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Decarbonizing Manufacturing and Supply Chains for Growth: Guide for C-suite Executives

WHITE PAPER
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Foreword



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Manufacturing and supply chains shape people's everyday lives and sit at the heart of the industrial net-zero transition. Decarbonization is increasingly becoming a strategic business priority for long-term resilience and growth. Since its launch in 2020, the S&P 500 Paris-aligned benchmark (PAB) has shown robust 16% annualized returns.¹ Yet many global leaders still face a persistent tension: how to decarbonize complex industrial value chains while protecting margins, ensuring resilience and sustaining growth, amid geopolitical fragmentation and economic volatility.

This white paper, developed by the World Economic Forum in collaboration with Tata Consultancy Services, reframes decarbonization as a value-creation strategy – one that can strengthen operational efficiency and supply chain resilience,

reduce exposure to volatility and unlock new revenue through product engineering and business-model innovation.

The report sets out an executive-level approach to strengthen the business case for industrial decarbonization, anchored in three interconnected outcomes: bottom-line impact, business continuity and top-line advantage. Supported by industry insights and real-world case studies of decarbonization solutions – drawn from industrial processes, materials and product design, energy transition and fuel switching, and supplier ecosystems and logistics – the report aims to help senior leaders navigate implementation complexity and translate ambition into actionable strategies with measurable outcomes.

Executive summary

A practical pathway for senior executives to turn decarbonization into measurable value.

Does decarbonization still matter for industry? Amid geopolitical fragmentation, persistent economic pressures and uncertain policies, some question whether decarbonization remains a strategic priority. For manufacturers and supply chain leaders operating with tight margins and complex global footprints, as climate ambition collides with short-term performance pressures, the debate has sharpened: Is decarbonization a competitive advantage or a financial and operational drain?

There is growing evidence to suggest that decarbonization is not a trade-off against growth and competitiveness. The Paris-aligned & Climate Transition S&P 500 PAB ESG Index has shown a track record of steady growth with a robust annualized return of 16%.² The competitive question is how to decarbonize in ways that create measurable business value. Industrial decarbonization, when embedded into core business strategy, can unlock efficiency and productivity gains, strengthen supply chain resilience, accelerate innovation, attract capital and talent, and gain new market access. The challenge for senior C-suite executives (CXOs) is to move beyond compliance-driven sustainability efforts towards integrated transformation, aligning operations, finance, procurement, technology and commercial strategy around a clear business case for decarbonization.

Since its establishment in 2022, the Forum's [Industry Net Zero Accelerator initiative](#) has been working with global manufacturers, supply chain leaders, academia, civil society and policy-makers to advance the decarbonization journey from ambition to implementation. Building on the knowledge assets developed to date, the initiative is now entering a new phase: equipping manufacturing and supply chain leaders with data-driven insights by providing a strategic business value canvas with supporting real-world case studies that demonstrate how decarbonization can drive competitive advantage, cost efficiencies and long-term value creation across industrial ecosystems.

Drawing on research and insights from consultations with over 50 industry leaders, academic experts and innovators working across 13 industrial sectors, this white paper aims to support senior executives in advancing decarbonization while strengthening competitiveness and unlocking new opportunities for growth. The paper is structured as follows:

Chapter 1 reframes the central challenge: decarbonization is not a cost to be managed, but a growth strategy to be seized – one made urgent by 200 years of compounding industrial and environmental consequences.

Chapter 2 builds the value canvas:

- **Bottom-line gains** through operational efficiency and smarter resource management.
- **Business continuity and resilience** through energy security, supply chain resilience, climate risk management and attracting talent.
- **Top-line growth** through market differentiation, product innovation and durable customer loyalty.

Chapter 3 is where theory meets the field: it surveys practical solutions across the full value chain, from efficiency upgrades, fuel switching and product design to supplier collaborations, circular business models and digitalization. Each solution is mapped against greenhouse gas (GHG) impacts, implementation complexity and – where they exist – proven financial returns, with supporting case studies. As well as providing inspiration, this chapter will help industrial leaders assess the business case for decarbonization and prioritize solutions in light of their impact and implementation complexity.

Chapter 4 summarises the way forward, highlighting the systemic collaboration needed to overcome gaps and strengthen the business case for decarbonization solutions.

The wider context of this report is the health of the planet and the impacts of climate change and extreme weather events on the resilience of the global economy. As the rapid increase in greenhouse gas emissions since industrialization is the main cause of climate change, the question is no longer whether industry can afford to decarbonize, but whether it can afford not to. Building on this paper, the Forum's Industry Net Zero Accelerator initiative will continue to showcase practical “how-to” approaches and recognise leading organizations that demonstrate strong decarbonization business cases across their value chains.

1

Reframing decarbonization as an opportunity for growth

Decarbonization requires a fundamental shift in mindset: it is not a cost to contain, but a strategic growth opportunity to consider by evaluating its business impacts.

2,500 billion tonnes

industry's CO₂ emissions since the industrial revolution, roughly 30% of historical emissions.

Green economy exceeds \$5 trillion per year

Decarbonization is the process of reducing and eliminating greenhouse gas and carbon dioxide emissions by human activities from the atmosphere. Since 1750, industrialization has relied on fossil fuels to power factories, railways and iron smelting. Emissions rose sharply in the mid-20th century, with atmospheric carbon dioxide (CO₂) increasing from 275 parts per million (ppm) to a new record high of more than 422 ppm in 2024,³ driving global warming, sea-level rise, extreme weather events and biodiversity loss. Industry has generated roughly 30% of historical emissions – about 2,500 billion tonnes (Gt) of CO₂ since the industrial revolution.⁴

New technologies such as artificial intelligence (AI) add further challenges, since cutting emissions from energy-intensive data centres remains complex.

This rapid and unprecedented industrial and technological acceleration reinforces the imperative for decisive climate action and a systematic transition towards a more environmentally sustainable development model. At the same time, the economic case for the transition is becoming increasingly clear. According to the 2025 annual report of the [World Economic Forum's Alliance of CEO Climate Leaders](#), the green economy continues to expand, now exceeding \$5 trillion annually – making it the world's fastest-growing sector after technology.⁵ Green revenues are rising at roughly twice the pace of conventional revenues.

“

At Koç Group, we view climate change as a business priority. We regularly assess and report climate-related risks while advancing decarbonization through our operations, investments, and technology and innovation efforts to strengthen competitiveness and create long-term value.

Levent Çakıroğlu, Chief Executive Officer, Koç Holding

BOX 1

Carbon emissions: direct, indirect and avoided



The definition of scope and ownership of carbon emissions attributable to industry has to date been addressed through accounting for direct emissions (scope 1) and indirect emissions (scopes 2 and 3), with a new category of “avoided emissions” (scope 4) gaining traction.

Scope 1 includes direct emissions from fossil fuel combustion and process-related emissions from owned assets. Hard-to-abate heating processes above 500°C are difficult to electrify, so decarbonization relies on technologies such as green hydrogen or carbon capture, utilization and storage (CCUS).

Scope 2 covers indirect emissions from purchased energy and can be reduced by adopting renewable energy.

Scope 3 includes other indirect emissions across the value chain, such as those arising from raw materials, logistics and product use, which are harder to track and manage.

Scope 4 refers to “avoided emissions” arising from the use of resource-efficient products. This scope requires more standardization and transparency in carbon footprint measurement and tracking.

Sources: see endnote.⁶



\$3.6
trillion

damage from climate-related disasters since 2000.

“CEOs are increasingly framing sustainability as a driver of business value rather than primarily a compliance or moral issue.

Bain & Company, 2025

Cost of inaction on climate risk is rising

The cost of inaction in the face of climate risk is striking. Since 2000, climate-related disasters have resulted in damage exceeding \$3.6 trillion, with associated risks continuing to increase.⁷

The number of countries, regions and companies adopting net-zero targets has more than doubled in the last five years. Yet while two-thirds of the world's largest public-listed companies now have net-zero goals and targets,^{8,9} a recent assessment of 164 companies found that only 8% had developed decarbonization plans, while just 4% had allocated working capital to drive the actions needed to meet their targets.^{10,11} This disconnect underscores the urgent need for actionable roadmaps that identify how climate action can unlock value.

