Martin Dahl
Lazarski University
martin.dahl@lazarski.edu.pl

Goal 12: responsible consumption and production

Introduction

As a systemic lever for climate action, biodiversity protection, pollution reduction, and social wellbeing within the 2030 Agenda, Sustainable Development Goal 12 (SDG 12) seeks to "ensure sustainable consumption and production patterns" (United Nations, 2015; UN DESA, n.d.). Through a life-cycle approach that lowers resource use, waste, and hazardous exposures while enhancing fairness and access, SDG 12 aims to divorce prosperity from environmental degradation throughout value chains (United Nations, n.d.; United Nations Statistics Division, 2024). The empirical rationale is compelling. Global material use has more than tripled since 1970 and, in absence of major policy shifts, is projected to rise by roughly 60% by 2060 relative to 2020 (IRP, 2024; World Economic Forum, 2024). Material extraction and processing drive sizable shares of greenhouse-gas emissions and ecosystem pressures (IRP, 2024). Meanwhile, the share of secondary materials in the global economy has declined—from ~9.1% in 2018 to ~7.2% in 2024 and ~6.9% in 2025—signaling a widening “circularity gap” (Circle Economy, 2024; Circle Economy & Deloitte, 2025). These trends indicate that efficiency gains and incremental recycling are being outpaced by absolute growth in throughput.

SDG 12 operationalizes SCP through interlinked targets on policy mainstreaming (10YFP), food loss and waste, chemicals and waste management, corporate sustainability reporting, and resource efficiency (UN DESA, n.d.; United Nations Statistics Division, 2024). Yet progress is uneven: many countries have SCP strategies, but implementation gaps persist, and environmental pressures continue to rise, with high-income economies consuming far more resources per capita than low-income ones (IRP, 2024; United Nations Statistics Division, 2025). Conceptually, advancing SDG 12 requires integrating circular-economy and sufficiency strategies - designing out waste, extending product lifetimes, enabling repair/reuse/remanufacturing, and aligning business models and macroeconomic incentives with absolute reductions in primary resource use (Chan et al., 2018; Circle Economy, 2024). This article evaluates SDG 12’s rationale, targets, progress, barriers, and actionable pathways.

Theoretical background: definitions, SCP and circular economy

Sustainable consumption and production (SCP) are a systems-oriented agenda that seeks to deliver human wellbeing within ecological limits by transforming how societies design, produce, distribute, use, and recover goods and services across their life cycles. A widely cited early formulation—emerging from the 1994 Oslo Symposium—defines SCP as the use of services and related products that meet basic needs and improve quality of life while minimizing the use of natural resources and toxic materials as well as emissions of waste and pollutants over the entire life cycle (Oslo Symposium, 1994). Contemporary UN guidance extends this life cycle emphasis by insisting that SCP requires simultaneous action on demand, supply, and the enabling environment: reshaping consumption practices and norms, advancing resource-efficient and low-toxicity production, and building infrastructures, standards, and institutions that render responsible options accessible, affordable, and reliable (UNEP & UN DESA, 2015; United Nations, 2015).

Two conceptual anchors structure this agenda. First, life cycle thinking, often operationalized through ISO 14040/44 life cycle assessment (LCA), evaluates environmental and social pressures from resource extraction through manufacturing, use, and end-of-life, thereby avoiding burden shifting across stages or regions (ISO, 2006a, 2006b). Second, decoupling distinguishes between relative improvements (impact intensity falls per unit of output) and absolute reductions (total impacts decline while welfare rises). In the context of planetary boundaries for climate, biodiversity, and pollution, SCP implies that absolute decoupling is necessary for key pressures if the 2030 Agenda's goals are to be met (Rockström et al., 2009; UNEP, 2011).

SCP foregrounds consumption-side dynamics as much as producer efficiency. Research on social practices demonstrates that consumption is not reducible to atomized, price-driven choice; it is patterned by infrastructures, norms, and institutions—urban form, repair ecosystems, digital platforms, and default settings that collectively script how services such as mobility, shelter, and communication are delivered and used (Tukker, 2015). Responsible consumption thus encompasses sufficiency—moderating demand and reconfiguring practices—alongside information tools (labelling, disclosure), demand-pull instruments (green public procurement), and behavioral mechanisms (choice architecture) that shift utilization rates and service levels without compromising wellbeing. Equally, production-side

transformations require clean energy and benign materials, but also durability, modularity, reparability, and designs that preserve embodied value and reduce hazardous exposures across global supply chains.

