In collaboration with
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WORLD ECONOMIC FORUM

Circular Economy Transformation

The Resilience-to-Growth Circularity Playbook for Industrial Solutions and Manufacturing

WHITE PAPER

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Foreword



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The past few years have been a stress test for industrial supply chains. Export controls, commodity price spikes, geopolitical disruption and competition for critical materials have exposed how quickly essential input constraints can slow growth. This has unveiled a structural flaw with linear production models premised on the availability of abundant and predictable resource flows.

Industrial Solutions and Manufacturing (IS&M) was chosen as a strategic focus area by the Circular Economy Transformation community. Its intense use of materials means it is reliant on volatile and concentrated supply chains, making linearity increasingly unstable and strengthening the case for a shift towards circularity at scale.

Circularity is much more than a sustainability play for industrial leaders. The circular economy is a source of competitiveness, resilience and growth. The opportunity lies in the vast number of machines and equipment already in use. Repair, refurbishment and modernization can deepen relationships with customers and create recurring revenue. Costs can be reduced by recovering materials and improving resource efficiency. The value of excess stock and returned goods can be captured to improve working capital, and the recovery and reuse of materials can help reduce exposure to volatile and concentrated primary material markets.

The 2026 Circularity for Competitiveness and Resilience Executive Survey carried out by the World Economic Forum and Bain & Company reinforces this trend. Among IS&M executives, 70% expect circular models to represent at least 20% of their revenues at full potential, while 65% anticipate seeing operating cost reductions. However, there is a mismatch between ambition and action, with only 26% of companies having a clear picture of their exposure to critical raw materials and rare-earth elements.

That gap matters because circular models require new capabilities, upfront investment, redesigned operations and partnerships. Their economics are not automatic and there are real trade-offs involved. This playbook has been created specifically to address that challenge. Drawing on executive insights and the experience of companies already scaling circularity, it sets out a practical three-step approach: **quantify** the risks and value at stake; **codify** the circular moves that matter most; and **amplify** them through leadership, technology, partnerships and finance.

We thank the Sectoral Taskforce on Industrial Solutions and Manufacturing of the Circular Economy Transformation initiative, the survey respondents and the companies that shared their experiences candidly. We hope this playbook will enable industrial leaders to transform circularity from an aspiration into a means of achieving durable competitive advantage.

Executive summary

The IS&M sector has reached a breakthrough moment: circularity can now unlock resilience and new value pools while advancing sustainability.

Industrial Solutions and Manufacturing is a major economic sector, yet its intense use of materials exposes it to volatile, concentrated and politically contested supply chains, making linear production models increasingly unstable. This in turn is elevating circularity from a sustainability priority to a strategic one, according to the findings of a 2026 survey, carried out by the World Economic Forum and Bain & Company, of 430 senior executives across 10 industries and seven regions, including 94 who lead IS&M organizations.[1,2] Of these, 80% say circularity is important or very important to their organization, mainly because of its positive impact on resource security and value creation. The response rises to 94% when executives are asked how important circularity will be within three years.

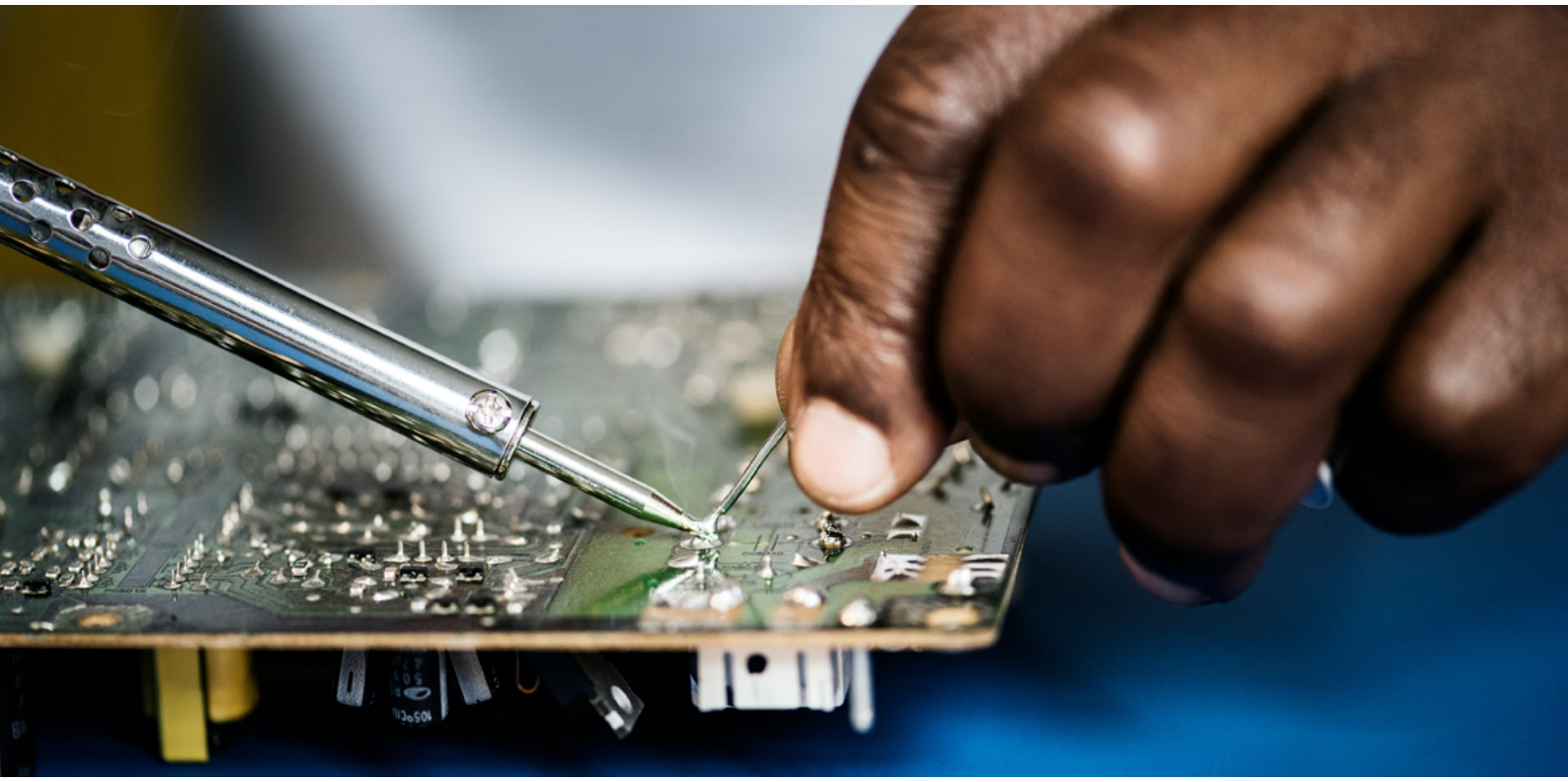
The prize for circularity is substantial and multidimensional. Circular businesses already generate sizeable, recurring revenues. At full circular potential, 70% of companies expect such activities to contribute to at least 20% of total revenues. Circularity lowers costs and boosts profits: 65% of executives expect it to reduce operating costs at full potential, while 77% of respondents say circularity could substantially address resource security if scaled.[3] Emissions reduction remains a valuable co-benefit rather than the driving rationale.

Ambition, however, has not yet translated into scale. Many companies remain caught between commitment and execution, held back by numerous barriers. These include challenging economics; operational complexity caused by circular flows not yet fitting neatly into systems designed for linear models; poor visibility of material risk combined with immature secondary markets; and fragmented ecosystems slowing progress. Additionally, corporate governance and culture are still largely geared to linear growth.

Companies that are scaling circularity follow a consistent, repeatable approach. This playbook sets this out in three steps. These companies **quantify** their input-risk exposure and the value at stake, turning a diffuse sense of risk into a ranked, financially grounded agenda. They **codify** the highest-value circular moves across a product's life cycle. And they **amplify** actions by investing in the vital enablers needed for scale. Such enablers include senior governance buy-in; data and technology; ecosystem partnerships; plus working-capital and capital-expenditure financing – with regulation engaged early as a catalyst. For first movers, today's actions become tomorrow's competitive edge.

1 The breakthrough moment

Growth opportunities combined with increasing supply shocks and cost pressures are strengthening the business case for circularity.



Key takeaways

- **The linear model is entering a new era of structural strain**. IS&M's scale and material intensity make it increasingly exposed to supply shocks, volatile input costs, critical-material supply concentrated across few sources and sustained margin pressure. These are no longer temporary disruptions, but persistent features of the operating environment. The winners will be those who master agile materials and resources strategies.

- **There is a powerful business case for circularity**. The long life of the sector's installed base – products and equipment already deployed and in use – can be turned into a major growth engine: products can be kept in use for longer through repair, refurbishment, remanufacturing and modernization; better used through service-led models such as leasing, rental and as-a-service options; and recovered for valuable products, components and materials at end of life (EoL). IS&M executives already see the upside: 70% expect circular activities to represent 20% or more of revenue at full potential, 65% expect operating-cost reductions, and circular models can also unlock working-capital efficiency, protect margins and strengthen resource resilience.[4]

IS&M is the bedrock of the global economy. It produces the machinery, equipment, heating and cooling systems, and the digital hardware and connectivity on which modern industry depends. It generated approximately $10.6 trillion in sales in 2025[5] and contributed around 3% of global GDP in value-added terms.

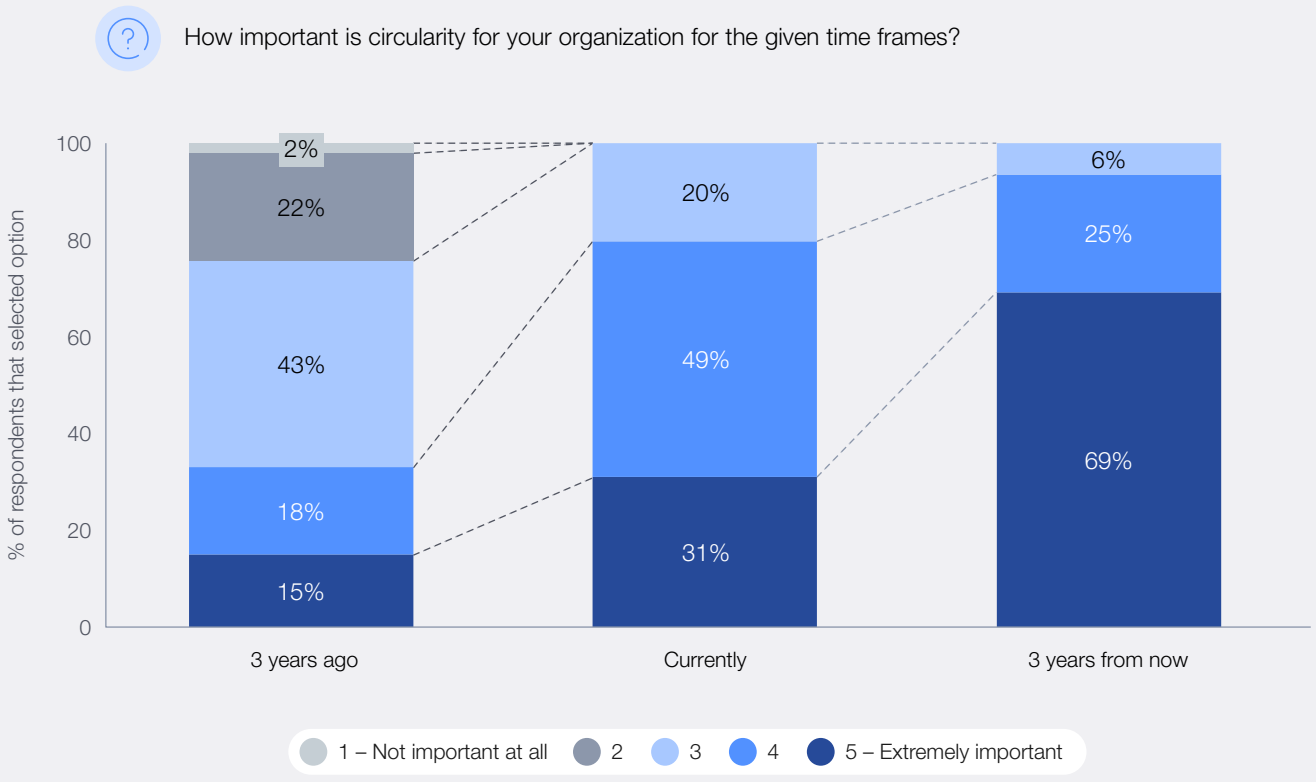
IS&M has a huge opportunity to lead circularity innovations. Best practices established at the very foundations of industry have the potential to cascade to all of the sectors it serves. The findings of the **2026 Circularity for Competitiveness and Resilience Executive Survey** conducted by the World Economic Forum and Bain & Company show that circularity is becoming a strategic priority for the IS&M sector. Two-thirds of respondents say their companies have embedded circular strategies across one or more divisions or fully integrated circularity into their core strategy.[6]

Today, 80% of executives describe circularity as important or very important to their organization, up from 33% three years ago. That share rises to 94% within three years, with the proportion calling it very important more than doubling from 31% to 69% (see Figure 1).[7]

The reasons given by survey respondents for pursuing circularity are primarily economic (see Figure 2), leaving further room to elevate it into a truly strategic, transformational, innovative and value-creating lever for the IS&M industry. As the risks associated with linear production increase, leaders that embrace a circular mindset and scale circular solutions will lock in a defining competitive advantage.

This playbook sets out a compelling case for change that goes beyond cost optimization and sustainability. It outlines where the largest value pools lie and charts a strategy for overcoming some of the barriers to adopting circularity at scale. It also profiles companies that are adopting circular solutions at scale with tangible improvements to resilience, profits and growth.

