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Detecting the loops

Investing in the Circular Economy

White paper

Marketing material for professional investors
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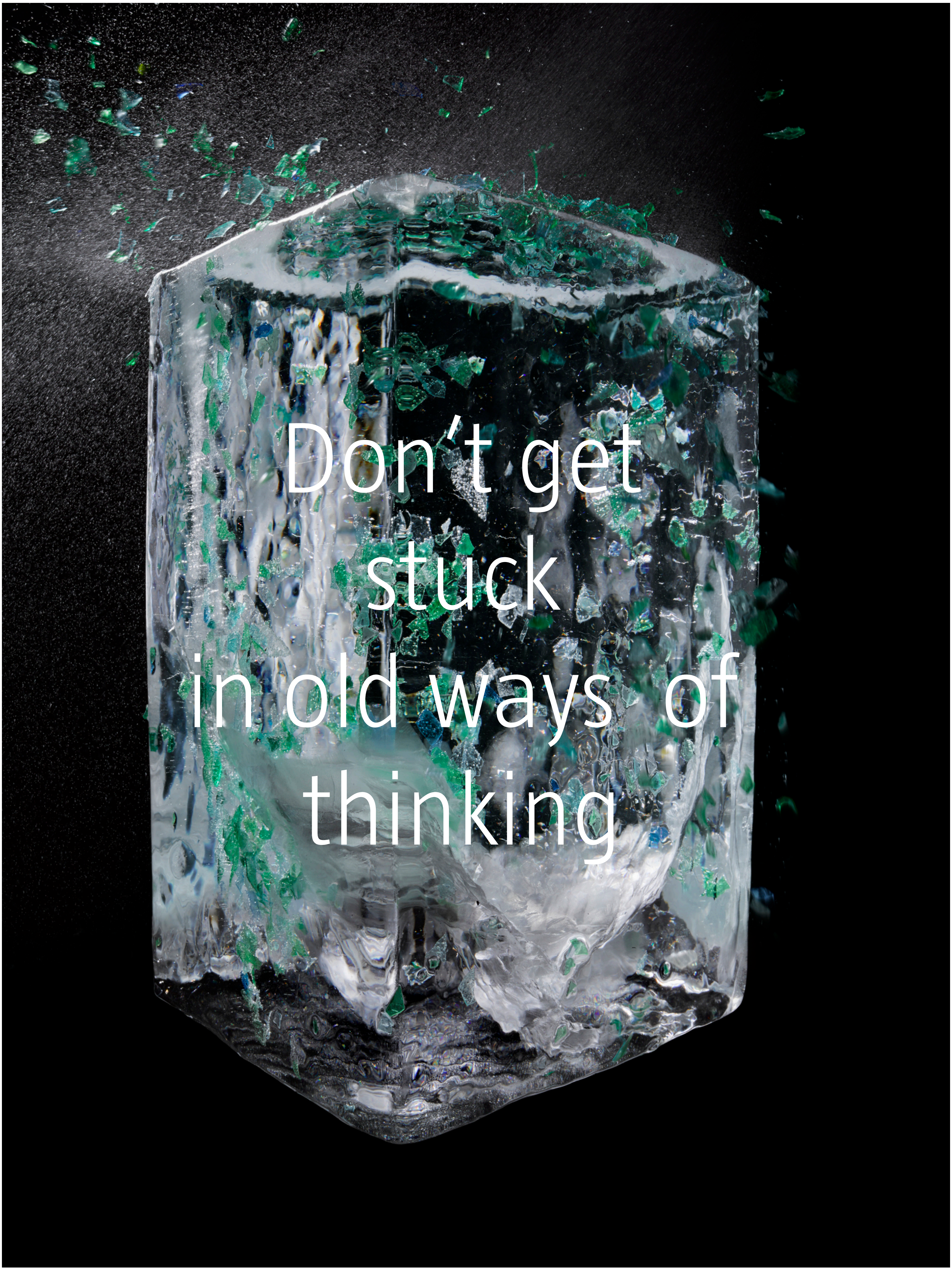
Don’t get
stuck
in old ways of
thinking

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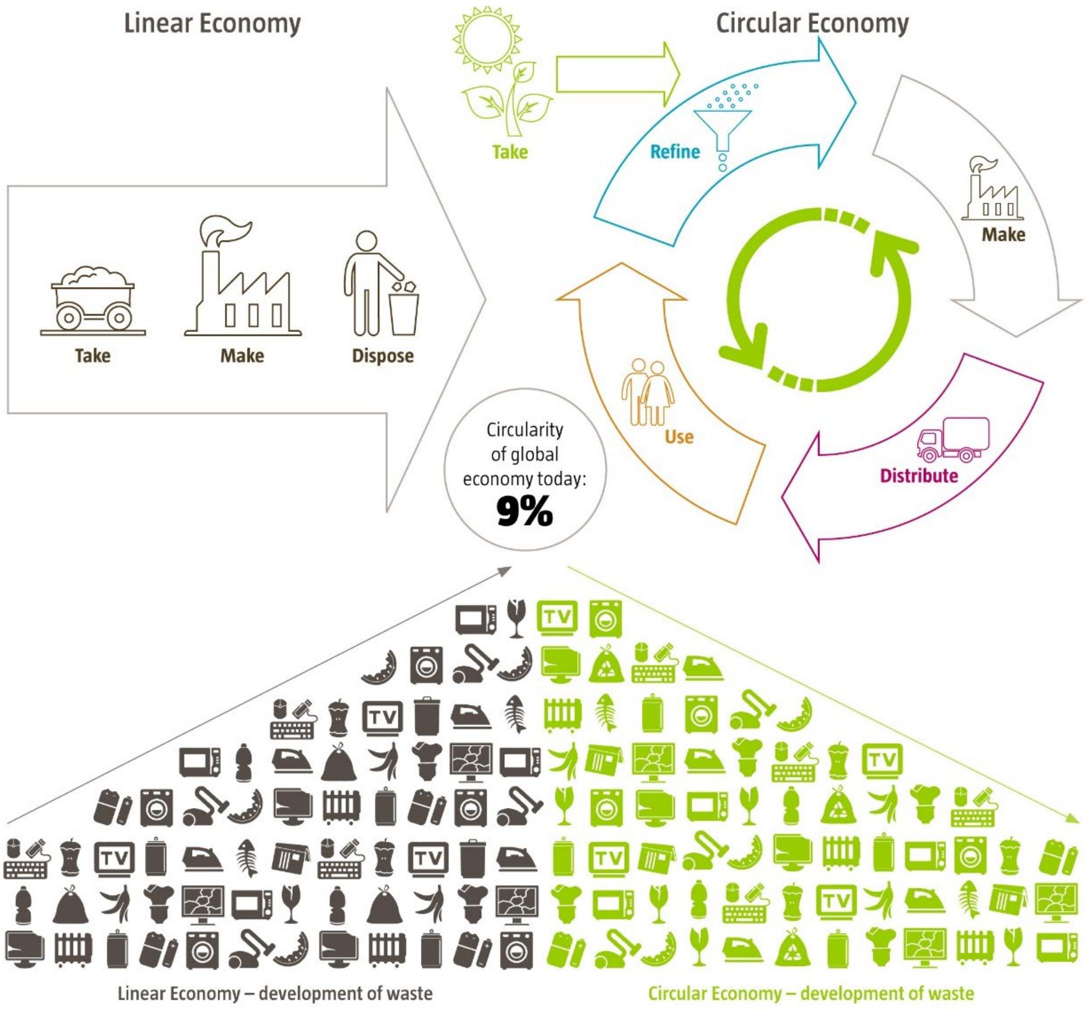
Preface

Today, the linearity of the global economy is becoming hard to escape; excess waste piled in landfills and littered along coastlines are visible hallmarks of a "take, make, dispose" paradigm fueled by business and devoured by consumers. Data and images captured by satellites reveal the extent of the damage is even more serious than the more readily visible trash here on the ground.[1] Pollution and environmental degradation at such scale are causing a severe loss of biodiversity and are destabilizing ecosystems. Excessive finite resource extraction is damaging the planet at alarming speed, outpacing the earth's ability to naturally regenerate and replenish itself.

Despite such worrying trends, the linear model is still going strong and continues to form the basis of much of today's production and consumption patterns. In fact, only 9% of primary resources, which include biomass, fossil fuels, metals, and non-metallic minerals, are being circulated in some form.[2]

Figure 1 | A new paradigm for production and consumption



Source: RobecoSAM and Circle Economy (2020)

[1] NASA satellite imaging showing dramatic changes to the Earth's terrestrial and atmospheric environments can be found at: https://climate.nasa.gov/images-of-change
[2] Circle Economy. (2020). *The Circularity GAP Report.* https://assets.website-files.com

However, Millennials and Gen Z lead a chorus whose volume is growing louder and their questions more pointed. What is the value in creating single-use plastic whose "life-in-use" spans a matter of minutes but whose "life-as-waste" spans up to 500 years? Do rock-bottom production costs justify the prolonged, externalized costs that society and environment must bear? And do they include the $5.2 trillion in annual subsidies to fossil fuel producers, providing the feedstock for petroleum-based products? [3] They are also asking: why are so many products unused and idle — like parked cars in a garage or office space in the built environment? Why can't products be designed for easy "dis"assembly and their parts and components efficiently reused? At the heart of all this ambivalence lies one fundamental question: Why do we continue to hang on to linear economy principles when their real, long-term impacts are so visibly damaging and their total costs exponentially high?

