SUSTAINABLE
BUSINESS
COP30

CIRCULAR ECONOMY & MATERIALS

WORKING GROUP DOCUMENT

CNI Brazilian National Confederation of Industry

SUSTAINABLE
BUSINESS
COP30

CIRCULAR ECONOMY & MATERIALS

WORKING GROUP DOCUMENT

CNI Brazilian National Confederation of Industry

LEADERSHIP SB COP30

Ricardo Mussa
SB COP Chair

Antonio Ricardo Alvarez Alban
President of the SB COP Business Council
President of the Brazilian National Confederation of Industry

Davi Bomtempo
SB COP Secretariat Leader

SUSTAINABLE
BUSINESS
COP30

CIRCULAR ECONOMY & MATERIALS

WORKING GROUP DOCUMENT

SB COP30
CNI
Superintendência de Meio Ambiente e Sustentabilidade - Supemas

CATALOGING IN PUBLICATION

S964p

Sustainable Business COP30
Circular economy & materials : working group document. -- Brasília : SB COP, 2025.

125p. : il.

ISBN 978-85-7957-249-4

1.Circular Economy. Título.

CDU: 502.131.1

SB COP30
Setor Bancário Norte
Quadra 1 – Bloco C
Edifício Roberto Simonsen
70040-903 – Brasília – DF
secretariat@sbcop30.com

SUSTAINABLE BUSINESS COP30

TABLE OF CONTENTS

FOREWORD BY THE WORKING GROUP CHAIR

TERCIO BORLENGHI JR.

CEO AND CO-FOUNDER OF AMBIPAR

It has been an honour to co-chair this important initiative. We've made meaningful progress despite challenges, thanks to strong collaboration and shared purpose. As we look ahead, we recommend establishing an International Materials Agency, developing a global circular economy taxonomy, and implementing policies that boost demand for low-carbon products and reduce virgin material use.

Tercio Borlenghi Jr.

Chair of the SB COP Circular Economy and Materials Working Group

CEO and Co-founder, Ambipar

FOREWORD BY THE WORKING GROUP DEPUTY CHAIR AND CO-CHAIRS

DEPUTY CHAIR

PATRÍCIA IGLECIAS

COUNSELOR, AMBIPAR

CHIEF SUSTAINABILITY OFFICER, USP

By reducing dependence on new resource extraction, we gain efficiency and foster a cultural shift in consumption—key to sustainability. Equally important is the responsible management of material flows, requiring shared data and cooperation across countries and institutions. The climate emergency demands not just technical solutions but systemic change. I thank CNI for enabling companies to work together helping shape COP30 policies and targets.

CO-CHAIRS

ANTHONY WATANABE

CHAIR OF ESBN TASK FORCE ON CIRCULAR ECONOMY & CHIEF SUSTAINABILITY OFFICER, INDORAMA VENTURES

Co-chairing the SB COP30 Circular Economy and Materials working group has been both productive and insightful. With Circularity essential in addressing climate change, it was encouraging to see many colleagues collaborate on recommendations for the COP Secretariat. As the world's largest PET recycler, Indorama Ventures supports expanding circularity in the coming years beyond COP30.

BRENDA RÜHLE

DIRECTOR CORPORATE & GOVERNMENT AFFAIRS, TETRA PAK

This paper reflects the power of collective ambition. Tetra Pak's commitment to circularity—across Brazil and globally—shows how industry can drive low-carbon transformation. COP30 is our launchpad; the journey toward circular materials must continue through future COPs.

JULIANA MARRA

DIRECTOR OF CORPORATE AFFAIRS, COMMUNICATIONS, AND SUSTAINABILITY, UNILEVER

The work carried out reflects the importance of the topic and the need to continue the broad debate in Brazil. A critical perspective, which includes all stakeholders in the chain and considers each context, is key. We have made progress in recent years in Brazil; however, the adoption of recommendations aimed at improving regulation and creating incentives is crucial for the circular economy to truly develop in the country.

LIGIA CAMARGO

DIRECTOR OF SUSTAINABILITY, BRAZIL, HEINEKEN

The SB COP initiative represents a strategic milestone in mobilizing diverse sectors around a collaborative and ambitious climate agenda toward COP30. It is rewarding to be part of this collective effort, which values dialogue, transparency, and a long-term commitment to sustainable solutions. Participating in SB COP meetings as a representative of Heineken reinforces our active role in the transition to a low-carbon economy and in promoting responsible practices that generate positive impact for society and the environment. Being involved in an initiative of this scale reaffirms our purpose to keep building bridges toward a greener, more inclusive, and resilient future.

LUCIANA STACIARINI BATISTA

PRESIDENT, BRAZIL AND SOUTH CONE, THE COCA-COLA COMPANY

It has been an honor to cochair the SB COP Circular Economy & Materials working group, contributing with our vision, learning from diverse perspectives, and building consensus on priorities. At The Coca-Cola Company, we are determined to help turn these ideas into tangible change that reshapes value chains, strengthens resilience, and restores natural systems.

A. REGULATION AND INCENTIVES

A.1 REGULATION AND INCENTIVES - EXECUTIVE SUMMARY

The circular economy is defined as the usage of a systemic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development (ISO 59000, 2024), and represents opportunities across the materials lifecycle, from circular design and production to circular use, and value recovery (Harmonized Circular Economy Finance Guidelines, IFC). It represents a fundamental shift in how we address today's most urgent global issues, such as climate change, biodiversity loss, and the overuse of natural resources. In contrast to the traditional linear model, which follows a "take-make-dispose" approach, the circular model focuses on solutions that extend the lifecycle of materials, drastically reduce waste, support the regeneration of ecosystems, and increase resilience by reducing dependence on natural resource extraction. This shift is not just about reducing environmental harm; it also brings significant economic and social benefits, offering fresh opportunities for innovation, improving resource productivity, advancing decarbonization, and generating green jobs.

Despite growing recognition of its benefits, the shift toward a circular economy remains too slow and fragmented. Recent data reinforces the urgency for action. According to the Circularity Gap Report 2025, published by Circle Economy, the global circularity rate fell from 7.2% in 2018 to 6.9% in 2021 (latest available data). This means that the majority of the resources entering the global economy are still following a linear path—being used once and discarded. The decline is driven by rising material extraction and consumption, especially in high-growth economies, outpacing gains in recycling and reuse. This alarming trend reveals a critical gap between ambition and implementation and underscores the need for policy-led acceleration. Without strong public intervention, the systemic shift required to decouple economic growth from environmental degradation will remain out of reach.

Regulations play a foundational role in this transition by creating structural conditions for circularity to thrive. Regulations provide legal certainty and promote the transition from less sustainable practices to more sustainable models if they are developed consistently with real life

conditions. Streamlined, coherent regulations are needed to improve price competitiveness, quality, and supply stability, ensuring circularity is achievable and competitive, while focusing on market improvements to increase transparency and reliable information access. They mandate product renewability, reparability, and recyclability, create obligations for take-back schemes, and it also fosters innovation by encouraging businesses to design products and services that anticipate and exceed regulatory thresholds. In this sense, well-designed regulation does not inhibit competitiveness—it drives it by promoting long-term efficiency, quality, and value creation.

Several national and regional regulatory frameworks have been established to advance circular economy principles; however, certain regulations focus on policies for repair or recycle in local contexts. Such policies will only be successful with a consistent global enabling policy like taxonomies that reduce complexities between markets. While regulatory harmonization remains a challenge, given the diverse economic contexts and policy traditions, identifying and incorporating global best practices is essential. Recognizing these distinctions is important in building policy environments that are both ambitious and smart. Ultimately, this contributes to creating a level playing field for companies, reducing compliance complexity, and accelerating innovation.

Considering the limited global progress toward circularity, as highlighted by the latest Circularity Gap Report and the Global Resources Outlook, our working group has identified three regulatory priorities that can serve as catalysts for systemic change. These include the establishment of an International Materials Agency to help governments improve transparency and data collection aligned with international standards while offering guidance to market participants; the development of a global circular economy taxonomy to enable circularity as a regulatory criterion and unlock green finance; and the implementation of policies and incentives to boost demand for low-carbon footprint products and promote technological innovation that reduces reliance on virgin raw materials, including the adoption of eco-design practices. Together, these recommendations underscore the critical role of regulation in accelerating the transition to a more resource-efficient, carbon-neutral, and circular global economy.

A.2 REGULATION AND INCENTIVES - INTRODUCTION

Although advances are increasingly acknowledged and best practices are emerging, the transition to a circular economy is progressing at an uneven pace across regions and sectors. In many industries, circular models remain the exception rather than the norm. Legacy systems, entrenched linear business models, and inadequate price signals continue to favor resource extraction and wasteful consumption. While businesses and consumers are beginning to adopt new practices, their ability to scale such initiatives is constrained by systemic market failures, a lack of enabling infrastructure, and insufficient policy support. Public policy therefore plays a pivotal role—not only as a technical instrument, but as a powerful driver that can shape markets, align incentives, and unlock innovation.

To deliver a meaningful transition to sustainable patterns of production and consumption, policy frameworks must move beyond traditional waste management approaches. They should address entire value chains, including sectors that depend on finite resources as well as those based on bio-based materials and products. When circular economy principles are applied to material value chains, through regenerative production systems, nutrient cycling, and material substitution, these policies can generate broader benefits for climate mitigation and biodiversity conservation. By enabling multiple use cycles and reducing reliance on extractive or environmentally harmful inputs, well-designed circular policies can foster more resilient economic systems while contributing to global environmental goals.

According to the Circularity Gap Report, a flagship publication by the Circle Economy Foundation that tracks global resource use and progress toward a circular economy, the world remains far from achieving meaningful circularity. The latest report reveals that only 6.9% of the materials used globally are cycled back into the economy, barely an improvement from previous years, signaling stagnation rather than momentum. This means that over 90% of the resources entering the global economy are still following a linear path—being used once and discarded. Moreover, 38% of global material use is classified as a net addition to stocks, such as buildings and infrastructure, which locks in resource consumption for decades to

come. Even the use of carbon-neutral biomass remains limited, accounting for just 21.5% of total material inputs. This data is driven by rising material extraction and consumption, especially in high-growth economies, outpacing gains in recycling and reuse. These figures underscore how incremental changes have failed to significantly move the needle, despite increasing awareness and policy support for circular economy principles.

As global climate discussions intensify ahead of COP30, there is a growing recognition that circular economy regulations play a critical role in accelerating decarbonization efforts. By promoting material efficiency, waste reduction, and sustainable resource use, well-designed circular economy policies directly contribute to the mitigation targets outlined in Nationally Determined Contributions (NDCs). Regulatory frameworks that incentivize the use of secondary raw materials, discourage landfill disposal, and optimize material use across economic systems (such as housing, food, mobility and energy), can reduce industrial emissions, decrease reliance on carbon-intensive virgin materials, and foster low-carbon production models (circular practices support reduction in emissions; however, not all circular strategies inherently lower emissions; some activities may deliver other benefits), key focus areas for COP30 negotiations.

Moreover, circular economy regulation supports COP30's broader adaptation and resilience goals by strengthening resource security and reducing vulnerability to supply chain disruptions. For instance, policies mandating extended producer responsibility or shared responsibility among the value chain and eco-design standards encourage companies to build products that are renewable, more durable, repairable, and recyclable. This not only minimizes environmental impact but also fosters economic resilience in local communities, particularly in developing countries that are often more vulnerable to climate-related shocks. Such measures align closely with COP30's emphasis on climate justice and capacity-building in the Global South. Another example of how circular economy principles contribute to adaptation and resilience is regenerative agriculture, as it reduces reliance on external inputs, and restores ecosystem functions. By rebuilding soil health, enhancing water retention, and increasing biodiversity, it regenerates natural capital rather than depleting it, creating systems that are more resilient to climate shocks such as droughts or floods. This approach not only sustains productivity over the long term but also aligns with the circular economy's aim of designing regenerative systems that adapt and thrive within a more sustainable economy.

Regulation on circular economy can play a key role in accelerating the shift toward sustainable design and production by setting clear requirements and incentives for companies to prioritize durability, recyclability, and resource efficiency. Policies that mandate eco-design standards, provide tax benefits for products with higher repairability, or require extended producer responsibility schemes encourage businesses to design products that last longer and can be more easily repaired, reused, or recycled. In doing so, regulation helps extend the life of materials, reduces waste, and fosters innovation in business models that support repair, remanufacturing, and service-based approaches, all of which are central to achieving a truly circular economy.

Finally, regulatory clarity in the circular economy space can help unlock climate finance, a top priority for COP30. Investors and financial institutions increasingly seek predictable regulatory environments that reward low-carbon and circular business models, including circular energy. By embedding circular economy principles into public procurement, tax incentives, and reporting requirements, governments can stimulate private sector investment in sustainable infrastructure and innovation. This alignment between regulation and finance mechanisms creates a multiplier effect—mobilizing the capital needed for countries to deliver on their climate commitments while accelerating the transition toward a more circular and low-carbon global economy.

In parallel, incentives are essential to unlock the economic viability of circular business models. Many circular approaches—such as product-as-a-service, remanufacturing, and closed-loop supply chains—require significant upfront investment, experimentation, and collaboration. Financial incentives such as tax credits, grants, subsidies, and innovation funds reduce the cost and risk of early adoption, especially for small and medium-sized enterprises. Public procurement policies that prioritize circular criteria help generate market demand, while access to low-interest financing enables the scale-up of new technologies. These incentives are not meant to replace regulation but to complement it, creating a push-pull dynamic: regulation pushes actors to meet minimum sustainability thresholds, while incentives pull them beyond compliance toward leadership and transformation.

To accelerate the potential of the circular economy, policy approaches must also be forward-looking and strategically coordinated. The next phase of circular policy must go beyond waste management and embrace the broader restructuring of value chains, business models, and consumer behavior. In this regard, three emerging enablers deserve special attention. First, the establishment of an international material agency could help improve data transparency, material traceability, and global cooperation on resource governance. Second, the development of a taxonomy for circular and low-impact materials and business models would help standardize definitions and criteria, aligning financial markets, regulators, and industry stakeholders. Third, demand-side policies and incentives to stimulate the uptake of low-carbon and circular products, including public procurement and carbon pricing frameworks—can create the economic signals needed to shift industries toward sustainability at scale.

Effective circular economy regulation requires more than isolated policies—it demands cohesion, a shared understanding of circularity, and access to enabling finance. Policy instruments such as circular economy taxonomy play a key role in this regard by providing clear definitions and classification systems that align stakeholders across sectors and borders. These frameworks not only support regulatory coherence but also help unlock green finance by giving investors and institutions a common language to identify and prioritize truly circular activities. Without such alignment, circular transition efforts risk fragmentation and limited impact.

Several national and regional regulatory frameworks have been established to advance circular economy principles across the world. While regulatory harmonization remains a challenge—given the diverse economic contexts and policy traditions—identifying and incorporating global best practices is essential. For example, some countries have adopted Extended Producer Responsibility (EPR) models, placing the burden of post-consumer waste management primarily on manufacturers and importers. Others follow a shared responsibility approach, where obligations are distributed across the value chain, including consumers, retailers, and public authorities. Recognizing these distinctions is important in building policy environments that are both ambitious and tailored. Ultimately, this contributes to creating a level playing field for companies, reducing compliance complexity, and accelerating innovation through clearer, more consistent regulation.

Selected Global and National Examples of Circular Economy Regulation and Incentives:

- European Union: The EU has established one of the most advanced circular economy frameworks in the world through its Circular Economy Action Plan, adopted as part of the European Green Deal. The plan includes targets for recycling, waste reduction, and landfill diversion, along with eco-design requirements to improve product circularity. The "right to repair" regulation promotes access to spare parts and repair services, while the EU Taxonomy helps align financial flows with sustainability goals. Public procurement rules and product passports are also being developed to support circularity in key value chains such as electronics, textiles, and construction. The European Union is also working in the Circular Economy Act, which will introduce economic incentives, harmonized definitions and streamlined cross-border logistics.
- Japan: Japan's Sound Material-Cycle Society Law is a cornerstone of its circular economy approach, promoting resource productivity and waste reduction at all levels of society. The law requires businesses to implement waste prevention measures, encourages the reuse and recycling of materials, and supports extended producer responsibility in sectors like packaging and home appliances. Japan's approach is characterized by long-term targets, detailed monitoring mechanisms, and a strong cultural alignment with resource efficiency, which has helped integrate circular practices into mainstream industrial and consumer behavior.
- Netherlands: The Dutch government has committed to becoming fully circular by 2050, with an interim goal of halving the use of virgin materials by 2030. To achieve this, it has introduced a wide range of policies, including mandatory circular procurement for public entities, the use of digital material passports for buildings, and innovation subsidies for circular startups. The Netherlands is also advancing sector-specific roadmaps for textiles, plastics, and construction, and uses regional pilot programs to scale successful models. Its collaborative governance model—engaging public, private, and civil society actors — is often cited as a benchmark for inclusive policy design.
- Brazil: Brazil's circular economy policy has gained momentum with the launch of the National Circular Economy Strategy (ENEC) in 2024 and the National Circular Economy Plan in 2025. These frameworks set up a ten-year roadmap structured around five strategic pillars: regulatory

frameworks, innovation and education, waste reduction, financial instruments, and intergovernmental coordination. Brazil's approach is notable for its inclusive design process—bringing together federal agencies, local governments, private sector representatives, and waste picker cooperatives. Special attention is given to the role of the informal sector, recognizing its contribution to material recovery and aiming to integrate it more fully into formal waste management systems.

- China: China has mainstreamed circular economy principles through a series of national policies and five-year plans. Its Circular Economy Promotion Law mandates cleaner production standards, encourages resource efficiency in manufacturing, and requires local governments to integrate circularity into industrial planning. China has also launched pilot eco-industrial parks and implemented mandatory audits for energy and material use in key sectors. More recently, its 14th Five-Year Plan has placed a renewed emphasis on high-quality growth and green consumption, promoting circular practices through digital tools, smart logistics, and e-commerce platforms.
- India: India has developed a comprehensive framework to embed circularity in its industrial and environmental policies. Extended producer responsibility regulations have been issued for plastics, e-waste, batteries, and tires, requiring manufacturers to establish take-back and recycling systems. In addition, the government has launched sectoral roadmaps for circularity in construction, steel, agriculture, and textiles. Circular economy has also been integrated into national resource efficiency strategies and state-level action plans. India's approach aims to address both environmental challenges and job creation, recognizing circularity as a pathway to sustainable economic development.
- Vietnam: Vietnam incorporated circular economy principles into its 2020 Law on Environmental Protection, making it one of the first countries in Southeast Asia to embed circularity into national legislation. The law establishes producer responsibility schemes, particularly for packaging, electronics, and vehicles, and introduces requirements for eco-design, product labeling, and green public procurement. Vietnam has also created national guidelines for circular business models and is piloting industrial symbiosis zones to encourage resource sharing among manufacturers. These efforts support the country's dual goals of environmental protection and economic modernization.
- Chile: Chile launched its Circular Economy Roadmap 2040, a national strategy developed through broad stakeholder consultation to transition

toward a sustainable, regenerative, and inclusive economic model. Also, Chile's Extended Producer Responsibility (EPR) Law (Ley REP), mandates that producers of priority products—including packaging, tires, batteries, and electronics—finance and organize the collection, recycling, and proper disposal of post-consumer waste. The law sets binding collection, and recovery targets and allows for the creation of producer responsibility organizations (PROs) to coordinate compliance. Chile also provides financial incentives and technical support for circular innovation, particularly in the mining and agriculture sectors, and has made circularity a key component of its national climate strategy.

- Canada (Quebec): Quebec has been a leader in advancing the circular economy within Canada, launching its own roadmap that combines regulatory action with business support. The province has introduced landfill bans for organic waste, strict recycling requirements, and funding programs for circular R&D. It has also developed partnerships between government, academia, and industry to pilot circular solutions in sectors such as construction, textiles, and food. The province's Green Economy Plan includes performance-based subsidies for circular technologies and emphasizes resource decoupling as a long-term goal.
- South Africa: South Africa's National Waste Management Strategy incorporates circular economy objectives within the broader framework of inclusive green growth. The policy supports extended producer responsibility, especially in packaging and electronics, while promoting local recycling industries and entrepreneurship. It also includes public education campaigns, landfill diversion targets, and incentives for waste-to-value initiatives. Recognizing its unique socio-economic context, South Africa places emphasis on creating green jobs, supporting township recycling hubs, and linking circularity with social equity.

As per examples above, several countries and regions have made important progress in designing circular economy policies, ranging from extended producer responsibility laws to eco-design standards and national roadmaps, these efforts remain fragmented and inconsistent across borders. Current regulations often reflect local or sector-specific priorities, lacking shared definitions, harmonized data protocols, and mechanisms for coordination. As a result, global supply chains face rising complexity, and businesses struggle to comply with divergent rules and reporting expectations. Many governments also lack access to reliable information on material flows, product footprints, and circular performance, which limits

their ability to design effective incentives or monitor progress. Without greater international coherence, national efforts risk being constrained in scope, scalability, and systemic impact.

