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Circular Economy in Practice Global Experiences and Policy Pathways for Pakistan

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Executive Summary

This report examines how circular economy principles are evolving across different economic contexts and explores how these lessons can inform the transition toward resource efficient systems in emerging economies. The analysis demonstrates that the circular economy is no longer confined to environmental discourse; it is increasingly shaping industrial strategies, investment priorities, and development pathways. Countries around the world are redesigning production and consumption systems so that materials remain in use for longer periods, waste streams are transformed into resources, and economic growth is aligned with environmental sustainability experiences from advanced economies show that circular transitions are often supported by comprehensive regulatory frameworks, strong institutional coordination, and mature recycling industries. These countries have embedded circularity within manufacturing systems, product design standards, and consumer markets. Their progress illustrates how policy coherence, technological innovation, and public participation can collectively enable large scale material recovery and industrial resource efficiency.

In contrast, developing economies are building circular systems through more adaptive and sector focused approaches. Structural realities such as infrastructure gaps, financial limitations, and reliance on informal recycling networks shape how circular strategies are implemented. Despite these constraints, many developing countries possess strong foundations for circularity through existing reuse cultures, repair practices, and informal material recovery systems. When supported by appropriate policies, financing mechanisms, and infrastructure investments, these practices can evolve into powerful drivers of sustainable economic transformation.

Pakistan presents a particularly significant case within this landscape. Rapid urbanization, expanding industrial activity, and rising consumption are generating increasing volumes of waste while placing growing pressure on natural resources. At the same time, the country possesses several structural advantages that can support circular transformation. Informal recycling networks already recover valuable materials from waste streams, the textile sector connects Pakistan to global manufacturing supply chains, the construction industry is expanding rapidly, and renewable energy systems are gradually reshaping the country's energy mix. These sectors provide an opportunity to redirect material flows toward recovery, reuse, and recycling.

This report identifies priority pathways through which Pakistan can advance its circular economy transition. These pathways include strengthening waste segregation systems, establishing Integrated Resource Recovery Centres (IRRCs) to support recycling markets, developing circular approaches in plastics and packaging, expanding circular textile production, promoting the recovery and reuse of construction materials, and enabling new circular industries linked to renewable technologies. Equally important is the development of financing mechanisms that mobilize resources from private industry, public institutions, and international partnerships to support circular infrastructure and innovation. By aligning policy direction, investment strategies, and industrial participation, Pakistan can gradually transform waste streams into productive resources while creating new economic opportunities.

Key Takeaways

- Circular economy systems are emerging worldwide as a strategic response to resource constraints, environmental pressures, and the need for resilient economic growth.
- Developed economies demonstrate how strong regulatory frameworks, industrial innovation and public engagement can enable large scale material recovery and circular production systems.

- Developing economies often rely on sector driven and incremental approaches that build upon existing reuse and recycling practices while gradually strengthening infrastructure and governance systems.
- Pakistan possesses significant circular economy potential through its informal recycling networks, strong textile manufacturing base, expanding construction sector and growing renewable energy landscape.
- Waste segregation systems and Integrated Resource Recovery Centres (IRRCs) are critical foundations for enabling recycling markets and strengthening resource recovery across urban areas.
- Circular approaches in plastics, textiles, construction materials and renewable technologies can generate both environmental benefits and economic opportunities when supported by coordinated policies and financing mechanisms.
- Small and medium enterprises play an essential role in scaling circular solutions, particularly in recycling, repair, refurbishment and material recovery industries.
- Strategic financing frameworks that mobilize industry contributions, SME financing channels, and international partnerships are essential for sustaining circular economy investments.

The transition toward a circular economy in many developing countries including Pakistan represents more than an environmental reform; it is a strategic opportunity to reshape how resources are managed within the national economy. By strengthening systems that recover materials, extend product lifecycles and encourage circular industrial practices, Pakistan can reduce environmental pressures while unlocking new avenues for economic growth and employment. The way forward requires coordinated action across government institutions, private industry, financial actors and local enterprises. When these efforts converge, circularity can evolve from an emerging concept into a practical engine of sustainable development for the country. Sometimes, the solutions are not supposed to be imported, because most of the solutions already exist and just needs to be recognized by integrating into policy action plans.

Acknowledgments

The completion of this report reflects the collective contributions of numerous institutions, experts, and stakeholders who shared their knowledge, insights, and experiences during its development. The authors extend sincere appreciation to the Institute for Global Environmental Strategies (IGES), Japan, whose intellectual leadership and continued engagement on circular economy transitions have provided valuable global perspectives that informed this work. We are also grateful to the United Nations Environment Programme – International Environmental Technology Centre (UNEP IETC) for its ongoing efforts to promote sustainable waste management and resource efficiency across developing economies, which continue to guide policy thinking in this field. Special appreciation is extended to the Ministry of Climate Change and Environmental Coordination and the Ministry of Commerce, Government of Pakistan, Ministry of Water Resources, Pakistan Agriculture Resource Council (PARC), Ministry of Industries and Production for their constructive engagement and policy insights during consultations related to circular economy development. The report has also benefited greatly from the perspectives shared by provincial Environmental Protection Departments, whose experiences in implementing environmental regulations and managing local environmental challenges helped ground the analysis in practical realities.

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1. Introduction

Every economy is built on the movement of materials. Minerals become metals, crops become food, forests become timber and energy fuels the systems that sustain production and consumption. For decades these flows have followed a simple direction. The resources are extracted, transformed into products, used and then discarded. This linear model has powered industrial growth, but it has also produced mounting consequences. Such as the valuable materials are lost as waste, ecosystems absorb growing levels of pollution, and economies become increasingly dependent on continuous resource extraction. As global demand for materials continues to rise, the limitations of this model are becoming more visible in both environmental and economic terms. The circular economy offers an alternative way of organizing these material flows. Instead of treating waste as the final stage of production, circular systems aim to preserve the value embedded in materials, products, and components for as long as possible. Resources are recovered, repaired, reused, remanufactured, and recycled so that economic value circulates within the system rather than being discarded. This approach requires rethinking how products are designed, how industries operate, and how societies manage waste streams. It also requires new forms of cooperation between governments, industries, financial institutions, and communities.

Across the world, countries are experimenting with different ways to implement circular economy principles. Some have introduced comprehensive regulatory frameworks that reshape manufacturing practices and product standards. Others have focused on strengthening recycling industries, developing eco industrial systems, or encouraging consumer participation in reuse and repair markets. While the policy instruments differ, a common objective underlies these efforts. Economies are searching for ways to maintain growth while reducing their dependence on virgin resources and minimizing the environmental footprint of production and consumption. The developing economies are entering this conversation with their own distinct realities. Rapid urban growth, expanding manufacturing sectors, and rising consumer demand are increasing the volume of waste and intensifying pressure on natural resources. Yet these same economies often possess long standing traditions of reuse, repair, and recycling that reflect practical responses to resource scarcity. Furthermore, the informal material recovery networks, secondhand markets and repair services already demonstrate elements of circularity that exist outside formal policy frameworks. When supported by appropriate infrastructure, financing mechanisms, and institutional coordination, these systems can form the foundation for broader circular transitions.

This report examines how circular economy strategies are being applied across different national contexts and considers how these lessons can inform emerging circular pathways in Pakistan. By analyzing experiences from both developed and developing countries, the report identifies the institutional approaches, sectoral opportunities, and financing mechanisms that can support circular transformation. The objective is not to replicate models from elsewhere but to interpret global experience in ways that reflect Pakistan's economic structure, industrial strengths, and environmental priorities. Through this analysis, the report outlines practical directions for strengthening resource recovery systems, enabling circular industries, and building a more resource efficient economic future.

1.1 Global Resource Pressures and the Rise of Circular Economy

Since 1970, global resource extraction has more than tripled and is projected to nearly double again by 2060, largely driven by metals and non-metallic minerals used in construction and

infrastructure[1]. This unsustainable throughput accelerates climate change, biodiversity loss, and pollution, while deepening material inequality between regions[2]. A circular economy (CE) responds to these challenges by (a) designing out waste and pollution, (b) keeping products and materials in use through reuse, repair, remanufacture, and recycling, and (c) regenerating natural systems [3]. Despite widespread uptake of CE rhetoric in national strategies, the global circularity rates the share of secondary resources in total inputs has fallen from 8.6% in 2020 to 6.9% in 2025, reflecting rapidly rising material demand outpacing recycling capacity [4].

1.2 Circular Economy and Sustainable Development Goals

The circular economy principles underpin SDG 12 on sustainable consumption and production and contributes directly to goals on water, energy, industry/innovation, cities, responsible consumption, climate, oceans and land (SDGs 6, 7, 9, 11–15) [5]. As per United Nations Environment Programme (UNEP's) SDG reporting notes hundreds of national SCP/CE policy instruments adopted since 2019, with growing focus on high-impact sectors (textiles, buildings, mobility, agri-food)[6]. From a mitigation perspective, the IPCC AR6 (WGIII) finds materials efficiency and circularity longer lifetimes, reuse/remanufacturing, design-for-lightweighting, and higher-quality recycling are under-utilized but high-impact mitigation options for industry and value chains. There are different strategic models which shows material-efficiency strategies could cut 2050 emissions from the material cycles of buildings and vehicles by large margins (e.g., up to 80% for residential buildings in G7/China; up to 70% for passenger cars in G7), highlighting circular economy transition role alongside energy decarbonization in meeting NDCs [7]. Multiple assessments converge that aligning resource efficiency with circular design, public procurement, and trade rules would reduce environmental footprints while improving resilience and jobs, particularly in emerging economies integrating into CE value chains [8].

1.3 Developed vs Developing Contexts: Structural Differences

Developed economies tend to combine comprehensive regulatory frameworks (eco-design/product standards, EPR with modulated fees, green public procurement), robust data/monitoring systems, and market instruments that create steady demand for secondary materials. The OECD's evolving EPR guidance documents these design features (targets, fee modulation, competition safeguards), as well as extensions into harder streams (textiles, construction products)[9].

Developing countries often pursue phased EPR and donor-supported pilots while struggling with enforcement capacity, financing and infrastructure deficits. Furthermore, the informal waste

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[1] Organisation for Economic Co-operation and Development (OECD), *Global Material Resources Outlook to 2060* (Paris: OECD Publishing, 2019).

[2] International Resource Panel (IRP), *Global Resources Outlook 2019* (Nairobi: UNEP, 2019).

[3] Ellen MacArthur Foundation, *Towards the Circular Economy* (2015).

[4] Circle Economy, *The Circularity Gap Report 2025* (Amsterdam: Circle Economy, 2025).

[5] United Nations, Transforming Our World: The 2030 Agenda for Sustainable Development (2015).

[6] United Nations Environment Programme (UNEP), Sustainable Consumption and Production: A Handbook for Policymakers (2021).

[7] Intergovernmental Panel on Climate Change (IPCC), *AR6 Working Group III Report* (2022).

[8] International Resource Panel (IRP), *Resource Efficiency and Climate Change* (2020).

[9] OECD, Extended Producer Responsibility: Updated Guidance for Efficient Waste Management (Paris: OECD Publishing, 2016).

systems are critical contributing to most of the recycling in many cities, so achieving inclusive circular economy requires integrating waste pickers and SMEs into formal value chains and financing models. The global snapshots show rapidly rising waste generation, persistent mismanagement (open dumping/burning), and the need for upstream prevention plus investment in collection/sorting to make downstream recycling viable [10]. Crucially, recycling alone cannot close the gap because with global circularity at 6.9%, scaling recycling without reducing overall material demand would still leave large deficits, hence the emphasis on prevention, product-lifetime extension, reuse systems and service-based business models tailored to local conditions in the global South [11] [12].

[10] World Bank, *What a Waste 2.0* (Washington, DC: World Bank, 2018).

[11] Circle Economy, Circularity Gap Report 2025.

[12] UNEP, Global Waste Management Outlook 2024 (Nairobi: UNEP, 2024).

PART I - Analytical Foundations

2. Conceptual Framework for Circular Economy Transitions

1.4 Core Principles (Reduce, Reuse, Recycle, Repair, Regenerate)

The circular economy (CE) is founded on core "R" principles aimed at minimizing resource use and waste. The key principles include Reduce (cutting down material and energy consumption at source), Reuse (extending the life of products by using them multiple times), Recycle (processing waste into new materials), Repair (maintaining and refurbishing products to prolong their lifespan), and Regenerate (restoring and renewing natural systems).[13] Together, these principles create a closed-loop system that keeps resources circulating at high value and designs out waste and pollution . By emphasizing actions like repairing goods and regenerating ecosystems, circular economy goes beyond traditional 3R waste management, ensuring that products and materials remain in use for as long as possible and that biological resources can recover and thrive.[14] In practice, adopting the 5Rs means companies and consumers shift toward sustainable design, maintenance, and end-of-life practices that significantly reduce the need for virgin raw materials and mitigate environmental impacts.

1.5 Policy Instruments and Regulatory Mechanisms

Effective policy frameworks and institutions are critical for accelerating the circular economy. Governments in leading regions have enacted comprehensive CE strategies – for example, the European Union's Circular Economy Action Plan (CEAP) sets out 54 actions spanning product design, waste legislation, and market incentives to drive the transition.[15] Such overarching policies provide clear targets and coordinated measures (e.g. waste reduction goals, extended producer responsibility schemes, green public procurement) that align stakeholders across sectors. Institutional enablers include dedicated bodies and cross-ministerial committees to implement CE roadmaps; for instance, Finland created a national roadmap led by its innovation fund and a multi-stakeholder steering committee to integrate circularity into government and industry planning [16] [17]. Strong policy signals and institutions help overcome barriers by stimulating investment in recycling infrastructure, facilitating public–private partnerships, and harmonizing regulations. Studies show that effective policies can "introduce circularity" by

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[13] The circular economy: definition and impact https://www.eskawater.com/circular-economy-definition-and-impact-2/#:~:text=The%20circular%20economy%20is%20an,materials%20are%20constantly%20being%20recirculated

[14] The circular economy & carbon reduction targets | Normative https://normative.io/insight/circular-economy/#:~:text=By%20its%20nature%2C%20a%20circular,use%20of%20resources

[15] https://unece.org/sites/default/files/2023-09/Circular%20Economy%20-%20Institutional%20Arrangements%20-%209.26.23%20-Circular%20STEP%20.pdf#:~:text=major%20driver%20for%20the%20development,March%202020%2C%20the%20European%20Commission

[16] https://unece.org/sites/default/files/2023-09/Circular%20Economy%20-%20Institutional%20Arrangements%20-%209.26.23%20-Circular%20STEP%20.pdf#:~:text=In%202015%2C%20Finland%E2%80%99s%20Prime%20Minister,A

[17] https://unece.org/sites/default/files/2023-09/Circular%20Economy%20-%20Institutional%20Arrangements%20-%209.26.23%20-Circular%20STEP%20.pdf#:~:text=steering%20committee%20composed%20of%2021,The%20roadmap%20provides%20recommendations

setting up reverse logistics systems and inspiring new business models, while providing financial incentives for innovation [18] [19]. In summary, robust legislation (like China's 2008 Circular Economy Promotion Law) combined with capable institutions (e.g. task forces, inter-agency collaboration platforms) act as enablers that embed CE principles into the economy's fabric and ensure initiatives are scaled and sustained[20] [21].

