## STRATEGIC FORESIGHT BOARD REPORT VOLUME-1



We're proud to launch our first Strategic Foresight Board report, providing insights on current and future trends, diving into key drivers and barriers to the Circular Economy (CE) and disseminating the knowledge to the wider community.

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The 2023 Report's main focus areas are: Intelligent Decentralization, the Circunomic theory, and Artificial Intelligence.



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# MARK ESPOSITO

We are faced with a climate crisis that is triggering catastrophic environmental circumstances and leading to repercussions on a global level. This should be a wakeup call for all of us to realize the urgency to take immediate, serious and decisive action to fight climate change. Moreover, we need honest conversations about the climate, its mitigation, its changing nature, as well as the way towards climate neutrality.

Notwithstanding the urgency, we are moving at a fast pace towards climate volatility, with a competitive call to push us to better understand that the sooner we act collectively the better it will be for our shared resources.

COP 27 presented an opportunity to act collectively and globally, but the outcome was largely interpreted negatively by the public. They were hoping for more decisive action and expected a stronger leadership, ultimately realizing that the political dimension of the crisis outweighed the environmental one. Nonetheless, COP27 was an important milestone to advance the conversation on the climate crisis even if it was unsuccessful in mobilizing the political willingness to take action, which has led to disappointment.

The need for more concrete political direction and, more importantly, significantly greater efficacy in its implementation is required. The increasing demand to move away from linear systems is evident and therefore the concept of a Circular Economy (CE) needs to be advocated as a viable alternative to witness a real system transformation. **The Circular Economy as a concept is well developed and builds on decades of scientific research across natural capitalism, industrial ecology and efficiency of supply chains.** While the concept is comprehensive, it still lacks the integration of financial models, technological advancements and introduction into a more substantiated ecosystem of cross industrial alliances.

However, the lack of definition, concrete frameworks, methods, as well as motivation and communication efficiency regarding the concept of circularity is resulting in confusion and unnecessary challenges. It is essential to develop an educational concept with an inclusive and equal approach to provide guidance, facilitate the adoption of a new system and enable people to develop trust in the concept. At the same time, this requires rethinking our way of life, a transformation of our mindset and the evaluation of economic models from the stakeholder viewpoint instead of the financial viewpoint. **In addition, it is worth mentioning that value chains are the blueprints of organizations; the more we understand how to transform their business propositions, the sooner we will be able to transition towards a circular model.** 

Circularity is a megatrend on its own that can drive the fourth industrial revolution and enforce lasting system change, while harnessing the scientific knowledge and with the focus on three main pillars:

- Emerging trends supporting Intelligent Decentralization.
- Circunomic Theory A Blueprint for Environmental, Social, and Governance (ESG) Systems Design.
- Artificial Intelligence A driving force towards circularity.

Focusing on these three pillars and implementing them in a unified structure will enable a paradigm shift.

In conclusion, there is a need in the world to understand that a Circular Economy has an impact across multiple domains, which goes beyond just recycling.

At the Circular Economy Alliance we are fully equipped to take on the mission to promote and facilitate the transformation to a Circular Economy. We offer a range of programs such as certification and training that enable the upskilling of people from different industries.

The global situation is very dramatic at the moment; we witness the impact of climate change on a global scale, accompanied by extreme weather events. All this happens at an accelerated pace and raises questions regarding the future of our planet. We need to act decisively with regards to the climate in a way that is not just lip service, or just compliance but much more about rethinking our strategies to achieve prosperity without overstretching the boundaries of the planet. This is becoming very important now, more than ever before, because we are on the verge of what could be a total climate disaster. The Circular Economy is founded in collective action and considers how we will be able to mitigate the shortcomings of short- termism in favor of a long-term view of how our actions will shape the future. The Circular Economy will only be possible once everyone across the world acts collectively.

## PREFACE



#### **JOYCE HALLOUN** Business Solution Manager

The last three years have been marked by social, economic and environmental crises, which have become increasingly severe. On a daily basis we are faced with the climate crisis and its consequences, from biodiversity loss and pollution to the risks associated with resource extraction. In summary, it appears that life as we know it may no longer exist. In addition to the climate crisis, the emergence of turbulent events such as the Covid-19 pandemic, the energy crisis, the war in Ukraine, and all the associated challenges, are calling for collective global instead of unilateral national action.

At Circular Economy Alliance (CEA) we are taking on responsibility by putting together an inclusive approach that takes into account the EU green deal initiative and the Circular Economy (CE) Action plan agenda. Education and research are the foundation of our organization; we are driven by our belief that sharing knowledge and uniting together will allow us to achieve a successful transition and build a green, just and sustainable future for generations to come. We are dedicated and persistent in our purpose to empower the global workforce and nations worldwide with the essential, innovative tools and skills required to facilitate the change needed to accomplish our purpose-driven goal.

We are reaching out not only on at EU-level but on a global scale to raise awareness for the need to scale up our practices, the way we live and do things, and most importantly the requirements for a change in mindset and cultural adaptation. Therefore, we listened, and we are taking concrete action from various angles.

With the aim of accelerating the pace towards a Circular Economy, we managed to bring together a group of innovators and renowned thought leaders on matters related to sustainability, Environmental Social Governance (ESG), fourth industrial revolution, circularity, new technologies, green financing and more to provide and support everyone interested in being a change maker and achieving climate neutrality by 2050, equipping them with the new skillset and knowledge required to do so. Moreover, we are collaborating with distinguished key partners and prominent stakeholders with the same mission, vision and mindset to make Circular Economy the new reality.

Therefore, the Circular Economy Alliance strategic foresight board, is providing insights on the current developments and future trends, key drivers and barriers to the Circular Economy, provide strategic guidance to the leadership of Circular Economy Alliance, and develop and enhance strategic partnerships with international business, academic and policy communities. Overall, it will support CEA in achieving its mission of promoting research-driven skills development for all and its vision of advancing a just and inclusive transition to the Circular Economy.

We are honored to be releasing the first Circular Economy Alliance Strategic foresight board report in support of this transition, with the focus on three main pillars:

- Emerging trends supporting Intelligent Decentralization.
- Circunomic Theory A Blueprint for Environmental, Social, and Governance (ESG) Systems Design.
- Artificial Intelligence A driving force towards circularity.

We invested across those three major trends, based on the global challenges, their possible solutions and their environmental impact.

Finally, we present a call to action to assess the viability of the results, increase their impact and maximize the value cycle.

## WHO WE ARE

We are a knowledge-driven organization dedicated to paving the path forward towards a Circular Economy. We enable sustainability by building



upon a solid, data-driven foundation to bridge knowledge gaps. Our doors are always open to learners determined to improve their capabilities and drive change. We are proud of our accomplishments and vocal when sharing them. We are grateful to play a part in growing the Circular Economy Community and we are excited to see the future we build together.

#### **Our Mission**

Strengthen the global workforce by giving professionals and organizations the complete, accredited, reliable, actionable skills and knowledge they need to become change agents while deploying Circular Economy best practices.

#### **Our Values**

#### Responsibility

We hold ourselves responsible to take meaningful, truthful, and concrete action so ideas and plans are executed to generate real and effective change throughout the society. We are determined to generate lasting results that keeps echoing throughout the future.

#### Inclusivity

Circular Economy affects every level of society. We believe anyone interested should have unrestricted, unbiased, transparent and inclusive access to the skills and knowledge required to play an efficient role in the green transformation and building a sustainable future.

