DHL WHITE PAPER

DELIVERING ON CIRCULARITY

PATHWAYS FOR FASHION AND CONSUMER ELECTRONICS

FOREWORD

The signs of climate change and environmental damage are alarming and increasingly visible. Extreme weather events are occurring more often and with higher intensity, and temperatures are continuously rising. In addition, there is a growing amount of waste – from plastics in oceans to overflowing landfills – which further threatens the health of our natural ecosystems and the people who live and work in them.

The transition to renewable energies is an important part of the solution to curb the greenhouse gas (GHG) emissions that drive climate change, and it is how we will move toward net zero. But we cannot rely exclusively on the increased use of renewable energies as the sole solution. Every industry is called on to examine what they can do in their specific case. Luckily, a complementary strategy exists that addresses the impact of both emissions and waste: circularity. Institutionalizing this model, which aims to maintain a product's value for longer, is crucial if we are to tackle a broad set of environmental concerns simultaneously.

The journey toward circularity is one that many industries must take, but the opportunity in consumer goods – particularly fashion and consumer electronics – merits a closer look. The presence of these industries in our lives is nearly universal, the measures that the industries' stakeholders can take are clear and manageable, and the potential positive impact is huge.

Circularity holds the promise of saving the environment while driving innovation and growth. Novel circular business models not only diversify product and service portfolios; expected positive customer engagement also serves as a clear brand booster. In other words, while circularity makes products more sustainable, solutions that also deliver business benefits make circularity sustainable.

The possibilities for fashion and consumer electronics companies in the circularity space are limitless. A unique chance now exists for brands to deepen their relationships with customers in ways that will quite literally help to save the planet. Logistics players can be the ideal facilitator of this new relationship and its many new moving parts, doing what they do best: orchestrating the intricate flow of goods.

Frank Appel
CEO, Deutsche Post DHL Group

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EXECUTIVE SUMMARY

Ensuring that global production and consumption is compatible with environmental goals lies at the core of sustainability. It requires a move away from the predominant produce-sell-use-waste model and toward one that significantly extends the "use" phase, adds new models to the "sell" phase, and turns waste into valuable inputs going back into the "produce" phase. This is circularity.

This report highlights the circularity opportunity in consumer goods, particularly as it relates to fashion and consumer electronics. Our analyses yield the following key insights:

THE BASELINE:
Significant environmental impact of fashion and consumer electronics
The fashion and consumer electronics industries drive a large share of GHG emissions and other environmental impacts (including resource, land and water use, as well as waste). Together, their carbon footprint makes up approximately 6% of global emissions. Currently, around 20% of garments produced are never used, and smartphones are often exchanged after just 2–3 years. Therefore, the positive impact that circularity in these two industries could have is pronounced, and industry front-runners are actively participating in the paradigm shift toward circularity.

THE MISSION:
Circularity holds large potential for net-zero and the environment
Up to 80% of emissions of an average fashion or consumer electronics item accrue during production. Hence, extending the product lifetime as much as possible is essential. The 5 Rs provide the critical dimensions to achieve circularity, by: Reducing use of virgin materials in production, Repairing products to extend their first lives, Refurbishing older products to go back on the market Reselling products to new owners, and Recycling products at end of life into materials for new production. Especially giving products a second life can curb emissions by 55 to 75% per device compared with producing a new device from virgin materials.

THE TRANSFORMATION:
10 + 3 building blocks and enablers to go from supply chain to supply loop
10 building blocks and 3 core enablers guide the successful transition toward circularity. Materials, products, and packaging must be innovated, agile production and novel use concepts launched, and smart product return and recycling developed. To bring these elements to life, supply chains need to be designed in a circular way, while ensuring visibility and close orchestration throughout and establishing circular consumer behaviors.

THE CALL FOR ACTION:
Collective stakeholder action needed
The transition must be a concerted effort from 4 stakeholder groups: brands will create circularity opportunities via new products and use models, customers will actively participate in circular behaviors, governments will create an environment that encourages these behaviors, and logistics players will enable the new circular flow of goods. Above all, only if all stakeholders take on their responsibility and act now – thereby accelerating a mutually reinforcing loop – can circularity become a reality.

While the successful transition toward circularity is certainly a shared responsibility and effort, logistics players are the natural backbone. Circularity changes the way materials and products move – from a straight line to a regenerative circle – and efficiently managing the flow of goods is what logistics is all about. We at DHL are looking forward to partnering with circularity's stakeholders by serving as an enabler for the new physical and data flows within the supply loop.

INTRODUCTION

Climate change is a persistent, global threat. Reducing GHG emissions is essential to slowing the rate of temperature increase, and two key measures are often seen as the main levers: transitioning toward sustainable energy and reducing carbon use (for example, petrochemicals) in the supply chain. These two interventions alone, however, are unlikely to drive down emissions enough to meet the targets that scientists and many world economies have set.

Circularity is the much-needed additional piece. At its heart, circularity describes a departure from the traditional produce-sell-use-waste paradigm toward more sustainability. Think of a circular economy as a design for an ecosystem that builds on sustainability, visibility, and multidirectional flows. To move away from the traditional paradigm, production volumes and materials need to be optimized, product life cycles must be extended, new models for product use have to be developed, and solutions for end-of-life recycling need to be found. According to research, this shift in the supply chain paradigm has the potential to cut emissions by up to about 40%,[1] and it is more cost effective than any other approach to decarbonizing the supply chain.[2] Moreover, beyond its ability to curb global warming, circularity can also positively impact other environmental and social issues, such as waste, land use, water use, and poor working conditions.

Because of its potential, circularity has received substantial attention across stakeholders and industries as a leading and holistic solution. Fashion and consumer electronics are at the center of the conversation and predestined as frontrunners in the solution given the characteristics of the products, consumption behaviors and usage-waste cycles within these industries. Since increased circularity builds on an increasing number of multidirectional flows of goods, logistics service providers are the needed enablers and accelerators of the transition. As such, this particular stakeholder group is positioned to take on the task of redesigning these flows in highly efficient, user-friendly ways.

WHERE WE STAND ON CIRCULARITY

The growing push to transform from a linear supply chain to a closed-loop supply model has gained traction from both private and public players. Stakeholders globally are driven to identify initiatives to reconfigure our economic and social practices into “loops.” Players across industries are making circularity an important aspect of their sustainability strategies. Examples of these efforts include the many initiatives of the Ellen McArthur Foundation and the Institute of Positive Fashion as well as multi-corporation partnerships, such as the Circular Electronics Partnership.

Given its potential for large environmental and social impact, circularity is also increasingly relevant for governments. Policy makers and regulators have already identified circularity as an action field: In the EU, textiles will have to be collected separately from household waste by 2025.[3] For consumer electronics, there is already a mandate to do so. In addition, the European Commission recently suggested legislation prescribing a “right to repair” for household goods[2] – and it is well imaginable that the scope of such regulation may be extended to other consumer goods in the future.

Mandates, however, are one thing; meeting the targets laid out in those mandates is another. For example, the EU electronic waste collection objective of 45% is still a stretch for several of its member states.[4] Closing this gap and fully transitioning toward circularity across supply chains and sectors will be challenging, but we believe that the building blocks of a functioning circular economy as well as the stakeholder-specific action steps we describe in this report are practical and powerful tools to address the challenge. As a whole, the implementation of circularity at scale will hinge on the economic viability of solutions, and stakeholders must identify plays that protect the planet and allow for an economically feasible transition for the industry.

WHY FASHION AND CONSUMER ELECTRONICS ARE IDEAL CANDIDATES FOR CIRCULARITY

A fully circular economy spans across supply chains and sectors. Among the sectors, the consumer goods space (including food products) is responsible for approximately 25% of global GHG emissions and is only second to the mobility sector.[1] Within the range of consumer goods, fashion and consumer electronics drive a particularly large share of GHG emissions and environmental impacts. As such, the positive impact that circularity in these two industries could have on climate, the environment, and society is tremendous.

While these industries are resource intense and in part behind other front-running industries (such as the automotive parts industry) in terms of circularity initiatives, their global consumer and supply-chain reach as well as high visibility make them one of the most pivotal participants of circularity. Specifically, they stand out due to 5 characteristics:

Resource-intense materials and production processes. Manufacturing in these two industries requires vast amounts of often nonrenewable resources (including raw materials and energy inputs) and is the source of significant emission levels.

Relatively few systematic circularity measures. Compared to leading sectors such as automotive parts, for example, the reuse, refurbishing, and recycling processes in fashion and consumer electronics are less advanced and widespread.

High reach and relevance to almost everyone. Some sectors are relatively niche, others have larger consumer bases – and then there is fashion and consumer electronics: almost every consumer is active in these two retail categories in both their private and professional lives.

Very complex and globalized supply chains. The supply chains of these two sectors cross many continents and companies, necessitating sophisticated coordination in the supply chain for maximum impact.

Strong visibility and multiplier effects. The industries are often in the focus of media attention and play a prominent role in the public dialogue. A move toward circularity in fashion and consumer electronics could therefore have broad signaling effects beyond the two industries, with both potentially serving as role models and helping other industries become more circular.

While fashion and consumer electronics represent particularly large opportunities in circularity, many of the circularity challenges are universal. Hence, the insights presented here can potentially be applied to other sectors, and industries across the board could certainly mitigate their environmental impacts by making circularity a bigger part of their product life cycles.

WHY LOGISTICS IS CRITICAL

Circularity is about the flows of physical goods and relies on the careful orchestration of the physical supply loop across different elements. Especially innovative business models around post-sale interventions such as reselling, repairing, refurbishing, and recycling will require novel multidirectional flows to be designed and managed. As a result, logistics will play a more pronounced role during the extended lifetime of products and raw materials. Visibility backed by digital technologies will be a central anchor to master the increasing complexity of the flow of goods and ensure ease of use for consumers.

These activities are at the core of what we do at DHL. We would like to lend our expertise to the important undertaking of circularity and play an even bigger role in addressing some of the biggest environmental and social challenges of our time.

THE BASELINE

THE ENVIRONMENTAL IMPACT OF FASHION AND CONSUMER ELECTRONICS

Fully appreciating what circularity in fashion and consumer electronics could mean tomorrow requires an understanding of the environmental challenges these industries are facing today.

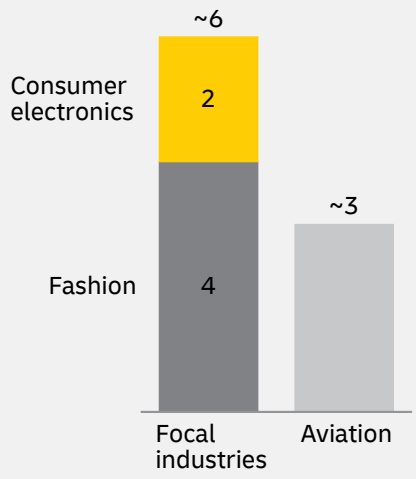
Both industries are managing particularly complex supply chains; which span several continents and incorporate diverse suppliers across different levels. Ultimately, this leaves a footprint on climate, natural resources, and society, with exemplary impacts outlined below. As active participants in the global paradigm toward sustainability, industry leaders have announced ambitious targets and are launching initiatives to lead their path toward circularity. Examples include Nike's "Guiding the Future of Design" workbook, which focuses on circular design, and Dell's "Circularity at work," with principles covering circularity along different stages of the product life cycle.