As such, the linear model of production and consumption continues to dominate, resulting in widespread resource inefficiency, excessive waste generation, and growing pressure on natural systems. International trade and supply chains often lack alignment on circular principles, creating fragmented standards, regulatory gaps, and limited incentives for circular practices to scale. These systemic barriers slow the adoption of circular solutions and hinder collaboration across borders. Considering the limited global progress toward circularity, as highlighted by the latest Circularity Gap Report, our working group has identified three regulatory recommendations that can serve as catalysts for systemic change. These recommendations focus on how well-designed regulatory frameworks can accelerate the shift to a circular economy by aligning incentives, clarifying responsibilities across the value chain, and fostering innovation. Each recommendation addresses a key area where regulation can unlock greater material efficiency, support decarbonization, and promote long-term competitiveness in a resource-constrained world:

- Recommendation 1: Establish an International Materials Agency to support governments to improve transparency and data collection in accordance with international standards, and to provide guidance to market participants
- Recommendation 2: Develop a global circular economy taxonomy that allows countries to enable circular economy as a criterion that could guide regulation and unlock green finance
- Recommendation 3: Implement policies and incentives to increase the demand for low carbon footprint products, as well technological development to reduce utilization of virgin raw material, including the stimulation of eco-design practices

A.3 REGULATION AND INCENTIVES – PRIORITIES

Considering the urgent need to transition from a linear to a circular economic model, well-designed regulatory frameworks and targeted incentives play a vital role in shaping market behavior, fostering innovation, and aligning responsibilities across the value chain. By addressing systemic barriers and creating the right enabling conditions, these regulatory mechanisms can accelerate the adoption of circular practices, enhance material efficiency, reduce GHG emissions, and support long-term competitiveness. As such, the recommendations outlined below are intended to serve as catalysts for progress toward a more sustainable and regenerative economy. Our priorities and the related benefits are detailed below.

Priority 1: Establish an International Materials Agency to support governments to improve transparency and data collection in accordance with international standards, and to provide guidance to market participants

Description

Innovation and collaboration for circular economy solutions require robust and transparent systems to measure material flows and their related impacts, assess progress, and inform policy design and investments. Yet, one of the most persistent barriers to circularity at scale is the fragmentation and inconsistency of data across geographies, sectors, and actors. Reliable information on the extraction, processing, trade, (re)use, and disposal of materials remains limited, inaccessible or non-comparable - making it difficult for policymakers and companies to make strategic decisions or track the real impact of interventions.

To address this gap, we recommend the establishment of an International Materials Agency (IMA), a specialized, neutral institution that would provide decision-makers with harmonized, accessible data on material flows and impacts across geographies and economic sectors, provide guidance on global standards and policy developments, and support both governments and businesses in aligning their resource use with climate and development goals. Rather than setting policy targets or enforcing regulations, its mission would be to serve as a trusted knowledge hub, providing governments, companies, and other stakeholders with transparency and coordination on global material use. The agency could be housed in an existing structure (i.e. international independent organization), to facilitate the creation, operation and governance process.

Key functions of the IMA - building on the contributions of existing institutions - would include:

1. Standardizing methodologies and indicators for tracking material flows and circularity metrics across sectors (e.g., housing, mobility, food, and energy) and jurisdictions, in alignment with ISO 59004:2024.
2. Supporting national statistical offices and companies in improving the quality and scope of their material-related data, in line with international standards.
3. Provide access to consolidated, transparent and easy to use data on global material flows and impacts, including material consumption and footprints, efficiency, and rates of reuse and recycling across geographies and economic sectors.
4. Developing science-based guidance and benchmarks on sustainable levels of material use by sector, helping to align national strategies with planetary boundaries and development goals (including a global orientation value - the "net zero for materials" - to catalyze coordinated global action). The Global Circularity Protocol for Business, a publication issued by WCDSB – World Business Counsil for Sustainable Development, has introduced guidance that would serve as a starting point for this process.
5. Facilitating peer learning and capacity-building, enabling governments and private sector actors to exchange knowledge and adopt best practices.
6. Encouraging alignment of economic instruments (such as taxes, subsidies, and green finance tools) with material-efficient and circular business models.

This proposal is strongly supported by findings from the Global Circularity Report 2025, which identifies data transparency and monitoring systems as foundational to scaling circular practices. According to the report, an international agency focused on materials could play a critical role in helping countries understand their material footprints, evaluate the effectiveness of policy interventions, and avoid unintended consequences such as shifting environmental impacts from one region or sector to another. The proposal also directly aligns with the Call to Action from the Co-Chairs of the International Resource Panel - which was launched during the Circular Economy Forum 2025 in São Paulo and is supported by 100+ organizations and individuals from the circular economy community.

To ensure that progress toward circularity is measurable, comparable, and actionable, the proposed International Materials Agency should collaborate with international standard-setting bodies—particularly ISSO — and emerging initiatives such as the Global Circularity Protocol. The ISO 59000 series, released in 2024, provides a robust foundation for defining, assessing, and tracking circular economy performance across sectors and geographies. By promoting the adoption and refinement of these standards, the Agency can help harmonize metrics globally, support evidence-based policymaking, and build trust among stakeholders.

By emphasizing its distinct role as a data provider and enabler, rather than a regulatory body, the IMA could earn the trust of both governments and businesses, positioning itself as a vital ally in the global effort to decouple economic development from resource extraction and environmental degradation.

Expected Benefits

- Stronger global transparency: A harmonized data infrastructure will improve the comparability and reliability of information on material stocks, flows, and impacts—such as location, availability, and composition. This enables evidence-based policymaking and supports targeted incentives, while also accelerating new business models and material flow strategies at both national and international levels.
- Improved national policy design and trade: Countries will be better equipped to identify value opportunities and inefficiencies in resource-intensive sectors, strengthen supply chain resilience, and inform trade negotiations or material-related partnerships.
- Greater alignment with climate and biodiversity goals: An improved understanding of the link between material use and environmental impacts will support policymakers and market participants to inform systemic mitigation strategies.
- Support for innovation and investment: Clear, credible data on material flows and their environmental and economic impacts helps investors identify high-potential circular opportunities. It can reduce information asymmetry, enable robust risk assessments, and link circularity to ESG metrics and sustainability-linked finance. This lowers due diligence costs, de-risks early-stage innovation, and increases the chances of channeling capital toward scalable circular solutions.

- Faster diffusion of best practices and coordination: Through its convening role, the IMA can provide a forum for dialogue and coordination across governments and the private sector - accelerating the adoption of best practices and responses to supply shocks, guiding the identification of technology requirements, and building capacity in developing economies.

Priority 2: Develop a global circular economy taxonomy that allows countries to enable circular economy as a criterion that could guide regulation and unlock green finance

Description

As countries and businesses seek to embed circularity into policy and investment frameworks, the absence of a shared, reliable classification system for circular economy activities remains a major obstacle. Without a clear and consistent understanding of what qualifies as "circular," it becomes difficult to create effective regulations, incentivize innovation, direct finance toward impactful solutions, and avoid misleading claims. In this context, we recommend the development of a Global Circular Economy Taxonomy — a foundational tool designed to clarify and codify circular activities across value chains and regions.

Rather than acting as a standalone or prescriptive system, this taxonomy is intended to serve as a reference framework that can be adopted, adapted, or integrated into existing and emerging sustainability regulations, disclosure requirements, and financing mechanisms. Its purpose is to enhance regulatory and market coherence by providing a voluntary but widely endorsed structure that supports countries, regulators, financial institutions, and businesses in identifying, evaluating, and prioritizing activities that contribute meaningfully to circularity.

Crucially, the taxonomy should be science-based yet adaptable, offering structured categories and performance criteria without imposing overly rigid rules. It could cover a spectrum of circularity—from low-barrier entry actions such as improved recycling, to advanced strategies like regenerative material systems or circular product design. The taxonomy should also be forward-looking, allowing for emerging technologies, business models, and innovation pathways to be integrated over time.

In practice, a Global Circular Economy Taxonomy would:

1. Support governments in aligning policies such as public procurement, eco-design regulation, extended producer responsibility (EPR) or shared responsibility (as applicable), and trade frameworks with circular goals.
2. Provide clarity to financial institutions looking to assess, benchmark, and invest in circular business models and technologies, reducing the risk of greenwashing and improving capital flows.
3. Assist companies and industry groups in measuring and reporting progress toward circularity, creating consistency in disclosures and sustainability claims.
4. Serve as a foundational resource for regulatory alignment, enabling coordination across jurisdictions while allowing room for national-level customization and policy ambition.

The development of such a taxonomy is also supported by insights from the Global Circularity Report 2025, which underscores the importance of clear definitions and robust classification systems to scale circular finance and policy instruments. Building on existing efforts, such as the Harmonized Circular Economy Finance Guidelines, developed by the IFC and a group of expert collaborators, a global harmonized approach can enhance coherence, enable comparability, and support mutual recognition across markets.

Expected Benefits

- Improved alignment of regulatory and financial systems with circular principles.
- Increased investment confidence by providing clear guidance for sustainable finance and risk assessment.
- Strengthened international cooperation through a shared conceptual and technical foundation.
- Reduction in policy and market fragmentation, facilitating smoother transitions for global businesses.
- Support innovation and new business models by identifying and validating circular practices.
- Enhanced credibility of circular claims in the eyes of regulators, consumers, and investors.
- Improved ability for financial institutions to identify qualifying assets and new opportunities for circular economy–labeled products, and for corporations to adapt projects and activities to meet circular economy criteria.

Priority 3: Implement policies and incentives to increase the demand for low carbon footprint products, as well technological development to reduce utilization of virgin raw material, including the stimulation of eco-design practices

Description

A successful transition to a circular and low-carbon economy requires not only changes in how products are made but also in how they are demanded, purchased, and valued. Currently, market signals do not sufficiently reward low-impact or circular products, which limits the business case for companies to scale such solutions. At the same time, many products continue to be designed for short lifespans, limited reparability, or high material intensity, further entrenching the linear model.

To address these barriers, we recommend the implementation of coordinated policies and market incentives that stimulate demand for low-carbon, circular, and resource-efficient products, while also encouraging innovation in design and production processes. This strategy should include both supply-side and demand-side levers, working in synergy to increase the availability, competitiveness, and visibility of circular solutions.

Despite global agreements on aligning financial flows with low-carbon and nature-positive solutions, current economic incentives largely favor the unsustainable production and consumption of materials. Targeted policy and fiscal reforms are essential to ensure that the environmental and social costs of materials – especially those associated with their extraction – are accurately reflected in material prices.

Policies and incentives should not only stimulate demand for products with a low carbon footprint but also encourage the adoption of circular design principles. This includes promoting products that are designed for repairability, modularity, and disassembly, as well as ensuring recyclability and the integration of recycled or regeneratively sourced inputs. While the production of circular products may not always result in lower GHG emissions in the short term, their extended lifespan, reduced reliance on virgin resources, and potential to keep materials in circulation contribute significantly to long-term sustainability and resource efficiency. Incentives should therefore be designed to recognize both the climate benefits and the broader circular value of products, helping to shift markets toward models that prioritize durability, reuse, and regenerative sourcing.

Key components of this approach include:

1. Green public procurement policies that prioritize circular and low-carbon criteria, including circular energy, across major sectors such as construction, mobility, packaging, electronics, and textiles, leveraging government purchasing power to shift markets.
2. Financial incentives for consumers and businesses, including tax reductions or subsidies for products that meet recognized eco-design standards or demonstrate superior material efficiency.
3. Supportive regulatory frameworks, including Extended Producer Responsibility (EPR) or Shared Responsibility schemes, depending on the local context. These systems allocate responsibility for product end-of-life management across different actors — from producers and importers to retailers and even consumers — creating financial and operational incentives for eco-design, reuse, and recycling. Shared responsibility frameworks can be especially effective in jurisdictions where informal sectors, local governments, or consumers play a significant role in the product lifecycle. While shared responsibility schemes may present challenges in terms of tracking and implementation, they have been introduced in different jurisdictions and should be given sufficient time and support to assess their effective operation alongside EPR mechanisms.
4. Clear labeling and certification systems that help consumers and institutional buyers identify low carbon footprint products and distinguish them from unverified claims, reducing information asymmetry and enabling informed decision-making.
5. R&D supports and innovation funding for the development of new materials, technologies, and design practices that reduce GHG emissions, extend product lifespans, and enhance reparability or modularity.
6. Promotion of circular business models, such as product-as-a-service or leasing schemes, which shift incentives from volume-based sales to long-term value retention and efficient resource use.
7. Integration of circular economy principles into domestic and international trade policies, including the development of standards that facilitate the safe and efficient cross-border flow of secondary raw materials, remanufactured goods, and certified circular products in global value chains.
8. Support for bio-based and regenerative materials, by incentivizing production systems that enable nutrient cycling, avoid ecosystem degradation, and substitute environmentally harmful materials, thereby delivering co-benefits for climate and biodiversity.

To maximize the effectiveness and alignment of these policies at the international level, we recommend supporting the creation of a Global

Circularity Protocol, as currently advanced by the World Business Council for Sustainable Development (WBCSD). This protocol would provide a common language, metrics, and standards to evaluate circular performance across industries and regions, reducing fragmentation and enabling harmonized action. By establishing consistent definitions, criteria for circular products and processes, and transparent reporting frameworks, the protocol would support interoperability between markets, facilitate cross-border trade in secondary materials, and help companies align with investor expectations and regulatory requirements. Embedding such a global reference system would enhance trust, comparability, and scalability of circular solutions, particularly for multinational companies and supply chains operating in diverse policy environments.

Expected Benefits

- Shift in market behavior that favors low-carbon and resource-efficient products across consumer and institutional purchasing.
- Greater innovation and investment in sustainable product design, business models, and circular supply chains.
- Reduction in greenhouse gas emissions and material consumption contributing to national and global climate goals.
- Increased use of secondary materials
- Clearer roles and responsibilities across the value chain, encouraging collaboration and systemic change.
- Enhanced global competitiveness of industries and companies that lead in circular performance and innovation.
- Empowered consumers and buyers, equipped with better information and incentives to support sustainable choices.

B. MATERIALS INNOVATION, WASTE MANAGEMENT, AND CIRCULAR SUPPLY CHAINS

B.1 MATERIALS INNOVATION, WASTE MANAGEMENT AND CIRCULAR SUPPLY CHAINS - EXECUTIVE SUMMARY

The circular economy emerges as a key paradigm to address contemporary challenges related to production, consumption, and waste management. To ensure an effective transition, recommendations should preserve fair market competition and promote the competitiveness of leading companies. Attention must be given to ensuring that region-specific regulations do not unintentionally disrupt global equity, as observed in discussions around Europe's Carbon Border Adjustment Mechanism (CBAM). The transition to circular supply chains requires a strong focus on material innovation, waste management, and circular business models, while also mobilizing investments, policies, and governance structures to support this transformation. The circular economy can play a crucial role in supporting the climate objectives of the UNFCCC by integrating practices that help limit temperature increases in accordance with the Paris Agreement. This includes explicitly integrating circular energy — such as biogas/biomethane produced from waste — as a bridge between organic waste, industrial decarbonization, and territorial resilience, amplifying both environmental and economic benefits.

It is important to highlight the concept of embodied emissions to showcase the emissions reduction potential of a circular economy. Embodied emissions refer to the greenhouse gases released across a product's full life cycle — from raw material extraction and processing to manufacturing, transport, and end-of-life treatment — rather than just those emitted during its use. Circular economy strategies can reduce GHG emissions across value chains by designing products with fewer inputs, reducing waste, using recycled materials, and sequestering carbon by storing it in biomass. Circular economy strategies focused on materials such as cement, aluminum, steel, and plastics have the potential to reduce GHG emissions by an estimated 40%. The Kalundborg Eco-Industrial Park illustrates how industrial symbiosis can turn by-products and waste streams into valuable

inputs for other industries. This approach combines material recovery with renewable energy generation, such as biogas, delivering tangible reductions in greenhouse gas emissions.

Highlighting the connection between circular materials innovation and emissions reduction will strengthen this alignment. This document examines these foundational concepts through the perspective of materials and circularity.

Material innovation is a strategic driver for achieving a carbon-neutral circular economy. For instance, steel produced using scrap in an Electric Arc Furnace (EAF) emits 90–95% less greenhouse gases compared to steel produced via a blast furnace and basic oxygen furnace (BF-BOF). Another example is in cement and concrete production, where replacing 60% of regular Portland cement with slag cement, a by-product of steelmaking, reduces emissions by 53%. Together, cement and steel account for 16% of global GHG emissions, making these sectors the third-largest emitter if they were a country and categorizing them as "hard-to-abate" sectors. Circular economy approaches can play a crucial role in decarbonizing these sectors by encouraging the development of more sustainable materials, such as bio-based, CO_2-based, and recycled-content substances, while replacing high-carbon and environmentally harmful alternatives. The success of these efforts depends on targeted investments and coordinated public-private policies. Moreover, validated research and development (R&D) initiatives are essential to expanding technological solutions and accelerating the adoption of practices that reduce or eliminate GHG emissions effectively.

Effective waste management is critical for resource conservation and emissions reduction. The gradual decomposition of biodegradable waste in landfills generates landfill gas (also referred to as biogas), which is rich in methane. Methane is a greenhouse gas (GHG) with a global warming potential more than 80 times greater than that of CO_2 over a 20-year time frame and has been responsible for half a degree Celsius of global warming to date. To combat methane emissions from landfills, many countries have prioritized diverting biodegradable waste into recycling (for materials like paper and cardboard), composting, or anaerobic digestion (for garden and food waste). In a "waste management as usual" scenario, emissions from waste management could increase by 91% compared to a circular economy scenario, where emissions are reduced by 153%. This reduction is achievable through integrating advanced

sorting and traceability technologies, reusing critical materials, and exploring energy recovery strategies. Ensuring accountability across the value chain and establishing quality standards for recycles is essential for enabling traceability and fostering trust in secondary material markets. Industrial models, like eco-industrial parks, exemplify how cross-sector collaboration can minimize waste while delivering both environmental and economic benefits. Mobilizing public and private capital is essential to finance circular business models. Financial instruments such as guarantees, concessional funds, and green bonds have the potential to increase funding flows toward circular solutions. Hybrid financing initiatives and externality pricing models can also help scale investments, particularly in developing countries.

Multisectoral collaboration is a cornerstone of a successful circular economy. By fostering synergies among companies, sectors, and regions, it becomes possible to drive innovation, share infrastructure, and reduce operational costs. Circular economy hubs, knowledge platforms, and regional innovation centers play an essential role in disseminating best practices and building both institutional and business capabilities necessary for a sustainable transformation.

Finally, emerging technologies are catalyzing solutions across all stages of the value chain. Digital product passports, blockchain, robotics, artificial intelligence, and data platforms are being applied to enhance transparency, trace materials, and improve system efficiency. These technologies are helping to transform circularity from an abstract concept into a viable and scalable operational model.

This document is structured around four key recommendation areas to promote circular innovation in materials: strengthening research, development, and market access for sustainable materials; establishing regulations and incentives aligned with circular principles; fostering industrial collaboration and resource exchange across value chains; and prioritizing repair and reuse, while advancing traceability and recycling as last-resort options, with a focus on digitization, automation, and innovation. Together, these recommendations offer concrete pathways to reduce dependency on finite resources, generate economic value, and promote regenerative, resilient, and climate-aligned supply chains.

B.2 MATERIALS INNOVATION, WASTE MANAGEMENT AND CIRCULAR SUPPLY CHAINS - INTRODUCTION

Today's efforts to combat climate change have focused mainly on the critical role of renewable energy and energy-efficient measures, which address 55% of emissions related to energy use. However, it is important to note that not all circular economy activities necessarily reduce greenhouse gas emissions. To strengthen this point, a visualization of the materials lifecycle, as presented in the Harmonized Circular Economy Finance Guidelines, could illustrate how circular economy activities span across all stages. However, meeting climate targets will also require tackling the remaining 45% of emissions associated with making products. Innovation in materials, waste management, and circular supply chains represents a transformative and essential response to addressing part of this 45% of emissions while also tackling biodiversity loss, resource scarcity, and pollution.[1]

Under today's linear model, we extract raw materials, manufacture products, and then dispose of them at the end of life. All the greenhouse gases released during mining, processing, and manufacturing stay locked into the product until it is sent to landfill or incinerated. At that point, we lose the embodied emissions and the value of those materials. To replace them, we must extract and process new virgin inputs, generating even more emissions.

In contrast, a circular model keeps materials in use, recapturing embodied emissions through reuse, repair, remanufacturing, and recycling. This prevents waste, cuts the need for new raw materials, and locks in both environmental and economic value. This transition is not only an environmental imperative but also an economic and social opportunity that opens new avenues for industrial innovation, resource efficiency, value retention, the creation of green jobs, and long-term competitiveness in a carbon-constrained world. According to modeling conducted by PwC, a circular economy transition in just the Asia-Pacific region alone can result in a 7.2% net decrease in emissions, a net increase of $340bn in GDP, and a net addition of 15 million jobs.[2]

1 An introduction to circular design by Ellen MacArthur Foundation (https://www.ellenmacarthurfoundation.org/news/an-introduction-to-circular-design)

2 CATL, Environment, Social and Governance Report, 2023 (https://www.catl.com/en/uploads/1/file/public/202404/20240417102933_uuiks9ljr8.pdf)

The Circularity Gap Report 2025 highlights a concerning trend: only 6.9% of the global economy is currently circular, marking a decline from 7.2% in 2018. Despite a modest increase in the use of secondary materials—from 7.1 billion tons in 2018 to 7.3 billion tons in 2021—the relentless growth in the consumption of virgin resources continues to outpace these gains. Global material extraction has tripled over the past five decades, now exceeding 100 billion tons annually, underscoring the unsustainable trajectory of resource use. This widening gap between the adoption of recycled or reused materials and the demand for primary resources signals an urgent need to fundamentally restructure our economic system. Transitioning toward a truly circular economy requires not only the scaling up of secondary material use but also a strategic shift toward raw materials derived from regenerative practices and sustainably sourced renewable materials. By prioritizing inputs that are replenished through responsible land management, agroecological methods, and renewable resource cycles, industries can reduce dependency on finite resources and mitigate environmental degradation. Integrating regenerative and renewable raw materials into production processes complements recycling and reuse, creating a more resilient and restorative approach to resource management. Science-based targets must guide this transformation, ensuring that material flows are optimized for circularity while safeguarding ecological integrity. Such a holistic strategy can help reverse the decline in circularity, slow the extraction of virgin resources, and foster a system where economic growth is decoupled from environmental harm. Ultimately, achieving significant progress in material circularity will depend on collaborative action across sectors, innovation in product design and supply chains, and a steadfast commitment to sustainability principles that balance human needs with planetary boundaries.

