January 2022

CIRCULAR ECONOMY HANDBOOK FOR UNIVERSITIES

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First Edition, 2022.

ISBN 978-9941-498-60-2

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Prepared by: Dr. Dariusz Prasek

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Dr. Dariusz Prasek

Doctor in Environmental Engineering, Independent International Expert in Sustainable Financing, Environmental, Social and Governance Areas. Former Director of Operations in Environmental and Sustainability Department of the European Bank for Reconstruction and Development

BIOGRAPHICAL INFORMATION

Dr. Prasek is an independent consultant in sustainable financing, environmental, social and governance areas with an experience in around 4000 investment projects across a number of sectors. Till recently he held a position of a Director of Operations at the Environment and Sustainability Department in the European Bank for Reconstruction and Development (EBRD). He was responsible for coordinating environmental and social due-diligence and monitoring of various Bank's investment operations. Dr. Prasek has been the key contributor to the development and implementation of the EBRD's Green Economy Transition Strategy which includes the implementation of the provisions of Circular Economy in the Bank's supported projects. Before joining the Bank, he was an Advisor for the United Nations Conference on Environment and Development (Earth Summit). Dr. Prasek holds a Ph.D. in environmental engineering from the Warsaw University of Technology, and from 1987 to 1991 was Assistant Professor at that university's Institute of Environmental Engineering. Dr. Prasek has published numerous articles in the fields of solid waste management, circular economy, environmental management, environmental aspects of project financing and is a member of many professional organizations. Dr. Prasek is a member of the United Nations Advisory Board on Circular Economy and Independent Expert on Development Financing at IDB Invest.

Contents

Acronyms and Abbreviations

APC	Australian Packaging Covenant
ASEAN	Association of Southeast Asian Nations
B&A	Batteries and accumulators
CCEA	Chinese Circular Economy Association
CE	Circular economy
CIM	Circular innovation model
CPG	Consumer packaged goods
CUM	Circular use model
EC	European Commission
EIB	European Investment Bank
ELV	End-of-life vehicles
EMF	Ellen MacArthur Foundation
EPR	Extended Producer Responsibility
EU	European Union
EU28	European Union
EUR	Euro
FMCG	Fast-moving Consumer Goods
GDP	Gross domestic product
GHG	Greenhouse gas
GoG	Government of Georgia
GPPR	Global Plastic Packaging Roadmap
ICT	Information and communication technology
IFRS	International Financial Reporting Standards
IoT	Internet of Things
kg	Kilogram
KPI	Key performance indicator
LCA	Life-cycle assessment
LWRB	London Waste and Recycling Board
MRF	Material sorting facility
MoEPA	Ministry of Environmental Protection and Agriculture of Georgia
NGFS	Network for Greening Financial Systems
OECD	Organisation for Economic Co-operation and Development
PACE	Platform for Accelerating the Circular Economy
PSS	Product-service system
R&D	Research and Development
RDI	Research, Development and Innovation
SDGs	Sustainable Development Goals
SIDA	Swedish International Development Cooperation Agency
SMEs	Small and medium-sized enterprises
TCFD	Task Force on Climate-related Financial Disclosures
TCO	Total Cost of Ownership
TEG	Technical Expert Group
UK	United Kingdom
UN	United Nations
VAT	Value-added tax
WEEE	Waste electrical and electronic equipment
WEF	World Economic Forum
WISP	Western Cape Industrial Symbiosis Programme

Foreword from the Author

The transition to a circular economy requires a radical change in the way we produce and consume. Products are designed for durability, upgradeability, reparability and reusability. Companies develop new business models generating revenue streams from services rather than products, while making more efficient use of resources and materials, and consumers use products efficiently and discard them in such a way that they can be turned into secondary materials that can enter a new production-consumption cycle. The circular economy concept is gaining attention in light of increasing consumption and resource use by a fast-growing population with rising standards of living. This is a new economic model that represents sustainable progress towards efficient green growth. Due to its expected environmental, climate, social and economic benefits, the circular economy is not only being strongly promoted by the EU institutions, as well as a growing number of national and local governments but it is also attracting increasing attention from the business community and from public and private financiers.

Like with any systemic change, the transition to the circular economy requires several elements of the system to change simultaneously. The inertia and resistance of the current linear economic systems prevent the transition from occurring. Concerted actions by a host of stakeholders are needed for change. Governments at all levels, businesses, innovators, academia, investors and consumers all have to play their distinct roles and contribute to the process. The recent years have seen a rapid development of the circular economy business models such as resource recovery, remanufacturing and product life extension, sharing and product-service. However, the market penetration of circular business models remains limited and there is a considerable scope for their future growth. Such growth should be supported by a well-functioning, non-distortive policy and regulatory framework, which ensures a level playing field for circular economy business models by eliminating legacy subsidies that reward linear behaviours and by fully pricing in risks and externalities associated with the linear production and use of materials. Such a framework facilitates and accelerates the allocation of capital to circular investments and activities. It stimulates private sector finance and allows optimal leverage of public funding.

There is a general consensus among many experts that in spite of the fact that there are several examples of effective EU, national such as the Netherlands, Sweden, Denmark and Finland and regional policies and programmes which support the increasing ‘circularity’ of economic systems, the existing policy frameworks and skills of the policy makers are insufficient to achieve a meaningful acceleration for the transition to the circular economy.

Various expert groups have identified several key recommendations to achieve concerted actions in the acceleration of the circularity measures. One of the common themes in these recommendations is the need to educate experts who would be in a position to develop taxonomy, implement circular economy standards and assess circular risks versus linear risks. Also, social and environmental benefits of the circular economy should become more explicit, quantifiable and disclosed, and should be taken into account in financing decisions. Work also has to be undertaken to set circular economy performance requirements for products and services.

Universities and other educational entities can play an important role in creating circular businesses. The principal objective should be to succeed in educating experts in a variety

of areas to correctly identify, conceptualise and develop circular business models and projects that are both sound and bankable, and congruent with a long-term development vision and strategy for the transition to the circular economy. These experts can advise and improve the economic viability and bankability of projects; and visualise collaborative arrangements within the supply chain to fully embrace the circularity principles, to ensure circular business models become the best option for companies willing to gain competitive advantage and maintain their market share while aligning their goals with society's goals. Awareness-raising both at the level of internal organisations and external stakeholders is crucial in this context.

The circular economy is not the responsibility of a chosen few. We all have the right to participate in the creation of a sustainable future. Circular economy education is not aimed at educating special experts in the circular economy. The objective is that in the future all of us will need to have sound knowledge of circular economy principles and basics, and to know how to implement circular economy solutions in our respective areas of expertise.

The Handbook provides basic information on the transition from linear to circular models with examples of several sectors. Particular emphasis has been put on skills and conditions required for financing circular economy projects, removing barriers and identifying main areas with high circularity potential.

This Handbook is intended for students and teachers of universities and other educational entities to provide initial information on the circular economy, and raise the level of awareness and skills required to incorporate circularity principles in a variety of economic activities they will be engaged in future. Practical examples of successful sectoral and country-wide policy interventions that promote the circular economy and references to the most recent sources of information on the circular economy make it valuable in the education process.

The Handbook has been prepared as part of the ongoing circular economy programme being implemented by the civil society organization Georgian Society of Nature Explorers "Orchis" supported by the Government of Sweden. This programme is the basis for the Georgia's accelerated shift to circularity. It is also a vital contribution to fulfil Georgian commitments under the Association Agreement with the European Union.

The author would like to express his sincere thanks to the Embassy of the Kingdom of Sweden in Tbilisi and the Georgian Ministry of Environment Protection and Agriculture for their invaluable comments and suggestions. Particular thanks go to Erik Illes, Head of the Swedish International Development Cooperation Agency / Deputy Head of Mission, Khatuna Zaldastanishvili, Programme Officer of the Swedish International Development Cooperation Agency and to Professor Solomon Pavliashvili, Deputy Minister of Environment Protection and Agriculture.

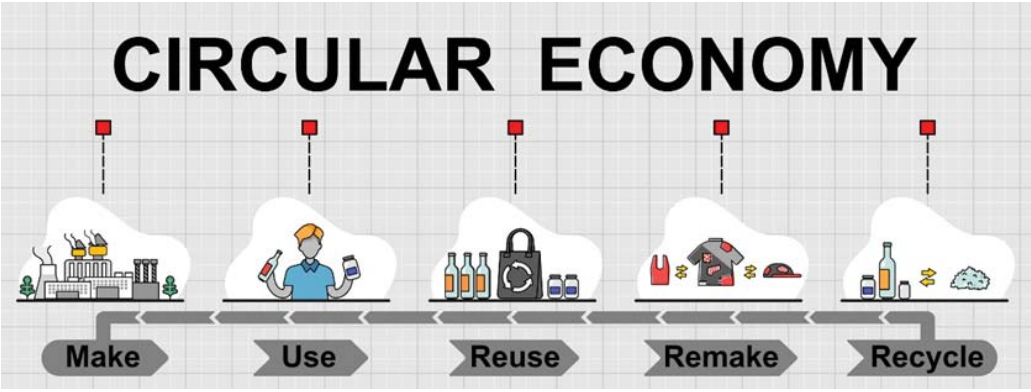
1 Definition

The circular economy (CE) is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In practice, it implies reducing waste to a minimum.

A circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the 'take-make-waste' linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources.

Circular development is a model of socially and environmentally responsible production and consumption that aims to build a sustainable society based on a circular model. The purpose is to be able to form a model that is no longer linear and transform towards a circular economy. This new form of society is based on the principle of circular economy. The aim is to enable economies and societies in general to become more autonomous, sustainable and in tune with the issue of environmental resources.

The circular economy is a framework of three principles, driven by design: **(i) Eliminate waste and pollution; (ii) Keep products and materials in use; and (iii) Regenerate natural systems.** It is based increasingly on renewable energy and materials, and it is accelerated by digital innovation. It is a resilient, distributed, diverse, and inclusive economic model. The circular economy is an economic concept often linked to the sustainable development, provision of the Sustainable Development Goals and the Green Economy but which goes further than the latter. Indeed, rather than only think to reduce the ecological and environmental impact of the industries and the amount of waste, it aims to transform our economy into one that is regenerative. In other words, the goal is to make the economy as circular as possible, by thinking to new processes and solutions for the optimization of resources, decoupling reliance on finite resources.



Definition

The principles of the CE concept include the 3Rs (reduce, reuse, recycle) and the 6Rs (reuse, recycle, redesign, remanufacture, reduce, recover).[1] The circular economy includes products, infrastructure, equipment and services, and applies to every industry sector. It concerns 'technical' resources (metals, minerals, fossil resources) and 'biological' resources (food, fibres, timber, etc.). Most schools of thought advocate a shift from fossil fuels to the use of renewable energy, and emphasize the role of diversity as a characteristic of resilient and sustainable systems. The circular economy includes discussion of the role of money and finance as part of the wider debate, and some of its pioneers have called for a revamp of economic performance measurement tools. Some studies point out how modularisation could become a cornerstone to enable circular economy and enhance the sustainability of energy infrastructure.

1 Jawahir IS, Bradley R. Technological elements of circular economy and the principles of 6R-based closed-loop material flow in sustainable manufacturing. Procedia CIRP 2016;40:103–8.

2 History

The notion of circularity has deep historical and philosophical origins. The idea of feedback, of cycles in real-world systems, is ancient and has echoes in various schools of philosophy. It enjoyed a revival in industrialised countries after World War II when the advent of computer-based studies of non-linear systems unambiguously revealed the complex, interrelated, and therefore unpredictable nature of the world we live in – more akin to a metabolism than a machine. The circular economy concept has deep-rooted origins and cannot be traced back to one single date or author. Its practical applications to modern economic systems and industrial processes, however, have gained momentum since the late 1970s, led by a small number of academics, thought-leaders and businesses. With current advances, digital technology has the power to support the transition to a circular economy by radically increasing virtualisation, de-materialisation, transparency, and feedback-driven intelligence.

The idea of circular flow for materials and energy is not new, appearing as early as 1966 in the book by Kenneth E. Boulding[2], who explains that we should be in a "cyclical" system of production. For its part, the term "circular economy" appeared for the first time in 1988 in "*The Economics of Natural Resources*"[3]. This notion was developed further, following three major events: the explosion of raw material prices between 2000 and 2010, the Chinese embargo on rare earth materials and the arrival of the economic crisis. Today, the climate emergency and environmental challenges have strongly influenced and pushed companies and individuals to rethink their consumption and production patterns. One of the answers to these challenges is presented by the circular economy model. Thus, new modes of production and consumption are emerging with the main objective of generating billions of dollars while controlling and reducing environmental consequences.

In their 1976 research report to the European Commission, "The Potential for Substituting Manpower for Energy"[4], Walter Stahel and Genevieve Reday sketched the vision of an economy in loops (or circular economy) and its impact on job creation, economic competitiveness, resource savings and waste prevention. The report was published

2 Boulding, Kenneth E. (March 8, 1966). "The Economics of the Coming Spaceship Earth" (PDF). In H. Jarrett (ed.) *Environmental Quality in a Growing Economy*, Resources for the Future, Johns Hopkins University Press, Baltimore, MD, pp. 3-14.

3 Kneese, Allen V. "The Economics of Natural Resources." *Population and Development Review* 14 (1988): 281–309. https://doi.org/10.2307/2808100.

4 https://www.researchgate.net/publication/40935606_Jobs_for_tomorrow_the_potential_for_substituting_manpower_for_energy

in 1982 as the book "Jobs for Tomorrow: The Potential for Substituting Manpower for Energy".

Ellen MacArthur Foundation (EMF), which was set up in 2010, partnering with a number of large companies and the McKinsey consultancy, produced in 2013 three publications 'Towards the Circular Economy'[5], the first of which contained the celebrated 'butterfly' diagram, which is reproduced in Figure 1. The report identified the key building blocks in making the transition to a circular economy, namely in skills in circular design and production, new business models, skills in building cascades and reverse cycles, and cross-cycle/cross-sector collaboration.

The Foreword to the report was written by Janez Potocnik, then European Commissioner for the Environment. In mid-2015 Potocnik introduced his Circular Economy Package[6] from the European Commission, by when it was clear that the concept had arrived in the mainstream – in business (through EMF) and politics.

In 2015, the European Commission adopted its first circular economy action plan. It included measures to help stimulate Europe's transition towards a circular economy, boost global competitiveness, foster sustainable economic growth and generate new jobs (See chapter 3.6).

Subsequently, the European Commission adopted the new Circular Economy Action Plan (CEAP)[7] in March 2020. It is one of the main building blocks of the European Green Deal, Europe's new agenda for sustainable growth. The EU's transition to a circular economy will reduce pressure on natural resources and will create sustainable growth and jobs. It is also a prerequisite to achieve the EU's 2050 climate neutrality target and to halt biodiversity loss. The new action plan includes initiatives along the entire life cycle of products. It targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented and the resources used are kept in the EU economy for as long as possible.

5 https://ellenmacarthurfoundation.org/towards-a-circular-economy-business-rationale-for-an-accelerated-transition

6 https://ec.europa.eu/environment/topics/circular-economy/first-circular-economy-action-plan_en#:~:text=In%202015%2C%20the%20European%20Commission,growth%20and%20generate%20new%20jobs.

7 https://ec.europa.eu/environment/strategy/circular-economy-action-plan_en

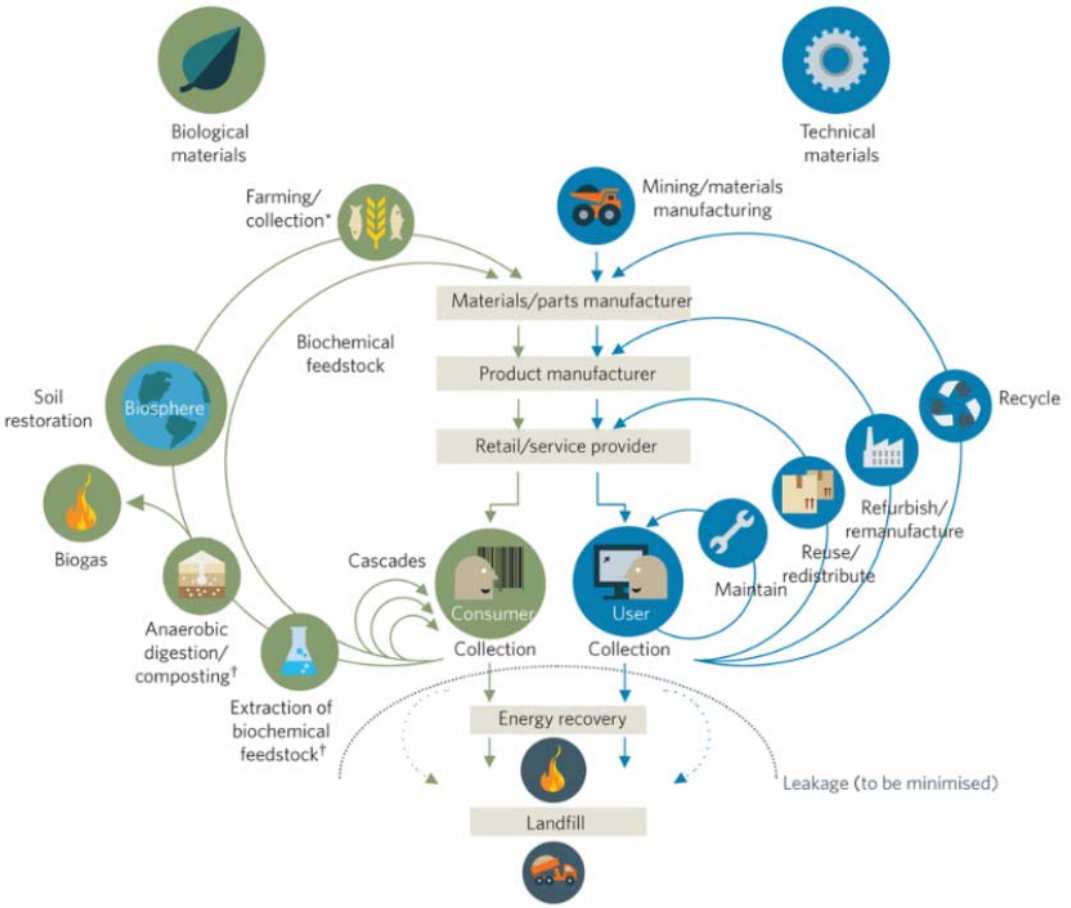


Figure 1. The Ellen MacArthur Circular Economy System Diagram

3 Circular Economy Background

Our current linear 'take-make-use-dispose' economy originates in the second industrial revolution, which generated considerable growth in prosperity in the years following the Second World War, but also increased resource use and propagated a consumption and throw-away society. The turn of the millennium saw the reversal of a 100-year trend with natural resource prices decreasing steadily in parallel to economic growth. Since then, real commodity prices have risen in tandem with economic growth and have thereby increased the focus on resource efficiency and security of supply.

While recessions in recent years have temporarily reversed these trends, price volatility and uncertainty remain. With expected future global population growth of about 500-750 million per decade, accompanied by rapid growth in living standards and purchasing capacity in less developed areas, it is predicted that material resource use may double between 2020 and 2050. This raises concern that the earth's finite resources may not be sufficient to sustain the expected increases in consumption and wasteful resource use. The increasing raw materials consumption also increases the costs and related externalities of extraction and transport of resources from more remote and less accessible deposits. Furthermore, it has been estimated that 20% of global material extraction ends up as waste.

In a fully circular economy, the concept of waste is minimised to the extent possible by carefully rethinking and designing products and industrial processes so that resources are kept in use in a perpetual flow, and by ensuring that any unavoidable waste or residues are recycled or recovered. The Ellen MacArthur Foundation has described the circular economy in a system diagram, shown in Figure 1, which comprises two material cycles: a biological cycle, in which residues are returned to nature after use, and a technical cycle, where products, components or materials are designed and marketed so that to minimise wastage. Such a circular system aims at maximising the use of pure, non-toxic materials and products designed to be easily maintained, reused, repaired or refurbished to extend their useful life, and later to be easily disassembled and recycled into new products, with minimisation of wastage at all stages of the extraction-production-consumption cycle.

This circular way of producing and consuming enables a decoupling of economic growth from extraction and consumption of materials. As such, a circular economy offers a way to hedge future resource and material supply risks for companies and increase their resilience to decreasing supplies and increasing price uncertainty and volatility. This will reduce resource dependency and – particularly by spurring innovation – also support competitiveness. It is also argued that the circular economy presents an opportunity for economic and industrial renewal with associated investment needs.