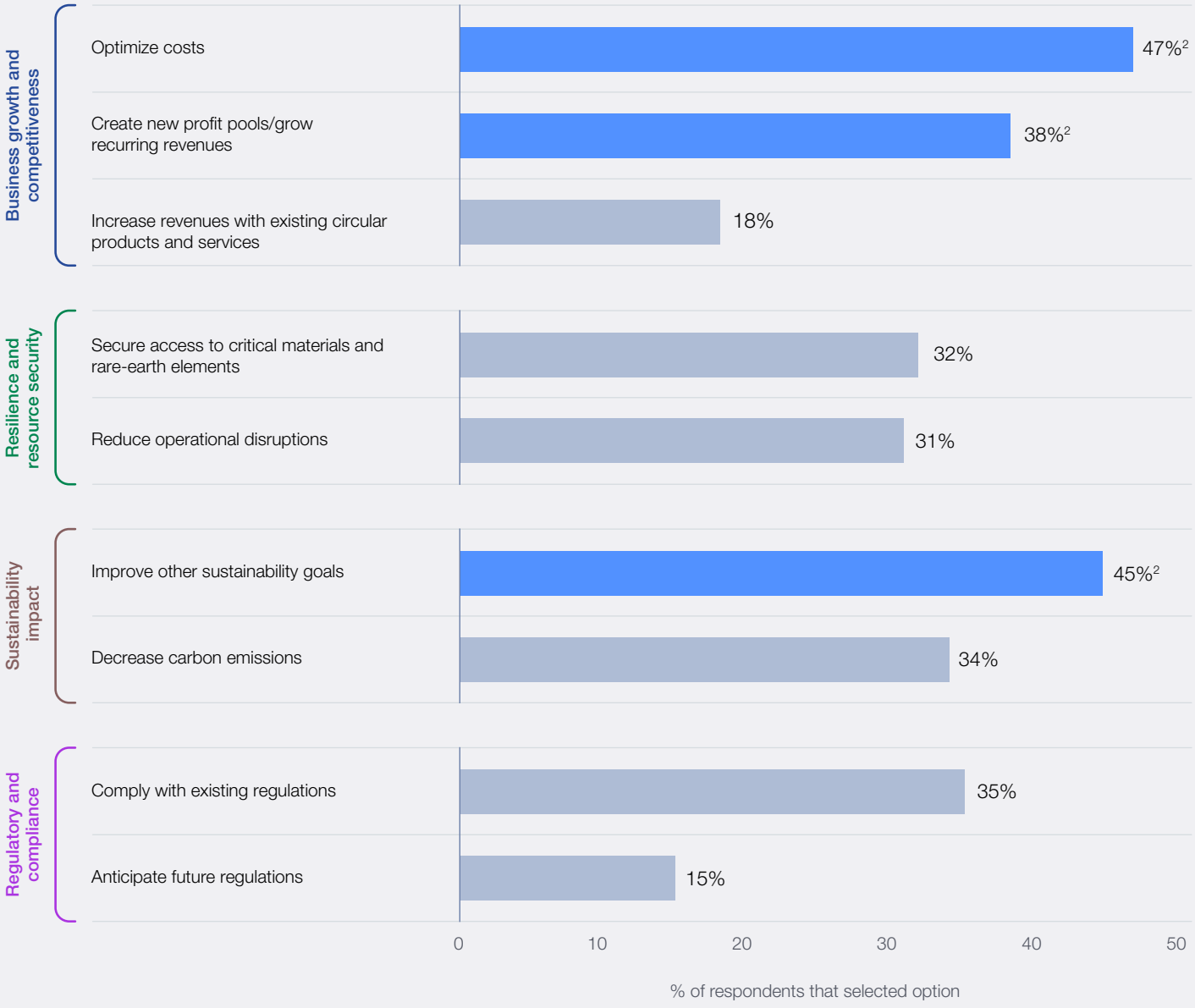
FIGURE 1 **Circularity is rapidly rising in strategic importance and is expected to increase further in coming years**



Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

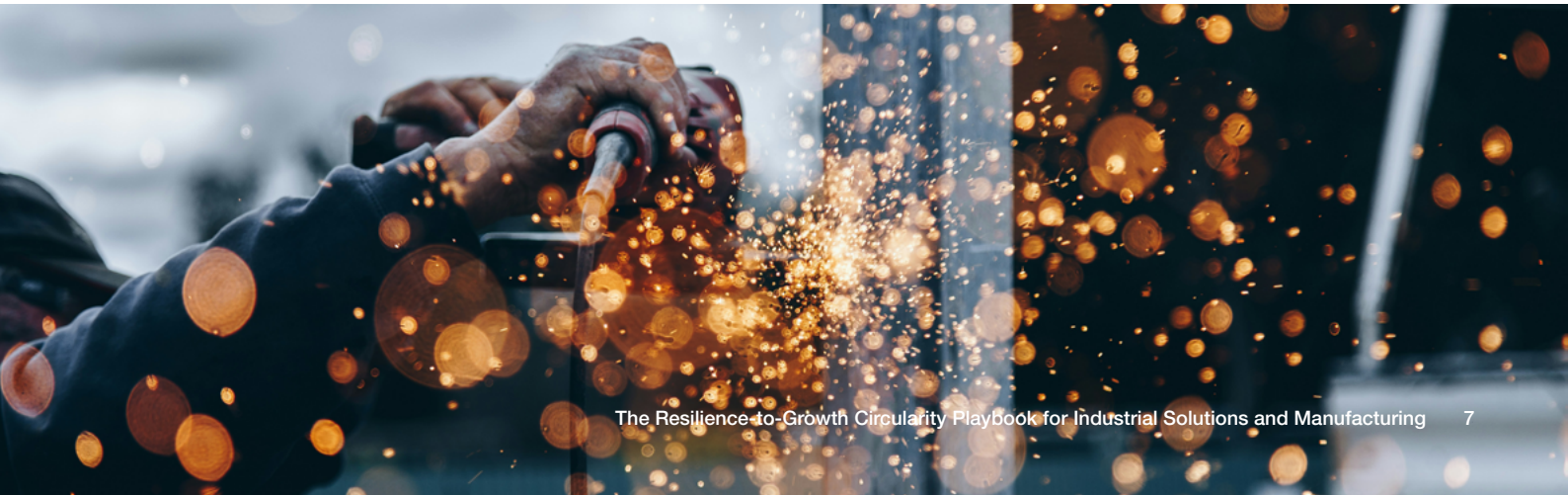
FIGURE 2 | **Circularity is driven by a combination of growth, resilience and sustainability priorities**

What are the main reasons your organization is pursuing circular initiatives today? Please select up to three of the most important reasons.[1]



Notes: 1. Totals do not sum to 100% of respondents as multiple answers are allowed; **2.** Dark blue bars indicate the top three options.

Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)



1.1 Converging factors boost the business case for circularity

For decades, manufacturers of industrial goods optimized relentlessly for linear efficiency and that model delivered. But linear production is now under pressure,[8] and those pressures are the ones that are unlocking the value of circularity. First, a growing number of customer segments are seeking to delay capital expenditure (CAPEX) and prolong the life of their equipment while enhancing their resource efficiency. This makes many circular value propositions a win–win for both clients and suppliers as it deepens the relationship and provides benefits to both. Second, equipment such as turbines, compressors, heavy machinery and automation systems depends on steel, aluminium, copper, nickel, lithium and rare-earth elements in volumes that make the sector unusually sensitive to shortages and price hikes. This results in recovery, refurbishment and resource efficiency becoming attractive alternatives to continued dependence on virgin materials.

Price volatility is becoming systemic. Energy shocks, for example, now reverberate through industrial inputs far beyond oil and gas. The near closure of the Strait of Hormuz in 2026, for example, disrupted global trade in nitrogen, LNG and crude oil that affected industrial inputs from aluminium to the feedstocks used in battery anodes.[9,10,11] Compounding the volatility is concentration. A single country, China, refines the great majority of 20 strategic minerals.[12,13]

This concentration has moved from theoretical risk to operational reality. In 2025, 228 import and export restrictions on critical minerals were enacted globally and rare-earth export controls forced at least one major vehicle manufacturer to idle a plant for three weeks when it could not secure high-powered magnets.[14,15,16] The outlook is structurally tight, with remaining global supplies of rare-earth elements and graphite covering only 35–40% of demand by 2035 should supply from the dominant geography be disrupted.[17,18]

These converging negative factors, added to increased competition and commoditization across IS&M sectors, are eroding profitability: average gross margins shrank from 32% to 27% in the 15 years to 2024.[19]

These destabilizing factors are reflected in the survey, where 81% of executives said they were likely or extremely likely to pursue circularity because of the rising cost or reduced availability of virgin materials.[20]

1.2 The installed base is the breakthrough opportunity

Industrial machinery is built to last decades. This enormous stock of machinery and equipment can be modernized, refurbished, shared, connected to the cloud or transformed in ways that generate new business for IS&M manufacturers and their downstream business partners, and create new opportunities to serve clients, winning their “loyalty for life”.

The installed base is additionally a bank of recoverable products, components, parts and materials, with current systems capturing only a fraction of that value. Long life cycles also highlight the vital contribution of design for circularity. A product designed without circularity in mind can lock in inefficiency for 20–40 years, foreclosing the ability to repair, modernize, remanufacture or dismantle it. Design decisions taken today therefore shape material flows, and competitiveness, for a generation or more.

Regulations encouraging recovery, traceability and design for circularity are helping to change mindsets by unlocking the circular value of the installed base: 63% of IS&M executives name regulation and policy as key enablers for their circular journey.[21]

In Europe, the Ecodesign for Sustainable Products Regulation (ESPR), the Right to Repair Directive (R2RD) and the Packaging and Packaging Waste Regulation (PPWR) are tightening requirements on product design, durability, repairability and recycled content.[22] China’s 15th Five-Year Plan embeds circularity through product carbon footprint tracking, zero-carbon industrial parks and expanded use of recycled materials.[23,24] India is broadening its End-of-Life Vehicle rules,[25] South Korea has built a circular-economy framework spanning production, distribution and use,[26] and Japan’s material-cycle strategy is actively building markets for recycled materials.[27]

For IS&M, the implication is profound: competitiveness increasingly depends on design for circularity, repair and remanufacturing capability, service-based models, product traceability and secure access to secondary inputs.

Executives note that policy could further support their circular journey through smoother cross-border movement of materials and products, and through greater standardization to reduce friction in global industrial supply chains.[28]

Evidence for the business case for circularity is strong and mounting by the day. It starts with the decoupling of business growth from material use and deepens by unlocking innovation, new business and revenue streams, more efficient ways of deploying working capital and stronger margins. The upshot is businesses that are more resilient against price or commodity shocks, more sustainable and more valued by their customers.

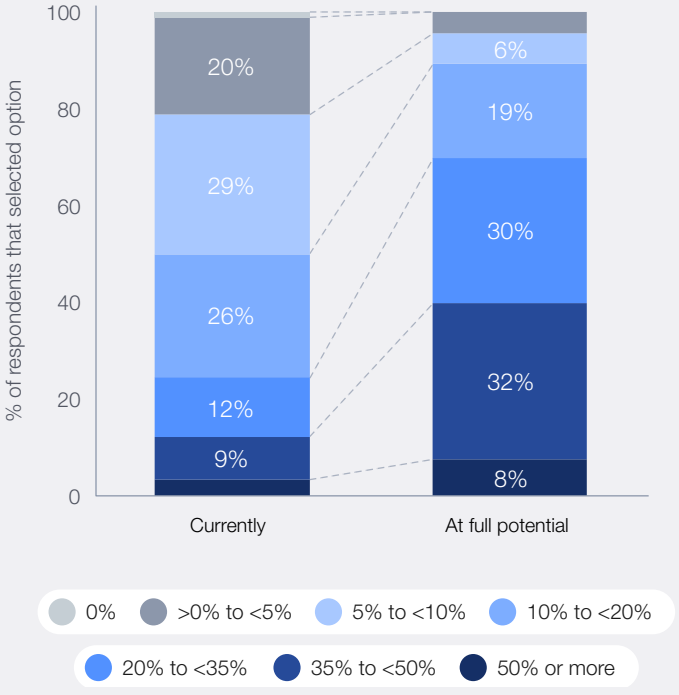
1.3 Unlocking new, recurring revenue pools

Almost all IS&M companies report some revenue from circular activities today, most commonly in the 5–20% range (see Figure 3).[29] Circular models improve customer intimacy and create "customers for life" through upgrades, retrofits, maintenance and service-based offerings, furthering companies' growth avenues.

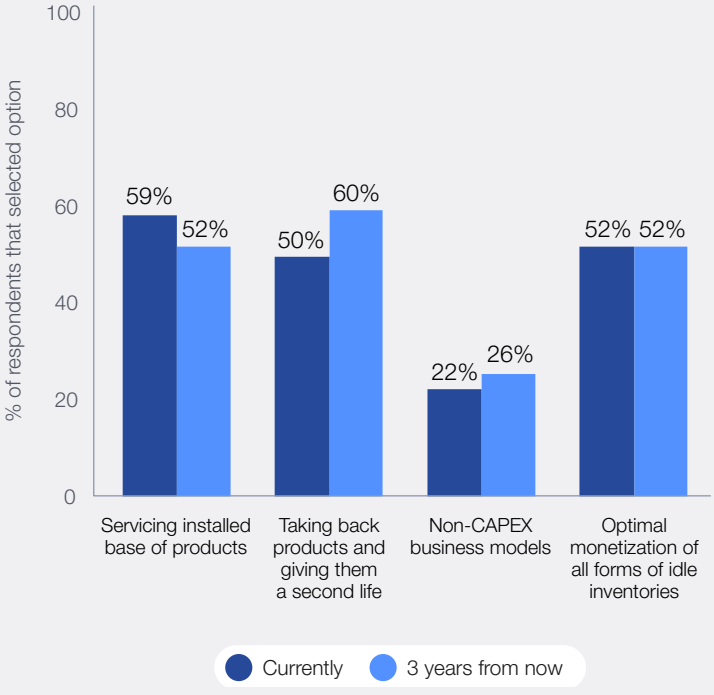
These models share a common logic: they decouple business growth from resource consumption, generate recurring income, deepen customer relationships and convert the installed base into a durable source of value. They also deliver tangible value to customers, whether through enhanced resource efficiency and lower operating expenses (OPEX), or through delayed or lower CAPEX from asset-life extension.

