GREEN ECONOMICS
Vol.3, No.3, 2025, pp.175-183
https://doi.org/10.62476/ge.33.175

THE CIRCULAR ECONOMY: BRIDGING THE GAP BETWEEN THEORETICAL IDEALS AND BUSINESS REALITIES

Lobar Anvarova[1*], Nahid Almasov[2]

[1]Turon University, Karshi, Uzbekistan
[2]Azerbaijan University, Baku, Azerbaijan

Abstract. The linear "take-make-waste" economic model is a primary driver of global environmental degradation, with over 90% of extracted materials wasted. The circular economy (CE) emerges as a transformative alternative, aiming to decouple growth from resource consumption by designing out waste, keeping products and materials in use and regenerating natural systems. This paper argues that while the CE presents a vital paradigm for sustainable development, its translation from theory into mainstream business reality is hampered by a complex web of economic, operational, cultural and regulatory barriers. Through an analysis of pioneering business models-Product-as-a-Service, resource recovery and remanufacturing-this paper demonstrates the model's viability. However, it concludes that a full-scale transition requires a synergistic approach, combining digital enabling technologies, innovative financing and a supportive ecosystem of policies that includes Extended Producer Responsibility, fiscal reform and Green Public Procurement to level the playing field for circular activities.

Keywords: *Circular economy, sustainability, business models, product-as-a-service, remanufacturing, digital technology.*

Corresponding Author: *Lobar Anvarova, Turon University, Karshi, Uzbekistan, e-mail: lobaranvarova1998@gmail.com*

Received: *16 June 2025;* ***Accepted:*** *3 August 2025;* ***Published:*** *22 September 2025.*

1. Introduction

The stark reality of our global material footprint is captured in a single, sobering statistic: the world is only 7.2% circular, meaning that over 90% of the materials we extract and use are wasted, ending up as pollution, landfill or greenhouse gas emissions (Circle Economy, 2023). This immense inefficiency is the direct consequence of the entrenched linear economic model - a system predicated on the endless extraction of finite resources, mass production and ultimate disposal. The environmental costs of this system-runaway climate change, unprecedented biodiversity loss and pervasive plastic pollution-are escalating to a point where they threaten global economic stability and human well-being.

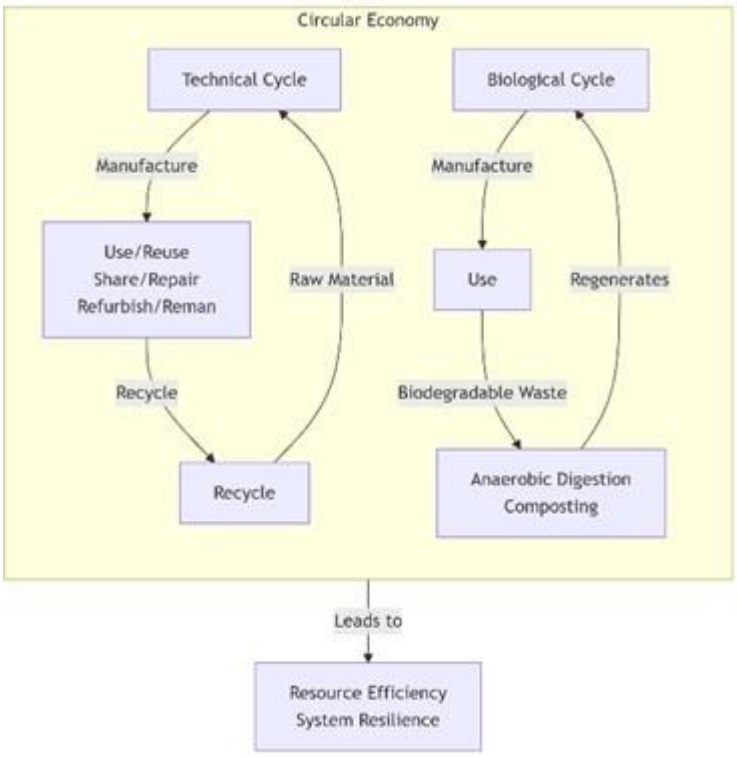
In response to these mounting challenges, the concept of the circular economy (CE) has surged from a niche idea into a mainstream proposition for a regenerative and viable alternative. It proposes nothing less than a systemic shift, redefining the very meaning of growth by designing waste and pollution out of systems, maintaining products and materials at their highest utility and value for as long as possible and regenerating, rather than depleting, natural capital. While the theoretical principles of the CE are robust, eloquently articulated by thought leaders and institutions, the practical journey from