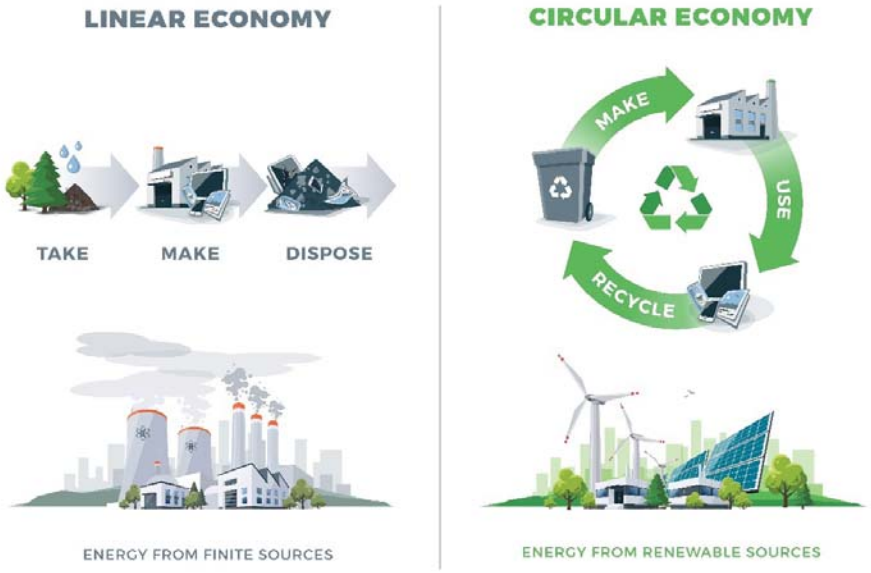


Figure 2. Linear economy vs Circular economy

3.1 Why We Need to Become Circular

The circular economy concept is gaining attention in light of increasing consumption and resource use by a fast-growing population with rising standards of living. Circularity refers to the circular flow and efficient use and reuse of resources, materials and products. This is a new economic model that represents sustainable progress towards efficient green growth, moving from a consumption and disposal-based linear model to extending the life and use of products and materials, and minimising wastage. Due to its expected environmental, climate, social and economic benefits, the circular economy is not only being strongly promoted by the European Commission and other EU institutions, as well as a growing number of EU Member States and cities, it is also attracting increasing attention from the business community and from public and private financiers. The circular economy clearly goes beyond resource efficiency and recycling, and provides the framework to develop new business models aimed at increasing the value, use and life of materials, products and assets and designing out waste from production and consumption.

Adopting the circular economy has a potential to put economies on the road to transformation to an economic system that uses natural resources in the most efficient way, preserves the value of materials and products by using them circularly, and reduces the negative impact of economic activities on the environment and health. Applying circular economy approaches can cut industrial emissions, reduce the production of and exposure to hazardous substances, and contribute to climate change mitigation. With its truly symbiotic effects on the economy and the environment, the circular economy is a way of achieving at least 12 out of 17 of the UN Sustainable Development Goals (SDGs).

Figure 3. The Circular economy can contribute to achieving at least 12 out of 17 of the SDGs

3.2 How Do We Start to Introduce Circularity

The transition to a circular economy requires a radical change in the way we produce and consume. In a circular economy, products are designed for durability, upgradeability, reparability and reusability, with a view to reusing materials from which they are made after they reach the end of their life. In the use phase, products are managed with a view to maximizing their utilization capacity and extending their useful life, thus maintaining their value for as long as possible. This is made possible by companies that develop new business models generating revenue streams from services rather than products while making a more efficient use of resources and/or giving new value to end-of-life products and materials. Consumers use products efficiently and discard them in such a way that they can be reused or, if this is technically or economically unfeasible, recycling operators turn them into secondary materials that can enter a new production-consumption cycle. This needs to be supported by the whole ecosystem - from enabling technologies and infrastructures to a form of market organization - that facilitates collaboration along and across value chains, and a form of governance and regulation that encourages companies to adopt circular approaches to social norms that make circular production-consumption patterns socially preferable. This paradigm is in contrast with the linear economy which is based on the 'take-make-use-discard' model - a model which maximizes the amount of products produced and sold, but does not focus on preserving materials. Such an approach prevents effective collaboration along value chains and stimulates the 'throw-away' consumer culture, with its noxious environmental consequences.

Like with any systemic change, the transition to a circular economy requires several elements of the system to change simultaneously. The inertia and resistance of the current linear economic systems prevent the transformation from occurring. Concerted actions by a host of stakeholders are needed for change: government at all levels,

businesses, innovators, academia, investors and consumers all have to play their distinct roles and contribute to the process.

The transition to a circular economy is at an early stage even in the most developed countries of the World. Despite circularity being firmly on the global and national agendas, and many public and private initiatives being developed, the Circularity Gap Report 2020[8] found that the circularity of the world is going in reverse. The global economy is only 8.6% circular, compared to 9.1% two years ago. The activities of economic operators are influenced by the systems that have been developed and optimized for the prevailing linear production and consumption. Regulations, markets, investment tools and practices, including financial risk assessment, are adjusted to linear models, and externalities linked to linear business models are largely not taken into account. This poses a problem for emerging circular models, which have to contend with the challenge of accessing finance, as the financial sector sees circular projects highly risky and often not bankable. When measuring risks, two main factors have to be taken into account: the first is the creditworthiness of the borrower (or the risk profile of the project), while the second is the value of the collateral (e.g. underlying assets or contracts). As new circular businesses often do not have a strong track record, these companies can easily be labelled as highly risky. Often initial investments to innovate and access the market are high, what may have implications for margins in the short run, but may lead to a quite profitable company in the longer run. The value of the collateral is measured by the market value of the company, where the valuation of assets (and their residual value) plays an important role. Asset valuation in a linear system is quite different from valuation in a circular system.

Value creation is increasingly knowledge- and data-intensive, and services trade has continued to grow at a faster pace than goods. The coronavirus crisis has speeded up these trends as it has exposed the vulnerability of complex value chains and just-in-time production and delivery. Business strategies and trade patterns are being redrawn. The fourth industrial revolution acts as a major driver. At the same time, it can serve as a powerful enabler of the circular economy transition. The digitalisation and new circular economy business models, such as sharing platforms and 'product-as-a-service' systems, are key elements of the new circular economy.

3.3 What Are Key Drivers of Circular Economy

There are three fundamental drivers of the circular economy:

- **Resource constraints:** With global resource demand growing quickly, there is increasing concern about looming shortages of critical raw materials and water. The same holds true for arable land, as demand for cotton, crops, etc. is growing. It is thus becoming imperative to rethink our resource use.

- **Technological development:** The introduction of new technologies, notably the internet of things (IoT) and big data tools, is enabling the development and introduction of new CE business models, which are often based on sharing and

8 Circle Economy (2020). Circularity Gap Report 2020. Retrieved from: https://www.circularity-gap.world/global

leasing but also reuse and remanufacturing. New technical systems and tools enable the tracking of products or materials during their life to enable extended use/lifespan and maintaining the highest possible value. Meanwhile, design and manufacturing capabilities are evolving with advances in production, material science and manufacturing, e.g. 3D printing and artificial intelligence.

Socio-economic development: Currently, about half the world's population lives in cities, and this will rise to six in ten by 2030, according to World Health Organization estimates. Increasing urbanisation supports the development of circular models since urban areas can easily host cost-effective collection and return systems for goods, materials and other resources, and thus promote the closing of circular loops, as well as asset-sharing schemes and systems for product reuse.

3.4 Why Is the Linear Economy Bad

The concept of the linear economy has now become unsustainable for several reasons:

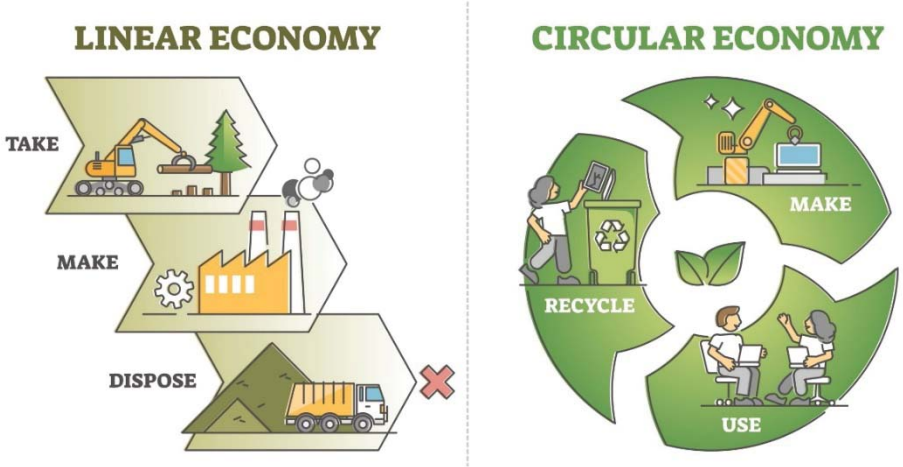
- **Resource depletion.** The higher the demand is for consumer products, the more supply we will have to acquire. The planet's finite resources (lumber, metal, cotton, etc.) are being depleted at an alarming rate, and we are running out of them fast. In 2017, it was estimated that we would need 1.7 earths to sustain our current consumption rates.

- **Ecosystem degradation.** Raw material extraction processes like deforestation, agriculture, fracking, mining are destroying our planet's ecosystems. The drastic change in our environment results in an increase in natural disasters (wildfires, floods, geohazards), air pollution, and biodiversity extinction.

- **Waste and pollution.** Manufacturing and distribution/transportation processes create unnecessary waste (sludge, defects) and pollution (chemical runoff in water, carbon emissions from trucks). By buying products, we also create post-consumer waste (packaging, spoiled food, things that are broken, clothes that no longer fit).

- **Bad consumer habits.** As a society, we have adopted the idea that 'newer is always better' and value things that are 'on trend/ in style'. Consumers simply replace defective and out of style products with new ones because it is affordable and accessible. This generates more demand, which results in more production.

- **Socioeconomic inequalities.** To keep up with consumers' high demand for products, we are seeing troubling trends such as fluctuating prices of natural resources, underpaid and overworked workers, improper handling of waste in poor communities, and political friction due to resource extraction. All these imbalances will become unmanageable as our global population grows daily.



A linear economy depends on two basic assumptions: one, that there will always be resources that can be extracted and two, that there will always be an "away" to send our discarded materials. While this seemed to be true at the dawn of the industrial revolution, we're realizing today that it is not. The world's population has grown from one billion people in the early 1800s to nearly 7.4 billion today, and we are using natural resources faster than they can regenerate. In particular, fossil fuels – which were created over millions of years – cannot be replaced. Even those resources with shorter regeneration period (e.g. forests, topsoil, etc.) are used so intensively that they hardly recover.

The assumptions upon which we've based our entire economic system are simply false. A linear economy cannot continue indefinitely – continuing resource constraints are

putting business and humanity at risk. The time is now to "close the loop" and create a more circular – and vibrant – economy that incorporates repurposing, redistributing, remanufacturing and reusing resources into our processes.

3.5 What Are Key Advantages of the Circular Economy

The circular economy offers the following opportunities for businesses to minimise their exposure to so-called "linear risks", reduce costs and exploit new market and business opportunities:

- **De-risk/hedge future commodity supply uncertainty and price volatility:** The circular economy offers the means to increase resilience and hedge risks related to uncertain future commodity supply and price volatility. As an example, the shift from selling products to services enables manufacturers to control and reuse or recycle components and raw materials used to produce goods as corporate assets.

- **Reducing manufacturing costs:** Design for reuse, disassembly and recycling, with a view to facilitating remanufacturing and reintroducing the products, is often less expensive than producing new parts from virgin materials. As an example, the remanufacturing of car parts is 30-50% less expensive than producing new parts and generates 70% less waste.

- **Avoided costs and new revenue streams:** Companies realise the rationale of evaluating their production chains to identify by-product and waste streams that could be avoided, reused or recycled. As a consequence, companies turn to resource management or reverse logistics partners rather than waste management companies to identify potential uses for their by-products and waste - an approach that cuts costs and increases efficiency while reducing resource consumption and environmental impact. Companies not able to reuse/recycle their own goods, by-products or waste can offer these to other companies and thus create symbiotic circular relationships. Such approaches create resilient circular business models, generate new revenue streams and avoid waste management costs.

- **New business opportunities and new markets:** The ability to increase the life of and revenues from a given asset through repair and refurbishment schemes enables new service-based business models and strengthen the customer relationship. In such models, companies design products to make the repair and component reuse easier, and may also provide consumers with information, tools and replacement parts to repair their products.

Figure 4. Circular economy can preserve value of products at their highest value

The circular economy assumes dynamic systems, a process of transformation rather than a specific end-point. The **DISRUPT** model gives it direction. It is based on the following key elements:

- **Design For the Future:** Adopt a systemic perspective during the design process to employ the right materials for appropriate lifetime and extended future use.
- **Incorporate Digital Technology:** Track and optimise resource use and strengthen connections between supply-chain actors through digital, online platforms and technologies.
- **Sustain & Preserve What's Already There:** Maintain, repair and upgrade resources in use to maximise their lifetime and give them a second life through take-back strategies, where applicable.
- **Rethink the Business Model:** Consider opportunities to create greater value, and align incentives through business models that build on the interaction between products and services.
- **Use Waste as a Resource:** Utilise waste streams as a source of secondary resources, and recover waste for reuse and recycling.
- **Prioritise Regenerative Resources:** Ensure renewable, reusable, non-toxic resources are utilised as materials and energy in an efficient way.
- **Team Up to Create Joint Value:** Work together throughout the supply chain, internally within organisations and with the public sector to increase transparency and create shared value.

3.6 Circular Development in Europe

Already since 2006, the European Union (EU) has been concerned about environmental transition issues by translating this into directives and regulations. Three important EU laws can be mentioned in this regard:

- The Ecodesign Framework Directive
- The Waste Framework Directive
- The Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation

On 17th December 2012, the European Commission published a document entitled "Manifesto for a Resource Efficient Europe".[9]

In July 2014, a zero-waste program for Europe was put in place aiming at the circular economy.[10] Since then, several documents on this subject have been published.

The circular economy is a development priority of the European Union, and it is part of the EU industrial strategy. The transition to a more circular economy is an essential contribution to the EU's efforts to develop a sustainable, low carbon, resource-efficient and competitive economy. In December 2015, the European Commission adopted an ambitious Circular Economy Package, which includes revised legislative proposals on waste to stimulate Europe's transition towards a circular economy, which will boost global competitiveness, foster sustainable economic growth and generate new jobs.

The CE Package comprised:

- An umbrella Communication, **Closing the Loop** - An EU action plan for the Circular Economy;
- A broad action plan with **54 concrete actions** with timetable and a monitoring section;
- **A legislative proposal** on waste management and recycling updating key waste sector Directives that was adopted in July 2018.

The action plan focused on the whole life cycle of products and comprised actions targeting product design, production and processes, consumption, waste management, and secondary raw materials.

The plan also comprised horizontal actions on innovation, investments and monitoring, as well as sectoral actions on plastics, critical raw materials, construction, biomass and bio-based materials. Its elements included the following:

- **Ecodesign** – to include reparability, durability, recyclability

9 "Manifesto for a Resource Efficient Europe". European Commission.

10 "Transforming ecological modernization 'from within' or perpetuating it? The circular economy as EU environmental policy narrative".

- Legislation on **fertilisers**, including organic and waste-based fertilisers
- Minimum requirements for the **reuse of wastewater**
- Actions on **Green Public Procurement**
- **Funding** of €650 million for "Industry 2020 in the Circular Economy" programme
- Quality standards for **secondary raw materials**
- **Strategy on plastic**, including marine litter
- **Interface** between chemicals, products and waste legislation

There were specific provisions for waste management, which included:

- **Long term recycling targets** for municipal waste and packaging waste, and to reduce landfilling
- Measures to promote **waste prevention**, including food waste
- Clearer rules for **preparation for reuse,** simplification on **by-products and end-of-use waste** status
- Extension of **separate collection of bio-waste** on top of glass/paper/plastic/metals
- Common minimum requirements for **extended producer responsibility** schemes

On 12th March 2020, the European Commission adopted **a new Circular Economy Action Plan** – one of the main building blocks of **the European Green Deal,** Europe's new agenda for sustainable growth. With measures along the entire life cycle of products, the new Action Plan aims to make the EU economy "fit for a green future", strengthen its competitiveness while protecting the environment. The new Plan focuses on the design and production for a circular economy, with the aim to ensure that the resources used are kept in the EU economy for as long as possible.

The key elements of the New Action Plan include the following:

- **Make sustainable products the norm in the EU.** The Commission will propose legislation on Sustainable Product Policy to ensure that products placed on the EU market are designed to last longer, are easier to reuse, repair and recycle, and incorporate as much as possible recycled material instead of primary raw material. Single-use will be restricted, premature obsolescence tackled, and the destruction of unsold durable goods banned.
- **Empower consumers.** Consumers will have access to reliable information on issues such as the reparability and durability of products to help them make environmentally sustainable choices. Consumers will benefit from a true 'Right to Repair'.
- **Focus on the sectors** that use the most resources and where the potential for circularity is high.
- **Ensure less waste.** The focus will be on avoiding waste altogether and transforming it into high-quality secondary resources that benefit from a well-functioning market for secondary raw materials.

The key focus sectors of the New Action Plan include the following:

- **Electronics and ICT** – a 'Circular Electronics Initiative' to have longer product lifetimes, and improve the collection and treatment of electronic waste
- **Batteries and vehicles** – a new regulatory framework for batteries for enhancing the sustainability and boosting the circular potential of batteries
- **Packaging** – new mandatory requirements on what is allowed on the EU market, including the reduction of (over)packaging
- **Plastics** – new mandatory requirements for recycled content, and special attention on microplastics as well as biobased and biodegradable plastics
- **Textiles** – a new EU Strategy for Textiles to strengthen competitiveness and innovation in the sector and boost the EU market for textile reuse
- **Construction and buildings** – a comprehensive Strategy for a Sustainably Built Environment promoting circularity principles for buildings
- **Food** – new legislative initiative on reuse to substitute single-use packaging, tableware and cutlery by reusable products in food services

For more information, please see https://ec.europa.eu/environment/strategy/circular-economy-action-plan_en.

4 Shifting to Circular Economy Business Models

4.1 Circular Economy Business Models

The shift to a circular economy requires companies to rethink not only their use of resources, but also to redesign and adopt new business models based on dematerialisation, longevity, refurbishment, remanufacturing, capacity sharing, and increased reuse and recycling. The Reference is often made to three circular business model categories, each of which focuses on a different phase of the value chain: (a) the design and manufacturing phase; (b) the use phase; and (c) the value recovery phase. These different CE business models can be illustrated in what is called a Value Hill, shown in Figure 5.

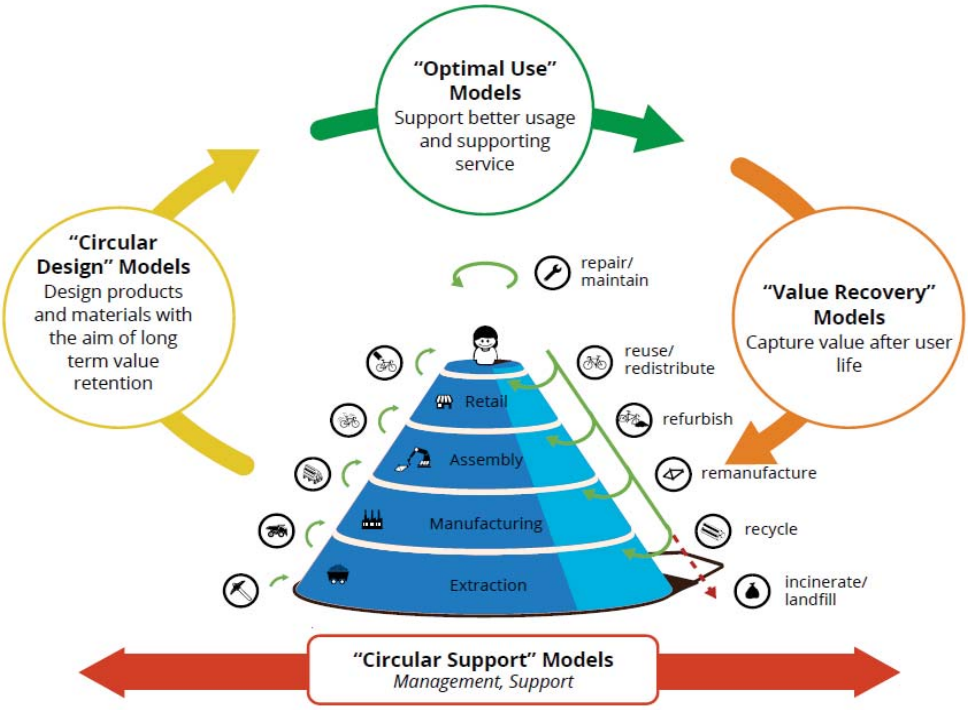


Figure 5. Different CE business models in the Value Hill

▶ **Circular Design Models** focus on the development of existing or new products and processes that seek to optimise circularity. Products are designed to last longer and/or be easy to maintain, repair, upgrade, refurbish, remanufacture or recycle. Additionally, new materials are developed and/or sourced, e.g. biobased, less resource intensive, or fully recyclable.

