice of materials, and to encourage more circular design strategies.

A lack of consistency or standards between councils was also considered to be a significant barrier, along with a lack of leadership from the Federal Government. Participants regarded policy and regulation as important shapers and enablers, but barriers were often encountered once the costs of change were recognised, and the risks became more apparent. NP05 mentioned one of the issues encountered in community repair hubs, where local regulations and liability concerns (particularly with electronics) could inhibit community involvement and hamper repair itself. This is one area that may need more specific support in legislation to encourage greater participation in the repair of broken objects.

Participants IP05 and IP06 also referenced government procurement policies needing to adopt a CE-approach, which could be included in tender processes. They also considered its absence as an important barrier to implementation.

A need to stimulate collaboration to encourage engagement in the circular economy at a local government level was also widely recognised. AP06 acknowledged the tension between councils being risk averse but needing also to be innovative to adopt a circular economy. Because councils are dealing with community money there is a tendency towards conservativism, even if they will become one of the main initiators of getting the circular economy up and running.

#### Leadership

Leadership emerged amongst a number of participants as a critical enabler of the circular economy. Participants agreed on the need for leaders and champions to demonstrate 'how it is done' for others. These leaders could be drawn from government, communities, businesses, NGOs or researchers. To successfully embrace the circular economy, participants emphasised both a bottom-up and top-down approach as necessary, and leaders in this process are needed at both ends of the continuum.

From the bottom-up perspective, while some cohorts of businesses are interested in the circular economy, there is a perceived lack of leadership in most regions, with

communities remaining largely unaware of its benefits. Champions in a region can demonstrate how the adoption of circular economy principles have provided them with a competitive advantage, and then others will be inspired to follow. As AP05 put it, 'there's nothing more powerful than word of mouth for industry to see if somebody else has a competitive advantage and want to go and find that competitive advantage for themselves'. Local success stories become powerful encouragements to others and help to set the tone.

While there is a perceived lack of leadership in most regions, some participants highlighted examples of industries where tangible demonstrations of the circular economy could be observed. For instance, AP05 related the story of a cheesemaker discovering that a waste product was more valuable than the cheese itself, and a potato seller who found that starch from potatoes could be more valuable than the potatoes on the market. Thus, the issue might not be the lack of champions as such, but a lack of understanding of what the circular economy means in practice, and a failure to promote these practices and the thinking behind them.

I think if we have a common understanding of what a circular economy is... and a shared understanding of what the outcome is, that people will want it in that region.

Vaughan Levitzke, Green Industries SA

From a top-down perspective, participants agreed that governments at the national, state and local levels are expected to embrace and lead circular economy efforts, particularly local councils. Several participants argued that councils need to take a lead on implementing the circular economy in their region.

This leadership can be demonstrated by identifying the critical issues affecting the region and setting and driving a circular economy agenda that is inclusive and has been shared with stakeholders. Local governments are now expected to provide more initiatives to incentivise the adoption of the circular economy within local businesses and communities, and also to promote collaboration with other councils in the region to further the circular economy. A number of participants also emphasised that there is currently strong support from SA politicians and bureaucrats who have largely acted to support a circular economy agenda for South Australia (AP01, AP02, AP07).

#### Consumer Attitudes and Behaviours

Consumer attitudes and behaviours emerged as a major theme in all the interviews. The attitudes and behaviours of consumers towards waste and its utilization was understood to be potentially both an enabler and a barrier to the development of a circular economy. The following seven topics were discussed by the participants under the heading of consumer attitudes and behaviours:

- Today's consumer ignorance of products, their impacts and where they come from;
- Well-established negative perceptions around the circular economy and 'waste' deriving from the linear economy;

- The need for a cultural shift in how the circular economy is presented and understood by consumers;
- The need for consumer education and embedding the circular economy into their lives and habits;
- The importance of creating a demand for circular products;
- The role of advertising in achieving this goal; and
- The more hopeful role of young people in embracing the circular economy and helping shift attitudes towards it.

Consumer ignorance about environmental challenges and the benefits of the circular economy were cited as a major reason why there was not enough demand for products resulting from circular economy systems. NP02 emphasized that 'we need to raise awareness of the negative legacy effects' of the linear economy in order to canvass the benefits of going circular, a sentiment echoed by NP03. AP05 remarked on the fundamental lack of understanding of many consumers who seem to have the attitude, 'what does it have to do with me'? According to NP03, this 'consumer ignorance holds back businesses from change, [and] disadvantages and slows development of circular economy'. From a business perspective, IP06 emphasised consumers' general ignorance of products made from recycled products, 'people have used concrete or timber for centuries. Low awareness about recycled product leads to lack of willingness to buy'.

Circular economy on its own is confusing, [and] so needs to be linked to what they [consumers] understand in terms of quality, provenance, ethics, etc, and presented within the framework of the social license to do business.

Sam Buccolo, Australian Design Council Consumer ignorance may lead to negative perceptions around the circular economy and waste. Negative perceptions of recycled products abound.

Participants IP04 and IP05 noted that recycled products 'may not be considered clean and hence markets such as supplying schools are often not allowed'.

Waste recycling is seen 'as someone else's problem' (IP04, IP05). According to AP01 negative perceptions can also lead to consumer 'cynicism, traditional thinking and politicizing concept or solutions, which creates division and diversion of energy'.

Adding to this problem is confusion around the meaning of the circular economy from a consumer's perspective.

According to NP01, 'circular economy on its own is confusing, [and] so needs to be linked to what they [consumers] understand in terms of quality, provenance, ethics, etc, and presented within the framework of the social license to do business'.

A majority of the participants stressed the need to create a cultural change to increase awareness about the importance of circular economy, its benefits, and the shared vision to develop it. Participant AP04 emphasised that 'the cultural change that goes with a circular economy cannot be underestimated'. 'People need to think that waste is gold'

concurred IP07. AP02 added to this that such a change required people to understand the economy in a different way: 'a mindset shift is needed, we don't need to continue to grow GDP, we don't need consumption to go up. We need to rethink what are our targets'.

A number of the participants emphasised that cultural change and a shift in consumer attitudes and behaviours can be brought about through consumer education.

According to AP06, 'community attitudes and perceptions need to change... the other main enabler will be [changing] community attitudes, and community perceptions... get the community attitudes and perceptions right, then they will be demanding products that are linked to the circular economy and they will even pay a premium for those products.'

This was reinforced by NP04 who argued that 'engaging consumers is vital – it needs to go beyond spin to educate with plain English information that is accessible and useful; engaging communities and institutions using a whole of government approach is

essential (e.g. politicians, bureaucrats)'. According to IP08, if the circular economy can be embedded into consumer habits, they may become 'part of it without even knowing. After several years it is forgotten about as it's just routine so a barrier might be that people do not talk about it anymore. Need to have an open mind and a mindset so that waste is automatically separated into separate bins'.

Some of the participants also emphasized the importance of advertising to engage consumers and to create demand. AP06 stressed that 'showing them [consumers] where their stuff goes, and what they can do' is critical to creating demand for more circular solutions and products. Participants repeatedly argued that for the circular economy to succeed 'consumers need to demand and want products that come out of the circular economy' (IP06).