theory to widespread business reality is complex, non-linear and fraught with structural and inertial challenges.

This paper contends that the circular economy is an indispensable paradigm for achieving sustainable development in the 21st century. However, its translation from a theoretical ideal into a mainstream business reality is significantly hampered by entrenched economic structures, operational complexities, deep-seated cultural preferences and outdated regulatory frameworks. Despite these barriers, a vanguard of pioneering companies is demonstrating not only the viability but also the profitability of circular models like Product-as-a-Service and remanufacturing. Their success points the way forward but also highlights the critical need for enabling policies and digital technologies to catalyze a broader transition. The following sections will explore the theoretical foundations of the CE, analyze its practical application through contemporary business models, introduce digital technology as a key enabler, critically examine the persistent barriers to its adoption and conclude with a comprehensive set of recommendations for policymakers, businesses and investors.

2. Theoretical Foundations and the Economic Imperative of a Circular Economy

The circular economy is often mistakenly reduced to an advanced form of recycling. In reality, it represents a fundamental redesign of our economic systems, challenging the core tenets of industrial-age capitalism. Moving far beyond the basic “3 R's” (Reduce, Reuse, Recycle), it is underpinned by three core principles derived from the work of the Ellen MacArthur Foundation (2015), which together form a cohesive framework for a new economic operating system.



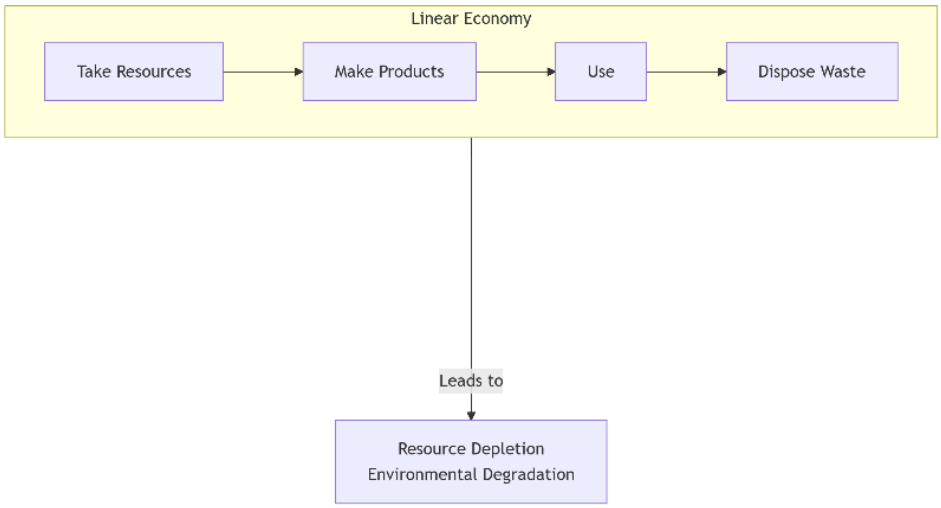


Figure 1. Contrasting the Linear and Circular Economic Models. The linear model follows a "take-make-waste" pathway, leading to resource depletion and waste. The circular model is a continuous positive development cycle that designs out waste, keeps products and materials in use and regenerates natural systems
Source: Adapted from the Ellen MacArthur Foundation

First, *design out waste and pollution*. This preemptive principle challenges us to view waste not as an inevitable byproduct to be managed, but as a critical design flaw to be eliminated. It draws heavily from the "Cradle to Cradle"® concept pioneered by McDonough and Braungart (2002), which mandates that products and systems should be conceived from the outset with their next life in mind. This involves selecting safe and non-toxic materials, designing for modularity and ensuring that every component can be continuously disassembled and safely returned as a nutrient for either the technical cycle (as a high-value material) or the biological cycle (as a biodegradable nutrient).