#### **Our Beliefs**

We believe education is a powerful key to unlock systemic change. Education can create a mindset transition from linearity to Circularity, creating new knowledge and practices at scale with boundless potential. We envision a new educational paradigm to help create a future where both people and the planet prosper. Nothing can be done or achieved without education, it is the key to open the door to transition, transformation and evolution. Upskilling and reskilling our practices is critical to achieving meaningful, impactful and successful progress on climate action and building a more sustainable future.

#### **Our Vision**

We want to live in a world that is peaceful, united, and in balance with the environment. Our vision depends a lot on learning from nature, getting people to change their habits and ways of thinking, and getting to a point where the Circular Economy isn't just a topic for scientific research and pilot projects but is used by all businesses to create green innovations.

#### Collaboration

We are continuously building collaborations and partnerships with stakeholders from diverse backgrounds because change needs to happen at both the individual and collective levels simultaneously. We facilitate dialogue between researchers, academics, and business leaders to achieve actionable practices with real world application.

#### Leadership

We lead by driving leaders to emerge. We thrive to inspire and motivate disruptive action towards sustainable change and achieving climate neutrality by 2050. The successful impact we are accomplishing indicates the bright path we are leading.

#### **Our Research**

Our research fills skills gaps to make Circular Economy principles practical and meaningful across global industries with the goal of adopting circularity in every sector of the world economy. As active leaders in a number of EU funded projects, CEA has earned the support of experts, practitioners, and front-line communities, creating interdisciplinary dialog with priority stakeholders.

LEARN MORE





## **STRATEGIC FORESIGHT BOARD**

The Strategic Foresight Board (SFB) will provide insights on the current developments and future trends, key drivers and barriers to the Circular Economy (CE), provide strategic guidance to the leadership of Circular Economy Alliance (CEA), and develop and enhance strategic partnerships with the international business, academic and policy community. Overall, it will support CEA in achieving its mission of promoting research-driven skills development for all and vision of advancing a just and inclusive transition to the Circular Economy.



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#### STRATEGIC FORESIGHT BOARD MEMBERS





**Dr. Mark Esposito** Strategic Foresight Board Chairman



**Amy Ryan** Strategic Foresight Board Vice-Chairwoman



Dr. Walter R Stahel Strategic Foresight Board Member



**Anne Babalola** Strategic Foresight Board Member



**Dr. Terence Tse** Strategic Foresight Board Member



Dr. Alessandro Lanteri Strategic Foresight Board Member



**Tze Ni Yeoh** Strategic Foresight Board Member



Manuel Maqueda Strategic Foresight Board Member



Henrik Homann Strategic Foresight Board Member



**Terry W Himes** Strategic Foresight Board Member



Catherine Weetman Strategic Foresight Board Member



**Dr. Juergen Schroeder** Strategic Foresight Board Member



Phanos Theophanous Strategic Foresight Board Member



## Circular Economy Megatrends





Emerging trends supporting Intelligent Decentralization



Circunomic Theory – A Blueprint for Environmental, Social, and Governance (ESG) Systems Design



Artificial Intelligence -A driving force towards circularity

## **Emerging trends supporting** Intelligent Decentralization







www.circulareconomyalliance.com

## MEMBERS INITIAL ANALYSIS





![](_page_9_Picture_3.jpeg)

#### 01. THE AIM OF WRITING THIS MEGATREND.

We want to highlight the importance of and crucial need for decentralized intelligence, the role it plays in reshaping everything including accelerating science and technology transformation, and how it improves overall resilience and efficiency. In addition, we explore how a Circular Economy can benefit from decentralized approaches.

![](_page_9_Picture_6.jpeg)

#### 02. THE PROBLEM HIGHLIGHTED IN THIS MEGATREND.

The drawbacks of centralized, mass-manufacturing with big production batches

and large-scale systems span economic, societal, technological, and political factors with negative implications on a global scale. We explore the need and urgency for new decentralized approaches that can offer benefits and create value in various ways.

![](_page_9_Picture_10.jpeg)

#### 03. THE ENVIRONMENTAL IMPACT OF THIS MEGATREND.

Intelligent decentralization offers a remarkable impact on the environment from various directions. It is able to reduce the impact of climate change on farmers, foresters, and other actors of the Bioeconomy as well as reducing the need to build and maintain expensive infrastructure such as airports and also improves self-sufficiency.

## INTRODUCTION

![](_page_10_Picture_1.jpeg)

Intelligent Decentralization solutions are technology-enabled, small-scale, locally relevant, and suitable for businesses, public services, individuals, and community groups. These solutions are responsive, improve overall resilience and efficiency, and reduce negative ecological impacts.

![](_page_10_Figure_3.jpeg)

Some examples of decentralization based on 'intelligent' technology are digital twins, 3D printing, platform technologies, robotics and Artificial Intelligence (AI), and machine learning. They enhance decision making, data processing, communication, and automation. Intelligent Decentralization solutions can be deployed by organizations and citizens and are becoming more common across a wide range of sectors include:

- Micro-factories and micro-resource recovery operations.
- Urban farming and community food systems.
- Platforms to facilitate sharing, swapping, and exchanging knowledge, information, objects (garments, vehicles, tools and toys), and resources.
- Networks to manage and distribute energy, resources, and information.

In contrast to large-scale centralized manufacturing, decentralized or networked operations are located close to the sources of demand, and set up to utilize local resources and labor. This improves flexibility and resilience, while reducing logistics costs and related Greenhouse Gas (GHG) emissions.

A Circular Economy profits from and promotes locally appropriate decentralized and networked approaches, such as agile, small-scale systems to:

- Produce food, fibers, bioplastics, and other biomaterials.
- Manufacture and customize products and infrastructure (e.g., 3D printing of houses and bridges in situ).
- Remarket, repair, refurbish, and remanufacture.
- Transform derelict objects and local waste streams into high-quality products.

#### **BACKGROUND** Globalization: The tide is turning

![](_page_11_Picture_1.jpeg)

The last three decades have seen widespread adoption of global supply chains, primarily to minimize productive labor costs. To benefit from this, many countries have chosen to specialize in the supply of cheap virgin resources, mass-manufacturing of key products or components, or low-cost/low-wage production. This results in long, complex, and multi-tiered supply chains, which on the one hand enable low production costs, but on the other hand compromise resilience, responsiveness, and flexibility.

Existing manufacturing systems were designed to operate with acceptable reliability, in what the Nobel Prize-winning physicist Hannes Alfven calls a "technological paradise," where "no acts of God can be permitted" and everything happens according to existing blueprints (Lovins and Lovins, 1982). Economies of scale, therefore, imply dis-economies of risks and lack of resilience in global supply chains - decentralization can reduce those risks .

The downsides of centralized, mass-manufacturing with big production batches is becoming clearer. For example, long-distance supply chains make it difficult to accurately forecast demand. The lack of reliable forecasts requires more safety and cycle stock, leading to obsolete inventory that may then be sold off cheaply, or eventually wasted. Materials and components are transported across continents to take advantage of the lowest-cost sources, increasing the transportation footprint. Emissions from logistic activities account for around 13% of the global GHG emissions (Ritchie, 2020). With companies committing to Net Zero strategies, and inflation impacting energy , logistics, and labor costs, these centralized models are becoming harder to justify. In contrast, Intelligent Decentralization allows the adaptation of product specifications to use resources which are locally and reliably available, while serving the trends for customization and made-to-order products.