FIGURE 3 **Circular revenue is expected to grow significantly**

What percentage of your organization's total revenue is currently generated – and what would you expect at full circular potential – from circular activities?



For each of the following circular revenue streams, please assess their current/expected contribution to overall revenues.[1] Rank top 2 with 1=largest contribution



Note: 1. Totals do not sum to 100% of respondents as multiple answers are allowed.

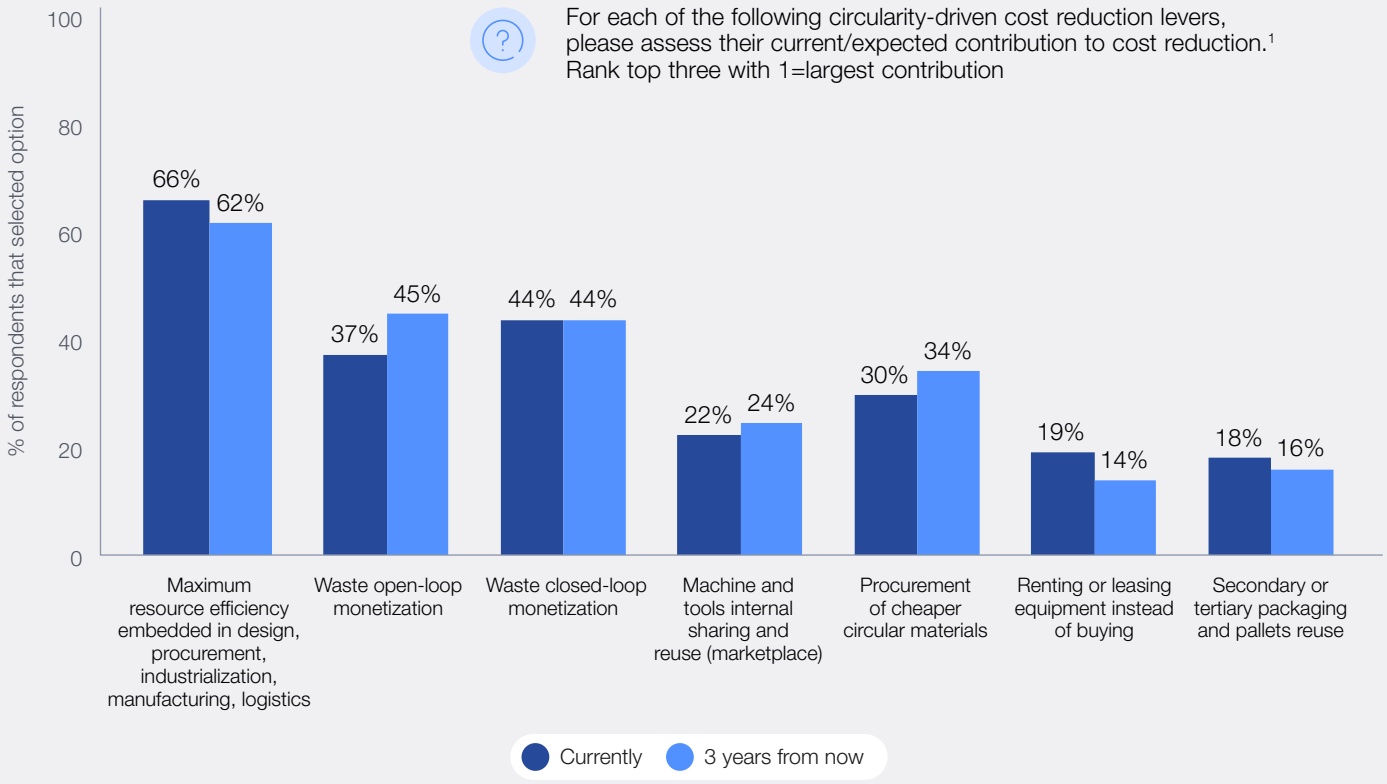
Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

1.4 Efficiency gains are tangible and show strong potential

Circularity is also a structural lever for cost reduction. These savings come primarily from reduced reliance on virgin materials, better material use and ability to extract value from waste streams and under-used assets. The scale of the opportunity is meaningful: 65% of executives in the survey expect circularity to reduce operating costs at full potential, with 56% anticipating reductions of 5% or more (see Figure 4).[30]

FIGURE 4 **Circularity is expected to deliver meaningful cost savings at scale**





Note: 1. Totals do not sum to 100% of respondents as multiple answers are allowed.

Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

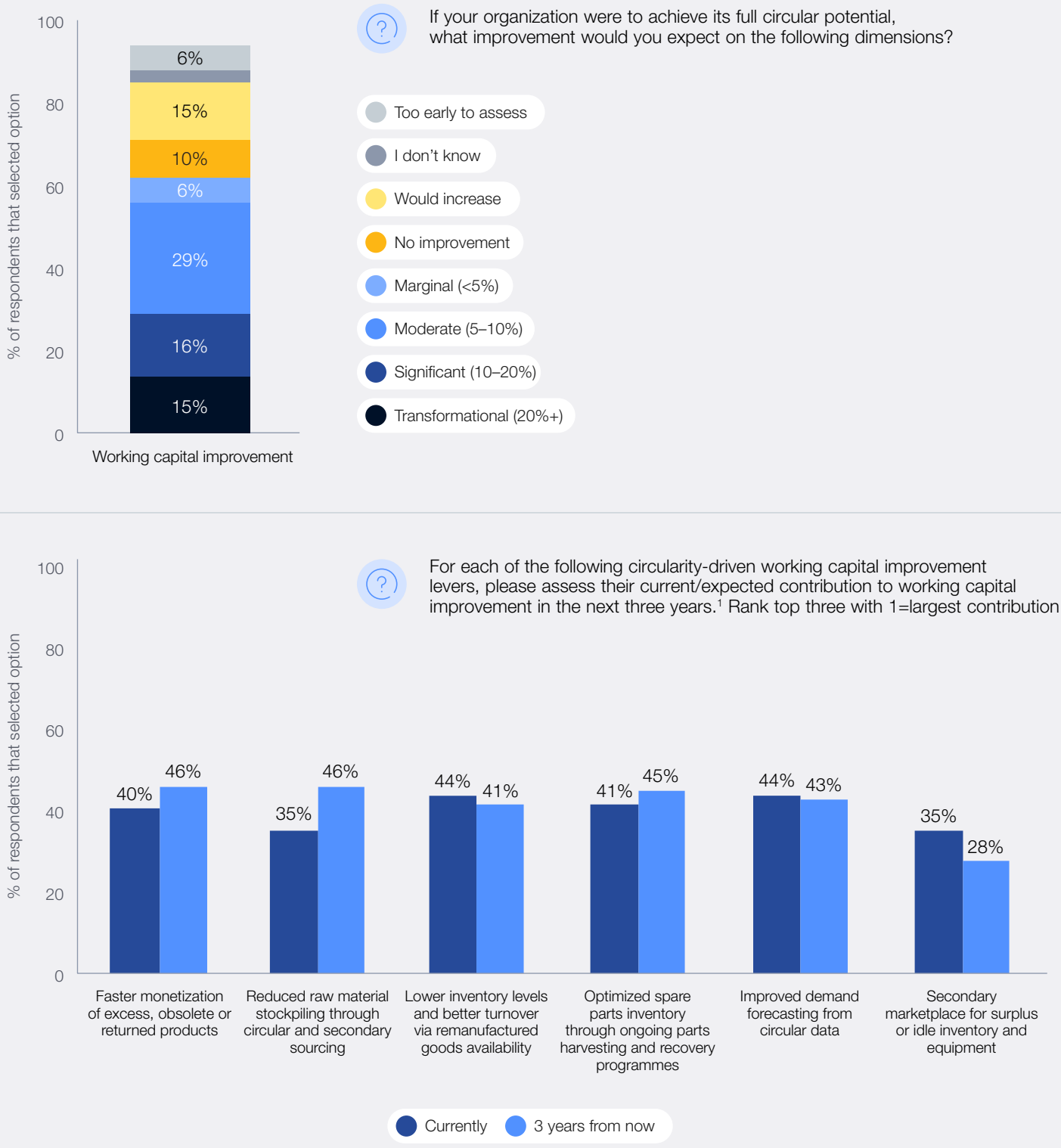
At the product level, remanufactured machinery can be restored to original-equipment specifications and perform as new, at roughly 40–60% of the cost of new equipment,[31,32,33,34] while requiring up to 85% less raw material and 80% less energy to produce.[35,36,37] This recasts the economics for parts and components. Design for circularity can compound these gains by reducing resource intensity at the source, maximizing recycled content and enabling later circular steps, including the ability to repair, upgrade, remanufacture and dismantle the components of capital goods.



1.5 More room for optimizing working capital

Circularity can improve the balance sheet – a feature that most companies are not yet exploiting to the full. Faster monetization of returned and idle inventory, lower raw-material stockpiling and improved asset use make circularity an important lever for cash efficiency at scale. Reduced raw-material stockpiling is expected to rise in importance over the next three years and the expected gains are significant. At full circular potential, 66% of executives anticipate working capital improvements: 60% expect gains of 5% or more and 15% expect transformational gains of 20% or more (see Figure 5).[38] Successful companies in this space assign specific responsibilities and set targets to track all waste streams and the speed and value at which they are monetized. Also, many IS&M companies are obliged to stock spare parts for 10 to 15 years to meet warranty commitments to their original equipment manufacturer (OEM) and other clients. Now, with a proactive approach towards remanufacturing, winners can create a virtuous ecosystem where every stakeholder gets a share of value created, while inventories of new products and components are shrunk.

FIGURE 5 | **Circularity is also expected to deliver meaningful working capital improvements**



Note: 1. Totals do not sum to 100% of respondents as multiple answers are allowed.

Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

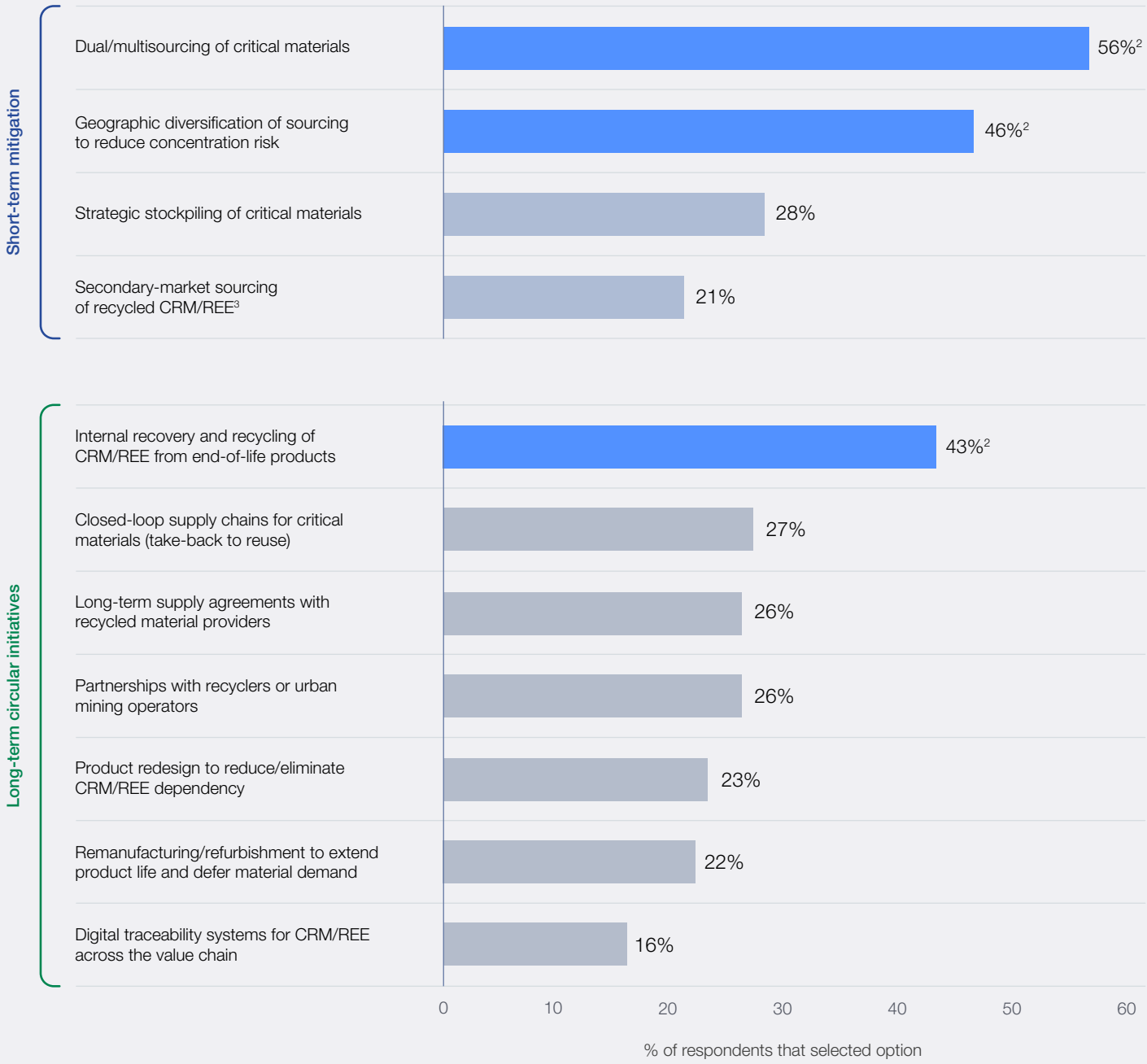
1.6 Circularity delivers greater resilience

In a sector so exposed to volatile and concentrated supply, circularity is emerging as a way to strengthen resilience by protecting profits as well as growing them (see Figure 6).[39]

Framed in this way, circularity tackles multiple ambitions concurrently: it opens new revenues and allows efficiency gains while hedging the material risks that result in cost increases and threaten the core business. The cost of inaction could far outweigh the cost of preparedness. Emissions reduction remains a valuable co-benefit, but for many companies it is no longer the primary reason why they are doubling down on circularity.[40] The business case increasingly stands on its own.