Participant AP05 explained that 'consumers need more knowledge of products and [their] origins. Consumers as community need to become engaged in circular economy, and this will involve education programs embedded at all levels'. A number of the participants felt that there was considerable hope that the young were more likely to embrace the circular economy, with their attitudes towards waste, recycling and circular economy a cause for hope. As NP06 put it, 'The younger generation are more interested in circular economy'.

'The younger generation are more interested in circular economy'.

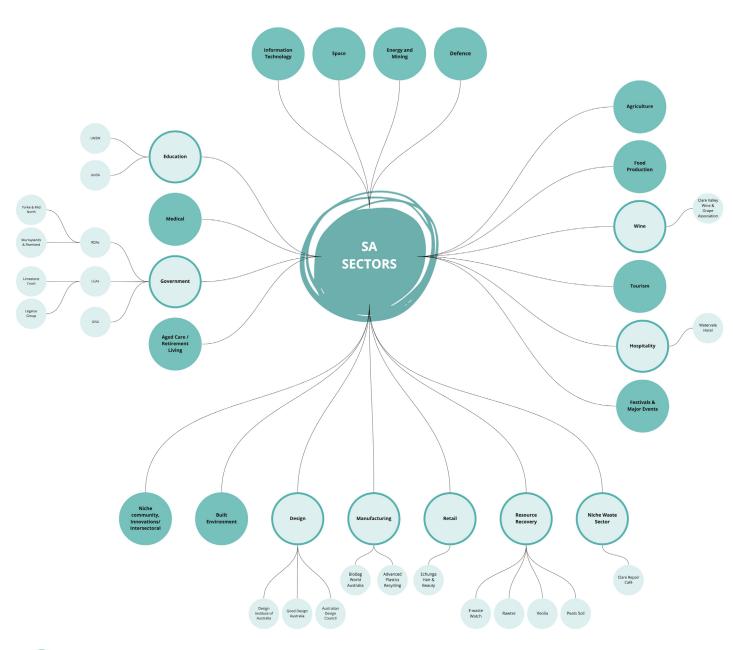
Anna Baum, Clare Valley Wine & Grape Association

### Stakeholder Mapping

Mapping provides insights into the network of stakeholders in any system, revealing where the relationships already exist and where gaps could inhibit circular economy pathways.

The map presented here reflects the initial scoping of relevant stakeholders across sectors in South Australia. Relationships across these sectors would need to be nurtured as part of the implementation of a circular economy in regional SA.

The map indicates where representatives from these sectors have participated in this research and where they have not. Further mapping and nurturing of these cross-sectoral relationships forms part of the recommendations to follow.



Sector to be engaged with

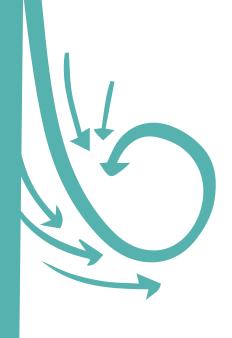
Sector engaged with as part of this research

Interview conducted with sector representative



The circular economy concept is understood here dynamically, as an iterative process to engage business, government and community in increasingly effective practices of reuse, resource conservation and waste avoidance, implemented through a broad range of pragmatic, technologically enhanced methods. Its aims, strategies and procedures are not exclusively the preserve of those that promote the circular economy, but sometimes held in common with

those in neighbouring fields, even in those fields notionally critical of the circular economy concept itself, or at least some of its claims, such as urban ecology and 'degrowth' (Korhonen, Honkasalo & Seppala 2018). The circular economy is thus not so much a well-defined destination as a pathway to a less resource intensive world, an 'umbrella' concept (Homrich et al. 2018) made up of many 'resource value retention options' (Reike et al. 2018) across the economy.



Our review of the literature revealed an increasing recognition of the economic, social and environmental benefits of the circular economy, although this often entailed a lively discussion of barriers to, and enablers for, its implementation (Kircherr et al. 2018; Jugend et al. 2020). Within the literature on circular economy, there was considerable attention paid to capturing value in new more circular ways, with a number of studies concentrating on circular business models (CBM). These often emphasised that most circular business models must depend on more transparent, circular supply chains and interfirm collaborations (Geissdoerfer, Vladimirova & Evans 2018; Hankammer et al. 2019). There is thus a growing awareness in the literature of how important thinking beyond the limits of the firm, the product, and the momentary transaction, is to capturing value in the circular economy (Pieroni et al. 2019).

There was also much discussion in the literature on the role of technologies in enabling more circular solutions, with the research tending to bifurcate into discussions of how to better monitor and manage material flows more efficiently for circular ends, and into more technical discussions relating to how these materials can be 'remade' or reformed into higher value products in innovative ways (Dev et al. 2020, Halse & Jaeger 2019, Antikainen et al. 2018). The potential role of product design to help develop circular business models was also a focal point in several research articles (Den Hollander et al. 2017). However, design tended to be linked primarily to the creation of circular business models (Bakker et al. 2020), and not to engaging and modifying presently 'linear' consumer attitudes and behaviour. Indeed, consumer behaviour, and a widespread reluctance to accept 'recycled' or reused products, was identified repeatedly as a key barrier to the development of a circular economy (Govindan & Hasanagic 2018; Maitre-Ekern & Dalhammer 2019).

While there was interest in the literature on communicating the advantages of the circular economy to consumers and businesses (Maitre-Ekern & Dalhammer 2019), there was less attention paid to pragmatic ways of educating consumers and communities on the advantages of the circular economy, and few successful cases. In fact, there was a dearth of literature on education for the circular economy, with a handful of exceptions which were mainly focused on the potential role of design to engage with consumers and encourage their take-up and understanding of the circular economy (Wastling, Charnley & Moreno 2018).

Our study fills a gap in this rapidly expanding field, especially as it applies to regional Australia. Derived from 22 interviews with experts in industry, government, design and community, our findings shed further light and provide greater clarity on the emerging themes identified in the literature review. Our analysis of the interviews below identified twelve key themes in three broad categories (technical, bridging and social) that could help progress the take up of the circular economy in regional South Australia. These are largely consistent with the themes emerging from our literature review.





