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Circular Transformation of Industries: The Role of Partnerships

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Foreword



Fernando Gomez
Head, Resource Systems and Resilience; Member of the Executive Committee, Centre for Nature and Climate, World Economic Forum



Kyriakos Triantafyllidis
Head of Growth and Strategy, Centre for Advanced Manufacturing and Supply Chains, World Economic Forum



Jenny Davis-Peccoud
Senior Partner, Global Head of Sustainability & Responsibility, Bain & Company



Hernan Saenz
Senior Partner, Global Head of Performance Improvement, Bain & Company



Jagjit Singh Srail
Director of Research in the Department of Engineering and Head of the Center for International Manufacturing, Institute for Manufacturing, University of Cambridge

In an era defined by unprecedented global challenges, the imperative for transformative change has never been more pressing. Circularity offers a blueprint to help us navigate these disruptive times, helping businesses to increase their resilience, reach new markets and customers, and grapple with the consequences of climate change, resource tensions and environmental degradation. But it is not a journey that can be taken alone. This white paper explores a fundamental catalyst of circular transformation: partnerships.

Solo initiatives limit companies' ability to extract value from circular strategies. Partnerships are the connective tissue that permits the flow of knowledge, information and circular materials – creating demand for new circular goods and services, ushering in new circular business models and establishing a shared commitment to building a circular future. To extract tangible insights from these concepts, the paper delves into archetypes of circular value creation and explores how they are defined by partnerships aiming to influence control and inflection points.

The examples in this paper are not meant to provide set paths for others to follow. Rather, they aim to inspire companies to explore the potential for partnerships to help accelerate their own circular journey, enhancing the resilience, profitability and sustainability of their businesses.

Those who lead the way and form disruptive circular partnerships will benefit from a first-mover advantage. Circularity leaders will need to engage their peers, their competitors and the upstream and downstream players in their value chains – and beyond – in ambitious pre-competitive and cross-industry coalitions to shape a systemic change that goes beyond the boundaries of one organization.

As we navigate the challenges of the 21st century, it is important to remember that our true strength lies not solely in our individual undertakings but in our ability to collaborate. Through partnerships, we can construct a circular world characterized by sustainability, resilience and prosperity for all.

We thank the members of the Circular Transformation of Industries community for their insights and their invaluable inputs to this paper.

Executive summary

Partnerships are essential to build the circular economy that the world needs.

Circular transformations are urgently needed in an increasingly resource-constrained world. Humanity consumes 70% more resources than the Earth's ecosystems can regenerate,¹ yet only 7.2% of materials that enter production processes today come from circular sources.² Adopting circular-economy principles can also unlock value for businesses in many areas, including improved resilience, additional sources of revenue and growth, resource efficiency and environmental sustainability.

Creating new circular value chains will require new partnerships. Taking a circular approach in isolation limits a company's capacity to extract value from such a strategy; partnerships offer a faster and more cost-effective route for accessing knowledge and circular materials, for informing policies and industry standards, and for creating a mass market for circular goods and services. In circular transformations, businesses may have to look beyond their value chains to source circular inputs or to find buyers for their by-products and spent materials. They may need partners to complement their own circular capabilities, to help transform production processes or to introduce new circular business models. As more companies enter the circular economy, these partnerships are likely to grow into multistakeholder coalitions that establish new, circular ecosystems.

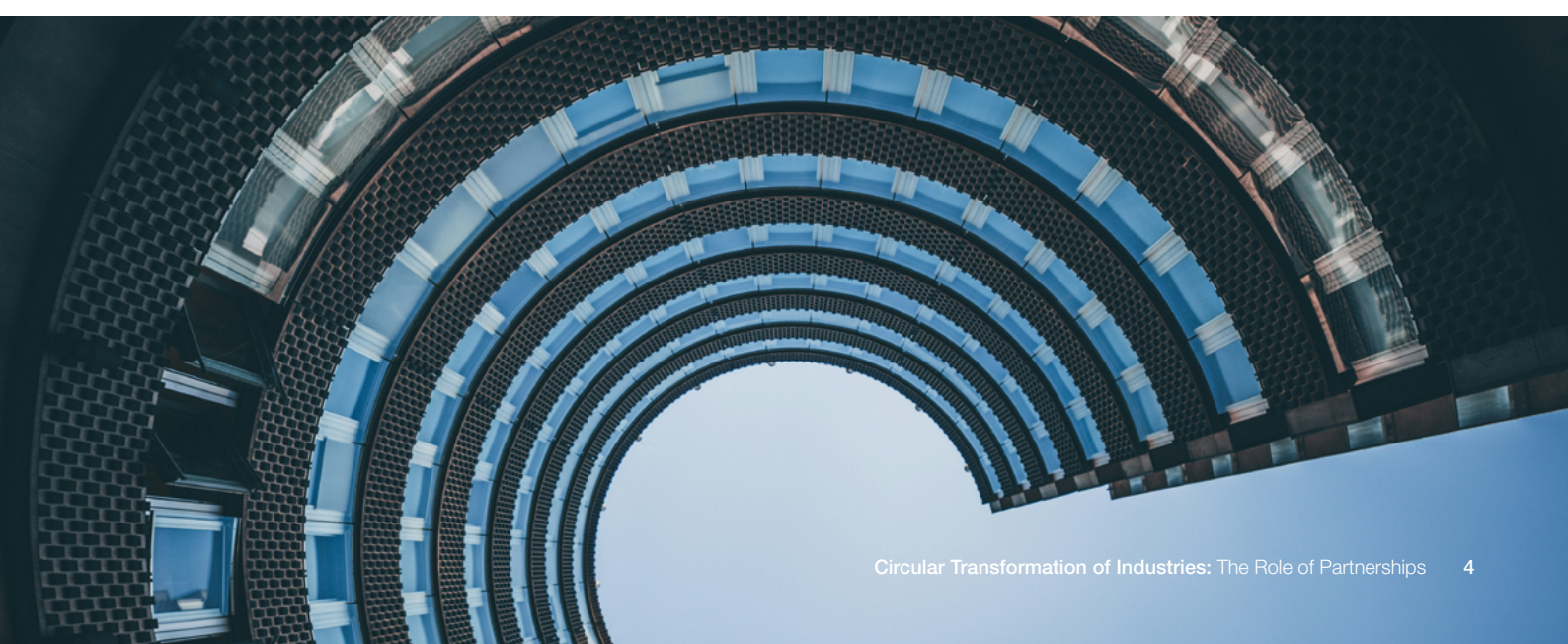
This paper identifies three archetypes for circular value creation and shares use cases on how partnerships play a crucial role in each of them. The first archetype focuses on replacing virgin materials with circular ones – for example, using recycled plastic or aluminium; this strategy can be appropriate for most manufactured goods, and especially those that have a short lifespan, such

as packaging. The second aims to reduce the demand for, and therefore output of, manufactured goods by increasing their useful lifespan; this is appropriate for high-value products that are durable and generally those that can be disassembled. The third archetype reinvents the business model as the enterprise adopts more circular ways of working; this opens new avenues for collaboration and business partnerships and is most suited to high-value, upgradeable products or services.

In developing a circular strategy, companies will need to identify the key sources of value, or control points, in their circular value chains. These include both material flows, such as access to circular feedstock, and information flows, such as how to repair or dispose of circular goods. A circular strategy will also need to consider a series of inflection points, including the factors that can accelerate the cost-competitiveness of circular goods, increase consumer confidence in refurbished products or create demand for new circular offerings.

In planning their circular strategies, chief executive officers must identify the archetype or combination of archetypes that can deliver most value to their companies, which control and inflection points are critical for success and what partnerships are needed to build their new circular value chains. A clear circular partnership strategy will help companies gain access to key control points and tip the relevant inflection points.

Circularity must become the new standard to ensure the resilience of businesses, economies and the planet, and it can happen only through partnerships.



1

The need for partnerships

More than nine out of ten executives cited partnerships as a critical enabler of the circular transformation.



Awareness of the need to decouple economic growth from resource consumption can be traced back to at least 1987, with the Brundtland Commission's report on sustainable development for the United Nations.³ But nearly four decades later, the global economy is still extracting more natural resources than the planet can replace. Scientists report that six out of nine "planetary boundaries" – which measure environmental health across land, water and air – have been broken.⁴ Only a circular economy can reverse this over-extraction by encouraging the maximization of the value of resources and finding new uses for what were once considered waste products and spent materials.

Today, only 7.2% of all material inputs in the economy come from circular sources.⁵ At the same time, global economic growth is being checked by material constraints, such as the acute scarcity of water in many drought-stricken agricultural regions and shortages of certain minerals and metals for electronic components of electric vehicles, energy transition technologies and information technology (IT) systems. Scientists believe a broader adoption of circularity principles could reduce global materials extraction and use by one-third, easing constraints on growth and enabling people to live within the environmental limits of the planet.⁶

For companies seeking to curb greenhouse gas (GHG) emissions and address scarcities of materials, circularity promises to unlock value in four areas: next-generation resilience; new sources of revenue; resource efficiency; and environmental sustainability.

