An Chomhairle Náisiúnta Eacnamaíoch agus Shóisialta
National Economic & Social Council
NESC

Moving Towards the Circular Economy in Ireland

A study for NESC by Dr Simon O'Rafferty

No. 144 October 2017

An Oifig Náisiúnta um Fhorbairt Eacnamaíoch agus Shóisialta
National Economic & Social Development Office NESDO

National Economic and Social Council

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1. The main tasks of the National Economic and Social Council shall be to analyse and report on strategic issues relating to the efficient development of the economy and the achievement of social justice.

2. The Council may consider such matters either on its own initiative or at the request of the Government.

3. Any reports which the Council may produce shall be submitted to the Government, and shall be laid before each House of the Oireachtas and published.

4. The membership of the Council shall comprise a Chairperson appointed by the Government in consultation with the interests represented on the Council, and

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   - Three persons nominated by business and employers' organisations;
   - Three persons nominated by the Irish Congress of Trade Unions;
   - Three persons nominated by community and voluntary organisations;
   - Three persons nominated by environment organisations;
   - Eleven other persons nominated by the Government, including the Secretaries General of the Department of Finance, the Department of Business, Enterprise and Innovation, the Department of Housing, Planning, Community and Local Government, the Department of Public Expenditure and Reform.

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7. The numbers, remuneration and conditions of service of staff are subject to the approval of the Taoiseach.

8. The Council shall regulate its own procedure.

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National Economic & Social Council

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Glossary of Terms[1]

Additive Manufacturing	a process by which digital 3D design data is used to build up a component in layers by depositing material. The term '3D printing' is increasingly used as a synonym for additive manufacturing.
Bio-Based Materials	a material intentionally made from substances derived from living (or once-living) organisms. These materials are sometimes referred to as biomaterials, but this word also has another meaning.
Bioeconomy	an economy using biological resources from the land and sea, as well as waste, as inputs to food and feed, and industrial and energy production. It also covers the use of bio-based processes for sustainable industries.
BioÉire Project	Irish Government-funded project identifying priority opportunities for Ireland's bioeconomy.
Biological Cycles	rhythmic repetition of biological phenomena in associations of organisms (populations, biocenoses), which serves as an adaptation to cyclic changes in their conditions of existence.
Circular Economy	an economy in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life [WRAP].[2]
Circular Economy Package	a programme of actions on the circular economy adopted by the European Commission in 2015, which consists of an action plan, *Closing the loop—An EU action plan for the Circular Economy*, follow-up initiatives and legislative proposals.
Civil Society	society considered as a community of citizens linked by common interests and collective activity.
Clustering	a strategy for implementing parallel processing applications enabling companies to leverage the investments already made in different sectors.
Collaborative Consumption	can be defined as the set of resource circulation systems, which enable consumers to both 'obtain' and 'provide', temporarily or permanently, valuable resources or services through direct interaction with other consumers or through a mediator.

1 Unless [ ] used, the definitions come from the top result in Google search (with only minor editing changes).

2 http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy

Eco-Design	an approach to designing products with special consideration for the environmental impacts of the product during its whole lifecycle. In a lifecycle assessment, the lifecycle of a product is usually divided into procurement, manufacture, use, and disposal.
Eco-Labels/Labelling	a voluntary method of environmental performance certification and labelling that is practised around the world. An ecolabel identifies products or services proven to be environmentally preferable overall, within a specific product or service category.
Extended Producer Responsibility (EPR)	an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's lifecycle
Gig Economy	a labour market characterised by the prevalence of short-term contracts or freelance work as opposed to permanent jobs
Industrial Symbiosis	an association between two or more industrial facilities or companies in which the wastes or byproducts of one become the raw materials for another
Intelligent Assets	connected smart devices including phones and computers, also referred to as the Internet of Things
Loop	a closed cycle of energy or nutrients
Producer Responsibility Initiative (PRI)	Initiatives in which product producers are supported to devise schemes that can fulfil the basic objectives of waste management legislation without resort to a 'command and control' approach. PRIs in Ireland can be found in the areas of Waste Electrical and Electronic Equipment (WEEE), batteries, packaging, end-of-life vehicles (ELVs), tyres and farm plastics.[3]
Regional Waste-Management Plans	For the purposes of waste-management planning, Ireland is now divided into three regions: Southern, Eastern-Midlands and Connacht-Ulster.
Resource Efficiency	using the Earth's limited resources in a sustainable manner while minimising impacts on the environment. It allows us to create more with less and to deliver greater value with less input**.**
Sharing Economy	an economic system in which assets or services are shared between private individuals, either free or for a fee, typically by means of the Internet

[3] (DECLG, 2014)

Social Enterprise	an organization that applies commercial strategies to maximise improvements in human and environmental wellbeing—this may include maximising social impact alongside profits for external shareholders
Social Capital	the networks of relationships among people who live and work in a particular society, enabling that society to function effectively
Standardised Purity	the quality and purity of a particular material (such as paper or glass) to an agreed standard
Sustainable Development Goals (SDGs)	Officially known as *Transforming Our World: The 2030 Agenda for Sustainable Development* from the United Nations, it is a set of 17 'Global Goals' with 169 targets between them.
Urban Fabric	The physical aspect of urbanism, emphasising building types, thoroughfares, open space, frontages, and streetscapes but excluding environmental, functional, economic and sociocultural aspects
Value Chain	the process or activities by which a company adds value to an article, including production, marketing, and the provision of after-sales service
Value Drivers	anything that can be added to a product or service that will increase its value to consumers.
Waste Hierarchy	a set of priorities for the efficient use of resources. The priority order available for managing wastes, ranked in descending order of preference: (1) prevention; (2) preparing for re-use; (3) recycling; (4) other recovery (including energy recovery); and disposal.[4]

[4] (European Parliament, 2008, European Communities, 2011)

Abbreviations

CRNI	Community Reuse Network
DCCAE	Department of Communications, Climate Action and Environment
EASAC	European Academies Science Advisory Council
EC	European Commission
EESC	European Economic and Social Committee
EPA	Environmental Protection Agency
EPR	Extended producer responsibility
GDP	Gross Domestic Product
GPP	Green public procurement
IDA	Industrial Development Authority
LCT	Lifecycle thinking
NGO	Non-profit organisation
NWPP	National Waste Prevention Programme
SDG	Sustainable development goals
SEAI	Sustainable Energy Authority of Ireland
UCC	University College Cork

Council Comments

1.1 Introduction

There is increasing recognition of the potential benefits for economies and societies of moving away from a 'make-use-dispose' model towards adopting a circular economy, thereby maximising resource efficiency and environmental protection.

A circular economy is one in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.[5] It is an economy that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles (Ellen MacArthur Foundation, 2015a). A fully circular economy requires a systemic and transformative approach to production and consumption that effectively designs out waste and keeps materials and resulting products in use for as long as possible (World Economic Forum, 2015).

A key building block for the circular economy is resource efficiency and efforts to reduce waste. Ireland's policy on waste management, *A Resource Opportunity: Waste Management in Ireland* (DECLG, 2012) focuses on resource efficiency and the virtual elimination of landfilling of municipal waste. The National Waste Prevention Programme (NWPP) as well as many other actions relating to waste, water and energy resource efficiency—including, the EPA's Be Green Programme, and Regional Waste Management Plans—are also integral to the development of Ireland's circular economy.

The circular economy is also closely linked to the bioeconomy. Many bio-based materials are renewable, biodegradable and compostable and, when due care and attention is focused on their lifecycle, environmental impacts and sustainable sourcing, they can become the basis for important circularity in an economy. The bioeconomy is thus increasingly being seen as the biological engine of the circular economy (European Commission, 2015c)

The circular economy is also a key means of working towards more long-term sustainable economic, social and environmental development. However, it is important to note that increased circularity will need to be supported by efforts to

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5 http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy

reduce and eliminate materials and practices that have negative environmental impacts (such as carbon emissions).

In 2016, NESC commissioned Dr Simon O'Rafferty to conduct a short research project on the circular economy in Ireland, as part of its sustainability remit and with support from the Department of Communications, Climate Action and Environment. The purpose of this work was to identify and document case studies of circular economy practices in Ireland and to examine some of the key enablers and barriers to their further development.

The purpose of these Council Comments is to introduce the research report and make some observations, both in relation to its findings and the circular economy more broadly. This paper is structured as follows. It first provides an overview of the international and national policy context for the circular economy. It then notes the NESC research and work undertaken in this area before outlining four Council reflections on the transition for Ireland towards a circular economy.

1.2 Policy Context

1.2.1 International Developments

The circular economy has become a policy priority of the European Commission in recent years, with a package of measures and legislative proposals adopted in 2015. There is also a growing business and social enterprise interest in adopting circular economy practices. The European Economic and Social Committee (EESC) argues that the transition to a circular economy will provide new economic opportunities and new markets, within and outside Europe, leading to the creation of new local jobs (EESC, 2016).

At EU level, the EU Circular Economy Package is at an advanced stage of legislative development, following the publication of the European Commission's plan in 2015, *Closing the Loop: An EU Action Plan for the Circular Economy* (European Commission, 2015b). A key aim is to help European businesses and consumers make the transition to a stronger and more circular economy where resources are used in a sustainable way.

The Closing the Loop Action Plan contains 54 measures covering a range of areas concerning consumption and production processes and products, across priority sectors including plastics, food waste, critical raw materials, biomass and bio-based products, and construction and demolition. It includes financial incentives for research and innovative policy measures using structural funds (€5.5bn) and Horizon 2020 (€650mn). This is combined with a suite of regulatory and legislative

actions aimed at changes to product design, production processes, waste management, consumption, procurement, boosting the market and monitoring. This Action Plan is well documented in the research and other recent documents from the European Commission.[6] Its measures are in the implementation stage, while the legislative ones are now with the European Parliament and Council of Ministers for final approval.

This Action Plan follows on from a strong focus in the EU 2020 Strategy on resource efficiency and a Roadmap to a Resource-Efficient Europe (European Commission, 2011). The European Commission estimates that the circular economy can save EU businesses €600bn. However, the combined economic, social and environmental benefits are likely to be considerably more. The World Economic Forum reported in 2014 that the materials-saving potential alone was estimated at over $1trn a year (World Economic Forum et al., 2014).

The World Circular Economy Forum

In June 2017, international focus on the circular economy intensified as 1,500 key people from more than 100 countries took part in the first World Forum on the Circular Economy, in Helsinki, Finland. This was organised by the Finnish innovation fund, Sitra. Participants included representatives from local and international business, policymakers, public bodies and civil society. The NESC Secretariat participated in the international event. Sessions on finance and business opportunities predominated. Some of the key messages from the Forum were outlined by Sitra and included:

- The circular economy has to factor in our global economic model and mainstream thinking.
- The circular economy can help achieve the Sustainable Development Goals.
- The transition to a circular economy should be driven by businesses and cities in particular.
- Regulation and economic instruments can be used such as public procurement and national roadmaps.
- The circular economy will generate growth, including jobs and enterprise, while also saving natural resources and reducing pollution.

[6] https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/towards-circular-economy_en

- Investment is needed in new technologies, business models, digitisation and innovation.

- The circular economy can combat climate change so as to achieve carbon-neutral and resilient societies.

- The circular economy will make waste a valuable resource. It will consume services and produce more durable, repairable, reusable and recyclable products (Sitra, 2017).

The Forum featured strong positive messaging around the circular economy as a 'win-win' across economic, environmental and social policy and commercial priorities; there was less discussion on some of the potential tensions and risks arising from a fundamental shift from a linear to a circular model.

However, the scale and diversity of the participants at this first event of its kind represented what might be a considered a departure for international discussion on resource efficiency and natural resources. The international business community was present and engaged in seeking out opportunities for new areas of growth, within current environmental constraints.

1.2.2 The Irish Context

As a small, open economy in the EU, Ireland's move towards a circular economy will continue to be shaped by EU policy and a shift in international corporate practices. These practices are in evidence through examples such as Dell running a recycling scheme for the plastic in its hardware; the French carmaker Renault collecting used parts for remanufacture, and the Swedish chain H&M recycling clothing (Thompson, 2016).[7]

Ireland, alongside other member states, is monitoring EU legislative developments and the implementation of the *Closing the Loop A*ction Plan, but has yet to outline its own policy approach to the circular economy. The Department of Communications, Climate Action and Environment recognises that, although certain elements of the package may prove challenging, the potential for jobs and the environment presents a valuable opportunity for Ireland.[8] The Draft National Planning Framework, *Ireland 2040: Our Plan*, includes a vision for Ireland to have a 'capacity for sustainable self-reliance based on a strong circular economy and significant progress towards a low-carbon, climate-resilient society' (Government of Ireland, 2017).

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[7] The World Economic Forum has created a collaboration called Project Mainstream, with the aim of bringing companies together to help deal with roadblocks and help mainstream the circular economy, including Philips, Kingfisher, Veolia, and DSM.

[8] http://www.dccae.gov.ie/en-ie/environment/topics/sustainable-development/circular-economy/Pages/default.aspx

Ireland is not alone in assessing the most effective policy response to the Circular Economy Package. A recent report by the European Environment and Sustainable Development Councils, of which NESC is a member, outlined the state of play of circular economy activity in 10 EU countries. It outlines the varied approaches taken, with Denmark and the Netherlands setting out long-term, high-level, focused strategies on the circular economy to 2030 and 2050 respectively, while Germany and Belgium have adopted strategies with more immediate timelines. Ireland and Portugal are noted as the two countries in the study that have yet to adopt a dedicated strategy. However, Portugal, as well as Luxembourg, is in the process of developing strategies for 2017 (van Buren & de Vries, 2017: 12). The report concludes that policies in the 10 countries and regions examined are increasingly shifting their primary focus from waste towards the entire resource and value chain. The policy goals are also more and more ambitious in realising (elements of) a circular economy. One of the biggest challenges, however, is to ensure the implementation of a holistic concept of the circular economy. While circular economy policy development across Europe is progressing, over 50 countries have bioeconomy policies (Philp, 2017). One key challenge is to align these effectively.

Ireland was an early actor in relation to waste-prevention activity through the National Waste Prevention Programme (NWPP), launched in 2004. This has been driven largely to implement the Waste Framework Directive (2008/98/EC), which has directed policy measures on waste management, compliance, enforcement, prevention and minimisation as well as re-use, recycling and recovery, with the EPA playing the most significant role in delivering and enforcing policy. In recent years, Ireland has taken a proactive stance to reduce the amount of waste sent to landfill. The percentage of municipal waste recovered (53.9 per cent) in 2012 exceeded the percentage landfilled (38.2 per cent) for the first time (CSO, 2015). However, over a third of our municipal waste is exported for recovery or recycling, which could in future be used in Ireland (EPA, 2014). The National Waste Prevention Programme (NWPP) seeks to encourage the transition to a circular economy, alongside many other actions relating to waste, water and energy resource efficiency.

The EPA, underpinned by the NWPP, runs a series of Be Green programmes that support many resource efficiency initiatives across schools, business, tourism, hospitals, schools and other sectors. These include the Local Authority Prevention Network, Green Business, Smart Farming, Community Reuse Network Ireland, SEAI energy efficiency programmes and initiatives such as the Community Reuse Network and Stop Food Waste. There has also been a heightened focus on waste management through the development of Regional Waste Management Plans and Offices (EPA, 2017).

Ireland's policy statement on waste management, *A Resource Opportunity: Waste Management in Ireland* (DECLG, 2012), has a focus on resource efficiency and the virtual elimination of landfilling of municipal waste. In its 2015 consultation document on resource efficiency, DCCAE stated:

> Exporting is a loss of waste resources that could otherwise be used to generate employment, open up new markets for Irish products, and boost domestic economic activity. The benefits of managing waste as a

> national resource, as part of the transition to a circular economy, are increasingly being recognized across Europe. (DECLG, 2015)

The Eco-Design Directive has also been instrumental in shifting products towards being energy-efficient and by labelling environmental standards. Enterprise Ireland, on behalf of the Department of Business, Enterprise and Innovation, has been working to support Ireland's implementation of EU eco-design regulations since 2005 and more recently in relation to energy labelling.[9]

Another key area is food waste and its considerable environmental impacts. Ireland generates approximately one million tonnes of food waste every year, with an estimated cost of €1bn.[10] Of this, 40 per cent comes from food production, 34 per cent from the commercial sector and 26 per cent from households. The EPA's Stop Food Waste programme began in 2009, funded under the National Waste Prevention Programme. The EPA has convened two Forums on Food Waste to bring together stakeholders from across the food chain. A Food Waste Charter was introduced earlier this year. The Minister for CCAE has established a Retail Action Group to tackle wasted food in the supply chain.[7] All major retailers, bar one, are participating.

Another area of policy development is a National Policy Statement on the Bioeconomy, with the publication of a recent discussion document and an open consultation process (Department of An Taoiseach, 2017). The discussion document points to the €2trn annual turnover of Europe's bioeconomy and Ireland's potential to achieve competitive advantage from its agri-food sector marine resources, pharmaceutical, IT and R&D capabilities. It points to the bioeconomy as being identified frequently as the biological dimension of the circular economy and how there will be areas of common focus between the Circular Economy Package and the bioeconomy. For example, while many bio-based materials are renewable, biodegradable and compostable, the use of biological resources will require attention to their lifecycle, environmental impacts and sustainable sourcing. (Barrett, 2016) The EU Bioeconomy Strategy, launched in 2012, has three pillars: investment in research, innovation and skills; reinforced policy interaction and stakeholder engagement, and enhancement of markets and competitiveness. This strategy is due to be reviewed in 2017.[11]

The context in which policy is being developed is fast-moving; many emerging practices are already 'disrupting' markets. These include: innovative business models for services or functions such as product leasing; sharing economy/collaborative consumption such as Dublin Bikes leasing and service-oriented business (e.g. Xerox selling copies made, not copying machines). Other circular economy practices may take longer to fully develop—for example, eco-

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9 https://dbei.gov.ie/en/What-We-Do/EU-Internal-Market/Ecodesign-/

10 http://foodwasteforum.ie/Irelands-food-waste/

11 http://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=strategy

design (European Parliament, 2012); viewing waste as a resource; reuse and repair of products; waste prevention and policy innovation (EEA, 2016c).

1.3 NESC Work on the Circular Economy

Previous NESC reports have pointed to the importance of effective waste management and greater resource efficiency as key parts of Ireland's development. Other work has highlighted the potential for natural (and renewable) resources to play a bigger role in indigenous industrial policy (NESC, 2002, 2005, 2012, 2016).

The current work examines the circular economy, drawing from the experience of organisations already engaging with key practices. This raises issues for its broader development in Ireland.

1.3.1 Research on the Circular Economy

The research for *Moving Towards the Circular Economy: Irish Case Studies* was conducted in the autumn of 2016 by Dr Simon O'Rafferty, and included interviews with 17 senior staff from 11 organisations on issues related to the circular economy. In addition, informal meetings were held with eight representatives from national and international organisations. Ten case studies were selected to explore different aspects of the circular economy within products and services, across the supply chain and within the sharing economy, and to include emerging practices, start-ups and social enterprises alongside more established firms.

The research report includes analysis of the rich material from these case studies, combined with an overview of the circular economy policy context.

1.3.2 Roundtable on the Circular Economy

The research report was presented to key stakeholders in April 2017, as part of a Roundtable, *Moving Towards the Circular Economy in Ireland.*

Over forty people attended the Roundtable, including representatives from departments, agencies, civil society organisations and business, as well as academics. The programme for the day and many of the presentations can be found on the NESC website.[12] Speakers included Paola Migliorini from the European Commission who provided an overview of their Circular Economy Package. Other international speakers were:

[12] http://www.nesc.ie/en/news-events/news/latest-news/nescs-workshop-roundtable-moving-towards-the-circular-economy-in-Ireland/

- Prof Mike Norton, European Academies Science Advisory Council (EASAC) on the key role of indicators for a circular economy

- Professor Jacqueline Cramer, Utrecht University Amsterdam, who outlined what a 'fixer/broker' role can bring to the multi-actor and multi-level challenge of the circular economy

- Ramon Arratia, Ball Corporation, on business models for circular economy practices

- Iain Gulland, Zero Waste Scotland, on the 'game changer' realisation of the potential economic value of the circular economy in Scotland

- Emma Shaw, Library of Things, London, on creating a successful social enterprise lending out tools and appliances and which creates a positive 'physical intervention' to a local community

The Roundtable focused on the research findings and case-study organisations, and the Irish experience of moving towards a circular economy; the EU and Irish policy context; international and national examples of innovation and practice, and the future development of an Irish circular economy. It addressed current practices in Ireland and the experience of the circular economy to date; the policy and practice context; examples of international innovation, and the future development of the circular economy in Ireland.

Four central questions were posed during the Roundtable to help navigate this complex area:

- **Current Experience:** *To what extent has Ireland already made progress towards the development of a circular economy?* The case studies illustrate a range of circular practices in business and not-for-profit organisations in Ireland. *How can these be further supported and, where barriers exist, what can be done to remove them?*

- **Policy and Practice:** *What are the potential roles for the State, business and civil society in the development of an Irish circular economy?* Given EU developments, what are the potential policy levers for governments? What new business models might achieve better resource efficiency? To what extent do social enterprises have a distinct and significant role to play?

- **Enabling Innovation:** *How can innovation in the circular economy be supported in Irish business, social enterprise and public policy?* What can we learn from experiments and developments in other jurisdictions? Is there a particular role for intermediary organisations to help connect and increase collaboration? What are

the risks as well as potential benefits in the journey to a more circular economy?

- **Future Development:** *What would be an ambitious approach to the development of the circular economy in Ireland?* Could distinctive aspects of Ireland's economy, environment and society provide an advantage in an increasingly competitive economic climate? What are the next steps for policy development?

The main themes that emerged were:

- There are enterprise and employment opportunities for Ireland in the transition to the circular economy.

- A multi-level, multi-modal policy approach is required that supports enterprise and public sector development of circular practices. This is best delivered with a cross-departmental agenda and collaboration to understand and embed circular economy practices. Interconnectivity is key and it requires a systemic perspective.

- Getting the governance and policy approach right from the start would ensure the right institutional supports and focus on innovation, as well as embedding learning loops. Institutions such as Zero Waste Scotland can be instrumental in driving action on the ground, particularly with financial supports to incentivise innovation.

- A focus on design is critical but has been underdeveloped in Ireland to date.

- Focusing on the social impact, and not just on the growth indicators, of economic activity is an important part of any circular economy strategy.

- Data will play a significant role in terms of material flow accounts and indicators for the circular economy.

Points made at the Roundtable discussions provided another valuable resource for the Council in the preparation of its comments.

1.4 Four Council Reflections

The Council welcomes this research as providing fresh insights into largely undocumented areas of practice in Ireland. As the report shows, there are surprising pockets of innovation and some very well established businesses at the frontier of the circular economy. The research report documents the opportunities and challenges for these companies and organisations as they strive to bring more circular practices to their business and enterprise models. Circular economy practices were also identified in civil society, community-led initiatives through the work of NGOs, social enterprises and co-operatives. This 'bottom-up' approach to examining the circular economy provides a key contribution to the emerging debate in Ireland.

The report also carefully maps out many of the complex challenges that these, and other organisations, have faced to date. It reflects on some of the key enablers and barriers to the development and discussion of circular economy practices more widely in Ireland.

The research report concludes with recommendations on the transition pathways, enabling conditions, metrics and innovation system needed to progress the circular economy. These provide a thoughtful basis for discussing the further development of the circular economy in Ireland.

To complement this work, the Council offers four broad reflections:

- There is momentum in circular economy practices in Ireland but action is needed to build on the early advantage.
- The full potential of the circular economy for Ireland has yet to be identified.
- The meaning and nature of the circular economy needs to be understood more widely.
- The development of the circular activity requires a holistic and strategic policy approach so as to maximise opportunities.

These will be briefly outlined in turn.

1.5 Reflection 1: There is momentum in circular economy practices in Ireland but action is needed to build on the early advantage

The Council considers that there is an early momentum in the building of circular economy practices in Ireland. The research points to Irish organisations developing innovative products from waste and unwanted materials and providing new service models, while others are creating opportunities for the sharing economy. This momentum is set within a heightened EU and global policy focus on the circular economy (as noted in Section 1.2).

The research identifies 10 case-study organisations active in Ireland. The diversity of these practices and services indicate the breadth of the circular economy. While the research report provides a detailed account of these, it is useful to briefly refer to them here:

1. **Wisetek**

   As part of their responsible IT recycling service, Cork-based Wisetek recondition and remanufacture IT equipment through the Wisetek Market, reducing what goes to landfill and creating income. The company employs nearly 200 people.

2. **Enrich Environmental Ltd**

   Based in Co. Meath, Enrich is one of Ireland's leading manufacturers of peat-free compost and soil products, and employs 18 people. The business developed after identifying opportunities in creating value from materials that were, at the time, being sent to landfill and contributing to a number of negative environmental impacts.

3. **The Rediscovery Centre**

   The Rediscovery Centre, located in Ballymun Dublin, is an environmental education and research social enterprise dedicated to providing education and community employment and training through reuse, repair, resource efficiency and lifecycle design. It functions as an umbrella organisation for four social enterprises that address the reuse and repair of the following product categories: Furniture, Paint, Bicycles and Fashion.

4. **Wellman International**

   The plastics sector in Ireland employs 6,500 people and accounts for €1.25bn of annual exports. Recycling of plastic material is a key growth area. Wellman International, located in Cavan, is a leading manufacturer of polyester staple fibre made from post-consumer and post-industrial recycled polyethylene terephthalate (PET). The company, founded in Ireland in 1973, employs approx. 270 people. In 2014 it had a turnover of around €135m. Collaboration is a key

part of the circular economy approach; Wellman International runs a project in which bottles collected from the Catalan seashore are recycled into clothing.

5. Sharing Economy

Ireland has some strong early adopters of sharing economy models and has managed to implement these very successfully.

(i) Sharing Economy Ireland is an advocacy group for the sharing economy in Ireland. It is a membership organisation made up of Irish-based companies operating within the sharing economy.

(ii) Go Car, a car-sharing company, began as a pilot in 2008 in Cork. It now has 190 cars in Dublin and Cork. Dublin City Council allows Go Cars to park free of charge in a range of locations.

(iii) Food Cloud is a social enterprise that matches food retailers that have surplus food with charities. It uses a digital platform to stream the matching process. It also redistributes food via warehouses in Dublin, Cork and Galway from 100 Irish businesses, including supermarket distribution centres and food producers, and delivers it to charities around the country. To date it has redirected 8,300 tonnes of food.

6. Ecocem

Established in Dublin in 2003, Ecocem produces low-carbon cement, employs 30 people in Ireland, the Netherlands and France, and has import facilities in the UK and Sweden. It upcycles materials that would otherwise go to landfill.

7. Perch and Orangebox

Perch is a Dublin-based product design company that specialises in furniture design, with particular strengths in research-led and applied human movement. Still at an early stage in relation to circular design, it is working with larger manufacturing companies in Ireland that are among the leaders in design for the circular economy, such as Orangebox.

8. Boomerang Enterprises

Based in Cork, this social enterprise recovers, disassembles and recycles mattresses to divert for re-use and/or recycling. It now has capacity to disassemble 150 mattresses per week, with a short-term target of 300 per week. Since it was established it has diverted over 7,000 mattresses from landfill.

9. Exergyn

Based in Glasnevin Dublin, Exergyn has since 2011 been developing a technology for converting the low-grade waste heat available in hot water into energy (electricity or motive power). The company believes that this technology, the Exergyn Drive, has the potential to reduce carbon emissions and energy bills

across multiple industries globally. In the last four years the company has been scaling up and developing the technology. It has raised €6m of investment and now employs 15 staff in total.

10.SMILE

This is Ireland's Industrial Symbiosis programme, launched on a preliminary basis in 2010 in Cork with support from the EPA, the Waste Regions and county and city councils. It provides to industry for free a platform through which synergies can be created between businesses that have surplus or unwanted materials and businesses that have a need for those materials. As of quarter one in 2017, the platform has almost 1,500 members. To date, the successful synergies represent 22,172 tonnes of waste diverted from landfill, with cost savings to businesses valued at approx. €4,439,021 (EPA, 2017: 14). A particular focus on industrial symbiosis in Ireland is being developed through an Industrial Symbiosis Working Group established by the EPA with Smile Exchange, DECLG (now DCCAE), Department of Enterprise, Ibec, the Waste Regions, UCC and Local Enterprise Offices among others, to see how a more circular economy can be supported in Ireland.

The research brings to light the range of circular economy practices underway in Ireland, and their associated benefits, including reduced resource use, related environmental benefits, economic benefits from cost savings and value creation, and social impacts such as job creation and wider social innovation. However, it also found that there are multiple financial, policy and regulatory constraints to future progress. As noted in many cases, the case study organisations are confronting barriers in relation to scaling up and further developing their initiatives.

The research points to the need to establish enabling conditions to nurture and support business and social innovation, as well as chart out pathways to progress towards a circular economy. The European Commission's Circular Economy Package will target some of these issues in time. However, the research indicates that, if Ireland is quick to avail of the many opportunities, it will benefit from economic, social and environmental rewards.

A supportive approach to the circular economy in Ireland could help to gain Irish enterprises competitive advantage. While there is no 'one size fits all' circular approach, insights from other countries can be useful in understanding what a process of customising a national approach might entail.

Scotland's government is investing in the circular economy because it has identified the potential for economic, environmental and social development. A critical part of its learning was research which identified that waste from Scottish whisky could boost the Scottish economy by £272m. Creating rural development opportunities and resource efficiency are important parts of the government's policy approach. The Dutch approach was to look at the overall strengths of the economy, identify key sectors and determine how these could be brought into the circular economy. Ireland will have its own priority areas; these could include the agri-food sector and the bioeconomy, waste to energy, biopharma etc., construction, plastics and WEEE,

and their supply and value chains. It is already recognised in Ireland that these sectors offer enormous potential.

Intrinsic to a circular economy is creating connections and cooperation. To create circular loops requires close collaboration across and within sectors and their supply chains, and multiple stakeholders in private and public sectors both nationally and internationally. Given Ireland's small scale, this may require forging links with other countries over particular materials and recyclables. On a local level, industrial symbiosis practices have been supported in Ireland since 2011 and the Smile Resource Exchange is demonstrating its potential for cost savings.[13]

The types of actions that could enable Ireland to build on this early momentum and to create a supportive environment for a circular economy are discussed in the three reflections that follow.

1.6 Reflection 2: The full potential of the circular economy for Ireland has yet to be identified

While resource efficiency and minimising waste are integral to a circular approach, it is evident from the current level of business interest that the circular economy offers the potential for broader gains. Governments are also gaining an appreciation of how it can be helpful as a policy lever for a low-carbon transition. Further, there is growing understanding that the circular economy has wider implications for the economy and society than simply being about maximising resources. It is complex, with many interconnected parts, and this requires policymakers to take a holistic and systemic approach.

The potential value of the circular economy has many facets. These are discussed here.

1.6.1 Job Creation

The socio-economic value of a circular economy lies in job creation, reduction in scarce raw materials and natural resources, and resource efficiency. There is also potential for job growth and enterprise development through new business and service models as well as enterprises using resources previously considered as byproducts or waste.

UK and Dutch research points to approximately 50,000 jobs that could be created from a transition to a circular economy in their respective countries (ESA, 2013, Bastein *et al.*, 2013). One Irish study estimated that 5,000 new jobs could be

[13] http://www.smileexchange.ie/

created through recycling materials such as plastics, paper, glass and WEEE, with a potential added GDP value of €1.65bn (Veolia, 2015). A study in Northern Ireland estimated that 5,500 jobs could be created in resource-efficient activities such as recycling, reuse, repair and remanufacturing, with lasting reductions in unemployment of around 1,300 people (ReNew, 2015).

While such jobs would range from low to high-skilled, from sorting recyclables to eco-design, they could be an important stimulus for employment, including in rural areas and areas of economic/social deprivation. For example, Wellman International, based in Cavan, has created 270 jobs. A Green Alliance (2015a) study shows that circular economy activities create jobs in occupations and regions with persistently high unemployment rates and contribute to reducing structural unemployment.

1.6.2 Social Dividend

As the Community Reuse Network in Ireland has stated, the social benefits associated with these jobs and training opportunities are important as they provide marginalised people with an opportunity to participate in society through skills training, and entry to the jobs market improves self-esteem and wellbeing. Furthermore, engagement with the community is increased (CRNI, 2016). The central role of social enterprises for rural and urban areas of disadvantage is an important part of the transition to a circular economy.

1.6.3 Environmental Value

The transition to a circular economy could bring considerable environmental benefits. The European Environment Agency outlines the potential environmental benefits of reducing emissions, less input of natural resources, few material losses or residuals, increased share of renewable and recyclable resources and energy, and keeping the value of products, materials and components in the economy (EEA, 2016c: 11).

As the research states, the global extraction of materials has tripled in the last 40 years, to 70 billion tonnes in 2010. Critical raw materials are becoming increasingly scarce. The extraction of raw materials is leading to negative environmental impacts such as air, water and soil pollution, climate change and biodiversity loss. However, resource use could be reduced in Europe by between 10 and 17 per cent through the implementation of current circular economy policies and interventions (European Commission, 2015a). In Ireland, a two per cent reduction in material consumption through resource efficiency measures could result in savings estimated at €928m (EPA, 2013b). This is likely to be a conservative estimate, since there are far greater potential reductions through additional innovation beyond the existing focus on eco-design, waste prevention and recycling (Meyer, 2011).

Progressing the transition to a circular economy would also reduce greenhouse-gas (GHG) emission levels. The OECD estimates that the management of materials accounted for between 55 and 65 per cent of national GHG emissions (OECD, 2012).

As much as two-thirds of Scotland's emissions are related to material consumption, which could be reduced through a circular economy. Research points to the potential to substantially reduce emissions by adopting a circular economy (European Commission, 2015a, EEA, 2016c). The Ellen McArthur Foundation and McKinsey Centre for Business and Employment (2015) estimate that adopting a circular economy in the mobility, food systems and built environment sectors in Europe could reduce emissions by 48 per cent by 2030 and 83 per cent by 2050, compared with 2012 levels.

While ensuring environmental benefits is important, it is challenging, and will require a regulatory dimension in practice in how it is delivered. This will be critical for non-renewable natural resources, particularly those that are increasingly central to a low-carbon transition (e.g. lithium for battery use). However, this regulation will need to be responsive to changing needs and uses. Regular monitoring of agreed 'safe' levels of use will be central to how natural resources are managed.

There are emerging debates on how environmental protection can be embedded in the circular economy and how environmental impacts can be limited. First, there is increasing focus internationally on environmental protection of biodiversity, habitats and species, and recognition of the contribution of ecosystem services to societies and economies. The benefits and impacts on nature remain invisible in most economies' measures of progress (GDP) but other measures are emerging that recognise the value of natural capital and how to measure it (UK, TEEB, etc.).[14] One view is that, until environmental impacts are taken into consideration, the real price of using natural resources will not be included in policy decisions. In his WCEF presentation, Janez Potocnick of the UNEP International Resources Panel argued that the greatest challenge to the development of the circular economy is the denial of environmental externalities. He pointed to the need to rebalance the costs of labour, the costs of resources and pollution.[15]

There are also concerns around how and where materials are reused, as this has a global reach. There are inequality and ethical issues relating to the developing world. Developing countries face the risk of being left with the world's waste. For example, 80 per cent of clothes sold in Uganda are second-hand. Some developing countries have high levels of child labour in waste sites; for example, children are sorting electrical waste in India.[16]

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[14] There is an ongoing debate on approaches to the value of nature, both intrinsic and monetary, that are relevant for a circular economy. Papers by Dr Patrick Bresnihan and Dr Craig Bullock for NESC on the value of nature can be found at: http://www.nesc.ie/en/news-events/news/latest-news/nesc-publishes-research-series-natures-values-from-intrinisic-to-instrumental-and-valuing-nature-perspective-and-issues/

[15] https://www.slideshare.net/WorldCircularEconomyForum/janez-potonik-world-circular-economy-forum-2017-helsinki-finland

[16] As described by UNEP Deputy Executive Director and Assistant-Secretary-General Ibrahim Thiaw at the World Circular Economy Forum, June, 2017. Also discussed by (Needhidasan *et al.*, 2014).

1.6.4 New Ways of Doing Business

With the growth of the sharing economy, new business models are emerging that offer products such as cars and bicycles for use rather than for ownership. In the UK, the sharing economy is projected to grow to £9bn over the next decade from £500m currently. Technological developments in web platforms, data analytics and artificial intelligence (AI) are helping to create new mechanisms to orchestrate systems for travel mobility (mobility as a service, Maas in Finland)[17]; sharing products (Library of Things) and distributing food waste (Food Cloud). The business sector internationally is rapidly engaging with circular approaches; e.g. *CEO Guide to the Circular Economy* points to a $4.5trn opportunity (WBCSD, 2017). The potential value is not just about bringing short-term financial gain; circular innovation is recognised as having a more strategic purpose. It is argued that it can boost the global economy's resilience by 'doing more with less' as well as providing new business opportunities; creating opportunities for increased competitiveness through innovative, more efficient ways of producing and consuming; and accessing new markets (CRNI, 2016).

1.6.5 Economic Savings

A reduction in the use of raw materials and natural resources to more sustainable levels has economic as well as environmental value. Over 96 million tonnes of materials such as metals, minerals, biomass, water and energy were consumed in Ireland in 2014 (CSO, 2016). Savings can be made through reducing and eliminating municipal, industrial and agricultural waste. Ireland exports most of its municipal solid waste abroad (843,053 tonnes in 2012), which results in the value of these materials and byproducts being captured elsewhere. The case-study research indicates that the recovery, reuse and recycling of materials such as plastics and food waste would bring substantial cost savings, as well as environmental benefits. For WEEE products, there are significant cost savings in the use of recovered components, in the order of 80 per cent. There is also value in finding new uses for natural materials, such as the potential of using cellulose nanofibres from wood and seaweed to replace plastics. [18]

Further cost savings could be made from resource efficiency, estimated for Ireland at €928m if a two per cent reduction in material consumption is achieved annually (EPA, 2013a). The value through cost-savings from greater resource efficiency was also illustrated in the research. Orangebox, a company that designs and manufactures office furniture, has prioritised resource efficiency as 45 per cent of its operating costs are related to materials. Boomerang and the Rediscovery Centre have identified new uses for existing products.

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17 http://maas.global/

18 https://in.reuters.com/article/autos-japan-wood-idINKCN1AU2FR

Wellman International, another case-study company, uses polyethylene terephthalate (PET) products as material for a range of new products across healthcare, the automotive industry, home furnishings and clothing.

More broadly, the economic value of a circular economy has been estimated for countries the Netherlands, Finland and Denmark. In the Netherlands, the circular economy could be worth 1.4 per cent of current GDP in terms of potential market opportunities (Ellen MacArthur Foundation, 2015b, Bastein *et al.*, 2013). Sitra (2015) estimate that the potential value of the circular economy in Finland could be €2bn to €3bn by 2030 through a focus on specific sectors. A study in Denmark concluded that, by 2035, circularity could increase Danish GDP by 0.8–1.4 per cent.

1.6.6 Manufacturing Practices Using Secondary Value Streams

There is increasing focus on the development of low-value outputs from secondary industrial value streams and waste streams; for example, in fertilisers and biofuels. The BioÉire research (Teagasc, UCD, DIT and others) has identified some value streams (Devaney & Henchion, 2017b).[19] Another area of innovation is in chemical production; Tipperary is a demonstrator region for sustainable chemical production for a circular economy. [20]

However, there is also potential in more sustainable manufacturing practices developing high-value outputs from secondary industrial value streams and waste streams, including new materials, alternatives to petrochemical products, materials technologies for reclamation of critical raw materials, high-surface-area materials applications, medical devices, etc. All can be made potentially from renewable sources and from waste and by product streams of Ireland's industries, using materials science and engineering. This is the focus of the Sustainable Materials Laboratory in the Environmental Research Institute (UCC), comprising organic chemists, atmospheric chemists, materials scientists, engineers, physicists, plant scientists, microbiologists and biochemists.

Another significant area is 3D printing (additive manufacturing) which could have a dramatic impact on reducing the extent of materials used in manufacturing. Additive manufacturing could use 50 per cent less energy on average, and save up to 90 per cent on materials costs compared to traditional manufacturing (US Department of Energy, 2012). The technology can create different structures from the same small set of materials to generate new and valuable materials, characteristics and variations (World Economic Forum *et al.*, 2014: 108).

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19 https://www.teagasc.ie/publications/2017/bioeire-results-launch.php

https://www.teagasc.ie/media/website/publications/2017/MHenchion_Beyond-BioEire.pdf

20 The European Commission has selected six model demonstrator regions that will receive advisory support from the European Sustainable Chemicals Support Service (ESCS). The aim is to encourage investment in sustainable chemicals production in Europe that will contribute to the development of the circular economy (Philp, 2017).

1.6.7 Basis for Clustering

The circular economy is by its nature a collaborative approach and can thus provide an important basis for clustering of activity within a region. Clustering is a proven strategy that provides potential for economies of scale and access to opportunities that would be outside the capability or scope of a business working alone (Enterprise Ireland, 2012).[21] Enterprise Ireland recognises the potential of clustering and has funded pilot supports in recent years. The medical devices sector in Galway is an example of a successful geographic cluster. The circular economy would seem to offer a rationale for a fresh approach for an Enterprise Strategy for indigenous sectors focused on clustering. This could increase the reliance on mainly local supply chains and provide resilience in the context of Brexit.

1.6.8 Added 'Policy' Value

Increasingly at a European level, there is a focus on the policy value of the circular economy as it offers one avenue to help progress a low-carbon transition. The EU and agencies such as the European Environment Agency point to the synergies and strengths of integrating these frameworks, rather than seek to progress them in parallel. The job potential of a circular economy has been a central driver of its progress at European level. Pursuing a circular economy can also bring further action in relation to the 2030 Agenda for Sustainable Development, and delivery of the Sustainable Development Goals and climate action, alongside community developmental potential for rural and disadvantaged urban communities. As noted by the OECD recently, in the context of the transition to a low-carbon society, it is worth reflecting on the potential synergies between policies for a circular economy, Sustainable Development Goals and climate action across key sectors such as agriculture, energy and transport (OECD, 2016). The circular economy and sustainable consumption and production can help operationalise the Sustainable Development Goals in practice (Potocnik, 2017). On a conceptual level, a focus on the circular economy requires policy reflection on the interconnectedness of materials, products, places and the social and environmental impacts.

This policy synergy is important in the context of responding to other fast-moving global trends. As repeatedly referenced at the World Forum, the circular economy is emerging in the context of, and aided by, fast-moving global trends such as technological, data and environmental. Technological trends, including digital (the Internet of Things, blockchain), physical robotics, energy storage, 3D printing, nano-technology) and biological (bioenergy, biomaterials, aero farming), are set to play a key role in the development of the circular economy. For example, the Internet of Things will provide information about what resources we have and what we are

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[21] https://www.enterprise-Ireland.com/en/News/PressReleases/2012-Press-Releases/New-%E2%82%AC2million-clustering-programme-to-promote-cooperation-between-businesses-and-create-more-jobs-%E2%80%93-Minister-Bruton.html

losing (World Economic Forum, 2016).[22] A related trend is the growth of big data in relation to asset use cars, property, goods as they move around a circular economy. In order to avail of car and goods sharing, consumers may increasingly be providing data and this raises issues of privacy and security—'exchanging data for value' (Sundstrom, 2017). Other megatrends include growing populations, urbanisation and climate change. These global trends can both offer new opportunities and exacerbate the problem (FinanCE Working Group, 2016).