Measurement is central to SCP because policy must manage both intensities and absolute scales. Material Footprint (MF) and Domestic Material Consumption (DMC) quantify primary materials embodied in final demand or used within an economy and underpin SDG 12 indicators on sustainable resource use. Consumption-based accounting attributes emissions, water use, or land-use change to the final consumer, revealing how impacts are outsourced along global value chains compared with territorial inventories. Resource productivity (GDP per DMC) and resource efficiency (output per unit input) summarize intensity but must be read alongside absolute levels to avoid an "intensity trap" in which total pressures rise as economies grow. Circularity rates (the share of secondary materials in total use), per-capita waste generation, recycling performance, and food loss and waste indicators capture specific nodes of the system, while corporate disclosure frameworks (GRI, ISSB, EU CSRD/ESRS) and product-level schemes such as Environmental Product Declarations translate SCP expectations into organizational and product claims (United Nations, 2015; United Nations Statistics Division, 2024). Two cross-cutting caveats temper indicator interpretation: rebound effects, whereby efficiency savings lower costs and stimulate additional consumption, and distributional effects, whereby high-income groups command outsized material and carbon footprints, necessitating equity-sensitive design and just-transition policies.

Within this broader frame, the circular economy (CE) provides a prominent implementation pathway for SDG 12. In its minimal definition, CE is an economic system that is restorative and regenerative by design, aiming to keep materials, components, and products at their highest utility and value for as long as possible while minimizing virgin resource inputs and harmful emissions (Ellen MacArthur Foundation, 2013; Geissdoerfer et al., 2017). Three design principles recur: design out waste and pollution through non-toxic chemistries and modular, disassemblable products; keep products and materials in use via maintenance, repair, reuse, refurbishment, remanufacturing, and high-quality recycling; and regenerate natural systems, for example through circular bioeconomy strategies that rebuild soils and biodiversity. These principles are often operationalized through a hierarchy of R-strategies that prioritize refusing, rethinking, and reducing (avoiding unnecessary product-service provision and dematerializing demand); reusing, repairing, refurbishing, and remanufacturing (slowing flows and extending lifetimes); and only thereafter repurposing, recycling, or recovering materials when higher-value loops are exhausted. Upstream strategies that avoid or slow material flows

typically outperform downstream recycling in environmental terms because of thermodynamic and quality constraints—implying that design choices and business models are decisive (Bocken et al., 2016).

Business model innovation is therefore a critical lever. Product-service systems (leasing, performance-based contracts), sharing and pooling platforms, take-back schemes with reverse logistics, and design-for-X (repair, upgrade, disassembly) can preserve value and align firm incentives with longevity rather than throughput. Yet these models scale only when governance conditions are supportive: standards for durability and reparability, consumer rights to repair, extended producer responsibility (EPR) that internalizes end-of-life costs, clear end-of-waste criteria that enable secondary markets, and liability and warranty rules that reward quality and safe reuse. Because supply chains are transnational, regulatory convergence in methods (e.g., LCA rules), data formats (e.g., digital product passports), and definitions (e.g., recycled content) reduces transaction costs, avoids greenwashing, and creates credible claims across jurisdictions. While public procurement generates predictable demand for circular offerings and can incorporate verifiable performance clauses that reduce investment risk, economic tools such as materials taxation, differentiated VAT, deposit-refund systems, pay-as-you-throw tariffs, and carbon pricing complement regulatory standards by coordinating price signals with environmental externalities.

A mature theoretical account of SCP also recognizes the limits of efficiency-only strategies and elevates sufficiency alongside efficiency and consistency. Efficiency reduces resource intensity; consistency substitutes benign materials and renewable energy; sufficiency addresses absolute demand by rethinking service levels, utilization, and norms. In mobility, this involves prioritizing access over ownership through compact urban design and shared fleets; in the built environment, adaptive reuse, design for longevity, and high occupancy rates; in electronics, long-lived, repairable, and upgradeable devices supported by spare-parts logistics and secondary markets. Such strategies often deliver high mitigation potential at low system cost when underpinned by enabling infrastructures and fair access, ensuring that responsible options are defaults rather than niche choices (Jackson, 2017; Tukker, 2015).