This white paper presents a framework (see Figure 1) to explain how companies can use a variety of resources and processes to attain these benefits. Specifically, there are six critical enablers that can support a company in achieving circular transformation at scale, including internal and external technologies, information, relationships and more.

Of these enablers, the creation of partnerships has been identified by 94% of executives as crucial for unlocking the full potential value of circular transformations.⁷ Businesses may therefore have to look beyond their value chains to source recycled inputs or to find buyers for their waste and spent materials. Companies will need to partner with stakeholders that complement their circular

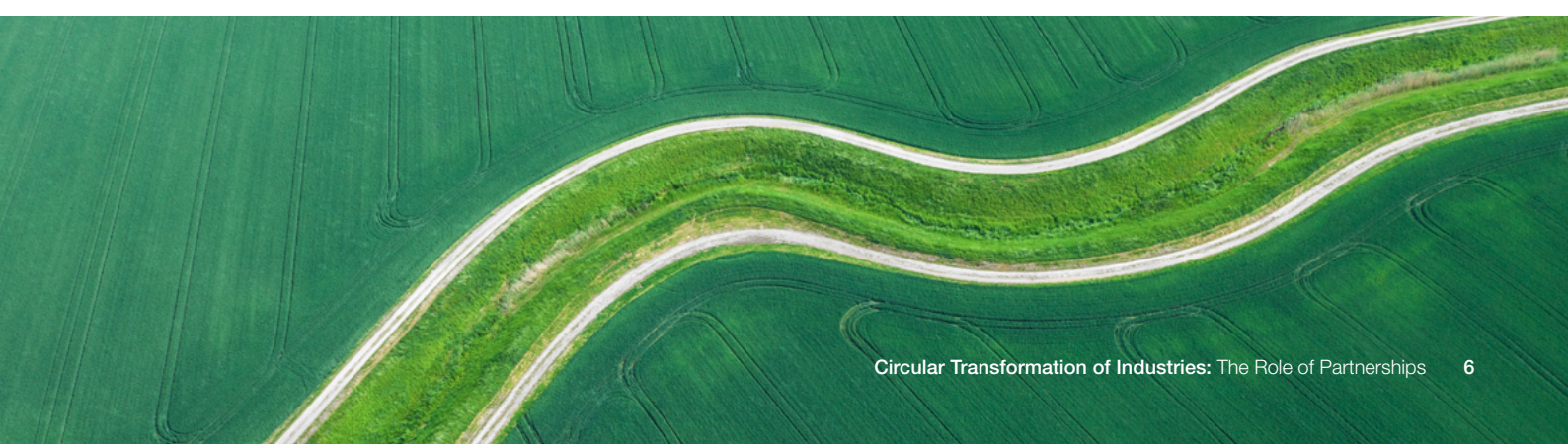
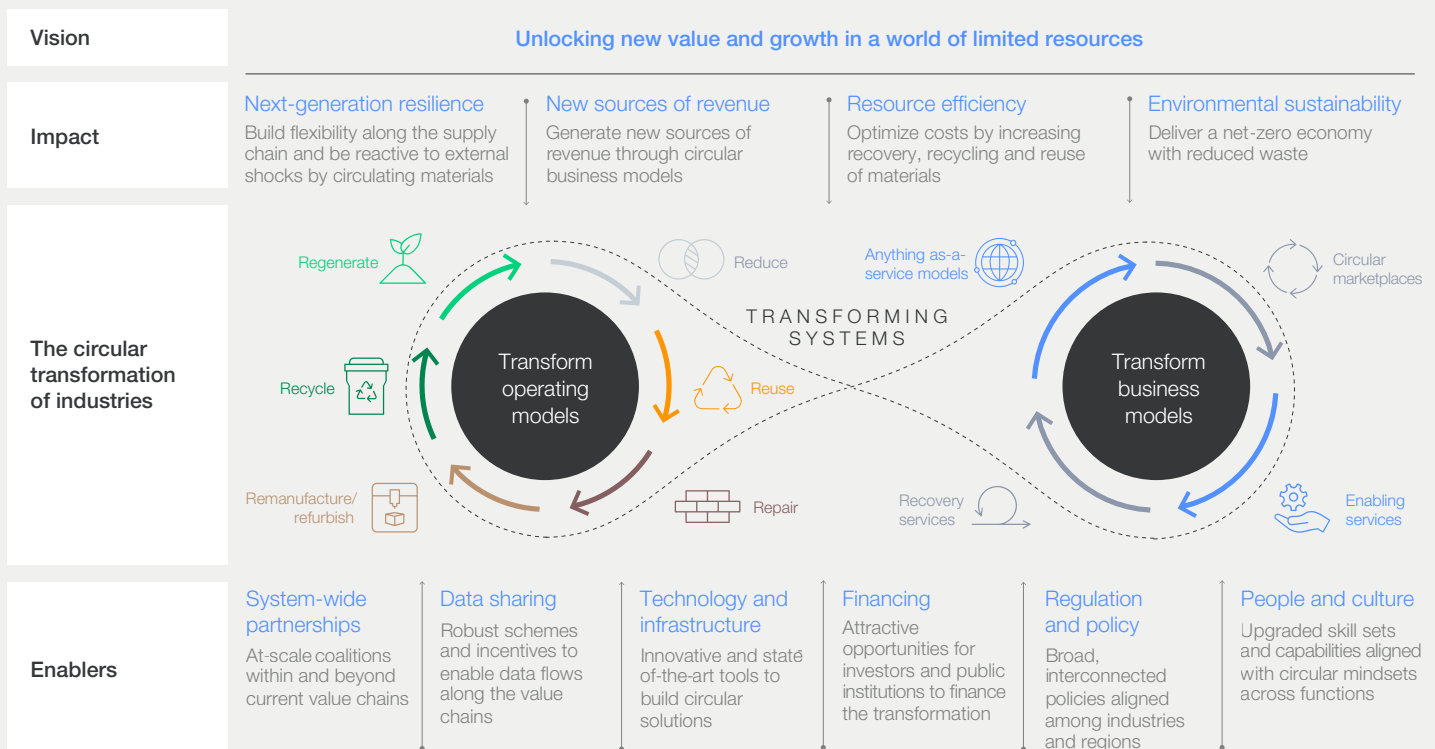
capabilities and assets. They will also need to transform their operating and business models to become circular.

As more companies engage in the circular economy, these partnerships are likely to grow into multistakeholder coalitions that establish a new business environment for circular enterprises.

This paper looks at the importance of partnerships in some successful examples of circular transformations. Rather than providing a step-by-step guide, the case studies seek to illustrate the wide variety of options businesses have when looking for solutions to their circular challenges. The final section of the paper outlines important recommendations to help CEOs achieve a successful transformation.

The overall aim is to inspire more leaders to take partnership-based action and drive the circular transformation of their industries.

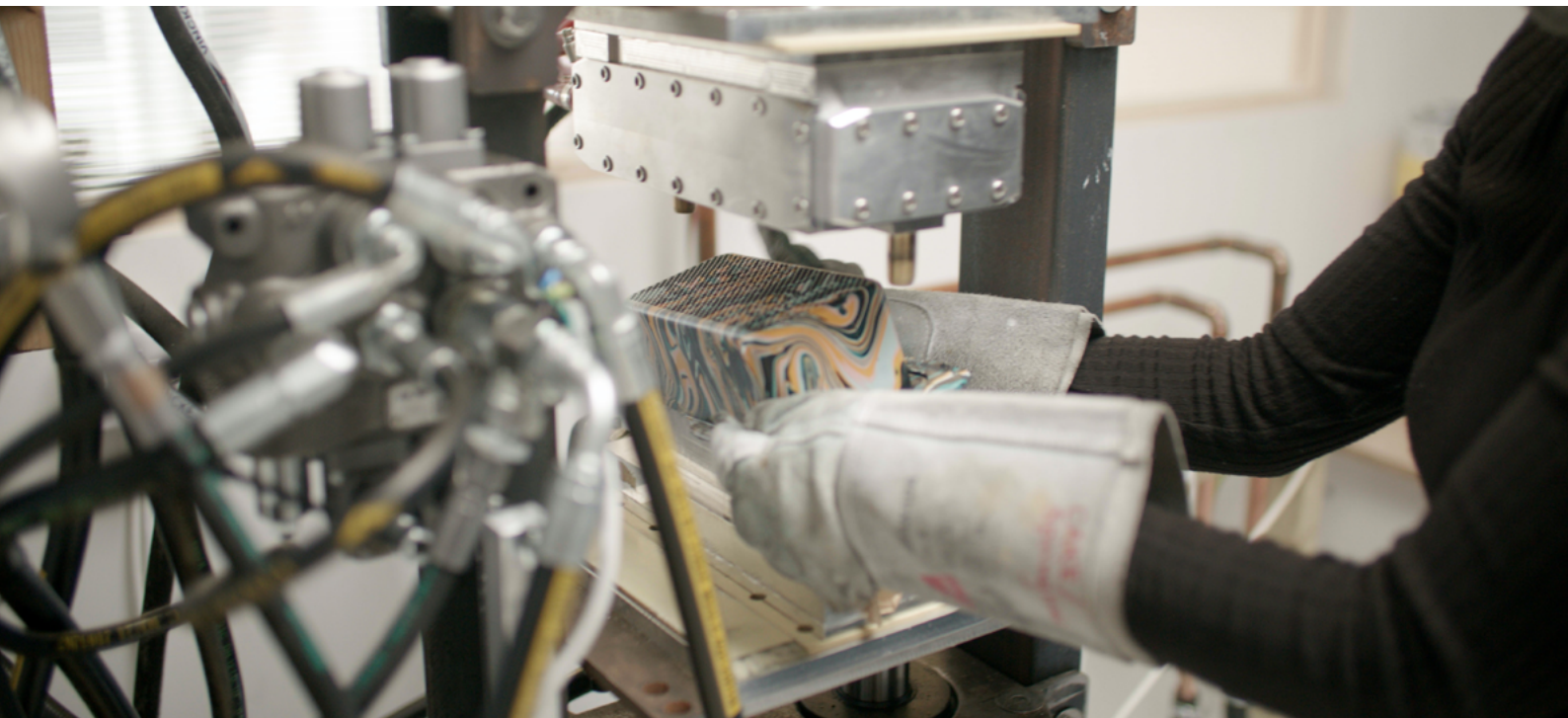
FIGURE 1 Operations and business-model changes required for circular transformation



