Storebrand

Whitepaper

Circular economy

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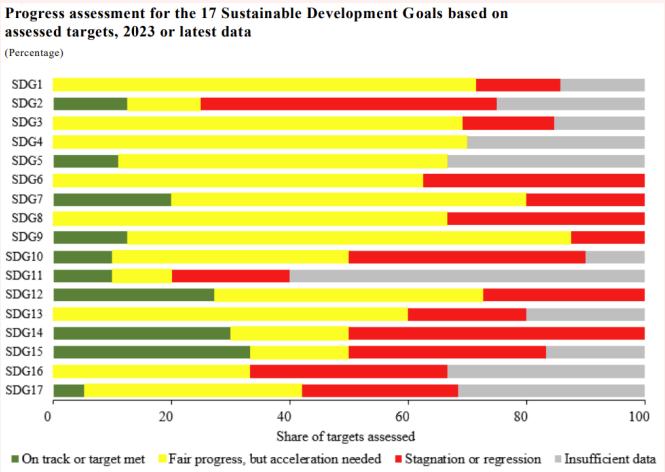
The SDGs as an Investment Theme

The United Nations (UN) Sustainable Development Goals (SDGs) were adopted by all UN member states in 2015. The SDGs represent a shared blueprint for global peace and prosperity towards 2030. The 17 goals highlight how ending poverty and conflict can be realized alongside strategies that improve health and education, reduce inequality, contribute to economic growth while safeguarding natural habitats, oceans and tackling climate change [1]. However, Figure 1 shows that the progress towards achieving the SDG targets has been insufficient. According to a recent SDG report, most targets only have some progress and are not on track to achieve the 2030 agenda [2].

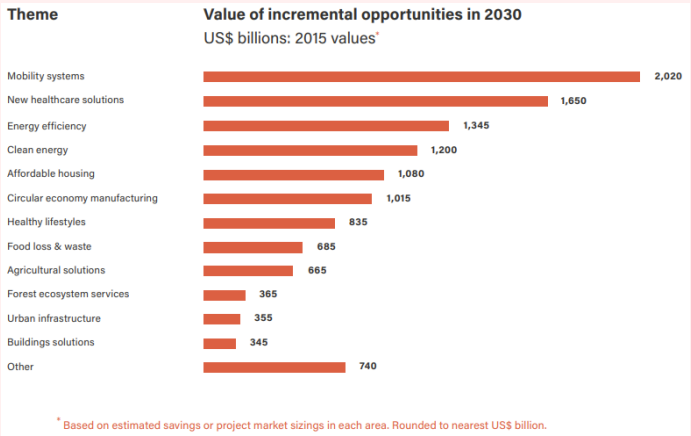
The SDGs provide a common target and language for sustainable development and facilitates business opportunities when finance flows towards sustainable projects. The UN Roadmap for SDG investing calls on the financial industry to disclose and incorporate long-term risk into investment decision making, implement sustainable investing strategies, scale up green financial instruments, as well as measuring and reporting on impact [3]. According to the Business and Sustainable Development Commission, achieving the SDGs opens market opportunities in four economic systems: Food and agriculture; cities; energy and materials; health and well-being [4]. Estimates show that a USD 12 trillion market value could be opened by 2030 if the SDGs are realized, creating 380 million jobs in the process [5]. An estimate by The World Business Council for Sustainable Development (WBCSD) of the distribution of these investment themes is found in the figure below.

Figure 1: Share of targets assessed according to the SDGs report of 2023 [2].



Source: General Assembly Economic and Social Council

Figure 2: The 12 largest business themes in world economy heading for the SDGs.



Source: Business and Sustainable Development Commission [5].

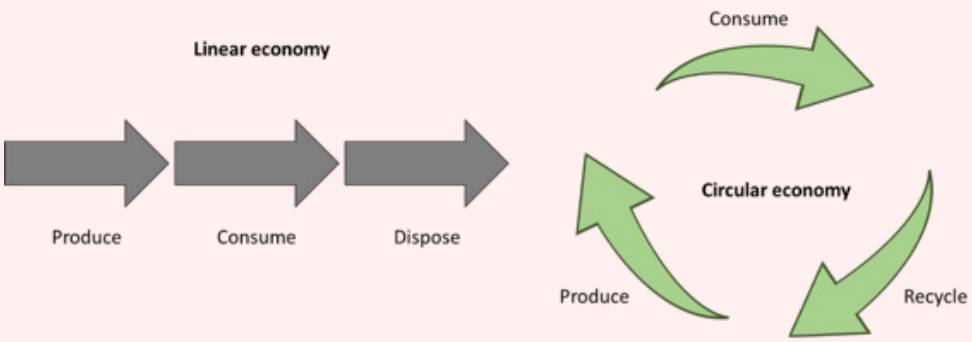
Solutions Theme: Circular Economy

The last decades have brought economic progress and prosperity to a rapidly growing population [6]. However, this growth has come at a cost. Beyond warming temperatures, human-induced planetary pressures have caused extreme weather, wildfires and poses the threat of extinction to nearly 1 million species [7]. Furthermore, the combined effects of increased urbanization and agricultural production, have resulted in the destruction of forests, marshes, and grasslands, leading to a resource consumption that exceeds the Earth's biomass capacity [8]. Notably, material consumption has risen over 65 percent globally in the last two decades, and projections indicate that humans will require three planets worth of natural resources, "the triple planetary crisis", by 2050 to sustain their current lifestyle [9] [10]. The fundamental causes of such triple planetary crisis are the unsustainable patterns of consumption and production, which not only endanger human health, but also threaten entire ecosystems and impede progress towards achieving the SDGs [11] [7].

If humans have the power to harm the planet through their actions, it is argued that they have the obligation to act towards pursuing a safer and more just world [7]. There is a global consensus recognizing the necessity of a fundamental shift in the way goods and services are produced and consumed [12]. To achieve sustainable limits for such a shift, it is required to reduce global material extraction and consumption by a third [13]. However, the current economy is built on a linear approach, where the earth`s limited resources are extracted, transformed into goods, and eventually discarded as waste [14]. Such an approach does not encourage reduced consumption and production. Therefore, a shift towards a circular economy will be instrumental in achieving a sustainable economy, as it could reduce global material extraction by one third and reverse the overshoot of planetary boundaries [15]. CE will also have a vital role in reducing 45 percent of the carbon emissions by 2030, and in achieving carbon neutrality by 2050 [16]. Furthermore, if circular approaches are included in food system, 49 percent of GHG emissions could be reduced by 2050 [9]. Consequently, the world is calling for the implementation of CE strategies and approaches [16].

Circular economy could be described as a concept that "aims to minimize waste and promote a sustainable use of natural resources, through smarter product design, longer use, recycling and more, as well as regenerate nature." [13] The field of circular economy has rapidly grown during the last decade and has emerged as an alternate way of organizing industrial systems, which seeks to ensure that social-ecological systems stay within sustainable limits [17] [18]. As the concept has evolved, different models and visualization of circular economy approaches have been developed. However, several models are built on the three pillars: Production, consumption and recycling. As visualized in Figure 3, the economy needs to develop from a linear model of producing, consuming, and discarding waste, to a circular model, where waste is recycled and used for new products. Such closed loop thinking is found to unleash efficiencies and increase throughput, as it maximizes a product`s value and lifetime, through recycle and repair processes [19] [20]. Consequently, a circular economy approach demonstrates great potential for several stakeholders that aims to maximize a product's value.

Figure 3: An illustration of the linear model and the circular economy.
While the linear model dispose waste, the circular model recycle waste to be used in new products.



Even though there is broad consensus for the necessity of CE, only the governments representing 55 percent of the world's greenhouse gas (GHG) emitters have announced specific targets for carbon emission reductions by 2030 [16]. Also, the energy systems in developing nations continue to rely on fossil fuels, which cause increased GHG emissions and are non-regenerative [21] [22]. An increasing population further compounds the issue. Although most consumers claim that sustainability is a top priority, a study finds that only 15 percent of global consumers are recycling waste, and only 17 percent are commuting in an eco-friendly manner [23]. In fact, as the standard of living has risen, manufacturing automation has led to mass production and consumption behavior, resulting in increased waste [16]. In addition, the expanding population leads to a higher food-demand and the UN projects that a 70 percent increase in food production is necessary by 2050. Such an increase entails an expansion of agriculture activity, which causes nature degradation as biodiversity loss and soil degradation [24] [25]. Consequently, despite the aim to adopt a CE practices, there remains a considerable gap between the desired objectives of a circular economy and the actual application of its practices.

In the context of a growing necessity for circular economy approaches, this whitepaper aims to demonstrate its potential. The paper will consist of three sub-themes, which are demonstrated as different pillars in the circular economy model: Production, consumption and recycling. Furthermore, as food systems account for a significant portion of the emissions, and offer substantial opportunities for increased circularity, they will be used as a prime exemplification of different circular economy considerations throughout the whitepaper.