1.6 Business Models and Innovation Ecosystems

Transitioning to a circular economy requires new business models and innovation ecosystems that fundamentally change how value is created from resources. So, five major types of circular business models are often highlighted:

(1) Circular supply chains that use renewable, recycled or highly durable inputs

(2) Product life extension models (through maintenance, repair, refurbishment and remanufacturing) to lengthen the useful life of goods

(3) Resource recovery and recycling systems that reclaim waste outputs and turn them into inputs for new processes

(4) Sharing platforms and product-as-a-service models that maximize asset utilization (for example, car-sharing or leasing services instead of ownership)

(5) Digital and service-driven models that use IT platforms to support reuse, tracking of materials, and performance-based services[22] [23].

These models often rely on innovation systems including networks of firms, research institutions, and government support to develop and diffuse new technologies (like advanced recycling techniques or materials tracing via digital passports) and practices. An example is industrial symbiosis, where clusters of industries exchange by-products and energy in an "eco-industrial park" setting: waste from one process becomes a feedstock for another, mimicking natural ecosystems [24]. Such collaborative innovation systems are being fostered in various countries (e.g. cross-industry waste exchange marketplaces and incubators for circular startups) to enable systemic innovations. Overall, circular business models coupled with supportive innovation systems drive the economic shift by making reuse and regeneration

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[18] https://docs.wbcsd.org/2019/09/WBCSD_Policy_enablers_to_accelerate_the_circular_economy.pdf#:~:text=Effective%20policies%20can%20introduce%20circularity,models%20and%20kickstart%20new%20initiatives

[19] https://docs.wbcsd.org/2019/09/WBCSD_Policy_enablers_to_accelerate_the_circular_economy.pdf#:~:text=1,12

[20] Chapter 7. Circular Economy Policies in China https://www.eria.org/RPR_FY2014_No.44_Chapter_7.pdf#:~:text=The%20fourth%20stage%20,industries%2C%20indicating%20a%20widespread%20trend

[21] https://unece.org/sites/default/files/2023-09/Circular%20Economy%20-%20Institutional%20Arrangements%20-%209.26.23%20-Circular%20STEP%20.pdf#:~:text=%28SITRA%29,the%20steps%20of%20the%20roadmap

[22] https://docs.wbcsd.org/2019/09/WBCSD_Policy_enablers_to_accelerate_the_circular_economy.pdf#:~:text=to%20a%20circular%20economy%20can,requires%20increased%20collaboration%20across%20society

[23] https://docs.wbcsd.org/2019/09/WBCSD_Policy_enablers_to_accelerate_the_circular_economy.pdf#:~:text=five%20business%20models%20%E2%80%93%20circular,and%20reuse%2C%20sharing%20and%20service

[24] The Circular Republic of China Materia Rinnovabile | Renewable Matter https://www.renewablematter.eu/en/the-circular-republic-of-china#:~:text=while%20Green%20Industrial%20Parks%20are,their%20goals%20complement%20each%20other

profitable, scaling up eco-design, and facilitating knowledge transfer for continuous improvement[25].

1.7 Measurement, Indicators, and Carbon Linkages

Measuring progress in circular economy initiatives is vital, and a set of indicators and tools has emerged to quantify circularity. One foundational tool is Material Flow Analysis (MFA), a systematic method to assess the flows and stocks of materials within an economy or process[26]. MFA tracks how raw materials enter, how products move through their life cycles, and where waste outputs go, thereby highlighting inefficiencies and opportunities for improvement [27] [28]. Building on MFA data, metrics like the Material Circularity Indicator (MCI) or sector-specific circularity metrics can be calculated to gauge the extent to which materials are cycled rather than lost [29]. At the macro level, the circularity rate (also known as the circular material use rate) is a key indicator used by the EU and others – it measures the share of total material input that comes from recycled or recovered sources, essentially the percentage of materials fed back into the economy's use versus the total material consumed [30]. For example, the EU's circularity rate was about 12.8% in recent years, meaning roughly an eighth of materials used are secondary; globally, this rate is much lower (on the order of 8–9%, according to Circularity Gap reports) highlighting room for improvement [31]. Another critical set of metrics relates to the carbon impact of circular strategies. Since producing new materials typically involves high energy use and emissions, circular interventions (like recycling aluminum scrap instead of mining bauxite, or designing products for longevity) can yield significant greenhouse gas reductions. Lifecycle assessment tools are used to calculate these emission savings. At a global scale, analysts estimate that adopting circular economy measures could cut worldwide GHG emissions by roughly 39% relative to business-as-usual, through reduced industrial energy demand and avoided waste emissions. Governments are increasingly including circularity in climate policy – for instance, China's recent five-year plan explicitly links CE measures to its carbon neutrality

[25] https://www.renewablematter.eu/en/the-circular-republic-of-china#:~:text=In%20the%20circular%20transition%20challenge%2C,%E2%80%9CCircular%20Economy%20Industrial%20Parks%20%E2%80%93

[26] Material Flow Analysis Measuring Circularity: A Comprehensive Guide for Sustainable

Business Practices - Evolveable Consulting https://evolveable.com/material-flow-analysis-measuring-circularity/#:~:text=Material%20Flow%20Analysis%20is%20a,the%20way%20for%20enhanced%20sustainability

[27] Material Flow Analysis Measuring Circularity: A Comprehensive Guide for Sustainable

Business Practices - Evolveable Consultinghttps://evolveable.com/material-flow-analysis-measuring-circularity/#:~:text=Material%20Flow%20Analysis%20is%20a,the%20way%20for%20enhanced%20sustainability

[28] https://evolveable.com/material-flow-analysis-measuring-circularity/#:~:text=2,of%20circularity%20in%20material%20flows

[29] https://evolveable.com/material-flow-analysis-measuring-circularity/#:~:text=MFA%20quantifies%20the%20amount%20of,of%20circularity%20in%20material%20flows

[30]Circular material use rate https://ec.europa.eu/eurostat/cache/metadata/en/cei_srm030_esmsip2.htm#:~:text=The%20indicator%20measures%20the%20share,to%20the%20overall%20material%20use

[31] https://normative.io/insight/circular-economy/#:~:text=An%20estimate%20from%20the%202021,global%20GHG%20emissions%20by%2039

2060 goal[32]. In summary, MFA provides the data foundation, circularity rates and related indicators track resource loops, and carbon impact assessments ensure that the circular economy's contribution to climate targets is quantified and visible[33].

[32]China's Circular Economy Policies: Review and Reflection https://circulareconomy.europa.eu/platform/sites/default/files/2023-08/China%E2%80%99s%20Circular%20Economy%20Policies_%20Review%20and%20Reflection.pdf#:~:text=,and%20three%20key%20tasks%20are

[33] https://evolveable.com/material-flow-analysis-measuring-circularity/#:~:text=4,strong%20business%20case%20for%20circularity

PART II - Circular Economy in Advanced Economies

3. Institutional and Regulatory Models in Developed Economies

1.8 European Model: The Netherlands within the EU Framework

The Netherlands has positioned itself as a pioneer in advancing a circular economy, setting the target to become 100% circular by 2050, with an intermediate milestone of reducing the use of primary raw materials by 50% by 2030 [34]. This ambition stems from the recognition that the linear "take-make-dispose" model is unsustainable, leading to environmental degradation, economic vulnerability and resource scarcity[35]. By embedding circular economy principles into its governance, industrial practices and local innovation systems, the Netherlands provides a globally recognized model for operationalizing circularity [36]. The Dutch approach emphasizes multi-level governance, stakeholder participation and strong alignment with European Union (EU) frameworks such as the Circular Economy Action Plan (CEAP) and the European Green Deal [37].

1.9 EU Circular Economy Action Plan (CEAP) and Green Deal alignment

The European Circular Economy Action Plan (CEAP) is one of the central building blocks of the European Green Deal, which sets out the EU's roadmap to achieve climate neutrality by 2050. The CEAP was first launched in 2015 and revised in 2020, signaling a shift from waste management to systemic transformation of entire value chains (European Commission, 2020). Its integration within the Green Deal ensures that resource efficiency, sustainable production, and reduced environmental impact are core to the EU's long-term climate and competitiveness agenda (European Commission, 2025).

A key element of the CEAP is the Sustainable Products Initiative (SPI), which underpins the Eco-design for Sustainable Products Regulation (ESPR). The ESPR extends product requirements beyond energy efficiency to durability, reusability, reparability, and recyclability (European Commission, 2020). This makes circular design principles mandatory across sectors, thereby aligning with the Green Deal's ambition of "sustainable growth decoupled from resource use." The Digital Product Passport (DPP), another major CEAP tool, will make information on a product's material content, reparability, and environmental footprint accessible throughout its lifecycle, enabling traceability and improved secondary raw material markets.

The CEAP also strengthens Extended Producer Responsibility (EPR) mechanisms, shifting the cost and responsibility of end-of-life management from consumers and municipalities to producers. By mandating take-back systems and incentivizing eco-design, EPR ensures that circularity is embedded at the product and producer level, reducing waste while creating accountability across supply chains. These mechanisms reflect the Green Deal's call for stronger producer responsibility and consumer empowerment in driving sustainable transitions.

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[34] Government of the Netherlands, A Circular Economy in the Netherlands by 2050 (2016).

[35] European Commission, Closing the Loop – EU Circular Economy Action Plan (2015).

[36] Hunt, Circular Amsterdam Case Study, 2020.

[37] European Commission, A New Circular Economy Action Plan (2020).

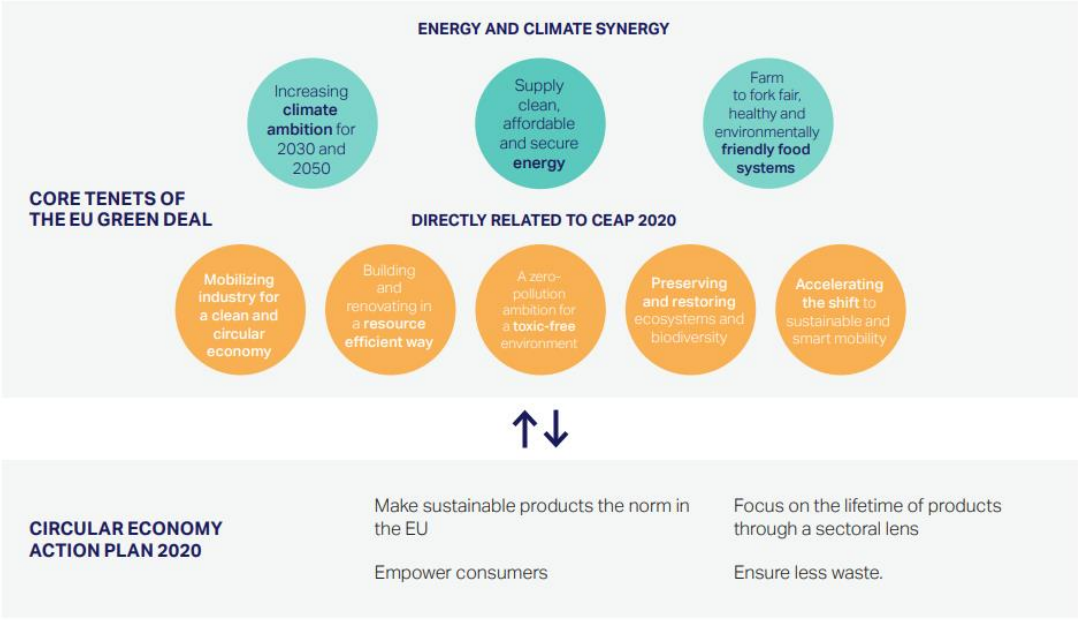

Figure 1: The Circular Economy Action Plan 2020 as part of EU Green Deal

Importantly, the CEAP targets seven priority value chains that are responsible for a significant share of Europe's environmental footprint: electronics and ICT, batteries and vehicles, packaging, plastics, textiles, construction and buildings, food, water, and nutrients (European Commission, 2020). These sectors were selected because they consume high levels of resources and have substantial circularity potential. For example, plastics are central to both CEAP and the Green Deal, with measures to reduce single-use plastics, improve recyclability, and mandate recycled content in new products (European Commission, 2020).

Table 1: CEAP 2020 Legislation and Impacts on Five Industries

Industry	CEAP 2020 Legislation	Industry Impacts
Electronics and ICT	- New "Right to Repair" measures by 2021 - EU-wide takeback scheme to return or sell back old mobile phones, tablets and chargers - EU guidelines for hazardous substances	- "Right to repair" focuses on requirements for manufacturers (not distributors/retailers). - IT systems must be redesigned to support repairs and processing of components. - Expanded product information on lifespan and spare parts availability required. - Downstream prices must be re-evaluated (e.g., affordable battery replacement vs. new product purchase).

Batteries and Vehicles	- Proposal for new regulatory framework for batteries (2020) - Review of rules on end-of-life vehicles (2021)	- Increased platform sharing and digitization (e.g., European Battery Alliance). - Rising raw material demand → pressure for sustainable sourcing and recyclability. - Increased R&D investment in new battery projects. - Car manufacturers must ensure 85–95% of new vehicles are reusable or recyclable by weight. - Impacts mainly on passenger vehicles and small trucks manufacturers.
Packaging	- Review to reinforce essential requirements for packaging and reduce (over)packaging and packaging waste by 2021	- Improves competitiveness of recycled materials vs. virgin materials. - Online sales growth increases regulatory pressure on packaging producers. - Increased R&D investment for reuse and recyclability design. - Need for industry collaboration and digital platform leadership.
Plastics	- Mandatory recycled plastic content and plastic waste reduction measures (2021/2022) - Restrictions on intentionally added microplastics (2021) - Policy framework for bio-based/biodegradable plastics (2021) - Tax on non-recycled plastic waste (from 2021)	- Internal targets to reduce virgin plastic use and increase post-consumer recycled content (PCR). - Taxes on non-recyclable waste will drive innovation. - Businesses must improve profitability of recycling plants. - New business models for plastic reuse and sustainable product innovation required.
Textiles	- EU Strategy for Textiles (2021) - High levels of separate collection of textile waste by 2025 per Member State	- Extended Producer Responsibility (EPR) schemes internalize end-of-life costs. - Strong SME role (90% of EU workforce in small businesses). - Shift toward high value-added products to avoid mass production and price hikes.