CLIMATE

The global fashion and consumer electronics industries have a sizable impact on climate change. A conservative estimate for the fashion sector suggests that it is responsible for about 4%[5,6] of annual global GHG emissions (up to 8%, according to other sources[7]) and that the consumer electronics sector's share of GHG emissions is approximately 2%.[8] Combined, these sectors represent twice the share of GHG emissions of the aviation industry (3%[9,10]) (Exhibit 1). For added perspective, fashion's and consumer electronics' combined 6% share of global GHG emissions is close to the overall emissions of the entire EU. At current consumption levels and under current approaches to managing the life cycles of these products, emissions from these industries would grow by 60% until 2030 and account for around 20% of the UN GHG emissions target for 2030, which is set at half of today's emissions[11] (Exhibit 2).

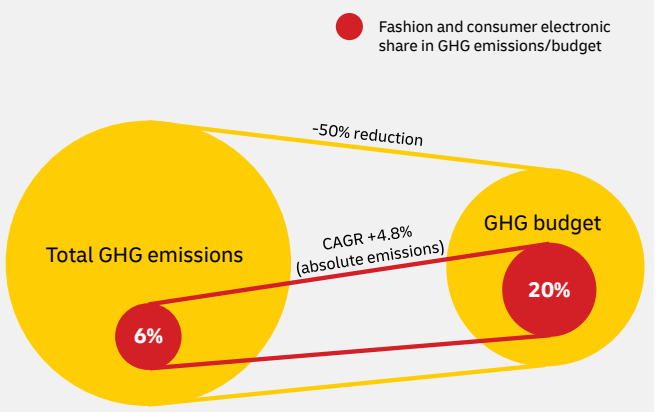
Yet, if the world is going to achieve the UN's target of limiting global warming to 1.5 degrees,[11] industries not only have to stop their trajectories of increasing emissions, they must reverse them. Hence, action is needed in these sectors and transitioning toward circularity can be an important stepping-stone toward the solution.

SHARE OF GLOBAL GREENHOUSE GAS EMISSIONS
PERCENT EXHIBIT 1



Source: McKinsey Fashion on Climate Report; Institute of Positive Fashion Circular Fashion Ecosystem Report; GreenIT Report "The environmental footprint of the digital world"; McKinsey & WEF Clean Skies for Tomorrow Report; Shift Project "Lean ICT" Report; European Commission "Reducing emissions from aviation"

FASHION AND CONSUMER ELECTRONICS GREENHOUSE GAS EMISSIONS
2020 VS. 2030, IN PERCENT OF TOTAL EMISSIONS EXHIBIT 2



Note: Assuming current consumption patterns and halved GHG budget in 2030 for 1.5 degree goal. The 50% budget reduction objective is based on the United Nations Framework Convention on Climate Change.
Source: United Nations Framework Convention on Climate Change; McKinsey "Fashion on Climate" Report; Shift Project "Lean ICT" Report

NATURAL RESOURCES

On top of these industries' direct contributions to climate change via their emissions, their current production and consumption patterns have pronounced adverse consequences on other aspects of our natural environment (Exhibit 3).

The consumption of nonrenewable resources is a key problem in both industries. Consumer electronics products in particular, be it smartphones, tablets, or laptops, typically require a two-digit number of different metals, including rare earths, in their production. For example, about 60 to 70% of the weight of an average smartphone comes from minerals and rare metals.[12] These resources are scarce, which makes collection and recycling key. The fashion industry depends on nonrenewable resources as well, as synthetic fabrics (such as polyester) are often produced using fossil fuels.

Another major issue is the extensive land use required by these industries. Fashion clearly has the largest impact, requiring 40 million hectares, mostly for cotton farming. This means that an area larger than the size of Germany and Switzerland combined is used.

The water consumed by the operations of the two industries is also substantial. For example, global water use in fashion amounts to 150 trillion liters annually. This is about equal to 40% of the yearly water consumption of US citizens.[13] A typical T-shirt requires up to 2,700 liters in its production because of the water-intense cotton farming,[14] which is equal to 18 filled bathtubs. Next to water consumption, production processes also contribute to the growing water pollution, for example, when chemicals used for dyeing leak into fresh water.[15]

Considering the end of the product lifetime, waste is another major issue. Electronic waste (e-waste) is the fastest-growing waste stream globally – often causing severe damage to the land and water resources described above – and consumer electronics are a primary contributor. Although there is a growing global market for e-waste (predicted to almost triple between 2019 and 2027[16]), 80% of consumer electronics e-waste is not even collected for recycling. Even Europe, the global leader, collects only 42.5% of its e-waste for recycling,[17] while the Americas collect less than 10%.[17] Waste from fashion products is often landfilled or incinerated – about 75% of the produced volume – causing additional emissions.[5]

ENVIRONMENTAL IMPACT OF FASHION AND CONSUMER ELECTRONICS EXHIBIT 3

	 Water use	 Land use	 Waste
	156.5 trillion liters	**40.6** million hectars	**146** million tons
Fashion	150	40	92
Consumer electronics	6.5	0.6	54
Equivalent to	~40% of US population's annual water consumption	More than the area of Germany and Switzerland	~50% of Europeans' annual waste

Source: Scientific Data "A global-scale data set of mining areas"; Green IT Report; Global E-Waste Monitor; BBC "Why clothes are so hard to recycle"

HUMANITY

In today's linear economy, increased raw material extraction and high levels of waste also create negative social implications. Regarding consumer electronics, the necessary mining activities for access to critical raw materials may come with dangers for workers, such as mine collapses and contact with toxic substances. In addition, consumer electronics waste that is not recycled properly and is instead discarded in illegal landfills may contain dangerous substances, such as heavy metals, that can be harmful to people who make a living from waste processing.

For industries to change course, circularity is key, as it helps to reduce resource consumption at the beginning of a product's life cycle, lengthen that product's lifetime, and extract maximum value from the product at the end of its lifetime. As argued previously, many consumer goods companies recognize their role in becoming more environmentally friendly, and several leading players have announced ambitious circularity targets.

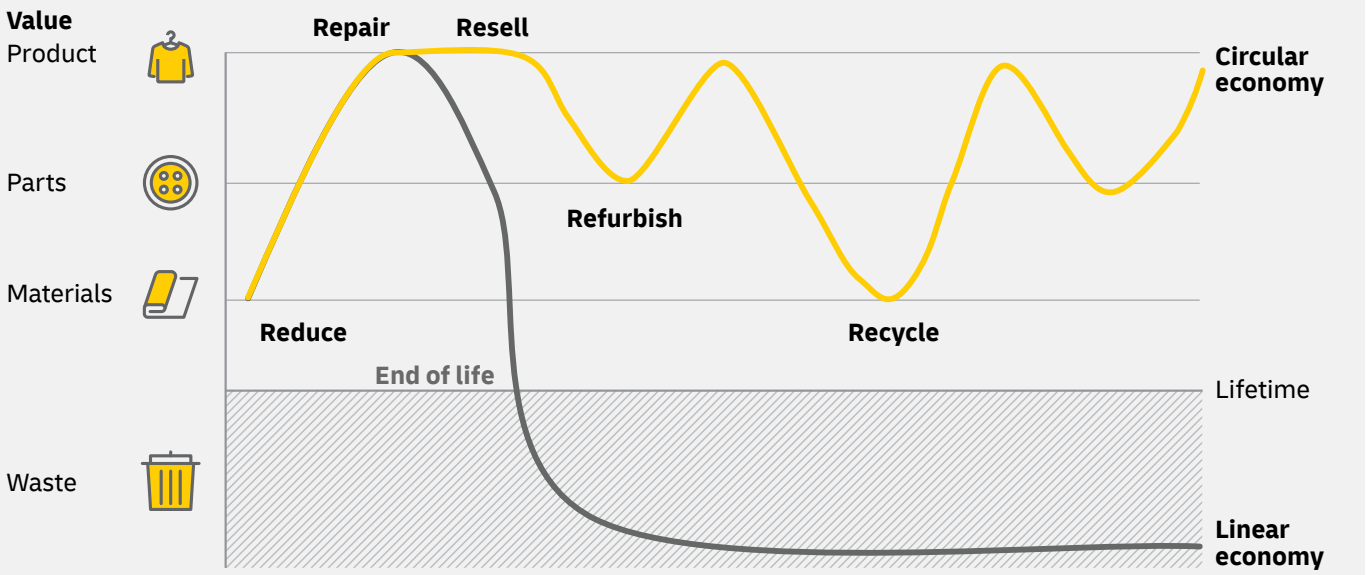
Circularity interventions will help to limit climate change, protect the natural environment, and improve living and working conditions for many of the planet's inhabitants. The report will focus specifically on circularity's direct impact on GHG emissions, as this is a particularly pressing issue and the clear benchmark that can be monitored by both governments and industry.

THE MISSION

CIRCULARITY HOLDS LARGE POTENTIAL FOR NET-ZERO AND THE ENVIRONMENT

The linear economy is based on the classic produce-sell-use-waste paradigm. In this model, manufacturers primarily focus on the production of the good and its components, transferring responsibility for how the product is used and disposed of to consumers. The circular economy instead aims to reimagine product design to manufacture and consume in a way that the goods produced, sold, and used today are recycled into the raw materials of tomorrow.[18] Under this paradigm, both manufacturers and consumers have more active roles, focusing on the efficient and economical use of resources and creation of new value for products beyond first use (Exhibit 4).

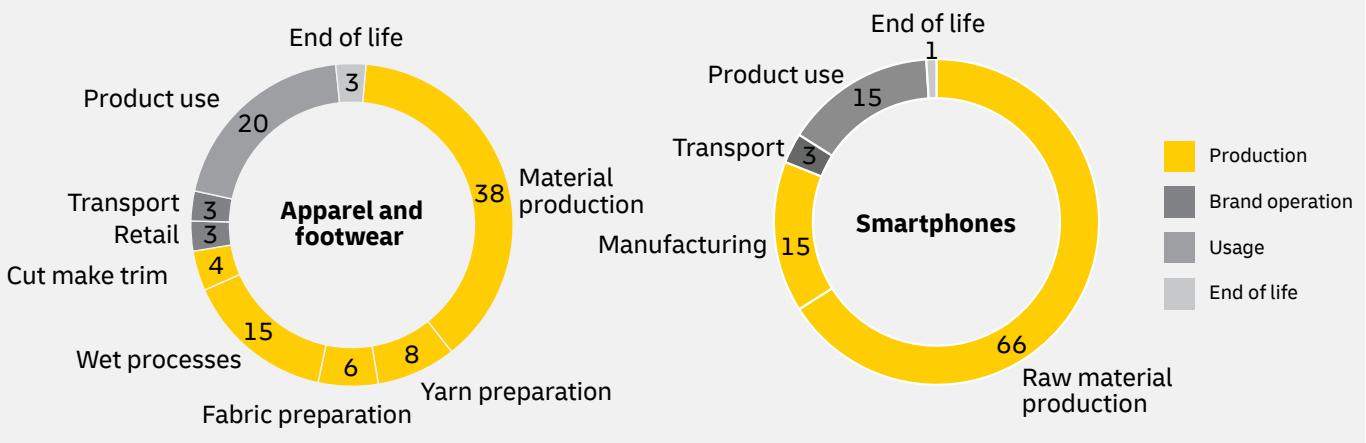
LINEAR AND CIRCULAR PRODUCT LIFECYCLE EXHIBIT 4



Source: Adapted from ETC/WMGE

The conservation and recycling of raw materials and resources is particularly meaningful and effective in the fashion and consumer electronics industries, as the largest share of GHG emissions come from raw materials and production (Exhibit 5). For example, in fashion, 71% of carbon emissions occur in the production phase,[5] while around 20% of emissions are caused during product use (especially by washing). Looking at one of the most ubiquitous consumer electronics products, smartphones also produce more than 80% of their emissions in the production phase, with 15% accrued during usage (especially through charging)[19]. Major parts of the production-related emissions occur during the extraction of raw materials, such as metals.