Facts and Figures

28 million

Hectares have been cut down every year since 2016 [26]

1 million

Species are in critical risk of extinction [27]

300 %

Increase in food production since 1970 [27]

800 million

People currently do not get enough food to meet their nutritional needs everyday [24]

71 %

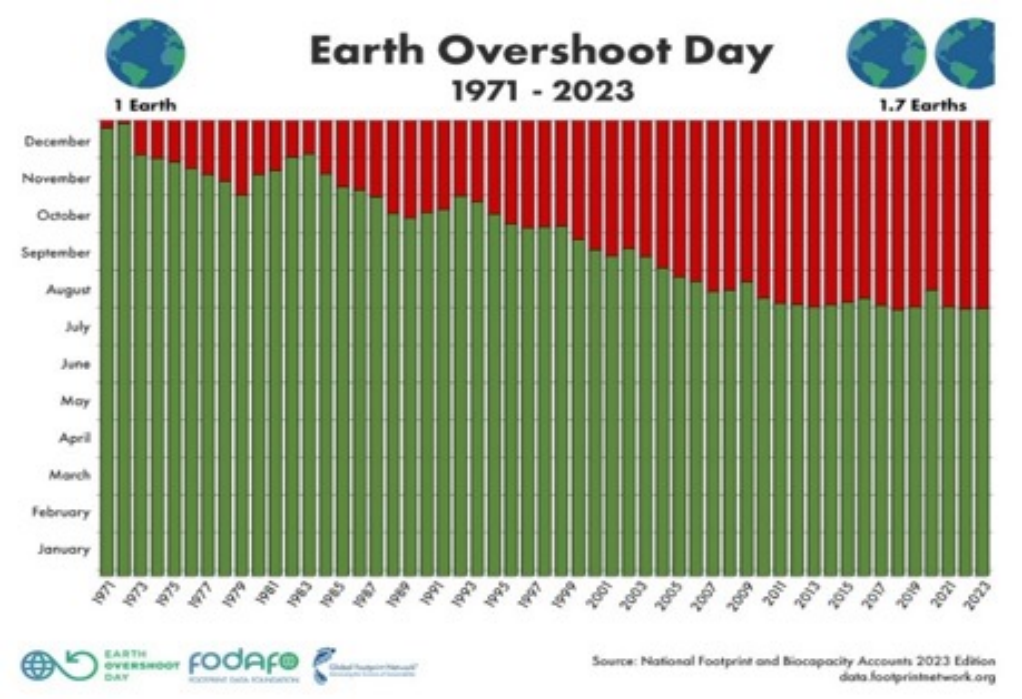
Higher recourse use is estimated per person in 2050 than today [24]

7.2 %

Resources are recycled back [13]

The urgency of circular economy becomes evident when considering Earth's Overshoot Day estimations, presented in Figure 4. The Earth Overshoot Day determines the date when humanity's consumption exceeds the Earth's biocapacity, leading to global overshoot for the remainder of the year. As illustrated in Figure 4, the Earth Overshoot Day has occurred earlier each year, necessitating resources equivalent to 1.7 Earths by 2023 [28]. Consequently, it is evident that human activity must change to sustain the Earth's resources.

Figure 4: The Earth biocapacity that suffices the humanity ecological footprint
The resource remainder of the year corresponds to the global overshoot. (Planet's Biocapacity / Humanity's Ecological Footprint) x 365 = Earth Overshoot Day



Source: Global Footprint Network [28]

Main SDGs Linked to Solutions Theme

Responsible consumption and production are relevant for several SDG targets. All these issues are interdependent, so it is difficult to achieve one without the other. In this paper, we are highlighting SDG 2, 12, and 14, not because they are more important than others, but because they have easily identifiable targets that, as an investor, we can use in the decision-making process. There are many linkages to other SDGs, which will be described in the subsequent sub-categories. Other relevant SDGs crossovers will be described in other thematic whitepapers.

SDG 2: Zero Hunger

Hunger and malnutrition pose significant barriers to human well-being and economic development. Projections demonstrate that 8 percent of the world's population will suffer from hunger. Despite global efforts, too many children continue suffering from malnutrition and the current annual rate of reduction in stunting must increase by 2.2 times to meet the zero hunger by 2030 [29]. The pressures to achieve these targets intensify pressures on natural resources, while impacts from climate change will also damage food systems. Furthermore, farmers around the world, making up a large share of employment in developing countries, struggle to make a livelihood from agricultural activities.

SDG 12: Responsible Consumption and Production

Ensure sustainable consumption and production patterns. This is about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs, and a better quality of life for all. In this context, it is required that the global economy need to speed up the decoupling of economic growth from resource use, by maximizing the socio-economic benefits of resources while minimizing their negative impacts [30].

SDG 14: Life Below Water

Healthy oceans are critical for life on Earth through their regulation of global climate and water systems, and through sustaining the natural resources that provide 17 percent of the global population's animal protein intake [31]. The earth's oceans are under ever increasing pressure from direct pollution and eutrophication, climate change, as well as fishing and aquaculture. Ocean plastic and debris are increasing rapidly. At today's pace, it is estimated that there will be more plastic debris than fish in the world's oceans by 2050. This is presenting a huge risk to the oceans and human life [32].

Investment Potential in Circular Economy towards 2030

Circular economy holds significant investment potential, as it enhances massive economic growth, estimated at 1.8 trillion EUR a year in Europe alone [33]. Notably, ventures that combine economic and societal targets demonstrate a 43 percent higher chance for expansion than purely commercial companies [34]. Additionally, an analysis conducted by Bocconi University, demonstrated lower risk for debt default and higher risk-adjusted returns for circular companies [33]. The economic potential for CE opportunities is further projected to reach USD 4.5 trillion between 2018 and 2030, where consumption demand, new regulation and capital flow contribute to such potential, which will be elaborated on in this section [34].

Several studies show that consumer demand for sustainable products is increasing, as is the willingness to pay for them. Research by NielsenIQ claims that 46 percent of consumers demand more sustainable products at a comparable price [35]. Also, today´s consumers require knowledge and detailed information on the environmental costs of what they consume [36]. However, quality is key, and 2/3 of consumers confess that they prioritize quality over sustainability. Also, for 41 percent of the consumers, a barrier for purchasing sustainable products is the costs associated with them [35]. To seek new opportunities, a company must change its product's design to meet customer requirements and consequently, improving quality and reducing costs for CE products poses great potential and will be important for customer satisfaction [36].

The introduction of new regulations has proven to stimulate green innovation and CE opportunities. Studies find that the transition and growth of new CE markets is strongly driven by environmental policy that promotes recycling, reduced waste, and decreased material requirements [37] [38]. Such innovation towards the transition to a CE creates significant opportunities for investors, innovation enablers, and the businesses themselves. Some of these opportunities are outlined by the Platform for Accelerating the Circular Economy (PACE), which emphasize the potential impact across five key sectors: Plastics, textiles, electronics, food and capital equipment [34]. Hence, regulations within the sectors will help identify potential opportunities and innovative solutions for more circular initiatives.

To build a circular economy, capital flow towards circular economy initiatives is required. During Circularity 23 with PACE this year, the concern of the inadequacy of capital directed toward building the infrastructure required for a circular economy, was evident [39]. Also, small and medium-sized enterprises (SMEs), as well as other organizations and actors, acknowledge the struggle to access adequate financing for the transition from linear to circular business models. As it is time-consuming to shift towards circular or regenerating practices, such transitions not only require investment and finance, but also knowledge transfer, community-building, and training throughout the transition period [9]. And thus, a lot of resources are associated with the circular economy transition. Hence, the panel for Circularity 23 with PACE underscored the importance of attracting more capital to support the development and scaling of circular infrastructure [39].

Transitioning the food systems towards a more sustainable path also brings new opportunities and economic benefits for operators in the food value chain [40]. Moreover, new technologies and scientific discoveries, combined with increasing public awareness and demand for sustainable food, will benefit all stakeholders [41]. Farmers, fishers, and aquaculture producers, as well as food processors and food services could make sustainability their trademark and guarantee a secure food chain ahead of their competitors. The transition to sustainability in the food sector presents a 'first mover' opportunity for all actors in the food industry [40]. As a result, food security and increased competitiveness will come along with the investments towards a more sustainable food chain.

Supporting Laws and Regulations

Even though the concept of circular economy is broadly discussed, it remains largely a voluntary movement. However, to correct market failures, some policy instruments are introduced to create stable and efficient markets for circular economy initiatives and include higher emission taxes, requirements, and increased support [42]. In general, The European Green Deal, sustainable finance and the EU taxonomy aims to transform the European economy and achieve climate naturality by 2050. More specifically, the circular economy action plan, the Farm to Fork strategy and new proposals to make sustainable products are directly affecting the incentives on circular economy and is described in Appendix along with other specific global initiatives for circular economy. Accordingly, this section will give a broad introduction of the European Green Deal and sustainable finance.

The European green deal and sustainable finance

To transform the European economy, the European Green Deal was presented by the European Commission in December 2019. As a part of the ambiguous plan and in compliance with the Paris Agreement, initiatives on Sustainable Finance were further introduced [43]. Sustainable finance focus on integrating environmental, social and governance (ESG) considerations into financial investments decisions, leading to long-term investments in sustainable activities. In this manner, sustainable finance has a key role to ensure policy objectives outlined in the European Green Deal [44].

To facilitate sustainable finance, the EU Commission announced a Sustainable Finance Action Plan (SFAP) for financing sustainable growth [45]. The SFAP is built on recommendations from the High-Level Expert Group (HLEG) on sustainable finance and outlines a comprehensive strategy to further connect finance with sustainability. The SFAP has three objectives.

1. Reorient capital flows towards sustainable investments.
2. Manage financial risks stemming from climate change, environmental degradation, and social issues, and
3. Foster transparency and long-termism in financial and economic activity.

Based on the SFAP, the EU has put in place a sustainable financial framework to obtain the objective of sustainable finance [32]. The framework consists of three building blocks:

1. A Classification System under the EU Taxonomy

The EU Taxonomy is a classification system that defines what is qualified sustainable in terms of economic activities. The taxonomy is developed by the Technical Expert Group (TEG), which was established by the European Commission to guide financing sustainable growth.

2. Disclosures under the Sustainable Finance Disclosure Regulation (SFDR) and Corporate Sustainability Reporting Directive (CSRD)

The objective of SFDR and CSRD is to improve transparency in the market for sustainable investment products, prevent greenwashing, and increase transparency regarding sustainability claims by sustainability disclosure. SFDR requirements cover a broad range of environmental, social, and governance (ESG) metrics to define the disclosure requirements for selling financial products. CSRD provides a framework regarding reporting of non-financial data.