Up to 80% of a product's environmental impact is determined at the design stage[3], and materials circularity is a critical factor in that design. Circular material innovation involves selecting bio-based materials, metals and alloys, polymers, glass, textiles, wood, composites, batteries, and building materials in ways that minimize incompatible mixes, make parts modular and clearly separable, and enable inputs to return to high-quality feedstock at end-of-life. Done well, circular material choices retain resource value, reduce reliance on virgin raw materials, and lower embodied emissions. However, successful material innovation needs

3 An introduction to circular design by Ellen MacArthur Foundation (https://www.ellenmacarthurfoundation.org/news/an-introduction-to-circular-design)

to be followed by the incorporation of circular materials across industry value chains

Successful, adaptation will require an alignment between innovation, circular economy principles, and regulatory frameworks, ensuring practices are conceptually sound and practical across various regulatory contexts — in materials, waste management, and supply practices. Incorporating the principles of industrial symbiosis and eco-design plays a crucial role in this process, enabling different industries to share resources and maximize collective efficiency. This includes investing in renewable, CO_2-based, and recycled materials; implementing waste management systems that maximize the value of end-of-life products; and transforming how supply chains operate to sustain regenerative practices.

In this context, mobilizing public and private capital to finance new business models and circular infrastructures is fundamental. Adaptable financial structures and incentive mechanisms can significantly drive the transition to sustainable business models. Collaboration between the public and private sectors can align interests, capitalize on innovation, and promote an efficient transition toward industrial ecosystems that not only meet sustainability goals but also encourage economic growth. With the support of innovative financial strategies and partnerships between multiple organizations, it is possible to create an environment that favors material innovation and effective waste management, transforming supply chains into circular and sustainable models.

Considering the role of different economic sectors, it is apparent that each has specific opportunities and challenges in the transition to circularity. It is important to recognize that recycled and renewable materials originate from various sectoral streams and currently have varied costs and availability, so circularity planning should ideally be supported by a comprehensive impact assessment to ensure cross-sectoral coherence and effectiveness. The outcome of these assessments can result in different circular pathways for sectors. For examples, the construction industry may adopt practices for material reuse, selective demolition, modular systems, and regenerative design techniques; while the textile and fashion industry may adopt the replacement of raw materials with recycled fiber, clothing rental, and extending product durability; and the electronics industry may invest in design for disassembly, remanufacturing programs, and recovery of rare metals.

The agricultural sector plays a fundamental role in the circular economy, not only for the generation of organic waste but also for its relationship with natural systems and food security. Reducing losses and waste along the chain, composting organic waste, producing biofertilizers, and integrating agro-industrial flows are essential practices. Agribusiness can also explore the potential of the circular bioeconomy through the cascading use of biomass and agricultural by-products, and generating renewable resources for use in sectors outside agriculture – for instance, the development and use of bioplastics can be a significant contributor to reducing the reliance on fossil based plastics..

Technological innovation is one of the main catalysts of the circular transition. Emerging technologies such as artificial intelligence, the Internet of Things, blockchain, additive manufacturing, and digital sharing platforms are being applied to track life cycles, monitor material use, predict failures, extend product life, and connect supply and demand in real time. These solutions allow significant gains in efficiency, reliability, and scale. However, for technology to truly contribute to circularity, it must be guided by principles of ethical design, accessibility, and inclusion.

The circular transition also requires the involvement of financial actors. Investment funds, public and private banks, insurers, and credit platforms can and should consider circular criteria in their risk analysis, product offerings, and resource allocation. Financing models based on circular performance, incentives for remanufacturing, and pricing mechanisms that internalize environmental externalities are important tools in this scenario. The financial sector can act as an inducer of change, channeling capital to companies and initiatives committed to regenerative cycles.

Another essential dimension is multisectoral governance. The circular economy is not siloed to just one policy area — it intersects themes such as climate, biodiversity, industry, trade, labor, science, technology, and education. It is crucial to align these intersections with the sector-specific challenges and opportunities identified earlier. This integration helps maintain a 360-degree perspective to ensure a holistic approach to circularity, ensuring that governance reflects the realities of diverse industries. Building circular public policies requires an interministerial approach, with the integration of goals, budget, regulation, and oversight. At the same time, it is necessary to strengthen actions at the subnational level, promoting regional consortia, alliances between cities, incentives for territorial innovation, and local circularity networks that interact with industry.

From a normative perspective, the set of international ISO standards for the circular economy aims to play a structuring role by providing a common language, objective criteria, and implementation guides. These standards offer a framework for diagnosis, solution design, circularity measurement, risk management, and stakeholder engagement. Public and private organizations can use these guidelines to align internal practices, qualify their actions in the market, and increase their transparency and responsibility to society.

Countries have unique characteristics that can be leveraged in the global transition to a circular economy. The economic make-up of countries can result in them being highly, moderately, or minimally impacted by the circular transition. This is broadly based on how much of the country's GDP is derived from extractives, manufacturing, or services sectors. The shift to a circular economy will play out differently across countries. The biggest advantages go to places with clear, enforceable rules; robust collection and reverse logistics infrastructure; material intensive industries that can use secondary inputs; strong repair and design capabilities; and access to finance and the right price signals. Major hurdles include weak or inconsistent policy, gaps in infrastructure, fragmented governance, large informal waste chains without safe integration, limited data, trade barriers for secondary materials, and misaligned incentives. Effective circular transition planning, that aligns national circular economy plans with other sustainable development strategies such as green industrialization and emissions reduction plans can set the stage for triple bottom line impacts green industrialization and emissions reduction plans can set the stage for triple bottom line impacts

Ultimately, the transition to circularity is not an alternative — it is a necessity. On a planet with clear physical and social limits, prosperity will only be possible if we build an economic model that respects these limits, recognizes the intrinsic value of natural resources, and values life in all its forms.

How can we unlock corporate value using circular economy

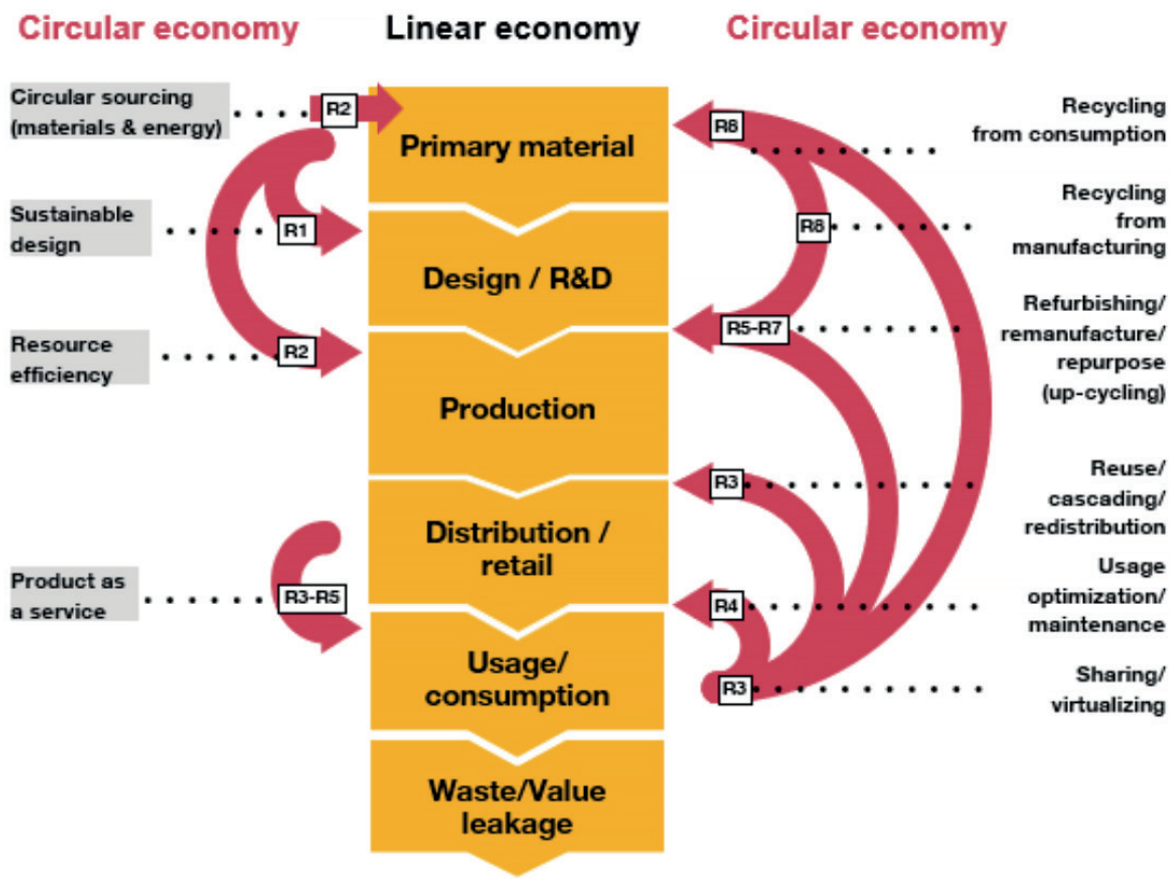
The '9R Framework for the Circular Economy' is the recognized blueprint for implementing circular models. This framework, ranging from R0 (refuse) to R9 (discard), provides an extensive set of interventions across the product and material value chain. 2024/2025 ISO 59004 aims to standardise this approach to resource management actions, outlined in Table 1 below. Implementing these principles enables businesses to capture and create value, fostering innovation, resilience, and sustainability in their operations. This broader perspective also allows better integration of biological materials and bioeconomy flows, particularly relevant in agriculture, FMCG, and pharmaceuticals. Actions such as cascading use, repurposing, and final valorization — highlighted both in the 9R model and ISO framework — are critical to extending the value of bio-based materials, in alignment with national priorities such as Brazil's National Circular Economy Plan (PNEC). International standards for bio-based materials have not yet been developed and should be considered to not ensure consistency in reusability and recyclability.to not ensure consistency in reusability and recyclability.

Table 1 – Guidelines for Resource Management Actions

Action	Description
Refuse	Eliminate redundant solutions, abandoning their function or offering the same function with a radically different solution.
Rethink	Reconsider design and manufacturing decisions. Increase the use of intensive services (e.g., through sharing or introducing multifunctional products to the market).
Circular supply	Select recovered or renewable resources, from sustainable sources or production. Use resources that can be easily recycled or returned to the biosphere. Reconsider formulations.
Reduce	Improve efficiency in manufacturing or using products, consuming fewer natural and material resources.
Repair	Restore a defective or damaged product so that it can be used in its original function.
Reuse	Reuse a discarded product that is still in usable condition and serves its original function.
Refurbish	Restore a product to a useful condition during its expected lifetime, maintaining similar quality and performance characteristics.

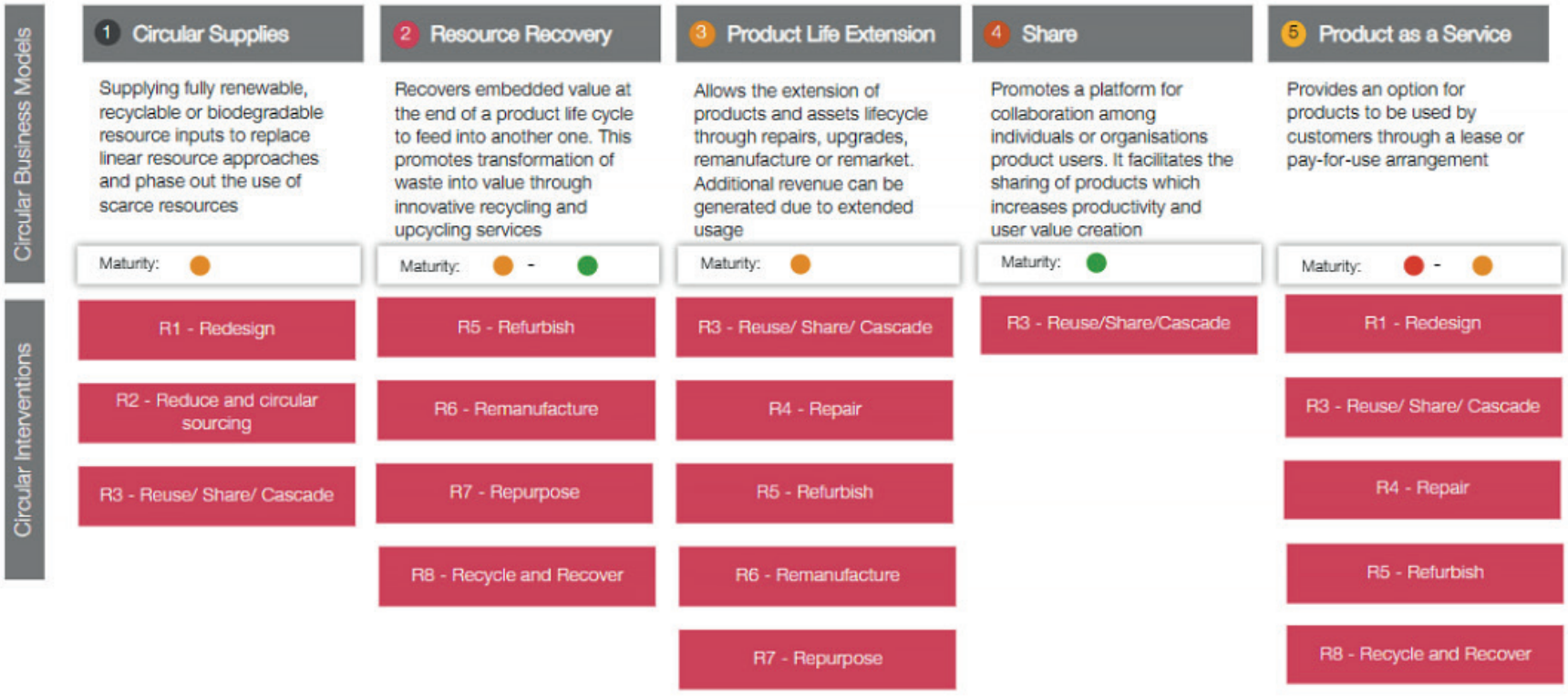
Remanufacture	Return an item, through an industrial process, to a condition similar to a new one from the perspective of quality and performance.
Repurpose	Adapt a product or its parts for use in a different function than originally intended, without making significant changes to its physical or chemical structure.
Cascading use	Transfer recovered materials from one cycle to another, optimizing flows through additional cycles, often with decreasing quality and quantity. This may include repeated use of renewable biological resources with decreasing quality, final treatments like composting, energy recovery, biodegradation, and safe material return to the environment.
Recycle	Recover and process a material to achieve the same quality (high grade) or lower (low grade), through recovery, collection, transport, sorting, cleaning, and reprocessing.
Recover energy	Generate useful energy from recovered resources.
Remineralize	Mining or extraction from landfills and waste treatment plants is possible in some cases, as long as the mining or extraction activities are sustainably managed.

Source: ISO 59004:2024, Circular economy – Vocabulary, principles and guidance for implementation



What business models are being created?

The five circular business models



Source: ING Economics Department, PwC Analysis

Building on the actions presented in the ISO framework, these resource strategies can be catalysed into five circular business models: circular supply, resource recovery, product life extension, sharing, and product-service systems. In addition to these five models, other practices should also be recognized, such as reuse of agricultural residues, product return schemes, companies outside the circular economy core supporting the transition, and extending product lifetimes through repair, refurbishment and remanufacturing. These models offer structured opportunities for businesses to improve value retention, reduce environmental impacts, and enhance competitiveness. The operationalization of these models draws directly from the management actions outlined in the table above, particularly through Maintenance, Repair, and Operations (MRO) and recycling practices. By vertically integrating these activities, manufacturers and service providers can significantly reduce dependence on virgin resources and transition towards more resilient and sustainable value chains. Shifting from traditional to circular business models represents a fundamental transformation in how businesses approach resource utilization, focusing on long-term resilience and environmental stewardship rather than short-term gains. This transition requires coordinated efforts across industries, robust policy support, and the adoption of innovative practices to ensure its success.

Here's a closer look at how traditional business models can shift to a circular model, some successful case study examples and the opportunities gained:

	Circular supplies	Resource recovery	Product life extension	Sharing	Product-as-a--service
Traditional model	Products are made from virgin raw materials.	Businesses dispose of waste or by-products.	Products are designed with a limited lifespan, leading to frequent replacements.	Businesses focus on individual ownership of products.	Businesses sell products directly to consumers, and ownership is transferred to the buyer.
Circular model	Companies use renewable, recyclable, or biodegradable inputs to reduce reliance on finite resources and minimize waste. This also includes the use of renewable raw materials and regenerative practices that substitute fossil-based inputs.	Companies identify streams of waste and find ways to reuse them, limiting waste and reducing resource extraction processes.	Companies design products that are durable, repairable, and upgradable, extending their useful life and reducing the need for new production.	The sharing economy emphasizes access over ownership where multiple users share a product or service. This reduces the overall demand for new products thereby decreasing production volume and resource usage.	Companies retain ownership of their product and offer it as a service (e.g., customers pay for usage rather than buying it outright). This incentivizes companies to maintain their products in good condition for extended use rather than frequently replacing them with new ones.
Case study	Dole Sunshine Company, the Philippines	Contemporary Amperex Technology Co Limited (CATL), China Mainland	Renault Group, France	A Distributed District Cooling (DDC) network in China Mainland	nommori (Circularity Co., Ltd.), Thailand
Opportunity	New markets for agricultural waste	Electric vehicle (EV) battery recycling	Repair and remanufacture of car parts to reduce costs	Lowers heating costs, CO_2 emissions, and capital outlay	Pay-as-you-use subscription fee increases recurring income

Source: Five Circular economy business models and case studies

1. **Circular Supplies:** Dole Sunshine Company (Dole), a global food and beverage company, has partnered with the Philippines-based social enterprise, Musa Fabric. Together, they have turned extracted banana waste fibers from Dole's Philippines plantations into yarn, creating over US$50 million in fashion products. Additionally, they train local communities in banana fiber extraction, weaving, and designing, thereby creating sustainable livelihoods. The initiative aims to reduce 258,720 tons of CO_2 e emissions. In a separate study, turning banana waste into fabric has increased Indian farmers' income by up to 300%. This success highlights the potential of converting other types of agricultural waste into fibers, offering similar economic benefits to communities.

2. **Resource Recovery:** Chinese Mainland battery producer, Contemporary Amperex Technology Co., Limited (CATL), through its subsidiary Brunp, handled 100,000 tons of used batteries (about 250,000 EV batteries), recovering up to 99.6% of nickel, cobalt, and manganese, and 91% of lithium from its products in 2023.[4] CATL estimates that only about 5% of EV batteries globally are currently recycled, with lithium extraction from spent cells being particularly challenging and costly.[5] To improve this, Brunp has developed or revised 369 battery materials and recycling standards, filed 4,527 patents, and invested US$4.5 billion in a Hubei recycling project, which is expected to recycle up to 500,000 tons of spent battery materials.[6] A similar project in Guangdong could see investments reaching US$3.3 billion.[7]

3. **Product Life Extension:** Carmakers such as Renault Group are renovating, repairing, and reusing used vehicles, batteries, and parts. Through its Refactory ecosystem, the company creates new value by closing the loop of a vehicle's life cycle, creating economic, environmental, and social value. Its Flins Refactory site, near Paris, undertakes:
    - Re-trofit: reconditioning of used vehicles
    - Re-energy: repairing and developing applications for batteries in second life such as energy storage
    - Re-cycle: for recycling, resource management and the manufacture of its E-Tech smart gearbox – a highly efficient hybrid gearbox
    - Re-start: a training and Research and Development center dedicated to the CE.[8]

    Based at the Flins Refactory, Renault Group launched The Remakers in May 2024 as a new European leader in automotive parts refurbishment, with a goal to achieve 50% business growth by 2030. The Remakers offers an expanded range of 9 families of automotive components, which are on average 30% more economical for the customer and more environmentally friendly. Given the substantial growth potential of the European replacement parts market — valued at approximately €6.8 billion in 2022 and projected to expand to €8.2 billion by 2030 — the launch of The Remakers aligns with a promising and expanding industry.