1.6.9 Circular Cities and Regions

Creating circular cities may present competitive advantages for cities seeking to attract multinationals and investment.[23] Globally, cities consume 75 per cent of natural resources (materials, energy, water) and produce 50 per cent of global waste and 60–80 per cent of GHG emissions (UNEP, 2012). Amsterdam has adopted a Circular Amsterdam strategy. This has included a new tendering process for circular building for land use; a supporting innovation programme and a 'learning by doing' approach by working with universities and sharing data. However, there is a strong focus on the potential for cities as hubs of the circular economy. The circular economy can be enabled through city-level decoupling and urban resource flows. UNEP's International Resource Panel argues that decoupling can be achieved by retrofitting urban infrastructures or building new ones that are more resource-efficient (Swilling *et al.*, 2013). It points out that 60 per cent of the built environment required to accommodate the earth's urban population by 2050 remains to be built.

Aligned to the circular economy is the pursuit of zero waste. This refers to waste management and planning approaches that emphasise waste prevention as opposed to end-of-pipe waste management.[24] Cities actively working towards being 'zero waste' include San Francisco (USA) and Ljubljana (Slovenia). Zero Waste Ireland (ZWAI) is a policy-oriented organisation, established in 2004, that focuses on zero-waste principles (whole lifecycle approach), where waste is seen as a resource.[25]

Regions are also actively working towards being zero-waste, and some are setting targets for resource use. Flanders in Belgium, for example, has set a target of 5kg per capita for waste reuse (EEA, 2016b).

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22 The World Economic Forum point to the synergy between the circular economy and the growth of 'intelligent assets', which include knowledge of the location, condition and availability of an asset (or product) (Ellen MacArthur Foundation & World Economic Forum, 2015: 8).

23 The Ellen McArthur Foundation supports a Circular Cities Network, including London and Copenhagen.

24 http://zwia.org/

25 http://zerowasteIreland.com/about-zero-waste-alliance-Ireland/

1.7 Reflection 3: The meaning and nature of the circular economy needs to be understood more widely

Aligned to an appreciation of the range of potential benefits from a circular economy is the need for a richer understanding of what the transition to a circular approach requires. While resource efficiency makes intuitive and practical sense, though hard to achieve, creating closed 'loops' for materials and products is more technically challenging. Further understanding is needed about the lifecycle of products, design, investment, the bioeconomy, barriers to reuse, material flows, gains and risks, and public dialogue. These are briefly outlined in turn.

1.7.1 Understanding the Lifecycle of Products

The research points to diverse entrepreneurial activity as 'circular' that may not have been recognised as such before, from reuse of IT equipment to composting and the bioeconomy to repairing furniture. The research brings these activities under the circular umbrella to both ground abstract discussion on the circular economy but also to act as a frame of reference for many other potential circular activities, not yet labelled as such. These activities have not only economic but also social and environmental drivers, and thus share commonalities while operating in different sectors. Future development of such activities would seem to require greater alignment and orientation towards a more systemic, integrative approach. For example, new business and social enterprise development may be hampered by inadequate understanding of the potential synergies between the materials used and their byproducts.

In broad terms, moving towards a circular economy requires a fundamental rethink about the lifecycle of any product. Lifecycle thinking (LCT) has been noted as a gap in Ireland's current resource efficiency practices by Coakley *et al.* (2011). There has been slow progress globally in making the shift across supply chains, given the level of systemic change required. The 'use, reuse' model at the heart of the circular economy requires a shift in how conventional product design, manufacturing and retail is configured. Critically, the emphasis has to shift to product design (eco-design), where 80 per cent of a product's environmental impact is determined. LCT considers all phases of production, distribution, use and disposal from the outset and requires the design to include the product's 'end of life'. Other elements of the circular economy include the leasing rather than selling of products, a collaborative model across supply chains, strong consumer support for reducing waste, and new models of product and materials recovery.

Other countries have progressed this, notably Japan, which has moved towards a highly efficient circular economy with a strong legislative framework that treats materials as circular goods and focuses on the full lifecycle of products. Manufacturers are legally required to run disassembly plants and recover materials that they regard as an asset—98 per cent of metals are recycled. Many WEEE

materials go back into the manufacture of similar products, a closed-loop key to a fully circular economy (IES, 2015).

1.7.2 Focus on Design

Critically, the redesign of products and process is the most critical but least-developed aspect of the circular economy. Rather than focusing on end-of-pipe solutions for resource use and reuse, attention has to be given to the lifecycle of products so that 'loops' are created for materials. For example, phones can be designed to enable easier dismantling at end of use. Apple developed Liam, a robot with 29 arms, that takes apart returned iPhone devices in seconds to recover their precious components, such as aluminium, copper, cobalt, gold and silver parts (Rujanavech *et al.*, 2016). While specific to each new product, a focus is also required on creating links between one product and the next so as to minimise waste. Design requirements will need to ensure that products are more durable and that barriers to their reuse and recycling are removed. This often involves a bird's-eye analysis of materials, products and byproducts beyond the supply chain to other sectors.

As part of its focus on eco-design, the European Commission has developed mandatory product design and marking requirements to make it easier and safer to dismantle, reuse and recycle electronic displays (e.g. computer monitors, televisions and electronic display integrated in other products). In addition, the European standardisation organisations are working to develop generic standards on the durability, reusability and recyclability of certain products (European Commission, 2017a).

The Ellen MacArthur Foundation and IDEO recently produced a tool, *The Circular Design Guide,* to help entrepreneurial innovators and students to get to grips with the circular economy (Ellen MacArthur Foundation, 2017).

1.7.3 Investment in Innovation as an Important Lever

There is a growing sense that moving from a linear economic model to one that is circular by design will require a transformation that involves systemic changes in product design, manufacturing, service models and the ways goods and services are consumed. In this sense, it will require innovation on many levels. As the research notes, while waste prevention and recycling are key aspects, the circular economy predominantly focuses on the technological, organisational and social innovations across value chains. While pockets of innovation are clearly evident, this will be limited without supportive policy and societal supports at local and national levels, aligned across sectors, including investment. The research points to the value of scaling up bottom-up initiatives in the areas of reuse, remanufacturing and refurbishment that are currently acting as niches of potentially beneficial future practices.

Fostering innovation is integral for new product design and services, and in exploring new approaches to promote positive consumer behaviour. Barriers exist

at the design stage of manufacturing as many products are currently designed and manufactured to minimise production costs and stimulate their fast replacement (Piscicellia & Ludden, 2016). Extending the product life of goods requires a shift in consumer expectation. Creating secondary markets for used goods (such as clothes, furniture and household goods) necessitates strong consumer acceptance and support. Case-study organisations working with recycled material emphasised that quality is the key and pointed to current problems such as the collection of household recyclables with high levels of contamination. Another related challenge is understanding and tackling food waste and enabling social and behavioural change. Social enterprises and start-ups have a particularly important role in identifying new opportunities. The governance of the circular economy will require recognition of levers such as supports for innovation, collaboration and design alongside regulation on materials, products and services, as illustrated by the Finnish and Scottish approaches. More research is required on these public governance challenges for a circular economy, alongside the broader challenges of the low-carbon transition.[26]

1.7.4 Digging Deeper into Key Sectors

The full complexity of the circular economy, and therefore an understanding of solutions, is not possible without digging deep into specific sectors. The breadth and depth of the European Commission's Circular Economy Package is illustrative of this challenge, as it delves into food waste, plastics and WEEE, among other sectors. This dropping-down into sectors requires collaborative working with a wide range of stakeholders that are expert in their sectors. However, in doing so, there needs to a continual reaching up and out to other sectors to share understanding of the production and consumption challenges being raised and to find solutions. In seeking to enhance the use of secondary materials, the production of waste becomes the least preferred option. Those considering the problem of plastic waste, for example, may uncover a solution through engaging with packaging, energy or pharmaceutical experts. New products for packaging, for instance, may in turn come from the agri-food sector.

Plastic waste is reaching chronic levels globally. The World Economic Forum and the Ellen MacArthur Foundation (2016) reported that, by 2050, oceans are expected to contain more plastics than fish (by weight). The *New Plastics Economy* outlines that most plastic packaging is used only once; 95 per cent of the value of plastic packaging material, worth $80bn to $120bn annually, is lost to the economy. Globally, only 14 per cent of plastic packaging is collected for recycling. Additionally, plastic packaging damages the environment—at a conservatively estimated cost of $40bn (UNEP, 2014). The report proposes a strategy in which plastics never become waste, and outlines concrete steps towards achieving the systemic shift needed

[26] The OECD has examined some aspects in its work on aligning policies: OECD (2015). NESC is planning further research on governance for low-carbon transition. See Work Programme at http://www.nesc.ie/en/news-events/news/latest-news/nesc-call-for-expressions-of-interest-for-sustainability-research-2017/

(Ellen MacArthur Foundation, 2016). In Ireland, while there has been an increase in the recycling of packaging waste, now at 68 per cent (by weight), a third is still not captured for recycling. Plastic waste is found along our shores and recently microplastics have been found in fish and therefore in the human food chain (Harris, 2017). A plastics strategy is expected in 2017 as part of the European Commission's Package.

The construction sector has considerable potential for recycling materials. The World Economic Forum (2014) points to this sector as the largest global consumer of resources and raw materials (World Economic Forum *et al.*, 2014). However, as the research points out, Denmark recycles 87 per cent of its non-soil construction and demolition waste (Engineers Journal, 2016). Embodied carbon in cement and steel can account for 40–50 per cent of the carbon footprint of a building, so any reduction in the use of new materials has many positive potential impacts (ICE, 2015). Ecocem, one of the case-study companies, produces low-carbon cement, using a byproduct of the iron industry.

1.7.5 Supporting the Bioeconomy 'Engine'

The bioeconomy has considerable economic potential, in bioenergy, biofoods and biopharma. Careful governance is required to align policy development for maximum traction. Emphasising the circular economy in how the bioeconomy develops will ensure that environmental sustainability and the broader systemic regulatory and policy changes are embedded from the start, and bring a systemic focus on balancing environmental, social and economic benefits in a broader circular approach. As previously noted, the Department of the Taoiseach recently published a bioeconomy discussion document as part of an open consultation process (Department of An Taoiseach, 2017).

1.7.6 Barriers Exist to Reuse

Reusing products is a critical part of an emergent circular economy. However, multiple barriers to reuse are holding back innovation. Many members of the Community Reuse Network in Ireland are finding it increasingly difficult to repair or refurbish goods, due to poor product design (CRNI, 2016). Difficulties include liability, producer responsibility and concerns over risk in reuse. While many of these are being tackled at the front line of emergent businesses and services, as well as through EU regulation and standards, there is a broader need to create a culture of reuse that governments and local authorities can be instrumental in fostering (free trade.ie, for example). However, this culture of reuse requires supports for behavioural change. For example, globally, there is no shortage of demand for second-hand devices, yet millions of phones sit in drawers in the US and Europe, while the same models fetch high prices on eBay (Green Alliance, 2015b).

1.7.7 Understanding Material Flows

Unlocking the full potential of the circular economy for basic materials means reorganising and streamlining materials into flows and loops of standardised purity (World Economic Forum, 2015). Ultimately this happens at a global level, as Ireland's size will be limiting in some cases. This points to a key step, which is to pick and reorganise a few materials streams that are already sizeable and well understood in terms of properties, economics and (emerging) treatment/processing technologies (World Economic Forum *et al.*, 2014).

1.7.8 Fuller Appreciation of Potential Gains and Risks

While there are opportunities and potential 'winners' in the circular economy, the potential risks and losses need to be appreciated. At the World Circular Economy Forum in Helsinki, the circular economy was positioned by some contributors as a win-win approach, in terms of economic, environmental and social gain. But others were more cautious, pointing out that that there would be economic losers; for example, through reduced consumption of some products because of reuse.

There are multiple narratives for a circular economy and what it could bring societally. For example, London's Library of Things and Dublin's Rediscovery Centre are social enterprises that adopt circular economy practices through providing a resource for communities. In broader terms, circular practices that are non-commercial may increase social capital and lead to "widespread networks of community gardens, repair cafes and time banks." (Narberhaus & von Mitschke-Collande, 2017).

Debate also focuses on the rapid growth of the sharing economy, which, though linked to the circular economy, is emerging as a separate and diverse set of strands aided by advancements in digital technology.[27] These include the sharing of assets such as cars, tools and equipment, to renting, swapping or leasing using digital technologies (e.g. Dublin Bikes). Some of these enterprises have been embraced at a community level but others have sparked controversy. The most notable examples are Airbnb and Uber, which highlighted the potential markets for under-used assets but have created difficulties for established businesses such as B&Bs and taxis, trying to compete with Airbnb and Uber but operating with higher overheads. For some, the benefits of earning additional income through the 'sharing' of personal assets such as a house and car are welcome; for others, a 'gig' economy can lead to more precarious working conditions.

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[27] http://circulatenews.org/2016/08/what-does-the-sharing-economy-mean-for-a-circular-economy/

Another aspect of the emerging debate focuses on the risks of pursuing a circular economy without reducing consumption and consumer behaviour change to ensure more balanced economic growth or even de-growth alongside circular economy progress (Narberhaus & von Mitschke-Collande, 2017). Adopting the guise of circularity, but without reducing resource use, may not enable a low-carbon and just transition. It is argued that, to achieve such a transition, economic growth is essential, but that it has to be decoupled from the environment and become restorative, rather than continuing to deplete the earth's resources. A focus on the potential for labour-intensive industry in the circular economy may be important in the shift away from fossil fuels.

1.7.9 Developing a Shared Understanding of the Circular Economy

The social and environmental aspects of a circular economy, while an important part of the rationale, are not often discussed in terms of what they would mean in practice. What are the societal implications of a circular economy? The wider discussion of what we want the circular economy to do for society, in terms of sustainable development, is often sidestepped because it is challenging. Environmental objectives may be clearer in terms of the ultimate goal of decoupling economic growth from natural-resources depletion and environmental degradation. The social aspects have not been as fully explored and there is limited information available on aspects such as gender, skills, occupational and welfare effects, poverty and inequalities (Rizos *et al.*, 2017: 25). There may be merit in putting ecosystem functioning and human wellbeing as the central objectives, as outlined in a critique by Murray *et al.* (2015).[28] They argue that 'only if societal needs are defined and included in the basic formulation [of the circular economy] can we hope to build on all three pillars of sustainable development'.[29] They further argue that a careful definition of its meaning and a shared understanding would allow real benefit to emerge for both environment and society. At a European level, it is useful that the circular economy is seen as an integral but interdependent part of a just transition to a low-carbon society, rather than as a singular destination.

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[28] See also (Bocken *et al.*, 2017).

[29] P.22.

1.8 Reflection 4: The development of the circular activity requires a holistic and strategic policy approach to maximise opportunities

While there is notable momentum, the Council considers that Irish progress towards a circular economy could be strengthened by a cohesive and strategic policy approach. Progressing the circular economy presents a governance challenge, since it is multilevel and multimodal, and has social, economic and environmental dimensions. Strong central policy support would be required to embed the circular economy into national policy priorities, including enterprise policy, regional and rural development and climate action. The research identifies some of the key public and private actors and stakeholders related to the circular economy across governance, skills and education, research and knowledge exchange, and supply and demand-side activities. These are engaged in resource efficiency, waste prevention and other circular economy activities, with the EPA and DCCAE playing a central role. Others include the Regional Waste Management Offices, local authorities, industry, the IDA, Ibec, Enterprise Ireland and the Department of Business, Enterprise and Innovation in relation to eco-design and labelling; SEAI on bioenergy; Community Reuse Network, universities, NGOs and social enterprises. This mapping of at least 27 national organisations indicates that the transition to a circular economy requires a broad and open reach. The research points to the value of a coherent policy mix of multilevel interventions that can be delivered across the public and private sectors as well as to individuals and communities. The EEA 2016 review of material resource efficiency policies concluded that circular economy activities in Ireland have been largely fragmented and *ad hoc* (EEA, 2016a).

Box 1: Scotland's Circular Economy Strategy (Scottish Government, 2016)

The Scottish Government launched an ambitious strategy for the circular economy, *Making Things Last,* in 2016. While containing broad national objectives to progress the circular economy, it identifies several priority actions, including the development of a more comprehensive approach to producer responsibility for products (such as mattresses and furniture) and reducing food waste by 33 per cent by 2025.

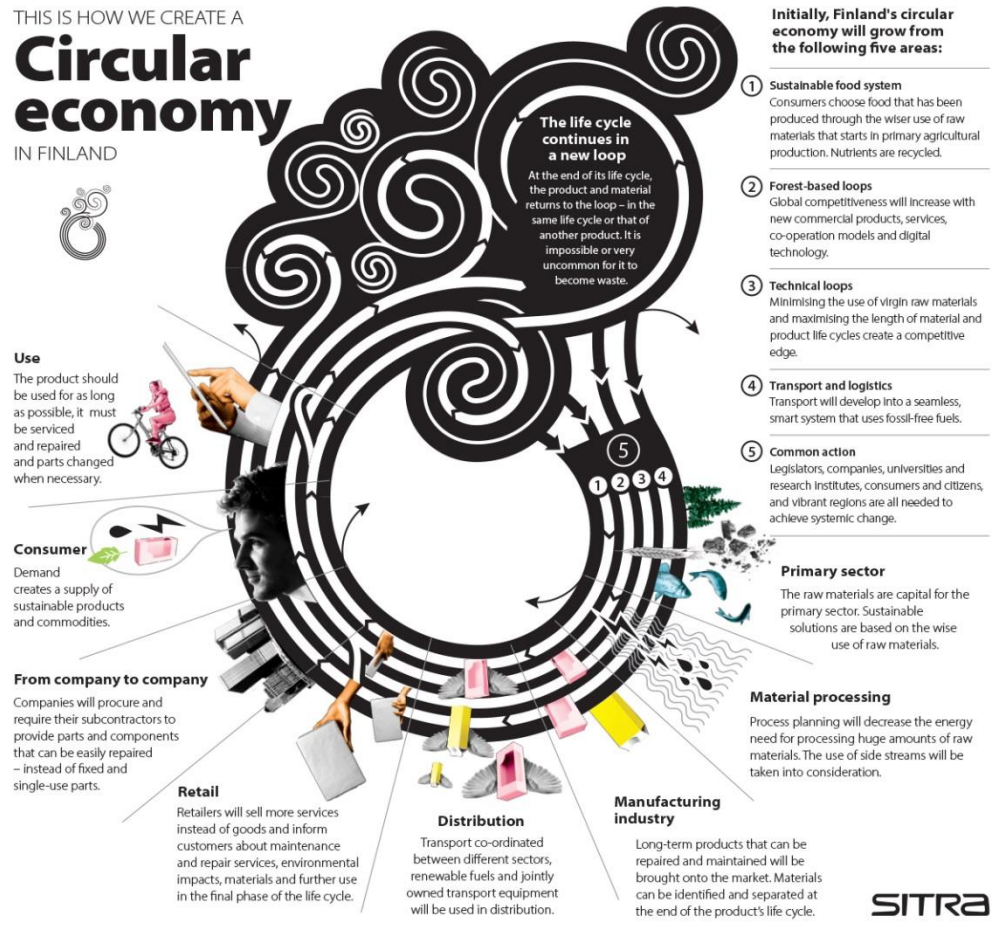
The strategy's four priority areas, based on their resource use, environmental impact and importance to the Scottish economy, are:

(1) Food, drink and the broader bioeconomy: the beer, whisky and fish industries could reduce costs by £500m to £800m a year by taking a more circular approach; (2) Remanufacture: contributes £1.1bn a year to Scottish GDP and could contribute £1.7bn a year by 2020; (3) Construction and the built environment: generates around half of all waste produced in Scotland, so can much increase resource efficiency, and (4) Energy infrastructure: significant potential to reuse equipment from decommissioned oil, gas and renewables infrastructure (£30-35bn is expected to be spent on oil and gas decommissioning by 2040).

Other countries have progressed towards a circular economy in a range of ways. In China, where the circular economy has been most developed, it has featured in the last two Five Year Plans drawn up by the Chinese government and is therefore central to core policy strategy (Zhijun & Nailing, 2007), cited in (Murray et al., 2015: 5). Finland and Scotland have developed specific strategies and roadmaps (see Boxes 1 & 2). These include implementing a range of supports and measures to promote circular economy practices. The Netherlands has developed a national programme, *A Circular Economy in the Netherlands by 2050,* which sets out to reduce primary natural resource consumption by 50 per cent by 2030 (Government of the Netherlands, 2016).

Box 2: Finland's Roadmap to a Circular Economy (Sitra, 2016)

Sitra was established in 1967 to mark Finland's 50th anniversary, with funds from the Bank of Finland. Prior to the World Circular Economy Forum, Sitra led in the development of 'Leading the cycle—Finnish roadmap to a circular economy 2016-2025'. The process of developing the roadmap involved 1,000 stakeholders and public-private partnerships, along with a staged process of wide and then narrower consultation involving key ministries.



1.8.1 Supporting Innovation

Public funding is being made available to stimulate circular activity and support start-ups in new circular business models. For example, Scotland has an £18m investment fund with the potential to increase this to £70m through European Regional Development Funds. The funding is focused on key sectors such as the bioeconomy, the built environment and energy infrastructure. Finland's Sitra is spearheading intensive circular economy investment. When funding support is not focused on circular economy practices, organisations find it more difficult to grow. For example, case-study organisation Exergyn found it difficult to raise finance in Ireland to develop its technology.

Other types of initiative to increase innovation include the North Sea Resources Roundabout, a voluntary agreement that seeks to address transnational barriers to the use of secondary raw materials in Europe.

1.8.2 Creating a 'Brokering' Role

The creation of a key broker or fixer role (played by an individual or an agency) is being used to bring sectors and stakeholders together. This involves tailoring institutional supports to particular aspects of the circular economy. For example, as part of Circular Amsterdam, Professor Jacqueline Cramer has been instrumental in convening key sectors to examine waste streams. These sectors include construction, mattresses and biomass, exploring how they can progress towards a circular economy. A key focus has been on closing material loops at local level. Then, work 'higher up' has to be done to ensure there is sufficient supply of a particular waste stream to be recycled and a clear demand for the material. Other key elements are securing the quality of the product, removing technical barriers and providing new financial and funding arrangements to get sectors off the ground.

In Scotland, Zero Waste Scotland is funded by the Scottish Government to support the delivery of its Circular Economy strategy and other low-carbon and resource efficiency policy priorities. The UK city of Peterborough has developed the Circular Peterborough programme to apply circular economy principles at city level. This involves the Circular City Champions Scheme, which brings together private and public sector organisations working to progress the circular economy.[30] Glasgow city is a circular economy 'hot spot.' Zero Waste Scotland, working with Glasgow's chamber of commerce, is examining the city's resource, energy and financial flows and developing pilot projects with key partners (Zero Waste Scotland, 2015).

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30 http://www.futurepeterborough.com/circular-city/

1.8.3 Developing Responsive Regulation and a Process of Standards and Verification

While the EU has a key role, national and sectoral developments are required for particular materials. Policy focus is directed at identifying and removing regulatory barriers; for example, in relation to product innovation, supply chain and product reuse.

There are barriers to scaling up higher-value processes such as producing biogas from anaerobic digestion or developing biopolymers using waste feedstock. For example, the case-study company Enrich has been challenged by issues arising from the regulation of source separation schemes of food and green wastes. The estimated food waste from brown-bin collections did not materialise, so the company has had to process other materials in order to ensure the plant's viability. Hopefully, this will improve as more brown bins are collected. The research provides an overview of the EU's framework of regulations, both current and planned, arising from the Circular Economy Package. However, implementing these will require a national focus by departments and agencies, such as the work on eco-design and eco-labels by Enterprise Ireland, and by the Department of Communications, Climate Action and Environment in relation to the Directives on waste, food waste, Green Public Procurement and fertilisers, among others. In addition, there is a role for organisations to contribute to new standards. For example, smaller organisations, including social enterprises, have a role to play in developing protocols and professionalising the reuse sector, such as the Rediscovery Centre's reuse protocols for key product groups. In addition, another case-study company, Ecocem, established an independently verified Environmental Product Declaration (EPD) for construction products, with support from the EPA.

Extended producer responsibility (EPR) seeks to achieve a reduction in the environmental impact of products, throughout their lifespan, from production through end of life. It involves a shift in responsibility (administratively, financially or physically) from governments or municipalities to producers (European Commission, 2014). It is being used for packing, WEEE, cars and other products within the EU, but France and Japan have developed it further. France has 14 mandatory EPR schemes for furniture, tyres and infectious healthcare waste. Japan requires manufacturers to use recycled materials and reusable parts in new products (Perella, 2017). Ireland has a Producer Responsibility Initiative (PRI) for tyres and is now introducing a more comprehensive compliance scheme.

Some countries are taking a lead on regulating for particular materials such as plastics, or on discrete challenges such as food waste. In 2016, the French government passed a law banning all plastic cups, cutlery and plates from 2020 (Science Alert, 2016). This does not include cups sold at point of sale, which are packaging and cannot be banned under the Packaging Directive. The Scottish Government recently announced it is planning to introduce a plastic bottle return scheme (Scottish Government, 2017).

1.8.4 Creating Opportunities for Public Dialogue on the Circular Economy

As civil society has a key role to play in increasing waste reduction, reuse and recycling behaviours, its involvement will be important in the success of transitioning to the circular economy. The European Environment Agency stated that the transition to a circular economy would be multifaceted and therefore need to involve all stakeholder groups: governments, businesses and finance, civil society and citizens (EEA, 2016b: 6). The EU has produced a video to communicate the potential of the circular economy.[31] A new European Circular Economy Stakeholder Platform has recently been established jointly by the European Commission and the EESC (European Commission, 2017b). This platform will be a 'network of networks' that goes beyond sectorial activities to highlight cross-sector opportunities and challenges.

Increased public understanding of the purpose and direction of a circular economy will be fundamental in shaping how it evolves (see also Section 1.7.9). This can be aided by and aligned with technological developments, such as apps developed to enable food sharing and reduce food waste. Indeed, food waste can act as a hook for wider public engagement on the circular economy.

There is scope for greater resource efficiency through capturing the public and private imagination. Irish businesses have started to engage with what a circular economy might mean for them as it accelerates, pointing to 'stronger commitment and a collaborative approach, involving governments, businesses and science as well as consumers and increased value chain cooperation' (Ibec, 2016). In Scotland, the second-hand Dingwall Superstore in the Highlands secured funding and support from Zero Waste Scotland after a nationwide call for collaborative bids from private, third and public sector groups to team up on major joint retail initiatives (Scottish Government, 2016).

Circular economy policy messages can convey the familiarity and common sense of resource efficiency, for example, such as making resource efficiency familiar 'going back to the future', given our grandparents' skills for resource management. Young people have an increasing environmental awareness, which can help inter-generational learning (see Box 3). In Japan, across all generations, there is a cultural appreciation of the practice of using all things as long as possible – evidenced by the term *Mottainai*, an expression that indicates regret when something useful, such as food or time, is wasted ((Ministry of the Environment, 2012).

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[31] https://www.youtube.com/watch?v=lK00v_tzkCI&feature=youtu.be

Box 3: Communicating the Circular Economy: The Story of a Pencil

'The Story of a Pencil', the journey of a pencil from a tree in Brazil to a compost bin in Ireland, was the winner of the EPA's Story of Your Stuff competition.[32] The contest asked students to illustrate the lifecycle of an everyday object: where it came from, how it was used and where it ended up. The short video from Iga Manulak and Emma Jackson of St Mary's College, Ballysadare, Co Sligo, can be watched at https://www.youtube.com/watch?v=dTS2BV94D_c

1.8.5 Tailoring Policy Measures and Supports

Policy supports that seem most effective are ones that that are tailored to business, social enterprise, households and research and development through an appropriately responsive institution.

Measures can include tax provisions on natural resource use and pollution, incentives to stimulate demand for reused and recycled goods, and regulations against planned obsolescence. For example, the Swedish government recently reduced the VAT levied on repaired products, from 25 to 12 per cent. The French government introduced specific regulations, such as demands that auto repair services offered reused parts to customers. Also in France, planned obsolescence is punishable by two years' imprisonment and a fine of up to €300,000. In relation to the sharing economy, subsidies such as free parking for GoCar allows customers to park for free in Dublin city centre. Green Public Procurement (GPP), the purchasing of goods, services or works with a reduced environmental impact, is a critical tool to promote circular economy practices (12 per cent GPP in EU is key lever). For example, in Ireland, the use of Community Benefit Clauses in government and local authority procurement could support social enterprises working to recycle or reuse products, such as Boomerang.

The European Commission's Circular Economy Package intends that GPP be used more widely to promote circular economy practices (EC, 2017).[33] This might be possible by focusing on services instead of products; a product's design and market dialogue could help promote circular procurement.[34] As stated by the Department of Communications, Climate Action and Environment, the Government's annual

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32 http://www.thestoryofyourstuff.ie/

33 http://ec.europa.eu/environment/gpp/index_en.htm

34 This was proposed by the EU-funded project SPP Regions. http://www.sppregions.eu/home/ —cited in (European Parliament, 2017).

public sector purchasing accounts for 10–12 per cent of Ireland's GDP, a large part of economic activity and demand.[35]

Other forms of support are required for institutions to provide guidance and co-ordination. In Ireland, the EPA has been supporting the development of reuse and repair through funding the Community Reuse Network (CRNI). The CRNI supports the work of 16 national community reuse organisations. As the research notes, however, while reuse and prevention are at the top of the waste hierarchy, funding supports are quite low relative to methods such as recovery and disposal.[36]

To be effective, policies need to intervene at a series of different points across the value chain. For example, in relation to electronics, these could have an impact at different points such as the design, materials, manufacturing, distribution and business models. This needs to be coupled with a focus on learning and monitoring to help progress innovative solutions at all levels of policy, which is central to the Dutch, Scottish and Finnish approaches.

1.8.6 Supporting Social Enterprise Development

Social enterprises play a key role in recognising circular economy opportunities. Circular business models are generally more labour-intensive than business models focused on simply selling products. Companies will need to employ people to collect, repair and disassemble products and provide customer services (Circulate, 2015). A focus on developing a coherent support infrastructure would assist social enterprises to transition from grant dependency to commercial viability. Social enterprises can provide economic, social and environmental benefit; for example, through reuse of scarce resources. Rediscover Paint, as part of the Rediscovery Centre, makes paint available for reselling and reuse that would otherwise have gone to landfill.

1.8.7 Developing Appropriate Indicators

Intelligent indicators and a systematic approach to data will be required, and much of this will come from Eurostat. European indicators are being developed currently as part of a Monitoring Framework for the circular economy, which will enable effective measurement of progress (European Commission, 2017c). Currently, as the European Commission points out, no set of indicators exists that captures all the main elements of the circular economy along the lifecycle of materials, products and services, and gives a solid understanding of the present and past performance of the EU as a whole, and of individual member states with regard to the transition.

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35 http://www.dccae.gov.ie/en-ie/environment/topics/sustainable-development/green-public-procurement/Pages/default.aspx

36 The Waste Hierarchy places waste avoidance and prevention as priority, with disposal as the last resort. http://www.dccae.g.ov.ie/en-ie/environment/topics/waste/waste-management-and-policy/Pages/Waste-Hierarchy.aspx

The European Academies' Science Advisory Council (EASAC) produced a report on *Indicators for A Circular Economy* in 2016, which pointed to the priorities to be monitored. These include: decoupling of resource use and environmental impact from economic activities, measurement of resource efficiency and waste reduction, and tracking material flows. However, it noted that these do not capture the environmental impact of resources extraction and use, or the objective of more efficiently using goods, including repairing and reusing (EASAC, 2016). It identified many relevant indicators already available on sustainable development, environment, material flow analysis, societal behaviour, organisational behaviour and economic performance.

1.8.8 Co-ordinating Research Projects and Funding Strands on the Circular Economy

This co-ordination of research nationally can help in accessing EU funds effectively for research and practice and identifying gaps where expert R&D is required. Cities and regions also have a key role to play in working collaboratively to research the circular economy. By engaging with stakeholders and learning from others, every city and region in Europe can move towards a more circular economy, finding different ways of thinking about resources, and redefining what is considered valuable (ESPON *et al.*, 2016). While some of the case-study organisations were able to secure EU research funds, there are other opportunities. The Rediscovery Centre secured €3.6m from the EU Life+ environment programme, for example. Exergyn sourced €2.5m through the Horizon 2020 SME instrument, which helps the company pitch to new investors. A small number of other research projects have emerged in recent years. The UCD-led AgroCycle project has been funded by Horizon 2020 for an €8m agri-food project. The BioÉire project sought to evaluate the growth opportunities, policies and initiatives shaping Ireland's transformation to a sustainable, low-carbon economy and identify bioeconomy priorities for Ireland to maximise national income, exports and job creation (Devaney & Henchion, 2017b, 2017a). The EU Life programme 2014–2020 is another funding opportunity, but only offers co-funding. Other research centres are active in researching new materials and materials from waste streams. The Amber Centre (Advanced Material and Bioengineering Research), funded by Science Foundation Ireland, and the Environmental Research Institute in UCC, are researching materials and materials technologies.

1.8.9 Networked Governance for Stakeholder Collaboration

New forms of cooperation and collaboration will be aided by advancing technologies for organisations (e.g. Food Cloud), but also for wider networks. For example, industrial symbiosis practices require forming new networks across sectors, as illustrated by the work of the Smile Resource Exchange. In addition, the

governance of a circular economy transition requires a collaborative problem-solving approach, such as that being used in the Netherlands in the 'Circular Hot Spot'.[37] This initiative is organised by the Circle Economy cooperative, with support from the Dutch government. It follows a report from the Dutch Advisory Council for the Environment and Infrastructure (Rli), *Circular Economy: From Wish to Practice* (June 2015), which concluded that more effective governance was needed to co-ordinate circular economy initiatives in the Netherlands.

Devaney *et al.* (2017) outline some of the key challenges for governance, and particularly for the bioeconomy, a part of the circular economy, suggesting that open dialogue will be important for more balanced policy development, commercial inclusion and public acceptance of the emerging bioeconomy across Europe and beyond.

1.9 Conclusions

A strong message emerges from the research, discussions and current literature as to the viability, potential and possible routes to a more circular economy. As argued here, there is nothing predetermined about what Ireland's approach to the circular economy will be. Each country has a unique set of capacities, strengths and constraints that have to be central to any approach adopted. As Ireland is a small open economy, European and global trends and developments will have a strong influence on our regulatory and policy frameworks. Nevertheless, as this paper argues, rather than adopting a wait and see approach, early action is likely to present Ireland with a number of opportunities.

The process of reflecting on the circular economy casts light on the relationships and processes involved in moving from raw materials through to end of life in a more systemic way. Taking a bird's-eye view for key sectors, materials and processes will be required to better understand how to create more closed loops and retain key materials and products in use for as long as possible.

A participative approach to identifying the direction for Ireland may be useful. Further discussion of what a circular economy could and should entail will be important, particularly given the key role and contribution that households and communities have to play in the transition. What would the enabling policy environment be to maximise Ireland's economic, environmental and social opportunities as a circular economy? How can balance be achieved between fostering new business models and the economic and social potential with environmental protection of natural resources?

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[37] http://www.netherlandscircularhotspot.nl/circularhotspot.html

While both commercial and social enterprise momentum is building in Ireland, there is a risk that it could remain undeveloped without a strategic, overarching policy focus. While Ireland has developed a strong foundation in resource efficiency, there is merit in starting to explore to what extent circular economy practices are or become transformative, and stepping beyond incremental efficiency measures (Hobson, 2016). Insights from Scotland, the Netherlands and Finland point to the key role of innovative supports in unlocking new products, services and technologies that can seize economic, environmental and social opportunities from across the spectrum of circular economy practices.

The Council has identified some areas for further consideration and discussion as Ireland continues its circular economy journey. These are:

- What kind of stakeholder processes would be of value for both setting a circular economy trajectory for Ireland and for digging deeper into sectors?

- As increasing monitoring of the use of materials and natural resources is required, how can capacity in this area be developed across departments and agencies to provide appropriate metrics and learning?

- What might be an appropriate institutional support (set of supports) to drive action on the circular economy nationally but also for to convene sectors and/or regions and acting in a 'brokering' role?

- How best can we respond to barriers for particular sectors, products and materials and develop a problem-solving and collaborative approach to finding the solutions?

- What mechanisms and processes are required to embed and safeguard natural resources, broader environmental protection and societal wellbeing in a circular economy approach?

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An Chomhairle Náisiúnta Eacnamaíoch agus Shóisialta
National Economic & Social Council
NESC

MOVING TOWARDS THE CIRCULAR ECONOMY: IRISH CASE STUDIES

April 2017

About NESC

The National Economic and Social Council (NESC) was established in 1973 and advises the Taoiseach (Prime Minister) on strategic policy issues relating to sustainable economic, social and environmental development in Ireland.

Acknowledgements

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About this project

As part of its sustainability remit, NESC began a research project exploring circular economy practices in Ireland. These practices were identified in Irish businesses but also in civil society, through community-led initiatives and the work of NGOs, social enterprises and co-operatives.

This work highlights both key enablers and barriers to their development as well as exploring their potential economic, social and environmental value. Ultimately a circular economy will be achieved when there is systemic change and this research will explore the emergence of sectoral or cross-sectoral systems that may allow a more comprehensive circular economy to emerge.

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Table Contents

EXECUTIVE SUMMARY

There is increasing recognition of the potential benefits for economies and societies from adopting a circular economy, thereby enabling innovation while maximising resource efficiency and environmental protection.

In broad terms, a circular economy reduces or eliminates waste flows and maximises the value of resources already available within the economy by extending the life of products through ecodesign for product durability, reuse, repair, sharing, refurbishment and recycling.

As part of its sustainability remit, NESC are committed to contributing to the current dialogue on the circular economy by undertaking an initial exploration of case studies on circular economy practices in Ireland.

The aim of this short research project was to highlight both key enablers and barriers to the development of the circular economy in Ireland as well as exploring their potential economic, social and environmental value.

This report presents a small selection of case studies that highlight activities related to the circular economy that already exist in Ireland.

The report highlights the tangible opportunities, particularly for businesses and social enterprises, while highlighting the regulatory and social challenges in facilitating the transition to the circular economy in Ireland.

The report is structured as follows:

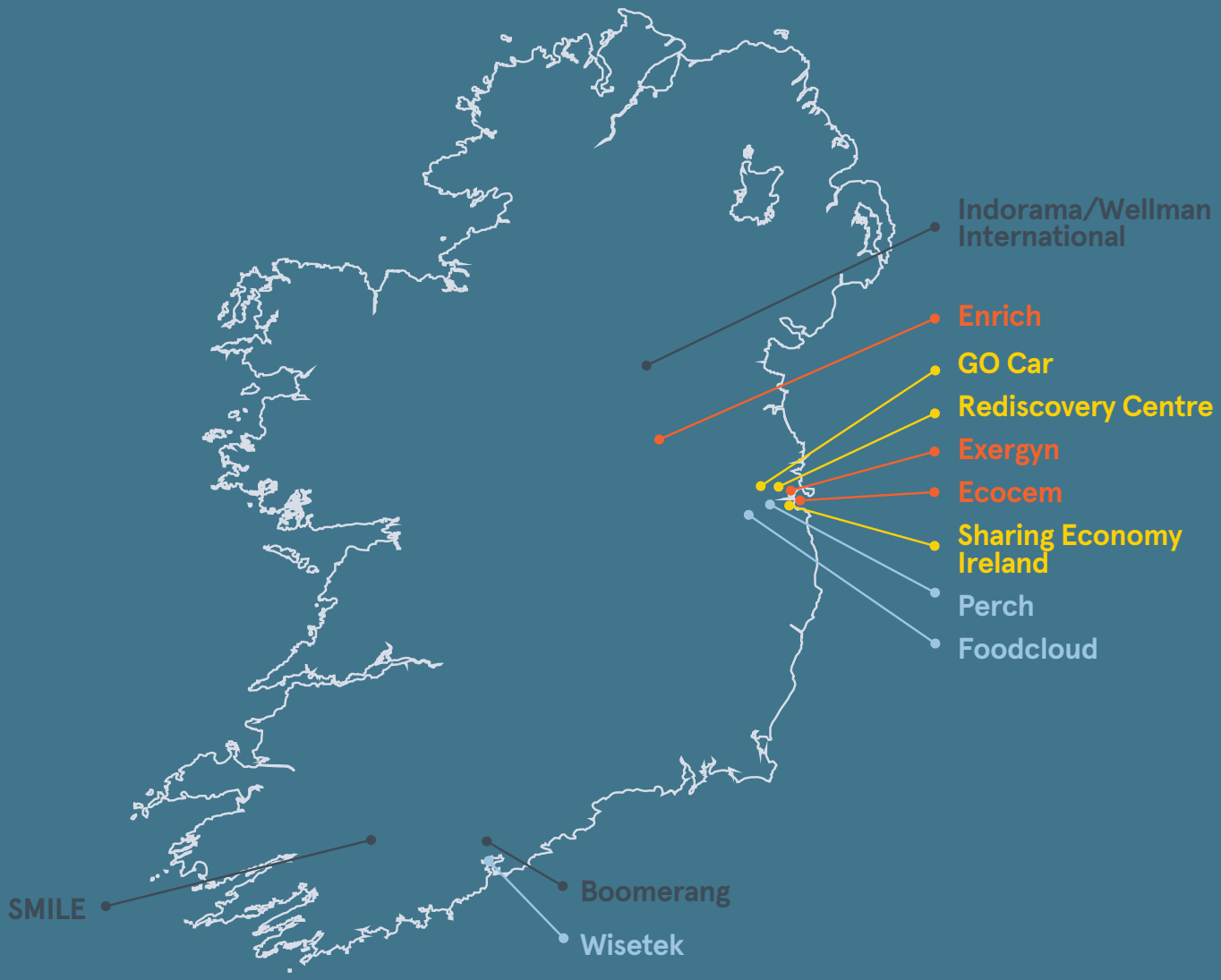
- Short introduction to the circular economy
- Brief overview of the Irish context
- Presentation of the case studies
- Summary of key reflections
- Annexes providing more detailed discussion on the context of the circular economy

The case studies in this report include companies and social enterprises from across Ireland that are involved in the delivery of circular economy innovations within products, services, supply chains and the sharing and social economy.

NESC consider now to be an opportune time to undertake this research as the EU Circular Economy Package is at an advanced stage of development and there is a growing pace of implementation of the circular economy principles within industry and social enterprises.

While there is growing evidence of opportunities to be gained from the circular economy, there are a number of complex challenges that demand policy attention.

Figure 1: Case Studies



Products

These case studies are predominantly focussed on circular product development. They are a combination of products that upcycle waste materials or improve energy performance.

Services

These case studies are predominantly focussed on the delivery of services that support the circular economy. They cover topics such as design, remanufacturing, reuse and remarketing.

Supply chain

These case studies are predominantly focussed on issues related to supply chains e.g. the recovery of materials across value chains or industrial ecology.

Sharing/Social

These case studies are predominantly focussed on the role of the sharing economy, social enterprises and community level actions.

Key factors driving the demand for a circular economy

Globally, material extraction has increased three-fold over the past four decades, growing from 22 billion tonnes in 1970 to 70 billion tonnes in 2010 (UNEP 2016). This is primarily due to emerging markets, increased consumption and population growth.

These increasing demands are leading to higher or more volatile prices for certain raw materials, increased scarcity of critical raw materials and slow rates of substitution of materials due to technological lock-in. The increasing extraction of resources is also resulting in wide ranging negative environmental impacts such as air, water and soil pollution, climate change and biodiversity loss.

Key sectors of the Irish economy are dependant on a sustainable supply of raw materials and natural resources such as metals, minerals, biomass, water and energy. In 2013, there was a direct consumption of approximately 102.2 million tonnes of these materials in Ireland (CSO, 2016). Domestic material consumption decreased from a peak of 182.7 million tonnes in 2007 but this 2013 figure represented a 10.2% increase compared to 2012.

The Irish Environmental Protection Agency (EPA) estimates that approximately 11.9 million tonnes of waste was generated in Ireland in 2014 and this represents a small increase from 11.8 million tonnes in 2012 (EPA, 2016). 49% of this waste (5.87 million tonnes) is industrial process and agricultural waste and 28% is from construction and demolition (3.31 million tonnes).