Finally, SCP is inseparable from questions of justice across global value chains. High-income consumption profiles drive extraction and waste burdens that disproportionately fall on lower-income producer regions. A just SCP agenda therefore integrates consumption-based metrics to reveal embedded impacts; supports producer-country upgrading via technology transfer, fair pricing, and reinvestment of EPR revenues in local waste, repair, and remanufacturing infrastructures; strengthens occupational safety and hazard management in

recycling; and safeguards equitable access to essential goods and services so that circular and responsible options are not luxury signals but the affordable norm (UNEP, 2011; United Nations, 2015). Taken together, these theoretical components clarify what "responsible" means for SDG 12: embedding life cycle and footprint metrics in decision-making; pursuing absolute impact reductions alongside efficiency; privileging upstream design and sufficiency over downstream fixes; aligning standards, data, price signals, and disclosure to create credible markets; building infrastructures for circularity; and integrating equity and just-transition principles throughout. The ensuing analysis applies this lens to the official SDG 12 targets and indicators, recent progress, and the policy pathways most likely to yield measurable, durable improvements by 2030 and beyond.

Targets and indicators

SDG 12 operationalizes responsible consumption and production through an integrated set of targets (12.1–12.c) and indicators that track policy uptake, resource pressures, and outcomes across value chains. Target 12.1 concerns the mainstreaming of SCP via the 10-Year Framework of Programs (10YFP/One Planet Network). Indicator 12.1.1 counts countries with SCP national action plans or policy instruments; analytically, the distinction between formal adoption and effective implementation/enforcement is crucial, as process indicators may not translate into impact without budgets, monitoring, and sanctions (UN DESA, 2023; UNEP, 2022).

Target 12.2 focuses on sustainable management and efficient use of natural resources. Indicators 12.2.1 (Material Footprint, MF, per capita and per GDP) and 12.2.2 (Domestic Material Consumption, DMC, per capita and per GDP) anchor the resource-use dimension. MF is compiled using multi-regional input–output (MRIO) models to attribute raw-material equivalents to final demand, while DMC is a territorial balance of extraction plus imports minus exports; taken together, they illuminate both consumption-based and production-based pressures and the risk of outsourcing material impacts through trade (IRP/UNEP, 2019; United Nations Statistics Division, 2024).

Target 12.3 addresses food loss and waste. Indicator 12.3.1a (Food Loss Index) measures physical losses from post-harvest to retail, and 12.3.1b (Food Waste Index) tracks waste at retail and household levels. Methodologies emphasize commodity-specific loss coefficients and nationally representative diaries or waste composition studies, highlighting the

need to pair infrastructural interventions (cold chains, logistics) with behavioral and regulatory measures (labelling, portion standards) (FAO, 2019; UNEP, 2021).

Target 12.4 concerns the environmentally sound management of chemicals and hazardous wastes. 12.4.1 monitors parties' progress in implementing multilateral environmental agreements (Basel, Rotterdam, Stockholm, Minamata), and 12.4.2 measures hazardous waste generated per capita, its transboundary movements, and the share treated in environmentally sound facilities. Persistent data gaps and definitional heterogeneity complicate comparability, underlining the importance of harmonized classifications and facility-level reporting (Basel Convention Secretariat, 2023; UNEP, 2019).

Target 12.5 aims to prevent waste generation, substantially increase reuse and recycling, and reduce disposal. 12.5.1 aggregates national metrics on waste generation per capita and recycling rates; cross-country comparability depends on consistent system boundaries (municipal vs. total waste; input- vs. output-based recycling rates) and the quality of mass-balance statistics (Eurostat, 2023; United Nations Statistics Division, 2024).

Target 12.6 promotes corporate sustainability reporting. 12.6.1 counts companies publishing sustainability reports, often under GRI, ISSB, or EU CSRD/ESRS frameworks. While disclosure improves transparency and decision-usefulness for investors and procurers, it is not itself an environmental-performance metric and should be triangulated with outcome indicators (GRI, 2021; IFRS Foundation, 2023; EFRAG, 2023).