Construction and Buildings	- Use of EU building sustainability framework Level(s) to integrate LCAs in procurement - Exploration of carbon reduction targets and carbon storage - Revision of material recovery targets and soil sealing reduction	- Waste regulations significantly impact construction sector. - Businesses must integrate Life Cycle Assessment (LCA) in procurement. - Material recovery targets embedded in business models. - Increased digital solutions (Digital Industrial Platform, Level(s) tools). - More cross-border value chain investment expected.
Food, Water and Nutrients	- Integrated Nutrient Management Plan - Bioeconomy Strategy and Circular Bioeconomy - Food Waste Reduction under Farm-to-Fork Strategy - Single-use packaging directives	- Reduced manufacturing, increased end-of-life treatment due to single-use bans. - Impacts farming (waste-to-energy), manufacturing (design/resources), consumers (labelling/transparency). - Cross-sector partnerships required (e.g., waste-to-fertilizer). - Supply chain-wide change management across regions.

By linking these actions to the European Green Deal, CEAP functions as its operational roadmap. While the Green Deal provides the overarching vision of climate neutrality, clean energy, and biodiversity protection, the CEAP translates these ambitions into concrete regulatory and market instruments that drive the EU's transition from a linear to a circular economy (European Commission, 2025). This alignment ensures coherence across policies, from decarburization to resource efficiency, and positions the circular economy as a critical lever for achieving both climate and industrial competitiveness goals.

1.10 Extended Producer Responsibility (EPR)

The Extended Producer Responsibility (EPR) is a cornerstone of the EU Circular Economy Action Plan (CEAP), designed to shift the responsibility for waste management from municipalities and consumers to producers. This policy approach compels manufacturers to take financial and organizational responsibility for the entire lifecycle of their products, including collection, sorting, recycling, and proper disposal. Within the European Green Deal framework, EPR is seen as a critical mechanism to operationalize the "polluter pays" principle while stimulating sustainable product design. By requiring producers to cover the cost of waste treatment and recovery, EPR creates incentives for eco-design, encouraging businesses to design products that are more durable, easier to repair and recyclable.

The EPR schemes are currently mandatory across several waste streams in the EU, including packaging, electrical and electronic equipment (EEE), batteries, and end-of-life vehicles

(European Commission, 2020). The Netherlands, for example, has successfully integrated EPR into its national policies for packaging, textiles and electronic waste, where producers finance collection systems and recycling infrastructure. Evidence suggests that EPR has improved collection rates: for instance, in the EU as a whole, 65% of packaging waste was recycled in 2019, compared to just 55% in 2005 [38]. Despite these successes, challenges remain. Studies highlight that many EPR schemes focus primarily on recycling, while insufficiently incentivizing upstream measures such as waste prevention, reuse, and repair. Furthermore, performance varies across Member States due to differences in governance structures, enforcement capacity, and producer compliance. For this reason, the revised CEAP (2020) proposed strengthening EPR through minimum performance requirements, harmonized reporting, and integration with other instruments such as the ESPR and DPP.

1.11 Digital Product Passport (DPP)

The Digital Product Passport (DPP), introduced under the Eco-design for Sustainable Products Regulation (ESPR), is another innovative tool of the CEAP that directly supports the Green Deal's objectives of resource efficiency and transparency. The DPP is a standardized, digital record containing essential information about a product's material composition, environmental footprint, reparability, and recyclability. Its purpose is to improve traceability and accountability across global value chains, making circularity actionable by enabling reuse, remanufacturing, and recycling. For example, if a smartphone contains rare earth metals, the DPP would provide recyclers with precise data to extract and reuse those materials, thereby reducing dependency on virgin resources. It also empowers consumers by giving them access to data about reparability and sustainability, thereby supporting informed purchasing choices.

The DPP is expected to become mandatory for high-impact sectors such as batteries, textiles, and electronics, which were identified in the CEAP as priority value chains due to their significant environmental footprint. Pilot projects are already underway: the EU Battery Regulation (2023) requires batteries to have digital passports by 2027, documenting carbon footprint, durability, and recycled content [39]. This not only ensures better material recovery but also aligns with the Green Deal's ambition to reduce Europe's dependency on critical raw materials. While promising, implementing the DPP comes with challenges. These include ensuring interoperability across industries, addressing data privacy concerns, and avoiding excessive compliance costs for small and medium-sized enterprises (SMEs). Nevertheless, by making supply chains transparent, the DPP represents a transformative step in scaling circular practices across the EU. Figure 2 shows the timeline of Digital Product Passport Implementation.[40]

[38] Eurostat, "Packaging Waste Statistics," 2021.

[39] European Commission, Digital Product Passport Initiative (2023).

[40] https://data.europa.eu/en/news-events/news/eus-digital-product-passport-advancing-transparency-and-sustainability

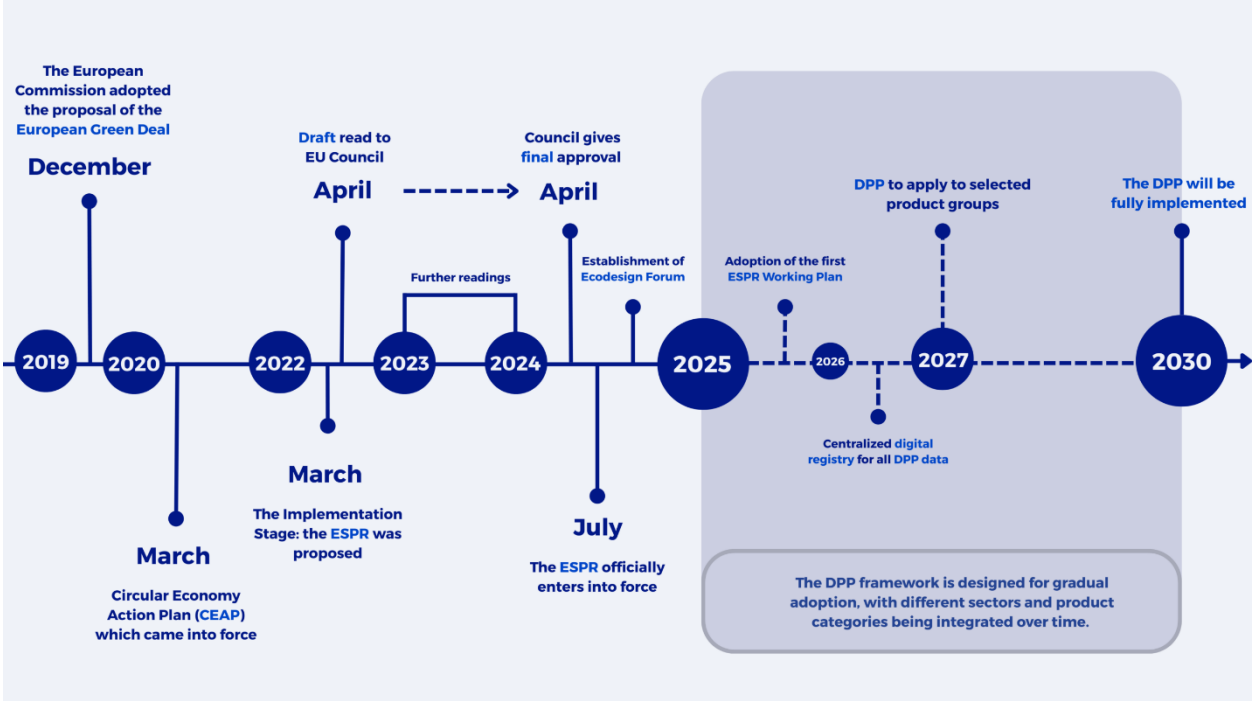

Figure 2: Timeline of DPP Implementation

3.4.1. Integration of EPR and DPP

The combined application of EPR and DPP illustrates how CEAP instruments reinforce one another within the European Green Deal. The EPR provides regulatory backbone that makes producers financially accountable for product end-of-life, while the DPP delivers the data and transparency needed to operationalize that accountability. Together, they close material loops by ensuring that products are designed for circularity and that accurate information is available to maximize recovery and reuse. This integration demonstrates how the EU is moving beyond traditional waste management to a systemic model of circularity that prioritizes both upstream (design, production) and downstream (reuse, recycling) interventions. By embedding these tools into its regulatory framework, the EU positions circularity not only as an environmental priority but also as a driver of competitiveness, innovation, and resilience under the Green Deal .

4. Netherlands (100% Circular Economy by 2050)

The Netherlands has positioned itself as a frontrunner in the global transition to a circular economy, setting the ambitious target of becoming a 100% circular economy by 2050, with an interim goal of halving the use of primary raw materials by 2030 [41]. This long-term vision demonstrates close alignment with the EU Circular Economy Action Plan (CEAP) and the European Green Deal, which prioritize resource efficiency, sustainable growth, and climate neutrality. The Dutch policy is structured around five priority value chains: biomass and food, plastics, manufacturing, construction, and consumer goods. These sectors were selected because they account for the highest share of raw material use and waste generation in the Netherlands, reflecting similar priorities identified in the CEAP.

To operationalize this vision, the Netherlands has promoted innovative governance mechanisms such as Green Deals, which are voluntary agreements between government, businesses, and knowledge institutions that support experimentation and scaling up of circular practices. Since 2011, over 200 Green Deals have been signed, covering areas such as phosphate recovery, circular construction, and sustainable plastics [42]. These collaborative mechanisms complement EU-level instruments such as Extended Producer Responsibility (EPR) and the Digital Product Passport (DPP) by fostering co-creation and practical demonstrations. Some concrete examples of progress include the Energy & Raw Materials Factory (ERMF), which recovers valuable resources such as phosphate, cellulose, and biogas from wastewater streams. At the city level, Amsterdam has pioneered the use of material passports in the construction sector, allowing building materials to be tracked and reused at the end of a building's lifecycle. These innovations demonstrate how local and national initiatives complement EU directives to embed circularity into infrastructure, industry, and consumption systems.

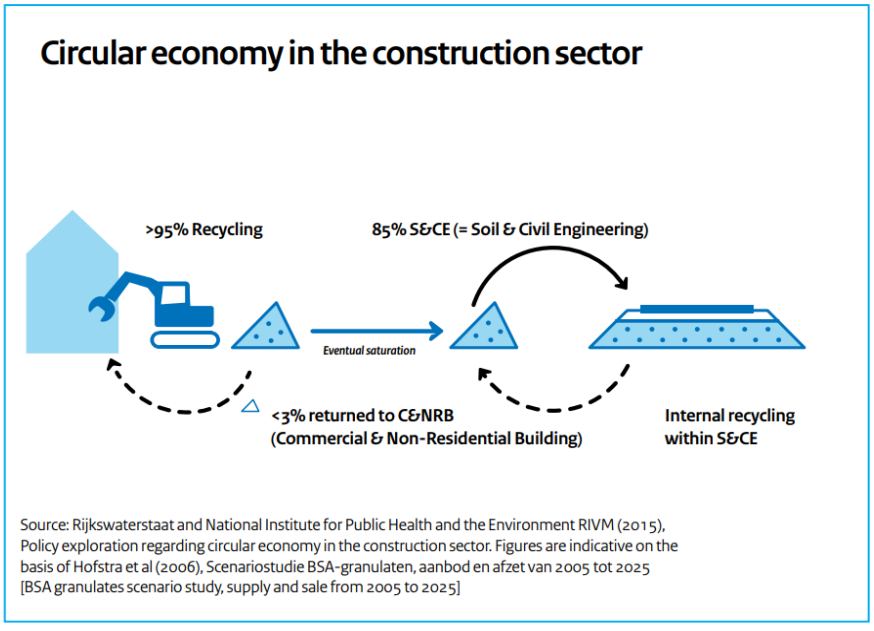

Figure 3: Circular Economy Demonstration in Construction Sector. 43

[41] Government of the Netherlands, Green Deals Programme Overview.

[42] Van Leeuwen et al., "The Circular Economy and the Dutch Model," 2018.

[43] https://circulareconomy.europa.eu/

Despite these achievements, challenges remain, particularly regarding high levels of consumer residual waste and the need to strengthen reuse and repair systems. For example, 80% of residual waste in the Netherlands still comes from households and small businesses [44]. Nevertheless, by setting clear national targets, embedding CE principles in governance, and aligning with EU-level frameworks, the Netherlands provides a strong model for accelerating circular economy transitions in Europe.

1.12 Japanese Model: Legal Precision and Industrial Symbiosis

41.1 Sound Material-Cycle Society Framework

The Basic Act on Establishing a Sound Material-Cycle Society (Act No. 110 of 2000)[45] is Japan's overarching law for promoting a circular, or "material-cycle", society. Its objectives include preventing/reducing waste generation; promoting the cyclical use of "circulative resources" (i.e. materials/products once discarded); and ensuring proper disposal of resources not recyclable. The Act assigns roles/responsibilities among the State, local governments, businesses/manufacturers, and citizens. It also mandates the creation of Fundamental Plans every ~5 years. The 4th Fundamental Plan was adopted in 2018, under which progress is monitored.[46]

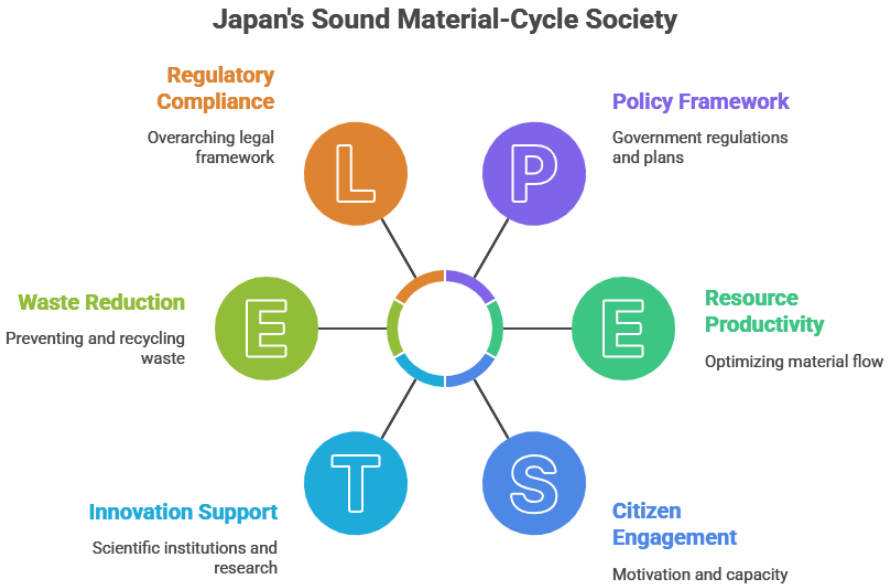

Figure 4: Japan's Sound Material Society Pillars.

4.1.2. Core Principles and Tools

The emphasis on the 3Rs (Reduce, Reuse, Recycle) but also extending to "longest possible use of products" and preventing waste from the design/production stage. Moreover, the use of

[44] Netherlands Environmental Assessment Agency (PBL), *Circular Economy Outlook*, 2018.

[45] Government of Japan, Basic Act for Establishing a Sound Material-Cycle Society, Act No. 110 (2000).

[46] Ministry of the Environment Japan, Fourth Fundamental Plan for Establishing a Sound Material-Cycle Society (2018).

quantitative targets in material flow, resource productivity, recycling rates, etc., have been integrated into the Fundamental Plans.