This question becomes even more puzzling when we consider the fact that there is a readily available solution that is rapidly gaining traction: circularity. In the circular economy value is retained and redeployed rather than destroyed. It takes the discarded outputs of a linear approach and turns them into value-added inputs within a new circular system. It goes well beyond waste treatment and recycling, and embraces the innovation and possibilities of digitization and new technologies. Advances in artificial intelligence, digital collaboration platforms, and cloud-based solutions have largely eliminated the need for physical assets like brick and mortar stores or onsite servers, helping to de-materialize entire value chains. With such high transformative innovation activity, the only reasonable question still left to ask is — which areas will fail to adapt and consequently fall off the linear cliff?

[3] Coady, D., Parry, I., Nghia-Piotr, L., Baoping, S. (2019).*Global Fossil Subsidies Remain Large: An Update Based on Country-Level Estimates*. International Monetary Fund. https://www.imf.org/en/Publications/WP/Issues/2019

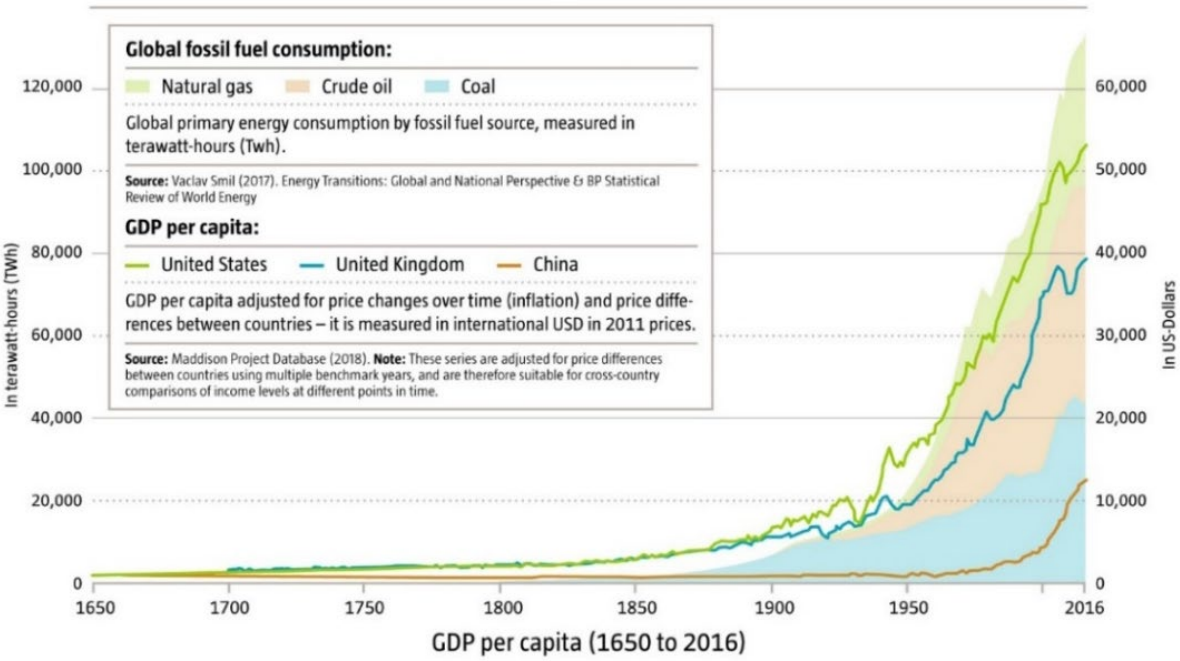
Linear industrialization – fossil fuels, mechanization, and mass production

To understand why the switch to the circular economy is a necessary part of a continuing evolutionary process, it is helpful to look back at the critical development phases that gave rise to the current linear operating model.

The line of history

The Industrial Revolution that began in Great Britain in the mid-18th century altered the global economic landscape. Scientific and technological breakthroughs triggered several waves of hyper-growth in industrial and agricultural production. Although various factors contributed to this innovative leap forward, a step-change in availability of fossil fuels played a crucial role. Whereas pre-industrial economies had been energy constrained, large-scale coal mining provided near limitless access to a high-density energy source that was stored over millions of years. The wide range of automated manufacturing processes that followed, for example steam-powered cotton spinning machines, increased production output significantly. While GDP per capita had changed relatively little in pre-industrial centuries, unparalleled productivity gains caused an unprecedented rise in economic growth. British real per capita income doubled from $400 in 1760 to $800 in 1860[4] and life expectancy rose by 15% to 40 years[5].

Figure 2 | A short story of production, consumption, and growth (1650-2016/17)



[4] Crafts, Nicholas F. R. (1985). *British Economic Growth During the Industrial Revolution.* Oxford University Press. As measured in 1970s US dollars.
[5] Wrigley, E. Anthony and Schofield, Roger S. (1981). *The Population History of England, 1541–1871: A Reconstruction*. Harvard University Press.

Review of World Energy

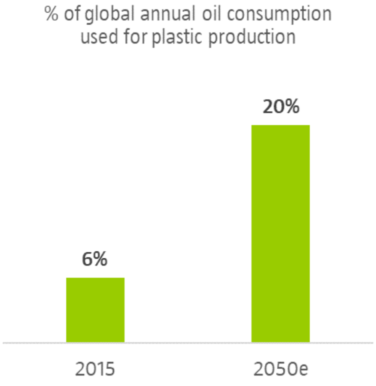
Economic growth triggered an increase in migration from the countryside to cities and the growing workforce supported further production expansions. The immense increase in economic scale and trade, was replicated by other countries, and the industrial revolution quickly spread to continental Europe, North America, and Japan. However, growing economic activity continued to be fueled by fossil energy, and the consumption of finite resources grew in an unprecedented manner (see Figure 2). Whereas 569 TWh (terawatt-hours) of coal energy was consumed globally in 1850, in only 50 years this increased ten-fold, to 5,728 TWh. In the following years energy-dense, fossil fuel sources like crude oil and natural gas consumption overtook that of coal. Between 1900-2000, overall resource extraction increased seven-fold from 7 to 50 billion tons and is forecasted to increase almost another four-fold to more than 180 billion tons by 2050[6].

Petrochemicals, plastics, and waste

The connection between fossil fuels and resource extraction is not limited to energy sourcing and mining but also extends to petrochemicals and plastics. Derived from crude oil and natural gas, petrochemicals are the principal building blocks (feedstock) of plastics. Today, more than 90% of all plastic is directly produced using virgin fossil feedstock. And if current growth trends continue, plastics will account for 20% of annual global oil consumption in 2050 compared to 6% today (see Figure 3).

The extraordinary growth in resource use and production over the past half century have been accompanied by the record increase in urban populations and consumption. As urban populations swell globally, consumption by a growing middle class is expanding even more. By 2050, global waste production is expected to further outpace population growth, growing twice as quickly. Even more dramatic is the increase in waste generation of lower-middle income classes, which will almost double in the next 30 years (see Figure 4).

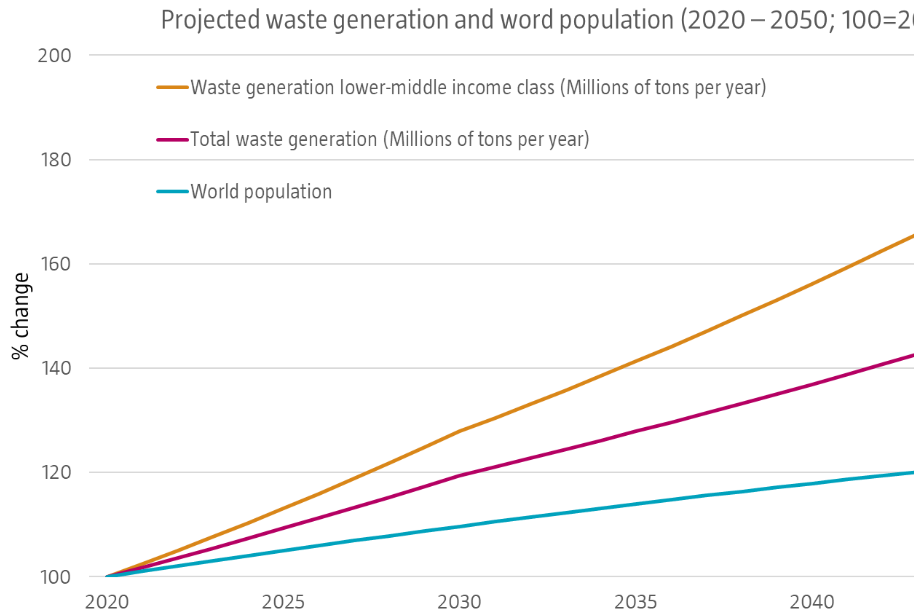
Figure 3 | Oil and Plastics – a deepening dependence



Source: RobecoSAM, WEF, Ellen MacArthur Foundation and McKinsey & Company (2016)

[6] European Commission, Joint Research Centre. (2018). *Raw Materials Scoreboard, 2018*. European Innovation Partnership (EIP) on Raw Materials. https://op.europa.eu/en/publication-detail/

Figure 4 | Projected waste generation and world population (2020 – 2050)