In food production and agriculture, diversity and resilience are seen as critical to address the challenges posed by climate change and to regenerate healthy ecosystems. Centralized food supply chains favor large-scale producers, and lead to high levels of food waste (a major source of GHG emissions). There is growing recognition that more diverse crops are required to reduce the risk of climate-related harvest failures. In contrast to large-scale farms, decentralized family farms are more likely to focus on maintaining soil fertility and on supporting biodiversity. Small-scale farms already grow 50% of our food calories on 30% of the agricultural land (Samberg et al., 2016). With equal access to resources, smaller farms tend to be more productive per hectare than much larger farms and are more likely to grow a wider variety of crops, contributing to agro-biodiversity and improving resilience (Houngbo, 2020).

![](_page_12_Picture_0.jpeg)

## value creation

![](_page_12_Picture_2.jpeg)

The Institute for the Future predicts a shift away from an era where companies are the main creators of value, 'Increasingly, individuals, communities, digital communities, and (possibly quite soon) autonomous digital agents are becoming empowered to create value outside traditional networks' (IFTF and GEMI, 2019). The Institute for the Future envisions these actors organizing and operating in a variety of ways to 'bring a spectrum of motivations to their work beyond simple financial gain.' It foresees a 'new spectrum of value creation, driven by distributed network technologies such as blockchain' and enabled 'by emerging technologies for the production of necessary goods (mesh networks, solar arrays, AI-powered food production, 3D printing, synthetic biology) and by communities motivated to take control of their own infrastructure and production of products and services.'

Climate change and threats to social cohesion are highlighting the importance of resilience across societies. As inequality - both real and perceived - increases around the world, we are observing a critical attitude towards globalization. A growing number of people question the promises of globalization, as it appears that the elites are the main beneficiaries. People are becoming angry, which has fueled populism and mistrust in the establishment.

In addition, people are becoming increasingly interested in 'what is behind the label', with questions such as who made my food or clothes, where was it produced and were the workers paid a fair wage. As governments are enforcing more comprehensive environmental and reporting standards, transparency becomes a priority for companies. Local sourcing and production sites make transparency easier, helping companies gain confidence about the ethics, the production methods, and the environmental standards of their supply factories.

## Reshaping everything – accelerating science and technology transformations

Existing manufacturing concepts focused on cheapest labor costs whilst transportation was relatively cheaper due to fuel subsidies and externalization of environmental impacts. However, the use of robots in manufacturing processes has changed this business model and the main factors of cost and uncertainty now stem from transportation. As a result, decentralized manufacturing is becoming the new normal.

Research from McKinsey predicts that in the 2020s, industrialized economies will experience more progress than in the past 100 years combined, as technology is reshaping health and material sciences, energy, transportation, and a wide range of other industries and domains (McKinsey, 2021). Major advancements in computational speed combined with technology convergences, major breakthroughs in health and material science, and groundbreaking product and service capabilities, result in significant opportunities and challenges for businesses and governments. The report highlights seven cross-industry trends, likely to disrupt company strategy, operations, and organization, including networked infrastructure (with cloud and edge computing), 'next-level process automation', faster connectivity, next-generation computing, applied Artificial Intelligence (AI), Software 2.0 enabled by neural networks, and trust architecture developments.

Some of the new technologies offer deeper support for decentralized approaches; for example, the inherent characteristics of Web3 include:

- Openness applications are open-source and transparent for everyone
- Trustless trust as a basis of interaction between different parties is unnecessary
- Permissionless anybody can access and utilize Web3 without authorization.

#### **ADVANTAGES** of Intelligent Decentralization

![](_page_13_Picture_1.jpeg)

It has become apparent that centralized, large-scale systems result in negative economic, societal, technological and political impact. In contrast, developments in intelligent technologies have highlighted the benefits of utilizing decentralized and networked approaches. With these approaches local operations are more agile and resilient. Supply chain disruptions can be catastrophic - and are increasingly perceived as a significant risk in every sector. Trade sanctions, the Suez Canal blockage in 2021, pandemic lockdowns, and energy shortages have halted production for many companies. Financial experts warn that the trend of globalization is coming to an end, driven by resource pressures, climate and biodiversity challenges, social inequality, and a changing world order. Companies and governments are reviewing their dependencies on other nations and are instead looking to onshore or 'nearshore' operations (Marks, 2022; Fink, 2022).

Decentralized approaches also create meaningful local jobs, helping to upskill and reskill the workforce. Declining industries have a negative impact on local economies, and the creation of new jobs is critical to enable a just transition to a low-carbon, regenerative economy, based on reuse instead of resource extraction. Micro-factories are established at an increasing rate, producing everyday objects and 'new generation' materials, such as:

- Open desk, a global platform for local furniture-making, allowing designers, makers, and customers to transact to create products on demand using open-sourced designs.
- Ginkgo Bioworks micro-factories design organisms capable of producing cultured ingredients for use in agricultural processing and food ingredient industries.

Micro processing plants innovations allow local waste materials to be recovered and transformed into useful resources, rather than exporting recyclable resources overseas:

- Bio-refineries create value-added products and biofuels from local agriculture and food waste.
- The Upcycle Centrum in the Netherlands supports startups that create new high value products from local waste.
- Nth Cycle, a metal processing company, has developed customizable and clean electro-extraction technology to enable local supplies of critical metals for the renewable energy transition (O'Connor and Weetman, 2021).
- Micro processing plants innovations allow local waste materials to be recovered and transformed into useful resources, rather than exporting recyclable resources overseas.

Urban farms, including indoor hydroponic systems with LED lighting and smart climate control powered by renewable energy, can provide nutritious salads and herbs with low food-miles and less food waste from damage in transit, and feature in the Circular Economy Strategy of Amsterdam (Amsterdam, 2022).

Platform technology shares the availability of unused food stocks. OLIO describes itself as the #1 sharing app, connecting neighbors with each other and with local businesses so that surplus food can be shared, not thrown away. France was a pioneer in legislation that mandates that shops and distributers give away any food produce nearing its sell-by date to charity. However, it is worth noting that platform technologies can lead to monopolies, with 'offshoring' of profits, worker exploitation and other issues.

![](_page_14_Picture_0.jpeg)

**Intelligent Decentralization** helps create resilient local bio-economies and improve the security of food, water and other bio-resources, through improved water retention of soil, reforestation, drip irrigation methods, salt-tolerant and drought-resistant plants. The circularity inherent in nature is enhanced by creating bio-economies of regenerative agriculture and increased biodiversity, preferring local natural materials such as timber for buildings and heating, bringing together local needs and resources. Networks like Fibershed connect local farmers, processors, and producers to create local bioeconomies for natural textiles.

Peer-to-peer exchange and sharing networks provide affordable, easy to access equipment, tools and transportation and thereby reduce excess consumption and wastage. Libraries of Things and Tool Libraries are expanding. They offer a wide range of items such as DIY tools, entertainment equipment, sports gear, arts and crafts, and more. There is a rise in the use of local sharing platforms, such as mobile tool library The Share Shed in the UK; Co Cars - a UK social enterprise club renting low emission and electric cars and bikes (Co Cars, 2022); Hiyacar – renting of affordable cars from trusted local owners in your community (Hiyacar, 2022); Fairbnb, a cooperative that reinvests in communities, connecting 'conscious travelers with fair hosts to promote stronger, more sustainable and equitable communities all around the world (Fairbnb, 2022). Business-to-business exchange platforms, like Rheaply, FLOOW2 and Globechain, help connect those who have underused resources and those who need them. Their 'translation dictionaries', help match everything from unused facilities, assets, equipment, vehicles, people, and consumables.