2

Three archetypes for circular value creation

Companies can opt to choose circular feedstocks, to extend the life of products or to reinvent their business platforms or services.



This section illustrates the three broad archetypes for creating value through circularity, with an example of each. All three reduce resource

extraction while meeting customer needs, and all three rely on new partnerships to achieve circularity goals.

Archetype 1

Circular feedstock

This archetype entails replacing the use of virgin materials with circular feedstocks – for example, recycled plastics or aluminium. This is done by connecting the product's end of life to its beginning of life, by using recycled products to manufacture new products.

Archetype 1 is relevant for most manufactured goods, and especially those that have a short lifespan, such as aluminium packaging. Companies

such as Ball Corporation, which makes aluminium cans, cups and bottles, primarily for the drinks industry, can recycle aluminium using only 5% of the energy used to produce virgin aluminium. Given aluminium keeps a high value after an end-of-life cycle,⁸ recycling it is not only environmentally but also financially beneficial.

Archetype 2

Lifespan extension

This archetype involves reducing the output of manufactured goods by increasing their useful lifespan. Strategies include repairing, reusing, refurbishing or remanufacturing products to new designs that make circularity easier to adopt. It is appropriate for high-value products that are durable and can be disassembled.

One company practising this approach is Schneider Electric, a large digital-automation and energy-management company. Schneider Electric has developed a refurbishing platform to extend the useful life of equipment, with the goal of reducing the extraction of raw materials needed to manufacture new ones.

Schneider Electric's circular transformation began with a survey which revealed that 30% of customers did not know what to do with its products at the end of their life cycle; 94% were interested in a take-back platform managed by the company, and 86% were interested in buying refurbished goods.

This indicated demand for circular solutions and led the company to rethink its entire value chain and reconfigure its product design, from the use of materials to making products easier to disassemble, repair and recycle.

Working with a network of partners, including a local company that has the capability to transport, sort and refine waste, Schneider Electric developed a platform for refurbishing operations that gives customers the option of purchasing circular products with the same warranty as new products and with the added environmental benefits of circular inputs. To encourage customers to return products, the company has an easy-to-use platform for the return of end-of-use goods, sparing customers the task of dealing with waste disposal and the associated costs. In 2023, 22% of the company's product families have at least one circular economy offer available, with a plan to reach 33% by 2025.

Archetype 3

Circular platforms and services

This archetype reinvents the business model, opening new avenues for collaboration and business partnerships. It is most suited to high-value, upgradable products.

HPE (Hewlett Packard Enterprise) is an information technology company that demonstrates the third archetypal strategy of reinventing business models via its as-a-service IT offerings. In 2019, the company announced plans to transition to an as-a-service company through more subscription-based, pay-per-use and as-a-service offerings. By enabling organizations to consume IT on an as-a-service basis, HPE offers them the ability to flexibly scale their IT to meet their needs and reduce IT inefficiencies such as carbon and energy use, materials and waste, which contribute significantly to environmental footprints. While the company will continue to provide its hardware and software in a licence-based model, these new offerings will enable customers to choose if they want a more traditional or more circular as-a-service experience.

The company has used a variety of partners to provide new services on this platform to improve its utility in contrast to traditional servers. Many medium-sized businesses lack internal data centres or the appropriate IT staff to support them. To solve this, HPE partnered with CyrusOne and Equinix, data centre and interconnection providers, to provide mid-sized companies with access to external data centres, thus allowing them to avoid having to build their own.

The three archetypes are not mutually exclusive and must be considered as part of a dynamic, evolving process. An organization can use any combination of the three to achieve its objectives: for example, using recycled materials (Archetype 1) to remanufacture products (Archetype 2) that are sold as a service (Archetype 3). Any archetypal strategy will aim to deliver benefits sought by an organization, such as increasing resilience, generating new revenue streams, achieving resource efficiencies and improving environmental sustainability.

3

Circular partnerships to accelerate the transformation

Companies must understand how partnerships, including with competitors, will enable them to access control points, such as materials and information, and tip inflection points such as experience and adoption curves.



Across these archetypes, a circular strategy is informed by identifying and acting upon control and inflection points (see Figure 2). Control points are the critical sources of value in a value chain; inflection points mark the moment when circular products become cost-competitive with their non-circular equivalents.

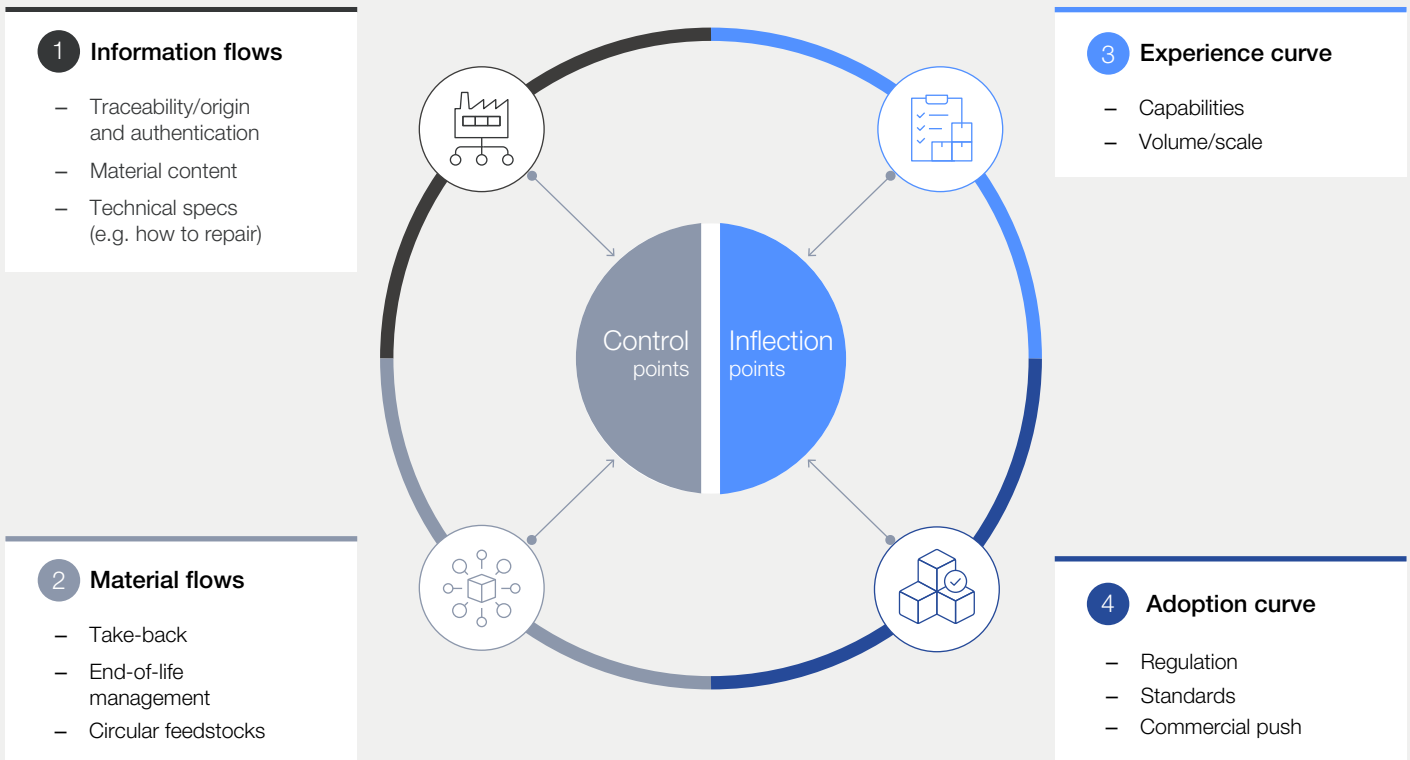
Control points include information, such as the technical knowledge of how to produce, repair and dispose of circular goods, and access to materials, including circular feedstock and used products for disassembly.