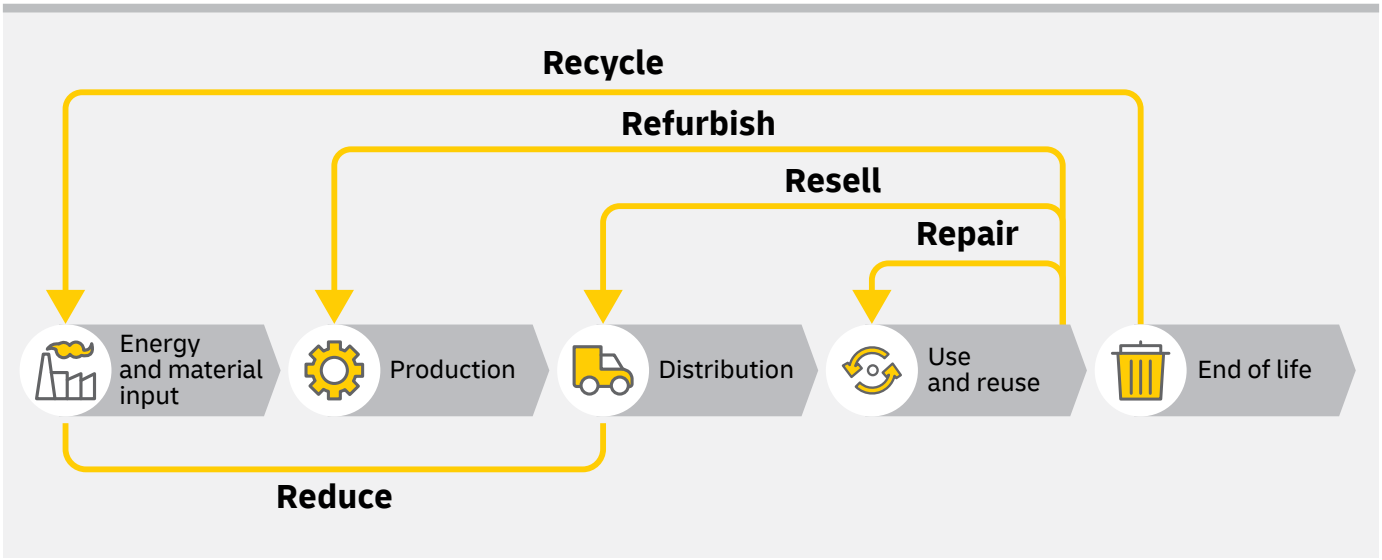
GHG EMISSIONS ALONG THE VALUE CHAIN
PERCENT EXHIBIT 5



Source: McKinsey "Fashion on Climate" Report; Shift Project "Lean ICT" Report; Green IT Report; Apple; Backmarket

Since production is the overwhelming driver of emissions in both fashion and consumer electronics, extending the lifetime of these products and putting their residual value back into the production phase are crucial elements of reducing production's footprint. Ultimately, the longer a product holds value, the less frequently it will need to be replaced. The 5 Rs of circularity – reduce, repair, resell, refurbish, recycle – provide the critical dimensions along which circularity can be achieved (Exhibit 6).

ROLE OF THE 5 Rs IN THE CIRCULAR PRODUCT LIFECYCLE EXHIBIT 6



REDUCE.

There is significant overproduction, especially in fashion (20 to 30%).[20,21] "Reduce" is the circularity "R" that refers to production, and it does so in two ways. First, it aims to reduce the overall volume; fewer new products need to be manufactured when the lives of existing products are significantly extended, production is increasingly on demand and overproduction is limited. Second, circularity also means that the profile of product inputs changes, where a shrinking share of inputs are raw/virgin materials and the negative impact of resource and materials use shrinks accordingly.

REPAIR.

Fixing damaged products whenever possible, either via do-it-yourself home repair or via professional repair services, is a clear intervention toward extending the life and maintaining the value of many consumer goods. Several fashion companies are already piloting offerings for fashion repair in combination with consumer education (for example, Patagonia's free repair offering to end consumers). In consumer electronics, Apple recently announced an offering of spare parts for common phone and laptop repairs to consumers, albeit limited to selected models. Government legislation known as "right to repair" reinforces this activity by ensuring that goods – particularly household appliances – are manufactured with ease of repairability in mind.

RESELL.

The average time a fashion product is used is little more than 3 years.[22] That length of time is just 2 to 3 years for smartphones.[23] Reselling is the opportunity for a product owner to sell products that are still highly functional but that they no longer wish to use. The reduction in GHG emissions from resale is significant, but resale rates in fashion and consumer electronics are lower than they are in other sectors – for example in automotive, where reselling cars is the default. In addition, there is a significant volume of totally unused fashion products (about $2.1 trillion[24]) in consumers' closets around the world. For example, the average UK consumer owns unused garments worth $270.[25] These products could be put to productive use via resale. Strong moves in this resale direction are already visible today, for example, in the fashion industry. A new ecosystem of digital resale-as-a-service offerings is emerging, where players such as Trove and Reflaunt operate the resell business on behalf of brands and retailers. In addition, both established (such as eBay, Zalando) and recently launched (such as Vinted) independent digital marketplaces allow for a peer-to-peer resale of garments.

REFURBISH.

Delivering a functional product, potentially with signs of usage, back to the manufacturer or to a dedicated refurbishment provider where it can be checked, enhanced, refreshed, or otherwise "brought back to life" and sold again is becoming increasingly important. Refurbishment in consumer electronics is increasingly commonplace, especially when it comes to smartphones or in a B2B context. Over the past years, several start-ups such as Backmarket and Refurbed have started to offer refurbished tech products. Refurbishment in fast fashion, however, is quite rare (Exhibit 7). Luxury fashion is a notable exception in this space, where rental models for refurbished clothing are more common (for example, platforms such as "Rent the Runway," which allow users to rent designer garments via subscription). Overall, refurbished garments – worn, returned to the production facility, restored, and resold – are responsible for 55% less GHG emissions over their lifetime (including use phase) than brand-new, virgin-material garments. The same holds for refurbished smartphones with up to 55% lower emissions than for virgin devices (Exhibit 7).

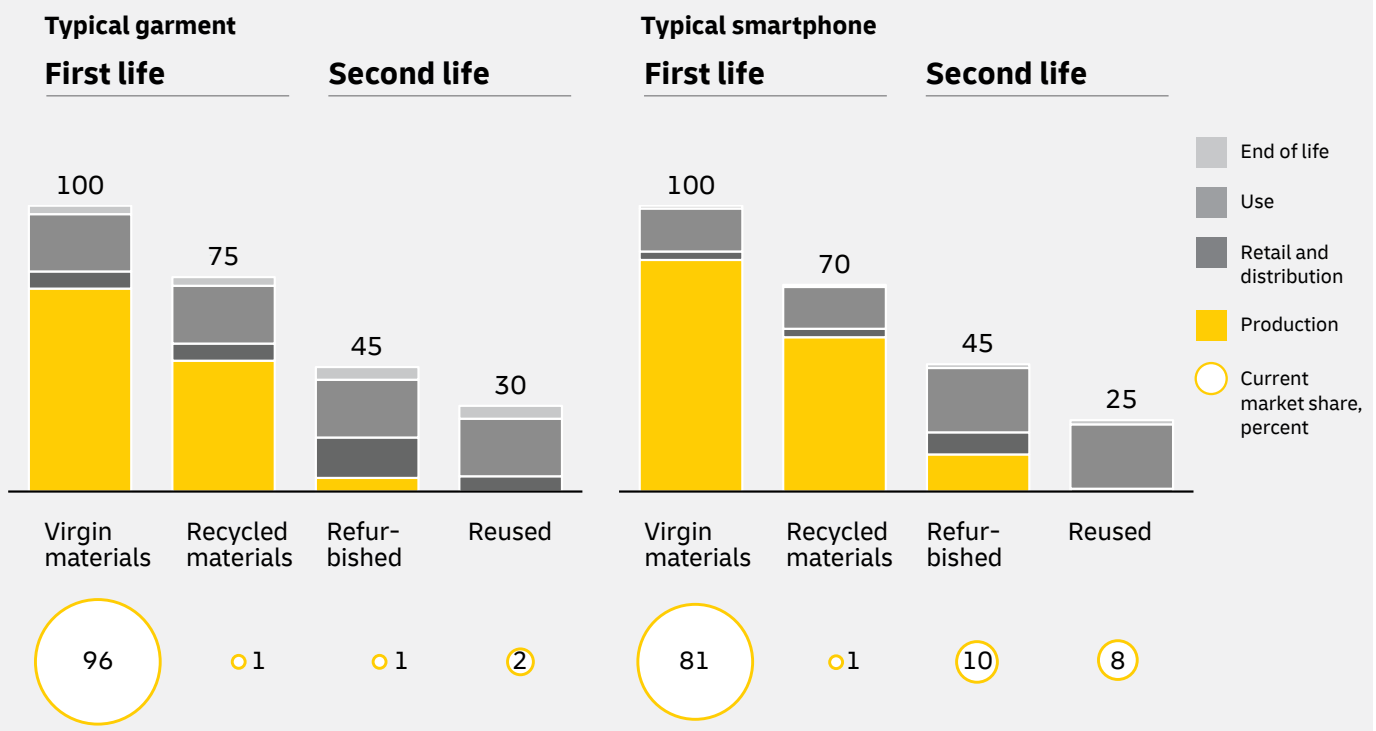
RECYCLE.

At some point, repairing or refurbishing will not be an option for a product that has "lived" a very long life. Still, there is value in this end-of-life product, and extracting that value (parts, components, materials) and feeding it back into the next production cycle is the essence of recycling. Globally, use of recycled materials in fashion production remains low, with about 95% of garments produced from virgin materials.[26] Some fashion retailers, however, are offering drop-off options for used clothing in combination with shopping vouchers to motivate more sustainable consumer behavior (for example, H&M with its "Let's close the loop" take-back program for used clothes).