Local solutions for local people have the potential to reduce waste and logistics footprints. Technology enablers facilitate connections between everything and everyone, providing opportunities for community-scale services, including micro-breweries, micro-bakeries, micro-credit, micro-insurance, and micro-factories. Tree nurseries in many regions offer rental plants to businesses and individuals, including 'Rent-a-Christmas tree'. In many European villages normal size books exchanges based on the principle of 'bring a book, take a book' exist, overseen by volunteers.

Community resilience, jobs and value also result from local renewable energy, including solar photovoltaic, wind, marine, micro-hydroelectricity and other innovative sources of low-carbon energy (all with the potential to produce green hydrogen), in addition to geothermal, solar warm water, waste-to-biogas, and rural 'organic' wastewater treatment plants.

For intelligent decentralization to succeed it is necessary for political powers to devolve to better address local and regional barriers to regenerative practices (e.g., taxing consumption of non-renewable resources, instead of labor) and rethinking legal structures (Intellectual Property Rights versus ethical franchising).

However, decentralization does not guarantee fair, ethical and democratic business practices. Whilst emerging technologies for decentralized knowledge, such as Web3 (Stackpole, 2022), decentralized currency, and decentralized governance are important enablers of intelligent decentralization, major actors of the Internet of Things and platform economy tend to decentralize costs and responsibility to workers but centralize profits (Stehr, 2022). In addition, the 'gig' economy that often forms the foundation of these platform businesses aims to remove many of the legal protections associated with being an employee (Beutler, 2022).

## CONCLUSION

Supporting the circularity of nature in a bioeconomy helps everyone: citizens, organizations, governments - and future generations. Intelligent decentralization can reduce the impact of climate change on farmers, foresters, and other actors of the bioeconomy, reducing the likelihood of water shortages and floods by tackling global issues through local mitigation and regeneration measures. These measures also help insurers and investors, by reducing the impact of natural hazards (extreme heat, wind, water, volcanic events) and protecting natural, cultural, human, and manufactured assets. Local resilience also benefits the owner-operators of essential infrastructure, including health systems and transport.

Improved resilience: legislation and policies can take advantage of local and regional human, cultural, natural resources and stocks of infrastructure, buildings, and manufactured objects. Decentralization and localization reduce the need to build and maintain expensive infrastructure including ports, airports and major highways, freeing up capital to regenerate nature and communities.

Societies can benefit from reduced infrastructure investment and maintenance costs, with less land needed for production and long-distance logistics (e.g., container ports, warehouses). Less need for mining activities, lower resource consumption, and reduced waste and pollution reduces environmental damage and the associated costs of mitigation and remediation. Local communities can benefit through jobcreation and more diverse economies. There is also a growing potential to establish exchanges of unwanted materials and underused resources (facilities, equipment, and even people).

For companies, the key message is "what got us here, will not get us there": those dependent on mass-production and centralized supply chains are likely to discover that they are less agile and resilient compared to their decentralized competitors, and more at risk to experience 'black swan' events. They also risk competing for in-demand resources from opaque and unreliable overseas sources, while struggling to meet the demands for zero-carbon, transparency and fair practices on trade, labor and taxes. Resisting change, failing to adapt to the 'new localism' and decentralized approaches risks stranding assets, including skill bases, technology and capital.

Intelligent Decentralization improves self- sufficiency by helping to keep valuable resources in the loop, available for local reuse. Agile organizations including startups, makers, artisans and small businesses who take advantage of new technologies to meet local needs will benefit.

How could the benefits of Intelligent Decentralization be amplified? Firstly, the role of governments and policy makers in encouraging Intelligent Decentralization solutions is crucial to accelerate preventive measures to reduce carbon emissions. minimize pollution of air, water, and land and to stop subsidizing consumption of nonrenewable resources. Secondly, businesses and public sector organizations may benefit from implementing Intelligent Decentralization solutions. Understanding the context of each business model, sector and customer base is of strategic significance. To succeed, organizations must assess the associated risks, such as climate, resources, biodiversity loss, supply chains, and understand how Intelligent Decentralization could improve their resource security, agility and resilience. In addition, organizations may consider how to localize their offering, to reduce their production footprint and improve their relevance. Lastly, citizens can actively participate in promoting an Intelligent Decentralization in their local economy, helping create vibrant, healthy, thriving places to live, work and invest.

![](_page_15_Picture_8.jpeg)

## Messages from the members

![](_page_16_Picture_1.jpeg)

![](_page_16_Picture_2.jpeg)

Dr. Walter R Stahel Strategic Foresight Board Member

A shift to a circular industrial economy means a disruptive change. It needs new business models and different policymakers' approach, based on new framework conditions including sustainable taxation.

![](_page_16_Picture_5.jpeg)

**Catherine Weetman** 

Strategic Foresight Board Member

We are all part of an interdependent network – people, organizations, and nature. We need system-scale changes to create a world fit for all of us, and that means working together for the common good.

![](_page_16_Picture_9.jpeg)

Anne Babalola Strategic Foresight Board Member

Circular Economy requires a systemic shift in the production -consumption value chain and consumer behavior. We must the linear reshape production cycle of take- make- dispose sustainable into а cycle.

![](_page_16_Picture_12.jpeg)

Manuel Maqueda

Strategic Foresight Board Member

A Circular Economy must embrace the radical collaboration model that underpins all living systems. Only a concerted effort can create cycles of value for all -where nothing is extracted nor wasted.

![](_page_16_Picture_16.jpeg)

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![](_page_18_Picture_0.jpeg)

Circunomic Theory – A Blueprint for Environmental, Social, and Governance (ESG) Systems Design

![](_page_18_Picture_2.jpeg)

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## MEMBERS INITIAL ANALYSIS

![](_page_19_Picture_1.jpeg)

![](_page_19_Picture_2.jpeg)

![](_page_19_Picture_3.jpeg)

![](_page_19_Picture_4.jpeg)

"Theory without practice is **Empty; Practice without** Theory is Blind; The Inherent Inseparability of Doctrine and Skills" ~ Harold Anthony Lloyd. Exploring the fundamentals of the Circular Economy and ESG (Environmental Social Governance), commonalities and divergence, in addition to the challenges that should be overcome to enable the transition to a Circular Economy is a megatrend of the future.

![](_page_19_Picture_6.jpeg)

IN THIS MEGATREND.

We consider the complex relationship between ESG and Circular Economy, lack of common definition for both, and the urgency to move from nascent to mainstream. The climate change emergency is prompting us to find and implement tangible solutions within a well-defined framework, that considers how we can accelerate our actions to achieve the green transformation while taking into account that the window of opportunity for change is closing.

![](_page_19_Picture_8.jpeg)

#### 03. THE ENVIRONMENTAL IMPACT OF THIS MEGATREND.

With the Circunomic Theory – A Blueprint for Environmental, Social, and Governance (ESG) Systems we promote a mindset and systemic transformation that can lead us away from linear systems with the aim to achieve circularity. By inspiring consumers, companies, producers and buyers we redefine and rethink supply chains, resulting in a direct impact on the environment.

## INTRODUCTION

![](_page_20_Picture_1.jpeg)

The Circular Economy (CE) is an economic model based on environmental, social, and governance (ESG) principles to deliver regenerative solutions and influence behaviors throughout the value chain. The economic benefits of a Circular Economy are largely dependent on the overall merit and success of the ESG practice or the circular concept integration.