Within this category, our findings highlight the critical importance of circular business model innovation, identified enablers of, and barriers to the development of a circular economy, regional material flow perspectives and how they can aid this development, and the specific value and potential role of design and technology in developing a circular economy. We provide a brief summary of these below:

- Circular Business Model innovation was regarded as pivotal by most of the participants, needing to become a 'core business process' for value capture aided by design for extended use and reuse. In agricultural settings, this was often linked to the goal of natural resource regeneration.
- Barriers to the development of CBMs were frequently discussed, with some noting the negative impact of narrow 'linear' type cost benefit analyses that tended to confirm the value of 'business as usual', whilst ignoring the wider, often damaging legacy of polluting environmentally destructive or wasteful practices.
- Enablers identified by the participants tended to emphasise
  the absence of these barriers, plus having local champions
  to actively engage business, community, and government,
  and to advocate or demonstrate various circular
  solutions. Other enablers frequently cited were the state
  government's waste levies and supporting legislation, such
  as the banning of plastic bags and more recent eradication
  of single use plastics.
- Material flow perspectives adopted by many of the participants led to an emphasis on the local or regional value of organic or green waste streams for regenerating natural resources, on capturing value from particular waste sources, even difficult ones, on deploying technology and design to better balance supply and demand, and on the under-recognised but critical role of the circular economy in decoupling material flows from impacts and emissions.
- The value of technology in conjunction with Industry 4.0 initiatives, in furthering the goal of the circular economy was also emphasised repeatedly, in measuring flows, reducing impacts, regenerating natural resources and implementing solutions.
- Design's role in the developing circular solutions, often linked to both technological solutions, reduced impacts and innovative business models, and especially its role in transforming the 'front end' of material flows to ensure extended use, reuse and repair, was also repeatedly emphasised by the participants.



Within the bridging themes our research identified localization, collaboration, deep cooperation, communication and education as being critical enablers of the circular economy. We provide a summary below:

- Localization in a regional setting even when crossing council boundaries was emphasised as essential to developing a circular economy. This was linked to the value of mapping capabilities and measuring material flows in particular regions, in order to help identify opportunities for new circular business models able to reduce impacts and retain resources within the region. Logistics, and the present dependence of many regions on linear solutions requiring expensive transport options, was also emphasised as a critical barrier to regional circular economy development, with traditional cost benefit analysis tending to render circular economy solutions seem 'expensive' relative to the much larger expense and environmental impact of dependence on long-distance transportation and centralized solutions.
- Collaboration in developing circular economy solutions was seen as critical, with many emphasising that local councils were best positioned to engage with all levels of government, business and community, to shift thinking and to engage communities on the value of the circular economy, with a particular emphasis on the need for collaborative systems thinking, or 'linked up' thinking and cooperative development across and between regions. The relationships underpinning such collaborative efforts could also be considered a form of cultural regeneration.
- A deeper cooperation between businesses and along supply chains to increase circularity and natural resource regeneration was also thought to have many regional benefits, with many of the participants emphasising the importance of cooperation in developing circular business models, since many successful examples of these depended on recognising synergies and novel ways of value capture.
- Communication and collaboration were understood as depending on each other, to expand an understanding of the circular economy and its benefits, with transparency and reliable information also emphasised, along with the value of success stories or narratives that could demonstrate the circular economy's benefits and not just in technical terms, but also in terms of regenerating the natural environment.
- e Education was widely seen as a key enabler for acceptance and engagement in the circular economy, and most agreed that it should be practical and embedded at all levels of school, vocational and higher education. Introducing graduate specialisations in the circular economy in universities to counter the effect of misunderstandings apparent in current business leadership was also emphasised and supports the need for regenerative approaches.



Within the social category there was a strong emphasis on the role of policy and legislation, including changes to government's procurement policies, leadership that champions the circular economy, the tangible demonstrations of success narratives, a shift in consumer attitudes and behaviours, and reflecting on all these the critical role of cultural change in facilitating the further development of the circular economy. We summarise these themes below:

- The role of policy and legislation in the development of the circular economy was widely appreciated, with levies and other legislative innovations, such as the banning of plastic bags and throwaway plastics, seen as significant tools to help shift the community and business towards greater circularity and circular economy thinking.
- Government procurement policies were also noted by several participants as important enablers of progress towards the circular economy, with council procurement seen as a significant enabler at a local or regional level, for instance using recycled materials from their own waste streams as a way of publicizing and increasing the take-up of circular economy in the region.
- Leadership involving 'circular economy Champions' was seen as a critical enabler of the circular economy, both from a bottom-up community perspective, for instance through local circular economy Hubs and Repair Cafes, and a top down one, driven by government programs funding innovative circular business models and improving access to circular solutions across the region.
- Tangible demonstrations and success narratives associated with champions or exemplar companies were also widely appreciated as significant enablers not only of engaging the community, but also of helping lead business and government towards a realisation of the circular economy's practical social, economic and environmental benefits in a regional setting.
- Consumer attitudes and behaviours, a barrier repeatedly emphasised in the literature, were also of concern to all participants, who saw ignorance, consumerism, legacy effects, along with wasteful habits and attitudes, as significant barriers, with a tendency to lock many people in the community in to the dominant linear economy of 'make, use and trash'. This theme was frequently linked to the above discussions of legislation, education, communication and collaboration, with the role of champions again being emphasised as helping overcome these and related barriers.
- Cultural change was emphasised as the essential precursor to acceptance and community engagement in the circular economy, and to the development of circular businesses, and this brought together most of the above themes, including community engagement, education and demonstrable success stories, and progress towards both cultural and natural resource regeneration.



Analysing and mapping these themes against the background discussions evident in the research literature, we determined that the circular economy in regional South Australia could be implemented most effectively through a series of short, medium and longer term targets. Where possible, these recommendations can be implemented in parallel.

Those listed under the medium term (1-3 years) and long term (1-5 years) are likely to require more complex and longer term collaborative processes of iterative development and commitment than those listed under the short term (1-2 years), some of which have already commenced. The realisation of these targets will require coordination between local government and Regional Development organisations and Green Industries SA, preferably facilitated by Regional Circular Economy Coordinators, a new leadership role included in the Short Term list of targets. How this is decided upon in relation to particular targets and their funding is beyond the scope of this report. Some of the medium and longer term targets will also require considerable research to effect, and what this might involve, and who might be tasked with this work, is beyond the scope of this report.



## short term targets... (1-2 years)

- Establish and fund Regional Circular Economy
  Coordinators to ensure the targets listed here
  are fully implemented.
- Align regional waste management strategies to support the goals of the circular economy, including downstream value capture from different waste streams.
- Collect and measure material flow and waste stream data from each region to support circular economy initiatives, and provide data able to be used to map capabilities and opportunities.
- Map circular economy capabilities and potential relationships in each region based upon this data, in and across industries within each region.



Develop a toolkit able to make the resulting capabilities transparent and accessible to consumers, businesses and other economic actors in and across each region.



Encourage and incentivise where possible the local processing of waste materials, including organic wastes, to reduce transportation, and improve environmental regeneration.



Initiate a range of educational programs for schools, businesses, industry, and communities to link the development of the circular economy to its social and environmental benefits, including meeting the Paris Agreement and the Sustainable Development Goals.



Develop guidelines for circular economy procurement targets for local and regional government organisations, and incentivise businesses to do same.

## medium term targets... (1-3 years)

- Establish 'Circular Economy Hubs' in regional centres to showcase the circular economy and provide opportunities for collaborative innovation and learning.
- Incentivise and encourage businesses, organisations and community groups such as maker spaces, repair cafes, and allied groups to co-locate to these hubs.
- Develop circular economy communication and educational packages to be distributed through these hubs to improve knowledge of the circular economy and its connection to the Sustainable Development Goals.



Embed regenerative agricultural solutions and allied conservation efforts into the regional circular economy and encourage and incentivise their adoption.