Inflection points are determined by economies of scale (the more circular goods that are produced, the lower their unit costs) and by consumer demand. Factors that can accelerate the cost-competitiveness of circular products include technical innovations that make circular production less expensive; regulatory incentives; new industry standards for circularity; and measures that

increase consumer confidence in the quality and environmental benefits of circular goods.

Identifying the key sources of value in a circular value chain, as well as the crucial inflection points, can help a company determine the best approach when implementing a circular strategy.

FIGURE 2 Control points and inflection points affected by circular partnerships



Partnerships are an effective way to put the different elements of a circular strategy into place. While companies can develop expertise in-house, partnerships offer a faster and more cost-effective route to accessing knowledge and circular materials, establishing policies and industry standards and creating a mass market for circular goods and services. This is in addition to lowering production costs and creating economies of scale.

In a circular economy, it is likely that partnerships will include a wider range of stakeholders and companies than exist in linear value chains, including potentially with competitors. The configuration and the goal of these partnerships will depend on the archetypes adopted to create circular value.

Each archetype relies on different capabilities that could be accessed through strategic partnerships. For example, partnerships could provide Archetype 1 companies with access to circular feedstocks. They could provide an Archetype 2 company with manufacturing capabilities for product refurbishment. In Archetype 3, partners can work together to drive commercial awareness and acceptance of new as-a-service business models. The examples below provide an illustration of the use of partnerships to influence control and inflection points in the different archetypes.

3.1 Partnering in **Archetype 1**: Accessing feedstock, securing uptake and extending geographical reach

Archetype 1 typically needs recycled content to use as circular feedstock. This is a particularly pressing need for manufacturers of products such as computer hardware, which are under pressure to reduce the amount of electronic waste (and associated hazardous and toxic substances such as lead and mercury) ending up in landfill.

In the case of Western Digital, a global data-storage company, the challenge is to recover high-value materials such as rare earth metals, using ecologically friendly recycling processes that nevertheless deliver a high degree of purity. Wiping disks and selling them as refurbished is in most cases not an option because of data protection concerns. Spent drives are thus sent to recycling companies to recover the valuable materials.

To implement its circular operation, Western Digital must collaborate with the entire supply chain. Upstream, it partners with suppliers to ensure the purity levels of recycled material are sufficient to replace 100% virgin materials. Downstream, it works with customers to recover drives for enhanced recycling or whole-drive reuse that would otherwise end up with lower recycling yield and limited material circularity. The company's goal is to have a greater than 90% recycled yield, including rare earth metal recovery.

Meanwhile, Bangkok-based Indorama Ventures, a world leader in the manufacture of PET (a polymer resin of the polyester family), is working with several industry partners to achieve a circular economy for sustainable plastics.⁹ The company regards recycled PET (rPET) as a new engine of growth, as it is a circular product with a lower carbon footprint than other packaging materials.

Nevertheless, Indorama Ventures faced challenges when trying to scale up the use of recycled PET in its operations in the Philippines. The first obstacle was the collection of plastic waste, the feedstock for recycled PET. In the Philippines, waste plastics are collected by individual garbage pickers. This makes consolidation costly. To solve this problem, the company partnered with bailers – small enterprises that consolidate plastic waste into large bails. In addition, it sponsored education programmes in schools to raise awareness of the importance of recycling.

Next, the company needed to find clients that would buy rPET in large volumes. A major bottling company not only agreed to buy the rPET, but also became Indorama Ventures' partner in a joint venture that has built the Philippines' largest recycling facility for food-grade rPET pellets – that

is, a recycled plastic that is suitable for direct contact with food and drinks – with an annual output of some 2 billion bottles a year. The proximity of the company's bottling plant to the recycling facility reduces transport costs and has been an important inflection point for the cost-competitiveness of rPET.

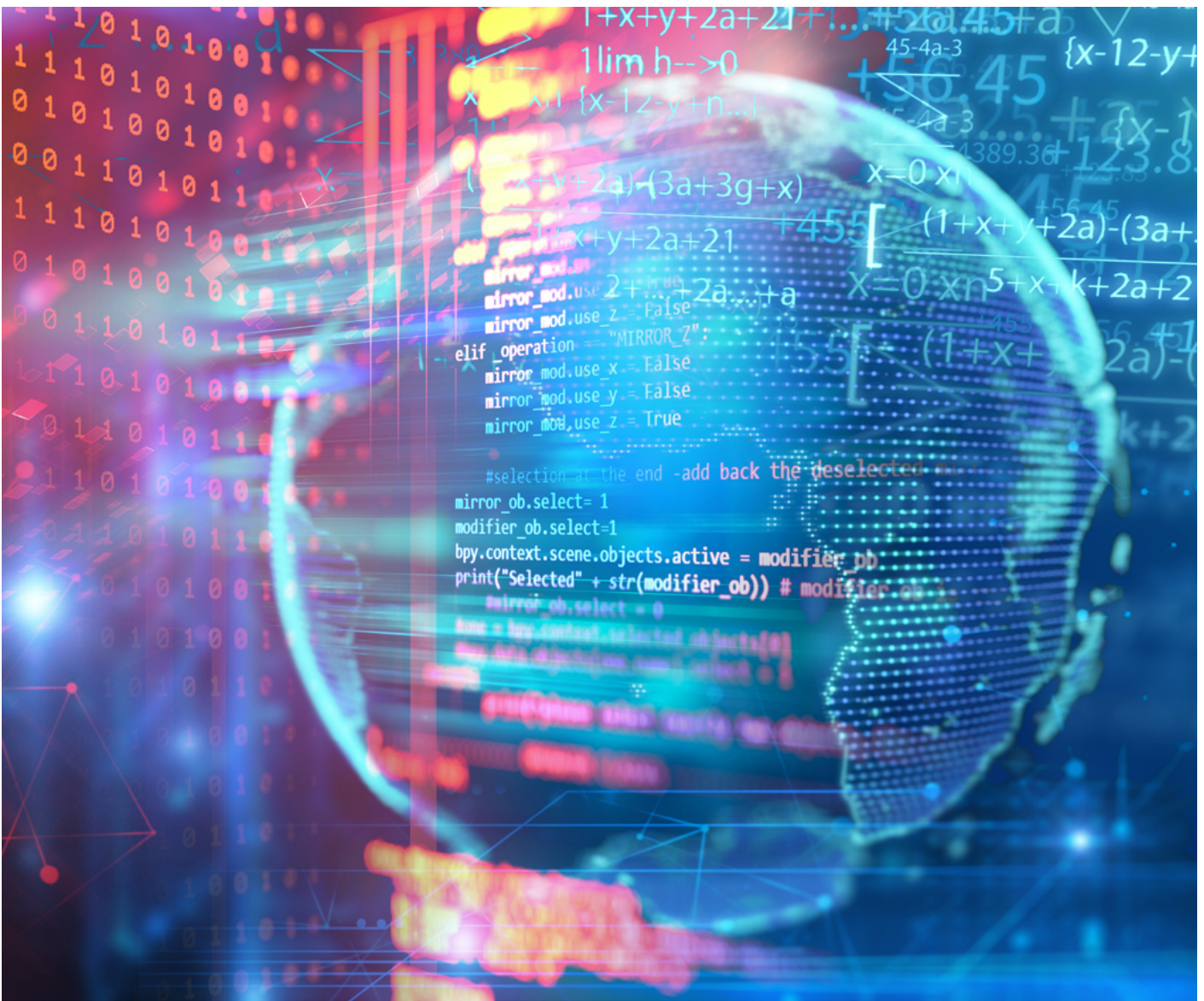
Finally, Indorama Ventures is working to improve its processes for recycling PET, by partnering with companies that have specific capabilities or promising technology for advanced recycling.

In developing a circular strategy, Indorama Ventures has used the playbook of Archetype 1 strategy to secure circular feedstock with its suppliers and to secure its uptake partnering with technology providers to improve processes. It has also used it with clients and investors to secure demand for recycled products. Partners have contributed to the success of its circular strategy in material control points (inputs from bailers and products for clients) and in inflection points as investors in the recycling facility that is producing recycled bottles at scale.

Gemini, a global circular-economy platform based in Belgium, addressed similar issues when setting up a recycling business in India. The main challenge was to secure plastic waste in sufficient volumes for recycling, as India uses less plastic per capita than Europe. As in the Philippines, collection was a challenge, as it is done informally and over large distances. This also complicates the logistics, as the small amount of waste collected by each picker must then be consolidated by an aggregator.

To tackle issues of scale, Gemini developed two types of partnership. Like Indorama Ventures, Gemini partnered with aggregators, supplying them with small bailing machines to be used on-site and to increase their own capacity; this helped to minimize logistics costs. Second, Gemini partnered with recyclers in regions not covered by its four newly built plants in India to extend its geographical reach and achieve economies of scale. To address labour issues, the company formalized waste collectors, covering social security and wages and providing for their fundamental needs, such as hygiene, sanitation and health benefits.