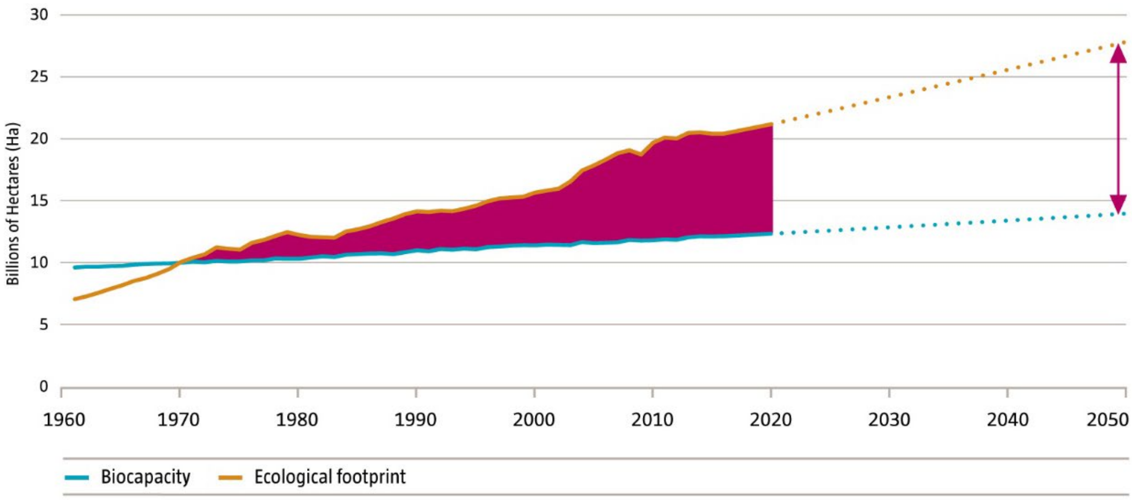
Source: World Bank (2018)[7], (100=2020 levels)

This imbalance has wide-ranging effects for cities, regions and entire ecosystems. Plastic waste increasingly accumulates in landfills or leaks to soils and the marine environment. At the present plastic leakage rate, there will be more plastic waste by weight in oceans than fish by 2050[8]. The projected ecological footprint is growing at a faster rate than the biocapacity of the planet to absorb its impacts, creating a state of ecological debt (see Figure 5). If current growth rates continue, the ecological deficit alone will reach nearly 15 billion hectares[9] in 2050 – corresponding to the total amount of land on Earth.

According to research by the Global Footprint Network, we are using resources at an average rate of 1.75 times higher than the Earth's regenerative capacity. This number varies from five times in the most developed regions to 0.5 times in regions that are not yet included in the industrial model[9]. The consumption of fossil fuels and deforestation increase the concentration of carbon dioxide in the atmosphere, leading to global warming and ocean acidification. The resulting rate of biodiversity loss has reached levels that can be referred to as a sixth mass extinction[10].

[7] Kaza, S., Yao L., Bhada-Tata P., and Van Woerden F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.* World Bank. https://openknowledge.worldbank.org
[8] Ellen MacArthur Foundation, McKinsey & Company, and World Economic Forum. (2016). *The New Plastic Economy. Rethinking the future of plastics*. http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf
[9] Own calculations based on the data from the Global Footprint Network (2020). *http://data.footprintnetwork.org/#/*
[10] Barnosky, A., Matzke N., Tomiya S., et al. (2011). *Has the Earth's Sixth Mass Extinction Already Arrived?* Nature 471. https://www.nature.com/articles/

Figure 5 | A widening ecological deficit



Source: Global Footprint Network and RobecoSAM (2020) in Billions of Hectares (Ha)

- **Extreme weather & losses –** avg. annual catastrophe-related insured losses grew by 7x between 1980-2018 [1)]
- **Rising resource demand –** use of global raw materials projected to double by 2060 [2)]
- **Growing waste –** every human being to produce ten times as much e-Waste over his lifespan than its body mass in 2030 [3)]
- **Linear consumption patterns –** textile industry to consumer a quarter of total carbon budget by 2050 [4)]

Sources: [1)] Swiss Re, [2)] OECD, [3)] UNU/UNITAR and ITU, [4)] Ellen MacArthur Foundation

The circular economy — retaining value

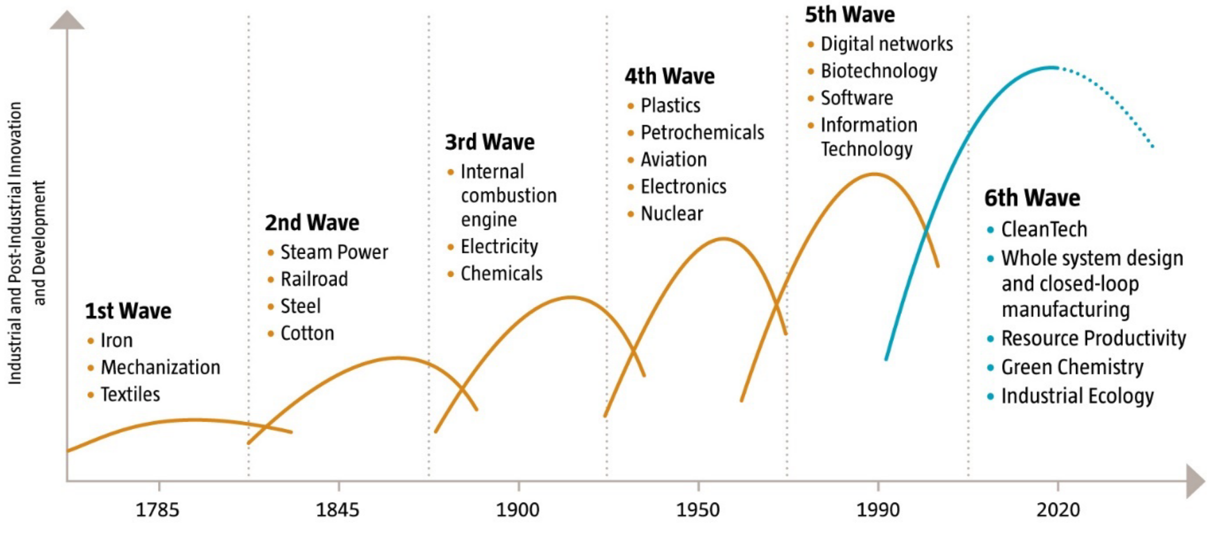
The global economy is in urgent need of a shift from a wasteful linear model of production and consumption (take, make, dispose) to one that is circular and regenerative in nature.

Conditions ripe for regenerative transformation

While industrialization brought economic growth, mass production, expanded trade, and improved life expectancies, the linear consumption patterns it spawned (distorted by supposedly cheap prices due to externalized environmental costs of finite production inputs) are destroying the ecological balance of the planet. Looking closer at historic innovation cycles since the industrial revolution (see Figure 6), it becomes obvious how fossil fuels, or more broadly the consumption of finite resources, played a critical role in the first four innovation waves. But despite the huge surges in productivity and progress, much of the resources extracted continued to be wasted.

The more recent fifth wave, which somewhat peaked in the late nineties of the last century, exhibits a structural change towards de-materialization (through digitization). The sixth wave, currently underway, can be characterized by the application of these digital enabling technologies across a wide-array of industries. In view of a matured understanding of the high environmental cost and accumulated environmental debt caused by past innovation cycles, circular economy principles like "closed-loop design" are gaining importance.

Figure 6 | Innovation Waves



Source: RobecoSAM, adapted from The Natural Edge Project (2005)[11]

[11] Hargroves, K. and Smith, M. (2005). *The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century*. The Natural Edge Project. Routledge.

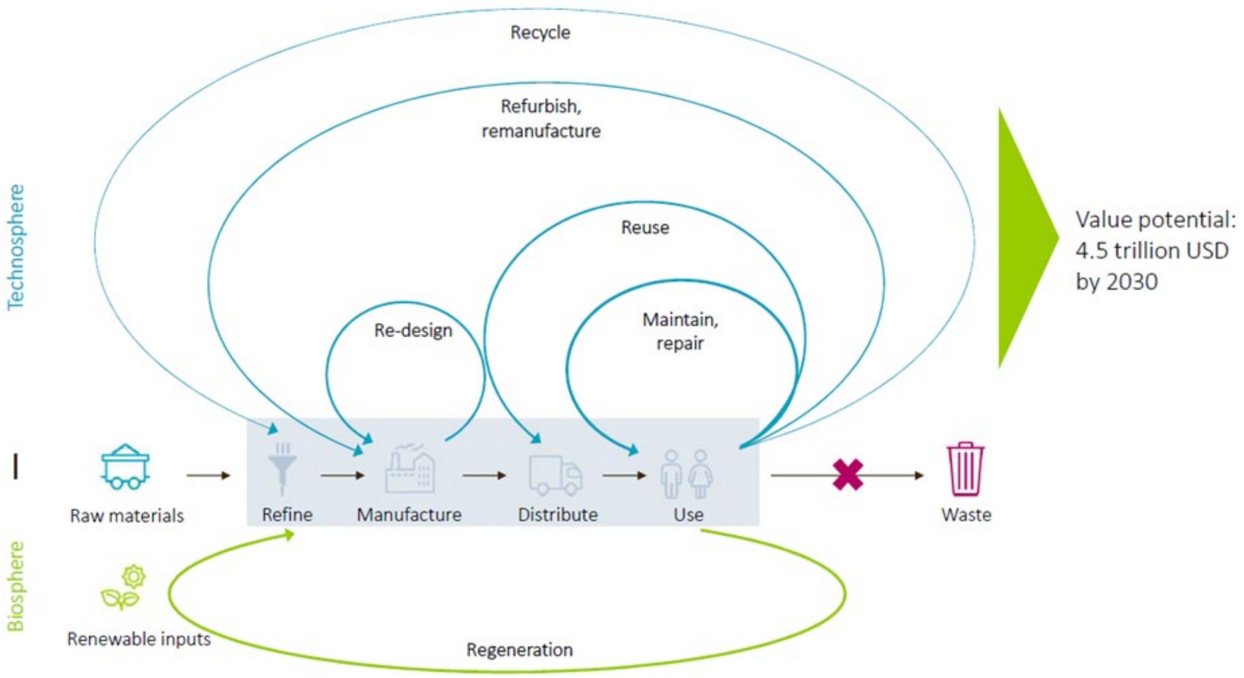
Preserving value through loops

So what characterizes the circular economy? The circular economy combines earlier concepts of closed-loop systems and their application to economic systems, such as cradle-to-cradle design[12], industrial ecology[13], and biomimicry[14]. In short, the circular economy keeps resources in use for as long as possible, so that their maximum value can be extracted while in use. Even after first use, products and materials can be recovered and regenerated for a "second-life" of service.