In summary, it becomes clear that adopting circularity in fashion and consumer electronics along the 5 Rs can significantly reduce the carbon footprint of a typical garment or smartphone. Second-life garments or smartphones cause 55 to 75% less emissions than new items from virgin materials (Exhibit 7). However, since about 45% of emissions of a garment with recycled materials are generated during production, using green energy is an additional necessary lever in reducing the footprint of goods made from recycled materials. This exemplifies the complementary relationship between circularity in product design and use and the transition toward renewable energies during production.

GHG EMISSIONS OVER THE LIFETIME
KG CO_2 EQ., INDEXED TO 100 FOR VIRGIN PRODUCT

EXHIBIT 7



Source: McKinsey "Fashion on Climate" Report; Mistra Future Fashion; BBC; Apple; Backmarket; Shift Project "Lean ICT" Report; Green IT Report

THE TRANSFORMATION

BUILDING BLOCKS AND ENABLERS TO GO FROM SUPPLY CHAIN TO SUPPLY LOOP

Every player in the consumer goods landscape – from producers to consumers to regulators to shippers – has a stake in circularity, and every player has a role in its implementation.

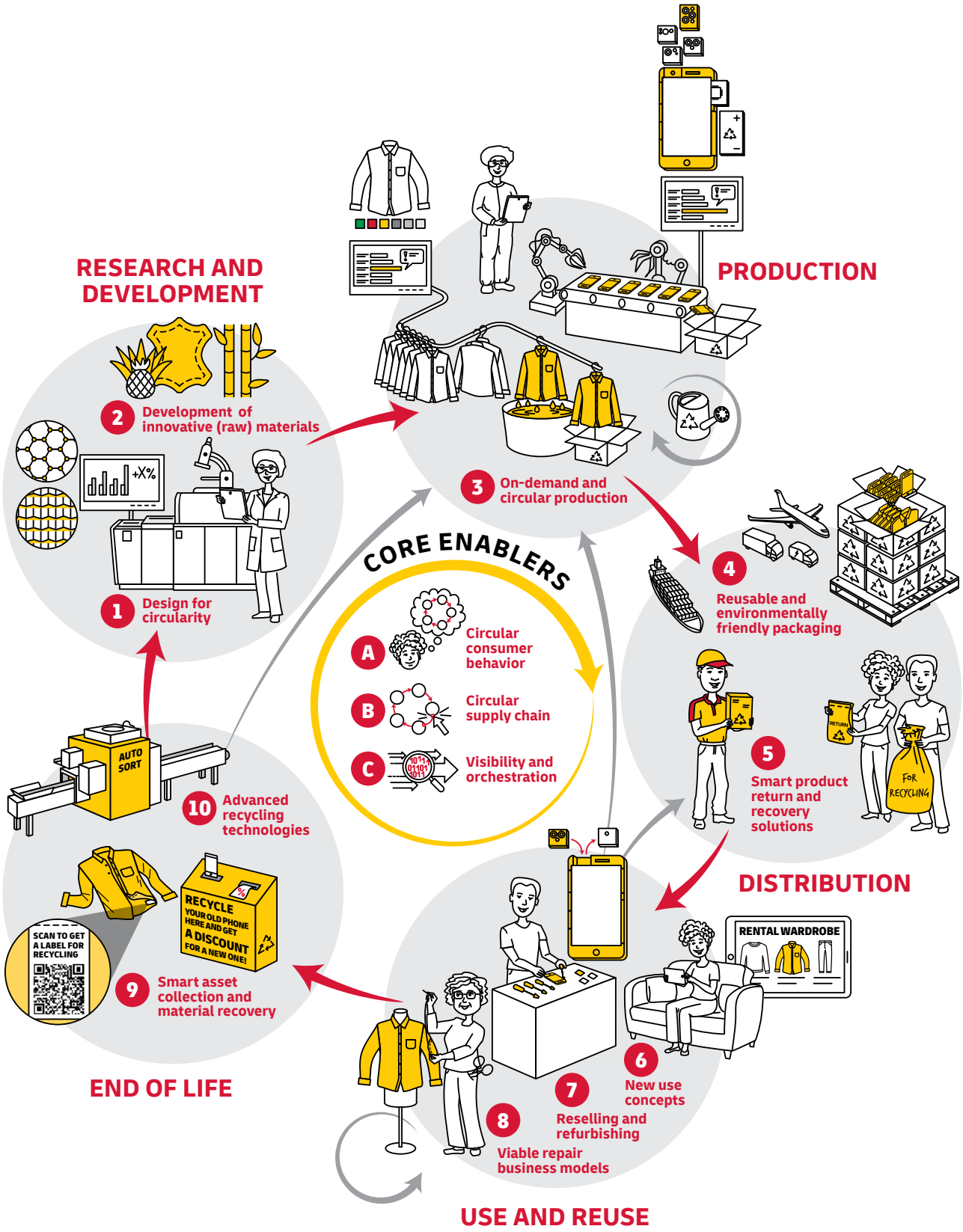
Transitioning from a traditional, linear supply chain and toward a closed and circular supply loop must take place in a way that benefits all stakeholders and society as a whole. At the same time, circularity also requires close collaboration among players as system-changing ideas are considered and new policy frameworks and business models are developed.

By definition, circularity will turn relationships between players that were once “one way” into ones that are bidirectional. The actions required of stakeholders will not happen independently; instead, they will be linked to each other in a mutually reinforcing loop. Real collaboration – not simple transactions based on individual interests – are essential to the successful transformations of supply chains.

In the collaborative effort toward supply chain redesign, the logistics industry holds key solutions and answers, and is pushing the frontiers to present novel approaches, especially for post-sale interventions, such as reselling, repairing, refurbishing, and recycling.

Looking at what it will take to transition from a supply chain to a supply loop, we have identified 3 core enablers and 10 buildings blocks.

3 CORE ENABLERS AND 10 BUILDING BLOCKS TO GO FROM LINEAR TO CIRCULAR SUPPLY CHAINS



A: CIRCULAR CONSUMER BEHAVIOR

The shift toward circular consumer behaviors is a critical driver of a successful transition to circularity. Circular consumer behaviors not only increase the number of goods that flow back into the cycle, but also signal demand to brands for circular products. Surveys suggest a growing trend of consumers demanding sustainable products, with more than 50% of consumers stating a willingness to pay more for a sustainable product. Bridging the gap between attitudes and actual behaviors is the key (as highlighted in the Zalando study "It Takes Two") and it depends on, among other things, i) offering attractive consumer incentives, ii) providing a conducive public- sector environment and regulatory guardrails, and iii) offering smart logistics solutions.

Significant progress is being made on both fronts, with businesses and regulators paving the way for consumers to modify their behaviors. Industry leaders are encouraging circularity-related activities among consumers by, for example, implementing product-collection models that make returning old products almost as simple as throwing them away, or offering vouchers and discounts for future purchases for customers who return their used products. As a positive side effect, this direct interaction with customers at the end of a product's life is also likely to strengthen customer loyalty. Logistics players further act as an accelerator by enabling easy and convenient return models, for example, when a delivery person both drops off new goods and picks up goods for recycling or reselling.

In addition, regulators are strengthening public knowledge and consumer awareness as well as creating guardrails to enable post-sale usage. One of the global recycling leaders, Austria, not only banned most types of waste from going to landfills, but also introduced education programs for young people about the importance of recycling. Similarly, several governments around the world are institutionalizing the circular economy concept, as exemplified by the EU Circular Economy Action Plan (see background reading box for additional details on the reform).

Smart logistics solutions (for example, multiuser repair warehouses, consolidated reverse logistics for returns and recycling) can furthermore act as an enabler for circular consumer behavior. Ultimately, consumers will be more likely to opt for circular choices if these are made as easy and convenient as possible by logistics service providers. For example, logistics players can jointly pick up return deliveries and end-of-life goods for recycling (see building block 5).

BACKGROUND READING:
THE EU CIRCULAR ECONOMY ACTION PLAN

The EU Circular Economy Action Plan, last updated in 2021, aims to make sustainable products the norm in the EU. By focusing on sectors with high resource use and potential for circularity, such as consumer electronics and textiles, the EU wants to be at the forefront of leading global efforts on the circular economy.

The plan includes a number of general initiatives, such as a sustainable product policy for enhancing product lifetimes, and a waste-reduction initiative through targeted harmonization of waste collection systems and industry rules across the EU.

In addition, it lays out several industry-specific initiatives. These include the Circular Electronics Initiative, which aims at designing consumer electronics in a way that extends product lifetime, and the Strategy for Sustainable Textiles, focusing on aspects such as reduction of hazardous chemicals in production processes and increased uptake of secondary raw materials.

B: CIRCULAR SUPPLY CHAIN

As circularity ultimately revolves around the movement and flow of goods, supply chains have to be redesigned and new supply models developed. Two main challenges arise, namely i) how to capture end-of-life products and unused items to reintroduce them into the cycle and ii) how to design product flows and cycles in the most suitable, efficient, and environmentally friendly way.

Accessing end-of-life products will require convenient return flows and collection that incentivize consumers to participate. The volume of return flows will increase as a result of circularity, implying that return flows need to be well integrated into the existing supply chain. As such, products with different post-sale interventions (for example, reselling, refurbishing, or recycling) or from both B2B and B2C flows (such as unsold items and consumer returns) can be transported and processed in a consolidated form to make the process convenient and efficient for consumers and logistics players.

Furthermore, when designing specific flows, a decision on the optimal point for, for example, sorting, needs to be made both from a process and from a geographical perspective. Moving such activities upstream can possibly help minimize the required transportation of a certain good. For example, if a logistics player presorts consumer electronics goods to determine whether their state justifies refurbishment or recycling, these goods can directly be sorted into their respective flow.

Overall, to successfully engage both manufacturers and consumers while protecting the planet, supply chains have to be designed in a cost-effective, convenient, and environmentally conscious way. Building a smart supply chain which optimally incorporates the circular flows of the 5 Rs (such as repair, refurbishment, and resale) sets a meaningful foundation for a successful circular setup. This includes a closer cooperation between providers delivering new goods and players transporting waste materials.

Supply chains have to be designed
cost-effectively, convenient, and environmentally conscious

C: VISIBILITY AND ORCHESTRATION

With the increased complexity of a circular supply chain, ensuring transparency and orchestration becomes even more important, yet challenging. For example, optimal production planning and inventory management require adaptations to be ready for a circular world. For instance, purchase scheduling of material inputs needs to be adjusted to the availability of recycled materials, and flows of post-sale products need to be considered in inventory management. To achieve the target picture, (i) digital technologies and (ii) logistics players are the critical enablers.