The proliferation of new frontier technologies such as AI and the internet of things (IoT) poses urgent new challenges. These technologies, while demonstrating the potential to improve productivity and efficiency, require massive computing power for scaling up. AI data centres can be both carbon- and resource-intensive, with emissions already equivalent to more than 8% of global aviation emissions.¹² The International Energy Agency (IEA) estimates that data centre electricity consumption will roughly double from 485 TWh in 2025 to 950 TWh in 2030, reaching around 3% of global electricity demand by that date. Meanwhile, AI-focused data centre electricity demand is projected to grow even faster, tripling over this period.¹³

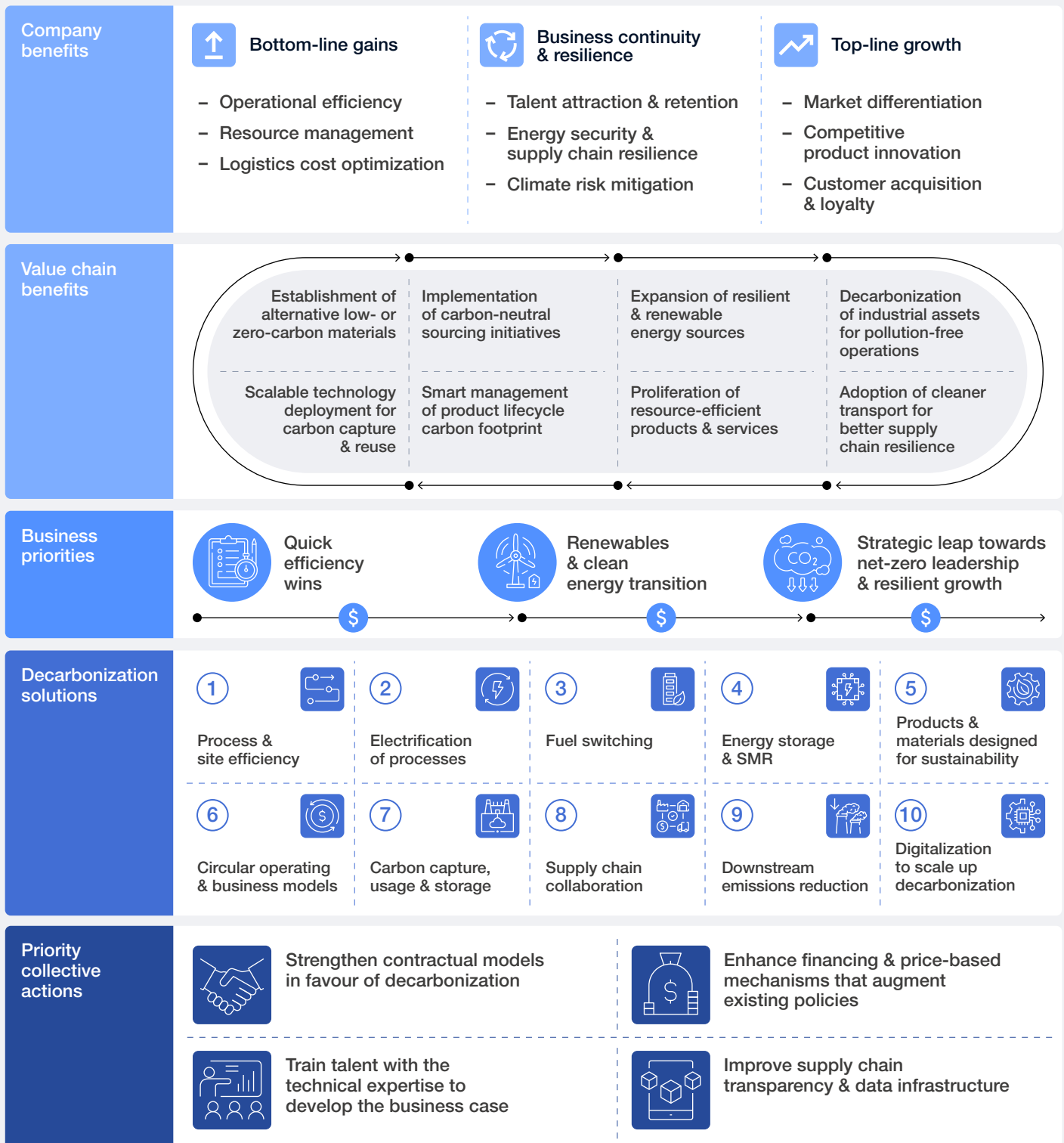
Sustainability moves from compliance exercise to value driver

Realizing a net-zero economy and strengthening climate adaptation across sectors will ultimately depend on a clear and compelling business case for decarbonization. The need to assess both the value and the practical implementation of net-zero strategies is becoming increasingly urgent. Analysis of statements made by the CEOs of 150 leading companies between 2018 and 2024 shows that leaders are increasingly framing sustainability as a driver of business value rather than primarily a compliance or moral issue.¹⁴

At the same time, companies are seeking actionable pathways to cascade net-zero targets across value chains and access practical solutions to deliver results, such as the case studies presented in [Chapter 3](#). This requires concrete, sector-relevant solutions that enable cleaner production while maintaining margins, strengthening market positioning and advancing supportive policy measures.

As summarised in [Figure 1](#), the following chapters outline the benefits that can be unlocked through decarbonization actions and analyse key decarbonization solutions through a business lens, drawing on insights from consultations with more than 50 industry leaders, thought leaders and innovators across 13 industrial sectors.

FIGURE 1 | Industrial decarbonization as a growth strategy



2

Decarbonization drives business value

Incorporating decarbonization into business strategy can drive bottom-line gains, business continuity benefits, top-line growth and value chain benefits.

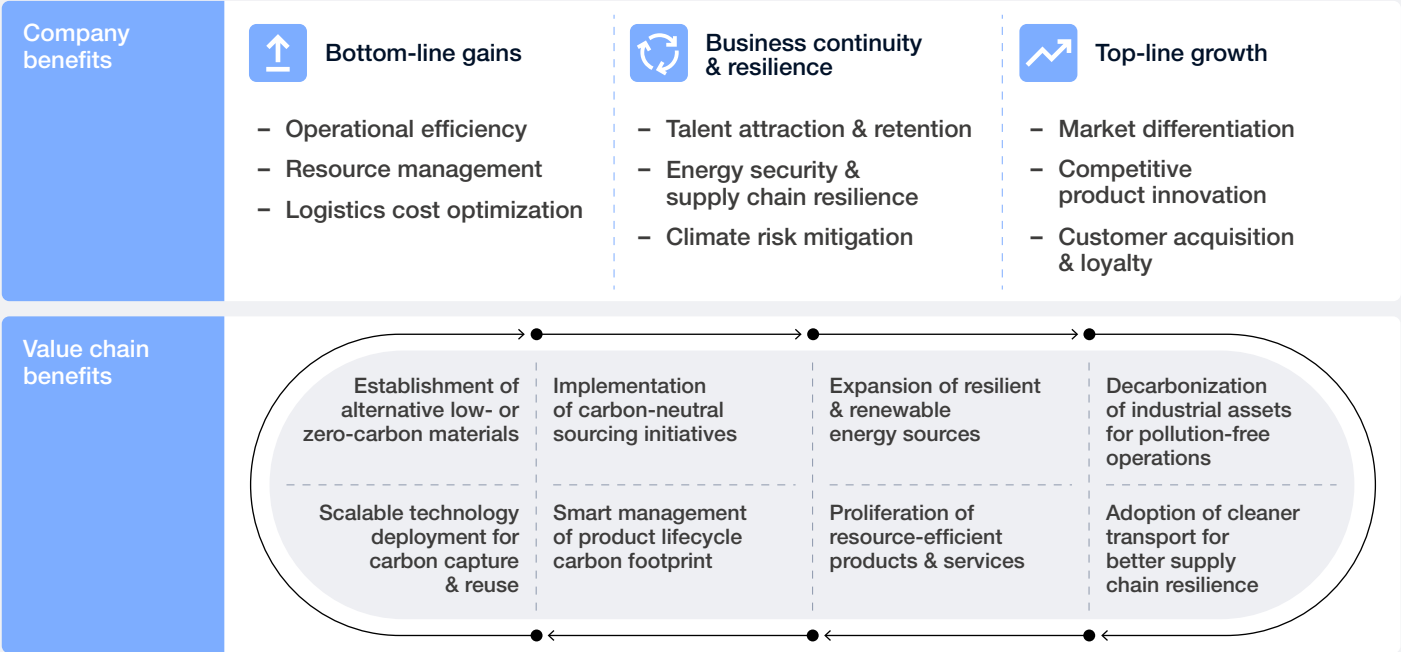
Industrial decarbonization is advancing more slowly than needed to meet global climate targets,¹⁵ constrained by factors such as high capital costs, policy uncertainty, infrastructure gaps and technical limitations.