If we consider the non-energy component, between 14% and 15% of domestic material consumption in Ireland leaves the economy as waste each year. An increasing proportion of this is exported so the value from these materials and by-products is captured outside of Ireland. For example, in 2012 42% of 1,450,710 tonnes of municipal solid waste collected was recovered in Ireland and the remaining 843,053 tonnes was exported.

While Ireland has achieved improvements in overall resource productivity since 2007 the means through which this was achieved were not sustainable.

The resource productivity improvements were primarily driven by the unintended consequences of the economic downturn, in particular the contraction of the construction sector, and were aligned with multiple negative social impacts such as unemployment, increased inequality and reduced wellbeing.

As the policy narrative returns to economic recovery and growth, it is unclear whether sufficient measures to decouple domestic material consumption from economic growth have been factored into new policy frameworks.

These combined issues suggest that there is a need to transition from this broadly linear economy towards a circular economy that maintains the value in products and materials through closed loop recycling, remanufacturing, reuse and repair and service based business models.

Benefits of a circular economy

A growing number of Irish businesses and businesses based in Ireland are already advancing the circular economy agenda in their sectors. The available evidence and predictive models suggests that a transition to a circular economy could positively contribute to the sustainable and competitive prosperity of Ireland.

It can achieve this by increasing resource productivity, decreasing import dependency of critical raw materials, capturing more value from secondary raw materials and increasing employment.

In their report, "Growth Within: A circular economy vision for a competitive Europe", McKinsey estimated that a transition to a circular economy in Europe could create a net economic benefit of €1.8 trillion by 2030 (McKinsey, 2015).

Additionally, conservative estimates focussing on just the waste processing and recycling sectors suggest that the circular economy in Ireland could add between 2100 and 5000 new jobs as well as €1.65 billion (0.7%) of GDP.

In addition to improving resource productivity, the circular economy can assist in bridging the gap between the actions agreed in the Paris Climate Agreement and the additional emission reductions required to achieve the 1.5 °C pathway.

For example, in a study examining four countries, the OECD estimated that the management of materials accounted for between 55% and 65% of national emissions (OECD, 2012). Additionally, Zero Waste Scotland identified that material consumption is responsible for over two thirds of Scotland's carbon emissions and the related emissions could be reduced through a circular economy.

These benefits will only be realised if well considered and systemic policy, enterprise and societal actions are undertaken. These actions include enhancing existing legislation and regulations, removing regulatory barriers, creating incentives for secondary material markets, developing appropriate finance mechanisms, improving evidence and data, building a stronger research and knowledge exchange infrastructure.

Current policy action

The circular economy has gained traction in the EU as it offers a route towards achieving existing ambitions towards transforming systems of production and consumption in order to meet the EU's 2050 vision of 'living well within the limits of our planet' (European Commission et al., 2014). In December 2015 the European Commission produced the latest version of their Circular Economy Package that set out key initiatives that assist in the transition.

There are three key reasons why it is important that a broader debate on and examination of the potential of the circular economy in Ireland is undertaken.

1. The Irish Government is obligated to respond to the new EU Circular Economy Package that contains a comprehensive framework of policy actions and ambitious targets.
2. If implemented coherently, the Circular Economy Package has the potential to assist Ireland in meeting multiple environmental policy objectives, including climate change targets, while creating a stimulus for employment in existing and emerging sectors.
3. Other regions are already gaining first-mover advantage in implementing the circular economy and this will potentially place Ireland at a disadvantage with regards its own transition to a circular economy.

The case studies presented in this report underline that while there are some actions and policy interventions in relation to waste prevention, the knowledge base and business support infrastructure in relation to the circular economy in Ireland is fragmented.

This research has highlighted the need for further clarification on potential pathways for policy, technological and social innovation that can enable the transition to a circular economy in Ireland. In short, while progress has been made in Ireland, significant challenges remain. Not least:

- Enhancing the circular economy innovation system in Ireland
- Establishing enabling conditions (incentives and other interventions)
- Establishing transition pathways (priority sectors, materials)
- Applying common metrics for measuring progress

SECTION 1: WHAT IS THE CIRCULAR ECONOMY?

Broadly speaking, economic systems tend to be linear in the sense that considerations regarding the design, production and use of products are separate from their recycling or end of life treatment. In this linear approach, materials and resources are extracted, manufactured into products; these products are used and eventually discarded.

Waste is created and value is lost at a number of stages during production and consumption of products. Key stages include:

- Sub-optimal material efficiency in raw material extraction, product development and product use
- Waste leakage and material loss during and following consumption - when products are disposed of and not recovered their embedded value is lost
- Lower value processing - more of a product's value can be retained through preparation for reuse or remanufacture than material recycling

The fragmentation of this linear system means that economic value is lost through waste and significant costs are incurred through negative externalities e.g. pollution, energy burden of raw material extraction, ocean plastic waste and environmental degradation.

The existing linear model of consumption and production has also been predicated on the assumption that natural resources are readily available with stable and secure supply of cost effective or cheap, abundant and relatively cheap to dispose of.

The Ellen McArthur Foundation suggests that a circular economy is one that is "restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" (EMF, 2015).

This suggests that a circular economy reduces or eliminates waste flows and maximises the value of resources already available within the economy by extending the life of products through ecodesign for product durability, reuse, repair, sharing, refurbishment and recycling.

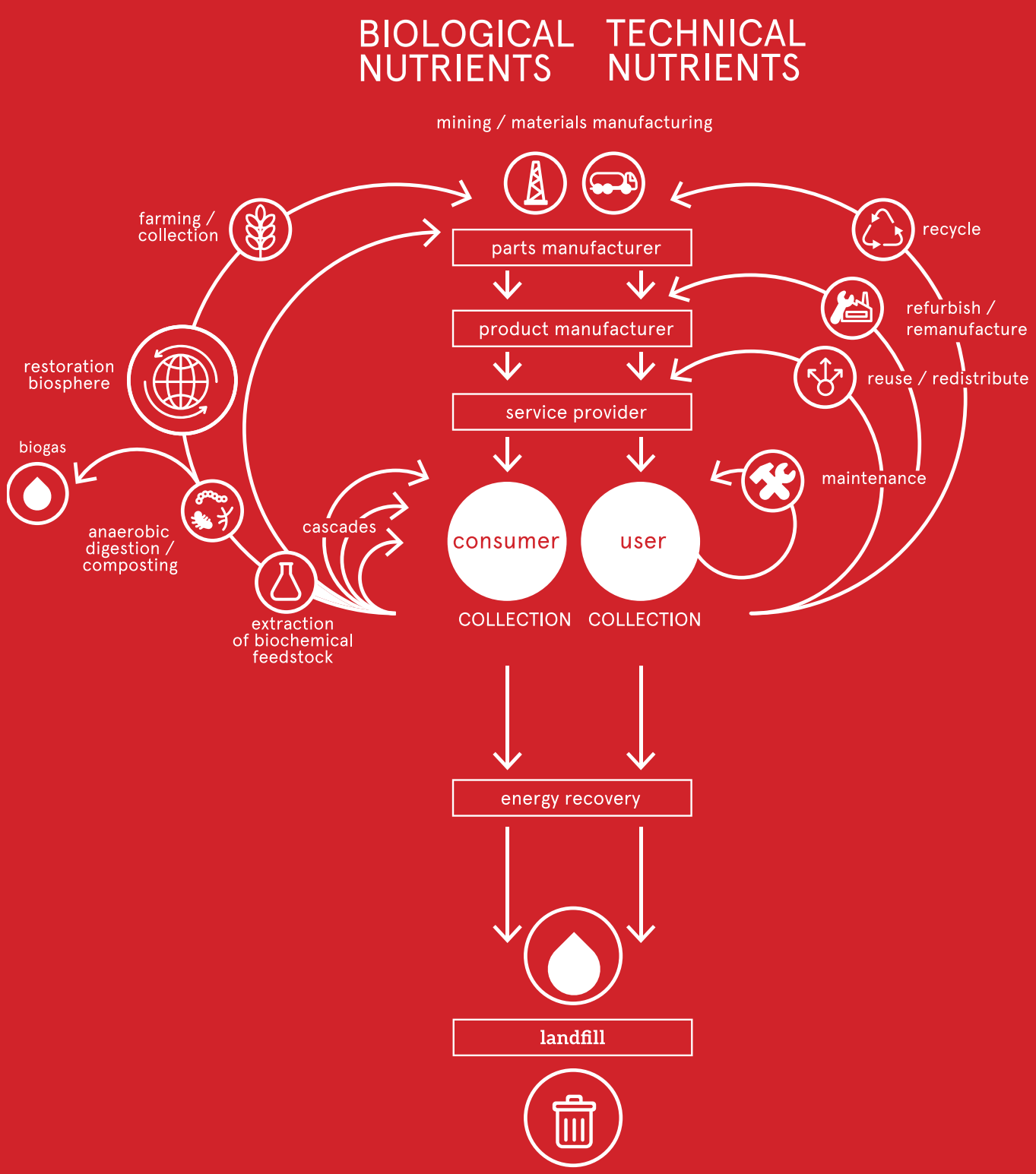
The circular economy is typically presented as a systematic approach to enabling economic prosperity while optimising the consumption of natural resources.

There are a number of "circular" aspects within the existing linear economies such as well-established practices of recycling, composting, repair and remanufacturing. In some cases these circular practices are nascent while other more established practices, such as recycling, still need significant improvements in terms of efficiencies and yield.

Figure 2 provides a simplified schematic of the circular economy and highlights the key strategies for implementation. The centre of this diagram highlights the basic linear stages of the production and consumption system; from raw material extraction through to consumption.

The circular arrows highlight potential strategies for circularity with respect to issues such as reuse, recycling or remanufacturing. Each of

Figure 2: Circular Economy diagram - adapted from EMF 2012



the strategies on the circular arrows present a possibility to create value while removing waste from the system.

Some of the value in the circular economy can be captured in existing business models but it is likely that new innovative business models, such as remanufacturing, will capture more value.

The Ellen McArthur Foundation and World Economic Forum sets out a basic framework that highlights four key areas where value can be created in the circular economy (Ellen MacArthur Foundation, 2014).

Inner Circle

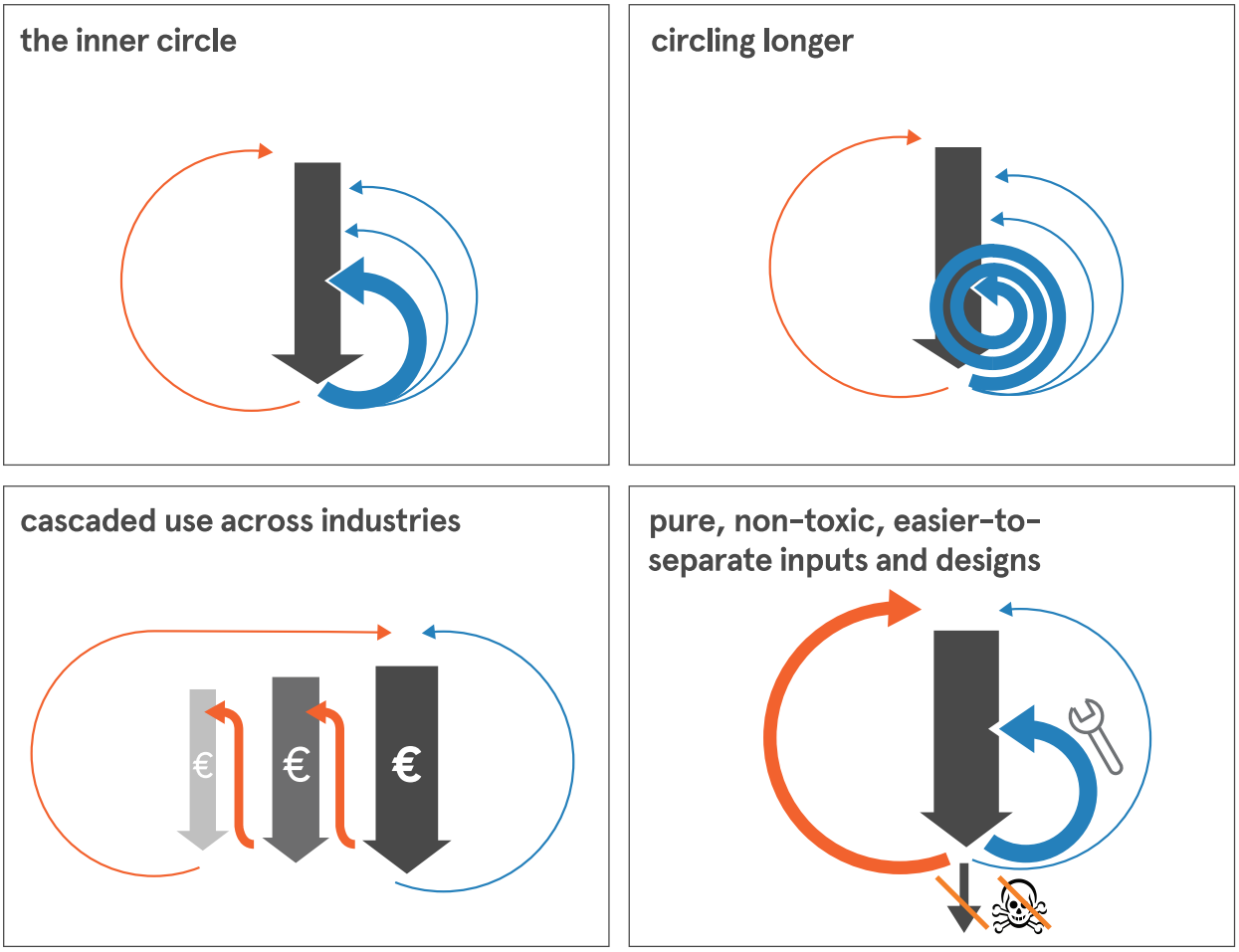
In more traditional recycling business models, enterprises design products and reverse logistics systems so that it is technically and economically viable to recycle product materials.

For biological materials the process should be designed so as to facilitate the return of nutrients to the nutrient cycle following optimal use.

Circling for longer

This includes business models that extend the life of products through various strategies such as

Figure 3: Models of creating value in the circular economy



remanufacturing, refurbishing, repair and reuse. These can capture value in a number of ways. This is typically achieved by offering additional services to extend the life of products or by reducing the costs of inputs into new products.

These approaches have been particularly successful in business-to-business markets. Reusing products or reselling them through secondary resale markets can also create value.

Cascaded use across industries

Cascading and industrial symbiosis business models primarily focus on creating value by facilitating the use of a material or components within another value chain.

Pure, non-toxic, easier-to-separate inputs and designs

This is more in line with the restorative and regenerative aspects mentioned by the Ellen McArthur Foundation. It involves the ecodesign of products and buildings that where possible use renewable and non-toxic inputs.

In addition to these more widely understood practices and business models, there are a number of emerging practices within the circular economy that have shown promising potential in specific sectors.

These include:

- Intelligent asset management and reverse logistics
- Biochemical extraction and biorefining
- Product service systems
- Circular forms of consumption
- Distributed manufacturing and FabLabs

While these practices show potential they have yet to reach significant scale.

One of the characteristics of discussions on the circular economy is that the strategies for circularity should distinguish between technical and biological materials (sometimes referred to as nutrients).

In this case, technical materials would include minerals, polymers, metals and alloys, non-biodegradable derivatives of hydrocarbons and other non-finite resources.

Whereas biological materials include agricultural and forestry products, natural fibres, bio-based wastes and other materials that are typically renewable, abundant and non-toxic.

It is important to note that while waste prevention and recycling are key aspects, the circular economy predominantly focuses on the technological, organisational, and social innovations across value chains.

In doing so it seeks to design out waste as an intrinsic strategy either by designing out waste at the front-end through ecodesign or by maintaining the value in products for as long as possible through service and product durability.

This is predicated on the principle that if waste prevention is not typically considered strategically at the design or business models stage the more costly and inefficient it is to address related environmental impacts.

SECTION 1.1: RATIONALE FOR THE CIRCULAR ECONOMY

With these issue in mind, the rationale for transitioning to a more circular economy is that benefits can be potentially accrued across key areas of the economy and society. These include reduced resource use, the related environmental benefits, economic benefits from cost savings and value creation and social impacts such as job creation and wider social innovation.

Rationale 1 Job creation

A study by the UK Environmental Service Association estimated that the transition to a more circular economy could help create 50,000 new jobs and €12 billion of investment in the UK (ESA, 2013).

These would be in a range of recycling sectors such as traditional recycling, organic treatment and energy from waste facilities.

A study by The Netherlands Organisation for Applied Scientific Research estimated that in the Netherlands the circular economy could create approximately 54,000 jobs (Bastein et al., 2013).

The study indicated that these jobs could be created in sectors such as base metals and metal product industries, the management of biotic waste and electronic and electrical equipment.

It is important to note that the type of jobs created in the circular economy vary greatly. For example, the preparation of products for reuse or recycling can be labour intensive and this will assist in creating low-skilled employment. Some of this employment is currently taken up by the social economy and a mix of state subsidised labour and job activation programmes.

The development of a more effective circular economy could support the transition from job activation programmes to permanent employment.

Services related to repair and remanufacturing will create medium-skilled employment, as it will require a range of technical competencies. Other areas of the circular economy such as ecodesign, biorefining and the sharing economy will help support high-skilled employment.

Rationale 2 Reduced resource use

A study by the European Commission estimated that between 10 and 17% of all material consumption (including fossils fuels) could be avoided through existing circular economy policies and interventions (EC 2015).

These existing interventions relate to ecodesign, waste prevention and recycling. Whereas Meyer (2012) suggests that more innovative approaches that are technically feasible could reduce the domestic material consumption of the EU by 24% by 2030. Were this reduction to be achieved it could increase EU GDP by up to 3.3% and create 1.4 to 2.8 million jobs.

A study by McKinsey that addressed the food, mobility and built environment sectors estimated annual savings through circular economy measures in the region of €600 billion in the EU-27 by 2030 (McKinsey, 2016). The report also suggested that these measures could create net benefit of €1.8 trillion by 2030. The report outlines some key innovations required to achieve this. These include:

- Mobility - car sharing, integrated transport modes, remanufactured cars, electric and self-driving vehicles.
- Food - reducing food waste, resource-efficient farming (e.g. as organic or no-till) and circular nutrient cycles (e.g. phosphorus recovery)
- Built environment - pre-fabrication, sharing of residential and office space, energy-efficient buildings and smart urban planning

Rationale 3 Low Carbon Economy

Importantly McKinsey and the Ellen McArthur Foundation have estimated that a circular economy could lead to reductions of greenhouse gas emissions in the order of 48 % by 2030 and 83 % by 2050 compared with 2012 levels.

This would be combined with a reduction in externality costs of up €500 million by 2030 (EEA, 2016).

This impact of the circular economy on greenhouse gas emission is also supported by a study by the European Commission. For example, one study estimates ambitious targets for recycling (municipal and packaging waste) alongside reduction in landfill could lead to a reduction in greenhouse gas emissions of around 424–617 million tonnes of carbon dioxide equivalent over 2015–2035 (European Commission, 2015).

Rationale 4 Cost Savings

A study undertaken by DEFRA estimated that UK businesses could achieve savings of £23 billion annually through circular economy measures such as resource efficiency (DEFRA and Oakdene Hollins, 2011). The German government estimated that a 20% reduction in resource and energy use in the country could lead to the creation of more than one million jobs and an increase of GDP by 12% (European Commission, 2014).

The Irish Environmental Protection Agency commissioned a report on developing a Roadmap for a National Resource Efficiency Plan. This report proposed a target of a 2% reduction in material consumption per annum through resource efficiency measures which, the report's authors suggest, could result in savings of about €928 million (EPA, 2013).

SECTION 1.2: THE CIRCULAR ECONOMY PACKAGE

The circular economy encompasses a broad range of issues such as materials, products, processes and value chains that have typically been addressed by different legislative and regulatory initiatives. Because of that, a transition to a circular economy requires a systemic, multi-level governance approach.

This approach needs to systematically consider the relationships between sectors, sectoral actors and value chains. It also requires interventions that enable behaviour change among producers and consumers, public sector innovation as well as creating the conditions for new innovations to be developed and scaled across markets.

Towards the end of 2015 the European Commission adopted a Circular Economy Package with a view towards stimulating the transition towards a circular economy in Europe. According to the Commission, this package will increase the recycling and re-use of materials and products while enhancing competitiveness and fostering employment through sustainable economic development.

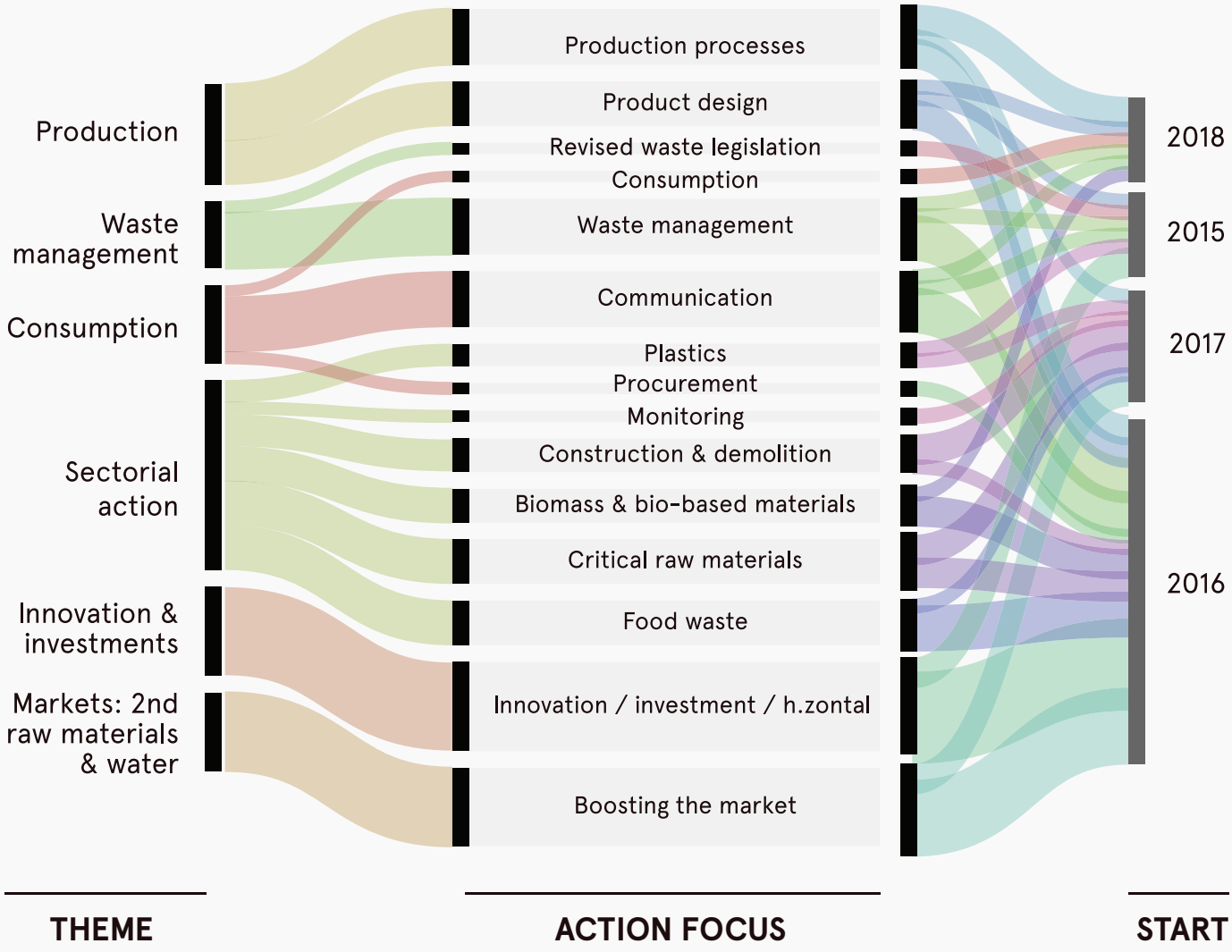
This Circular Economy Package is a revised package based on a version published by the previous Commission. Civil society organisations and NGOs have strongly argued that the changes reduced the overall ambition of the Package. This is primarily due to lower targets by 5% and extended timelines for achieving targets.

The revised package removed the non-binding 30% resource efficiency target, targets for food waste reduction, and requirements for mandatory biowaste collection systems by 2025. Civil society organisations and NGOs have also argued that the Commission's own impact assessment indicated that the higher targets were achievable with significantly more positive impacts.

The packages contains over fifty measures that address the full life cycle impacts of consumption and production. The key elements of this revised package include:

- Financing of over **€650 million under Horizon 2020 and €5.5 billion under the EU structural funds**
- Measures to **promote reparability, durability and recyclability of products**
- A **common EU target for recycling** 65% of municipal waste by 2030
- A **binding landfill target** to reduce landfill to maximum of 10% of municipal waste by 2030
- A ban on landfilling of separately collected waste
- Actions to **reduce food waste** including a common measurement methodology
- Promotion of **economic instruments to discourage landfilling**
- Simplified and improved definitions and harmonised calculation methods for recycling
- A **strategy on plastics** that addresses recyclability, biodegradability, hazardous substances and reducing marine litter
- Concrete measures to promote **re-use and stimulate industrial symbiosis**
- Economic incentives for producers to put **greener products on the market** and support recovery and recycling schemes (e.g. for packaging, batteries, electric and electronic equipment, vehicles)

Figure 4: Circular Economy package summary



SECTION 2: THE IRISH CONTEXT

While the debate on the circular economy has evolved over the last few decades, it has only begun to occur at a visible level in Ireland over the last 4 to 5 years. The discourses in Ireland have included a number of converging strands of thinking, most notably in relation to waste and resource efficiency but also the potential business impacts and opportunities.

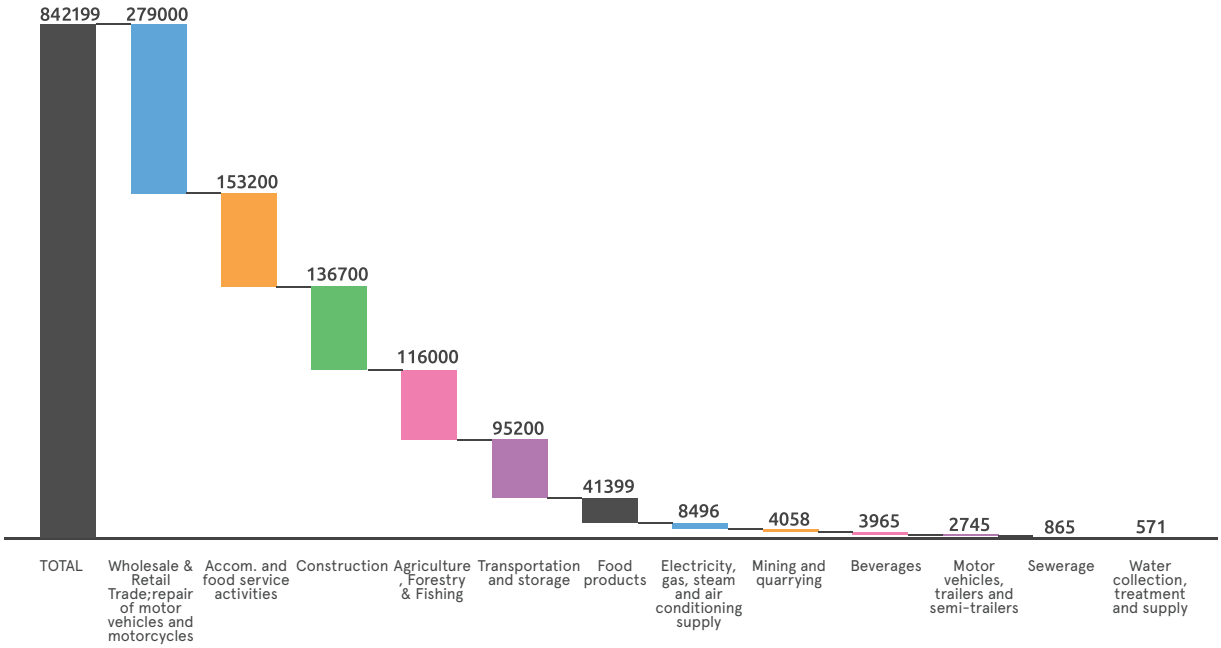
There has been until recently less focus on the more systemic issues such as whole lifecycle of products, sustainable consumption, priority materials or priority sectors or the role of the social economy and social enterprises.

It is broadly accepted that the built environment, food and mobility account for 70-80% of resource use (European Commission, 2011). It is important to recognise, in the context of the circular economy, which aspects of these resource intensive sectors are reflected in the industrial production and service sectors of Ireland.

An estimation of employment in key sectors related to these three areas suggests that they account for approximately 45% of total employment in Ireland (Figure 5). This figure would be higher when factoring in ancillary services, the production of fuels, construction products and other related industrial sectors.

The value of Irish industrial production is currently largely concentrated in four sectors; pharmaceuticals, chemicals, food and computers (CSO 2015). By way of example, the Irish pharmaceutical sector accounted for 36.9% of total national Net Selling Value (NSV) in 2015 compared to 3.5% in the EU28.

Figure 5: Employment across typically resource intensive sectors



In addition to this, the pharmaceutical and chemical sectors accounted for the most significant percentage increase in NSV in Ireland between the years 2013 - 2015 (Figure 6). In the same period, the NSV of food products manufactured in the same time period rose 8.2%.

The continued prosperity of these sectors in Ireland, such as Food and Drink, Pharmachemical, Medical Technology, is dependent on the sustainable supply of raw-materials. This underlines the need to consider national characteristics, regional variations and the design of context relevant interventions that support the transition to a circular economy.

This also implies that in the areas where there is little primary production the focus can be on creating value from secondary materials, remanufacturing or repair service rather than the closed-loop recycling of end products. For example, where the focus is on producing or selling capital assets (e.g. machinery) there are opportunities from offering modularity, service offerings and leasing.

It is also worth noting that there are a number of existing services in Ireland that are relevant within the context of the circular economy. These include the development of ICT and other digital innovations alongside traditional repair and maintenance services.

For example, in 2013 there were 11,465 enterprises across repair services for motor cars, computers and household goods as well as leasing and rental services for a number of goods. These enterprises employed almost 17,000 people (Figure 7).

There are a number of relatively low cost interventions that can work with these traditional repair and leasing sectors. For example, as part of its Energy Transition for Green Growth Act, the French Government mandated that all auto repair providers need to offer customers repaired and remanufactured parts. The Swedish government is trialling a reduced VAT rate on repaired goods in an attempt to incentivise the greater use of repair instead of purchasing new products.

Figure 6: Total Net Selling Value of Production by Sector for 2015

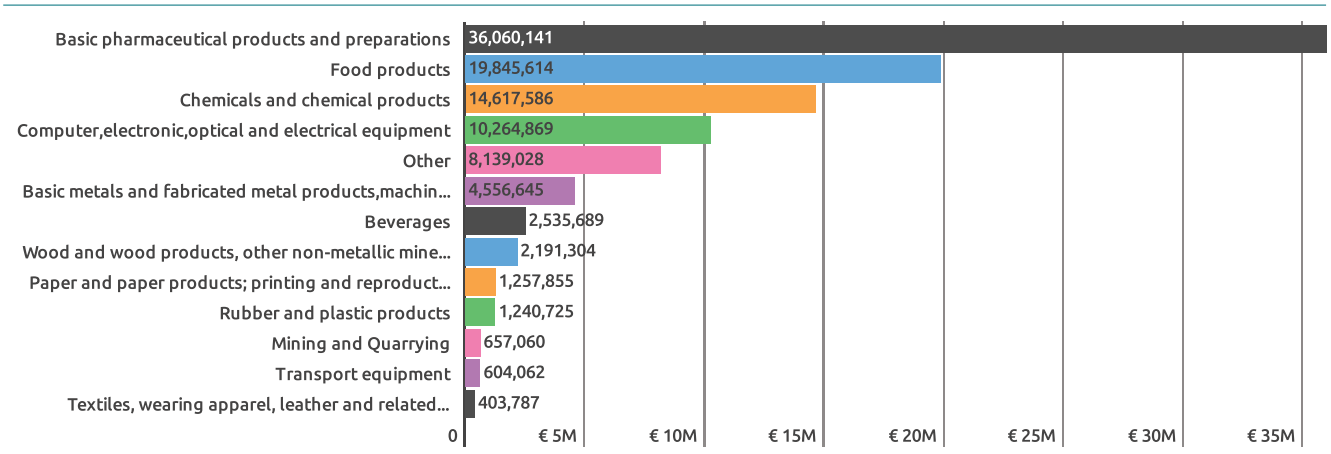
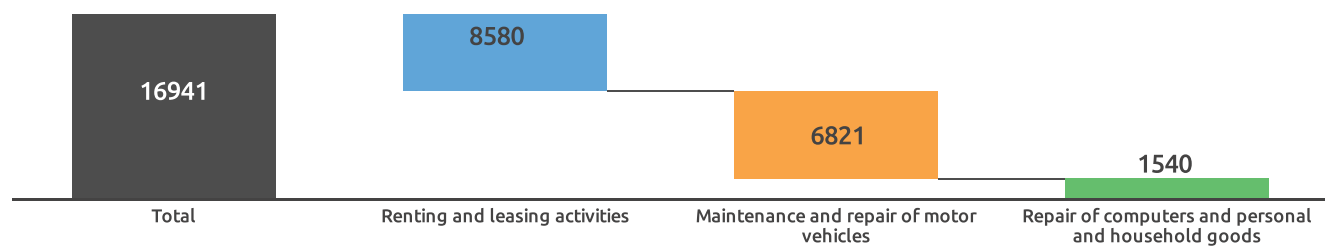


Figure 7: Employment in key repair and leasing services



SECTION 2.1: IRISH RESOURCE CONSUMPTION & WASTE GENERATION

The Irish manufacturing sector is connected globally through a flow of materials, financial resources, knowledge and innovation. Therefore the resilience of these key sectors is dependant on external socio-technical, economic, political, and environmental trends.

Although there is no national framework on critical raw materials, their secure supply contains common challenges with national energy policy that is driven by objectives regarding security of supply and cost competitiveness. Ireland is reliant on imports for over 35% of total domestic material consumption.

This figure increases significantly with regards to import dependency of fossils fuels (78%) and metallic minerals (98%).

Ireland imports approximately 90% of its total energy and this has resulted in a policy focus on greater energy independence through increased use of renewable energy alternatives.

The same argument could be made that policies and interventions for the circular economy in Ireland could assist in improving the supply security of other critical raw materials in order to maintain continued competitiveness.

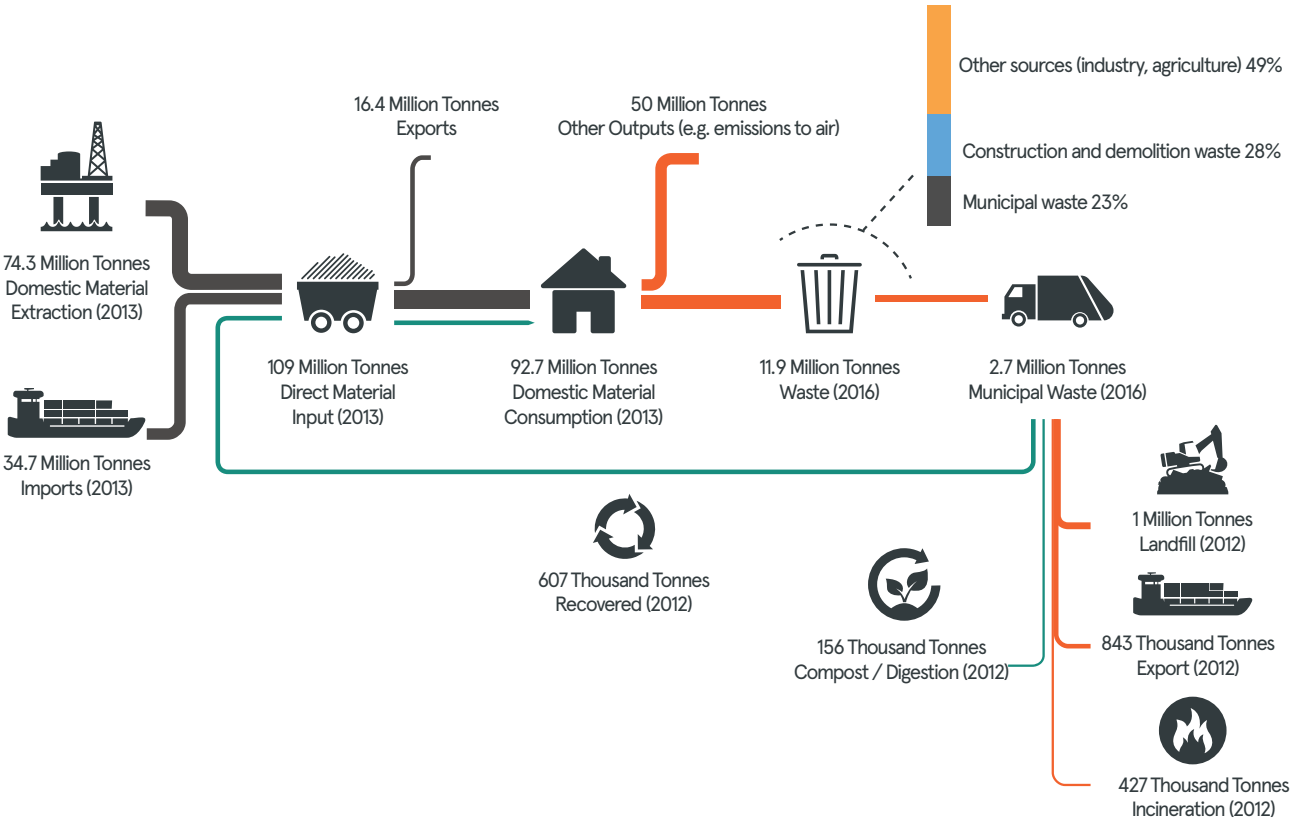
As mentioned, the Irish Environmental Protection Agency (EPA) estimates that approximately 11.9 million tonnes of waste was generated in Ireland in 2014 (EPA 2016). While progress has been made by Ireland in introducing waste prevention and resource efficiency programmes, the reliance on export and lack of glass manufacturing facility, paper mill or metal smelter represents a lost opportunity with regards the circular economy in Ireland.

The operational landfill capacity in Ireland is almost maximised with the EPA estimating potentially less than one year of capacity based on the use rate of 2015. In 2012 Ireland had 18 operational landfills and this capacity has decreased to six active landfills in 2016. This potential opportunity for growing a more circular economy has in the short term led to a reliance on export and energy recovery.

In 2012, 42% of 1,450,710 tonnes of municipal solid waste collected was recovered in Ireland and the remaining 843,053 tonnes was exported. This figure does not include other waste such as municipal sludges, effluents and other industrial wastes.

Between 2011 and 2012 the export of baled municipal waste for energy recovery on mainland Europe increased by 36%. This is due to an undersupply of waste to these incinerators. In 2012, Ireland's first municipal waste incinerator was operational and this increased the recovery of municipal waste as a fuel by 17%.

Figure 8: Material Flow of Irish Economy (Estimates from multiple sources)



Irish Waste Management Policy

Ireland does not yet have a dedicated national circular economy strategy or action plan. There are a number of existing strategies that guide issues related to the circular economy and many of these have been strongly influenced by European strategic goals and regulatory requirements, notably the Waste Framework Directive.

On a national level, the 2011 National Reform Programme for Ireland identified the role of "decoupling economic growth from resource use" in employment creation opportunities. The revised Reform programme in April 2016 identifies a "resource efficient economy" as a funding priority within the context of European Structural & Investment Funds. This priority is combined with promoting jobs and growth, combating unemployment and social exclusion and promoting R&D.

Additionally the 2016 Action Plan for Jobs highlighted the necessity for resource efficiency as part of the overall approach to achieving competitiveness and job creation. The Action Plan for Jobs also recognises that planned increases in the landfill levy are necessary to drive improved waste prevention and recycling.

Similar resource efficiency objectives are also contained within the most recent national sustainable development framework: Our

Sustainable Future (2012). The thematic focus of the sustainable development framework is broader in that it includes issues such as sustainable consumption & production as well as conservation & management of natural resources.

It is more wide-ranging however and includes themes from diverse areas such as public health, education, social inclusion and economic resilience.

More specifically, waste management policy in Ireland has evolved since the 1990s through four primary policy strategies. These include Changing Our Ways (1998), Delivering Change (2002), Taking Stock & Moving Forward (2004) and A Resource Opportunity (2012).

This most recent policy document encompasses key issues relating to the implementation of the Waste Framework Directive (2008/98/EC) such as waste management, compliance and enforcement, prevention and minimisation as well as re-use, recycling and recovery. This policy is intended to be delivered up to 2020 and has been the precursor to a number of related strategies, interventions and initiatives.

One of the key related strategies related to resource efficiency is "Towards a Resource Efficient Ireland: A National Strategy to 2020". This strategy includes reference to the circular economy although it is not a dominant focus.

Ireland was also an early investor in waste prevention through the National Waste Prevention Programme (NWPP) that launched initially in 2004.

The scope of this NWPP is broad in that it seeks to develop actions and interventions that:

- Recover resources from waste streams
- Address inefficient consumption of water, energy and resources
- Support the re-use and end-of-life recovery of products
- Encourage the transition to a circular economy

The NWPP has also developed a range of interventions that may be relevant in the circular economy. These include:

Green Business and Green Enterprise

Green Business and Green Enterprise are programmes that are aimed at building capacity for resource efficiency in businesses across different sectors.

Green Business focuses on offering subsidised consultancy on resource efficiency to small companies whereas Green Enterprise offers grants for undertaking R&D.

Stop Food Waste

Stop Food Waste is a national programme running since 2009 that aims to reduce food waste in households and small businesses such as cafés, pubs serving food and small local supermarkets.

The programme is focussed on behaviour change and combines education, training as well as peer networks and support champions.

Local Authority Prevention Network

The Local Authority Prevention Network is a waste prevention programme running since 2006 that works with Irish local authorities in order to build their capacity to develop local waste prevention projects.

The network provides technical assistance, funding and training to local authority staff.

SMILE Resource Exchange

SMILE Resource Exchange is the national industrial symbiosis programme. This free service allows businesses to exchange resources that would otherwise be classified as waste.

Freetrade Ireland

freetradeireland.ie is an online reuse platform that allows users to exchange unwanted products for free. According to the EPA, FreeTrade Ireland diverted 18,220 items from landfill in 2014.

This accounts for approximately 216 tonnes or 1,944 tonnes of CO2 equivalent. FreeTrade Ireland has 51,200 members with over 26,000 unique visitors to the platform in 2014.

The team behind FreeTrade Ireland also manage a Public Resource Exchange Platform that is the same service for public sector organisations.

Community Re-Use Network

Community Re-Use Network Ireland is a network of national organisations operating at a community level that are involved in re-use, repair and recycling.

The network operates on the behalf of member organisations in order to advocate for re-use and repair within the context for the circular economy.

rx3 programme

The rx3 programme involve the market analysis and development of standards for recyclates and secondary raw materials. The rx3 programme conducted an analysis of green public procurement.

Regional Waste Management Plans

One other notable development with regards resource efficiency policy in Ireland has been the development in 2015 of Regional Waste Management Plans and associated regions.

These three regions include Southern, Eastern-Midlands and Connacht-Ulster. The plans address the principles of the circular economy in that they focus on identifying initiatives that increase the value of secondary raw materials as opposed to a sole focus on recovery of waste.

The plans also include actions in relation to resource efficiency and waste prevention. In line with the broad principles of the circular economy the plans also aim to build capacity for reuse, repair, and preparing for reuse and supporting the growth of secondary material markets and enterprises in the region.

The plans are intended to connect with existing regional and national enterprise support infrastructures. These regional waste plans are each targeting a 1% reduction in household waste per annum over the period of the plan (2015 – 2021).

SECTION 2.2: IRISH CIRCULAR ECONOMY INNOVATION SYSTEM

The circular economy demands multi-level interventions that involve multiple actors across value chains. While this requires trans-national interventions, it is potentially useful to define the national or sub-national circular economy "Innovation System" when considering the design of interventions.