In a simplified linear supply chain, raw materials –most often from finite resources—are refined for the manufacturing process, distributed to consumers, and finally end up as waste in landfills or within the natural environment. The circular economy uses renewable resources or previously discarded outputs and by-products as production inputs. Keeping natural resources as well as finished products in use for as long as possible reduces not only waste but preserves value and diminishes the need for extracting increasingly scarce finite resources. This is achieved by creating multiple loops along the value chain (see Figure 7).

Given that up to 80% of a product's environmental impact is determined at the design phase, the re-design loop plays a key role to achieve higher circularity of products. This includes a thorough analysis of where substitution of finite resources by renewable ones is feasible and can extend all the way to the complete re-engineering of a product's design to ensure it supports repairability and reuse. Further down the value chain, re-use loops can be exploited to intensify the use-phase of products. Examples are already being created within the sharing economy where rental models are transforming the utilization of goods like cars, electronics, and clothing. Hand in hand with increased utilization, maintenance and repair loops are expected to gain importance, as they help to extend the lifetime of products. Refurbish and remanufacture loops reintroduce used components and parts into the manufacturing process and with that retain their embedded value. Finally, the recycling loop aims to prevent waste and emission leakage by redirecting basic materials as an input into the supply chain.

Figure 7 | Keeping products in the loop creates value



Source: RobecoSAM and Accenture (2015)

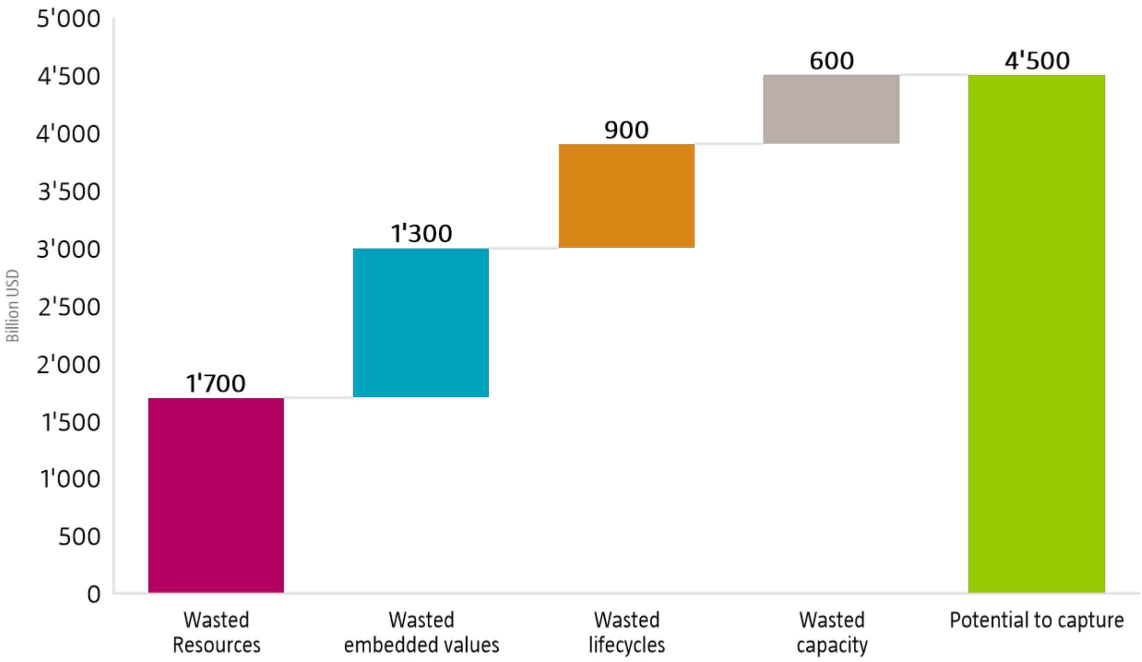
[12] McDonough, W., and Braungart, M. (2003). *Towards a sustaining architecture for the 21st century: the promise of cradle-to-cradle design*. UNEP Industry and Environment. http://www.c2c-centre.com/
[13] Lifset, R., and Graedel T. E. (2002) Industrial ecology: goals and definitions. In Ayres, R. U. and Ayres, L. W. (Eds.), *A Handbook of Industrial Ecology* . (pp. 3-15) Edward Elgar Publishing Limited. https://www.elgaronline.com/
[14] Benyus, Janine M. (1997). *Biomimicry: Innovation Inspired by Nature*. William Morrow.

The value proposition

The switch to the circular economy is not only a necessity for the planet, it is also expected to bring tangible economic and societal benefits compared to the "business as usual" scenario. A study by the Ellen MacArthur Foundation and the McKinsey Center for Business and Environment estimated a net 7% addition to European GDP by 2030 if the EU introduces policies to improve material and resource use efficiency[15]. Furthermore, global business consultant Accenture estimated that the switch to the circular economy could unlock USD 4.5 trillion of value globally by 2030[16].

Looking in greater detail, the $4.5 trillion opportunity consists of four broader areas (see Figure 8). "Wasted resources" accounts for the largest share ($1.7 trillion), while almost as significant is the waste of "embedded values" ($1.3 trillion). Given the wasteful consumption and the lack of circular design, it is estimated that another $900 billion opportunity can be exploited by extending the life-time of products or by adding life-cycles, for example with the help of reverse logistics solutions[17]. Finally, the often underestimated adverse impact of heavily under-utilized assets like cars or medical equipment (with utilization rates as low as 42% for ultrasound, MRI, or CT scanners[18]) creates another $600 billion market opportunity for the likes of sharing economy and product-as-service businesses.

Figure 8 | A Wasted Opportunity



Source: RobecoSAM and Accenture (2015)

[15] Ellen MacArthur Foundation and the McKinsey Center for Business and Environment. (2015). *Growth Within: A Circular Economy Vision for A Competitive Europe*. https://www.ellenmacarthurfoundation.org/

[16] Lacy, P., Rutqvist J., (2015). *Waste to Wealth: The Circular Economy Advantage*. Palgrave Macmillan.

[17] In contrast to traditional logistics, which moves a finished product to its final destination, reverse logistics relates to the operations related to moving "used/consumed" goods to points where they can be refurbished, reused, or recycled and used as inputs for a new supply loop.

[18] Crisostomi, E., Ghaddar, B., Haeusler F. et al. (Eds.) (2020). *Analytics for the Sharing Economy: Mathematics, Engineering and Business Perspectives*. Springer International Publishing.

Digitization and regulation – powerful structural forces driving the transition to circularity

Exponential growth in digitization across economic sectors will accelerate de-materialization. Meanwhile, support and momentum from governments that recognize the value of circularity for the global environment and their respective economies is also building.

Collaboration and 'systems thinking'

The circular economy is more multifaceted than a linear one. First, as by-products and production waste are looped back as inputs into production, companies able to adjust manufacturing processes can tap into a much more heterogenous range of materials, further expanding the availability and diversity of production inputs. Flexibility of supply chains is also getting renewed attention in the wake of disruptions caused by US-China trade war and the COVID-19 pandemic.

Second, instead of simply dumping by-products and production waste into landfills, businesses can recover value, if they find customers who are able to deploy those streams in a productive way. Technology is playing a crucial role in creating a seamless system; it not only provides the sensing and processing power for measuring resource flows, but it also connects players across the value chain. Industry collaborations form a critical part of the circular economy. They open doors for managing the flow of resources between companies in the same value chain or even those in different industries. Moreover, digital collaboration creates a whole new world of opportunities complete with virtual marketplaces, communication tools, and information exchange platforms.

Tagging the value chain

With the Internet of things (IoT) dramatically increasing the number of connected devices (see Figure 9), data availability is growing exponentially. Digital penetration of production and logistics improves the traceability of resources and product flows, making them easier to quantify. Increased visibility and tracking enables not only better control over potential waste production, but also creates more accountability for companies along the value chain. Asset tagging and RFID[19] technologies employ remote sensing with geolocation capabilities and are just a few of the digital advances being used by industries to improve product quality, reduce waste, and ensure efficient product delivery. For example, Google geo-positioning systems optimize the logistics of operations in real time, just as ride-hailing platforms Uber and Lyft optimize the logistics of passenger mobility[20].

Tracking and optimizing logistics is just one avenue where digitization can help reduce costs, waste, and inefficiencies. Machine learning is another avenue where problems can be forecasted, pre-empted, and resolved before they cause drags or lags in production or use phases. Data from ubiquitous sensors combined with machine learning can contribute to various solutions for optimizing product use-time. One example is predictive maintenance that can be used to monitor connected vehicles like hybrid transportation buses that have been equipped with fuel cells. Real-time data tracking of the battery status, engine performance and other critical parts, helps avoid unnecessary down-time and extends vehicle life via optimized servicing.