To help address these challenges, the World Economic Forum introduced a roadmap for industrial decarbonization in its 2023 report, [The “No-Excuse” Framework to Accelerate the Path to Net-Zero Manufacturing and Value Chains](#).¹⁶ This framework introduces a four-stage approach for translating decarbonization ambitions into practical and scalable action:

- 1. Build the foundations
- 2. Change the game internally
- 3. Drive systemic collaboration
- 4. Make it simple, inclusive and exciting

Stage 1 establishes the foundations of a corporate net-zero strategy by creating a robust governance structure, measuring and monitoring carbon footprints, and embedding accountability across the organization. A critical priority at this stage is integrating decarbonization into core business strategy, enabling companies to capture both short- and long-term value creation opportunities while strengthening resilience and mitigating transition-related risks at the company level and across the value chain (see Figure 2).

FIGURE 2 Value from decarbonization viewed through business lenses



2.1 Bottom-line gains, business resilience and top-line growth

68%

of workers consider their employer's environmental policies and practices important when choosing a company.

65%

consider them important when deciding whether to stay.

PwC, 2024

This chapter expands on Stage 1 of the “No-Excuse” framework by reframing decarbonization not as a cost to be managed, but as a growth strategy to be seized. Decarbonization can serve as a source of business value and competitive advantage, enabling organizations to integrate climate action into core strategic decision-making. Drawing on insights from the Forum’s consultations with industry leaders, thought leaders and innovators across a wide range of industrial sectors, this chapter focuses on a business value canvas that views the decarbonization opportunity through three lenses: bottom-line gains, business continuity and resilience, and top-line growth.

↑ Bottom-line gains

Decarbonization pathways can deliver targeted bottom-line gains through:

- **Operational efficiency:** Streamlining processes, improving asset performance and optimizing operations can reduce emissions while generating cost savings within months and delivering returns on investment (ROI) in less than a year.
- **Resource management:** Using materials, energy, water and labour more effectively can reduce waste, lower operating costs and generate significant emissions reductions.
- **Logistics cost optimization:** Improving transport efficiency through measures such as shipment consolidation, route optimization and modal shifts can reduce fuel consumption, lower logistics costs and decrease carbon emissions.

↻ Business continuity and resilience

Decarbonization can strengthen business continuity and resilience, helping organizations navigate periods of disruption and uncertainty by:

- **Talent attraction and retention:** Integrating sustainability into corporate strategy can enhance an organization’s employer value proposition, helping attract, engage and retain high-quality talent. A 2024 survey by PwC found that 68.6% of workers considered their employer’s environmental policies and practices important when choosing a company, while 65.5% considered them important when deciding whether to stay.¹⁷
- **Energy security and supply chain resilience:** Adopting renewable energy and improving the efficiency of energy, materials and water use can reduce exposure to resource supply shocks and price volatility. Resilience can be further strengthened through collaboration with suppliers that are better positioned to withstand disruptions, helping minimize operational risks across the value chain.
- **Climate risk mitigation:** Reducing emissions and strengthening climate adaptation measures can lower exposure to both the physical and transition risks associated with climate change, such as meeting policy requirements and compliance obligations. Beyond improving their own resilience, companies can combine technical expertise with local knowledge to develop climate adaptation solutions that support vulnerable communities while creating shared economic and financial value.



Top-line growth

Decarbonization can support long-term revenue growth and competitive advantage through:

- **Market differentiation:** Companies can strengthen their competitive position by demonstrating credible leadership in decarbonization through transparent reporting, robust carbon claims, business model innovation and responsible brand positioning. These efforts can differentiate the organization from competitors, enhance brand reputation and build trust among customers, investors and other stakeholders.
- **Competitive product innovation:** Developing low-carbon products enables companies to address evolving customer needs while staying ahead of technological and regulatory change. For example, automakers are adopting lower-carbon battery chemistries and recovering critical materials to reduce embodied emissions in battery production, while improving product performance, energy efficiency and long-term value creation.
- **Customer acquisition and loyalty:** In a 2022 IBM survey of more than 16,000 consumers in 10 major economies, 77% said they want to make more sustainable choices.¹⁸ As sustainability becomes an increasingly important purchasing criterion,¹⁹ lower-carbon products and services can help companies attract new customers, strengthen customer loyalty and expand market opportunities among buyers seeking more sustainable alternatives.



DP World is turning decarbonization into commercial advantage – deepening customer value and building resilient, recurring revenue for long-term growth.

Ayla Bajwa, Group Senior Vice President – Sustainability, DP World

2.2 Value chain benefits

While these business value benefits are experienced at the enterprise level, their impacts extend beyond individual organizations. When scaled up across value chains and ecosystems, they can drive broader economic competitiveness, strengthen industrial resilience and contribute to societal progress.

Many of the benefits realized at the company level can create additional value for suppliers, customers, industry partners and communities. Adopting an end-to-end value chain perspective when developing decarbonization business cases enables organizations to identify value creation opportunities across the full product life cycle, from raw material extraction through use, recovery and reuse.

This approach elevates emissions reduction from a compliance exercise to a source of competitive advantage. It also helps uncover synergies across the value chain, positioning carbon intensity as a critical performance metric alongside cost, quality and reliability.

Beyond business benefits, decarbonization generates broader societal value through cleaner air, improved public health, greater energy security and more resilient economies, supporting sustainable prosperity for both individuals and communities.

Business-driven review of decarbonization solutions

Assessing solutions across emissions impact, implementation complexity and financial returns can help prioritize actions and strengthen the business case for transformation.

This chapter offers some practical tools to operationalize and deliver the business value benefits presented in [Chapter 2](#). These tools are based on insights gained from the Forum's consultations with industry leaders and experts on how best to unlock the full value of industrial decarbonization.

Section 3.1 proposes a phased approach, spanning three levels of business priorities, which balances immediate performance improvements with long-

term resilience and competitive advantage. Section 3.2 presents 10 practical decarbonization solutions, which are assessed against their potential to reduce greenhouse gases (GHGs), their complexity to implement and their likelihood of delivering the business value benefits detailed in [Chapter 2](#). Section 3.3 offers six real-world case studies that demonstrate how organizations are deploying these solutions in practice.

3.1 Phased approach across three levels of business priorities

This approach spans three levels of business-driven priorities, beginning with near-term efficiency gains, accelerating the transition to lower-carbon operations, then progressing to transformational leadership and sustained value creation.



Priority 1 Quick efficiency wins

The first priority is to capture quick efficiency wins through targeted measures that deliver tangible operational and financial benefits within one to two years. These actions typically include:

- Improvements in energy and material efficiency.
- Asset optimization.
- Process enhancements.
- Energy-saving initiatives that reduce operating costs while requiring minimal disruption to core business activities.

Beyond delivering emissions reductions, these initiatives can strengthen business performance,

free up capital for future investments and build organizational momentum for more ambitious decarbonization efforts.



Priority 2 Renewables and clean energy transition

The second priority is to accelerate the transition to lower-carbon operations through initiatives such as:

- Renewable energy adoption, including solar and wind power.
- Electrification of industrial assets.
- Deployment of electric mobility solutions.

Building on the gains achieved through operational efficiency measures, these investments can deliver deeper emissions reductions while strengthening energy resilience and improving long-term operational performance. Typically realized over a three-to-five-year timeframe, these actions support the vital shift needed to transition from high-emission fossil-based energy and industrial



materials to low-carbon, renewable and recyclable alternatives for decarbonization. They also help organizations reduce exposure to energy price volatility, enhance competitiveness and establish the foundations for long-term resilience in a rapidly evolving industrial landscape.



Priority 3 Strategic leap towards net-zero leadership and resilient growth

The third priority is to drive a strategic shift towards net-zero leadership and resilient growth, through continuous collaboration with value chain partners. This includes:

- Transforming manufacturing processes through breakthrough product design and process innovation.
- Integrating clean energy at scale.
- Adopting circularity.

- Redesigning both upstream and downstream value chain operations to reduce emissions.