Broadly speaking, an innovation system is composed of networks of actors and institutions that develop, diffuse and use innovations. Rather than emphasising issues such as inputs and outputs of the innovation process, it is mostly concerned with how various innovation actors relate to one another and promote knowledge development and diffusion of innovation. As such, the innovation system perspective focuses on the institutional set-up in which innovation occurs and the various market interactions and knowledge flows between different actors within an innovation system.

This can be particularly useful when looking at the regional or national dimension of innovation and how government, intermediary organisations and other actors are interacting to create the appropriate conditions for innovation, in this case with regards to the circular economy.

An innovation system can be made up of both hard and soft institutions. Typically 'hard' institutions include universities, research institutes, and government agencies and 'soft' institutions refer to the rules, routines and norms characterising the action and interaction of the various actors (Tödtling and Trippl, 2005).

Key components include the actors (e.g. companies, people), business innovation sub-systems and knowledge sub-systems.

The Innovation System perspective highlights the role of the institutional or structural framework of a region, the companies of that region (including knowledge structures) and the public and semi-public knowledge institutions. It also highlights the interaction between the various actors and components.

Importantly the innovation systems perspective highlights how innovation is dynamic and non-linear.

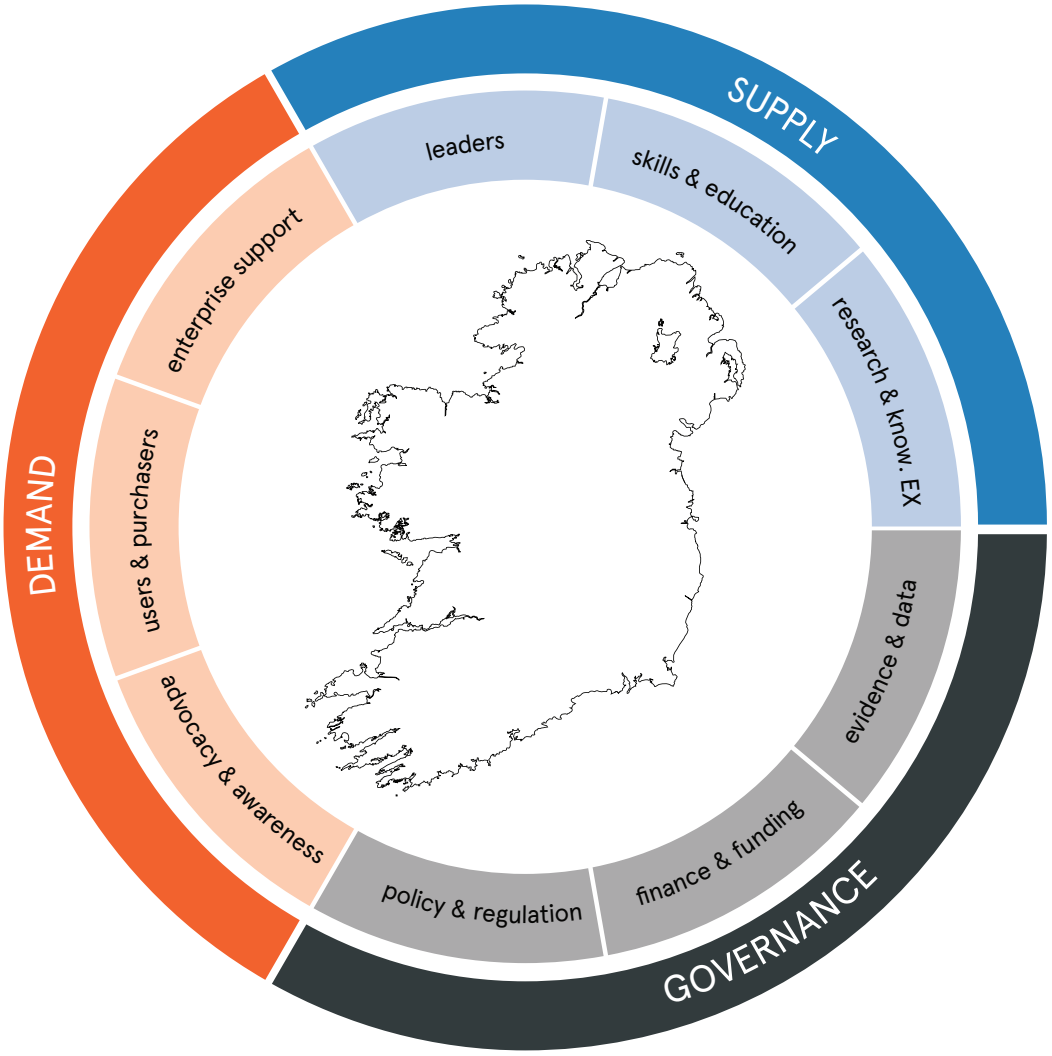
For the purposes of this study the research team proposed the application of the innovation systems perspective to help identify potential strengths and weaknesses in the in the Irish circular economy innovation system.

Figure 9 provides an overview of this proposed model of a national circular economy Innovation System for Ireland. It outlines the general conditions, structural elements and actors within the Irish innovation system.

This representation highlights the role of the institutional or structural framework of a region, the companies of that region (including knowledge structures) and the public and semi-public knowledge institutions.

National actors and stakeholders were identified under the following themes (see page opposite).

Figure 9: Circular Economy Innovation System



Supply side - creating circular economy outputs

- Leaders (leading examples in Ireland)
- Skills & education (who is providing CE skills)
- Research & knowledge exchange (leading research centres/researchers)

Demand side - creating demand

- Enterprise support (supports for enterprise inc. social enterprise)
- Advocacy & awareness
- Users & purchasers (users and purchasers of CE products and services)

Governance - combination of push and pull

- Policy and regulation
- Evidence & data (sources of quality evidence & data on CE)
- Finance & funding (providers of finance and funding)

During the course of this project, the researcher facilitated a workshop with the EPA that mapped the circular economy in Ireland. This workshop involved 38 individuals from 27 national organisations

This workshop highlighted a number of issues with regards the transition to a circular economy in Ireland and the existing circular economy innovation system. The workshop highlighted that there were a number of relevant stakeholders already working on certain aspects of the circular economy in Ireland but these stakeholders are dominant across certain activities.

For example, there was a dominant focus of organisations involved in advocacy and awareness, knowledge exchange and policy but less of a clear focus on finance, enterprise support, skills and education.

Figure 10 provides an overview of the key national actors and stakeholders that were identified during this workshop.

In addition to this general profile, this workshop highlighted that while there are a number of actors and stakeholders within the Irish circular economy innovation system many are insufficiently resourced and there was a lack of interaction between them.

This means that the existing infrastructure is not achieving a level of impact that will support the transition to a circular economy in the short term. There are a number of activities being implemented on a relatively small scale that are showing positive potential and these should be scaled up.

Circular Economy Research

With regards the research component, the workshop attendees identified a lack of focussed expertise with regards research for the circular economy in Ireland. There were pockets of research activity led by small numbers of typically individual researchers but there were no dedicated research centres or centres of expertise. This means that Irish researchers will be less able to compete for the €650 million of Horizon 2020 funding that has been allocated to circular economy related research.

Ireland currently has no dedicated strategy for targeting funding under this Horizon theme and there is no dedicated research centre on the circular economy. There are a number of individual research teams in some universities delivering research programmes that are relevant within the context of the circular economy.

While this work is often of a high quality it is typically fragmented and research teams are under-resourced. There has been recent success in Irish SMEs receiving funding through Horizon 2020 through calls related to Energy and this exemplifies that when strategies are resourced Ireland can successfully compete for Horizon2020 funding.

While the circular economy is not explicitly mentioned in national research programmes, the general topic of resource efficiency is included in general terms within the Report of the Research Prioritisation Steering Group convened by the Department of Jobs, Enterprise and Innovation.

The focus in this regard is on resource efficiency being supported by research on topics such as smart grids, novel materials and manufacturing. There is no indication that the issue will be addressed through other research disciplines such as economics or other social sciences.

The EPA's Research Programme 2014-2020, which is focussed on developing evidence-based scientific knowledge, has included a focus on the circular economy within the context of socio-economic research.

It must be noted that these resource-centric activities are also supported by a wider support infrastructure and policy strategies. This includes the Greentech programmes of the Industrial

Figure 10: Circular Economy stakeholders in Ireland (identified at workshop)

Supply side - creating circular economy outputs

Enterprise support

SMILE
Enterprise Ireland
EPA
IBEC
IDA
Local Authorities
Regional Waste Management Offices

Users & purchasers

BIA Foodcloud
BITC Members
Camara
Online resellers
Free Trade Ireland
Individuals, Bargain Hunters
Origin Green Members
Social Enterprises
Waste industry

Advocacy & awareness

Business in the Community
CRNI
DCCAE
EPA / NWPP / CRNI
Multinationals
NGOs
Regional Waste Management Offices
Repak
Waste industry

Demand side - creating demand

Policy & regulation

CRNI
DCCAE
EPA
Local Authorities
NGOs
WEEE Ireland

Finance & funding

DCCAE
Enterprise Ireland
Environment Fund
EPA
Local Authorities

Evidence & data

Enterprise Ireland
EPA
ESRI
IBEC
Local Authority Prevention Network
National Waste Collection Permit Office
Repak
Reuse Organisations
Universities
Waste industry

Governance - combination of push and pull

Leaders

BIA Foodcloud
Dublin Bike Scheme
Enrich Soil Solutions
Go Car
IAMECO
Rediscovery Centre
Rothar
Share Ireland
SMILE
Sunflower recycling

Skills & education

An Taisce
Clean Technology Centre
Eco Unesco
EPA / Green Schools
Rediscovery Centre
Rehab
Recreate
Social Enterprises

Research & knowledge exchange

Clean Technology Centre
Enterprise Ireland
EPA
Joint Programme Initiatives
NESC
Rx3
Universitiy of Limerick
UCD School Food and Biosystems Engineering

Development Agency (IDA) and Enterprise Ireland and Sustainable Nation, Resource Efficient Farming and Food Harvest 2020, Sustainable Energy Authority of Ireland interventions and the Office of Government Procurement's work on an Action Plan on Green Public Procurement.

One of the emerging debates in the context of the circular economy in Ireland is the role of the social economy and social enterprise. The support structure for social enterprise in Ireland is still in the nascent stages of development.

There has been a dominant focus on projects that provide finance and mentorship through competitive mechanisms. More comprehensive support mechanisms such as supportive legal structures, national support services, multiple scale finance and accredited training programmes are only emerging in recent years.

Attitude of Irish business and social enterprises

While some national industry bodies and employers representatives are discussing the potential of the circular economy there is a lack of comprehensive data and evidence on the preparedness and attitudes of Irish businesses and social enterprises.

Unlike other OECD and EU countries, Ireland does not publish data on Environmental Protection Expenditure that would typically cover expenditures on prevention, reduction and elimination of pollution or any other degradation of the environment resulting from production or consumption processes.

In June 2016, the European Commission published results from a survey that explored SME activities in relation to the circular economy (DG for Communication, 2016). This is a summary of the 400 responses from Irish SMEs.

The survey indicated that 73% of European SMEs have invested in the transition to a more circular model for their businesses over the past three years. Of the actions taken by Irish SMEs, waste is the most active area of investment (Figure 11).

Among Irish SMEs there is low awareness of financial incentives for the circular economy and therefore most of the actions undertaken were self financed. Also, few SMEs consider there to be easy to access information on the circular economy.

These two issues are relatively important in that the key barriers to implementing the circular economy include the perceived administrative costs, lack of easily accessible finance and a lack of internal expertise (Figure 12).

Figure 11: SME Circular Economy activities, last 3 years. n=400 (Eurobarometer 2016)

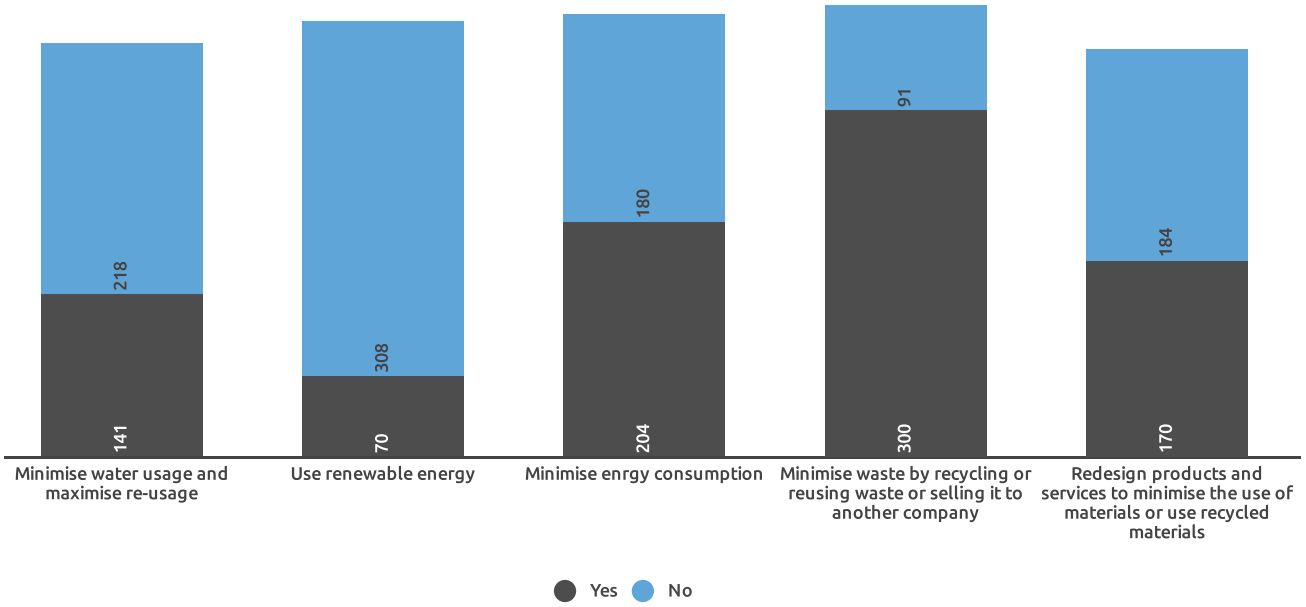
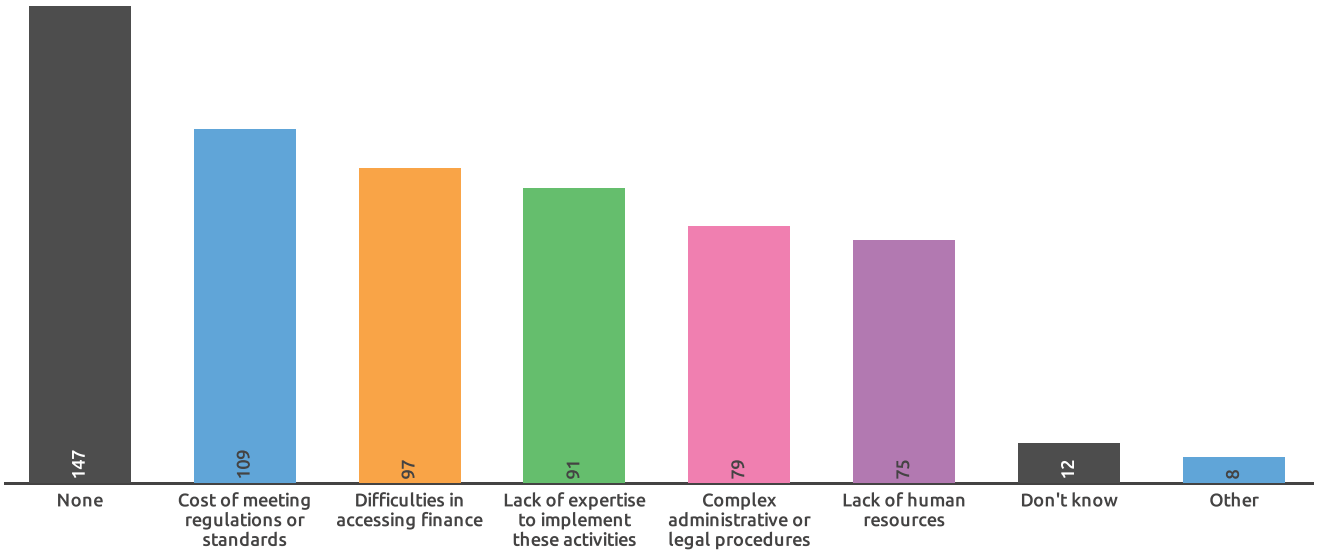


Figure 12: Issues undertaking circular economy activities. n=400 (Eurobarometer 2016)



SECTION 3: IRISH CASE STUDIES

In order to build on these perspectives, this research developed a series of case studies on practices related to the circular economy in Ireland.

The field and desk research for these case studies was undertaken during September and early October 2016. It involved 11 interviews with 17 senior staff from companies (CEO or Managing Director), social enterprises and intermediary organisations across Ireland working on issues related to the circular economy.

In addition to these interviews, informal meetings were held with 8 representatives from national and international organisations. Additionally, the research team attended an event on the circular economy in Brussels alongside European Economic and Social Development organisations. The resulting case studies provide an insight into business practices in Ireland with regards the circular economy.

The case studies facilitate an exploration of the possible strengths and weaknesses of the circular economy innovation system in Ireland.

The case studies highlight that businesses and social enterprises are already creating value through the circular economy despite a low level of "circular economy" specific policy support.

The case studies highlight how in some cases the regulatory system creates the conditions for the circular economy to flourish whereas in some cases it can create a precarious commercial context.

The case studies also highlight how the existing innovation support infrastructure is not oriented towards the circular economy from a number of perspectives.

Selection of case studies

The cases were identified through a non-probability sampling method. This included dialogue with national experts and desk research. From an initial sample of 50 potential cases, the final case studies were selected using a simple analytical framework.

A review of the literature on circular economy enterprise and business models highlighted a number of common model archetypes. (Table 1)

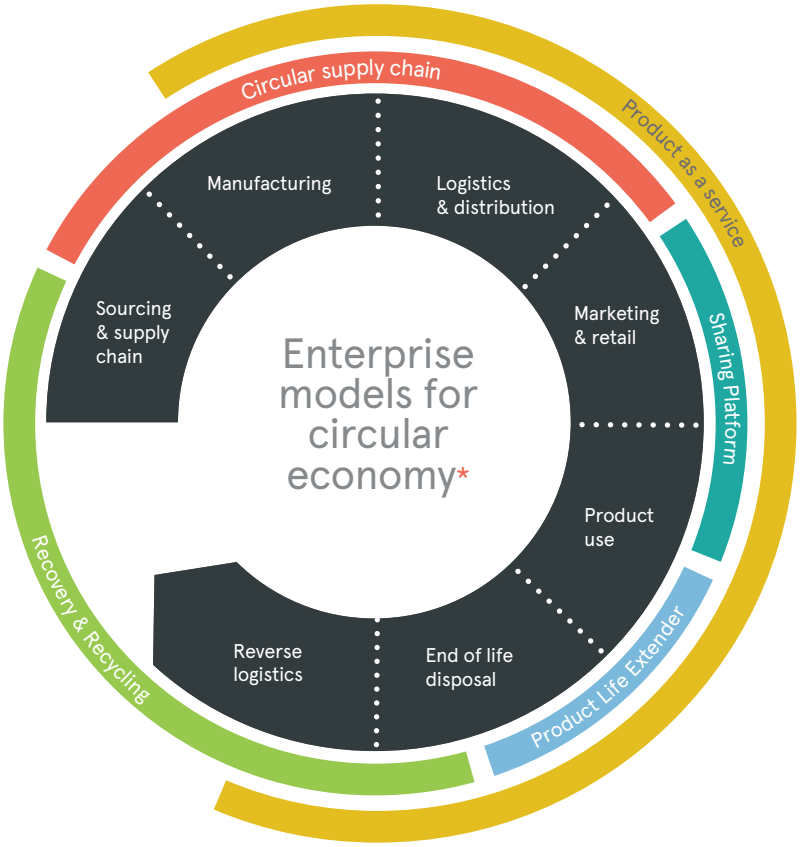
This framework of Product, Service, Supply Chain and Sharing/Social was used to identify priority case studies. In addition to this framework, consideration was also given to factors such as:

- accessibility
- representation across the main circular economy strategies (Figure 14)
- relation strategically important issues (e.g. food waste)
- examples of emerging practices
- technology based start-ups and social enterprises

Table 1: Circular Business Model Archetypes

	Product	Service	Sharing/Social	Supply chain
Accenture 2014	Product life extension Resell Repair/upgrade Remanufacture	Product as a service	Sharing platforms	Circular supplies Resource recovery Re-/upcycle Waste as resource Returning by-products
Bakker, et al. 2014	Classic long life model Hybrid model	Performance model Access model		Gap exploiter model
Kiørboe, et al. 2015	Product design Reuse Repair	Service based models	Collaborative consumption	Recycling and waste management
REBUS 2015	Incentivised return & re-use Long life	Product Service System Dematerialised services Hire & Leasing	Collaborative consumption	Asset management Collection of used products

Figure 14: Circular Economy Business Strategies



Product Life Extender
repair, reuse
remanufacture
durability inc. service model

Circular supply chain
renewable feedstock
re-selling

Sharing Platform
peer to peer lending

Recovery & Recycling
upcycling
downcycling
biorefining

Product as a service
digital service
product service system

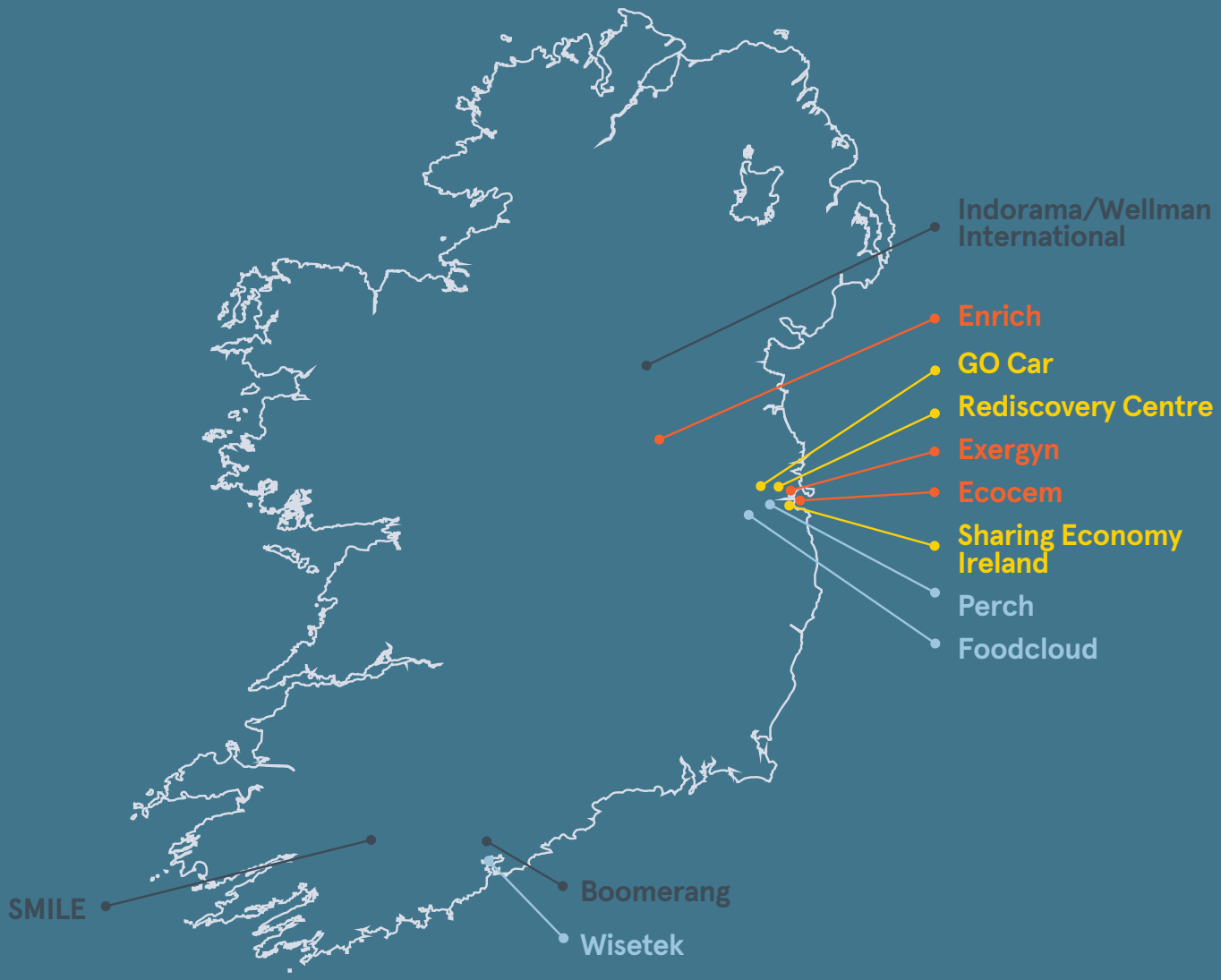
* Based Accenture report

Using the above framework and with consideration to the key Circular Economy Business Strategies the following case studies were selected for interview, a site visit or combination of both. Those marked with an star were developed through desk research or email exchange.

Table 2: Final Case Studies

	Theme	Focus	Location
Wisetek	Services	Reuse and Remanufacturing	Cork
Erich Soil Products	Products	The bio-economy and closed loop recycling	Meath
Rediscovery Centre	Sharing / Social	Developing cultures of reuse and repair	Dublin
Wellman International	Supply Chain	The plastics economy and closed loop recycling	Cavan
Sharing Economy Ireland	Sharing / Social	Collaborative Consumption and the Sharing Economy	Dublin
GoCar*	Sharing / Social	Collaborative Consumption and the Sharing Economy	Dublin
Foodcloud*	Services	Collaborative Consumption and the Sharing Economy	Dublin
Perch and Orangebox	Services	Design for the circular economy	Dublin
Boomerang Enterprises	Supply Chain	The role of Social Enterprises in the circular economy	Cork
Exergyn	Products	Financing and fostering innovation	Dublin
SMILE	Supply Chain	National Industrial Symbiosis Programme	Cork
Ecocem	Products	Upcycling of waste materials	Dublin

Figure 1: Case Study locations



Products

These case studies are predominantly focussed on circular product development. They are a combination of products that upcycle waste materials or improve energy performance.

Services

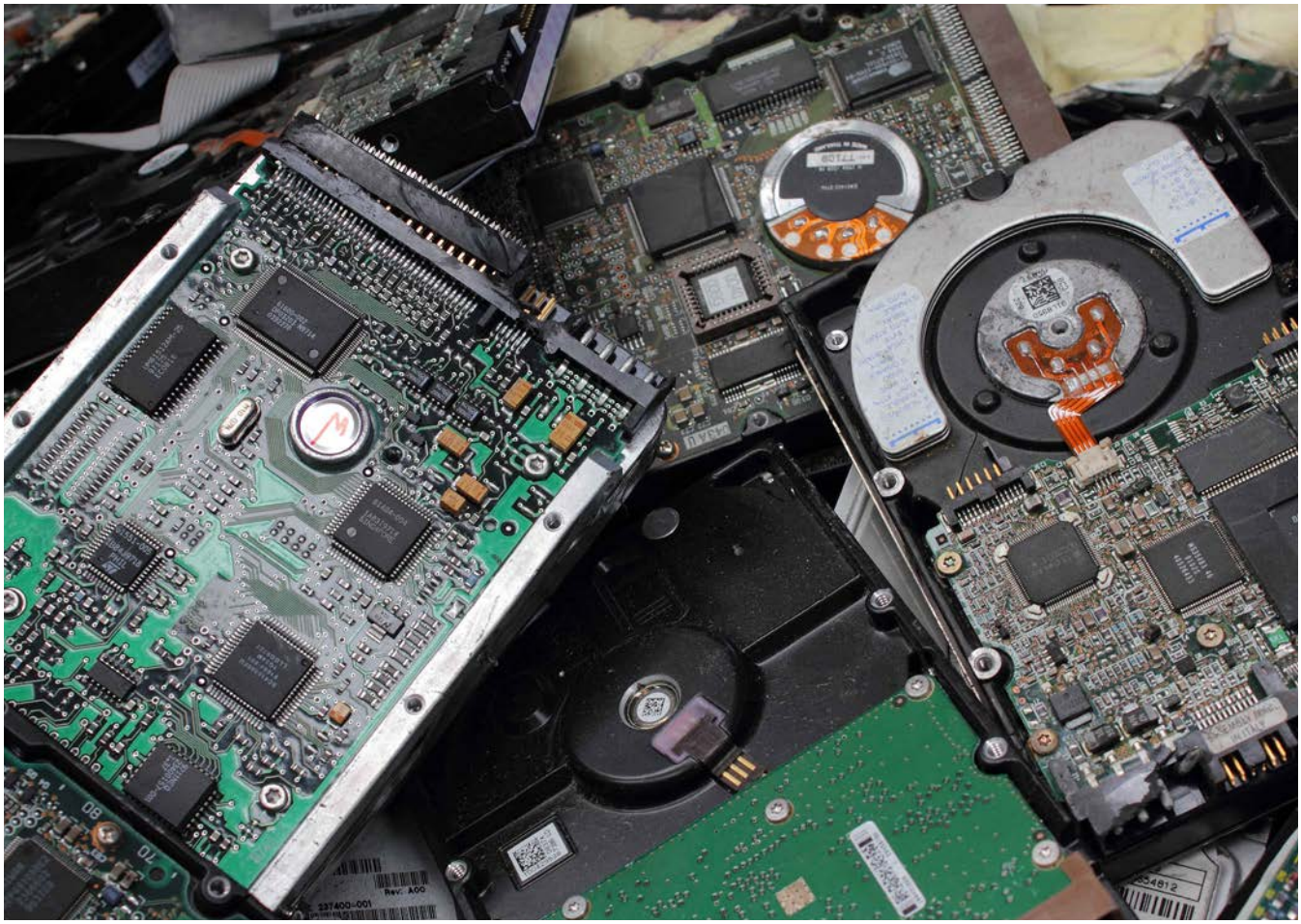
These case studies are predominantly focussed on the delivery of services that support the circular economy. They cover topics such as design, remanufacturing, reuse and remarketing.

Supply chain

These case studies are predominantly focussed on issues related to supply chains e.g. the recovery of materials across value chains or industrial ecology.

Sharing/Social

These case studies are predominantly focussed on the role of the sharing economy, social enterprises and community level actions.



CASE 1: "REUSE AND REMANUFACTURING" WISETEK

Waste electric and electronic equipment (WEEE) is one of the fastest growing waste streams globally with estimated increases of 3-5% per year. This is mostly driven by the fact that Electric and Electronic Equipment (EEE) are consumed at an increasing rates and some EEE have a relatively short cycle between product purchase and end of life.

According to the United Nations University "Global E-Waste Monitor 2014", 41.9 million tonnes of WEEE were discarded in 2014 and not recovered through any recycling, remanufacturing or reuse system (Baldé, 2015). The report estimated this waste stream to be worth approximately €49 billion. The UN Environment Programme estimated in May 2015 that up to 90% of the global WEEE was is illegally traded or disposed of through landfill (UNEP, 2015).

In Europe approximately, 9 million tonnes of WEEE is generated annually, alongside between 7 and 8 million tons of end of life vehicles which can contain similar materials. In the European context the UN Environment Programme suggests that the WEEE waste stream contains 300 tonnes of gold, 201,000 tonnes of silver and 16 million tonnes of steel. This level of leakage in the system underlines the market failure in relation to WEEE and this gives rise to significant negative externalities through environmental and social impacts both at the material extraction and disposal stages.

WEEE has received significant regulatory attention in recent years. This is primarily due to the fact that WEEE is one of the fastest-growing waste streams. There are also particular concerns regarding the toxic aspects of WEEE, the losses of critical raw materials (CRMs) and the resource intensity of producing EEE.

With regards CRMs, Europe is largely dependent on imports of these materials and many are critical for the development of products in key sectors such as renewable energy, medical devices, electric motors and electronic products more generally.

In 2010, the European Commission drafted a list of 14 key CRMs that are critical for the European economy. These materials include antimony, beryllium, cobalt, fluorspar, gallium, germanium, graphite, indium, magnesium, niobium, platinum group, rare metals [e.g. neodymium, dysprosium], tantalum and tungsten (European Commission, 2010).

Some of the challenges with CRMs relate to supply risks and volatile pricing but also supply can be concentrated in particular countries. For example, over 90% of the current global supply of neodymium (magnetic material in diverse products such as wind turbines, electric car engines) is located in China and this makes Europe susceptible to fluctuating prices and other supply risks.

There are other challenges relating to the supply of materials, such as gallium, being located in countries such as the Democratic Republic of Congo with high levels of political instability and conflict.

99% of global Gallium consumption is in integrated circuits and optoelectronic devices, 74% of Indium is used in flat panel displays and 27% of cobalt in rechargeable batteries (Zepf et al., 2014). It is also worth noting that there is more gold in a ton of WEEE than in a ton of ore.

Coupled with these supply risks, CRMs also pose a challenge with regards the circular economy because they are contained in low concentrations in products that are dispersed or unrecoverable due to poor collection systems or illegal trading of WEEE. Currently only 35% of WEEE in Europe is recovered and processed in approved facilities.

There are also technical limitations of existing recycling processes, in particular metallurgical recovery, in that many of the smelters or recycling companies extract certain commodity materials from products that they recycle and these CRMs in lower concentrations are lost in the process.

Another key challenge with WEEE is the variable concentration of materials in WEEE entering the recycling system. This can affect investments in recycling infrastructures, as companies will struggle to predict the material composition of historic WEEE that they will be receiving. This is driven by the rapid development in technology and diverse applications.

A commonly cited example was the transition between Cathode Ray Tube (CRT) televisions and the various flat screen technologies such as LCD screen. Some regions provided subsidies and investment in the development of recycling infrastructure to deal with CRT recycling only for the technology to transition rapidly. This made the recycling infrastructure redundant.

There are also other sociological factors including the fact that WEEE can remain in households for long periods of time. A commonly cited example is the fact that many households have a number of items of WEEE in their homes. For example, one estimate suggests that there may be 11,250 tonnes of unused mobile phones in homes across the UK. There are various reasons why people hold onto broken products such as a lack of convenient paths to recycling, emotional attachment and concerns about data protection.

In addition to these factors affecting the composition of WEEE, some regulations are also having an, albeit positive, impact. For example, the RoHS Directive will reduce the quantities of hazardous substances such as lead, hexavalent chromium, mercury, cadmium, polybrominated biphenyls and polybrominated diphenyl ethers in WEEE.

Circular economy Strategies - Reuse and remanufacturing

While there is a broad range of strategies relating to WEEE, reusing products and components is a key strategy in the transition towards a circular economy. Reuse differs from recycling in that it extends the use phase of products and in doing so conserves the physical assets in the product. These assets being the raw materials and embodied energy.

The Waste Framework Directive states that member states should develop interventions and measures to “promote the reuse of products and preparing for reuse activities, notably by encouraging the establishment and support of reuse and repair networks”.

Coupled with this, the WEEE Directive states that Member States shall promote where appropriate “the separation at the collection points of WEEE that is to be prepared for re-use from other separately collected WEEE”. While this is the case within the regulations experience has shown that reuse organisations are often restricted from accessing collection points and because of that EU reuse rates vary significantly.

Although there are global variations in regulatory implementation the Business to Business (B2B) aspects of the WEEE regulations establish that producers must take back and manage WEEE from end user and if they do not take back the WEEE directly they need to make a formal financial arrangement with the end user that facilitates the management of WEEE through authorised waste contractors. The development of an IT asset recovery industry demonstrates that there is commercial value in developing a more circular system for B2B EEE.

While the large-scale reuse of EEE has not happened as rapidly as intended there are many examples of commercial practices that are based on circular economy principles. For example, as part of a broader circular economy and zero waste strategy Google is implementing a programme of component and equipment reuse within its data centres. In 2015, Google reported that 52% percent of the components used for data centre upgrades globally were refurbished inventory. In addition to this Google resold almost 2 million units into the secondary reuse market.

In order to explore these issues in the Irish context we explored the practices of an Irish company that has developed a successful circular economy business based on reuse and remanufacturing.

Wisetek

Wisetek, based in Cork, is a global provider of lifecycle management services, secure data-elimination & responsible IT recycling services for enterprise IT systems. The company was founded in 2007 by Sean Sheehan and has developed a strong reputation as key providers of a 'one-company solution' that includes reverse logistics, asset value recovery and manufacturing services.

Incentivised return of WEEE is an important circular economy business model in that it can offer a financial incentive for the return of used products, which are then refurbished and re-sold. The financial incentive, which forms part of the Wisetek offering, is that OEMs and other clients can reduce their physical storage and data destruction costs while also complying with global WEEE regulations.

Wisetek's clients include some of the electronic industry's leading OEMs. This includes EMC (now DELL EMC), McAfee, VCE Tyco, and Dell. VCE are a provider of cloud infrastructure and are a joint venture between EMC and Cisco. In providing services to these manufacturers, Wisetek assists them in meeting obligations of EU and international WEEE Regulations.

Wisetek are also more broadly facilitating the transition to the circular economy by ensuring the diversion of useable IT equipment from landfill while providing income for both the company and other organisations across the IT value chain. Aside from facilitating direct reuse of components, a key feature of the Wisetek business model is that they resell reconditioned and remanufactured IT equipment through their Wisetek Market.

The company has expanded rapidly since it was founded and now employs almost 200 people. Approximately 160 of these staff are located in the international headquarters in Cork. The company also has facilities in the US and Thailand.

One of the focus areas for development of the Wisetek business is in the area of data centres and data centre equipment such as servers. While servers may be located within individual office networks they are increasingly co-located in purpose built data centres. These data centres can provide IT services, such as cloud computing, from any location.

Because of the rapid advancements in server performance they tend to be upgraded or refreshed regularly. The very large data centres may upgrade on an annual basis. This ensures optimal performance of the servers and reduced energy consumption. These servers are often bespoke and this means that only core components need to be replaced. This means that racks, server cases and other longer lasting components can be reused.

Since the launch of Wisetek, a key client was EMC who have been a global leader across a number of IT sectors such as data storage, information security, virtualization and analytics. In 2016 an acquisition of EMC by DELL was finalised with a deal was worth US $60 billion and was reportedly the largest technology sector acquisition to date.

Wisetek process

Wisetek offer a number of services but suggest that the key circular economy priorities are the recovery of components for direct reuse within client's operations and the remarketing of components globally through the Wisetek Market website. They ensure a commercially viable model as the clients receive "optimal financial pay-back

from the flow of used assets". Facilitating the use of recovered components reduces the input of virgin CRMs and other materials as well as reducing the overall embodied energy of the final products. These components can be described a functionally identical to other components but offer significant cost savings. Wisetek suggest that these savings from used parts recovered from returned systems can be in the order of 80%.

For those components that cannot be reused or remarketed, Wisetek recycle these in facilities that are externally certified to the R2:2013 standard. Typically components will have to be sent for recycling if they are irreparably defective or if there is no spares demand. Wisetek branded this certification as the Wisetek Sustainable EARTH standard. This standard covers the full downstream refining process and is supported by reporting on all WEEE materials.

Importantly, Wisetek follow the guidelines and recommendations of the Basel Convention that provide controls on the transboundary shipments of hazardous wastes. This contributes to the Wisetek guarantee of full traceability for OEMs of their recycled material through each stage of downstream processing. This on the one hand protects the OEM from potentially unethical recycling practices that may adversely affect their brand but also provides more accurate data on their potential income from recycling.

Wisetek also develop a platform called TotalRMA™ that analyses and values all materials (components and products). This ensures that the materials are collected, reconciled and processed efficiently and in a cost effective manner. The TotalRMA™ platform improves the interactions between logistics and administration functions but importantly it provides a connection with the customers and various sub organisations such as sales and engineering.

In addition to these circular economy priorities, the company also provides a secure data-elimination service and have recently developed Product Operations Centres in Thailand and the US. These operation centres can provide additional services such as product assembly, configuration to order as well as improved logistics coordination.

Wisetek Facilities and Certifications

The company's Irish operation includes four facilities in Cork that include the headquarters and approximately 150,000 sq.ft of Electrostatic discharge (ESD) compliant facilities. The facilities in Cork are certified to the R2 Standard for Responsible Recycling (R2:2013), ISO 14001:2004 and OHSAS 18001:2007 among others. The location of facilities in Cork provides access to international transportation connections via Cork port and Cork Airport.

The R2 certification originated in the US and addresses the operational and environmental challenges in electronics recycling and repair. It is a voluntary, market-based mechanism for ensuring best practices and it emerged from a three year long multi-stakeholder process that was facilitated by the US-EPA. The certification is directed at WEEE recyclers, refurbishers and remanufacturers and OEMs. Wisetek were the third company in Europe to receive the certification and the fifth company in Australasia.

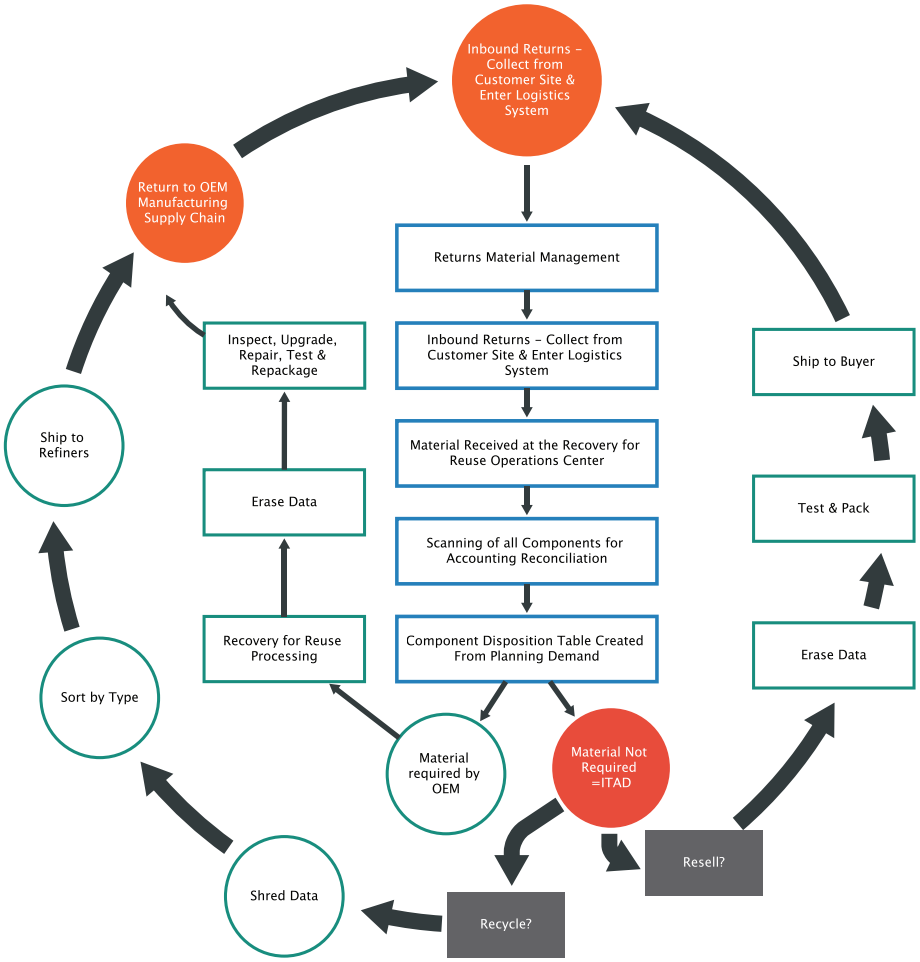
The Thailand facility is located at Laem Chabang, Thailand's largest port. This 37,000 sq.ft facility is also ESD compliant but importantly it is strategically located with regards the global manufacturing and recycling infrastructure. Because of this it can offer services to leading OEMs in Asia. This facility is licensed to process WEEE and has the same level of certification as the Irish facility.