Second, *keep products and materials in use*. This principle aims to maximize the utility, function and value of resources at their highest possible level for as long as possible. It is operationalized through two key cycles:

- *The Technical Cycle:* This loop manages finite materials and involves strategies of sharing, maintaining, reusing, redistributing, refurbishing and remanufacturing. The goal is to recapture and preserve the energy, labor and value embedded in manufactured goods.
- *The Biological Cycle:* This loop focuses on renewable resources and entails returning biodegradable materials to the earth through processes like composting and anaerobic digestion, thereby regenerating living systems and restoring natural capital.

Third, *regenerate natural systems*. A truly circular model moves beyond the "do less harm" mentality of sustainability to an actively positive one of regeneration. It favors agricultural practices-such as agroecology and permaculture that rebuild topsoil, enhance biodiversity and improve watershed health. By putting more back into the environment than it takes out, a circular economy creates a positive feedback loop that strengthens ecological resilience.

The economic rationale for this transition is compelling. A seminal report by the Ellen MacArthur Foundation and McKinsey & Company (2015) estimated that adopting circular principles in Europe alone could generate a net economic benefit of €1.8 trillion by 2030, equating to a 7% GDP increase compared to the current development path.

These benefits would stem from substantial material cost savings, reduced volatility and supply chain risks, stimulation of innovation in product design and material science and the creation of new employment opportunities in sectors like repair, remanufacturing and reverse logistics. This model promises not just environmental sustainability but also greater economic resilience and competitiveness.

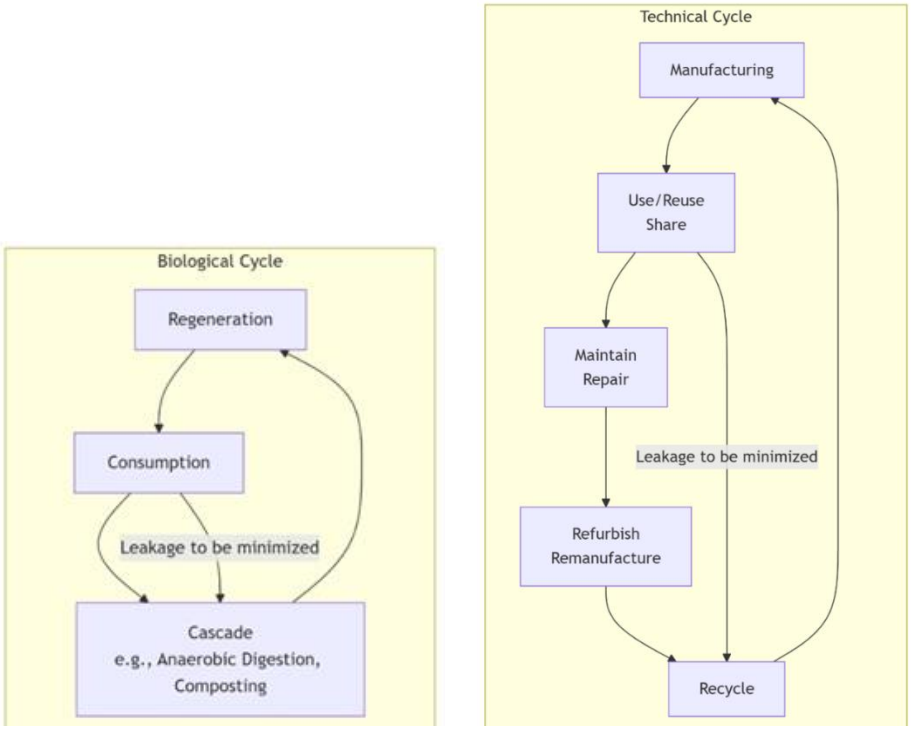


Figure 2. The Circular Economy "Butterfly Diagram". This model illustrates the continuous flow of materials in two separate cycles: The technical cycle (managing finite materials) and the biological cycle (regenerating renewable materials). The goal is to keep products and materials in use for as long as possible in the inner loops, minimizing leakage and value loss
Source: Adapted from the Ellen MacArthur Foundation

