GROWTH POTENTIAL

All insights in this document come from our downloadable report, Financing the circular economy

ELLEN MACARTHUR FOUNDATION

GROWTH POTENTIAL:

PLASTICS AND PACKAGED GOODS

Key circular economy strategies

- Eliminate problematic and unnecessary plastics and packaging
- Innovate plastics to be reusable, recyclable or compostable
- Ensure plastics are reused, recycled or composted in practice

Drivers of circular economy growth potential

- **High** potential for growth in the short-medium term
- **Increasing** potential for growth in the short-medium term
- **Emerging or limited** potential for growth in the short-medium term

Innovation and corporate action	
Industry action	• Growing number of plastics commitments by large FMCGs and retailers, e.g. 850+ organisations united behind vision for a circular economy for plastics, the New Plastics Economy Global Commitment signatories represent over 20% of the plastics value chain
Demand for recycled materials	• Global demand for recycled plastic grew by 17% between 2012 and 2016[240] • Increased interest in recycling from plastic producers, evidenced by major M&A activity (e.g. Borealis) • Reusable plastic containers for fresh produce are projected to be one of the fastest growing produce packaging segments in the US[241] (e.g. Amcor's sales of reusable and refillable PET containers in markets where refill programmes exist doubled in the two years up to 2019)[242]
Innovation	• Ongoing innovation across the value chain including reuse models, packaging design to increase recycled content and reusability, recyclability and compostability, development of renewable feedstocks, and chemical recycling

Policies and regulation	
Increasing policies and regulation	• Single-use plastics bans have been announced around the world including in China, India and South East Asia, 34 African countries, various Central American, Latin American and Caribbean countries and cities, several US states and cities, and across the EU (e.g. Single-Use Plastics Directive banning ten single-use plastic products by 2021) • 63 countries had EPR measures in place in 2018 (e.g. Indonesia, Chile),[243] such as product take-back schemes, deposit return systems (e.g. Australia's 'Return and Earn' scheme), and waste collection; the new EU EPR schemes for certain single-use plastic products cover costs of collection, awareness raising, clean-up, and reporting[244] • Increasing landfill taxes, essential requirements for packaging (e.g. recycled content mandates for beverage containers in California) • National recycling targets (e.g. EU target 22.5% for plastic)
Incentives	• Circular economy regulation, including new EU circular economy Action Plan, EU Packaging and Packaging Waste Directive • Subsidies and support for innovation (e.g. Smart Sustainable Plastic Packaging)

Customer preferences and macrotrends	
Changing preferences and behaviour	• Increasing customer pressure regarding plastic pollution (e.g. 'BBC *Blue Planet II* effect') • Changing behaviour towards reusable instead of single-use (e.g. reusable cups and water bottles) • 92% of EU citizens approve of action to reduce single-use plastics[245] • Positive customer response to trials of unpackaged food products by major supermarkets (e.g. Waitrose) demonstrates potential for consumers to adapt to reuse models
Climate change and global challenges	• Eliminating unnecessary plastics, and reusing and recycling plastics, can contribute significantly to objectives on climate change (global CO_2 emissions from plastics production and end-of-life processing could be reduced by 56% in a circular scenario by 2050)[246]

Types of circular economy opportunity areas

- Circular design and innovation
- Circular business models
- Reuse, repurpose, and redistribute
- Repair, remanufacture, and refurbish
- Collect, sort, and recycle
- Regenerative and renewable practices and materials
- Enabling digital technologies

Current circular economy opportunity areas

Innovations that eliminate the need for packaging
(e.g. dissolvable/edible packaging, solid shampoo, farm-to-fork)

Business models based on reusable packaging

Collection of plastics
(e.g. connecting informal waste sector to formal waste collection through digital tech)

Identification and sorting technologies
(e.g. digital watermarks)

Renewably sourced materials
(e.g. plastics made from agricultural by-products)

Innovative sorting and recycling technologies
(e.g. chemical, solvent-based, robotic sorting)

Examples: Large corporates

Coca-Cola Brazil
has invested USD 400 million in the expansion of their reuse infrastructure (bottle cleaning and refilling facilities)[247]

Nestlé
has committed to invest up to CHF 2 billion (USD 2.9 billion) to shift to food-grade recycled plastics and to innovate packaging solutions

Unilever
has committed to halve its use of virgin plastics by 2025

Borealis
acquired plastics recyclers Ecoplast Kunststoff-Recycling, mtm plastics, and mtm compact to increase recycled plastic production

L'Oréal
has committed EUR 50 million (USD 58.96 million) to fund circular projects, including new business models to tackle plastic pollution

Indorama Ventures
committed USD 1.5 billion to invest in plastics recycling infrastructure

SABIC and BASF
have developed chemical recycling technologies to produce recycled plastic from mixed after-use plastic streams

TC Transcontinental
acquired Enviroplast to vertically integrate plastics recycling in its flexible plastic packaging production

Examples: Innovators

Algramo
operates a refill system for detergent and has established multiple corporate partnerships, including with Unilever and Nestlé

Bockatech
has developed technology to produce low cost reusable plastic containers, which are also lightweight and recyclable

Loop
operates an online shopping platform for branded food and cosmetic products in returnable and reusable packaging

MIWA
offers a complete business ecosystem for smart-powered reusable packaging (it has recently partnered with Nestlé)[248]