3. Investment Tools under the EU Climate Benchmarks.

The investment tools include benchmarks, standards, and labels, that aim to facilitate financial market participants that try to align their investments strategies with the EU's environmental objectives.

Sub-themes

As a part of the circular economy model, this whitepaper focuses on three sub-themes that lay the foundation of c circular economy success: production, consumption, and recycling. This section will elaborate the sub-theme's potential, connection to the SDG targets and possible related solution companies. Moreover, as development in the food sector is crucial for reducing emissions and achieving circular economy benefits, this industry will be used to exemplify contributing factors for the different sub-themes

1. Production

Examples of key SDG targets

The world's demand for raw materials will nearly double by 2060, in pace with the expanded economy and population [43]. However, the supply of such materials is limited. While the linear model includes using the earths limited resources, the circular economy model tries to eliminate the usage of raw materials by designing products that could re-enter the economy at the end of their life cycle [44]. Accordingly, circular economy demonstrates resource efficiency, through narrowing, slowing, and closing material- and energy flows [45].

The production processes associated with circular economy enables reduced pollution and raw material dependency. The extraction and processing of raw materials such as biomass, fossil fuels, metals and non-metallic minerals is polluting air, water and soils, and thereby causes environmental damage [46]. According to the European Environment Agency, industrial processes and product usage are responsible for around 9 percent of greenhouse gas emissions in the EU [47]. Hence, limiting the consumption of raw materials will mitigate the consequences of climate change. Another consequence of such consumption is associated with EU's dependence on raw materials from other continents [47]. According to Eurostat, the EU has tripled the raw material trade since 2002, with a net trading balance of around EUR 49 billion in 2022 [48]. Accordingly, increased material efficiency in the production process could reduce the risks associated with supply, such as price volatility, availability and import dependency [47]. As the benefits of a circular production process are clear, this sub-section will address some opportunities within this field, considering eco design, chemistry and enzymes and bioplastics.

Eco-design

For products to successfully be recyclable and sustainable, the product design is essential [49]. An eco-design could be defined as the product's ability to work continuously while ensuring the lowest environmental impact and includes considerations regarding the products durability, reliability, reusability, resource efficiency, carbon footprint and expected waste generation [36] [50]. Research indicated that 80 percent of a product's environmental impact originates from the design phase and that there is a causal relationship between the implementation of an eco-design process and the reduction of negative environmental and societal impacts [51] [52]. Research has also shown that implementing an eco-design approach can positively affect firm's performance trough cost savings, waste reduction, customer satisfaction, increased market share, and supplier relationships [36]. Accordingly, a focus on eco-design solutions poses great potential to mitigate climate change and increase firm performance.

Due to an increased willingness to purchase sustainable products, eco-design has grown in popularity [35]. Moreover, 44 percent of consumers want retailers to assist them in being sustainable trough sustainable products and eco-design [35]. The willingness to buy such products may also be rooted in the associated benefits, as eco-products enable consumers to use products longer, save money and repair products, which reduce energy and resources consumption for the same purposes [53]. In 2021 alone, the impact of the current eco-design measures, saved EUR 120 billion in energy expenditure for EU consumers and led to a 10 percent lower annual energy consumption [54]. Accordingly, eco-design products enable increased customer satisfaction and reduced societal costs.

Chemistry and Enzymes

It is becoming increasingly clear that assessing the benefits of chemicals without harming human health and the environment is important to achieve the 2030 Sustainable Development Agenda [55]. The European Chemicals Agency (ECHA) found that over 75 percent of the chemicals consumed was hazardous to human health [56]. However, society's reliance on chemicals continue to grow and has nearly doubled since 2000, driven by industrialization, urbanization and the rise of chemical-intensive industry sectors such as construction, electronics, agriculture and food processing [55]. Even though some chemical release can be harmful and accelerate climate change, chemicals are also part of the solution through chemical innovation and nanomaterials [56]. The concept of sustainable chemistry, which OECD defines as "a scientific concept that seeks to improve

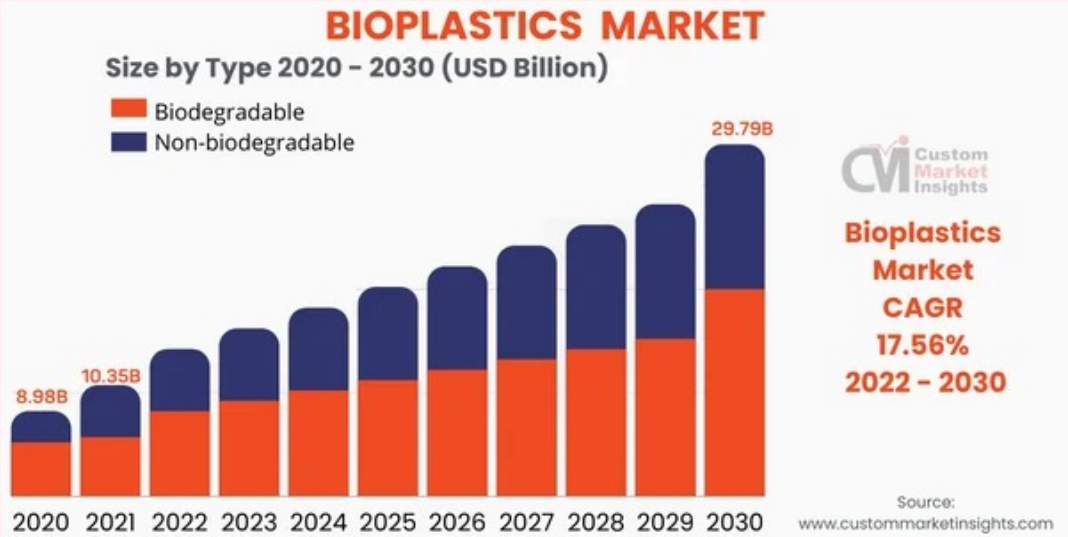
the efficiency for natural resources to meet human needs for chemical products and services", will therefore be important for a sustainable development [57]. Moreover, innovations in green and sustainable chemistry enable sustainable product design, foster sustainable and resilient supply chains, reduce pollution, enhance resource efficiency, improve environmental health and safety and increase the re-use and recyclability of products to foster a circular economy [55].

Biosurfactants are a great alternative for reducing the consumption of toxic chemicals. Surfactants can be made using raw materials derived from natural or synthetic feedstocks, or a combination of the two. Since 2005, the EU regulation has only allowed the use of readily biodegradable and completely degradable surfactants, where biosurfactants are more efficient and less toxic than chemical surfactant [58] [59]. As surfactants are widely used in various fields of the global economy, the global market for biosurfactants was cumulated at USD 1.2 billion in 2022 and is projected to reach USD 1.9 billion by 2027 [60].

Bioplastics

Plastics provides various solutions and functionalities, making them difficult to replace [61]. Most plastics are made from fossil fuels and contribute to increased greenhouse gas emissions and pollution if the plastic is not properly managed. However, bio-based and biodegradable plastics are alternatives to conventional plastic material and could reduce plastic litter and reliance on fossil fuel feedstocks [62]. Bioplastics are typically plastics manufactured from bio-based materials and could be either biobased, biodegradable, or feature both properties [63] [64]. These materials enable a circular economy, as they are made from renewable or recycled raw materials [63]. According to a market research study published by Custom Market Insights, the Global Bioplastics Market size & share revenue was valued at approximately USD 10.35 billion in 2021 and is expected to reach USD 29.79 billion by 2030 [65]. Accordingly, the reliance of bioplastics poses great potential for facilitating CE and reduce fossil fuel reliance.

Figure 5: Share of Biodegradable Plastics



Source: GlobeNewswire, «Global Bioplastics Market Size» [65]

A Sector Example: Food systems

Sustainable Agriculture

One-quarter of the world's greenhouse gas emissions come from the food and agriculture sector [66]. Projections indicate that only a modest EU-level decline of 2 percent of agricultural emissions is expected by 2030 compared to 2005 levels [67]. Consequently, reducing emissions from food production will be one of the greatest challenges in the coming decades. However, methods for decarbonize agriculture are less clear and requires several solutions as improvements in agricultural efficiency and technologies that make low-carbon food alternatives scalable and affordable [66]. As the use of fertilizers are crucial in agricultural production and represents 10.6 percent of agricultural emissions and 2.1 percent of the global GHG emissions, some solutions opportunities associated with fertilizers and pesticides are considered [68] [69]:

Green ammonia: Ammonia is a gas used in the production of mineral fertilizers. Instead of producing fertilizers of hydrogen produced from fossil fuels, green ammonia uses renewable and carbon-free energy to produce hydrogen. Today, green ammonia is more commonly seen as a potential in low-carbon shipping fuel but can also be used to produce carbon-neutral fertilizer products. Moreover, the production technology enables reduced emissions from nitrous oxide (N2O), a potent greenhouse gas, by more than 90 percent compared to traditional ammonia production [70]. The global market for green ammonia is rapidly increasing, from a value at USD 0,3 billion in 2023 to USD 17.9 billion in 2030 [71].