Examples include the following:

- **Product design:** Provides products that are designed to make them long and useful life, and/or be easy to maintain, repair, upgrade, refurbish or remanufacture.

- **Process design:** Develops processes that increase the reuse potential and recyclability of industrial and other products, by-products and waste streams.

- **Circular Supplies:** Provides input materials such as renewable energy, bio-based, less resource-intensive or fully recyclable materials.

▶ **Optimal Use Models** aim to increase the value and use of a product during an extended life. These business models often build on retained ownership of a product, e.g. by providing a service rather than selling a product, and/or take responsibility for the product throughout its useful life, e.g. through maintenance services, or add-ons to extend the life of a product. Examples include the following:

- **Product as a Service:** Delivers product performance rather than the product itself through a combination of the product and services. Ownership of the product is retained by the service provider. Primary revenue streams from payments for performance delivered.

- **Sell and Buy-back:** Sells a product on the basis that it will be purchased back after a period of time.

- **Sharing Platforms** (Access provider): Enables an increased utilization rate of products by enabling or offering shared use/access/ownership.

- **Lifetime Extension:** Extends the useful life of products and components through repair, maintenance, or upgrade.

- **Tracing facility:** Providing services to facilitate the tracing, marketing and trade of secondary raw materials.

▶ **Value Recovery Models** focus on maximising recovery and recycling of products and materials after use into new products or useful resources in order to reduce wastage and conserve resources. The development of *reverse logistics*, i.e. return from the point of consumption to the point of production, is essential for this model. It should be considered that for some materials, recycling involves a loss of quality, and for products also loss of design as well as technical and energy inputs. Acknowledging this, difference can be made between *downcycling*, which results in lesser quality and reduced functionality, and *upcycling*, which involves transforming by-products and waste into new materials or products of higher quality or better environmental value.

Examples include the following:

- **Recaptured material supplier:** Sells recaptured materials and components to be used instead of virgin or recycled material.

- **Refurbish & Maintain:** Refurbishes and maintains used products in order to sell them.

- **Recycling facility:** transforms waste into raw materials. Additional revenue can be created through pioneering work in recycling technology.

- **Recovery provider:** Provides take-back systems and collection service to recover useful resources from disposed products or by-products.

- **Support lifecycle:** Sells consumables, spare parts and add-ons to support the life cycle of long-lasting products.

▶ **Circular Support Models** focus on the management and coordination of circular value networks and resource flows, and optimising incentives and other supporting activities in a circular network. Circular support models also include the development or deployment of key enabling technologies supporting, enabling and facilitating the other business models.

4.2 Implication of Transition to Circular Economy Models

Moving from traditional linear business models entails several implications:

▶ Change in core capabilities

New competences are required for enhanced performance. There are five areas that circular business models should focus on, mainly because they differ from the traditional models: (1) strategy; (2) innovation and product development; (3) sourcing and manufacturing; (4) sales and product use; and (5) return chains. These competences should not only be established within the company, but should be organised with the whole supply chain.

▶ Better collaboration

A traditional business sees the upstream part of the supply chain predominantly as cost drivers, and the downstream part - as the source of revenues. Within the supply chain this approach is a zero-sum-game: one's profit is another's loss. A circular business cannot succeed without aligned collaboration, which will benefit the whole chain leading to a positive sum.

▶ Lock in leading to higher switching costs

The downside of collaboration and improved relationships is the risk of 'lock in', resulting in higher switching costs. If long-term contracts are used or if parts of the supply chain are intertwined, it is more difficult to switch, if other suppliers offer better solutions or a better price-quality ratio. It is difficult to estimate the economic consequences of the higher switching costs and the impact on the efficiency of the economy.

▶ New owner platforms and other value chain entities

Changes in business models will lead to the appearance of new entities in the value chain. It is not clear yet what the role of these new entities will be, but they should be in line with the changing competences, e.g. owner platforms, reverse logistics, and refurbishment specialists. Better insights into these new entities and their part in adding value to the chain can help to estimate sectorial changes (in labour impact and other economic indicators, like value creation).

▶ Changes in incentives

If ownership does not follow the product through the chain, incentives change. When the producer remains the owner of a product, its longevity and easy maintenance become much more important – because the producer bears the costs of failure and repair, in contrast to a linear model, where these risks (besides guarantees) are transferred to the user (e.g. owner). As interest in good performance is moved upstream in the chain, it can be expected that products will become more durable.

▶ Changes in liability

There is a downside to the changing incentives: users are usually more careful with products that they own. When the producer remains the owner of a product, it can be expected that certain 'fair use policies' will form part of the transaction. The legal implications of product usage and the accompanied risk premiums will be included in the business models.

4.3 Challenges and Policy Implications of Circular Economy Business Models

Circular business models – those that serve to reduce the extraction and use of natural resources and the generation of industrial and consumer wastes – operate in a number of economic sectors such as plastics[11] production and reprocessing[12], agribusiness[13], metallurgy. Because these business models use already existing materials and products as inputs, their environmental footprint tends to be considerably smaller than that for traditional business models. This idea is supported by the life cycle analysis literature[14], where it has been demonstrated that secondary raw materials, repaired

11 Ellen McArthur Foundation (2018), Eleven companies take major step towards a New Plastics Economy, https://www.ellenmacarthurfoundation.org/news/11-companies-take-major-steptowards-a-new-plastics-economy

12 Long, X. et al. (2017), "Strategy Analysis of Recycling and Remanufacturing by Remanufacturers in Closed-Loop Supply Chain", Sustainability, Vol. 9/10, pp. 1-29, https://ideas.repec.org/a/gam/jsusta/v9y2017i10p1818-d114402.html

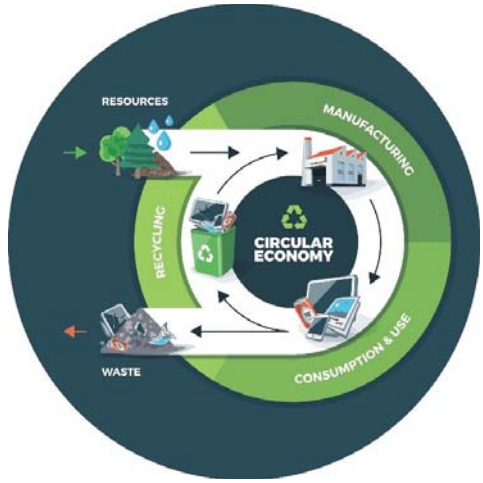
13 Jagtap, S. (2017), IoT Concepts for Improving the Resource Efficiency of Food Supply Chains, http://www.manufacturingfoodfutures.com/documents/utilization-of-internet-of-thingsconcepts-to-improve-resource-efficiency-of-food-supply-chains-sandeep-jagtap.pdf

14 OECD (2019), Business Models for the Circular Economy: Opportunities and Challenges for Policy, OECD Publishing, Paris. https://doi.org/10.1787/g2g9dd62-en

and remanufactured products, and shared assets typically have relatively small global warming, acidification and toxicity potential. As such, continued adoption of circular modes of production, to the extent that they displace the production from traditional modes, could have important first order environmental benefits.

The market penetration of circular business models remains limited and is usually no more than 5 to 10% in economic terms[15]. Circular business models occupy a peripheral position in most markets. Recycled pulp and paper, metals, and plastics represent small proportions of global material output, while remanufactured industrial and consumer products represent an even smaller share of global manufacturing. Sharing of under-utilised housing capacity has grown rapidly, but now only accounts for several percent of the annual short stays in most major cities. The same is true for user-oriented product-service system models, which account for less than 1% of the market. The most successful circular model of production – producing secondary raw materials from waste – only accounts for 30 to 40% of the physical output of the sectors where it is best established in (pulp and paper and steel)[16].[17] Other forms of circular production – the refurbishment and remanufacturing, the sharing of spare capacity, and the provision of services rather than products – continue to represent a small fraction of the overall output (either in physical or economic terms).

Although it is clear that some of these business models such as resource recovery, remanufacturing and product life extension, sharing and product-service[18,19] have experienced rapid recent growth, much of these have been confined to a handful of economic niches. Sharing models in the accommodation sector or product-service systems in the transport sector are frequently cited examples. Transitioning to a more circular and resource efficient economy – one where environmental impacts associated with economic production and consumption are significantly reduced – will require much more widespread penetration of these business models.



15 Bocken, N. et al. (2016), "Product design and business model strategies for a circular economy", Journal of Industrial and Production Engineering, Vol. 33/5, pp. 308-320, http://dx.doi.org/10.1080/21681015.2016.1172124.

16 Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", Science Advances, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782

17 Van Ewijk, S., J. Stegemann and P. Ekins (2017), "Global Life Cycle Paper Flows, Recycling Metrics, and Material Efficiency", Journal of Industrial Ecology, http://dx.doi.org/10.1111/jiec.12613

18 AmCham (2017), China (Ningbo) Remanufacturing Industry International Cooperation Forum, https://www.amcham-shanghai.org/en/article/china-ningbo-remanufacturing-industryinternational-cooperation-forum-0?lang=en

19 European Commission (2016), Study on socioeconomic impacts of increased reparability of increased reparability - EU Law and Publications, https://publications.europa.eu/en/publication-detail/-/publication/c6865b39-2628-11e6-86d0-01aa75ed71a1

Shifting to Circular Economy Business Models

There remains considerable scope for the future growth of circular business models. However, any such development will be subject to economic realities – more widespread adoption of these business models will not take place unless there is a solid underlying business case. In some cases, the attractiveness of the business case may diminish as market share increases. For example, in the context of recycling, it is well documented that the unit cost of recovering steel or aluminium from household appliances is significantly higher than recovering them from relatively simple bulky products like vehicle chassis. In other cases, the attractiveness of the business case will improve as market share increases. This is especially relevant for those business models characterised by network effects: consumer acceptance of platform models and car sharing schemes is likely to increase as the membership base – and services offered – grows. It may also be relevant for other business models that are characterised by some form of path dependence, or that benefit in some way from the emergence of related business models[20]. In the context of remanufacturing, addressing the trade rules that hinder cross border flows of product cores would allow remanufacturing to become more widespread and, perhaps, generate lower costs through either learning externalities or scale economies.[21]

The business case for circular business models will also evolve alongside broader societal level trends. Changes in policy frameworks, consumer preferences and available technologies have the potential to stimulate adoption in much the same way as in the past.[22] The emergence of technologies associated with the so called Fourth Industrial Revolution seems particularly promising in the context of circular business models. Improvements in robotics, artificial intelligence, sensor technology, and 3D printing will have widespread consequences, particularly when coupled with increasingly pervasive digital networks. The Internet of Things (IoT), which is just one of the potential implications of these developments, will present an array of opportunities for more efficient food and energy use[23,24]. Research undertaken by the World Economic Forum (WEF) in New York[25] city suggests that digital connectivity in concert with smart sensors could also vastly improve the convenience of ride sharing, to the extent that 80% of all journeys could be shared.

Not all circular business models are created equal; it is not entirely clear which have the greatest scalability and environmental potential. As such, it may be prudent to avoid targeting policies at specific business models, and instead focus on implementing a policy framework that provides coherent incentives for closing and slowing resource loops, and narrowing resource flows throughout the economy. Also the barriers that hinder the emergence of these business models vary widely according to a business model considered and sectors they are applied in.

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20 Parker, D. et al. (2015), Remanufacturing Market Study, http://www.remanufacturing.eu/assets/pdfs/remanufacturing-market-study.pdf

21 Wang, Y. (2016), Remanufacturing Mission to China, https://connect.innovateuk.org/web/remanufacturing/article-view/-/blogs/newremanufacturing-standards

22 Lavery, G. et al. (2013), The Next Manufacturing Revolution, http://www.2degreesnetwork.com

23 Ashman (2017), The Internet of Things: paving the way for renewable energy? – Capgemini Worldwide, https://www.capgemini.com/2017/08/the-internet-of-things-paving-the-way-forrenewable-energy/

24 Jagtap, S. (2017), IoT Concepts for Improving the Resource Efficiency of Food Supply Chains, http://www.manufacturingfoodfutures.com/documents/utilization-of-internet-of-thingsconcepts-to-improve-resource-efficiency-of-food-supply-chains-sandeep-jagtap.pdf

25 WEF (2016), Understanding the Sharing Economy, http://www3.weforum.org/docs/WEF_Understanding_the_Sharing_Economy_report_2016.pdf

There are various reasons why the market share of circular business models may be suboptimal. One common characteristic of these business models is that they use virgin resources and environmental goods less intensively than traditional businesses that they compete against. These inputs are cheaper than they would be if the externalities – the environmental damages – resulting from their use were addressed. This probably serves to provide traditional business models with a competitive advantage. Policy can help to ensure that the full environmental costs of production and consumption activities are reflected in market prices.

Core to many circular business models, particularly the circular supply, resource recovery and product life extension models, is the need for collaboration within and across value chains. Externalities resulting from design decisions made by traditional manufacturing firms have implications for the feasibility of material recovery and product life extension activities further downstream. Similarly, the existence of search and transaction costs can make it difficult for industrial symbiosis to emerge across sectors. Policy can help to improve collaboration within and across sectoral value chains. Fostering industrial symbiosis clusters, promoting online material marketplaces, establishing secondary raw material certification schemes, and, more generally, facilitation of cooperation within and across value chains may be worthwhile initial steps.

Policy misalignments are sometimes also hindering the emergence of circular business models. One example concerns the provision of subsidies to extractive and material processing sectors, which can extend into the billions of dollars for fossil fuels (OECD, 2015)[26], metals (OECD, 2017)[27], fisheries (OECD, 2018)[28], and agriculture (OECD, 2016)[29]. Another example concerns the tendency to tax labour inputs at significantly higher rates than capital and natural resource inputs. A recent Club of Rome report on the circular economy (Wijkman, Skånberg and Berglund, 2016)[30] states that "modern tax systems in the EU apply high rates to employment while leaving the use of natural resources tax-free or even subsidized". For the same reason as that outlined above, these policies probably serve to favour traditional modes of economic production. Policy makers could therefore consider what objectives the existing fiscal policy is serving, and whether a fiscal realignment could lead to improved environmental and equity outcomes.

There are also a variety of status quo biases that effectively lend inertia to current patterns of economic development, often at the expense of the emergence of circular business models. One example concerns the elevated price volatility that is present in secondary materials markets. This volatility – which is itself a product of limited market development

26 OECD (2015), OECD Companion to the Inventory of Support Measures for Fossil Fuels 2015, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264239616-en

27 OECD (2017), Mapping Support for Primary and Secondary Metalproduction, https://one.oecd.org/document/ENV/EPOC/WPRPW(2016)2/FINAL/en/pdf

28 OECD (2018), Fisheries Support Estimate, http://www.oecd.org/tad/fisheries/fse.htm

29 OECD (2016), OECD'S PRODUCER SUPPORT ESTIMATE AND RELATED INDICATORS OF AGRICULTURAL SUPPORT Concepts, Calculations, Interpretation and Use, http://www.oecd.org/tad/agricultural-policies/full%20text.pdf

30 Wijkman, A., K. Skånberg and M. Berglund (2016), "The Circular Economy and Benefits for Society Jobs and Climate Clear Winners in an Economy Based on Renewable Energy and Resource Efficiency", http://www.clubofrome.org/wp-content/uploads/2016/03/The-Circular-Economy-and-Benefits-for-Society.pdf

– probably disincentivizes investment in new secondary production capacity. Another example concerns various trade regulations that serve to limit cross border flows of secondary materials and used products (OECD, 2018).[31] While many of these restrictions serve a clear purpose within the linear economic system, they may hinder the development of the reverse logistics that is central to some circular business models. A final example relates to regulatory exceptions that are often granted to heavily polluting or incumbent firms, thereby hindering the entry of firms with more circular business models. Policy could therefore aim to ensure that existing regulatory frameworks are coherent and fit for purpose, and not serving to preserve an existing status quo.

Another major challenge concerning status quo bias relates to consumer behaviour. In some cases, the development of markets for circular products and services appears to be held back by a lack of consumer interest. For example, in most consumer goods sectors, there are only a small number of manufacturers that attempt to differentiate themselves by marketing long lived, but relatively expensive products (the clothing manufacturer Patagonia is one such example). Despite the fact that higher quality products may be cost competitive when considered over their useful life, many consumers prefer to opt for low quality substitutes. Policy makers could therefore consider how existing educational and information programs can be improved to provide individuals with a better understanding of the unintended consequences of their consumption choices. The use of behavioural insights and nudges, such as through labelling requirements, may be a promising way forward. Policy makers interested in promoting more widespread adoption of circular business models could, in addition to addressing the issues highlighted above, implement a range of additional enabling policy measures. These policies will clearly differ according to the business models concerned, but can be thought of generally as promoting either the supply of circular products ("supply-push measures") or demand for them ("demand-pull measures"). Examples of the former include eco-design standards, strengthened Extended Producers Responsibility (EPR) schemes, and the provision of targeted Research and Development (R&D) funding. Examples of the latter include differentiated VAT rates, recycled content mandates, product labelling standards, and green public procurement.

Finally, one issue highlighted in this review is the importance of rebound effects, whereby initial reductions in resource extraction and use are partially offset via various indirect economic feedbacks. Any future transition to a more resource efficient and circular economy will be at least partially driven by the diffusion of material efficient production technologies and the emergence of more cost competitive circular business models. The

31 OECD (2018), International Trade and the Transition to a More Resource Efficient and Circular Economy, https://one.oecd.org/document/COM/TAD/ENV/JWPTE(2017)3/REV3/en/pdf

resulting reduction in price levels is likely to trigger a rebound effect as consumers may allocate the associated savings to additional consumption, and manufacturers substitute towards inputs that have become relatively cheap (probably including natural resources). Policy can influence the composition (and therefore the environmental footprint) of the rebound effect by ensuring that the full social costs of production and consumption are reflected in market prices.

4.4 The Environmental Impacts of Circular Business Models

One reason for the recent interest in promoting a circular economy transition is the reduction in environmental impacts that could result. Circular business models, by closing resource loops and by slowing and narrowing resource flows, will, in theory, reduce the environmental footprint of production and consumption activities. That said, what is the evidence that these business models actually serve to displace resource extraction, processing, and disposal? And how does this translate into improved environmental outcomes? Or which business models hold the greatest promise in this respect?

Establishing the environmental impacts associated with the emergence of circular business models is complex task for various reasons:

- Each individual business model, or business model sub-type, operates in more than one economic sector. For example, sharing models are best known in the short-term lodging and transport sectors, but are also relevant across a wider range of consumer products. This diversity makes it difficult to generalize about the likely environmental impacts. The emergence of a particular business model in a specific economic sector will have implications across a range of environmental impact categories including, but not limited to, global warming, pollution of air, soil and water, acidification, eutrophication, toxicity, and solid waste generation potential. Changes in each environmental impact category can emerge at different points in the product lifecycle. For example, remanufacturing heavy machinery probably reduces the greenhouse gas emissions associated with upstream material extraction, transport and processing but, to the extent that it results in an energy efficiency differential between new and remanufactured products (e.g. when new products are based on advanced energy efficient technologies, it can also affect the emissions during the machinery's in-use phase. The environmental impacts of a particular business model probably change as that business model develops. For example, it is likely that the greenhouse gas mitigation potential associated with recycling will decrease at high recycling rates. The emergence of a particular business model in a specific sector will lead to changes in relative prices and an array of indirect economic effects. The resulting changes in activity levels in other sectors will also have an environmental impact.

The approach to assessing the relative environmental desirability of different circular business models has been undertaken by De Groene and Ethica (2015)[32], who term the resulting output the "circularity ladder" (Figure 6). Based on their work, product life extension and sharing models appear to be environmentally preferable to resource recovery business models. They, by slowing resource loops and narrowing resource flows respectively, have the potential to reduce the amount of waste generated. In contrast, the influence of resource recovery business models tends to be limited to diverting already existing waste towards material and energy recovery facilities. Product-services can have an influence throughout the entire waste hierarchy. Product-Service Systems (PSSs), by including after-sales service in the sales proposition, extend the life of products and prevent or at least minimise waste generation. Result-oriented PSS variants can have a similar impact since service providers have a greater incentive to use material inputs sparingly. Both result-oriented and user-oriented PSS variants, where product ownership is retained by the manufacturer, can create better incentives for recycling.