By partnering with reclaimers and bailers, Gemini secured circular feedstock – a key material control point. And through partnerships with other recycling plant operators, it has extended and accelerated its scale of operations and geographical reach without the need for additional investment, greatly accelerating its learning inflection point in a new market.



3.2 Partnering in **Archetype 2**: Accessing products, repair data and capabilities

Partnerships are also important for companies seeking to extend the useful life of products, typical of Archetype 2 circular strategies. Partners can supply critical data flows: for example, traceability, telemetrics and predictive maintenance to determine when a product needs repair or refurbishment. Data can also be used to increase customer confidence in buying refurbished products, thereby accelerating customer adoption.

Siemens, a multinational technology, digitalization, automation and manufacturing conglomerate based in Munich, Germany, is working on the full traceability of all components to familiarize its clients with how products are sourced and to give them a best-fit circularity strategy for each product, increasing the adoption of circularity.

The company is developing a product passport, accessible through a QR code lasered on to the item, which can be used to support each step of an individual product's journey through the supply chain, in addition to supplying all information about a product and a virtual representation of the item. The passport will include information on sustainability and recommendations on preferred circularity strategies, such as how, when and where products can be repaired. Siemens runs a global repair network comprising 134 sites, which includes its own manufacturing sites and certified third-party repair centres. The hope is that these digital solutions and experience with the repair centres will increase customer engagement with circular strategies and build trust among suppliers, companies and customers.

Circular strategies can also play a vital role in extending the operational lives of larger, fixed assets by many years. This is particularly true of utilities that currently burn fossil fuels to generate electricity. The risk they face is that an accelerated transition towards renewable energy could leave them with millions of tons – and billions of dollars’ worth – of “stranded assets”, or the forced retirement of conventional energy-producing equipment and facilities before the end of their useful lives.

Repurposing gas-fired turbines to run on greener fuels is a circular strategy that can help prolong the useful lives of conventional power-producing equipment. This was the option chosen by JERA Americas, an energy company, when it decided to modify a natural gas-fuelled turbine at Linden Cogen, one of its co-owned facilities, to enable it to run on a blend of natural gas and a hydrogen-containing refinery off-gas. As hydrogen does not contain carbon and produces water rather than heat-trapping CO₂ when combusted, this offers a greener alternative to conventional fuels.

JERA Americas turned to Hanwha to modify and improve the turbine’s fuel gas delivery system and gas-turbine combustion system. Hanwha, a global

diversified industrials group whose portfolio includes clean energy, materials and aerospace businesses, re-engineered and retrofitted the turbines to run on a fuel blend including the hydrogen-containing gas, which is supplied by an adjacent petrochemical refinery owned by Phillips 66. This is itself a by-product of Phillips 66’s refining activity, further strengthening the circular value chain.

Hanwha sees its role as helping its customers to adapt to the energy transition in a way that minimizes the customers’ capital expenditure and maximizes the return on investments. By future-proofing JERA’s asset, the collaborative circularity solution extended the life of productive machinery and eliminated the need to extract more virgin materials to build new low-carbon assets. It also saved on the energy needed to mine, refine and process these virgin materials and the costs of construction. Moreover, Hanwha’s modified components are designed for additional incremental upgradeability to ensure clients such as JERA can increase the amount of hydrogen used as a fuel source as government air-quality standards are updated.

3.3 Partnering in **Archetype 3**: creating new markets

Circular strategies that reinvent business models through circular platforms and services are characteristic of Archetype 3 companies. Here again, partnerships are critical for success.

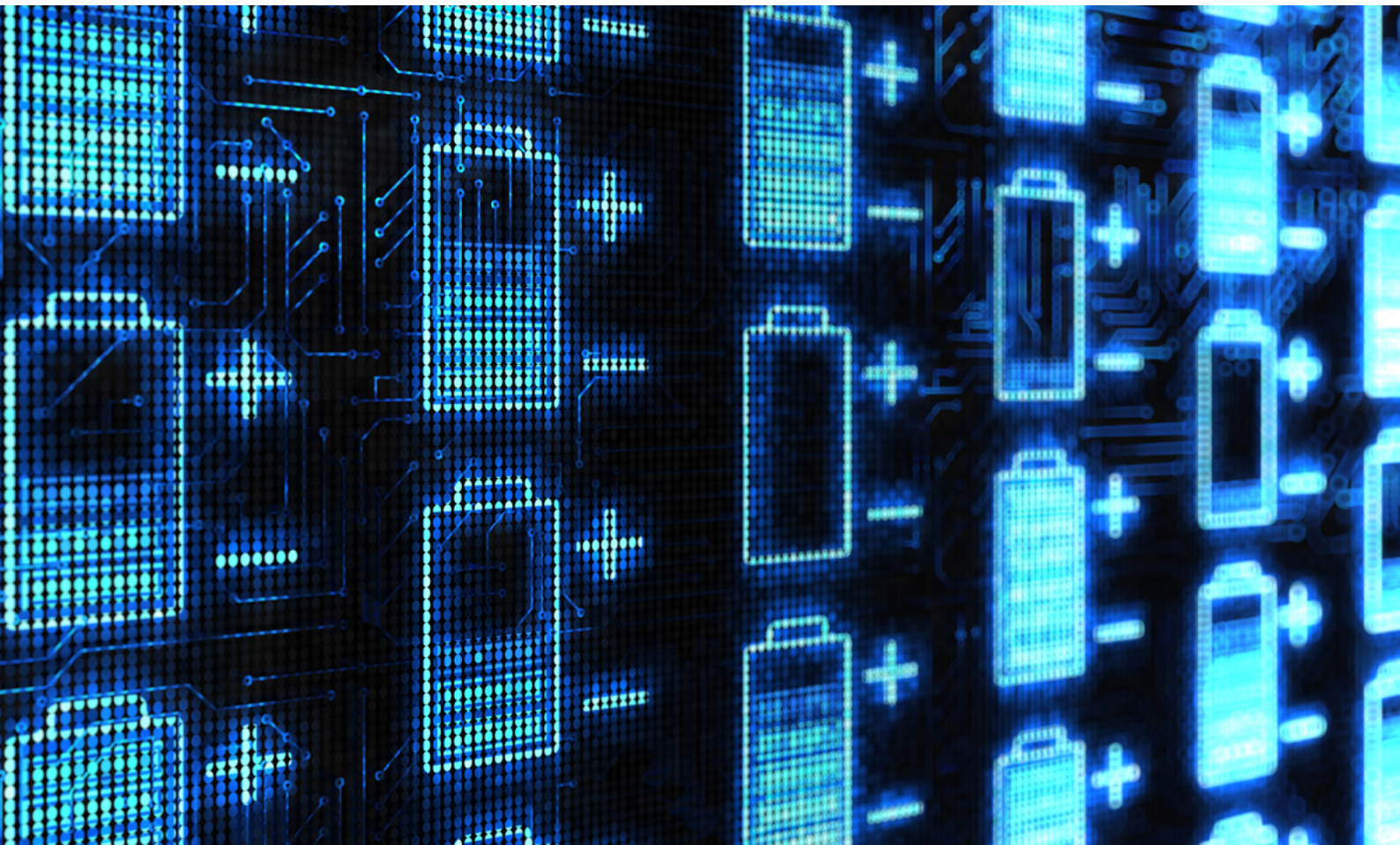
The lifestyle brand Ralph Lauren is spearheading a programme with industry peers, marketplaces and technology providers to create a tech-enabled solution for resellers to receive enhanced product data from brands once they have validated a product via digital ID. Brands struggle with the large volume of fakes that flood the market, and resellers and consumers find it difficult to access quality product information in second-hand markets. Ralph Lauren, and other members of the World Economic Forum’s Centre for Advanced Manufacturing and Supply Chains, realized this was holding back customers from purchasing pre-used items. Buyers’ inability to ascertain the authenticity of a second-hand item, including its original look and other details such as size, was limiting the market for circular products.

The digital ID solution, which can be accessed via a QR code, can validate authenticity quickly and inexpensively for resellers via an easy-to-access guarantee of authenticity embedded in Ralph Lauren clothing that provides all participants with new information flows. This new data brings improved outcomes for all parties. It enables brands to advance in their circularity commitments by providing a new life for their products and extending their use. Resale platforms, an inherently circular business model, also benefit as they can guarantee that the items on their sites are authentic and can provide customers with additional experiences based on the continued data flow with brands.

4

Circular coalitions to drive precompetitive agendas

Organizations cooperating in industry-wide coalitions are establishing the ground rules for the operation of the circular economy.



Some examples in the previous section hint that certain circular strategies providing first movers with a competitive advantage may also benefit the wider business environment. This is particularly true when elements of an enabling environment for circularity require collaboration along the value chain. Design standards, policies that promote circularity or data-sharing mechanisms within value chains are all products of collaboration that will benefit multiple

actors, even competitors. They are necessary elements of a systems change and do not come about through companies acting on their own.