Biofertilizers: These fertilizers are an alternative to synthetic fertilizer and can meet the growing demand for organic and sustainable products. Biofertilizers conserve and sustain natural resources and enables organic farming and reduce pest population using natural enemies (microbiological such as bacteria, fungus and virus, and microbiological including other insects) [68] [72]. The biofertilizer market is valued for about USD 3.15 billion by the end of 2026 [73]

Production

Company Highlight:
DS Smith

About

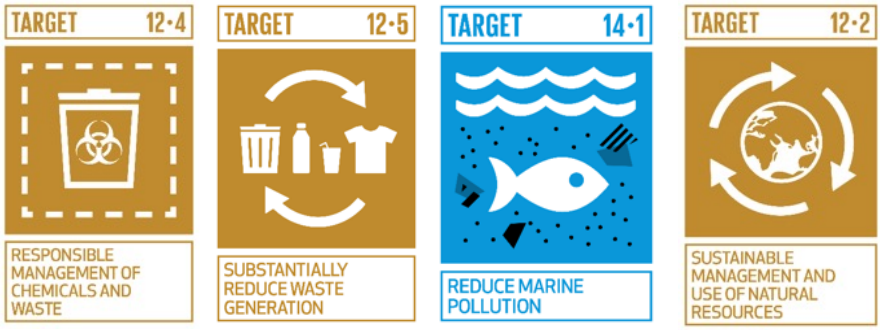
DS Smith is a global provider of sustainable packaging solutions, paper products and recycling services [74]. Their vision is to become the leading supplier of sustainable packaging solutions [75]. The company especially aims to deliver on the circular economy model by removing unnecessary plastics packaging and base their sustainable fiber-based packaging on recyclable materials [76]. In May 2019 they became a strategic partner of the Ellen MacArthur Foundation, and thereby took a lead in the circular economy packaging industry [77].

Impact on SDG Targets

DS Smith' ambitions are organized into four pillars: Circularity, decarbonization, creating a safe and inclusive workspace, while protecting and regenerating nature. By reducing waste, pollution and protecting natural resources, DS Smith contributes to SDG 12 regarding sustainable consumption and production. Also, by reducing CO2 emissions, they help achieve SDG 13, considering climate action. Lastly, SDG 15, regarding life on land, is achieved by protecting and restoring ecosystems [78].

2. Responsible Consumption

Examples of key SDG targets



Current challenges, such as climate change and resource scarcity, are accelerated by consumption patterns [79] [80]. By shifting consumption patterns towards more sustainable choices, both usage and acquisition rates can decline and thus, serve increased human equality and mitigate climate change [81]. In our unequal world, the eight wealthiest people have the same wealth as the 50 percent poorest [82] . Hence, the rich consumer class enjoys access to endless diversity of goods, while the poorest suffer from air, land and water pollution arising from the production of these products. Drawing on these findings, this whitepaper addresses two types of solutions associated with the increased consumption: A shared economy and food system efficiency.

Shared Economy

The shared economy is an economic model, where activities towards acquiring, providing, or sharing access to goods and services are facilitated by a community-based online platform [83]. The model has changed the way people engage in a variety of activities, including travelling, trading, working, and borrowing money [84]. A shared economy could reduce the consumption of goods and transform a linear economy, as goods could be shared among consumers and not owned by individuals [34] [85]. Moreover, a shared economy could reduce waste and increases the probability of reappearance, as a product owner is responsible for the goods and is expected to upgrade and maintain the products [85]. The global sharing economy market size was valued at nearly USD 150 billion in 2022 and is expected to expand 32 percent annually during the forecast period, surpassing USD 793 billion by 2028 [86]. Hence, the shared economy market enables reduced waste and poses a significant investment potential.

A Sector Example: Food systems

Sustainable Food

One of the main issues associated with food consumption is the unsustainable dietary patterns [87]. Higher income tends to increase the demand for high energy dense food, such as processed and animal-source food, fruits and vegetables [87]. However, several studies concludes that a plant-based diet and less consumption of animal-sourced foods, could improve human health, reduce the risk of diet related diseases as well as reducing the negative environmental effects. A major requirement in order to transform the food industry, is therefore to shift consumption towards more sustainable food products [88].

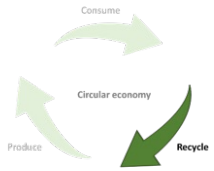
A solution to reduce the demand for animal-sourced food is trough plant-based substitutes. Plant based meat uses between 72 percent and 99 percent less water and between 47 percent and 99 percent less land when produced. The market for plant-based products has expanded significantly the recent years, as companies have started to produce plant-based burgers and other products that are virtually indistinguishable from conventional meat substitutes [89]. Moreover, the global plant-based meat market was valued at USD 4.4 billion in 2022 and is expected to grow 24.9 percent annually from 2023 to 2030 [90].

Food Safety

Climate change is already affecting food security through increasing temperatures, changing precipitation patterns, and greater frequency of extreme weather events. Hence, there are currently 821 million people that suffer from undernourishment, of which 151 million are children under five years old. Moreover 613 million women and girls aged 15 to 49 suffer from iron deficiency, while 2 billion adults are overweight or obese [91]. In this context, the concept of food security becomes evident, which is the definition for the convenient and affordable access to sufficiently safe and nutritious food [92]. As access to enough safe and nutritious food is the key to a good and sustainable life, investments to improve food security will be fundamental to achieve the SDG.

Improving food security has gained increased attention, leading to several opportunities within the private sector. The World Bank Group works with partners to build food systems that can feed everyone by improving food security, promoting 'nutrition-sensitive agriculture' and improving food safety. The Bank is a leading financier of food systems and by 2022, USD 9.6 billion in new commitments to agriculture and related sectors was conducted [92]. Also, technological solutions that can increase crop yields while reducing environmental stress, have key roles for improving food security [93]. This market was valued at USD 22 billion in 2022 and is expected to grow at an annual rate of 13.1 percent from 2022 to 2032, reaching USD 75 billion by 2032 [94].

3. Recycling and Reuse



In conjunction with production and responsible consumption, the way goods are being recycled and wasted is essential attributes for closing the circular economy loop. According to Statista, the recycling and waste industry poses great potential, as the global waste and recycling services market is projected to be worth USD 88.01 billion by 2030, an increase from USD 57.69 billion compared to 2021 [95]. Accordingly, recycling and waste management are noteworthy investment solutions.

Recycling and Waste Management

Despite the necessity of circular economy implementation, material extraction is rising every year and circularity declined from 9.1 percent in 2018 to 7,2 percent in 2023 [13]. Additionally, the EU produces more than 2.2 billion tons of waste every year [47]. Consequently, more virgin materials are used, and more waste is provided. If waste is not handled properly, it could significantly increase public health risks, pollution, plant and animal death and lower biodiversity [96] [97]. Accordingly, solutions that focus on reducing waste and enhancing sustainable waste management practices will be crucial for future sustainability. Such solutions could include sustainable designs, production, banning production of nonrecyclable products and recycling [98] [97].
Products made by plastics are introducing major waste issues, as 75 percent of the plastic produced since 1950 has ended up as waste and 66 percent of the plastic waste is at the risk of polluting the environment. Such pollution contributes to climate change, as plastics leaks into the environment, contain chemicals and microplastics that can pose risks to human health and the ecosystems [99].

Moreover, global estimates indicate that most plastic packaging are used once, and over 95 percent of the plastic, estimated at USD 80–USD 120 billion annually, is lost after its initial use [97]. Enacted in July 2021, the Single-Use Plastic Directive promotes the transition to a circular economy by banning the use of single-use plastics across all countries of the European Union, including cutleries, plates, cotton buds, straws, and balloon sticks [98]. Hence, developmental waste management that facilitates new business models and design thinking, has great potential as the legalisation shifts to a more sustainable consideration. As an example, the reusable straw market is projected to grow to a valuation of USD 2 billion in 2023 to USD 4.4 billion in 2033 [100].

Another solution to reduce the environmental impact caused by waste, is through recycling. Recycling describes the process where materials are re-entered back into the industrial flow and becomes parts of new products cycles [101]. The recycling industry is likely to become more competitive and grow but will remain a significantly smaller industry than mining primary materials [102]. However, there is a great innovation and investment potential for solutions associated with plastic recycling. As plastic contributes to climate change, environmental sustainability could be achieved by building a circular economy for plastics through recycling processes [99]. Innovation and technical improvements within the field of plastic are on the horizon, as the global market is valued at USD 69.4 billion in 2023 and is projected to reach USD 120 billion by 2023 [103].

A Sector Example: Food systems

Food Waste

Food is not only produced in an unsustainable manner, but nearly one third of the food produced is wasted [104]. Moreover, 15.4 percent of the global food production is wasted at farm stage, which results in unnecessary hunger for 10 percent of the world's population and pollution associated with its production [105] [104]. Hence, food loss reduction and waste management could significantly contribute to a more equal and sustainable society, as it could improve food security and lower GHG emissions.

There are different technologies for eliminating food loss and waste. Improvements in processing, cool and dry storage are common solutions that could reduce losses and improve the quality and availability of food [106]. The global cold-storage market accounted for USD 115.6 billion in 2021 and is estimated to achieve a market size of USD 323.6 billion by 2030, growing 12.5 percent annually from 2022 to 2030 [107]. Accordingly, new technology to minimize food loss and waste poses great potential for future investments.

Organic resources from by-products could be recycled, thus minimize the waste associated with food systems. By advancing processing technologies, food producers could optimize the usage of raw material and upcycling production waste rather than discard it [108]. Bio-based compounds could be used in the manufacture of a variety of products, including bio-composite packaging for food, natural additives for food ingredients, and agricultural products such as fertilizers and biodegradable mulching pots [109]. Further, bio-based packaging could reduce the agricultural plastic demand, which is estimated to be approximately 8 million–10 million tons each year [110]. Also, these by-products are free from contaminants and can safely be returned into the soil as organic fertilizers, and thereby provide additional value as bioenergy sources [111]. The market driven by the conversion of food waste into bio-based products and organic fertilizers is poised to grow more than 4 percent annually from 2019 to 2023 [112]. As a part of the food waste management market, the market size is estimated to grow 4.8 percent annually from 2022 to 2027 and forecasted to increase by USD 10 billion by the same year [113].