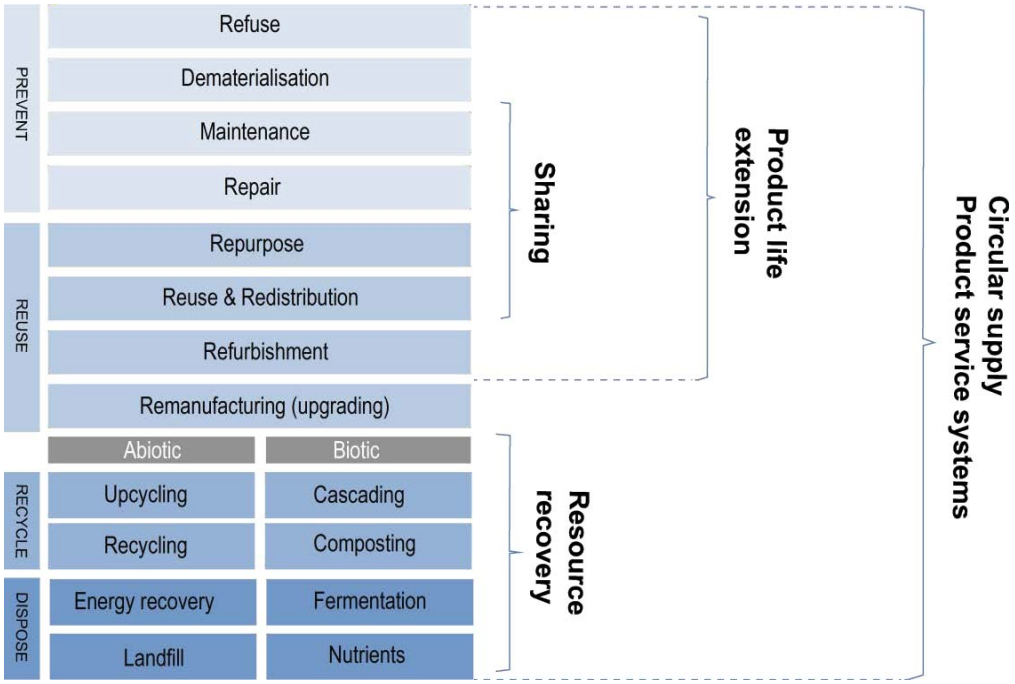


Figure 6. Circularity ladder approach - adapted from De Groene and Ethica (2015)

32 De Groene, Z. and Ethica (2015), Boosting Circular Design for a Circular Economy, http://degroenezaak.com/wpcontent/uploads/2015/03/Boosting_Circular_Design_for_a_Circular_Economy_FINAL.pdf

The circularity ladder approach provides a useful "first-pass" assessment of the relative environmental desirability of different circular business models. However, there are two main issues to be aware of. First, the waste hierarchy ranks waste management options according to the environmental impacts associated with the end-of-life phase of the product lifecycle; it is unclear whether the ranking remains valid when the entire product life-cycle is taken into account. For example, if the in-use environmental impacts of long-lived, energy or water intensive consumer products are considered, it may not always be the case that product repair is preferable to recycling, especially when new products have significantly improved energy or water efficiency. Second, the circularity ladder provides little insight into the likely *magnitude* of the environmental benefits associated with remanufacturing activities, or other CE business models – this aspect is better addressed by Life-Cycle Assessment (LCA) approach.

The LCA is an internationally standardized methodology for establishing the environmental footprint of a particular product (good or service). Within the requirements of ISO 14040 and 14044, an LCA must comprise the following steps:

- Goal and scope definition which sets the goal and intended use of the LCA, and scopes the assessment concerning system boundaries, function and flow, required data quality, technology and assessment parameters.
- Inventory analysis (LCI) which consists in collecting data on inputs (resources and intermediate products) and outputs (emissions, wastes) for all the processes in the product system.
- Impact assessment (LCIA), phase during which inventory data on inputs and outputs are translated into indicators of potential impacts on the environment, on human health, and on the availability of natural resources.
- Interpretation of results where the outcomes of the LCI and LCIA are interpreted according to the goal of the study, and where sensitivity and uncertainty analysis are performed to qualify the results and the conclusions.

A LCA can either be undertaken for a product in isolation, or for one product relative to another. This distinction is important in the context of this chapter, which seeks to establish the environmental footprint of circular modes of production, either relative to other circular modes (e.g. recycling vs remanufacturing), or relative to more traditional modes (e.g. recycling vs primary material production). Because their underlying scope and assumptions often differ, it is generally difficult to compare the results from different LCA studies. As such, the data presented here are taken mostly from individual studies that effectively compare two LCAs: one for the footprint of the "circular" product, and one for the footprint of the "traditional" product. This is the origin of indicators like avoided resource extraction, energy use, and waste disposal.

The analysis[33] has highlighted the complexity involved in assessing the environmental impact of circular business models. Not only are there a wide range of business models involved, but there are also a variety of different approaches available to estimate their impacts. In addition, the impacts associated with each business model often appear at different parts of the product lifecycle. Based on the results, it is possible to draw four main conclusions:

33 OECD (2019), Business Models for the Circular Economy: Opportunities and Challenges for Policy, OECD Publishing, Paris. https://doi.org/10.1787/g2g9dd62-en

- Results from the LCA literature indicate that the environmental footprint of the output from circular modes of production can be significantly smaller than that associated with traditional modes. As such, the emergence of circular business models, to the extent that this results in the displacement of traditional forms of production, is likely to have a positive direct impact on environmental outcomes. By closing and slowing resource loops, and by narrowing resource flows, these business models will lead to less extraction, transport, processing and disposal of virgin resources, and thereby reduce the environmental pressures associated with these activities.

- The LCA and related studies do not account for indirect economic effects associated with the emergence of circular business models. This emergence, conditional on improved competitiveness of circular modes of production, will place downward pressure on prices, and is likely to lead to a range of rebound effects. As a result, households may direct new disposable income towards additional consumption, and this will have an associated environmental footprint. Further, reduced demand for primary materials, and the lower prices that this stimulates, may encourage manufacturing firms to use relatively more such inputs. Indirect economic feedbacks are important, and potentially could at least partially, offset the direct environmental benefits associated with the emergence of a circular business models.

- Comparing the relative environmental potential of different circular business models is difficult. Making such an assessment is complicated given that a particular business model typically operates in multiple sectors, and has implications across a range of environmental impact categories, often in multiple political jurisdictions. Thus, while it might be possible to compare the environmental footprint of recycling or repairing an old vehicle, blanket statements about the relative desirability of resource recovery vs product life extension business models (for example) is fraught. Although the circularity ladder approach provides some insight on this issue, it is unclear to what extent the waste hierarchy ranking of waste management activities reflects environmental impacts higher in the product lifecycle. For example, some LCA studies suggest that reuse may not necessarily be preferable to recycling when the products involved are long lived, have an input intensive use phase, and are experiencing rapid efficiency improvements.

- In case of product life extension, sharing and product service system business models, there is a tension between changes in product lifetimes and the diffusion of relatively efficient new product designs. Put differently, this strain reflects a trade-off between environmental impacts associated with different parts of the product lifecycle. Products that last longer will tend to reduce the extraction and processing of virgin resources (and the associated environmental impacts of these activities), but may also hinder the diffusion of relatively efficient new products. Product category is critical here; this issue is again of most concern for products that are long lived, have an input intensive use phase, and are experiencing rapid efficiency improvements.

Therefore, while the lifecycle environmental impacts of circular goods and services are mostly significantly smaller than those of linear ones, uncertainty about rebound effects, product innovation and other factors tend to muddy the picture, and prevent

from drawing more general conclusions across business models, sectors and product groups. The environmental outcomes of circular business models will therefore need to be carefully assessed on a case-by-case basis.

4.5 Business Drivers for Switching to Circular Models

The business case for the adoption of circular business models is not static, but varies according to a broad set of societal level factors. Changes in consumer behaviour, the threat of new regulation, or concerns about the stability of key supply chains represent considerable business risks for firms operating traditional business models, and can stimulate switching towards greener, more circular modes of production. In a similar way, the appearance of new technologies can reduce the cost structure of relatively circular production, thereby creating opportunities for potential adopters.

Regulatory risk is becoming a significant concern for firms that operate traditional business models. One example concerns the emerging prospect of more widespread and stringent carbon pricing. This probably partly explains the broader adoption of internal shadow carbon pricing within the private sector, and the diversification of some fossil fuel producers into renewable electricity technologies. Another example concerns the potential introduction of more stringent product design and material recovery standards in various countries. The recent adoption of bans on certain products made from plastic (e.g. such as single carrier plastic bag bans) in a number of countries, as well as the recent European Union strategy on plastics are such examples, and probably represents a significant risk for firms whose products rely heavily on virgin plastic inputs.

Many **emerging renewable energy and information & communication technologies** are heavily reliant on materials that are geographically concentrated in a handful of countries. More than 80% of the global production of rare earth elements – a key input in several renewable energy technologies – takes place in China. Similarly, about half of global cobalt production – a key input in smartphone, laptop, and automotive batteries – takes place in the Democratic Republic of Congo. For the firms that manufacture these products, geo-politically related supply chain disruptions are an important operational risk, but one that can be partially mitigated by the adoption of the circular supply, resource recovery, or product-service system models.

Heightened consumer awareness is creating new sources of reputational risk for established firms. Concerns about human rights abuses, dangerous working conditions, financing conflict have existed in the jewellery and clothing sectors for many years, and have led to a proliferation of labelling schemes intended to differentiate ethically produced products from otherwise. In the environmental sphere, similar concerns – about global warming, plastics pollution and biodiversity loss among others – may be creating new impetus for the adoption of greener or more circular modes of production. The recent pledges made by eleven leading consumer goods firms (including Coca Cola, Unilever, and L'Oréal) to use 100% reusable, recyclable, or compostable packaging by 2025 (Ellen McArthur Foundation, 2018)[34]

34 Ellen McArthur Foundation (2018), Eleven companies take major step towards a New Plastics Economy, https://www.ellenmacarthurfoundation.org/news/11-companies-take-major-steptowards- a-new-plastics-economy

may partially reflect this issue.

The appearance and diffusion of new technologies have also been an important factor in the evolution and growth of circular business models. The emergence of the internet and the widespread uptake of digital devices have been particularly important. First, increased connectivity has reduced the transaction costs and risk associated with sharing goods, and increased the convenience of leasing rather than owning goods. Second, connectivity has allowed, in combination with smart sensor technology, real time monitoring of product performance, which is probably facilitating certain types of the product-service system. Third, connectivity has allowed, in combination with digitalisation, a variety of consumer products to be significantly dematerialised. In addition to the content related goods described above, digitalisation has also affected education (through the growth of so called massive open online courses) and work travel (through the emergence of teleconferencing).

Improvements in more traditional production technologies have also enhanced the business case for some circular business models. In the case of the circular supply model, the rapid developments in solar and wind generation technologies are well documented, and have allowed renewable facilities to become increasingly competitive with their fossil fuel based equivalents. In the case of the resource recovery business model, the emergence of mechanised material sorting facilities (MRFs) has significantly improved the separation of different waste streams, thereby reducing the cost of secondary material production. In the case of the repair and remanufacturing business models, improvements in sensor technology have allowed faults to be diagnosed relatively quickly, again improving the underlying business case.

Technological change is also creating a variety of risks in the context of resource use and environmental pressure. The emergence and diffusion of a variety of labour saving technologies – ranging from robotics in production to snow movers and leaf blowers in consumption – may have actually increased the environmental footprint of some activities. In addition, rebound effects have probably offset at least some of the reductions in resource extraction that have been realised by efficiency improvements. Finally, the continued growth of green technologies may be shifting the environmental burden associated with resource extraction and use away from the atmosphere (in the form greenhouse gas and sulphur and nitrogen oxide emissions for example) towards water and land. The extraction and processing of the aluminium, copper, lithium, and rare earth elements used widely in the automotive, energy and ICT sectors have a variety of often toxic by-products such as mine waste, process tailings, and smelter residues. Predicting the market penetration of a particular business model beyond the immediate future is a necessarily subjective exercise. Business model adoption will be driven by the attractiveness of the underlying business case which, in turn, will depend on the evolution of an array of technological, policy, and behavioural factors.

Organizations become more circular, sustainable and competitive through:

- Identification and effective management of current and future business impacts, risks and opportunities to improve resilience, avoid environmental harm and drive societal benefits;
- Making the most of resources while minimizing the production of waste (e.g. ensuring unused and/or unwanted items are returned to productive use);
- Strengthening relationships through effective collaboration with the value chain;
- Developing trust and confidence through greater accountability and transparency; and
- Using the principles of the circular economy as a framework for improving or completely changing the value proposition as a result of stimulating learning and innovation, thereby enabling the organization to begin the transition to a more circular and sustainable mode of operation if it makes sense to do so.

4.6 Supportive Policy Framework for Circular Economy Business Models

As mentioned in Section 4.3 of the Handbook, it may be prudent to avoid targeting policies at specific business models, and instead focus on implementing a policy framework that provides coherent incentives for closing and slowing resource loops, and narrowing resource flows throughout the economy.

A supportive, well-functioning, non-distortive policy and regulatory framework is a key precondition for the transition to a circular economic model. Such a framework should be designed to enable the intrinsic value of materials to be preserved or enhanced along production systems and value chains, and to minimise at the same time the level of inputs of virgin materials. There are several examples of effective EU[35,36], national such as the Netherlands[37], Sweden[38], Denmark[39] and Finland[40] and regional policies which support the increasing 'circularity' of economic systems. However, there is a general consensus among the EU Commission's Expert Group on Circular Economy Financing[41], experts from investment funds as well as experts from national and supranational lending institutions, including the European Investment Bank, that the current policy and regulatory framework is not sufficient for circular economy business models and value chains to thrive.

35 https://circulareconomy.europa.eu/platform/

36 For an overview of the 2015 and 2018 Circular Economy Packages, see, for instance http://ec.europa.eu/environment/ circular-economy/index_en.htm

37 https://circulareconomy.europa.eu/platform/en/strategies/circular-economy-netherlands-2050

38 Sweden transitioning to a circular economy - Government.se

39 https://en.mfvm.dk/focus-on/circular-economy/strategy-for-circular-economy/

40 https://www.ym.fi/en-US/The_environment/Circular_economy

41 Accelerating the transition to the circular economy https://op.europa.eu/en/publication-detail/-/publication/02590134-4548-11e9-a8ed-01aa75ed71a1

Shifting to Circular Economy Business Models

A well-functioning policy and regulatory framework ensures a level playing field for circular economy business models by eliminating legacy subsidies that reward linear behaviours, and by fully pricing in risks and externalities associated with the linear production and use of materials. Such a framework facilitates and accelerates the allocation of capital to circular investments and activities. It stimulates private sector finance, and allows optimal leverage of public funding.

There is a general consensus among the EU Commission's Expert Group on Circular Economy Financing as well as other groups of CE experts that the following four principles should be considered when formulating these policy interventions:

- Value preservation/creation;
- Proportionality (to the level of externality);
- Progressive dematerialisation;
- Sensitivity to innovation.

In addition, any policy development should be coherent and well-integrated with the effective and timely implementation of existing related policies such as climate, environment protection, and waste management related policies. In any case, the circular economy policy should avoid rebound or distorting effects, particularly with respect to other policy objectives to reduce greenhouse gas emissions and environmental pollution, to ensure sustainable use of natural resources and achieve the SDGs. The policy changes should also reflect the adaptive capacity of the businesses, and include appropriate phase-in and phase-out mechanisms.

The following have been identified as a priority for policy interventions by the EU Expert Group on Circular Economy Financing, which analysed barriers and identified the main areas that have the potential to encourage a greater allocation of finance to circular economy business models and systems:

- Subsidies should be removed and the negative externalities of linear economic activities internalised; where this is not politically feasible, subsidies (in a suitable, non-distortive form) to circular economic activities proportionate to their positive externalities should be considered;
- Public tools such as public procurement should be used to accelerate the market for circular economy products and services;
- Public funds should be activated as a 'de-risking' instrument to mobilise more private capital for scale-ups with a circular scope;
- Technical assistance should be provided to help businesses and local administrations understand linear risks and the economic and societal benefits of the circular economy;
- 'Response measures' which mitigate the economic and social impacts of communities, sectors and regions particularly exposed to the legacy of linear economic systems (e.g., mining) should be introduced;
- Priority should be given to policy interventions that comprehensively address multiple environment, social and governance risks.

4.7 Technical Assistance for Circular Economy Businesses

Gaining access to finance for circular business models and investments is an essential hurdle that needs to be overcome in the transition to a circular economy. Part of the challenge comes from the inability of businesses to clearly identify and communicate benefits of their circular concepts in terms of profitability, risk mitigation and increased sustainability of operations. Potential circular businesses often have limited capacity to articulate benefits of their circular economy business models to financiers and investors. Strengths of circular businesses, such as decreased exposure to resource price volatility or a more consistent cash flow through 'product-as-service' models, are not being embedded in business plans and proposals shared with financiers.

This lack of capacity and experience in communicating circular economy benefits has a negative impact on financiers' perception of circular economy businesses. In using the same evaluative methods as a linear investment to articulate a circular economy project's benefits, businesses entrench the concept that linear business practices are the most profitable and present less risk. If circular economy businesses were able to provide more comprehensive assessments of their business plans to financiers that take into consideration the reduction of linear risks and increased stability of cash flows, then financiers would be able to understand advantages of pursuing and supporting circular economy investments.

> An interesting platform to support circular businesses is being provided by London Waste and Recycling Board (LWRB).[42] The LWRB provides support to businesses of all sizes and at different stages of their lifecycle, from start-up to maturity which includes creation of jobs through developing new business models and revenue streams from waste products and circular technologies, with the potential to add significant GDP to London's economy.

Companies also often lack capacity to identify circular economy opportunities in their current operations. Shifting away from linear production and consumption models requires firms to view their inputs and outputs from a different perspective in which materials and products are only a means to providing a service, and where there is a potential additional value to capture in all resource flows. Therefore, companies that

42 https://www.lwarb.gov.uk/what-we-do/circular-london/circular-economy-investment-for-businesses/

could potentially benefit from adopting circular business models and technologies are unaware of opportunities they are missing.

In order to overcome these issues, the capacity of businesses should be increased to enable them to identify circular opportunities in their operations, and assess and communicate benefits of circular practices to financiers and investors. Circular business models and technologies often do not have sufficient levels of market penetration for firms to consider them as viable alternatives to current practices. Cost-effective e-waste recycling is a relevant example of a technology that has a significant market value, but is underutilised to date despite this fact. Recovering gold, copper and other metals from e-waste is now cheaper than extracting these metals from virgin sources in mines.[43] Despite these advantages, less than 20 per cent of e-waste today is properly recycled.[44]

Businesses must have tools and training is needed to communicate competitive advantages of circular economy investments in comparison to linear practices. The objective is to have a market of circular economy businesses that can successfully access finance to expand their operations due to their competency in and awareness of the inherent strengths of their circular economy approaches.

The technical assistance for circular economy businesses should address multiple barriers to scaling up the use of circular technologies:

- Provide support to businesses to identify, disclose and where possible mitigate linear risks in their portfolios and operations. Beneficiaries would receive training and expert input to assess their level of exposure to linear risks. Companies that already employ circular economy business models would receive support to communicate benefits of these approaches to potential financiers using the mitigation of linear risks to demonstrate their competitive advantage. Technical and financial advice would help to make linear risk evaluations a mainstream part of companies' reporting and increase market understanding of operational and potential financial benefits of pursuing circular strategies that mitigate these risks;

- Provide support for existing businesses to introduce circular economy technologies and business models in their operations. Companies would receive expert input to identify opportunities to extract additional value from waste streams and reduce their material intensity while increasing their ability to create value. Both larger corporates and small & medium size enterprises (SMEs) should benefit from this support. Large corporates would be able to address inefficiencies or linear risks in their supply chains, while SMEs would have the potential to transform their business model to align with circular economy principles;

- Increase the capacity and market representation of start-ups pursuing circular economy business models. Circular economy technologies and business models have the ability to transform markets; however, young companies need access to capital in order to invest in and scale up their operations. Technical and financial advice will help start-ups to develop business plans focused on circular economy approaches

43 Global E-waste Recycling Sales Market 2018 and Industry Forecast 2025.

44 Zeng, Mathews and Li. 'Urban Mining of E-Waste is Becoming More Cost-Effective Than Virgin Mining.' Environmental Science and Technology. 52, 8, 4835-4841.

to share with financiers. This support will promote the adoption of circular business models and technologies, and increase finance for circular economy businesses;

- Make sure that SME organisations have the necessary capacity to provide specialised advisory or counselling services to their members and SMEs in general to become more circular. Since SMEs would first turn to their own organisations to have support on how to go from linear to circular, it is important that SME organisations are in a position to respond to this demand in order not to delay the systemic chance that the circular economy needs to take off.