While many of these initiatives can be started earlier, at this stage the emphasis shifts towards the broader value they create across industry ecosystems, regional economies and end markets. By moving beyond operational improvements, organizations can help accelerate system-wide transformation while strengthening long-term competitiveness and resilience.

This phased, priority-driven approach enables companies to establish a clear operational pathway for decarbonization. Financial benefits generated from early efficiency gains can be reinvested into initiatives at subsequent priority levels, helping alleviate capital constraints while reducing the implementation, technology and policy risks associated with scaling up decarbonization solutions.

To support these investment decisions, a robust understanding of return on investment (ROI) and total cost of ownership (TCO), defined as the full lifecycle cost of an asset or solution, is essential to assess the business case and prioritize the right decarbonization solution.

3.2 Ten decarbonization solutions in focus

This section reviews 10 selected decarbonization solutions linked to the Forum's "No-Excuse" framework across its four stages, viewed through a business-focused lens (see Figure 3).

FIGURE 3 Ten decarbonization solutions



These decarbonization solutions are analysed across three dimensions to provide practical insights that inform decision-making (see Table 1):

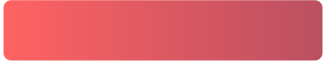
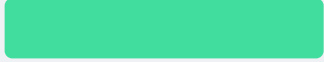
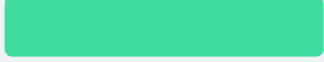
1. **Business value benefits** – potential value that can be unlocked (bottom-line gains, business continuity and resilience, top-line growth).
2. **Greenhouse gas emissions** – potential reductions (graded medium or high).

3. **Implementation complexity** (graded between low, medium and high).

The findings draw on the Forum's consultations across the manufacturing and supply chain sectors with leaders who are advancing the latest net-zero and industrial decarbonization initiatives. These insights are complemented by secondary data from industry-focused research and publications.



TABLE 1 | Ten decarbonization solutions – a business-driven overview

Decarbonization solution	Key business value benefits that can be unlocked			Greenhouse gas (GHG) reduction potential	Implementation complexity
 Process and site efficiency					
 Electrification of industrial processes					
 Fuel switching					
 Energy storage and small modular reactors (SMRs)					
 Designing products and materials for sustainability					
 Circular operating and business models					
 Carbon capture utilization and storage (CCUS)					
 Supply chain collaboration					
 Downstream (use phase) emissions reduction					
 Digitalization to scale up decarbonization					
	 Bottom-line gains	 Business continuity	 Top-line growth	Greenhouse gas (GHG) reduction potential  Low ————— Medium —————> High  Implementation complexity	

Note: The impact analysis is conducted at a general level and may vary by sector and region.



“ The World Economic Forum’s Lighthouse sites have achieved over 50% productivity improvements, more than 80% defect reductions and around 30% CO₂ reductions.

50%

of energy used by UK industry is lost as waste heat.

The Royal Society

Solution 1

Process and site efficiency

With attractive returns on investment, operational benefits and the potential to reduce up to 40% of energy-related emissions, energy efficiency measures are often the preferred starting point for industrial decarbonization at the asset, process and site levels. Governments are supporting their adoption through policy mechanisms such as India’s Perform, Achieve and Trade (PAT) scheme, which sets energy-intensity targets,²⁰ and China’s Top-1,000 and Top-10,000 programmes which require industrial facilities to implement energy-saving measures.²¹

Historically, technology transfer has played an important role in improving industrial efficiency, as manufacturing know-how and best practices moved across regions through increasingly globalized supply chains. Today, companies are accelerating efficiency gains through the deployment of advanced technologies, including variable-speed drives for industrial motors, digital optimization tools and large-scale waste heat recovery systems. Advanced factories recognised by the World Economic Forum’s [Global Lighthouse Network](#) initiative have demonstrated the effectiveness of advanced technology solutions for improving efficiency. On average, Lighthouse sites have achieved over 50% productivity improvements, more than 80% defect reductions and around 30% CO₂ reductions.²²

Improving industrial heat efficiency is a particularly important first-step priority for fossil fuel-based heating systems that are energy-intensive and vulnerable to fuel price volatility, as retrofitting and electrifying industrial heat assets can require significant upfront investment (see Solution 2). In Europe, elevated gas prices have reduced payback periods for industrial waste heat recovery investments

to approximately five to seven years, significantly improving their economic attractiveness.²³

According to the Royal Society, about 50% of energy used by UK industry is lost as waste heat,²⁴ highlighting the potential for waste heat recovery and reuse to deliver significant cost savings and improve bottom-line performance. In parallel, sectors such as pharmaceuticals have demonstrated that improving industrial heat efficiency as a first step can reduce energy demand and costs while strengthening the business case for subsequent investments in low-carbon heat technologies and fuels.²⁵

Solution 2

Electrification of industrial processes

The decarbonization potential of electrification varies across sectors. Electrification is often the most effective pathway for decarbonizing low- to medium-temperature industrial processes (below 500°C).²⁶ For example, Danfoss’ Lighthouse factory demonstrates how industrial electrification, combined with factory retrofits and high-efficiency heat pumps, can reduce emissions while improving operational performance.^{27,28}

While approximately 50% of industrial fossil fuel consumption could be electrified with technologies available today,²⁹ electrifying processes that require high temperatures (e.g. above 1,000°C) remain more challenging, particularly in energy-intensive industries such as steel, cement and glass, where commercially mature and cost-competitive solutions are still emerging.

Nevertheless, early industrial-scale examples are demonstrating what is possible. ArcelorMittal’s Sestao plant in Spain produces steel using electric arc furnace (EAF) technology powered by

“ Australian mining company Fortescue has committed to deploying 475 zero-emission battery-electric trucks, excavators and bulldozers across its operations.

renewable electricity, while SSAB's Oxelösund plant in Sweden has adopted EAF technology as part of the broader HYBRIT initiative. By combining renewable electricity with process innovation, these projects illustrate the potential for low-emission steel production.^{30,31}

Compared with fossil fuel-based alternatives, electrified processes can significantly improve energy efficiency and reduce direct emissions. However, in some sectors, particularly hard-to-abate heavy industries, electrification is often most effective when deployed alongside complementary decarbonization pathways such as energy storage, low-carbon fuels, small modular reactors (SMRs) and carbon capture, utilization and storage (CCUS), as explained in Solutions 3, 4 and 7.

Despite the substantial emissions reductions offered by electrification, the significant capital investment required hampers commercial viability and remains a barrier to large-scale adoption. Public-private partnerships and targeted policy support can help improve project economics and accelerate deployment. One example is Tata Steel's £1.25 billion transformation of its UK operations towards lower-carbon steelmaking, supported by a £500 million investment package from the UK Government.³² Further, the associated social impacts need to be addressed by reskilling or upskilling workers currently operating fossil-based assets (e.g. blast furnaces) with new skills such as managing electrode regulation, power profiles and electrical energy inputs using software control systems to support the transition towards electrification.

Solution 3

Fuel switching

Scaling up fuel switching requires enabling infrastructure, affordable financing and supportive policy mechanisms, such as carbon pricing, feed-in tariffs and targeted investment incentives. A growing number of industrial leaders are demonstrating the viability of fuel-switching pathways. For example, Novelis completed the UK's first industrial-scale hydrogen fuel-switching demonstration in the aluminium sector at its Latchford facility. The initiative was supported by the UK Department for Energy Security and Net Zero through its £1 billion Net Zero Innovation Portfolio.³³

Similarly, Australian mining company Fortescue has committed to deploying 475 zero-emission battery-electric trucks, excavators and bulldozers across its operations, alongside battery-electric haulage solutions capable of recovering up to 60% of energy through regenerative braking. The company has recently commissioned two battery-electric locomotives and is investing in integrated energy systems combining large-scale solar, wind, battery storage and transmission infrastructure.^{34,35}

Although upfront costs are often significant, lower fuel and utility costs, reduced exposure to carbon pricing and improved energy security can make the total cost of ownership (TCO) for fuel switching more attractive than the business-as-usual alternative. For example, commercial rooftop solar photovoltaic (PV) installations in the UK typically achieve payback periods of 6-10 years.³⁶ As hydrogen markets emerge and demand expands, the business case for fuel switching could become more attractive. A recent study on power-to-hydrogen (P2H) technologies in Ordos, China, analysed the levelized cost of cleaner fuels (LCOX) for decarbonizing long-distance transport and chemical feedstock production. The study found that the hydrogen pathway can be economically viable, supported by growing demand market opportunities for hydrogen in China.³⁷

Despite these advances, expanding fuel switching across industrial value chains remains challenging. Switching to cleaner fuels in supplier operations, heavy-duty transport and specialized maritime vessels often requires significant capital investment. These challenges are particularly acute for small and medium-sized enterprises (SMEs), which frequently face resource and financing constraints when investing in both operational and logistics decarbonization (see [Case Study 6](#)).