Recycling and Reuse

Company highlight:

Tomra

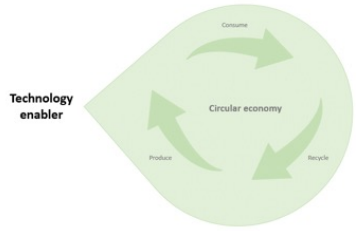
About

TOMRA provides solutions that enable the circular economy with advanced collection and sorting systems by employing sensor-based sorting and grading technology. TOMRA's offer includes reverse vending machines, food manufacturing technology and recycling. As an example, the company designs and manufactures sensor-based sorting machines and integrated post-harvest solutions, transforming global food production to maximize food safety and minimize food loss. Altogether TOMRA has approximately 105,000 installations in over 100 markets worldwide [114].

Contribution to SDG

TOMRA's vision of leading a resource revolution and mission to create sensor-based solutions for optimal resource productivity significantly contribute to achieving the agenda for SDG 12, regarding responsible consumption and production. Their business operations, such as managing natural resources, reducing food waste and food loss and reducing waste through recycling and reuse, all contribute to achieve the SDG 12 targets. Additionally, these operations have cross-over effects to other SDG goals as 2 zero hunger, 13 climate action, 11 industry innovation and infra structure, sustainable cities and 14 regarding life below water, to mention some [115].

4. Technology Enabler, Optimizing Resources and Renewables Dependency



Technological innovations could facilitate a variety of different circular business models [116]. Today's technology enables faster and more agile learning processes through interactive cycles of designing, prototyping, and gathering feedback, which are needed for the complex task of redesigning key aspects of a CE [117]. Accordingly, emerging digital technology, such as the Internet of Things (IoT), Big Data Analytics (BDA), Artificial Intelligence (AI), and 3D-printing, has radically changed the way products are made, delivered, sold, and consumed [118].

Research studies have especially emphasized IoT and AI as key technologies for a transition to circular economy [119]. The Internet of Things enables devices to exchange data with each other in real time, through Internet communication or wires [120]. Such technology facilitates predictive analysis of the CE processes, which includes the opportunity to track and monitor the product lifecycles for organizations, and thus enables resource optimization [119]. Moreover, such tracking could predict demand and manage inventory, and thereby reduce waste. To enable optimal decision-making of data provided by IoT, AI technology is further introduced [121]. Such technology could eliminate waste by assessing the best practices for remanufacturing and recycling, as well as detecting the optimal moment for preventative maintenance and improving machinery operations [119] [122] [123]. A McKinsey report recommend using AI to circular economy initiatives, as it enables designing circular products through iterative machine learning, and thus optimize the circular infrastructure and reverse logistics required to close the circular loop on products and materials [117].

The potential for IoT and AI technology for sustainable procedures are growing. The biggest technological gains are still likely to be found in the future, particularly in the business to business (B2B) sector, as McKinsey suggests, this sector will benefit from 65 percent of the total value released by IoT by 2030 [122]. The global green technology and sustainability market is forecasted to grow from roughly USD 13.76 billion in 2022 to almost USD 62 billion in 2030, with an annual growth rate of 20.8 percent from 2023 to 2030 [124].

A Sector Example: Food systems

Technology in Agriculture
New technology within agriculture enables food systems to be optimized and thus, play an increasingly important role in enhancing food security [93]. There exist opportunities in different parts of the food systems, including farming, processing, logistics, and consumption. Innovative ideas and technological advances such as sensor systems and networks enable automation, increase production, and provide a more efficient resource allocation. Technology could also improve crop yields by eliminating waste and streamlining operations, which straighten the food supply chain [120]. There is also a growing interest for the application of AI to the agriculture sector, as it could extract or exploit the information from the product and production processes and support systems for better decision making [125]. The AI in agriculture is projected to grow from USD 1.7 billion in 2023 to USD 4.7 billion by 2028, and hence poses a great investment potential.

Technology Enabler

Company Highlight: Autodesk

About

Autodesk delivers software-tools for improved flexibility and empowers innovators to solve important design problems in different sectors, including architecture, engineering, construction, product design among others [126]. Autodesk is a leader in Computer-aided Design (CAD) and 3D modeling. The company offers over 90 software products with various applications but are leading providers of Computer-aided Design (CAD) and 3D modeling [127]. The 3D CAD assists the creation and manipulation analysis, and thereby enables optimized design [128]. These widely used software programs can help drafting construction documentation, explore design ideas, visualize concepts through photorealistic renderings and simulate how a design performs in the real world [129].

Contribution to SDG

According to Autodesk`s sustainability report they contribute to SDG 6, 7, 8, 9, 11, 12, and 13 [130]. As this whitepaper considers circular economy, the contribution to SDG 12, sustainable consumption and production, will be emphasized, as they are working towards reduced waste and equip their stakeholders with awareness regarding the impact of materials use and support them to make sustainable choices. Also, SDG 7 regarding affordable and clean energy should be emphasized, as Autodesk are committed to use 100 percent renewable energy in their operations, and help their customers develop buildings, infrastructure, and products that are energy efficient and accelerate the use of clean and regenerated energy. Lastly, the company aims to help customers design, build, and maintain more sustainable, safe, and resilient cities, which will be crucial as populations continue to swell. Hence, the company is contributing to achieve SDG 11 regarding sustainable cities and communities [130].

Shortcomings Circular Economy

Even though there is a consensus regarding the need and potential for a circular economy, there are some mentionable shortcomings that could challenge the transition to circular economy practices. The concept of circular economy is complex, and solutions within the concept may not be clearly defined or understood, as well as it is context-dependent [131] [132]. Such complexity poses challenges as circular economy processes require holistic system changes, which is both time consuming and dependent on collaboration with different stakeholders [132]. Specifically, it is estimated that implementing regenerative practices takes at least three years. Additionally, not only adequate investment and finance are required, but also knowledge transfer, community-building, and training throughout the transition period is necessary [9]. Consequently, it is not straight forward to implement circular economy practices, as such practices are time consuming and complex.

Appendix

The European Green Deal and the EU Taxonomy set the baseline for sustainable practices within EU, however, there are also initiatives more directed towards circular economy practices, as presented in Table1 and Table 2. While Table 1 presents initiatives within the EU, Table 2 includes initiatives outside the EU regulations.

Table 1: Initiatives for CE within the EU

Initiative	Year	About
The Farm to Fork Strategy	2020	The Farm to Fork Strategy is considered as an important part of the European Green Deal, aiming to make food systems fair, healthy and sustainable [133]. The strategy created a new approach to ensure that agriculture, fisheries and aquaculture, and the food value chain contribute to reach net zero emission by 2050 [134]
The Circular Economy Action Plan	2020	The Circular Economy Action Plan is a main building block of the European Green Deal and announces initiatives along the entire life cycle of products. The plan targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented and that resources are recycled [135].
EU rules on packaging	2022	The Commission has proposed EU-wide rules which aims to improve packaging design and reduce waste, and increase the use of bio-based, biodegradable and compostable plastics [47].
New proposals to make sustainable products	2022	The Commission has presented a package of European Green Deal proposals to make sustainable products the norm in the EU, boost circular business models and empower consumers for a green transition [136].
The proposal for a new Eco-design for Sustainable Products Regulation (ESPR)	2022	The rules proposed under ESPR set a wide range of requirements on the eco-design for sustainable products. The rules will apply to all products on the EU market and will be compliant with international trade rules [137]

Table 2: Initiatives for CE outside the EU

Initiative	Year	Geographic area	About
China's circular economy Promotion Law and Basic Act on Establishing a Circular Society	2000	China	The law aims to facilitate a circular economy, raising resources utilization rate, protecting and improving environment and realizing sustainable development [138].
National Sword Policy	2017	China	The policy restricts the import of secondary raw materials for processing and aims to decrease the import of low-quality plastics that are difficult to sort and recycle [139] [140].
Action Plan on Zero Plastic Waste Strategy	2018	Canada	The action plan reduces the harmful environmental impacts of plastic waste through strategies that provide greater prevention, collection and value recovery of plastics [99].
Organic Law for an Inclusive circular economy	2021	Ecuador	The laws that aim to facilitate an ecological transition and includes policies for reducing plastic pollution [141].
LAC Circular Economy Coalition	2021	Latin America and Caribbean	The coalition published a circular vision for the region and aims to support circular projects by giving them financial subsidies [139] [142].
Legislative package for circular economy efforts	2021	California	The package aims to allocate investments towards recycling systems by raising consumer awareness and industry accountability [51].
Plastic Resource Circulation Act	2022	Japan	The act aims to eliminate landfills and reduce energy recovery of plastics waste by scaling up mechanical and chemical recycling [99].