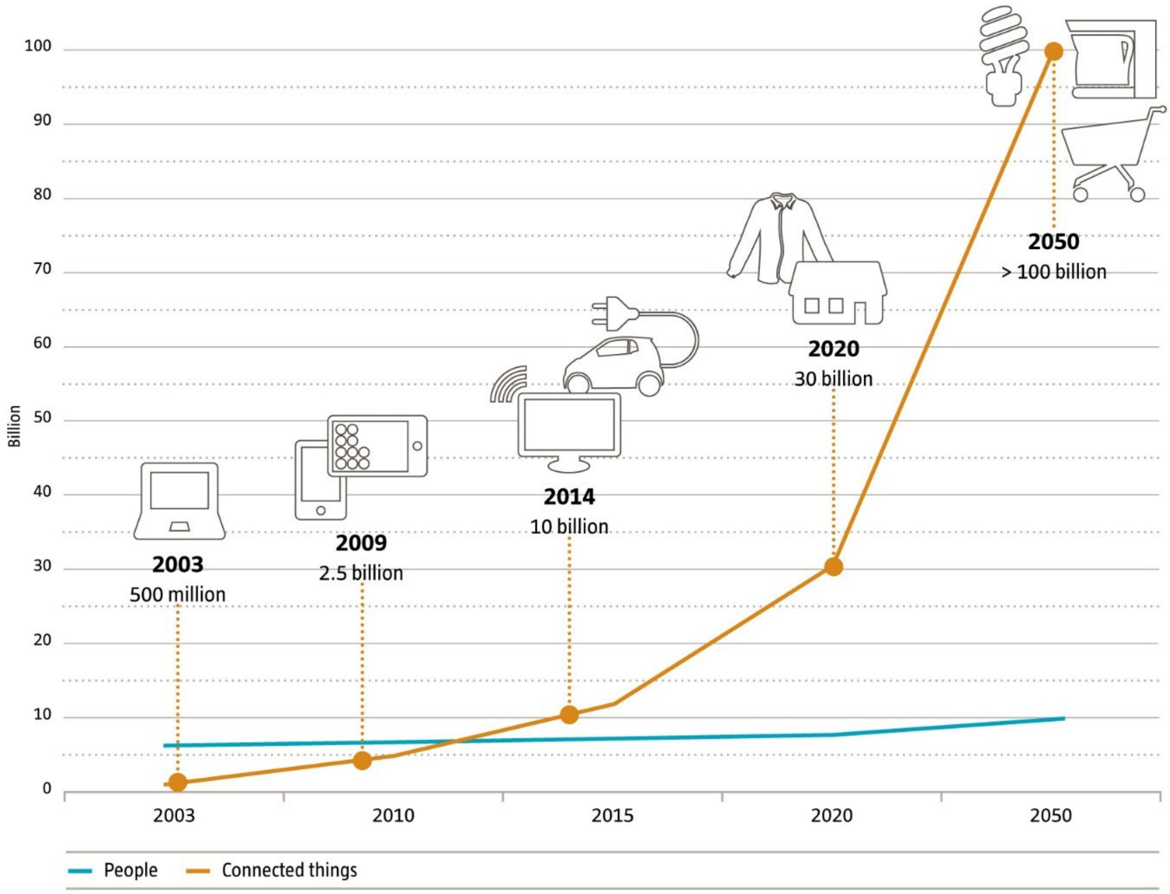
[19] Radio-frequency identification (RFID) uses electromagnetic fields to identify and track tags attached to products.
[20] Accenture Strategy and World Economic Forum.(2019). *Harnessing the Fourth Industrial Revolution for the Circular Economy: Consumer Electronics and Plastics Packaging*. https://www.weforum.org/whitepapers/

Room to grow— circularity with scale

The omnipresence of cloud computing and the rise in digital processing power enables vast data collection and analysis capabilities. More efficient AI-enabled management of big data can identify performance bottlenecks and predict energy consumption patterns to boost efficiency. However, for circularity to reach its full, value-saving potential, both digitization and scale are required. The processing power needed to digest record amounts of data require large-scale data centers, interconnected networks, and increased energy consumption—a consequence seemingly at odds with circularity principles.

However, rapid innovation cycles are improving the energy efficiency of server farms. In fact, some leading players have already been able to lower energy intensity by 30% per unit of data capacity, on an annual basis. Furthermore, data center providers have long understood the need to improve the energy mix they use— a vision that is clearly expressed in the collaborative industry initiative the "Future of the Internet Power (FoIP)" which aims to power the internet completely on renewable energy. In some developed markets, frontrunners are already sourcing up to 50% of power from renewables. Decoupling scaling capacity growth and energy intensity helps to re-align technological advancements with circular economy principles.

Figure 9 | Exponential growth of connected devices



Source: RobecoSAM and Accenture (2015)

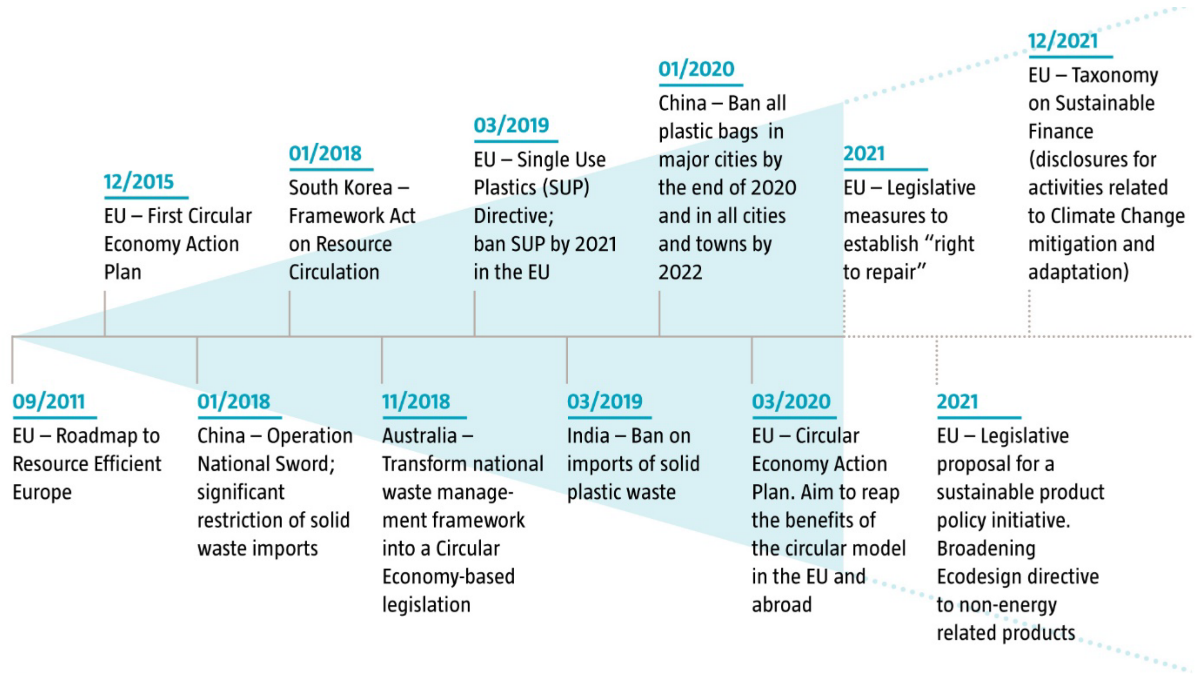
Circular economy principles – blueprints for regulatory action

Governments at the city, provincial, state and supranational level in both developed and emerging markets are introducing new laws to tackle waste and promote the ideas of circularity (see Figure 10). The regulation of waste and recycling which began with a focus on single-stream item waste (i.e. glass, plastic, cardboard) has shifted to a more comprehensive and holistic approach that includes waste prevention, re-use, recycling, as well as energy re-capture via treatment of organic waste.

In Asia, China introduced circular economy principles in the last two of its five-year development plans, and India is on target to eliminate all single-use plastic by 2022. The Indian states of Himachal Pradesh, Karnataka, Delhi, and Tamil Nadu—regions collectively home to nearly 160 million people—have already banned single-use plastic items like shopping bags, cutlery, cups, and plates.

The European Union (EU) announced the new Circular Economy Action Plan in March 2020, which overhauls a first plan significantly, in December 2019, the European Commission announced the "European Green Deal" with the circular economy as a key priority for its implementation[21]. These are foundational policy proposals and are expected to represent 50% of the EU's effort to achieve net-zero carbon emissions by 2050[22].

Figure 10 | Circular economy principles in global policy frameworks



Source: RobecoSAM

[21] For more information on the contents of the European Green Deal policy visit, https://ec.europa.eu/info/node/123797#policy-areas
[22] Simon, F. (2019, November 13). Circular economy erected as 'number one priority' of European Green Deal. *EURACTIV*. https://www.euractiv.com/section/circular-economy/

Detecting the loops of the circular economy

The scope and reach of the circular economy are wide-ranging. In the following, we lay out our criteria for determining which opportunities across disparate industries and value chains are ripe for investment and which are poised to deliver, in our view, the most economic and environmental value in the immediate and long-term future.

Our framework for investing in the shift towards a circular economy combines three essential elements 1) an analysis of resource consumption—what resources are used and by which industries 2) the useful life span of products, and 3) end-of-life cycle management (which provides insights into the environmental impact of products and resources used). Put more simply, we consider who is using what, how long it is being used, and what happens after the use-time?

Resource consumption – who is using what?

The world economy today consumes approximately 100 billion metric tons (100 Gt) of primary resources annually—of which 91% is extracted directly from the earth. The majority of these resources extracted are finite and include minerals (51 Gt), fossil fuels (15 Gt) and ores (10 Gt) (see Figure 11). That means only 9% of all primary resources are circulated in some form. While biomass is the second highest category of consumed resources (25 Gt), it is plant-based and can be replanted and replenished relatively quickly. Moreover, products made from biomass tend to be more biodegradable than their fossil-based counterparts.