Advanced technologies and tracking tools provide the digital backbone to achieving transparency in an environment of circular and multidirectional product flows. Tracking at the product level has seen various innovations and is an area with significant research and development activities. For example, in the consumer electronics space, existing solutions include tagging, chemical tracing, and optical solutions to ensure traceability of a good along the value chain. The newest and leading innovations that are in early pilot phases can even endure industrial assembly and production processes. This allows products to be traced throughout their entire life cycle, including the downstream level and point of use. Additionally, latest technologies are blockchain secured to ensure accuracy of information by combining a physical marking with a digital twin. Such novel developments are expected to have strong use cases in sectors such as luxury fashion to ensure authenticity, printed circuit boards and semiconductor segments to prevent tampering, as well as the jewelry/gold industry to ensure environmental, social, and governance (ESG) compliance along the value chain. Moreover, the at-scale and cost-efficient application of these technologies would enable industries to manage inventories and stocks optimally.

Logistics players are the natural anchors and orchestrators, offering profound expertise and experience in tracking and tracing goods across entities and transportation modes, as well as with data analytics. Implementing frontier technology and big data solutions lies at the heart of logistics tasks already today. Technologies will evolve to meet the needs of a circular economy, including production planning (such as accounting for recycled materials) and inventory management (such as accounting for predicted return flows). Advancements on the technological side will furthermore need to be embedded and closely linked to the physical supply loop to reap the benefits of transparency end to end.

These three core enablers, strengthening circular consumer behavior, redesigning supply chains, and ensuring visibility and orchestration, are fundamental to a functioning “supply loop.” 10 building blocks provide the basis for making such a supply loop a reality. The activities and objectives associated with the building blocks are distributed across the phases of a product’s life cycle – from R&D to end of life.

RESEARCH AND DEVELOPMENT: OPTIMIZE RAW MATERIALS AND PRODUCT DESIGN

1. Design for circularity

Today, many products are designed with a focus on ease of manufacturing and design, which often means that the road to waste is short. A move toward a design for circularity is urgently needed. Key challenges to be addressed in this domain include i) the large number of different materials in one product and ii) the difficulty of disassembly. Above all, the feasibility of combining a circular product design with business growth and profitability is imperative to incentivize companies to innovate their product portfolio.

The immense number of different materials in a single product is easily illustrated by a typical sneaker, which contains more than a dozen different materials. Recycling this sneaker would require cumbersome and – if even possible – costly disassembly, which is a key reason that only 1% of garments are currently recycled in a so-called closed-loop manner, where materials from end-of-life items are used for newly produced items of the same type.[26] Mono-material design, where a single material and a single recycling method are used in the manufacturing of a product, could facilitate recycling and is already being implemented by some sneaker makers (for example, Adidas' mono-material "Futurecraft Loop" sneaker).

A typical sneaker contains **>12** materials and several different glues

The repair and recycling of many products is further complicated by the ways in which certain materials or component parts are held together. Snaps and glues make for easy assembly, but they make disassembly virtually impossible. Back to the earlier example, a sneaker is typically held together by various different glues, which limits the potential for individual raw materials to be extracted. "Debonding on demand" is a design approach that starts with the whole product life cycle in view and uses reversible adhesives. One example of this incorporates "release functions" into the adhesive system, allowing external triggers, such as UV-irradiation, heat, or the use of electric currents or magnetic fields, to be applied to reduce the adhesive strength of the glue.[27]

Another example of how circularity-minded design can facilitate disassembly is the concept of modularity, one of the leading trends in consumer electronics. Modular smartphones (such as Fairphone, G5 by LG, and ShiftPhone) are considered best practice in terms of sustainable design, as they can be easily disassembled, even enabling consumers to exchange individual parts for facilitated repair. However, this market is largely niche today – supposedly due to relatively high costs in relation to the perceived technical performance when compared to conventional smartphones. Nonetheless, as innovations and product designs continue to develop, it could mean that one day, purchasing smartphone parts will be more commonplace than purchasing entire smartphones. Such consumption patterns would also lead to notable savings in the use of nonrenewable resources, including reductions in socially and environmentally hazardous mining activities.
The customer experience, especially in e-commerce, can also be supported from a logistics perspective. For example, logistics service providers can offer brands "green" delivery options to complement the circular product design and reinforce the positive consumer perception of end-to-end sustainability.

2. Development of innovative (raw) materials

Material innovation is another pivotal enabler of a closed-loop supply chain, revolving around both i) energy-efficient materials and ii) easy-to-recycle materials.

Energy efficiency means using materials that are more sustainable, in terms of either resource use or emissions. For example, hemp is considered a particularly environmentally friendly fabric, as the natural fiber requires less water, fewer pesticides and fertilizers, grows faster, and yields more per square meter of field. With the example of a t-shirt, one made from hemp requires about 50% less water than one made from cotton. Hemp also yields around 50% more fabric (in weight of fiber) compared to cotton for the same area of farmland. Put differently, considering that about 80% of land use in fashion is driven by cotton production, switching to hemp fibers would mean that up to 40% of current land use for fashion could be avoided. To illustrate, this could amount to up to 16 million hectares, exceeding the entire land area of Bangladesh.

Plant or fruit "leathers" made from waste materials, are another example of energy-efficient materials starting to gain traction. A leading example, Piñatex, is made from the leaves of pineapples, which are a by-product of the existing pineapple harvest. The material can be used for fashion, accessories, and upholstery and is considered more sustainable than traditional leather, requiring less water and no toxic chemicals. The leftover leaf waste is recycled and used for fertilizer or biomass.

In addition, players are introducing recycled fibers generated (in part) from their own waste materials (for example, Inditex's Refribra™Lyocell). New materials are also being developed to replace the rare metal indium, which is a standard component of touch screens on consumer electronics devices. For example, researchers from the University of Sydney have discovered that a combination of silver and tungsten oxide, two relatively widely available materials, can serve as an alternative touch screen material.[28]

Developing innovative materials with the goal of easy recycling often goes hand in hand with the mono-material described in the previous building block. If, for example, sneaker design is going to move from more than 12 different materials to just one, the single material will need to be further developed or enhanced to provide the level of functionality of all of the previous materials.

There is also an important benefit for companies in using recycled materials in production: it entails increased stability in raw material supply, thereby improving a company's resilience to supply chain disruptions and price fluctuations. To make the most of these easy-to-recycle materials, logistics service providers will need to ensure that the recycled materials are returned back into the cycle in the most efficient and sustainable way. This also includes the challenge of identifying where in the global production cycle the recycled materials should find their next purpose based on economic and environmental considerations.

PRODUCTION: REDUCE RESOURCE USE AND LEVERAGE RECYCLED MATERIAL

3. On-demand and circular production

To make production circular both at the process and the outcome level, two main challenges need to be tackled, namely (i) circular resource use in the production process and (ii) reducing overproduction.

Production processes naturally create waste, such as leftover materials and wastewater. To achieve circularity in production, manufacturers need to develop solutions that both minimize the amount of production waste generated and reuse as much of the waste as possible. For example, wastewater can serve various purposes, such as for industrial cooling or – when pure – watering outside areas. As such, the reuse of wastewater is an impactful and comparatively easy-to-implement measure to mitigate the high water use in fashion and consumer electronics.

Even when production processes are optimized for circularity, the often-remaining overproduction is one of the largest issues that industries such as fashion are faced with. Approximately around 20% of garments produced are never used.[20] Even just halving the amount of overproduction could put 8 million hectares of land (approximately the area of Austria) to an alternative use and reduce fashion waste by almost 10 million tons (approximately the amount of cumulative municipal solid waste in Australia). Reduced water pollution would be another positive side effect leading to societal benefits. Optimizing for agility is therefore a critical element of circularity, with demand-driven manufacturing and late-stage differentiation being two activities supporting this objective.

Around **20%** of globally produced garments are never used

First, on-demand or demand-driven manufacturing means – in theory – only producing a garment once a customer has purchased it, eliminating the guesswork around demand, thereby helping to reduce overproduction and potentially waste. Several start-ups have even combined this zero-inventory, made-to-order model with user-friendly tech solutions to personalize products, for example, by incorporating customized measurements for jeans. Second, late-stage differentiation or postponement can mean that a fashion brand produces "greige/uncolored" garments and only differentiates the product at the later dyeing or color definition stage, when actual demand is clearer. This allows manufacturing processes to be more agile and demand-driven and is especially promising in industries with frequently changing consumer preferences and trends.

To successfully implement on-demand production, supply chains need to be particularly performant and reliable. Logistics players will need to optimize flows to accommodate fast turnarounds. In addition, overproduction also goes hand in hand with redundant inventories. To minimize these and introduce a higher level of agility into inventory management, logistics service providers can support brands with demand forecasting (for an example of recycled materials returned into new production flows or also based on expected end of warranty, see core enabler B) and predictive inventory rebalancing. Furthermore, logistics service providers can offer marketplaces and auctions to connect businesses with the purpose of selling and exchanging surplus items.

DISTRIBUTION: OPTIMIZE DELIVERY AND RETURN PROCESSES

4. Reusable and environmentally friendly packaging

In light of increasing product flows, ensuring that packaging contributes to the circularity solution rather than the waste problem is key. Both i) packaging for the inner product as well as ii) external shipping packaging need to be optimized for maximum circularity.

The inner-packaging issue is increasingly tackled by producers, for example, smartphone manufacturers that are moving from plastics toward recyclable or biodegradable packaging materials, such as pulp. Similarly, leading fashion players are shifting from single-use plastics toward paper to wrap their garments.

The external (shipping) packaging has received less attention thus far, although it contributes up to 30% of total e-commerce-related GHG emissions.[29]The major consideration in external packaging is the trade-off between package emissions and package waste. In other words, players need to strike a balance between lower emissions/single use and higher emissions/multiuse, and also consider compostability and recyclability.

External packaging contributes **30%** of total e-commerce emissions

Across all packaging materials, reusability and recycling are critical levers to curb emissions and the environmental impact. Consider that 7 trees are needed to produce 1,000 new corrugated cardboard boxes,[30] and 15 to 17 trees are saved per ton of recycled paper.[31] Moreover, the production of recycled paper requires around 60% of the energy needed to produce paper from virgin trees. In a simplified example, comparing an approximately 120 gram reusable plastic bag with an around 180 gram single use carton, the reusable shipping bag is more environmentally friendly than the carton from the very first shipment. In more complex cases, the tipping point toward reusable packaging typically occurs at low two-digit numbers of usage. In addition, the size and amount of the packaging must be addressed, specifically ensuring that only as much packaging as is absolutely necessary is used in product transportation.

Logistics service providers are an integral part of the road to sustainable packaging at scale. Not only do they bring substantial experience with a wide range of newly available packaging solutions, but their expertise can also support brands in determining which packaging to best use for certain routes or types of goods. Furthermore, the key to reusable packaging is to actually collect and reuse it. While of course the consumer can do so by returning a good, logistics players also play a critical role in collecting packaging and managing flows. In an ideal ecosystem, reusable packaging is shared across players and industries with logistics players supporting such joint networks.

Governmental support can be instrumental in innovating new packaging materials. For example, the UK government launched a joint initiative with the private sector providing funding of more than £200 million for research on new forms of packaging, from plants to wood chippings and food waste.

Overall, developments in packaging have the additional benefit that they are directly noticed by end consumers. Particularly environmentally conscious consumers will notice the change in how their products are packaged for transportation and delivery, and their appreciation will benefit the brands involved. Logistics players can help operationalize these efforts by establishing an easy, convenient, and cost-effective system to allow consumers to return containers back into the pool.

