COVESTRO x GC INSIGHTS

How Sustainable Materials are Shaping the Future of Circular Economy

A GUIDE FOR BUSINESS LEADERS OF EMERGING TRENDS, CHALLENGES, AND SOLUTIONS ACROSS INDUSTRIES

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GC Insights

How Sustainable Materials are Shaping the Future of Circular Economy

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March 2024

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EXECUTIVE SUMMARY

We are standing at the crossroads of the climate crisis, and the need to accelerate efforts to reduce greenhouse gas emissions is increasingly urgent. More stringent policies come up in the global circular economy across industries. According to the United Nations Development Programme (UNDP), over 70 countries were already applying various circular economy policies across the life cycle of their productive sectors in 2022. The shift from a linear to a circular economy is the key to staying competitive for businesses as there are plenty of compelling benefits of embedding a circular mindset into business strategies. Leadership and innovation in business are vital to making progress.

The circular economy is changing the way businesses operate and create value, where **sustainable recycled materials[1] has a prominent role to play.** This whitepaper aims to share the leading insights into the circular transition with **more sustainable engineering plastics**[2] combined with innovative solutions in transforming industries towards a circular and sustainable future.

To guide you through this transition, **Covestro**, a global leading manufacturer of high-quality polymer and innovative recycling materials solution provider, cooperating with **GC Insights**, a sustainability-focused research and consulting firm, prepared this whitepaper that addresses the key pain points, potential opportunities and solutions from across industries.

Part I introduces the macro trends that are transforming the current linear economy to a more sustainable circular economy, from the emerging trends towards a circular economy with more stringent global policy developments, to more ambitious corporate commitments, and actions. It also explores evolving demands and preferences from consumers for circular products.

Part II highlights the challenges and gaps in meeting the circular demands. These include distinctions among various eco-labels, inefficiency in take-back programs, and hard-to-recycle materials. Lack of traceability and hidden greenwashing concerns are lagging circular progress in the market. Overcoming these challenges and creating a more sustainable, resource-efficient world, requires collaboration among government policies, business innovations, and increased consumer awareness.

Since there are no stand-alone solutions to these challenges. **Part III delves into five market-leading solutions and case studies that enable circular transition**, through standard eco-label programs, digital traceability solutions, circular design, closed-loop design and repurpose strategies, etc. These are some of the best practices for leading businesses looking to tackle the headwinds embedded in circular transitions.

Together, we are inviting business leaders to explore opportunities, exchange insights on common challenges, and identify solutions embedded in circular economy transitions with more durable and sustainable engineering plastics.

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[1] Recycled Materials: A recycled material is the output of a recycling operation, and it can be considered as such when substances or objects previously classified as waste achieve a non-waste status. (from "Guidance on Waste Definitions" by European Commission Circular Plastics Alliance, 2021)

[2] Engineering plastics exhibit higher performance than standard materials, making them ideal for tough engineering applications. They have gradually replaced traditional engineering materials such as wood or metal in many applications because, not only do they equal or surpass them in their weight/strength ratio and other properties, but they are also much easier to manufacture, especially in complicated shapes. (Plastics Europe, 2024)

PART I THE FUTURE OF CIRCULARITY: A LOOK AT EMERGING TRENDS

1.1 Leaderships in A Circular Economy Era

The UNDP states our current "linear economy" relies on extracting raw materials, converting them into products, and discarding them as waste. **Only 7.2% of used materials are recycled, which has a significant burden on the environment and contributes to the climate, biodiversity, and pollution crises.**

In contrast, the circular economy aims to minimize waste and promote sustainable use of natural resources through smarter product design, longer use, recycling, and more. It also aims to regenerate nature. By adopting circular economy practices, we can tackle the problem of pollution and play a critical role in solving other complex challenges such as climate change and biodiversity loss. Leadership and innovation from business are vital to the transition to a circular economy.

Countries are increasingly delivering their National Determined Contributions (NDC). Circular economy approaches can accelerate their transition to inclusive, resilient, and lower-carbon economies, support natural systems regeneration, respond to climate crises, and create green jobs.

The Ellen MacArthur Foundation[3] defines a circular economy as a global economic model that is restorative and regenerative by design, effectively decoupling economic growth from natural resource consumption while maintaining product, object, and material value.

The key to a circular economy is to use the economy to facilitate the cycle with circular consideration throughout the value chains of the products and services. It requires system-wide thinking to build "circulation" (see Exhibit 1).

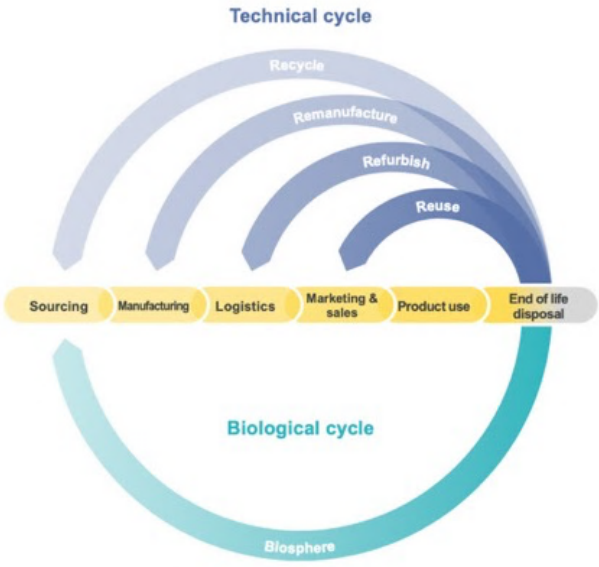

Exhibit 1 Circular economy diagram from Circular Design Guidebook by Covestro and REnato lab

[3] The Ellen MacArthur Foundation: a non-profit organisation that creates evidence-based original research on the benefits of a circular economy, and how it can contribute to solving global challenges like climate change and biodiversity loss.

The Circular Design Guide defines five circular design strategies – Modular Design, Circular Material Choices, Design for Extended Product Life, Product as a Service, and Dematerialization, – which can assist designers in thinking about how to apply the concepts of a circular economy during product design (see Exhibit 2). Read more about circular design in Covestro's Circular Design Guidebook[4].

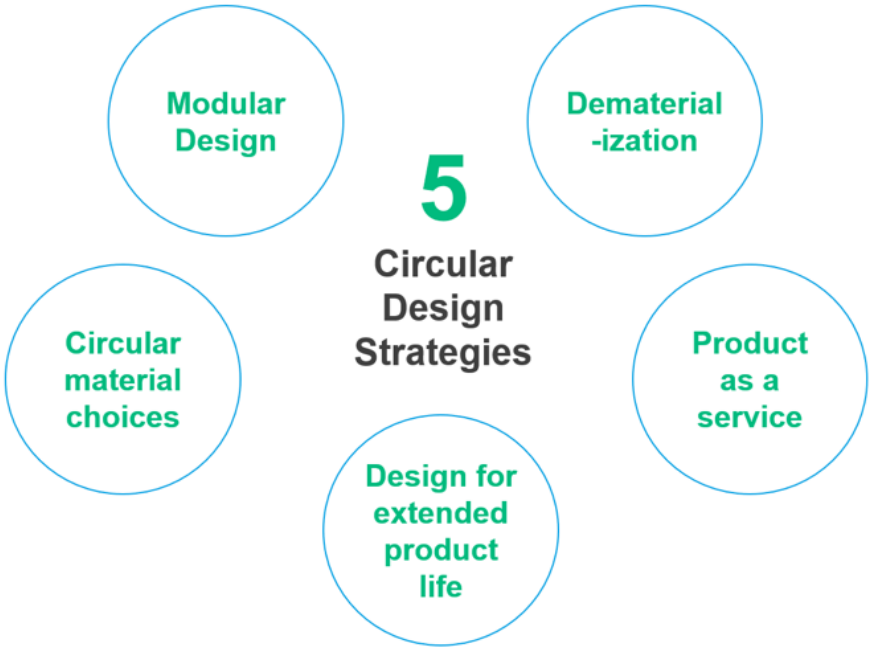

Exhibit 2 Five Leading Circular Design Strategies from Circular Design Guidebook by Covestro and REnato lab