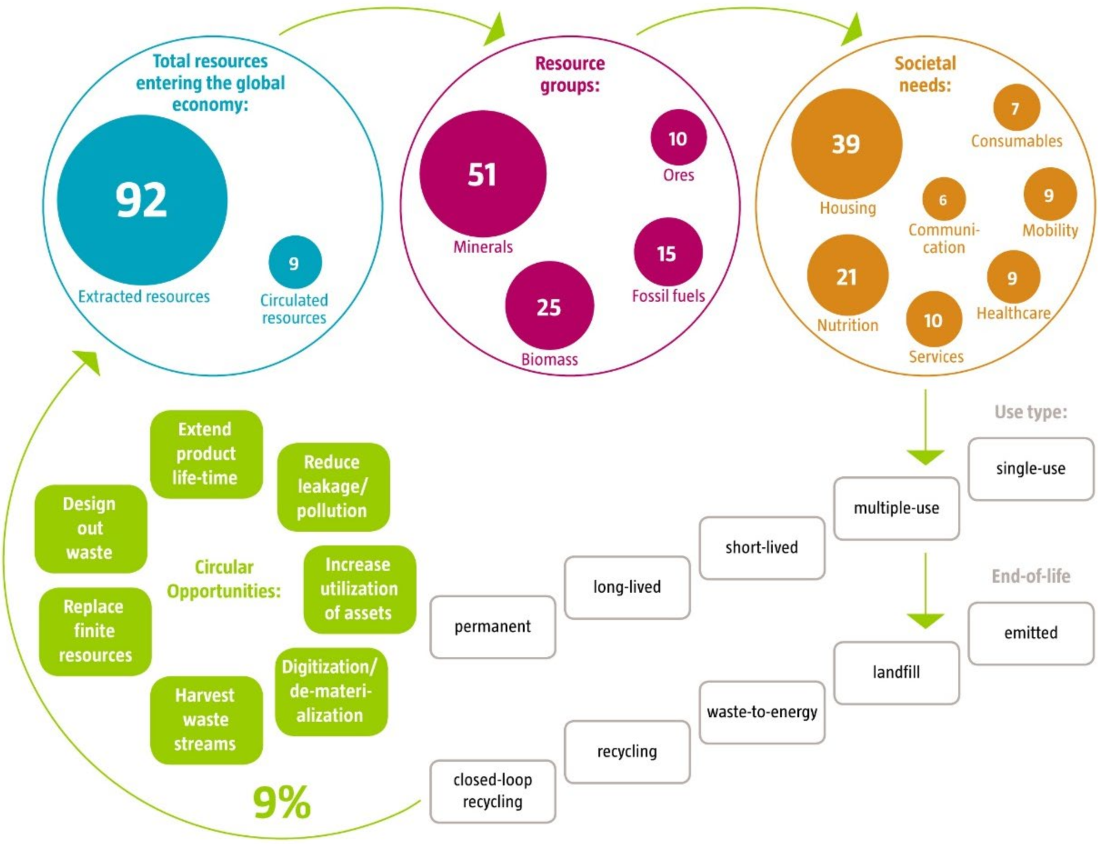
When classifying the areas that consume the most resources, seven broad categories which exhibit substantial differences with regards to end-product use can be differentiated. While the housing sector consumes large quantities of resources (39 Gt), their use-phase tends to be long-term, stretching over decades; in addition, their end-of-life management is often pushed on to future generations.

In the consumables category, beneficial or adverse implications are more immediately visible, especially for fossil-fuel based synthetic materials which are not bio-degradable. The nutrition sector is the second largest consumer of resources (21 Gt). Although a large proportion comes from renewable biomass, significant quantities of natural gas and phosphorus are consumed to fertilize crops. This is particularly worrying in light of rising global food waste generation and the enormous environmental footprint of food production.

Product lifespans – how long is it used?

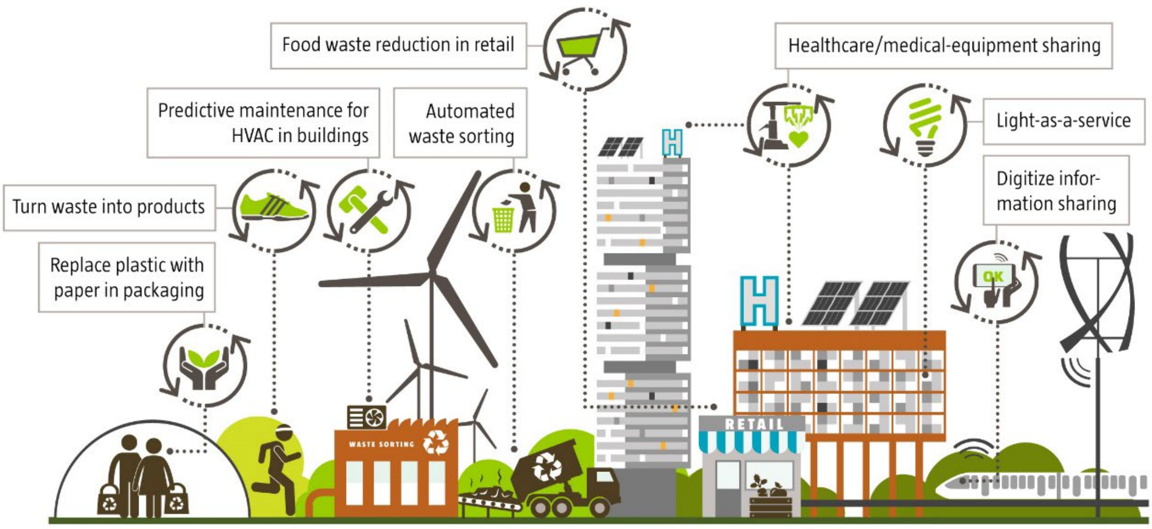
We consider the use-time of products or services as a key determinant in our evaluation, as it is informative of how quickly resources are flowing through the system and how urgently decomposition solutions or even complete replacements are required. For short use-times we prioritize recyclability, observable collection rates, and biodegradability, as they are key determinants of practical circularity for those products. For example, actual recycling rates, in contrast to theoretical ones, shed light on the extent to which resources truly achieve a second or multiple life cycle. For products with long lifespans, like building materials used in the construction sector, environmental impact during use-time becomes a more important issue in our assessment, which is echoed by a strong regulatory push towards full-life cycle assessments and extended producer responsibilities for the sector.

Figure 11 | Global annual resource flow and circular opportunities



Source: RobecoSAM adapted from Circle Economy (2020). Figures in gigatons (GT), 1 GT=1 billion metric tons.

Figure 12 | Surrounded by circular opportunities



Source: RobecoSAM

End of life management – what happens after use?

Life Cycle Assessment (LCA) studies and toxicological risk assessments are a good starting point for assessing the potential environmental impact and human health hazards of products and services. However, these methods are still evolving and may not fully capture the complexity of all environmental issues. For example, LCAs sometimes paint a mildly positive picture of plastic because of its lightweight attributes. However, plastic waste accounts for 50-80% of the debris accumulating in the ocean[23] leading to the deaths of animals by choking and suffocation, and it is estimated to have an adverse economic impact of USD 13 billion per year[24].

There are also concerns that microplastics could have adverse impacts on humans and ecosystems as they move through the food web[25]. These effects are only starting to be integrated into LCA studies and are still not fully understood [26]. The European Commission has the world's most advanced chemical regulations and requires rigorous testing of single chemicals before they are released to the market. Still, there are considerable uncertainties around the toxicity of chemical mixtures[27]. Given the holistic view of the circular economy, we combine data from LCA and risk assessment studies with qualitative reviews of current evidence and expert opinion to fairly assess negative or positive environmental impacts of products and services (see Figure 12 for circular opportunities).

"The great divide"— linear versus circular product models

Based on the aforementioned framework, we can approximate where to map products and services on a scale from pure linearity to full circularity (see Figure 13). The figure plots contrasting examples of linearity and circularity.

The classic example of a linear product is the single-use plastic bag. It is made from virgin plastic and has an extremely short use time. Moreover, it has negative environmental impacts due to high leakage rates and high micro-pollution risks during the decomposition process. Given their lightweight advantage compared to paper and a "theoretically" high recyclability rate, LCAs sometimes assume a low carbon footprint over their full lifetime. However, actual recycling rates that fall below 10% for the estimated one to five trillion plastic bags[28] consumed globally every year, significantly reduce the validity of those findings. In contrast, a good example of a circular product is the recycled paper bag made from sustainably sourced virgin fiber and recycled several times, extending its effective lifespan. In addition, a faster decomposition rate combined with unproblematic leakage into the environment, contribute to an overall better circularity assessment.

Products-as-a-service models also demonstrate how products can be adapted for a circular economy landscape, moving them across the linear-circular divide. For example, lighting-as-a-service models minimize material consumption through integrated lifecycle management, as they incentivize producers to prioritize durability like longer lifetime of fixtures or 'parts harvesting'. They also promote lighting efficiency, which is demonstrated by projects that cut electricity consumption by up to 50% versus traditional lightbulbs.[29] Moreover, refurbish and upgrade options can be better customized based on performance data collected by the service provider.

The area of biochemicals provides a broad range of opportunities to push products from the linear towards the circular sphere, encompassing a variety of product groups like auto, textiles, and paints. Although the environmental impact depends on various factors including the sourcing of the feedstock, biodegradability and health effects are generally superior compared to their petrochemical alternatives. Market adoption has been rising especially in applications like biosurfactants (used to replace the chemical surfactants) [30] in detergents, personal care products, and industrial processes.