---

4 CATL, Environment, Social and Governance Report, 2023 (https://www.catl.com/en/uploads/1/file/public/202404/20240417102933_uuiks9ljr8.pdf)

5 Eco-business, Recycling can meet China battery mineral needs by 2042: CATL boss, 2024 (https://www.eco-business.com/news/recycling-can-meet-china-battery-mineral-needs-by-2042-catl-boss/)

6 CATL, Environment, Social and Governance Report, 2023 (https://www.catl.com/en/uploads/1/file/public/202404/20240417102933_uuiks9ljr8.pdf)

7 Digitimes Asia, CATL aims to establish EV battery recycling sites in Europe, North America, 2024 (https://www.digitimes.com/news/a20230630VL206/catl-battery-recycling.html)

8 Wards Auto, Second Renault 'Refactory' to Recycle, Renew Used Vehicles, 2023 (https://www.wardsauto.com/renault/second-renault-refactory-to-recycle-renew-used-vehicles)

4. **Sharing:** A Distributed District Cooling (DDC) network provides cooling to multiple buildings through a centralized chiller plant, reducing the need for individual plants. This lowers energy consumption, carbon emissions and costs, as heating, ventilation and air conditioning (HVAC) systems account for 40-60% of building energy use or 15% of global energy consumption.[9] (Paragraph 111) Singapore's SP Group is to invest over US$27.6 million in a district cooling and heating system for a sports park in Chengdu, Chinese Mainland. Operational in 2025, it will improve energy efficiency by over 30% for cooling and 50% for heating, saving 2,900 megawatt hours (MWh) of electricity and reducing carbon emissions by 1,700 metric tons annually.[10]
5. **Product-as-a-service:** nornnorn (Circularity Co., Ltd), a Bangkok based, Singapore-incorporated start-up, is pioneering a pay-as-you-use subscription service for premium quality recyclable mattresses. It makes mattresses more financially viable for hospitality businesses, related industries and individual consumers, while minimizing waste generation and reducing emissions by collecting and recycling used mattresses. The company aims to serve 367,000 B2C and 41,000 B2B subscriptions by the end of 2029. It expects to recover at least 2.3 million mattresses, or around 73,000 tons of materials and prevent at least 70,000 tons of GHG emissions. It plans to extend its service to other durable consumer goods, such as electronics, solar cells and batteries, further contributing to sustainable consumption patterns.[11]

Alongside the push for fully circular business models, scaling circular practices within incumbent firms is essential. Not every company can pivot its core model quickly, however they can use a clear business case to select activities from existing operations that are ripe for circular disruption and deliver both sustainable and economic value in the specific business context.

Considering the importance of advancing material innovation, waste reduction, and circular supply chains, our working group has identified four recommendations that can act as catalysts for systemic change. These recommendations focus on how innovation, collaborative financing, and

9 National Library of Medicine, Sustainability of Heating, Ventilation and Air-Conditioning (HVAC) Systems in Buildings, 2022 (https://pmc.ncbi.nlm.nih.gov/articles/PMC8776175/)
10 China Daily, Singapore's SP Group to build cooling system for sports park, 2024 (https://www.pwc.com/gx/en/issues/esg/asia-pac-esg/reinventing-asia-pacific-2025.pdf)
11 Switch Asia, Circular Economy Business Case Studies in Southeast Asia, 2024 (www.switch-asia.eu/resource/driving-mattress-recycling-through-a-circular-economy-product-subscription-platform/)

strategic transformation of supply chains can accelerate the transition to circular practices, integrating resource efficiency, sustainability, GHG reduction, and competitive advantages. Each recommendation addresses a fundamental area where coordinated action can reinforce material innovation, improve waste management, and strengthen supply chains, promoting innovation and collaboration in a progressively sustainability-oriented world:

- Recommendations 1: Promote and scale R&D, innovation and market access for low-carbon materials
- Recommendations 2: Strengthen and deploy public–private financing tools to support circular innovation in business models, infrastructure, and supply chains across sectors and regions
- Recommendations 3: Facilitate collaboration and synergies across multiple organizations to expand resource sharing and innovation, generating competitive advantages and systemic transformation
- Recommendations 4: Enhance traceability and expand recycling and repair through circular economy technologies

By exploring these concepts comprehensively, we aim not only to transform current practices but also to pave the way for a resilient and sustainable future, where the circular economy favors environmental, social, and economic well-being.

B.3 MATERIALS INNOVATION, WASTE MANAGEMENT AND CIRCULAR SUPPLY CHAINS - RECOMMENDATIONS

Given the strategic contributions of materials innovation, waste management, and circular supply chains, the following four recommendations were defined to guide coordinated actions. These recommendations aim to accelerate systemic transformations by aligning resource efficiency, sustainability, and competitiveness through innovation in material development, circular infrastructure investment, and collaborative supply chain transformation.

Recommendation 1: Promote and scale R&D, innovation and market access for low-carbon materials

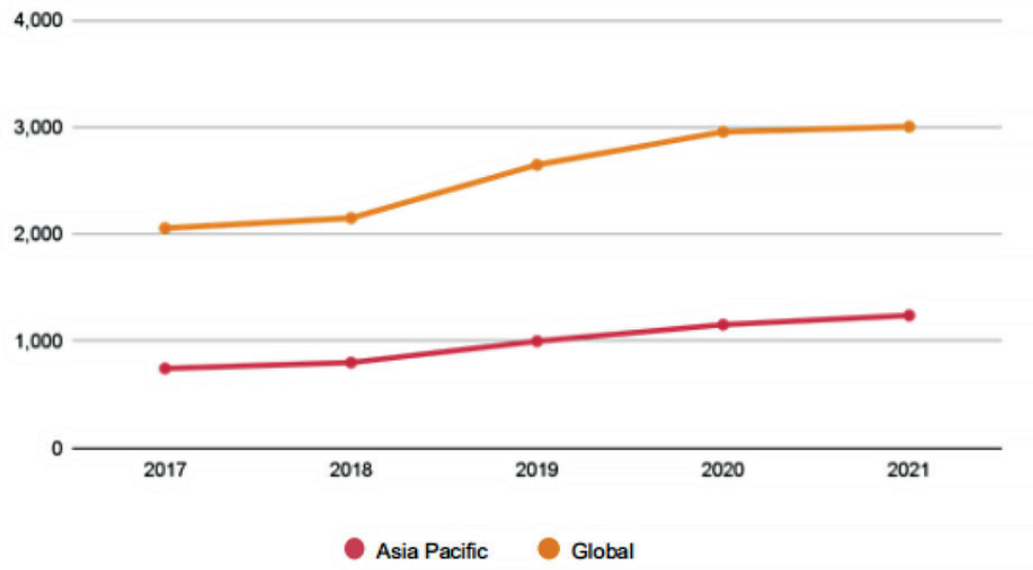
To accelerate R&D and market access for circular, low carbon materials technology push must be combined with market pull. The key challenge lies in implementing and scaling these solutions, beyond research and development. For R&D, funding applied research and pilot plants; opening shared test facilities; offering tax credits and using public funds to provide loans and guarantees that lower risk for the first commercial plants such as blended and outcome-based financing may be helpful. For market access, creating demand with green public procurement and pooled offtake from buyer groups, setting clear phased standards for recycled content and low embodied carbon, and using simple price guarantees can help close the gap. These steps may move new materials from lab to scale, securing early customers, and drive costs down.

This can be done by:

- On the R&D side, bringing R&D labs, pilot lines, investors, and standards bodies into a unified ecosystem where technical expertise, risk, and capital flow freely. In these clusters, materials producers, OEMs, recyclers, and service providers form consortia that share data, align on specifications, and fast-track process validation. Open “innovation marketplaces” then connect start-ups, academia, and corporates to co-develop prototypes, license breakthroughs, and spin out new ventures. Further, it may be helpful to focus on resources where scale is possible by standing up sector focused innovation labs for steel, cement, chemicals, plastics, batteries, textiles and others.

- On the market side, securing early market pull to achieve scale-up including by embedding rising recycled content and low embodied carbon thresholds in public and largebuyer procurement. Aggregate demand through buyer alliances and sign bankable offtake contracts that match plant ramp-up profiles; where costs are higher at first, use timebound price floors. Update product standards to accept certified low carbon, recycled inputs on a performance basis (e.g., lowerclinker cement, higherrecycled aluminum and plastics), and require thirdparty certification with digital product passports so buyers can verify attributes. Remove friction in trade by aligning "endofwaste" rules, customs codes, and quality grades for secondary materials, and stand-up exchanges or auctions with inventory finance so smaller suppliers can participate.

The rise in global patents for waste management technologies, which went up 46% from 2017 to 2021 — reflects growing momentum in areas such as material recovery, recycling, and reuse. These developments indicate growing momentum for circular innovation across a range of industries, including construction, packaging, agriculture, and beyond.



The market for circular and low-carbon materials is evolving but faces challenges: standards and measurement are fragmented; demand is uncertain and often won't cover the price premium; first commercial plants face high capital and technology risk; crossborder rules for secondary materials are unclear; and feedstock quality is inconsistent. A coordinated push can move the needle: aligning simple, trusted rules to measure carbon

and recycled content; create predictable demand with phased procurement and offtake; share risk on first plants through blended finance, guarantees, and timebound price support; invest in collection and sorting to secure reliable feedstock; and streamline trade rules for secondary materials. This is the first step to reducing costs and risks; proving what works faster; giving investors and buyers clearer signals; and narrowing the gap between pilots and scale,

Recommendation 2: Strengthen and deploy public–private financing tools to support circular innovation in business models, infrastructure, and supply chains across sectors and regions

Despite the significant investment required for infrastructure and business transformation, only 2% of tracked investment volumes currently support the circular economy, with most capital still directed toward linear, resource-intensive industries that contribute to emissions. Circular business models offer a compelling investment case by enhancing resource efficiency, unlocking new revenue streams, accessing untapped markets, mitigating environmental impacts, and delivering greater value with fewer material inputs. The Harmonized Circular Economy Finance Guidelines are the first to establish clear eligibility criteria for circular economy financing and provide a methodology to quantify eligible transaction volumes. Referencing these Guidelines alongside the EU Sustainable Finance Taxonomy—particularly as discussed on page 33—enables a more robust and transparent approach to circular economy finance. The Guidelines detail specific financing instruments and outline a standardized assessment framework, supporting investors and stakeholders in identifying and scaling circular opportunities. By adopting these harmonized standards, financial institutions can better align capital flows with circular objectives, drive systemic change, and accelerate the transition toward a more sustainable economy.[3] Investment in the circular economy can be divided into two categories:

1. Investment in incumbent linear businesses transitioning to circularity: capital to redesign products, integrate reverse-logistics systems and scale recycling of key materials.
2. Investment in circular-native ventures and infrastructure: funding startups, digital platforms and facilities built from the ground up to enable closed-loop material flows.

Financing both categories is essential. Channeling capital into incumbent firms accelerates the decarbonization of today's emissions-intensive industries, while backing circular-native enterprises seeds breakthroughs for tomorrow's low-carbon circular economy.

Public–private collaboration is essential: public grants, guarantees, and subordinated debt lower risk for circular projects, while private banks, pension funds, and VCs provide the scale financing needed. One example of this partnership is between the EIB and Intesa Sanpaolo, which set up a €1 billion risk-sharing facility (€500 million EIB guarantee + €500 million dedicated Intesa loans) to finance Italian mid-caps prioritizing circular-economy, green-tech, digital, and R&D investments.

Public–private partnerships and blended finance mechanisms are key to mobilizing resources and scaling innovative initiatives. Financial institutions can play a central role by offering instruments tailored to circular businesses, including guarantees, concessional loans, and fiscal incentives. The goal is to reduce financial risks, unlock private capital, and direct investments toward regions and sectors where circular transformation is most needed. It is also important to harness financial innovation such as blended-finance structures, performance-linked bonds, use-of-proceeds based grants among others to match the cash-flow profiles and risk/return requirements of diverse circular projects, from asset-heavy recycling plants to service-based product-as-a-service models. At the same time, developing a harmonized framework by building on initiatives by financial institutions such as ABN AMRO, ING and Rabobank on circular economy finance guidelines[12] and Intesa Sanpaolo Group on circular economy financing[13], and standards by governments and multilateral organizations EU Sustainable Finance Taxonomy, IFC's Harmonized Circular Economy Finance Guidelines[14], the Global Reporting Initiative and emerging circular-economy metrics can help track investment flows and outcomes consistently, ensuring transparency, comparability and real-world impact.

12 Circular Economy Finance guidelines (https://www.ing.com/Newsroom/News/ABN-AMRO-ING-and-Rabobank--launch-finance-guidelines-for-circular-economy.htm)

13 Intesa Sanpaolo Group (https://group.intesasanpaolo.com/en/sustainability/support-to-esg-transition/support-to-circular-economy)

14 IFC Circular Economy Finance Guidelines (https://www.ifc.org/en/insights-reports/2025/harmonized-circular-economy-finance-guidelines)

Key components include:

- Creating financing programs and instruments that engage both public and private entities
- Designing fiscal policies that incentivize circular investments
- Developing regional funds tailored to circular economy strategies
- Supporting innovation in circular infrastructure (e.g., logistics, repair hubs, reverse supply chains)
- Fostering cooperation between financiers to share best practices and resources
- Considering measures of success, as they are often obstacles to funding

Expected Benefits

- Expansion of investments directed at circular infrastructure and business models
- Acceleration of solutions tailored to local and regional needs
- Increased pipeline of circular business projects across diverse sectors
- Greater visibility and adoption of circular economic models at scale

Recommendation 3: Facilitate collaboration and synergies across multiple organizations to expand resource sharing and innovation, generating competitive advantages and systemic transformation

Promoting collaboration and the sharing of inputs and knowledge between different actors is essential for driving innovation and building competitive ecosystems. Cross-sector agreements, involving relevant sector associations, can be pivotal to driving circular business models. This recommendation includes the creation of regional hubs for the circular economy and direct partnerships between manufacturers, retailers, cooperatives, and other actors in supply chains. Eco-industrial parks are one example of how these strategies can be implemented, as seen in Denmark, where industrial symbiosis — in which the waste or by-products of one process become the raw materials for another — amplifies innovation and sustainability across sectors.

Key components include:

- Developing regional circular economy hubs as centers of collaboration
- Encouraging formal resource-sharing and cross-sector agreements across stakeholders

- Hosting workshops and forums for knowledge exchange and innovation
- Building shared platforms for materials and technology optimization
- Facilitating consortia to jointly fund innovation projects

Expected Benefits

- Increased sharing and optimization of resources between industries
- Formation of competitive ecosystems that lead circular innovation
- Accelerated development and scaling of innovative circular solutions
- Greater visibility and impact of circular initiatives across entire industries

Recommendation 4: Enhance traceability and expand recycling and repair through circular economy technologies

Promote the adoption and scaling of circular economy technologies that deliver measurable business impact across industries. This includes embedding traceability into supply chains, automating waste sorting, fostering the invention of new materials, and expanding the use of digital twins to simulate complex systems. By doing so, companies can capture both environmental and economic value, while accelerating the reshaping of industries from packaging and textiles to construction, electronics, and mining.

1. Transparency, Traceability and Monitoring: Circular systems depend on knowing where materials come from, how they are used, and where they end up.
    - Digital Product Passports, blockchain ledgers, and IoT-enabled tags make this possible, creating a digital identity for every product. These tools not only facilitate compliance with regulation (e.g., EU's Eco Design for Sustainable Products and Battery Passport[15]) but also open secondary markets for recycled materials.
    - Monitoring systems AI-enabled lifecycle assessment software[16] and geospatial monitoring complement traceability by measuring flows of energy, water, and materials in real time.

Industries applying these solutions may include textiles (to certify recycled fibres), construction (through material passports for buildings), and electronics (to ensure responsible recovery of rare metals).

15 Circulor (https://circulor.com/articles/worlds-first-battery-passport)
16 Siemens (https://news.siemens.com/en-us/teamcenter-sustainability-lifecycle-assessment/)

2. Intelligent Sorting, Recovery and Advanced Recycling: One of the largest barriers to circularity has been the cost and complexity of recovering value from mixed waste streams.
    - AI-powered robotics[17] and hyperspectral imaging now enable high-precision sorting of plastics, textiles, and e-waste.
    - Advanced recycling processes are expanding the frontier of what can be reused: chemical depolymerization[18] and enzymatic recycling are turning PET, polyester, and nylon back into virgin-quality monomers, while hydrometallurgy and direct lithium extraction improve recovery rates of critical battery minerals.

In packaging, this reduces dependence on virgin polymers; in mining and energy, tailings reprocessing creates new sources of critical minerals; and in electronics, urban mining technologies unlock secondary supplies of copper, cobalt, and rare earths. However, as these technologies (such as chemical recycling scale), their environmental footprint and cost profile needs scrutiny. Furthermore, this underscores the importance of upstream action on material and product design, where a large share of lifecycle impacts can be prevented.

3. Materials Science and Bio-Based Innovation:
    - Bio-based polymers, fibres, and composites offer renewable alternatives to fossil-based inputs, while advanced chemistry enables these materials to be biodegradable or more easily recyclable. International standards for bio-based materials have not yet been developed and should be considered to not ensure consistency in reusability and recyclability.
    - For example, bio-enzyme solutions are being applied to textile and plastic recycling[19], and new bio-based materials such as mycelium leather and algae-based packaging are being tested as well[20].

In consumer goods and fashion, these materials reduce reliance on petroleum-derived plastics; and in food and beverage packaging, compostable bio-based plastics are becoming viable replacements for single-use materials.

17 Bryson Recycling Paper Line Case Study (https://recycleye.com/bryson-recycling-paper-line-case-study-2/)
18 ChemCycling®: Creating a circular plastics economy with chemical recycling (https://plastics-rubber.basf.com/global/en/plastics-hub/chemcycling)
19 Forbes (https://www.forbes.com.au/news/entrepreneurs/this-startups-ai-designs-enzymes-that-can-eat-plastic-waste/); Carbios (https://www.carbios.com/en/enzymatic-recycling/)
20 EU Commission (https://cordis.europa.eu/article/id/460097-biotechnology-brings-mycelium-based-materials-to-market)

4. Digital Twins:

    - Digital twins create virtual replicas of physical products, assets, or even entire industrial ecosystems. They allow companies to simulate how products will wear, how factories consume resources, and how infrastructure can be designed for disassembly and reuse.

In manufacturing, twins enable predictive maintenance and optimize production for minimal waste[21]. This not only reduces costs but also builds resilience by anticipating resource bottlenecks before they occur.

Technology	Company	Case study
Blockchain battery passport	Volvo	Implemented a blockchain-based battery passport in EVs to meet regulatory standards, qualify for sustainability-linked incentives, and enable verified traceability.
Digital product IDs for apparel	H&M	Piloted digital IDs that link garments to repair and recycling services, increasing customer participation in circular programs and improving transparency.
Advanced chemical recycling (ChemCycling)	BASF	Converts mixed plastic waste into new feedstock; reported 43% CO_2e reduction versus virgin plastic, enabling high-quality recycled inputs.
AI-enabled sorting for recycling	AMP Robotics	Deployed AI/robotic systems in MRFs, delivering USD 120–200K annual labor savings per line and about 11% higher material capture rates.
Sensor-based mineral/ore sorting	TOMRA	Uses advanced imaging to sort minerals more efficiently, reducing downstream energy use and improving resource recovery.
Battery materials recovery (hydrometallurgical)	Li-Cycle	Recovers lithium, nickel, and cobalt from spent batteries to supply EV value chains, in partnership with energy and manufacturing firms.

21 LG Smart Park (https://www.lg.com/global/newsroom/news/home-appliance-and-air-solution/lg-smart-park--named-lighthouse-factory-for-futuristic-manufacturing-technology/)

5. **Volvo** has implemented a blockchain-based battery passport in its electric vehicles, helping meet regulatory standards and qualify for sustainability-linked incentives.
   H&M piloted digital IDs in its apparel line, connecting garments to repair and recycling services and encouraging customer participation in circular programs.

   Strategic Impact:

   - Builds consumer trust through transparency
   - Enables access to government incentives and certifications
   - Supports circular services like resale, repair, and recycling

6. **Recycling & Repair Technologies** including advanced recycling, AI-enabled sorting, and autonomous mining are improving material recovery, reducing emissions, and lowering costs. BASF's ChemCycling™ cuts CO_2 e by 43% compared to virgin plastic, while AMP Robotics delivers USD 120–200K in annual labor savings and 11% higher capture rates.

   This innovation helps companies unlock new revenue streams, reduce operational costs, and meet sustainability targets.

   Recycling & Repair Technologies: Maximizing Resource Efficiency & Cost Savings: These technologies focus on recovering valuable materials from waste and extending product lifecycles. They span advanced recycling processes, intelligent sorting systems, and low-impact extraction methods — all contributing to reduced emissions, lower costs, and improved resource security.

   Advanced Recycling & Battery Recovery: Chemical recycling methods are being used to process complex waste streams, producing high-quality recycled materials that can substitute virgin inputs. For instance:

   - BASF has developed a process to convert mixed plastic waste into new feedstock, helping manufacturers reduce their carbon footprint. Li-Cycle, in partnership with energy companies, is recovering critical minerals from used batteries to support the growing demand for electric vehicles.

AI & Robotics-Enabled Sorting: Automated sorting systems powered by AI and sensor technologies are improving the precision and speed of material recovery. For example:

- TOMRA uses advanced imaging to sort minerals more efficiently, reducing energy use in downstream processing.
- AMP Robotics has deployed AI-driven systems in municipal recycling facilities to improve material capture and reduce labor costs. Reduce operational costs and carbon emissions
- Enhance supply chain resilience through material recovery
- Accelerate return on investment via automation and efficiency gains

C. RESEARCH, EDUCATION AND BEHAVIOR

C.1 RESEARCH, EDUCATION AND BEHAVIOR - EXECUTIVE SUMMARY

A successful transition to a circular economy is not possible without a deep cultural and behavioral shift, underpinned by science, innovation, and education. While regulation and financial mechanisms are essential for shaping enabling environments, it is ultimately people—through their knowledge, decisions, and habits—who drive the adoption of circular practices. Research and education are foundational pillars in building the skills, technologies, and values required to advance circularity across all sectors and regions. They provide intellectual and practical infrastructure for designing out waste, closing material loops, and unlocking long-term value for society, which ultimately contributes to fight climate change.