![](_page_20_Figure_3.jpeg)

The waves model shows the disruption phases Release, Reorganization and Eruption during the shift/transition from the old to the new paradigm Source: The 'need for speed': Towards circular disruption—What it is, how to make it happen and how to know it's happening - Blomsma - Business Strategy and the Environment - Wiley Online Library

Since its inception, receptivity for CE has increased steadily and it is even considered a potential economic solution. As the concept of CE continues to evolve, yet to reach megatrend status, the study of circunomics provides a theoretical foundation of ESG and offers suggestions for the most successful combination of various factors.

The set of factors that influence a circular system and its overall operation at any given moment in time, may not appear entirely logical nor well understood. It is an inherently complex dynamic system that cannot be represented by a single data point. Instead, the Circular Economy is an ecosystem influenced by a set of influencing factors that constantly regenerate and evolve over time.

If an economy continues to transition under the governance of historical rules, whose influence may no longer apply in the age of technology, future growth can be threatened. The resiliency of an economic system subjected to disruptive momentum, with either negative or positive trends, is indicative of the capacity of the system to absorb and retain its momentum of circularity.

The value of a Circular Economy is that it facilitates societal transformation through the implementation of environmental, social, and governance systems that create value through regeneration. Moreover, the introduction of a Circular Economy on a systemic level needs to address the core model of production. The impact of a Circular Economy on the cultural construct of society defines the point of transformation. This impact on established mindsets can now be determined through the reinforcement and integration of a holistic circular model rather than focusing on a narrow field. It can indicate whether an economy can absorb the negative or positive circular behaviors or whether the system collapses under its own rigidity. The ESG factor provides an understanding on the ranges of performance within an unbounded system to achieve of a common goal, such as climate change mitigation and impact reduction. The ESG principles are a broad concept that when being considered for implementation, the rate of transformational outcome will be important and can offer the global market data points highlighting an inflection point of behavior.

## BACKGROUND

![](_page_21_Picture_1.jpeg)

In 2022, the United Kingdom recorded its hottest day ever, breaking meteorological records across the country. Climate change is literally becoming a hot issue that can no longer be denied. The Conference of Parties (COP) meet annually to discuss and debate climate policy; yet its overall effectiveness is become questionable. Recently, an NGO and active participant of the COP was asked, "What is the point of working on COP28 goals when agreements made at COP-26 have yet to be completed?" Climate change cannot be solved by individuals, who struggle to comprehend the drastic impact to the environment. For instance, for some, it has been a challenging task to sacrifice their personal convenience by walking or using public transport instead of using a car. As energy prices have increased significantly, people still leave the lights on, even when not needed. The socioeconomic classes tend to dictate what type of implementation and incentive is available to modify behavior.

As mentioned previously, the popularity of ESG does not enable sustainable change, as its concept offers little guidance for a company to improve their operation in a circular or process-enhancing manner. Concepts linking ESG and Circular Economy principles can offer clarification.

In fact, the Circular Economy is not a new phenomenon. The intense consumption of natural resources has lead to depletion and increased pollution since the beginning of the industrial revolution. Before the industrial revolution, resource cycles were more closed loop and models such as re-using, and re-manufacturing were more common and widespread. Today, we have the modern means to re-introduce this Circular Economy while maintaining a high standard of living. For example, digital intelligence can be applied to innovations such as passports for materials to increase their tracking, reuse, and recirculation at the end of a a product life span. The adoption of advanced logistics could accelerate the shift towards product-as-a-service models, thus reducing incentives for single-use packaging and increasing incentives for design-for-durability and design-for-recyclability. Ultimately, this minimizes waste and creates more value for the consumers.

The challenge that remains is performance measurement. Additionally, regulations require drafting, implementation and enforcement of their compliance. The standardization of circular economic practices is needed to monitor, evaluate and scale. The requirements for internationally agreed upon principles, terminology, a framework of a Circular Economy, and the development of a management system and standard will enable the acceleration of the transition and maximize the efforts towards achieving the Sustainable Development Goals (SDGs) and in parallel would introduce specific methods for measuring and assessing circularity (ISO, 2018).

Moreover, the impact of the Circular Economy on jobs and the labor market is highly significant and requires readiness. There is a need for upskilling and reskilling of the global workforce to equip them with the know-how, tools and practices to enable circular business models locally. Jobs will be lost to automation, but many others will be created, and therefore an emphasis on education and the knowledge transfer of new approaches and methods is required to accomplish an efficient transformation.

![](_page_22_Picture_0.jpeg)

# Transformational versus incremental

The concept of ESG is attracting attention and is apparent that ESG concepts are more popular than the circularity concept itself. Nonetheless, the concept of circularity is essential to the ESG framework. The dominance combined with its vagueness makes it difficult to implement and achieve the intended outcome. ESG is not as prescriptive as Circular Economy when it comes to developing action items. On the one hand, the lack of concrete definitions helped make ESG an easy metric to achieve, often turning into lip service or a public relations exercise. On the other hand, the broadness of ESG makes it challenging to achieve certain transformational goals and yet, the concept of a Circular Economy specifically directs in creating a better future for the world. In summary, it may be the wrong approach to solely focus on ESG. The term "economy" and its influence on modern society serves as the primary regulator for decision-making. Is the "economy" solely based upon on the outcome of one decision? Do the influencing factors evolve over time? The influences and outcomes of decisions are intractely woven throughout the global economy. In order to influence the inertia of the economy, we must build upon the experience of past governance.

The principles of Circular Economy offer a fundamental change by encouraging value creation throughout the supply chain and focusing on the regeneration of ecosystems. The Circular Economy calls for the re-thinking on how goods and services are delivered, the shift from a linear economic "make-use-dispose" model to a "closed-loop" model. The circular model is decoupled from a business model of intense resource consumption and is instead one of reuse, repair, remanufacture, and recycle. Yet, this model remains bound by societal and cultural rules and barriers. Environmental Social Governance systems exhibit a versatility to utilize and balance an unbounded system to achieve a common goal – mitigation and reduction of climate change

![](_page_23_Picture_0.jpeg)

#### Circular Economy in practice

The value Circular Economy offers is a transformation of the cultural construct of society, potentially resulting in a new system. This mutually reinforcing mechanism is a way to consider how the integration of a stakeholder model, versus a narrower model. contributes to this mindset. Additionally, much more interaction can be expected within the diverse supply chain within a Circular considering Economy. when the horizontal distribution of multiple value chains, and the impact circularity has on each of them. The assessment of the effectiveness of ESG should not be limited to a definition, but also consider its impact and adoption.

Manv companies have expressed interest in circularity, the challenge, however, is the resource-intensive implementation. Although some companies have been exposed the concepts of ESG, it is unknown to many. The somewhat vague idea of ESG can distract from the principles of Circular Economy, but also promote sustainable thinking through an initiative such as banning plastic bottles on company property. Companies need to learn about the Circular Economy and also increase their awareness regarding their own sustainability claims.

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![](_page_24_Picture_0.jpeg)

### CONCLUSION

The consequence of failing to take concrete action against climate change is not equally distributed across society. While some may afford to isolate from climatic challenges (lack of access to air conditioning, working outside in the heat, increase in food cost and deteriorating quality) there are others who cannot avoid the impact, like consumers, companies, producers, or buvers. As mentioned previously, economic incentives mav motivate certain actors to behave in a more sustainable manner, but those actions are insufficient. A true return on investment from a Circular Economy or ESG initiative should be based upon several objectives and criteria and not only consider financial objectives. Instead, the focus should be on the outcomes and the development of evaluation criteria is required.