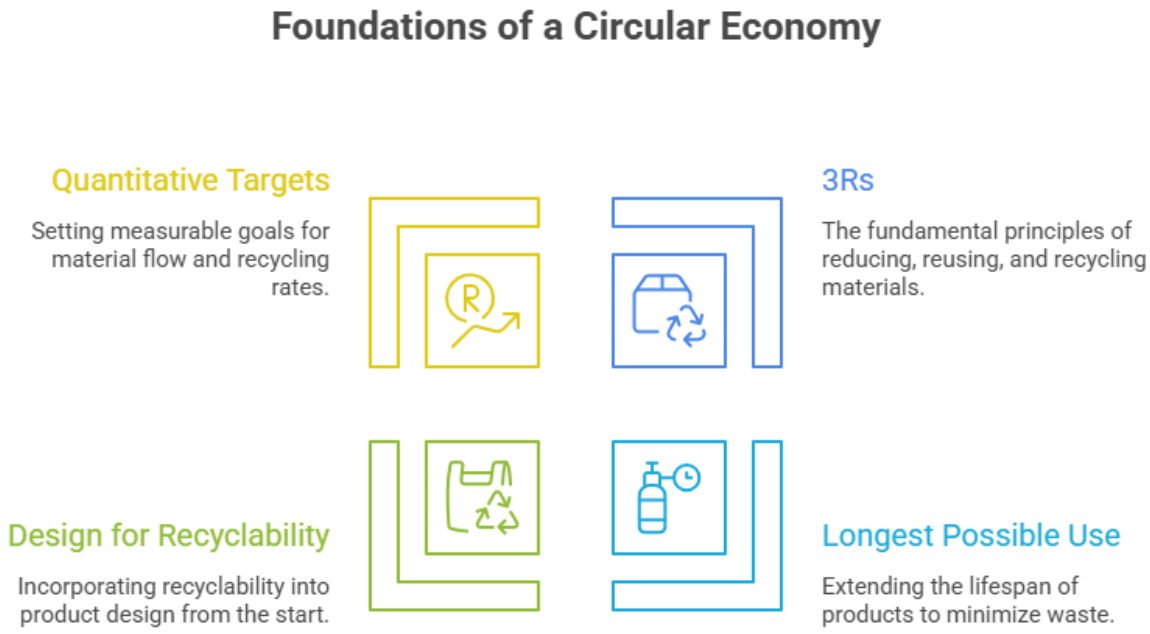

Figure 5: Foundations of Circular Economy for Japan

4.1.3 Achievements / Outcomes

Over time, Japan has developed a rather mature policy infrastructure: well-defined legal obligations for multiple actors, periodic evaluation, data collection, and scientific institutions (e.g. national institutes, research centres) that support measurement of flows and technologies.

Challenges

- Some gaps remain in fully closing loops (e.g. reducing the share of low-value waste / residue in recycling, or optimizing design for recyclability).
- Ensuring that citizens and local governments have the capacity and motivation to follow rules, and that enforcement remains consistent across municipalities of varying resources.

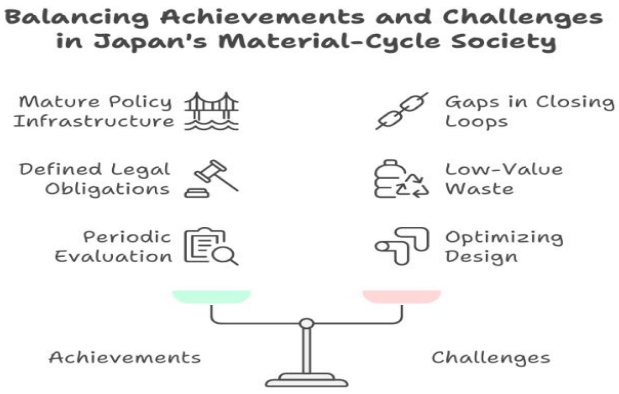

Figure 6: Challenges and opportunities in Japan's MCS

4.1.4 Appliance Recycling Law & End-of-Life Vehicle Recycling System

These are among Japan's leading examples of Extended Producer Responsibility (EPR) in practical deployment.

Home Appliance Recycling Law (Law for the Recycling of Specified Kinds of Home Appliances)

Enacted in June 1998, enforced April 2001. It targets specific major appliances (originally: air conditioners; CRT TVs; refrigerators/freezers; washing machines). Later amendments in 2009 added LCD/plasma TVs and clothes dryers.

Under this law:

- **Consumers pay** a collection & recycling fee when disposing of these appliances; they deliver old appliances to retailers or specified collection points.
- **Retailers are obliged** to take back appliances when new ones are bought or replaced and facilitate their delivery to manufacturers or licensed recycling plants.
- **Manufacturers / Importers** are responsible for actual recycling according to government standards; setting up/contracting recycling plants; separating components; feedback into product design.

The recycling rates have increased over time; required recycling percentages (by weight or material) have been raised in amendments. For example, in the 2009 revision: air conditioners' rate increased from 60% to 70%, etc. The process in recycling plants: dismantling and sorting manually, then mechanical shredding/separation; feedback to design to ease future recycling (e.g. easier disassembly, clearer materials labeling) is part of the system.

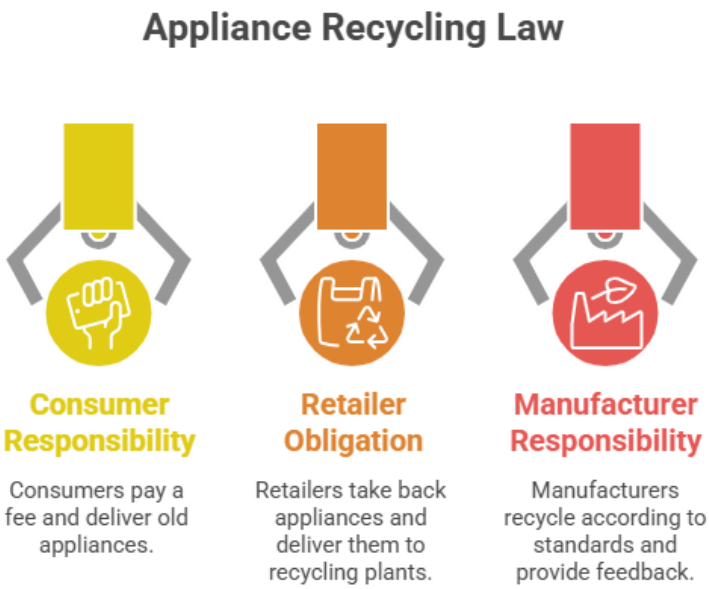

Figure 7: Japan's Appliance Recycling Law

End-of-Life Vehicle (ELV) Recycling Law

Passed in 2002 (Act No. 87), gradually implemented starting in 2003; full enforcement in 2005. Its aim is to reduce waste from vehicles (especially shredder residue (ASR)), properly handle hazardous/deleterious components (airbags, fluorocarbons), and promote reuse/recycling.

- Key stakeholder obligations:
    - **Vehicle owners:** take ELVs to registered collection operators; pay a recycling fee (often at the time of vehicle registration or inspection) which covers parts like airbags, fluorocarbons, etc.
    - **Automakers / importers:** collect back vehicles; remove designated parts; set recycling fees; ensure recyclability via design improvements.
    - **Dismantlers,** fluorocarbon recovery operators, shredders: must be licensed or registered; follow specified handling and processing standards.
- Outcomes:
    - High participation: e.g. tens of thousands of collection companies, dismantlers, etc.
    - Reuse + recycle of around 75-80% by weight per vehicle on average; efforts to minimize ASR.

- Challenges:
    - ASR (automobile shredder residue) remains significant, both in volume and as a disposal burden. Reducing ASR further requires advances in design, materials, and disassembly.
    - Profitability issues for dismantling/shredding firms when scrap prices are low or disposal/transport costs are high.

Figure 8: Japan's End-Of-Life Vehicle Recycling Law.

Eco-Town Programs and Industrial Symbiosis

Japan's Eco-Town Program, established in 1997, is a policy scheme intended to promote local/regional industrial clusters in which wastes from one industry or company become inputs for others (industrial symbiosis) under a zero-emission or near-zero emission philosophy. It aims to revitalize local economies while reducing environmental burdens. The program works by local governments + industry associations formulating a plan; upon approval by national ministries (Ministry of Environment and Ministry of Economy, Trade & Industry), such plans receive multi-faceted support (financial, technical, regulatory). The Eco-Town approved projects include diverse industrial recycling, remanufacturing, and reuse operations; sometimes waste heat recovery; or looped material flows. The idea is to localize supply chains, reduce transportation/emissions, create jobs in recycling / material recovery. The Industrial symbiosis in Japan (within Eco-Town or more broadly) has involved sectors such as metals, plastics,

chemical by-products; for example, waste gas or effluent from one facility is treated and used by another; ash or slag used as construction material, etc. These also tie back into the Sound Material-Cycle Society framework.

Figure 9: Synergy in Eco-Town Industrial Symbiosis

Consumer Engagement & Waste Separation

In Japan, household waste (municipal solid waste) separation is quite detailed and local variation exists, but many municipalities require residents to separate waste into multiple categories (burnable, non-burnable / incombustible, recyclables, oversized, and further sub-categories for paper, plastic bottles, cans, glass, etc.) The non-compliance often means waste is not collected; municipalities provide guidelines / pamphlets / calendars; some areas even inspect bags or label non-compliant bags. As examples: "oversized garbage" (large furniture or large appliances) follow special rules; certain appliances are outside local collection under municipal waste and fall under the Appliance Recycling Law (so consumers pay recycling fees / coordinate with retailers or specific collection points). The municipal initiatives / community groups do awareness raising; sometimes model projects under the 3R (Reduce, Reuse, Recycle) concept are adopted locally (food waste reuse, community composting, "reuse exchange" events etc.).

Strengths & Lessons from Japan's Practice

- **Clear legislation with assigned responsibilities:** Laws like the Basic Act, Appliance Recycling Law, ELV Law clearly define who does what (owners, manufacturers/importers, collectors, government).
- **Economic instruments plus regulation:** Obligations for fees (recycling/collection) assigned to consumers or producers; licensing / registration requirements for companies; standards of recycling/reuse.
- **Data, monitoring, evaluation:** Government tracks material flows, publishes Fundamental Plans, evaluates progress, revises targets. For example, in the appliance recycling law, collecting/cycling rates have increased and fees adjusted over time.
- **Design for recyclability:** Feedback to product design is embedded (ease of disassembly, material labeling, standardization) especially for appliances and vehicles.
- **Local / community level engagement and enforcement:** Municipalities with waste separation rules; community norms and awareness are strong; non-compliance has consequences (non-collection, etc.).
- **Industrial clustering and infrastructure:** Eco-Towns help concentrate resource recovery and reuse infrastructure, helping economies of scale.

Challenges & Limitations

- **Cost / profitability pressures:** When raw material or scrap prices fall, or transport/disposal costs rise, firms in recycling/dismantling/shredding may struggle. This can threaten system sustainability.
- **Residue / non-recyclable waste:** ASR (automobile shredder residue), non-recyclable components, or those that are difficult to process remain a challenge. Better design, material substitution are needed.
- **Uneven implementation across regions:** Local governments vary in capacity; smaller towns or rural areas may struggle with collecting separated waste, maintaining infrastructure, ensuring compliance.
- **Consumer burden and cost:** Recycling/disposal fees and the effort required for correct separation can be seen as burdens on consumers; need to balance incentives / free rider problems.
- **Illegal dumping / informal / unlicensed activity:** Especially for ELVs or appliances, dealing with unlicensed dismantlers or improper disposal remains a risk.

Implications / Transferable Insights

Here are some practices from Japan that seem especially transferable or instructive for other countries (both developed and developing):

Table 2: Best Practices from Japan that are transferable to both developed and developing countries.

Practice	What Makes It Work	Considerations for Adaptation
Legislation with clear obligations + roles (owners, producers, municipalities)	Ensures accountability; clarifies who pays for what; reduces ambiguity.	Needs legal/regulatory capacity; alignment across levels of government.
EPR with fee payment by users plus manufacturer / retailer obligations	Helps internalize disposal / recycling costs; aligns incentives to design better products.	Need to ensure fees aren't prohibitively high; ensure transparency so consumers accept fees.
Phased approach with progressive tightening of targets	Allows industry to adjust; builds infrastructure gradually.	Requires political commitment and consistent evaluation; intermediate targets.
Industrial symbiosis / Eco-Towns	Economies of scale; reduced transport; fosters reuse of by-products.	Needs regional planning; clustering of industries; sometimes financial / tax incentives.
Strong public awareness and household behavioral norms	Enables waste separation; reduces contamination; supports compliance.	Cultural norms matter; need for educational programs; support for households with less capacity.
Monitoring, enforcement, licensing of actors in the waste/recycling value chain	Prevents illegal dumping; ensures quality and safety; maintains system integrity.	Must invest in inspection, staffing, legal follow-through; penalties must be meaningful.

1.13 Korean Model: Economic Instruments and Framework Legislation

The Republic of Korea is recognized as one of the most advanced circular economy regulators in Asia, having combined economic instruments, extended producer responsibility (EPR) and framework legislation to drive a systemic transition toward resource circulation.

Volume-Based Waste Fees (VBWF)

Korea pioneered volume-based waste fee systems (VBWF) in 1995, introducing charges on mixed waste disposal through government-issued standard garbage bags while recyclables and food waste were collected separately. This economic signal significantly reduced per-capita waste generation and increased recycling rates [47]. According to the Ministry of Environment, VBWF reduced household waste by nearly 30% within five years of implementation and remains a cornerstone of municipal CE governance [48]. Comparative studies highlight VBWF as a model for Asia, influencing similar schemes in Japan, Taiwan, and parts of China [49].

Extended Producer Responsibility (EPR)

Korea's EPR system was introduced in 2003 to replace earlier deposit-refund schemes. It obligates producers and importers of packaging materials (paper, plastics, glass, metal) and specific products (lubricants, tires, batteries, fluorescent lamps, WEEE, and ELVs) to meet recycling targets. Non-compliance incurs recycling charges, creating strong incentives for compliance. The Korea Environment Corporation monitors EPR fulfillment and reports steadily increasing recycling rates for packaging plastics and e-waste [50]. Academic assessments show EPR in Korea has reduced landfill dependence and spurred investment in recycling infrastructure, though challenges remain in balancing producer costs and recyclers' market stability .

Circular Economy Strategy and Resource Circulation Law

To consolidate these instruments, Korea enacted the Framework Act on Resource Circulation in 2016 (effective 2018), setting a national vision for CE through waste reduction targets, mandatory resource circulation assessments for large-scale waste generators, and extended reporting requirements. The Act was followed by the First Basic Plan for Resource Circulation (2018–2027), outlining policy goals such as reducing per-capita waste generation by 20% and increasing recycling to 82% . In 2021, Korea updated its legal base with the Act on the Promotion of Transition to a Circular Economy and Society, broadening its scope beyond waste management to encompass product design, industrial by-product utilization, and green procurement. The strategy also integrates CE into Korea's carbon neutrality roadmap, aligning with international goals for sustainable consumption and production [51]. Korea's experience highlights the value of combining price-based instruments, producer accountability, and strategic legislation to foster circularity, offering a benchmark for both OECD and emerging economies.