As we proceed to enter a more circular economy, it's important to select not just "recyclable materials[5]", but also "materials benefiting product circulation". Sustainable materials create sufficient value after disassembly, such as sustainable engineering plastics that exhibit higher performance than standard materials with circular design in mind for products.

1.2 National Policies Driving Circular Agendas

Globally, nations are trying to fulfil their National Determined Contributions (NDCs) through circular economy development. The regulatory approach to circular economy is on the rise (see Exhibit 3). For instance, from 2023, the European Commission has adopted various green initiatives, including proposals on green claims, the right to repair, and a revised circular economy monitoring framework. The proposed directive on end-of-life vehicles mandates that 25% of the plastic used in new vehicles must come from post-consumer recycled sources, of which 25% (meaning 6.25% in total) should come from end-of-life vehicles, hence closing the loop. For the first time, the key focus of this directive has covered the increasing use of recycled plastics in vehicles.

[4] Covestro: https://solutions.covestro.com/en/highlights/articles/cases/2021/circular-design-guidebook-electronics

[5] Recyclable: A characteristic of a product, packaging or associated component that can be diverted from the waste stream through available processes and programmes and can be collected, processed and returned to use in the form of raw materials or products. (EN ISO 14021:2016 + A1:2021 (E), 7.7.1)

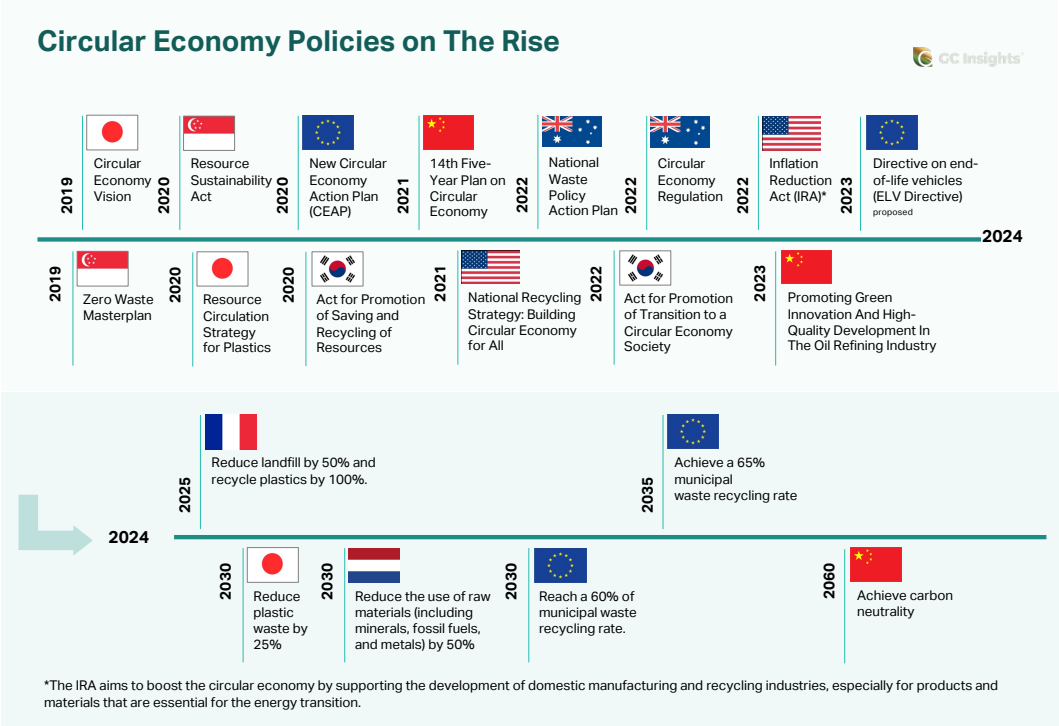

Exhibit 3 Circular Economy Policies on The Rise by GC Insights[6] (selective examples)

These regulations and policy actions demonstrate the global aspiration to lead the circular economy transition and create a cleaner and more competitive market that aligns with the National Determined Contributions (NDC) and sustainability goals. Businesses that want to seize this opportunity need to plan and design their products with circularity in mind to maintain their edge.

1.3 Corporate Actions Toward Circularity

The circular economy intends to extend the lifespan of products, redesign them with circularity in mind, reuse parts of them and recycle their materials to minimize waste by reusing, recycling, and refurbishing products and materials. Several key industries play a crucial role in advancing the circular economy. For example, circular manufacturing emphasizes designing products for durability, repairability, and recyclability. Continued innovation in materials, production processes, and product design can boost circular manufacturing efforts and benefit its downstream circulation applications. Below are some circular product commitments and programs introduced by leading international companies, including the utilization of sustainable materials (see Table 1):

COMPANY	**CIRCULAR PRODUCT COMMITMENT(S) AND PROGRAM(S)**
	Electronic
DELL TECHNOLOGIES INC.	"By 2030, for every metric ton of our product a customer buys, one metric ton will be reused or recycled. By 2030, more than 50% of our product content will be made from recycled, renewable or reduced carbon emissions material."

[6] Read more Circular Economy Policies and Sustainability, ESG-related policies here: https://www.gc-insights.com/news-1

XIAOMI CORPORATION	"Over the next five years (from 2022 to 2026), Xiaomi aims to recycle 38,000 tons of e-waste accumulatively and utilize 5,000 tons of recycled materials in our products. Through product refurbishment projects, product take-back programs, Extended Producer Responsibility (EPR) and more."
AMAZON.COM, INC.	"Sustainable Product Selection: As of January 2024, the Climate Pledge Friendly program added 53 certifications. The new certifications recognize improvements in at least one aspect of sustainability, from recycled content to energy efficiency. Amazon Second Chance program, including Amazon Trade-In and Amazon Device Recycling and more."
ALPHABET INC.	"Use recycled or renewable material in at least 50% of plastic used across our consumer hardware product portfolio by 2025. Through "trade-in programs, e-waste recycling programs, and more."
Automobile	
PORSCHE AG	"Porsche has anchored targets for the use of circular materials in all new all-electric vehicle projects where production begins after 2026. In the case of the Taycan and Cayenne, for example, the material used to protect door coverings and hoods in transit has been switched out for a mono-material that is more than 99% recyclable."
TOYOTA MOTOR CORPORATION	"In the lead-up to 2050, Toyota aims to build a society that maximises plastic recycling on a global scale. For this purpose, we aim to increase the use of recycled plastics by more than three times compared to current levels by 2030. In addition to existing initiatives for collection and recycling of bumpers replaced during repairs at dealers, we are planning to use recycled plastic materials from automobile shredder residue (ASR) in new vehicles by utilising the crushing and sorting technologies."
FORD MOTOR COMPANY	"Established an interim target of 20% renewable and recycled plastics by 2025 in new vehicle designs for North America, Europe and Turkey and 10% in China. Ford is the first automaker to use 100% recycled post-consumer plastics to produce automotive parts. In 2021, Ford used 100% recycled ocean plastics to produce automotive parts."
GEELY AUTOMOBILE HOLDINGS LIMITED	"Geely Auto's Geometry E uses plastics made from plant straw and felt lining from recycled PET fibres, which has passed the GRS global recycling standard certification. The new Volvo EX90 will have 48 kilograms of recycled plastic and bio-based materials. Plastic material filled with plant stalk is used to make the door fender."