Target 12.7 advances sustainable public procurement (SPP). 12.7.1 assesses the degree to which national SPP policies and action plans are in place, and 12.7.2—where reported—captures the share of tenders/contracts meeting environmental and social criteria. Shifting from policy presence to verifiable performance (e.g., minimum durability, reparability, or recycled-content thresholds) is pivotal for impact (UNEP, 2022).

Target 12.8 strengthens education and awareness for sustainable development and lifestyles. 12.8.1 evaluates integration of Education for Sustainable Development (ESD) and Global Citizenship Education in policies, curricula, teacher education, and assessment—qualitative but strategically important for durable demand-side change (UNESCO, 2021).

The enabling targets 12.a–12.c address boundary conditions. 12.a supports scientific and technological capacity for SCP in developing countries (12.a.1: international support for clean technologies and environmental infrastructure). 12.b promotes tools to monitor sustainable tourism impacts, notably Tourism Satellite Accounts and sustainability indicators (12.b.1). 12.c seeks to rationalize inefficient fossil-fuel subsidies while protecting vulnerable groups; 12.c.1 measures subsidy levels relative to GDP, government expenditure, or per unit of energy, a

politically salient metric with methodological challenges (price-gap vs. inventory approaches; tax expenditures vs. direct transfers) but high leverage on market signals (OECD, 2023; United Nations Statistics Division, 2024).

Taken as a whole, the SDG 12 indicator architecture intentionally combines process indicators (policies, plans, disclosure) with pressure and outcome indicators (material footprints, waste generation, hazardous-waste treatment, food loss/waste). Policy evaluation therefore must (1) ensure accounting coherence between production- and consumption-based metrics (12.2), (2) close data gaps—especially for hazardous waste and food waste—through standardized definitions and MRV systems, (3) avoid the "intensity trap" whereby efficiency improves but absolute pressures still rise, and (4) operationalize digital value-chain transparency (e.g., product passports, Environmental Product Declarations) to connect targets 12.2–12.7 with procurement and investment decisions. Interpreting progress credibly requires reporting impact metrics (e.g., declines in MF/DMC, increased secondary-material shares) alongside implementation evidence (e.g., enforceable SPP criteria, phasedown of fossil-fuel subsidies, verified ESM of hazardous wastes), aligning the indicator suite with the overarching aim of wellbeing within planetary boundaries (Rockström et al., 2009; IRP/UNEP, 2019).

Progress and gaps (global and regional)

Global progress toward SDG 12 is characterized by broader policy adoption and better measurement frameworks alongside stubborn absolute increases in resource use and waste, producing a paradox of rising process compliance amid insufficient environmental outcomes. Successive UN assessments underscore that while more countries report national SCP strategies and related action plans, the aggregate trajectory remains off track for 2030; material use continues to grow and food waste persists at scale, suggesting that policy presence has not consistently translated into impact (United Nations Statistics Division [UNSD], 2024, 2025). The International Resource Panel (IRP) estimates that global material throughput has expanded rapidly over the past two decades and, absent structural reforms, could rise by roughly 60% by 2060 relative to 2020, locking in pressures incompatible with climate, biodiversity, and pollution objectives (IRP, 2024). From a metric standpoint, consumption-based Material Footprint (MF) and territorial Domestic Material Consumption (DMC) jointly reveal the geography of responsibility: in high-income regions, MF often exceeds DMC because of embodied materials in imports, whereas several middle-income regions show strong growth in both indicators driven by construction minerals and biomass (IRP, 2019, 2024; UNSD, 2024).

This divergence highlights why relying on territorial accounts alone risks obscuring outsourced impacts along global value chains and why policy needs to integrate consumption-based indicators to avoid "leakage."