Solution 4

Energy storage and small modular reactors (SMRs)

Decarbonization pathways discussed in previous sections, such as electrification, will require a significant expansion of clean electricity generation, accompanied by investments in grid infrastructure and energy storage systems to manage growing demand and maintain system reliability. Thermal energy storage (TES) is emerging as an important enabler of industrial heat electrification. Recent analysis suggests that electrifying industrial heat with eight-hour TES systems could achieve internal rates of return (IRR) exceeding 15% in most European countries by 2030.³⁸

Small modular reactors (SMRs), particularly when combined with energy storage technologies, are being explored as a reliable low-carbon energy source for hard-to-abate sectors, including chemicals, steel, refining, mining and data centres. A key advantage of SMRs is their ability to provide stable, around-the-clock energy for industrial operations. In a typical configuration, SMRs can supply low-carbon baseload power, while batteries or other storage technologies provide operational flexibility and peak-load management.

The International Atomic Energy Agency (IAEA) lists more than 80 SMR designs, with generating capacities up to 300 MWe per module. If licensed by nuclear safety authorities to be produced

“ Sustainable consumer packaged goods grew 2.3 times faster than conventional alternatives in the United States in 2024.

at scale, they are expected to cost less than larger nuclear power plants as their shorter build schedules in a factory setting lowers unit cost over time.^{39,40} Compared with conventional nuclear power plants, SMRs offer the potential for modular deployment and greater flexibility in matching industrial energy demand.

However, while SMRs can significantly reduce scope 1 and scope 2 emissions associated with industrial energy use, their commercial deployment remains constrained due to their unit costs – approximately \$6,000-8,000 per kilowatt of installed capacity – being four to six times higher than utility-scale solar PV or onshore wind.⁴¹ Achieving widespread adoption will require further technology advances to improve thermal-to-electrical conversion efficiency, more supportive regulatory frameworks, and sufficient project pipelines to unlock economies of scale and reduce TCO over time.

Solution 5

Designing products and materials for sustainability

Product design and material innovation can deliver bottom-line efficiencies, business continuity benefits and top-line growth, particularly when supported by enabling industry standards, market incentives and policy frameworks.

On bottom-line benefits, for example, Unilever reduced the carbon footprint of its deodorant products by cutting aluminium use by 25% in

its packaging design through the introduction of compressed aerosol technology. The design of smaller-sized cans also improved logistics efficiency, enabling 53% more units to be transported per shipping pallet (see [Case Study 1](#)).

On top-line growth and capital access for business continuity, a survey found that 73% of manufacturing companies reported revenue growth linked to sustainable design initiatives, while 76% reported improved access to capital.⁴² Consumer demand is also increasingly favouring sustainable products. According to the 2024 Sustainable Market Share Index™, sustainable consumer packaged goods (CPG) grew 2.3 times faster than conventional alternatives in the United States.⁴³

Schneider Electric has introduced EcoDesign transformation across the entire product lifecycle. The company's impact revenues, including from products and services with demonstrated environmental benefits, reached 75% of total revenues in 2025 (see [Case Study 2](#)).

Similar design-led approaches are needed in the construction sector, which accounts for more than 37% of global emissions.⁴⁴ Expanding the use of lower-carbon materials, including sustainably sourced timber, bamboo and alternative construction materials, can help reduce reliance on emissions-intensive steel and cement. Equally important is designing buildings to use fewer materials overall and maximizing the use of recycled and circular materials. Together, these approaches can play a critical role in accelerating the sector's decarbonization.



\$4.5 trillion

economic value the transition to a circular economy could unlock globally by 2030, according to OECD.

Solution 6

Circular operating and business models

The transition to a circular economy could unlock up to \$4.5 trillion in economic value globally by 2030, according to the Organisation for Economic Co-operation and Development (OECD).⁴⁵ It can create new revenue streams through leasing, refurbishment, resale and material recovery, while improving resource efficiency and long-term resilience.⁴⁶

Circularity can also deliver significant emissions reductions. While efficient resource use and lower energy demand can reduce scope 1 and scope 2 emissions, circular supply chains can also generate scope 3 benefits via reduced reliance on the upstream extraction of virgin materials as well as downstream improvements in product use, reuse, recycling and end-of-life management. These approaches are particularly valuable for recovering critical minerals and rare earth materials, helping to strengthen supply chain resilience while reducing environmental impacts.

Circularity cannot succeed through individual corporate efforts alone – it needs an enabling ecosystem. For example, when Unilever reduced its carbon footprint by cutting aluminium use and increasing post-consumer recycled resin in its deodorant packaging (see [Case Study 1](#)), industry partnerships with organizations such as the British Aerosol Manufacturers' Association (BAMA) and the Aluminium Packaging and Recycling Organization (ALUPRO) played a key role by helping strengthen recycling infrastructure.

A notable example of recovery and reuse of critical materials is demonstrated by Western Digital (see [Case Study 4](#)). The company has achieved a 95% reduction in scope 3 category 1 emissions, compared to the linear approach with virgin material extraction and processing.

However, transitioning from the linear “take-make-dispose” model to circular approaches centred on refurbishment, reuse and recycling is inherently complex. It requires companies to redesign products, reconfigure supply chains and adapt to evolving customer behaviours – involving coordinated action across technological, financial, policy and organizational dimensions.



Western Digital is showing how circular innovation can cut emissions, strengthen supply resilience and turn sustainability leadership into long-term competitive advantage.

Jackie Jung, Chief Sustainability Officer and Vice-President of Global Operations Strategy, Western Digital

Solution 7

Carbon capture, utilization and storage (CCUS)

Carbon capture, utilization and storage (CCUS) is recognised as a potential decarbonization solution, especially for hard-to-abate sectors. Its economic viability remains highly dependent on the specific project design, supportive policy frameworks and the availability of enabling infrastructure.

In general, carbon capture projects retrofitted onto existing facilities tend to be more expensive than installations integrated into new-build facilities, reflecting the higher complexity of modifying existing assets. At the same time, both engineered and nature-based carbon capture and removal approaches are advancing, supported by the emergence of CCUS hubs across Europe, China and the United States.⁴⁷

Government-backed revenue mechanisms and supportive policy interventions can play a critical role in improving the economics of CCUS deployment. For example, policy measures in the United States, Europe, the Middle East, Australia and East Asia have stimulated significant investment in carbon capture technologies aimed at reducing residual emissions from hard-to-abate industrial processes.⁴⁸

Nonetheless, scaling up CCUS remains challenging due to uncertainties surrounding the future demand for captured carbon utilization, as well as concerns related to the long-term storage, safety and public acceptance of sequestration solutions.

Large-scale industrial adoption will require closer collaboration between technology providers, carbon offtake partners and governments, supported by appropriate policy incentives, increased transparency and commercial mechanisms.⁴⁹ Strengthening these ecosystem partnerships will be essential to reduce costs, create stable demand for captured carbon and accelerate deployment at scale.



Solution 8

Supply chain collaboration

Companies that cultivate strong partnerships with their supply chains – including energy suppliers, logistics providers, and suppliers of materials and components – often enjoy an advantage in enhancing their resilience, accelerating decarbonization and creating long-term value.

Unilever, for example, prioritizes engagement with suppliers where it can have the greatest impact, providing tools, guidance and capacity-building support to help suppliers measure product carbon footprint (PCF) data and set science-based emissions reduction targets (see [Case Study 1](#)). Similarly, Schneider Electric worked with over 1,000 strategic suppliers through its Zero Carbon Project – part of the Schneider Sustainability Impact (SSI) 2021-2025 programme – achieving more than 50%

reduction in emissions from suppliers' operations (see endnote in [Case Study 2](#)).