Despite growing awareness of circular economy principles, systemic adoption remains limited and uneven. One major challenge is that consumers often perceive circularity as a sacrifice—an inconvenience that requires changing habits or paying more for sustainable products. To overcome this perception, education efforts must emphasize that circularity is not about doing less, but about gaining more: through cost savings, better product quality and durability, fighting climate change, environmental regeneration, local job creation, and stronger community ties. When framed correctly, circular behaviors can be seen as aspirational—empowering individuals to make decisions that align economic value with social and environmental responsibility.

At the same time, the circular economy demands new technical and digital skills, such as recycle, repair, remanufacturing, renewal, material separation, reverse logistics, and digital tracking of products and components. However, millions of workers, particularly in the informal and low-income sectors—currently lack access to training, certification, and career pathways in these emerging fields. Without inclusive upskilling and targeted education, the circular transition risks deepening social and economic inequalities, leaving behind those most in need of opportunity. A transition requires investment in human capital and deliberate strategies to formalize, train, and empower the workforce that is already playing a key role in circular practices.

To support this transformation, our working group has identified three priority areas. First, the launch of a Global Circular Education Pact, which would foster widespread behavior change by integrating circularity into formal curricula, lifelong learning platforms, and global public awareness campaigns. This pact aims to build shared understanding and ownership of circular goals among consumers, communities, and professionals. Second, the promotion and financing of applied research and innovation, led by universities and startups, and implemented through collaborative pilot projects with industry. These initiatives are critical to accelerating the development of circular technologies and business models tailored to local and sectoral contexts. Third, the training and upskilling of workers, especially those engaged in material recycle, recovery, reuse, and repair—ensuring that the circular workforce is equipped, recognized, and connected to stable economic opportunities through certification, career development, and social protection.

Together, these priorities aim to strengthen the social, scientific, and human foundations of a global circular economy, and represent a contribution to the climate agenda. They address the need for cultural transformation, technological advancement, and social inclusion, ensuring that circularity is not just a policy goal, but a lived experience for all. Only by investing in people, knowledge, and equitable opportunity can we unlock the full potential of circularity to deliver prosperity within planetary boundaries, especially climate.

C.2 RESEARCH, EDUCATION AND BEHAVIOR - INTRODUCTION

The transition to a circular economy is not merely a matter of deploying new technologies or adjusting business models—it is fundamentally a cultural, educational, and behavioral shift. Regulation and financial incentives are essential levers for systemic change, but they cannot operate in isolation. It is ultimately people—their ideas, knowledge, values, and everyday decisions—who determine whether circular principles take root in society. For circularity to move beyond pilot programs and isolated innovations, we must invest in the intellectual, social, and human foundations that enable it: research, education, and behavior change.

At its core, a circular economy challenges conventional assumptions about value, ownership, consumption, and waste. Rather than designing products to be used and discarded, circular thinking promotes a regenerative system where materials flow in closed loops, waste is eliminated, and economic activity is decoupled from resource depletion. This model is inherently interdisciplinary, involving not just engineers or designers, but educators, social scientists, urban planners, economists, and civil society actors. However, most education systems, training programs, and public narratives still reflect the linear economy's logic—emphasizing throughput, growth, and efficiency, rather than durability, regeneration, and sufficiency. As a result, circular thinking is often absent from the very places where habits and knowledge are formed: schools, universities, workplaces, and homes.

To overcome this gap, we must treat education and knowledge-building as strategic infrastructure. This means embedding circular economy principles into national curricula, vocational training, and professional development. It also means integrating circularity into lifelong learning opportunities and informal educational settings—from community centers to digital platforms. When education systems reflect circular values, they not only prepare future workers with the technical skills required for emerging jobs, but also cultivate informed, empowered citizens who understand the broader purpose of sustainability transitions. This cultural foundation is critical for long-term resilience and transformation.

However, knowledge alone is insufficient. Behavioral change must be at the heart of the circular transition. Despite growing awareness, the adoption of circular practices among consumers remains limited and inconsistent across sectors and regions. One of the main barriers is the widespread perception that circularity implies sacrifice: paying more for sustainable goods, accepting limited product availability, or making inconvenient lifestyle adjustments. This framing discourages engagement and reinforces the idea that sustainability is a luxury, not a necessity.

To shift this narrative, circular behaviors must be rebranded as aspirational and rewarding. Consumers need to see tangible benefits: cost savings through product longevity and sharing, pride in repairing and reusing, access to higher-quality goods, and a sense of participation in environmental regeneration. Public campaigns, social marketing, and education initiatives should focus not only on raising awareness, but also on reshaping preferences, building social norms, and demonstrating positive outcomes.

A key contribution to understanding consumer behavior in the circular economy comes from the recent study "The Tipping Point: Building Trust in the Circular Economy," released in June 2025 by the British Standards Institution (BSI) in partnership with the University of Cambridge Institute for Sustainability Leadership. The study, based on surveys across multiple regions, reveals that while the concept of the circular economy is gaining visibility, widespread adoption is still hindered by trust and practical barriers. In the study, 57% of consumers report being familiar with the term "circular economy," though this awareness varies significantly by country, age group, and education level. The most powerful motivator for circular behaviors is cost saving, cited by 68% of respondents among their top three reasons for participating. This was closely followed by the desire to create a positive environmental impact (67%), indicating that economic and ecological values are becoming increasingly intertwined in consumer decision-making.

However, the study also highlights a persistent trust and convenience gap that prevents circular practices from reaching a broader audience. Consumers expressed substantial concerns about circular products, with 56% citing issues of quality, 51% raising safety concerns, and 49% doubting reliability. Furthermore, circular products and services are still widely perceived as less convenient or more expensive, with cost identified as the most significant barrier to adoption. Notably, 32% of respondents

pointed to a lack of trust in environmental claims as a deterrent, and 59% stated that a recognized label or standard would increase their confidence in circular offerings. These findings underscore the importance of building trust through transparency, standards, and consumer communication, reinforcing the need for education, labeling, and certification systems that can support widespread behavior change.

In parallel, the circular economy demands a profound transformation of the labor market. New roles are emerging in product repair, reverse logistics, materials science, service-based business models, and circular design. These fields require hybrid skillsets: combining technical proficiency with systems thinking, digital literacy, and collaborative problem-solving. However, the global workforce is not yet equipped to meet these demands. According to the International Labor Organization, millions of workers, particularly in developing countries, are engaged in informal recycling, repair, and reuse activities—but lack formal training, legal protections, or pathways to decent work.

Without targeted investment in education and upskilling, these workers risk being excluded from the benefits of circularity, even as they perform essential roles in existing circular systems. Many high-potential job sectors—such as electronics repair, textile sorting, and remanufacturing—remain underdeveloped due to a shortage of technical training programs and inadequate public investment in green skills. Moreover, gender disparities persist, with women underrepresented in technical circular economy roles, even as they often lead community-based waste management and reuse efforts.

A just circular transition must therefore prioritize inclusion, formalization, and capacity-building. This means providing training programs tailored to informal workers, women, youth, and low-income communities—groups that are often on the frontlines of material recovery but face systemic barriers to education and recognition. It also requires creating partnerships between governments, businesses, educational institutions, and community organizations to ensure that training leads to real economic opportunities. Certification schemes, access to social protection, and pathways for entrepreneurship must be part of the equation.

Despite growing recognition of the circular economy's potential, progress in research, education, and behavior change remains fragmented and uneven across countries and sectors. Many education systems continue to reflect

linear models, with little emphasis on system thinking, material cycles, or regenerative design. Circular skills—such as repair, remanufacturing, and resource recovery—are often absent from vocational training, and public awareness campaigns are sporadic or narrowly targeted. Moreover, informal workers who play a key role in circular practices, especially in developing countries, often lack access to training, certification, or formal recognition. These gaps risk limiting the speed, inclusiveness, and effectiveness of the circular transition.

At the same time, promising initiatives have begun to emerge at national and local levels, demonstrating how education, research, and behavior-focused strategies can unlock circular value. Countries are experimenting with curriculum reform, training programs, innovation hubs, and public engagement to build the human and cultural infrastructure needed for circularity. While these efforts are still in their early stages and often vary in scale, focus, and resources, they provide valuable models that can be adapted and scaled globally. The following examples illustrate diverse approaches to strengthening the enabling conditions for circular research, learning, and action across different regions.

- **Finland**

Finland is widely recognized as a global leader in circular economy education, having made significant investments to embed circular thinking across its entire education system. In 2017, the Finnish government launched a comprehensive education initiative aimed at integrating circular economy principles from early childhood through to higher education. Between 2018 and 2019, more than 70,000 students participated in circular economy education across primary and secondary schools, vocational institutions, and universities. The teaching materials were developed collaboratively with schools through a series of national projects, and the initiative quickly became institutionalized as a permanent feature of the Finnish curriculum. Students were introduced not only to the basics of waste sorting and resource efficiency but also to broader concepts such as sustainable business practices, creative problem-solving, and the societal relevance of circularity. Feedback from schools indicated a high level of student interest and engagement, with many expressing a desire to contribute to a more sustainable future.

This systemic approach to education has positioned Finland as a frontrunner globally in circular economy learning, with the Ellen MacArthur Foundation highlighting the country's higher education programs as among the most advanced. Recognizing that the transition to a circular economy will impact nearly every profession, Finland's Strategic Programme for the Circular Economy (2021) further reinforced the importance of developing circular expertise as a core work-life skill. This includes targeted investments in vocational education, upskilling, and lifelong learning, enabling professionals across diverse sectors to apply circular principles in their fields. As circularity becomes embedded not only in products and processes but also in daily decision-making and workplace practices, Finland's model offers a compelling example of how long-term vision and coordinated policy can build the cultural and professional capacity needed for system-wide transformation.

- **Netherlands**

The Netherlands' National Circular Economy Programme (NCEP) 2023–2030 recognizes that achieving a fully circular economy is not possible through technological or regulatory measures alone—it requires a fundamental shift in consumer behavior, mindset, and skills. To this end, the program emphasizes education and behavioral change as critical enablers across all value chains.

To influence behavior, the government introduced a dedicated Behavioral Strategy for Citizens and the Circular Economy, which outlines a structured approach based on behavioral science. The strategy focuses on three pillars:

1. Designing the environment to make circular choices easy, accessible, and appealing, for example, through better product labeling, return systems, or repair infrastructure.
2. Removing behavioral barriers and leveraging social norms, trust, and incentives to promote behaviors such as reusing, repairing, or buying second-hand products.
3. Fostering a circular identity, encouraging citizens to see circularity as a positive and natural part of their everyday lifestyle.

This strategy is already being applied in sectors such as textiles, electronics, and furniture, where pilot programs help test and scale consumer engagement strategies. In parallel, the NCEP invests in education and awareness at multiple levels. Circular economy themes are

being incorporated into school curricula, vocational training, and public campaigns. The government supports lifelong learning initiatives and skill development, particularly in repair, maintenance, and sustainable design. These educational investments are aimed at creating a workforce ready for circular jobs, while also shaping a more informed and empowered citizenry.

- **Brazil**

Brazil's "Plano Nacional de Economia Circular" places strong emphasis on transforming both societal behavior and educational pathways to support circular economy principles. The plan is structured around five strategic axes; notably, the Innovation & Education mandates the creation of environmental education programs, support for critical and creative thinking, and targeted capacitybuilding across all levels—from elementary to postgraduate education. These programs are designed to foster a deeper understanding of resource reduction, reuse, and circular product design among citizens, professionals, and public agents.

Complementing these educational measures, the plan also incorporates behavioral strategies aimed at aligning public attitudes with circular goals. It includes the training of public servants and industry professionals on circular production methods, as well as initiatives to raise broad social awareness about the benefits of circular choices. Specific actions include support for wastepicker cooperatives, integrating them into formalized value chains with improved working conditions, visibility, and recognition. The government also plans to enhance traceability mechanisms, product guarantees, and technical standards (e.g. reparability, durability, recyclability), which collectively address key consumer concerns—making circular products more trustworthy and reliable. Through this combination of education, professional training, public campaigns, and regulatory tools, Brazil aims to shift both individual behaviors and institutional cultures toward sustainable, circular modes of living and working.

Brazil has also pioneered inclusive circular training by working with waste picker cooperatives, which represent a large portion of the informal recycling sector. Programs in cities like São Paulo and Belo Horizonte provide cooperatives with vocational training, administrative capacity-building, and business support. These initiatives help integrate informal workers into formal value chains while promoting social inclusion.

- **Thailand**

Waste Hero Education is a global, free educational initiative with the ambitious goal of empowering 1 million people by 2030 through learning about recycling fundamentals, achieving zero waste, and building a circular economy. The program offers activitybased lesson plans and workshops tailored for students and university/youth groups. These lessons are structured into progressive levels, each featuring beginner, intermediate, and advanced versions.

The educational material creation process has also been independently validated, and the materials have been independently tested with educators in classrooms in the United Kingdom, Zimbabwe, Bangladesh, the United States and Mexico, in both offline and online formats. The materials are also designed to be iteratively improved over time as they are adapted, edited, contextualized and built on by educators for their own specific learning contexts.

- **Rwanda**

Rwanda's National Circular Economy Action Plan, launched in December 2022 and spanning through 2035, aims to integrate circular economy principles across key sectors, and includes targeted policies embedding circular economy principles in primary, secondary, and university curricula, along with vocational circular training courses. This educational component is designed not just to raise awareness, but to shift long-term behaviors: students are taught to design out waste, valorize organic and postharvest resources, and apply circular principles in day-to-day life and future professions.

Complementing education, the plan calls for widespread behavior change campaigns to instill new habits around waste separation at source, composting, and the use of sustainable materials.

- **Kenya**

The Kenya Climate Innovation Center (KCIC) plays a pivotal role in advancing the circular economy in Kenya through education, capacity building, and innovation support. As a business incubator focused on climate-smart solutions, KCIC provides technical assistance, access to finance, and entrepreneurial training to ventures in waste management, regenerative agriculture, renewable energy, and resource efficiency. Through its programs, the center fosters circular business models that emphasize

reuse, recycling, and waste reduction. Its commitment to sustainable agricultural practices and regenerative value chains demonstrates a clear vision of economic transition that benefits both the environment and the creation of green jobs and income opportunities.

Beyond supporting enterprises, KCIC has made strong investments in education and behavior change—recognizing them as essential foundations for a successful circular economy. The center conducts hands-on training, awareness campaigns, and community outreach targeting youth, women, and local stakeholders, with a focus on responsible consumption, local innovation, and the value of circular solutions. By equipping individuals with practical skills in material reuse, sustainable design, and waste management, KCIC helps foster a culture of circular thinking rooted in knowledge and collective action. This educational approach is crucial to transforming mindsets and building an ecosystem where citizens and entrepreneurs are empowered to lead the transition toward a more resilient and regenerative economy.

- **Singapore**

Singapore's Zero Waste Masterplan places strong emphasis on education and behavior change as foundational pillars for achieving a circular economy. Through national campaigns, the government promotes sustainable habits like using reusables, reducing food waste, and proper recycling. These efforts are supported by school-based programs, which introduce students to environmental responsibility from a young age. Public engagement is further deepened through community workshops, composting events, and co-designed local initiatives that make sustainability both visible and actionable.

Behavior change is reinforced by smart policy design. The Resource Sustainability Act mandates waste segregation, packaging reporting, and extended producer responsibility (EPR) schemes, while also enabling economic nudges like charges for disposable bags and incentives for recycling. User-friendly infrastructure, including smart bins and clear labeling, makes it easier for citizens to adopt circular practices. Singapore's strategy integrates education, regulation, and behavioral science to create a supportive ecosystem where circular actions become routine, making it a leading example in Asia for combining public awareness with systemic change.

Recommendations

As countries prepare to update their climate strategies and economic development plans in the lead-up to COP30, it is essential to recognize that circularity is not only about materials and technologies, it is about people, knowledge, and culture. Without widespread public understanding, skilled professionals, and supportive social norms, circular policies will struggle to achieve real-world impact. It is essential to recognize that circularity is not only about materials and technologies - it is about people, knowledge and culture.

To address these challenges, our working group has identified three key recommendations to advance research, education, and behavior in the circular economy:

- Launch a global circular education pact for behavior change.
- Promotion and finance research by universities and startups for the development of technologies and circularity solutions, and partnership with companies for implementation of pilot projects.
- Training of people engaged in circularity practices (adding, retaining, and recovering the value of resources).

C.3 RESEARCH, EDUCATION AND BEHAVIOR - PRIORITIES

Achieving a truly circular economy requires more than technical innovation and regulatory reform demands a deep transformation in how individuals, communities, and institutions think and act. Education, research, and capacity-building are essential to unlock the cultural, behavioral, and skills-based shifts needed to embed circularity into everyday life and professional practice. By investing in people and knowledge systems, we can foster inclusive participation, empower innovation, and accelerate widespread adoption of circular principles. The following recommendations aim to strengthen the social and human foundations of circular economy systems.

Recommendation 1: Launch a global circular education pact for behavior change

Description

The global transition to a circular economy will not succeed without a profound transformation in how individuals think, act, and engage with material systems. While regulatory frameworks and financial incentives are essential enablers, it is people—through their knowledge, decisions, consumption patterns, and work—who ultimately determine the pace and depth of change. Current education systems and public engagement efforts remain insufficient to meet the scale of this challenge. Consumers still often perceive circularity as a constraint rather than an opportunity, and millions of workers, especially in the informal economy, the training and recognition needed to contribute meaningfully to circular value chains. Global experience shows that behavior change, and circular education are achievable when approached through structured, inclusive, and well-funded initiatives. In Finland, circular principles have been fully integrated into the national curriculum, reaching students in primary schools, vocational institutions, and universities. The country's long-term strategy links circularity to work-life skills, supporting both lifelong learning and cultural transformation. Similarly, the Netherlands has adopted a behavioral science-based strategy to influence citizen choices across

sectors like textiles and electronics—focusing on making circular options more accessible and desirable, while simultaneously embedding circular topics into formal education and public campaigns.

Brazil, Rwanda, Kenya, and Singapore offer further evidence that education and public engagement are not just complementary but central to achieving systemic circularity. Brazil's National Circular Economy Plan prioritizes inclusive education and workforce training, particularly through partnerships with waste picker cooperatives. Rwanda's Circular Economy Action Plan embeds circularity in school curricula while launching national awareness campaigns. Kenya's Climate Innovation Center combines entrepreneurship training with hands-on community education, especially among youth and women. Singapore's Zero Waste Masterplan blends formal environmental education with public campaigns and grassroots initiatives that promote responsible consumption. These examples highlight the critical role of government coordination, cross-sector partnerships, and community participation in shaping new behaviors and mindsets.

To address these challenges, we recommend the launch of a Global Circular Education Pact — a voluntary, multi-stakeholder initiative aimed at embedding circularity into education, training, and public engagement systems worldwide. The Pact would act as a global framework and catalyst, mobilizing international cooperation to mainstream circular economy education at all levels, promote widespread behavior change, and build the human capital needed for a just and inclusive transition.

Key implementation components:

1. Governance and coordination:
   The Pact could be hosted or coordinated by an international platform or alliance, in partnership with governments, universities, development agencies, NGOs, and the private sector. A secretariat or steering committee would oversee implementation, ensure inclusivity, and monitor progress. This mirrors the governance models of similar initiatives, such as the UNESCO Greening Education Partnership.

2. Three core pillars:
    - Circular Literacy and Curricula Integration: Support national education ministries and institutions to embed circular economy principles into formal curricula—from primary education to university—as well as technical and vocational training. Curriculum development can draw on existing open-source frameworks such as the Ellen MacArthur Foundation's Circular Economy Learning Pathways.
    - Public Awareness and Consumer Engagement: Launch global and regional campaigns (through media, social platforms, public institutions, and influencers) to reframe circular behaviors as positive, aspirational choices linked to quality of life, community resilience, and environmental regeneration.
    - Workforce Upskilling and Inclusion: Invest in scalable and inclusive training programs—particularly for low-income, informal, and vulnerable workers—focusing on skills such as recycling, repair, remanufacturing, material sorting, and digital tracking. Partner with labor organizations and industry associations to create certification pathways and formal job transitions.
3. Financing mechanisms:
   Governments, international donors, and development finance institutions could allocate resources to support Pact activities, including curriculum reform, teacher training, grassroots campaigns, and worker upskilling. Matching grants and blended finance can encourage private sector participation.
4. Monitoring and evaluation:
   The Pact would establish key performance indicators (KPIs) and report mechanisms to track progress on education outcomes, behavior shifts, and workforce integration. Regular global reports could assess impact, share best practices, and inform policy refinement.

Expected Benefits

- Widespread behavior change: A global shift in cultural norms and consumer habits, positioning circularity as aspirational and empowering.
- Equitable workforce development: Marginalized groups gain access to circular economy careers through inclusive training and recognition systems.

- Enhanced national policy capacity: Countries are better equipped to implement circular economy roadmaps through aligned educational strategies.
- Acceleration of innovation: Universities and vocational institutions serve as incubators of new circular business models, technologies, and entrepreneurship.
- Improved global cooperation: The Pact provides a shared reference and collaboration platform, enabling consistent action across diverse geographies.
- Support for just transition: Ensures social justice and economic inclusion are embedded in the circular transition, addressing structural inequalities.