On food loss and waste (Target 12.3), the empirical picture has sharpened as methodologies improved and country coverage expanded. UNEP's latest Food Waste Index suggests that about 19% of food available to consumers was wasted in 2022—approximately 1.05 billion tons—with households responsible for the majority, yet retail and food service also significant (UNEP, 2024). FAO's work on post-harvest losses complements this by tracing upstream inefficiencies to infrastructure gaps—cold chains, storage, and logistics—particularly salient in parts of Sub-Saharan Africa and South Asia (FAO, 2019). These data collectively imply that effective strategies must pair infrastructural investments to reduce upstream losses with behavioral, regulatory, and fiscal measures that curb downstream waste, including clarifying date labelling, rethinking portion norms, and aligning incentives in hospitality and retail (FAO, 2019; UNEP, 2024). Regional nuance matters: while per-capita household waste is highest in many high-income settings, emerging evidence indicates substantial waste across income groups, driven by different mechanisms—logistics and storage constraints in low- and middle-income countries versus consumer behavior and marketing practices in high-income ones (FAO, 2019; UNEP, 2024).

For chemicals and hazardous waste (Target 12.4), reported progress includes wider ratification and incremental implementation of the Basel, Rotterdam, Stockholm, and Minamata conventions, but persistent data gaps and heterogeneous interpretations of "environmentally sound management" (ESM) impede comparability and obscure informal-sector risks in parts of Africa and Asia (Basel Convention Secretariat, 2023; UNEP, 2019). Strengthening facility-level reporting, harmonizing classifications, and investing in safe treatment capacity remain preconditions for credible improvement. On waste prevention and circularity (Target 12.5), several jurisdictions—especially in the European Union—have expanded Extended Producer Responsibility (EPR), set recycled-content and eco-design requirements, and piloted digital product passports, yet global per-capita waste generation is still rising and the share of secondary materials in the world economy remains low, indicating that efficiency gains and downstream recycling are being outpaced by growth in primary extraction and consumption (IRP, 2024; UNSD, 2024). Methodological inconsistencies across countries (municipal vs. total waste boundaries; input- vs. output-based recycling rates) further complicate benchmarking and policy learning, underscoring the need for standardized mass-balance statistics (Eurostat, 2023; UNSD, 2024).

Corporate disclosure (Target 12.6) and sustainable public procurement (Target 12.7) illustrate the broader pattern of "from presence to performance." The move toward mandatory sustainability reporting—via GRI's updated Universal Standards, the launch of the ISSB's IFRS S1/S2, and the EU's CSRD/ESRS—has materially improved transparency and decision-usefulness for investors and procurers, but disclosures are not outcome metrics and must be triangulated with independent indicators of footprints, durability, reparability, and toxicity (EFRAG, 2023; GRI, 2021; IFRS Foundation, 2023). Likewise, many countries report SPP policies, yet the environmental effect hinges on enforceable technical criteria and third-party verification in tenders and contracts; where such criteria exist (e.g., minimum durability or recycled-content thresholds), procurement can create predictable demand that scales circular designs, but uptake beyond early adopters remains uneven (UNEP, 2022; UNSD, 2024).

A central systemic headwind is the persistence—and in some years resurgence—of fossil-fuel subsidies targeted by Target 12.c. Following the 2021–2023 energy price shocks, consumption subsidies reached record or near-record levels, with inventories documenting extensive price supports and tax expenditures across many economies (International Energy Agency [IEA], 2023; Organization for Economic Co-operation and Development [OECD], 2023). Such subsidies dilute the price signals that SCP policies seek to sharpen, undermining incentives for resource efficiency, repair, reuse, and low-emission alternatives. Durable reform is politically and socially complex, particularly in regions where energy affordability and inflation management are salient, but the literature consistently identifies well-designed, targeted social protection as a means of reconciling equity with subsidy rationalization (IEA, 2023; OECD, 2023).

Five contrasts are notable at the regional level. In Europe and Northern America, territorial emissions and some intensity metrics have improved, and policy architecture for circularity is comparatively advanced; however, high consumption-based footprints persist due to imported embodied materials, and absolute material use remains high (IRP, 2019, 2024; UNSD, 2024). Eastern and South-Eastern Asia continue rapid infrastructure build-out with rising non-metallic minerals use; while several economies are accelerating circular-economy policies, hazardous-waste management capacity and enforcement vary widely (IRP, 2024; Basel Convention Secretariat, 2023). Latin America and the Caribbean have experienced strong post-2015 DMC growth tied to construction and biomass, with improving yet uneven data on hazardous waste and EPR performance (IRP, 2024; UNSD, 2024). Sub-Saharan Africa faces a dual challenge of meeting basic service needs while managing fast-growing urban waste streams; investments in primary waste services, safe recycling, and cold-chain infrastructure

for food loss reduction yield high social returns but face financing constraints (FAO, 2019; UNEP, 2024). Western Asia and North Africa exhibit high levels of consumption subsidies for fossil fuels alongside water-energy-food system stresses, complicating the price-signal reforms central to Targets 12.2 and 12.c (IEA, 2023; OECD, 2023).