FIGURE 6 **Circularity resilience initiatives**

Which circularity-driven mitigation strategies does your organization currently have in place (or plan to implement) to reduce dependency on critical raw materials and rare-earth elements? Please select all that apply.[1]



Notes: 1. Totals do not sum to 100% of respondents as multiple answers are allowed; **2.** Dark blue bars indicate the top three options; **3.** CRM/REE = critical raw materials and/or rare-earth elements.

Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

2 Barriers to execution

A significant mindset shift is needed to enable circularity's full potential to emerge.



Key takeaways

- **Economics and operations still constrain scale**. Circular models often require upfront investment and operational costs, while return on investment (ROI) can struggle to compete with low-cost and large-scale linear alternatives. At the same time, circular flows are difficult to integrate into operating models built for predictable, one-way linear flows, especially where reverse logistics, variable returned-material quality, processing complexity and data gaps remain unresolved.
- **Ecosystem conditions are not yet mature enough**. Limited installed base and materials visibility, underdeveloped secondary markets, inconsistent quality and volumes, fragmented regulations, export controls and uneven partner ecosystems make it difficult to secure reliable circular inputs and move products, components and materials across borders at scale.
- **Governance and culture remain anchored in linear growth**. Unclear ownership of the end-to-end product and materials life cycle, incentives still tied to unit sales and throughput, limited internal capabilities and resistance to new business models can keep circular economy transformation stuck in pilot mode, even when the strategic case is clear.

The business case for circularity is strong, but a tangle of internal and external barriers still slows its adoption. The operational and cultural obstacles companies face are set out below.

Circular businesses are still optimizing their economics. Cost remains the biggest barrier to scaling circularity. High operational costs for transport and processing are cited by 45% of executives and high upfront investment by 35%, with high logistics or labour costs rated a likely or highly likely headwind by 74%.[41] Additionally, weak returns are the single most-cited reason why companies pause circular pilot projects. Early economics can be tough: Turkish multinational household appliance manufacturer Arçelik's nationwide Waste Electrical and Electronic Equipment (WEEE) recycling programme ran at a loss in its early years before breaking even as consumer awareness grew and collection rates improved. The lesson from the leaders, though, is that patience pays off: first-mover investment today builds the cost advantage of tomorrow.

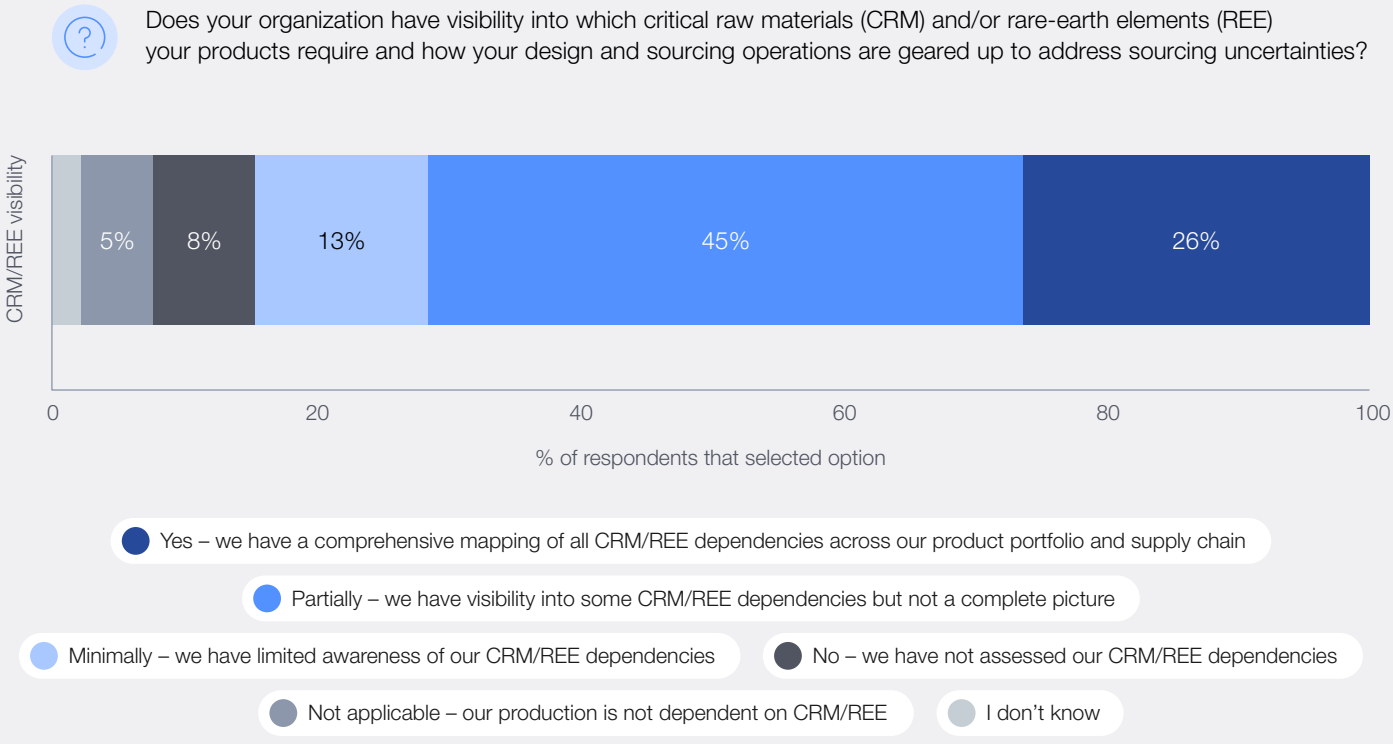
Circular flows don't fit neatly into linear systems – yet. Circular production flows, and the supply chains behind them, are simply harder to set up than linear alternatives. Companies point to a common set of challenges: managing complex return flows; limited infrastructure for circular operations; inconsistent quality in returned products or materials; more diversified processing; difficulty slotting circular processes into existing linear supply chains; and a lack of data systems and traceability to tie it all together and make fast and repeatable decisions at scale.

Systems built for forward flows don't easily adapt to reverse ones. Processing technology itself can be a bottleneck: improving material purity while lowering processing costs remains a shared challenge, as the solar energy division of Hanwha Group, Qcells, has found while building out its US operations. (The earlier white paper, *The Art of Scaling Circular Supply Chains*,[42] explores these operational challenges in more depth.)

Limited visibility, enhanced risks. A staggeringly low 26% of companies have comprehensive visibility into their critical-material dependencies (see Figure 7).[43]

Even where exposure is well understood (see Figure 8), sourcing secondary raw materials and refurbished parts is often made complex by inconsistent quality and volumes (see Figure 9).[44]

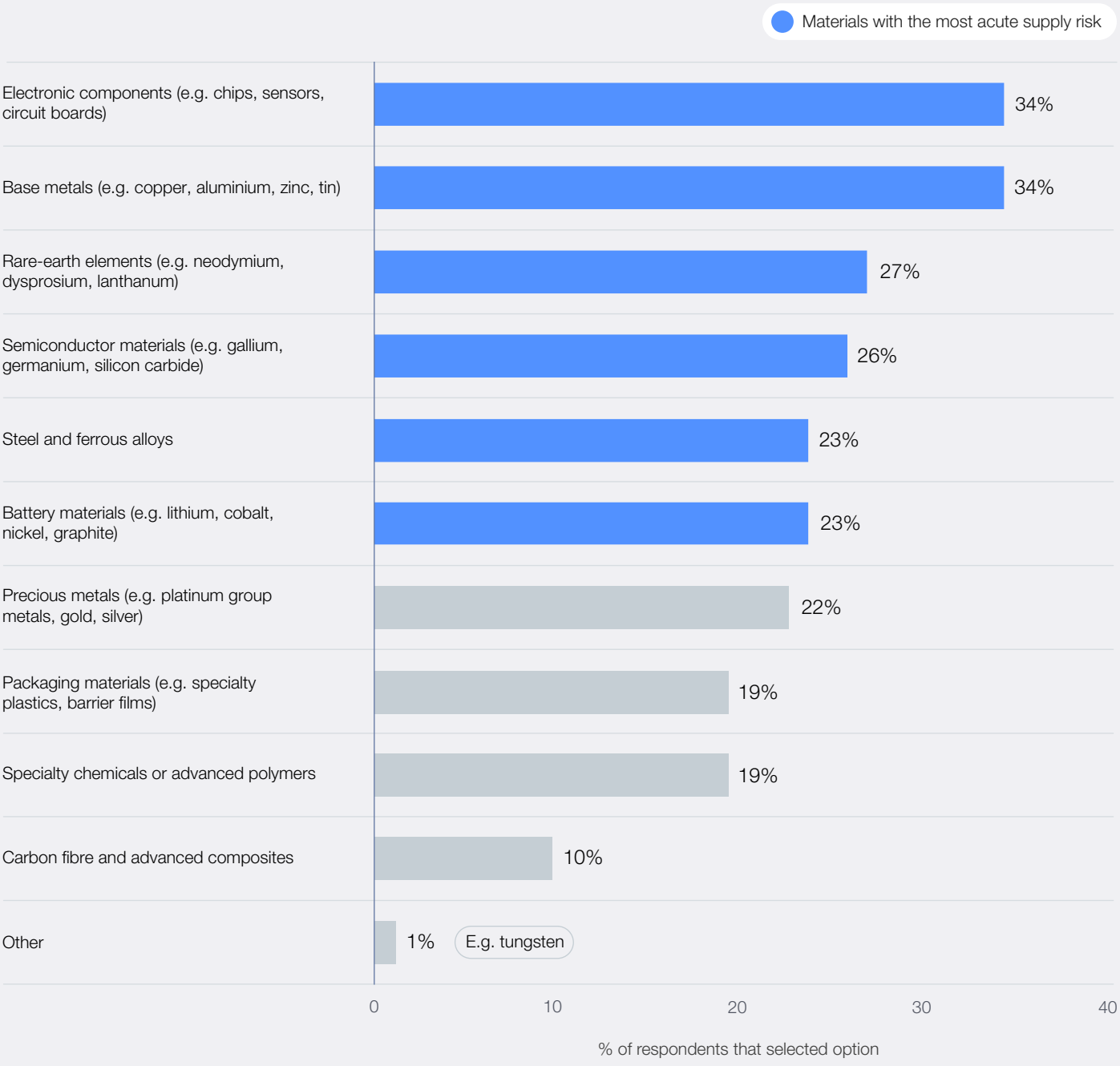
FIGURE 7 **Most organizations have partial or no visibility into critical material dependencies**



Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

FIGURE 8 | **Electronic components, base metals and rare-earth elements represent the most acute supply risks**

Which material categories or components present the most acute supply risk for your organization? Please select up to three.[1]



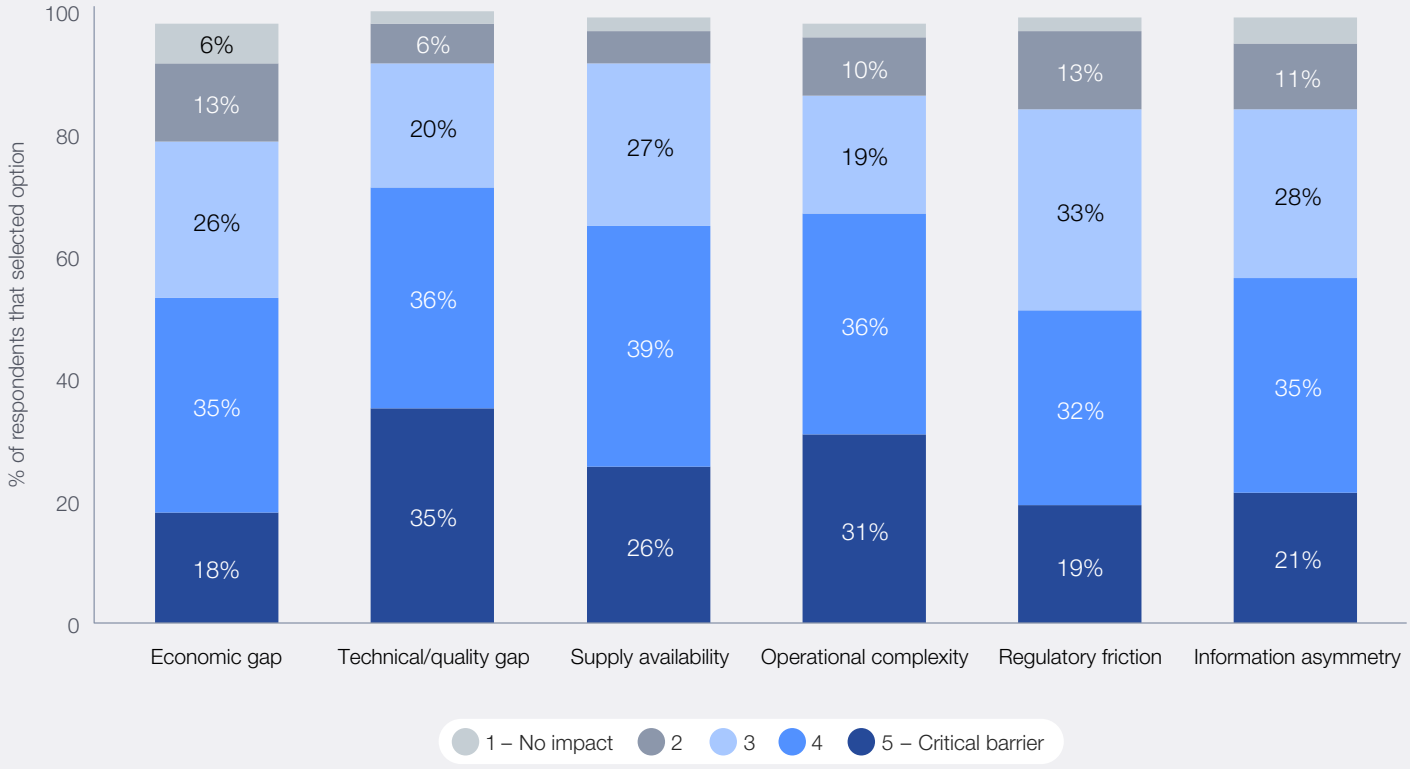
Note: 1. Totals do not sum to 100% of respondents as multiple answers are allowed.

Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

Secondary-material markets, overall, still have room to grow: only around a third of global steel and aluminium production currently comes from recycled sources[45,46] and the picture is tighter still for critical materials – several are barely recycled at all, others sit at recycling rates of just 1–5%, and less than 1% of rare-earth elements are recovered today.[47,48] The materials most worth recovering are, for now, often those with the least-developed secondary markets – which is exactly where the opportunity lies for early movers (see Figure 9).[49]

FIGURE 9 **Technical and quality gaps remain the primary barriers to scaling secondary material use**

To what extent do the following barriers prevent your organization from increasing its procurement of secondary (recycled) materials?



Source: 2026 Circularity for Competitiveness and Resilience Executive Survey by Bain & Co. and World Economic Forum (June 2026, N=94)

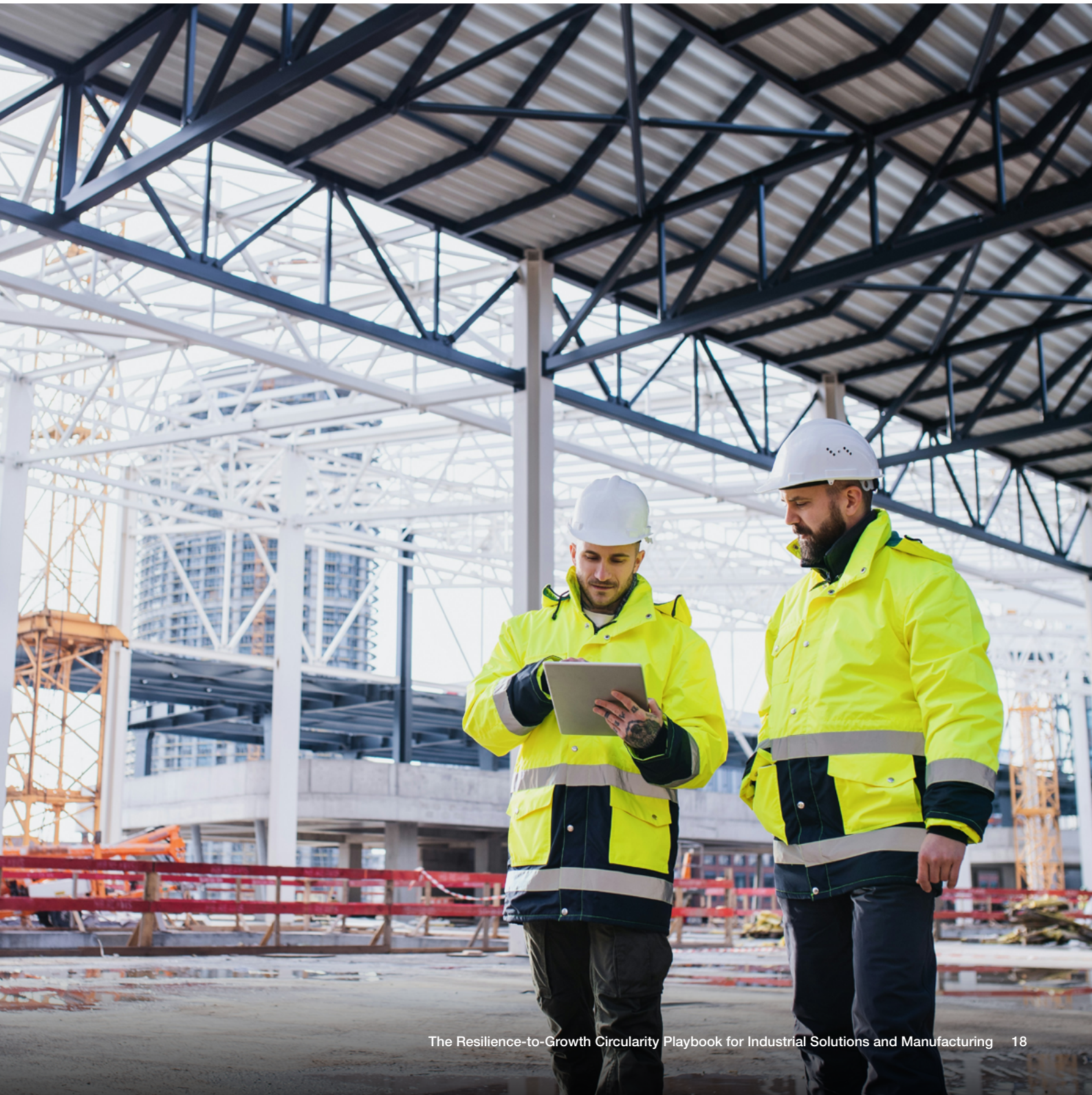
Executives surveyed are clear on what would unlock these markets: universally accepted quality standards and certification, recycled-content mandates and harmonized cross-border shipment rules. Economic incentives such as tax credits or virgin-material levies were also flagged as helpful.[50] Secondary materials may still carry a price premium over virgin alternatives today, reflecting limited economies of scale and the cost of steps such as collection and treatment – but that gap is set to narrow as markets mature.

A fragmented ecosystem slows everyone down. Building circular value chains is still hard. Companies in the survey cite the challenge of finding the right partners (22%) and agreeing profit-sharing arrangements (13%). Nearly half (46%) of executives see partnerships and ecosystems as important to performance, yet only 6% of companies have a fully functioning circular ecosystem today.[51] Export restrictions, along with a lack of common standards and regulation, are the most cited obstacles. For Schneider Electric, the French multinational specializing in energy technology, digitalization and automation, finding recycling partners with the right technical capabilities was the single biggest challenge in scaling its closed-loop silver recovery initiative – a reminder that the right partnership can unlock progress that no company can achieve alone.

Governance and culture can still pull towards linear systems. Some of the deepest-rooted barriers are cultural, not technical, especially in a sector built around capital goods designed to last a decade or more. Key performance indicators (KPIs) and incentives across IS&M companies still tend to reward new-product sales, and therefore shifting towards more modernization, more remanufacturing and more recurring service contracts can meet internal resistance, particularly where new business models are seen as competing with the dominant historical model.

Closing the gap between ambition and scale, then, depends as much on governance and mindset as on technology or capital. GEA, one of the world's largest manufacturing system suppliers for the food, beverage and pharmaceutical sectors, and the heating and cooling system manufacturer Trane Technologies, both historically built around engineering and equipment sales, implemented deliberate cultural change and internal education to bring business-unit teams on board. This is a reminder that one of the biggest unlocks is often company culture, tone at the top and belief systems about "what success looks like", rather than sheer technology or material change.

These barriers are real, but not insurmountable. The companies profiled in the next section are already working through them – and their experience points to a clear, structured way forward for scaling circularity.



3 The winning playbook

Leaders who have scaled circular solutions are following a clear strategy: one that ensures resilience and growth.



Key takeaways

- **Circularity is a mindset, not a mandate**. The companies pulling ahead are deliberate about value creation across the product life cycle and they focus their efforts where they count most – on the product families, geographies and customer segments where circularity opens value pools, strengthens resilience or lifts margins.
- **Quantify first**. Scaling starts with a clear picture of where the best circular opportunities lie and where material risk threatens profit.
- **Codify the moves that matter**. Leaders pick the circular initiatives that genuinely move the needle, and then standardize them to ensure their replicability.
- **Amplify through an array of enablers**. Governance changes, new data and technology, and ecosystem partnerships drive circularity at scale – with new incentives and KPIs tied to life-cycle value generation.

Circularity matters for the IS&M sector and the prize is substantial. Yet ambition alone rarely enables companies to scale. What sets the leaders apart is discipline: a sharp focus on where circularity creates the most value and a methodical approach to scaling it. Companies leading on circularity use it as a multipurpose strategy, on the one hand inventing new revenue streams for installed-base value maximization and customer intimacy, and on the other guarding against the material and supply risks that threaten profit.

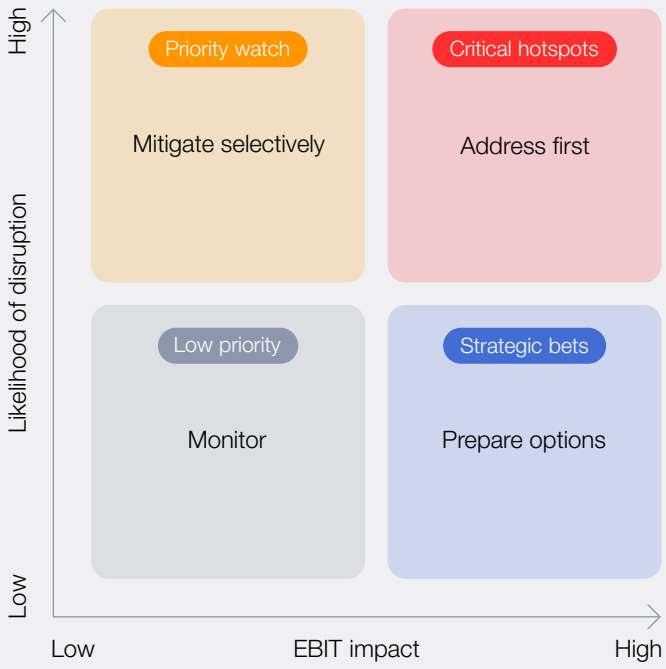
This section sets out a structured path forward in three steps: **quantify** the value at stake and the risk exposure; **codify** the circular moves that unlock that value and reduce that exposure; **amplify** by building the conditions needed to scale. Together, these steps help companies focus capital and management time on the moves that matter most, rather than spreading effort across a long list of pilot initiatives. Co-developed through the World Economic Forum's Circular Economy Transformation community, this framework draws on executive consultations, the **2026 Circularity for Competitiveness and Resilience Executive Survey**,[52] leading industry case studies and lessons learned from companies already scaling circularity.

3.1 Quantify: Map the risk, measure the opportunity

Prioritization is difficult to sustain without evidence. Today, just 26% of IS&M executives say they have full visibility over their critical raw material and rare-earth dependencies, and only 1% use standardized external metrics to track circular revenue.[53] The **quantify** step closes gaps, both by mapping input-risk exposure and by identifying the circular value pools worth pursuing.

Mapping material exposure: One task is to map the critical materials and components on which the business depends, including critical raw materials and rare earths, and to trace that dependency by business unit, product line, supplier and geography. Each dependency is then scored on two dimensions: the likelihood of disruption (based on criticality, price volatility, supplier concentration, country risk and substitution options, environmental impact, etc.) and how much it would hurt earnings before interest and taxes (EBIT) if supply of the material became constrained. Plotting the two produces a ranked agenda, with critical hotspots to fix first, strategic bets around which to build options, priority items to watch and lower-priority exposures simply to monitor. The result is a **material dependency heat map** (see Figure 10), which turns supply risk into a clear, financially grounded action plan.

FIGURE 10 **Material dependency heat map**



Source: World Economic Forum and Bain & Co.

An effective technique at this stage is **riskiest assumptions testing:** instead of stress-testing every variable equally, leaders focus on the assumptions that the whole dependency picture rests on – the ones that would do the most damage if proved wrong – and build scenarios around them. Uncovering these core assumptions early, before capital is committed, allows mitigation actions to be sequenced against the risks most likely to materialize.

Two manufacturers show how this works in practice. GEA (case study 1) uses a structured, nature-related risk assessment to map priority commodities and sourcing hotspots across its supplier base. Trane Technologies (case study 2) has built a standardized way to view supply risk at every level – part, commodity, plant, product and enterprise.

Measuring the value of opportunities: Another task is to assess circular maturity across the value chain (see Figure 11) to determine what already exists, what is ready to scale, where circular activities must be built from scratch, and what the overall potential is of each initiative. For example, Siemens, a global technology company, uses its Robust Eco Design (RED) framework to assess maturity and prioritize the most relevant ecodesign requirements (case study 6).

CASE STUDY 1

GEA: Mapping material dependencies across the value chain

GEA manages material risk through its Raw Materials Commitment and Sustainable Procurement programme that pairs quantitative purchasing data analysis with a formal method for assessing nature-related dependencies. Using the Taskforce on Nature-Related Financial Disclosures (TNFD) Locate, Evaluate, Assess, Prepare (LEAP) methodology, GEA systematically maps priority commodities and sourcing hotspots across its supplier base. Steel-related product groups have emerged as a key focus, given their weight in GEA's equipment manufacturing and their exposure to emissions intensity, supply concentration and regulation.