Recommendation 2: Promotion and finance research by universities and startups for the development of technologies and circularity solutions, and partnership with companies for implementation of pilot projects

Description

Innovation is a cornerstone of the circular economy, but the path from ideas to large-scale adoption remains fragmented and underfunded. Many promising solutions—ranging from alternative materials and zero-waste manufacturing processes to reuse-based business models and circular digital platforms—never move beyond the lab or prototype phase due to a lack of investment, coordinated research, and implementation partnerships. Bridging this gap requires not only technical expertise but also ecosystem collaboration that brings together academia, startups, and the private sector.

Universities and research institutions are well positioned to explore high-impact technologies and system solutions, while startups bring agility, experimentation, and a drive to disrupt existing models. However, these actors often face significant barriers, such as limited funding for applied research, difficulties accessing industry networks, and lack of pathways to scale. Meanwhile, many companies, especially small and medium enterprises (SMEs)—are eager to engage with circular innovation but lack the resources or knowledge to initiate such projects on their own.

To unlock this potential, we recommend the establishment of targeted funding programs and innovation platforms that support circular research and early-stage implementation. Public and private resources should be mobilized to finance applied research, support pilot initiatives, and strengthen bridges between academia, entrepreneurs, and industry actors. By enabling joint experimentation and knowledge exchange, these efforts can accelerate the development and diffusion of circular technologies that are not only technically sound but also viable in real-world markets.

Key implementation components and examples:

1. Dedicated funding programs:

   Governments, development banks, and philanthropic foundations should establish grant programs and investment vehicles to support applied circular economy research and early-stage innovation. These could prioritize cross-sector collaboration and co-finance projects involving both research institutions and private-sector partners.

   - The EU's Horizon Europe program funds collaborative circular innovation across sectors, including a project that is focused on the development of circular systems.
   - In Chile, CORFO (Chilean Economic Development Agency) provides grants to circular startups that partner with universities to co-develop technology solutions for industrial waste reuse.

2. University-industry innovation hubs:

   Create or scale up regional circular innovation hubs hosted by universities or technical institutes. These hubs would serve as platforms for co-development, testing, and validation of circular solutions, with embedded mentorship and support from industry, local government, and accelerators.

   - In Finland, Helsinki-Uusimaa Circular Hub is a regional initiative that brings together municipalities, companies, research institute to develop pilot projects, and in partnership with leading European innovation valleys, is carrying out the project European Circular Innovation Valley
   - The African Circular Economy Alliance (ACEA) supports regional innovation hubs that connect universities with entrepreneurs and corporates across Kenya, Rwanda, and Nigeria.

3. Startup acceleration and venture support:
   Develop circular-specific startup accelerators, with tailored funding, mentorship, and networking opportunities. Programs should prioritize underrepresented regions and provide additional support to women- and minority-led enterprises.
   - The "Circular Valley" accelerator in Germany offers global startups mentoring and access to a network of partners including industry, R&D and government, to pilot their solutions in real supply chains.
   - The "IKEA Social Entrepreneurship" accelerator offers operational support and strategic development through mentors and advisors, as well as support within product design, social impact and networking.

4. Pilot project partnerships:
   Facilitate partnerships between startups, universities, and companies (especially SMEs) to co-design and implement real-world pilot projects. These pilots would serve as proof of concept for circular solutions in sectors such as construction, agriculture, fashion, packaging, and electronics.
   - In Brazil, the SENAI Innovation Institute collaborates with manufacturing firms and tech startups to pilot circular production lines using industrial symbiosis and AI.
   - In the Netherlands, "Fashion for Good" links apparel brands with circular startups and research labs to pilot innovations, creating an ecosystem to transform and build a regenerative industry.

5. Open innovation platforms and knowledge exchange:
   Promote digital platforms that connect innovators, researchers, investors, and companies to share knowledge, case studies, and data. These platforms can reduce duplication, promote transparency, and speed up solution scaling across borders.
   - Circle Lab by Circle Economy is an online platform for cities, businesses, and citizens to explore, brainstorm, and implement circular business models and strategies to tackle universal and local challenges, and it hosts over 1,500 curated circular economy studies and tools. The Ellen MacArthur Foundation's network collaboration aims to demonstrate through projects with the potential to have significant impact on how materials are used in economy, connecting members, partners and strategic partners.

Expected benefits

- Faster scaling of solutions: New technologies and business models move from research to implementation more efficiently through structured collaboration.
- Increased private sector engagement: Companies gain practical entry points into circular practices through low-risk pilot programs.
- Ecosystem development: Stronger innovation ecosystems emerge at the regional level, with cross-cutting linkages between research, entrepreneurship, and policy.
- Greater equity in innovation: Targeted support ensures that circular innovation is inclusive and reaches underserved geographies and communities.
- Accelerated climate and resource goals: Proven circular technologies contribute directly to reducing material waste, emissions, and environmental impact.

Recommendation 3: Training of people engaged in circularity practices (adding, retaining, and recovering the value of resources)

Description

A successful circular economy depends not only on innovation and policy reform, but also on people, the individuals and communities who carry out the everyday work of collecting, repairing, sorting, remanufacturing, and recovering materials. These circularity practices form the operational backbone of the system and are essential for closing loops and extending product life cycles. From electronics refurbishers and repair shop technicians to waste pickers, industrial plant workers, and designers applying eco-design principles, circularity relies on a diverse and distributed workforce with sector-specific knowledge and applied skills.

Yet, many of the people currently engaged in these activities work in precarious, low-paid, or informal conditions. They often lack access to formal education, specialized training, or basic social protection. In particular, informal workers—such as recyclers and waste pickers—are frequently excluded from national statistics, regulatory frameworks, and industry recognition, despite providing essential environmental and social services. Even within formal sectors, circular roles tend to be undervalued, with few structured career development opportunities or clear paths for professional growth. The result is a workforce that is critical to sustainability goals, but poorly supported and marginalized.

Addressing these disparities is essential for achieving a just and inclusive transition. Circularity cannot scale equitably if the people doing the hands-on work are left behind or replaced without support. Instead, targeted training and capacity-building programs must prioritize the upskilling and formal recognition of those already engaged in circular practices, especially in underserved regions and communities. Initiatives should also proactively involve women, youth, and historically disadvantaged groups, who are often overrepresented in the informal sector but underrepresented in leadership or technical roles.

In addition to technical instruction, training systems should support broader empowerment. This includes financial literacy, health and safety awareness, entrepreneurship skills, and digital access—particularly for those seeking to launch or grow small businesses in repair, reuse, or material recovery. Educational pathways must also evolve to include circular economy modules in vocational programs, higher education, and public employment services, ensuring that circularity is not treated as a niche, but as a core component of future jobs and skills.

We recommend the development of inclusive, demand-driven training systems that are co-designed with companies, local authorities, cooperatives, and civil society to ensure contextual relevance and uptake. These systems should be anchored in real labor market needs and paired with supportive policies that promote decent work, social protection, and access to financing. Only through deliberate investment in human capital can the circular economy become both scalable and equitable, delivering environmental, economic, and social benefits while recognizing and uplifting the people who make circularity work.

Key implementation components and examples:

1. National and regional circular training programs
   Governments should integrate circular economy principles into national training agendas by embedding relevant competencies into technical and vocational education and training, adult education, and workforce development initiatives. These programs should focus on practical skills for roles in sectors such as construction, manufacturing, electronics, agriculture, and waste management, and be regularly updated in collaboration with industry. Additionally, local authorities can play a key role in delivering training through municipal programs, public-private partnerships, or employment stimulus packages targeting green and circular jobs.

- In the Netherlands, the National Circular Economy Program funds the development of modular training curricula tailored to priority sectors like textiles, construction, and food systems, integrating circularity into both initial training and continuous professional development.
- Rwanda's National Circular Economy Action Plan emphasizes workforce development through TVET institutions and includes circular skills as part of its green growth strategy, focusing on youth employability and entrepreneurship.

2. Industry-led training and certification

Companies, business associations, and industrial clusters should take a proactive role in developing and delivering job-specific circular training programs, both internally and across supply chains. These initiatives can support workers with skills in eco-design, maintenance and repair, reverse logistics, sustainable materials management, and remanufacturing. Training should be paired with recognized certification schemes, offering workers credentials that are transferable across employers and regions. This increases job mobility and professional recognition, while helping companies identify qualified talent.

- In Germany, the REMONDIS Group provides structured training programs for circular economy professionals across its operations, and collaborates with public education providers to standardize qualifications for material handlers and recycling specialists.
- In Brazil, SENAI's technical certification programs in circular industrial processes—including remanufacturing and reuse of inputs—are co-designed with local manufacturers and contribute to national workforce development strategies.

3. Local empowerment and informal sector inclusion

Informal workers and community-based organizations are at the front lines of circularity in many countries, especially in the Global South. Governments and NGOs must prioritize their integration into formal systems through inclusive training and recognition mechanisms. Programs should be delivered in accessible formats (e.g., community-based training, mobile workshops, visual aids) and supported by measures such as access to equipment, safety protocols, and cooperative development. Formalizing these roles not only improves working conditions and income security but also enhances the efficiency and traceability of material flows.

- In Colombia, the Asociación Nacional de Recicladores works to professionalize informal waste pickers through training in material sorting, collection logistics, and safety, helping them gain formal contracts with municipalities and recyclers.
- In India, SWaCH—Pune's cooperative of waste collectors—offers training, legal support, and digital tools to improve productivity and inclusion in city-wide circular initiatives.

4. Circular economy education for public sector and educators

   For circularity to become mainstream, public officials and educators must also understand its concepts and applications. Training civil servants, especially those working in procurement, infrastructure, planning, and waste management—ensures that government decisions align with circular economy goals. Similarly, teachers and curriculum developers must be equipped to introduce circularity in schools, universities, and adult learning programs. Investments in capacity-building for these stakeholders can unlock systemic change across education and policy landscapes.

   - Finland is a global leader in this area, embedding circular concepts across all levels of education and teacher training, with a special focus on environmental stewardship, systems thinking, and design for sustainability.
   - In Kenya, the National Industrial Training Authority partners with counties to deliver circular training for municipal officers and engineers working in water and sanitation, resource management, and procurement.

5. Digital platforms and blended learning

   To reach diverse learners across geographies, socioeconomic backgrounds, and sectors, digital learning tools should be developed and scaled. Online platforms can host training modules, certifications, webinars, and collaborative forums, allowing learners to access materials on demand and at their own pace. Blended learning approaches that combine digital content with in-person mentorship or peer exchange can increase retention and real-world application. Special efforts should be made to ensure mobile accessibility, multilingual content, and content adapted for users with low literacy or limited formal education.

- The Circular Jobs Initiative by Circle Economy provides an interactive online portal that maps circular job roles and associated skills, offering free learning resources and career planning tools for workers and educators.
- UNIDO's Learning Hub delivers modular e-learning programs for circular production, eco-design, and sustainable industrial practices, targeting SMEs and technical professionals worldwide.

Expected Benefits

- Workforce readiness: Workers are better equipped with the skills needed to implement circular models in key sectors.
- Inclusive transition: Marginalized groups and informal workers are recognized and empowered within circular value chains.
- Sectoral innovation: Companies benefit from trained personnel capable of identifying circular opportunities and operationalizing them.
- Public sector alignment: Policymakers and educators are able to drive systemic change with informed strategies and programs.
- Behavioral shift: Training promotes a mindset of resource stewardship and systemic thinking, accelerating cultural change toward circularity.

D. PRIVATE SECTOR CASES

D.1. ALPARGATAS AND THE CIRCULAR ECONOMY: BUILDING THE RUBBER RECYCLING CHAIN

Company Overview

Alpargatas is a global company, founded and headquartered in Brazil for over 118 years. The company is committed to inspiring the world with incredible brands that bring lightness and joy to the daily lives of consumers.

With more than 11,000 employees*, it is a publicly traded company, with shares listed on the São Paulo Stock Exchange since 1913. Its operations are based and consolidated in Brazil, with four manufacturing plants, and it is also present in more than 100 countries, concentrating efforts in 15 priority markets.

Alpargatas owns the Havaianas brand, known for its flip-flops that have represented Brazilianness, comfort, and style since 1962. Today, there are more than 1,300 exclusive Havaianas stores worldwide – 860 in Brazil and 444 abroad.

Havaianas products are sold in more than 100 countries, with more than 350,000 points of sale in Brazil alone, always in partnership with distributors and wholesalers.

Initiative Description and Objectives

More than providing comfort and well-being for consumers who purchase its products, the company aims to inspire its customers and society to adopt sustainable practices that contribute to the conscious use of resources.

Considering this perspective and the characteristics of its business, “circular economy” is one of the three structural pillars of the company’s Sustainability Strategy, in addition to being one of the material themes validated from the perspective of its stakeholders in the last materiality review.

The company’s challenge with the circular economy is at the core of its flagship brand: Havaianas, known for its flip-flops. The primary raw material for the soles of Havaianas products is expanded rubber (SBR), whose circular chain is still in a very early stage of development.

Regarding waste from Havaianas' production, 90% is also related to rubber, considering, for example, scraps from the molding process, which are only partially reincorporated into production. Currently, what is not reused internally is directed externally, combining with what is collected through Havaianas reCICLO — Alpargatas' reverse logistics program developed to promote the flip-flops' circularity.

reCICLO was created in 2020. Since then, its management has accumulated numerous lessons learned and practice revisions, as, unlike materials like aluminum and PVC, the circular chain of rubber is not yet consolidated. For this reason, reCICLO mobilizes efforts from one end to the other to close this cycle — technically and financially.

Alpargatas aims for circular rubber to reach the status of a profitable, high-quality raw material, generating value for all involved parties. Initially, the program focused on collecting as many flip-flops as possible. After more than four years of work, the focus now reflects the complexity and enormous challenge of fully developing the rubber's circular chain and sustaining it.

Therefore, Alpargatas' involvement goes beyond collection and proper waste disposal; it actively works on the complete development of the chain: from collecting flip-flops at stores and recycling cooperatives via selective collection (which was previously unviable due to a lack of commercial interest in the material), to transforming them into new raw material and, later, into products sold on the market. In this way, the company is pioneering and innovating by building an ecosystem that creates technical and commercial value for rubber waste through partnerships and joint work with various actors involved in beneficiation and transformation, creating new products from flip-flops' rubber and boosting its business revenues. Additionally, developing this chain also allows for the disposal of industrial rubber waste (which was mainly sent for coprocessing with payment), signaling important environmental and decarbonization gains, while also opening up profitability opportunities for the company.

reCICLO operates in different countries, with over 400 collection points. In each context, Alpargatas seeks to structure the rubber circular chain ecosystem for Havaianas flip-flops, with different stages of development— Brazil being the focus country with more significant advances.

In the case presented, the evolution of Alpargatas' journey in circular economy practices, the established partnerships, launched products, and reCICLO results in Brazil will be showcased.

Scalable Emission Reduction Potential

It is well known that one of the main challenges for decarbonization — not only of this industry but of all industries — is increasing circularity in production, reducing dependence on virgin raw materials and the manufacturing process of these inputs. In this specific case, for example, virgin rubber emits 3kg of CO_2e per kg and currently accounts for over 37% of the supply chain emissions — a significant proportion that remains true for many supply chains using this input. Therefore, structuring, enabling, and sustaining a rubber recycling chain — the primary raw material for Alpargatas' product, the Havaianas flip-flops — is of utmost importance.

This approach not only addresses waste management from pre- and post-consumer products but also aims to achieve meaningful decarbonization results throughout the entire lifecycle.

From a technical perspective, analyzing the circular rubber chain, the large availability of waste and the lower energy intensity of recycling processes — compared to virgin rubber manufacturing — create a significant environmental benefit potential in the collection, residue beneficiation, and subsequent transformation into new products. Studies by the Royal Melbourne Institute of Technology in Australia, applied to rubber used in the tire industry (compressed SBR), show that rubber recycling reduces GHG emissions by 72% compared to other waste disposal methods such as coprocessing or landfilling (Tushar et al., 2022). Alpargatas (which uses a raw material very similar to that of the tire industry in its Havaianas flip-flops, expanded SBR) is conducting specific Life Cycle Analysis studies on its circular chain and the solutions developed within this context to calculate the actual emission savings.

Since this chain was not previously structured, years of process development and stakeholders 'engagement were necessary before it could begin measurement efforts — which are still underway but hold great potential. If you focus solely on industrial waste, between 2021 and 2024 — years during which Alpargatas invested in developing the rubber circular chain — the company increased the volume of waste sent

to recycling by 187%, compared to the waste generated, resulting in a 46.48% reduction in associated GHG emissions (since there was no disposal through coprocessing). Thus, by ensuring the extension of rubber's useful life through circularity, the company aims to directly focus on reducing environmental impact — including GHG emissions — generated by its production as well as waste and product disposal.

Innovation Presented

The circular chain of expanded rubber is still in its early stages. This is evidenced by the fact that Havaianas flip-flops did not have any commercial value for recycling cooperatives before the Havaianas reCICLO program. Even if they were destined for selective collection or collected by waste pickers, they would inevitably be discarded and end up in landfills.

For excess industrial rubber (which could not be reused in the process), the primary disposal method has always been coprocessing. The challenge, therefore, is to fully structure this recycling chain so that it can absorb these volumes and eventually supply part of the demand for virgin rubber as raw material. To this end, Alpargatas has invested in research and innovation (including open innovation), seeking out local partners and developing various solutions, in addition to providing support for market access and commercialization of the final products.

The core stages of this process today are: Collecting used flip-flops from collection bins at Havaianas stores and partner cooperatives, which perform sorting through selective collection; After collection, the material is beneficiated, transforming into new raw materials (granules, mats, and plates) that are sent to transformation partners responsible for converting them into new products. After significant joint development, the company currently works with three beneficiators and four transformators in the South, Southeast, and Northeast regions of Brazil.

It's important to emphasize that for this structure to be economically and environmentally viable, these entire ecosystems must be developed locally (primarily in Brazil, which is a large continental country).

Open innovation has greatly driven the development of Havaianas rubber recycling solutions through partnerships that enable co-creation, eco-development, and co-innovation. As a result, the investments and risks are shared, and cooperation accelerates the conception of long-term

solutions that are technically viable and commercially sustainable for all involved stakeholders. When prospecting for beneficiators and transformation partners, the assessment focuses on their work structure and interest in processing rubber (which requires investment and testing of the material in their processes), as well as technical and financial aspects. Once these feasibilities are confirmed, contracts, commercial agreements, and working routines are established to monitor growth strategies, ensuring mutual value creation.

To enable the chain, Alpargatas goes beyond partnerships with transformators; it fosters a potential market for the new products.

Initially, Alpargatas relied solely on active prospecting for partners. As initiatives and the portfolio of solutions grew, companies began proactively approaching the Havaianas team — such as Assa Abloy, which discovered the reCICLO program at partner stands at FEICON 2024, Latin America's largest construction and architecture fair, and proposed new partnership routes.

The solutions developed through the first quarter of 2025 were:

- Rodado Force Eco: a wheel for hand carts made with 85% post-consumer Havaianas rubber, developed by Grupo Force. It contains 2.3 kg of recycled raw material and lasts four times longer than a pneumatic tire. The product, showcased at FEICON 2024, is available for online purchase via Grupo Force, which has sold nearly 2,000 units since launch. In January 2025, Tramontina and Grupo Force announced an established partnership: the commercialization of the wheel made from industrial waste from Havaianas, which is widely sold in the domestic market.
- Havaianas reCICLO Color Mix Flooring Line: presented at FEICON 2024, developed by the Minas Gerais-based company Aubicon for environments like gyms. The flooring is made with over 90% raw material from post-consumer waste, with 5% coming from reCICLO. It's sold in "Peso Livre Evolution" (plates) and "Impact Roll" (rolls) formats. By the end of 2024, "Peso Livre Evolution" started being sold through Leroy Merlin's online platform. In addition to this line, Aubicon offers variations made from industrial rubber waste in more than three colors.
- Havaianas reCICLO Home Line: developed by Grupo Force and launched at FEICON 2025, it includes placemats, pot rests, and coasters, all 100% made with reCICLO rubber and sold online.
- Door Handles and Knobs Line: developed by São Paulo-based LaFonte, part of Assa Abloy, with coatings made from reCICLO rubber combined with metal bases. This solution was presented in March 2025 at Expo Revestir, Latin America's largest building materials event.

- Revoada REmix Line: bags, wallets, and other accessories developed by Revoada, a company specializing in corporate gifts. The products, already available for order since 2024, can be found in the partner's catalog. Other solutions are under development.

Implementation

Considering the significant volume of Havaianas sandals sold (more than 226 million pairs in 2024), Alpargatas recognizes its responsibility not only in the manufacturing and commercialization processes of its products but also in their use and post-use. In this context, at the end of 2020, the company launched its reverse logistics program, Havaianas reCICLO, aiming to extend the end-of-life cycle of its products and offering consumers the possibility of proper disposal of their flip-flops.

The program was initially created within an R&D structure (later managed by the commercial unit in Brazil, until it was fully absorbed by the Sustainability area). Its debut included the pilot implementation of the collection system in just 3 owned stores. In 2021, it was expanded its implementation to 8 more franchises, initiated partnerships with 3 cooperatives, and also tested the collection model in 9 residential condominiums.

Still that year, they identified that, although collection was taking place, the destination of the collected waste was becoming a challenge since there were no partners or structures willing to receive it. Then the company started a line of research and development focused on solutions for recycling expanded rubber.