Já Fui Mandioca
(formerly CBPAK) turns a non-edible starch component of cassava into a compostable packaging material, and has partnered with BASF to produce a protective film to improve durability

RePack
provides a reusable and returnable packaging service for e-commerce

GROWTH POTENTIAL:

FASHION AND TEXTILES

Key circular economy strategies

- Adopt new business models to increase utilisation (e.g. resale, rental)
- Extend useful life through reuse and repair
- Ensure clothes are made from safe and renewable materials
- Ensure textiles are collected, sorted, and reused or recycled

Drivers of circular economy growth potential

- **High** potential for growth in the short-medium term
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- **Emerging or limited** potential for growth in the short-medium term

Innovation and corporate action	
Industry action	• Growing number of fashion brands committing to and acting on reuse or rental models, and design for durability, material health, recyclability, and traceability (e.g. The Jeans Redesign project)[249]
Innovation	• Ongoing innovation across the value chain, including reuse models, packaging design to increase recycled content and reusability, recyclability and compostability, development of renewable feedstocks, and chemical recycling[250]

Policies and regulation	
Increasing policies and regulation	• Increasing regulation, e.g. new EU circular economy Action Plan, and French Circular Economy Law banning the destruction of unsold or returned consumer products, affecting luxury goods brands
Political priorities	• Increasing interest from global platforms like the UN (through UNEP, UNFCCC) and the OECD • Policy Hub has proposed the need for green recovery principles boosting circularity in the Textile, Apparel, and Footwear industry for the EU Green Recovery Plan[251]

Customer preferences and macrotrends	
Changing preferences and behaviour	• Growing awareness of the current fashion system's drawbacks, is driving the shift to, e.g. safer chemicals and regenerative sourcing[252] • Disappearing stigma around buying second-hand and increased convenience of resale and rental due to enabling digital platforms

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Current circular economy opportunity areas

Clothing resale business models
(e.g. consignment or peer-to-peer)

Clothing and textiles collection and sorting infrastructure

Digital enabling tech
(e.g. tracking and tracing)

Clothing rental business models

Fibre-to-fibre recycling technologies

Materials innovation
(e.g. fibres from regenerative sources / by-products)

Examples: Large corporates

H&M Group
has committed to '100% Circular and Renewable' by 2030, including use of recycled materials in all its products, and reusable, recyclable or compostable packaging by 2025

Lojas Renner
launched a collection of recycled clothing using technology to recycle discarded textiles from their suppliers

GAP Inc
committed to circular design and exploring circular business models (e.g. with thredUP, a leading fashion resale platform)

The RealReal
sells authenticated second-hand luxury goods and was valued at over USD 1 billion at IPO

Rent the Runway
offers one-off or subscription clothing rental and has been valued at over USD 1 billion

Examples: Innovators

The Renewal Workshop
turns unsellable apparel into renewed products, made from used or recycled materials feedstock

Stuffstr
partners with retailers to buy back and recirculate used clothing, increasing clothing utilisation

YCloset
is a fashion rental platform, with more than 15 million customers across China (it has partnered with H&M to test the subscription model)

AHLMA
sources over 80% materials from leftover fabric, open sources designs, and has a repair lab

Lizee
helps brands set up a rental service model using their logistics and managed service solution

Depop
is a peer-to-peer vintage and pre-owned fashion marketplace and online community

HireStreet
offers a clothing rental service for high street apparel

GROWTH POTENTIAL:

FOOD AND AGRICULTURE

Key circular economy strategies

- Source food grown regeneratively, and locally, where appropriate
- Apply circular practices to controlled or precision agriculture solutions (e.g. nutrient and water looping for vertical or indoor farming)
- Prevent surplus edible food in production
- Design food products and supply chains to eliminate waste, bring production closer to consumption, and regenerate nature and soils
- Transform food by-products into new products, biomaterials, and agriculture and aquaculture inputs to return nutrients to the soil
- Collect and recover resources from post-consumer organic waste

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Innovation and corporate action	
Industry action	• Increasing industry action on climate change mitigation and tackling biodiversity loss, e.g. OP2B, an international business coalition on biodiversity including Barry Callebaut, Danone, McCain, Nestlé, Walmart • Growing industry understanding of circular economy benefits beyond packaging and waste management
Innovation	• Emerging business models that redistribute surplus food and reduce food waste • Increasing AgTech innovation (e.g. regenerative agriculture, microbe engineering, robotics, advanced data analytics, and agriculture management software)

Policies and regulation	
Increasing policies and regulation	• Increasing regulation (e.g. reducing food waste), with fragmented incentives for regenerative practices, but attention is growing, e.g. the EU's New Circular Economy Action Plan, EU 'Farm to Fork' Strategy, EU Biodiversity Strategy, carbon farming initiatives in California (e.g. Marin Carbon Project)
Public procurement	• Public procurement policies (e.g. Brazil National School Feeding policy prioritises local, organic, regenerative food sourcing; Good Food Purchasing Program in cities across the United States)
Political priorities	• Attention on food security by shifting to regionalised, resilient food systems, reinforced by the Covid-19 crisis, is creating a rapidly changing landscape (e.g. relocalisation of supply chains)