The assessment feeds a prioritized set of actions. GEA requires suppliers to meet sustainability criteria and applies responsible sourcing controls for conflict minerals as standard practice. To see further than direct supplier relationships allow, GEA has sharpened its supplier engagement programme to trace raw material origin beyond Tier 1 suppliers. This gives visibility into parts of the supply chain that are usually opaque. Industry initiatives such as SteelZero help move lower-emission steel at market level, complementing GEA's own supplier engagement. In short, GEA has turned a risk-assessment exercise into a forward-looking procurement strategy – using the visibility it generates to advance both resilience and circularity.

CASE STUDY 2

Trane Technologies: A structured approach to material issues and opportunities

Trane Technologies takes a structured approach to identifying and monitoring the challenges and opportunities that are relevant to its business, customers and stakeholders. Within this context, the company continues to advance its approach to supply-chain resilience and resource stewardship. This includes using those insights to continually prioritize and strengthen its actions related to materials, sourcing and operations. By taking this continuous improvement approach, the company is working to strengthen resilience, support the value delivered to customers and reinforce long-term business performance.

Circularity is an important part of this journey. As Trane Technologies continues to evolve its circularity strategy, the company sees opportunities for circular approaches to support resilience, make better use of resources and contribute to business value. Framed this way, circularity is not separate from enterprise performance; it is one of the ways in which the company can help build adaptability, deliver customer value and support long-term growth.

FIGURE 11 | **Circular value chain**

01 Design and sourcing

- Design for virgin resource efficiency
- Design for circular life cycle
- Design of connectable products

Value for companies

- New revenue from circular products
- Lower production costs
- Less exposure to scarce materials
- Shareholder value/ESG rating[1]

Value for their clients

- Improved product efficiency
- Reduced life-cycle cost
- Greater supply assurance
- ESG goals enablement

02 Life-cycle operations

- Repair/retrofit/upgrade/ modernization services
- Refurbishment services/ remanufacturing
- Enabling digital services

Value for companies

- Growth of services revenues
- Higher "customer lifetime value"
- Wider accessible market
- Improved WC[2] management

Value for their clients

- Total cost of ownership (delayed CAPEX, lower OPEX)
- Resource efficiency
- Optimal performance
- Environmental excellence

03 Use phase and business models

- Leasing models
- As-a-service models (e.g. pay-per-use)
- Rental models
- Sale of second-life products

Value for companies

- Securing recurring revenues
- New revenue from second-life products
- Lifelong intimacy with clients
- Improved asset usage

Value for their clients

- CAPEX to OPEX (cash preservation)
- On-demand scaling
- Focus on core

04 End-of-life and recovery

- Product end-of-life take-back programmes
- Dismantling for parts and component harvesting
- Materials open- and closed-loop recycling

Value for companies

- Lower COGS[3]
- Improved WC through recovery
- Secured EBIT through securing secondary materials
- Waste monetization

Value for their clients

- Lower product costs
- Lower packaging handling costs
- Responsible end-of-life solution

Supply-chain resilience and new growth avenues

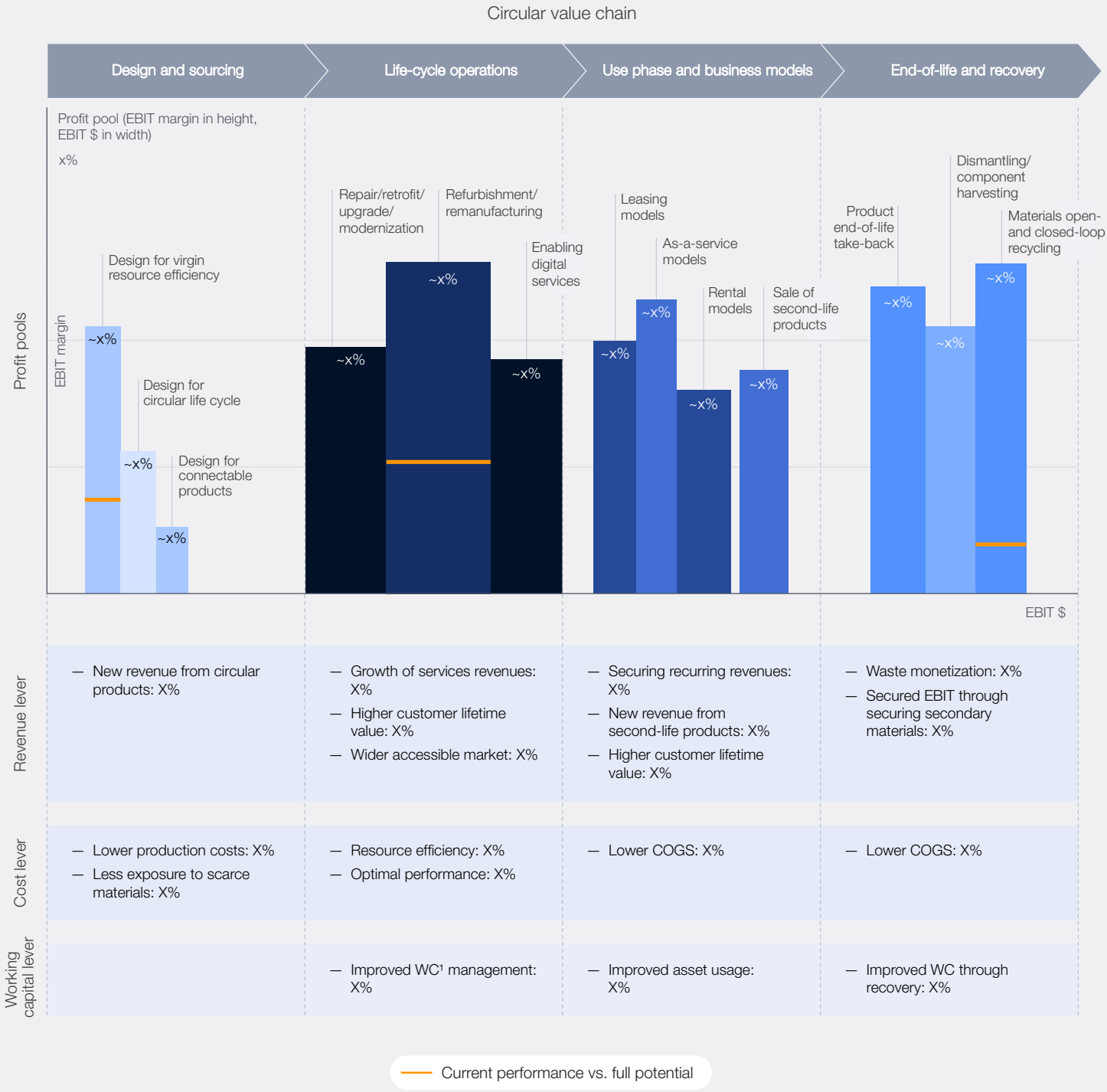
Note: 1. ESG = environmental, social and governance; **2.** WC = working capital; **3.** COGS = cost of goods sold.
Source: World Economic Forum and Bain & Co.



For each initiative, leaders calculate its full potential across revenue, cost savings and working-capital improvement, plotting the results on a circular profit pools map that shows EBIT margin potential against absolute EBIT value – distinguishing what's already captured from what's still possible (see Figure 12).

Value can accrue on three fronts at once: first, customers get better product efficiency, lower life-cycle costs and greater supply assurance; second, companies gain new circular revenue, lower production costs and better working capital; third, players along the entire supply chain benefit by reducing their exposure to scarce materials and protecting their margins. The strongest moves deliver on all three fronts at once, as Qcells shows (case study 3).

FIGURE 12 **Circular profit pools – an illustrative example**



Note: 1. WC = working capital.

Source: World Economic Forum and Bain & Co.

CASE STUDY 3

Hanwha Qcells: Quantifying the opportunity in solar-panel recycling

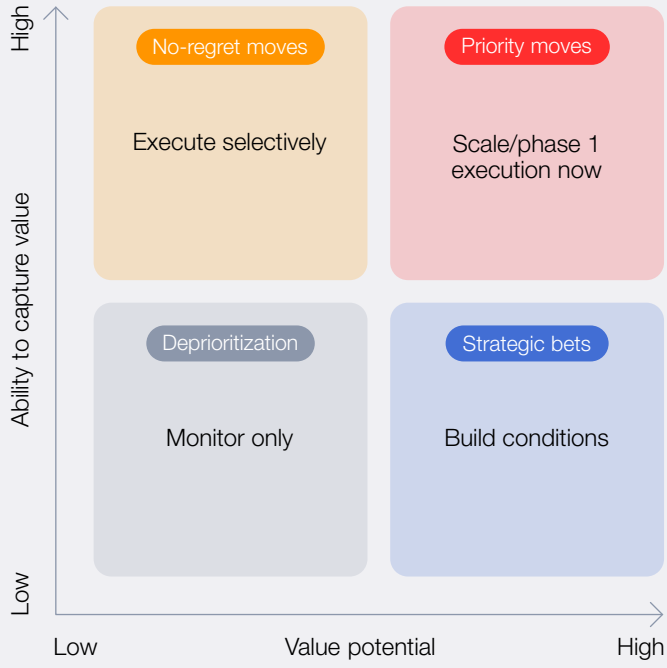
Hanwha Qcells, a leading supplier in both the US residential and commercial solar markets, operates EcoRecycle by Qcells, a solar panel recycling business, in the US.

EcoRecycle has an internal valuation function, supported by Qcells, to track its business case and key value drivers. The internally estimated net present value (NPV) and internal rate of return (IRR) reveal that the business is set to create significant profitability and be very capital-efficient. It is also expected to recover the value of its investment relatively quickly, in conjunction with the rising demand for treatment of EoL modules in the years to come. Incubated inside Qcells and now operating independently – with continued technical support from Qcells' Cartersville manufacturing site – EcoRecycle is still an early-stage business in an immature US recycling market. But the demand trajectory is clear: waste solar modules are projected to reach 3.7GW by 2030 and 14.8GW by 2040,[54] a growing volume base that will only strengthen the financial case over time.

3.2 Codify: Choose the actions that reduce risk and/or create value

With hotspots identified and value pools mapped, the next step is choosing which circular initiatives to adopt. These are prioritized on two axes: **value potential**, combining the ability to reduce material risk and improve EBIT, and **ability to capture value**, reflecting maturity, investment required, time to impact and ecosystem readiness. Plotting these dimensions produces a **circular initiative prioritization matrix** with four action zones: priority moves to launch now; no-regret moves to pursue selectively; strategic bets that first require groundwork; and initiatives to deprioritize and monitor (see Figure 13).

FIGURE 13 **Circular initiative prioritization matrix**



Source: World Economic Forum and Bain & Co.

In practice, some companies tend to implement a mix of short- and long-term initiatives on their way to full circularity. Facing immediate supply risk, most start with short-term fixes: dual or multisourcing (56%) and geographic diversification (46%), which ease pressure without structurally reducing exposure.[55] IS&M companies are further ahead on product-side circular models than on service-based ones: 52% have fully scaled repair and retrofit (versus a 36% all-industry average) and 36% have fully scaled refurbishment and remanufacturing (versus 24%). Service and ownership models – as-a-service, rental, leasing – lag behind, fully scaled by only 15–20% of respondents, which points to real headroom for manufacturers ready to move first.[56]

A growing number of leading companies are adopting life-cycle thinking (LCT) as a strategic lever for growth and not just a compliance exercise. LCT provides a steady stream of insight for product innovation, operational redesign and supply-chain development, as well as for new revenue streams and business models. Embedded at executive level, it turns what's often seen as an engineering discipline into a board-worthy agenda item.

The cases that follow show what this looks like in practice: GEA and Trane Technologies (case studies 4 and 5) embed circularity across the entire value chain, from material selection through life-cycle services to EoL recovery. Siemens (case study 6) illustrates how a company-wide mandatory ecodesign methodology builds circularity systematically into the development of hardware, software and services from the earliest design stage – when most of a product's life-cycle impact is set. Schneider Electric (case study 7) shows how more than a decade of initiatives, from closed-loop silver recovery to upstream rare-earth partnerships, can add up to a coherent material-resilience strategy. Arçelik and Qcells (case studies 8 and 9) show how proprietary EoL recovery can turn waste streams into a secure supply of secondary materials, and create refurbished product businesses.

CASE STUDY 4

GEA: Embedding circularity across the full equipment life cycle

GEA positions circularity as a transformation lever across the life cycle of its long-life equipment. Its ambition is for all new solutions launched from 2030 onwards to be circular-ready. It formalized its circularity approach in 2021 with a 5R framework: Reduce, Reuse, Repair, Remanufacture and Recycle, initially focused on spare parts and packaging. By the end of 2026, all service parts and machinery packaging must comply with one of the five Rs. Since 2024, the scope has expanded to full equipment solutions, with circular design principles being rolled out across divisions.

- **Circular product design**. Equipment is designed for maintenance, upgrades and retrofits. Seven criteria define a circular-ready solution, covering resource-efficient design, digital connectivity, lifetime service concepts, EoL instructions, zero freshwater-use options, renewable-energy compatibility and 5R-compliant parts and packaging.
- **Sourcing**. GEA is targeting over 50% lower-emission steel by 2030, alongside stronger supplier compliance and better data on carbon footprint, recycled content and material origin to improve traceability.
- **Life-cycle operations**. A connected installed base enables remote monitoring, predictive maintenance and performance optimization, keeping equipment at peak performance for longer.
- **Business models**. GEA uses service-level agreements, digital twins, product life-cycle management tools and connected equipment to support a shift towards ongoing performance partnerships. It sets service sales growth and service sales share as core KPIs. GEA's solutions also enable circular material flows for customers, including PET recycling, citrus-oil recovery and biopolymer recovery from wastewater.
- **End of life**. Machines are routed to repair, refurbishment or recycling based on their condition, value and performance, with full traceability.