Short-term economic impacts on companies will be the cost required to transition and to the resulting impact on a broad range of stakeholders, that include operations, Boards of Directors, consumer price and pricing mechanisms, the entire supply chain actors as well as the inflationary trends that emerge as a result.

We are observing a new beginning of circunomics which additionally acts as a major influence on our collective and individual decision making in modern societv. Is our modern definition of "economy" still based on the outcomes of such decisions? Will there ever be a time when such decisions, as well as their economic, environmental and societal consequences change? The causes and consequences of the current global economic structure led to the belief that economic change still requires knowledge founded in the past. A Circular Economy, on the other hand, is unlimited in its scope and range of influence. However, it remains bound by cultural and societal norms and barriers more so than by tangible rules and regulations. Environmental Social Governance systems exhibit a versatility to create and balance an unbounded system to achieve a common goal - mitigation and reduction of impact.

While ESG offers limited concrete action, it is likely to be adopted within the vernacular society, as are the regenerative of ecosystems of Circular Economy. ESG meets the challenges of implementing circularity, such as the difficulty of adopting shifting certain practices. consumer preferences, changing the regulatory environment, and growing support for entrepreneurship. These challenges need to be addressed to facilitate the successful implementation of a Circular Economy in the future.

## Messages from the members

![](_page_25_Picture_1.jpeg)

![](_page_25_Picture_2.jpeg)

DR. MARK ESPOSITO

Strategic Foresight Board Chairman

Acting on the Circular Economy requires stakeholders to think how a pluralistic society is engaged to rethink value and its distribution in society.

![](_page_25_Picture_6.jpeg)

AMY L. RYAN

Strategic Foresight Board Vice-Chairwoman

Self-guided actions expose linear mindsets whose decisions threaten future generations. The entire globe, simultaneously affected by an event, underscores our shared vulnerabilities and strengths.

![](_page_25_Picture_10.jpeg)

DR. TERENCE TSE Strategic Foresight Board Member

Climate change is a problem for everyone. As we could see from our collective effort to combat Covid, we must show the same determination and urgency to turn Circular Economy into reality.

![](_page_25_Picture_13.jpeg)

**TZE NI YEOH** Strategic Foresight Board Member

Collective, inclusive empowerment is key to our efforts to foster systemic change. Collective action widens our scope for solutions and results yet accommodates for diverse and localized context.

![](_page_25_Picture_16.jpeg)

#### **Circunomic Theory** – A Blueprint for Environmental, Social, and Governance (ESG) Systems Design

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![](_page_26_Picture_23.jpeg)

## Artificial Intelligence -A driving force towards circularity

![](_page_27_Picture_1.jpeg)

![](_page_27_Picture_2.jpeg)

![](_page_27_Picture_3.jpeg)

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## MEMBERS INITIAL ANALYSIS

![](_page_28_Picture_1.jpeg)

![](_page_28_Picture_2.jpeg)

#### 01. THE AIM OF WRITING THIS MEGATREND.

![](_page_28_Picture_4.jpeg)

We want to highlight how Al can provide new opportunities when applied to the Circular Economy, ranging from the design of circular products, components, and materials to the operation of circular business models and the optimization of infrastructure to ensure circular flows of products and materials. Moreover, we explore the challenges associated with AI as well as its implications on the labour market.

#### 02. THE PROBLEM HIGHLIGHTED IN THIS MEGATREND.

![](_page_28_Picture_7.jpeg)

Regardless of the numerous positive impacts of Al, and its endless possibilities to contribute to the acceleration of the transition to a Circular Economy, there are significant concerns associated with the rapid growth of Al technologies, its environmental pollution and more specifically its considerable carbon emission levels.

#### 03. THE ENVIRONMENTAL IMPACT OF THIS MEGATREND.

![](_page_28_Picture_10.jpeg)

Al has the potential to disrupt every aspect of all industries, the way people live and work, and change the distribution of jobs between different sectors. It can enable a more efficient and sustainable management of resources, the interpretation of complex environmental data and information, and provide a platform for disseminating sustainability knowledge.

## INTRODUCTION

CIRCULAR ECONOMY

Artificial Intelligence (AI) is an overarching term for technologies with the ability to perform tasks that would otherwise require some form of human intelligence. Machine learning (ML), one discipline of AI, allows machines to autonomously perform tasks, that are commonly carried out by humans, by learning from experience and adjusting to new inputs. In addition, AI enables machines to make decisions using algorithms that either follow rules and/or utilizing machine learning through iterative processing and reviewing of large quantities of data to identify and replicate patterns.

In addition to the existing applications of artificial intelligence in personal and economic areas, further developments in AI technologies enable significant impact across a wide range of applications in various industries, such as medical science and healthcare, education, food production and distribution, efficient public and private transportation, and ultimately in tackling climate change. If applied properly, AI could be transformative and help accelerate the move towards a fairer and more efficient Circular Economy.

![](_page_29_Figure_4.jpeg)

Diagram source: Ghoreishi, M., & Happonen, A. (2020). New promises AI brings into Circular Economy accelerated product design: a review on supporting literature. E3S Web of Conferences.

![](_page_30_Picture_0.jpeg)

![](_page_30_Picture_1.jpeg)

The Ellen MacArthur Foundation (2019) noted that Artificial Intelligence has the potential to be an enabler and an accelerator in the transition to a Circular Economy. The study identified that Artificial Intelligence technologies can be applied to three key aspects of a Circular Economy: design of circular products, components, and materials; the operation of circular business models; and the optimization of infrastructure to ensure circular flows of products and materials.

#### 1. Design of circular products, components, and materials:

Al can enhance and accelerate the development of new products, components, and materials suitable for a Circular Economy through iterative machine-learning-assisted design processes that allow for rapid prototyping and testing.

#### 2. Operate circular business models:

Al can increase the competitive strength of circular business models, such as product-as-a-service and leasing. By combining real-time and historical data from products and users, Al can help to increase product circulation and asset utilization through pricing and demand predictions, predictive maintenance, and smart inventory management.

#### 3. Optimise circular infrastructure:

Al can be incorporated when building and improving the reverse logistics infrastructure which is required to 'close the loop' on products and materials by supporting the processes to sort and disassemble products, remanufacture components, and recycle materials.

Despite the positive contributions to the implementation of a Circular Economy, there are environmental, ethical, safety, and societal risks associated with the rapid growth of AI technologies. For example, for AI to work fairly and efficiently, issues around bias, discrimination, privacy, autonomy, regulation, risk management, and human oversight need to be addressed (Rodrigues, 2020).

Another key aspect that has to be considered is the contribution of AI to environmental pollution. On the one hand, AI has contributed positively to reduce carbon emissions such as through designs to lower the utilization of carbon manufacturing methods, in 'smart' power grids, and in more efficient infrastructure. On the other hand, AI is also a carbon emitter because it requires significant computing power. There are concerns that as machine learning models are using and storing more and more data, they are generating significant carbon emissions and incur substantial electricity costs in the process (Dhar, 2020). The carbon impact of the infrastructure required for the development and deployment of AI and the associated algorithm design needs to be quantified and considered as so far the discussions around AI have primarily focused on its economic potential instead of prioritizing the environmental responsibility of its carbon emissions.

## BACKGROUND

CIRCULAR ECONOMY

"**Artificial Intelligence** is the New Electricity" and "Just as electricity transformed industry after industry 100 years ago, I think AI will now do the same" are just some of the quotes of Andrew Ng, the VP and Chief Scientist of Baidu (Pagambam, 2018).