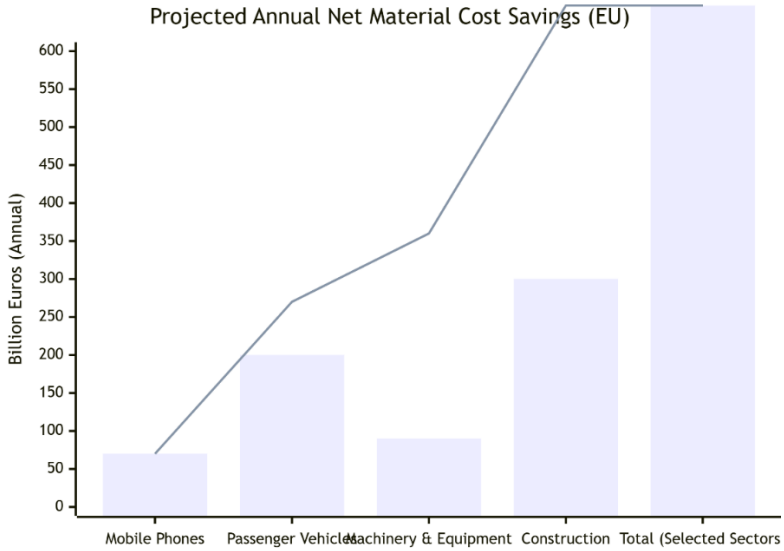


Figure 3. Projected Net Material Cost Savings in the EU from Circular Economy Practices
Source: Adapted from Ellen MacArthur Foundation & McKinsey Center for Business and Environment (2015), Growth Within: A circular economy vision for a competitive Europe

3. From Theory to Practice: Business Models in Action

A growing cohort of innovative companies is moving beyond rhetoric, proving that circularity can be a powerful source of competitive advantage, customer loyalty and long-term resilience. These pioneers are leveraging business models that create value from longevity, performance and reuse rather than from volume and planned obsolescence.

3.1. Product-as-a-Service (PaaS)/Servitization

One of the most transformative models is PaaS, which shifts the business value proposition from selling physical products to selling performance, access or desired outcomes. Under PaaS, companies retain ownership of their products and internalize the costs of durability, maintenance and end-of-life recovery, fundamentally aligning their incentives with resource efficiency.

- *Case Study: Philips "Lighting as a Service" (LaaS):* Philips no longer merely sells light bulbs to cities or corporations. Instead, it contracts to provide agreed-upon levels of illumination. The client pays a monthly fee for *light*, not hardware. This model incentivizes Philips to design hyper-efficient, long-lasting and easily upgradable LED systems, as they remain responsible for maintenance, energy consumption and ultimate disposal. At the end of the contract, Philips reclaims the fixtures for refurbishment, harvesting of valuable components or recycling, thus securing critical materials and closing the loop. This creates a powerful win-win: clients benefit from predictable operational expenses, reduced energy bills and hassle-free maintenance, while Philips builds stable, long-term revenue streams and deepens customer relationships.

3.2. Resource Recovery and Industrial Symbiosis

This model transforms waste streams into valuable revenue streams, often through innovative supply chain partnerships that mimic the waste-equals-food ethos of natural ecosystems.