GEA's circularity programme is scaling towards 2026 and 2030 milestones: all service parts and packaging compliant with the 5Rs by 2026; all new solutions circular-ready, supported by EoL instructions and zero freshwater-use options by 2030; 80% of the serviceable installed base connected by 2030; and service sales reaching 40% of total sales, growing at more than 6% a year alongside growing refurbishment and second-life revenues.

CASE STUDY 5

Trane Technologies: Circularity across the full product life cycle

Trane Technologies, a global climate innovator, is building a circularity strategy for its entire value chain through its commitment to Design Systems for Circularity by 2030.[57] Spanning material selection, product design, service, remanufacturing, reuse and end-of-life recovery, the approach positions circularity as a business transformation lever for resilience, growth, emissions reduction and resource efficiency while creating value for customers, the supply chain and the business. Building on decades of remanufacturing and life-cycle service experience, Trane Technologies now runs a governed, KPI-driven programme across product development, sourcing, manufacturing and service operations. The strategy is organized around six pillars:

- **Material selection**. Recycled content is rising across steel, aluminium, copper, plastics and refrigerants. In one case, a key aluminium alloy's recycled content rose from around 20% to 84% without any loss of performance. In partnership with its suppliers and supply-chain teams, Trane Technologies continues to develop collaboration opportunities to shift its sourcing pathways to higher recycled content alternatives.

- **Sustainable and circular design**. Circularity is embedded in product development through a shared framework across product management, engineering, materials, chemistry, operations and procurement. This improves durability, repairability, recycled content and carbon performance. For example, in 2025, Trane Technologies began developing a closed-loop system for steel, aluminium and copper scrap generated at its North American manufacturing facilities. The company will continue its long-standing collection of metal scrap, aiming to recycle or reuse it to reduce wasted direct input materials. Where feasible, it partners with suppliers to redirect scraps of high-value commodities and alloys back to them, preserving the value of the materials.

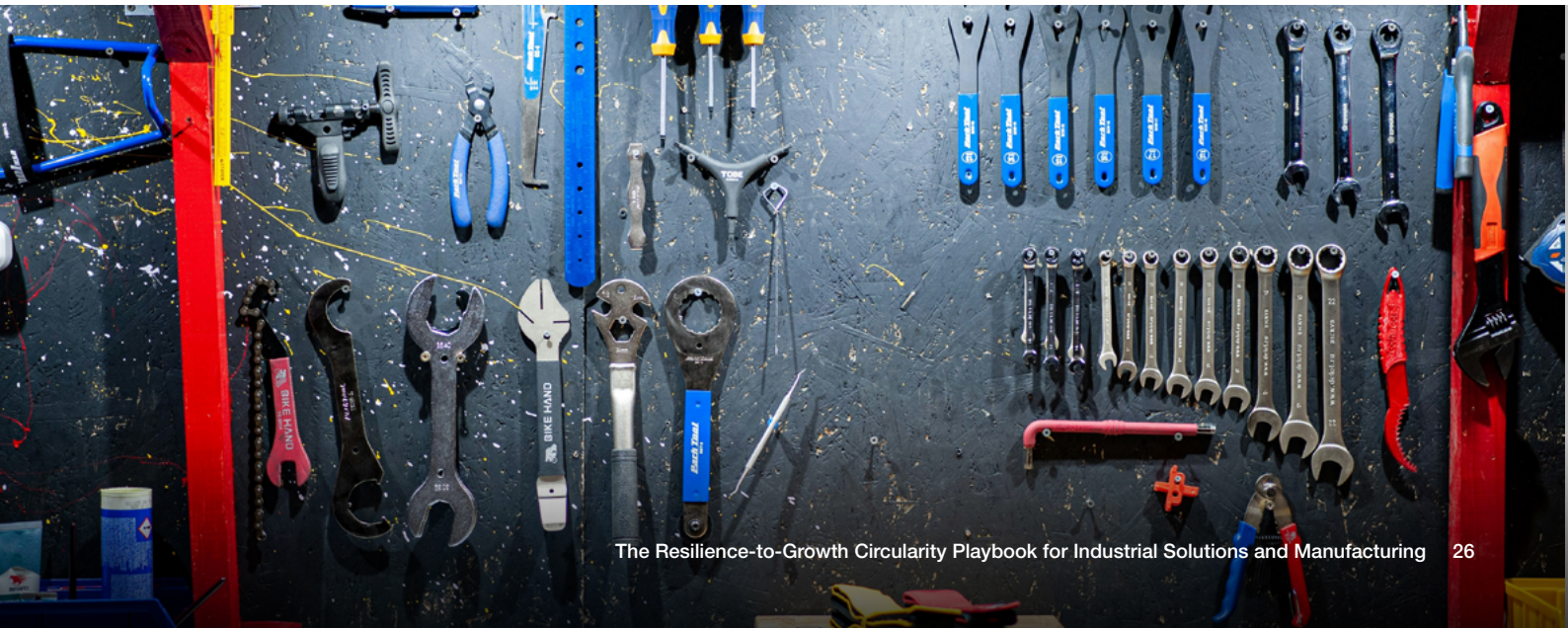
- **Remanufacture and repair**. Trane Technologies restores used components through disassembly, cleaning, repair, testing and reassembly, preserving value while reducing the need for new manufacturing. In 2025, the company's global teams remanufactured more than 9,200 components, including compressors, motors, controllers, electronics and starters. Remanufacturing has also helped supply hard-to-find parts during industry shortages.

- **Maintain, prolong and share**. Technician-led overhauls, upgrades and artificial intelligence (AI)-enabled diagnostics keep equipment performing at near-new levels, delay replacement and extend asset life further.

- **Reuse and redistribute**. Rental, buyback, refurbishment and certified pre-owned programmes – including Thermo King's certified pre-owned refrigeration units – keep equipment in circulation and deliver a tangible bottom-line impact for fleet managers.

- **Recycle**. Trane Technologies embeds material recovery into manufacturing and reverse logistics. At its Galway facility in Ireland, waste streams are separated and redirected – scrap metal into raw material, cardboard into packaging, timber into mulch – cutting disposal costs and creating material savings.

Momentum is building: revenue from remanufactured products and services grew by 31% year-on-year to $282 million in 2025; 178 product development projects used the circular design framework; 44% of primary materials contained recycled content; and refrigerant reclamation avoided 794,750 tonnes of CO_2e – more than double 2024 levels. Some 80% of global manufacturing facilities have achieved zero waste to landfill. Dedicated circularity impact metrics and targets, including a 10% circular revenue goal and a commitment to more than double circular material use by 2030, were introduced in 2025, marking the transition from embedded practice to a formally governed, KPI-driven programme scaling across product development, sourcing, manufacturing and service operations.



CASE STUDY 6

Siemens: Embedding ecodesign in hardware, software and services

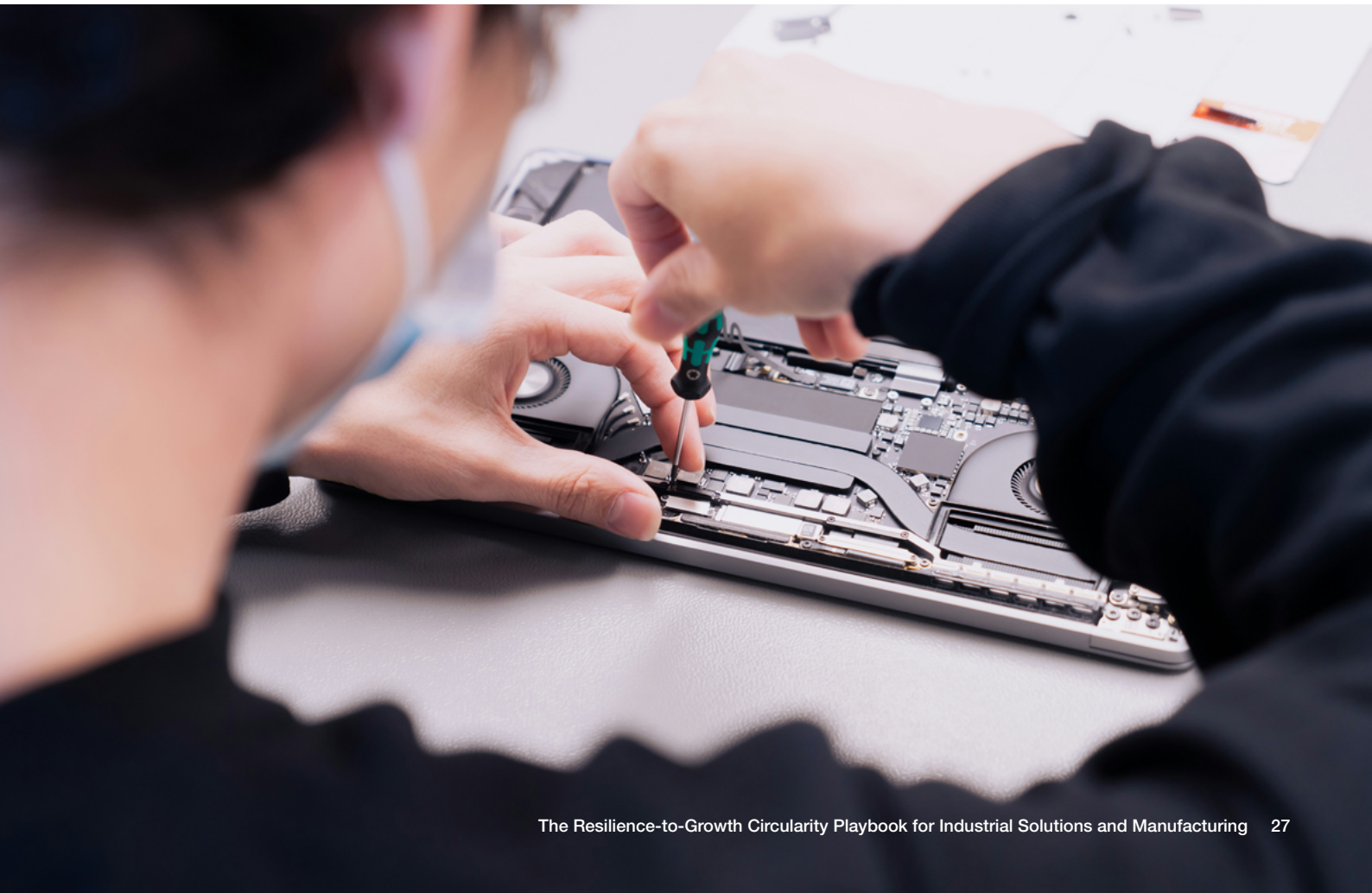
Siemens empowers industries, infrastructure and mobility to transition from linear to circular with its technologies. One of the key levers of its circularity approach is creating circular products. Siemens embeds circularity from the earliest design stage – where most of a product's life-cycle impact is set – through its Robust Eco Design (RED) framework. RED is guided by a life cycle-based set of ecodesign criteria. These criteria systematically improve the environmental performance, resource efficiency and circularity of portfolio elements across three stages: sustainable materials, optimal use and value recovery.

Robust Eco Design is a mandatory methodology spanning all relevant hardware, software and services. For hardware, it covers aspects such as secondary and lower-impact materials, energy efficiency in use, durability, repairability, upgradability and recyclability. For software, it focuses on energy and resource use in development and operation. For services, it considers both the footprint of service delivery and the role of service models in improving asset performance, utilization and lifetime.

Robust Eco Design became the basis for the Siemens EcoTech framework launched in 2024, which shares standardized environmental data with customers via Siemens EcoTech Profiles (SEPs).[58] RED runs in three maturity phases. First, teams identify and prioritize the most relevant ecodesign requirements. Second, they quantify environmental impacts through life-cycle assessment. Third, they identify and evaluate improvement measures and integrate them into design decisions and the Product Lifecycle Management (PLM) process.

Digitalization enables RED to scale across the portfolio. Siemens uses an integrated digital life-cycle assessment approach to harmonize how environmental data is collected, calculated and communicated. The approach also automates inputs and calculations, enabling comparable outputs across business units and service offerings. Ecodesign application across the portfolio delivers measurable environmental improvements. For example, the SIRIUS 3RW5 refurbished soft starter produces 50% lower CO_2 emissions compared to a new device, while still delivering the same performance and safety features.

By fiscal 2025, Robust Eco Design covered 67% of Siemens' relevant portfolio and 69% of relevant revenue. By 2030, Siemens aims to apply RED to 100% of the relevant portfolio and enable its customers to avoid more than 1,000 million tonnes of cumulative CO_2e emissions. To accelerate the transition to a circular economy through ecodesign, further 2030 targets were set for phasing out selected substances of concern, substituting a share of standard thermoplastics with sustainability-enhanced thermoplastics in 50% of relevant products, pursuing 100% sustainable product packaging and providing recyclability statements for all relevant products.



CASE STUDY 7

Schneider Electric: Building material resilience through circularity

Schneider Electric has embedded circularity into its resilience strategy to reduce dependency on critical primary materials, including silver, rare earths, copper and steel. Its approach combines regionalized supply chains, closed-loop material recovery, circular product design, material substitution, life-cycle extension and upstream partnerships.