Wisetek culture and management

The Wisetek leadership team have focussed on developing a positive organisational culture and effective management team. They have received external recognition for this through a number of awards. In 2010, Cork Chamber of Commerce awarded the company the Emerging Company of the Year award and in 2011 they won an award for the High Growth Company of the Year.

In 2016, Wisetek were named among the "best managed companies in Ireland" by Deloitte. Sean Sheehan, an EY Entrepreneur of the Year finalist,

Figure 16: Wisetek Process / Business Model



previously worked as a senior manager with the EMC Corporation. In this role he managed part of their WEEE and asset recovery system. The company has built a strong board that includes former Intel Ireland general manager Jim O'Hara, ex-senior VP at EMC Dick Lehane and former Bord Gais CEO John Mullins

Indicative of this managerial approach, Wisetek plays an active role in developing sectoral standards and advocating for the circular economy. Jim Sheehan, Wisetek's Chief Remarketing & Sustainability Officer was recently appointed to the R2 Technical Advisory Committee. This committee operates on behalf of Sustainable Electronics Recycling International, the housing body of the R2 standard.

This Technical Advisory Committee consists of representatives from stakeholder groups such as industry, regulatory agencies, public interest groups, downstream vendors, and trade experts. Wisetek are now one of the key companies in Ireland advocating for the circular economy and their growth has provided an insight into the potential for the circular economy in Ireland.

Challenges

Some of the key challenges identified during the interviews were the rapidly changing technologies, sector leaders and shifting regulatory landscape. It is fair to suggest that the global WEEE regulation provided the context that allowed the business to grow and it is hoped that this regulatory context will continue to support the Wisetek business model.

CASE 2: "BIO-ECONOMY & CLOSED LOOP RECYCLING" ENRICH SOIL PRODUCTS

In recent years the bio-economy has emerged alongside the circular economy as an overarching strategy for transitioning to more sustainable consumption and production systems. In basic terms, the bio-economy focusses on the use of biological resources as an alternative to fossil based resources in the creation of new commercial products.

These products typically include food, materials, chemicals, fuels and bioenergy. Because of this, the bio-economy intersects with a broad range of sectors such as agriculture, forestry, fisheries, food and drink, chemicals, biotechnology and energy.

Much of the recent interest in the bio-economy has been focused on using biological resources more effectively and efficiently while also developing new applications such as bio-plastics, bio-refineries and biofuels.

Although it is a number of years old now, a study in 2009 suggested that in Europe these more contemporary bio-based applications generated €57 billion of turnover and the companies involved employed approximately 300,000 people.

While this is significant, at the time the wider agricultural, forestry and food sectors had a turnover of €1,990 billion and employed 21.2 million people (Clever Consult BVBA, 2010). While broadly speaking these bio-based solutions can deliver environmental and economic gains and support the circular economy, care is required with regards feedstocks and applications so that biological resources are managed and consumed within their sustainable limits. Recent concerns with this include the use of biomass for energy and fuels.

It is worth noting that a number of national strategies make a distinction between the bio-economy and the bio-based economy. Although there is no consensus internationally, by way of example, the Flemish National Strategy suggests that the bio-economy describes the production of biomass (primary production or using waste as a feedstock) as well as the use of biomass for food energy and material uses. Their strategy suggests that the bio-based economy is a distinct subset of these broader activities and focusses on the use of biomass for energy, chemicals and materials. Linking the circular economy and the bio-economy.

One of the clear interfaces between the bio and circular economy is the use of waste as a feedstock in producing new products. The broad use of waste in the bio-economy is still a nascent practice but a small number of national bio-economy strategies and the Circular Economy Package recognise waste as a potentially significant feedstock.

The development of circularity in the context of the bio-economy will require innovation at a policy and business level. This innovation will involve the development of improved collection systems for different bio-based waste (e.g. agricultural waste, food waste), improved partnership between waste generators and waste users, improved data on the national and sub-national resource base and likely feedstock, specific investments in research and development.

A number of recent strategy documents for the circular economy have prioritised agricultural and food wastes (Bastein et al., 2013; McKinsey, 2015; World Economic Forum, 2015). On the one hand the priority is seen to focus on food waste prevention through a variety of interventions but also in the opportunities around processing food waste through composting and energy production (e.g. Anaerobic digestion, biorefining). A key benefit of improving these systems of composting and energy production is that they displace virgin material consumption.

With regards to the Circular Economy Package there is a broad action relating to biomass and bio based products with an aim to scale the development of these products as an overarching strategy to decarbonise the European economy and develop more resilient energy systems. Coupled with this the Package includes proposed changes to the Fertilisers Regulations so that large scale fertiliser production and nutrient recycling can be properly incentivised in the EU. The package estimates that by 2025 25% of mineral fertilisers will be replaced with organic fertilisers.

The Circular Economy Package also places focus on the role of agriculture and forestry sectors within the circular economy. These roles include the supply of fully recyclable feedstock and raw materials, optimisation of natural resource yields through circularity, reuse of organic materials and nutrients recovery.

In order to explore some of these issues in the Irish context, we included a case study addressing the closed loop recycling of food waste and other biomass.

The Irish context

The bio-economy is a key feature of Ireland and one of the main pillars of national sustainable development. The related sectors are of major significance for economic growth and jobs, particularly in rural communities. According to estimates, the key bio-economy sectors in Ireland (agriculture, fisheries and aquaculture, forestry, food industry, forest industry and bioenergy and biofuels) account for approximately 162,000 jobs in 2010 with an additional 45,000 jobs elsewhere in the value chain.

Ireland has an abundant supply of natural resources and bio-wastes that have significant potential with regards the production of new products and process technologies. However, this potential is not being fully captured and many opportunities are being missed.

The predominant focus of the bio-economy in Ireland is on lower value products such as commodity horticulture products and bio energy. There is much less priority given to higher value outputs such as bio-chemicals or bio-based materials. That is not to say the lower value products are inferior but these companies will face significant competition with other lower cost and ultimately less sustainable waste disposal options.

There are three broadly applied processes for dealing with bio-waste in Ireland.

Anaerobic digestion

This is a controlled process in oxygen free equipment where microorganisms break down organic materials. In addition to food and green wastes, anaerobic digestion can process manure and sewage sludges. Anaerobic digestion captures biogas as a new energy source (methane and carbon dioxide) and a solid residual known as digestate. The digestate can be composted or applied to soil.

By way of illustration, as of 2014 Ireland had six anaerobic digestion plants of various scales processing a variety of waste material. This compares with Northern Ireland that had 26 plants. A number of studies have suggested the reasons for this low level of anaerobic digestions in Ireland. These include

- Complex planning and licensing system (8 different permissions required)
- Complexity and costs with grid connection
- A lack of attractive feed-in tariffs
- Difficulties in raising finance
- Perceived uncertainty with regards waste policy

Composting

A biological process in which microorganisms (e.g., bacteria and fungi), earthworms and insects break down organic matter (e.g. green and food wastes). The output, known as compost, is a soil like material that can be applied in agricultural fertilisers.

In addition to the above, a key emerging process is bio-refining. This is the production of low-volume but high-value chemical or fuel products through the conversion of biomass. A 'bio-refinery' can produce more than one product or type of energy.

While bio-refining is still only an emergent practice in Ireland there have been a number of projects exploring the potential within the wider context of the bio-economy. For example, the Bio Base North West Europe project, Competence Centre for Biorefining & Bioenergy and the Dept. of Agriculture, Food and the Marine-funded BioÉire project.

While developments still appear to be in the early stages of development, here are new research projects exploring related aspects of the bio-economy and circular economy in Ireland such as Agrocycle. This project, lead by UCD, received €8 million funding from Horizon2020 and launched mid 2016.

The project will be exploring the circular economy in the Agri-Food sector in Ireland. This level of funding underlines that there is remarkable potential for innovation and growth in the circular economy in this and related sectors.

This innovation potential will be met when resource flows and sector actors such as companies and farmers interact in order to open up new opportunities for using waste and raw materials in creative ways.

Ultimately, the goal should be to promote innovation, maximise the use of under-exploited natural resources and minimise the production of waste.

To explore the intersections of the bio-economy and the circular economy, we developed a case study that addressed the closed loop recycling of biomass and food waste.

Enrich Environmental

Enrich Environmental Ltd based in Kilcock, Co. Meath is one of Ireland's leading manufacturers of peat-free compost and soil products. The company was established by Tim Duggan in 2002 and initially operated as a maintenance company that collected waste products from landscaping companies. Since then, Enrich has developed into a successful and award winning business based

Figure 17: Anaerobic Digestion

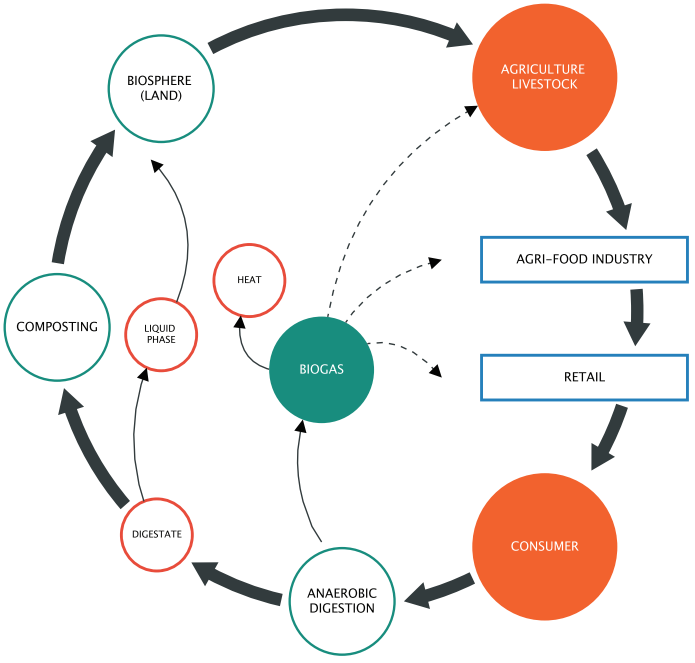
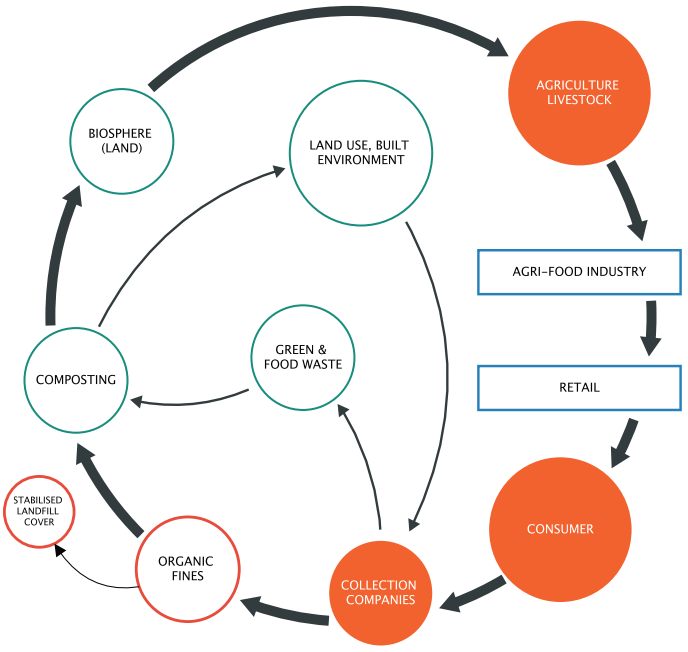


Figure 18: Composting process



on circular economy principles such as closed loop recycling and using a feedstock that would have otherwise been waste.

Tim suggested that the business developed after identifying opportunities in creating value from materials that were, at the time, being sent to landfill where it contributed to a number of negative environmental impacts.

At the time of setting up the company, Tim was a student of environmental management and was driven by a motivation to help the transition to sustainability through business and practical implementation of environmental practices.

After two years of collecting green waste materials, the company expanded and diversified into the manufacturing of horticultural products that use composted green wastes. The site is currently capable of process approximately 10,000 tonnes of material annually with developments underway to increase this capacity to include the processing of commercial and domestic food waste.

The company currently employs 18 people and has received a number of awards such as the Green Technology Awards the Cré Cup Award. Cré are the Composting and Anaerobic Digestion Association of Ireland.

The company distributes products across Ireland and internationally. Typical customers include professional landscape contractors and designers, civil engineering contractors, topsoil providers, local authorities and golf courses.

They also produce a range of specialist soils for specific applications such as roof top gardens and green roofs. Typically customers are requiring a high quality product while others are also demanding more sustainable options.

The company has established a trusted customer base and their products are used in many high profile construction and landscaping projects in Ireland. Enrich is building up a loyal customer base, with similar environmental ideas and an increasing awareness of the dual benefits of incorporating sustainable products into their projects. Enrich will consult with each customer to insure proper design and application of the product so to achieve best results.

Enrich is an active participant in sectoral networks and associations such as ALCI (Association of Landscape Contractors of Ireland) and Cré. Through this they advocate for a more sustainable approach to business. In the spirit of being a responsible business, Enrich became the first company in Ireland to achieve accreditation under the Compost Quality Assurance Scheme CQAS-441:2012

This approach to the business is also carried through this motivation to educate the public on the process of composting and the importance of the circular economy and closed loop recycling.

Enrich regularly provides tours to schools and other groups. These tours in part explain in a very tangible way the process of recycling but Tim is also keen to ensure that the business explains the importance of recycling and wider benefits of sustainable approaches to business. They also undertake outreach to schools to support them with composting activities.

Production process

Enrich apply two key composting methods; Windrow and Enclosed/In-vessel composting.

Windrow composting allows the processing and composting of green waste (e.g. park and gardens wastes) in the open air. The term windrow refers to the fact that the material is initially screened, shredded and then laid out in narrow piles called windrows.

In basic terms, the composting process begins when a windrow of screened and shredded green waste is piled into a windrow and then moved and turned with a new windrow added alongside. The moving and turning of the windrow allows for oxygen to be introduced to the mix. In dry summer months the windrows are watered to ensure that optimal conditions are maintained for composting.

The windows are constantly monitored to ensure optimum oxygen concentration, moisture content

and temperature are maintained. It will take approximately 10 months for one windrow to be fully composted and ready for final processing.

This final processing can include additional screening or the combination of materials in order to produce different landscaping products.

Enrich are also processing construction and demolition waste. For example, crushed brick can be added to the final compost to make a specialist lightweight roof soil.

More recently, the company made a multi-million euro investment in an enclosed (in-vessel) composting plant that can process food waste and organic fines. The processing of food waste from households and meat-containing food wastes are controlled by the Animal By-Products Regulations.

These regulations set out that these food wastes must be processed in controlled conditions so that pathogens cannot be transferred between the plant and wild animals. This also allows for variable control of temperature, oxygen and moisture levels in the compost at each stage of processing.

The process is similar to windrow in that it is a multistage process that introduces oxygen in order to facilitate the composting but almost all stages occur under cover.

Enrich have also introduced sustainable systems for filtering odours. There is typically a final stage of maturing the compost outdoors, usually followed by an outdoor maturation stage.

Consulting services

In addition to producing compost and other horticultural products, the company is involved in soil consulting. They are in a position to offer consulting services because of the experience and team Tim Duggan has developed since launching the business a decade ago.

This consulting service includes assisting clients in testing, analysing and specifying the properties and performance of soil products.

While the company is driven towards innovation and growth the ethos of ensuring their solutions and new products are based on circular economy principles, sustainable and cost-effective.

Challenges

Some of the key challenges identified during the interviews were the regulation of source separation schemes of food and green wastes. The company suggested that investments in plants to process food waste were made based on estimated feedstock that should be available through the collection of brown bins and commercial food.

The level of feedstock has not yet materialised and this places significant commercial pressures on the sector. The company needs to process other materials, such as organic fines from municipal waste, in order to ensure the plant's viability.

Cré, on whose board Enrich sit, have estimated that there is approximately 1,447,194 tonnes of organic waste generated in Ireland. This is composed of an estimated 654,000 tonnes of organic fraction of household Biodegradable Municipal Waste (BMW), 331,691 tonnes of commercial organic BMW and 597,816 tonnes of industrial organic waste.

A study by Indecon for Regulatory Impact Assessment for the Food Waste and Bio-Waste Regulations estimated that up to 231,893 tonnes of household brown bin could be collected. An EPA study on the commercial sector, there could be a potential of 562,381 tonnes of household and commercial brown bin material that could be collected and sent for composting/ anaerobic digestion. However in 2015, only approx. 143,000 tonnes was collected.

Based on this, Cré estimate that the waste collectors are only collecting 27% of this potential in 2015. This is despite national regulations requiring the collection of brown bin material since 2010 for the commercial sector and 2013 in the household sector. Cré suggest a number of factors are giving rise to this such as more cost effective export markets, household behaviour regards separation and enforcement.

CASE 3: "CULTURES OF REUSE & REPAIR" REDISCOVERY CENTRE

Within the circular economy reuse and repair are dominant strategies for extending the life of products, reducing material inputs and minimising waste. Existing reuse and repair practices are diverse and range from individuals repairing their own products, professional third party repair services, community reuse and repair services, manufacturers and retailers offering repair services and warranty agreements as well as second hand sales such as through charity shops or online retailers.

More recent practices such as Fab Labs, Maker Spaces, Hacker Spaces and other forms of distributed manufacturing play a role in this context of repair and reuse.

While the cost of some technologies for distributed manufacturing, such as 3D printing, have reduced significantly and their growth facilitated through open source models there is scant evidence that they have yet reached sufficient scale to impact dominant production and consumption systems.

In some product categories, the commercial viability of reuse and repair has led to the development of established and persistent markets and related social practices. For example, repair services are a well established aspect of the automotive sector.

Whereas for other product categories, such as white good and electronics products, the market and social practices for repair and reuse have weakened. For some of these products the commercial viability of running repair services has been reduced and much of the space has been taken up by social economy organisations such as charities and social enterprises.

Some national governments are testing different interventions to improve the incentive for repair and reuse. For example:

- The Swedish government recently reduced the VAT levied on repaired products, reducing VAT from 25% to 12%)
- The French government, within their Energy Transition for Green Growth Act, introduced regulations against planned obsolescence making planned obsolescence punishable by two years' imprisonment and a fine up to €300,000. They also introduced specific regulations such as demands that auto repair services offered reused parts to customers.
- The Spanish government set a national target of 50% of waste to be recycled or prepared for re-use with 2% of furniture, textiles, electrical, and other suitable goods to be directed towards reuse.
- Flanders in Belgium set a regional target 5 kg per capita of waste to be re-use

In Ireland, the EPA has been supporting the development of reuse and repair through funding the Community Reuse Network (CRNI). The CRNI supports the work of 16 national community reuse organisations.

Alongside building capacity and advocating for the community reuse sector in Ireland, the CRNI undertake research projects that seek to improve

reuse practices and improve the evidence base for the sector.

While these interventions play an important role, there is a lack of evidence on the scale of impact with regards the transition to the circular economy.

On the one hand consumption related behaviours are difficult to change because social attitudes and social practices are deeply embedded and the cost of repairing can be higher than replacing with new products. These costs are not just associated with unit costs but there are other transaction costs due to inconsistent and, sometimes, inconvenient access to reuse retailers and repair services.

It is worth noting that the CRNI have highlighted that while reuse and prevention are at the top of the waste hierarchy they often receive the least state support through subsidy, fiscal incentives and other interventions. This warrants further examination given that the labour-intensity of the reuse and repair sectors could contribute positively to national and regional employment and social agendas.

Clearly there are a number of structural and socio-technical factors constraining the growth of reuse and repair across a number of product categories but one key challenge is related to design and business models. Certain products are not designed to be repaired or the repair of them is technically challenging or impossible because spare parts or repair information are not available.

Because of these factors the Circular Economy Package will be addressing issues such as proportionate requirements on product durability requirements, provision of repair information and spare parts, enforcement of the guarantees on products, tackling false green claims as well as emphasising circular economy aspects in new or revised criteria for Green Public Procurement.

It must be noted that the provision of repair information covers the provision of consumer facing information as well a standardised protocols on repair and reuse for professional services, including community reuse.

To explore some of these issues in the Irish context we developed a case study on one of the established reuse and repair services in Ireland.

Rediscovery Centre

The Rediscovery Centre, located in Ballymun Dublin, is an environmental education and research social enterprise dedicated to providing education and community employment and training via innovative reuse. These enterprises use waste and unwanted materials as a resource and raw material for new product design.

The Rediscovery Centre has its origins in the Ballymun Regeneration project and a series of community environmental projects run by Ballymun Regeneration Limited (BRL) in 1997. BRL were a Limited Company wholly owned by Dublin City Council and was the main formal body responsible for overseeing the demolition of the Ballymun flats.

The waste infrastructure of the flats consisted of a chute into which residents on each floor would put their waste. This meant that there was no culture or practice of segregating waste. In order to facilitate the transition from the flats to houses or smaller apartments, BRL decided to develop a community education project around waste.

The intention initially was to educate the residents in different segregation practices so that when they moved into their new homes they would be in a position to start recycling.

The projects were very practical and built around the interests of the community. It included establishing bring centres for recyclables in the basement of the tower blocks, ongoing interaction with residents that dropped off items, classes and waste games for the youth as well as composting classes and free composting bins.

Following these initial projects the projects scaled up and the Rediscovery Centre was formalised as an organisation that eventually spun out of BRL. The Rediscovery Centre is still located in Ballymun and still provide practical example of the circular economy at a community level through reuse, repair, resource efficiency and "life cycle design".

The overarching strategy is facilitate positive behavioural change through effective education and provide workplace skills training and development for local people, interns and graduates. The Rediscovery Centre also advocates for the circular economy alongside capacity building through training and corporate services.

The Rediscovery Centre functions as an umbrella organisation for four social enterprises that address the reuse and repair of the following product categories; Furniture, Paint, Bicycles, Fashion. Previously all these social enterprises were located in different locations around Ballymun but they have now all relocated to the new Rediscovery Centre, a purpose built centre of excellence for reuse and education for sustainable development.

Rediscover Paint

Rediscover Paint is a community paint reuse scheme managed by the Rediscovery Centre. Rediscover Paint is built on a similar model to other community paint projects, such as Community RePaint, but it was the first such project in the Republic of Ireland. Rediscover Paint sources paints from civic amenity sites (local authority recycling centres) and other local sources and makes these available for reselling and reuse. It stocks a variety of water based paints such as interior and exterior paints, emulsions and undercoats.

The paint that is collected is processed in order to produce as consistent a colour as possible to customer requirements and repackaged in reused paint tins. These paint tins are also relabelled and provide the customer with additional information such as the best timeframe within which the paint should be used.

Rediscover Paint aims to resell this paint so that it can compete on price with new paint. Rediscover Paint provides a membership scheme that allows customers to pay different subscription rates to access different quantities of paint over the course of a 12-month membership. The typical customer include schools, community groups and youth projects.

The project has recently received funding from the EPA's Green Enterprise programme which will see the expansion and automation of their operations and will include an increase in paint distributions channels.

Rediscover Fashion

Rediscover Fashion is an award winning retail and training enterprise that aims to divert textile waste from landfill through the design and repurposing of garments and textile-based accessories and home-ware.

According to Rediscovery Fashion, 93% of textile waste in Ireland is sent to landfill, export or for energy recovery. In addition to developing garments and other textile based products, Rediscover Fashion provides sewing courses at beginner, intermediate and advanced levels with a focus on reusing textiles and upcycling. Rediscover Fashion estimate they are now diverting 500kg of textiles from landfill each year.

As with other Rediscovery Centre projects, Rediscover Fashion seeks to inform and advocate for the circular economy and change public perception of waste. They aim to achieve this through good fashion design and selling high quality upcycled products. In terms of advocacy, Rediscover Fashion is a member of the Ethical Fashion Forum which is an international trade body dealing with sustainable fashion.

The project provides training and educational opportunities to local long term unemployed participants and early school leavers. Progression rates for trainees into full time education or employment are very high.

Rediscover Cycling

Rediscover Cycling is a bicycle reuse social enterprise. This initially began as a repair workshop wherein people could bring bicycles and they would be provided access to the necessary tools and equipment. They recently changed their business model and are now focussing on taking bicycles that are donated by members of the public and made available through recycling centres.

Through a community training and education programme these bikes are reconditioned and then resold through their retail space or online through existing online reselling platforms. Rediscover Cycling offers training to local people on how to repair and maintain bicycles.

The project also offers regular bike service clinics at customer sites, such as the weekly service at Dublin City University, and provides popup clinics for corporate clients and community groups. They also provide short bicycle mechanic courses for the general public at their new centre.

Rediscover Furniture

Rediscover Furniture is located in the same premises as Rediscover Fashion, Paint and Cycling and similarly repairs, reuses and resells preloved or reused goods.

They also provide services such as restoration of antique furniture, re-upholstering and re-finishing. Members of the public donate much of the furniture that they process but they also offer a collection service. They are unable to accept all furniture and have a process of pre-auditing what they take so they can ensure there is scope for repair and reselling. The project provides skills training for local participants on labour activation programme, runs public courses and provides outreach community training.

Ecostore

In addition to the above activities, the Rediscovery Centre ran an Ecostore in Ballymun that incorporated a retail space for their products as well as a space for workshops and their education and training programme. The Ecostore has been relocated to the new centre and will open to the public in March 2017. In addition to Rediscovery Centre products the shop will sell quality upcycled and sustainable products from other Irish and European producers.

Rediscovery Centre Education programmes

The Rediscovery Centre's education programmes have been delivered since 2005 when the centre was first accredited to the Discovery Primary Science and Maths network.

Initially programmes were broadly based around issues related to waste prevention reuse and resource efficiency but over the past 12 years have expanded into other environmental areas.

The centre now offers a comprehensive environmental education programme which is being delivered in the new centre specifically designed to facilitate education for sustainable development. The centre also provides outreach programmes

They report that their workshops have engaged with over 22,000 school pupils over the last three years with a waiting list for future classes. The majority of schools are from the greater Dublin Area but many are further afield. Programmes are offered at primary, secondary and third level. The centre also provides corporate training, skills development and consultancy to

businesses on practical measures towards improving environmental performance, initiating environmental management systems and establishing reuse projects.

WISER (Working with Industrial Spaces to Exemplify Reuse) Life

The Rediscovery Centre has been fortunate to have a team with the skills, capacity and motivation to scale up from an initial project to develop a broad range of actions, projects and social enterprises. This process of scaling is continuing with the success of the WISER Life project.

In 2014, the Rediscovery Centre managed to secure €3.6 million in funding from the EU LIFE+ environment programme. This funding has allowed the Rediscovery Centre working in partnership with Dublin City Council to reuse the Boiler House that powered the original Ballymun flats and repurpose the building as the new Rediscovery Centre.

All of the different Rediscovery Centre projects and social enterprises previously located in different units throughout Ballymun moved into the new centre in Dec 2016 which opened its doors to the public in March 2017.

The vision for the Boiler House was to act as a "3D textbook" that exemplifies the circular economy through its refurbishment, operation and the activities that will be undertaken in the building.

It will act as a hub for the various social enterprises that will have greater exposure and connectivity with the planned education, training and research programmes. Many of the facilities within the building and the site will act as demonstrators for more sustainable construction practices.

Challenges

As mentioned, the Rediscovery Centre has been fortunate to have a team that were capable of scaling the initial projects and having the vision to see the potential in developing a larger scale centre. As with other similar projects there have been many challenges such as ensuring that the separate enterprises were financially viable. Where difficulties were identified they managed to close unviable projects or develop new viable models.

The development of the WISER Life project is a significant undertaking for the size of the team available. There were potentially a number of challenges with the development and refurbishment of the Boiler House.

This includes, not least, the specification of more sustainable construction materials and the integration of reuse in building development that few contractors in Ireland would have experience in working with.

They were fortunate to find a willing project partner in Dublin City Council and an architect and contractor that understood the vision of the WISER Life Project

Much of what the Rediscovery Centre does is innovative in the Irish context in the sense that they have a strong focus on combining community employment and training opportunities within the context of a circular economy project. The team are involved in a number of national and European research and outreach activities.

The research activities, such as developing reuse protocols for key products groups, will assist in professionalising the reuse sector but also potentially helping to create higher value outputs. This in turn will improve the commercial viability of the reuse and repair enterprises.

The outreach activities are in part about building the brand of the Rediscovery Centre but also exploring the viability of scaling the model outside of Ballymun.


ECOCEM


GREEN AWARDS 2016
The Green Product Award
Winner
Ecocem Superfine

CASE 4: "UPCYCLING WASTE BY-PRODUCTS" ECOCEM

Globally the construction sector is facing anumber of unprecedented challenges driven by dynamic pressures such as population growth and rapid urbanisation, particularly in emerging markets. Estimates of population growth predict that by 2050 there will be 9 billion people living on the planet and approximately 75% of these will be living in cities and urban areas.

Construction has been an economically important sector in Ireland. More importantly, buildings and the built environment form part of our everyday life and political discourse.

According to the World Economic Forum, the Engineering & Construction sector is the largest global consumer of resources and raw materials (WEF 2014). In addition to consuming almost 50% of the steel produced globally it accounts for up to 40% of solid waste and between 25-40% of global carbon emissions.

This trend is likely to increase with demands for the production of affordable housing, public buildings, transport infrastructure and public space.

Estimates suggest that the sector generates approximately 30% of all waste generated annually in the EU. Construction and demolition (C&D) waste is all waste that arises from construction and demolition activities (including excavated soil from contaminated sites). The EU has established mandatory targets for the recycling of C&D wastes but a number of technical and infrastructural challenges remain.

For example, the identification and classification of valuable materials or hazardous waste can be challenging particularly if they are not appropriately segregated.

Many of the materials that make up C&D wastes are recyclable or can be reused, but reuse and recycling rates vary widely across the EU. For example, Denmark recycles 87% of its non-soil C&D waste.

The most recent EPA National Waste Report indicates that collected C&D wastes in Ireland have decreased by 83% from a peak of 17.8 million tonnes in 2007 to just over 3 million tonnes in 2011. The most significant fraction of this waste in 2011 was soil and stones (1,975,844 tonnes) accounting for almost two thirds of the total. The remaining third included materials such as rubble, plastic, glass, metals and timber.

It is important to note that the carbon embodied in construction materials, particularly cement and steel, can account for 40-50% of the carbon footprint of a building.

Additionally, up to 80% of the energy consumed during the construction phase of a building can be related to the preparation and management of materials such as foundations and key structures. The remaining energy is largely consumed through transportations and on-site energy use.

The McKinsey report "Growth Within", that was commissioned by the Ellen McArthur Foundation, suggests that while the imperative for innovation and the transition towards circularity in the

built environment is pressing, the Engineering & Construction sector is broadly fragmented, slow to adopt new technologies and very slow to implement innovative solutions. This is partly driven by the regulatory context the sector is operating in. This resistance to innovation is coupled with productivity stagnating in the US and German construction sectors while productivity increased in other sections of the economy.

Having said that, the sector in some regions has been collaborating to push forward the sustainability and circular economy agendas. For example, the UK construction industry has been investing in sustainability and circular economy approaches in order to bring about cost and resource efficiencies.

The UK Contractors Group Built Environment Commitment was launched in 2014. This commitment was agreed by the Contractors Group that represents 30 major construction contractors in the UK who are responsible for a third of UK construction industry output. This commitment includes a number of actions towards resource efficiency, waste reduction and the circular economy.

Additionally, the Resource Efficiency Action Plan Task Group which includes members of the Brick Development Association and Mineral Products Association are collaborating with the UK Contractors Group and the National Federation of Demolition Contractors. They are also engaging with architects and designers to address the Circular Economy throughout the building supply chain.

Circular construction strategies

The application of circular design strategies in the construction sector has the potential to increase national resource productivity alongside emissions reductions across the construction value chain. There are a number of circular construction strategies already being implemented albeit on a relatively small scale. For example, prefabrication of building components and surface-mounted cabling reduce overall construction costs while making the recycling of these materials more efficient.

The design of prefabricated or 3D printed components could also enable the reuse of components in refurbishment or new build projects.

This would require architects and engineers to consider the demolition phase during the design phase. Designing in consideration for the demolition phase could improve the recycling yields of materials such as steel while reducing processing and handling costs.

Many of the circular strategies demand supply and value chain collaborations. This means that stakeholders from designers, architects, commissioners, users, policy makers and component manufacturers may need to collaborate.

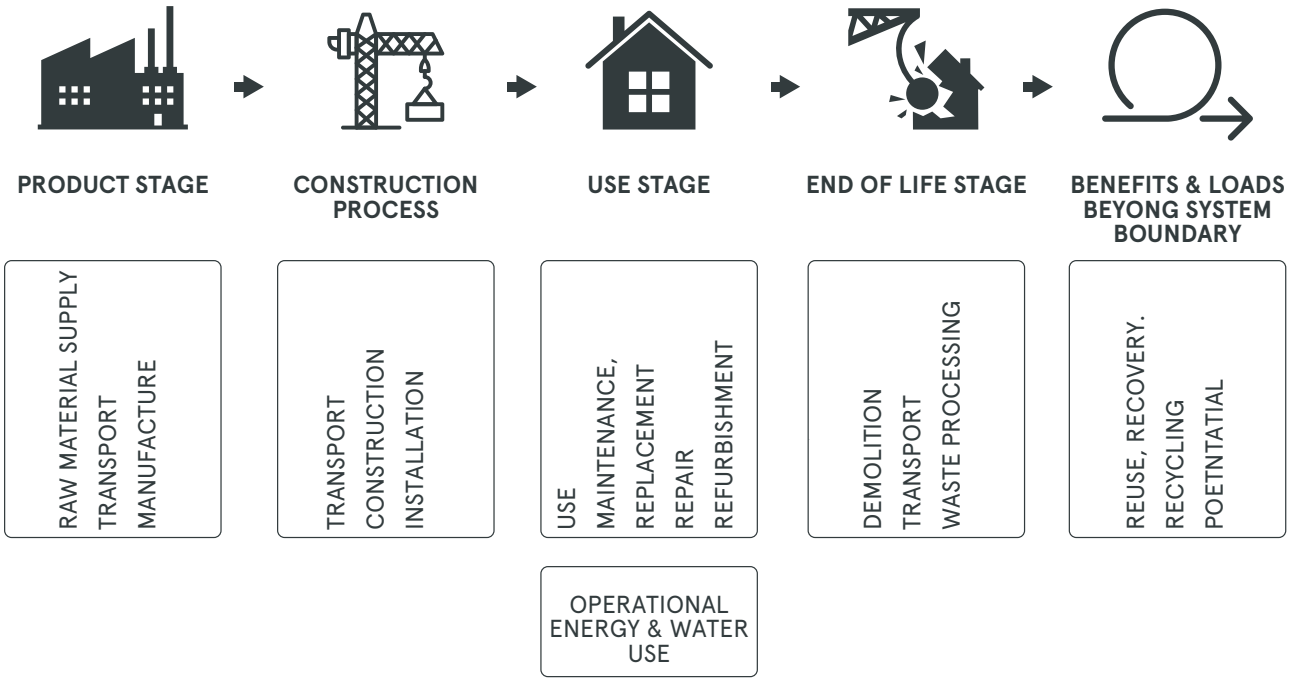
New technological developments in the construction sector will facilitate this. For example, this principle being adopted in building management through the use of building information modelling (BIM).

While it supports the effective design and construction, BIM also supports the maintenance and lifetime extension of a building. BIM also supports the decommissioning or demolition phase because the Building Information Files provide a component directory. This facilitates the recovery of valuable components and identification of hazardous wastes.

A key strategy in the context of the circular economy is tackling the underutilisation of existing buildings. Tackling the regulatory and legal blockage preventing these vacant properties from being used could help reduce the resources required for the provision on new housing.

A study by SITRA, the Finnish Innovation Fund, estimated that if regulations were to allow the conversion of office space into apartments, the

Figure 19: The Life Cycle stages of a building according to EN-15978: 2011



leasing of one third of Helsinki region's vacant office spaces could provide €255 million in annual rental income.

While the vacancy rates for offices in Dublin are low (approximately 7.8% Q4 2015), the Housing Agency estimates that there are 230,000 vacant houses across Ireland. In Dublin there are approximately 7,995 vacant houses and 16,321 vacant apartments.

Similarly, efficiency gains can be achieved through the multi-purposing of existing buildings. This could be achieved through common activities, such as schools acting as community centres in the evening, or through the retrofitting of modular interiors and building components.

Another strategy within the context of the circular economy is the substitution of high-embodied energy construction materials with low-carbon or renewable alternatives.

In order to explore these issues in the Irish context we looked at the practices of an Irish company that uses waste by-products in the manufacturing of construction materials.

Ecocem

While Ireland does not have a specific strategy for the circular economy in the construction sector, there have been some developments in recent years towards more general advancements regarding more sustainable construction practices and the use of low carbon construction materials.

Ireland has a strong tradition of manufacturing products and materials for the construction sector. In recent years a number of these companies have produced more sustainable products and materials servicing the Irish and export markets. One such company is Ecocem which was established in 2001 by entrepreneur Donal O'Riain.

Ecocem was set up as 100% Irish owned. After 6 years of successful operations they attracted investment from Saint Gobain for a 30% stake in the company.

Ecocem continues to grow and now has production plants in Ireland, the Netherlands and France with import facilities in the UK and Sweden. The company currently employs over 30 people across their operations in Ireland and the UK.

Ecocem positions itself as a producer of low carbon cement as their product has a significantly lower embodied carbon than the most commonly used cements in Ireland e.g. Portland cement.

The material produced by Ecocem is known as GGBS (Ground Granulated Blastfurnace Slag) and is a by-product of the iron industry. The production process comprises the rapid cooling of blastfurnace slag by adding water which granulates the material and then refining the granulated material in a milling plant, producing a fine cementitious powder. Ecocem's Irish milling plant is located in Poolbeg in the docklands of Dublin.

Embracing the concepts of the circular economy, Ecocem's up-cycling of materials which would otherwise go to landfill contributes to the maintenance and value of materials in the economy, reducing emissions and increasing competitiveness in Ireland and Europe.

The GGBS produced by Ecocem, and other Irish companies, has high performing technical properties compared to traditional Portland cements.

These properties include higher strength gains, increased service due to enhanced durability which leads to longer times to first repair and replacement.

In addition to the enhanced technical qualities there are benefits of higher environmental performance. GGBS is commonly specified in construction projects procured in both the private and public sectors. Ecocem GGBS is specified in a diverse range of applications such as precast products, ready-mix concrete, mining industry and soil stabilisation.

Verification and life cycle assessment

Ecocem were one of the first companies in the Irish construction sector to conduct a product life cycle assessment and establish an independently verified Environmental Product Declaration (EPD).

EPDs are the life cycle assessment methodology used in the EU to establish and communicate the environmental impacts of construction products or materials. EPDs are developed in accordance with EN15804 "Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products" and are harmonised across the EU.

There are 11 impact categories which include, Global Warming, Acidification, Eutrophication, Human Toxicity, and Ecotoxicity.

The Ecocem EPD is third party verified and covers the life cycle from the quenching process of the blastfurnace slag to the production of the final product.

This accounts for all emissions and energy consumed in each stage of extraction, production and shipping of materials from locations across Europe to Dublin, up to the point where it leaves the Dublin milling plant. This is described as a cradle-to-gate life cycle assessment in that it does not include all end use applications.

EPDs can be beneficial in terms of supporting Green Public Procurement as well as changing behaviour across sectors. EPDs aim to be a transparent communication tool that limits the potential for greenwashing. Importantly for Ecocem, EPDs also align with industry standard green building rating systems such as BREEAM and LEED.

Challenges

Clearly cement has a number of significant challenges with regards sustainability. The cement sector alone accounts for 5% - 8% of all global CO2 emissions. This surprises many as the aviation industry accounts for 2% of global emissions but maintains a higher public interest.

A small number of stages in the production of cement account for the majority of emissions. These include the use of fossil fuels to achieve temperatures of approximately 1450^{O}C in kilns and breakdown of the key constituent material, limestone.

There are technically viable interventions to reduce the impact of the sector and these can be taken with relative ease and comparatively low cost. This includes upgrading or retrofitting old kilns to improve thermal efficiencies. The Carbon Disclosure Project estimates that the retrofitting of kilns could reduce the energy demand and related emissions by two-fifths.

However, in saying this, substitute cementitious materials provide an immediate opportunity to reduce environmental impacts. An essential constituent of Portland cement is a material called 'clinker'.

This is the primary source of pollutants in the Portland cement production process. The less clinker included in the final cement mix means there is less resulting emissions.

The most common cement mix used is CEM II. This produces approximately 750 Kg of carbon for every tonne produced.

GGBS on the other hand produces 42 Kg of carbon for every tonne produced. GGBS is not typically used as a standalone material but is blended or mixed with Portland cement to achieve a final concrete mix. Under the concrete specifications in Ireland (I.S EN 206-1), up to 70% of GGBS can be blended with Portland cement. GGBS reduces significantly the amount of clinker required in the mix.

A blend of 50% GGBS and 50% Portland cement is common. Ecocem's strategy has been to provide GGBS to the concrete producers, who in turn use this cementitious material to reduce the amount of Portland cement (clinker) in the final concrete mix, which in turn significantly reduces the environmental impacts of the concrete mix.

A common question regarding GGBS is in relation to supply risks. To date there have been no supply issues for Ireland. Ecocem, for example, have long term supply contracts agreed with the primary steel producers in Europe.

The production of steel tends to rise and fall in a similar manner as the construction sector, both of which are strongly connected with economic activity. For example, in 2012, 23 million tonnes of slag was produced in Europe and only 60% used. At the height of the 'Celtic Tiger' construction era, Ireland used approximately 7 million tonnes of cement per annum. As such, Ecocem is well placed to continue growing its supply into Ireland.


INDORAMA
WELLMAN INTERNATIONAL LTD.

CASE 5: "PLASTICS & CLOSED LOOP RECYCLING" WELLMAN INTERNATIONAL

A foundational principle of the circular economy is recycling of materials into new, ideally equal or higher value products. Unlike other recycling processes that downcycle the quality and value of materials, closed loop recycling aims to increase the value of recycled materials through a seamless and continuous process.

Plastics are one of the materials that have received intense focus in recent decades with regards to closed loop recycling. There are a number of reasons for this not least the ubiquity of the material and its essential role across many critical applications. The critical applications of plastics include medical devices, renewable technologies, transportation as well as keeping food safe for consumption and reducing waste.

Approximately 90% of the feedstock for the plastics industry is fossil based, mainly oil and gas. For certain applications this number will be higher as recycling rates will vary between applications. According to the Ellen McArthur Foundation, estimates vary between 4 and 8% of the global oil consumption being directed towards plastics. Roughly 50% of this is used as feedstock and 50% is used as an energy input into the production processes.

Estimates suggest that the production of various plastics have been increasing approximately 8.7% year on year and in 2012 global production was approximately 288 million tonnes (UNEP, 2014). This growth in production is likely to increase in particular in emerging markets. Therefore if there is not an increase in the circularity of the plastics sector the demand for oil and gas feedstock will increase and this will compete with other end use applications such as transport and other energy.

While plastics bring many benefits there are also a number of challenges within the context of the circular economy. For example, The United Nations Environment Programme estimates that the total "natural capital cost" of consumer plastics is approximately US $75 billion per year (UNEP, 2014).

They estimate that these negative externalities relate to issues such as ocean plastic waste, the loss of value through landfilling, poorly controlled incineration in developing economies and various greenhouse gas emissions.

Many plastics are also composed of a base polymer combined with various additives that help to improve performance, durability or allows for different applications.

These additives can include pigments, flame retardants and plasticisers. Some substances such as Bisphenol A (BPA) have been identified as "substances of Very High Concern" due to potential adverse effects on human health.

Circular Economy Plastics Strategy

The Commission's Circular Economy Package identified plastics as a priority material and will develop a specific strategy for plastics and the plastics sector.

This will include:

- limitations on landfilling of plastics contained in municipal waste
- increasing recyclability and bio-degradability
- addressing plastic Marine Waste
- setting a target of 55% for recycling and preparation for re-use of packaging waste

This target is seen by the Commission and plastics industry as ambitious given that the rate of recycling for plastics packaging in Europe was less than 40% in 2014.