[23] Barnes, D.K.A., Galgani, F., Thompson, R.C., Barlaz, M. (2009). *Accumulation and fragmentation of plastic debris in global environments*. Royal Society Publishing. pp. 1985-1998.
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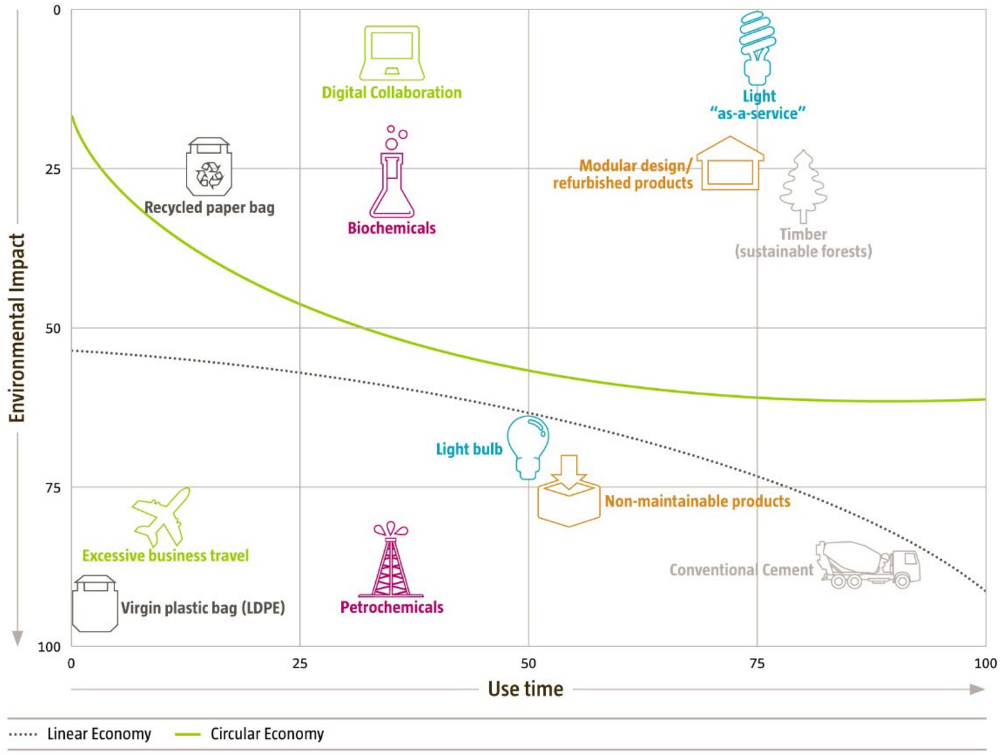
[29] Signify. (2019). Managed Services. Circular Lighting. Case Study: Schiphol Airport Amsterdam. https://www.signify.com/global/lighting-services
[30] The name "surfactants" derives from **surf**ace **act**ive agents, chemical- or biological compound used as cleansing agent.

Figure 13 | Mapping the circularity of products & services



Source: RobecoSAM, 2020

The framework described above is used to define the investment opportunity set for the RobecoSAM Circular Economy Strategy. In addition to the thematic assessment of relevant sectors and single companies, we verify our findings with each company's contribution to the United Nations Sustainable Development Goals (SDGs) using the RobecoSAM SDG methodology. For example, SDG Goal 12, "Responsible Consumption and Production", makes particular references to the circular economy. This goal's specific targets include promoting innovation and design solutions that support more sustainable lifestyles, halving per capita food waste, increasing resource efficiency, and achieving environmentally sound management of chemicals and waste. While constructing the circular economy investment universe, we apply our proprietary SDG framework to identify companies whose products or services have a positive impact on the SDGs.

Defining the investment clusters

The RobecoSAM Circular Economy Strategy consists of four distinct investment clusters and corresponding sub-clusters. Investment clusters are groups of companies among the investable universe that offer related products or services. This structured framework enables us to efficiently concentrate the strategy on the leading players in the most promising investment areas, while maintaining well-diversified exposure across all segments of the circular economy value chain.

Redesign Inputs

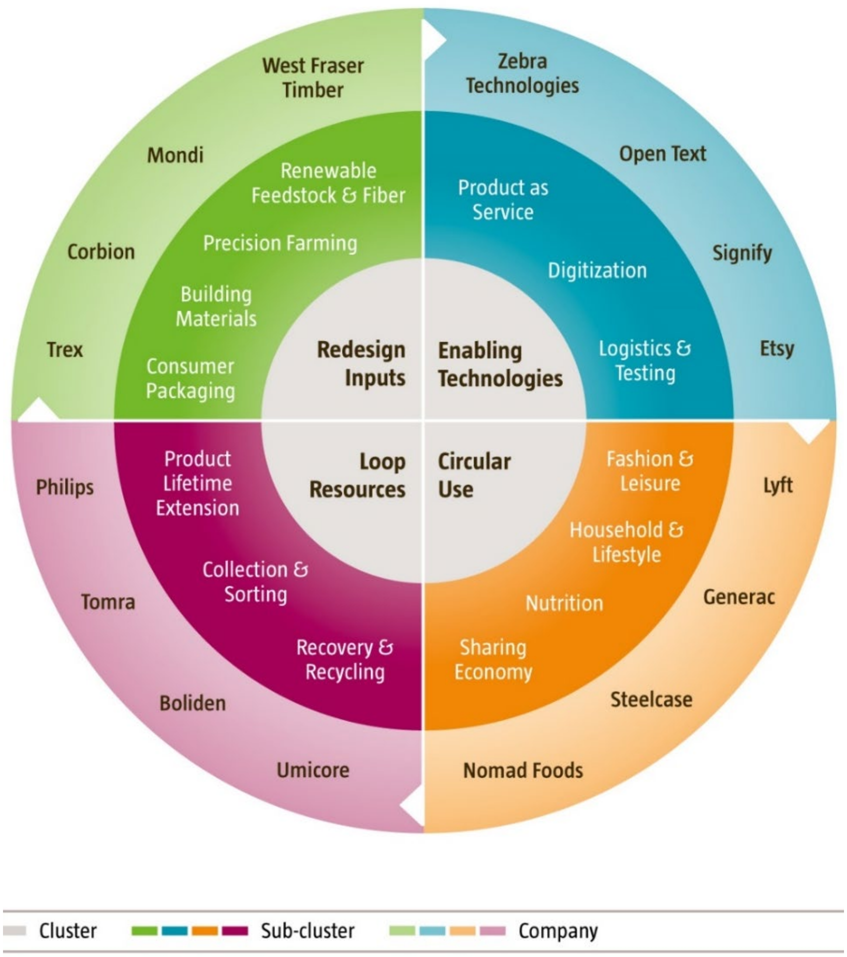
Following the logic of a simplified supply chain, the "Redesign Inputs" cluster captures investment opportunities that exploit the shift from fossil-based inputs to renewable ones. The ongoing R&D activities of several companies underscore the rising interest in developing renewable feedstock, as changing consumer preferences shift in this direction. For example market leader in lactic acid production, Corbion, is commercializing the production of polylactic acid (PLA) as a bioplastic alternative for polystyrene or polypropylene in packaging, consumer goods, automotive, and textiles applications. The company is also investing in the expansion of its biobased product portfolio. Through its acquisition of California biotechnology company, Terravia, Corbion gained access to unique capabilities for producing algae oils and proteins that can be applied in aquaculture, food, and personal care industries. Although it is still necessary to conduct life cycle assessments of final products, Terravia's algae oil was estimated to have a 50% lower greenhouse gas footprint compared to palm kernel oil[31].

Examples of renewable feedstock can also be found in the forest industry, which has long-operated in line with circular economy principles. Wood from sustainably managed forests can be recycled several times and residues are being used as inputs for biofuel and bioplastic production. Accordingly, the use of building products from sustainably managed forests improve the carbon footprint of real estate developments, making them an attractive alternative to other building materials. Companies like U.S.-based Trex are going one step further, creating new inputs by blending waste streams of different industries. For example, their outdoor decking and furniture products are made from reclaimed wood fiber and recycled plastic film from grocery stores. In addition to lower resource use and reduced waste, the products have superior lifetime characteristics versus traditional products and cost less for consumers over their full lifetime.

[31] Solazyme. (2015) *Microalgae. Macro Solutions.* https://www.bio.org/sites/default/files/legacy/bioorg/docs/

RobecoSAM's Circular Economy Strategy investment clusters and sub-clusters

Figure 14 | RobecoSAM Circular Economy Strategy's investment framework



Source: RobecoSAM, 2020

Enabling Technologies

The "Enabling Technologies" cluster includes companies that provide the infrastructure for circular economy businesses, contribute to de-materialization of production, or create new business models by replacing linear ones.

The solution-as-service business model has the advantage of aligning the interest of customers and producers: 1) in creating higher durability of products and 2) in sharing information on product use—both of which support improved capacity and resource use. Examples can be found in the product-as-service sub-cluster which replaces the purchase of physical goods or equipment with a service attached to a product. An example is "Light-as-Service" offered by Dutch energy efficient lighting specialist Signify. Under its circular lighting offering, the company offers customers lighting solutions, which lowers their electricity consumption and includes full life-cycle management of LED light-bulbs and products.

Digital solutions can contribute positively to higher circularity in various forms as Etsy, the e-commerce platform specializing in handmade or vintage items demonstrates. Producers of non-mass items have traditionally been at a disadvantage in reaching the critical mass targets necessary to attract the attention of merchandisers for physical stores. Etsy enables them to connect with interested buyers via their Marketplace-as-a-Service offering. Customers buy goods directly from sellers who pay a fee to list their items on the platform. The average annual growth rate of 28% for active buyers since 2012, underscores the increasing interest in alternative items and platforms compared to mass manufactured goods via brick and mortar stores.

Circular Use

On the consumer side, the widespread use of social media has not only facilitated the exchange of lifestyle and fashion trends, it has also made it easier for influencers to campaign for certain products like alternative meat or sustainably sourced apparel. By the same token, influencers can boycott brands whose products are linked to environmental pollution, which can have a lasting impact on brand image. In this context, the "Circular Use" cluster invests in companies that support circular consumption patterns through sustainable sourcing, the sharing economy, product longevity, and reusability across end-user markets like household products, apparel, nutrition, leisure, and shared-service platforms.