Case Study: *Interface Inc.'s "Net-Works" Program:* The carpet tile manufacturer faced a challenge: sourcing sufficient high-quality recycled nylon. Their innovative solution was to partner with coastal communities in the Philippines and Cameroon to collect discarded fishing nets-a major pollutant that damages marine ecosystems and constitutes up to 10% of all ocean plastic waste. These nets are purchased, providing supplemental income to local families and are then recycled into nylon yarn for new carpet tiles. This initiative not only secures Interface a stable, high-quality recycled material source but also cleans up critical ocean habitats, enhances its brand reputation and creates shared value for vulnerable communities. It is a quintessential example of a regenerative, circular supply chain.

3.3. Product Life-Extension through Remanufacturing

This model focuses on keeping products and components in use at their highest value for as long as possible, challenging the culture of disposability.

Case Study: *Caterpillar's "Cat Reman" Program:* Caterpillar, a global leader in heavy machinery, operates one of the world's largest remanufacturing programs. The company takes back end-of-life engines, transmissions and hydraulics from its customers. These components are not simply repaired; they are brought to a like-new condition through a rigorous industrial process involving complete disassembly, cleaning,

inspection and rebuilding to original factory specifications. The resulting "reman" product is sold with a warranty identical to a new part but at a 40-60% discount. This program allows Caterpillar to capture value that would otherwise be lost, strengthen customer loyalty by lowering total cost of ownership and drastically reduce the raw material, energy and water required compared to manufacturing new components-often by over 80%.

4. The Digital Enabler: Technology's Role in Closing the Loop

The practical implementation of these business models is increasingly facilitated by a suite of digital technologies that provide the visibility, intelligence and connectivity required to manage complex circular flows. These technologies are becoming the central nervous system of the circular economy.

• **Internet of Things (IoT):** Sensors embedded in products can monitor their condition, usage and location. This data is crucial for PaaS models to bill accurately and schedule predictive maintenance. For example, a sensor in a Philips light fixture can alert the company to a potential failure before it happens. IoT also enables efficient take-back schemes by providing real-time data on product availability for refurbishment.

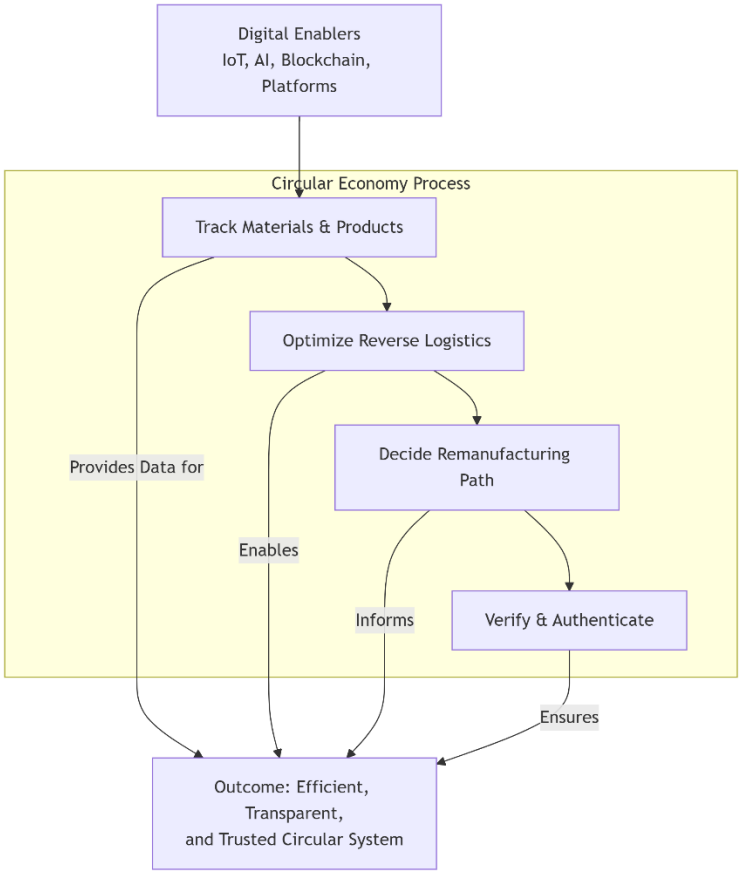


Figure 4. The Role of Digital Technologies in Enabling Circular Business Models. Technologies like IoT, AI and Blockchain provide the data, intelligence and connectivity needed to manage the complex flows of a circular system, making it visible, efficient and scalable