Establish a circular champions network and a regional 'Circular Leadership Program' to further professional and business engagement in the circular economy.



Develop and embed circular economy content, develop postgraduate qualifications and research programs in tertiary institutions.

# long term targets... (1-5 years)

- Collaboratively develop a technology and digital strategy to enhance transparency and measure progress towards circularity and carbon reduction, with specific reference to the Sustainable Development Goals.
- Establish a circular design incubator program within the proposed Centre for Excellence to support circular technological business innovation.
- Initiate a circular economy marketing and branding package to encourage and incentivise businesses and consumers to engage in the circular economy.

- Develop a circular economy policy and funding program for business and industry to enable the circular economy and discourage the linear economy.
- Expand the proposed 'Circular Economy Centre of Excellence' to support the implementation of the circular economy in regional SA, through encouraging design, research and innovation, education and strategic development towards the goals of the circular economy.

#### Conclusion

The circular economy is not so much a fixed destination as a series of linked iterative pathways to a less resource intensive world, spanning everything from reduced consumption, to extending product use, product service systems, systematic reuse, repair, remanufacturing, recycling and material reformation. We have emphasised in our recommendations the role of local and regional actors to collaboratively kickstart processes of circular business development and innovation, ranging from local and regional procurement for government and business, to progressive policy development able to incentivise and lend weight to the creation of regional circular economies.

The implementation of the circular economy at a regional level will have many benefits, including generating new business opportunities and encouraging local economic and social development. These more circular activities have been predicted to reduce the environmental impacts associated with the linear economy, to regenerate natural resources and reduce the emissions associated with climate change. These goals can all be tied explicitly to the Sustainable Development Goals and the obligations of the Paris Agreement targets.

The recommendations made here provide a series of interrelated and pragmatic targets for the progressive roll out of the circular economy across the regions in South Australia. For example, mapping capabilities in each region would reveal synergies and potential partnerships between economic actors able to develop innovative circular ventures. Similarly, establishing regional circular economy hubs could help local governments and regional development agencies engage the community and local business in experiencing and learning about the circular economy, and these could also act as conduits for communication and educational packages also listed amongst the targets.

The environmental significance of this initiative has been emphasised repeatedly in the literature: up to 70% of global greenhouse gas emissions has been traced to material flows, and controlling these is the unique promise of the circular economy. More detailed studies, some suggested here, and more direct collaboration between researchers, councils, businesses, communities and state government agencies, will be necessary to realise the full benefits outlined in this report.

## References

Alelyckan Recycling Park, Gothenburg, Sweden (2020), available at https://www.urbanwins.eu/alelyckan-recycling-park-in-gothenburg/

Appelgren, S., & Bohlin, A. (2015a) 'Circulating Stuff through Second-hand, Vintage and Retro Markets', special issue of *Culture Unbound*, 7: 3-11.

Appelgren, S., & Bohlin, A. (2015b) 'Growing in Motion: the circulation of used things on second hand markets', *Culture Unbound*, 7: 143-168, available at http://www.cultureunbound.ep.liu.se

Antikainen, M., Uusitalo, T., Kivikytö-Reponen, P. (2018), 'Digitalisation as an Enabler of Circular Economy', *Procedia CIRP*, 73: 45-49.

Australian Packaging Covenant (APCO), available at https://apco.org.au/

ARL (2020) Australasian Recycling Label (Planet Ark), available at https://recyclingnearyou.com.au/arl/

Australian Circular Economy Hub (Planet Ark) (2020b) Circularity in Australian Business, available at https://acehub.org.au/knowledge-hub/research/circularity-in-australian-business-2020

ATSE (2020) Towards a Waste Free Future (report), available at https://www.atse.org.au/research-and-policy/publications/publication/towards-a-waste-free-future/

Avdiushchenko, A. (2018) 'Toward a Circular Economy Regional Monitoring Framework for European Regions: Conceptual Approach.' *Sustainability.* 10.12: article no. 4398.

Baldassarre, B., Calabretta, G., Bocken, N. M. P. & Jaskiewicz T. (2017) 'Bridging sustainable business model innovation and user-driven innovation: A process for sustainable value proposition design'. *Journal of Cleaner Production*, 147: 175-186.

Baker-Brown, D. (2019) 'Who is mining the Anthropocene?' in Charters, M. (ed), *Designing for the Circular Economy* (London: Routledge): 336-343.

Baker-Brown, D. (2017) The Reuse Atlas: a designer's guide towards a circular economy (London: RIBA publishing)

Bakker, C. A., Mugge R., Boks C., & Oguchi M. (2020) 'Understanding and managing product lifetimes in support of a circular economy', *Journal of Cleaner Production*, 279: article number 123764.

Bakker, C.A., den Hollander, M.C., van Hinte E. & Zijlstra Y. (Author) (2014) *Products that Last: Product Design for Circular Business Models* (Delft, Netherlands: TU Delft Library)

Bauwens, T., Hekkert, M. & Kirchherr, J. (2020) 'Circular futures: What will they look like?' *Ecological Economics*, 175, art. no. 106703

Belkhir, L., & Elmeligi, A. (2018) 'Assessing ICT global emissions footprint: Trends to 2040 & recommendations' *Journal of Cleaner Production*, 177: 448-463.

BIOREGIO Interreg Europe (2020) https://www.interregeurope.eu/bioregio/

Bocken, N., Strupeit L., Whalen K., & Nußholz J. (2019) 'A review and evaluation of circular business model innovation tools', *Sustainability* (Switzerland), 11 (8), art. no. 2210.

Bocken, N.M.P., Rana, P. & Short, S.W. (2015) 'Value Mapping for Sustainable Business Thinking', *Journal of Industrial Production Engineering*, 32: 67-81.

Boffey, D. (2020) 'Amsterdam to embrace doughnut model to mend post-coronavirus economy', Guardian, April 8, 2020, https://www.theguardian.com/world/2020/apr/08/amsterdam-doughnut-model-mend-post-coronavirus-economy

Boulding, K. (1966) 'The economics of the coming spaceship earth'. In. K. Boulding et al. (Eds.) *Environmental Quality in a Growing Economy.* Baltimore, NJ: Johns Hopkins University Press.

Camacho-Otero, J., Boks, C. & Pettersen, I. (2018) 'Consumption in the Circular Economy: A Literature Review', *Sustainability*, 10.8: 2758-2773

CGRi, The Circularity Gap Reporting Initiative, available at https://www.circularity-gap.world

Cherrier, H., Ture, M., & Ozcaglar-Toulouse, N. (2018) 'Considering 'waste value' in the circular economy', in Crocker, R., Saint C., Chen G. & Tong Y. (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 91-101.

Commonwealth of Australia (2020) Department of Environment, Waste Publications and Data, available at http://environment.gov.au/protection/waste/publications

Cooper, T. & Salvia, G. (2018) 'Fix it: Barriers to repair and opportunities for change', in Crocker, R. & Chiveralls, K. (eds), *Subverting Consumerism: Reuse in an Accelerated World* (London: Routledge): 147-165.