Industry-wide collaboration can amplify these efforts. For example, the Sustainable Markets Initiative Health Systems Task Force brings together global healthcare leaders – including AstraZeneca, GSK and Sanofi – in a CEO-led public-private partnership focused on supply chain decarbonization, shared supplier engagement and the roll-out of net-zero solutions across the sector.⁵⁰

Beyond reducing emissions, such collaborations can create broader business value. Co-innovation with suppliers in areas such as new materials, circular business models and cleaner technologies, combined with digitalization (see [Solution 10](#)) can strengthen the business case for decarbonization, by delivering procurement savings, improving margins, enhancing supply chain resilience and creating new growth opportunities.⁵¹



By empowering SME suppliers with AI-driven carbon management, we cut emissions, improved product sustainability and unlocked hidden efficiency opportunities, delivering over 100% ROI in six months.

Zongchang Liu, Chief Digital Officer, Foxconn Industrial Internet

Logistics providers play a critical role in reducing scope 3 emissions across industrial value chains. Shipping alone generates more than 1 billion tonnes of CO₂e annually, while the high cost of retrofitting vessels and evolving regulatory requirements continue to create challenges for decarbonization.⁵²

To address these barriers, companies are increasingly adopting innovative approaches.

For example, DP World's Carbon Inset Programme converts verified emissions reductions from cleaner marine fuels into certificates that customers can apply towards reducing their reported scope 3 supply-chain emissions (see [Case Study 3](#)), enabling both customers and logistics providers to reduce emissions within their own value chains while supporting long-term customer retention and business growth.

Solution 9

Downstream (use phase) emissions reduction

For appliance and equipment manufacturers, a significant share of value-chain emissions occurs downstream, when products are used by customers. Leading companies are addressing these emissions by designing products, services and systems that consume less energy, optimize energy use during operation and enable customers to shift towards lower-carbon technologies.

For example, Koç Group's Beko brand demonstrates how artificial intelligence and connected technologies can reduce energy consumption during the use phase of appliances by enhancing customer engagement (see [Case Study 5](#)). Koç Group's field data indicates that connected appliances can reduce annual emissions by 11-15 kg CO₂e per appliance, equivalent to an 8-10% reduction, with greater monetary benefits for less energy-efficient models.

By reducing the electricity required to operate products over their lifetime, such innovations directly address manufacturers' downstream emissions and enhance customer attraction with utility cost savings.

Trane Technologies, for instance, is expanding its range of high-efficiency, low-carbon heating and cooling solutions, including integrated heat pumps and low global-warming-potential (GWP) refrigerants, alongside refrigerant recovery and reuse programmes.^{53,54} In Portugal, a Trane heat pump supported an industrial dehumidification process while delivering 1,750 kW of free heating as a by-product of energy-efficient cooling.⁵⁵

Addressing downstream emissions can be complex because manufacturers have limited control over how products are used, while adoption depends on customer economics, supporting infrastructure and policy conditions. Companies therefore need to combine innovation with measures that enable adoption, including engaging customers to understand usage patterns and benefits. The business case can be substantially strengthened by reducing lifecycle costs, collaborating across the value chain to build enabling infrastructure and services, and working with policy-makers to create favourable market conditions.

Solution 10

Digitalization to scale up decarbonization

Digitalization is a critical enabler of industrial decarbonization if deployed responsibly. Digital technologies deployed at scale could enable emissions reductions of up to 20% by 2050 across the three most emissions-intensive sectors: energy, materials and mobility.⁵⁶ New frontier technologies such as prescriptive AI could optimize industrial operations for cost-carbon trade-offs and dynamically schedule energy-intensive production tasks to low-carbon windows.⁵⁷ AI can help organizations optimize energy consumption, manage intermittent renewable energy supplies, and provide real-time visibility into operational performance and emissions outcomes to inform decisions.⁵⁸

Leading companies are embedding digital capabilities at the core of their decarbonization strategies. For example, Beko's Eskişehir Refrigerator Factory demonstrates how digitalization can be integrated at scale to support the production of next-generation appliances (see [Case Study 5](#)). These capabilities help identify new opportunities to improve resource efficiency, reduce emissions and enhance operational performance across the product lifecycle. Foxconn Industrial Internet (FII)'s Viet Nam factory integrates AI 360-degree cameras and digital twin technology, with an AI-enabled product eco-design platform ensuring 80% eco-designed product coverage, unlocking unseen carbon optimization opportunities (see [Case Study 6](#)).

In addition, by integrating operational and supply chain data collected through digitalization into business decision-making and adopting mechanisms such as internal carbon pricing (ICP), organizations can translate emissions into measurable financial impacts and strengthen executive alignment around decarbonization priorities.

While digital technologies have demonstrated their potential to enhance operational efficiency and reduce scope 1, 2 and 3 emissions, their full benefits can only be realized through close collaboration among business, operations, sustainability and technology teams. Integrating digital capabilities across organizational functions is essential for translating data-driven insights into measurable decarbonization and financial outcomes.

3.3 | Real-world case studies

CASE STUDY 1

Unilever rethinks consumption through innovative materials

Unilever cuts packaging emissions through recycled and refillable designs, advancing its net-zero goals, lowering costs and strengthening brand-led growth, with these brands contributing 75% of topline growth through greater material efficiency.

Company

Unilever

Decarbonization solution

① ② ⑤ ⑥

Focus

- Material efficiency
- Design innovation
- Inclusive collaboration

Challenge

Unilever has set science-based targets to achieve net-zero emissions across its entire value chain by 2039. Its climate transition action plan (CTAP), backed by shareholders in 2024, prioritizes absolute emission reductions by 2030 – especially scope 3, which represents over 98% of its total footprint.

Solutions

- Increased post-consumer resin in packaging.
- Introduced refillable product formats (e.g. deodorant cases).
- Redesigned packaging to reduce material use and improve supply chain efficiency.

These initiatives show measurable financial benefits from sustainability investment (e.g. higher growth, improved margins, lower operating costs), while strengthening brand leadership in responsible business. Unilever also signals long-term growth vision through process-efficiency gains and design-led innovation impacts to deliver high-quality value creation for shareholders by embedding sustainability in its growth strategy.

GHG impact

- Scope 3 forest, land and agriculture (FLAG) emissions reduced by 14%.*
- Scope 3 energy and industrial emissions reduced by 8%.*

Top-line growth

- From 2010-2020, sustainable brands grew 69% faster than the rest of the company portfolio.
- “Sustainable Living Brands” accounted for a record 75% of its turnover in 2018.
- The company is now focusing on its “Power Brands” to strengthen resilience and deliver impact at scale by embedding climate, nature, plastics, and livelihoods into its business growth strategy.

Key takeaway

Design-led material efficiency can reduce costs and emissions while supporting premium brand positioning.

Note: *2025 emissions against 2021 baseline.

Source: Unilever, 2020-2024.⁵⁹



CASE STUDY 2

Schneider Electric accelerates eco-design for products

Schneider Electric has accelerated its EcoDesign transformation, embedding sustainability across the entire product lifecycle.

Company	Schneider Electric
Decarbonization solution	1 5 6
Focus	<ul style="list-style-type: none">– Resource efficiency– Circular design– Inclusive collaboration

Challenge

As industries worldwide work to decarbonize and reduce pressure on natural resources, companies must rethink how products are designed and manufactured. Moving away from a linear “take-make-dispose” model towards a more circular and resource-efficient approach has become a key business and sustainability challenge. This transition is far more complex than a simple material substitution and involves qualification campaigns to demonstrate equivalent performance in terms of mechanical properties, thermal resistance and regulatory compliance.

Solutions

- Launched and accelerated its EcoDesign transformation by embedding sustainability across the entire product lifecycle.
- Applied eco-design principles that reduced material use; selected more responsible materials; improved product energy efficiency during use; extended product lifetimes; enhanced repairability, serviceability and recyclability at end of life; and reduced packaging impacts.
- Transitioned from virgin to recycled plastics, which emerged as one of the most visible and scalable examples of EcoDesign in action. The proportion of primary and secondary packaging that was free from single-use plastic increased from 13% to 85% in 2025.

What first started as an environmental initiative is now increasingly delivering business value. By combining circularity, engineering excellence and business performance, Schneider Electric is turning sustainability ambitions into tangible product innovation and market differentiation.

GHG impact

- By the end of 2025, the Group helped customers avoid 862 million tonnes of CO₂ emissions through its products and solutions.

Bottom-line gains

- Eco-Design reduced material waste by 25% in production at Schneider Electric’s Wuhan Factory.

Business continuity and resilience

- Improved supply chain resilience through diversified material sources.
- Green material content in its products increased from 7% to 48% in 2025.