• **Blockchain:** This technology offers a secure, transparent and immutable ledger for tracking materials and products throughout their lifecycle. It can be used to verify the authenticity and recycled content of materials, provide a "passport" for products detailing their components and disassembly instructions and ensure transparency in complex supply chains like Interface's Net-Works, allowing consumers to verify the ethical and environmental claims of their purchases.

• **Artificial Intelligence (AI) and Big Data:** AI algorithms can optimize reverse logistics, the most complex part of circular operations. They can determine the most efficient routes for collecting used products, decide in real-time whether an item should be repaired, refurbished or recycled based on its condition and optimize sorting processes in recycling facilities to maximize material purity and value.

• **Digital Platforms:** Online marketplaces for secondary materials (e.g., Rubicon) and refurbished goods (e.g., Back Market) are creating efficient markets that connect buyers and sellers, facilitating the "keep products in use" principle at scale. These platforms reduce transaction costs and build trust in the quality of circular goods.

Without these digital tools, managing the data and logistics required for a circular economy would be prohibitively inefficient and costly. They are a critical force in bridging the gap between circular theory and business practice.

5. The Implementation Gap: A Critical Analysis of Barriers to Adoption

Despite the compelling logic, proven case studies and enabling technologies, the circular economy remains far from the mainstream. Its widespread adoption is stifled by a powerful array of systemic barriers that protect the incumbent linear system and create a "valley of death" between pilot projects and scale.

5.1. Economic and Financial Barriers

The most immediate hurdle is economic. The high upfront capital investment required to redesign products, establish reverse logistics networks and develop new material processes is a major deterrent, especially for small and medium-sized enterprises (SMEs). Furthermore, the prevailing economic system is structurally biased towards linearity. Virgin materials are often cheaper than recycled alternatives due to direct and indirect subsidies for fossil fuel extraction, the externalization of environmental costs (e.g., pollution, carbon emissions) and the economies of scale enjoyed by well-established linear supply chains. The financial sector also often lacks the metrics and understanding to accurately value circular business models and assess their risk, leading to difficulties in securing financing.

5.2. Operational and Technical Barriers

The operational challenges of "closing the loop" are immense. Establishing reverse logistics is a reliable, cost-effective system for collecting, sorting and transporting used products from millions of dispersed consumers back to centralized facilities is orders of magnitude more complex than the streamlined, one-way logistics of the linear model. This challenge is compounded by the fact that the vast majority of existing products are not designed for disassembly, repair or recycling. They are made from inseparable material composites, held together with permanent adhesives and lack standardized

components, making the recovery of high-quality materials technically difficult, labor-intensive and expensive.

5.3. Cultural and Behavioral Barriers

Deep-seated social and consumer attitudes present a significant market hurdle. The powerful cultural association of "new" with "better" and the perceived status of ownership creates a psychological barrier against purchasing refurbished or remanufactured goods. A cultural preference for ownership over access (e.g., leasing clothing or furniture) must be overcome. This skepticism is often exacerbated by a legitimate fear of greenwashing, where superficial or misleading claims of circularity erode consumer trust in all sustainable offerings, making it harder for genuine circular businesses to gain traction.

5.4. Regulatory and Policy Barriers

Perhaps the most pervasive barrier is the existing regulatory framework, which was designed for and inadvertently reinforces the linear economy. Outdated regulations can legally define remanufactured goods as "used" in a way that implies inferiority, creating liability concerns. Many tax systems place a higher burden on labor than on resource extraction, making repair services (which are labor-intensive) more expensive relative to buying new products (which are resource-intensive). Furthermore, there is a critical lack of standardized definitions and certifications for recycled content and circularity, leading to market confusion and an inability to hold companies accountable for their claims.