Customer preferences and macrotrends	
Health	• Rising awareness of food-related health issues, including diabetes and obesity • Growing preference for diverse ingredients (e.g. proteins, indigenous species) and shifting dietary preferences (e.g. towards plant-based, local and seasonal)
Climate change and global challenges	• Emerging awareness of the connection between agriculture and biodiversity loss, soil depletion, and water issues • Increasing understanding of agriculture as major contributor to climate change (CO_2 emissions from the global food system could be reduced by 49% in a circular scenario by 2050)[253]

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Current circular economy opportunity areas

Technologies to turn organic waste streams, including human waste, into commercially viable agriculture inputs

Regenerative agricultural practices, including shifting from synthetic to organic fertilisers, employing crop rotation, and using greater crop variation

(e.g. agroecology, rotational grazing, agroforestry, conservation agriculture, and permaculture)

Community Supported Agriculture model, which connects growers and consumers providing mutual support and sharing the risks and benefits of food production

Geospatial mapping solutions that provide visibility into food flows and organic waste streams to effectively capture and transform them

Design of food products and menus based on circular economy principles

(e.g. innovate new plant-based protein options as alternatives to meat and dairy, develop products and recipes that use food by-products as ingredients, and encourage customers towards them)

Digital customer-facing tools to create transparency on food products and supply chains

Examples: **Large corporates**

Danone
has committed EUR 2 billion (USD 2.4 billion) to scaling regenerative agriculture, reducing virgin plastic in packaging, and shifting to renewable energy, and has pledged to source 100% of ingredients produced in France from regenerative agriculture by 2025

AB Inbev
turns brewing by-products into protein-rich food products

Balbo Group
uses regenerative farming practices to achieve 20% higher productivity than conventional sugarcane production

General Mills
has committed to advance regenerative agriculture practices on 1 million acres of farmland by 2030, and have invested over USD 5 million to advance soil health on US agricultural lands, including RegenAg pilot projects

Examples: **Innovators**

Apeel Sciences
has developed an invisible coating made from plant material that extends the shelf-life of loose fruit and vegetables

Winnow
uses AI machine-vision technology to reduce food waste in commercial kitchens

Sanergy
sanitation company treats human waste with black soldier flies to create agriculture products

Row 7
seed company brings diverse plant varieties to food service players, individuals, and chefs

Feitosa Foodtech
turns surplus bananas, otherwise wasted on farms, into banana ketchup

Agricycle
provides drying technology to farmers in places like Africa to turn surplus fruits into shelf-stable snacks

Kaffe Bueno
valorises spent coffee grounds into cosmetics and food products

Greenplat's Plataforma Verde
blockchain software provides geospatial mapping of organic material flows

Ecovative
grows mycelium-based biomaterials to create, e.g. alternative meat products and biodegradable packaging materials

Agriprotein
uses insects to convert organic waste into valuable proteins

GROWTH POTENTIAL:

ELECTRONICS

Key circular economy strategies

- Design products for repairability, disassembly and recyclability, using recycled materials
- Keep electronics in use for as long as possible through circular business models (e.g. rental or product-as-a-service) and by repairing, refurbishing, reusing, reselling, repurposing or remanufacturing components and products
- Maintain value of materials by collecting, sorting, separating, and recycling materials after a product's useful life

Drivers of circular economy growth potential

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Innovation and corporate action	
Increased demand for finite resources	• Increase in urban mining/recycling efforts as the demand for rare earth metals rises in the electronics industry, with only 1% of rare earth elements currently being recycled
Innovation	• Technologies such as IoT, AI, 5G, or blockchain are enabling new business models (e.g. streaming services, subscription models) • Emerging design for repairability and reverse logistics solutions

Policies and regulation	
Increasing policies and regulation	• Increasing directives and regulation, such as new EU circular economy Action Plan, national policies and regulations (e.g. in Malawi, South Africa), right-to-repair, restrictions on hazardous substances, EPR on Waste Electrical and Electronic Equipment (WEEE) (e.g. China's Regulation on the Administration of the Recovery and Disposal of WEEE; South Korea's EPR scheme for e-waste covers 27+ products nationally)
Political priorities	• Mounting political interest in access to rare earth metals (e.g. EU critical raw materials work), reinforced by Covid-19 crisis and geopolitical tension (e.g. US-China trade)

Customer preferences and macrotrends	
Changing preferences and behaviour	• More and more customers are opting for cheaper, as-new refurbished electronics or access-over-ownership models to get access to newest products, especially in the fast-moving electronics space

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Current circular economy opportunity areas

Electronics resale platforms and refurbished electronics marketplaces

Repair, maintenance, and upgrade of devices

Disassembly and recycling technologies

Access-over-ownership business models
(e.g. rental, peer-to-peer lending or subscription pay-per-use models)

Electronics reverse logistics/infrastructure for collection and sorting

Examples: **Large corporates**

Apple
have committed to use 100% recycled or renewable resources in all products in future and use customer returns programmes and robotic disassembly to increase material recovery from used iPhones

HP
offers an IoT enabled subscription model ('printing-as-a-service'), closed loop cartridge recycling, and has partnered with Sinctronics to recover and create value out of HP end-of-use electronic equipment

Dell
designs products for reuse, repair, and recyclability, and committed to source 100% recycled or renewable materials for packaging by 2030

Samsung
offers subscription models that allow an upgrade to the latest device for a monthly fee