Cooper, T. (ed) Longer Lasting Products: Alternatives to the Throwaway Society (Farnham, UK: Gower Publishing)

Crocker, R., Saint C., Chen G. & Tong Y. (eds) (2018) *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald)

Crocker, R., & Chiveralls, K. (eds) (2018) Subverting Consumerism: Reuse in an Accelerated World (London: Routledge)

Crocker, R. (2018a) 'From 'Spaceship Earth' to the Circular Economy: the problem of consumption', in Crocker, R., Saint C., Chen G. & Tong Y. (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 13-34.

Crocker, R. (2018b) 'Acceleration, Consumerism and Reuse: A changing paradigm', in Crocker, R. & Chiveralls, K. (eds), *Subverting Consumerism: Reuse in an accelerated world* (London: Routledge): 11-33.

Crowther, P. (2018) 'Re-Valuing Construction Materials and Components through Design for Disassembly', in R. Crocker et al. (eds) *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 309-322.

De los Rios, I.C., & Charnley, F.J.S. (2017) 'Skills and capabilities for a sustainable and circular economy: The changing role of design', *Journal of Cleaner Production*, 160:109-122.

De Man, J. C., & Strandhagen, J. O. (2017) 'An Industry 4.0 research agenda for sustainable business models'. Procedia Cirp, 63: 721-726.

Den Hollander, M. C., Bakker, C. A., & Hultink, E. J. (2017) 'Product design in a circular economy: Development of a typology of key concepts and terms'. *Journal of Industrial Ecology*, 21.3: 517-525.

DeLorenzo, A., Parizeau, K., & von Massow, M. (2019) 'Regulating Ontario's circular economy through food waste legislation', *Society and Business Review*, 14.2: 200-216.

Desrochers, P. & Geloso, V. (2016) 'Snatching the wrong conclusions from the jaws of defeat: a historical/resourceship perspective on Paul Sabin's *The Bet: Paul Erlich, Julian Simon and our gamble over the earth's future* (Yale University Press 2013): Part 1: The missing history of thought: Depletionism vs Resourceship', New Perspectives on Political Economy, 12.1-2: 5–41

Dev, N. K., Shankar, R., & Qaiser, F. H. (2020) 'Industry 4.0 and circular economy: Operational excellence for sustainable reverse supply chain performance.' *Resources, Conservation and Recycling,* 153, art no 104583.

Dodick, J., & Kauffman, D. (2020) 'A Review of the European Union's Circular Economy Policy. Report from Project The route to circular economy'. Project funded by European Union's Horizon. Available at http://www.r2piproject.eu/wp-content/uploads/2017/04/A-Rview-of-the-European-Unions-Circular-Economy-Policy.pdf

Doughnut Economics Lab (2020) Doughnut Economics Action Lab, available at https://doughnuteconomics.org/

EEA (European Environment Agency) (2017) 'Circular by design: Products in the circular economy', European Environment Agency Report, available at https://www.eea.europa.eu/publications/circular-by-design/#parent-fieldname-title

Ehrenfeld, J.H. & Gertler, N. (1997), 'Industrial Ecology in Practice: The Evolution of Interdependence at Kalundborg', *Journal of Industrial Ecology*, 1.1: 67–79

Elmualim, A., Mostafa S., Chileshe N. & Rameezdeen R. (2018) 'Construction and the Circular Economy: Smart and Industrialised Prefabrication', in Crocker R., Saint C., Chen G. & Tong Y. (eds) *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald), 323-336.

EMF (2020a) The circular economy: a transformative Covid-19 recovery strategy (Ellen Macarthur Foundation) available at https://www.ellenmacarthurfoundation.org/publications/covid-19

EMF (2020b) Upstream Innovation Guide: A guide to packaging solutions (Ellen Macarthur Foundation) available at https://plastics.emf.org/upstream

EMF (2017a) Toolkit for policymakers: A circular economy toolkit for policymakers providing tools and methods needed to embark on a circular economy transformation (Ellen Macarthur Foundation) available at https://www.ellenmacarthurfoundation.org/resources/apply/toolkit-for-policymakers

EMF (2017b) Circular Design Toolkit (Ellen Macarthur Foundation), available at https://www.ellenmacarthurfoundation.org/resources/learn/circular-design-toolkit

EMF (2017c) The New Plastics Economy: A Circular Economy for Plastic in which it never becomes waste (Ellen Macarthur Foundation), available at https://www.ellenmacarthurfoundation.org/our-work/activities/new-plastics-economy

EMF (2017d) The Circular Economy Learning Hub (Ellen Macarthur Foundation) available at https://www.ellenmacarthurfoundation.org/explore

EMF (2013a) Towards the Circular Economy 1: Economic and business rationale for an accelerated transition (Isle of Wight: Ellen Macarthur Foundation)

EMF 2013b) Towards the Circular Economy 2: Opportunities for the consumer goods sector (Isle of Wight: Ellen Macarthur Foundation)

ENOLL (2020) European Network of Living Labs, available at https://enoll.org/

EU circular economy Plan 2020 (2020) Circular Economy Action Plan: The European Green Deal, available at https://ec.europa.eu/environment/circular-economy/index\_en.htm

EU WEEE (2020) Waste Electronic & Electrical Equipment available at https://ec.europa.eu/environment/waste/weee/index\_en.htm

Esbensen, K.H. & Velis, C. (2016) Transition to circular economy requires reliable statistical quantification and control of uncertainty and variability in waste. *Waste Management and Resources*, 34.12: 1197-1200.

EU (2015) A new Circular Economy Action Plan For a cleaner and more competitive Europe, Document 52020DC0098, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN

EU (2020) Circular Economy Action Plan, available at https://ec.europa.eu/environment/circular-economy/index\_en.htm

Fischer-Kowalski, M. (1998) 'Society's Metabolism: The intellectual history of materials flow analysis, Part 1, 1860-1970' Journal of Industrial Ecology, 2.1: 61-78.

Fleischmann, K. (2019) 'Design-led innovation and Circular Economy practices in regional Queensland', Local Economy, 34.4: 382-402

Flourocycle (2020) Flourocycle, available at https://fluorocycle.lightingcouncil.com.au/

Franco, M. A. (2019) 'A system dynamics approach to product design and business model strategies for the circular economy.' *Journal of Cleaner Production*, 241, 118327

Frosch, R.A., Gallopoulos, N.E. (1989) 'Strategies for manufacturing', *Scientific American*, 261.3: 144–152.

Fry, J., Lenzen, M., Giurco, D. & Pauliuk, S. (2018) 'Australian Regional Waste Footprints', in Crocker, R., Saint, C., Chen, G. & Tong, Y. (eds) *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 179-190.

Fuller, R.B. (1969). Operating manual for Spaceship Earth. San Francisco: Arcana.

Geissdoerfer, M., et al. (2017) 'The circular economy – a new sustainability paradigm?' Journal of Cleaner Production, 143, 757-768.

Geissdoerfer, M., et al. (2018a). 'Business models and supply chains for the circular economy', *Journal of Cleaner Production*, 190: 712-721.

Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018b) 'Sustainable business model innovation: A review' *Journal of Cleaner Production*, 198: 401-416.

Gnoni, M.G., Mossa, G., Mummolo, G., Tornese, F. & Verriello, R. (2017) 'Supporting circular economy through use-based business models: the washing machine cases', *Procedia CIRP*, 64: 49-54.

Goh, C.H., Short, M., Bolan, N.S. & Saint, C. (2018) 'Biosolids: the growing potential for use', in Crocker, R., Saint, C., Chen, G. & Tong, Y (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 67-90.

Goldsworthy, K. (2017) 'The Speedcycle: a design-led framework for fast and slow circular fashion lifecycles', *The Design Journal*, 20.1: S1960-S1970

González-Sánchez, R., et al E (2020) 'Main Dimensions in the Building of the Circular Supply Chain: A Literature Review', *Sustainability*, 12: 6

Govindan, K & Hasanagic, M. (2018), "A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective", *International Journal of Production Research*, 56.1-2: 278-311.

GISA (2021) Green Industries SA Strategic Plan 2021-2025, available at https://www.greenindustries.sa.gov.au/resources/gisa-strategic-plan-2021-2025

GISA (2020a) Driving the Circular Economy, available at https://www.greenindustries.sa.gov.au/driving-the-circular-economy

GISA (2020b) Reducing Food Waste, available at https://www.greenindustries.sa.gov.au/reducing-food-waste

GISA (2020c) Innovative Resource Recovery, available at https://www.greenindustries.sa.gov.au/innovative-resource-recovery

GISA (2020d) Reforming Packaging and Single-Use Items, available at https://www.greenindustries.sa.gov.au/reforming-packaging-single-use-items

GISA (2020e) Reforming Household and Food Waste, available at https://www.greenindustries.sa.gov.au/reforming-household-waste

GISA (2020e) Global Leadership Program in the Circular Economy, available at https://www.greenindustries.sa.gov.au/global-leadership-program

GISA (2017) Benefits of a Circular Economy in South Australia, available at https://www.greenindustries.sa.gov.au/resources/potential-benefits-of-a-circular-economy-in-south-australia---report-(2017)

Gregson, N., Crang, M., Fuller, S. & Holmes, H. (2015) 'Interrogating the circular economy: the moral economy of resource recovery in the EU', *Economy and Society*, 44.2: 218-243.

Grove, M. (2020) 'The "right to repair" inquiry by the Productivity Commission could make planned obsolescence obsolete', The Fifth Estate (online), available at https://www.thefifthestate.com.au/business/government/the-right-to-repair-inquiry-by-the-productivity-commission-could-make-planned-obsolescence-obsolete/?utm\_source=The+Fifth+Estate+-+newsletter&utm\_campaign=49f6ee9e35-8\_Dec\_2020&utm\_medium=email&utm\_term=0\_5009254e4c-49f6ee9e35-44048073&ct=t(8\_Dec\_2020)

Halse, L.L. & Jæger, B. (2019), 'Operationalizing Industry 4.0: Understanding barriers of Industry 4.0 and Circular Economy', *IFIP Advances in Information and Communication Technology*, 567: 135-142.

Hankammer, S., Brenk, S., Fabry, H., Nordemann, A. & Piller, F.T. (2019) 'Towards circular business models: Identifying consumer needs based on the jobs-to-be-done theory' *Journal of cleaner production*, 231: 341-358.

Henninger, C.E., Alevizou, P., Goworek, H. & Ryding, D. (eds) (2017) Sustainability in Fashion: A Cradle to Upcycle Approach (Cham, Switzerland: Springer)

Henry, M., Bauwens, T., Hekkert, M. & Kirchherr, J. (2020) 'A typology of circular start-ups: An Analysis of 128 circular business models', Journal of Cleaner Production, 245, article number 118528.

Homrich, A. S., Theodoro, D. S., & de Carvalho, M. M. (2017). 'PSS creating business for sustainability: the Brazilian Olive Oil case in Mantiqueira Community'. *Procedia CIRP*, 64.1: 405-410

Homrich, A. S., Galvão, G., Abadia, L.G. & Carvalho, M.M. (2018) 'The circular economy umbrella: Trends and gaps on integrating pathways', *Journal of Cleaner Production*, 175: 525-543

Hussain, M. & Malik, M. (2020), 'Organizational enablers for circular economy in the context of sustainable supply chain management', *Journal of Cleaner Production*, 256: art. no. 120375

Henry, M., Bauwens, T., Hekkert, M. and Kirchherr, J. (2020) 'A typology of circular startups: An Analysis of 128 circular business models', *Journal of Cleaner Production*, 245, 118528\*

Hopkinson, P., De Angelis, R., & Zils, M. (2020), 'Systemic building blocks for creating and capturing value from circular economy', *Resources, Conservation and Recycling*, 155, art. no. 104672

Hughes, R. (2017). The EU circular economy package – life cycle thinking to life cycle law? *Procedia CIRP.* 61, 10-16.

Invest EU (2020) The Invest EU Programme (2020-2027), available at https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/whats-next-investeu-programme-2021-2027\_en

Jacobs Group (2015) A Bio-Energy Roadmap for South Australia (Adelaide, Renewables SA – Jacobs Group Report)

Jacobsen, N.B. (2006). Industrial symbiosis in Kalundborg, Denmark: a quantitative assessment of economic and environmental aspects. *Journal of Industrial Ecology*, 10.1–2: 239–255.

Jugend, D., De Camargo Fiorini, P., Paula Pinheiro, M.A. & Ribeiro da Silva, H.M. (2020) 'Building circular products in an emerging economy: An Initial Exploration Regarding Practices, Drivers and Barriers Case studies of new product development from medium and large Brazilian companies', Johnson Matthey Technology Review, 64.1: 59-68.

Kalmykova, Y., Sadagopan, M., & Rosado, L. (2018) 'Circular economy – from review of theories and practices to development of implementation tools', *Resources, Conservation & Recycling*, 135: 190-201.

Kirchherr, J., Piscicelli, I., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A. & Hekkerta, M. (2018) 'Barriers to the circular economy: Evidence from the European Union (EU)', *Ecological Economics*, 150: 264-272.

Kjaer, L. L., Pigosso, D.C.A., Niero, M., Bech, N.M. & McAloone, T.C. (2019). 'Product/service@systems for a circular economy: the route to decoupling economic growth from resource consumption?' *Journal of Industrial Ecology*, 23.1: 22-35

Korhonen, J., Honkasalo, A., Seppala, J. (2018) 'Circular Economy: The Concept and its Limitations', *Ecological Economics*, 43:37-46.

Lane, R. (2014) 'Understanding the dynamic character of value in recycling metals from Australia', *Resources*, 3:416-431

Lahane, S., Kant, R., Shankar, R. (2020) 'Circular supply chain management: A state-of-art review and future opportunities', *Journal of Cleaner Production*, 258, art. no. 120859

Levitzke, V. (2020) 'The Development of a Circular Economy in Australia', in S.K. Ghosh (ed), Circular Economy: Global Perspective (Springer Nature: Berlin): 25-42.