The wide-ranging potential of AI includes accelerated connectivity, data collection, processing, and analysis while making informed decisions and developing targeted measures autonomously (McKinsey, 2019). These features present an opportunity for a fundamental shift in how operations and processes are conducted, and decisions are made in practically every industry and aspect of our lives. The range of applications that are affected by AI continues to expand because of technological developments in natural language processing, machine learning, and image recognition. As the capacity and range of AI applications progresses and develops, it has the potential to disrupt every industry as well as the way people live and work. For a Circular Economy, Artificial Intelligence has the potential to drive innovations that will enable a systemic shift. This presents opportunities to develop a large number of strategies for reworking and reusing resources with minimal human interference.

Al applied in the context of a Circular Economy also enables more efficient and sustainable management of resources. Specifically, the collation, analysis, and interpretation of complex environmental data and information to enhance the understanding of environmental issues and to prioritize the necessary actions (Botterill, 2018). Al applications also provide a platform for propagating sustainability knowledge, enabling behavioral changes that benefit the planet on all levels.

In their study, the MacArthur Foundation and McKinsey use the example of two value chains, food and agriculture and consumer electronics, to illustrate the range of potential applications of AI across sectors (The Ellen MacArthur Foundation, 2018; McKinsey, 2019). These examples, one centered on biological materials and the other on technological materials, illustrate the potential of AI to increase the circularity in a broad range of economic areas.

Another example of the practical benefits of AI in advancing issues related to Circular Economy is the use of AI by Google in optimizing its temperature-sensitive data centres. In 2016, a subdivision of DeepMind (the AI subsidiary of Google) developed an Artificial Intelligence approach to optimize the cooling of these data centres. Although the cooling had already been optimized by engineers, the AI algorithm developed by DeepMind was able to further optimize the cooling and therefore reduce energy expenditures by an additional 40 percent – a substantial improvement compared to human performance (Kissinger, Schmidt and Huftenlocher, 2021).

These examples illustrate the benefits of AI across three separate industries, demonstrating that the opportunities for AI to contribute and add value to a Circular Economy are not industry specific. Combining the power of AI with a vision for Circular Economy presents a significant, and a largely unused opportunity, to harness one of the greatest technological developments of our time to support efforts to fundamentally reshape the economy into one that is regenerative, resilient, and sustainable.

Creating a broader awareness and understanding of how AI can be used to support a Circular Economy is essential in encouraging applications which exceed the areas of circular design, operating circular business models, and optimizing circular infrastructure. Ultimately, AI has the potential to be applied to the complex task of redesigning whole networks and systems, such as redesigning supply chains and optimizing global reverse logistics infrastructure, in any sector.

## **UTILIZATION OF AI** in a Circular Economy

The Ellen MacArthur Foundation (2019) and McKinsey (2018) estimate the global economic opportunity AI could bring by 2030 at \$13 trillion. The potential impact AI could have when applied in a Circular Economy is thought to be substantial, but remains largely unused, however. The Ellen MacArthur Foundation (2019) suggests some areas for consideration to harness this potential; mainly, understanding where the opportunities are for different stakeholders and establishing the conditions to realize them effectively.

The study explores relevant opportunities in the fields of food and agriculture and consumer electronics, employing case studies and potential use cases (The Ellen MacArthur Foundation, 2019). Stakeholders are able to explore relevant opportunities for Circular Economy applications of Al, based on a comprehensive understanding of the capabilities of Al, as well as an appreciation of how Circular E conomy principles could be applied to their area of interest or industry. In addition, AI has the potential to create opportunities to promote a Circular Economy within the food and agricultural sector. Eliminating food waste involves reducing avoidable food waste, preventing edible food from being thrown away, and valorising unavoidable food waste and by-products. Globally, more food is grown than is required to feed the world, but up to one-third of all food is spoiled or wasted before it is consumed by people. In 2011, food losses and waste amounted up to a third of the entire produced food, which is equivalent to \$1 trillion (FAO, 2011).

#### Food waste occurs at three stages:

during production and processing; during distribution and storage; and during preparation and consumption. Preventing food waste at each level relies not only on solutions technological and better alignment in the supply chain but also relies on changes in human behavior and purchasing patterns. It is worth noting that in emerging economies, 40% of loss occurs post-harvest and at the processing stage while in industrialized economies more than 40% of loss occurs at the retail and consumer stages. Therefore, the use of AI solutions to reduce production and processing waste depends to a large extent on access to relevant technology and infrastructure in emerging economies.

![](_page_32_Picture_6.jpeg)

![](_page_33_Picture_0.jpeg)

Al-enabled precision farming techniques can help reduce waste in agriculture and food production, and there is also potential for AI to be used in reducing food waste during processing (Javaid et al., 2022). Once packed and shipped, fresh food is evaluated multiple times for regulatory and sometimes company specific requirements including quality, safety, size and appearance before reaching the retail and food service operations. Quality managers inspect batches of products according to guidelines and processes documented in lengthy handbooks. This manual process is time consuming, expensive, and inaccurate. The decision to accept or reject a batch is based on a small sample size and is often subjective. When trailers of produce are rejected, the seller has to find a buver in a secondary or terminal market. If no buyer is found, the food is sent to a landfill.

Technology which enables automated, objective inspection, potentially implemented upstream from distribution hubs, can have a dramatic impact on reducing food waste by providing data to drive appropriate decision-making (Magnin, 2019). For example, the Food Team at Google, in collaboration with X (formerly Google X), the moon-shot lab within Alphabet, is exploring how visual imagery techniques could help accelerate the food inspection process to improve food supply chain efficiency to minimize waste, and to enable more accurate retail planning.

Consumer electronics have become an essential part of our daily lives, affecting work, leisure time, communication, and even social interaction. Nonetheless, products are disposed of after a short period of use. Every year 10,5 million tons of consumer electronic waste (e-waste) is produced (Balde et. al, 2017). Globally only 20% of this waste is recycled through channels that allow for the recovery valuable materials while of avoiding damage to the environment or to human health. The majority of e-waste is discarded rather than recovered or recycled, which leads to the loss of embedded energy, resources and value, as well as resulting in severe negative environmental and social consequences, especially in the informal recycling sector. Al approaches can be developed to circulate and re-purpose consumer electronics, products, components, and materials.

An important aspect of change is the design of products and materials. Consumer electronics and their components need to be designed in a standardized and modular way to allow for disassembly, refurbishment, remanufacturing, and for the recovery of materials. At the same time, personal data needs to be easily transferable to promote device reuse and access models such as phone-as-a-service. Finally, manufacturers need to ensure that products maintain software compatibility to allow for upgradability and to avoid the disposal of fully functioning devices.

Al technology has the potential to accelerate and support the design and product development process. Algorithms are capable of rapidly generating large quantities of design alternatives and optimizing for multiple circular variables. Al can also be used to change how materials are designed in the making of electronics. For example, significant effort is invested to identify safer alternatives to flammable liquid electrolytes used in lithium-ion rechargeable batteries. Researchers at Stanford have used AI and machine learning to screen more than 12.000 lithium containing compounds employing everal criteria including stability, cost, and abundance, to identify 21 solid electrolytes that could potentially replace the volatile liquids in the future (Shwartz, 2016).

Summe authors authors

## CONCLUSION

Based on the wide-ranging possibilities for the use of AI in personal, commercial and industrial applications, the potential impact of AI is significant. In applications that promote the implementation of a Circular Economy, several stakeholders are affected including customers, manufacturers, product designers, mining companies, farmers, retailers and many more. A key issue that continues to capture universal attention is its impact on the human labor market and the future of work (Malone, Rus and Laubacher, 2020).