References

[1] United Nations, «The 17 goals,» [Internett]. Available: https://sdgs.un.org/goals.
[2] General Assembly Economic and Social Council, «Progress towards the Sustainable Development Goals,» 2023. [Internett]. Available: https://unstats.un.org/sdgs/files/report/2023/secretary-general-sdg-report-2023--EN.pdf.
[3] United Nations Secretary-General's, «Roadmap for Financing the 2030 Agenda for Sustainable Development,» 2021. [Internett]. Available: https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/07/EXEC.SUM_SG-Roadmap-Financing-SDGs-July-2019.pdf.
[4] UNDP, «Sustainable development goals, Business and the SDGs,» [Internett]. Available: https://www.undp.org/sdg-accelerator/business-and-sdgs.
[5] Business & Sustainable Development Commission, «Better Business, Better World,» January 2017. [Internett]. Available: https://sdghub.com/project/better-business-better-world/#:~:text=The%20Business%20and%20Sustainable%20Development,was%20launched%20in%20January%202016.&text=It%20identifies%20key%20actions%20business,to%20a%20sustainable%2C%20inclusive%20economy.
[6] UN, «Why population growth matters for sustainable development,» UN, https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2022_policy_brief_population_growth.pdf, 2022.
[7] UNDP, «Human development report 2021/2022,» 2022. [Internett]. Available: https://hdr.undp.org/system/files/documents/global-report-document/hdr2021-22pdf_1.pdf?_gl=1%2Am482tc%2A_ga%2AMTY3NTA4NTU4Ny4xNjg5ODYwMjk0%2A_ga_3W7LPK0WP1%2AMTY4OTkzNzEyOS4yLjEuMTY4OTkzODA2NC41Mi4wLjA..
[8] The world counts, «Number of planet Earths we need,» 2023. [Internett]. Available: https://www.theworldcounts.com/challenges/planet-earth/state-of-the-planet/overuse-of-resources-on-earth.
[9] UNDP, «What is circular economy and why does it matter?,» 2023. [Internett]. Available: https://climatepromise.undp.org/news-and-stories/what-is-circular-economy-and-how-it-helps-fight-climate-change.
[10] UN environment programme, «Rethinking How We Live, How We Buy and What We Consume,» 2014. [Internett]. Available: https://www.unep.org/news-and-stories/press-release/rethinking-how-we-live-how-we-buy-and-what-we-consume.
[11] UN, «Goal 12: Ensure sustainable consumption and production patterns,» [Internett]. Available: https://www.un.org/sustainabledevelopment/sustainable-consumption-production/.
[12] USDN, «Sustainable Consumption Toolkit,» [Internett]. Available: https://www.usdn.org/sustainable-consumption-toolkit.html.
[13] UNDP, «What is circular economy and why does it matter?,» 2023. [Internett]. Available: https://climatepromise.undp.org/news-and-stories/what-is-circular-economy-and-how-it-helps-fight-climate-change.
[14] Ellen macarthur foundation, «What is a circular economy?,» [Internett]. Available: https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview.
[15] Circle economy, «The circularity gap,» 2023. [Internett]. Available: https://assets.website-files.com/5e185aa4d27bcf348400ed82/63ecb3ad94e12d3e5599cf54_CGR%202023%20-%20Report.pdf.
[16] L. Chen, J. Wang, D. Rooney, M. Yang, G. Misgwa, O. Ahmed, S. Fawzy og P.-S. Yap, «Circular economy strategies for combating climate change and other environmental issues,» 2022. [Internett]. Available: https://link.springer.com/article/10.1007/s10311-022-01499-6.
[17] U. Awan og R. Sroufe, «Sustainability in the Circular Economy: Insights and Dynamics of Designing Circular Business Models,» 2022. [Internett]. Available: https://www.mdpi.com/2076-3417/12/3/1521.
[18] S. Kennedy og M. Linnenluecke, «Circular economy and resilience: A research agenda,» 2022. [Internett]. Available: https://onlinelibrary.wiley.com/doi/pdf/10.1002/bse.3004.
[19] PWC, «What is the circular economy model?,» [Internett]. Available: https://www.pwc.com/gr/en/advisory/risk-assurance/sustainability-climate-change/circular-economy-model.html.
[20] M. A. Camilleri, «The circular economy's closed loop and product service,» 2018. [Internett]. Available: https://circulareconomy.europa.eu/platform/sites/default/files/circular_economy_closed_loop_and_product_service_systems.pdf.
[21] C. Su og F. Urban, «Circular economy for clean energy transitions: A new opportunity under the COVID-19 pandemic,» 2021. [Internett]. Available: https://www.sciencedirect.com/science/article/pii/S0306261921001963.
[22] National Geographic Society, «Nonrenewable Resources,» 2022. [Internett]. Available: https://education.nationalgeographic.org/resource/nonrenewable-resources/.
[23] Mintel, «Sustainability & Consumer Behaviours: How to engage your audience,» 2023. [Internett]. Available: https://www.mintel.com/consumer-market-news/consumer-attitudes-towards-sustainability/?_bt=657074821648&_bk=sustainability%20market%20trends&_bm=b&_bn=g&_bg=151536718267&utm_medium=cpc&utm_source=google&utm_content=Threepipe-GO20053915087~GO1515367182678g.
[24] Population Matters, «Resources & Comsumption,» [Internett]. Available: https://populationmatters.org/the-facts-resources-consumption/.
[25] E. Midler, «Environmental degradation: Impacts on agricultural production,» 2022. [Internett]. Available: https://ieep.eu/publications/environmental-degradation-impacts-on-agricultural-production/.
[26] The world counts, «We are consuming the future,» 2023. [Internett]. Available: https://www.theworldcounts.com/challenges/planet-earth/state-of-the-planet/overuse-of-resources-on-earth.
[27] UN, «UN Report: Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating',» 2019. [Internett]. Available: https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/.
[28] Global Footprint Network, «Past Earth Overshoot Days,» 2023. [Internett]. Available: https://www.overshootday.org/newsroom/past-earth-overshoot-days/.
[29] United Nations, «End hunger, achieve food security and improved nutrition and promote sustainable agriculture,» 2023. [Internett]. Available: https://sdgs.un.org/goals/goal2.

[30] UN, «Ensure sustainable consumption and production patterns,» 2023. [Internett]. Available: https://sdgs.un.org/goals/goal12.
[31] C. Boyd, A. McNevin og R. Davis, «The contribution of fisheries and aquaculture to the global protein supply,» 2022. [Internett]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8771179/.
[32] UN, «Conserve and sustainably use the oceans, seas and marine resources for sustainable development,» [Internett]. Available: https://sdgs.un.org/goals/goal14.
[33] Ellen MacArthur Foundation, «Financing the circular economy,» [Internett]. Available: https://ellenmacarthurfoundation.org/topics/finance/overview.
[34] World Economic Forum, «Circular Trailblazers: Scale-Ups Leading the Way Towards a More Circular Economy,» 2021. [Internett]. Available: https://pacecircular.org/sites/default/files/2021-02/WEF_Circular_Trailblazers_report_2020.pdf.
[35] NielsenIQ, «The changing story of sustainability,» 2023. [Internett]. Available: https://nielseniq.com/global/en/landing-page/tl-the-changing-story-of-sustainability/.
[36] N. Dahmani, A. Belhadi, K. Benhida, S. Elfezazi, F. E. Touriki og Y. Azougagh, «Integrating lean design and eco-design to improve product design: From literature review to an operational framework,» 2022. [Internett]. Available: https://journals.sagepub.com/doi/pdf/10.1177/0958305X21993481.
[37] D. McGinty, «5 Opportunities of a Circular Economy,» World resources institute, 2021. [Internett]. Available: https://www.wri.org/insights/5-opportunities-circular-economy.
[38] G. Cainelli, A. D'Amato og M. Mazzanti, «Resource efficient eco-innovations for a circular economy: Evidence from EU,» 2020. [Internett]. Available: file:///C:/Users/E23/Downloads/CainelliDAmatoMazzanti2020ResearchPolicy-CircularEconomy-InnovationsintheEU.pdf.
[39] Platform for accelerating the circular economy, «Circularity 23 second day digest: Funding the future: unlocking circular investments,» 2023. [Internett]. Available: https://pacecircular.org/node/520.
[40] European Comission, «Farm to Fork,» 2020. [Internett]. Available: https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf.
[41] European Comission, «Farm to Fork strategy,» [Internett]. Available: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en.
[42] Deloitte, «Study for a National Strategy,» 2020. [Internett]. Available: https://www.regjeringen.no/contentassets/70958265348442759bed5bcbb408ddcc/deloitte_study-on-circular-economy_short-summary.pdf.
[43] OECD, «Raw materials use to double by 2060 with severe environmental consequences,» 2018. [Internett]. Available: https://www.oecd.org/environment/raw-materials-use-to-double-by-2060-with-severe-environmental-consequences.htm.
[44] Ellen MacArthur Foundation, «Eliminate waste and pollution,» [Internett]. Available: https://ellenmacarthurfoundation.org/eliminate-waste-and-pollution.
[45] Q. Liu, A. H. Trevisan, M. Yang og J. Mascarenhas, «A framework of digital technologies for the circular economy:,» 2022. [Internett]. Available: https://onlinelibrary.wiley.com/doi/pdf/10.1002/bse.3015.
[46] European Parliament, «Parliament seals ban on throwaway plastics by 2021,» 27 March 2019. [Internett]. Available: https://www.europarl.europa.eu/news/en/press-room/20190321IPR32111/parliament-seals-ban-on-throwaway-plastics-by-2021.
[47] European Parlliament, «Circular economy: definition, importance and benefits,» 2023. [Internett]. Available: https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits.
[48] Eurostat, «Extra-EU trade in raw materials,» 2023. [Internett]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Extra-EU_trade_in_raw_materials&oldid=562723#General_view_on_EU_trade_in_raw_materials.
[49] Ellen MacArthur Foundation, «Circulate products and materials,» [Internett]. Available: https://ellenmacarthurfoundation.org/circulate-products-and-materials.
[50] DNV, «Ecodesign for Sustainable Products Regulation,» [Internett]. Available: https://www.dnv.com/services/ecodesign-for-sustainable-products-regulation-231914.
[51] M. Weick og N. Ray, « Regulatory landscape of the circular economy,» EY, 2022.
[52] T. Zeng, J. Dechênes og F. Durif, «Eco-design packaging: an epistemological analysis and transformative research agenda,» 2020. [Internett]. Available: https://archipel.uqam.ca/15051/1/D4063.pdf#page=97.
[53] European accreditation, «Proposed Ecodesign for Sustainable Products Regulation – aligned with the New Legislative Framework,» 2023. [Internett]. Available: https://european-accreditation.org/proposed-ecodesign-for-sustainable-products-regulation-aligned-with-the-new-legislative-framework/.
[54] European commission, «Ecodesign for Sustainable Products Regulation,» [Internett]. Available: https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en.
[55] H. V. D. Veen og M. G. Kapadia, «Transitioning to a circular economy trough chemical and waste management,» 2021. [Internett]. Available: https://www.undp.org/sites/g/files/zskgke326/files/2022-03/UNDP-GEF-Transitioning-to-a-Circular-Economy-Through-Chemical-and-Waste-Management.pdf.
[56] European chemicals agency, «Chemicals and climate change,» [Internett]. Available: https://chemicalsinourlife.echa.europa.eu/global-warming-and-chemicals.
[57] OECD, «Sustainable chemistry,» [Internett]. Available: https://www.oecd.org/chemicalsafety/risk-management/sustainable-chemistry/.
[58] Cesio, «Surfactants and sustainability,» 2017. [Internett]. Available: https://www.cesio.eu/index.php/about-surfactants/contribution-to-surfactants-and-sustainability.
[59] A. Moldes,. L. Rodríguez-López,. M. Rincón-Fontán,. A. López-Prieto, X. Vecino og J. Cruz, «Synthetic and Bio-Derived Surfactants Versus Microbial Biosurfactants in the Cosmetic Industry: An Overview,» 2021. [Internett]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7956807/.
[60] MarketsAndMarkets, «Biosurfactants Market,» [Internett]. Available: https://www.marketsandmarkets.com/Market-Reports/biosurfactant-market-163644922.html?gclid=Cj0KCQjwiIOmBhDjARIsAP6YhSWFWaniajhQaGgQQjoF7-zrBpsu3BA3bZ1m-8krlAh-3GT2rZVsuytsaAiEhEALw_wcB.
[61] The norwegian environment agency, «Bio-Based and Biodegradable Plastics,» 2018. [Internett]. Available: https://www.miljodirektoratet.no/globalassets/publikasjoner/m1206/m1206.pdf.
[62] European comission, «Biobased, biodegradable and compostable plastics,» [Internett]. Available: https://environment.ec.eu-