In sum, SDG 12 has achieved meaningful advances in policy frameworks, disclosure regimes, and measurement, but absolute decoupling from environmental pressures has yet to materialize globally. Closing the gap requires accounting coherence between production- and consumption-based metrics, harmonized waste and hazardous-waste definitions, robust MRV systems, and—critically—price-signal alignment through fossil-fuel subsidy reform that is paired with targeted social protection. When combined with enforceable design and procurement standards and credible corporate reporting, these steps offer the most plausible path to shift from policy presence to measurable reductions in footprints before 2030 (IRP, 2019, 2024; UNSD, 2024, 2025; UNEP, 2022, 2024).

Challenges related to SDG 12

Delivering SDG 12 at scale is constrained by interlocking challenges spanning transnational supply chains, credibility of sustainability claims, and the coherence and enforceability of public policy. Global value chains fragment responsibility across multiple tiers of suppliers, jurisdictions, and intermediaries; as a result, environmental burdens and social risks are frequently displaced to upstream stages that are weakly visible to brands and regulators (Gereffi, 2018; IRP, 2024). Consumption-based indicators routinely exceed territorial accounts in high-income economies, underscoring how embodied materials and emissions are outsourced through trade and how territorial policy alone can miss offshored impacts (IRP, 2019, 2024). Methodologically, measuring and allocating Scope 3 (value-chain) impacts remains difficult for firms, owing to data gaps, supplier heterogeneity, and double-counting risks; while the Greenhouse Gas Protocol provides guidance, consistent, auditable primary data across tiers are still the exception rather than the norm (GHG Protocol, 2011/2023). The consequence is a persistent asymmetry: corporate and national strategies are often evaluated on partial data (e.g., operational footprints or DMC), even though the most material impacts lie in upstream extraction and processing or downstream use and end-of-life.

These structural features of supply chains interact with market and informational failures that enable greenwashing. Firms have incentives to emphasize process adoption (codes of conduct, certifications, pledges) and incremental efficiency while downplaying absolute

throughput and product design choices that would reduce demand or material intensity (Delmas & Burbano, 2011). Heterogeneous eco-labels, unverifiable claims, and selective disclosure erode trust and impede efficient markets for genuinely low-impact products (OECD, 2021). Although corporate reporting frameworks have converged—through the Global Reporting Initiative (GRI, 2021), the International Sustainability Standards Board's IFRS S1/S2 (IFRS Foundation, 2023), and the European Sustainability Reporting Standards (EFRAG, 2023)—disclosure remains an input to accountability rather than a guarantee of environmental performance. In practice, reported indicators are not always decision-useful for public buyers or consumers: durability, reparability, hazardous substance profiles, and end-of-life performance are rarely expressed in standardized, comparable formats at product level, and forward-looking targets can be misaligned with capital expenditure and revenue models (Tørstad et al., 2020). Emerging policy responses—such as the European Union's initiatives on empowering consumers for the green transition and the proposed "green claims" framework—seek to police unsubstantiated claims and require substantiation based on recognized life-cycle methods, but effective enforcement and international interoperability remain ongoing challenges (European Commission, 2023; OECD, 2021).

Public-policy architecture faces its own frictions. First, price signals are often incoherent with SCP objectives. Fossil-fuel subsidies and other environmentally harmful supports dilute incentives for resource efficiency, repair, and substitution, offsetting gains from eco-design and procurement policies (IEA, 2023; OECD, 2023). Second, regulatory fragmentation across jurisdictions raises transaction costs and invites regulatory arbitrage: diverging definitions of "recycling," thresholds for recycled content, or criteria for "environmentally sound management" complicate cross-border trade in secondary materials and can trap value in down-cycling (Basel Convention Secretariat, 2023; Eurostat, 2023). Third, many instruments still emphasize downstream waste management over upstream design and sufficiency. Without binding durability and reparability standards, extended warranties, right-to-repair provisions, and chemical restrictions, recycling alone cannot overcome thermodynamic limits and quality losses (Bocken et al., 2016; Geissdoerfer et al., 2017). Fourth, public procurement—potentially a high-leverage demand-side tool—often stalls at policy adoption; moving from general sustainability clauses to enforceable, verifiable performance criteria remains uneven, especially outside early-mover regions (UNEP, 2022).