Health Care	
NOVO NORDISK A/S	"Reduce the amount of plastic we use by gradually shifting towards durable rather than pre-filled devices. We are also working to shift to non-fossil fuel plastics, for example by harnessing waste carbon and hydrogen from energy supply processes, including the use of carbon capture. ramped up initiatives to stop our pen devices, classified as medical waste, from going into landfills. A take-back initiative in Denmark that reuses the plastic in these devices has now been expanded to a full-scale national solution, while new recycling pilots have been launched in the UK, France and Brazil. Our take-back of insulin pens initiative, piloted in Denmark, in 2022 achieved a good return rate with a monthly average of 18.3%."

Table 1 GC Insights Retrieved from company public disclosures, ESG reports and announcements on relevant circular strategies (see reference list).

The circular economy is the future of business. It is a system that eliminates waste and pollution and circulates products and materials at their highest value. An increasing number of companies across different industries have adopted and centred their circular strategies as a pivotal part of their business models to offer their customers eco-friendly and cost-effective solutions. Businesses can follow their example and accelerate their transition to the circular economy.

1.4 Increasing Demands for A Circular System

Consumers are becoming more environmentally conscious and are interested in sustainable brands and their offerings. Exhibit 4 shows the primary motivations for consumers to purchase sustainable products and brands.

According to research conducted by First Insight, Inc., and The Baker Retailing Centre at the Wharton School of the University of Pennsylvania (2022) on "Consumers Demand Sustainable Products and Shopping Formats" indicates that the primary reason consumers purchase sustainable products and brands is to help the environment. Nearly 30% of consumers want to improve the environment, while 23% wish to reduce production waste, 22% want to reduce their carbon footprint, and 17% are concerned with animal welfare.[7]

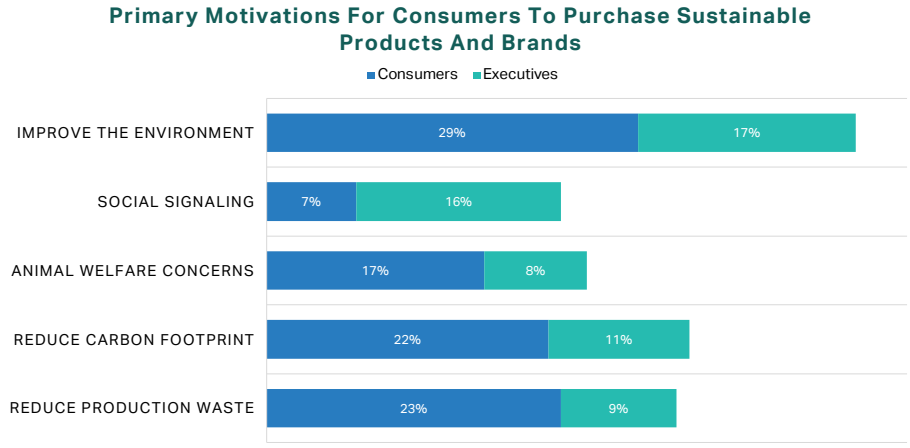

Exhibit 4 Primary Motivations for Consumers to Purchase Sustainable Products and Brands

[7] Data from First Insight, Inc. and The Baker Retailing Centre at the Wharton School of the University of Pennsylvania (2022) The consumer study is based on the results of a U.S. consumer study of a targeted sample of more than 1,000 respondents fielded in July 2021.

In addition, the demands for high-quality recycled plastics are expected to expand with high green premiums according to findings from McKinsey & Company (2022). By 2030, the supply of high-quality recycled plastics could increase from around 5 million tons to 20-30 million tons. However, this increased supply is still significantly lower than the expected demand from various applications such as consumer electronics and automotive. The demand for high-quality recycled plastics is expected to grow from 11 million tons in 2020 to 66 million tons in 2030. This supply-demand imbalance is expected to reach more than 35 to 45 million tons by 2030, leading to the potential for high green premiums[8], see Exhibit 5.

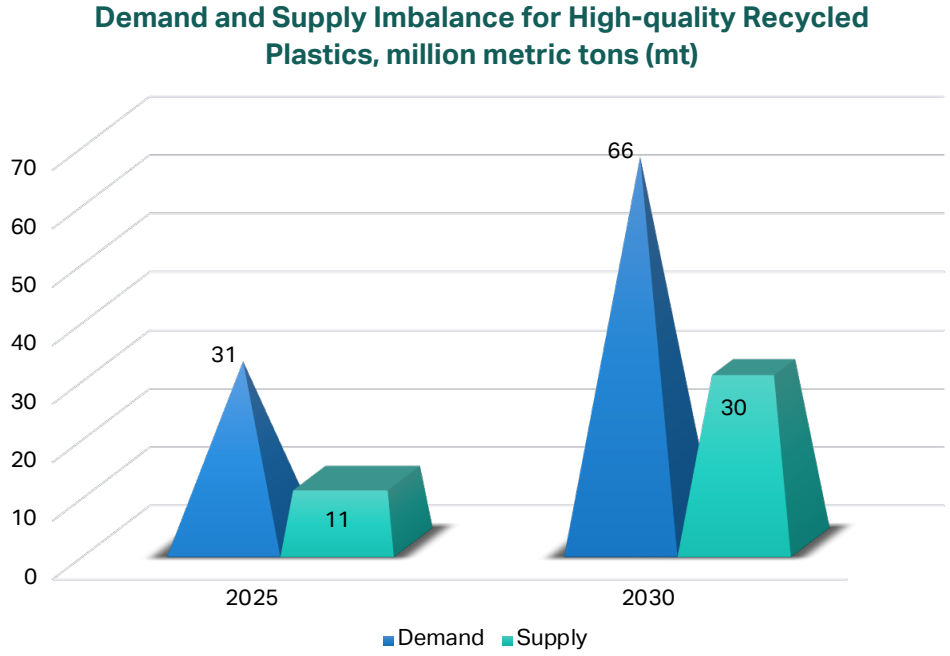

Exhibit 5 Demand and Supply Imbalance for High-quality Recycled Plastics[9], million metric tons (mt) data from both GC Insights and McKinsey & Company (2022)

The demand for high-quality recycled plastics is increasing due to various factors, such as consumer sentiment, corporate commitments, anti-pollution regulations, access to funds, and new business models, etc. This provides market opportunities, pricing power, green premiums, and other business incentives to boost corporate actions towards a circular economy. Transitioning to a circular economy is crucial for addressing climate change and resource constraints.