For both reusable and lower-emission packaging solutions, the industry will continue to innovate and develop. We expect characteristics of the product and the delivery flow to influence which packaging solution is considered most appropriate and environmentally friendly. For example, product characteristics such as required stability and physical properties (for example, size and weight) will largely influence the decision. Also, product and customer segments, as well as whether a good is delivered nationally or across borders, will play a role. For instance, it seems more likely that a garment may be shipped in thin pouches made of recycled plastic, whereas large electronic devices may come in a stronger exterior packaging to be picked up for reuse. Fashion products are particularly suited for reusable packaging solutions as, on average, more than every second shipment is returned.

5. Smart product return and recovery solutions

Smart product return facilitates the return of bought, but unwanted products by customers, and recovery solutions incentivize the return of products that have been used but still have residual value in the supply circle. Possible solutions to promote both include (i) financial incentives and firm-offered digital interfaces for consumers, (ii) regulations on handling of product returns, and (iii) digital technologies to facilitate reduced need for returns.

Financial incentives are already successfully used in return management. It is highly convenient and financially attractive for consumers to return nonsuitable products after purchase, as free return shipping with print-at-home shipping codes and full money back for unwanted products is offered as a default by most major e-commerce players.

To avoid resource waste in the handling of returned products, several countries have initiated regulatory measures. For example, France recently announced a ban on the destruction of returned consumer products, which aims at securing the valuable resources contained in products. Calls for adopting this regulation internationally are frequent.

Combining different types of **return flows** is key lever

For logistics players, the key lever will be to combine different types of return flows. For example, the ability to collect standard returns of unwanted products together with end-of-life products (see building block 10) could increase convenience for consumers, while also contributing to circularity. Therefore, the critical challenge will be to optimize the operational setup of returns for maximum efficiency. For certain return flows, especially in fashion, ensuring a high speed of reintegrating returned products into sellable stock is critical. In this instance, high speed allows brands to minimize stock and reduce the risk of products being disposed as a result of becoming "outdated." In cases where speed is not the prioritized objective, efficiency in terms of both ecological and economic dimensions is at the forefront (for example, combining shipments to ensure full capacity in transportation vehicles is used). To match customer return preferences with logistics capacities, digital portals are a valuable tool.

Digital technologies can further reduce the need for product returns by consumers by offering more meaningful information to guide the purchase decision. For example, VR-assisted garment size determination can increase the likelihood that the product received by consumers matches their hopes and expectations. This can potentially reduce ordering of identical items in adjacent sizes, which is typically caused by a lack of information and certainty around sizing. Moreover, information campaigns promoting consumer awareness of the environmental impact of excessive overordering can be a helpful approach.

USE AND REUSE: EXTEND THE PRODUCT LIFE CYCLE

6. New use concepts

To ensure a wide adoption of new circular use concepts, these novel business models must be developed with both sustainability and profitability in mind.

Models such as pay-per-use, product rental, and product lease can play important roles both in terms of environmental impact and business revenue. In the B2B market, business models such as notebook lease are gaining traction quickly. In B2C, these models remain a niche – exceptions include selected luxury fashion firms that rent out garments (such as Tulerie) and start-ups in the consumer electronics space that started rental models (such as Grover). Options such as leasing out technical equipment in combination with taking over responsibility for potential repairs could increase consumer adoption while also being commercially attractive and sustainable. Sharing products via peer-to-peer platforms can also be part of the solution to maximize resource utilization. Here, companies will need to establish the necessary digital ecosystem to enable novel circular business models.

Logistics service providers are already able to provide secondary marketplaces spanning across industries and brand sizes. To develop these further to meet the demands of circularity, the platforms must be built to optimally integrate the expected returns and refurbishing flows. In addition, the majority of new use concepts will require particularly accurate and customer-centric delivery. For example, when renting an outfit for a specific occasion, even the slightest delay in delivery will significantly affect customer satisfaction. As such, logistics players will be an integral part of bringing these new use models to life and ensuring trust in the timeliness and reliability of deliveries.

7. Reselling and refurbishing

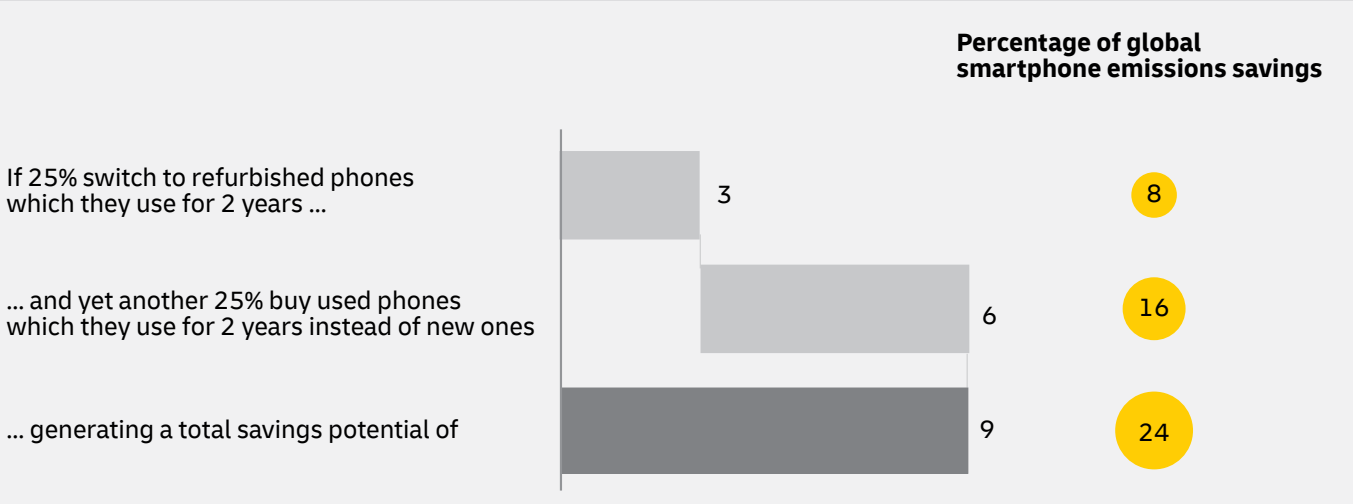
Reselling and refurbishing products is an essential element of circularity with the immediate aim of extending the value and the life of consumer products. Implementing and scaling these two models will be built on i) a strong logistics backbone, ii) an understanding of the use models' environmental impact, and iii) the creation of business models around them.

Logistics companies play an important role, especially in refurbishing, with their ability to support the reverse logistics of getting functional but no-longer-needed products back from the consumer. Logistics can also help as an intermediary by screening returned products for their suitability for refurbishment and resale and then forwarding them to the respective partner. As refurbishment and resale models come with additional transportation flows (for example, fashion items sent back to Asia for refurbishment), smart and sustainable shipping solutions embedded in a circular supply chain design are ideal to optimize transportation flows and resource use and minimize unnecessary transportation and emissions. It should be noted, however, that transportation emissions are a relatively small, single-digit share of the total GHG footprint of fashion and consumer electronics products (compared to production causing around 80%), such that a "transportation leg" for refurbishment and resale is environmentally sensible.

As is the case with several of these building blocks, smartphones are a great example of how monumental the environmental impact of extended use could be, for example, through reselling and refurbishing. If 25% of customers worldwide replaced their smartphones with a refurbished one instead of a brand-new one, annual GHG emissions would be reduced by 3 million tons (Exhibit 8). If another 25% of customers replaced their devices with secondhand phones, an additional 6 million tons of CO_2 emissions could be saved. Cumulated, these two changes in consumer behavior would save approximately 24% of global smartphone emissions. For comparison, these savings are about equal to the emissions caused by more than 7,000 full-capacity roundtrip flights between Frankfurt and Sydney. Apart from their impact on GHG emissions, such behavior adaptations would also contribute to the protection of nonrenewable resources (such as rare earth metals) and freshwater (for example, by preventing acidic water from potentially ending up in rivers).

However, resold and refurbished items will need sufficiently large ecosystems if they are to gain significant market share. Manufacturers will need to make strategic investments in these markets, and governments need to create a regulatory climate that supports this. This activity also requires significant consumer buy-in. Educating consumers about the potential of refurbished and resold products and incentivizing them to be active in these markets – for example, by paying them to return clothing they no longer wear or older smartphones that sit around unused – is the other piece of the puzzle.

GLOBAL GHG SAVINGS FROM LONGER USE TIMES AND NEW USE MODELS OF SMARTPHONES
MILLION TONS CO_2E[1] EXHIBIT 8



1 Compared to a scenario where consumers buy only new smartphones every 2 years

Source: Shift Project "Lean ICT" report; Green IT report; Backmarket; Apple

8. Viable repair business models

Repairing malfunctioning or damaged items rather than replacing them with a new item would be the norm in a circular world. Logistics players offer valuable services for facilitating repairs. While several conflicts of interest arise from this new norm, there are also emerging signs that these conflicts can be resolved.

Logistics can be an important player in facilitating repair: This goes up to the point where small repairs can be outsourced to logistics providers (for example, sewing, ironing, and cleaning), operating dedicated multiuser repair warehouses. Furthermore, to the extent that there is risk in facilities receiving a large share of goods for repair that are, in fact, beyond repair, logistics providers offer dispositioning solutions to effectively recycle unrepairable items early in the reverse process, thereby avoiding unnecessary transportation. Also, in the case of larger repair or refurbishing businesses receiving items from a wide range of origin points, logistics service providers are able to bundle these in meaningful quantities to optimize the frequency and size of return flows.

The conflicts of interest are not to be ignored. If brands and manufacturers start to offer repairs for damaged products at a large scale, they forego the margin of selling a new product. Hence, they have an incentive to make repairs rather expensive. In fact, professional product repair often comes with a high markup compared to relatively lower prices for new products, creating the dilemma for consumers in which repairs may not seem economical compared to purchasing new products. However, there are economic reasons that make repairs rather expensive today: the small scale and often manual nature of repair procedures for fashion and consumer electronics products at tailors or small repair shops make repairs less efficient than large-scale and fully automated production lines.

Hence, it is crucial to develop new scalable repair business models with attractive economics for providers and consumers, while also ensuring convenient access to repair services for consumers. Both companies and regulators have started initiatives here: some fashion players have introduced dedicated repair services for end consumers, allowing consumers to hand in their clothes for repair while shopping (for example, Adidas's cleaning service for sneakers). From a company perspective, repair offerings may become particularly attractive in a circular economy with rental, leasing, and refurbishing business models (see building block 6), as opposed to a linear (sales-focused) economy. Repair offerings will also naturally tie the customer to the brand by adding another interaction point and extending the usage time of a brand's product. The role of governments can be to incentivize consumer uptake of repair options. Sweden, for example, taxes certain repair services at a rate 50% less than the tax on the purchase of new items. Across the EU, the "right to repair" – though limited in the products to which it applies – will enforce free access to repair and maintenance information for third-party repairers as well as end consumers and extended access to software updates for consumer electronics.