Lindahl M. (2018) '11 Key issues when designing solutions for a Circular Economy,' in M. Charter (ed) *Designing for the Circular Economy* (London: Routledge): 113-122.

Maitre-Ekern, E., & Dalhammar, C. (2019) 'Towards a Hierarchy of Consumption Behaviour in the Circular Economy.' *Maastricht Journal of European and Comparative Law.* 26.3: 394-420.

Mate, K. (2018) 'The ByeBuy! Shop: Testing Shopping Scapes in a Circular Economy', in Crocker, R. et al (2018) *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 123-141.

Maroufi, S., Maroufi, S., Echeverria, C.A., Pahlevani, F. & Sahajwalla, V. (2018) 'Green Manufacturing: From Waste to Value Added Materials', in Crocker, R., Saint, C., Chen, G. & Tong, Y. (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 261-280.

Meadows, D.H., Meadows, D.L, Jørgen Randers & Behrens III, W.W. (1972) The limits to growth: A report for the Club of Rome's project on the predicament of mankind (New York: Potomac)

Merli, R., Preziosi, M. & Acampora, A. (2018) 'How do scholars approach the circular economy? A systematic literature review'. *Journal of Cleaner Production*, 178: 703-722

Mestre, A. & Cooper, T. (2017) 'Circular Product Design: A Multiple Loops Life Cycle Design Approach for the Circular Economy', *The Design Journal*, 20.1: S1620-S1635

McDonough, W. & Braungart, M. (2002) Cradle to cradle: Remaking the way we make things (New York: North Point Press)

McDowall, W., Geng, Y., Huang, B. & Barteková, E. (2017), 'Circular Economy Policies in China and Europe', *Journal of Industrial Ecology.*, 21.3: 651–661.

McGinley, T. (2018) 'Towards an agile circular economy for the building industry', in Crocker, R., Saint, C., Chen, G. & Tong, Y. (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 281-294.

Michelini, G., Moraesa, R., Nobre da Cunha, R. & Costa, J. (2017) 'From linear to circular economies: PSS conducting the transition', *Procedia CIRP*, 64: 2-6.

Mobilemuster (2020) Mobilemuster, available at https://www.mobilemuster.com.au/

Moraga, G., Huysveld, S., Mathieux, F., Andre, Blengini, G.A., Alaerts, L., Van Acker, K., de Meester, S. & Dewulf, J. (2019) 'Circular economy indicators: What do they measure?', *Resources, Conservation and Recycling*, 146: 452-461.

Moktadir, M.A., Ahmadib, H.B., Sultana, R., Zohra, F.J., Liou, J.J.H. & Rezaei, J. (2020) 'Circular economy practices in the leather industry: A practical step towards sustainable development', *Journal of Cleaner Production*, 251, art. no. 119737,

Momete, D.C. (2020), 'A unified framework for assessing the readiness of European Union economies to migrate to a circular modelling', *Science of the Total Environment*, 718, art. no. 137375

Mugge, R. (2017) 'A consumer's perspective on the circular economy', in J. Chapman (ed), Routledge Handbook of Sustainable Product Design (London: Routledge): 375-389.

NTCR (2020) National Television and Computer Recycling Scheme (Department of Agriculture, Water and the Environment, Commonwealth of Australia), summary guides available at https://www.environment.gov.au/protection/waste/publications/factsheet-national-television-and-computer-recycling-scheme-householders

Nußholz, J.L.K. (2017), 'Circular business models: Defining a concept and framing an emerging research field', *Sustainability (Switzerland)*, 9, 10, art. no. 1810.

Offenhuber, D. (2017) Waste is Information: Infrastructure Legibility and Governance (Cambridge, MA: MIT Press)

PACE (2018) Platform for accelerating the Circular Economy (World Resources Institute), available at https://pacecircular.org/

Paintback (2020) Paintback, available at https://www.paintback.com.au/

Palmer, P. (2005 [1978]) Getting to Zero Waste, San Francisco: Purple Sky Press.

Park, M. (2010) 'Defying obsolescence', in T. Cooper (ed) Longer Lasting Products: Alternatives to the Throwaway Society (Farnham, UK: Gower): 77-106.

Pearce, D., & Turner, R. (1989) Economics of Natural Resources and the Environment, Baltimore, NJ: Johns Hopkins University Press.

Pedersen, E. R. G., Earley, R., & Andersen, K. R. (2019) 'From singular to plural: exploring organisational complexities and circular business model design', *Journal of Fashion Marketing and Management*.

Peng, S., Cui, H., & Min, J. (2018) 'Research on the Sustainable Water Recycling System at Tianjin University's New Campus', in Crocker, R., Saint, C., Chen, G. & Tong, Y et al (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 295-307.

Pieroni, M. P., McAloone, T. C., & Pigosso, D. C. (2019) 'Business model innovation for circular economy and sustainability: A review of approaches.' *Journal of Cleaner Production*, 215: 198-216.

Pomponi, F., & Moncaster, A. (2017). 'Circular economy for the built environment: A research framework'. *Journal of cleaner production*, 143: 710-718.

Prendeville, S., Cherim, E., & Bocken, N. (2018) 'Circular Cities: Mapping Six Cities in Transition', *Environmental Innovation and Societal Transitions*, 26: 171-194.

PREP (2020) PREP - Packaging Recyclability Evaluation Portal, available at https://prep.org.au/main/content/home

PwC (2021) Building a more circular Australia: The Opportunity of Transitioning to a Circular Economy, available at https://www.pwc.com.au/important-problems/environment-social-governance/building-a-more-circular-australia.html

Ranta, V., Aarikka-Stenroos, L., Ritala, P. & Mäkinen, S.J. (2018) 'Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe'. Resources, Conservation and Recycling, 135: 70-82.

Raworth, K. (2017) Doughnut Economics: Seven Ways to think like a 21st Century Economist (London: Random House)

Reike, D., Vermeulen, W.J.V., & Witjes, S. (2018) 'The Circular Economy: New or Refurbished as circular economy 3.0? – Exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options', Resources, Conservation & Recycling, 135: 246-264.

Rich, N. (2019) Losing Earth (London, Picador)

Rivera, J.L., & Lallmahomed A. (2016) 'Environmental implications of planned obsolescence and product lifetime: a literature review,' *International Journal of Sustainable Engineering*, 9.2: 119-129

Rizos, V., Tuokko, K., & Behrens, A. (2017) 'The Circular Economy: A review of definitions, processes and impacts' (No. 12440). *Centre for European Policy Studies*.

Ritzén, S., and Sandström, G.O (2017) 'Barriers to the Circular Economy–integration of perspectives and domains,' *Procedia Cirp* 64: 7-12.

Rome, A. (2015). 'Sustainability: The launch of Spaceship Earth', Nature. 527, 443-445.