[8] Green premiums: Premium levels were estimated based on the willingness of consumers to pay, including bespoke analysis for each end use, additional capital and production costs to decarbonize operations, and expected scarcity of low-CO_2 materials, where applicable. (McKinsey & Company, 2022)
[9] High-quality Recycled Plastics: plastics recycled to a similar product grade. (McKinsey & Company, 2022)

PART II THE HURDLES OF CIRCULAR ECONOMY TRANSITION

2.1 The Maze of Eco-Labels

According to the Ecolabel Index[10], there are roughly 456 ecolabels in the market, covering various categories such as agriculture, energy, environment, health, and waste management. And around 37 ecolabels are related to waste management & and recycling. For example, the EU Ecolabel is a voluntary label that covers a wide range of product categories and services and guarantees that they have a lower environmental impact throughout their lifecycle. The EU Ecolabel[11] criteria include requirements for recycled materials, minimal packaging, and easy recyclability. While Environmental Product Declaration (EPD)[12] is another creditable certificate in the market, €h provides relevant, verified and comparable information to help and support organisations to communicate the environmental performance of their products (goods and services) credibly and understandably. (see Exhibit 6)

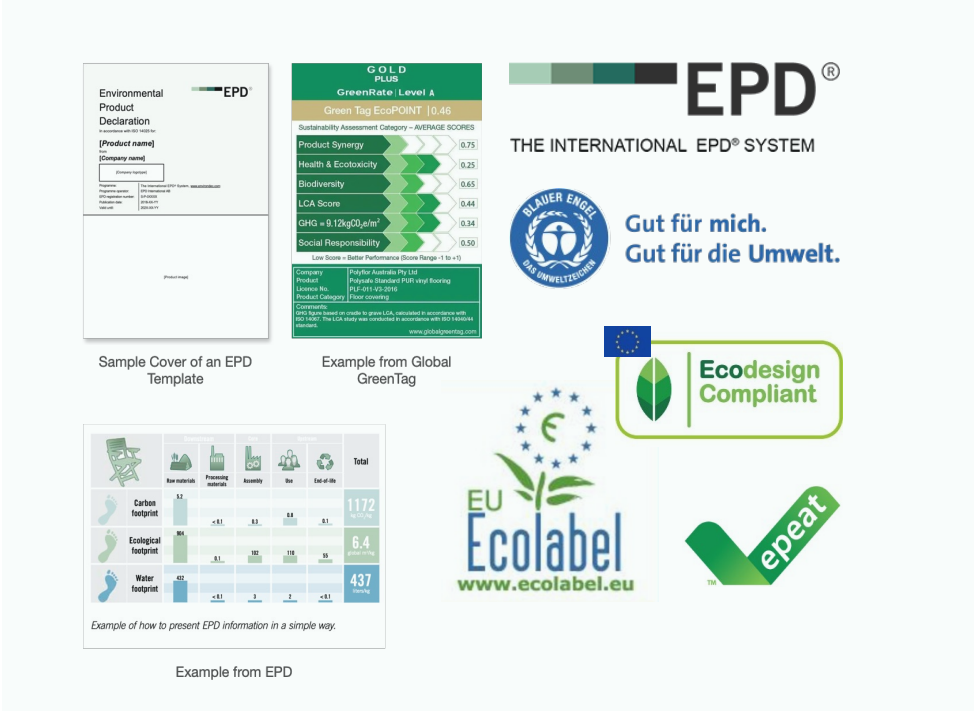

Exhibit 6 Ecolabels Example from GC Insights

Consumers and brands are often confused by these labels[13]. As there are growing numbers of green labels and circular claims[14] accompanied by surrounding confusions on their merits and methodologies. Many labels could be confused with general eco-labels and, lack of transparency in methodologies and assessment processes has raised greenwashing concerns for some of the marketing eco-labels.

[10] Ecolabel Index: the global directory of ecolabels

[11] The EU Ecolabel is a world-renowned, voluntary scheme promoting goods and services that clearly demonstrate environmental excellence, based on standardised processes and scientific evidence.

[12] Learn more about EPD here: https://www.environdec.com/resources/lca-consultants .

[13] "Label" describes a logo or stamp highlighting a product or service's specific characteristic(s), which may also be used as a form of trademark. A label may or may not represent a certification. Sources: (ISO 14020); (UN Environment and ITC 2017); (Organisation for Economic Co-operation and Development [OECD] 2011)

[14] "Claim" refers to assertions made by companies about benefits. qualities or characteristics of their goods and services. Sources: (ISO 14020); (UN Environment and ITC 2017); (Organisation for Economic Co-operation and Development [OECD] 2011)

While lack of details on traceability and transparency requirements in regulations and guidelines has been spotted even with increased scrutiny of policy requirements for circularity. Challenges in unified standards and universal frameworks for proof of the traceability of recycled plastic material from the source are consequential. The recycled content of each product can differ, which leads to confusion and unfair advantages for certain companies trying to verify their recycling claims without standardised clarifications (such as declaring the highest recycled materials used in one component versus the average recycled materials used in an entire device) and transparency needed to understand the calculation and methodologies behind such recycling claims.

Thus, to find solutions in navigating through the various choices of eco-labels is crucial to verify and communicate the sustainability outcomes achieved, check out the latest market solutions in Part III-3.1 How to Choose the Right Eco-Labels for Your Businesses or get connected with experts in GC Insights for further discussion. **It is crucial to provide clarity in communication of the recycled claims with detailed and up-to-date disclosures of the definitions, standards, methodologies, calculations, and other material information when applying for product eco-labels.**

2.2 Recycling Capability Is Yet to Build

It is worth noting that a study by the Journal of Marketing (2023) uncovered that consumers exhibit a higher willingness to pay for products that are part of a circular take-back program in comparison to when they are not. The driving force behind this willingness lies in a concept known as psychological ownership. Circular products offer control over the disposal of the product, which taps into consumers' sense of ownership, prompting them to place higher value on these items.

Nowadays, companies offering take-back programs such as used consumer electronics, and other consumer goods as part of their efforts in closing the circular loop for post-consumption waste management. However, a few challenges are making the "take-back process" inefficient.

According to a joint survey by the World Economic Forum, SAP and Qualtrics, lack of programs/services to enable recycling, not knowing how to participate in recycling programs, inconvenience of recycling, and lack of trust in recycling programs are ranked the top barriers to recycling. In addition, limited consumer incentives, lack of clear guidance for recycling and lack of design-thinking for recyclability, such as improved durability, and reduced complexity in composition to make dismantling for recycling easier are among the top concerns to ensuring recycling initiative works.