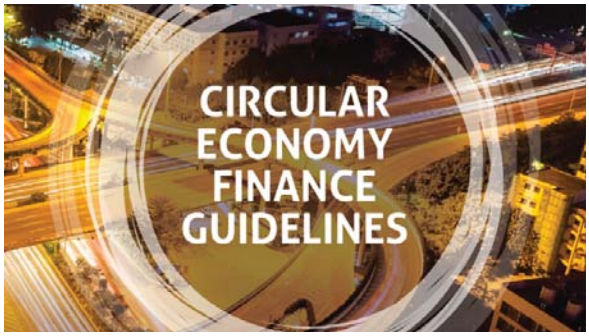
The most relevant players for providing circular economy advisory services are: public financial institutions such as multilateral development banks and promotional banks, specialised agencies, consultancies and experts as well as educational institutions such as technical universities. There are several potential avenues for these actors to provide technical and financial assistance to businesses seeking to adopt or scale up their use of circular technologies and measures.

The strengthened technical and financial advisory services could increase the uptake of circular economy technologies and business models while facilitating access to finance for circular economy businesses. This could have two major impacts. First, it could stimulate the market of circular economy businesses that employ similar strategies to gain competitive advantage using resource management. The market for circular economy technologies would then benefit from the increased economies of scale as technologies become more widely adopted. Second, it could help to communicate benefits of circular economy approaches to financiers. Investors, who currently prioritise support for linear business models, would see financial benefits of supporting circular investments. This would help to build financial institutions' and financiers' understanding of circular economy approaches, and their understanding of potential risks of supporting linear business models. In addition, a well-structured technical assistance programme could accelerate the emergence of new competences and skills, and create growing market opportunities for providers of circular economy advisory services. A useful example of this approach is a toolkit for policymakers led by the Ellen MacArthur Foundation, with the Danish Business Authority and the Danish Environmental Protection Agency as key contributors.[45] It is also worth reviewing examples to stimulate circular economy initiatives at the municipal level provided by the Finnish Innovation Fund – SITRA.[46]

45 https://www.ellenmacarthurfoundation.org/assets/downloads/government/EMF_TFPM_FullReportEnhanced_11-9-15.pdf

46 https://www.sitra.fi/en/projects/interesting-initiatives-taken-municipalities-support-circular-economy/

4.8 Dedicated Financial Instruments for the Circular Economy Business Models



Moving to the circular economy will require a significant increase in demand for finance to support circular economy businesses and products. The current volume of 'circular finance' is insufficient to support a transformation in how the value of materials is captured and preserved. While circular economy technologies and business models exist, they cannot reach the level of market penetration necessary to have impact on the operations of value chains. In order to transform value chains, companies with circular economy business models and products need to be able to access finance to scale up their operations. Access to finance must be available across all sectors, as the transformation to the circular economy must take the form of a systematic shift.

In the transitional period, when the mainstream financial institutions are not fully willing or able to consider the potential of the circular economy and do not invest in circular economy projects, the objective is to ensure the access to finance to a growing number of businesses that develop viable projects; although they will require a specific approach for managing financial risks. Public finances that aim to stimulate national and regional economies, job creation, infrastructure development and environmental mitigation could be deployed in such a way that they also support the circular economy. Ideally, this is done through suitable financial instruments that are designed with the circular economy in mind so that all important barriers and challenges to circular economy projects are considered in the design of the instrument.

At the EU level, the provision of circular economy finance could be channelled through the new or existing instruments such as the EU InvestEU[47]. Specifically, a share of the EUR 38 billion InvestEU budget could be dedicated to circular economy investments. A combination of equity, guarantee and risk-sharing financial instruments could be introduced in InvestEU to target circular economy investments. The four windows of InvestEU all speak to the potential benefits of the circular economy. Therefore, a common proportion of each window could be dedicated to supporting the circular economy. This is promoted by the approach that determines the overall proportion of InvestEU for climate change and the environment, where 50 per cent of the sustainable infrastructure window must contribute to the EU's objectives on climate change and the environment, while a common 30 per cent target is applied overall.

If InvestEU finance for the circular economy follows this approach, where a common percentage of the fund's resources are dedicated to the circular economy, it should be done preferably as a dedicated allocation separate from the 30 per cent for climate

47 https://europa.eu/investeu/home_en

change. Taking a cross-cutting approach to the allocation of circular finance across InvestEU's windows reflects the multi-sectoral realities of the circular economy, where its application cannot be defined solely within the label of sustainable infrastructure, innovation or SMEs.

The InvestEU circular economy funding would be disseminated through the instrument's designated implementing partners, namely the EIB group, national promotional banks and multilateral development banks. These institutions have both the capacity and the connections to local business communities to effectively deliver the circular economy finance to help companies apply or scale up their use of circular economy business models and technologies.

The provision of circular economy finance could be channelled through new or existing financial instruments. A combination of equity, guarantee and risk-sharing financial instruments could be introduced to target circular economy investments. Funds or instruments for the circular economy would help to scale up finance for circular economy businesses and products. The budgetary guarantee and its contribution to equity investments and risk-sharing instruments would help to leverage additional external finance attracted to the decreased risk of investments. This would help to increase the market penetration of circular technologies and business models, with the goal of reaching a scale sufficient to have a meaningful impact on how supply chains operate and retain the value of materials. Businesses seeking finance for circular economy investments would also benefit from increased access to and availability of finance.

4.9 New Circular Economy Sources of Revenue and Review the Organisation's Strategy

Business and financial complexities inherent in many circular economy projects pose an additional challenge to project promoters when approaching investors or seeking finance. Project promoters, in particular SMEs, do not have the expertise and resources to structure and prepare a sound credit story to investors and improve their bankability prospects. As a result, projects that have the potential of being commercially viable fail to access finance or the right form of finance.

The principal goal of project promoters should be to succeed in correctly identifying, conceptualising and developing circular economy business models and projects that are both economically sound and bankable, and congruent with a long-term development vision and strategy for the transition to a circular economy. Awareness raising both of internal organisations and external stakeholders (including within and across value chains) is key in this context.

Organisations often lack dedicated internal resources with necessary time, expertise and skills to lead and coordinate in the conceptualisation, preparation and implementation of circular economy strategies, initiatives and projects. The lack of required skills and expertise is particularly important as the availability of advisory services specialized in the circular economy is limited in the market. As a consequence, organizations

struggle to acquire and develop the knowledge necessary to identify and assess circular economy business opportunities and initiate innovative business models and projects. Organizations should consider allocating specific resources to develop an internal capacity to better identify and develop circular economy projects.

Each organisation has its own strategic and operational dynamics and business culture, which determine the preferred 'direction' for creating and implementing required changes supporting circular economy initiatives. Organisations should customise approaches to their specific operational modalities, however should consider the following:

- Introduce and institutionalise management involvement at the highest level in defining/ interpreting 'circular' as a strategic priority for business and operations, as well as in identifying and formulating measures that can be undertaken to introduce circular principles in the organisation and in the business model;

- Review existing organisational and operational arrangements to identify and assess existing activities that have the potential to trigger circular behaviours and generate business opportunities;

- Explore and elaborate new business model options that incorporate:
    - Strategies to create circular value, which act directly upon material and product resources in the business model (e.g. repair, material recycling/ upcycling);
    - Value proposition strategies, which deliver circular value to customers (e.g. product-to-service system, asset sharing);
    - Strategies to create value through networks, which support the involvement of actors beyond the company borders in order to achieve circularity across networks (e.g. industrial symbiosis, value chain collaboration).

To implement these recommendations, specific tools and management systems need to be developed. Some resources are already available, such as the **Circulator** tool at the EU level,[48] and could be used as a basis for further developments and methodological work leading to:

- Circular strategies and visions, which reflect the involvement and response of key staff and relevant value chain actors, e.g. clients, suppliers, governmental bodies, shareholders, etc.;

- Cost-benefit models, which evaluate circular and linear risks, and allow comparison of alternative business scenarios;

- Customisable action plans that are based on the collaborative involvement of key staff in the organisation, and that enable implementation strategies to be optimised based on resources available and expected market response;

48 www.circulator.eu

- Key performance indicators (KPIs) for goals and accountability that are consistent and aligned with sectoral, regional and/or country targets.

5 How to Assess Risk Associated with Financing Circular Economy Projects

The circular economy presents a multi-trillion-dollar economic opportunity. Shifting towards a circular economy model will not only deliver climate and other environmental and social benefits, but also provide significant new and better growth opportunities. For instance, adopting circular economy principles in Europe, in mobility, built environment, and food could offer annual benefits of EUR 1.8 trillion. Research suggests that if a circular approach were adopted in just five sectors (steel, aluminium, cement, plastic, and food), annual GHG emissions would fall by 9.3 billion tonnes of CO_{2eq} by 2050, equivalent to the reduction that could be achieved by eliminating all transport emissions globally. Now is the time for finance to capitalise on this momentum and help accelerate the circular economy transition. While the recent growth in financing is promising, far more capital and activity will be needed to scale the circular economy and fully seize its opportunity. All aspects of finance will play an important role in bringing forward the transition to a circular economy. Investors, banks, and other financial services firms have the scale, reach, and expertise to stimulate and support businesses to make the shift. There are few problems but there are also solutions.

5.1 What is the problem

Circular economy business models and projects face a wide range of risks ranging from market/value chain risks, (e.g. supply of feedstock, volume and price, demand for products such as secondary raw materials) to technological risk (e.g. unproven technologies), operational risks (e.g. interruption in the supply of raw materials), cash flow risks (e.g. delayed cash flows as a result of pay-per-use models), legal risks (e.g. maintenance and/or take back obligations, responsibilities in case of damage), and client risks (e.g. change in client base and behaviour).

A first step when deciding whether to finance a circular project or business is to assess the associated risks, which will be reflected in a higher required rate of return or risk premium. In view of the particularities of the circular economy, this is not straightforward. Assessing the risks of a circular project or business should be related to the assessment of its counterfactual, a linear economy project or business. Investors become increasingly aware of the linear risks as a result of the 'take-make-use-discard' model. Circle Economy[49] refers to the exposure to linear risks, like market risk as a result of resource scarcity or price volatility, operational risks like supply chain failures, or even reputational risks as a result of negative publicity and lower credit ratings. There are some well-developed tools for the initial assessment of the circular economy projects such as ScreenLab.[50]

The financial industry's tools to assess credit risk are often less sensitive to the specific nature of the risks posed by the circular component of projects or entire projects. This also applies to the assessment of the linear risks, especially for long-term financing. Existing models insufficiently capture the specific financial profile (e.g. asset ownership, cash flow dynamics, depreciation) of circular economy business models and projects. Also, for the linear industry, they do not always identify the risks of remaining in the linear model (e.g. climate, societal, regulatory, tax, etc.), while for the circular industry, they fail to value the benefits/risk mitigants of circularity, often resulting in penalising effects.

5.2 What Are the Potential Solutions

In response to the problems described above, we need to assess the existing (linear) credit risk assessment methodologies in order to identify which linear financial metrics are most affected by circular projects and businesses. Subsequently, develop alternative measures and/or suggest necessary adjustments to improve the comparability between linear and circular models in the different sectors (i.e. ensuring comparability of the financial metrics of circular and linear projects). We also need to recalibrate the risk measurement methodologies of linear projects and companies to take into account linear risk. Recalibrating should aim to identify, standardise and introduce in the methodologies a set of measurable and relevant parameters estimating linear risk (e.g. regulatory risk, raw material or component-related risk, environmental and social risks and liabilities, etc.) (i.e. accounting for linear risk).

49 Circle Economy is a not-for-profit organization working on practical and scalable implementation of the Circular Economy - https://www.circle-economy.com/

50 http://www.screen-lab.eu/deliverables/Table-rev4.pdf

5.3 Other Factors Which Influence the Bankability of Circular Economy Projects or Businesses

Due to the presumed associated risks, circular economy projects or businesses, especially SMEs, face the challenge of having access to finance. The available financial instruments offered by commercial and non-commercial lenders are not always recognised by the market as being able to finance circular economy projects. Also, often, project promoters, in particular SMEs, lack knowledge about what funding and financial instruments are available and fit for circular economy projects/businesses.

5.4 Potential Financial Implications

There could be numerous financial implications, but let's name just a few. They can include: default of payback due to longer payback periods for the required working capital; illiquidity and costly collection of collateral due to assets being located at customer sites; decreasing value of collateral over time due to depreciation; and unknown residual value of many products, due to small market of circular output companies.

5.5 Mitigating Measures

Risk mitigation strategies are important to convince internal or external financiers, depending on the individual funding requirements. They can include: shortening payback period by changing pricing model to get higher cash flows in beginning; showing benefit of higher and more stable profit margins based on additional lifecycles and reduced dependence to volatile commodity prices; leveraging supply chain for securities, i.e. supply chain finance/ reversed factoring; collecting deposit to reduce risks connected to bankruptcy; checking creditworthiness of customers; and introducing risk premiums in the pricing scheme.

We also need to be more specific in defining funding needs of circular models, such as: model expected net cash flow through estimating price or monthly fee appropriate for product or service (depending on e.g. asset handling, insurance, services, operating costs); modelling growth scenario taking into account the cyclic back-flow of assets in different conditions; and calculating expected net cash flow based on fees and scenario to name just a few.

To offer circular business models, companies need to define their financing needs such as finance for upfront investments and working capital during operations. Capital requirements to be flexibly available as new products need to be financed as soon as new contracts are signed. There is also a need to assess risks and offer securities: the most relevant aspects include client quality, strength of portfolio, asset quality such as a high resell price which reduces risk as it gives high collateral, and finally, the contract robustness, which can reduce risk of high fluctuation of customers, and deposits reducing risks of default in payback in case of bankruptcy.

5.6 Role of Financial Community to Facilitate Financing Circular Economy Projects

The 'newness' of circular business models does not necessarily imply that financial implications are specific to circularity. For instance, in the case of Circular Innovation Models (CIM) financing of innovation carries a certain amount of risk, but this would have been the case for any innovation. Therefore, this is not a financing issue that is specific for circular business models. Financial issues are particularly manifest in circular use models (CUM). These models aim to keep control over assets and retain added value. The change from selling assets to providing them as a service (PSS models) has consequences for a company's balance sheet, working capital, and cash flows. Combined with the uncertainties concerning the residual value of the assets, uncertain consumer demand and absence of legal structures, the risks of PSS models are currently high. This means that financial institutions are unable to price these risks adequately if consider them separately from the linear risks, which can result in high interest rates or a refusal to grant a loan at all.

Financial institutions determined to stimulate the transition to a circular economy can start by redefining risk. It is not only the risks of the new circular model that need to be assessed, but also the risks posed by the existing linear model. Moreover, it needs to be realised that the perceived circular risk is mainly due to the newness of the circular economy concept. Since circular business models are sustainable by design (i.e. excluding any linear risks), investing in circular businesses will lower the risk.

There is both a responsibility and an opportunity for financial institutions not to wait for this to happen, but to actively assess the companies in which they invest, evaluating their societal and environmental purpose, and their resilience to meet the challenges that the future will bring. In that sense, the linear risk can be mitigated by coming to terms with 1) the unsustainability of the current situation, 2) the financial implications in the form of stranded assets, and 3) a proactive attitude in stimulating circular business activities.

It is essential that shareholders, customers, suppliers and third-party finance providers, including banks and asset lenders, understand the longer-term objectives and the benefits that will arise from the investment in circular businesses. This will provide businesses the support they require to make the transition to a more circular model and lock in those future benefits. In helping circular supply chains to align incentives, financial institutions could invest time in creating the appropriate financial and legal structures to 1) invest in circular supply chains, and 2) place ownership of assets/receivables within supply chains.

The traditional way of financing a company can be a barrier for businesses adopting a circular model. In particular, the perceived residual value of a product needs further

attention: we do not know yet how residual value contributes to the business model, but it plays an important role in the attractiveness of going circular. The current mindset of consumers is a challenge to some circular business models. Consumers need to become used to not throwing away products, instead keeping them in the loop, and move towards using products rather than owning products (decoupling use from ownership).

There is currently a vast array of financial offerings that can help to provide companies with financial flexibility in their strategic, operational, and financial decisions. A change to a circular business model may, however, include a need for new offerings, or a different view on the elements of existing offerings. The evaluation of the 'risk' of a company will need to change if the transition is to be successful, because a circular business model has a different risk perspective to that of a linear business model. This is partly due to innovations, such as replacing product sales with PSS models. This has implications for both - the cash flow profile and balance sheet of a company. On the other hand, financial institutions may need to take a different approach in assessing the risks of a traditional linear company. These risks may be higher than currently perceived, for instance because externalities may need to become included in pricing in the future.

Another new approach will be the analysis of supply chains instead of individual companies. As companies move towards a circular business, collaboration within chains becomes more important. This can also have implications for a financial view, where one can envisage financing chains instead of companies. The total risk of a supply chain can be significantly lower than the risk of one company within that chain. This may also drive a need for specific 'vehicles' to be used in the actual financing of a chain. The legal framework used in financing companies will need to be adapted to enable and support these changes.

Financing the adjustment to a circular supply chain will require extensive analysis not only of the borrower, but also of the supply chain. Loan pricing is currently based on the creditworthiness of the borrower rather than on the solidity of the supply chain it belongs to. Once entered into a collaborative model, the borrower's creditworthiness will be strongly correlated with the solidity and reliability of the supply chain. Circular supply chains entail longer relationships between business partners, and the legal framework to support such relationships. One is to expect longer-term intake/off-take agreements needed to mitigate the downsides of specialisation, and various other legal arrangements destined to add more certainty to longer-term cooperation between the various partners.

As companies' incentives and economic realities change, these longer-term agreements add a significant number of variables that need to be factored in when assessing credit risks. It is important to consider that collaborative models between actors within or across supply chains will be instrumental in the move from a product-to-service business model. The main uncertainty will be whether the relationship with the supply chain partner(s) will last long enough to pay off, and whether it is legal under competition law. This will likely lead to an increased cost of capital unless appropriate purchase/supply commitments can be put in place to mitigate the supply chain risk.

Given that products flow in cycles through the supply chain, it may be desirable to finance this supply chain mechanism rather than a single company. This means the borrower would become a collective of companies, gathered around a specific product (or range of products). This would result in incentive alignment, since all chain partners

are responsible for the risks taken and share the gains when the project is successful. Another aspect closely linked to this idea is to transfer ownership from a single company to the supply chain. This would again have certain effects on the balance sheet etc. However, in this situation it would become the shared balance sheet of the supply chain. When financing the entire supply chain, it would make sense that the collateral (assets and receivables) is owned by the same entity as the one granted the loan/investment.

Notwithstanding the positive impact of circular economic business models, the approach to the appraisal and assessment of investment opportunities to support circular economic business models has to be no less rigorous and robust than that undertaken in relation to more traditional linear businesses. Indeed, the risks and challenges require very careful evaluation as part of the overall investment decision-making process. Central to this assessment are: management strength and track record of the level of strategic and operational support required to complement this; the underlying growth opportunity and the impact on this of external market factors; the extent of the changes required to the existing business model (if any) and the associated implementation risk; for businesses in the earlier stages of the life cycle, the development and commercialisation challenge, risk and roadmap; and the alignment of strategy and stakeholder objectives.

5.7 Potential Opportunities for Equity Investors

Over and above the provision of risk capital, equity investors are uniquely positioned to support and positively influence the development of the underlying business strategy. In the case of 'private' capital, this influence is possible through active participation at investee company board level, and perhaps with certain specialist equity providers, additional support covering, for example, operational best practice and market development opportunities.

In the listed equity arena, there are two primary mechanisms that could support the financing of the circular economy: firstly, through investment policy, i.e. using the lens of the circular economy to identify and select businesses that will benefit from the adoption of the circular models within their own business, and/or enable the development of the circular economy in other businesses; and secondly, through the active engagement of shareholders to exert influence on the strategy of businesses, encouraging the adoption of circular economy principles. Recent evidence of the power of shareholder lobbying (e.g. the influencing of major oil and gas companies' investment strategies) suggests that this is effective. The availability of the right combination of equity risk capital and positive strategic and operational influence will not only support the businesses at the core of the transition to the circular economy, but will also help de-risk the proposition for other funders.