ropa.eu/topics/plastics/biobased-biodegradable-and-compostable-plastics_en.
[63] J.-G. Rosenboom, R. Langer og G. Traverso, «Bioplastics for a circular economy,» 2022. [Internett]. Available: https://www.nature.com/articles/s41578-021-00407-8.
[64] European bioplastics, «What are bioplastics,» [Internett]. Available: https://www.european-bioplastics.org/bioplastics/#:~:text=Bioplastics%20are%20not%20just%20one.
[65] GlobeNewswire, «Global Bioplastics Market Size,» 2023. [Internett]. Available: https://www.globenewswire.com/en/news-release/2023/02/06/2601766/0/en/Latest-Global-Bioplastics-Market-Size-Share-Worth-USD-29-79-Billion-by-2030-at-a-17-56-CAGR-Custom-Market-Insights-Analysis-Outlook-Leaders-Report-Trends-Forecast-Segmentation-Grow.html.
[66] H. Ritchie, «Food production is responsible for one-quarter of the world's greenhouse gas emissions,» 2019. [Internett]. Available: https://ourworldindata.org/food-ghg-emissions.
[67] European Environmental Agency, «Greenhouse gas emissions from agriculture in Europe,» 2022. [Internett]. Available: https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-agriculture.
[68] ScienceDirect, «Biofertilizer,» [Internett]. Available: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biofertilizer.
[69] S. Menegat, A. Ledo og R. Tirado, «Greenhouse gas emissions from global production and use of nitrogen synthetic fertilisers in agriculture,» 2022. [Internett]. Available: https://www.nature.com/articles/s41598-022-18773-w.
[70] Yara, «Green fertilizers: everything you need to know,» [Internett]. Available: https://www.yara.com/sustainability/transforming-food-system/green-fertilizers/what-you-need-to-know-about-green-fertilizers/.
[71] Markets and Markets, «Green ammonia market by technology,» 2023. [Internett]. Available: https://www.marketsandmarkets.com/Market-Reports/green-ammonia-market-118396942.html.
[72] R. Seenivasagan og O. Oluranti Babalola, «Utilization of Microbial Consortia as Biofertilizers and Biopesticides for the Production of Feasible Agricultural Product,» 2021. [Internett]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8614680/.
[73] M. Ptaszek, L. Canfora, M. Pugliese, F. Pinzari, G. Gilardi, P. Trzciński og E. Malusà, «Microbial-Based Products to Control Soil-Borne Pathogens: Methods to Improve Efficacy and to Assess Impacts on Microbiome,» 2023. [Internett]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9867489/.
[74] DS Smith, «Our Company,» [Internett]. Available: https://www.dssmith.com/company/our-company.
[75] DS Smith, «Strategy,» [Internett]. Available: https://www.dssmith.com/company/strategy.
[76] DS Smith, «Our Circular Business Model,» [Internett]. Available: https://www.dssmith.com/company/strategy/business-model.
[77] Ellen MacArthur Foundation , «DS Smith: Membership status: Strategic Partner,» [Internett]. Available: https://ellenmacarthurfoundation.org/ds-smith.
[78] DS smith, «DS Smith Annual Report 2023,» 2023. [Internett]. Available: https://www.dssmith.com/investors/results-presentations/annual-reports.
[79] Tunn, Bocken, v. d. Hende og Schoormans, «Business models for sustainable consumption in the circular economy: An expert study,» 2019. [Internett]. Available: sciencedirect.com/science/article/abs/pii/S095965261833693X?via%3Dihub.
[80] J. Camacho-Otero, C. Boks og I. N. Pettersen, «Consumption in the Circular Economy: A Literature Review,» 2018. [Internett]. Available: https://www.mdpi.com/2071-1050/10/8/2758#sec3-sustainability-10-02758.
[81] L. A. Haigh, «21 circular economy solutions: changing how we eat, live and travel for a more sustainable world,» 2022. [Internett]. Available: https://www.weforum.org/agenda/2022/03/21-circular-economy-solutions.
[82] L. Elliott, « This article is more than 6 years old World's eight richest people have same wealth as poorest 50%,» 2017. [Internett]. Available: https://www.theguardian.com/global-development/2017/jan/16/worlds-eight-richest-people-have-same-wealth-as-poorest-50.
[83] The investopedia team, «Sharing Economy: Model Defined, Criticisms, and How It's Evolving,» 2020. [Internett]. Available: https://www.investopedia.com/terms/s/sharing-economy.asp.
[84] G. Quattrone, N. Kusek og L. Capra, «A global-scale analysis of the sharing economy model – an AirBnB case study,» 2022. [Internett]. Available: https://epjdatascience.springeropen.com/articles/10.1140/epjds/s13688-022-00349-3.
[85] North sea region, «Action plan to promote sharing economy and circular economy in Helsingborg,» 2020. [Internett]. Available: https://northsearegion.eu/media/17975/action-plan-to-promote-sharing-and-circular-economy-in-helsingborg.pdf.
[86] New media whire, «Sharing Economy Market Size 2023, Share | Growing Report [2028],» 2023. [Internett]. Available: https://finance.yahoo.com/news/sharing-economy-market-size-2023-141551534.html?guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAAItCJGPXXQT4tbC81Z2Eq8vfsArdatQ-lVzNHlcrrmcFBMl95B8Ye-gRavTN-qPY70znHkX4-qbEmfS7w9twC7M_cGxl_SxuPfPlfXNmgsc9.
[87] Food and Agriculture Organization of the United Nations, «The future of food and agriculture,» 2017. [Internett]. Available: https://www.fao.org/3/i6583e/i6583e.pdf.
[88] García-Oliveira, Fraga-Corral, Pereira, Prieto og imal-Gandara, «Solutions for the sustainability of the food production and consumption system,» 2020. [Internett]. Available: https://www.tandfonline.com/doi/pdf/10.1080/10408398.2020.1847028?casa_token=AE1EVZtLv4gAAAAA:gSW9bMFakoqPlnoNDRypQA2EMTBxd62NB-9TYaNJvaNlY20wEfjtcm1-bNUGmg-7Mip58nahH9gx8hQ.
[89] Good food institute, «Plant-based meat,» [Internett]. Available: https://gfi.org/plant-based/.
[90] Grand view reasurch, «Plant-based Meat Market Size,» 2021. [Internett]. Available: https://www.grandviewresearch.com/industry-analysis/plant-based-meat-market.
[91] IPCC, «Climate Change and Land,» [Internett]. Available: https://www.ipcc.ch/srccl/.
[92] The world bank, «What is Food Security?,» [Internett]. Available: https://www.worldbank.org/en/topic/agriculture/brief/food-security-update/what-is-food-security.
[93] F. Carrier, «How food security can feed investment opportunities,» 2022. [Internett]. Available: https://www.rbcwealthmanagement.com/en-us/insights/how-food-security-can-feed-investment-opportunities.
[94] Spherical, «Global Agritech Market Insights Forecasts to 2032,» 2022. [Internett]. Available: https://www.sphericalinsights.com/reports/agritech-market.
[95] Statista, «Global waste recycling services market size in 2020 and a forecast to 2030,» 2022. [Internett]. Available: https://www.statista.com/statistics/239662/size-of-the-global-recycling-market/#:~:text=The%20global%20waste%20recycling%20services,environmental%20impacts%20of%20waste%20increases..
[96] Clean management, «How Improper Waste Disposal Affects the Environment,» [Internett]. Available: https://cleanmanagement.com/blog/how-improper-waste-disposal-affects-the-environment/.