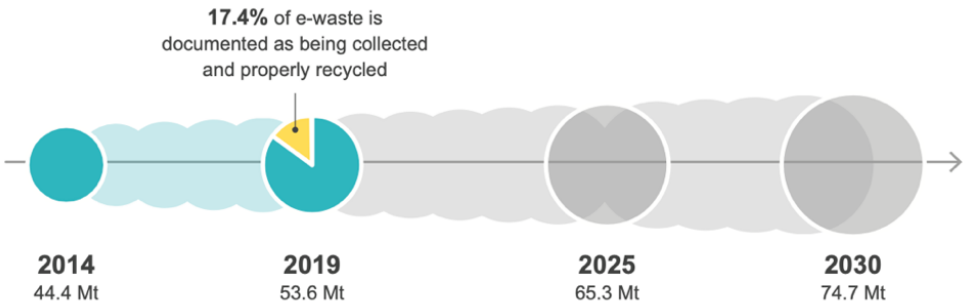

Exhibit 7 Global E-waste generated by year from Circular Design Guidebook by Covestro and REnato lab

As global E-waste generated by year is at a low efficient rate (see Exhibit 7), circularity technology and circular design-thinking have a prominent role to play. Check out the latest market solutions in Part III-3.3 Case Study I Automobile: Mono-Material Design for Full Circularity and Part III-3.4 Case Study II Electronic: Closed Loop Recycling Design of Laptops for more inspiration.

2.3 Lack of Traceability, The Hidden Greenwashing Concerns

According to a report by the European Union (EU) on traceability across circular value chains, **traceability is essential for the sustainable management of waste and the transition to a circular economy**, and it helps to ensure that recycled materials are of high quality and meet the required standards. According to the United Nations Economic Commission for Europe, the **availability of and access to reliable information are crucial for the circular economy**. **This includes agreed classification systems and mechanisms to track and report related data.**

Traceability and transparency can also be misused or abused by some actors to make false or misleading claims about their environmental credentials or practices. This is known as greenwashing, which is a form of deceptive conduct that can harm consumers, investors, regulators, and the environment. (EU, 2021)

ISO 22095 Chain of Custody defines five models of chain of custody[15], each with different requirements for the suppliers. The standard is helpful to enhance the transparency of specific claims regarding materials or products and thereby support the reliability of these claims. **However, understanding and following the right chain of custody with transparency and a track record of quality data could be difficult for suppliers.**

Clear communication on the mass balance approach is essential for the chemically[16] 'recycled content' claim to be understood by the end user. As pointed out by the Ellen MacArthur Foundation, it is also crucial to explain the difference between chemically (mass-balanced) recycled material and mechanically [17] recycled material (e.g., segregation approach). Businesses can find it inspiring to the emerging digital traceability solutions presented in Part III-3.2 Traceability and Co-Branding to Drive Customer Engagement.

[15] 1) Identity Preserved - In this approach, the physical traceability of the material is maintained throughout the supply chain. This means that the alternative material is kept separate from other materials at all stages of the process. 2) Segregation -This approach also maintains physical traceability but allows for the mixing of materials from different certified sources. The mixed material is then sold as certified. 3) Controlled Blending - in which carefully defined and uniformly implemented mixing of products with and without the specified alternative material is permitted. 4) 'Book And Claim' Accounting System: This system involves the trading of certificates in open markets. The sustainable material is not physically traced in the supply chain. Instead, certificates representing the sustainable material are traded separately. It's a virtual solution to a physical problem based on a one-atmosphere approach. 5) Mass Balance Approach: The mass balance approach is an accounting principle that matches inputs with outputs from a recycling or production process to determine the recycled or renewable content.

[16] Chemical recycling is the process of converting polymeric waste by changing its chemical structure and turning it back into substances that can be used as raw materials for the manufacturing of plastics or other products.

[17] Mechanical recycling is processing plastic waste into secondary raw materials or products without significantly changing the material's chemical structure.

2.4 The Surging Circular Demand Curve

Impact indicators from consumers, corporations, industries, and governments show an increasing demand curve for high-quality recycled plastics (see Exhibit 8).

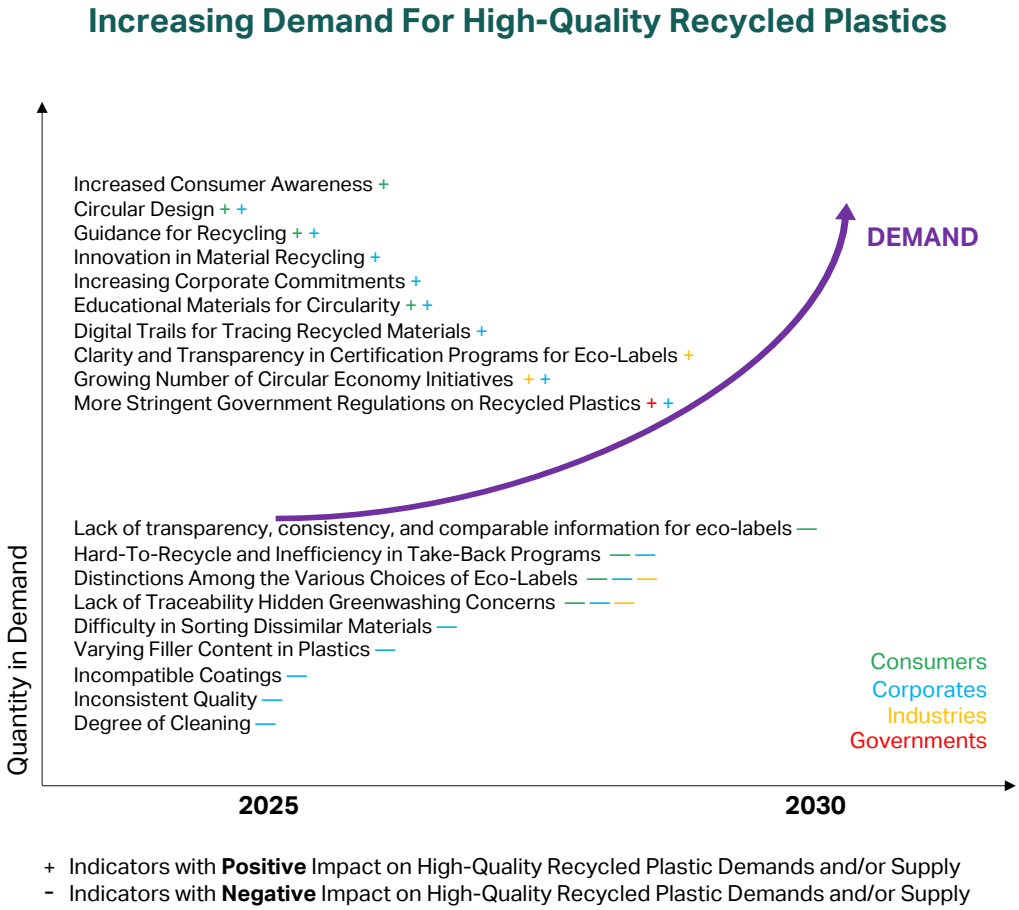

Exhibit 8 Impact Indicators Driving Increasing Demand for High-Quality Recycled Plastics from GC Insights

There is a massive demand for high-quality sustainable engineering plastics from consumers, corporations, industries, and government policies. It creates a competitive advantage for brands that use sustainable plastics, as they can attract and retain customers who value sustainability. Recycling constraints and rising demand will likely remain undersupplied for high-quality recycled plastics until even after 2030.