6 Circular Economy Reference Documents

General documents, studies and other information on the circular economy

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13. Circle Economy. (2019). Circularity Gap Report 2019. Retrieved from: https://www.circularity-gap.world/global

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15. The Circularity Gap Report NL 2020 https://publish.circle-economy.com/circularity-gap-report-NL
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CE case studies

1. Circle Economy Various CE case studies http://www.circle-economy.com/reports-insights/
2. Circular Flanders Various Belgian case studies https://www.vlaanderen-circulair.be/nl/doeners-invlaanderen
3. Ellen MacArthur Foundation Various CE case studies https://www.ellenmacarthurfoundation.org/case-studies
4. Encore Encore regions and circular economy. Best case studies 2016. 2016 https://www.irekia.euskadi.eus/uploads/attachments/8492/ENCORE_Regions_and_Circular_Economy_WEB_pdf?1474877920
5. London Waste & Recycling Board. London: the circular economy capital. Towards a circular economy – context and opportunities 2015 http://www.lwarb.gov.uk/wpcontent/uploads/2015/12/LWARB-circular-economyreport_web_09.12.15.pdf
6. Luxembourg Centre for Circular Economy Various CE case studies http://www.lcce.lu/circular-economy-in-practice/
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European Institutions: websites and documents

1. DG Environment Website dedicated to the Implementation of the Circular Economy Package and Action Plan http://ec.europa.eu/environment/circulareconomy/index_en.htm
2. DG REGIO Information on CE Funding from European Structural and Investment Funds (ESIF) http://ec.europa.eu/regional_policy/en/policy/themes/environment/circular_economy/
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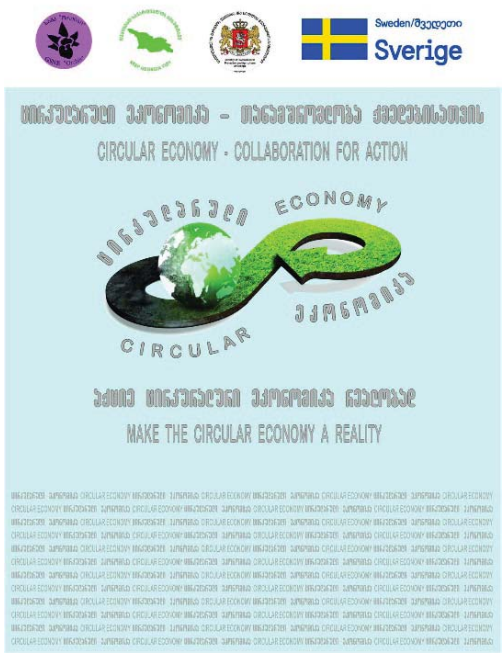
Annexes Examples of Successful Implementation of Circular Economy Measures

Annex 1 Circular Economy in Georgia

With the general objective of replacing the 'end-of-life' concept with an economic system that closes material loops, Georgia has recently embarked on an accelerated path to transition to the circular economy. With the concerted efforts of the Government of Georgia (GoG), civil society organisations, academia and international partners, Georgia initiated the development of the circular economy strategy and roadmap aimed at comprehensive approach from multiple points of view including production, consumption, waste management, secondary raw materials, innovation, investments as well as ongoing initiatives, in different sectors, by different players, and at different stages of the value chain or different stages of development. Several necessary steps to promote the circularity have already been undertaken.

Awareness Raising Programme on the Circular Economy

With the support from the Government of Sweden, Georgia launched in 2019 a 4-year awareness programme aiming at promoting the circular economy and acceleration of the transition to the circularity within the country. The programme is being implemented by CSO Georgian Society of Nature Explorers "Orchis" with the involvement of international and national experts, and support of the GoG, among them the Ministry of Environmental Protection and Agriculture (MoEPA), Ministry of Economy and Sustainable Development, etc. The programme envisages several awareness raising and information dissemination activities, and provides recommendations to various groups of key stakeholders, including policy makers, public authorities, financial institutions, project promoters, business sector and academia as well as general public how to accelerate the implementation of circular economy principles at various levels of economic activity.



- To date there have been five one-day awareness raising circular economy conferences targeting the following groups: (i) policy makers; (ii) project promoters and municipalities; (iii) business community; (iv) financial institutions; and (v) the Parliament of Georgia and key decision makers.
- All conferences to date have been well attended by parliamentarians, top level government officials both at central and local levels and key business leaders. At the conferences the key topics covered included general information on the circular economy principles and road to the circular economy, the legacy of the industrial

era, current trends – problems vs opportunities, comparison of linear vs circular approaches, circular economy business models as well as information regarding EU Circular Economy Policy including the original Circular Economy Package of 2015, and a new Circular Economy Action Plan adopted in 2020.

- Every conference included specific recommendations for a targeted audience, such as recommendations for policy makers, financers, project promoters and business leaders, and academia. The conferences focused on aspects such are the role of key stakeholders in the transition to circularity, supportive policy and environment, improving financing conditions, financial risk management and cash flow analysis for various circularity business models, providing incentives and removing barriers for CE projects and initiatives. At each conference, the participants were provided with a set of handouts including the most recent sources of information on circular economy, a guidance on typical circular economy projects as well as specific reference documents for targeted groups of stakeholders.
- In addition to the conferences, a series of articles were published on topics relating to the circular economy covering general information and awareness raising, current status of transition to circularity in Georgia and in more advanced countries, as well as more specific topics such as financing of circularity projects and risk management.
- Part of the programme was also the preparation of a Circular Economy Handbook for Policy Makers and Project Promoters as this group has been identified as key for the initiation of the accelerated transition to the Circular Economy. The Handbook was published in May 2021. This publication, i.e. the Circular Economy Handbook for Universities has been also written in the frames of the CE programme, and it is targeted to high schools to facilitate to the development of capacities, skills and expertise needed to identify, design and implement CE projects and measures.

Circularity Mapping in Georgia and Development of Recommendations for the National Circular Economy Strategy

As the programme on raising awareness on the Circular Economy in Georgia had been received very positively by a number of key stakeholders, the GoG approached Swedish International Development Cooperation Agency (SIDA) to support them in mapping the circularity of the Georgian economy with a view to provide recommendations to develop a Road Map to Circularity and adopt a Circular Economy Strategy. The request has been approved by the Government of Sweden, and the programme is currently at its initial stages of implementation.

The key objectives of the Circularity Mapping programme include the following:

- Mapping of the level of circularity of the economy in Georgia in close cooperation with the GoG;
- Identifying and establishing appropriate national quantitative circular economy policy targets and circular ambitions for the country in close cooperation with the GoG;
- Identifying sectoral circular economy opportunities;
- Determining priority sectors for circular economy initiatives and sector-specific policy options in close cooperation with the GoG.
- Developing recommendations for the Circular Economy Roadmap and Strategy of Georgia.

The implementation of the programme is led by an International Expert in the Circular Economy with the support of a group of local Georgian experts having a sound knowledge of the Georgian economy as well as environmental, social and governance issues. In addition, the Government of Georgia has formed an inter-ministerial coordination board, which includes members from different government departments (including business/ industry and environment), to ensure broad expertise as well as early buy-in from these key departments. The task group of sectoral experts and the inter-ministerial coordination board that are established for the implementation of the CE mapping programme are cooperating closely to efficiently meet the defined objectives and make the economy of Georgia circular.

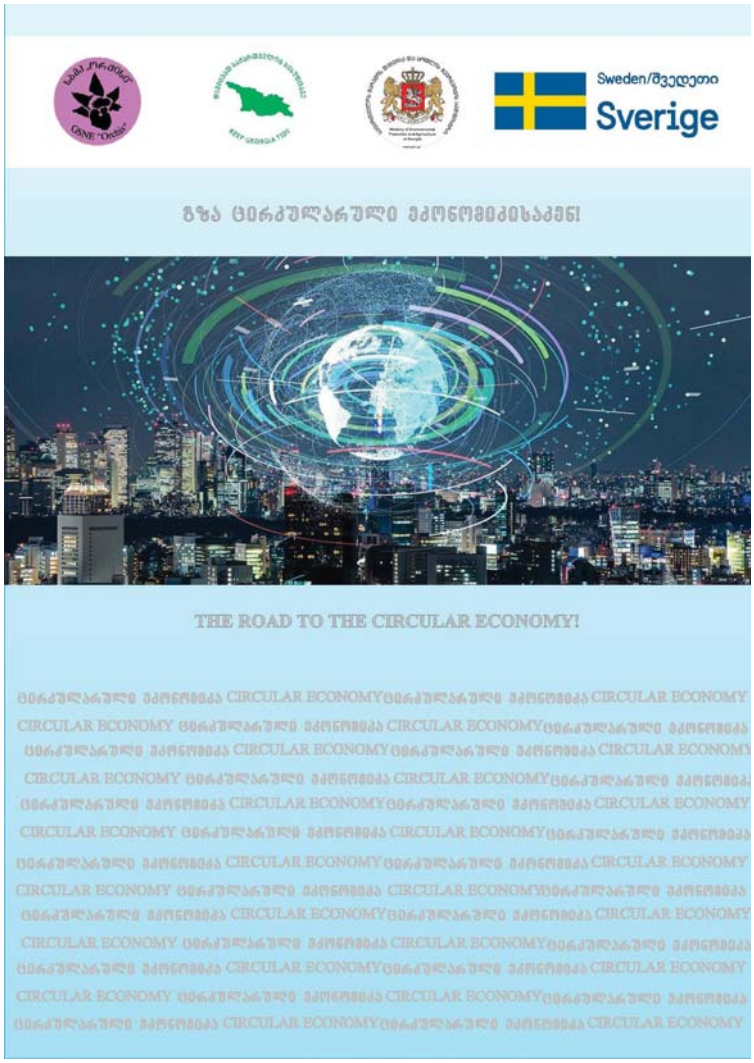
Other Initiatives by the Government of Georgia

In 2015 Georgia adopted a new Waste Management Code to establish a modern waste management system, and among them have introduced the Extended Producer Responsibility (EPR) principle. The EPR which is directly linked to the green and circular economy development is considered a key financial and operational instrument which promotes the implementation of waste management schemes in line with the waste hierarchy as laid down by the Code and the development of a resource-efficient economy. By introducing the EPR, producers will take over the responsibility for collecting or taking back used goods and for sorting and treating for their eventual recycling. The MoEPA, with the support from the European Union, UNDP and the Government of Sweden, has been actively working in this area since 2017.

- The purpose of the EPR is to improve environmental performance of the waste management system, and to mobilize financial resources needed to ensure the reuse, separate collection, recycling, recovery and/or other treatment of waste. It is based on the “polluter pays” principle, which is the cornerstone of the environmental policy. The EPR facilitates the attraction of private investments in the waste management infrastructure, and the creation of different jobs in the country.
- The implementation of the EPR is supported by regulations and guidelines covering such topics as: (i) liabilities and requirements for the setting up and authorization of individual and collective compliance schemes and EPR organizations by producers (including importers); (ii) rules for the establishment of the EPR register and

producers' registration; (iii) scope of decision authority and liabilities of involved parties; (iv) technical regulations on the collection and treatment for each category of specific waste; (v) targets to be achieved for the gradual adoption of the EPR; and (vi) control mechanisms. These technical regulations were developed through the support of EU, USAID, SIDA and UNDP, considering experience of Sweden, Germany, Austria, Greece, and other countries, and using participatory approach to ensure active engagement of all key stakeholders and especially businesses subject to the EPR.

- The MoEPA has also prepared several technical regulations for handling under the EPR such materials and products as waste electric and electronic equipment, waste oils, end-of-life tyres, and waste batteries. These regulations are currently going through the formal approval process. Some other regulations that will address packaging wastes and on end-of-life vehicles are currently under the preparatory and review processes.



Annex 2 Denmark and the Circular Economy

One of the first steps was a project initiated and performed by the Ellen MacArthur Foundation around creating a tool kit for policy makers, which was to describe a methodology for circular economy policymaking. The project looked at the circular economy opportunity from a country and policymaker perspective, and aimed to provide policymakers with an actionable toolkit to help accelerate the transition towards the circular economy. Part of the project was to perform a case study on Denmark which identified circular economy opportunities, barriers and policy options in the country. The results showed that introducing the circular economic principles to the Danish economy would:

- Increase GDP by 0.8 – 1.4 %
- Reduce consumption of selected resources by up to 50 %
- Reduce Danish carbon footprint by 3-7 %
- Create 7 000 – 13 000 jobs by 2035

The results were based on the following five sectors, which cover 25 % of the economy:

- Food and beverage
- Construction and real estate
- Machinery
- Plastic packaging
- Hospitals

Denmark has a long and rich tradition of innovating policies that stimulate the circular economy. It introduced the very first deposit-refund scheme for beverage containers in the 1980s. It has incrementally increased landfill taxes since they were introduced in 1987. In 2011, it set the target to be fully independent from fossil fuels by 2050. More recently, Denmark has laid out a comprehensive waste management strategy in 'Denmark Without Waste I/II', focused on moving from incineration to recycling and waste prevention, respectively. It has established the Task Force for Resource Efficiency, the National Bioeconomy Panel, the Green Industrial Symbiosis programme, and the Rethink Resources innovation centre. Denmark participates in international initiatives such as the Ellen MacArthur Foundation's CE100 programme. This country is internationally recognised as a front runner in the circular economy. A case in point is the Danish Business Authority winning the 2015 'Ecolab Award for Circular Economy Cities/ Regions' at the World Economic Forum in Davos.

Selected KPIs reveal that Denmark has indeed an advanced starting position compared to other European countries:

- Waste generated per unit GDP: 40 tonnes/EUR million vs. 69 for EU28.
- Waste diverted from landfill: 93% vs. 59% for EU28.
- Recycling rate113: 60% vs. 53% for EU28.
- GHG emission per unit of GDP: 225 tonnes CO_{2eq} per EUR million vs. 343 for EU28.
- Share of renewable energy: 26% of gross final energy consumption vs. 14% for EU28.

Yet even Denmark has significant opportunities to further transition towards circularity. Across the economy, significant material value is left on the table as most waste streams and by-products are used for relatively low-value applications. Of 93% waste diverted from landfill, only two thirds are recycled – the rest is incinerated. In the construction sector, 87% of materials is recycled, but mainly for low-quality applications and there is only an estimated 95% of its most important material (steel) is recycled, yet there is less than 1% an estimated remanufacturing. Nearly 100% of industrial organic waste is being valorised, but mainly in low-value applications such as incineration, direct fertilisation, or animal feed, while only ~3% of waste is used in biogas production and there is less than 1 % of cascading bio-refining. In addition, the headline figures quoted above hide pockets of opportunities. Municipal waste per capita is the highest in the EU (~750 kg/capita vs. ~480 kg/capita EU28 average). There is an estimated 80-90 kg annual avoidable food waste per household. Only ~15% plastic packaging is collected for recycling from households, of which only half actually gets recycled in new resin.

The Danish food and beverage industry has developed a track record of minimising processing waste and finding productive use for its by-products and remaining waste streams – but mostly in relatively low-value applications. It therefore has a significant opportunity to increase the value extraction from its by-products and waste streams by using cascading bio-refineries. While anaerobic digestion and other basic bio-refining technologies exist today, the technology to derive – in cascaded applications – high-value compounds is still an estimated five years away. If technological development continues and plant capacity is built up, modelling suggest that these cascading bio-refineries could yield, by 2035, a potential net value of EUR 300–500 million annually. In parallel, reducing the levels of avoidable food waste from 80–90 kg/capita to 40–50 kg/capita, enabled through building awareness and capabilities among households and businesses and improving technologies across the value chain, could save Danish households and businesses an estimated EUR 150–200 million annually by 2035.

Bio-refining seems to have the highest circularity potential to achieve the Denmark's target to become 100% circular by 2035. For that reason, according to a study by the Ellen MacArtur Foundation, these are **the key recommendations for policy makers** to overcome this barrier:

- **As a starting point,** including bio-refineries in the government's long-term strategic plans. This could guide and reassure investors - even more so if accompanied by a policy package to deliver the strategy.
- **In the short term,** providing capital to deploy commercial-scale versions of mature bio-refinery technologies. Promising policies include providing low-cost loans or loan guarantees for the deployment of mature bio-refining technologies for example through existing Danish business support schemes, and financing at market rates that is better tailored to investors' needs (as provided for example by the UK Green Investment Bank in municipal energy efficiency). Public-private partnerships to finance the deployment of mature bio-refining technologies also hold promise. An interesting example is the Closed Looped Fund NY that provides zero- or low-interest loans to municipalities or companies, albeit more active in developing recycling infrastructure.
- **In addition, creating markets** for bio-refinery output. Pricing externalities, setting targets (e.g. a minimum target for second-generation fuels within the EU's biofuels target) could contribute to such market development.
- **In the longer term, stimulating development of advanced, high-value bio-refining technologies.** The government could set up or fund cross-institutional R&D clusters to accelerate the move into high-value chemicals, nutraceuticals, pharmaceuticals etc. These could take on various forms, like the UK Catapults, a powerful example of public private partnerships in R&D, or the German Fraunhofer Institute, which plays an important role in European innovation with its long-term perspective and clearly defined mission to support application-oriented research.
- **Complementing these measures with a business advice service.** The primary goal would be to help bio-refinery entrepreneurs navigate a relatively complex regulatory and policy environment, but it might also help the bio-refinery community shape this environment.
- **Identifying and communicating necessary changes to EU policy** (or its national implementation) to address the unintended consequences of some safety-focused regulations that unnecessarily restrict the trade in bio-refinery feedstock or products.
- **Informing and educating consumers** using information campaigns on the importance of avoiding food waste; a communication campaign to educate consumers about best-before and use-by labelling: augmenting the national school curriculum with knowledge about food, nutrition, preservation, judging the freshness of food, seasonality, and appropriate ingredient and portion sizing.
- **Creating the right framing conditions to avoid food waste in** retail. This could include adjusting regulations so as not to discourage the donation of food due to liability concerns; encouraging such donations, as was recently voted into law in France or by setting up brokering platforms to facilitate matching donors and beneficiaries, and clarifying the information on best before dates for food and beverages to further facilitate such donations.
- **Stimulating the capability building through training programmes** to ensure that procurement, retail and kitchen staff possesses the necessary skills and tools to minimize food waste.

- **Introducing fiscal incentives** such as variable charging schemes for household waste. A small number of small- and mid-size Danish municipalities have implemented weight-based charging. Experiences in other countries show that fee-differentiated collection schemes are also feasible in larger cities with more multi-family buildings, and Switzerland has made such schemes mandatory in all municipalities.
- **Setting national or EU-level quantitative food waste targets**. This would provide overarching guidance to consumers and businesses on the government's objectives, and would likely be a very useful complement to some of the other policies.
- **Motivating supermarkets to reduce waste** (e.g. shifting more fresh produce sales to weight-based models). League tables at local authority level have proven their value in shifting practices regarding other environmental/social challenges and could work here as long as it does not require sharing confidential data.

Construction & Real Estate has been identified as one of the sectors with the highest potential for circular economy. There are three main opportunities for the construction and real estate sector to become more circular. Industrialised production processes, modularisation and 3D printing could reduce both building times and structural waste if technology development continues and traditional industry habits are overcome. Reuse and high-quality recycling of building components and materials could reduce the need for new materials and decrease construction and demolition waste, if the split incentives created by a fragmented market are addressed. Sharing, multi-purposing and repurposing of buildings furthermore could reduce the demand for new buildings through better utilisation of existing floor space. Modelling suggests that the annual potential value unlocked by 2035 if these three opportunities are realised could amount to EUR 450–600 million, 100–150 million, and 300–450 million, respectively.

The following policy options could be considered to further progress the circularity in Denmark:

► **Complementing building codes with circularity ratings and targets:**

- Ratings indicating the circularity potential of materials and construction techniques.
- Circular economy targets that set minimum requirements using a scoring mechanism. Denmark and the UK have already introduced energy efficiency and carbon ratings. This could be deployed to stimulate circularity, for example with energy standards that incorporate carbon/kWh scores for both the energy embedded in the materials and that used during operations—with recycled materials scoring considerably better than virgin ones.
- If targets are set, it is important that technology neutrality is maintained and the government is not prescribing the technologies, materials, or techniques to be used. In general, interventions along these lines would be expected to be most effective if introduced gradually, for example with gradually increasing standards as has been the case for energy efficiency within the Danish building regulations. In addition, these interventions would likely have impact across the three circular economy opportunities in the sector.

- **Supporting module production facilities.** The government might choose to play a role in motivating the financial industry to move into this area as such production facilities can yield good returns. If this is not an option or does not yield results at the desired scale or speed, low-cost government loans could also start addressing the access to capital barrier. If concessionary financing is undesirable, government agencies might provide loans at market rates that have been designed to meet the complex financing needs of nascent industries. For example, the UK Green Investment Bank has recently developed innovative loan products that are tailored to the specific needs of companies and local authorities wishing to make investment in energy efficiency improvements, which is a similarly immature market.

- **Creating legal framework for 3D printing materials.** Regulating input materials for 3D printing is necessary to realise the full potential of the technology. The timing is right to work on this, as the 3D printing industry is still young and supply chains are not yet mature and locked in. Given its complexity, developing this internationally—at the EU level or beyond—would make most sense. Along with material policies there is also a need for safety, quality, and environmental standards for the processes and technologies themselves.

- **Bringing together all stakeholders** in the construction value chain to work on systemic solutions to address the lack of skills and established norms that stand in the way of industrialising production. This could take the form of an industry-wide partnership focused on knowledge sharing and collaboration, a project with specific short-term objectives, or a private public partnership.