A perfect example is Steelcase, the market leader for circular furniture and workspace design. In 2004, Steelcase launched the Think® chair, the world's first Cradle to Cradle™ certified product made with up to 28% recycled and 95% recyclable materials. Furthermore, the disassembly of parts for re-use or recycling is simple requiring only five minutes with common hand tools. Since then, Steelcase has expanded its circular offering with 50-plus Cradle to Cradle Certified™ products complemented by rental models and decommissioning programs for secondary markets to extend product lifetime.

The sharing economy has already spawned a number of disruptive business models like Lyft, Uber, and Airbnb. By providing GPS-enabled smartphone apps to connect drivers and customers, these firms exploit the systematic underutilization of physical assets. The increase in car pooling and home sharing also raises the question of vehicle insurance coverage and homeowner risk assessments—creating a growing opportunity for companies able to collect and interpret usage data for these new business models.

Loop Resources

Moving to the end of the traditional linear economy, and accordingly the end-of-life management of products, the "Loop Resources" cluster provides exposure to companies that extend product lifecycles or which recover embedded value from disposed products. Given the circular economy's aspiration to eliminate waste before it is produced in the first place, lifetime-extension is a key solution. For example, health technology company, Philips, runs a comprehensive circular economy program which includes the take-back and refurbishment of equipment like MRIs, ultrasound machines, and CT scanners. Components undergo a rigorous factory testing process, followed by software and hardware upgrades, and finally are calibrated according to customer needs. Philips reports that refurbished products typically cost 20% less than new products, thus creating an attractive offering for many hospitals and clinics. By 2025, the company aims to extend circular practices to all medical equipment.

Turning to recycling, China, once the world's largest importer of all kinds of waste, unsettled global waste streams with a series of bans on waste imports from abroad. Neighboring Malaysia and the Philippines soon followed. These developments underline the necessity of upgrading recycling capabilities in countries where the waste was initially produced. Here companies like Tomra from Norway play an essential role. Their reverse vending machines provide automated handling of empty beverage containers returned for recycling. Tomra reports that 40 billion used beverage containers are captured annually. Furthermore, it sorts and recovers materials, which include food, mineral, waste, and metal, from a diverse set of industries. Its metal recycling solutions alone recover 715,000 tons of metals every year.[32]

Another benefit of developing recycling capabilities is their potential to reduce dependency on imported materials. Boliden, a smelter operator in Sweden, has the capacity to process 120,000 tons of electronic waste (E-waste) annually, including circuit boards from computers and mobile phones. The smelter processes the end-of-life electronic material, extracting copper, nickel and other precious metal thereby reducing the demand for virgin material. Utilizing recycled material reduces import dependency, an especially attractive proposition for regions like the EU, where approximately two-thirds of virgin copper is imported.[33]

[32] Tomra. *About Reverse Vending.* https://www.tomra.com/en/collection/reverse-vending/about-reverse-vending
[33] Copper Alliance. *The structure of Europe's copper industry.* https://copperalliance.eu/about-us/europes-copper-industry/

Outlook

The boundless appetite for natural resources, fueled by linear production and consumption patterns, is exceeding the planet's regenerative capacity. Regulatory actions for higher circularity are amplified by consumers opting for circular products. The recent COVID-19 pandemic provides a glimpse into the extensive de-materialization possibilities ahead, empowered by maturing digitization solutions across several sectors. Understanding the structural transition to the circular economy creates compelling investment opportunities for forward-looking investors.

A world ready for change

Linear economy principles have generated enormous wealth creation over the last three centuries. However, the scale-up of linearity created wasteful production and consumption patterns as well. As evidence of the negative environmental impacts surface, there has been a sharp shift in government action and consumer sentiment. Upcoming regulatory changes leaning towards the adoption of higher circularity are gaining momentum. Examples like the new EU Circular Economy Action Plan from March 2020 demonstrate that a more comprehensive vision of the circular economy is replacing one-dimensional targets like standalone waste directives.

Changing laws are a powerful driver for change. But it is even more encouraging to see that consumers in many markets are already aligned with government plans. In some areas they are even farther ahead, which is why many young businesses are exploiting opportunities that embrace concepts of sharing today. At the same time, peer pressure for incumbents is building to make the apparel, leisure, and nutrition industries more circular. This has led to tangible targets like the commitment of companies representing 20% of all plastic packaging produced globally to make 100% of plastic packaging reusable, recyclable, or compostable by 2025.[34]

Equipping business for transformation

As companies move towards higher circularity, gaining a detailed understanding of where they stand with their operating models becomes ever more relevant. In this regard, it is encouraging to see momentum building across various initiatives to provide the best framework to get the job done. In 2017, the British Standards Institution published voluntary guidelines for companies looking to implement more circular business solutions. To provide a more operational and standardized framework, the World Business Council for Sustainable Development launched its Circular Transition Indicators (CTI) and the Ellen MacArthur Foundation published its comprehensive circularity measurement tool, Circulytics, early in 2020.

Although these tools are still evolving, they help research and development teams to better assess the holistic, full life-cycle impact of future products, allowing design decisions to be made in line with circular economy principles. Considering the EU's 2020 Circular Economy Action Plan that pushes for environmental accounting principles that include circular economy performance data, these measurement tools are expected to be deployed by forerunners in their respective industries.

Regulations for new foundations

Moreover, the EU's Sustainable Finance Disclosure Regulation has included the transition to the circular economy among its six environmental objectives and will further clarify the definition by setting criteria for activities that significantly contribute to the circular economy. Based on an initial categorization system[35], activities need to be linked to circular

[34] Ellen Macarthur Foundation, *New Plastics Economy*. https://www.newplasticseconomy.org/projects/global-commitment
[35] European Union. *European Circular Economy Stakeholder Platform*. https://circulareconomy.europa.eu/platform/en/

design and production models, optimal use models, circular value recovery models, or tools and applications supporting circularity. There is also a direct link to climate change mitigation objectives. For example, plastic manufactured by mechanical or chemical recycling, or based on renewable feedstock and resulting in a lower carbon footprint, are defined to contribute to climate change mitigation.

Circularity reinforces economic resilience

The COVID-19 pandemic unveiled vulnerabilities within global supply chains. Food systems were disrupted, and hospitals and pharmacies faced mask and personal protective equipment shortages —also the result of an overreliance on linear business models [36]. As a potential remedy for future uncertainties, diversification and reshoring of supply chains would support a shift from linear to systems thinking. In this scenario, the value potential and supply stability of as yet underexploited local waste streams (e.g. from recycled e-waste) could be reassessed and significantly alter the flow of resources through the global economy.

As in every economic contraction, the question of whether societies can still afford environmental objectives in times of distress is raised. The immediate pandemic shock caused some countries and municipalities to delay, for example, single-use phase outs by several months. However, with the structural environmental deficit becoming more concerning, and circular solutions in our hands, there is a consensus that backsliding into linear thinking is not an option. On the contrary, major governments and institutions remain firm in their commitments towards the circular economy. The European Commission[37], the International Monetary Fund[38], Germany[39], and Japan[40] have all announced plans for a greener and more sustainable economic recovery.

The time is ripe for directing the global economy towards higher circularity. Based on recent innovations and technological advancements, prospects for de-materialization look better than ever. Companies pursuing circular business models are set to win from the structural changes ahead, with innovation leaders applying circular economy principles to differentiate their product offering. Forward-looking investors can benefit by allocating capital to business models, whose products are either already aligned with these principles or enable the transition.

Contact
For more information go to:
www.robeco.com

[36] Strasser, Bruno J., and Schlich, T. (2020). A history of the medical mask and the rise of throwaway culture. *The Lancet*. https://www.thelancet.com/journals/lancet/article/

[37] European Commission. (2020, May 27). Europe's moment : Repair and prepare for the next generation. [Press release] https://ec.europa.eu/commission/presscorner/detail/en/

[38] International Monetary Fund, Fiscal Affairs Department. (2020). *Greening the Recovery, Special Series on Fiscal Policies to Respond to COVID-19.* https://www.imf.org/en/Topics/climate-change/green-recovery

[39] Nienaber, M., Wacket, M. (2020, April 28). Germany's Merkel wants green recovery from coronavirus crisis. *Reuters*. https://www.reuters.com/article/us-climate-change-accord-germany

[40] Farand, C. (2020, June 1). Japan to launch 'green recovery' platform and ministerial meeting. *Climate Home News.* https://www.climatechangenews.com/2020/06/01/japan-launch-green-recovery-platform-ministerial-meeting/

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The sale of the Fund qualifies as a private placement pursuant to section 2 of Uruguayan law 18,627. The Fund must not be offered or sold to the public in Uruguay, except in circumstances which do not constitute a public offering or distribution under Uruguayan laws and regulations. The Fund is not and will not be registered with the Financial Services Superintendency of the Central Bank of Uruguay. The Fund corresponds to investment funds that are not investment funds regulated by Uruguayan law 16,774 dated September 27, 1996, as amended.

Additional Information concerning RobecoSAM Collective Investment Schemes
The RobecoSAM collective investment schemes ("RobecoSAM Funds") in scope are sub-Funds under the Undertakings for Collective Investment in Transferable Securities (UCITS) of MULTIPARTNER SICAV, managed by GAM (Luxembourg) S.A., ("Multipartner"). Multipartner SICAV is incorporated as a Société d'Investissement à Capital Variable which is governed by Luxembourg law. The custodian is State Street Bank Luxembourg S.C.A., 49, Avenue J. F. Kennedy, L-1855 Luxembourg. The prospectus, the Key Investor Information Documents (KIIDs), the articles of association, the annual and semi-annual reports of the RobecoSAM Funds, as well as the list of the purchases and sales which the RobecoSAM Fund(s) has undertaken during the financial year, may be obtained, on simple request and free of charge, via the website www.robecosam.com.