[97] UNDP, «Transitioning to a circular economy trough chemical and waste management,» 2021. [Internett]. Available: https://www.undp.org/sites/g/files/zskgke326/files/2022-03/UNDP-GEF-Transitioning-to-a-Circular-Economy-Through-Chemical-and-Waste-Management.pdf.
[98] M. Igini, «3 Waste Management Solutions from Around the World,» 2022. [Internett]. Available: https://earth.org/waste-management-solutions-from-around-the-world/.
[99] OECD, «Workshop report on flexible food-grade plastic packaging,» 2023. [Internett]. Available: https://www.oecd.org/chemicalsafety/risk-management/workshop-report-flexible-food-grade-plastic-packaging.pdf.
[100] Future market insigts, «Reusable straw market snapshot (2023 to 2033),» 2022. [Internett]. Available: https://www.futuremarketinsights.com/reports/reusable-straws-market.
[101] P. Cicconi, «Eco-design and Eco-materials: An interactive and collaborative approach,» 2019. [Internett]. Available: https://www.sciencedirect.com/science/article/abs/pii/S2214993719300442.
[102] OECD, «Raw materials use to double by 2060 with severe environmental consequences,» 2018. [Internett]. Available: https://www.oecd.org/environment/raw-materials-use-to-double-by-2060-with-severe-environmental-consequences.htm.
[103] Markets and Markets, «Recycled plastics market by source,» 2023. [Internett]. Available: https://www.marketsandmarkets.com/Market-Reports/recycled-plastic-market-115486722.html?gclid=Cj0KCQjwiIOmBhDjARIsAP6YhSUS6oscdXw3dEPy9ZDF3yiussBKiK6iwSxNzefvDQtIFAH8owKgihcaArAJEALw_wcB.
[104] Ellen MacArthur Foundation , «A circular economy for food will help people and nature thrive,» [Internett]. Available: https://ellenmacarthurfoundation.org/topics/food/overview.
[105] WWF, «Driven to waste: The Global Impact of Food Loss and Waste on Farms.,» 2021. [Internett]. Available: https://wwfeu.awsassets.panda.org/downloads/driven_to_waste___the_global_impact_of_food_loss_and_waste_on_farms.pdf.
[106] Food and Agriculture Organization of the United Nations, «Reducing food loss and waste central to tackling climate change, food insecurity and to making more efficient use of our natural resources says FAO expert,» 2022. [Internett]. Available: https://reliefweb.int/report/world/reducing-food-loss-and-waste-central-tackling-climate-change-food-insecurity-and-making-more-efficient-use-our-natural-resources-says-fao-expert.
[107] Process cooling, «Cold-Storage Market Expected to Reach $323.6 Billion by 2030,» 2022. [Internett]. Available: https://www.process-cooling.com/articles/90751-cold-storage-market-expected-to-reach-3236-billion-by-2030?v=preview.
[108] Tetra Pak, «Four concrete actions to help reduce food waste,» 2022. [Internett]. Available: https://www.tetrapak.com/about-tetra-pak/stories/food-waste-value-chain?utm_source=google&utm_medium=ppc&utm_campaign=_global_stories_hub&utm_content=stories_hub_sem_ads_four_actions_to_reduce_food_waste&gclid=CjwKCAjwq4imBhBQEiwA9Nx-1Bi9tyC3P0UncgBYW-cCPo.
[109] E. commission, «Turning food and crop waste into new products,» 2019. [Internett]. Available: https://ec.europa.eu/research-and-innovation/en/projects/success-stories/all/turning-food-and-crop-waste-new-products.
[110] World bank group, «Agricultural pollution, Plastics,» 2018. [Internett]. Available: https://openknowledge.worldbank.org/server/api/core/bitstreams/fcecccdb-15be-5822-b060-fe9df5c924b0/content.
[111] Ellen MacArthur Foundation, «Food and the circular economy,» [Internett]. Available: https://ellenmacarthurfoundation.org/food-and-the-circular-economy-deep-dive.
[112] Businesswire, «Global Food Waste Management Market 2019-2023,» 2019. [Internett]. Available: https://www.businesswire.com/news/home/20190828005435/en/Global-Food-Waste-Management-Market-2019-2023-Conversion-of-Food-Waste-Into-Bio-Based-Products-and-Organic-Fertilizers-Technavio.
[113] Technavio, «Food Waste Management Market by Method, Application, and Geography - Forecast and Analysis 2023-2027,» 2023. [Internett]. Available: https://www.technavio.com/report/food-waste-management-market-size-industry-analysis.
[114] TOMRA, «About TOMRA,» [Internett]. Available: https://www.tomra.com/about-tomra.
[115] TOMRA, «TOMRA is working to transform how we obtain, use and reuse the planet's resources to enable a world without waste.,» [Internett]. Available: https://www.tomra.com/about-tomra/sustainability.
[116] Bioregional, «4 key enablers that will speed up the circular economy,» [Internett]. Available: https://www.bioregional.com/news-and-opinion/4-key-enablers-that-will-speed-up-the-circular-economy-part-1.
[117] McKinsey, «Artificial intelligence and the circular economy: AI as a tool to accelerate the transition,» 2019. [Internett]. Available: https://www.mckinsey.com/capabilities/sustainability/our-insights/artificial-intelligence-and-the-circular-economy-ai-as-a-tool-to-accelerate-the-transition.
[118] Q. Liu, A. H. Trevisan, M. Yang og J. Mascarenhas, «A framework of digital technologies for the circular economy: Digital functions and mechanisms,» 2021. [Internett]. Available: https://onlinelibrary.wiley.com/doi/pdf/10.1002/bse.3015.
[119] C. Chauhan , V. Parida og A. Dhir, «Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises,» 2022. [Internett]. Available: https://uis.brage.unit.no/uis-xmlui/bitstream/handle/11250/3045140/1-s2.0-S0040162522000403-main.pdf?sequence=1&isAllowed=y.
[120] W.-S. Kim, L. W.S og Y.-J. Kim, «A Review of the Applications of the Internet of Things (IoT) for Agricultural Automation,» 2020. [Internett]. Available: https://www.researchgate.net/publication/347182626_A_Review_of_the_Applications_of_the_Internet_of_Things_IoT_for_Agricultural_Automation.
[121] P. Sandner, J. Gross og R. Richter, «Convergence of Blockchain, IoT, and AI,» 2020. [Internett]. Available: https://www.frontiersin.org/articles/10.3389/fbloc.2020.522600/full.
[122] Ellen MacArthur Foundation, «Success in managing complexity: the role of the Internet of Things in creating a circular economy,» [Internett]. Available: https://ellenmacarthurfoundation.org/tech-enablers-series/part-3.
[123] H. Wilts, B. R. Ggracia, R. G. Garlito, L. S. Gómez og E. G. Pierto, «Artificial Intelligence in the Sorting of Municipal Waste as an Enabler of the Circular Economy,» 2021. [Internett]. Available: https://www.mdpi.com/2079-9276/10/4/28.
[124] Statista, «Green technology and sustainability market size worldwide from 2022 to 2030,» 2023. [Internett]. Available: https://www.statista.com/statistics/1319996/green-technology-and-sustainability-market-size-worldwide/.
[125] European parlament, «Artificial intelligence in the agri-food sector,» 2023. [Internett]. Available: https://www.europarl.europa.eu/RegData/etudes/STUD/2023/734711/EPRS_STU(2023)734711_EN.pdf.
[126] Autodesk, «Corporate info,» [Internett]. Available: https://www.autodesk.com/company/newsroom/corporate-info.
[127] Sculpteo, «Choose the best Autodesk software for your project in 2023,» [Internett]. Available: https://www.sculpteo.com/en/3d-learning-hub/3d-printing-software/best-autodesk-software/.
[128] Sculpteo, «3D CAD: Computer Aided Design,» [Internett]. Available: https://www.sculpteo.com/en/glossary/cad-definition-en/.

[129] Autodesk, «CAD software,» [Internett]. Available: https://www.autodesk.com/solutions/cad-software.
[130] Autodesk, «FY23 Impact Report,» 2023. [Internett]. Available: https://damassets.autodesk.net/content/dam/autodesk/www/pdfs/autodesk-fy2023-impact-report-rollout-final-160523.pdf.
[131] European Economic and Social Committee, «Circular economy strategies and roadmaps in Europe: Identifying synergies and the potential for cooperation and alliance building,» 2019. [Internett]. Available: https://www.eesc.europa.eu/sites/default/files/files/qe-01-19-425-en-n.pdf.
[132] World economic forum, «The circular economy: how it can lead us on a path to real change,» 2022. [Internett]. Available: https://www.weforum.org/agenda/2022/05/the-circular-economy-how-it-can-be-a-path-to-real-change/.
[133] European commission, «Farm to Fork strategy,» [Internett]. Available: https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en.
[134] European commission, «Farm to Fork Strategy,» 2020. [Internett]. Available: https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf.
[135] European commission, «Circular economy action plan,» [Internett]. Available: https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en.
[136] European commission, «Green Deal: New proposals to make sustainable products the norm and boost Europe's resource independence,» [Internett]. Available: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2013.
[137] European commission, «Ecodesign for Sustainable Products Regulation,» [Internett]. Available: https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en.

Team Solutions

The Solutions Investment Team is responsible for identifying solution companies, for use across Storebrand Asset Management, as well as for Solution funds: Storebrand Global Solutions, Storebrand Renewable Energy, Storebrand Smart Cities and Storebrand Equal Opportunities.

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SDG Target Icons: Global Goals, available at https://www.globalgoals.org/resources
SDG Icon grid: UN, available at https://www.un.org/sustainabledevelopment/news/communi-cations-material/