The Circular Electronics Partnership (CEP)¹⁰ and the Global Battery Alliance¹¹ are two examples of coalitions formed to promote a neutral, precompetitive space to advance circular agendas and drive this systemic change.

CEP was formed in 2021 to lead the transition towards an economically viable circular industry. It was established by the Global Electronics Council, the Global Enabling Sustainability Initiative, the World Economic Forum, the Responsible Business Alliance, the World Business Council for Sustainable Development and the International Telecommunication Union.

The coalition now includes more than 20 businesses working on common, precompetitive pathways to circularity spanning the full product life cycle: designing for circularity; generating demand for circular products and services; scaling responsible business models; increasing the official collection rate; aggregating for reuse; and recycling and scaling secondary markets.

In this endeavour, the CEP is tackling some of the industry-wide obstacles faced by circular strategies. For example, the movement of end-of-life electronic goods across borders can be financially burdensome and administratively complex, which both limits the availability of these products in the markets that have most use for them and curtails the full economic and environmental potential of a circular electronics industry. To facilitate the movement of such goods, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal¹² is reviewing the prior informed consent (PIC) procedure – the process for requesting explicit consent prior to the import, transit and export of hazardous materials¹³ – including the introduction of a digital PIC procedure.

As part of this process, the CEP and World Economic Forum are currently exploring a pilot project for implementing an e-PIC in the Pacific, subject to engagement by countries in the region. The pilot hopes to shed light on how to facilitate the movement of end-of-life circular electronics products and decrease the administrative and financial costs of recycling, refurbishing or remanufacturing. By acting together in the design and execution of this pilot programme, the entire industry stands to benefit.

Another example of a multistakeholder coalition is the Global Battery Alliance (GBA), which works to scale the sustainability, responsibility and circularity of the battery value chain. It currently has nearly 150 member organizations.

Batteries are a cornerstone of the energy transition. However, the industry's consumption of lithium and rare earth metals, both limited in supply, has raised concerns regarding the ethics and sustainability of the value chain. These concerns could, in turn, prevent a rapid scale-up in the production of electric vehicles.¹⁴

In response, the GBA has created a battery passport¹⁵ as a framework to increase transparency and accountability along the battery value chain. It establishes a digital twin of the physical battery with standardized, comparable and auditable data on material provenance, the battery's manufacturing history, its sustainability performance (for example, its carbon footprint) and important information for recycling or disassembly.

The battery passport's primary objective is to increase consumer confidence in the product by providing end users with trusted data on sustainability and performance. The precompetitive nature of the GBA enabled the creation of a data standard that will benefit all members as they design their circular strategies.

Both the GBA and CEP illustrate how organizations can work together at a precompetitive stage to address gaps in circular value chains. To do so, companies must distinguish between the circularity gaps that present opportunities for competitive advantage and those that must be dealt with as an industry, or a value chain, to advance systemic change.

Conclusion

Companies need to engage with the circular economy for their own and the world's survival, working together to overcome associated challenges.

Circularity must become the new standard of doing business, and this must happen now. Companies that lag behind will face market disruptions and eventually be taken over by those able to transform their business and operating models. To maintain a competitive position and deliver on their sustainability ambitions, companies must execute bold strategies to scale up their circular efforts and grasp the opportunities offered by evolving markets.

Almost by definition, scaling circularity will require organizations to work together in new, more interconnected ways. Partnerships will be forged both within a business's value chain and outside of it. They may include new relationships that did not have a reason to exist in the past. To achieve this, companies must develop new approaches to partnerships for circularity. They must embed their partnership strategy in their broader business strategy and consider key elements such as how partnerships allow them to act on control and inflection points.

CEOs should consider five next steps when planning their circular strategies:

- Understand which of the three archetypes (or combination of them) can extract the most value from circular transformations

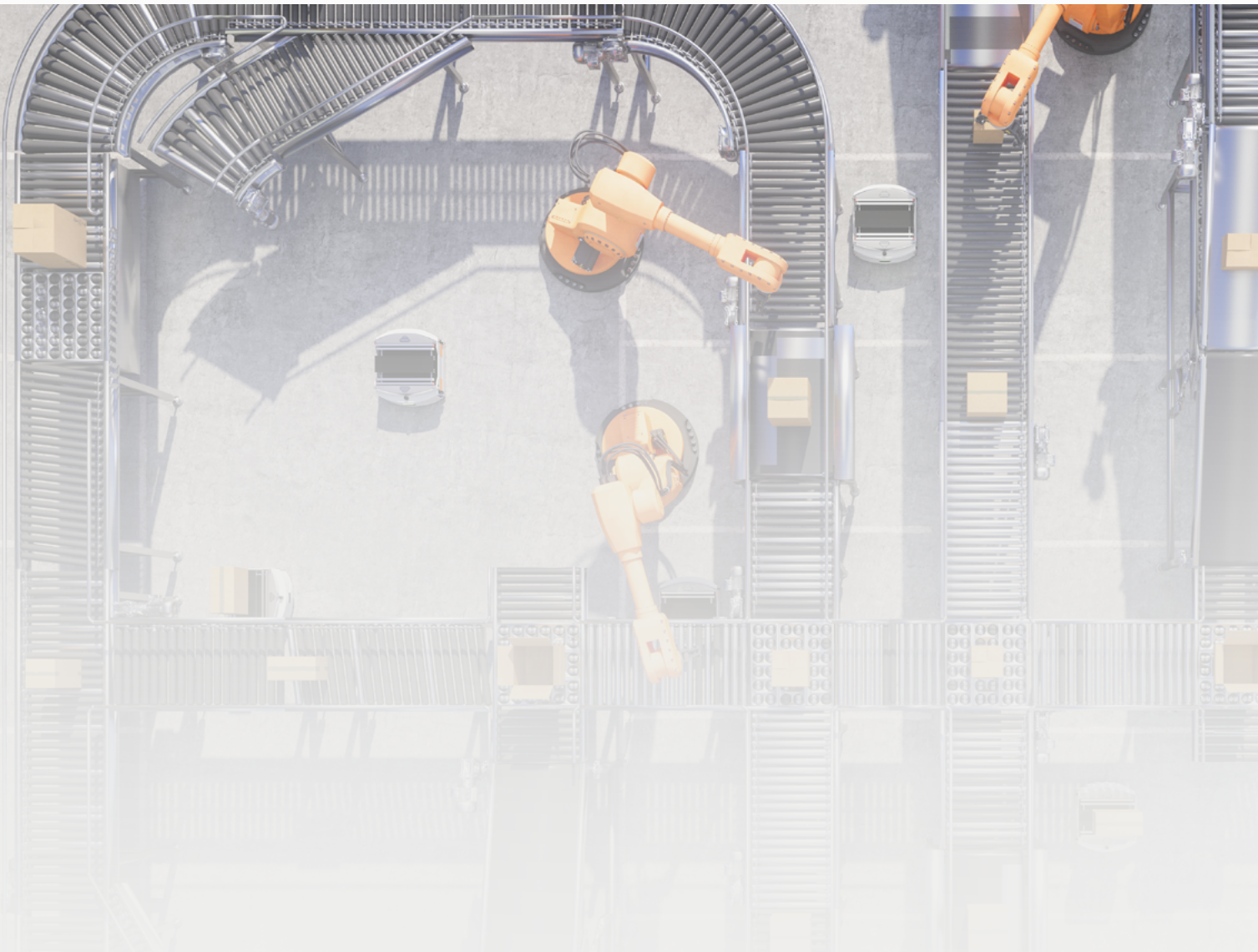
- Identify the control points (materials, technology) they will need to access in their future circular value chain
- Define which levers can positively affect inflection points, with the goal of lowering production costs quickly and accelerating consumer adoption of circular products and services
- Create a clear circular partnership strategy to gain access to these control points and help tip the relevant inflection points
- If necessary, consider building a value chain-wide coalition to set up the infrastructure necessary for change beyond their own organizations.

The World Economic Forum, together with its partners Bain & Company and the University of Cambridge, launched the Circular Transformation of Industries initiative to support businesses in overcoming the challenges associated with their circular transformation, in particular exploring and piloting how to form ecosystems and partnerships to accelerate their circular journeys. Learn more and join the community on the Forum's [Circular Transformation of Industries](#) web page.

Appendix:

Additional case studies

The case studies below take a more detailed look at some of the change stories covered in this paper.



CASE STUDY 1

Schneider Electric – circular business model transformation

Industry	Energy management and industry automation
Employees	135,000+
Case maturity	Scaling stage

Schneider Electric is rethinking its entire value chain by bringing circularity to the whole company, from product design criteria including material use to ease of disassembly and repairability, and recyclability. The transition started with a survey revealing that 30% of customers did not know what to do with their products at the end of the life cycle; 94% were interested in a take-back platform managed by Schneider Electric, and 86% were interested in buying refurbished products. This showed there was a desire, interest and market for a circular solution managed by Schneider

Electric. The company developed a platform that enables it to conduct its own remanufacturing and refurbishing operations through its network partners. This platform gives customers the possibility of purchasing circular products with the same warranty as new products but with added environmental benefits. To encourage customers to return products, Schneider uses an easy take-back platform to declare end-of-use goods, so customers do not have to deal with waste disposal and the associated costs themselves.