What the Circular Economy Package suggests is that funding through Horizon 2020 and related funding mechanisms will be provided to the plastics using sectors to improve the design of products in order to increase recovery and recycling rates.

Plastics sector in Ireland

According to Plastics Europe, the European plastic industry employs more than 1.4m people and generates revenues of €300 billion. According to Plastics Ireland, the sector employs 6,500 people and accounts for €1.25 billion of annual exports. The plastics sector in Ireland is composed of approximately 231 companies across a range of different applications and services.

The vast majority of companies (n=207) are involved in polymer processing such as moulding (e.g. injection, rotational, extrusion) and thermoforming. A number of companies are involved in a combination of processing, supply (equipment and raw materials) and services. There are 17 companies involved in the supply of raw materials supply and 7 involved in compounds and pigments.

While there is potential to expand the production of recycled plastics in Ireland there are still a number of structural barriers. There are still comparatively high levels of contamination of post-consumer plastics in Ireland so the waste industry finds it more cost effective to export the waste for processing overseas.

This is exacerbated by issues such as a high global demand for plastics with strong prices and the design of products consumed in Ireland not making recycling viable due to high employment costs. The transition from a reliance on commodity exports and the development of circular economy for plastics based on indigenous plastics recycling would be improved through enhanced segregation of waste. This would allow Irish companies to capture the value in materials that are currently exported and this would provide opportunities for employment and economic growth.

Wellman International

Wellman International, located in Mullagh, Co. Cavan, is a leading manufacturer of polyester staple fibre made from post-consumer and post-industrial recycled Polyethylene Terephthalate (PET). The company was founded in Ireland in 1973 and currently employs approximately 270 people. In 2014 the company had a turnover of approximately €135 million.

Wellman International is Europe's largest recycler of post-consumer PET bottles and they process over 2.6 billion plastic bottles annually. The company estimates this to equate to an annual saving of 892, 967 barrels of oil compared to the production of virgin PET.

The ranges of fibres produced by Wellman are applied in a wide variety of products and high performance sectors. This includes hygiene, home furnishings (pillows, duvets, mattresses), automotive components, clothing (e.g. fleece jackets) as well as medical applications.

The company brings four decades of experience in producing polyester fibres and are well positioned to meet the quality and performance requirements of growth markets such as hygiene. In addition to the plant in Ireland, the company operates two recycling plants in Europe.

The plants in The Netherlands and France process post-consumer PET drinks bottles and between them produce approximately 70,000 tonnes of recycled PET fibre. At these sites the PET bottles are sorted to specification, washed and

then granulated and transported to Ireland for processing. The company also relies on almost 100 other raw material suppliers that provide a range of "waste" PET for recycling. This includes out-of specification polymer granules from polymer manufacturers, by-product PET film and packaging manufacturers, PET from other polyester fibre production plants as well as virgin PET granules. Almost 80% of the raw material mix is from post-consumer waste.

One of the issues cited by the company was a desire to increase the sourcing of PET from Ireland as the majority of the raw material is imported. The company faces a similar challenge to other closed loop recycling companies in Ireland in that the Irish market is small and this limits the supply of raw materials. Additionally, the collection infrastructure in Ireland limits the supply of high quality uncontaminated PET.

Having said that, the company has partnered with Shabra Recycling in order to access PET from Ireland. Shabra are a reprocessing and manufacturing company based in County Monaghan. Shabra undertake a similar process to the two recycling plants owned by Wellman International in that they collect plastic bottles from waste collectors and waste management companies in Ireland. They then sort, clean and flake these bottles at their facility. The PET flakes are then sold to Wellman so they can be used to manufacture fibres.

Both Wellman International and Shabra Recycling have engaged in EPA funded research programmes that sought to develop strategies and potential actions to improve the plastics recycling value chain in Ireland. One of the outputs of the Rx3 research programme was a practice guide for Waste Plastic Management in Ireland. This guide set out measures to improve the quality of collection systems and higher quality recyclate across the supply chain.

One dilemma with regards the circular economy is that Shabra has capacity to accept more PET bottles and Wellman International have a desire to purchase more flakes but the quality from waste collectors and materials recovery facility operators needs to improve. In addition to this, the waste collectors and MRF operators need households and businesses to limit the contamination of plastics they send for recycling.

The opportunity to improve the quality and quantity of plastics recycling demand a combination of quality standards, improved collection infrastructure and communication campaigns.

Wellman production process

The process of making staple fibre can be summarised as follows:

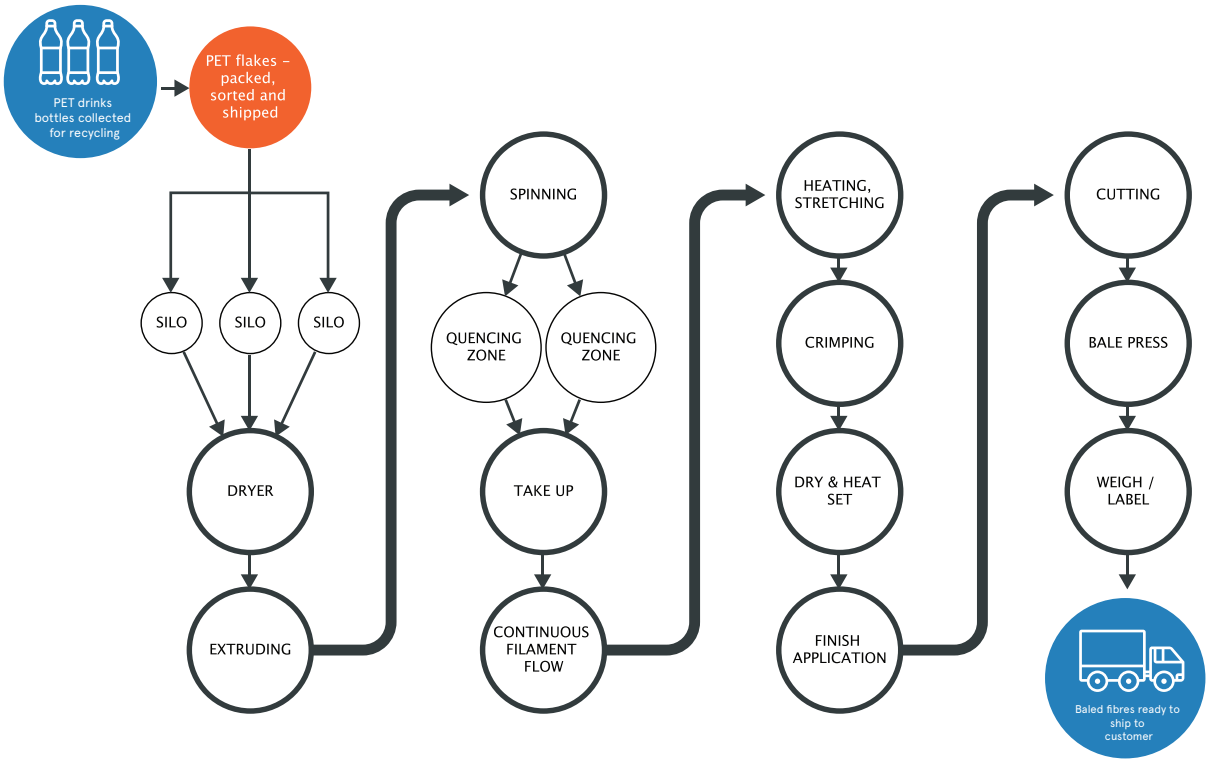
- Raw material is tested, sorted, prepared and dried for delivery to the extruder.
- The clean, dried raw material is melted and filtered in the extruder and molten polymer is delivered at pressure to spin packs.
- The spin pack creates thousands of individual strands of polymer fibre that are air-cooled
- The material is collected in cans as tow band
- The tow bands are heated and stretched
- The strands are crimped to give bulk and set to maintain the crimp.
- They are then coated with a lubricant to enable further processing by the customers.
- Finally the strands are cut to the required length, baled and wrapped for delivery to the customer

Life Cycle Assessment

The Wellman International production process was subject to an independent third party Life Cycle Assessment (LCA). This study was conducted by Li Shen, Ernst Worrell and Martin K. Patel from the Science, Technology and Society Group, Copernicus Institute, Utrecht University.

The primary purpose of the LCA was to compare the environmental impacts of bottle-to-fibre PET and virgin PET. The rationale for the focus on fibre production is that there are existing LCA studies comparing different post consumer recycling options for PET. The study investigated four recycling technologies; mechanical recycling, semi-mechanical recycling, back-to-oligomer recycling and back-to-monomer recycling.

Figure 20: Wellman International rPET production process



The results of the study showed that recycled PET fibre offers 40–85% non-renewable energy savings and 25–75% global warming potential savings compared to virgin PET. The study also showed that bottle-to-fibre recycling reduces impacts across many of the environmental categories studied.

With regards to non-renewable energy savings and global warming potential recycled PET fibres are comparable to cotton, modern viscose (i.e. Lenzing Viscose Austria), Tencel and Poly Lactic Acid (bio-polymer) but better than PolyPropelene and virgin PET.

Indorama

In 2011, Wellman was acquired by Indorama Ventures PLC that is one of the world's leading vertically integrated Polyester Value Chain producer. Indorama Ventures is based in Thailand but has a global manufacturing and distribution network across Asia, Europe and North America. A rationale for the purchase was that Indorama could help meet customers' sustainability requirements and the general demands for products made of post consumer recycled materials.

Indorama Ventures services diverse end use markets such as personal and home care, health care, beverages, textile and automotive. The company had a turnover of US$ 6.8 billion in 2012. Alongside investments in High Value Added products the company is also investing in recycling and the circular economy.

Indorama Ventures have a broad ambition to be a 'zero waste' company within the beverage and fibre segments of their business.

The company is actively involved in developing strategies for the circular economy through the Ellen McArthur Foundation. Indorama Ventures are a lead partner in "Project Mainstream" alongside companies such as Royal DSM, Ecolab, Philips, SUEZ and Veolia. This project aims to address some of the more complex structural barriers to the circular economy.

Challenges

One of the key challenges with regards plastic in the circular economy is the highly fragmented nature of the sector and the diverse applications of the materials. From an international perspective there is a lack of structured co-ordination of standards.

This has given rise to a complex array of material combinations (e.g. co-moulding), national and regional collection schemes and well as different quality sorting and reprocessing systems. There still remains some confusion at the consumer end due to various national and private sector labelling schemes, for example on packaging.

Improve segregation, collection and secondary markets for recycled materials

This is an issue that has been addressed repeatedly for many decades but it warrants repeating. If more value is to be captured from plastics that would otherwise be waste, it is essential the entire system of collection, recovery, reprocessing and recycling is improved. The exporting of waste creates a disincentive to develop indigenous secondary markets for recycled materials.

Driving up the quality of recyclate will make reprocessing and closed loop recycling commercially viable. Creating a viable market for reprocessing post-consumer waste as a feedstock would also drive innovation in the collection systems that ensure that waste is not leaking from the system e.g. marine litter.

Clearly this demands cross-sectoral and multi-level collaboration. DCCAE are examining this issue through the "Exporting a Resource Opportunity? Measures to Maximize Resource Efficiency and Jobs in Ireland" but lessons can be drawn from global initiatives such as the OECD responsible supply chain partnership, value chain interventions in the Netherlands and insights from the Rx3 project and National Industrial Symbiosis group.

Clearly advances have been made towards industry commitments and enhancing existing policy interventions and these will be advanced through the Circular Economy Package. There is scope to allocate research investment in developing improved materials and reprocessing technologies.

Incentivising better design

Wellman International highlighted that there is the technical capacity for closed loop recycling of the products produced by their customers but a common barrier to this, in combination to collection systems, is the design of products. Typically the design of products will make disassembly and recycling challenging and cost ineffective.

This can be through relatively simple design decisions such as the combination of incompatible materials. The Circular Economy Package acknowledges this challenge with design and contains measures that may help incentivise better design. The Package also targets labelling and environmental information so that collection systems can be improved.

Reducing virgin feedstocks

One global challenge is the decoupling of plastic and polymer manufacturing from virgin fossil feedstocks. While there are ongoing and commercial scale developments in bio-based feedstocks, bio-plastics, or the use of sequestered greenhouse gases (e.g. carbon dioxide and methane) the development of secondary markets for waste is still a key aspect of the circular economy. The Wellman case study presented above highlights how this is possible but significant development is required to scale this across to other plastics.

Reducing "leakage"

A common feature of the linear economy is leakage of materials. This describes the loss of materials from the waste and production system, for example through improper disposal.

If the Circular Economy Package can facilitate an improved after-use economy of plastics alongside other measures, such as dematerialisation, this could better incentivise the development of more effective collection systems.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Use by the Hour
Free City Parking
drive different


Sharing
Economy
Ireland


Weetabix
Cloud

CASE 6: "COLLABORATIVE CONSUMPTION & SHARING ECONOMY" GOCAR, FOODCLOUD

One of the overarching principles of the circular economy is that the existing value in materials and products should be kept in circulation or use for as long as possible. The rationale is that this facilitates resource efficiency by minimising the needs for new resource extraction, production or distribution.

This principle has led to the emergence of business models and design strategies around product durability or extending the life of products through remanufacturing or service models. Another approach that has grown increasingly popular in the last decade is the notion of the sharing economy.

The basic rationale of the sharing economy is that in many developed economies there is an excess of products and other goods and this has led to a under-utilisation of capacity.

The sharing economy encompasses a broad range of strategies for providing access to this under-utilised capacity. These strategies typically include renting, lending, swapping, bartering and gifting (giving for free).

There is an evidence base on the under utilisation of goods with many popular examples such as the average car is parked more than 90% of the time, the average power drill is only used 12 minutes over its lifetime, office spaces are unoccupied 30-50% of the time during working hours and one third of all food is wasted across the value chain (McKinsey, 2015).

Because the sharing economy has emerged rapidly in recent years it has evaded strict definition. While the term "sharing economy" is now pervasive it is often used to describe different interrelated models such as the peer-to-peer economy, collaborative economy, on-demand economy, gig economy, solidarity economy and collaborative consumption.

Some of the key definitions include:

Collaborative consumption:

This is an advancement on existing models of consumption and it includes practices such as renting, leasing, lending and swapping.

These practices are now supported by digital technology and social media. Examples include FLOOW2, Airbnb.

Sharing economy

This is more generally sharing of the use of assets that have under-utilised capacity. Examples include GoCar, Dublin Bikes

Peer to Peer

This is similar to collaborative consumption but instead of renting, leasing, lending and swapping from a company or the public sector the user is connected with another person.

Examples include Tool Libraries, Trylio, Landshare, Peerby, BlaBlaCar.

Solidarity economy

This describes more socially oriented networks that exchange goods and services, typically without money but using time-sharing, bartering and the gift economy. Examples include Trade School, Open Source, Local Exchange Trading Systems

Collaborative economy

This describes decentralised networks and marketplaces that unlock the value like Etsy or eBay.

On-demand economy

This describes an economic activity enabled by digital marketplaces that meet consumer demand via immediate access to and convenient provisioning of goods and services. Common examples in Ireland would include Hailo, Hassle, Deliveroo

Proponents of the sharing economy suggest that it is driven by three key impacts and benefits. These include:

- Economic: resource efficiency, higher asset productivity more efficient use of financial resources
- Environmental: more efficient and sustainable use of resources;
- Social: increased social capital and new social relations between people via peer to peer exchange

It is reasonable to suggest that the sharing economy is dependant on a number of socio-technical innovations and transitions. For example, one shift that has occurred in the social context has been a shift from institutional and organisational trust towards peer trust and this has facilitated the development of collaborative ecosystems.

There are many examples of this across different domains. For example, there are emerging platforms for peer-to-peer lending wherein "the middleman" is removed and individual investors can lend directly to a borrower without the need for complex institutions. There are global examples such as Kiva but also examples in Ireland such as Grid Finance. There are similar practices in areas such as education where platforms such as Trade School and Skillshare facilitate the exchange of knowledge outside the context of academic institutions.

As mentioned, technology is facilitating the growth of the sharing economy and collaborative consumption. In addition to the common digital technologies such as mobile and more widely accessible internet other technologies such as sensors and the internet of things open up potential for creating real-time data that facilitates new service and collaborative consumption practices.

Origins of the sharing economy

Many of the early stage examples of the sharing economy developed through a global network of grassroots initiatives there are a number of large scale commercial enterprises that are utilising aspects of the sharing economy models. This has resulted in, broadly speaking, two narratives on what the purpose and scope of the sharing economy should be. These narratives differ between policy-makers, entrepreneurs and activists. On the one hand there is a narrative that the sharing economy represents an approach to digitally enabled innovation that can disrupt incumbent business models while generating new forms of economic activity.

On the other hand there is a dominant narrative that suggests the sharing economy facilitates and is facilitated by socio-technical innovations that can address a multitude of issues such as unsustainability and inherent inequalities of market economies.

Those advocating this narrative suggest that the sharing economy can break the cycles of hyper consumption while creating opportunities for more efficient utilisation of resources and reduced environmental impacts. Some advocates of this narrative also suggest that the sharing economy can bring about a more equitable distribution of goods and service while increasing social capital among participants.

Regardless of these broad narratives, it is worth noting that while the notion of sharing, bartering and gifting have existed as fundamental forms of human exchange, the advancement of online communities, social media platforms and mobile technologies have facilitated the sharing among people within a wider community and across countries.

There is now a diverse range of sharing platforms dealing with an equally diverse range of products. This includes:

- Food (e.g. Casserole Club)
- Tools (e.g. Community tools libraries)
- Bicycles (e.g. Dublin Bikes, VeloGo, Spinlister)
- Cars (e.g. GoCar, ZipCar, RelayRides)
- Working or parking spaces (e.g. Citizen Space, JustPark)
- Car rides (e.g. e.g. Lyft, Uber)
- Short-term rental (e.g. AirBnB, Roomorama)
- Gardens (e.g. Shared Earth, Landshare)
- Boats(e.g. Boatbound, GetMyBoat)
- Clothing, portable appliances, electronics, and household items (e.g. Peerby, Trylio, Rent My Dress, Neighborgoods)

According to PwC, this global sharing economy is worth US $15 billion per year and they project to grow to US $335 billion in 10 years. In the UK the sector is projected to grow to £9 billion over the next decade as it is worth £500m currently.

It is also worth noting that a 2014 survey by the European Commission suggested that 96% of European Citizens consider resource efficiency to be important but only 21% have leased or rented a product instead of purchasing a new product and only 27% are users of sharing services. It must be noted that these are not strict definition in that many of the commercial examples are interrelated and share aspects across the different models.

Links with the circular economy

While there is still no common definition of the sharing economy, there are many potential links between the sharing and circular economy. There is potential for sharing and collaborative models of consumption and production to play a role in extending the life of a product or maximising utilisation. Digitally-enabled sharing solutions also increase the utilisation of existing products, rather than the production of new products.

The Circular Economy Package makes reference to the role the sharing economy can play in developing new models of consumption. It recognises that technologies and platforms for the sharing economy are developed at the national, regional and local level and the development of these can be supported through Horizon 2020 and Cohesion Policy funding. While the package does not outline specific actions on the sharing economy it notes that the Single Market Strategy is forming a European agenda for the collaborative economy.

In terms of the circular economy, many of the existing sharing economy models also exploit higher value opportunities than with say recycling. For example, there is minimal financial input on behalf of the individual exchanging or sharing a product but the integrity, embedded energy and labour costs within the product is maintained.

This evolution has taken place in a context of fast-developing mobile technology and a growing acceptance of access to rather than owning products. The issue of access over ownership is only viable when the overall convenience and benefits to the customer are greater.

Some commentators suggest that the overarching socio-technical transition with regards demands for changing relationship between businesses and customers, the increased desire for access over ownership alongside the proliferation of mobile technologies makes sharing and collaborative consumption a "low-hanging fruit" option within the circular economy.

On the other hand, while the circular economy can take advantage of digital technologies to maximise use of and optimise resources and material flows there is less evidence on the social values emerging within these systems of collaborative consumption or the obvious tensions between the two narratives mentioned above.

Challenges

A question that is sometimes overlooked in the discussion on the sharing economy is how the manufacturers of products that people are sharing are impacted by the practice. For example, at what point does sharing make the production of the goods being shared commercially unviable.

For example, there is some research which suggests that used goods exchanged in secondary markets can directly compete with new products and that the demand for new products can be cannibalised by used goods (Chen et al., 2013; Coase, 1972; Fudenberg and Tirole, 1998; Waldman, 1997).

Conversely, there is also some evidence to suggest that if a company designs a product that is sufficiently durable to facilitate sharing or resale in secondary markets they can typically demand high prices for the original products sold. It is important to note that there are conceptual differences between sharing economy and secondary use markets in that sharing typically, but not always, denotes a temporary transfer of ownership.

The rapid emergence of the circular economy has also brought with it a number of critical discussions. For example, debates have emerged with regards the role of employment rights within the "gig economy" which is a subset of the sharing economy or the effect of services such as AirBnB on local property prices and possible contraventions of local planning laws. One of the challenges is that the sharing economy is emerging rapidly and regulation has been slow to adapt.

While there are perceptions with regards commercial threat to existing businesses, there is evidence that the emergence of the sharing economy has shifted practices in many established sectors. This includes businesses and manufacturers changing business models so they can offer aspects of what customers demand from the sharing economy e.g. Access to on-demand services, consistent and converged retail experiences, rental rather than ownership, ability share own goods.

For example, AccorHotels, a leading French hotel chain, has changed its selling model to offer rooms at other hotel on its website, German car manufacturers such as Opel, Daimler AG and BMW are assisting their customers to rent out vehicles through various mechanisms such as apps and approximately 40% of Amazon's turnover is through providing access through its "marketplace" to third party products.

Also, General Motors collaborate with RelayRides to allow owners to rent out their vehicles by introducing features such as remote unlocking of doors by authorised renters using their smartphones. The rationale behind this is that the offering will allow customer offset the cost of ownership.

Irish context

Even with the economic growth potential, contribution to the circular economy and regulatory risks there is no existing policy framework on the sharing economy in Ireland and there is no visible

leadership at a policy level. Key documents such as the 2015-2017 Strategy of the Department of Jobs, Enterprise & Innovation, Action Plan for Jobs, and Dublin Action Plan for Jobs make little or no reference to the sharing economy. It could also be argued that Ireland has a strong innovation support eco-system and technology sectors that could benefit from the transformative potential of the sharing economy.

There is some tacit acceptance that the sharing economy is potentially beneficial but this discussion is tied in closely to the general optimism about the growth of the tech sector in Ireland. There is a risk that in the absence of leadership a few negative examples could impact on the longer term system conditions that enable the growth of the sharing economy. This means that the positive potential with regards reducing resource use, fostering entrepreneurship and innovation, community benefit and increasing social capital may be diminished.

While there is little top down leadership or advocacy for the sharing economy, an organisation called Sharing Economy Ireland has emerged in the last two years. Sharing Economy Ireland, founded and lead by Elizabeth Douet, is the only advocacy group for the sharing economy in Ireland. It is a membership organisation made up of Irish based companies operating within the sharing economy. Sharing Economy Ireland also works in collaboration with Rachel Botsman's network on collaborative consumption.

Elizabeth describes the challenges around growing the circular economy in Ireland as being centred on traditional economic interventions to support innovation not being prepared for newly emerging economic models. Having said that, Elizabeth is clear that Ireland potentially has the right ingredients of a supportive eco-system.

She also highlighted how Ireland is often a successful early adopter of models of the sharing economy and has managed to implement these very successfully. For example, the Dublin bike sharing scheme has achieved a scale and market penetration that other regions have been unable to achieve.

Case Studies

In order to explore some of these issues we developed case studies on examples of the sharing economy in Ireland.

Go Car

Go Car is Ireland's only car sharing service. Although potentially more accurately described as an "on demand" service, GoCar operates in Dublin and Cork and works on a pay-per-trip basis within a membership scheme.

GoCar has seen steady growth in recent years and has 5000 members and has facilitated 20,000 trips. Based on a survey conducted in 2011, the key motivations for users to join the service include saving money, minimising hassle related to car ownership, only occasional use of a car required and environmental considerations.

The basic business model is that GoCar charges customers by the hour and kilometer. There is a one-off fee for joining and GoCar cover all costs such as road tax, insurance and all fuel. GoCar customers can also avail of free parking at any pay-and-display parking space in Dublin.

Most of the 160 vehicles on offer through the service are low emission but in October 2016 GoCar launched a GoElectric range in partnership with BMW.

Many cities have seen the development of car sharing schemes with the key rationale being the maximisation of utility among vehicles in the city or town by sharing across multiple users.

GoCar Background

GoCar initially launched in 2008 as a pilot in Cork city. This pilot was delivered in partnership with one of the world's largest car sharing platforms, Cambio. Following this pilot, GoCar expanded its service into Dublin in 2010.

Even though the company had been operating on a pilot scale, 2013 was the first time the company received a formal licence to operate in the city. This licence was supported by a newly drafted package of city bylaws.

This licence granted by Dublin City Council to GoCar allows customers to avail of the 30,000 pay-and-display parking spaces in the city free of charge. The costs for parking are covered by the permit fee the company pays to the Local Authority.

This license initially allowed the company to leave 50 vehicles in approximately 30 different locations across the city. These locations were highly visible and convenient locations for the target demographic of the company.

This support from Local Authorities in Dublin and Cork helped to develop the market for GoCar as the convenient location and ease of parking is a key factor in the attractiveness of car sharing shames.

From the Local Authority perspective, car sharing schemes could play a role in future traffic management plans for the city. The key assumption was that it would reduce traffic.

Additionally, evidence from other cities showed that once car sharing schemes were properly incentivised a small proportion of users would either sell their cars or not purchase in the first instance.

This would increase the use across other forms of public transport and cycling. While there is still no overarching policy or framework, these actions by the Local Authority have assisted in promoting a sharing economy in Ireland.

One of the characteristics of the growth of GoCar in Ireland is that it depended on partnership with Local Authorities (Dublin City Council, Fingal and Dún Laoghaire-Rathdown County Councils and Cork City Council) and Central Government. This support included creating the conditions that allow the company to develop a market.

This level of interaction was evident in the early pilot stages. For example, the initial 6 month action plan that led to the launch of the pilot scheme in Cork was presented to a Reference Group that consisted of staff from the following:

- City Council Traffic and Planning Departments,
- County Council Planning Department
- Commuter Plan Manager from the University
- Regional manager of local public bus company
- Manager of the city marketing partnership
- Senior executive and local developer,
- Traffic superintendent from the Gardai
- Managing director of an international ICT company

In addition to facilitating the development of GoCar through the issuing of licences for access to parking spaces, the Local Authority has developed an electric car charging infrastructure that supports the expansion of the service into electric vehicles.

Some of the key barriers to developing the service included:

- New concept to the market
- Increasing levels of car ownership
- Lack of legislative definition of Car-Sharing
- Securing appropriate insurance
- Lack of existing systems (service and software) already in place in Ireland
- Limited access to start-up finance and the financial crisis

Food Cloud

The challenges around food waste are complex and require multilevel interventions. It is estimated that globally four billion metric tonnes of food are produced annually yet due to a number of factors 30–50% (or 1.2–2 billion tonnes) of all food is wasted and never reaches human consumption.

According to the European Parliament, households produce the greatest proportion of EU food waste (42%), followed by agriculture and food processing (39%), food service/catering (14%), and retail and accounts for approximately 5% of food waste (Katsarova, 2014).

The reasons for this waste are diverse and span the full food value chain. For example, in the UK one estimate suggests that 30% of vegetables harvested are rejected before reaching retailers.

The figure is higher for some products. For example, 46% of potatoes grown are not even delivered to retailers. This can be due to factors such as 6% being lost in the field during harvest and 40% being discarded due to specifications by retailers.

FoodCloud is a social enterprise based in Ireland that aims to address the challenge of food waste by matching food retailers and other food businesses with surplus food with charities that can use food.

FoodCloud differentiates itself from other food sharing and redistribution schemes (e.g. Fareshare, FoodCycle, Company Shop, The Real Junk Food Project, Olio) by providing a digital platform that streams the matching process between surplus food supply and demand.

The smartphone app they developed allows businesses with surplus food to notify charities of the excess food available, charities can then accept and collect what they need depending on requirements.

FoodCloud touches on aspects of collaborative consumption and the sharing economy in that it creates value from surplus goods and touches on aspects of the circular economy in that it prevents food waste.

FoodCloud received initial support from TCD Enactus, NDRC's Launchpad and won the Arthur Guinness Projects in 2013. Foodcloud developed a strong relationship with Tesco who started using the app towards the end of 2013. Following this, FoodCloud received funding from the EPA and they were also selected as a Social Entrepreneurs Ireland Impact Award.

FoodCloud currently have 13 staff, 200 member charities and 90 participating food businesses. Since launching, FoodCloud have diverted 2,321 tonnes of food.

One of the key barriers to food redistribution is concern with regards food safety. The Circular Economy Package includes an action on clarifying relevant EU legislation related to food waste in order to facilitate food donation. FoodCloud have been working the Food Safety Authority to help businesses overcome this barrier in the Irish context.

CASE 7: "DESIGN FOR THE CIRCULAR ECONOMY" PERCH AND ORANGEBOX

Design plays a key role within the circular economy. The European Commission suggests that 80% of the environmental costs of a product are determined at the design stage. While this figure is contested and will vary between product categories the broad principle is that unless "circularity" is considered strategically at the design stage the harder it is to implement once a product is manufactured and on the market.

Once a product is on the market commitments are made to the use of particular combinations of materials, business models, infrastructures and consumer behaviours.

At the most basic level, product design has a key role in ensuring that products are designed for repair, durability and disassembly and maximise recovery of materials at the end of the product's life. A consistent challenge for the recycling sector is maximising the yields from products particularly if they have not been designed with recycling in mind.

Service design has a key role in designing usable services that support the circular economy such as sharing services, repair services and more widely collection and recycling services.

Communication design also has a role to play in terms of developing effective communication and branding strategies that inform and excite people about their role within the circular economy.

For example, designers can develop more effective products and service offerings that incorporate behavioural insights so that the relevant circular economy strategy, such as repair, is both meaningful, easy to do and desirable.

Within the Circular Economy Package the European Commission suggests that it will undertake a number of measures towards influencing product design. For example it will look to enhance existing policies with regards design such as the Ecodesign Directive to incorporate "circular" design strategies. Importantly it suggests that efforts will be taken toward improving coherence between the Circular Economy Package and other EU product related policies.

This issue of linking the circular economy with other design related policies would be an interesting challenge for Ireland considering the development of an Irish national design policy is only at the nascent stage. In order to explore this further this case study looks at the role of design in Ireland and the potential for building capacity around design for the circular economy.

Irish Context Design Policy

The design sector is a heterogeneous sector made up of a number of different design disciplines such as product design, architecture, graphic design, fashion, service design, digital and interaction design, advertising among others. Typically the practitioners of design are based in-house within design using companies or as external design businesses.

A recent study by the Department of Jobs, Enterprise and Innovation estimated that between 45,000 and 48,000 people are employed across the various design occupations in Ireland (2.48% of total employment). Approximately 48% of the design sector in Ireland would be classified as digital design and this would include practices such as software design, computer game design and web development.

While there is a support infrastructure for the design sector in Ireland there is as of yet no standalone design policy. There are some support agencies and networks such as the Institute of Designers in Ireland, Design and Crafts Council as well as a growing number of regional design hubs such as Pivot Dublin.

In 2015 the Irish Government invested in the Year of Irish Design 2015. This was a programme exploring, promoting and celebrating design in Ireland. Thorough this year, 180 local projects and events were funded across Ireland, some of which dealt with issues such as sustainability and social design.

Some of the outputs of this year included design policy position papers such as the "Policy Framework for Design in Enterprise in Ireland". This document provides a foundation through which deeper analysis of possible design policy in Ireland could be explored.

The documents address issues of sustainability in very broad terms and do not yet make specific reference to emerging opportunities through the circular economy.

Perch Design

Perch are a Dublin based product design company. They specialise in furniture design with particular strengths in research-led and "Applied Human Movement". Simon Dennehy, currently the company CEO, founded Perch in 2008.

The company now employs five designers as part of nd interdisciplinary team with skills and experience in product design, project management, research & development, graphic design branding & design of spaces.

Perch have launched a number of furniture products with a particular emphasis on producing chairs for schools and other education providers. This heritage is partly born out of the fact that in 2009, Perch were part of a consortium delivering an FP7 research programme related to Task Furniture in Education.

One of the key products that Perch have launched is the Ray Chair. This chair produced in collaboration with the Danish furniture company Labofa, provides an ergonomic seat for primary schools that facilitates active learning.

The design of the seat allows for more dynamic movement and reduces the period of static sitting. The chair also addresses problems such as poor back alignment by allowing the pelvis to rotate until the spine is neutrally balanced.

Perch suggested that while the chair was not designed with the circular economy in mind the design and construction could lend itself to efficient assembly and disassembly for future recycling. This includes the use of minimal materials and small number of fixings.

The chair provides a good insight into the common challenges for designers in the context of the circular economy. For example, the back rest of the chair is manufactured using glass reinforced nylon. This allows for the production of a lightweight chair with minimal components that is more durable than other school chairs but, while now technically recyclable, it is not commonly recycled by many recycling companies.

Often glass reinforced plastics end up in either landfill or energy recovery. The energy recovery of glass reinforced plastics is typically sub-optimal because the calorific or energy content is low but

the ash output is high. What this underlines is that even when designers design products from a circular economy perspective and make the best possible design decisions they can be constrained by a number of systemic factors they have little control over. In this case, there is a lack of viable materials for specification and the recycling infrastructure is fragmented.

Emerging circular design practice

Perch set themselves apart from other product design companies of a similar size in that instead of focussing on offering contracted design services, Perch seek to develop longer term relationships with client companies. In this way Perch can build strong relationships with clients and work through the early stages of research and discovery, through to product trials and international commercialisation.

This business model is not unique in the design sector but it is not common as it demands a strategic approach to managing client relationships. These relationships allow Perch to be involved in post-commercialisation phases, which increases their depth of knowledge about the sectors they are designing for.

This is partly driven by the motivations and skills of the Perch management team but it is also commercially sound. It has been very difficult to run a product design agency in Ireland due to a number of factors such as Ireland having a small and not particularly design intensive manufacturing sector. Also, Ireland has had a fragmented business support infrastructure for design, and product design in particular.

An interesting aspect of this business model and symbiotic relationships Perch develop with clients is that they happen to be working with larger manufacturing companies in Ireland that are among the leaders in design for the circular economy. This is influencing the perspective of the Perch design team. Simon Dennehy says the company recognises the emergence of the circular economy agenda in business and it is gradually becoming of part of the front end design process.

To illustrate this it will be worth exploring the design practices and business models of two of Perch's key clients.

Orangebox

Orangebox design and manufacture office furniture. This includes hard and soft furnishings such as chairs, desks, screen systems as well as entire work spaces. The company was founded in 1998 and emerged from management buy-out of another furniture manufacturer. The company has a long tradition and commitment to sustainable business and have been embedding circular economy principles throughout its business.

In the last three years the company has doubled their turnover to £41 million, increased staff numbers and now employ over 300 people at its manufacturing and design facility in South Wales. While the company designs and manufacturers in the UK they sell products in Europe, North America, Africa and the Far East.

Like many manufacturing companies, Orangebox initially invested in environmental management and developed industry standard approaches to waste and energy management. These practices were focussed on having efficient facilities and identifying costs savings through resource efficiency where possible.

In the last eight years the company has sought to increase their environmental performance by embedding sustainability and circular economy thinking into their front-end design process and embodying this in the products they sell.

This process of embedding sustainability and circular economy into the design process and wider business model is a significant challenge as it requires investment, upskilling of staff,

trialling and piloting of new methods, building new partnerships across value chains, undertaking research as well as organisational culture change.

The company is now at a stage where their design ethos is that products are designed with material sustainability and longevity in mind. They seek to eliminate any toxic materials, recycled materials are used wherever possible and remanufacturing, reuse or repair of their products is built in at the design stage.

Orangebox also undertake carbon footprinting and life cycle assessments that identify environmental impacts of its products during the extraction, production and end-of-life stages of the product life cycle. This also allows the company to transparently communicate the environmental performance of their products to their customers.

One example of this approach to design is exemplified in their "Do chair". This chair was specifically designed for resource efficiency and disassembly and while they achieved a reduction in raw material inputs they also reduced embedded energy and production costs.

Approximately 45% of the chair's components are manufactured within 10 miles of the factory and over 90% are sourced from within Europe. Even though it was designed with the circular economy in mind it has now become their fastest selling chair to date and was a winner of the FX international interior design award.

Some of the design considerations that improve the circularity of their products include specifying durable materials, streamlining components, integrating functions and designing products for manually disassembly that support either recycling or efficient remanufacturing.

Designing for efficient disassembly and reassembly requires significant innovation in material specification and product assembly For example, in a previous chair, the design team took inspiration from Tupperware closures in order to allow for the chair back to the assembled with minimal fasteners. They also design chairs so that all other parts such as upholstery, castors and seat foam can be easily removed and replaced.

The company has also piloted a vertically integrated approach to the circular economy by establishing a recycling centre at their manufacturing facility.

This allows Orangebox to offer customers a take-back service wherein when new products are shipped to customers they can take the existing chairs back and disassemble and resell materials to reprocessors.

In addition to this, Orangebox initiated a partnership with a Welsh social enterprise that can refurbish furniture. Orangebox worked with the social enterprise to upskill the local workforce.

Since then the company has launched G64R, which is a remanufactured version of their G64 chair. Orangebox launched this chair in collaboration with the Premier Sustain remanufacturing facility, the Renew Centre. This is the UK's only independent and dedicated commercial remanufacturing, refurbishing and repairing facility. The Renew Centre is a £1 million facility with 5,000 square feet of remanufacturing space.

It has industrial CNC machines as well as facilities for upholstery, metal spraying, carpentry, CAD design and furniture fitting. The G64R complies with the British Standard 8887-220. This standard covers the design for manufacture, assembly, disassembly and end-of-life processing of products.

One of the commercial drivers for exploring the circular economy as part of the business model is that 45% of the company's operating costs are related to materials. Because of that, any potential for recovery or reuse of materials such as through remanufacturing can have a direct benefit with regards profitability and competitiveness.

Orangebox see a range of benefits from taking a circular economy approach to design. These include enhanced brand value and additional financial revenue generated through sale of remanufactured products. Orangebox also suggest that these sustainability initiatives instil pride in its workforce, which in turn contributes to a positive company culture.

Orangebox also engage with the furniture sector in the UK to advocate for taking a circular economy approach, For example, they have collaborated with the one of the key sectoral organisations, Furniture Industry Research Association, to provide training sessions to other furniture industry companies so they can learn about the circular economy approach and how to build it into design practice and business models.

Holmris & Labofa

Labofa, the company that Perch worked with to produce the Ray Chair, have recently been acquired by Holmris. This means that Labofa join one of Scandinavia's fastest growing furniture manufacturers with a turnover in 2015 of almost €70 million.

Holmris export furniture globally and their main markets are Scandanavia, UK, Germany, Switzerland, Benelux and USA.
Holmris already have a strong focus on environmentally responsible production and their factory in Bjerringbro is accredited to the ISO 14001 standard for environmental management.

Building on this, Holmris recently acquired the Aarhus company 3R Kontor that are specialising in the purchase and sale of recycled office furniture. The company named 3R stands for Reuse, Recycle and Refurbish.

The company takes furniture that customers are finished with and audit the chairs for their repairability and remanufacturability. Those they can work with are professionally cleaned, inspected and repaired before being resold. Holmris decided to acquire 3R because there was a demand from their customers to find secondary markets or responsible recycling of their used office furniture.

Challenges

Design undoubtedly plays a crucial role in facilitating the transition to a circular economy. It achieves this through the design of products and services that enable circularity of materials and products (recycling and repair) while potentially facilitating behaviour change.

Having said that, the ability to influence design practice through policy intervention is very challenging. For example, interventions to date have sought to:

- Build skills and capacity of designers to design better products and services
- Influence the requirement of designed outputs (e.g. ecodesign directive)

One of the key weaknesses of these interventions is that they do not address the commercial and market drivers that influence design briefs.

This challenge is greater in Ireland as many of those designing products or services at scale tend to be working for international companies that fall outside the scope of Irish government interventions.

Some actions that can be taken include:

- Engaging with design sector organisations (e.g. IDI, Design and Crafts Council) to develop design for circular economy CPD programmes
- Supporting design competitions for professional and students designers
- Funding circular design research (with Irish Research Council and Science Foundation) on topics such as service design for the circular economy


Mattress
Recycling
epa
Cork
Environmental
Forum
Cork
County Council
TRANSIT
Cork City Partnership Ltd


seai
GET
INVOLVED

CASE 8: "THE ROLE OF SOCIAL ENTERPRISE" BOOMERANG ENTERPRISES

As mentioned, a key principal of the circular economy is that natural resources are cycled or cascaded through a series of closed loop processes. Businesses can then add value through various strategies such as leasing, repair and refurbishment, maintenance services all which aim to increase the lifespan of products.

One of the characteristics of this aspect of the circular economy and related business models is that they can be more labour intensive than those focussed on selling products in the traditional linear fashion. At its most basic level this is because more people will need to be employed in collection, repair, disassembly or provision of extension services to customers.

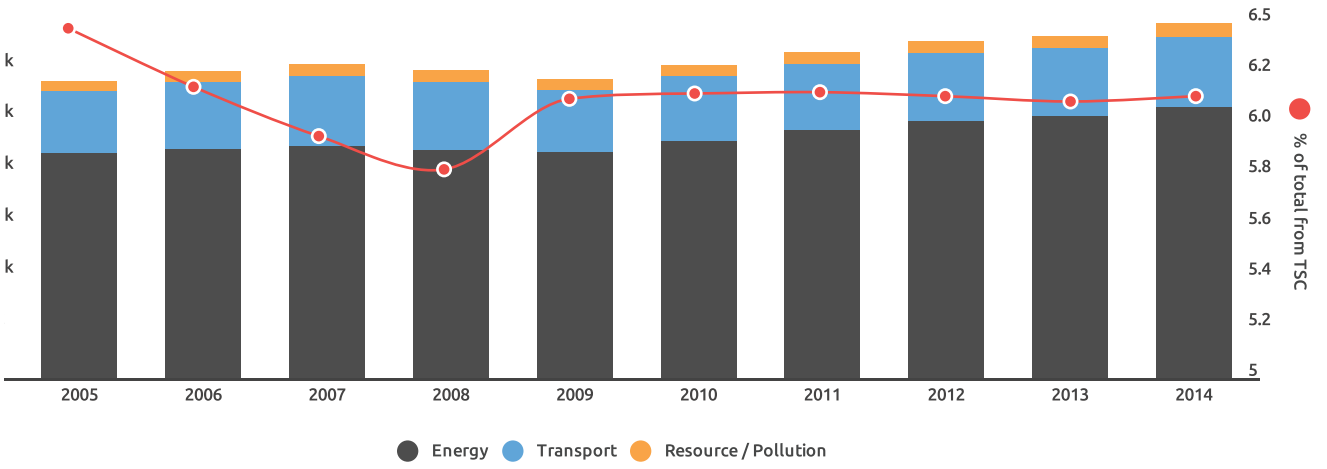
This challenge with regards the labour intensity of the circular economy has given rise to a number of interrelated debates. The first of these is related to how many systems of taxation increase the costs of labour and thus reduce the viability of circular business models.

According to Eurostat, less than 0.2% of the tax revenues in the EU stem from taxation on resource use and pollution (Eurostat, 2015). This is coupled with the fact that approximately 50% was derived from labour taxes and social contributions.

Environmental taxes that include energy and transport alongside resource use and pollution account for 6.3% of all tax in the EU in 2013. This proportion is low and has been decreasing as a total proportion of taxes since at least 1995.