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[47] Seoul Solution, "Volume-Based Waste Fee System," 2020.

[48] Ministry of Environment Korea, Waste Statistics Report (2017).

[49] OECD, Extended Producer Responsibility in Korea (2014).

[50] Ministry of Environment Korea, EPR System Overview (2020).

[51] UNEP, Global Waste Management Outlook (2021).

Figure 10: Korea's Circular Economy Principles

5. Cross-Cutting Insights from Developed Economies

- **Strong Regulatory Frameworks and Compliance Mechanisms**

Developed economies such as the Netherlands, Japan and Korea demonstrate that well-structured, enforceable, and transparent regulatory frameworks are the backbone of a successful circular economy. These frameworks integrate legislation across product life cycles, covering eco-design, waste prevention, EPR, and green public procurement, ensuring accountability among producers, consumers, and local governments. For instance, the European Union's Circular Economy Action Plan (CEAP) and Japan's Sound Material-Cycle Society Act legally embed circularity targets and define clear institutional responsibilities. Effective compliance systems, through regular audits, data reporting, and performance-based penalties, ensure consistent enforcement. This combination of strong regulation and compliance creates predictability for industries to invest in circular business models and for consumers to trust the system.

- **Investment in Infrastructure and Data Systems**

A defining strength of developed economies lies in their long-term investment in physical and digital infrastructure to support CE transitions. Robust collection, sorting, and recycling facilities, combined with advanced waste treatment technologies, make material recovery both efficient and profitable. Countries like Japan and Korea have established nationwide networks of recycling plants, eco-industrial parks, and resource circulation centres, often supported by continuous R&D investment. In parallel, digital data systems, such as the EU's upcoming Digital Product Passport (DPP), enable traceability, lifecycle monitoring, and transparent material flow accounting. These data-driven systems not only enhance accountability and market confidence but also provide evidence-based insights to refine policy and improve circular performance.

- **Market Incentives for Secondary Materials**

Creating economic value for secondary materials is central to sustaining circular economies. Developed countries employ a blend of fiscal and market-based instruments, tax incentives, deposit-refund schemes, recycling credits, and mandatory recycled-content standards, to ensure steady demand for secondary raw materials. For example, the Netherlands uses public procurement and "Green Deals" to de-risk private investment and create predictable markets for circular products. Korea's volume-based waste fee (VBWF) system and EPR charges similarly internalize environmental costs, encouraging waste minimization and high-quality recycling. These mechanisms align economic incentives with environmental objectives, making circularity a competitive advantage rather than a compliance burden.

- **Citizen Engagement and Behavioral Change**

Behavioural change among citizens is a critical driver of CE success in developed contexts. Japan's rigorous household waste separation rules and community-led awareness programs exemplify how social norms and public participation underpin system effectiveness. European countries promote consumer empowerment through right-to-repair laws, eco-labels, and awareness campaigns encouraging sustainable consumption. Citizen trust and compliance are sustained through transparency, convenience, and continuous education. Ultimately, behavioural alignment ensures that policies translate into tangible circular outcomes, reducing contamination, improving product return rates, and fostering shared responsibility for sustainable resource use.

PART III - Circular Economy in Emerging & Developing Economies

6. Transition Pathways in Developing Contexts

1.14 China: State-Led Industrial Circularity

China presents a pivotal case of circular economy implementation in a developing country context. Although officially classified as a developing nation, China is the world's largest emerging economy and its pursuit of CE has far-reaching global impact due to the sheer scale of its resource use and emissions. China was one of the earliest countries to enact dedicated CE legislation: the Circular Economy Promotion Law was passed in 2008 (effective January 2009) to provide a legal framework for improving resource efficiency nationwide [52]. This law institutionalized 3R principles (reduce, reuse, recycle) across production and consumption activities and signaled a shift of China's development model toward circular practices [53]. In parallel with the law, the government launched ambitious pilot programs. In 2005–2007, the State Council and National Development and Reform Commission (NDRC) rolled out two waves of circular economy pilot projects spanning 27 provinces, key industries, and 20 industrial parks[54]. These pilot eco-industrial parks demonstrated industrial symbiosis: for example, in one flagship park, waste from sugar processing is converted into alcohol and fertilizer, forming a closed-loop industrial ecosystem [55]. By fostering such synergies, China has mitigated pollution while boosting resource recovery (one report noted a 93% reduction in wastewater pollutants in the Guigang eco-park after symbiosis measures) showcasing how developing contexts can adapt the Kalundborg-style model at large scale[56].

Table 3: Major policy instruments and milestones in China's circular economy strategy (2005–2025)

Instrument / Initiative	Key Features	Lead Institutions
Circular Economy Promotion Law (2008)	Legal foundation for 3R principles across production and consumption	NPC, NDRC
Eco-Industrial Parks Pilot Program (2005–2010)	Industrial symbiosis, closed-loop processes in designated parks	NDRC, Provincial Governments

[52] https://www.eria.org/RPR_FY2014_No.44_Chapter_7.pdf#:~:text=The%20fourth%20stage%20,industries%2C%20indicating%20a%20widespread%20trend

[53] https://www.eria.org/RPR_FY2014_No.44_Chapter_7.pdf#:~:text=1,Circular%20economy%20in

[54] https://www.eria.org/RPR_FY2014_No.44_Chapter_7.pdf#:~:text=Table%207,utilisation%2C%20recycling%20of%20waste%20household

[55] https://www.eria.org/RPR_FY2014_No.44_Chapter_7.pdf#:~:text=Box%201.%20Guigang%20Eco,and%20ranks%20first%20in%20Guangxi

[56] https://www.eria.org/RPR_FY2014_No.44_Chapter_7.pdf#:~:text=Figure%207,is%20consumed%20in%20the%20demonstration

5-Year Plan Integration (2011–2025)	CE targets embedded in national development strategy	State Council, Ministry of Ecology & Environment
Green Supply Chain Pilots (2016–)	Company- and city-level pilots with sustainable procurement and take-back	MIIT, NDRC
Carbon Neutrality Integration (2021–)	CE tied to China's 2060 carbon neutrality pledge	State Council, NDRC

Source: Adapted from NDRC (2008); UNEP (2021); Li et al. (2020).

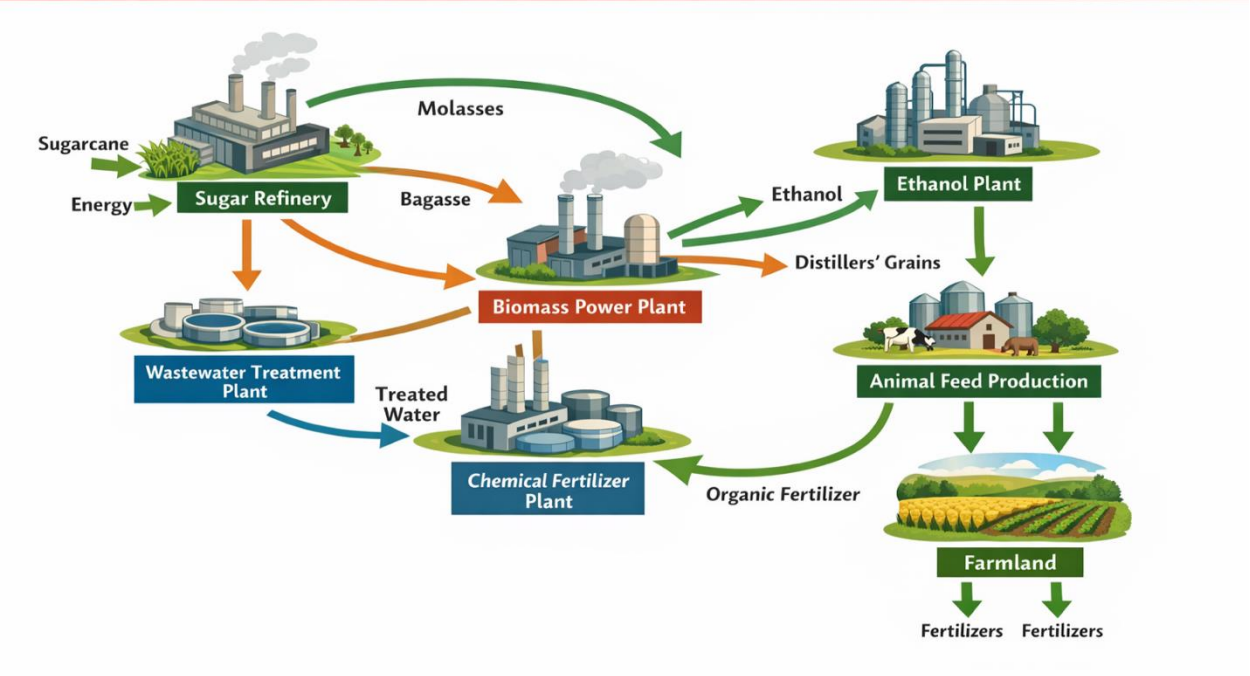


Figure 11: Illustrative material and energy flows in a Chinese eco-industrial park (e.g., Guigang), showing sugar–alcohol–fertilizer loops.

China has also piloted green supply chain initiatives to extend circularity through entire value chains. Since around 2016, authorities have designated hundreds of Green Supply Chain pilot enterprises and cities, encouraging companies to adopt sustainable procurement, cleaner production, and product lifecycle management practices. Over 100 firms were officially recognized as green supply chain pilots, integrating recycling and low-carbon innovations into their operations. These efforts are backed by high-level strategies: China's recent Five-Year Plans and policies (e.g. the 14th FYP 2021–2025) set numerical targets for resource recycling and explicitly tie CE to climate objectives (viewing circular economy as a means to help achieve China's carbon neutrality by 2060 goal)[57]. China's CE journey thus serves as both an inspiration

[57] https://circulareconomy.europa.eu/platform/sites/default/files/2023-08/China%E2%80%99s%20Circular%20Economy%20Policies_%20Review%20and%20Reflection.pdf#:~:text=2020%20to%20prioritize%20internal%20circulation,In

and a test case for other developing countries seeking to transition from linear growth to a circular, sustainable paradigm.

1.15 Chile: Regulatory Leap via EPR

Chile has rapidly emerged as a regional leader in circular economy policy, institutionalizing an ambitious national roadmap that targets a regenerative, circular model by 2040. The Roadmap for a Circular Chile (Hoja de Ruta para un Chile Circular 2040) provides the strategic vision, guiding principles and priority actions across material value chains and public policy instruments, and positions Chile as one of the first Latin American countries to adopt a comprehensive CE roadmap at national level[58].

- **First in Latin America with an Extended Producer Responsibility (EPR) Law**

Chile is recognized as the first country in Latin America to adopt a comprehensive Extended Producer Responsibility (EPR) law, under Law No. 20.920 (2016), known as the Waste Management, Extended Producer Responsibility and Recycling Promotion Law (Ley REP). This framework obliges producers and importers of priority products such as packaging, oils, electrical and electronic equipment, batteries, and tires to manage the entire life cycle of their products, including post-consumer stages. By legally transferring responsibility to producers, the law has stimulated investments in collection, sorting, and recycling infrastructure and promoted eco-design in key sectors. It has since become a benchmark for Latin America, inspiring similar regulations in countries such as Colombia and Peru.

- **Strong Circular Economy Roadmap 2040**

In 2021, Chile launched its Circular Economy Roadmap 2040 (Hoja de Ruta para un Chile Circular al 2040)**,** setting the vision of becoming a fully circular country by 2040. The roadmap establishes four strategic pillars innovation, culture, regulation and territories and sets interim goals for 2030 and 2040**.**

- By 2030, Chile aims to reduce municipal solid waste generation per capita by 25%, achieve a 65% recycling rate for municipal solid waste, and generate at least 180,000 green jobs linked to circular activities.
- By 2040**,** 75% reduction in municipal solid waste sent to landfills, 100% of priority products regulated under EPR schemes, and the full integration of circular economy principles across production, consumption, and waste management systems (Ministerio del Ambiente, 2022).

Table 4: Key targets from Chile's Circular Economy Roadmap 2040, as structured under the 2021 EPR framework.

Target Area	Roadmap Goal (2040)	Responsible Agency
Packaging Waste Reduction	Reduce by 30% (compared to 2019 baseline)	MMA, Local Municipalities
Recycling Rate Increase	Increase to 65% national average	MMA, Recycling Industry
Industrial Symbiosis Growth	Expand symbiosis projects to 100 municipalities	CORFO, Regional Governments

[58] Ministerio del Medio Ambiente Chile, *Hoja de Ruta para un Chile Circular 2040* (2021).

Green Jobs Creation	Create 180,000+ green jobs	Ministry of Labor, CORFO	
EPR Law Compliance	Full EPR compliance in 7 priority sectors	Superintendencia del Medio Ambiente (SMA)	

Example from the 2040 Roadmap

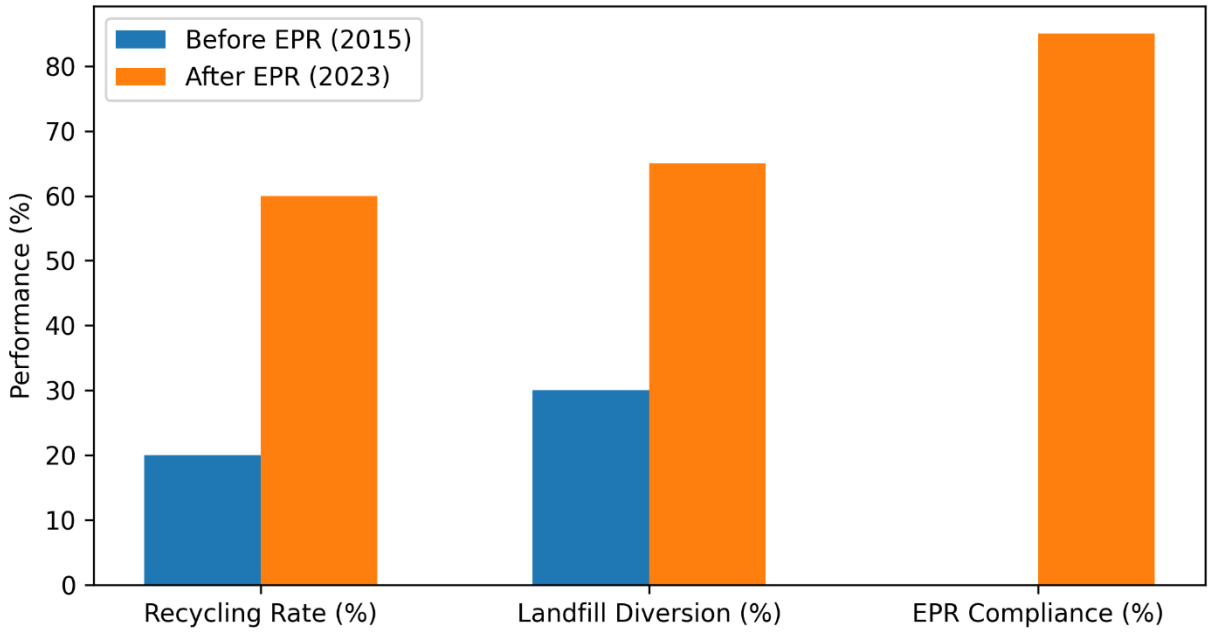
One highlighted action is the development of a National Eco-design and Innovation Program that mandates eco-design criteria for packaging and consumer goods. This program aims to reduce unnecessary material use, extend product lifespans, and improve recyclability, ensuring that by 2040 all products placed on the market are recyclable, repairable, or reusable.