In 2022, new collection models were tested, trying to increase the volume captured. Alpargatas partnered with 8 Casas Bahia stores while continuing to expand the coverage of owned stores, franchises, and cooperatives. As its engagement and development on the subject matured, the company realized that, beyond the need for post-consumer rubber solutions, the industrial processes also generated many scraps not reincorporated into the production cycle, and their destination also presented a great opportunity for improvement and mitigation. Thus, they initiated developments focused on industrial rubber.

In 2023, the expansion in stores and partnerships with cooperatives continued, seeking to broaden its reach. Additionally, a pilot was carried out in an Ecopark (an ecological and mechanized sorting center). Still

addressing the challenge started the previous year regarding industrial rubber, the company began developing new internal processes for valuing this material (involving controlling, fiscal flows, waste management operations, and grinding processes).

In 2024, the focus was on optimizing the collection structures already implemented to enhance volume and reduce costs (which had grown significantly in recent years). Furthermore, they started supplying residual raw materials with high added value and began finalizing the "go-to-market" processes for the circular solutions developed for post-consumer waste, together with its transforming partners. This way, the chain would start to sustain itself.

To drive and enhance this development, in 2024, the company invested BRL 1.4 million in the program's operation and in developing applications for circular raw materials with its partners.

Results

Over the last 4 years, Alpargatas invested in structuring a circular chain for rubber, covering and developing stages of 1. collection, 2. sorting and storage, 3. processing, 4. transformation, and 5. market access. In this context, the company measure part of the success through its public goal, which aims to guarantee the existence of a circular chain for Havaianas rubber, operating healthily, through two fronts: 1. Ensuring end-to-end recycling of 100% of the volume of Havaianas flip-flops returned through the reverse logistics program in Brazil, and 2. Ensuring end-to-end recycling of 100% of the volume of vulcanized rubber waste generated in factories. In 2024, 68.5% of this target was achieved. Some of the results are:

- In 2024, 68.5% health in the rubber recycling chain;
- 72% considering post-consumer waste (+12.5% compared to 2023);
- 65% considering industrial waste (+31% compared to 2023);
- 187% increase in the volume of industrial waste destined for the circular rubber chain after 4 years of investment and development (2021 to 2024);
- 218% growth in the price per kilo of industrial rubber waste, from 2021 to 2024;
- 869% increase in revenue from the sale of industrial rubber waste. In the last year, from 2023 to 2024, this indicator doubled, increasing by 116%;

- 46.48% reduction in tCO_2e emissions associated with the category;
- From the perspective of Havaianas reCICLO – company's reverse logistics arm, the program has already collected more than 337,000 pairs of flip-flops, equivalent to around 118 tons of waste and 4.2 full Maracanã stadiums of fans wearing Havaianas;
- By extending the lifespan of rubber through circularity, used flip-flops, which previously had no technical or commercial value, are reincorporated into new chains, gradually reducing their disposal in landfills or inappropriate locations;
- From 2021 to 2024, they increased from 1% to 41% the number of Havaianas stores with the reverse logistics program in Brazil;
- The collection volume via Brazilian stores grew 102% in just one year (2023 to 2024), accompanied by growth of 38% in cooperatives and 128% in the partner Ecopark (technological and mechanized sorting center);
- Globally, there was an increase of 147,000 pairs of flip-flops collected (+44% compared to 2023), 95% of them in Brazil;
- All new stores and those undergoing renovations will already include the collection bins as fixed furniture;
- There are already 200 monobrand stores (owned and franchised) in 25 Brazilian states engaged in reverse logistics.

In addition to the direct environmental gain, it is also worth recognizing the advancement in income generation for the people involved in the sorting and waste sales stages. Today there are 76 cooperative partners of Havaianas reCICLO, located in 13 states across the South, Southeast, Midwest, North, and Northeast regions of Brazil. Since the beginning of the program, cooperatives have contributed to collecting more than 200,000 pairs of flip-flops. In 2024 alone, there was a 38% increase in collection through this entry point compared to 2023, benefiting 3,582 cooperative families working in this process. This amount currently represents 75% of the total volume collected, compared to 25% collected in brand stores.

Key Takeaways

The initiative is directly connected to Priority 2 - Recommendation 4 of the Circular Economy and Materials Work Group, presented in this document, considering that it presents technology for recycling and reusing the materials.

D.2. AMBIPAR CIRCULAR CITIES: INTEGRATED SOLUTIONS FOR URBAN CIRCULARITY

Company Overview

Ambipar is a Brazilian multinational company operating in the environmental management and sustainability industry, with a global presence in over 40 countries across the Americas, Europe, Africa, and Asia, with more than 600 operational sites and with more than 23,000 employees worldwide. The company provides services of integrated solutions for waste management, environmental emergencies, logistics, and circular economy initiatives.

Ambipar supports industries, governments, and communities in addressing environmental challenges, delivering sustainable solutions that generate positive environmental, social, and economic impacts, while contributing to the global transition toward a low-carbon and circular economy.

The company's mission is to contribute to making companies and society sustainable, preserving the world for future generations.

Initiative Description and Objectives

Ambipar's Circular Cities initiative is designed to enable low-carbon urban circular ecosystems by promoting territorial arrangements that integrate reverse logistics, traceability, certification, local value chains, and social inclusion. The program focuses on strengthening selective collection, empowering recycling cooperatives, professionalizing waste sorting centers, and connecting municipalities, businesses, and citizens in a shared model for circular economy. Its main objective is to reduce landfill dependency, recover valuable materials, and generate inclusive socio-environmental benefits across urban areas.

It is designed to establish a systemic and scalable model of urban circularity that combines economic efficiency, environmental stewardship, and social inclusion. Moving beyond isolated actions, the program delivers an integrated platform that connects selective collection systems, recycling centers, condominium solutions, reverse vending machines, traceability tools, and large-scale public education initiatives.

The initiative also aims to professionalize recycling cooperatives, transforming them into structured social partners through capacity-building, governance support, and income-generation mechanisms that enhance their integration into the formal economy. By engaging municipalities, companies, large-scale waste generators, and citizens, the model strengthens local value chains, is aligned with Brazil's National Solid Waste Policy (PNRS), and contributes to the advancement of the Sustainable Development Goals and the Paris Agreement.

Ultimately, the project objective is to present a territorial arrangement that enables the transition to circularity to be not only technologically advanced and environmentally effective but also fair, inclusive, and aligned with the global demand for urgent climate action.

Scalable Emission Reduction Potential

The Circular Cities model demonstrates its capacity for scalable emission reduction. By integrating selective collection systems, cooperative partnerships, and digital traceability, the initiative diverts recyclable materials from landfills, preventing methane emissions and reducing the demand for virgin raw materials. Since its implementation, it has recovered over 263,000 tons of recyclables and avoided more than 140,000 tons of CO_2 emissions, delivering measurable and verifiable benefits.

Its modular design allows replication across municipalities of all sizes - from small towns through inter-municipal consortia to large metropolitan areas - as well as within corporate and residential complexes. When implemented by multiple companies and public authorities, the model can drive systemic decarbonization of urban waste management by simultaneously mitigating methane emissions from landfills and reducing CO_2 through recycling and material substitution.

By linking cooperatives, municipalities, and corporate value chains, the initiative also addresses Scope 3 emissions across sectors, fostering shared responsibility for circularity. This systemic approach not only generates socio-environmental value but also contributes directly to the Paris Agreement targets by scaling measurable emission reductions and embedding low-carbon practices into urban and industrial ecosystems.

Innovation Presented

The initiative introduces a pioneering model by structuring waste sorting centers into Social Partnerships with governance and productivity frameworks, supported by traceability systems and blockchain-based recycling credits. This closes the implementation gap in urban circularity by combining social inclusion, technology, and financial mechanisms to professionalize informal recycling networks, expand capacity, and ensure transparency and credibility of results.

The Circular Cities initiative delivers an important integration of technology, infrastructure, and social innovation within post-consumption management. By combining blockchain-based traceability, geolocation-enabled smart routing, and electronic invoicing with physical infrastructure such as recycling hubs, reverse vending machines, and condominium collection systems, it creates a transparent and auditable circular value chain.

Its innovation also resides in the social partnership model, which formalizes waste picker cooperatives through governance support, training, and income-generation mechanisms. This hybrid approach aims to transform previously informal and fragmented practices into a structured, market-oriented system that generates certified recycling and carbon credits.

By embedding social inclusion and climate action within a single scalable framework, Ambipar aims to bridge the gap between regulatory requirements and the tangible, traceable delivery of circular economy outcomes.

Implementation

The program follows a structured, multi-step process for implementation in each city:

1. Regional diagnosis and mapping of waste flows;
2. Creation of working groups with public and private stakeholders;
3. Training and capacity-building for municipalities and cooperatives;
4. Implementation of selective collection infrastructure and logistics;
5. Professionalization and social franchising of cooperatives;
6. Deployment of smart collection routes using geotechnology to reduce fuel use;
7. Integration of recycling credits and certification systems;
8. Continuous monitoring of socio-environmental indicators.

Investments range from approximately US$ 70,000 for small units to US$ 110,000 for larger centers, with a total budget exceeding BRL 11 million since 2020.

Challenges such as limited public engagement, regulatory uncertainties, and volatile recycling markets were mitigated through partnerships, training, and social technologies that strengthen resilience and inclusiveness.

Results

Since 2015, more than 263,000 tons of recyclable materials have been recovered and reintegrated into industrial supply chains, avoiding over 140,000 tons of CO_2 emissions through landfill diversion and certified recycling credits. The program has supported 247 sorting centers across 120 cities, strengthened 115 cooperatives, and trained and qualified more than 4,000 workers, increasing cooperative members' income by an average of 20.7%.

In addition, the initiative has redirected over BRL 25 million in material value to cooperatives, engaged 121 corporate partners, and deployed 466 reverse vending machines and six social warehouses, with three more under development. More than 1,244 training sessions have been delivered, and structured selective collection has been implemented in over 1,000 housing complexes and educational programs have reached more than 500,000 residents, fostering awareness and behavioral change.

These achievements indicate that the initiative is technically and financially viable, and a transformative model that integrates climate action, circular economy, and social inclusion at scale. Moreover, this model is ready to be replicated across Brazil and internationally, offering a meaningful contribution to addressing some of the key challenges of circularity: logistics, infrastructure, and the social inclusion and development of the workforce.

Key Takeaways

The initiative is connected to Priority 2 - Recommendation 3 and 4 of the Circular Economy and Materials Work Group, presented in this document, considering the collaborative model between different actors and the use of new technologies. And it is also connected to Priority 3 – Recommendation 3, that presents the importance of training of people engaged in circularity practices.

D.3. XLABS: A PROVEN EDTECH PLATFORM ACCELERATING PRIVATE SECTOR CAPABILITY AND CROSS-SECTOR COALITIONS TO DELIVER CIRCULAR MATERIALS INNOVATION FROM DESIGN TO IMPLEMENTATION

Company Overview

Circularity is a circular economy strategy consultancy. It was founded by Louise Nash as part of a Master of Technological Futures from the AcademyX Institute and works to help businesses unlock new value and solve environmental challenges by becoming Circular by Design.

As an impact-driven organisation, Circularity acts on a deep-rooted belief that environmental impact can be designed out and its mission is to radically redesign business for a more resilient and regenerative future.

The organisation work aim to activate circularity across the ecosystems using a design-thinking process to discover, define, design and deliver outcomes for business, communities and the planet.

Initiative Description and Objectives

XLabs takes place in New Zealand, it builds business capability and creates space for collaboration to identify, design, prototype, test and implement circular economy solutions that transform material systems at speed and scale.

The initiative was designed and created by 2019 and 2020 and it was the result of the growing urgency to embed these principles to radically redesign business for a resilient, regenerative future.

Through XLabs business may collaborate to each other and implement solutions in a structured manner.

XLabs delivers circular solutions within 12 months through early partner engagement, a design-led process, facilitated sprints, and clear milestones, leveraging AI tools and expert guidance for rapid, scalable, and accountable impact. For the example, deliver the program over 4.5 years in New Zealand with participation of over 350 businesses, 88% implement their solutions within 6-12 months.

The XLabs funding is from both government funding/grants, industry association investment and businesses participating.

Scalable Emission Reduction Potential

With an average 53% increase in material circularity and 88% of companies implementing solutions within 12 months, XLabs is a proven, fast, and replicable model to reduce emissions and resource extraction across industries in line with Paris goals. The CO_2 impact has been rigorously quantified as up to 75% lower carbon footprint compared to the global average of stainless steel, leading to an estimated reduction of approximately 10 million tonnes of CO_2e annually from customers' emissions.

Until now, the estimated CO_2 avoided emissions by maintaining 1 million tonnes of materials in flow amount to approximately 1.7 to 3.5 million tonnes of CO_2e avoided (average CO_2e savings according to global lifecycle data US EPA WARM).

Innovation Presented

XLabs uses its proprietary "Circular by Design" method, validated through a Master's in Tech Futures, including the steps of Smart Materials , Regenerative Behaviours, Circular Business Models, Networked Participation, Embedded Intelligence, Closed Loop Systems.

Through its six transformative methods, immersive sprints, expert workshops, and prototyping, it helps businesses shift effectively from linear to circular.

The program is designed to guide participants through these proprietary methods over a series of workshops – to experiment, imagine and design new solutions to their real-world challenges. Accelerating innovation for a more resilient future.

At the heart of the work there is an innovation toolkit designed to unlock a regenerative mindset. This toolkit guides businesses to explore, ideate, prototype and implement solutions to systemic problems. Delivered as the key artifact of its founders Masters of Technological Futures, the Circular by Design methods were shaped by over 250 interviews with leading circular experts and over 1,000 case studies of circular innovations. Turning in-depth industry knowledge and circular thinking into actionable innovation.

Implementation

The implementation of the initiative includes the following steps:

1. Design, write and create the XLabs circular economy program - 01/07/2019 - 01/11/2020 - Completed;
2. Deliver the program over 4.5 years in New Zealand with participation of over 350 businesses, 88% implement their solutions within 6-12 months. - 01/12/2020 - 01/07/2025 - Completed;
3. Take it Global: In new regions, confirm local funding, pricing, partners and venue for LIVE sessions. - 02/11/2025 - 19/12/2025 - Not Completed;
4. Co-Design Program with partners - 12/01/2026 - 09/02/2026 - Not Completed;
5. Launch and onboard teams from participating organizations alongside experts - 10/02/2026 - 10/04/2026 - Not Completed;
6. XLabs Learn online course opens - 01/05/2026 - 22/06/2026 - Not Completed;
7. XLabs LIVE 5-day design sprint culminating in a live pitch - 06/07/2026 - 10/07/2026 - Not Completed;
8. XLabs Coach - 6 months from concept to implementation - 13/07/2026 - 15/01/2027 - Not Completed;
9. Sharing the stories - video case studies and PR - 09/09/2026 - 21/05/2027 - Not Completed;
10. Repeat and launch Y2, then Y3, building the momentum and partners across industries and priority sectors building a community of a wide cross section of businesses implementing circular economy solutions - 01/02/2027 - 29/12/2028 - Not Completed.

The planned budget of this initiative was US$ 1,000,000 and so far, the realized budget is US$ 1,500,000.

Results

The initiative drives private sector profit by cutting waste and costs via scalable circular solutions. With 53% material circularity gains and low digital delivery costs, participants and funders see positive returns within 1–3 years.

The main results identified are the following

- 88% of XLabs participants implemented circular solutions in 6–12 months, raising material circularity by 53% and scaling capability across 351 organizations, 80,000 staff and $20B in revenue;
- 90% of participants came away from the program with a better understanding of what the circular economy is and felt confident they could apply it to their jobs;
- 87% were very satisfied with the program with a net promoter score of 50 (over 30 is considered excellent);
- Average increase in circular material flows from circular solutions implemented of 53%;
- 60 circular solutions have been co-designed to date by participants in the XLabs program: 22 focused on materials that regenerate living systems, such as growing methods, food waste prevention, forestry, soil and bioeconomy and 38 for technical solutions in plastics, renewable energy, transportation, textiles, and building materials;
- To date, 1 million tonnes of resources have been kept out of landfill and the environment through the circular solutions at Xlabs;

Key Takeaways

The initiative is directly connected to Priority 2 - Recommendation 3 of the Circular Economy and Materials Work Group, presented in this document, considering that it aims to enable collaboration and synergies among multiple organizations, and includes innovative and disruptive solutions for transforming linear business models into circular ones.

D.4. CIRKLO: SCALING BRAZIL'S LARGEST PET BOTTLE-TO-BOTTLE RECYCLING PLATFORM

Company Overview

Cirklo is the largest independent PET bottle-to-bottle recycler in Brazil, created by the merger of Green PCR and Global PET. With operations in São Paulo, Paraíba, Alagoas and Pará, the company combines cutting-edge technology and a robust collection network of suppliers to produce high-quality, food-grade recycled PET (rPET).

Supported by impact-driven private equity firm eB Capital and international investor Circulate Capital, Cirklo employs over 450 people and generated approximately R$ 800 million in revenue in 2024.

Its mission is to accelerate circularity in Brazil by transforming post-consumer PET into a sustainable resource for the beverage and packaging industries.

Initiative Description and Objectives

The initiative aims to build the largest bottle-to-bottle recycling platform in Brazil, capable of processing over 5.5 billion bottles annually. Investments have been directed into state-of-the-art equipment - such as laser sorters and nitrogen atmosphere reactors - and a nationwide sourcing strategy through collection hubs and partnerships with cooperatives.

Objectives include: (i) scaling high-quality rPET production, (ii) reducing GHG emissions by substituting virgin resin, (iii) promoting inclusive employment for waste pickers, under socioeconomic challenging conditions, and (iv) supporting compliance with Brazil's National Solid Waste Policy.

Scalable Emission Reduction Potential

If adopted by multiple companies, this model could drive systemic changes in packaging circularity.

At full capacity, Cirklo's operations are expected to avoid up to 148,000 tons of CO_2e annually, equivalent to taking 32,000 cars off the road for an

entire year, while ensuring compliance with the Paris Agreement targets. By scaling inclusive sourcing networks and recycled-content adoption, the model can be replicated globally to reduce dependency on virgin plastic and lower lifecycle emissions across industries.

Innovation Presented

Cirklo pioneers a new standard for rPET in Brazil by incorporating internationally benchmarked technologies - such as precision laser sorters and nitrogen-based reactors - delivering resins that meet the most demanding food-grade standards. As a result, Cirklo produces recycled resin capable of manufacturing bottles with properties virtually identical to those made from virgin resin. Beyond technology, its approach innovates by combining industrial-scale recycling with inclusive socioeconomic impact: integrating over 85,000 waste pickers through cooperatives and scrap yards into its value chain. This dual focus on quality and inclusivity closes Brazil's implementation gap in recycling at scale.

Implementation

The implementation of the initiative included the following key steps:

1. Acquisition of plants;
2. Procurement and installation of advanced equipment;
3. Ramp-up of production capacity;
4. Development of a proprietary collection hub network.

The collection infrastructure is still under development, with the first hubs expected to launch in 2025.

The project required an estimated USD 37 million in equity and debt financing.

Challenges such as feedstock access and price competitiveness against

virgin resin were addressed through partnerships, M&A of sourcing operations, and advocacy for regulatory incentives like recycled-content mandates. Implementation started in 2022 and is expected to achieve full scale by 2027.

Results

Cirklo has already established itself as a transformative force in Brazil's recycling landscape. In 2024 alone, the company produced approximately 65,000 tons of high-quality rPET, directly avoiding 84,000 tons of CO_2e emissions.

With its current trajectory, Cirklo is on track to surpass R$ 1 billion in revenue by 2027, while consolidating its leadership in food-grade recycled resins that can replace virgin PET without compromising performance.

On the social front, Cirklo employs more than 450 people and positively impacts on the livelihoods of over 85,000 waste pickers through partnerships with 39 cooperatives and 78 scrap yards. By 2027, this reach is expected to expand to more than 150,000 individuals, driving inclusive growth in one of Brazil's most vulnerable labor segments.

From a circularity perspective, Cirklo is pioneering a proprietary collection hub network that will secure traceable, large-scale feedstock and provide up to 4,000 tons of PET per month by 2027. With this integrated model Cirklo aims to be the cornerstone of Brazil's bottle-to-bottle recycling ecosystem - proving that sustainability, economic returns, and social inclusion can advance hand in hand.

Key Takeaways

The initiative is connected to Priority 2 - Recommendation 4 of the Circular Economy and Materials Work Group, presented in this document, considering the use of new technologies. And it is also connected to Priority 3 – Recommendation 3, that presents the importance of engaging the cooperatives.

D.5. CPFL SOLUTIONS REFORMER: EXPANDING SOLUTIONS IN THE CIRCULAR ECONOMY VIA ELECTRICAL ENERGY EQUIPMENT REFURBISHMENT

Company Overview

CPFL is a Brazilian company with more than 112 years of experience in the power sector, contributing to the country's economic progress and to the well-being of millions of citizens. Its business is diversified, covering all segments: generation, transmission, distribution, and solutions for customers. It is one of the largest companies in Brazil in terms of net revenue.

The company mission is:

> "We provide sustainable, accessible and reliable energy to all walks of life, and enhance a safer, healthier and prosperous life of people in regions where we operate.
>
> We propel our business growth in a more strategic and competitive way, keep its dynamics and vitality, and create a more standardized, diversified and international corporate culture, while nurturing its legacy.
>
> We protect the level playing field for each employee's growth and attract all talents to join CPFL."