The circular economy is a complex and dynamic system that requires constant adaptation and innovation to overcome the challenges and gaps. Fortunately, there are many inspiring examples of businesses that are embracing circular solutions and creating positive impacts on the environment and society.

PART III CIRCULAR TRANSITIONS: SOLUTIONS AND OPPORTUNITIES

There are no stand-alone solutions to these challenges. This part delves into five market-leading solutions and case studies that enable circular transition, through standard eco-label programs, digital traceability solutions, circular design, closed-loop design and repurpose strategies, etc. Let us dive into some of the best practices from leading businesses looking to tackle the headwinds embedded in circular transitions.

3.1 How to Choose the Right Eco-Labels for Your Businesses

Some market-leading ecolabels require the disclosures of the recycling rate of the labelled products. Below is a list we summarised from Amazon Climate Pledge Friendly, a program facilitated by Amazon to help customers discover and shop for more sustainable products (see Exhibit 9).

Exhibit 9 Selected sustainability certification from Amazon Climate Pledge Friendly

Products that meet certain sustainability criteria are eligible to receive "the Climate Pledge Friendly" badge. Badges are displayed on the product page, making it easier for customers to identify and choose products with lower environmental impact, at the same time, Amazon promotes products with certified eco-labels and provides more visibility via higher ranking and better position on the webpage. Since Amazon launched Climate Pledge Friendly in 2020, the **search rates** for labelled products have increased significantly. With 818 million Climate Pledge-friendly certified products sold, and a 120% increase (550k in total) of Climate Pledge Friendly products available from 2021. Additionally, 19 customer experience enhancements highlighting sustainable products, such as new search functions and clearer digital badges. **10% more product views through search, detail pages, and recommendation widgets, when labelled Climate Pledge Friendly**, according to the latest number published by Amazon's Sustainability Report.

To qualify for the Climate Pledge Friendly program, products typically need to be certified by recognized third-party sustainability certifications. These certifications may include labels related to energy efficiency, reduced carbon footprint, and other environmentally friendly attributes. Below are some of the popular ecolabels included in

the Amazon Climate Pledge Friendly Programs that require recycled content disclosure (see Exhibit 10):

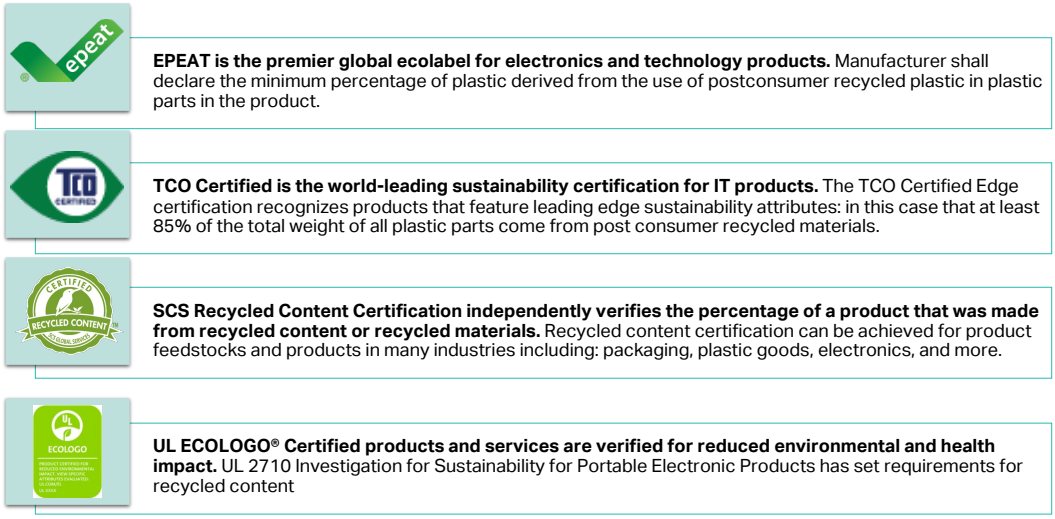

Exhibit 10 Ecolabels that require recycled content disclosure

ISCC – International Sustainability and Carbon Certification (ISCC) PLUS certification is another voluntary scheme that applies to the bioeconomy and circular economy for food, feed, chemicals, plastics, packaging, textiles and renewable feedstock derived from a process using renewable energy sources. (see Exhibit 11) ISCC PLUS is recognised by SAI, Blue Angel, Textile Exchange, FEFAC, FSS and many more. As its recognition across international markets, products obtained ISSC PLUS certification could gain **brand visibility, and creditability in circular claims**, **and gain access to more international markets that value this standard**. The certification scheme has also become part of the Climate Pledge Friendly program on Amazon for the US marketplace.

Exhibit 11 The ISCC On-Product Logos from ISCC

Transparency in the disclosure of recycled content is not merely a compliance requirement or a tool for companies to deliver on their circular commitments. It is, in fact, a powerful instrument for tracking progress, enhancing market exposure, and driving sector-specific innovation. These certifications, often tailored to specific industries, provide a unique lens through which companies can assess their performance and identify opportunities for improvement. **Companies that prioritize transparency can comply with regulatory standards, gain a competitive edge, enhance their brand reputation, and demonstrate their commitment to sustainability and circularity.**

In certain scenarios during chemical recycling, the volumes or values of goods or materials from the desired sources are too low to be shipped, stored or processed separately, or the technical processes do not allow for differentiation. In such scenarios, the **Mass Balance Approach** serves as the prevailing traceability method. This accounting principle aligns inputs and outputs within a production process, enabling the determination of recycled or renewable content. It is used to measure and track alternative inputs and outputs in several industries like renewable energy and the plastics industry. In advanced recycling and the use of renewable materials, mass balance traces, measures, and reports the number of recycled or renewable materials used to create a product. The main principle of mass balance is that the total inputs should be balanced with the outputs. For example, Covestro's RE product series uses alternative raw materials that have been assigned renewable raw materials through mass balancing as well as renewable energy and can thus be certified as having up to 89% sustainable materials and a net carbon footprint of up to zero. The Principle of Mass Balance Approach at a glance (see Exhibit 12):