Plastics and Textiles Pilots

Chile has implemented several sector-specific pilots under its Roadmap 2040.

- **Plastics:** In 2019, Chile introduced the Plastic Bag Ban Law (Law 21.100)**,** making it the first country in Latin America to completely prohibit single-use plastic bags nationwide. Building on this, the roadmap pilots focus on circular plastics initiatives such as refill systems in retail, recycling incentives, and biodegradable alternatives.
- **Textiles:** Responding to the growing issue of textile waste, particularly in the Atacama Desert, Chile is piloting programs to integrate textiles into its EPR framework. Pilot projects focus on second-hand clothing markets, textile recycling plants, and partnerships with fashion retailers to implement take-back systems and promote reuse. These initiatives address the pressing environmental and social challenges created by fast-fashion imports and textile dumping (The Guardian, 2025).

Figure 12: Estimated shift in circular material use, landfill diversion, and compliance rates before and after Chile's EPR Law



Source: OECD (2022); Fundación Basura (2023); author-generated visualization.

1.16 Pakistan: Emerging Sectoral Pathways

- **Status overview and policy direction**

Pakistan's circular economy (CE) transition is nascent but accelerating, with most concrete movement in plastics (EPR discourse and policy road-mapping), textiles (buyer-driven circularity pressures), and construction (resource-efficiency and circular construction framing). Pakistan represents a developing-country context where the transition toward a circular economy is expected to emerge through sector-specific pathways rather than through a single comprehensive regulatory overhaul. The country faces increasing resource constraints, rapid urbanization and rising waste generation, which collectively create strong incentives for adopting circular resource management strategies. Recent policy initiatives, particularly the proposed National Circular Economy Policy, are intended to provide a structured framework to move Pakistan away from a linear "take–make–dispose" economic model toward a system that prioritizes resource recovery, waste reduction, and material reuse across key economic sectors

The national momentum around plastics rose sharply in 2022 with the launch of the National Plastic Action Partnership (NPAP) Roadmap by the Government of Pakistan and the World Economic Forum (Global Plastic Action Partnership) to guide systemic actions that include EPR, design standards, and improved collection and recycling [59]. Parallel analyses from SWITCH-Asia map Pakistan's current plastic policy instruments across federal and provincial levels and highlight implementation gaps as well as a need for coherent, upstream measures (SWITCH-Asia, 2025).

Pakistan has also advanced enabling built-environment codes that while primarily energy-focused can complement CE objectives. The Energy Conservation Building Code (ECBC-2023) was notified via S.R.O. 416(I)/2024 on 20 March 2024, establishing mandatory efficiency provisions that can dovetail with material efficiency and lifecycle thinking [60]. Islamabad Capital Territory's ban on polythene bags (2019) and subsequent enforcement notices illustrate growing policy interest in plastics reduction, albeit with uneven implementation [61]. Regionally, evidence on plastics leakage to rivers (including the Indus system) and marine environments highlights the urgency of upstream prevention and improved waste systems [62].

- **Plastics: EPR pilots, packaging policies, and systems gaps**

The NPAP Roadmap (2025) sets out pathways to reduce plastic leakage and improve circularity across the value chain, with emphasis on EPR, product and packaging redesign, data systems, and inclusive models that integrate informal actors. The SWITCH-Asia's Plastic Policies in Pakistan (2025) catalogs the existing policy mix federal frameworks, hazardous waste policy, and a patchwork of provincial single-use restrictions while noting that only parts of the plastics lifecycle are covered coherently, and that enforcement remains inconsistent. At the city/provincial level, single-use bans (e.g., polythene bags) have been adopted but frequently struggle in implementation, limiting real-world diversion. New EPR proposals emerging from national consultations (e.g., 2025 multi-stakeholder events) typically call for phased targets, producer registries, fee modulation, and transparent reinvestment into collection/sorting, with inclusive integration of waste pickers to avoid livelihood disruption and to harness existing recovery capacity. Complementary international evidence shows that downstream recycling

[59] The Guardian, "Textile Waste in Atacama," 2025.

[60] National Energy Efficiency & Conservation Authority (NEECA), *ECBC-2023 Notification* (2024).

[61] Pakistan Environmental Protection Agency (PEPA), Plastic Ban Enforcement Reports.

[62] World Bank, Plastics Circularity and Marine Pollution (2024).

alone cannot offset rising demand; upstream prevention and design-for-circularity are critical (World Bank, 2024).

- **Textiles: buyer-driven compliance and emerging circularity**

Pakistan's export-oriented textile sector faces intensifying buyer requirements for traceability, reduced environmental footprint, recycled content, and take-back/repair logistics pressures that function as "soft EPR" in the absence of domestic mandates (United Nations Conference on Trade and Development [UNCTAD], 2025)[63]. New evidence produced jointly by Reverse Resources and National Textile University (NTU) estimates 887 kilotons of pre-consumer textile waste annually and ~809 kilotons of imported second-hand clothing, a resource base that, if formalized via standards, digital tracking, and investment could support textile-to-textile recycling and higher-value reuse markets (Reverse Resources & National Textile University, 2025)[64]. However, the current ecosystem remains fragmented and largely informal, with financing, technology, and policy incentives cited as binding constraints (Reverse Resources & National Textile University, 2025; UNCTAD, 2025).

Policy opportunities identified include:

- Recycled content and eco-design standards for priority product categories.
- Public procurement pilots for recycled fibers.
- Enabling green finance and risk-sharing instruments.
- Producer responsibility models co-designed with leading buyers; and
- Integration of circularity targets into sectoral export strategies and Pakistan's climate plans (UNCTAD, 2025).

Construction: resource efficiency and circular construction

Among CE domains, construction shows the clearest Pakistan-specific blueprint as per the 2025 SDPI working paper that synthesizes design-for-disassembly, modularity, reclaimed materials markets, and demolition waste management as pillars for a circular construction pathway [65]. The paper argues for embedding circularity into codes and permitting. e.g., recycled-content requirements, selective demolition protocols, material passports, and public procurement of secondary aggregates combined with training for developers and municipal authorities (Naeem et al., 2025). Alignment with the ECBC-2023 (energy) and the Pakistan Green Building Code (PGBC-2023) would help mainstream lifecycle thinking, even while those codes themselves focus primarily on energy performance and green construction practices rather than full material circularity.

- **Barriers and policy gaps**

Governance & enforcement. Fragmented mandates across federal/provincial tiers complicate end-to-end CE policy design and monitoring; enforcement capacity is uneven, especially for single-use bans and waste segregation rules (SWITCH-Asia, 2025; PEPA, 2019, 2024).

Data systems. Reliable, disaggregated material flow and waste data remain limited, constraining EPR target-setting, fee modulation, and performance tracking (SWITCH-Asia, 2025; World Bank, 2024).

[63] UNCTAD, Trade and Circular Textiles Report (2025).

[64] Reverse Resources and National Textile University, Textile Waste Study (2025).

[65] Naeem et al., Circular Construction Pathways in Pakistan (2025).

Informal sector integration. A large share of collection and recycling is performed by informal actors; new EPR frameworks that omit them risk social exclusion and reduced recovery efficiency (SWITCH-Asia, 2025).

Financing & technology. Scaling material recovery facilities, reverse logistics, and advanced recycling requires patient capital and risk-sharing mechanisms; SMEs face technology and skills gaps, notably in high-quality secondary materials production (Reverse Resources & National Textile University, 2025; UNCTAD, 2025).

Standards & eco-design. Absent or non-binding eco-design and recycled-content standards slow upstream prevention and suppression of low-value waste generation (SWITCH-Asia, 2025; UNCTAD, 2025).

Priority pathways (near- to medium-term)

1. **Phased EPR for packaging plastics** with realistic targets, producer registries, fee modulation tied to recyclability/recycled content, and inclusive contracts for waste-picker organizations.
2. **Municipal source-segregation pilots** paired with integrated resource recovery centers (IRRCs) which means empowering the waste picker (*Kabariya)* and adding the picker to formal registration system where the picker is responsible for sorting the waste at IRRC as per the model developed by the Akhtar Hameed Khan Foundation in different cities of Khyber Pakhtunkhwa and Punjab, and performance-based funding to build predictable feedstock for recyclers. The fund can also be collected from producers or by charging a minimal fee as the import duty to the plastic importers, which can be routed to a national fund that can support SMEs and recycling facilities.
3. **Textile CE pilots** (e.g., cut-waste valorization, take-back/repair hubs, recycled-content yarns) co-designed with anchor buyers; support with standards, labels, and green finance. Incentivizing the used textiles sector for waste upcycling
4. **Circular construction policy package**: selective-demolition rules, recycled-content thresholds in public projects, material passports, and integration of circularity provisions into ECBC/PGBC enforcement; train officials and developers.
5. **Public procurement** to create steady demand for secondary materials (recycled plastic products, secondary aggregates, recycled fibers) and to de-risk private investment.
6. **Data and MRV**: national material-flow accounts and EPR reporting systems (digital registries) to underpin targets and transparency

Figure 13: Potential Sectors for Circular Economy Transition in Pakistan.

6.3.1 Proposed Extended Producer Responsibility (EPR) Fundamentals for Plastics in Pakistan

The Extended Producer Responsibility can serve as a central policy mechanism for transitioning Pakistan's plastic economy toward a circular system where materials are recovered, reused, and reintegrated into production cycles. In the current context, plastic packaging and products are introduced into the market without sufficient responsibility for their post-consumer management. An effective EPR framework would redistribute responsibility across the value chain by requiring producers, importers, and brand owners to assume financial and operational roles in managing plastic waste generated from their products. The primary objective of such a system is to ensure that plastics placed in the market are eventually collected, segregated, and routed into recycling streams rather than entering unmanaged waste systems.

A foundational requirement of EPR in Pakistan is the establishment of a transparent reporting and registration system for entities introducing plastic materials into the market. The producers, importers and brand owners (PIBOs) should be required to report the type and quantity of plastics they place into the market annually. This information would allow regulatory institutions to understand plastic material flows, track compliance, and design realistic recovery and recycling targets. Moreover, reliable data on plastic generation and recovery is essential for building accountability within the system and enabling evidence-based policy interventions.

A second core principle involves creating a predictable financing structure that supports the development of circular infrastructure. The plastic recovery systems cannot expand without sustained financial resources. An EPR mechanism should therefore establish a dedicated financing stream either at Federal level where (provincial coordination committees under Environment Protection Departments are also members to help route the fund to the provinces as well) through which obligated companies contribute toward strengthening waste

management and recycling systems. These resources can support investments in waste segregation infrastructure, logistics systems, recycling industries and small enterprises engaged in circular plastic manufacturing. The financing system should prioritize long term system development rather than isolated waste management projects.

The segregation of waste represents another critical pillar of an effective EPR system. Recycling markets depend on clean and traceable material streams, which cannot be achieved when waste remains mixed at the collection stage. Therefore, establishing structured segregation nodes such as Integrated Resource Recovery Centers (IRRCs) where *Kabariyas* (informal waste pickers) manage basic waste sorting, can enable plastics to be separated, weighed and routed into appropriate recycling channels even including SMEs. These facilities would act as operational hubs that connect municipal waste collection systems with recycling industries and circular enterprises.

An inclusive circular economy framework must also recognize the role of informal waste workers who already contribute significantly to plastic recovery in Pakistan. Waste pickers, collectors and small aggregators form the backbone of existing recycling supply chains. So, the EPR implementation should therefore prioritize mechanisms that integrate these workers into formal recovery systems while ensuring occupational safety, fair participation and improved working conditions. This is possible via IRRCs. Their inclusion can significantly improve recovery efficiency while addressing social safeguards within the circular transition.

Another important element is the introduction of **eco-modulation mechanisms that differentiate between recyclable and difficult-to-recycle plastics**. Products that rely heavily on virgin plastic materials or complex packaging formats should carry higher environmental responsibility within the EPR system. The eco-modulated fee structures can encourage producers and consumers to shift toward packaging that is easier to recycle or incorporates recycled plastic content. In addition, minimal environmental charges linked to virgin plastic consumption can help discourage excessive reliance on newly produced polymers while simultaneously generating financing for recycling systems. Such pricing signals gradually shift market behaviour without placing disproportionate economic burdens on consumers.

Finally, EPR implementation in Pakistan should follow a phased transition pathway. The circular systems require time to develop, and regulatory obligations should correspond with the growth of segregation infrastructure, reporting systems and recycling capacity. Furthermore, the initial phases can emphasize voluntary commitments, system building and data generation, followed by the introduction of mandatory reporting requirements and gradually increasing recycling targets. Over time, such a framework can create a stable circular plastics economy where recovered materials re-enter manufacturing supply chains and dependence on imported virgin polymers is reduced. Together, these fundamentals provide the institutional, financial and operational building blocks for implementing EPR in Pakistan. By combining transparent reporting systems, stable financing mechanisms, segregation infrastructure, social inclusion, eco-modulated plastic pricing and phased regulatory enforcement, the country can create a practical pathway toward a functional circular plastics economy.