- **Regionalization**. Since redesigning its supply-chain network in 2012 and launching its Tailored, Sustainable, Connected strategy in 2019, Schneider has spread manufacturing, engineering and distribution across regions – reducing concentration risk and enabling local recycling and life-cycle services.
- **Governance and life-cycle operations**. Circularity has been embedded in strategy since 2015 (via the Ellen MacArthur Foundation's CE100 network) and is now tied to public reporting, executive oversight and life-cycle services. For example, EcoFit modernization services help customers upgrade and extend installed equipment life, while EcoStruxure-enabled predictive maintenance supports earlier intervention and improved performance that extend asset life.
- **Material substitution.** Schneider aims to reduce virgin material dependency. AirSeT switchgear replaces sulphur hexafluoride with pure air insulation and vacuum interruption technology, cutting reliance on a high-impact, increasingly regulated gas. An Environmental Data Programme includes around 120,000 data points, with entries on materials, carbon footprint and EoL attributes.
- **Closed-loop recovery.** To reduce exposure to critical materials, Schneider's closed-loop silver model, scaled at its Le Vaudreuil plant in France, collects and sorts silver scrap, which is then refined by a regional partner and reintegrated into production – with Schneider retaining ownership throughout, cutting costs and exposure to price swings.
- **Upstream partnerships**. A 2023 partnership with ArcelorMittal brought recycled steel into electrical enclosures in Europe; a 2026 agreement with Torngat Metals supports a more diversified rare-earth supply chain.

The results: 428,450 tonnes of material taken back since 2017, exceeding the target; 48% of materials now qualifying as green, close to the 50% goal; 90% of turnover from products disclosing 14+ environmental attributes; and roughly 1,300 tonnes of CO_2 saved annually at Le Vaudreuil alone. Schneider's experience shows how circularity can grow from a waste-reduction exercise into a structural lever for resource security and margin protection.

CASE STUDY 8

Arçelik: Building a nationwide WEEE recycling infrastructure

Arçelik has built circularity around its own EoL recycling infrastructure, giving it direct access to recovered materials and tighter control over Waste from Electrical and Electronic Equipment (WEEE) compliance and reverse logistics. What started as a compliance programme in Türkiye is now a genuine advantage as Europe tightens recycled-content rules.

Since 2014, dedicated plants in Eskişehir and Bolu have made Arçelik the first company in Türkiye to operate as both producer and recycler – recovering plastics, metals and glass to contribute to the circular economy. Collection is driven by the Let's Return to Nature campaign, offering discounts for returning old appliances of any brand. Recovered plastics increasingly flow back into new products – from dishwasher components to materials made from recycled PET bottles and fishing nets. Refurbishment centres at manufacturing plants, running in Türkiye since 1997 and now also in the United Kingdom, Italy and Romania, extend product life further.

Between 2014 and 2025, Arçelik's two WEEE plants processed around 1.98 million units, saving 597GWh of energy, avoiding roughly 290,000 tonnes of CO_2 and saving 9.4 million tonnes of water by changing old products for more energy- and water-efficient ones. In 2025 alone, the company refurbished 148,862 units globally, while continuing to build towards its 2030 target of 40% recycled plastic content.

CASE STUDY 9

Hanwha Qcells: Building the first closed-loop solar-panel recycling network in the US

Hanwha Qcells launched EcoRecycle by Qcells in 2025 to address EoL solar panel waste and build a closed-loop domestic solar supply chain in the US. The first initiative of its kind in the US, EcoRecycle serves Qcells' own modules and customers across residential, commercial, industrial and utility segments and, together with Qcells' Georgia facilities, forms the country's first vertically integrated solar supply chain, with an annual production capacity of 8.6GW.

Based in Cartersville, Georgia, EcoRecycle can process around 250MW – 500,000 panels – a year at full capacity, recovering glass, aluminium, silver and copper. Aluminium frames in good condition are resold to aluminium producers, and the recovered aluminium is repurchased by the Qcells team for use in solar module production at its Dalton plant, creating a direct closed loop between EcoRecycle and Qcells' manufacturing operations.

Silver is recovered and treated as profitable, given its high market value. Copper from junction boxes is a further recovery stream for which a sustainable recycling pipeline is under development. Glass, the most abundant material by volume, is recovered with reuse potential. A collection partnership with Greentech Renewables has opened public hubs in Tampa and Palmetto, Florida, as the first step towards a wider network.

At the same time, state regulation is emerging and EcoRecycle is well-placed to meet rising demand for compliant recovery. The programme is forecast to avoid 32,595 tonnes of CO_2 emissions a year based on projected recycling capacity, which will additionally reduce waste to landfill and reintroduce recovered materials into domestic supply chains. The latter also directly strengthens the resilience of the domestic supply chain by reducing dependence on imports.

For the initiatives that clear the prioritization bar, leaders define a **Phase 1 execution charter** to test the business case before committing further capital (see Figure 14). The detailed structure matters because the most common reasons IS&M companies cite for discontinuing circular initiatives are weak initial returns (35%) and shifting priorities (19%). A strong execution charter is designed to catch these pitfalls early.[59]

FIGURE 14 **Phase 1 execution charter framework**

		Criteria for Gate 1 review Initiative needs to pass "ready to execute" checks	
Value potential	1	Phase 1 execution objective	Is it clear which risk hotspot and value pool the phase 1 execution addresses, and why now?
	2	Scope	Have the circular initiative, product line, geography, customer segment and materials in scope been defined?
	3	Business case	Are the expected revenue, cost savings, WC improvement,[1] EBIT[2] and carbon/regulatory value quantified and realistic?
Planning	4	Detailed workplan	Have timelines, owners, approvals, training and communication plan, dependencies, meeting cadence and risk mitigations been defined?
	5	Operating model	Have required changes to design, sourcing, production, logistics or sales been specified?
	6	Enablers	Have data and technology requirements, key partners and the financing and investment model been identified and defined?
	7	Success KPIs	Have leading and lagging indicators been set to measure the success of the phase 1 execution?
	8	Scale decision gate	Are clear criteria defined for whether to scale, pivot, pause or stop after the phase 1 execution?

Criteria for Gate 2 review
Phase 1 execution success review

Execution of the plan
- Have all the actions in the workplan been completed?
- Do the conditions that enabled phase 1 execution success still hold at scale?

Delivery of KPIs
- Have the leading and lagging KPI impacts been met?
  - Are actual and forecast values correctly recorded?
- Which are the most impactful dimensions of the phase 1 execution?

Moving to scale
- Have the criteria in the scale decision gate been met?
- What is the recommended next step: scale, pivot, pause or stop – and what does the scale roadmap look like?
- What investment and partnerships are needed to move from phase 1 execution to full deployment?

Notes: 1. WC = working capital; **2.** EBIT = earnings before interest and taxes.

Source: World Economic Forum and Bain & Co.

3.3 Amplify: Build the conditions to scale

Even the best circular moves can stall without the conditions to scale them. Leaders build four enablers in parallel: leadership and governance; data and technology; ecosystem and supply-chain partnerships; and financing.

1. **Leadership and governance**. Scaling circularity requires senior ownership, clear decision rights, aligned KPIs and incentives, and accountability across strategy, procurement, operations, commercial, sustainability and finance. It's one of the strongest levers – rated high or transformational by 56% of executives[60] – yet it is still under-implemented, which is why leaders embed circularity into performance management through metrics such as product life-cycle value, customer lifetime value and the share of non-linear revenue generated from the installed base. Leaders who scale circularity in their operations can earn executive sponsorship early by prioritizing quick wins that generate visible financial impact. Governance choices are decisive in the cases studied: Siemens has made its RED methodology mandatory, with a 100% coverage target in its sustainability framework; Trane Technologies embeds circularity-related objectives in employee performance management and has set a target of 10% of circular revenue by 2030. A growing number of leaders are also reframing the business case around non-linear growth, not just EBITDA (earnings before interest, taxes, depreciation and amortization), recognizing that circular models can unlock recurring revenue pools that linear models structurally cannot access. This reframes the business case for circularity from cost-efficiency to market expansion, and creates a real opening for IS&M companies to compete on new terms.

2. **Data and technology**. Circular operations run on the traceability of materials and components, installed-base visibility, product passports, internet of things (IoT)-enabled asset intelligence and digital twins. Adoption is accelerating: 49% of IS&M companies already use AI in one or more circular initiatives and 40% plan to within a year. Technology and data are rated high or transformational by 54% of executives in the survey.[61] Used well, AI combines connected-product data, customer insights, material-dependency mapping and market signals to recommend the next best circular action. Foxconn Industrial Internet (case study 10), which provides smart manufacturing integration solutions, shows how a data-driven waste-management system can be scaled across an entire manufacturing network. GEA, for instance, is targeting 80% connectivity across its serviceable installed base by 2030. AI serves as the intelligence layer of circular enterprises, supporting material-risk forecasting, circular profit-pool identification, recovery optimization and next-best-action recommendations across the value chain.

CASE STUDY 10

Foxconn Industrial Internet: A certified, tech-enabled, zero-waste manufacturing network at scale

Foxconn Industrial Internet (FII) has scaled a technology-enabled zero-waste model through its Integrated Sustainable Waste Management framework, launched in 2024 via its Zero Waste Blue Paper. This applies a **6R hierarchy** – Refuse, Reduce, Reuse, Recycle, Recover, Refuse Landfill – across sourcing, design, manufacturing, distribution and EoL.

Detailed waste audits map where waste is generated and how it moves across sites, turning waste management into a data-driven optimization exercise. Findings are shared across the network through structured feedback loops – in 2025, audits across 15 sites surfaced 18 effective solutions shared with nine other sites, accelerating standardization and avoiding repeated problem-solving. An ESG IoT platform tracks energy and carbon in real time, alongside a full life-cycle digital traceability system for recycled metals; in aluminium processing, this traceability helped FII reach a 75% recycled-aluminium rate.

From a single testing site in 2022, FII has scaled to 16 sites certified at Platinum level under the UL 2799 Zero Waste to Landfill standard, aiming for full coverage of key waste-generating units by 2030. In 2025, the company achieved a 96.1% recycling and recovery rate for non-hazardous waste, reached 85% recycled metal use in precision component manufacturing – avoiding 43,086 tonnes of virgin metal use and cutting 590,621 tCO_2e a year – as well as recycling 19,823 tonnes of plastic packaging. Digital hazardous-waste screening at its Taiyuan campus in China also cut disposal costs by RMB 3.24 million ($480,000) a year.



3. **Ecosystem and supply-chain partnerships**. Few companies can build the full circular value chain alone. (The earlier white paper, *The Role of Partnerships*,[62] explores partnerships in more depth.) Partnerships are how leaders gain access to suppliers, customers, recyclers, remanufacturing partners, reverse-logistics providers, technology players and industry coalitions. Rated high or transformational by 46% of executives in the survey,[63] partnerships increasingly work as a resilience tool – aggregating demand, stabilizing the supply of recovered materials, sharing infrastructure and reducing exposure to volatile virgin markets. Collective action is gaining ground, with 52% of executives already in, or exploring, buyers' alliances.[64] Schneider Electric accelerated its closed-loop silver model by finding the right regional refining partner, as well as securing upstream materials through steel and rare-earth partnerships. GEA works through industry initiatives such as SteelZero to increase demand for lower-emission steel.

4. **Financing**. Circular supply chains require upfront investment but pay off over the medium term, so leaders line up funding to cover working capital and to scale circular infrastructure, service models, take-back systems and remanufacturing capacity.[65]

   How financing is structured matters as much as the amount that is available. Schneider Electric redesigned its internal financial flows to retain ownership of silver scrap and pay only for refining. This ultimately improved working capital by eliminating scrap dealers' long payment terms. Recurring-revenue models can also make circularity self-financing, as Trane Technologies' remanufacturing and rental offerings show.

Regulation runs through all four enablers. Rather than treating evolving rules on critical materials, recycled content, traceability, public procurement and extended producer responsibility as compliance burdens, leaders engage with them early to help shape workable standards and capture the incentives available to first movers, including tax advantages, subsidies and preferential procurement.

When risk is quantified, the right moves codified and the conditions to scale amplified, circularity shifts from reactive risk management into a genuine source of competitive advantage, protecting profit against supply shocks while opening new growth avenues amid sustained margin pressure.

Conclusion

Circularity thinking is becoming a defining competitive differentiator and the advantage belongs to those who act deliberately, now.

The forces affecting the IS&M sector are structural, not cyclical, and they are converging. Multiple IS&M players face pressure on volumes and margins, with a growing number of new entrants offering competitive alternatives, triggering commoditization risks – alongside the growing risk of disintermediation and disconnection from end customers. Additionally, material volatility, supply concentration and tightening regulations are raising the cost of the linear model just as the installed base, secondary materials and circular business models are becoming genuine sources of value. A group of companies is already turning that convergence into resilience and growth. For most organizations, the question is no longer whether to pursue circularity, but how quickly and effectively to scale it.

Five priorities are critical to mobilizing the collective partnerships and systemic changes needed to scale circularity:

- **Own circularity at the top**. Make circularity a core strategic and profit-and-loss issue, with clear C-suite ownership, decision rights, and KPIs and incentives tied to life-cycle value and supply continuity, rather than to linear success alone.
- **Quantify exposure and value first**. Build the evidence base on material dependencies and circular value pools so that capital and management attention flow to the hotspots and opportunities that matter most.
- **Focus, then sequence**. Concentrate on the highest-value moves across the life cycle and progress deliberately, rather than spreading efforts thinly.
- **Invest in the enablers**. Put in place the data and technology, ecosystem partnerships and financing structures that carry circular initiatives from testing to scale, and plan for working capital from the outset.
- **Shape the system**. Engage early with evolving standards and regulation and join buyers' alliances and industry coalitions to help build the secondary markets no single company can create alone.

None of this requires perfect conditions. For the IS&M sector, circularity offers a way to secure critical inputs, protect margins and open new growth avenues, recreating opportunities for further customer intimacy, all at once. The early movers showcased in this playbook began before circular business models, secondary markets, standards and business cases were fully mature; in doing so, they built the capabilities that now set them apart. The opportunity is strategic, and the moment to act is now.

The World Economic Forum will continue to provide a collaborative platform to enable a growing, resilient and sustainable economy through the adoption of circularity at scale. As a next step, the Forum will launch a cross-sector circularity blueprint and extend the playbook to other strategic sectors, inspiring action by defining the key enablers of circularity that drive industry-wide transformation while showcasing best practices from circularity champions.

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Endnotes

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