BACKGROUND READING:
"RIGHT TO REPAIR"

The "right to repair" is an EU initiative suggested as part of the Circular Economy Action Plan. It demands free access to repair and maintenance information to create an equal playing field for third-party repairers. In addition, it aims at strengthening the position of consumers by suggesting a mandatory minimum availability and maximum delivery time for spare parts. Consumer electronics are identified as a priority sector for enforcing the "right to repair," including a right to update obsolete software.

So far, the application of the "right to repair" applies only to manufacturers of washing machines, dishwashers, refrigerators, and video displays (including TVs). Providers in these product categories must offer spare parts and repair documentation for up to 10 years, with the requirement of delivering spare parts within a certain time.

As of now, there is no "right to repair" across all industries. However, the EU intends to extend the applicability of the legislation to other industries over the next years.

END OF LIFE: MAXIMIZE VALUE EXTRACTED AFTER PRODUCT LIFETIME

9. Smart asset collection and material recovery

Extracting value from end-of-life products is essential to a successful transition from a linear to a circular supply chain in consumer goods. The key challenges are to i) increase collection rates within formal collection systems and ii) increase consumer motivation to return end-of-life products.

At the national level, Germany's high density of collection containers in combination with high consumer awareness of the value of recycling make it the global leader in the collection of old clothes, with a collection rate of 84%. Similarly, the regulatory framework in Northern Europe has led to a 59% collection rate of e-waste.[17] If end-of-life collection everywhere reached the levels in leading countries, e-waste and fashion waste avoidance could amount to a total of more than 75 million tons annually, equal to the weight of all registered passenger cars in Germany.

75 million tons additional recycling materials if all countries achieve top nations' recycling rates

Next to implementing national collection systems, motivating consumers via incentives is an important lever to increase systematic waste collection. Examples include minimizing consumer costs for product disposal and offering vouchers to consumers for returning end-of-life items. On the business side, a leading tech player, Cisco, has launched a takeback program where it commits to 100% product return at no cost to the consumer.

Customers also need to be assured that their data is safe when disposing of electronic products. Surveys suggest that for example in China, more than 65% of consumers choose to discard, not recycle, their old electronic devices, as they fear their personal information could be leaked.

For both challenges, logistics service providers are an important part of the solution. For example, asset recovery tools allow for better control of the return process and exploit residual product value by reselling products to second markets via logistics' partners. In addition, to address the concern of data leakage, major logistics players offer expertise in data wiping combined with a high established trust level, eliminating the possibility of personal data being stolen and re-assuring customers that the return of their end-of-life products is a secure and risk-free proposition. Next to offering these solutions at scale, they also need to continuously develop these in accordance with new product innovations.

10. Advanced recycling technologies

Once materials are collected, successful recycling hinges on two factors: i) collecting sufficient quantities to be recycled and ii) using advanced technologies.

The low-volume challenge is particularly pronounced in the textile industry: the mechanical recycling of cotton requires a 90% purity of cotton waste (meaning cotton from one color). As such, large quantities of cotton are needed, and it is often challenging to get the necessary quantities of cotton waste.

90% purity of cotton waste needed for mechanical cotton recycling

To support the collection of sufficient quantities for recycling, logistics players have the capacity to steer and aggregate volumes of appropriate waste flows, creating a scalable business case for investing in new technologies and innovations. Furthermore, logistics service providers can presort goods to increase the efficiency of the recycling technologies. This could be by product type needed for recycling (for example, clothing items by material) as well as by condition (for example, sorting out items that may be more suitable for refurbishment or repair).

In terms of technological advancements, advanced recycling technologies are needed to increase material valorization. Examples include improved sorting, for example, using robots with image recognition abilities, which enables the application of the correct recycling method depending on material type.

For consumer electronics, state-of-the-art technologies allow for the prediction of e-waste flows for recycling and then for an automated grading process, identifying if products really need to be recycled or could still be resold. Furthermore, industry leaders are developing robots to disassemble smartphones, recovering all valuable materials more efficiently than traditional recycling systems (for example, Apple's disassembly robots to reclaim valuable materials stored in iPhones). When recovered, the recycled materials can be used as input materials for new goods, as for example with Apple's recent laptop made from 100% of recycled aluminum.

For the fashion industry, automated sorting technologies have the capability to sort by different materials, but these are still in the early stages of development. Scaling up such technologies could lead to significant improvements in circularity, with the potential of being transferrable to other verticals.

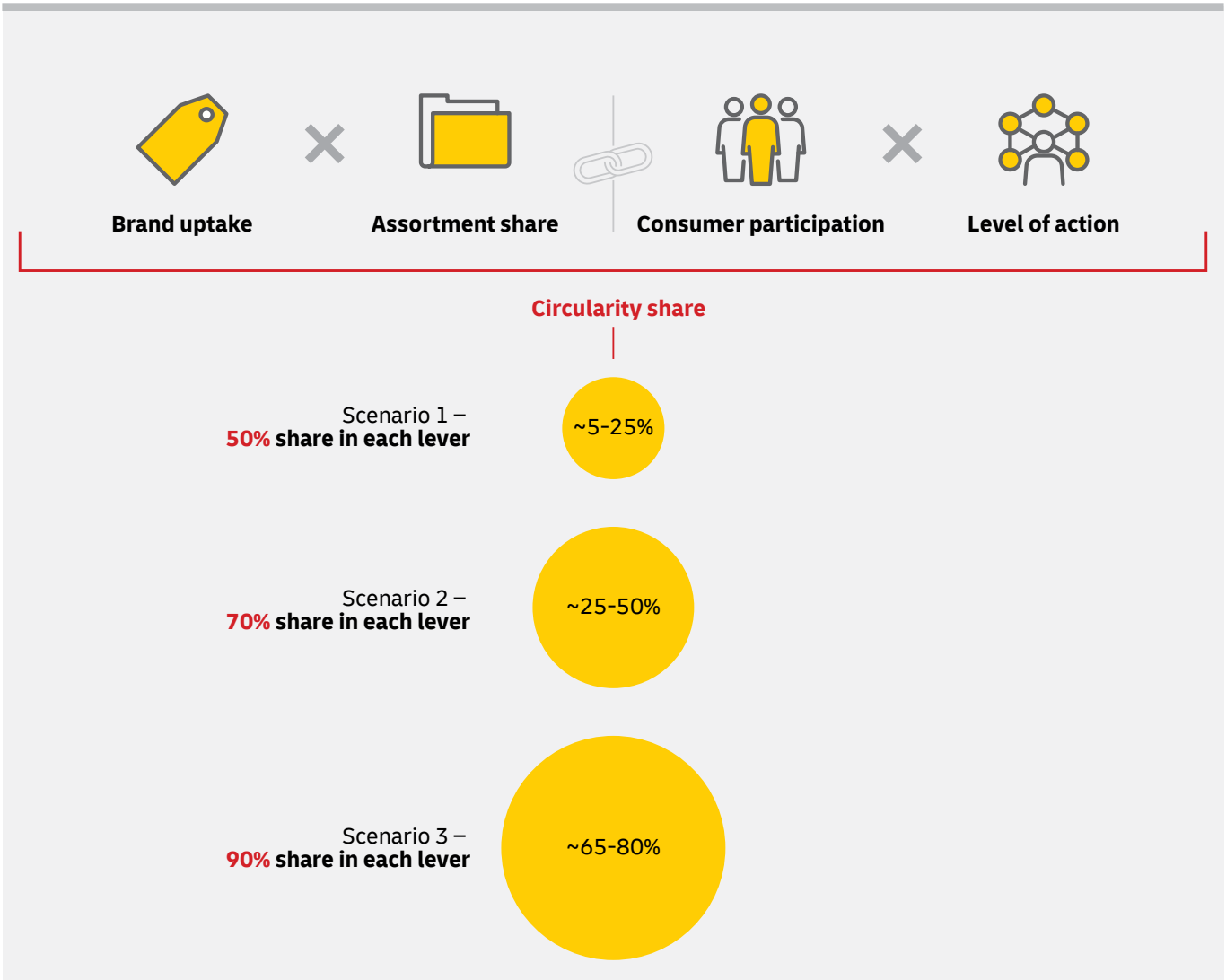
THE CALL FOR ACTION

COLLECTIVE STAKEHOLDER ACTION NEEDED

A transformation from linear to circular supply chains in fashion and consumer electronics is the function of 4 key levers (Exhibit 9). Not only must all 4 levers be engaged, but uptake in each must be substantial if circularity is going to live up to its potential of significantly reducing GHG emissions and helping nations meet their carbon targets.

The good news is that there are multiple stakeholder groups in the transition to circularity, and no stakeholder has to shoulder the responsibility on their own. A concerted effort among all stakeholders can make the challenge of circularity not just achievable, but a rewarding proposition with benefits – beyond the obvious benefit of addressing climate change – that accrue for each stakeholder.

CIRCULARITY AS A FUNCTION OF 4 LEVERS
RELATIONSHIP BETWEEN CIRCULARITY LEVERS AND CIRCULARITY ADOPTION SHARE – ILLUSTRATIVE EXAMPLE EXHIBIT 9



The 4 key levers that jointly determine the achieved share of circularity include, on the brand side, brand uptake and assortment share and, on the consumer side, consumer participation and level of action:

BRAND UPTAKE
The share of brands that offer circularity-focused products or business models (for example, 10 leading shoe manufacturers collectively representing 30% of the market start using new, innovative leather alternatives)

ASSORTMENT SHARE
The share of a brand's total portfolio that is circularity-focused (for example, a sneaker manufacturer introducing 3 new, fully recyclable shoes next to its existing product portfolio of 10 nonrecyclable shoes)

CONSUMER PARTICIPATION
The share of consumers who have adopted circular behaviors (for example, every second consumer is aware and convinced of adopting circular behaviors and choices)