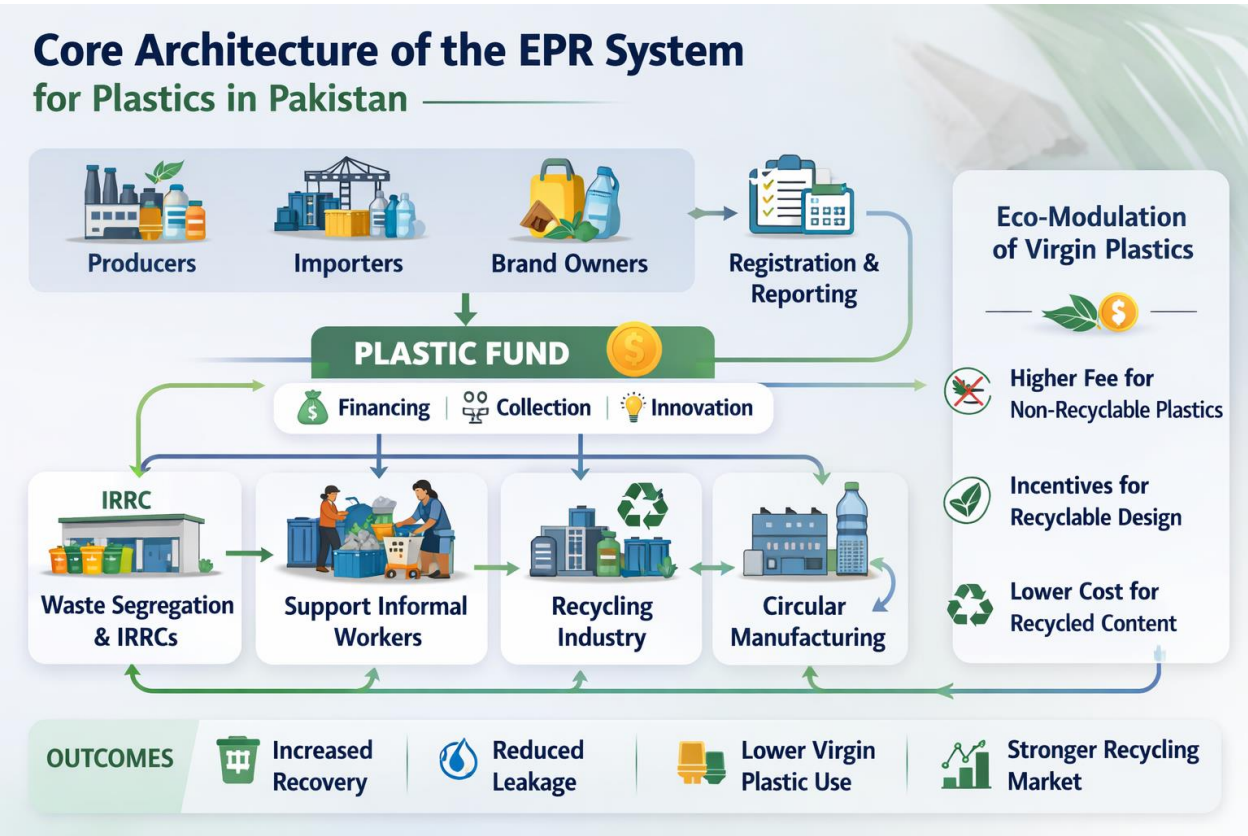


Figure 14: Proposed Core Architecture of the EPR System for Plastic Waste Management in Pakistan.

1.17 Financing Strategy for Circular Economy Transition in Pakistan

The transition toward a circular economy in Pakistan requires a coherent financing architecture that mobilizes domestic resources, private sector participation, and international cooperation. Identifying priority sectors such as plastics, textiles, construction materials, recycling industries, and circular technologies is only the first step; the implementation of circular systems depends on sustainable funding mechanisms that can support waste segregation infrastructure, Integrated Resource Recovery Centers (IRRCs), recycling enterprises, and circular product innovation. A national circular economy financing approach should therefore focus on establishing dedicated funding pools that channel resources toward resource recovery, recycling systems, and circular industrial development while ensuring coordination between federal institutions, provincial governments, and industry stakeholders. In the plastics sector, a national plastic circularity financing mechanism can serve as an anchor for circular economy investments. This could involve the establishment of a national plastic fund supported through voluntary contributions from producer organizations and companies placing plastic products into the market, allowing the private sector to participate in financing post-consumer waste management systems. Additional financing streams could emerge through minimal environmental charges on virgin plastic materials entering the market and through the allocation of a portion of import duties on plastic polymers. Revenues generated through these mechanisms could be directed toward expanding waste segregation systems, financing Integrated Resource Recovery Centers, strengthening recycling supply chains, and supporting enterprises engaged in plastic recovery and processing. Such a mechanism would simultaneously strengthen domestic recycling capacity while reducing environmental leakage of plastic waste. Beyond plastics, sector specific financing approaches are needed to accelerate circular innovation across other industries. In the textile sector, collaboration between the

formal textile industry and the used textile trade can help finance recycled and upcycled clothing lines, supported by government led certification systems that promote circular textile products in domestic and international markets. In the construction sector, financing mechanisms can encourage enterprises specializing in the recovery and reuse of construction materials, while real estate and infrastructure projects integrate recycled materials into building practices. Circular renewable energy systems also require financing models that support SMEs engaged in recovering valuable materials from solar panels and batteries as these technologies expand across the country. Strengthening access to finance through microfinance institutions and SME credit facilities will be essential for scaling circular enterprises in recycling, repair, refurbishment, and resource recovery sectors. At the same time, Pakistan can attract investment by presenting circular economy projects as bankable opportunities while strengthening regional cooperation in South Asia and advocating globally for stronger responsibility frameworks in which high consumption economies contribute to financing waste management and recycling systems in countries managing global waste streams.

7. Cross-Cutting Insights from Developing Economies

The transition toward a circular economy (CE) in developing countries is shaped by institutional capacity constraints, limited financing, heavy reliance on the informal sector, and strong external influence from donors and multinational buyers. While developed countries often implement CE through comprehensive legislation, infrastructure investment, and high levels of consumer engagement, developing contexts reveal a different trajectory, one that is gradual, experimental, and adaptive. The experiences of China, Chile, Pakistan, and others highlight four key lessons:

1. **Pilot-based approaches with donor and NGO support**

In developing economies, CE initiatives frequently begin as small-scale pilots, often designed and financed through external support rather than embedded in national budgets. These pilots allow governments and stakeholders to test feasibility, build institutional knowledge, and generate momentum for scaling up.

- **China** initially experimented with eco-industrial parks and green supply chain pilots in selected regions, often supported by bilateral cooperation with the EU, UNIDO, and the World Bank. These pilots generated measurable results, such as reductions in industrial waste and energy consumption that later informed the drafting of the Circular Economy Promotion Law (2009).
- **Chile**'s circular economy journey gained traction through donor-backed pilots in plastics and textiles recycling, supported by international initiatives like the Ellen MacArthur Foundation's CE platform. Such external partnerships provided credibility, technical expertise, and visibility that helped accelerate adoption of the CE Roadmap 2040.
- **Pakistan** remains at a nascent stage, where donor and CSR-backed pilots dominate CE efforts. For instance, EPR pilots in plastics (supported by multinational consumer goods companies and local NGOs) are being trialed in major urban centers. These efforts remain fragmented but serve as important learning laboratories that may guide future regulatory frameworks.

Lesson: Donor/NGO-backed pilots are crucial for lowering entry barriers, but countries must ensure these do not remain isolated projects. Institutionalization and scaling through policy adoption are necessary for lasting impact.

2. **Gradual regulatory strengthening (phased EPR, bans, standards)**

Developing countries cannot leap directly into fully fledged CE regulations due to weak enforcement systems and industry resistance. Instead, they adopt a gradualist approach, starting with voluntary measures, soft regulations, and targeted bans before moving to mandatory extended producer responsibility (EPR) schemes.

- **China's Circular Economy Promotion Law (2009)** represents the first comprehensive national CE legislation in a developing country. It was phased in gradually: beginning with energy efficiency and resource conservation targets in heavy industries, followed by stricter rules on industrial symbiosis, recycling markets, and consumer product stewardship.
- **Chile** provides a Latin American example where gradualism has worked effectively. Its 2016 EPR Law (Law 20.920) introduced producer responsibility for priority products such as packaging, tires, batteries, and electrical appliances. Implementation was sequenced over several years, accompanied by capacity-building for producers and municipalities.
- **Pakistan**, while lacking a national CE law, shows how sectoral policies and voluntary compliance mechanisms can serve as stepping stones. For example, packaging EPR

pilots and textile sector standards driven by global buyers illustrate how phased compliance builds pressure for domestic regulatory reform.

Lesson: Incremental regulatory strengthening through phased bans, voluntary standards, and progressive EPR adoption enables industries and governments in developing economies to adjust without triggering resistance or compliance failure.

3. **Leveraging informal sector participation**

The informal sector plays a disproportionately important role in waste collection, sorting, and recycling in most developing countries. Unlike developed economies, where formal systems dominate, CE transitions in the Global South require policies that acknowledge and integrate these actors rather than displace them.

- **In China**, informal recyclers historically managed a large share of household waste and secondary raw material recovery. Over time, the state sought to formalize and integrate them into urban recycling systems, balancing efficiency with the need to enforce quality standards.
- **In Chile**, the government recognized the critical role of grassroots waste pickers, or recicladores de base, and gradually incorporated them into municipal waste management contracts, offering training and legal recognition. This inclusion not only improved recycling rates but also enhanced the livelihoods of vulnerable communities.
- **In Pakistan**, the kabariwala system, informal scrap dealers, scavengers, and recycling networks remains the backbone of plastics and textiles recovery. They provide cost-efficient recycling services where municipal systems are absent. However, their work is often unsafe, unregulated, and undervalued. A successful CE transition will depend on upgrading their role through formal recognition, social protection, and integration into producer responsibility schemes.

Lesson: The informal sector is not a barrier but an asset. Its efficiency and coverage can accelerate CE adoption if integrated into formal frameworks with safeguards for workers' rights and health.

4. **Regional collaboration and South–South learning**

Developing economies increasingly benefit from regional knowledge exchange and South–South partnerships, which allow them to adopt practices that are more context-appropriate than importing developed-country models wholesale.

- **China's** leadership in CE has influenced other Asian countries through ASEAN+3 platforms, the Belt and Road Initiative's green guidelines, and UNEP-led South–South cooperation programs. Its experience in industrial symbiosis parks has become a reference for resource-efficient industrialization in emerging economies.
- **Chile** is pioneering CE policy in Latin America, and its Circular Economy Roadmap 2040 is being used as a template by neighboring countries like Colombia and Peru, which are drafting similar frameworks.
- **For Pakistan and South Asia**, collaboration under platforms like ESCAP's regional CE initiatives, the Basel Convention regional centers, and plastic treaty negotiations provides avenues for mutual learning, capacity-building, and harmonization of standards. Regional cooperation can also help address transboundary waste trade, a critical issue for South Asia.

Lesson: South–South and regional cooperation allows developing countries to adapt tested solutions from peer economies, reducing the risks of policy misfit, while collectively addressing shared challenges such as plastic pollution and cross-border e-waste flows.

PART IV - Comparative and Strategic Analysis

8. Comparative Assessment: Structural Differences and Convergences

1.18 Policy Design and Governance Capacity

Developed countries tend to have more comprehensive and integrated circular economy policies, whereas developing countries often rely on fragmented initiatives or pilots. In the EU and other advanced economies, governments have adopted holistic CE action plans and laws – for example, the EU's Circular Economy Package encompasses broad legislation on waste, eco-design, plastics, and a monitoring framework, creating a unified strategic direction. Such comprehensive policy design ensures alignment across sectors and scales (national to local) and provides long-term regulatory certainty for businesses to invest in circular solutions.

By contrast, many developing countries do not yet have an overarching CE policy; instead, efforts may consist of isolated pilot projects, sector-specific regulations, or short-term programs. This difference is partly due to capacity constraints: surveys indicate that developing nations struggle with limited institutional capacity to formulate and enforce wide-ranging CE regulations. As a result, policy measures in developing contexts can be piecemeal for instance, a city-level waste recycling scheme here, a pilot industrial symbiosis park there without a binding national strategy to connect them. Even in China, which has a national CE law, early implementation leaned heavily on pilot cities and parks before scaling up.

1.19 Financing and Investment Models

Financing the circular transition presents a major divergence between developed and developing worlds. Developed countries generally have better access to capital for green projects – they can mobilize public funding (e.g. EU structural funds, innovation grants) and attract private investment into circular business models more readily, supported by mature financial markets and green financing frameworks.

In contrast, developing countries face significant investment gaps in CE infrastructure and enterprises. A lack of domestic financial resources, higher perceptions of risk, and competing development priorities mean fewer funds are available for things like modern recycling facilities, remanufacturing plants, or circular start-ups. Indeed, respondents in a global survey identified limited access to finance as one of the greatest challenges for scaling up CE in developing economies. The majority of investment in many low and middle-income countries still flows into traditional linear sectors (e.g. virgin resource extraction, conventional manufacturing) rather than circular ventures. Foreign direct investment patterns reinforce this: it's noted that "the majority of (foreign) investments are directed at linear resource extraction and processing" in developing regions, underscoring a shortage of capital for circular initiatives. This investment gap is often compounded by weaker incentives – whereas developed nations might offer tax breaks or procurement preferences for circular products, developing nations may lack the fiscal space or policy mechanisms to do so at scale.

Bridging these financing gaps likely requires international support (through development banks, climate finance mechanisms, technology transfer grants) and improvements in the business case for circular projects in developing contexts. Without adequate investment, promising CE projects in poorer countries struggle to move beyond pilot scale, creating a stark contrast with the more finance-fueled circular innovations seen in wealthier economies.

1.20 Role of Private Sector and Informal Economy

The actors driving the circular economy also differ between developed and developing countries. In developed economies, the private sector (formal) plays a leading role – large companies and startups alike are adopting circular business models, from multinational manufacturers running product take-back programs to tech firms enabling sharing platforms. These companies operate in regulated environments and often in response to consumer and policy pressures for sustainability.

Conversely, in developing economies, the informal sector is a crucial player in circular activities. A significant portion of recycling, repair, and reuse in many developing countries is handled by informal workers and micro-enterprises for example, waste pickers, scrap dealers, and informal repair technicians. Estimates suggest that in urban areas of the Global South, millions of people earn livelihoods through informal waste management and recycling services. This large and active informal sector has the advantage of existing circular practices (high rates of material recovery and repair at low cost), but it poses challenges for integration and upgrade.

Coordination between the formal private sector and informal actors is often weak: informal recyclers can out-compete formal recycling companies by operating with lower costs and by accessing waste streams directly at the source. As one study notes, "with the informal sector capturing a large share of material f lows, more formalized recycling processes cannot source enough feedstock to be economically viable" in countries like India or Nigeria.

Furthermore, the informal nature means these activities are typically unregulated and have poor labor and environmental standards, unlike the highly regulated waste management industry in developed nations. Governments in developing countries face a dual task: recognizing and professionalizing the informal sector (to improve safety and efficiency) while also encouraging formal businesses to enter the circular economy space. By contrast, developed countries have mostly formalized systems (e.g. licensed recycling firms, authorized repair centers), and the challenge there is more about scaling business innovation and consumer uptake, rather than basic material collection.

1.21 Technology and Innovation Adoption

There is a pronounced gap in the availability and adoption of technology for circular economy between developed and developing nations. Developed countries not only invest heavily in R&D for new circular technologies (such as advanced recycling processes, bio-based materials, digital tracking systems), but they also have the infrastructure and skills to implement these innovations rapidly. In developing countries, access to technology is a limiting factor – both in terms of physical equipment and human capital.

Many developing economies struggle to acquire cutting-edge recycling or remanufacturing equipment due to high costs and limited access to finance (as noted in 6.2), and they may also lack technical expertise or training for operating such systems. Moreover, the diffusion of innovation is slower: for instance, while a European company might deploy AI-enabled sorting robots for recycling, a recycler in a low-income country might still rely on manual sorting and decades-old techniques.