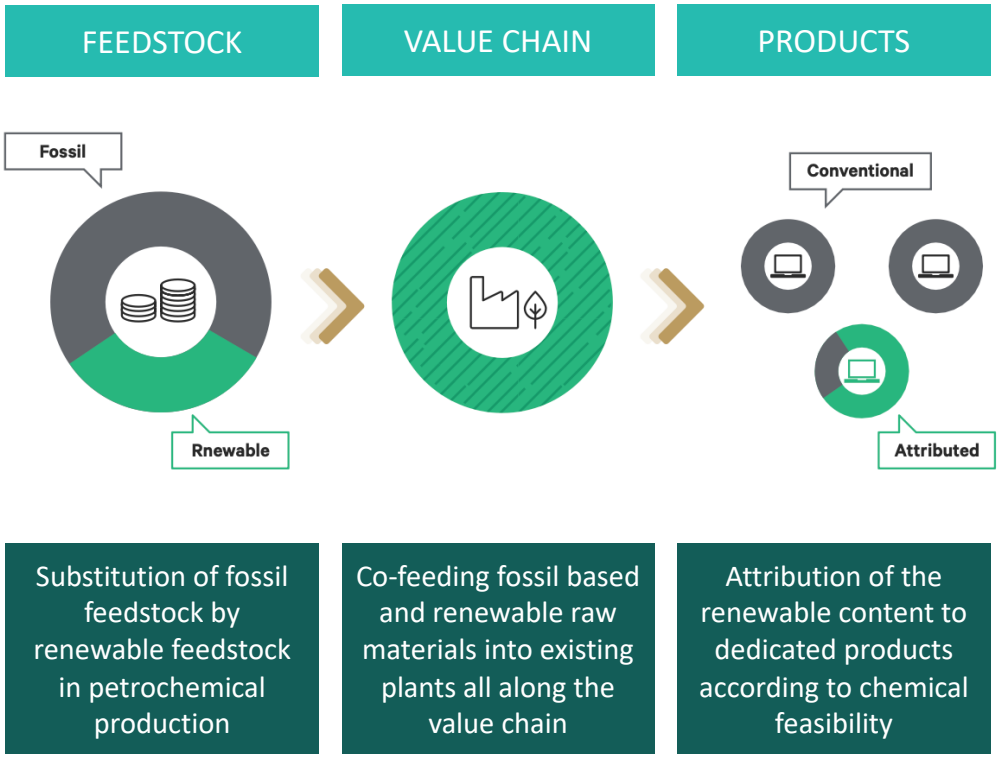

Exhibit 12 Principle of Mass Balance Approach by Kaynemaile Architectural Mesh (2023)

3.2 Traceability and Co-Branding to Drive Customer Engagement

Traceability for sustainability claims is a key aspect for companies to advance sustainability and prove claims and attributes of sustainable products. According to the

United Nations Global Compact (UNGC), companies undertake traceability programmes to improve their supply chain management in various ways. Traceability for recycling claims and the use of recycled content materials could help businesses capture the green premiums from meeting increasing consumer demands for circularity, boost consumer engagement, improve reputation and brand values through circularity and avoid the risk of greenwashing as mentioned in Part II 2.3 Lack of Traceability Hidden Greenwashing Concerns.

Energy Expert (能耗宝) is a platform developed by Alibaba Cloud that enables online measurement and verification of product carbon footprints, certification of green products, etc. The process of transforming one used 19L water bottle from Nongfu Spring, a beverage company from used plastics is traced with the Energy Expert platform, into 156 pens with KACO, a stationery brand, who, in return, cobrand this stationery product line with Nongfu Spring. Covestro collaborates with Nongfu Spring and uses their end-of-life water bottles as one of the traceable sources for post-consumer recycled (PCR) polycarbonate (PC), which is then compounded with virgin polycarbonates for customers like KACO. According to the data from Energy Expert, this process saved 5.85gCO_2e per pen produced, compared with the use of 100% virgin plastics.

Recycled plastics with traceability technology have immense potential, and this co-branded product is a great example of that. It has achieved significant sales success, ranking among the top 10 products in KACO's e-channels. (see Exhibit 13) By emphasising the value of **traceable sustainable materials through co-branding**, it has **helped raise low-carbon awareness among end consumers**. **The consumer market plays a crucial role in driving the successful implementation of carbon neutrality and bridging by digital traceability and co-branding are key to promoting circulation throughout value chains.**

Exhibit 13 Energy Expert, Covestro turns Nongfu S'ring's used water bottles into pens with Kaco. Images show the digital trace and sales campaign on e-commerce channels of KACO's pen using recycled materials

Besides the use of recycled materials highlighting their traceability, and to encourage further the transition to a circular economy, Covestro has created several "design for recycling" concepts including a car headlamp, a drug delivery device, and a laptop computer.

3.3 Case Study I Automobile: Mono-Material Design for Easier Recycling

It demonstrates how a sleek mono-material module can be easier to recycle, use fewer parts, and be lightweight, all while integrating emerging sensor and lighting technologies. (Exhibit 14)

Sharing the same PC-based origin reduces the work of sorting, separation and storage at the end of the headlamp's useful life. All parts in this cutting-edge headlamp demonstrator are made from high-value Makrolon® TC, DS, ST grades and Bayblend® polycarbonate + ABS blend. According to Covestro, instead of sorting materials by metal and glass types, or even by specific colours, all recyclate can be processed in a single PC-based stream, or just two streams separating transparent from opaque raw materials. Initial testing of the recyclate PC material shows it is robust and well-suited for use in thermoplastic housings.

With over 50 fewer individual parts, this concept LED headlamp system is much less complex than comparable solutions, translating into less tooling and process operations for the manufacturer of the assembly. Moreover, the complete headlamp demonstrator weighs 1.8 kg less than a typical headlight with similar features, which can aid the driving range of an electric vehicle or improve fuel economy. The reduced complexity and streamlined manufacturing translate to a solution that can help save costs per headlamp compared to conventional designs.

Exhibit 14 Working car headlamp concept using only polycarbonate (PC) resins

3.4 Case Study II Electronic: Laptops Design for Easier Disassembly

Today's supply chain for recycling engineering polymers is not sufficient for these closed-loop economies. Challenges include the difficulty in sorting dissimilar materials, incompatible coatings, varying filler content in plastics, degree of cleaning, and overall inconsistent quality. For electronic products such as laptops, the removal of metal connectors, is a major drawback to the streamlined recycling of such assemblies, since a longer time is required for disassembly, which translates into increased recycling costs. (see Exhibit 15 for the conventional design solution) To reduce or eliminate problems, a need exists in the art for laptop parts to contain a greater amount of homogenous plastic and fewer metal connectors, so they may be more quickly removed, recycled and repaired, than those made according to the state-of-the-art.

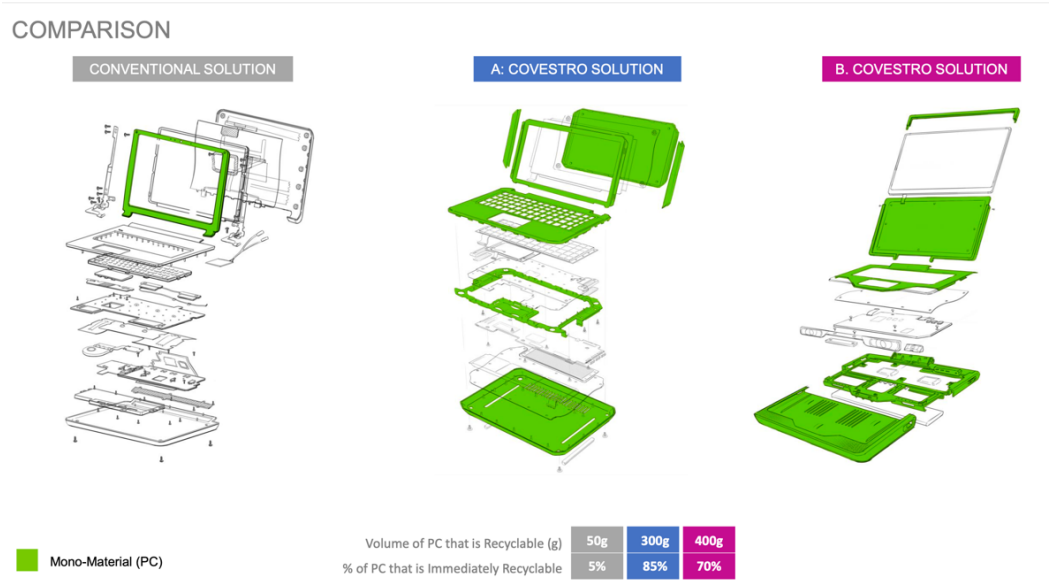

Exhibit 15 Conventional Design vs Covestro's two concepts (Design for Disassembly), highlighting the PC/ABS parts that are easily recycled from Covestro (2023)

Through the idea of design for disassembly, Covestro sees the residual plastic from these devices as a valuable raw material that should be reclaimed and has developed a series of design concepts for notebooks (Exhibit 16), to maximize the amount of easily recyclable PC/ABS. Common threads in these new designs are using fewer glues and adhesives, replacing metal components with plastics, where possible, and replacing screws, in favour of plastic-to-plastic joining methods, like heat staking. Other, more complex re-designs, calling for a major overhaul of displays, electronic boards, and EMI shielding are deployed as well. Recyclers may benefit from an added revenue stream derived from the supply of high-quality thermoplastics back to plastics manufacturers.