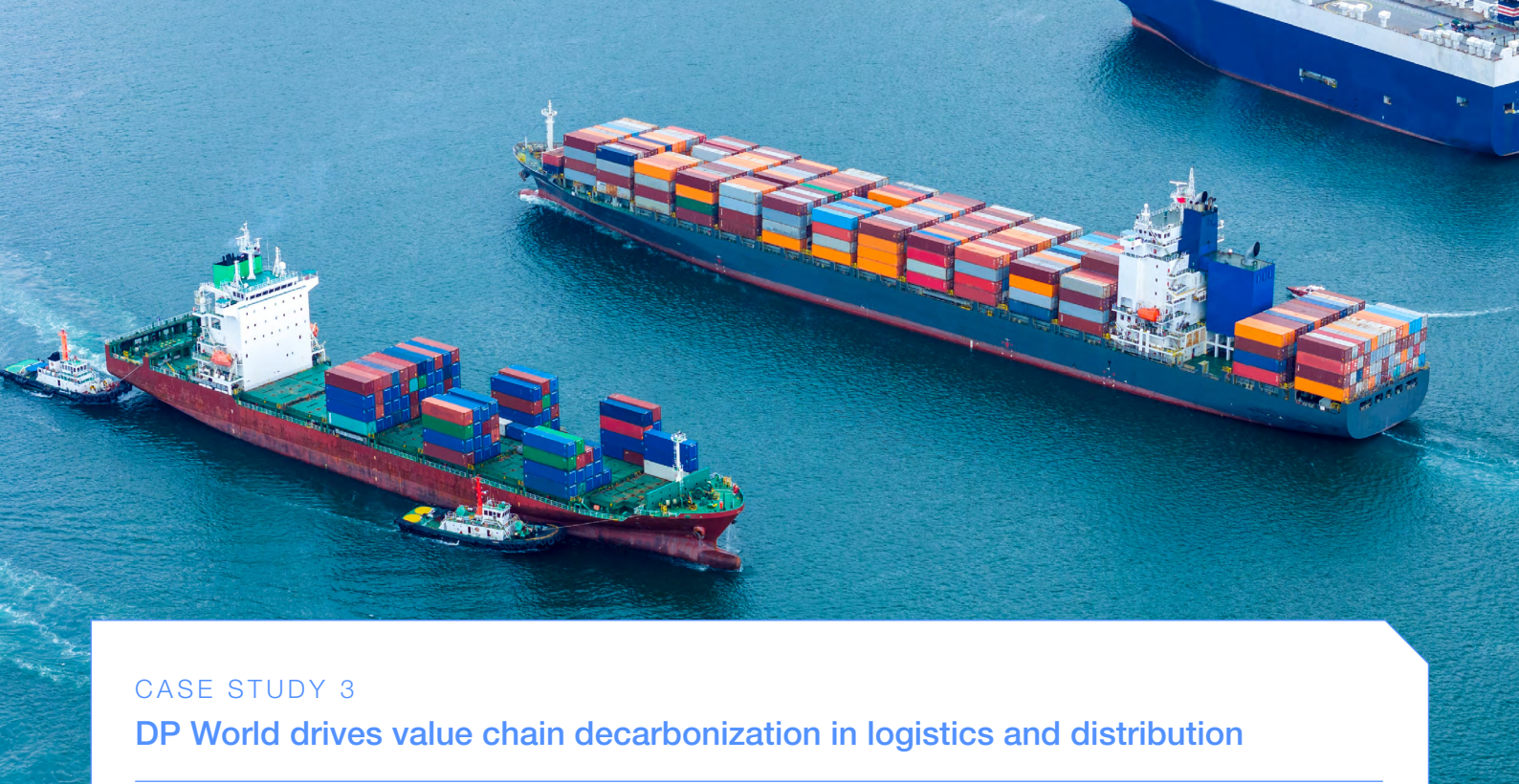
Top-line growth

- Creates market differentiation and supports the growing demand for lower embodied carbon products in strategic segments such as data centres.
- The Group’s impact revenues, including from products and services with demonstrated environmental benefits, reached 75% of total revenues in 2025.

Key takeaway

EcoDesign can turn sustainability challenges into business opportunities, creating products that are both more circular, with lower carbon impacts, and increasingly competitive in markets where embodied carbon matters.

Source: Forum consultation with Schneider Electric, 2026; Schneider Electric, 2021-2026.⁸⁰



CASE STUDY 3

DP World drives value chain decarbonization in logistics and distribution

DP World is pioneering a carbon insetting programme to track and expand lower-carbon, short-sea shipping.

Company	DP World
Decarbonization solution	3 8
Focus	<ul style="list-style-type: none">– Supplier engagement– Innovative value-chain collaboration

Challenge

DP World aims to cut absolute carbon emissions by 42% against a 2022 baseline by 2030 and achieve net zero by 2050. The primary challenge was digitalizing end-to-end visibility for road transport, alongside scaling up alternative fuels.

Solution

- Pioneered initiatives such as the UK Carbon Inset Programme and Unifeeder GreenBox,* which track and reward lower-carbon, short-sea shipping.
- Provided suppliers with independently certified carbon credits, allowing them to reduce their customers’ scope 3 emissions significantly.
- Utilized low-carbon fuels in its Unifeeder subsidiary and offered carbon credits to cargo owners.

Building on strong early uptake, DP World increased the credit for each loaded container entering its UK ports five times, registering 250,000+ TEUs** and issuing 9,000+ tCO₂e in carbon inset credits in its first few months. Credits are independently verified by Bureau Veritas or similar bodies using the 123carbon platform, following the Smart Freight Centre’s methodology.

GHG impact

- Reduced net carbon emissions by 90% at DP World’s Southampton hub.

Top-line growth

- Reduced lending risks to global small and medium enterprises, by offering a 250kg CO₂e credit value and enhanced revenue through client retention.

Policy alignment

- Aligned with the Climate Change Act (legally binding UK to net zero by 2050), EU’s “Fit for 55”, ETS reforms and CBAM.***

Key takeaway

Beyond its environmental impact, the programme delivers strong ROI for both DP World and suppliers by meeting regulatory requirements, strengthening their competitiveness and brand reputation.

Notes:

* Carbon insetting is a climate strategy where a company invests in carbon reduction or removal projects directly within its own value chain, rather than purchasing external carbon offsets. Unifeeder Greenbox is a green logistics tracking tool that allows importers to reduce and verify their scope 3 supply chain emissions.

** TEU = Twenty-foot equivalent unit. One TEU represents the volume of a standard 20-foot-long intermodal shipping container.

*** ETS = Emissions Trading System; CBAM = Carbon Border Adjustment Mechanism, a key element of the EU’s climate policy, designed to prevent carbon leakage by ensuring that imported goods face a carbon cost comparable to domestic products under the EU ETS. CBAM came into force on 1 January 2026, while the UK is finalizing legislation to launch its own mechanism in 2027.

Source: DP World, 2026.⁶¹

CASE STUDY 4

Western Digital innovates for critical minerals resilience

Western Digital repurposes retired data centre storage devices, recovering feedstock and creating value by capturing 90% of rare earth elements.

Company

Decarbonization solution

Focus

Western Digital

1 5 6 8

– Material efficiency

– Design innovation

– Ecosystem collaboration

Challenge

Western Digital aims to achieve net-zero operational (scope 1 & 2) emissions by 2032 and run operations on 100% renewable energy by 2030. In addition, the company targets a reduction in scope 3 use-phase emissions intensity of 50% per petabyte by 2030 (vs. 2020) and a reduction in direct material emissions of 20% by 2030 (vs. 2024).

Solutions

- Phased approach in terms of decarbonizing its scope 1 and 2 emissions, with focus on efficiency improvement and reduction in consumption.
- Progressively acquired clean energy to run its operations, currently at 66%.
- Launched a pioneering initiative to recover materials from hard drives at scale, in partnership with electronics manufacturers, recyclers and regulatory bodies.*

Western Digital's advanced recovery and rare earth materials capture programme recovers rare earths (e.g. neodymium, praseodymium) and metals (e.g. aluminium, steel, copper, gold) from end-of-life hard disk drives (HDDs), enabling an advanced recovery and closed-loop recycling system. By building a domestic US supply chain for critical materials, it reduces exposure to global market volatility and tariff risks.