Implementation challenges	Enabling partnerships	Enabling strategies
<p>Lack of circular economy education, and the necessity of a change in mindset, to understand why a circular transformation is needed, how this can be achieved and when this will be implemented.</p> <p>Complex product design requiring simplification and updating of some company and/or industry-wide standards.</p> <p>Rapid product sorting, as the data is difficult to manage.</p> <p>Once products have reached their first end of cycle, and are classified as waste, they cannot be handled by standard logistics providers and must be processed by waste management companies. This limits the return flow of products in circular operations for reprocessing.</p> <p>Circular operations imply an increase in inventory.</p>	<p>Upstream – Schneider Electric has partnered with a local recycling/refining company that has the capability to transport waste, sort and refine. Future partnerships will be sought to increase scale for the circular model, e.g. green steel or copper. Co-innovation will be central to these new models from the outset.</p> <p>Downstream – the key criterion for selecting partners is that they have the capacity to propagate the circular value effectively and efficiently and have a solid regional footprint. These partners include distributors, system integrators and panel builders as promoters of the circular model and as collectors of information during their regular customer interactions. If the partners are large enough, they can regularly ship back to Schneider Electric. Trusted partners are preferred: their technical skills, footprint capabilities to master the flows, customer relationships and collaboration is already proven. By taking back the product from customers, they avoid it being classified as waste and instead it is managed internally.</p>	<p>The capability to capture in-service knowledge is critical to creating more business opportunities for customers.</p> <p>The capacity to offer same-as-new quality, warranty and cost through internal infrastructure using the extensive test bed of the original manufacturer or global competency centre.</p> <p>Regulation that encourages a more circular economy, such as extended producer responsibility, which was introduced mainly in France (AGEC),¹⁶ is encouraging customers to return products. In Europe, the circular economy action plan includes provisions that support circular strategies, but it has not yet been mandated.</p> <p>Management is driving the circular transformation strategy by forming cross-functional teams focused on circularity, creating a dedicated line of business. This runs the transformation and the business in tandem, introducing internal standards and definitions, e.g. the repairability index.¹⁷</p>



Impact

Next-generation resilience – through take-backs, Schneider Electric is securing some of the supply of critical materials that are under supply stress. During supply-chain disruptions, the company has already been able to significantly reduce lead-time by providing circular electronic components.

New sources of revenue – in 2023, 22% of Schneider Electric's product families will have at least one circular economy offer available. By 2025, the company envisages 33% of product families will be covered.

Resource efficiency – products that offer circular options, such as refurbished products, can decrease resource use. In 2022, Schneider Electric significantly increased its offering of circular products to serve the growing demand, doubling the number of references available up to 6,400. In 2023, the Group expects to add more than 3,000 new references to its circular offering.

Environmental sustainability – by 2025, Schneider aims to have avoided 420 million metric tons of primary resource consumption through take-back at end-of-use (since 2017), and by Q2 2023, it had already achieved 284 million metric tons of reductions. This programme enables savings in waste, material, energy consumption, CO₂ emissions and/or water.



CASE STUDY 2

Western Digital – reuse of computer drives

Industry	Computer drive manufacturer
Employees	53,000
Case maturity	Discovery and pilot stage

Western Digital is currently transitioning to circularity by mapping all value streams to identify circular opportunities for data storage devices. Its internal circular operating model consists of life extension, reuse and resale of drives and advanced recycling. The company is modelling the projected rates of retired drives that could benefit from advanced elemental recycling. Internal drives previously

designated for testing are being repurposed. Initially, the goal is for both internal and external failed drives to go through an elemental recovery phase to achieve high throughput and maximize yield. The desired outcome is to have a greater than 90% recycled yield, including the recovery of rare earth elements used in the drives.

Implementation challenges	Enabling partnerships	Enabling strategies
<p>Data security – making sure that deep erasure can occur and be validated.</p> <p>Ensuring that circular drives reach credible third-party hands and supply chains.</p> <p>Lack of technology and a recycled content traceability platform to verify that incoming material contains the specified amount of recycled content.</p> <p>Discovering partners with advanced sorting and recycling capabilities specific to hard disk drives yields improvements, allowing for more eco-friendly methods of rare earth recovery.</p>	<p>Upstream – Western Digital needs to work with suppliers to report recycled content and develop a database, business process and documentation to track and revise as recycled content is increased. The recycled content would then be incorporated into the company’s supplier scorecard. Some joint research and development would be conducted with suppliers to explore alternative materials or processes that are competitively priced with raw materials.</p> <p>Downstream – after use, it is important to capture the drives for advanced recycling purposes, including recovery of rare earth materials. Developing circularity models to enable advanced recycling requires establishing relationships and partnerships for each product and subcomponent. In addition, through these partnerships, Western Digital is working with advanced recyclers to develop processes that are more efficient at increasing recycled yield and rare earth recovery via new scientific breakthroughs, while incorporating automation for enhanced materials segregation.</p>	<p>A growth mindset with change management aspects is required to introduce new business models into well-established companies with a cross-functional, collaborative environment for strategic and cost-effective models.</p> <p>Launching an environmental, social and governance (ESG) platform and developing internal technology and platforms for traceability and mechanical capabilities to provide recycled content levels for incoming materials.</p> <p>Strong regulations with proven standards for securely erasing the drives so that data is not retrievable.</p> <p>Providing leadership for short- and long-term capital investment projection for circular initiatives.</p>



Impact

Next-generation resilience – over the next five years, more than 5 metric tons of rare earth metals will be recovered.

Resource efficiency – these drives would represent 80% of Western Digital’s current shredded volume that can go into a new reused/refurbished channel. An additional 20% of drives would be channelled into parts-harvesting or elemental recovery recycling efforts.

Environmental sustainability – life-cycle analysis suggests the following impacts:

~50% reduction of CO₂e for recovered rare earths vs. mining, ~70% reduction of CO₂e for recovered drives vs. new and ~30 kg of CO₂e lower emissions per reused/refurbished drive. Internal analysis is ongoing, and these numbers are subject to revision.



CASE STUDY 3

Siemens – product repair network

Industry	Technology
Employees	311,000
Case maturity	Scaling stage

Siemens Digital Industries (DI) has a global repair network consisting of 134 repair centres, with Siemens operating a number of its own facilities. While some of its manufacturing sites work as lead repair centres to set the repair standards, smaller repair centres act as a simple point-of-contact for the customers to arrange for their products to be

fixed. On top of that, Siemens is collaborating with partners that serve as certified third-party repair centres. The network has a global range and is managed by Siemens DI customer services. It is capable of expanding the lifespan of a variety of Siemens products, ranging from motors and drives through to automation machinery.

Implementation challenges	Enabling partnerships	Enabling strategies
<p>Limited visibility on end-to-end (e2e) life cycle of the product due to Siemens' business-to-business model (product sold to a machine builder, which then sells it to its end customers to use for their own manufacturing).</p> <p>Lack of awareness of and incentives for customers to engage with circularity.</p> <p>Overseeing a huge repair network is difficult; constant changes, either from Siemens' own restructuring or from repair partners' alterations.</p> <p>Risk of undermining the Siemens product promise of robustness and longer-than-average lifespan.</p> <p>Difficult to implement processes and regulations for taking products back, which also requires changes in infrastructure.</p> <p>Long technology implementation time.</p>	<p>Repair network – actively entering into partnerships to serve customers quickly and in the right place (repair). Certification process for qualification as a partner repair centre and continued auditing process. Fostering strong partnerships by focusing on strategic partners instead of constantly increasing the number of partners.</p> <p>Technology providers – internal Siemens DI-wide project team consisting of research and development, product managers, construction and mechanics, and factories to deliver consistent solutions (QR code, prospective product passport).</p> <ul style="list-style-type: none"> – Partnership with cloud providers for the data lake infrastructure. – Cooperation, exchange and presentation (of QR code) with other big players at several fairs. Existing product integration partners can be leveraged to reach end customers and gain transparency regarding the visibility of the e2e life cycle of products. 	<p>Technology and infrastructure:</p> <ul style="list-style-type: none"> – Digital IDs and in the future also more advanced solutions such as the product passport are seen as the main enablers for the circular economy by serving as an interface for the end customer. – Technology and relevant infrastructure are therefore very important: cameras on assembly lines, software interfaces and updates on lasers and printers; introduction of new International Electrotechnical Commission (IEC) standards; establishing several interfaces in internal systems. – Strong, well-established repair network serves as a partner and basis for new business models, e.g. long-life repair. <p>People and culture:</p> <ul style="list-style-type: none"> – Intensified collaboration between multiple departments and business units (i.e. customer services, manufacturing, product management). – Creating awareness and emphasizing necessity of new sustainable business models helps to nudge mindset shift and change business approach. – Defining a strategic positioning on circular transformation with a standardized and homogeneous approach. – With the help of the digital IDs, Siemens is planning on developing an incentive system for all actors in the ecosystem to engage in the circular model (especially take-back incentives for products). <p>Regulation and policy:</p> <ul style="list-style-type: none"> – Internal and external regulations and policies will help to boost and promote sustainable and circular business models.