6. Conclusion and Comprehensive Policy Recommendations

The circular economy is far more than a theoretical ideal or a mere environmental strategy; it is an essential, viable and increasingly urgent pathway toward a sustainable, resilient and prosperous economic future. As demonstrated by pioneers like Philips, Interface and Caterpillar, innovative business models can successfully align profitability with planetary health, creating value for shareholders, customers and society at large. However, these leaders remain laudable exceptions.

The analysis confirms that the transition is hindered by a powerful constellation of economic, operational, cultural and regulatory barriers that individual companies cannot overcome through innovation alone.

For the circular economy to move from the fringe to the core of global economic activity, a supportive and coherent ecosystem of policies is required to correct market failures, level the playing field and de-risk investment in circularity. Key recommendations include:

1. **Implement and Strengthen Extended Producer Responsibility (EPR):** Governments must mandate robust EPR policies that make producers fully financially and physically responsible for the end-of-life management of their products and packaging. Well-designed EPR schemes create a powerful economic incentive for producers to design for circularity from the very beginning, as they will bear the cost of recycling or disposal.

2. **Execute a Fundamental Tax Shift:** Policymakers must explore bold fiscal reforms that shift the tax burden from desirable outcomes (e.g., labor) to undesirable ones (e.g., pollution, resource extraction). Reducing taxes on labor-intensive repair services

and increasing taxes on virgin material use and landfill disposal would instantly make circular activities more economically competitive.

3. **Leverage Green Public Procurement (GPP):** Governments, as the largest consumers in most economies, must use their immense purchasing power (often representing 12-15% of GDP) to create guaranteed, high-volume markets for circular products and services. By prioritizing recycled, refurbished and servitized models in their tenders, they can drive innovation, reduce costs through economies of scale and send a powerful market signal.

4. **Invest in Collaborative Infrastructure and R&D:** Public and private investment is crucial for building the shared infrastructure of the circular future. This includes funding for R&D in circular material science and design, establishing standardized and efficient collection and sorting systems and creating industrial parks geared towards industrial symbiosis, where one company's waste becomes another's feedstock.

5. **Establish Clear Standards and Labels:** Governments and international standards bodies must develop clear, harmonized definitions and certifications for circularity (e.g., recycled content, reparability scores, material health). This will combat greenwashing, empower consumers to make informed choices and create a level playing field for businesses.

In conclusion, the journey from a linear to a circular economy is a monumental task that requires nothing short of a systemic transformation. It is not a switch to be flipped but a direction to be traveled. No single actor can do it alone. Success hinges on a new era of collaboration between bold businesses creating innovative models, policymakers setting the right rules and incentives, investors allocating capital with a long-term perspective and consumers embracing new ways of consuming. By combining this multi-stakeholder effort with the power of digital technology, we can finally bridge the gap between the theoretical ideal of a circular economy and its tangible business reality, building an economic system that operates within planetary boundaries and works for the long-term benefit of both people and the planet.

References

Circle Economy (2023). The circularity gap report 2023.

Ellen MacArthur Foundation (2015). *Towards a Circular Economy: Business Rationale for an Accelerated Transition*, 20.

Ellen MacArthur Foundation, McKinsey & Company (2015). Growth within: A circular economy vision for a competitive Europe.

European Commission (2020). A new circular economy action plan: For a cleaner and more competitive Europe.

Kirchherr, J., Reike, D. & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221-232.

McDonough, W., Braungart, M. (2002). *Cradle to Cradle: Remaking the Way We Make Things*. North Point Press.

Preston, F. (2012). *A Global Redesign? Shaping the Circular Economy*. Chatham House.

Stahel, W.R. (2016). *The Circular Economy: A User's Guide*. Routledge.

The Guardian (2018). We can't recycle our way out of this problem - the companies waging war on waste.

World Economic Forum (2016). *Intelligent Assets: Unlocking the Circular Economy Potential*, 56.