The deployment of Artificial Intelligence technology has the potential to significantly disrupt labor markets. Depending on the nature of the job, workers could either benefit from technology or find themselves competing with it (Frank et. al, 2019). Whilst AI technology can promote the productivity of some workers, it also has the capability of replacing the work conducted by others, making their roles obsolete. As developments in AI continue, the impact is noticeable in almost all occupations where machines can replicate human thought processes and actions (Chui, Manyika and Miremadi, 2016). This impact pertains specific skills as well as entire occupations. This may ultimately result in increased unemployment and mav contribute to growing global economic inequality.

Despite these challenges, there is also a general consensus that AI will promote the development of many other new occupations that cannot be assessed yet. This new shift that AI will create in the workplace will lead to the development of new professions such as intelligent systems and robotics engineers, data mining and knowledge extraction specialists, data scientists, semantic web & ontology engineers, and many others (PwC, 2021). On the one hand, AI in the Circular Economy will change the distribution of jobs between different sectors of activity. It will reduce the demand for raw materials and jobs in the extractive and manufacturing industries. On the other hand, AI in the Circular Economy will enable the creation of sustainable jobs that cannot be relocated such as in the repair and reuse of products and resources (Green Alliance, 2021).

![](_page_34_Picture_4.jpeg)

#### **Creating Collaborative Networks**

Al can be an enabler and accelerator of the global transition to a Circular Economy. Technological developments are already driving the transformation of our economy and our way of life. Once these developments embrace Circular Economy principles, value is created andmore comprehensive benefits for society are generated. However, employing Al in production requires a clear understanding of the actual problem to be solved. In addition, the Circular Economy transition requires a network of trusted partners, as it cannot be done by one institution alone.

Elements of AI applications such as data generation, collection, and sharing are the result of cooperation between all the stakeholders. It is only by global or communal cooperation that AI can transform our global economy and minimize waste. Collaboration between relevant stakeholders and a degree of oversight is required to support the systemic application of AI, ensuring that data can be shared in an open and secure manner, and that AI is developed and deployed in ways that are inclusive and fair to all.

#### Creating awareness and data accessibility

Creating greater awareness and understanding of how AI can support a Circular Economy is essential in encouraging applications in design, business models, and infrastructure. Exploring new ways to increase data accessibility and sharing will require new approaches and active collaboration between stakeholders. Access to relevant, high-quality data, both to train algorithms and to use as input data, will be essential for the development of AI applications intended for a Circular Economy.

#### Re-education and re-skilling of labour force

With the continued development of Al technologies, almost all occupations where machines can replicate human thought processes and actions will be impacted. This may lead to increased unemployment and may contribute to the growing economic global inequality. There is a need for studies into the impact of mass unemployment due to the Al-enabled automation and for the re-education and re-training of workers who have been made redundant as a result of the increased automation.

## **Personalized Messages** from the members

![](_page_35_Picture_1.jpeg)

![](_page_35_Picture_2.jpeg)

Henrik Homann Strategic Foresight

Board Member

The transformation towards a Circular Economy must be designed to inspire, educate and eventually to activate. It only works on the back of a collaboration across sectors and value chains.

![](_page_35_Picture_5.jpeg)

Anne Babalola Strategic Foresight Board Member

Circular Economy requires a systemic shift in the production-consumption value chain and consumer behaviour. We must reshape the linear production cycle of take- make-dispose into a sustainable cycle.

![](_page_35_Picture_8.jpeg)

## Artificial Intelligence -A driving force towards circularity

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![](_page_36_Picture_1.jpeg)

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![](_page_37_Picture_0.jpeg)

## **Reporting process**

We developed the content of the report based on our global assessment of the topic of Circular Economy, its megatrends, and the current developments revolving around circularity. Leaders and relevant subject matter experts from various backgrounds relating to circularity, sustainability, and ESG developed and reviewed the report content.

Our Business Solution manager "Joyce Halloun", SFB Chairman "DR. Mark Esposito " and CEA's senior leaders reviewed the final report prior to publication.

#### **Disclaimer:**

This report, compiled by members of the Strategic Foresight Board of the Circular Economy Alliance, aims to provide a bird's-eye view of issues with potential long-term implications for the Circular Economy domain that are of strategic importance. The report includes an indicative list of references and makes extensive use of the members of the Strategic Foresight Board's knowledge, expertise, and network reach.

## JOIN THE GLOBAL COMMUNITY COLLABORATING FOR A BETTER FUTURE

#### **The Circular Economy Alliance**

Works to unite businesses, NGOs, and government institutions lead the transition from a linear to a Circular Economy.Together, we can achieve a sustainable, longterm change with a positive impact. We can generate growth while being regenerative by taking collective action, sharing experiences and best practices, and leading by example. The transition to Circular Economy is strongly aligned with the UN SDGs and helps us invest in a new economic model that is good for people, good for business, and good for the planet.

#### Why become a member?

As a certified CEA Community Member, you will continuously be in the loop as you help with your actions to slow, narrow, and close it! You will receive regular updates, continuous access to new research-based knowledge on the Circular Economy, and invitations to events, conferences, presentations, workshops, and networking opportunities. As the field of CE evolves, so will the best practices, strategies, and skills necessary for adopting it successfully. CEA and CERC are committed to regularly updating the CE certificate curriculum and Body of Knowledge to include the latest developments. Certified members will be notified of changes to maintain the relevance of their CE expertise. In addition, you will receive 'early bird' and 'loyalty' discounts on all future educational and training products developed by CEA and CERC.

#### Global network of CE Stakeholders

The CEA Community is a network of scholars, private and public sector organizations, and professionals sharing knowledge and experiences to help accelerate the transition to CE. Our interactive community platform makes it easy to find talent, partners, or CE expertise based on geography or sector. Discovering circular businesses near you to collaborate with or learn from opens valuable new opportunities. Members of the community receive insider updates on the latest research on CE, breaking news, and other exclusive privileges. Active membership in our global community of certified Circular Economy professionals strengthens your credibility in the field and enhances the signaling power of your certification.

## Circularity runs through partnerships

Successful adoption of CE can be achieved only through ecosystemic collaboration. As a member of the Circular Economy Alliance, finding partners, suppliers, consultants, auditors, service providers, and environmental organizations to partner with is simple. You will access a global network of certified professionals and organizations with a verified commitment to circular practices.

#### LEARN MORE

![](_page_39_Picture_0.jpeg)

![](_page_39_Picture_1.jpeg)

CERC is one of the first globally established research centers dedicated to Circular Economy. The Circular Economy Research Center has been acknowledged by the European Circular Economy Stakeholder Platform as one of the good practices in the domain of Circular Economy.

![](_page_39_Picture_3.jpeg)

CEA is a dedicated, committed and knowledge-driven organization exclusively focusing on paving the path for a seamless transition to Circular Economy. We are on a mission to bridge the skills gap, upskill and reskill the global workforce to accelerate the transition to Circular Economy.

#### **ACCELERATE YOUR** CAREER

![](_page_40_Picture_1.jpeg)

#### Acquire the credentials to kickstart your career in **Circular Economy!**

A certification in Circular Economy will give you the skills and credentials that will fast-track you to become a key player within your organization. Become an agent of change and lead the change towards the sustainable future you want to see.

# Accelerate & Career &

![](_page_40_Picture_5.jpeg)

![](_page_40_Picture_6.jpeg)

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