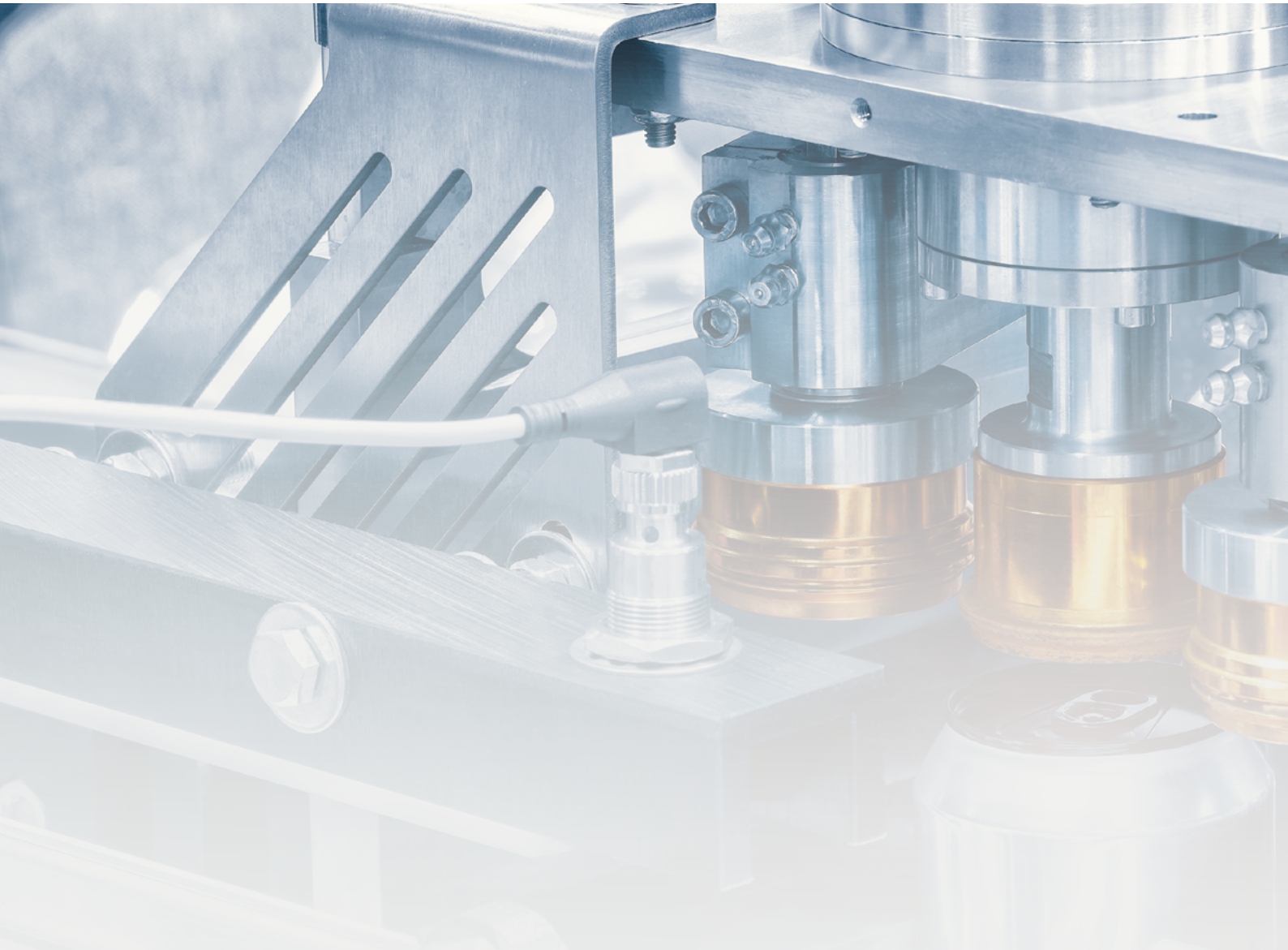
Impact

Next-generation resilience – information on the lead repair centre shows: fewer than five working days repair lead time and 98% delivery reliability.

New sources of revenue – with long-life repair retrofitting and enlargement of industrial computing, Siemens is expecting to generate additional revenue of more than €1 million per year.

Resource efficiency – 35,000 field and customer repairs per annum and covers a portfolio of 5,500 different products.

Environmental sustainability – Siemens' overall target for CO₂ emissions is net-zero operations by 2030.



CASE STUDY 4 Ball Corporation

Industry	Aluminium packaging manufacturer
Employees	23,000
Case maturity	Development stage

Ball Corporation's approach to sustainability has evolved over the years to become an integral part of the company's strategy, shaping its competitive and economic advantage.

Since the company's growth potential relies in part on its ability to transform itself into a fully circular

and decarbonized business, it has embarked on a business journey to transform its aluminium packaging (cans, cups and bottles) into a total circular solution that spans high recycled content, ultra-low-carbon primary aluminium, and reuse and refill applications.

Implementation challenges	Enabling partnerships	Enabling strategies
<p>Meeting national and subnational recycling targets.</p> <p>The lack of policies that mandate the efficient collection, sorting and recycling, and reflect the true cost and circularity benefits of aluminium, hence enabling greater availability of used beverage cans in a can-to-can closed loop.</p> <p>The need for ultra-low-carbon primary aluminium technologies available at scale.</p>	<p>Upstream – sustained, close supply-chain collaboration based on aligned climate vision and goals with suppliers and their suppliers to support Ball's target of 85% recycled content by 2030, and piloting recycled content and low and ultra-low carbon primary aluminium products.</p> <p>Midstream – Partnership with Boomerang Water to provide reusable, recycled aluminium bottles for a point-of-use bottling system that washes, sanitizes, rinses, fills and caps water bottles, eliminating waste and carbon emissions produced by manufacturing and transporting traditional, disposable bottles.</p> <p>Downstream – engagement in initiatives and with venues to support the collection of cans and cups and drive consumer awareness regarding the sustainability advantages of aluminium packaging.</p>	<p>Extended producer responsibility and deposit-return system regulations where the schemes and fee structure are reflective of the true costs and circularity benefits of aluminium, enabling the effective collection, sorting and recycling of used packaging.</p> <p>Investment in developing in-house sustainability and circularity capabilities (e.g. climate transition plans, life-cycle assessment).</p> <p>Membership of the First Movers Coalition's (FMC)¹⁸ aluminium group, leading strong, consistent demand for low-carbon primary aluminium.</p> <p>Working with key suppliers on innovative procurement commitments to support the investment in recycling and low-carbon rolling mills.</p> <p>Research and development to improve light weighting (making products lighter) and efficiency in operations to mitigate Scope 1 and 2 emissions.</p> <p>Development of serialized coding for packaging to track containers throughout their life cycle, currently being trialled, to streamline collection and sorting.</p>



Impact

Next-generation resilience – recycled content targets mean less reliance on the supply of primary aluminium, and higher resiliency of the upstream value chain, which is fundamentally dependent on collection and recycling rates.

New sources of revenue – the high residual value of aluminium justifies the economics of collection and high recycling rate. Benefits to local economies include increased sales of recycled aluminium; new jobs in collection, sorting and reprocessing of recycled material; and wage increases. Ball and Resource Recycling Systems, a consultancy firm, estimate that, in the United States, taking recycling rates from roughly 40% to 90% would keep 1.3 million metric tons of aluminium out of landfills, generate \$1.6 billion in sales of recycled aluminium, add more than 100,000 jobs and raise wages from \$2.1 billion to \$5 billion.¹⁹

Resource efficiency – the current recycled content of Ball products is between 60% and 65%, with a global target of 85% by 2030, enabled by a 90% recycling rate. Aluminium bottles developed by Ball for Boomerang Water are certified for over 150 use cycles.

Environmental sustainability – with the production of recycled aluminium requiring only 5% of the energy needed to produce primary aluminium, circularity is the key lever of the climate transition plan. By 2030, Ball aims to achieve a 55% emissions reduction across all scopes without relying on offsets, a 90% recycling rate to enable 85% recycled content and 10% ultra-low carbon primary aluminium as per the FMC commitment the company has made.

Contributors

World Economic Forum

Maria Basso

Centre Curator, Advanced Manufacturing and Supply Chains, World Economic Forum

Lucy Burton

Project Fellow, World Economic Forum;
Senior Associate Consultant, Bain & Company

Pietro De Gaetano

Project Fellow, World Economic Forum;
Manager, Bain & Company

Anis Nassar

Lead, Resource Circularity, Centre for Nature and Climate, World Economic Forum

Stacey Weismiller

Initiatives and Communities Lead,
Advanced Manufacturing and Value Chains,
World Economic Forum

Bain & Company

Tessa Bysong

Partner

Arnab Hazra

Senior Manager

University of Cambridge

Lisa Rossi

Research Fellow; Doctoral Researcher,
University of Cambridge

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Designer, 1-Pact Edition

Alison Moore

Editor, Astra Content

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World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org