Rosa, P., Sassanelli, C., Urbinati, A. & Chiaroni, D. (2020), 'Assessing relations between Circular Economy and Industry 4.0: a systematic literature review', *International Journal of Production Research*, 58.6: 1662-1687

Salvador, R., Vetroni Barros, M., Mendes da Luza, L., Moro Piekarski, C. & Carlos de Francisco, A. (2020), 'Circular business models: Current aspects that influence implementation and unaddressed subjects', *Journal of Cleaner Production*, 250, art. no. 119555,

Salvia, R., Andreopoulou, Z.S., & Quaranta, G. (2018) 'The circular economy: A broader perspective for rural areas', *Rivista di Studi sulla Sostenibilita*, 4: 1-14.

SCREEN: Synergic Circular Economy across the European Union (2020) available at http://www.screen-lab.eu/overview.html

Shanahan, M. (2018) 'Can economics assist the transition to the Circular Economy?' in Crocker, R., Saint, C., Chen, G. & Tong, Y. (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 35-47.

Silvestri, F. Spigarelli, F., Tassinari, M. (2020) 'Regional development of the Circular Economy in the European Union: a multidimensional analysis', *Journal of Cleaner Production*, 255, art. 120218

Singh, N., Hui D., Singh R., Ahuja I.P.S., Feo L. & Fraternaliet F. (2017) 'Recycling of plastic solid waste: A state of the art review and future applications', *Composites Part B: Engineering*, 115: 409-422.

Singh, J., & Ordonez, I. (2016) 'Resource recovery from post-consumer waste: important lessons for the upcoming circular economy', *Journal of Cleaner Production*, 134:342-353.

Stahel, W.R. (2016) 'Circular Economy', Nature, 431: 435-437.

Stahel, W.R. and Reday-Mulvey, G. (1981) Jobs for tomorrow: The potential for substituting manpower for energy: Report for the Commission of the European Communities (New York: Vantage Press)

Su, B., Hesmati, A., Geng, Y., Yu, X. (2013) 'Review of the circular economy in China: Moving from rhetoric to implementation',—Journal of Cleaner Production, 42, 215-227.

Taito-Matamua, L., Fraser, S. & Ok, J. (2018) 'Renewing Materials: Implementing 3D printing and distributed recycling in Samoa', in Crocker, R., Saint, C., Chen, G. & Tong, Y. (2018) *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 191-212.

Tukker, A. (2015) 'Product services for a resource-efficient and circular economy – a review', Journal of Cleaner Production, 97:76-91

Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S. & Valkokari, P. (2019), 'Unlocking circular business: A framework of barriers and drivers', *Journal of Cleaner Production*, 212: 90-98.

Tyre Stewardship Australia (2020) Tyre Stewardship Australia, available at https://www.tyrestewardship.org.au/

UNCRD (2017) Seventh Regional 3R Forum in Asia and the Pacific (Advancing 3R and Resource Efficiency for the 2030 Agenda for Sustainable Development) Chair's Summary, available at www.uncrd.or.jp/content/documents/4667Chair%20Summary-Adelaide%20 3R%20Forum-FINAL%20CIRCULATION.pdf

URBACT: Driving Change for Better Cities (2020) https://urbact.eu/circular-economy

UrbanWins (2020) available at https://www.urbanwins.eu/

Vermunt, D.A., Negro, S.O., Verweij, P.A., Kuppens, D.V. & Hekkert, M.P. (2019), 'Exploring barriers to implementing different circular business models'. *Journal of Cleaner Production*, 222: 891-902.

Vence, X., Pereira, Á. (2019), 'Eco-innovation and Circular Business Models as drivers for a circular economy', *Contaduria y Administracion*, 64 (1), art. no. 1806.

Vezzoli, C., Ceschin, F., Diehl, J.C & Kohtala, C. (2015) 'New design challenges to widely implement 'Sustainable Product-Service Systems', *Journal of Cleaner Production*, 97:1-12.

Waller, V., Blackall, L., & Newton, P. (2018) 'Composting as everyday alchemy: producing compost from food scraps in twenty-first century urban environments', in Crocker, R. & Chiveralls, K. (eds), Subverting Consumerism: Reuse in an Accelerated World (London: Routledge): 186-203.

Ward, B. (1966). Spaceship Earth (New York: Columbia University Press).

Wastling, T., Charnley, F., and Moreno, M. (2018) 'Design for Circular Behaviour: Considering Users in a Circular Economy,' Sustainability. 10.6: 1743.

Webster, K. (2013). *The Circular Economy: A Wealth of Flows*. (Isle of Wight: Ellen MacArthur Foundation).

Weetman, C. (2016) A circular economy handbook for business and supply chains: Repair, remake, redesign, rethink (London: Kogan Page).

Whalen, K.A. (2019) 'Three circular business models that extend product value and their contribution to resource efficiency,' *Journal of cleaner production* 226: 1128-1137.

Whalen, C. J., & Whalen, K.A. (2020) 'Circular Economy Business Models: A Critical Examination,' *Journal of Economic Issues* 54.3: 628-643.

Wieser H. (2016) 'Beyond Planned Obsolescence: Product Lifespans and the Challenges to a Circular Economy.' *Gaia*, 25.3: 156-160

Winans, K., Kendall, A. & Deng, H. (2017) 'The history and current applications of the circular economy concept.' Renewable and Sustainable Energy Reviews, 68, 825-833.

WRAP (2015) Employment and the circular economy: job creation in a more resource efficient Britain: Job Creation in a more efficient Britain (Green Alliance and WRAP), summary available at www.wrap.org.uk/sites/files/wrap/Employment and the circular economy summary.pdf

Yu, F., Han, F. & Cui, Z. (2015). Evolution of industrial symbiosis in an eco-industrial park in China. *Journal of Cleaner Production*. 87, 339–347.

Yuan, Z.Y. (2006) 'The Circular Economy: A New Development Strategy in China.', Journal of Industrial Ecology, 10:1-2: 4–8.

Zeng, H, Chen, X, Xiao, X & Zhou, Z. (2017), 'Institutional pressures, sustainable supply chain management, and circular economy capability: Empirical evidence from Chinese eco-industrial park firms', *Journal of Cleaner Production*, 155: 54-65, DOI: 10.1016/j. jclepro.2016.10.093

Zhang, A., Venkatesh, V.G., Liu, Y., Wan, M., Qu, T. & Huisingh, D. (2019) 'Barriers to smart waste management for a circular economy in China', *Journal of Cleaner Production*, 240, art. no. 118198

Zhao, X. (2018) 'China's policies for promoting the circular economy: Past-decade experiences, future plans and success stories', in R. Crocker et al (eds), *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (London: Emerald): 49-65.

Zhijun, F; Nailing, Y (2007) 'Putting a circular economy into practice in China' Sustainability Science, 2: 95–101.

Zero Waste Scotland, available at https://www.zerowastescotland.org.uk/

Zero Waste Scotland (2021), Scottish Material Flow Accounts (MFA) Report, available at https://www.zerowastescotland.org.uk/research-evaluation/material-flow-accounts-mfa

Zink, T., & Geyer, R. (2017) 'Circular economy rebound', *Journal of Industrial Ecology*, 21(3), 593-602.

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ISBN 978-1-922046-35-2