- **Supporting R&D.** Funding programmes to develop and bring to commercial scale new techniques in the 3D printing of building components and explore technological synergies between component printing and the on-going digitisation of construction. A technology challenge prize (as for example promoted by Nesta in the UK) could also be considered.

- **Launching public procurement pilots.** Such pilots could serve a triple purpose: demonstrate the viability and benefits of existing circular materials and construction techniques, stimulate the development of new materials and techniques (design competitions offer an alternative), and develop the necessary guidance and procedures for procurement teams to be able to accommodate such new or unfamiliar elements (e.g. adjustments to the typical pre-construction dialogues).

- **Adjusting public procurement practices.** This would allow for more public construction projects with higher resource efficiency by encouraging technological standards that facilitate later repair, remanufacturing, or reuse (e.g. in lighting or heating, ventilation and air conditioning); use of recycled or reused materials and components; procurement of decommissioning services that focus on value preservation; or mandating the inclusion of performance models or Total Cost of Ownership (TCO) metrics. As a first step, an advisory mechanism on circular public procurement practices could be set up. This could be complemented with training programmes for public procurement teams. At a later stage the actual procurement rules themselves might be adjusted.

- **Funding for industry training programmes** tailored to the various actors along the construction value chain (architects, engineers, entrepreneurs, construction workers, etc.) covering off-site production and on-site assembly of components as well as 3D printing techniques.

- **Supporting the creation of material inventory software** to keep track of the materials used in construction, maintenance, and renovation projects from start to finish and provide information on their lifetime impacts and opportunities for looping. Such support could come in the form of a publicly funded design competition.

- **Creating a 'positive materials list'.** A comprehensive database of construction materials that are favourable for circular design could help inform, educate, and inspire developers, architects, and clients alike. The initiative could define the criteria a material has to meet to get on the list and create an initial set of materials. It could also be expanded with commercially available branded products – it would require the initiative to define a simple application process through which companies can submit their products, and set up a review board. Such a list could then be taken over at the EU level, so as to inform other member states and create more consistency for companies in the industry.

- **Clarifying the legislation** governing (participants in) sub-letting residential and office space, and sharing business platforms (like Airbnb and Liquidspace) by defining unambiguously who is entitled to practice it (private tenants, commercial players) and which regulation they need to follow. Doing so could lower the risks perceived by individuals and companies wanting to engage in such transactions.

- **Creating financial incentives or financial support** to local, regional and national public-sector entities such as schools and other public infrastructure could help overcome hesitance towards renting out their properties when not in use (without distorting competition), and possibly remove some practical barriers such as locks that need to be added or changed. This could also have demonstration effects for private owners, facility managers in industrial and commercial real estate, and landlords.

- **Setting up municipal access portals** that provide information on public building availability and matches users with providers. This could start out with public buildings; private spaces could be added later, for instance in case a territory is too small or not sufficiently densely populated to warrant a commercial intermediary.

Plastic packaging is a central challenge to the circular economy. Although some of the potential solutions require multi-stakeholder alignment at international level, two opportunities stand out in Denmark at the national level: increased recycling and introduction of bio-based materials. By addressing the need for improved collection systems and working together with stakeholders on ways to increase standardization, Denmark could increase the recycling of packaging to 75% by 2035, saving both embedded energy and carbon. In addition, Danish companies could develop a competitive advantage in bio-based materials, if the need for accelerated technological development and creating functional end-of-use pathways is addressed.

Mobilized in 2014, as part of the MainStream Project, the Global Plastic Packaging Roadmap (GPPR) initiative leverages the convening power of the World Economic Forum, the analytical capabilities of McKinsey & Company, and the circular economy innovation capabilities of the Ellen MacArthur Foundation. The vision of the Global Plastic Packaging Roadmap (GPPR) is of an economy where plastic packaging never becomes waste but re-enters the economy as defined, valuable, biological or technical nutrients – a 'new plastics economy'. The GPPR provides an action plan towards this new plastics economy as an economically and environmentally attractive alternative to the linear model. The project is driven by a steering committee composed of nine global leading company CEOs and more than 30 participant organizations across the entire plastics value chain ranging from plastics manufacturers to brand owners and retailers in FMCG to municipal waste collection and after-use treatment systems. This integrative project setup allows for accelerating systemic change through innovation and collaboration. The GPPR works collaboratively with a number of existing initiatives focused on ocean plastics waste including the Global Oceans Commission, Ocean Conservancy, the Prince's Trust International Sustainability Unit, governmental institutions and policymakers. The project's unique focus on systemic change will complement and inform these other initiatives. Besides fostering innovation and collaboration across the value chain, the GPPR project will also inform and influence policy on a corporate and governmental level, by highlighting interventions that either hinder or accelerate the transition towards the new plastics economy. First results from the GPPR will be published in January 2016 at the World Economic Forum in Davos.

The following policy options could be considered to accelerate the circularity in **the plastic packaging sector.** These options are the result of an initial assessment of how cost-effectively different policy options.

- **Mandating the improvement of the collection infrastructure** for household plastic waste in municipalities. Nordic country experience suggests that kerbside collection generates less contamination than the 'bring' approach.

- **Increasing the national target for the plastics recycling** rate from 22.5% to up to 60%. This would move Denmark from the minimum level under current EU law to the levels envisaged in the 2014 EC review of waste policy and legislation presented as part of the EC's circular economy proposals. This could also help insure targets and objectives are well defined.

- **Standardising collection and separation systems** across municipalities to pave the way for economies of scale and stronger sorting and treatment capabilities at the national level. This could lead to a higher profitability of domestic recycling operations.

- **Reviewing fiscal incentives** around incineration of plastics. This could both tackle the externality barrier and accelerate the shift towards the complete recycling of plastic waste. In Denmark the taxation rate is already high in comparison with other European countries, so policymakers might consider differentiating the tax rate based on whether or not plastics are separated out before incineration. Catalonia has such a differentiated incineration tax rate for organics collection programmes.

- **Bringing together all stakeholders** in the plastics supply chain to work on systemic solutions to address split incentives that affect plastic recycling. This could take the form of a project with specific short-term objectives, or a network, or a private public partnership.

- **Working towards EU-wide rules and standards**

  - on the plastics used in retail packaging solutions to better ensure recyclability. Ultimately this could result in a EU-wide positive list of material/format combinations for which recycling performance is superior.

  - for waste recovery and management procedures so as to create more standardized outputs and allow better trade opportunities for the waste processors.

  - on minimum shares of recycled material in plastic products (as in California) in order to increase and stabilise market revenues for plastic recycling.

- **Setting up league tables ranking** neighbourhoods based on their recycling performance. In the UK for example the Department for Environment, Food and Rural Affairs maintains such a league table and provides information to households on how their communities' recycling rates compare to others. A study made by the University of Guildford concluded that this type of feedback encouraged households to recycle more.

- **Fund collaboration in the R&D and design phases.** With sufficient budget available this could take the form of funding R&D platforms—the further development of bio-based materials in collaboration with large CPG companies could follow international best-practice models for public-private innovation (for example the Fraunhofer Institute in Germany and UK's Catapults). More modest collaboration support could bring together designers and engineers in formats that draw inspiration from the packaging eco-design advisory services that Eco-Emballages offers in France.

- **Investing in improving end-of-use pathways** for bio-based and biodegradable materials (including plastics and food waste) in the collection/separation systems.

- **Working to clarify the EU regulatory framework** for approving new materials for food packaging so as to minimise unintended consequences that could hamper innovation and growth in the bioplastics industry.

Annex 3 Slovenia as a Case Study for the Public Sector Involvement[51]

Circular Change – Public Sector as the Core – the policies for the circular transition are coordinated through an interdepartmental collaboration when determining all policies. In Slovenia, a Circular Economy is already specified as a goal in the Government's strategic and vision documents, but also require more comprehensive policies which include: • Upgrading national statistics and accounts, • Introducing sustainability accounting, • Changing taxation policies, • Measures in the field of the use of space, • Changing subsidy policies, • Adjusting investment policies, • Restructuring the banking sector, • Transitioning to green public procurement, • Directing science and research, supporting innovations, • Building a suitable infrastructure, • Educating and raising awareness among stakeholders.

The majority of activities are linked to the Ministry of the Environment and Spatial Planning with strong cooperation with other ministries, notably the Ministry of Economic Development and Technology, the Ministry of Finance and the Ministry of Education, Science and Sport. Selected activities in the Slovenia's road to the Circular Economy include the following:

- There is an on-going reform of the fiscal policy to be more flexible in adapting to promote the transition to circular business operations.
- Harmonization of subsidy policies – certain policies between individual sectors are being harmonized to promote circular management.
- At the level of Strategic Research and Innovation Partnerships (SRIP), action plans and metrics for monitoring performance (and circularity) are being synchronized.
- Green public procurement is being developed and gradually implemented.
- Emphasis on learning and consolidating good practices – a dialogue between stakeholders and the strengthening of recognizability of good circular practices that set an example and promote a circular transition are encouraged through inter-sectoral cooperation that is already underway on the level of the Partnership for the transition to the green economy.
- Representatives of the Government Office for Development and European Cohesion Policy are routinely being involved in the preparation of an emerging framework for the monitoring of the circular economy at EU level in order to harmonize national and European circulation indicators.
- There is a continuous work on promoting investments in circular business models – concrete measures that direct domestic and foreign investors towards the circular economy, reward and promote long-term oriented

51 Road Map Towards the Circular Economy in Slovenia https://circulareconomy.europa.eu/platform/sites/default/files/roadmap_towards_the_circular_economy_in_slovenia.pdf

investments in circular practices, include the existing ones and develop new financial instruments for efficient circular management have become guidance for the Ministry of Finance and the Ministry of Economic Development and Technology.

- Circular Agricultural Policy – the Ministry of Agriculture, Forestry and Food is currently developing guidelines and conditions for the development of agriculture in the direction of circular models, taking into account the opportunities brought about by bio-economics and promote innovative approaches both in food production and in management of forest value chains.

- The Ministry of Education, Science and Sport is upgrading existing programs and establishing new ones that would speed up the circular transition.

- Economic diplomacy – the consular corps is being acquainted with the established international links in the field of the circular economy within the framework of the Ministry of Foreign Affairs and, on this basis, strengthening the business links and international competitiveness of Slovenian circular pioneers.

Annex 4 Examples of Successful Policy Actions from Various Countries

Case Study: Information and awareness

Since the concept of the circular economy is still not widely known among the public or in the business community, policy interventions aimed at increasing information and awareness play an important role. These policies aim to change ingrained patterns of behaviour and ways of thinking that companies and individuals have developed over long periods of time. They also seek to plug gaps in information that prevent or restrict circular economy opportunities. A related barrier is that of imperfect information. Since the circular economy requires business to cooperate across traditional sectoral and functional silos, an understanding of the economic potential and the practicalities is important, and often lacking. An example of targeted information delivery by the public sector is Denmark's Esbjerg municipality where officials inform farmers about agricultural plastics waste during farm inspections as part of the municipal waste management plan. Information and awareness campaigns can be broadcast to the general public, for example the food waste prevention campaign in Catalonia, or provided to consumers through product labelling: South Korea's Eco-label indicates not only the emissions of pollutants associated with the product, but also the conservation of resources through the product's life cycle relative to other products of the same category.

Case Study: Collaboration platforms

When pursuing circular economy opportunities, businesses incur transaction costs finding, and interacting with, suitable collaboration partners along and across value chains. Similarly, circular economy opportunities can be held back by a lack of commercially viable technology. In both cases there is a case for policy support to facilitate partnerships either between businesses or across business and academia. Collaboration platforms can take various forms, including industrial symbiosis, public-private agreements, R&D clusters and voluntary industry initiatives. Companies that look for collaboration partners for circular business ventures, but are challenged by a lack of information or find the transaction costs involved high, can benefit from industry collaboration platforms. These include industrial symbiosis programmes, examples of which include the Green Industrial Symbiosis programme in Denmark, the UK's National Industrial Symbiosis Programme, the Western Cape Industrial Symbiosis Programme (WISP) in South Africa and eco-industrial parks in China. Similar platforms include the Textiles Recycling Valley initiative in Northern France, where the local government is directly fostering collaboration around textiles flows in four clusters to develop innovation in recycled textiles. Cooperation can be centred on an association or an institution with government involvement, for example the Chinese Circular Economy Association (CCEA) and the Circular Economy Institute in France. Voluntary industry initiatives can work where a circular economy opportunity requires change along

the value chain: the Australian Packaging Covenant (APC) is an agreement between government, industry and community groups to improve packaging sustainability; and EcoProFabrics is a joint project, part-funded by the EU Eco-Innovation Initiative, of six companies in the Netherlands that closes a clothing production loop. When the barrier to the viability of a circular economy opportunity is a lack of cost-effective technology, R&D collaboration can be effective. Rethink Resources is an innovation centre in Denmark for resource-efficient production and product design. It is a partnership between universities, technology centres, manufacturing companies and the Danish Ministry of Environment and aims to support resource efficiency in companies. It provides new knowledge about product design, manufacturing processes, closed-loop, life-extension and new business models. The German government has provided funding to foster a leading-edge cluster for lignocellulose bio-refining, and the UK government is funding research clubs on integrated bio-refineries and bio-based processing. In Scotland there is a public-private partnership arrangement funding the Institute for Remanufacture at Strathclyde University.

Case Study: Business support schemes

In seeking out circular economy opportunities, companies can face economic barriers such as lack of access to technology, capital and in some cases challenges to profitability, and market failures such as insufficient competition, split incentives and transaction costs. Policy interventions in this area can take the form of financial support, such as grants and subsidies, and capital injections and financial guarantees, but also importantly technical support, advice, training, demonstration of best practices and development of new business models. A particular focus of these support schemes will likely be SMEs, which can lack the internal capacity, capabilities and financial resources to take advantage of these new opportunities. Examples on the ground are often instruments that offer a mixture of both financial and non-financial support. Denmark's Fund for Green Business Development is an example that provides grants, advice, support for partnerships and pilot projects, and an acceleration programme for new green business models. In South Korea the 'Green Up' offers environmental management consultations with SMEs aimed at enhancing competitiveness, reducing resource costs and improving environmental performance; and the Eco-Design programme provides technical and financial assistance to SMEs commercialising eco-innovation initiatives for their products and services. REBus, an EU Life+ funded collaborative project in the UK and Netherlands, provides technical expertise to businesses to develop resource-efficient business models in textiles and electricals (in the UK the focus is on building the financial case for a transition to a circular business model; in the Netherlands it is through public procurement).77 Finally, an example of tailored, on-demand business support around circular economy opportunities is the Green Deal in The Netherlands.

Case Study: Public procurement and infrastructure

When businesses face the barrier of entrenched customs and habits or a lack of markets for a circular economy opportunity, the public sector can step in to provide purchasing power. A circular public procurement approach is achieved when public organisations meet their needs for goods and services in a way that achieves value for money throughout the life cycle, for the organisation and for wider society, while minimising materials losses and environmental impacts. To this end circular economy standards can be incorporated into procurement law or guidelines, lists of preferred suppliers or materials can be drawn up, and capabilities and skills in concepts such as total cost of ownership (TCO) and measures of material circularity can be built in procuring departments. Examples include Denmark's Government Strategy on Intelligent Public Procurement, which contains initiatives to support circular procurement practices and puts in place dissemination activities and partnerships on green public procurement. In Flanders the government has created a market for high-quality recycled aggregates through their own procurement. US has integrated circular economy thinking into several levels of its public procurement policy. If the barrier holding back circular business practices is insufficient public infrastructure – such as waste collection systems and treatment facilities – public sector budgets can provide investment that enables private sector circular economy activity and potentially investment. An example is the South Korean government's construction of secondary infrastructure in order to boost car sharing as part of the Seoul Sharing City programme. Governments can also help by opening up access to the sharing of their own assets such as buildings and vehicles on platforms to be used by individuals or organisations such as in Flanders where the government is considering expanding a programme to share with the public its cars when they are not in use, for example at weekends.

Case Study: Regulatory frameworks

Regulatory policy interventions can address barriers of several types, including profitability and split incentives, and are of course critical to address regulatory failures. In cases where circular economy activity is hampered by the unintended consequences of existing regulations, it can be helpful to form a taskforce on circular economy or resource efficiency. Examples include Denmark's Taskforce on Resource Efficiency, Finland's working group on National Material Efficiency Programme and the UK's Circular Economy Task Force. Where the barrier is that of inadequately defined legal frameworks, new or adapted product, waste, industry, consumer, competition and trade regulations may be needed. These could come in the form of restrictions on, or requirements relating to, existing activities. Examples include New York City's ban of Styrofoam cups; France's requirements for manufacturers to display on product labels for how long spare parts will be available and to offer free repair or replacement for the first two years after purchase; California's amendments to its rigid plastic packaging container regulations to more effectively require plastic resin manufacturers to use at least 25% of recycled resins in their products; and France's proposal to ban large supermarkets from throwing away unsold food, instead either donating it to charity or

sending it for composting or for use as animal feed. Such interventions can equally come in the form of lifting existing restrictions or setting a positive legal framework for circular economy activities. Examples include Japan's policy to give food waste to pigs under highly sanitary conditions; Nevada's legislation to permit the licensing and operation of autonomous vehicles; The US's Good Samaritan Law that limits the liability of food companies and retailers for products they donate to charities; and the Basel Convention's new guidelines that could also allow countries to classify products and parts as destined for reuse or extended use, or for repair and refurbishment, to exempt them from the convention's requirements on the export of hazardous wastes.

Case Study: Fiscal frameworks

The main barriers to circular economy opportunities that fiscal instruments could address are those of profitability for companies and unpriced externalities. Similar to regulations, fiscal instruments can be applied either to discourage non-circular activities on the one hand or explicitly support circular economy opportunities on the other. An example of a fiscal instrument applied to a product difficult to incorporate into a circular system is Ireland's levy on disposable plastic carrier bags. Examples of pricing more fully the negative externalities of waste (management) through fiscal interventions are Denmark's high and incrementally increasing taxes on landfilled or incinerated waste and Finland's levy and deposit system on disposable drink containers. Examples of tax breaks for circular economy products and processes include New York's tax credit in favour of remanufacturing firms and China's reduced or eliminated VAT on goods produced from recycled materials.

Annex 5 Examples of Successful Implementation of Circular Economy Measures in Industry[52, 53]

Resource recovery models: upcycling at FREITAG

FREITAG is a Swiss manufacturer of bags, accessories, and clothing founded in 1993 by Markus and Daniel Freitag. The company produces its bags from used truck tarpaulins, car safety belts, and old bicycle inner tubes. By upcycling these materials, new value is created from what would otherwise be discarded waste. FREITAG has gained considerable scale in recent decades, each year around 400 000 products are produced out of 460 tons of truck tarps, 130 000 car seatbelts, and 12 000 bicycle inner tubes.

Circular Economy in IT: 3stepIT - Finland

3stepIT provides IT devices to businesses and the public sector, and is involved in the three steps of a device's life cycle: helping customers find the right device, monitoring its use and ultimately ensuring the reuse of the device once the customer longer needs it. The idea for 3stepIT dates back to the late 1990s, a time when more and more people started to have computers and mobile phones. Devices often change ownership, but their use is not monitored and they are not systematically leased. Today, the company manages around two million devices, of which just over half a million are returned from customers to the company every year. The company cleans and services the devices and clear their memory. Up to 98 per cent of these devices end up with a new owner after the processing, and the remaining 2 per cent is recycled and recovered as raw material. The manufacturing of phones, computers and tablets consumes natural resources. This makes it important to ensure that a device's life cycle is as long as possible. The monitoring and reuse of devices reduces their carbon footprint by 40 per cent. This also reduces the number of necessary devices and the amount of generated electronic waste. The demand for procuring laptops and devices responsibly is growing. Finland and the EU are planning legislation that will lead companies towards a circular economy.

Product life extension models: remanufacturing at Caterpillar

Caterpillar is the world industry leader of construction and mining equipment, diesel and natural gas engines, industrial gas turbines and diesel electric locomotives. Its brand "Cat® Reman" sells exclusively remanufactured products and is currently employing around 4 000 people in 17 locations worldwide. In 2014, Caterpillar remanufactured more 2 million components with associated material savings of 75 400 tons. As a manufacturer of capital-intensive machinery, remanufacturing makes sense from a business perspective: Around 65% of its operating expenses are already material-related. Caterpillar then sells its remanufactured products at

52 Sourced at https://circulareconomy.europa.eu/platform/en/knowledge/money-makes-world-go-round

53 Sourced at https://www.sitra.fi/en/projects/interesting-companies-circular-economy-finland/

a discount compared to new ones, but with an identical warranty. Still, it is more profitable to sell a remanufactured product than a brand new one, in particular when it is leased out. Then gross profits can be up to 2.75 times higher than selling original equipment. Remanufacturing at Caterpillar is also desirable from an environmental perspective. Around 86% less energy is consumed during remanufacturing compared to producing a new product from virgin material. Remanufacturing a cylinder head, for example, uses 86% less energy, 93% less water, and emits 61% less GHGs.