Cisco
has pledged 100% product return using returns programmes to repurpose, repair, refurbish, and remanufacture telecom equipment

Electrolux
is trialling subscription pay-per-use business models for hardware products in China and Sweden

Reclite
collect, transport, and recycle waste electronics in South Africa and surrounding countries

Examples: **Innovators**

Grover
offers 'pay-as-you-go' subscriptions to the latest user tech, including e-scooters

Fairphone
offers a modular mobile phone, allowing customers to replace and upgrade parts easily

Teleplan
offers lifecycle care of technology products, focusing on screening and testing, repairing and refurbishing, and recovering value from large flows of used electronics

Refind Technologies
develops systems for automatic classification and sorting of e-waste, such as batteries and phones

Back Market
is a marketplace for refurbished consumer electronics and recently raised USD 120 million from Goldman Sachs, Aglaé Ventures, and Eurazeo Growth[254]

ReUrbi
collects discarded IT equipment from businesses, then dismantles/ refurbishes it and sells it under the Remakker brand, including warranty and technical assistance, at prices that are up to 50% lower than for new products

Close the Gap
refurbishes and redistributes used IT equipment for educational, medical, and social projects in developing and emerging countries

GROWTH POTENTIAL:

AUTOMOTIVE, TRANSPORT, AND LOGISTICS

Key circular economy strategies

- Design vehicles and mobility infrastructure for shared use, adaptability, disassembly and recyclability, accompanied by a shift to electrification
- Keep materials in use by remanufacturing and upgrading of parts, vehicles, and infrastructure
- Diversify modes of transport and operating models (e.g. multimodal public transport-as-a-service)
- Plan cities and regions to optimise mobility (including freight), and enable effective reverse logistics and resource flows

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Innovation and corporate action	
Established circular practices	• Second-hand car market is already well-established, with car manufacturers often refurbishing and reselling • Car manufacturers have started to launch their own car-sharing programmes with varying uptake
Innovation	• Further shift towards and innovation into electrification of mobility • Ongoing innovation in autonomous driving and connected vehicles, but feasibility of implementation at scale is still uncertain • Development and implementation of digital solutions that optimise logistics and support the consolidation of freight services and reverse logistics, including local 'last mile' solutions

Policies and regulation	
Increasing policies and regulation	• Increasing regulation on emissions restrictions, design with recycled content, end-of-life vehicle reuse and recycling, rechargeable batteries, product-as-a-service mobility solutions (e.g. Reusability, Recyclability, and Recoverability Directive 2005/64/EC, which requires that new vehicles to be sold in the EU be designed so that minimum thresholds of parts and materials may be reused, recycled or recovered at the end of a vehicle's use-cycle,[255] EU circular economy Action Plan) • Increasing regulation on smart mobility (e.g. EU circular economy Action Plan)
Incentives	• Incentives for car-sharing (e.g. Chinese central government and local municipalities have issued multiple policies to encourage car-sharing, which is expected to grow rapidly in China)[256] • City planning to ease congestion and air pollution is changing approaches to transport in cities, including walking and cycling action plans (e.g. London's Walking Action Plan and 450km of new Cycleways planned by 2024; Seattle, Brussels, and Milan are all limiting car use and developing dozens of miles of bike lanes following the Covid-19 lockdown)

Customer preferences and macrotrends	
Changing preferences and behaviour	• Increasing demand for electric vehicles (the global EV market is forecasted to grow by 21% annually between 2019 and 2030)[257] • Changing customer preferences towards access-over-ownership (e.g. car-sharing market exceeded USD 2.5 billion in 2019 and is estimated to grow at 24% annually between 2020 and 2026)[258] • Rapid growth in online shopping, including food and grocery, increasing required logistics and reverse logistics capacity (e.g. online spend in UK grew by 13% year on year (YoY) in July 2019),[259] accelerated by Covid-19 crisis (online YoY revenue growth for US retailers was up 68% as of mid-April 2020)[260]
Changing demographics	• Rapid urbanisation, with 68% of world's population expected to live in cities by 2050, shared multimodal public transport becomes increasingly viable[261]

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Current circular economy opportunity areas

Remanufacturing of spare parts and recycling of materials

Circular business models including car-sharing, ride-sharing, logistics and freight load-pooling, mobility/infra-as-a-service, and multimodal integrated public transport, accompanied by a shift to EVs

Digital platforms that enable circular businesses such as sharing models

Examples: Large corporates

Renault
has increased the use of recycled materials in their vehicle design, as well as used vehicle collection, dismantling, reuse, and remanufacturing, the recycling of components, batteries and vehicles, and it launched ZITY, an all-electric car-sharing service

DHL
has introduced modular delivery 'Cubicycle' units which can be loaded onto electric cargo bicycles for last mile inner-city deliveries in Frankfurt and Utrecht

Daimler and **BMW**
have formed a joint venture, Share Now, which offers 'mobility-as-a-service' car-sharing in urban areas

Toyota
has launched initiatives to establish certified automobile dismantling facilities and has rolled out car-to-car recycling technologies globally

LKQ Corporation
recovers, recycles, refurbishes or remanufactures parts from trucks and cars to produce spare parts which can be used to repair and upgrade vehicles

Examples: Innovators

Whim
offers access to (almost) all types of transport through an integrated mobility-as-a-service scheme in Helsinki, the West-Midlands, and Antwerp