CPFL's ability to execute and manage electric energy assets was further strengthened by State Grid Corporation of China's arrival in Brazil. The Chinese group is the company's majority shareholder and is the driver behind the integration of the most advanced technologies in the electric energy sector, which boosts the operational efficiency of all businesses.

CPFL Renováveis is the main vector for growth on renewable energy of CPFL' generation segment. Its portfolio currently comprises approximately 4 GW of installed capacity: 8 HPP; 49 wind farms; 47 small and micro hydroelectric power plants (SHPPs and MHPPs); 4 biomass-powered plants; 1 solar plant

CPFL is the largest company in the electricity distribution segment in terms of the amount of energy sold, with a 13% share of the national market. It has four companies operating in the states of São Paulo and Rio Grande do Sul, Minas Gerais and Paraná, in a concession area covering 687 municipalities, serving some 10.5 million clients. In 2024, it distributed 72.897 TWh of energy in its concession areas, an increase of 4.2% on energy sales.

CPFL Soluções (CPFL Brasil + CPFL Serviços) is dedicated to supplying integrated solutions to modernize, provide more efficiency, and optimize customer relations with electric power, creating savings and better performance. Teams of specialists act on a variety of fronts, with consulting, planning, management, sales, infrastructure projects and provision of renewable energy certificates. With over 2.1 thousand customers served throughout Brazil, CPFL's main products/services are:

- Power management: Specialized advice for energy management & savings.
- Electrical maintenance: Customized plans for preventive, predictive and corrective maintenance, aiming for greater efficiency and savings.
- Energy efficiency: Customized solutions that enable greater efficiency & profitability.
- Free energy market: Complete support in the selection of energy suppliers and negotiation of supply conditions, price and contractual terms.
- Energy infrastructure: Diagnosis and solutions for executing construction, O&M projects, as well as retrofitting electrical installations.
- Decarbonization: Commercialization of carbon credits & renewable energy certificates (I-RECs) to promote more sustainable production chains.
- Solar energy for companies: Projects for self-generation of clean and renewable electrical energy.

Initiative Description and Objectives

The Equipment Refurbishment Unit, managed by CPFL Serviços and located in São José do Rio Pardo (SP), Brazil, is a key initiative grounded in circular economy principles. The facility specializes in refurbishing distribution transformers (from 5 kVA to 500 kVA), voltage regulators, and reclosers,

enabling their reintegration into electrical distribution networks. In addition, since 2023, there is a Pole Recycling process at this site, in which the crushing activity enables to recycle 1,000 pieces per month by selling gravel to construction operations and steel for steelmaking industry.

Its core objectives are:

- Extend the lifespan of electrical equipment;
- Reduce greenhouse gas emissions by minimizing the demand for virgin raw materials;
- Avoid landfill disposal of used equipment;
- Promote reverse logistics and material circularity across the electrical sector;
- Generate revenue and employment, contributing to local economic development;
- Comply with ESG commitments, including reforming at least 70,000 pieces of equipment by 2030 (Commitment 10) and ensuring 100% reverse logistics for network components (Commitment 11).

Scalable Emission Reduction Potential

The initiative has strong scalability potential and can significantly contribute to emission reductions aligned with the Paris Agreement. Through life cycle assessments (LCAs), it is confirmed that most of a transformer's carbon footprint originates from raw material extraction and processing. This is consistent with other references that estimate 84% of transformer emissions come from raw material phases.

By refurbishing used transformers and utilizing recycled components (such as regenerated insulating oil and reindustrialized copper), the Refurbishment Unit avoids the need for new production, thereby:

• Reducing Scope 3 emissions related to material procurement;

• Significantly lowering embodied carbon in equipment;

• Offering a model that can be replicated by other utilities globally, especially where waste from electrical infrastructure is abundant.

Innovation Presented

This initiative is pioneering in the Brazilian power sector, introducing:

- A fully integrated circular system for electrical equipment, including testing, recovery, refurbishment, and recycling;
- An in-house lab certified under ISO 17025, which performs individual analysis of equipment oil for PCB (polychlorinated biphenyls), ensuring environmentally sound handling and disposal;
- In-house regeneration of insulating oil, achieving self-sufficiency with a capacity of 300,000 liters/month, improving agility and cutting environmental impacts;
- Use of reindustrialized copper for transformer windings, reducing material costs by up to 80% compared to new wire purchases;
- Consolidation of crushing units for cables, insulators, and meters allowed for the recovery of 267 tons of aluminum, 223 tons of copper, 187 tons of iron, and 24 tons of HDPE in 2024;

A facility that can crush 1,000 poles per month, generating in 2024 more than 30 tons of metal and 2,39cubic meters of graves.

The innovation lies not only in technical efficiency but in aligning economic value generation with environmental stewardship.

Implementation

The implementation of the Refurbishing Facility included the following steps:

1. Establishment of a state-of-the-art refurbishment center in São José do Rio Pardo (SP);
2. Acquisition of advanced equipment and certification under ISO 9001, ISO 14001, ISO 17025, and Inmetro standards;
3. Development of a trained workforce, currently at 318 direct employees, with expansion to include oil regeneration and materials recovery;
4. Engagement with suppliers through a pilot project to assess the carbon footprint of purchased materials and equipment;
5. Establishment of reverse logistics systems with regional operational bases to collect, sort, and transport equipment;
6. Integration with CPFL Soluções and CPFL Distribuidoras to ensure alignment across operations.

The planned budget of this initiative was BRL 100,000 and so far it was the realized.

Challenges included managing hazardous materials (e.g., PCB) and ensuring traceability and quality, which were addressed through laboratory testing, standardized processes, and regulatory compliance.

Results

The "Reformadora" has demonstrated tangible environmental, social, and financial outcomes, including:

- GHG and Resource Impact:
  - Over 40,000 refurbished equipment by 2024;
  - 38,200 refurbished units between 2022 and June 2025, including 10,000 in 2024 and 4,700 in first semester of 2025;
  - Avoidance of emissions associated with virgin raw material use;
  - 100% of components from non-recoverable equipment directed to reverse logistics or recycling in 2024 and first quarter of 2025;
  - 640 tons of monthly waste treated across São Paulo and Rio Grande do Sul units.
- Circular Economy Metrics:
  - Refurbished 9,876 equipment in 2024 alone, recovering 267 tons of aluminum, 223 tons of copper, 187 tons of iron and 24 tons of HDPE.
  - 5,500 crushed utility poles in 2024, generating:
- 30,000 kg/month of recycled metal (BRL 530,000 in revenue);
- 2,390 m^3 of recycled gravel (BRL 30,000 in revenue);
  - 300,000 liters/month of capacity to regenerate mineral insulating oil;
  - Recovery of high-value materials from dismantled equipment;
  - Use of regenerated oil and reindustrialized copper in refurbished products.
- Financial Performance:
  - Refurbishing Facility generated BRL 45 million in revenue in 2024;
- Cost savings of up to 80% on materials through recycling and reuse
  - Pole Crushing Process has generated BRL 560 thousand in revenue in 2024.

- Social Impact:
  - Creation of over 318 direct jobs in São José do Rio Pardo;
  - Compliance with environmental and quality certifications without nonconformities.

Additionally, the certifications ISO 9001, ISO 14001, ISO 17025 and Inmetro Label were achieved by the Refurbishing Unit.

CPFL considers that this initiative is a scalable, innovative, and replicable model for emission reduction, waste minimization, and value generation in the utility sector.

Key Takeaways

The initiative is directly connected to Priority 2 - Recommendation 4 of the Circular Economy and Materials Work Group, presented in this document, considering that it presents technology for repairing and refurbishment that may be applicable to other companies.

D.6. REMANUFACTURING - TOO GOOD TO BE REPLACED!

Company Overview

SKF was founded in 1907. It is a Swedish company represented in around 130 countries, with more than 38,000 employees and 17,000 distributor locations worldwide.

SKF's solutions may be used, wherever there is movement. Less friction. More progress.

The company makes some of the world's most innovative products and solutions to reduce friction. SKF understands that less friction means more energy saved. And it can help society to move forward to a more energy-efficient future, and to do more with less.

Initiative Description and Objectives

Too good to be replaced. Under the message that "You don't throw out a classic. You bring it back. Better", with the SKF Remanufacturing initiative, bearings perform like new ones at a lower cost, shorter lead time, and manufacturing CO_2 footprint. It allows the company to have the same product, with the same standards, and no shortcuts.

With over 25 years of remanufacturing experience, over 20 specialized centers worldwide, and a track record of reducing over millions of kilograms of CO_2, SKF makes remanufacturing work globally.

Scalable Emission Reduction Potential

The potential for CO_2 avoidance is up to 90% as the bearing material, of which the steel, is the largest contributor to the carbon footprint of its products.

The Remanufacturing approach could virtually be applied by any steel component manufacturer in the industry, as long as the component hasn't run to failure.

When more companies apply circular practices like this, and instead of buying virgin material use existing, sometimes discarded products as "feed stock", it has the potential of resource efficiency and reduced emissions.

SKF quoted the Ellen MacArthur Foundation as saying that “To achieve net-zero by 2050, we need to address the way we make and use products, materials, and food. A circular economy is essential to tackle the remaining 45% of global greenhouse gas emissions that the energy transition alone cannot address”.

Innovation Presented

The remanufacturing operation used to be like a workshop, manual processes and one-piece handling. It was far from the optimized and automated linear manufacturing of new bearings in the rest of its global footprint.

Now SKF is applying the same extensive experience and expertise in material, R&D, inspection and automation of the manufacturing processes to the remanufacturing operations. turning the workshops into factories. Further the process experts are developing new optimized methodologies adapted to the unique needs of the reverse one-piece flow such as new robotic handling tools for honing.

Implementation

The implementation of the initiative includes the following steps:

1. Remanufacturing operations established - 09/1997 - 03/2024 – Completed
2. Redefined strategy for growth - 01/2024 - 09/2024 – Completed
3. Market evaluation and business plan. - 09/2025 - 06/2026 - Not Completed
4. Improved Remanufacturing operations with expanded footprint established. - 03/2024 - 12/2026 - Not Completed
5. Resources trained in the full value chain. - 07/2025 - 06/2026 - Not Completed
6. Go to market strategy per region agreed. - 09/2025 - 11/2025 - Not Completed
7. Awareness campaign development including marketing material. - 04/2025 - 09/2025 – Completed

Many challenges are found such as: general maturity of the market / hesitance to buy “used products”; customers need to be trained in how to dismantle more carefully and the company also needs separate return procedures; There are obstacles with customs / paper handling sending products cross border and in general the reverse logistics has been a challenge to avoid one-piece flow; The company needs adapted digital support / order handling process as the traditional ERP only support the traditional linear production.

SKF is now starting to engage its Distribution network to bundle volumes.

The planned budget of this initiative was US$ 10,000,000 and so far, the realized budget is US$ 3,500,000.

Results

In 2024 approximately 4,500,000 kg of steel was reused, globally. With a global SKF CO_2e emission’s average of 3.6 kg CO_2e per kg of new bearing and CO2e emission’s average of 0.135 kg CO2e for the ReMan (Remanufacturing) operations. Which resulted in 15,600,000 kg CO2e avoided.

In addition to the results related to climate change, positive side effects were identified such as: Increase of the reliance on non-virgin material; Reduction of the costs for the company and for its customers; Reduction of the lead time and risk of standstill for end users; Increase of the employee’s motivation to contribute to a better tomorrow; Maintenance of jobs of the employees, besides the reduction of production of new large sized bearings.

Key Takeaways

The initiative is directly connected to Priority 2 - Recommendation 4 of the Circular Economy and Materials Work Group, presented in this document, considering that it presents technology for repairing and remanufacturing that may be applicable to other companies.

REFERENCES

- International Organization for Standardization. (2024). ISO 59000: Circular economy – Vocabulary, principles and guidance for implementation.
- Circle Economy Foundation. (2025). Circularity Gap Report 2025.
- International Finance Corporation. (2025). Harmonized Circular Economy Finance Guidelines.
- Royal Melbourne Institute of Technology. (2022). Studies on rubber recycling. Journal of Sustainable Materials Management.
- British Standards Institution & University of Cambridge Institute for Sustainability Leadership. (2025). The Tipping Point: Building Trust in the Circular Economy.

ANNEXES

ANNEX A – ACRONYMS

ACEA	African Circular Economy Alliance
AI	Artificial Intelligence
BSI	British Standards Institution
CBAM	Carbon Border Adjustment Mechanism (EU)
CORFO	Chilean Economic Development Agency
CO_2	Carbon Dioxide
BF-BOF	Blast Furnace – Basic Oxygen Furnace
CCU	Carbon Capture and Utilization
DDC	Distributed District Cooling
DPP	Digital Product Passport
EAF	Electric Arc Furnace
EIB	European Investment Bank
ENEC	National Circular Economy Strategy
EPR	Extended Procucer Responsibility
ESG	Environmental, Social and Governance
ESPR	Ecodesign for Sustainable Products Regulation (EU)
EU	European Union
EV	Electric Vehicle
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HVAC	Heating, Ventilation and Air Conditioning
IFC	International Finance Corporation
IMA	International Materials Agency
ISO	International Organization for Standardization
KCIC	Kenya Climate Innovation Center
MWh	Megawatt-hour
NCEP	National Circular Economy Programme (Netherlands)
NDC	National Determined Contributions
NGO	Non-Governmental Organization
OEM	Original Equipment Manufacturer

R&D	Research and Development
PNEC	Plano Nacional de Economia Circular (National Circular Economy Plan, Brazil)
SENAI	Serviço Nacional de Aprendizagem Social (National Servide for Industrial Training, Brazil)
SMEs	Small and Medium-sized Enterprises
TVET	Technical and Vocational Education and Training
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Counsil for Sustainable Development

ANNEX B – COMPOSITION AND MEETING SCHEDULE

Distribution of Members by country

Brazil	29
Argentina	1
Belgium	1
Colombia	2
Estonia	1
Finland	2
Germany	1
India	1
Italy	1
Japan	1
Latvia	1
Netherlands	1
New Zealand	2
Paraguay	1
Rwanda	1
Spain	2
Sweden	2
Switzerland	1
Thailand	1
United States of America	1
Uruguay	1

Distribution of Members by gender

Male	33
Female	121

Task Force Chair

Name	Organization	Position	Country
Tercio Borlenghi Junior	Ambipar	CEO and Co-founder	Brazil

Task Force Deputy Chairs

Name	Organization	Position	Country
Patrícia Iglecias	Ambipar | USP	Counselor l Chief Sustainability Officer (CSO)	Brazil
Roberto Azevêdo	Ambipar	Global Chief Operating Officer (Global COO).	Brazil

Task Force Co-Chairs

Name	Organization	Position	Country
Ligia Camargo	Heineken	Director of Sustainability, Brazil	Brazil
Juliana Marra	Unilever	Director of Corporate Affairs, Communications, and Sustainability	Brazil
Luciana Staciarini Batista	The Coca-Cola Company	President, Brazil and South Cone	Brazil
Brenda Rühle	Tetra Pak	Director Corporate & Government Affairs	Brazil
Anthony Watanabe	Indorama Ventures	Chair of ESBN Task Force on Circular Economy & Chief Sustainability Officer	Thailand

Task Force PMO

Name	Organization	Position	Country
Lisa Lieberbaum	GSS	PMO GSS	Brazil
Carolyne Caetano Gonçalves	GSS	PMO GSS	Brazil
Cecilia Michellis	GSS	PMO GSS	Brazil
Francine Hakim Leal	GSS	PMO GSS	Brazil

Task Force CNI Focal Point

Name	Organization	Position	Country
Larissa Malta	CNI	Policies and Industry Analyst	Brazil

Task Force Members

Name	Organization	Position	Country
João Zeni	Electrolux	Director of Sustainability at Electrolux for Latin America	Brazil
Francisco Razzolini	Klabin	Executive Director of Sustainability, Innovation, and R&D&I	Brazil
Harald Tepper	Philips	Sustainability Director	Netherlands
Vinicius Patel	Porto do Açu	Director of Operations	Brazil
Leonardo Bia	Novo Nordisk	Vice President of Corporate Affairs and Sustainability	Brazil
Adriano Scarpa Tonaco	Indústria Brasileira de Árvores l IBÁ	Climate Change Manager	Brazil
Sarah Bonadio	Alpargatas	Global Director Corporate Affairs & Sustainability	Brazil
Luiz Gustavo Leal Machado Talarico	Ambev	Sustainability Director	Brazil
Jorge Soto	Braskem	Sustainability Director	Brazil
Malin Pettersson-Beckeman	IKEA Group	Head of Sustainability Partnerships & Engagement	Sweden
Samantha Walmsley-Bartlett	Circularity	Global Circularity Strategist	New Zealand
Jason Weller	JBS	Global Chief sustainability officer	United States
Carla Klein	Saint-Gobain	Sustainability Manager Latam	Brazil
Cristina Riestra	Spanish Confederation of Employers and Industries	Deputy Director of Industry, Energy, Environment, and Climate	Spain
Filip Rosengren	SKF	Global Head of Sustainability	Sweden
Heidi Peltonen	Outokumpu	Vice President, Sustainability	Finland
Sabīna Alta	Laflora Ltd	Development Director	Latvia
Kai Realo	Ragn-Sells	CEO	Estonia

Fábio Brasiliano	Associação Brasileira da Indústria de Higiene Pessoal, Perfumaria e Cosméticos l ABIHPEC	Director of Sustainable Development	Brazil
Yaroslav Memrava Neto	AEGEA	Vice President	Brazil
Alexandre Aquino	Stellantis	Circular Economy VP	Brazil
Lívia Plácido	ECOARI	Chief Operating Officer (COO)	Brazil
Roberta Bruno de Souza Carneiro	Siemens Energy	EHS Director	Germany
Felipe Cardoso	Eco Panplas	CEO	Brazil
Emily Ewell	Pantys	CEO	Brazil
Felipe Guimarães	Energy Source	Head of Reverse Logistic	Brazil
Mariano Piñeyrua	TraceSurfer	CEO	Uruguay
Pedro Alberto Pradanos Zarzosa	Veolia Brasil	CEO	Brazil
Anis Nassar	World Economic Forum l WEF	Resource Circularity Lead	Switzerland
Kari Herlevi	SITRA	Director of Programs	Finland
Eric Ruzigamanzi	World Resources Institute l WRI	Circular Food Systems Program Manager	Rwanda
Kate Bushby	Mint Innovation	Head of Commercial Strategy & Growth, EVP Commercial Strategy& Growth	New Zealand
Gustavo Castellano	Loma Negra	Sustainability Manager	Argentina
Roberto Recalde	Unión Industrial Paraguaya | UIP	Technical representative	Paraguay
Nieves Cifuentes Valero	Naturgy	Corporate Environmental Manager	Spain
Koji NOMURA	Keidanren l Japan Business Federation	Deputy General Manager, Dr. Sci., Sustainability Department, TAIHEIYO CEMENT CORPORATION	Japan
Janez Potocnik	UNEP International Resource Panel | Systemiq | FFA | RISE	Co-Chair at UNEP Partner (Systemiq), Chairman (FFA), Chairman (RISE)	Belgium
Mónica Villegas Carrasquilla	Asociación Nacional de Empresarios de Colombia l ANDI	Circular Vision Director	Colombia

Nandini Kumar	Confederation of Indian Industry	Senior Consultant, CII- Centre of Excellence for Sustainable Development (CESD), Confederation of Indian Industry (CII)	India
Fernando Valente Pimentel	Associação Brasileira da Indústria Têxtil e de Confecção l ABIT	Superintendent Director of ABIT – Brazilian Textile and Apparel Industry Association	Brazil
Bruno Pelli	Vale	Director of Mining Technical Services at Vale S.A.	Brazil
Perpétua Almeida	Agência Brasileira de Desenvolvimento Industrial l ABDI	Director of Sustainable Economy and Industrialization	Brazil
Diego Loaiza	Essity	General Director	Colombia
Victoria Santos	Instituto Clima e Sociedade l iCS	Manager of Energy and Industry	Brazil
Nico Kohlhas	GIZ	Project Director	Brazil
Antonio D'Amato	Seda Group	President	Italy

Task force Meetings Schedule

Date	Format
May 29th	Online Meeting
July 4th	Online Meeting
August 1st	Online Meeting
August 29th	Online Meeting

ANNEX C – PARTNERS

Knowledge Partner

Network Partners

DISCLAIMER AND ACKNOWLEDGEMENTS

This report was developed within the scope of the SB COP initiative, with the support of consultancy acting as Knowledge Partner, who assisted the Working Group by consolidating discussions, providing data, and offering technical assistance. The content reflects the collective contributions and decisions of the Working Groups, mainly composed of private sector representatives and coordinated by SB COP and CNI.

The analyses, data, and opinions presented herein are intended solely for informational and discussion purposes. They do not constitute technical, legal, financial, or investment advice, nor do they create any commitment by the participants. The involvement of the Knowledge Partner and Network Partner does not imply endorsement of the recommendations or conclusions. No responsibility or liability is assumed by the Knowledge Partner, Network Partner, their professionals, or any participating organizations for decisions or actions taken based on this report.

Each participant remains fully independent in business decisions, relying on their own judgment and publicly available information. This publication does not contain non-public or sensitive information, except where explicitly indicated for SB COP use. References to specific cases, products, or services do not imply endorsement.

SUSTAINABLE
BUSINESS
COP30

9 788579 572494

CNI Brazilian National Confederation of Industry