Product Service System models: light as a service at Philips

Philips started to experiment with the ESCO business model after being approached by one of its clients, the German architect Thomas Rau. Both sides agreed on a specific outcome: an exact level of brightness for Mr Rau's architect's office in Amsterdam. It was left to Philips how to achieve this goal with the most cost-effective solution. Philips would also retain ownership of its lighting equipment, being in charge of the installation, maintenance, upgrades, and end-of-life recovery. By applying the newest lighting technology – light-emitting diode (LED) lights – Philips was able to cut the energy costs of the architect's office by 35%. After this successful project, Philips then reached out to public clients and approached the city of Washington, DC. The company offered to replace over 13 000 light fixtures in the city's parking garage with LED lights at no cost to the city. Only afterwards, Philips would earn money as a portion of the projected energy savings. The replacement was forecasted to reduce the energy usage by 68% or 15 million kWatt hours per year, resulting in $2 million in annual savings. It was estimated that these savings will remove over 11 000 metric tons of CO2 from the environment which is equivalent to removing over 2 300 cars from the road. The case of Philips shows that there are large environmental and economic benefits from upgrading existing lighting infrastructures. The global potential of this practice can be further illustrated by referring to the *Enlighten Initiative* which is a public/private partnership between the United Nations Environment Program, OSRAM, and Philips Lighting, with the support of the Global Environment Facility. The website states that the share of electricity used for lighting accounts for around 15% of global energy consumption and for 5% of global greenhouse gas emissions. By switching to efficient on-grid and off-grid solutions, more than $140 billion could be saved every year, reducing CO_2 emissions by 580 million tons annually.

Circular Economy in Textile Industry: "Lindström's – Finland

In the 1990s, the began to focus on the textiles-as-a-service business. Companies need different kinds of textiles, but owning, storing and caring for them requires money and natural resources. Lindström provides companies with the textiles they need They look after the entire life cycle of the products, from design to reuse. They design and manufacture textiles only for the companies' needs and make them as durable as possible. This results in reducing the overconsumption and save natural resources. Lindström collaborates with several operators to ensure that the entire life cycle of the product is in line with the circular economy. In a traditional linear operating model, companies manufacture and sell their

products. In the circular economy model, partners are needed for activities such as the recycling of textiles that are no longer used and the development of new textile fibres that are more suitable for the circular economy. Digitisation plays an important role in the textiles-as-a-service model. Nearly all textiles provided by Lindström have a microchip enabling to ensure that the customers have the right number of textiles. This way, unnecessary textiles can be moved from one site to another and avoid having to acquire new textiles too early. Lindström monitors the use and the wear and tear of the textiles so that they can develop the products and make them last even longer.

Bundles – Circular Use Model

For clean laundry, you need more than a washing machine. Bundles is a start-up that sells washing cycles instead of washing machines. A device is attached to the washing machine in the customer's home to monitor how it is used. These statistics are displayed in the Wash-App, which provides the customer with insights into the overall cost of doing their washing, including energy, water and detergent consumption. In addition, the Wash-App displays tips to reduce costs and gives immediate feedback on the effect of different sorting, dosing and programming schemes. Not only does this reduce costs for the customer, but also extends the lifetime of the washing machine. To stimulate 'good behaviour', customers who use the machine optimally will be rewarded with a reduced monthly fee. Bundles is responsible for the installation, maintenance and repair of the machine, but also replacement if the machine becomes outdated or broken. Moreover, the time that a washing machine is out of order is reflected in a reduction of the customer's monthly fee. This is an extra incentive for Bundles to deliver excellent service. There are three different bundles available, for a small household, an average-size household and a larger household.

Bundles shapes the relationship with its customers as an operating lease, which means that Bundles retains ownership of the washing machine. This means that an investment of around €1,000 is needed for a new machine for every new customer, until the asset base is large enough to circulate machines that are paid off completely. This upfront investment has a payback period of five to six years and therefore leads inevitably to a funding need. At the moment Bundles is funded through crowdfunding, a couple of informal investors, and equity support from a start-up accelerator. Although this support was necessary for the start-up, these structures are relatively expensive and short term, and are therefore not sustainable for the long-run funding of the company. Together with Rabobank, Bouwinvest, a real-estate investor, and Miele, contours of future sustainable financing structures were explored, the results of which are discussed below.

Miele is currently the main supplier of washing machines and is therefore an important chain partner for Bundles. Miele designs its washing machines as far as possible according to circularity principles. For example, the machines are weighted by cast iron instead of concrete, which is easier to reuse. At the time of writing, however, Miele is not (yet) willing to take back used components for remanufacturing, and therefore other parties are needed to enter the chain and take up the role of recapturing material and refurbishing used machines. This means that the residual value of the machines is still assumed to be zero (or at best scrap value). To increase the residual

value, collaboration between the designer of the washing machines and a new end-of-life company is essential.

Circular Plastic Replacement Packaging: Paptic - Finland

In 2015, the European Union imposed restrictions on the use of plastic bags in an effort to reduce the related harmful effects to the environment. Paptic decided to replace plastic bags with alternative which could prove to be interesting to the market. Paptic produces a material based on softwood pulp used in responsible packaging that replaces disposable plastic packaging. Paptic is used in shopping bags, shipping envelopes used by online retailers and product packaging, which are used in around 200 Finnish and foreign retail chains. Paptic combines the best features of paper, plastic and fabric: flexibility, durability, strength and recyclability. Once a bag or other form of packaging made from Paptic has reached its end, it can be recycled as packaging paper or cardboard. Recyclability is the lifeblood of the Paptic materials. They are as such suitable for the current recycling system. It was important to develop a product that works like plastic but that consumers recognise as recyclable, as they do for packaging paper and cardboard. Paptic products can be used again and again. Some of the Paptic clients, started to print user instructions on the bottom of their Paptic bags, notifying their customers that the bags are at their best after 10 uses. Paptic products can be manufactured with the paper machines already on the market. The demand for paper is decreasing as printing products become digitalised. This way there can be use of the otherwise idle paper machines in paper production. The material is thin, making it does not require making any major changes to the machines.

Replacing cement with industrial side streams – Betolar – Finland

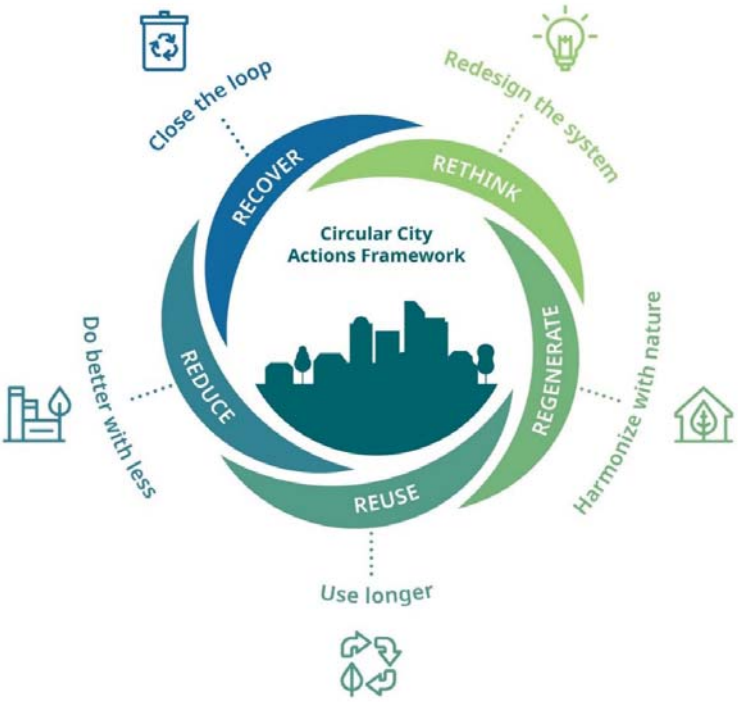
Five per cent of the world's CO_2 emissions originate from cement production. Betolar is currently replacing cement with binding agents made from side streams from the steel, mining, forestry and energy industries. Nearly anything can be used as a raw material, including ash, gypsum sediment or tailings. Instead of aiming to set up their own factories, Betolar is selling a licence concept that includes a tailored Geoprime formula and the support necessary for adopting the new production method. Introducing the method does not require any major investment: for instance, switching to low-emission garden paving manufacturing requires the client to only invest in one additive container and a pump. In one factory, machines were only halted for a minute and a half when the factory switched from cement concrete slab production to the cement-free alternative in their factory acceptance test. The solution is a significant new opportunity for the concrete industry. It allows for avoiding emissions from cement production and leaving virgin raw materials alone in binding agent production.

Annex 6 Circular Cities[54]

A circular city is one that promotes the transition from a linear to a circular economy in an integrated way across the urban space and multiple city functions in collaboration with residents, businesses and the research community.

Circular development is not only about reducing material and waste production. This pathway also supports local governments in improving human wellbeing and health, achieving climate neutrality, protecting and enhancing biodiversity, and promoting social justice, in line with the Sustainable Development Goals.

However, how cities can build a circular economy can seem complex and perplexing. **The Circular City Actions Framework was developed by ICLEI, Circle Economy and Metabolic to introduce cities to the range of strategies and actions available to them as they work towards circular development at the local level.**



How to use the Circular City Actions Framework?

The Circular City Actions Framework provides urban changemakers with five complementary strategies they can use to start working towards a more circular system. The framework is action-based to provide users with concrete strategic directions and showcase the desired outcomes of each strategy.

54 Sourced at https://www.circle-economy.com/

These five complementary strategies and their sub-strategies address the different roles that local and regional governments play, from public service delivery to cooperation with local stakeholders, asset management, urban planning and regulation. They can be applied to all production, consumption and waste management processes influenced by the city or its residents and are most effective when implemented in parallel. They can be used in stakeholder consultations to illustrate what the circular economy looks like at the local level and jointly identify relevant interventions.

Rethink → Redesign the system

Structurally support circular systems, rethink how value chains are organized and phase out linear incentives.

Outcomes: • Urban systems are adaptive and support long-term sustainability • Urban systems support self-sufficiency • Residents are reconnected to value chains • Community links and inclusiveness are fostered • Consumption-based emissions are addressed • All residents have equitable access to goods and services.

- **Support cross-sectoral collaboration and restructure the urban space, consumption and production systems for sufficiency:** Amis (United States) established 20-minute neighbourhoods as part of its Climate Action Plan 2030. The goal is for 90% of Portland's residents to be able to easily walk or bicycle to meet daily necessities by 2030

- **Support ownership systems and governance models that distribute value more equally:** Ghent (Belgium) actively supported the setup of a renewable energy cooperative, REScoop. Through collective ownership of homeowners' solar panels, members can share energy efficiency, so that even homes with less sunlight can benefit from the cooperative.

- **Divest from incentives, policies, investments and assets that support the linear economy:** Madrid (Spain) plans to significantly reduce its residual waste capacity, with a progressive phase out of incineration. The city's waste strategy plans for the local incinerator to be scaled down to 50% of its capacity in 2022 and to be finally closed down by 2025.

Regenerate → Harmonize with nature

Ensure all infrastructure and production-consumption systems positively contribute to local resource and nutrient cycles and respect ecosystems' regeneration rates.

Outcomes: • Products and services are made from lowest-impact and renewable resources • Production and consumption systems do not exceed the carrying capacity of natural ecosystems • Ecosystem restoration is facilitated and prioritized • Biodiversity is restored and protected, contributing to public health • Carbon sinks are optimized • Urban systems are better equipped to adapt to climate change impacts • Amenity value of nature is increased, contributing to health and well-being in the city.

- **Restore local ecosystems and respect their carrying capacities:** New York City (United States) carried out an ecosystem services strategy through an urban-rural partnership to preserve the pristine quality of its drinking water.

- **Prioritize lowest impact resources and nature-based solutions:** Shenzhen (China) turned a 105-acre abandoned agricultural experiment station into a park that incorporates sponge city principles (e.g. small swales to catch runoff, ponds with native rushes, permeable pavement).

- **Facilitate regenerative industries and resource/nutrients cycles:** Amis (Taiwan) implemented traditional and regenerative agricultural practices on peri-urban riverbank settlement.

Reuse → Use longer

Extend the use of existing resources, products, and infrastructure.

Outcomes: • Consumption of primary resources is reduced • Materials are reused at their highest possible value • Energy needs are reduced • Consumption-based emissions are addressed • Total waste is reduced • Material and economic value is relocalized, contributing to the local economy • Local employment is supported • Community links are fostered.

- **Support reuse, repair, remanufacturing and maintenance of existing resources, products, and infrastructure:** Brisbane (Australia) runs regular reuse and upcycle workshops and demonstrations to help citizens learn repair and remanufacturing skills.

- **Facilitate second-hand markets and sharing and exchange platforms:** Seoul (South Korea) has made sharing services part of its transport demand management policy, which targets individuals without cars. The city's Namun car sharing policy aims to have 2,000 stations across the city (5 stations per city district) by 2030. The city also provides bike and scooter sharing services. Public transportation and sharing cards can be used to access most services.

- **Design and regulate for extended use:** Rio de Janeiro (Brazil) ensured the Handball Court designed for the 2016 Olympics could be repurposed into schools around the city.

Reduce → Do better with less

Design infrastructures, processes and products to minimize material & energy consumption and waste generation during production, use and end of life.

Outcomes: • Toxic / hazardous substances are eliminated • Overconsumption of products and resources is reduced • Total extraction is reduced • Total material input is reduced • Total energy input is reduced • Total waste is reduced • Total GHG emissions is reduced • Reliance on scarce resources is reduced • Health impacts linked to pollution are reduced.

- **Minimize waste across the lifecycle:** York (Canada) conducted a food waste audit and is implementing waste-reduction pilots with supermarkets and restaurants.

- **Encourage efficient infrastructure and production systems with optimal resource footprints:** Jaipur (India) hosts the Jaipur Integrated Texcraft Park Private Ltd., an eco-friendly textile production park with facilities for water recycling, rainwater harvesting, and energy conservation.

- **Encourage sustainable consumption:** Melbourne (Australia) partnered with a local nonprofit to create the "We Need to Talk About Food" to support sustainable food consumption.

Recover → Close the Loop

Enable the recovery of materials at their end of life and facilitate their reintroduction in production processes.

Outcomes: • Total extraction is reduced • Total material input is reduced • Total energy input is reduced • Total waste is reduced • Upskilling and employment opportunities are supported • The local economy and innovations are supported • Emissions and environmental impacts linked landfilling and burning of waste are avoided.

- **Design for easy separation and recovery:** Turku (Finland) joined forces with 14 neighbouring municipalities to build a wastewater treatment plan designed to facilitate nutrients capture and heat recovery.

- **Collect, label and sort waste to facilitate material/resource recovery at the local level where appropriate:** Quelimane (Mozambique) collects organic waste from 11 markets as part of the "Quelimane Limpa" project. The waste is then taken to a local composting facility and turned into compost for distribution in neighbouring gardens.

- **Process waste and ensure its re-entry into industry:** Ashaiman Municipality (Ghana) works with Safi Sana, a circular economy business. Safi Sana collects sewage from public toilet blocks and organic waste, from which it generates biogas and compost, for an on-site seedling nursery.

The Circular City Actions Framework builds on the 3 circular economy principles developed by the Ellen MacArthur Foundation, the 9 Rs Framework and Circle Economy´s Key Elements Framework and adapts them to fit the specific context of cities and sharpen the focus on stimulating systemic change.

With support from MAVA Foundation, Circle Economy, Metabolic, the Ellen MacArthur Foundation and ICLEI are working jointly to refine the Actions Framework and pair it with a policy toolbox as well as a monitoring framework for local governments to localize the circular economy.

Glossary[55]

ANAEROBIC DIGESTION
Microbial breakdown of organic matter in the absence of oxygen. In a circular economy, anaerobic digestion can be used to convert food by-products, sewage sludge, and other biodegradable materials into digestates (or 'biosolids') that can be used as soil enhancers and biogas.

BIOLOGICAL CYCLE
The processes - such as composting and anaerobic digestion - that together help to regenerate natural capital. The only materials suitable for these processes are those that can be safely returned to the biosphere.

CIRCULAR ECONOMY
A systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature.

It is underpinned by a transition to renewable energy and materials. Transitioning to a circular economy entails decoupling economic activity from the consumption of finite resources. This represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits.

COMPOSTING
Microbial breakdown of organic matter in the presence of oxygen. In a circular economy, composting can be used to convert food by-products and other biodegradeable materials into compost, which can be used as a soil enhancer.

DURABILITY
The ability of a product, component or material to remain functional and relevant when used as intended. Durability often applies to the physical attributes of a product (its ability to resist damage and wear), though with some products durability can be technological (for example the ability of software to be upgraded many times), and it can be emotional (for example the ability of certain clothes to stay desirable over time).

FINITE MATERIALS
Materials that are non-renewable on timescales relevant to the economy, i.e. not geological timescales. Examples include: metals and minerals; fossil forms of carbon such as oil, coal, and natural gas; and sand, rocks, and stones.

LIFESPAN/LIFETIME
The period of time from when a product is released for use after manufacture to the moment it becomes obsolete beyond recovery at product level.

LINEAR ECONOMY
An economy in which finite resources are extracted to make products that are used - generally not to their full potential - and then thrown away ('take-make-waste'). It is a wasteful and polluting system that degrades natural systems

55 Sourced at https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/glossary

MAINTAIN
Keep a product in its existing state of quality, functionally and/or cosmetically, to guard against failure or decline. It is a practice that retains the highest value of a product by extending its use period.

NON-VIRGIN MATERIALS
Materials that have been previously used. This includes: materials in products that have been reused, refurbished or repaired; components that have been remanufactured; materials that have been recycled. Also referred to as secondary materials.

RECYCLABILITY
The ease with which a material can be recycled in practice and at scale.

RECYCLE
Transform a product or component into its basic materials or substances and reprocess them into new materials. Embedded energy and value are lost in the process. In a circular economy, recycling is the last resort action.

REDISTRIBUTE
Divert a product from its intended market to another customer so it is used at high value instead of becoming waste. For example, a supermarket can redistribute surplus edible food to a food-bank.

REFURBISH
Return a product to good working order. This can include repairing or replacing components, updating specifications, and improving cosmetic appearance.

REGENERATIVE PRODUCTION
Regenerative production provides food and materials in ways that support positive outcomes for nature, which include but are not limited to: healthy and stable soils, improved local biodiversity, improved air and water quality. In agriculture, regenerative production schools of thought include agroecology, agroforestry, and conservation agriculture.

REMANUFACTURE
Re-engineer products and components to as-new condition with the same, or improved, level of performance as a newly manufactured one. Remanufactured products or components are typically provided with a warranty that is equivalent to or better than that of the newly manufactured product.

RENEWABLE ENERGY
Energy derived from resources that are not depleted on timescales relevant to the economy, i.e. not geological timescales. Examples include: wind, solar, hydropower, hydrothermal, ocean (wave and tidal), geothermal, and biogas from anaerobic digestion.

RENEWABLE MATERIALS
Materials that are continually replenished at a rate equal to or greater than the rate of depletion. Examples include: cotton, hemp, maize, wood, wool, leather, agricultural by-products, nitrogen, carbon dioxide, and sea salt. To fit in a circular economy such materials (where relevant) must be produced using regenerative production practices.

REPAIR
Operation by which a faulty or broken product or component is returned back to a usable state to fulfil its intended use.

REPAIRABILITY
The ease with which a product or component can be repaired.

REUSE
The repeated use of a product or component for its intended purpose without significant modification. Small adjustments and cleaning of the component or product may be necessary to prepare for the next use.

REVERSE LOGISTICS
Supply chains dedicated to the reverse flow of products and materials for the purpose of maintenance, repair, reuse, refurbishment, remanufacture, recycling, or regenerating natural systems.

SHARING
The use of a product by multiple users. It is a practice that retains the highest value of a product by extending its use period.

TECHNICAL CYCLE
The processes that products and materials flow through in order to maintain their highest possible value at all times. Materials suitable for these processes are those that are not consumed during use - such as metals, plastics and wood. In the technical cycle the opportunities to maintain and generate value come through retaining the greatest proportion of the energy and labour embedded in the product. This is achieved, in order of value, by: maintaining, prolonging, sharing; reusing and redistributing; refurbishing and remanufacturing; and recycling.

VIRGIN MATERIALS
Materials that have not yet been used in the economy. These include both finite materials (e.g. iron ore mined from the ground) and renewable resources (e.g. newly produced cotton).