BlaBlaCar
enables car-pooling, using spare capacity in private vehicles on existing journeys

Convoy
is a platform that enables local freight drivers to pick up additional jobs en route and utilise empty load capacity

Connected Energy and **Powervault**
use second-life EV batteries for energy storage systems

Mobike
offers a bike-sharing service using IoT technology in dozens of cities across the world

Pony
operate a shared micro-mobility rental scheme with decentralised vehicle ownership

Black Bear Carbon
turns used tyres into a raw material called 'carbon black' which can be used in a range of products, including pen ink, smartphone covers, and new tyres

GROWTH POTENTIAL:

TECHNOLOGY, MEDIA, AND TELECOMMUNICATIONS

Key circular economy strategies

- Improve knowledge of an asset's location, condition, and availability using technology solutions to optimise circular economy value drivers (e.g. extend use cycle, increase utilisation, loop an asset, recover and reuse/recycle)
- Design technology and telecom equipment and infrastructure for life extension, upgrade, reuse, and disassembly
- Reuse, redeploy, upgrade, refurbish, and recycle tech and telecoms equipment and infrastructure (e.g. servers, network equipment)
- Operate shared data centre and network infrastructure (Infra-as-a-Service)

Drivers of circular economy growth potential

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Innovation and corporate action	
Increased demand for finite resources	• Increase in urban mining / recycling efforts as the demand for rare earth metals increases in the electronics industry, with only 1% of rare earth elements currently being recycled
Innovation	• Technological innovation (AI, IoT, blockchain) keeps rapidly broadening the scope for circular business practices • Cloud and edge computing are increasingly enabling intelligent assets • Companies enabling virtualisation and offering (streaming) services have already significantly disrupted the industry (e.g. Spotify, Kindle, Netflix), with the subscription e-commerce market, from streaming media to personal care products, having grown by over 100% annually from 2011 to 2016[262]

Policies and regulation	
Political priorities	• Growing understanding of how tech can enable solutions for urgent challenges (e.g. EU circular economy Action Plan, European approach to Artificial Intelligence and Robotics)

Customer preferences and macrotrends	
Changing preferences and behaviour	• Customers increasingly switching to subscription streaming models (global video streaming market exceeded USD 42 billion in 2019 and is estimated to grow by 20% annually between 2020 and 2027)[263]
Digitalisation	• Increasing global digitalisation and connectivity (3.5 billion people globally had mobile internet connectivity in 2019)[264] gives citizens access to digital platforms and marketplaces, resulting in trends such as growth in online shopping (including groceries) • Adoption of 5G could further enable IoT tech supporting the circular economy (e.g. predictive maintenance of smart home appliances)

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Current circular economy opportunity areas

Technologies that enable circular economy value drivers
(e.g. predictive maintenance, automated sorting, reverse logistics planning)

Virtualisation of physical products
(e.g. media streaming)

As-a-Service delivery models for network infrastructure

Repair, refurbish, and resale of tech equipment

Development of enabling telecom technologies
(e.g. 5G)

Examples: Large corporates

Google
applied circular economy principles to their data centres and server management, including buying remanufactured servers (18% in 2017), refurbishing existing equipment, and reselling used hardware

Thyssenkrupp
is using elevator data and IoT technology to enable predictive maintenance

Crown Hosting
provides data centres as a service to the public sector in the UK

KPN
set a target to get close to 100% circular operations and services by 2025 by applying circular design principles, and by the end of 2019, 18 suppliers had signed their KPN Circular Manifesto, representing more than 70% of its spend on materials

Cisco
provides infrastructure, platform and software-as-a-service delivery models, as well as a Takeback and Reuse Program for network equipment

Examples: Innovators

Provenance
uses blockchain technology to provide information about products and supply chains across multiple use cycles

ZenRobotics
combines AI and robotics to recover recyclables from waste

ReGen Villages
has developed software and a simulator which uses artificial intelligence and machine learning to address the integration of high yield organic food, clean water, renewable energy and circular waste to aid resource management at the neighbourhood scale

Closing the Loop
has partnered with **T-Mobile** and **Samsung** to collect and recycle a scrap phone for each new phone sold in the Netherlands, offsetting the material footprint on a one-to-one basis

GROWTH POTENTIAL:

ENGINEERING AND CONSTRUCTION

Key circular economy strategies

- Offer existing, underutilised building spaces for short-term use on online platforms to maximise the utilisation of existing assets
- Retrofit existing buildings for alternative uses and design new buildings to be adaptable to extend useful life
- Deploy and operate a portfolio of relocatable buildings –which are modular, designed for deconstruction and made of durable, high-quality materials – on unused sites to create short-term, or interim, spaces
- Create futures contracts, in which value is tied to the estimated future value of materials in a building when deconstructed, which can be traded on a centralised exchange to enable recovery and reuse of construction materials.
- Complement the reuse of deconstruction materials by using materials that are renewable, non-toxic, have a high recycled content, and/or are sourced locally
- Pay for performance through product-as-a-service subscriptions for building fixtures and fittings (e.g. heating-, cooling- or lighting-as-a-service)