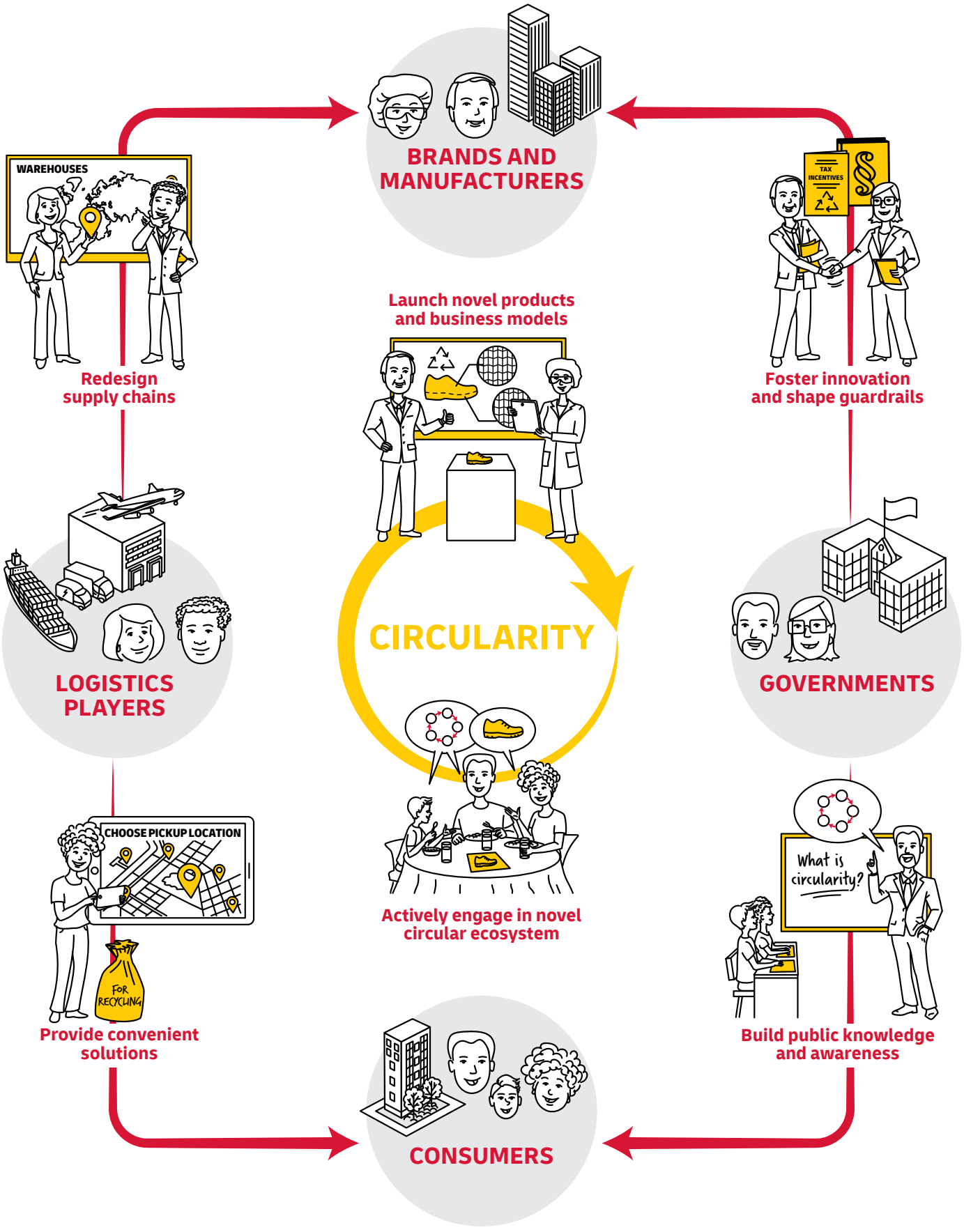
LEVEL OF ACTION
The share of a participating consumers' product-related behaviors that are circular (for example, a convinced consumer might recycle used clothing, but still throw electronics into the household trash).

Uptake in each of these levers must reach a critical level before the combined effect of circularity has a significant impact on the share of circularity. For example, in a very simplified illustration and not accounting for the direct interplay between supply and demand, if half of all fashion and consumer electronics brands implement circularity across half of their portfolios, and half of all consumers in these industries commit to making half of their product-related behavior circular, then around 5 to 25% of circularity would be achieved. If all levers reach over 70%, a circularity share of up to 50% can be achieved. To put this into perspective, to avoid the same amount of annual GHG emissions as a 50% circularity share in fashion and consumer electronics, all global streaming users would have to stop watching online video content for approximately 5 years. Hence, circularity seems like a comparably convenient and manageable way to reduce emissions.

The path toward circularity will require action from all stakeholders: brands, consumers, logistics players, and governments. These stakeholder actions will not happen independently; they will be inextricably linked to each other in a mutually reinforcing loop – not unlike the supply loop of circularity itself. Brands and manufacturers will create circular offerings, and consumers will thus adopt circular behavior and demand additional circular offerings from brands. Logistics players will facilitate those offerings, and governments will incentivize the push and pull of both consumer behavior and manufacturer activity.

This transition will happen over three time horizons that span the next two decades, but there is a clear road that stakeholders can already take today. Innovating and piloting are the hallmarks of this first phase of work, which will lay the indispensable foundation for large-scale circularity efforts. The second and third horizons are geared toward expanding and institutionalizing the successes that are achieved between now and 2025.

INTERPLAY OF 4 STAKEHOLDER GROUPS IN A CIRCULAR ECONOMY



The following is a road map for the immediate next steps for each major stakeholder group. As depicted in the previous illustration, the set of activities are at once interrelated and specific to each group.

BRANDS AND MANUFACTURERS

The work of brands and manufacturers includes circularity target-setting and the business model adjustments that move them toward those targets. Ultimately, it is the work of this stakeholder group to also think beyond "products" and move beyond circularity across every facet of their organizations.

Measurable targets. With an eye toward specific reductions in GHG emissions, brands and manufacturers must define the exact and measurable targets related to the 5 Rs of circularity that make sense for them.

Product and business model innovation. Brands and manufacturers must determine how products might need to be adapted – potentially from design to material use to production – in order to align with circularity. They will also need to pilot the new "circularity oriented" business models that are most commercially attractive. This includes designing systems that help facilitate customer participation in these models, such as rewarding customers for sending products in for recycling.

Partnerships with peers and suppliers. By definition, circularity relies on the interrelatedness of and communication between multiple players. In order to set up data sharing and define industry standards in this new economy, brands and manufacturers will need to launch partnerships with each other. This also entails supporting smaller suppliers in their transition toward circularity.

Holistic circularity. Finally, brands will look beyond just the manufacturing of their products. The largest share of GHG emissions in fashion and consumer electronics is in production, but circularity at its best is an across-the-business commitment. Industry players should also think about how to drive circularity throughout their entire organizations. Finally, a holistic approach to circularity also includes raising consumer awareness on the topic, such as via marketing campaigns.

CONSUMERS

Consumers can commit to engaging in more circular behavior of their own, helping other stakeholders optimize 5 R-related interventions by offering feedback, and by sharing their experiences with their social networks, contributing to scale:

Circularity behavior. Not all consumer-level circularity actions will be perceived with the same level of ease and interest by all consumers. Consumers can commit to their own "pilots" by actively trying different circularity behaviors: perhaps waiting one more year before upgrading their smartphone, or repairing the pair of boots they had planned on throwing away.

Adapted purchasing behavior. Consumers will also have to adapt their purchasing behavior toward circular products to steer manufacturers toward the development and production of such products.

Peer education. Just as word of mouth is essential in the linear economy, it can play a key role in the adoption of circularity. Consumers can use the tools at their disposal – from texting to social media – to share what they have learned along their own circularity journeys.

Feedback loops. The other 3 stakeholder groups will be conducting tests of their own as they seek to create, implement, and institutionalize the various aspects of circularity. Part of this testing will depend on consumer feedback, so consumers who actively engage and participate in early circularity-focused programs will be key to their success.

LOGISTICS PLAYERS

The actions that logistics players will take involve innovation and transparency along the supply chain and efficiency in transportation. Growing experience will make logistics players essential repositories of knowledge, so they will ultimately be responsible for transferring best practices across industries.

Supply chain redesign. Innovating the supply chain to meet the needs of a circular goods flow is crucial. This will include extending reverse logistics offerings and solutions for sophisticated and cost-effective return flows, creating new offerings for packaging, repair, refurbishment, asset collection and sorting, and building capabilities and capacities for the increased quantity of flows.

Supply chain transparency. Logistics players should double down on technologies that create visibility across the entire supply chain, that interface well with all systems and transportation models, and that are accessible to all relevant parties.

Transportation decarbonization. In addition, low-emissions solutions should be considered for the diverse set of future flows and particularly the additional return flows resulting from circularity (for example, transportation vehicles running on renewable energies).

Exchange of best practices. As the orchestrators of flows, logistics players will be in a key position to help transfer successful, novel solutions (for example, reusable and environmentally friendly packaging solutions) from one industry to another.

GOVERNMENTS

The work of governments will be to use both their economic and legislative influence as well as their immense public platforms to encourage circularity via legislation, incentivize innovation, track progress, and promote awareness of the importance of circularity.

Regulatory guardrails. Public-sector agencies can enact rules that both encourage the transition toward circularity and then guide its implementation. A ban on the destruction of functional products, for example, can prescribe circular behavior, while rules for recycling can be the guardrails that lead to standardized processes that are adopted widely.

Technology and product innovation. Through financial support, investments, and incentive programs, governments can support the innovations in technology – such as new materials – and products that circularity demands.

Public awareness. No stakeholder group has broader society-level reach than the government. It can use this impact – via public campaigns, school curriculums, or more – to raise awareness on the importance and impact of circularity and continue strengthening the societal demand for sustainability.

Monitoring and progress management. Governments have a role to play in monitoring circularity progress and impact at the national and global levels. Ensuring high-quality, meta-level data collection and management is one of these roles, as it enables the tracking of and reporting on circularity activities and impact.

THE POWER OF CIRCULARITY

In summary, circularity in fashion and consumer electronics represents a massive opportunity in the global effort to combat climate change. To recap, up to 75% of the lifetime emissions of a single product can be avoided by using a second-life product.

Circularity has started to become a self-reinforcing interplay between manufacturers and consumers, with governments creating a conducive environment for a range of “closed loop” activities and logistics players providing efficient infrastructure for a new, more complex, environmentally friendly flow of goods. As such, transitioning from supply chains to supply loops puts us on a clear path to reducing GHG emissions.

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ABOUT DP DHL GROUP

Deutsche Post DHL Group is the world's leading logistic company. The Group connects people and markets and is an enabler of global trade. It aspires to be the first choice for customers, employees and investors worldwide. To this end, Deutsche Post DHL Group is focusing on growth in its profitable core logistics businesses and accelerating the digital transformation in all business divisions. The Group contributes to the world through sustainable business practices, corporate citizenship and environmental activities. By the year 2050, Deutsche Post DHL Group aims to achieve zero emissions logistics.

The Group is home to two strong brands: DHL offers a comprehensive range of parcel and international express service, freight transport, and supply chain management services, as well as e-commerce logistics solutions. Deutsche Post is Europe's leading postal and parcel service provider.

Deutsche Post DHL Group employs approximately 570,000 people in over 220 countries and territories worldwide.

ABOUT DHL ERETAIL & FASHION

As the leading logistics provider for the eRetail & Fashion industry, DHL plays an integral role in fashion logistics solutions supporting businesses across the value chain around the globe. From small online start-ups to multinational brands, we make sure the complexities of logistics and supply chains, such as inbound, warehousing and delivery, are looked after and taken care of by us to fit the nature and specifications of our clients. With over 13m square meters of warehousing space and an unrivalled transportation network in 220 countries, we pair global reach with local knowledge to provide agile and sustainable solutions to re-design supply chains and enable circular business models.

ABOUT DHL TECHNOLOGY

As the leading logistics provider for the technology sector, DHL knows that smart devices require smart solutions. Servicing a wide range of technology customers in more than 220 countries and territories worldwide, we understand the changing landscape of modern technology and the evolving challenges facing your business. At DHL, we offer our customers unparalleled experience in logistics services, ranging from transport of air freight and express shipments to warehousing and service logistics solutions, as well as our industry-leading expertise on emerging topics such as circular economy solutions.

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