Measurement, reporting, and verification (MRV) capacity is a cross-cutting constraint. For national statistics, the coexistence of production-based (DMC) and consumption-based (MF) accounts requires methodological literacy among policymakers to avoid the "intensity

trap," wherein relative efficiency improves while absolute pressures grow (UNSD, 2024). For firms, credible product-level information hinges on interoperable data architectures—digital product passports, environmental product declarations, and harmonized life cycle rules—yet agreement on data schemas, governance, and access remains a work in progress (EFRAG, 2023; GRI, 2021). In low- and middle-income countries, statistical systems often lack the resources to produce timely MRIO-consistent datasets or to monitor hazardous-waste flows, which obscures hotspots and weakens enforcement (Basel Convention Secretariat, 2023; UNEP, 2019). These gaps matter because misinformation and uncertainty create room for greenwashing and impede targeted interventions.

Political economy further complicates reform. SCP implies shifting rents away from linear throughput toward longevity, service models, and secondary markets; incumbents in extractive, petrochemical, and fast-moving consumer sectors can mobilize to slow or water down standards and to maintain favorable fiscal treatment (Jackson, 2017; Tørstad et al., 2020). Distributional concerns are real: removing broad price subsidies without compensating transfers can hurt vulnerable households, and introducing durability requirements can raise upfront prices if financing and service ecosystems are absent (IEA, 2023; OECD, 2023). A just-transition lens is therefore essential—linking subsidy reform to targeted social protection, reskilling programs in repair and remanufacturing, and support for producer-country upgrading so that value is not merely captured by downstream brands (UNEP, 2011; Gereffi, 2018).

A final challenge is strategic focus. Many SCP roadmaps privilege "win-win" efficiency and recycling while neglecting sufficiency—the moderation of absolute demand and the redesign of service provision (e.g., mobility as access, buildings optimized for occupancy and adaptive reuse, electronics designed for longevity and upgradeability). Evidence suggests that sufficiency options often deliver high mitigation and resource benefits at low system cost when supported by enabling infrastructures (repair services, spare-parts logistics) and consumer rights (Jackson, 2017; Bocken et al., 2016). Aligning macro-signals (tax shifts from labor to resource use, landfill/incineration performance standards, carbon and materials pricing) with product-level rules (durability, reparability, non-toxicity) and credible disclosure is therefore the central public-policy task if SDG 12 is to transition from policy presence to measurable reductions in material footprints and wastes by 2030 (EFRAG, 2023; GRI, 2021; UNSD, 2024).

Conclusion and recommendations

Across the evidence reviewed, SDG 12 has advanced from concept to policy architecture, yet the core paradox persists: process indicators have improved, while absolute pressures from material use, waste, and hazardous substances remain stubbornly high. Global material throughput continues to rise, and the share of secondary materials in the economy remains low, indicating that efficiency and downstream recycling are being outpaced by growth in primary extraction and consumption (IRP, 2019, 2024; UNSD, 2024). On food systems, improved measurement underscores that losses and waste are systemic rather than marginal, spanning both infrastructure gaps upstream and behavioural drivers downstream (FAO, 2019; UNEP, 2024). Disclosure regimes and public-procurement policies have proliferated, but transitions from policy presence to performance proof are uneven, and fossil-fuel subsidies frequently counteract price signals intended to favor resource efficiency and circularity (EFRAG, 2023; IFRS Foundation, 2023; IEA, 2023; OECD, 2023). In short, the pathway to 2030 requires coordinated interventions that reshape demand, design, and governance—linking upstream product rules and credible metrics to downstream incentives and investment.