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Innovation and corporate action	
Demand for finite resources	• Rapid urbanisation is projected to double demand for steel and nearly double demand for cement by 2050 • Unmet housing needs mean 1 billion new homes will be required worldwide by 2025[265]
Industry action	• Growing awareness among leading clients and investors of the positive business case for adopting circular models and increasing body of research and knowledge and papers published on the topic • Large demonstration development projects have been designed and constructed using circular principles (e.g. Triodos Bank HQ and Park 20|20 in Amsterdam)

Innovation and corporate action	
Innovation	• Ongoing innovation in business models (e.g. Madaster's platform creates material passports for buildings and tracks the value of materials over time),[266] and building materials and design (e.g. hemp fibre cladding on Flat House by Practice Architecture)[267]
Cost benefit	• In 2019 solar, wind, and hydropower projects were being deployed at their fastest rate in four years and renewable power capacity is expected to expand by 50% between 2019 and 2024.[268] According to BNEF analysis, utility-scale solar PV and onshore wind are now the cheapest forms of new-build energy generation across two-thirds of the global population[269]

Policies and regulation	
Increasing policies and regulation	• Focus area of the new EU circular economy Action Plan, e.g. material recovery targets for construction and demolition waste and its material-specific fractions • European Waste Framework Directive (2008/98/EC) has set a target for 70% of non-hazardous construction and demolition waste to be reused, recycled or recovered by 2020 • Increased policy focus at the city-level, e.g. The New London Plan requires all new developments of a certain size to submit a Circular Economy Statement to help architects embed circular economy principles,[270] and Victoria State government's 'Recycled First' programme for infrastructure requires the prioritisation of recycled and reused materials[271]
Incentives	• Decarbonisation of the energy sector is still high on the political agenda (e.g. EU Green Deal), with incentive schemes varying and evolving across geographies (e.g. solar panels vs home batteries)

Customer preferences and macrotrends	
Changing demographics	• Demographic evolution across regions requires different and changing housing needs • Shifting working patterns require flexible spaces, accelerated by Covid-19 crisis
Climate change and global challenges	• Increasing awareness that the construction sector accounts for over one-third of global resource demand and is a major contributor to climate change (a circular scenario could reduce global CO_2 emissions from building materials by 38% or 2 billion tonnes CO_2 in 2050, due to a reduced demand for steel, aluminium, cement, and plastic)[272]
Changing preferences and behaviour	• In 2019, over 40% of customers expressed a preference for renewable utility generation (25% in 2018), and 45% said they would be willing to pay more for 100% renewable energy[273] • Growing interest in decentralised, off-the-grid energy production and storage, driven by e.g. growth in the global EV market (forecasted CAGR of 21% between 2019 and 2030)[274]

Types of circular economy opportunity areas

- Circular design and innovation
- Circular business models
- Reuse, repurpose, and redistribute
- Repair, remanufacture, and refurbish
- Collect, sort, and recycle
- Regenerative and renewable practices and materials
- Enabling digital technologies

Current circular economy opportunity areas

Digital technologies which enable circular economy business models in engineering and construction, including material passports and predictive maintenance

Infrastructure- and product-as-a-service business models for infrastructure assets, fixtures, fittings, and furniture

(e.g. solar panels offered as a service to individuals and businesses)

Buildings as material banks

Note:
Commercial-scale pilots are needed to demonstrate proof-of-concept of emerging real estate and infrastructure circular business models

Examples: **Large corporates**

Steelcase
adopted product-as-a-service systems enabling recovery and redeployment of furniture, and pay-for-use models

BAM
constructed Circl, ABN Amro's circular pavilion in Amsterdam, with architects CIE

The Crown Estate
updated Development Sustainability Principles require design teams to incorporate circular principles into real estate development projects[275]

Arup
apply circular design principles to projects with clients and partners (e.g. The Circular Building, London, with Frener & Reifer, the Built Environment Trust and BAM, HAUT, Amsterdam, Transport Infrastructure Ireland, 1 Triton Square with British Land, and the Quay Quarter Tower in Sydney with AMP Capital and 3XN/GXN)

Interface and Tarkett
design and manufacture modular carpet tiles using recycled materials which can be disassembled and recycled after use

Schneider Electric
offers an Uninterruptible Power Supply rental service in Spain, with remote asset management and predictive maintenance to extend asset life

GE
offers digital and service solutions to monitor, predict, and optimise wind turbine performance and maintenance, and have a repair and refurbishment centre for spare parts[276]

Enel's
Futur-e project is redeveloping the sites of 23 thermal power stations using circular economy principles

Examples: **Innovators**

GlobeChain
is a digitally enabled reuse marketplace for construction material, while collating data

Kaer
offers air-conditioning as a service, taking responsibility for the design, installation, and operation of the AC system

Oxara
facilitates the reuse of construction waste (excavation material) and produces low cost secondary building materials

Strukton
has developed a mobile concrete recycling plant, Circuton, which recycles demolished concrete on-site into materials that can be reused to produce new concrete

Enlighted
provides an IoT-based energy service system, claiming it saves their clients 60–70% on lighting and 20–30% on heating/cooling

Winsun
uses 3D printing technology for construction

GROWTH POTENTIAL:

WASTE MANAGEMENT AND WATER

Key circular economy strategies

- Design for reusability, repairability, durability, recyclability, and/or compostability, including phasing out hazardous materials and substances of concern
- Collect and sort used products and materials (both non-renewable, e.g. metals, plastics, chemicals, etc.; and renewable, e.g. wood, paper, cotton) for reuse, remanufacturing, and recycling
- Reuse, remanufacture, and recycle materials, components and products, and improve efficiencies of recycling and recovery systems
- Collect, sort, and compost or anaerobically digest food and other organic material, and create valuable products from residual biosolids (e.g. fertiliser)
- Recover, reuse, and recycle water and resources from wastewater

Drivers of circular economy growth potential

- **High** potential for growth in the short-medium term
- **Increasing** potential for growth in the short-medium term
- **Emerging or limited** potential for growth in the short-medium term

Innovation and corporate action	
Innovation	• Automation increasingly being implemented in the waste management process (e.g. robotic sorting) • Technology and data-driven innovation, such as route optimisation, smart bins and trucks, RFID technology, and fill sensors • Development of new recycling technologies, particularly focussed on plastic (e.g. chemical recycling) • Technological innovation in resource recovery from wastewater (e.g. water innovation projects funded under Horizon 2020)[277]

Policies and regulation	
Increasing policies and regulation	• Stricter waste regulation, e.g. landfill taxes in the EU (EUR 5-100/ tonne),[278] Australia (USD 42-105/tonne),[279] and California, US (USD 36-50/ tonne),[280] single-use plastic bans, EPR schemes, essential requirements for packaging, and China's National Sword policy banning import of waste in 2018, including plastic, paper and metal, which has increased global waste disposal costs • National recycling targets (e.g. EU targets for plastic, paper, wood, glass, and metals)
Incentives	• Circular economy regulation, including new EU circular economy Action Plan, EU Packaging and Packaging Waste Directive, is helping to develop high-quality secondary raw materials markets • National governments and cities implementing circular economy roadmaps (e.g. Colombia, France, Slovenia, Germany, China; and London, Charlotte, Beijing, São Paulo, Mexico City, Cape Town), including approach to waste management and water

Customer preferences and macrotrends	
Changing preferences and behaviour	• Growing awareness of waste and pollution, particularly single-use plastic and plastic leaking into the ocean, resulting in changing attitudes, spending and behaviour away from linear business models (e.g. fast fashion and single-use plastic) • Recycling rates in Europe have increased by 16% between 2004 and 2017 for municipal waste, and by 13% between 2005 and 2016 for packaging waste[281] • However, global waste is expected to grow to 3.4 billion tonnes by 2050, more than double population growth over the same period, with at least a third not managed in an environmentally safe manner[282]

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Current circular economy opportunity areas

- **Collection, sorting, and recycling capacity**
- **Anaerobic digestion of post-customer organic waste**
- **Resource recovery from wastewater**
- **High-quality recycling technologies**
- **Use of organic waste as feedstock for innovative materials**
- **Automated sorting technologies**

Note:
In general, waste-to-energy is a linear activity which results in the loss of finite materials. It is therefore **not** considered to be part of a circular economy

Examples: **Large corporates**

SUEZ
generated 36% of their 2018 revenues in Europe from recycling and recovery activities, and becoming 100% circular through reuse and recycling is part of their 2030 value proposition; and opened in 2020 a pioneering industrial unit for the recovery of ultra-fine metal particles from household and industrial waste

Renewi
are a waste-to-product business that collect and recycle waste and turn it into secondary raw materials and products

Veolia
generated EUR 4.8 billion (USD 5.66 billion) in 2018 (50% of waste revenues) from circular economy activities, including recycling, biogas and wastewater recycling, and partnered with Unilever to jointly improve infrastructure for a circular economy for plastics

GFL
has invested in circular processes across material streams, including soil recycling and reuse in construction and development, and converting organic waste into compost and fertilisers

Cambrian Innovation
offers distributed wastewater treatment and resource recovery as a service via its water-energy purchase agreement

Examples: **Innovators**

TerraCycle
has programmes to recycle 'difficult to recycle' products, such as multilayer packaging and chewing gum

Loop Industries
produce recycled plastic feedstock of virgin quality using chemical recycling

TOMRA
provides reverse vending machines, waste sorting, and recycling solutions and technology

TriCiclos
integrates the operation of collection, sorting, and recycling stations with the education of communities and strategic consulting with businesses to help them design out waste

Recycling Technologies
have developed mass-producible modular technology which can be installed on existing waste sites to recycle plastic waste into feedstock for new plastic production

Kudoti
uses a digital platform to streamline collection, sorting, processing, and recycling of materials streams across Africa to reduce pollution and improve material recovery

AMP Robotics
uses AI and robotics to automate the identification, sorting, and processing of complex waste streams

GROWTH POTENTIAL:

INDUSTRIAL MANUFACTURING

Key circular economy strategies

- Use recycled or regeneratively sourced, renewable materials in production
- Design waste out of production processes, and reuse or valorise by-products of production
- Design and manufacture products to be durable, repairable, and easy to disassemble
- Keep products in use through disassembly and demanufacturing, remanufacturing of parts, products and machinery, and production of spare parts to repair and upgrade products, machinery and infrastructure
- Keep materials in use through recycling end-of-life parts, products, and machinery to recover the materials as secondary inputs for manufacturing processes

Drivers of circular economy growth potential

- **High** potential for growth in the short-medium term
- **Increasing** potential for growth in the short-medium term
- **Emerging or limited** potential for growth in the short-medium term