This is counter to the advice of a number of think-tanks, international agencies and economists who suggest higher tax rates can be a mechanism for dealing with negative externalities

Figure 21: Environmental tax as a proprtion of overall tax



In the context of the circular economy an argument has been made that a shift in taxation would decrease the cost of labour while increasing the costs of natural resources would help create conditions for the circular economy (Stahel, 2016). An extension of this argument has been that reducing the costs of labour will help to address the challenges of unemployment and underemployment.

Coupled with the debate on tax reform has been the debate on the VAT system. For example, an argument has been made that goods that have been produced with secondary materials could be exempt from VAT because VAT has already been paid on the materials. The suggestion is that such a move would incentivise reuse and recycling and rectify the situation where virgin materials can be less expensive that recycled.

It must be noted that these debates require much deeper exploration and that any related interventions would require a high level of sophistication. On a basic level, alterations to structural and pricing regimes may result in competitive disadvantages and this would limit the viability of any intervention.

One of the other related debates has been about the role of the social economy and social enterprises. An assumption has been that where circular economy functions are labour intensive and commercially unviable the social economy will step in to provide that function. An example of this is where a social enterprise that remanufactures furniture employs people who are otherwise excluded from the labour market and that labour is subsidised by the state.

There are many successful examples of these types of social economy approaches but when considering the scale required for a transition to a circular economy they demand further examination with regards to the support infrastructure for social enterprises.

Boomerang Case Study

In order to illustrate this we explored a case example of the recycling of a common waste stream that is problematic from a number of perspectives not least the cost effectiveness.

Boomerang Enterprises

Mattresses are a common item of bulky waste that causes a number of problems when disposed of. They typically enter the waste stream via legal routes such as household and commercial waste recycling centre, skip collection or kerbside collections by local authorities. Mattresses have also been a common feature of flytipping and other illegal waste practices.

It is not possible to accurately identify the number of mattresses disposed of each year in Ireland as there is only preliminary data available on the composition of bulky waste. One estimate suggests that 800,000 mattresses are disposed of annually with the majority of these going to landfill. Currently Ireland has two social enterprises dedicated to recycling mattresses, EcoMattress in Dublin and Boomerang Recycling in Cork.

One of these, Boomerang Enterprises, based in Ballyvolane Cork, recovers, disassembles and recycles mattresses in order to divert for re-use and/or recycling. Boomerang was established formally in 2014. The enterprise is managed by Paul Kelly but was initiated and continues to be lead by Cork Environmental Forum.

It is more widely supported by a network of organisations such as Cork City and County Councils, the EPA, SMILE Resource Exchange, Cork City Partnership, the Health Action Zone. Boomerang also connects with a number of local community support groups and the Department of Social Protection.

The initial motivation for establishing Boomerang was that the Cork Environmental Forum identified the lack of mattress recycling facilities in Cork while a large number of mattresses were being disposed of and illegally dumped. The forum decided to establish a project that would encourage the diversion of bulky goods from landfill and dispose of them in an environmentally friendly manner.

The initial funding was secured through the EPA Green Enterprise Programme (in collaboration with Cork County & City Councils, Cork Environmental Forum, Cork City Partnership and the local community). Through this, Boomerang is in a position to provide local employment for a Project Manager and for a minimum of 6 Tús Scheme Workers. These TUS Scheme workers tend to be living within the communities close to Ballyvolane.

Since launching, Boomerang has been refining and scaling up its operation. It now has capacity to disassemble 150 mattresses per week with a short term target of 300 mattresses per week. Since it was established it has diverted over 7,000 mattresses from landfill.

The enterprise has an environmental impact through diverting some waste from landfill but it also provides young Tús Scheme workers an opportunity to up-skill and receive training in different operation practices such as manual handling. In a relatively short period of time, Boomerang have managed to develop a national profile and have been shortlisted for community awards such the "Get Involved" sustainable communities award and the "Northside Business Awards".

Boomerang are collaborating with SMILE in a new research project with Dublin Institute of Technology (Crest Centre) and Waterford Institute of Technology that will explore secondary markets for the textiles from the mattresses.

Challenges with recycling mattresses

There are a number of common challenges with mattresses. Firstly they are bulky items that take up significant storage space at transfer sites, recycling facilities and in landfills. Secondly, they are often a composite construction of varying design and material content. These materials can include a wooden frame, polyurethane foams, steel springs, steel assembly, variety of synthetic fabrics, and natural fibres such as horsehair as well as construction elements such as staples.

A typical household mattress can have a lifespan of between 5 and 20 Years (Mattress-Find 2013). This lifespan depends on a range of factors such as design and consumer behaviour. As mentioned, these mattresses enter the waste stream through a number of routes typically kerbside collection or deposited at a civic amenity site.

According to Griffiths et al (2013), the most common mattresses in production are:

- Open spring mattresses: These are the most common and are typically composed of an inner frame constructed of steel coil springs wired together. Some open spring mattresses are attached to a wooden frame.
- Pocket spring mattresses: These are composed of an inner frame of steel coil springs independently pocketed in fabric
- Memory foam mattresses: These are made of a polyurethane foam that is viscoelastic and adjusts to the body of the user.
- Foam mattresses: These are typically polyurethane slabs

The panels of synthetic fabrics are often attached to the spring assembly by staples and these panels are in turn stitched together. Mattresses also typically contain a variety of foams and bulking materials of varying quantity, quality and recyclability.

Mattresses are also of varying size and weights, such as a single or double mattress, and these can weigh between 15 kg for single mattresses and 40 kg for doubles. Depending on the mattress design, approximately 45% of the total weight can be due to the steel spring assembly.

Other challenges with recycling mattresses relates to the fact that legacy waste from old mattresses may contain polyurethane foams that contain POPs and the collection of bulky wastes has typically led to contamination of mattresses. Having said that, collection systems in Ireland are improving with some dedicated collection areas at recycling centres that allow for the segregation of mattresses.

Internationally, the processing of mattresses for recycling occurs in either an automated or manual process and this is determined broadly by the national or regional recycling infrastructure and

more specifically by the design of the mattresses to be recycled. The general options for recycling are that the steel springs and housings can be sent for recycling, stitched panels and co-mingled materials are sent to landfill or energy recovery whereas unstitched panels can be sent for recycling.

While mattresses may be suitable for reuse following a deep clean, some studies suggest that the consumer acceptance of reused mattresses is low. This is primarily due to hygiene concerns. An argument has been made by the former Department of Environment in the "Review of the Producer Responsibility Initiative Model in Ireland" that the reuse of mattresses may require a mindset shift.

Another study by DEFRA into the acceptability of reuse of certain products noted that that while people initially say they will not reuse mattresses due to hygiene concerns many people share mattresses with stranger in hotel or rented accommodation.

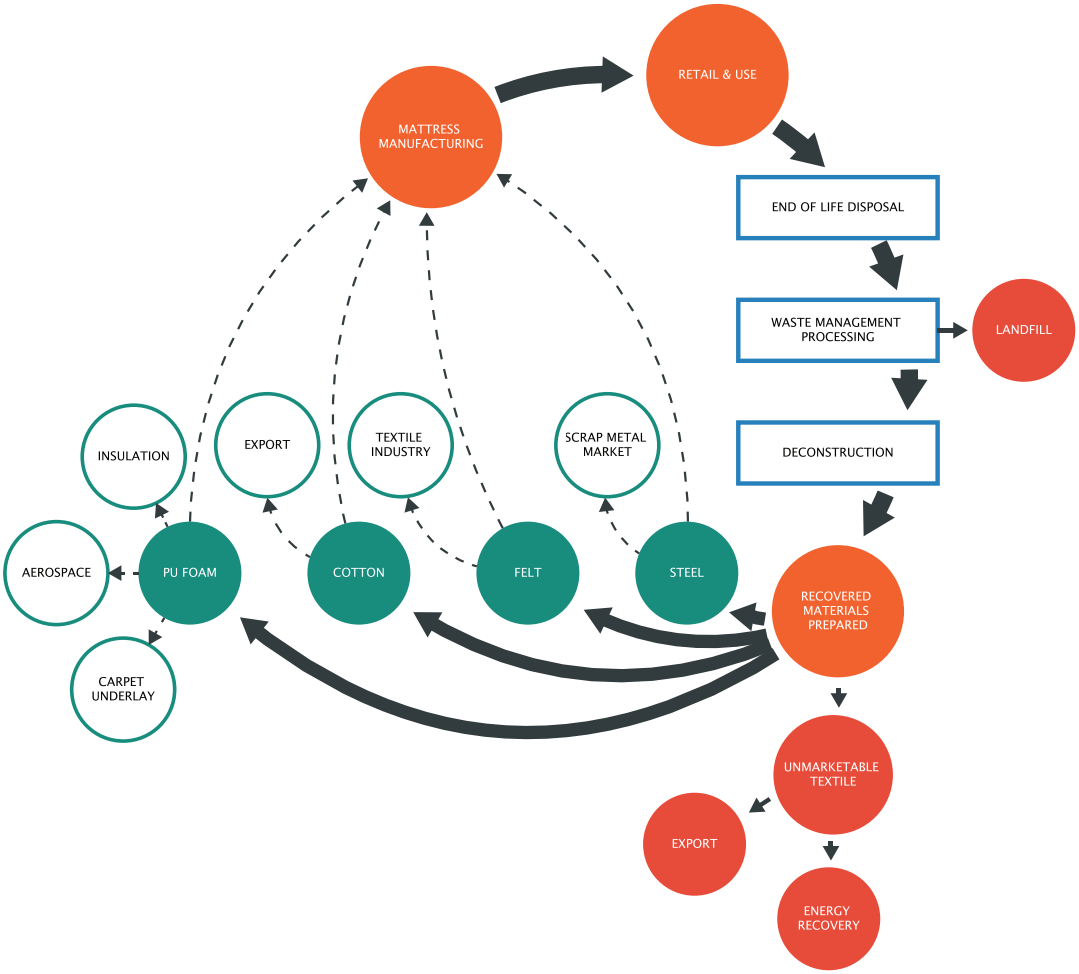
Boomerang recycling process

The primary Boomerang facility is a covered area within the Ballyvolane Business Park. They access mattresses from a number of sources such as bulky kerbside collections, waste collection companies, directly from retailers, hotels and individual households. The overall process of recycling at Boomerang involves:

- Delivery of mattresses to the facility direct from suppliers or other storage facilities
- initial screening and storage on site
- Operators manually separate the fabric and "comfort material" panel from the spring assembly using hand tools.
- The panel assembly (fabrics and foams) are baled and sent for energy recovery or recycling
- Steel springs and housings are cleaned and sold to the steel reprocessing market

A practical challenge for Boomerang is that the design and construction of a mattress will

Figure 22: Mattress Recycling Process



determine the process for deconstructing and effective extraction of the panel materials and spring assemblies. For example, some mattresses use staples to attach the felt or foams to the spring assembly. Were the mattress designed with stitching or some form of button this would improve the speed and efficiency of deconstruction.

Boomerang applies a manual deconstruction method. This typically involves one or two operators working at a large table in the middle of the facility. The operator makes incisions into one end of the mattress with a hook knife or blade.

The mattress is the opened in order to gain access to materials inside. This can include stapled needle felt or other forms of felt. The upper and lower layers that surround the springs and assemblies can then be removed. This is a manual process and can involve tearing the material away from staples.

Once this stage is complete the spring and spring assembly can be removed and separated for eventual distribution to a steel processor. This transportation can significantly add to the overall recycling cost as Boomerang will often be required to deliver the material to reprocessors.

A generic flow chart for mattress recycling is shown in Figure 22. The figure identifies the interactive stages and material flows and identifies key stages for Boomerang Enterprise alongside other potential material flows.

Challenges

While Boomerang has launched very successfully they face a number of challenges, not least ensuring commercial viability of the operation. This appears to be driven by a number of factors such as scale, volatility of steel prices, markets of other secondary materials.

Having access to Tús workers bring a number of benefits not least the desire for Boomerang to have a meaningful social impact in the community. There has been a high success rate with the Tús workers transitioning to further employment. The 12 month term that Tús worker have with Boomerang is good in the sense that the worker are committed for an extended period of time and can receive sufficient levels of training and skills development. Although the 12 month term can be challenging for Boomerang in that there are phases of uncertainty with regards planning before new cohorts arrive.

The process requires a number of stages between the Department of Social Protection, the local partnership, the individual seeking employment and it can be challenging for Boomerang to predict staffing levels.

Possible actions

There is a need to develop capacity within the social economy in Ireland. A focus on developing a coherent support infrastructure would assist social enterprises to transition from grant dependency to commercial viability.

There are a number of possible interventions with regards social enterprises. These include:

- For government and intermediary organisations to actively engage with the European Commission's Social Business Initiative
- Build on existing programmes (Social Entrepreneurs Network, Social Innovation Fund, Social Entrepreneurs Ireland) to provide more widely available capacity building programmes to support and facilitate social innovation and social entrepreneurship
- Develop guidelines on providing access to government and local authority procurement opportunities for social enterprises and the development of Community Benefit Clauses
- Mainstream social entrepreneurship and social economy enterprises into the Action Plan for Jobs and wider business support infrastructure
- Prioritise further research and reflect social enterprises better in national statistics collection to increase understanding, recognition and visibility.


HORIZON 2020

CASE 9: "FINANCING, FOSTERING INNOVATION & START-UPS" EXERGYN

A defining aspect of the circular economy is that it demands social, business model and technical innovation. The Circular Economy Package sets itself apart from previous waste and resource efficiency policies and interventions in that it places a strong emphasis on the financing of innovation towards a circular economy.

Broadly speaking, previous environmental or resource efficiency policy interventions were predominantly focussed on changing the behaviour and business practices of existing companies.

There are many structural limitations to these interventions impact on their capacity to change business behaviour. For example, business behaviours are determined and constrained by socio-technical, sectoral, value chain or geographic factors that are outside of the scope of environmental or resource efficiency policy.

Also, it is fair to suggest that the policy and legislative framework relating to waste and resource efficiency has not been oriented towards adequately supporting innovation or the market uptake of resource efficient innovations. An outcome of this is that opportunities to better achieve policy objectives through innovation and the co-financing of innovation are missed.

In recent years national, local and regional governments have explored new methods to fostering innovation related to environmental or sustainability issues. These interventions include challenge funds, competition based financing, accelerator programmes, innovation platforms and green deals.

Within the Circular Economy Package the Commission specifically addresses the issues of supporting and financing innovation. This has resulted in the inclusion of actions such as Horizon 2020 funding under the theme 'Industry 2020 in the circular economy' and an allocated budget of €650 million.

This is coupled with a commitment to working with the European Investment Bank and the European Investment Advisory Hub to facilitate the financing of industry projects relevant to the circular economy.

One action that has been included is the concept of Innovation Deals. These deals act as a mechanism through which the regulatory obstacles (e.g. legal ambiguity) that prevent the scaling up of potentially beneficial innovations can be addressed more effectively.

The deals act in favour of entrepreneurs by developing agreements between commercial stakeholders and public authorities. These deals are being piloted and the Commission intends to test five Innovation Deals within the scope of the circular economy.

These deals share common characteristics with other "deal-type" interventions. For example, the North Sea Resources Roundabout is seeking to address a number of transnational barriers to the use of secondary raw materials that in turn hinder the emergence of a strong secondary material

market in Europe. While some of these issue address specific structural barriers, regulatory failures and market failures, they address the broader issue of creating favourable conditions for innovation.

On that basis it will be important to consider the "innovation eco-system" in Ireland and how it creates the conditions to support innovations that facilitate the transition to the circular economy. This may require the existing innovation and business support infrastructure in Ireland to be augmented with instruments that are supportive towards circular economy innovations (e.g. new business models) or new instruments.

Case Study

To explore this further we explored a case of an Irish start-up company that is developing an innovative product and technology that is relevant to the circular economy.

Exergyn - Monetising waste heat

Exergyn, based in Glasnevin Dublin, has since 2011 been developing a technology for converting the low-grade waste heat available in hot water into energy (electricity or motive power). The company believes this technology, the Exergyn Drive, has the potential to reduce carbon emissions and energy bills across multiple industries globally.

Although energy is typically an indirect focus of the circular economy, the technology being developed by Exergyn is aligned with the circular economy in the sense that it is creating value from waste hot water.

The Exergyn Drive can be applied to any process that generates consistent output of low grade waste heat. This can include outputs within the range of 77^{0}C – 90^{0}C with relatively low flow rates (e.g. 2 litres per second). The company suggest that their technology can be used in combination with a broad range of existing industrial processes that produce low grade waste water.

This can include waste to energy plants, gas extraction from landfill and district heating schemes. Although the possible applications are broad, the company is initially focussed on some key industrial applications such as Power Plants, Cargo Shipping, Combined Heat & Power, Geothermal and Biogas.

Exergyn has already spent at least two years researching initial markets such as biogas. They have mapped over 7,000 biogas sites across Europe that they believe could be using their technology.

Exergyn has an initial interest the UK biogas sector primarily as there is currently no usage of existing low-grade waste heat and there is a programme of feed-in tariffs that incentivise selling energy to the grid.

Process

The Exergyn Drive does not use fuel in the conventional sense as it uses low-grade hot water. The Exergyn Drive acts as an energy recovery device by exploiting the properties of nitinol, a nickel-titanium alloy. This metal is often referred to as a "shape memory".

This memory alloy can be used to power a drive mechanism because it shrinks when exposed to heat, for example a flow of heated waste water, and returns to its original form when cooled. Exergyn have patented aspects of their technology (WO 2016097060 A1).

The Exergyn team

Alan Healy is the Exergyn CEO and has entrepreneurial experience in companies of all scales in Ireland, the UK, South Africa, Australia and the US. Dr. Kevin O'Toole is the Director of

Research & Development and is an experienced manufacturing and design engineer.
Kevin has a PhD in shape memory alloy actuator technology.

Dr. Barry Cullen is the chief technology officer and has a PhD in advanced engineering thermodynamics. Barry has commercial experience in the installation of natural gas and novel gas fired CHP installations.

In the last four years the company has been scaling up and developing the technology. They have raised €6 million of investment and now employ 15 staff in total. The team is drawn from various disciplines but includes expertise in engineering, business and material science.

Of the €6 million of finance already raised, €2.5 million of this came through the SME instrument of the Horizon 2020 research and innovation programme. The rest of the finance has been raised through a variety of sources including venture capital, Enterprise Ireland and the NDRC.

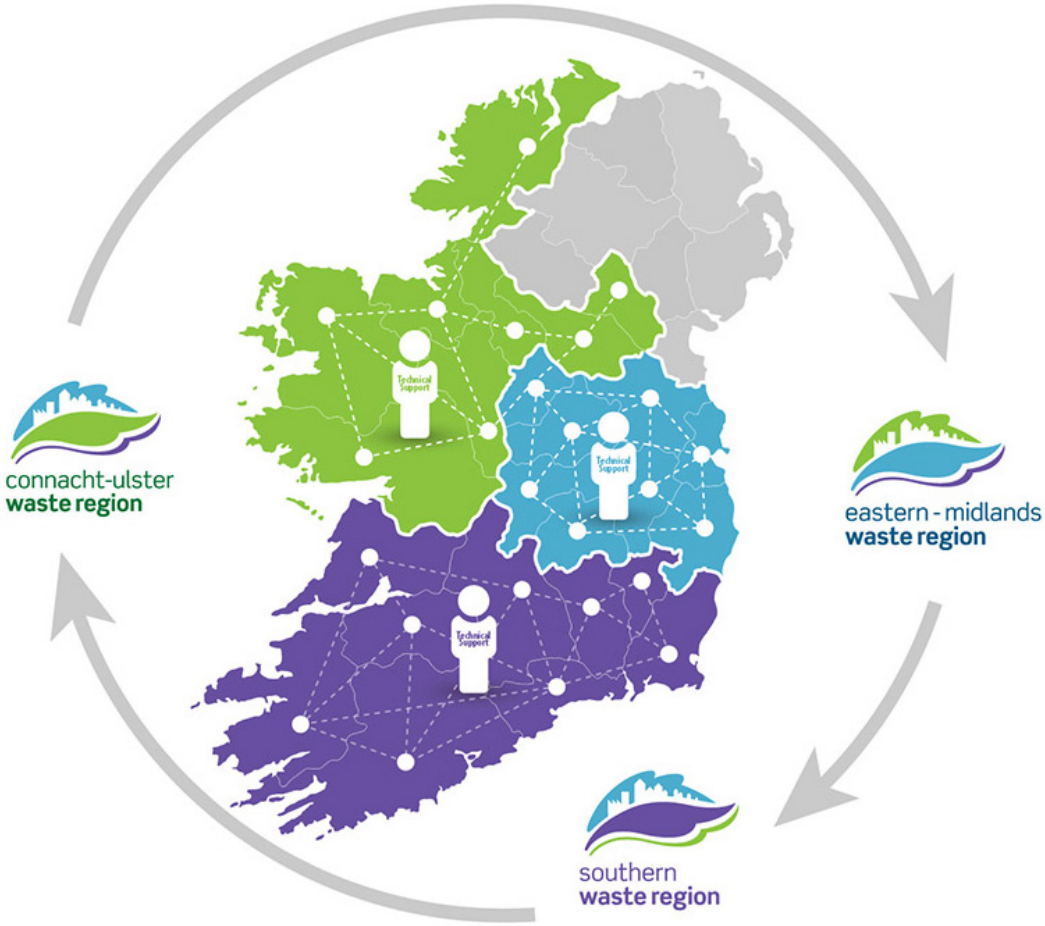
Apart from the finance allowing Exergyn to grow their team, the support from Horizon 2020 has helped validate the company and improves their capacity to pitch to new investors.

Support infrastructure

Exergyn are based in the DCU Alpha innovation campus. DCU Alpha launched in 2013 and is predominantly focussed on supporting the development and scaling of new technologies and businesses within the 'cleantech' sector. Companies in this sector are diverse but typically seek to produce innovative and sustainable products and services that address key challenges with regards water, waste, energy and emissions.

One of the characteristics of DCU Alpha that sets itself apart from other incubator or spin-out facilities in Ireland is that it is focussed on developing hardware and products. The trend, within Ireland at least, has been to provide an innovation support eco-system and infrastructure at the early stages of development for software and IT companies.

This issue of the nature and focus of enterprise support in Ireland being seen to be oriented towards software and certain forms of technology was a key issue for Exergyn and other companies involved in product development. Because of this, companies such as Exergyn have had to focus on raising finance outside of Ireland in order to develop their technology.


connacht-ulster
waste region
eastern - midlands
waste region
southern
waste region


smile

CASE 10: "INDUSTRIAL SYMBIOSIS" SMILE RESOURCE EXCHANGE

Industrial symbiosis is a key strategy within the circular economy. At its most basic level, Industrial Symbiosis describes the physical exchange of resources such as materials, water, energy and other by-products between companies. Typically Industrial Symbiosis will occur between processing and manufacturing industries where the surplus or waste materials from one company becomes the input or feedstock for another.

Lombardi and Laybourne (2012) suggest that Industrial Symbiosis "engages diverse organisations in a network to foster eco-innovation and long-term culture change. Creating and sharing knowledge through the network yields mutually profitable transactions for novel sourcing of required inputs, value-added destinations for non-product outputs, and improved business and technical processes".

Industrial symbiosis has been practiced at different scales globally for a number of decades. Industrial symbiosis is a systems and network based approach to the circular economy in that the exchanges can be physical resources, finance as well as knowledge.

While Industrial Symbiosis as a concept is not bound by issues such as sector or proximity, many early examples of the practice were defined by proximity and co-location, such as in eco-industrial parks. One of the first and most widely known examples of this is the Kalundborg Eco-industrial Park in Denmark that was developed four decades ago.

In Kalundborg, approximately eight companies from different sectors operate a closed cycle of industrial production through the exchange and trade in wastes and by-products.

These waste and by-products include ash, gasses, steam and sludges. A variety of by products are traded, such as steam, gypsum, fly ash, gas, heat, sludge. The close proximity means that the cost effective transportation between companies is achieved.

Kalundborg Eco-industrial Park recovers heat to an equivalent annual electricity consumption of 75,000 families, saves 3 million cubic metres of water and avoids approximately a quarter of a million tonnes of carbon dioxide emissions.

Typically commercial drivers for this form of industrial symbiosis include:

- Reduce costs (e.g. waste disposal costs, landfill levy, transportation)
- Adding value to what was previously a waste
- Resource and supply security
- More general regulatory requirements around resource efficiency

Other forms of industrial symbiosis are designed around the partnership and network model of industrial collaboration, sometimes supported by structured programmes, digital platforms or a combination of both.

In taking this approach, industrial symbiosis can complement traditional policy instruments, such as voluntary agreements, that are aimed at addressing

Figure 23: Kalundborg Industrial Symbiosis

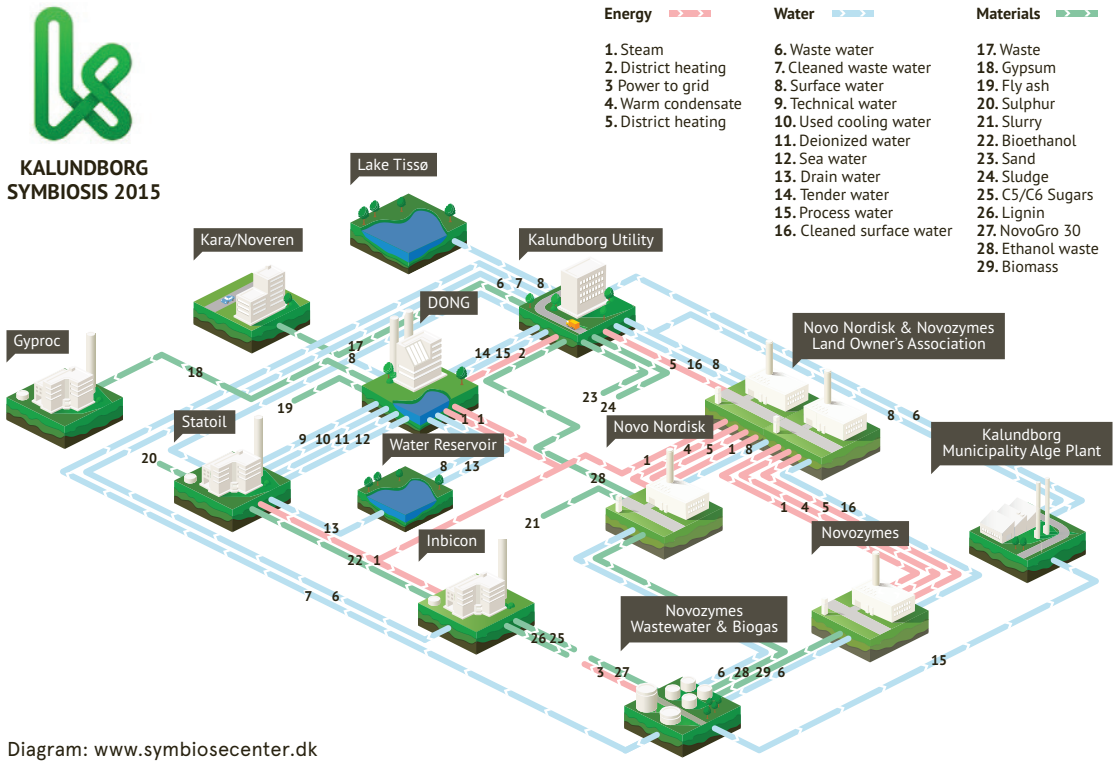


Diagram: www.symbiosecenter.dk

value chain or life cycle impacts. Examples of this can be seen in some countries such as the Netherlands, where partnership approaches have been developed to address value chain and life cycle impacts across seven priority waste streams.

National and local governments often play an important role in facilitating the Industrial Symbiosis process. For example, the UK National Industrial Symbiosis Programme developed a network of 15,000 companies. The programme identified resource transactions between companies that were mutually beneficial and profitable.

The programme has diverted more than 47 million tonnes of industrial waste from landfill. In doing so it created and safeguarded 10,000 jobs and generated sales of approximately £1 billion (International Synergies, 2015). An assessment of the British experience suggested that the benefit/cost ratio of an initial five-year programme was between 32:1 and 53:1.

Models of Industrial Symbiosis can also have different temporal characteristics. For example, some models involve one off exchanges whereas others are based on longer-term partnerships. The longer-term partnerships combine and leverage financial and non-financial resources of partner companies towards the achievement of common or company specific goals.

More generally, it is worth noting that Industrial Symbiosis is related to the broader policy initiatives aimed at developing resource efficiency and responsible global supply and value chains. For example, the OECD recently developed Guidelines for Multinational Enterprises to promote responsible supply chains through partnerships and co-operation.

These guidelines support the development of a transparent environment that supports international investors in making positive contributions. These guidelines include sector-specific guidance for the minerals and agricultural sectors. These guidelines are being developed for the garment and footwear sector, one of the largest consumer sectors globally.

Within the Circular Economy Package, the Commission is proposing to revise legislative proposals on waste to clarify rules on by-products to facilitate Industrial Symbiosis. Additionally, the Commission intends to help create a level-playing field across the EU with regards Industrial Symbiosis.

The Circular Economy Package identifies two high-potential aspects of industrial symbiosis; the reuse of gaseous effluents and remanufacturing. Both these approaches are already applied in different sectors but the intention is to apply research and innovation financing (e.g. Horizon 2020) and Cohesion Policy funds in exploring how these approaches can be scaled up across new sectors.

Case study

In order to explore Industrial Symbiosis in the Irish context, we developed a case study on Ireland's only Industrial Symbiosis programme.

SMILE "Ireland's industrial symbiosis programme"

SMILE is Ireland's Industrial Symbiosis programme and was launched on a preliminary basis in 2010 with funding from Cork County & City Council and South Cork Enterprise Board (now Local Enterprise Office, South Cork) .

SMILE is provided to industry for free and provides a platform through which synergies can be created between businesses that have surplus or unwanted materials and businesses that have a need for those materials. These synergies can include direct reuse of materials or using a waste material as a feedstock in the production of new products.

SMILE is managed by Macroom E and receives funding from the EPA through its national Waste Prevention Programme, Cork County Council, Local Enterprise Office South Cork and the Waste Management Regions. Macroom E is an enterprise centre based in Macroom, Co Cork and is a wholly-owned subsidiary of Cork County Council.

Macroom E differentiates itself from other enterprise support centres and programmes in that it has a broad focus on environmental business practices. In addition to SMILE, Macroom E delivers a number of other environmental programmes and services such as the Green Shoots Emerging Entrepreneurs Programme, Evaluator.ie, Circular Ocean and SourceIT.

The online platform that is provided by SMILE is open to any business from any sector across Ireland. When it originally launched it was branded as a resource exchange programme and was focussed on the Cork region. Since 2014 it has expanded nationwide and rebranded itself as the national industrial symbiosis programme.

Having grown from that initial base of membership the expansion nationwide has seen the number of members grow. As of quarter 1 in 2017, the platform has almost 1,500 members:

Southern Region (918)
Eastern-Midlands (389),
Connacht-Ulster (83)
National/Other (67)

Transitioning from resource exchange to national programme

One of the characteristics of SMILE Resource Exchange is that it initially developed as a resource exchange model. This model was focussed on reuse opportunities of surplus materials (e.g.

overstock) or potentially waste products (e.g. surplus office furniture following an office refit).

The online platform allows companies to publish waste materials or products that they feel another company could use as a resource. The role of SMILE is to broker synergies between those supplying waste materials and those seeking the materials.

Whilst the resource exchange model was successful in developing a growing member base, a number of limitations were identified by Macroom E. These were identified through an evaluation of the programme but also through a review of international industrial symbiosis programmes.

One of the key challenges identified was that Macroom E only had sufficient resources to deliver and manage the platform. They were unable to offer technical expertise that would be required to facilitate higher value exchanges. These higher level exchanges could include higher tonnages but also the exchange of process material that could be used as an input or feedstock into a new production process.

In early 2015 SMILE trialled the rollout of a national network of technical experts that could support members in making exchanges. These three technical experts are located in each of the three waste management regions across Ireland i.e. the Eastern Midlands, Southern and Connacht Ulster Waste Management region.

The pilot ran for five months and the technical consultants worked with a combination of existing and new members. There were 57 successful synergies and five of these were large-scale (10+ tonnes).

In addition to this pilot, during 2015, SMILE helped to identify 359 possible exchanges. Of these, 85 were successful and resulted in an estimated 5,000 tonnes of material diverted from landfill. There is no public register of the material composition but SMILE estimate that these exchanges amounted to a cost saving of €1,229,201.

Based on the success of the pilot in 2015, the technical support was continued in 2016, where 75 successful synergies were completed, representing 11,741 tonnes diverted from landfill at a cost saving valued at €1,964,700. 63 of these successful synergies were attributable to the technical support consultants.

One of the characteristics of the SMILE programme is that it has relied heavily on effective communication. For example, the SMILE newsletter has over 6500 subscribers and they are very active on social media, presenting at partner events as well as publishing through traditional national media.

Potential spillover benefits of Industrial Symbiosis

While the specific objectives of Industrial Symbiosis may be determined by the particular model that is applied, there are potentially wider benefits to participants. These include:

- Networking effects: trusted partners, knowledge exchange
- Technology transfer: cross-sector transfer of technical knowledge;
- Behaviour / attitude change: deeper knowledge and increased perception of value of other sectors, material, by-products
- Human capital: improved working practices
- Brand equity: improved commercial reputation and external perception of trustworthiness
- Potential new product development and spin-outs: increased capacity for new product development

Challenges

While a number of barriers to commercial collaboration are well documented e.g., trust,

scale, power relations, regulations, sector culture there are some specific barriers to Industrial Symbiosis that are worth highlighting. For example, the process involves a number of costs such as transactional costs, direct staff costs, communication and co-ordination costs.

These costs will increase depending on the model of Industrial Symbiosis that is applied. For example, the more complex the model the likelihood is that costs will increase.

This demands that national programmes should be prepared to articulate and demonstrate the value-added of a particular model that is applied. It would help to provide comparable data on the costs and benefits of an Industrial Symbiosis approach compared to an alternative approach.

It can be challenging to evaluate Industrial Symbiosis programmes that are not self-contained e.g. eco-industrial parks. This is because national programmes are unlikely to be able to assess each transaction as they are out of the control of the programme. Therefore Industrial Symbiosis should be seen to be complementary to other policy instruments.

Additionally, Industrial Symbiosis is not a panacea as it is not appropriate in all circumstances and there are still substantial infrastructural and regulatory challenges to overcome.

Initial scope for development

Clearly SMILE has managed to launch and scale a national programme without significant levels of investment. They have recently been commissioned to undertake a study that will help key barriers in sectors with high potential for industrial symbiosis.

Without pre-determining the outcomes of this study, the section below outlines some initial criteria for building on successes of SMILE in Ireland.

For government

The government needs to create a positive enabling environment for industrial symbiosis ensuring the appropriate policy and legal structures are in place (such as the transfer of waste between sites), ambitious levels of funding for appropriate institutions to facilitate Industrial Symbiosis. This can be supported by:

- Developing accurate and appropriate indicators for exchange and programme level progress
- Investing in monitoring, evaluation and learning - help identify priority sectors and materials.
- Supporting specific interdisciplinary research programmes on Industrial Symbiosis - e.g. Socio-technical barriers, technical limitations, organisations behaviour, legal structures

The government can also further explore the commercial barriers to industrial symbiosis and if appropriate provide tax relief on symbiotic exchanges if the financial return from an exchange is less than the asset on the company balance sheet

For Industrial Symbiosis programmes

The National Industrial Symbiosis programme should continue developing pilots and exemplars around priority sectors and waste streams and in particular those suited to Industrial Symbiosis.

This will help to create a stronger evidence base on the mutual benefits (win-win) for participating companies. These pilots can act as test-beds for incentives that may motivate companies to achieve the programme objectives (e.g. tax relief).

As with other similar programmes, flexibility needs to be designed into the programme alongside competencies in brokering, facilitation and change management. The programme can also establish clear and enforceable lines of accountability

SECTION 4: REFLECTIONS & TENTATIVE RECOMMENDATIONS

This short research project highlighted that the transition to a circular economy will be driven, in part, by the need for Ireland to respond to and implement the actions contained within the new EU Circular Economy Package. In doing so there is significant potential to improve national resource productivity, capture value from materials that would otherwise be exported as waste, create new employment in existing and emerging sectors as well as support the transition to a low carbon economy.

The case studies underline that while there are some actions and policy interventions in relation to waste prevention, the knowledge base and business support infrastructure in relation to the circular economy in Ireland is fragmented. The benefits from the circular economy in Ireland will only be realised if well considered and systemic policy, enterprise and societal actions are undertaken.

The points below outline some of the key issues emerging from the case studies. While the issues highlighted specifically relate to the cases studied, they speak to broader sectoral and cross-sectoral challenges that require policy attention.

Wisetek

- Remanufacturing and reverse logistics business models are enabled by e-waste regulations, underlining an important role for the regulatory context in enabling the transition to a circular economy
- As a spin-out, the business model will be sensitive to changes in Waste regulations in the Circular Economy Package
- There are clear commercial opportunities in developing new service-based business models, remanufacturing and cascading of secondary materials

Enrich Soil Products

- The anticipated feedstock (food waste) against which investment decisions were taken have not materialised as quickly as expected
- The business is competeing with waste exports and low incinerator capacity in Europe resulting in the need to process less desirable waste streams (organic fines) that reduce yields and return on investment
- Regulatory barriers preventing scaling up of higher value processes such as producing biogas from anaerobic digestion or bio-polymers using waste feedstock
- There are commercial opportunities in processing side waste streams (e.g. C&D waste) when developing higher value products

Rediscovery Centre

- There is an important and currently underserved role of community level action for the circular economy
- Community organisations will potentially play a key role in creating cultures for the circular economy and related behavioural changes
- National reuse protocols are being developed but no structured co-ordination of this as yet

ECOCEM

- Construction sector highly fragmented, dominated by incumbents
- Little evidence of co-ordinated actions in sector on the circular economy
- Limited prepardness for dimished waste infrastructure and evolved regulatory system
- Lack of R&D and academic research programmes to support sector

Wellman International

- Low quantities of high quality indigenous feedstock due to Irish collection systems and small scale of Irish market
- The design of end-use applications hindering full closed-loop system
- Automation reducing direct employment

Sharing Economy

- No national policy or enterprise support in Ireland for sharing economy but there is a single bottom-up sector representative body
- Significant potential for aspects of sharing economy to enable circularity
- No evidence of broad awareness of the circular economy in the sector

Design - Perch and Orangebox

- The lack of a national design policy limits dialogue on emerging issues such as the circular economy
- There is no formal training programme on design for the circular economy in Ireland
- To remain viable, Perch need to innovate the traditional design consultancy model e.g. a partnership model

Boomerang Enterprises

- Lack of easy to implement social and environmental metrics to communicate impact
- Lack of legal framework for social enterprises in Ireland
- National support infrastructure for social enterprise is fragmented and competition based
- Social enterprises will sometimes have limited capacity to invest or scale-up and can be dependant on local support services

Exergyn

- Irish business support services are perceived to be dominated by non-hardware sectors
- Irish private investors focussed on digital products as opposed to product development
- The company is having to go outside of Ireland to receive support e.g. European Commission and UK based accelerator programmes.

SMILE

- There is a lack of clear and commonly agreed definitions of Industrial Symbiosis
- Challenges in scaling to higher value exchanges (existing barriers and market failures)
- Only early stage evidence on success of new network of regional experts

Employment potential

One of the features of the circular economy that was highlighted in the report is the potential labour intensity and the different types of employment that can be created. Conservative estimates focussing on just the waste processing and recycling sectors suggest that the circular economy in Ireland could add between 2,100 and 5000 new jobs as well as €1.65 billion (0.7%) of GDP (Veolia, 2015).

Given that the case studies presented in this report are located across Ireland, there is a strong argument towards the circular economy supporting regional employment strategies. In addition to core employment potential the circular economy provides a number of opportunities for employment schemes and placements for research students. For example, enterprise based PhD or Masters programmes would support enterprises as well as build capacity within the Irish research system.

Ad-hoc implementation by industry

The case studies highlighted that some Irish businesses and social enterprises are already benefiting from circular economy approaches such as closed loop recycling, remanufacturing, reuse and repair. While that is the case, insights from the case studies suggest that existing policy arrangements are acting to limit the scaling up of these practices and their implementation is dependant on individual businesses and enterprises rather than a coherent sectoral or regional strategy.

Role of the social economy

The research highlighted that while social enterprises will play a key role in achieving the circular economy, the support infrastructure for this is still nascent in Ireland. The lack of an appropriate legal or regulatory framework, a dominance of competition based finance and a positioning within the social protection or social inclusion departments are potentially constraining the growth of the sector.

Supporting a low carbon economy

The report also highlighted how the circular economy can help with decarbonisation and in doing so it has the potential to help Ireland achieve higher emission reductions in addition to those contained within the Paris Climate Agreement. Quantification of the potential emission reductions was outside of the scope of this report but it warrants further analysis.

Value chain approaches

One of the key attributes of the circular economy is that it provides the potential to create opportunities across supply and value chains. Some regions, such as the Netherlands, have experimented with multi-stakeholder value chain based interventions. These systemic interventions help to articulate a broader vision for the circular economy while helping to remove friction points and perverse incentives within the existing regulatory system.

To that end, the case studies highlighted that in Ireland there is unrealised potential to create higher value from secondary raw materials through processes such as biorefining of agri-food waste and higher value activities such as circular product design and remanufacturing.

Public sector innovation

There is a clear opportunity for the circular economy to drive policy and public service innovation. At a basic level, the Circular Economy Package demands innovation and the appropriate allocation of resources. Once of the fundamentals of the Circular Economy Package are operational, Ireland could innovate around policy interventions that play to Ireland's strengths within the context of a circular economy.

This could be supported through means such as behavioural insights, policy experimentation (e.g. randomised control trials, field trials) and policy labs. The national strengths that could be targeted through policy experimentation could be sectoral (e.g. agri-food), labour market (e.g. high quality technology skills) or scale (e.g. networks).

SECTION 4.1: TENTATIVE RECOMMENDATIONS

While this short research project helped to advance the discussion on the circular economy in Ireland, it also highlighted the need for further clarification on potential pathways for policy, technological and social innovation that can bring about the required transformations in Ireland. In short, while progress has been made in Ireland, significant challenges remain. Not least:

- **Enhancing the circular economy Innovation System in Ireland**
- **Establishing enabling conditions (incentives and other interventions)**
- **Establishing transition pathways (priority sectors, materials)**
- **Applying common metrics for measuring progress**

Challenge 1 Enhancing the circular economy innovation system in Ireland

Many of the regulatory building blocks for the circular economy are already in place at a European level. These include EU, national and sub-national policies, interventions and initiatives as well as a growing network of intermediary organisations working on the transition to a circular economy. It is expected that these will continue to influence the trajectory of policy and intervention development in Ireland.

A key challenge in Ireland is that many of these existing initiatives address separate parts of the transition to the circular economy as they focus on specific policy 'silos'. It is broadly accepted that the transition to a circular economy requires systemic innovation with multi-level interventions within and between sectors and across value chains. Such an approach needs to take into account the effects of different incentives as well as the distribution of economic impacts along a value chain.

This transition to a circular economy in Ireland demands a coherent mix of multi-level interventions that can be delivered across the public and private sectors as well as to individuals and in communities.

This includes regulations, economic incentives, new models of funding, value chain agreements, incentives for value chain collaboration and behaviourally informed interventions (e.g. the use of social norms and if appropriate "nudge-type" interventions).

As well as developing new sub-national strategies and an integrated national framework, the short-term focus should be on boosting the circular economy innovation system in Ireland. Particular focus should be on identifying existing interventions that show promising levels of impact and scaling these, revising existing policies as well as removing specific regulatory barriers.

The Circular Economy Package can act as a framework through which existing efforts around resource efficiency are augmented with additional investment.

Given the infrastructural constraints there could be a short-term focus on facilitating the scaling of bottom-up initiatives that are currently acting as niches of potentially beneficial future practices. For example, in the area of reuse, remanufacturing and refurbishment.