Technology transfer from developed to developing countries is therefore critical for closing this gap. However, it faces challenges like intellectual property restrictions, trade barriers, and the need for local adaptation of technologies (machinery must cope with different waste compositions or climate conditions, for example). The digital divide is another aspect – modern circular models often lean on digital platforms (for sharing, asset tracking, etc.), yet in some developing regions, a large share of the population lacks access to the internet or smartphones,

hindering adoption of such innovation. According to a survey, along with finance, lack of access to technology was identified as a top barrier to scaling CE in developing countries. This refers not only to heavy industrial tech but also to softer technologies like software systems for resource mapping or marketplace apps for secondary materials.

Developed countries typically have supportive ecosystems (universities, innovation hubs, government incentives) that promote continuous CE innovation – e.g. the Netherlands actively pilot's new material tracking systems, Japan invests in robotics for disassembly whereas developing countries may depend on importing technologies or partnering with foreign firms. Successful instances of technology transfer (such as donating advanced recycling equipment or joint ventures to build local remanufacturing facilities) can greatly accelerate circular adoption in developing economies.

1.22 Monitoring, Enforcement, and Compliance

Monitoring progress and enforcing compliance with circular economy policies is generally more robust in developed countries and more challenging in developing ones. Developed nations usually have established statistical systems and regulatory agencies to track indicators like recycling rates, waste reduction, and corporate compliance with waste laws.

For instance, the EU has a CE monitoring framework with indicators (e.g. circular material use rate, waste per capita) reported annually, and environmental agencies that inspect and enforce standards (such as regulations on product take-back or landfill bans). While enforcement is not perfect even in rich countries (issues like illegal shipment of waste to poorer countries persist), there is at least institutional capacity and rule of law to pursue violators and adjust policies. In developing countries, monitoring and enforcement often lag due to institutional weaknesses.

Governments may lack reliable data on material flows or waste handling, making it difficult to gauge circularity objectively. More critically, enforcement of regulations (where they exist) is frequently inconsistent. A striking example is e-waste management in India: despite rules on electronic waste, over 95% of e-waste is processed in the informal sector (urban slums) by untrained workers with no safety equipment, indicating that laws on paper are not being effectively enforced on the ground. This leads to environmental hazards and lost resource recovery potential. Similarly, bans on single-use plastics or scrap import restrictions in some developing countries are sometimes evaded due to weak border controls and the economic incentive to flout rules .

The causes include limited funding and staff for regulators, corruption, and the sheer scale of informal operations that operate outside the legal framework. Compliance by industries can also be an issue – companies in developing regions might not face the same pressure or penalties to meet circular economy standards as their counterparts in countries with stricter governance. Therefore, developing countries often experience a compliance gap, where policies exist but are not fully implemented.

In comparison, developed countries typically have more effective enforcement mechanisms, though they must continuously update them (for example, improving electronic tracking of waste and stricter auditing of recycling processes) to address new challenges. Strengthening monitoring and enforcement in developing nations may involve capacity-building (training inspectors, developing data systems) and community engagement to ensure that regulations are observed.

1.23 Transferable Practices & Adaptation Pathways

8.6.1 What Works Across Contexts

Certain circular economy (CE) practices have demonstrated broad relevance regardless of economic development stage:

- **Extended Producer Responsibility (EPR):** Successful in both developed (EU, Japan, Korea) and developing countries (Chile, China). While design and enforcement vary, EPR creates accountability for waste streams such as packaging, electronics, and plastics.
- **Repair and Reuse Systems:** Community repair centers in Europe and the thriving informal repair economy in South Asia illustrate the universal potential of extending product lifespans.
- **Green Public Procurement (GPP):** Governments can act as market shapers by prioritizing low-carbon and circular products in procurement, creating demand signals across all contexts.
- **Awareness Campaigns:** Consumer behavior changes whether Japan's meticulous waste separation or grassroots campaigns in Chile has been essential in building circular mindsets.
- **Key insight:** These tools work best when tailored to the governance capacity, consumer culture, and industrial maturity of each country.

Developed-to-Developing Knowledge Transfer Opportunities

Developed countries can accelerate CE adoption in developing contexts through:

- **Technology Transfer**: Sharing digital tools (e.g., product passports, tracking systems, eco-design software) that enable traceability and material recovery.
- **Regulatory Templates**: Offering model laws and standards (e.g., EU CEAP, Japan's recycling laws) that can be adapted by developing countries in phased ways.
- **Capacity Building & Skills Training**: Partnerships to develop local expertise in waste auditing, eco-innovation, and compliance monitoring.
- **Financing Mechanisms**: Providing concessional finance, blended finance instruments, and innovation funds to address investment gaps in recycling infrastructure and industrial symbiosis.
- **Global Supply Chain Alignment**: Ensuring that CE standards in trade (e.g., textiles, packaging) include support for supplier countries like Pakistan, rather than punitive requirements.

Adaptation of Practices Considering Capacity, Infrastructure, and Culture

For developing economies, direct adoption of advanced CE frameworks often risks failure. Instead, practices should be sequenced and culturally embedded:

- **Phased EPR Implementation:** Begin with priority waste streams (plastics, electronics) and scale gradually as monitoring capacity improves.
- **Infrastructure-Light Models**: Encourage repair and reuse through informal markets and community hubs before moving to high-tech recycling systems.
- **Cultural Leverage Points**: Utilize existing social behaviors (e.g., thrift culture, second-hand use in South Asia) to normalize circularity.
- **Informal Sector Integration**: Instead of displacing waste pickers and recyclers, policies should formalize and support their role with safety nets, training, and inclusion in EPR systems.

- **Regional Pathways**: South–South cooperation (e.g., China–Pakistan industrial park exchanges, Chile's role in Latin America) can help contextualize CE frameworks better than importing European model's wholesale.

1.24 Risks of Direct Policy Transfer

While knowledge transfer is valuable, uncritical adoption of developed-country practices carries risks:

- **Greenwashing:** Companies may adopt superficial recycling or eco-label initiatives without genuine impact, especially if monitoring systems are weak.
- **Inequality:** Formal CE policies could marginalize informal workers who currently sustain recycling ecosystems in developing economies.
- **Affordability Issues:** Eco-products and circular services may remain inaccessible to low-income groups, undermining inclusivity.
- **Regulatory Burden**: Overly strict, imported standards without local capacity could lead to non-compliance, economic strain on SMEs, and resistance from industries.

Key Insight: Effective CE transitions require context-sensitive pathways—balancing ambition with feasibility, inclusivity, and cultural alignment.

Part V - Policy Takeaways

9. Policy Recommendations

1.25 For Developed Economies

- **Policy Gaps in Developed Countries**

Although developed countries have been at the forefront of circular economy (CE) initiatives, significant policy gaps remain. Fragmentation of standards across jurisdictions undermines the comparability of recycling and Extended Producer Responsibility (EPR) schemes (OECD, 2016). Weak technology transfer mechanisms mean CE innovations developed in advanced economies are slow to reach emerging markets, limiting global impact (Preston, 2012). Trade in secondary raw materials is hindered by divergent certification and data requirements (Geng et al., 2012). In addition, global cooperation on CE is often ad hoc, relying on bilateral projects rather than robust multilateral governance (van Ewijk and Stegemann, 2016). Finally, insufficient finance and risk-sharing mechanisms constrain the scaling of CE infrastructure in developing regions (Preston, 2012; Kirchherr et al., 2018).

- **Policy Recommendations**

To strengthen the global transition to a circular economy, developed countries must move beyond domestic reforms and embrace their unique responsibility as global leaders. Their economic weight, technological capabilities, and political influence place them in a position to set the pace of change, but fragmented standards, limited technology transfer, and weak global cooperation continue to undermine progress (Preston, 2012; OECD, 2016). The following recommendations outline a pathway for developed countries to close these gaps and accelerate a coordinated, inclusive, and effective transition.

1. **Strengthen Global Cooperation:** Developed countries should establish a multilateral Circular Economy Partnership (CEP) to coordinate international targets, pool research and development (R&D) resources, and share best practices. This platform could enable joint demonstration projects, foster cross-border investments, and build political momentum for scaling circular solutions worldwide.
2. **Promote Technology Sharing:** Setting up regional technology and innovation transfer hubs would ensure that advanced CE solutions such as waste-to-resource technologies, digital product passports, and eco-design frameworks are accessible to developing regions. Managed intellectual property tools like patent pools and open licenses can reduce costs of adoption, while enhancing knowledge flows between academia, industry, and governments.
3. **Harmonise Standards and Metrics:** Internationally aligned standards are crucial for scaling CE practices. Developed countries should promote a common taxonomy of circular materials and processes, develop interoperable digital product passports, and agree on shared recyclability, reparability, and recycled-content criteria (Geng et al., 2012; European Commission, 2020). Harmonizing Extended Producer Responsibility (EPR) schemes would ensure consistent obligations for producers across markets, reducing leakage and administrative burdens.
4. **Leverage Trade and Procurement Policies:** Public procurement and trade measures should be used to stimulate global demand for circular products. Tariff reductions for secondary raw materials, preferential trade rules for eco-designed products, and procurement quotas in public contracts can create predictable markets and incentivize businesses to shift towards circular models.

5. **Ensure Certification and Social Inclusion:** Developed countries should lead in designing harmonized certification and accreditation systems to guarantee the quality and safety of secondary raw materials traded internationally. At the same time, inclusive strategies are needed to integrate informal waste sectors in developing regions through training, licensing, and microfinance ensuring that social justice accompanies technical progress.
6. **Strengthen Monitoring and Evaluation:** A globally agreed set of circular economy indicators should be established to track progress consistently. Key metrics could include the circular material use rate, lifecycle emissions, and waste prevention rates. This evidence base would enable countries to compare performance, identify gaps, and refine policies iteratively .

1.26 For Developing Economies

- **Policy Gaps in Developing Countries**

Developing countries often face significant challenges in transitioning from linear to circular economy (CE) models. Key gaps typically include lack of regulatory frameworks such as EPR laws, weak formal inclusion of informal waste sectors, underdeveloped infrastructure for waste collection and recycling, and limited local technical capacity to adopt advanced circular technologies (Halog & Anieke, 2021). Furthermore, many do not have cross-border collaboration or harmonised agreements to facilitate movement of recycled materials, shared standards, or donor support for scaling CE infrastructure. Without addressing these gaps, CE remains a vision rather than practice in many low- and middle-income contexts.

- **Recommendations for Developing Countries**

Developing countries face unique structural and institutional challenges in adopting circular economy (CE) practices, including fragmented governance, inadequate waste management infrastructure, limited regulatory enforcement, and high reliance on informal waste systems (Halog & Anieke, 2021). To accelerate their CE transition while ensuring inclusivity and economic viability, a phased and adaptive policy approach is essential. The following recommendations outline key priority actions.

1. **Phased Implementation of Extended Producer Responsibility (EPR):** Developing nations should adopt a stepwise EPR framework, starting with high-visibility product streams (such as packaging, e-waste, batteries), moving gradually to more complex ones (textiles, vehicles). Early phases should include public awareness campaigns, pilot take-back schemes, and simplified compliance obligations, allowing producers, regulators and market actors to build capacity and learn from implementation. By doing so, regulatory burdens are managed, informal resistance is reduced, and EPR becomes politically and economically more viable.
2. **Integration of the Informal Sector:** Since informal waste collectors play a central role in waste recovery in many developing settings, policy must include them formally. This could be via licensing, training, providing tools for safer work, integrating them into formal collection and sorting systems, and recognizing their role in achieving collection and recycling targets. Such inclusion improves material quality, expands collection reach, and supports livelihoods, while enhancing traceability and CE metrics.
3. **Donor-Backed Infrastructure and Financial Support:** Many countries lack recycling and processing infrastructure (sorting facilities, material recovery plants, composting units). Developed countries (through bilateral aid, multilateral banks, or donor funds) should provide grants, concessional finance, or blended finance arrangements to support infrastructure build-out. These should be tied to performance metrics and include technical assistance to ensure operations are sustainable. Infrastructure support must also consider access for rural and peri-urban areas, not only major cities.

4. **Capacity Building and Technical Assistance:** Governments should invest in capacity building training regulators, businesses, and communities in eco-design, lifecycle assessment, product reparability, material science, and efficient waste logistics. Partnerships with universities, NGOs, and international agencies are essential. Technical assistance programs can help draft EPR regulations, build standards for recycled content, and set up data systems for CE monitoring.
5. **Roadmaps for Cross-Border Collaboration:** Developing countries should embed cross-border collaboration into their CE strategies: through trade agreements including circular clauses (facilitating movement of secondary materials), South–South knowledge partnerships sharing technology, joint pilots among neighboring countries, and regional standards harmonization. These collaborations reduce duplication, lower trade barriers for recycled inputs, and enable economies of scale for circular infrastructure and markets.

10. Conclusion

The transition toward a circular economy (CE) represents a systemic shift from the linear "take-make-dispose" model to one that prioritizes resource efficiency, regeneration, and sustainable growth. This report's comparative analysis of developed economies (the Netherlands, Japan, Korea) and developing contexts (China, Chile, Pakistan) reveals that while all are moving toward circularity, their approaches differ in pace, depth, and institutional readiness.

In developed economies, success is underpinned by strong regulatory frameworks, long-term national strategies, and effective enforcement. The EU Circular Economy Action Plan, Japan's Sound Material-Cycle Society framework, and Korea's Resource Circulation Act illustrate how clear legislation, Extended Producer Responsibility (EPR), eco-design standards, and digital product tracking systems embed circularity across value chains. Consistent data collection and compliance mechanisms provide the foundation for accountability and innovation, while sustained investment in recycling infrastructure and green R&D drives competitiveness and low-carbon growth.

Market-based incentives and citizen engagement are equally vital. Economic tools, such as deposit-refund systems, fee modulation, and green procurement, create stable demand for secondary materials. Meanwhile, high levels of public participation in waste separation, repair, and reuse strengthen social acceptance of CE principles, proving that behavioural change is essential for sustained progress.

In developing countries, circular transitions are emerging through adaptive and incremental approaches. China's Circular Economy Promotion Law and Chile's 2040 CE Roadmap demonstrate the value of phased regulation and donor-supported innovation. Pakistan's early pilots in plastics, textiles, and construction show momentum but underscore persistent challenges in enforcement, financing, and data systems. The informal sector remains central to recycling and must be formally integrated to ensure inclusivity and efficiency.

Several key lessons cut across contexts: (1) policy coherence and institutional alignment are critical; (2) financial and data systems are the backbone of accountability; (3) citizen participation and behavioural change sustain implementation; and (4) technology transfer and regional cooperation bridge capacity gaps.

Ultimately, circularity is a shared global endeavour, driven by different starting points but united by common objectives. Developed countries must lead through technology sharing, financing, and harmonized standards, while developing nations should prioritize phased, context-sensitive adoption. Achieving circularity will require not only regulatory strength and investment but also cultural transformation and international solidarity. Only through such coordinated efforts can circular economy pathways contribute meaningfully to the Sustainable Development Goals and a resilient, low-carbon future.

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