3.5 Case Study III Healthcare: Repurposed Injection Pens

A great attempt to "take-back" for recycling and repurpose strategy in healthcare has been brought by Novo Nordisk, a Danish multinational pharmaceutical company. The company has launched the PenCycle Recycling Scheme, a recycling initiative for pre-filled injection pens. This is the first of its kind in the UK and is designed to address the challenge of recycling injection pen devices used by people living with diabetes, obesity, and growth disorders. The initiative aims to prevent these devices from ending up in landfills or being incinerated. The pens can be returned via local participating community pharmacies, pre-paid Royal Mail boxes, or through an at-home collection pilot service for people using growth hormone pens. The pens will be returned to Denmark where the plastic will be recycled into a range of items, such as chairs and lamps.

Participating pharmacies will receive a PenCycle Starter Pack which will contain all necessary materials, including practical guidance on the initiative, patient information, and materials for patients to take home and start PenCycling.

The pilot alone aims to recycle over 150,000 pre-filled plastic injection pen devices, ensuring over two tonnes of plastic materials are diverted from UK landfills. By the end of 2022, it is expected that 1.1 million pre-filled plastic injection pen devices will have

been recycled, with a potential to recycle over 3 million pen devices in 2023, preventing over 56 tonnes of plastic waste.

To support recycling in the healthcare sector, Covestro has also introduced a new proof-of-concept drug delivery device, manufactured from its portfolio of medical-grade polycarbonate resins. The device uses discrete polycarbonates in each piece, **simplifying sorting and recycling after the disposal of bio-contaminated pieces.** (see Exhibit 16)

Exhibit 16 Drug Delivery demonstrator, which utilizes Makrolon® polycarbonate and Bayblend® PC+ABS from Covestro

SUMMARY & RECOMMENDATIONS

The circular economy is a key concept for achieving sustainable development and addressing the global challenges of climate change, resource scarcity, and environmental degradation. It aims to shift from a linear model of production and consumption, where materials are extracted, used, and discarded, to a circular model, where materials are kept in use for as long as possible, through prevention, reuse, recycling, and regeneration.

This whitepaper provides insights into the latest trends, challenges and best practices in the transition to a circular economy, and offers actionable recommendations for businesses looking to pivot into circularity. By adopting these practices, businesses can reduce their environmental footprint, increase resource efficiency, and create new revenue streams. The case studies provide real-world examples of how these solutions have been implemented and the benefits they have brought to businesses. It is an essential read for corporate readers who are looking to stay ahead of the curve in the transition to a circular economy.

Key Recommendations for Businesses:

Circular Strategy:

- Adopt circular strategies that create value for your customers, shareholders, employees, and society at large.
- Prioritise circularity in product design with durability in mind.
- Choose the right eco-labels that fit your circular agendas and provide international recognition, consistency in methodologies, and guidance to improve transparency.
- Demonstrate your circular commitment by reporting on your progress and performance in achieving your circular targets.

Circular Innovation:

- Study the latest trends in sustainable materials and recycling techniques.
- Innovate in your business models, such as product-as-service.
- Innovate and collaborate across the value chain to find new solutions for circularity.
- Seek out co-branding opportunities and explore solutions across industries.

Circular Engagement:

- Engage with consumers and other stakeholders to raise awareness and demand for circular products and services.
- Focus on the latest trends in digitally enabled traceability solutions to create a traceable sustainable material profile and improve consistency in circular strategies.
- Use creative marketing strategies to improve inclusion and customer engagement.
- Keep an eye out for policy guidance on circularity-related regulations, and work with policymakers to ensure any confusion around circular policies could be addressed to ensure alignment and consistency in compliance.

Transitioning to a circular economy is crucial for addressing climate change and resource constraints. **GC Insights** is positioned to address such challenges with increasing research capacity on regulatory requirements across industries and a growing expert network in the circular economy and sustainability strategies to help businesses understand and stay connected to leading sustainable solutions.

Finally, the circular economy presents a multitude of opportunities for businesses, policymakers, and industry leaders. By embracing circularity, we can accelerate the transition to a more inclusive, resilient, and environmentally friendly economy, ultimately securing a sustainable future for all.

GLOSSARY

Terms	Explanation	Reference
Circular Economy	The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used again and again, thereby creating further value.	European Parliament
Closed-loop	Closed-loop Recycling means that recycling of a material can be done indefinitely without degradation of properties. In this case, conversion of the used product back to raw material allows repeated making of the same product over and over again.	The Pennsylvania State University
ISO	ISO (International Organization for Standardization) is an independent, non-governmental international organization with a membership of 167 national standards bodies.	ISO
Mass-balance	The mass balance approach makes it possible to track the amount and sustainability characteristics of circular and/or bio-based content in the value chain and attribute it based on verifiable bookkeeping.	ISCC - International Sustainability and Carbon Certification
Recycle	'recycling' means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations;	European Parliament DIRECTIVE 2008/98/EC
Recycled	Material that has been reprocessed from recovered [reclaimed] material by means of a manufacturing process and made into a final product or into a component for incorporation into a product.	EN ISO 14021:2016 + A1:2021 (E), 7.8.1.1 b)
Recycled content	Proportion, by mass, of recycled material in a product or packaging. Only pre-consumer and post-consumer materials shall be considered as recycled content, consistent with the following usage of terms. 1) Pre-consumer material Material diverted from the waste stream during a manufacturing process. Excluded is reutilisation of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it. 2) post-consumer material Material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.	EN ISO 14021:2016 + A1:2021 (E), 7.8.1.1 a)

Recycled material (versus recyclate)	Material that has been reprocessed from recovered [reclaimed] material using a manufacturing process and made into a final product or a component for incorporation into a product.	EN ISO 14021:2016 + A1:2021 (E), 7.8.1.1 b)
Recycling	'recycling' means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations;	European Parliament DIRECTIVE 2008/98/EC on waste and repealing certain Directives
Traceability	The ability to trace the history, application or location of an object. When considering a product or a service, traceability can relate to: — the origin of materials and parts; — the processing history; — the distribution and location of the product or service after delivery.	ISO 9000:2015 Quality management systems — Fundamentals and vocabulary

EXHIBITS

DISCLAIMER

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