There is an opportunity to learn from other regions in terms of leveraging funding to support innovation, industrial symbiosis, clustering, and bottom up initiatives among citizens.

For example the new Cohesion Policy investment framework (e.g. smart specialisation), Horizon 2020 and COSME investment in research and systemic eco-innovation, European Social Fund investments in training, education and skills development.

There is a need to explore how these existing national and EU funding initiatives can be combined to leverage private finance and other forms of investment, in particular with regards to supporting emerging sectors.

Challenge 2 Establishing enabling conditions

The case studies highlighted that businesses and social enterprises have been able to benefit from adopting a circular economy approach even in the absence of coordinated policy effort and intervention.

The challenge is that social enterprises can struggle to become commercially viable and businesses are dependant on leaders that see the value in addressing the circular economy and are seeking early mover advantage.

The Exergyn case study highlighted that a dominant focus on policy interventions for the circular economy is on changing behaviours of existing businesses and enterprises. There is less focus in Ireland on creating the conditions through which disruptive innovation and new businesses models will emerge.

Additionally, while there is a comprehensive support infrastructure for digital and software products there is a sense that the same support is not extended to hardware or product manufacturers.

This was reflected in part through the support available from the innovation intermediaries in Ireland as well as the private finance system, such as venture funders.

Consideration should be given to how the innovation support infrastructure can be augmented to better support enterprises developing products, hardware or product-service systems.

A key discussion with regards the development of appropriate incentives is the removal of regulatory disincentives. For example, in the case study on Enrich soil products, the regulatory barriers to developing capacity for anaerobic digestion was highlighted.

There are lessons to be drawn from the government of the Netherlands with regards to strategically identifying and where possible removing or reducing the regulatory barriers to the circular economy.

As mentioned, the support infrastructure for social enterprise in Ireland is still nascent. There is a dominant focus on competition based finance and fragmented training programmes.

This is coupled with a weak legal framework for social enterprises in Ireland. This will be a significant challenge as it is widely recognised that social enterprises and more widely the social economy will play an important role in the circular economy.

Challenge 3 Establishing transition pathways (priority sectors, materials)

The case studies presented in this report highlight some of the potential of the circular economy across a range of sectors. This cross-sectoral perspective highlighted some of the common challenges and considerations when designing future interventions.

As the circular economy innovation system in Ireland evolves it may be pragmatic and prudent for national and local governments as well as regional assemblies to develop intervention strategies based on priority materials, products and sectors.

This prioritisation should help to focus efforts on those materials, products and sectors that have the greatest potential for circularity within the scope of possible policy interventions. The EPA has commissioned a study into the priority sectors in Ireland with regards resource efficiency interventions.

The process of prioritisation can be complex as there will be a number of national and sub-national priorities, existing sectoral programmes and various capacities for intervention. The following are generic steps that may assist in prioritising:

- **Identify sectors and materials with significant environmental impacts and high circularity potential.** This includes identifying issues such as material and energy intensity, volume of waste generated, share of waste landfilled or incinerated.
- **Map the intersections between these materials and products with nationally or regionally significant sectors**. This could include factors such as sector size, growth (measured by share of gross value added, contribution to employment, international competitiveness. It may also include anchor companies and strategically important sectors
- **Map the innovation system** that is relevant to those sectors to help determine strengths and gaps in the capacity to intervene.

Care needs to be taken to ensure biological resources are managed and used within their sustainable limits. This focus on sectors with high impact and high potential circularity should not crowd out support to currently developing niche and emerging sectors such as design, sharing economy and remanufacturing.

It is important that sectoral organisations and trade associations develop a clearer understanding of the role the circular economy can play in enhancing competitiveness. While this report did not provide a detailed sectoral analysis it did highlight a number of examples of how the circular economy has lead to the development of new business, employment and innovation.

The existing approaches to addressing the “low hanging fruit” options of achieving incremental cost savings through resource efficiency still need to be pursued but businesses and social enterprises need to address the higher value potential such as in business model innovation and new product design.

There are a number of general steps that can be taken. These include:

- **Identifying risks associated with the existing model of business.** For example, developing a clearer picture of vulnerabilities related to raw material price volatility or material scarcity, potential supply chain disruptions or impacts on the licence to operate through emerging legislation.
- **Identifying the loss of revenue and value through wasteful processes and practices.** For example, utilising existing support mechanisms in Ireland to identify the leakages and resource inefficiencies in existing business and operating models. This process can also assist in identifying potential new value creation through industrial symbiosis.
- **Redesigning products and or business models.** The identification of lost value through resource inefficiencies can help identify new potential product, service or business model opportunities. For example, this could include augmenting existing manufacturing with a leasing model, maintenance contracts or remanufacturing services. This process may involve new partnerships rather than developing internal capacity.

Challenge 4 Applying common metrics for measuring progress

It is important to stress that the opportunities from the circular economy vary considerably across different sectors, products and value chains. It is also true that in some sectors the transition will emerge without significant additional intervention.

For example, in business-to-business value chains where materials have high embedded value and where the transition to circular or service based models is already viable.

Policy discourse on the circular economy should reflect the brorder role it will play in bringing about technical and social innovation and employment potential. The focus needs to shift away from a dominant focus on waste while recognising the important interplay between technical and biological resources (i.e. move to a bio-economy).

There is also a need to explore the interactions between environmental policy and other policy domains in Ireland such as social and economic policy as they all play a role within the circular economy.

The interactions and potential trade-offs between existing national policy initiatives, such as in the areas of construction and food, need to be considered in relation to the circular economy. While possibly not achievable in the short term there should be an overarching principle of policy coherence and removal of regulatory disincentives.

One example of this could be in the area of definitions in waste legislation, coherence between waste and bioenergy legislation but also horizontal policies (e.g. procurement, VAT).

There is a need to improve transparency, evidence, national environmental-economic accounts (material flow accounts) that take greater account of specific characteristics of the circular economy such as multiple cycles of materials through remanufacturing and reuse.

Similarly, there needs to be greater support towards the update of corporate disclosure, organisational environmental footprints, re-use protocols (EPA funded work underway) and quality standards for circularity (e.g. remanufacturing).

This shift towards greater transparency can ensure internal visibility within businesses and organisations, support internal investment decisions as well as external investment decisions (e.g. pension funds and ethical investment funds).

While it will be important to build capacity in area where Ireland will have a clear circular advantage, e.g. bio-economy, chemical and food sectors, the focus should be on shifting towards higher value activities. For example, in addition to supporting the development of composting and anaerobic digestion there is a need to learn from the recent research programmes examining bio-refining and the potential of this in Ireland.

ANNEX A: EU POLICY CONTEXT

From recycling and resource efficiency to a 'circular economy'

The recent rapid growth in popularity of the circular economy is in part due to the fact that many of the fundamental principles and mechanisms have been developed over the last four to five decades and are already being implemented at various scales, albeit in a fragmented manner.

In 1966 Kenneth Boulding proposed the idea of circular material flows through an economy. This perspective was developed upon in the environmental economics literature that has presented a number of theoretical perspectives on moving from a linear to a circular economy (for example Dasgupta and Heal, 1979; Mäler, 2013; Smith, 1972).

In 1982 Walter Stahel coined the phrase "Cradle to Cradle" to describe the process of designing products with strategies that extend the life of those products. These strategies include reuse and service models to extend the life of the product. Walter Stahel's wider aim was to dematerialise the industrial economy.

More recently, national and regional governments are implementing many of the key features of these theoretical perspectives on the circular economy.

As environmental concerns increased throughout the 1980s and 1990s alongside concerns about waste and resource constraints many regions developed improved waste management infrastructure. This includes improved physical infrastructure for the collection and treatment of waste alongside national waste prevention programmes and dedicated business support programmes.

For example, Japan introduced a range of measures over 15 years ago that regulated the recycling of products and launched a 'Plan for establishing a sound material-cycle society' in 2003.

The issues of resource efficiency and increasing resource productivity were tied into the broader discussion on European recovery following the 2008 financial crisis. As part of the wider 'Europe 2020 Strategy' the European Commission published 'Resource Efficient Europe'.

This set out an initial vision for boosting resource efficiency to address the combined issues of competitiveness, employment, resource security and more general environmental impacts.

To support the implementation of this, a High Level Group was established. This group issued a manifesto for a resource-efficient Europe and policy recommendations as well as inputting into the European Resource Efficiency Platform (EREP).

Following from this, the European Commission published an initial proposal for the circular economy in 2014. The basis of this initial proposal was a series of studies that stressed the importance of improving resource efficiency across entire value chains.

Current policy context

As mentioned a number of regions have already initiated regulatory and policy frameworks supporting the transition to the circular economy. In the EU context, a number of the regulatory building blocks that may support the transition to a circular economy are already in place.

On that basis, it is reasonable to argue that in a number of areas the transition is already underway.

The EU has a comprehensive framework of regulations dealing with issues related to the circular economy such as:

- Reducing impact of raw materials - Environmental Impact Assessment Directive, Mining Waste Directive, Raw Materials Initiative, Water Framework Directive, Fertiliser Regulation, Biomass Action Plan, Forest Action Plan, proposed Soil Directive, CAP, proposal on Indirect Land Use Change (ILUC), proposed Soil Framework Directive

- Improving environmental performance of products and materials - Construction Products Regulation, Eco-design Directive, Type-approval of motor vehicles Directive, Illegal Timber Regulation, Product Environmental Footprinting (PEF).

- Improving consumer information for use and repair - Ecolabel Regulation, Energy Labelling Directive, Directive on the sale of consumer goods and associated guarantees, product quality and marketing standards, Regulation

- Producer responsibility for end of life products - Waste electrical and electronic equipment Directive (WEEE), Restriction of Hazardous Substances in Electrical and Electronic equipment Directive (RoHS), Batteries Directive, End-of-Life Vehicles Directive (ELV), Packaging and Packaging Waste Directive

Reducing carbon emissions - Renewable Energy Directive (RED), Renewables obligations, incentives and feed-in tariffs, Climate strategies & targets. Emissions Trading System (EU ETS)

- Regulations to limit landfill and reducing impact of waste - Waste Framework Directive (requirements for collection schemes), Waste Shipment Regulation, Animal by-products Regulations, Communication on future steps in biowaste management in EU, standards for compost and digestate

- Improving recycling of key materials - EU Structural and Cohesion Fund investment in waste collection infrastructures, PAYT systems, mandatory take-back requirements, Sewage Sludge Directive

- Restrict toxic substances in the environment - Directive on Industrial Emissions, VOC Solvents Emissions Directive, REACH Regulation, Nitrates Directive, Pesticides legislation (including Directive 2009/128/EC)

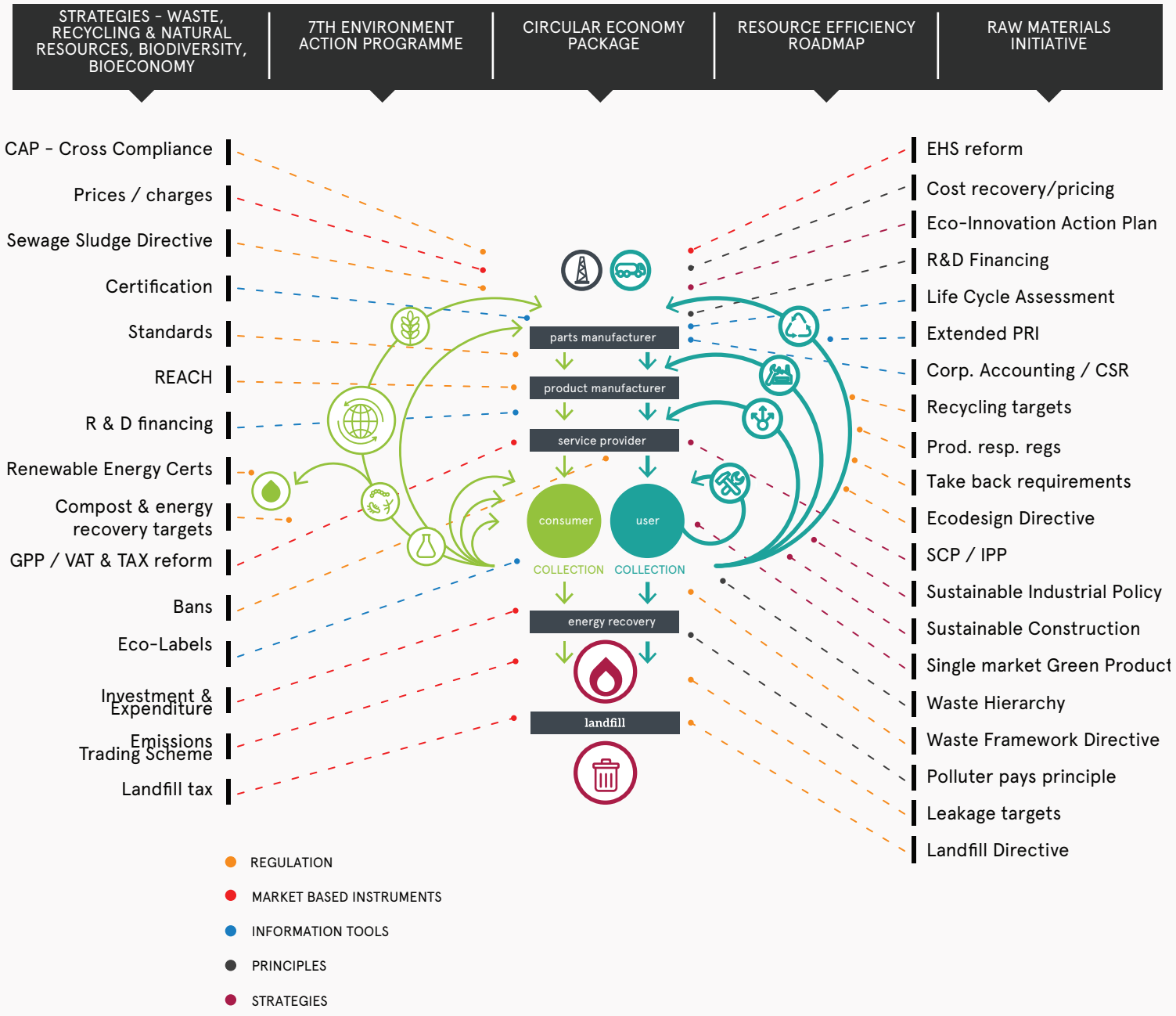
- Aside from existing regulations and interventions, the circular economy concept is integrated within EU policy strategies such as the 7th Environment Action Programme and the Green Action Plan for SMEs.

Figure 24 provides an overview of some key policies and initiatives that are already playing a role in different parts of the circular economy.

In a broad sense the Waste Framework Directive (EC 2008) provides the legal context for waste prevention and establishes the principle of the waste hierarchy.

This hierarchy places prevention before reuse, reuse before recycling, recycling before energy recovery and lastly disposal. This Waste Framework Directive required all member states to produce Waste Prevention Programmes by the end of 2013 (EC 2008)

Figure 24: Existing EU policy initiatives supporting the Circular Economy



A key challenge with many of the existing waste regulations is that they are incremental and material-based. One key step towards the systematic approach of dealing with the life cycle impacts of products and services can be seen in the European Commission's development of an Integrated Product Policy (IPP) in 2003. IPP promoted 'life-cycle thinking' and created a series of policy instruments such as the Ecodesign of Energy Using Products Directive.

Arguably IPP set some of the groundwork for the eventual publication of the Roadmap to a Resource Efficient Europe. This roadmap was adopted in 2011 and formed part of the Europe 2020 Strategy which was the growth strategy of the European Commission aimed at "establishing a smart, sustainable and inclusive economy with high levels of employment, productivity and social cohesion" (European Commission, 2012).

The Roadmap to a Resource Efficient Europe attempted to consolidate a number of strands of previous waste and resource efficiency legislation towards the principle of the circular economy.

The Roadmap was not a legislative framework in the sense that it did not place specific legal requirements on member states. Instead it began the process of establishing common benchmarks and national targets and preliminary indicators for measuring resource efficiency.

An output of the Roadmap was the European Resource Efficiency Platform, which comprised of stakeholders from politics, policy making, industry, civil society and academia. While the impact of this platform is unclear, it achieved in advancing the debate towards developing a more comprehensive programme for the circular economy.

At the same time the EU Raw Materials Initiative was being developed. This took a more comprehensive approach towards examining the future availability of raw materials that are essential to the EU and member states.

One important outcomes if this initiative was the identification of fourteen materials (mainly metals) that are critical and require consideration in terms of securing future supply. The initiative suggested that this securing of supply could be achieved through various approaches. This includes resource diplomacy that would facilitate a level playing field in terms of accessing materials from outside the EU, securing supplies within Europe and improving resource efficiency and recycling.

The initiative highlighted that one approach towards securing supply from within Europe includes the reopening of mines and more effectively accessing resources from urban mines. The initiative also provides a better evidence base on which the low yields of critical material recovery were highlighted.

These activities began to consolidate the debate towards developing a specific legislative for programme for the circular economy. This was accelerated because Horizon 2020, the EU's framework programme for research and innovation, included specific funding allocations for research related to 'circular economy' and 'Industrial Symbiosis'.

It must be noted that globally a number of regions such as Japan and China are already at an advanced stage in terms of policies for the circular economy. In 2000 Japan introduced the Fundamental Law for Establishing a Sound Material-cycle Society and the Law for the Promotion of Efficient Utilization of Resources.

This regulatory framework contains many features of the circular economy but includes advanced aspects such as Individual Producer Responsibility and has resulted in recycling rates for metals of 98%.

Circular Economy Package Phase 1

In 2014, under the guidance of Environment Commissioner Janez Potocnik, an initial Circular

Economy Package was published. This package included proposals to amend six waste-related directives and improve the overall coherence of EU waste legislation. These proposals were accompanied by a European Commission Communication "Towards a circular economy: A zero waste programme for Europe".

The proposal included new EU wide recycling targets and tightened rules on incineration and landfill. These targets included:

- 70 % recycling for municipal waste by 2030
- 80 % recycling of packaging waste by 2030
- Landfill bans from 2025 for plastics, metals, glass, paper, card and biodegradable waste.

In addition to these binding targets the Package included non-binding targets in relation to food waste (30 % reduction by 2025) and resource productivity (30 % increase by 2030).

It is important to note that this Package was published towards the end of the 2010-2014 Commission and it created widespread disagreement and debate. One the one hand some industry partners indicated that the ambitious targets for recycling and resource productivity were unachievable within the proposed timeframe and civil society organisations and NGOs were concerned with a limited focus on re-use and remanufacturing.

A key argument made against the recycling and resource productivity targets was that there was a lack of commonly agreed baseline data on which progress could be measured.

The new Junker Commission withdrew the package. This was partly in light of these debates but also a renewed desire to cut 'red tape' and simplify the regulatory context. There was also a desire within the Commission to more clearly position the circular economy within the context of commitments towards boosting jobs and growth by removing barriers to the development of new markets and business models.

The Commission also argued that the package "had a rather exclusive focus on waste management, without appropriately exploring synergies with other policies" (European Commission, 2015).

ANNEX B: CHALLENGES RELATED TO A CIRCULAR ECONOMY

Potential losers within the circular economy

While the various studies outlining the benefits of the circular economy are encouraging it is important to note that the transition to a circular economy will have winners as well as losers. The transition to a circular economy demands radical and systemic innovation over and above any current level of action.

This will have associated transition costs relating to investments in physical and knowledge infrastructures, dealing with economic "losers" in terms of sectors and technologies that will be phased out as well as more robust regulatory systems.

By way of example, at a basic level, the increase in reuse and repair will lead to fewer new goods being purchased. This may lead to a loss of income to product manufacturers, transporters and dealers that do not develop circular innovation strategies and business models.

Moreover, one needs to keep in mind the wider EU and global dimension as circularity does not have to be bound by the borders of a specific country, but should be conceived within the wider EU and global context at the same time.

For example, certain elements in the chain of circularity (e.g. remanufacturing) could take place outside the country of original manufacture. This has implications in terms of trade and governance that need to be taken into account.

General barriers to a circular economy

The barriers that restrict the transition to the circular economy are well documented. Some of these barriers exist due to typical market failures such as imperfect information, bounded rationality, weak price signals, split incentives across value chains and negative externalities but there are also social, institutional, organisational, governance, infrastructural and regulatory barriers.

It is important to note that these barriers manifest at the micro level in terms of underinvestment in circular economy business practices, competitive disadvantage from implementation or a lower level of appropriation of value.

While it is not the intention of this report to provide a detailed analysis of all barriers, key barriers include:

Governance and regulatory barriers

- Weak pricing and economic signals with regards commodity resources through subsidisation or externalisation of costs - these weak signals do not encourage more efficient resource use
- Poor or non-alignment of incentives across value chains (e.g. between consumers, producers and recyclers) - this leads to fragmentation of impact from interventions.
- Complexity of monitoring and reporting of environmental data - in particular this data needs to be provided to different suppliers,

customers and regulatory agencies
- Weak implementation of sustainable or circular public procurement in the public and private sectors
- Poorly structured support infrastructures for social enterprises e.g. reliance on seed capital and competition based financing
- A lack of coherence between policies creating disincentives and barriers (e.g. animal by-products Regulations and food waste, transboundary shipments of waste)
- The lack of recyclate standardisation and a lack of common end of waste protocols for businesses
- A lack of common standards for product-level circularity and low uptake of existing methodologies e.g. Product Environmental Footprint
- The currently high costs of sustainable certification, reporting and life cycle assessment

Technical barriers

- Underinvestment in and a lack of skills for circular product design that enables greater levels of re-use, repair remanufacture and recycling
- Fragmented maintenance chain - in particular the decline of repair and reuse infrastructure
- Poor systems of source separation of waste - in particular food waste, packaging
- A disconnect between supply and demand of reuse resources, products, and parts.

Organisational barriers

- A lack of internal capacity for circular design or business model innovation within businesses (SMEs in particular) leading to a reliance on external consultants. This incurs additional costs but there may also be a lack of available consultants in a region or sector
- Potentially poor appropriability in investment in circular design strategy or business models. For example, investment in product durability may result in value captured by third parties in secondary markets.
- Path dependency and lock-in to existing technologies and infrastructure - in particular with products, materials and recycling
- Information barriers
- Information asymmetries with regards cost-benefits and economic incentives across value chains
- Low but growing consumer and business acceptance of circular business models e.g. sharing, leasing, performance-based payment models
- Unfavourable perceptions of risk and benefits of circular business models among lenders and investors
- Retail practices - e.g. buy one get one free offers by food retailers
- Social practices locking in unsustainable behaviours - perceptions on product obsolescence, the growth and rigidity of urban mines

Infrastructural barriers

A key barrier in the Irish context is infrastructure. The circular economy requires different forms of infrastructure and if these are deficient or missing this can be a barrier to the circular economy. For example, the circular economy requires infrastructure for reverse logistics wherein products can be sourced for re-use, remanufacture or other forms of recycling.

This typically involves the physical infrastructure with regards warehouses, transfer stations and ports as well as the logistics providers. The typical recycling infrastructure is also required. For example, a barrier to the circular economy in Ireland is that the fact that there is no facility for glass manufacturing, paper mill or metal smelter.

There are challenges with regards the commercial viability of this infrastructure given the size of the Irish market and that the under-capacity

within mainland Europe, in particular for waste to energy facilities. It is not possible to prevent the shipment of waste out of Ireland and the low costs of incineration reduces the perceived viability of investment in recycling infrastructure in Ireland.

There is also a socio-technical dimension with regards to infrastructure in that the quality of recyclate can be a barrier to the efficient utilisation of existing infrastructure. For example, in 2011 the Rx3 report suggested that there was capacity to reprocess almost 320,000 tonnes of plastic yet this was not being utilised due to the segregation infrastructure (Rx3, 2011).

The Circular Economy Package seeks to tackle the deficiencies of earlier resource efficiency policies by addressing some of these market failures more systematically, by taking account of multi-level perspectives and interactions between measures across value chains. For example, the package seeks to address ineffective policy tools, a lack of common measures and discrepancies across member states (such as recycling systems and measurement), a lack of coherence between existing policy instruments and the variable nature of administrative burden across member states.

In addition to addressing these barriers, a key policy objective is the creation of optimal conditions that facilitate the creation of viable markets for secondary raw materials and the scaling up of circular business models. This objective should focus on bringing about environmental, economic and social benefits such as the creation of jobs, improved consumer protections, improved access to raw materials and reduced material extraction.

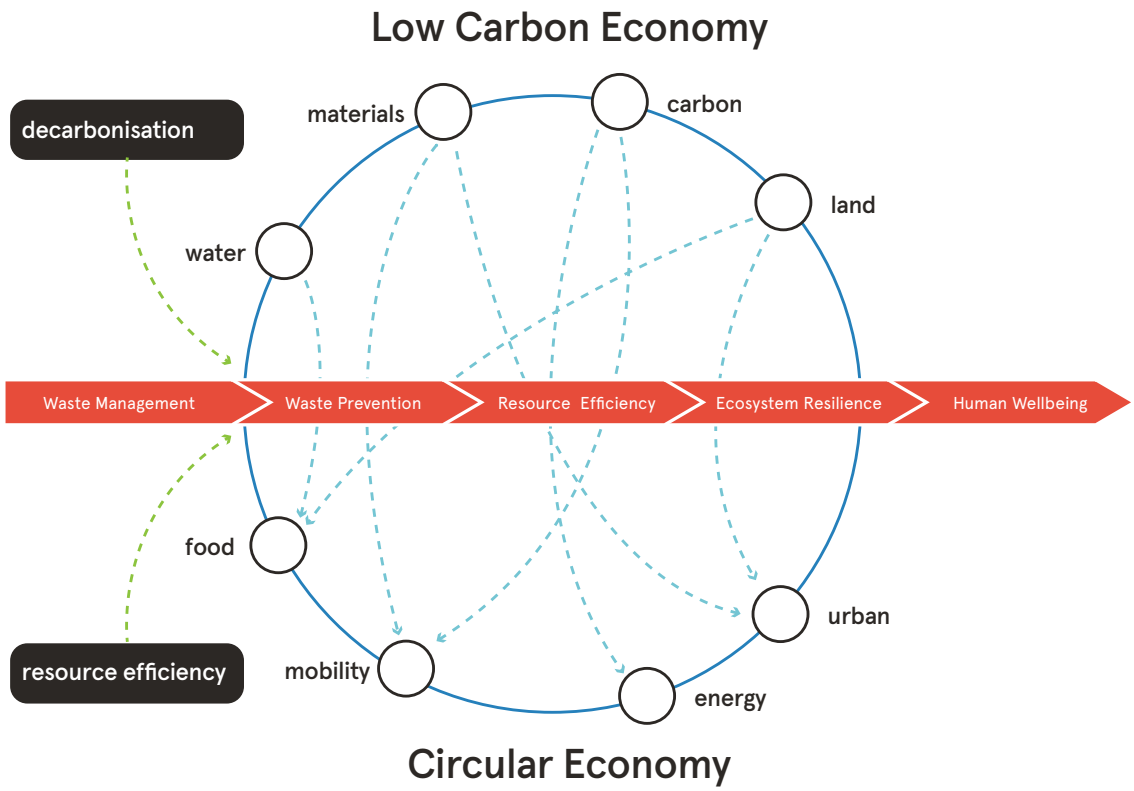
ANNEX 3: A SOCIO-TECHNICAL CHALLENGE

The circular economy can be described as a socio-technical challenge in that there are technical challenges with regards to harmonised systems for waste prevention, management and treatment alongside new individual behaviours, social practices and a more systemic shift towards 'circular business models'.

This shift needs to also consider planetary boundaries and the inter-relationships between economic development and the resilience of social-ecological systems. The circular economy demands integration across policy domains that are typically treated independently. At a basic level this includes alignment and integration between socio-economic policies and environmental policy domains such as energy, construction and engineering, resources and mobility.

Figure 25 highlights in basic terms how the circular economy can work alongside other policy domains in order to bring about shared outcomes.

Figure 25: Integration between Circular Economy and other policy domains



Additionally, a circular economy demands systemic changes across value chains such as changes to product and service design, new enabling technologies, new ways of extending product lifetimes and more effectively transforming waste into a resource.

The circular economy is therefore also a multi-level and multi-actor challenge in that it requires new relationships and forms of collaborations between governments, businesses, researchers, civil society and citizens. These new multi-actors also demand policy and public sector innovation at different policy levels and policy domains.

The circular economy has a temporal dimension in the sense that while it seeks to respond to existing ecological stressors for which there is sufficient evidence it also demands management of emerging risks and opportunities, for example socio-technical innovations and new social practices. This demands that existing retrospective and near-future environmental policies are augmented with foresight techniques.

In order to conceptualise the multi-level and temporal aspects of the circular economy it may be useful to consider the multi-level perspective as proposed by Geels (2011).

The multi-level perspective describes an analytical framework(s) that seeks to understand how societies, communities and businesses remain locked into particular pathways and embedded social and technical practices.

One key aspect of the multi-level perspective is that it considers the lock-in into particular socio-technical pathways to be driven by a combination of social, economic, cognitive, institutional and technological processes that sometimes collude to lock-out more sustainable practices.

Within the multi-level perspective, there are three primary scales of interest (Figure 26).

These include:

- Landscape: the macro-level structuring of the exogenous socio-economic context
- Regimes: the meso-level 'mainstream' arrangement of dominant structures that shape the system - that niches wish to change, or to react to
- Niches: micro-level 'protected spaces' for innovation and disruption from which new technologies or socio-technical practices emerge

While each level has distinct dynamics that are interdependent, it is important to note that research suggests that regimes can enforce a path-dependency that limits the diversity of innovations or favours incremental innovations (Garud and Karnoe, 2001). On the other hand, radical innovation tends to emerge from niches so the regime can limit the transformative potential of innovation.

Although only very briefly highlighted, what these multi-level and socio-technical perspectives suggests is that systemic policy challenges will have inherent uncertainties and this demands new approaches to policy development and implementation. It also underlines that in order to integrate environmental and social sustainability a paradigm shift in economic thinking and practice is urgently needed.

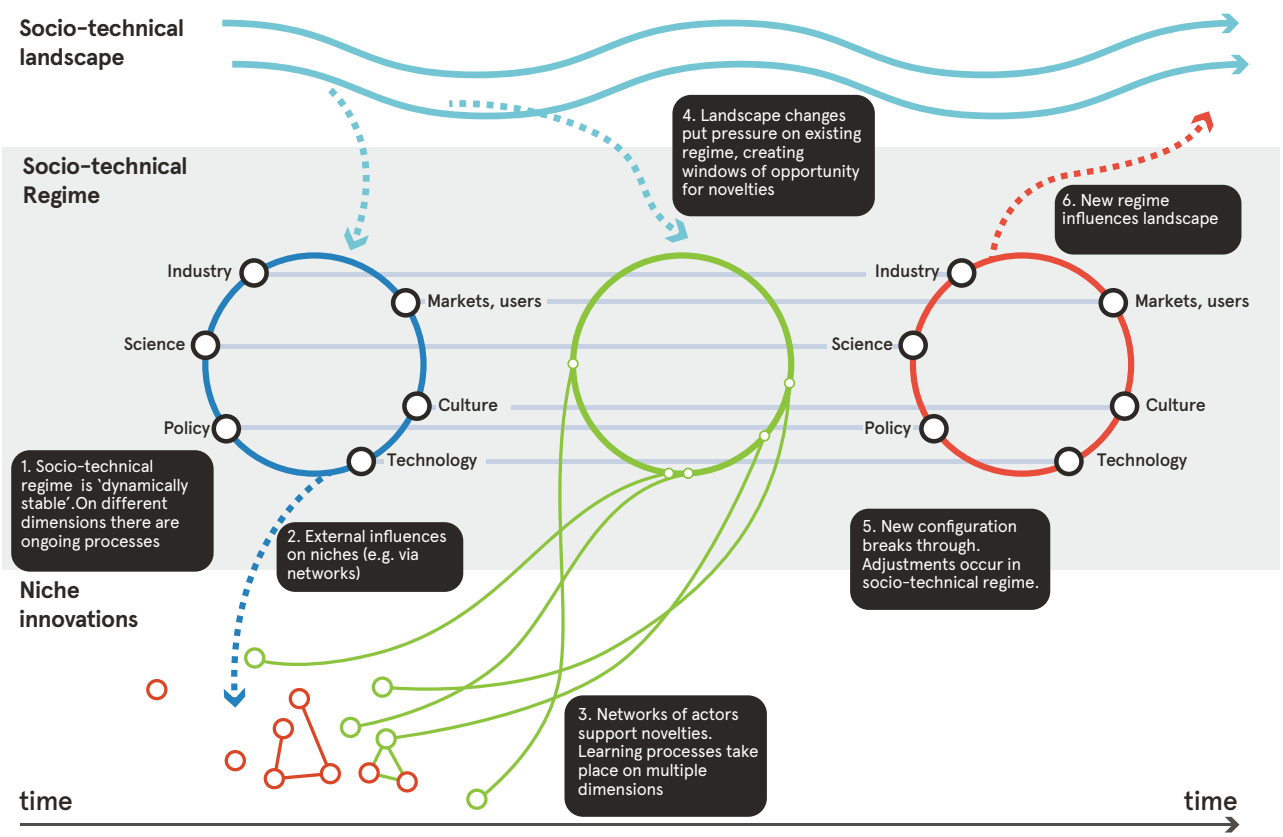
It is important to note that the circular economy concept is typically framed in micro-economic terms in the sense that it seeks to systematically make the flows of materials, exchange of goods and services and processes for dealing with waste more circular.

On that basis is fair to argue that, it in the manner it is currently framed in EU policy, it is not a new economic model but a restructuring of the existing model based around the more efficient use of resources.

This point is often contested in the sense that the circular economy seeks to overcome deeply ingrained tensions in the pursuit of sustainable development within the context of existing economic systems. In a broad sense, the circular economy will share many common characteristics as other models such as the green economy and industrial symbiosis.

While much of the focus of the circular economy debate revolves around material flows and waste, there are also significant socio-economic dimensions. For example, there are well-understood interactions between the use of natural resources, human health and well-being, and the functioning of ecosystems in trade goods and services.

Figure 26: Multi-level perspective - adapted from Geels



ANNEX 4: MULTI-LEVEL INTERVENTIONS FOR THE CIRCULAR ECONOMY

Annex 4 of this report outlines a number of the common policy interventions for the circular economy. Many of these interventions have emerged from various policy frameworks for waste and resource efficiency.

As mentioned above, one of the features of the circular economy is that it is activating a range of multi-level interventions that are both top-down and bottom-up. In order to further illustrate this point, this section provides a brief snapshot of four interventions occurring at different levels. It is worth noting that these interventions have been developed without and agreed Circular Economy Package in place.

National level: The Netherlands government-wide programme for a circular economy

The Netherlands has often been a front-runner with regards sustainable development, resource efficiency and sustainable consumption and production. In September 2016, the government of the Netherlands invested €27 million in a new national programme for a circular economy. This programme called "A circular economy in the Netherlands by 2050" sets out the national ambition of by 2030 reducing primary natural resource consumption (minerals, fossil fuels and metals) by 50%.

The programme sets out a framework of measures to "future-proof" the economy of the Netherlands. In addition to broader measures for using resources efficiently the government is developing actions that will assist in making sure products and materials are designed in such a way that they can be reused with a minimum loss of value.

The Government of the Netherlands has a strong policy and regulation foundation in which to build this circular economy programme. Some of the previous programmes and interventions that have been in place include:

- From Waste to Raw Material
- Biomass Vision 2030
- Value Chain Agreement for Plastic Recycling
- Green Deal Sustainable Concrete Chain
- "100-100-100" project for municipalities

The "100-100-100" project aims to make citizens aware of the amount of raw materials in their waste. Each municipality challenges 100 residents or families to separate their waste 100% for 100 days. This was delivered in 29 municipalities with 3000 households in 2016.

The government has been sending increasingly less non-recyclable residual waste to incineration plants. In 2014, 82% of paper and cardboard was recycled and 94% of metal was recycled, well above the European and national targets.

The new national programme for the circular economy has five priority areas for implementation. These include:

1. Fostering legislation and regulations

This involves better understanding the dynamics between regulatory drivers and barriers. The

government has been working to remove regulatory barriers to the circular economy and to date has removed 80 regulatory barriers. These barriers related to issues such as the reuse of products, classifications of waste and refurbishment of large equipment and products.

This priority area also addresses specific issues such as circular product design, circular business models and product reuse.

2. Intelligent market incentives

This broadly relates to improving market incentives and pricing regimes to favour circular business models. It will include making adjustments to some instruments of tax law, levies and subsidies in order to facilitate the transition to a circular economy.

It will also address issues such as circular government procurement by incorporating total cost of ownership and social issues in purchasing guidelines. The government will also improve the tendering of waste management contracts. They have already been successful in pushing up the quantities of source separation.

3. Financing

The government of the Netherlands are keen to leverage private sector finance to develop the circular economy. The three main Dutch banks (ABN-AMRO, RABO and ING) published a joint statement on the necessity to support circular entrepreneurship. The government will also be undertaking a review of the knowledge within existing financial products and risk management approaches in light of the circular economy.

The intention is to support the financing of commercially and technologically sound projects that are currently difficult to finance. This includes developing infrastructure for the bio-economy such as bio-refineries.

4. Knowledge and innovation

The government is reviewing the national knowledge and innovation agenda in 2017 in collaboration with scientific institutes and other research providers. Through this the government intends to increase the focus on the circular economy in relevant sections of the Dutch National Research Agenda. The government are explicit in aiming to increase access to the €650 million euros that has been allocated under Horizon 2020 for circular economy related research.

As part of this overall approach to improving access to knowledge and data, Statistics Netherlands and the National Institute for Public Health and the Environment are developing accessible national data sets relevant to the circular economy. This will build on data such as the natural capital accounts and Natural Capital Atlas.

5. International cooperation

The government recognises the need to have an international perspective and help to create the proper international conditions for the transition to a circular economy. They are already supporting the application of the Natural Capital Protocol via the World Bank and International Finance Corporation alongside the use of natural capital accounts by government.

To build on this, the national programme will invest international partnerships that facilitate the transition to the circular economy. This includes increasing the number of international green deals such as the recently launched North Sea Resources Roundabout.

Sub-national level: Glasgow City as a 'Circular Economy Hotspot'

One of the recent developments with regards strategies for the circular economy has been the move towards developing interventions at the sub-national level. This includes strategies that focus specifically on regions and cities. For example, the Ellen McArthur Foundation recently launched a peer-referral Circular Cities network and research hub in collaboration with University College London.

This network launched initially with nine cities: Austin, Boulder, Copenhagen, London, Ljubljana, New York City, Peterborough, Phoenix and Rio de

Janeiro. There may be challenges with this scale of intervention given the global dimension of value chains and the relationship between local and national or transnational governance. Having said that, cities and regions may act as a useful context in which niche innovation and social practice can be facilitated before scaling out.

One of the key rationales for focussing on cities is that estimates suggest by 2050 75% of the global population will be based in cities. Cities are already responsible for 75% of natural resource consumption and 60-80% of greenhouse gas emissions (UCL 2015, UNEP, 2012).

Cities also often have plentiful under-utilised resources. For example, in London there are 57,000 empty homes and there are various potential interventions that could help to make use of these resources.

The Scottish Government has taken a proactive approach towards developing policy interventions and innovation support programmes to accelerate the circular economy. Through Zero Waste Scotland the government has already produced a national strategy on the circular economy and has developed an £18 million circular economy innovation fund for SMEs.

This innovation investment fund is co-financed by the Scottish Government and the European Regional Development Fund. The fund will invest in the feasibility testing and scaling up of products, technologies and business models that will assist in the transition to the circular economy.

The Scottish national strategy identified key action areas for job creation through the circular economy. For example, the Scottish government identified that remanufacturing is worth £1.1 billion to the Scottish economy and with appropriate policy interventions that could increase to £1.7 billion and add 5,700 new jobs.

In addition to the overall strategy Zero Waste Scotland has partnered with the Glasgow Chambers of Commerce to develop a strategy to make Glasgow, Scotland's largest city, a 'Circular Economy Hotspot'. The implementation of this will involve a series of actions and interventions such as undertaking a review of city level resources, energy and financial flows, capacity building with key city level influencers and the delivery of specific pilot projects relevant to the Glasgow economy.

Intermediary level: Ontario circular economy Innovation Lab (CEIL)

The last decade has seen the growth of policy labs and other public sector innovation units around the world. Typically these policy labs are located within national or local government or are independent but work with government departments and agencies.

While policy labs take various forms and scale they are characterised by their experimental, creative and citizen-centred approach to developing policies and public services. They are often interdisciplinary and involve designers, social and political scientists and artists in working with citizens or other stakeholders to develop alternative solutions to policy challenges.

Although diverse they are often applying methods such as design thinking, behavioural insights and foresight along side more traditional methods of policy development such as programme evaluation. Another characteristic of labs is that they seek to develop participatory and problem-solving attitudes in order to co-create solutions with those groups most impacted by policies.

While the majority of policy labs have some national or sub-national focus the European Commission recently launched an EU policy lab. This lab is managed by the Joint Research Centre and is delivering projects on topics as diverse as the sharing economy, advances and experiments in participatory sensing and the implementation of EU regional policy.

Building on these perspectives of policy labs, the Ontario Circular Economy Innovation Lab (CEIL) is a new multi-level lab that is bringing together private and public sector leaders and innovators to develop approaches to implementing the circular economy in Canada. The CEIL launched in June 2016, will run for four years and is managed

by The Natural Step. Like most policy labs, the CEIL process is iterative and has a number of aspects that will occur over different timeframes. For example, it will involve short focussed labs on specific issues (similar to design sprints in the private sector) that focus on specific circular economy challenges as well as 12-month fellowships wherein individuals (leader in business, public sector) will receive more in depth training.

The lab will explore the best options within the Canadian context for accelerating the transition to the circular economy. The focus is predominantly on building commercial and policy capacity within Canada for the development of circular economy solutions.

It must be noted that these solutions will not just be commercial solutions but include new programmes, standards, partnerships, business models and policies.

There are some shared characteristics with interventions delivered in the late 1990s in the context of Integrated Product Policy. For example, Product Panels were interventions delivered in Scandinavia that brought together public, private and civil society actors to address sector specific environmental challenges.

There was some evidence that these interventions were successful, primarily due to their sub-national dimension and sectoral focus. The sub-national dimension reduced the complexity of the intervention and facilitated implementation.

Aside from the novel process of the CEIL, one of the aspects of note is that the focus is on identifying actions that can be implemented within the Ontario context while having stakeholders that have global value chains.

One of the challenges with the Circular Economy Package is that that is a comprehensive framework that may not account for national or sub-national variations with regards policy capacity, priority sectors and material flows.

Bottom-up: Open Source Circular Economy Days

Open Source circular economy Days (OSCEdays) is an open network of individuals interested in collaborating, developing projects and sharing knowledge and resources in the circular economy. The primary focus of the network is to stimulate a debate and practical action towards a circular economy and the use of Open Source principle, methodologies and technologies.

While OSCEdays is a global network of volunteers and enthusiasts, it is lead by a team of 12 individuals. This team is interdisciplinary and includes engineers, designers, artists, economists and business consultants. OSCEdays also has partnerships with 25 organisations such as Fab Labs, Waste Management companies, Open Source networks, Maker Spaces and circular economy Labs.

The OSCEdays started in June 2015 as an event that was convened online but made up of individual events in 33 cities around the world. The second event happened 12 months later and involved events in 73 cities.

To date, OSCEdays projects have been exploring topics such as Open Source business models, the role of Open Hardware (e.g. Open Energy Monitors) and circular behaviours. While there are broad themes, the groups in each city that participate explore topics relevant to that city by connecting with local projects across a range of sustainability themes.

OSCEdays is also collaborating with the Ellen McArthur Foundation in delivering the Disruptive Innovation Festival. This festival of the circular economy is supported by the foundation partners such as Google, Unilever, Philips and Renault but is also delivered with a range of grassroots organisations such as OuiShare (sharing economy), Wired (technology news), Springwise (Entrepreneurship network) and CollabAmerica (Social Innovation network in Brazil).

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