1. **Align metrics with outcomes.** Governments should embed both production-based (DMC) and consumption-based (Material Footprint) accounting in national planning and monitoring to avoid offshoring impacts and the "intensity trap" (IRP, 2019; UNSD, 2024). At firm and product levels, disclosure should be made decision-useful by coupling corporate reporting (GRI/ISSB/ESRS) with interoperable product-level information (environmental product declarations, digital product passports) grounded in harmonized life-cycle rules, so that buyers and regulators can verify durability, reparability, toxicity, and end-of-life performance (EFRAG, 2023; GRI, 2021; IFRS Foundation, 2023).
2. **Rebalance from downstream fixes to upstream design and sufficiency.** Binding eco-design requirements for durability, reparability, upgradeability, and non-toxic materials should be prioritized over exclusive reliance on end-of-pipe recycling, which is limited by thermodynamics and quality losses (Bocken et al., 2016; Geissdoerfer et al., 2017). Policy packages should explicitly include sufficiency—moderating absolute demand through service redesign (e.g., mobility as access), extended warranties, right-to-repair, and business models that reward longevity and high utilization. Public procurement can lock in these criteria by specifying measurable performance thresholds (minimum lifetimes, repairability scores, recycled-content floors) and enforcing third-party verification (UNEP, 2022).

3. **Correct price signals while protecting the vulnerable.** Rationalizing inefficient fossil-fuel subsidies remains a necessary condition for SDG 12 because such subsidies dilute incentives for repair, reuse, and low-impact substitutes across the economy (IEA, 2023; OECD, 2023). Successful reform should be staged and paired with targeted social protection and productivity-enhancing investments (public transport, building retrofits, efficient appliances), preserving equity while restoring scarcity signals that support circular design and procurement.
4. **Strengthen MRV and statistical capacity, especially in LMICs.** Credible progress requires consistent mass-balance statistics on waste and hazardous waste, facility-level reporting aligned with the Basel, Rotterdam, Stockholm and Minamata conventions, and MRIO-consistent national accounts to track embodied impacts in trade (Basel Convention Secretariat, 2023; UNSD, 2024). Development finance and technical assistance should prioritize data infrastructures (national waste registries, digital product passport pilots, LCA competence centers), because measurement gaps enable greenwashing and impede targeted interventions.
5. **Modernize value-chain governance.** Policymakers should mandate supplier data sharing for high-risk sectors, harmonize definitions that currently fragment markets (recycling, "environmentally sound management," recycled content), and reduce regulatory arbitrage that traps value in down-cycling or shifts hazards to informal sectors (Basel Convention Secretariat, 2023; Eurostat, 2023). Trade and industrial policies can support producer-country upgrading—repair, remanufacturing, safe recycling—so that circular value is not captured solely by downstream brands (Gereffi, 2018).
6. **Target food loss and waste with dual strategies.** Upstream investments in cold chains, storage, and logistics should be paired with downstream measures that reshape incentives and information: clarified date-labelling standards, portion and packaging redesign, and procurement rules for catering and hospitality (FAO, 2019; UNEP, 2024). Cities are pivotal nodes for implementation, combining waste service reforms (pay-as-you-throw, separate biowaste collection) with social programmes (food-redistribution networks).
7. **Finance the transition and de-risk scaling.** Blended finance and green public banks can underwrite repair ecosystems, remanufacturing hubs, and hazardous-waste treatment capacity where private capital is scarce. Tax shifts from labor to resource and

pollution bases can improve macro-coherence, while performance-based procurement contracts provide stable demand signals for circular SMEs (UNEP, 2022; OECD, 2023).

8. **Embed justice and political durability.** Because SDG 12 redistributes rents from linear throughput to longevity and service, just-transition measures—reskilling, regional development, consumer affordability safeguards—are essential to sustain coalitions for reform (Jackson, 2017). Equity considerations also argue for consumption-based targets or budgets in high-income contexts, preventing burden shifting to lower-income producer regions (IRP, 2019, 2024).

Taken together, these recommendations translate the SDG-12 vision into an implementable sequence: fix the metrics; regulate upstream design and sufficiency; realign prices and procurement; build MRV capacity; govern value chains for transparency and equity; and scale finance with just-transition safeguards. With these elements in place, countries and firms can move from policy presence to measurable reductions in material footprints, waste, and hazardous exposures—advancing wellbeing within planetary boundaries by 2030 and laying credible foundations beyond.

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