Innovation and corporate action	
Demand for finite resources	• Manufacturing firms in the EU spend on average ~40% on materials
Innovation	• Manufacturers continue to innovate in advanced manufacturing and digital technologies, such as AI, cloud computing, advanced analytics, robotics, additive manufacturing, and 3D printing to the value chain to reduce waste in production • Transition to renewable energy sources to power production

Policies and regulation	
Increasing policies and regulation	• Increasing regulation, (e.g. new EU circular economy Action Plan, EU Industrial Strategy, EPR policies, landfill taxes) • REACH regulation also covers by-products from production, with additional compliance requirements in place for by-products considered to be harmful to human health and the environment

Customer preferences and macrotrends	
Changing preferences and behaviour	• Growing awareness of negative impacts of waste and pollution
Resilience to global shocks	• Covid-19 crisis has created significant disruption to trade flows and manufacturing, supply chains, with some reshoring of manufacturing expected and increased instances of repair and remanufacture (e.g. of ventilators)

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Current circular economy opportunity areas

- **Additive manufacturing of components, products, and spare parts**
- **Disassembly, demanufacturing, and component and material reuse**
- **Circular business models offering products-as-a-service**
- **Remanufacturing of components, vehicles, and machinery**

Examples: **Large corporates**

Caterpillar's
Cat Reman programme, produces same-as-new quality components and replacement parts for a fraction of the cost of a new part

Rolls Royce's
'Power-by-the-Hour' engine maintenance management approach (e.g. TotalCare programme) uses predictive analytics for lifecycle engine maintenance, and enables up to 95% of used engine parts to be recovered or recycled

Siemens Mobility
3D printing of train and rail parts cuts manufacturing times by 95%

IBM
has demanufacturing and asset recovery centres to demanufacture used electronics and harvest parts for reuse or resale

Neptuno Pumps
remanufactures industrial pumps and reuses or recycles end-of-life parts to manufacture new pumps and spare parts

Jaguar Land Rover
recycles aluminium from end-of-life vehicles back into high-quality aluminium for the manufacture of new vehicle bodies

Examples: **Innovators**

3YOURMIND
has developed additive manufacturing software for 3D printing of spare parts, enabling **Deutsche Bahn** to create a 'digital spare parts warehouse' for maintenance of vehicles and **Bosch** to produce industrial plastic parts in small quantities, and 3D printing of parts for hospitals and medical centres in response to the Covid-19 crisis

Novo Nordisk
and eight other private and public companies, have a commercially successful industrial symbiotic partnership in Kalundborg, exchanging 25 different resource streams creating cost savings and socio-economic benefits

Warner Babcock Institute has developed an additive to help recycle old asphalt into new

Urban Mining Company
has developed a technology to reprocess rare earth magnets from end-of-use products (e.g. electronics) into new magnets

GROWTH POTENTIAL:

PAPER, PULP, AND FORESTRY PRODUCTS

Key circular economy strategies

- Source renewable materials from regenerative sources
- Keep materials in use by reusing and recycling paper, pulp, and wood through cascades of use, before safely returning them to the biosphere

Drivers of circular economy growth potential

- **High** potential for growth in the short-medium term
- **Increasing** potential for growth in the short-medium term
- **Emerging or limited** potential for growth in the short-medium term

Innovation and corporate action	
Established circular practices	• Recycling rates already fairly high, e.g. ~85% recycling rates of paper and board packaging in Europe in 2018[283]
Demand for alternative materials	• Plastic packaging disruption offers opportunities for alternative materials such as paper and cardboard (the shift away from plastic packaging is estimated to create an extra USD 700 million in demand for corrugated cardboard in Europe and the US between 2018 and 2022, equal to 0.4% per annum of incremental growth)[284]

Policies and regulation	
Increased policies and regulation	• China's National Sword policy banning import of waste in 2018, including plastic, paper, and metal, has increased global waste disposal costs and driven down recycled paper input costs (China took ~70% of the world's waste exports in 2017) • National recycling targets (e.g. EU targets for paper and wood)

Customer preferences and macrotrends	
Changing preferences and behaviour	• Increasing customer pressure and changing behaviour for packaging solutions ('BBC's *Blue Planet II* effect')

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Current circular economy opportunity areas

- **Use of high-quality recycled content to replace virgin input**
- **Use of paper or cardboard to replace plastics in packaging**
- **Automated sorting technologies**

Examples: Large corporates

DS Smith
a global packaging company and a net positive recycler, committed to manufacture 100% reusable or recyclable packaging by 2025

Stora Enso
design for circularity and have a value chain Circular Packaging Programme for driving collection and recycling of paperboard packaging

Smurfit Kappa
has a Better Planet Packaging innovation initiative to design alternatives to problematic packaging formats

International Paper
is targeting circular solutions throughout their value chain and is one of the largest users of recovered fibre globally

Examples: Innovators

The Loop Factory
has developed a manufacturing technology for dry moulded cellulose-based packaging from pulp, named Yangi, which is renewable and recyclable

Noble Environmental Technologies
have developed ECOR, a composite panel made from recycled waste fibres, using only water and heat

Spinnova
turns wood and cellulose waste streams into textile fibre

Paptic
has produced a bio-based, recyclable, reusable packaging material made from wood fibres

Sulapac
produces packaging from renewable materials, including by-products from wood processing

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