GHG impact

- Reduced scope 3 category 1 emissions** by 95% compared to virgin material mining.

Bottom-line gains

- Converted 50,000 lbs. (~22,700kg) of hard disk drives into high-value materials.
- Achieved high rate of material recovery: 90% traceability of rare earth materials; 80% feedstock recovery of neodymium and praseodymium.

Key takeaway

High-yield recovery technologies and processes enable efficient material reuse, laying the foundation to scale up rare earth capture across adjacent industries such as electric vehicles and wind turbines.

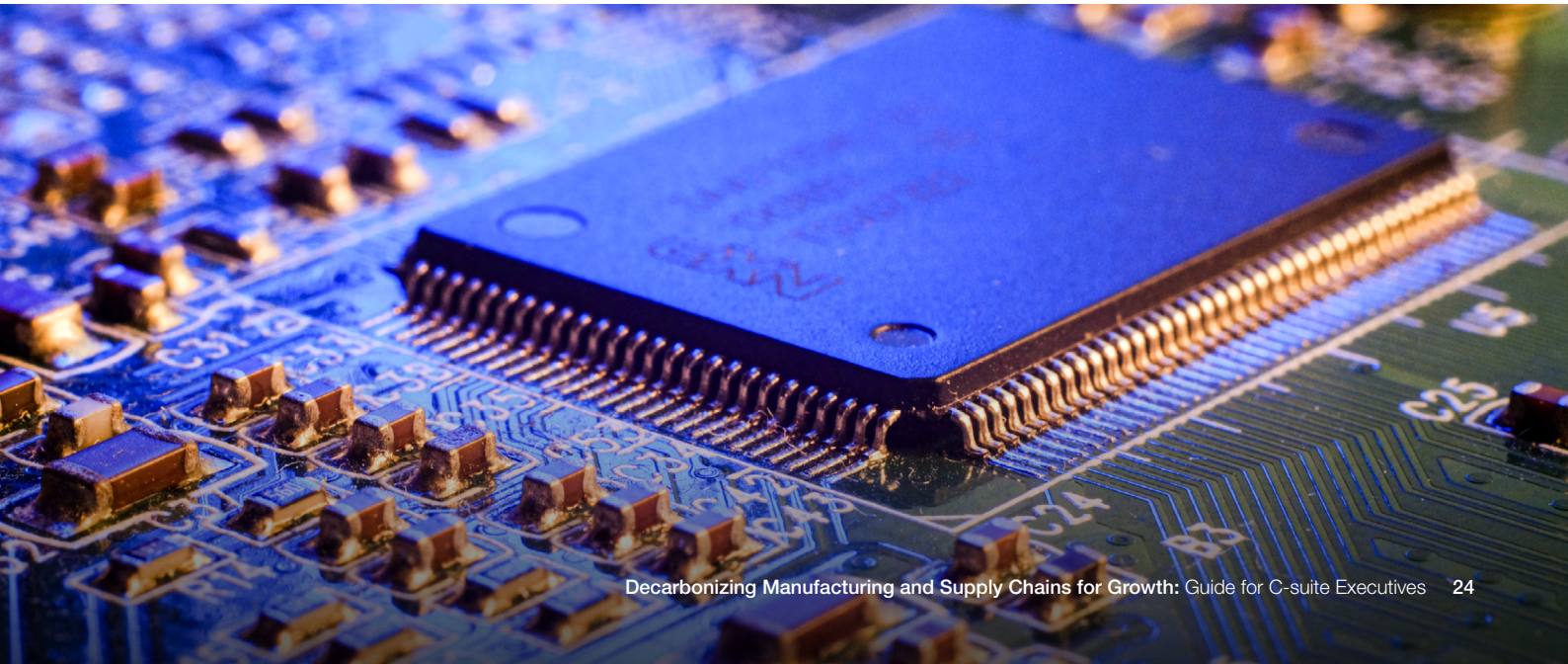
Collaboration with policy-makers has helped shape guidelines for responsible product stewardship and recycling standards, while industry associations have supported knowledge-sharing and more consistent reporting frameworks across the sector.

Notes:

* Partners include the Global Electronics Council, Microsoft, PedalPoint Recycling, Critical Materials Recycling.

** Scope 3 category 1 emissions represent all upstream, cradle-to-gate emissions from the production of products and services a company purchases or acquires.

Source: Western Digital, 2025-26.⁶²



CASE STUDY 5

Koç Holding leverages digital technologies and green financing to accelerate decarbonization

Koç Holding uses digital technologies, efficiency projects and green financing to cut value-chain emissions and scale up low-carbon solutions.

Company	Koç Holding
Decarbonization solution	1 3 5 7 8 9 10
Focus	<ul style="list-style-type: none">Digital and design innovationGreen financing

Challenge

Koç Holding operates across several sectors critical to industrial decarbonization. In the durable goods sector, Beko (the Group's home appliance manufacturing arm) operates 122 subsidiaries in 57 countries, with 38 production facilities. Scaling up low-carbon home appliances is a key challenge, particularly in emerging markets where penetration remains low. Increasing the energy efficiency of appliances can enable significant emissions reductions during the use phase.

In the energy sector, where the core transformation takes place, Tüpraş (the Group's oil refining business) is pursuing a long-term transformation by reducing emissions and developing a balanced clean-energy portfolio, with the goal of achieving carbon neutrality by 2050.

Solutions

- Beko's Eskişehir Refrigerator Factory, recognised as a World Economic Forum Lighthouse advancing digital manufacturing, applies AI- and IoT-enabled technology in its CoolAdapt products to learn user behaviour, cutting appliance energy use by up to 20%.
- Tüpraş refineries implemented 112 energy efficiency projects in 2025. In 2026, the company established the capability to produce sustainable aviation fuel (SAF) through co-processing in its existing refinery units to meet domestic needs.
- As the venture capital arm of Tüpraş, Tüpraş Ventures invests in early- and growth-stage climate tech startups with a \$50 million venture capital commitment up to 2030.

Product performance can be directly linked to sustainability-linked financing, where scope 3 (use phase) emissions reduction is a key KPI. Beko mobilized over EUR 600 million in sustainable financing instruments to scale up solutions that deliver real, verifiable energy savings, more than half of which were used to develop energy-efficient products.

By investing beyond the scope of conventional commercial solutions, Tüpraş Ventures helps de-risk future capital-intensive decisions and bridges the gap between long-term strategic ambitions and executable technology pathways.

GHG impact

- CoolAdapt refrigerators field data shows annual CO₂ emission cuts per appliance of 11 kg (C-class, ~8%) and 15 kg (E-class, ~10%).
- Reduced 142,940 tonnes of CO₂e emissions in Tüpraş refineries in 2025.

Bottom-line gains

- Beko's Eskişehir Refrigerator Factory's digital transformation delivered 43% increase in production capacity, 17% reduction in transformation costs and 20% reduction in customer complaints.
- 2,448 TJ of levelled annual energy savings in Tüpraş refineries in 2025.

Top-line growth

- Nearly half (48.3%) of Beko's revenue in 2025 came from energy-efficient products.
- Tüpraş is playing a key role in developing Türkiye's SAF ecosystem and has enabled the country's first domestic SAF agreements with airlines.

Key takeaway

Digital transformation can enhance productivity while reducing costs and emissions. Early ROIs achieved in digital projects help unlock green financing for innovation and scale up of low-carbon technologies.

Source: Forum consultation with Koç Holding, Koç Group, 2026.⁶³

CASE STUDY 6

Foxconn supports SME suppliers through digital technologies

Foxconn Industrial Internet's AI-powered digital platforms enable 80% eco-design product coverage and support SME suppliers to decarbonize.

Company	Foxconn Industrial Internet
Decarbonization solution	① ⑤ ⑥ ⑧ ⑩
Focus	<ul style="list-style-type: none">– AI-powered platform– Supplier engagement

Challenge

Foxconn Industrial Internet (FII) provides high-end smart manufacturing and industrial internet services globally. In Viet Nam, its supply chain includes 128 local suppliers (90% SMEs) responsible for over 70% of FII's scope 3 upstream emissions.

Accurate carbon calculation is essential to FII's target of achieving net-zero emissions across its entire value chain by 2050. However, navigating over 10 standards and policies, plus 50,000+ emission factors is extremely challenging for suppliers without carbon expertise. As a result, only 10% of FII's data was high quality. Meanwhile, over 90% of FII Viet Nam's products must meet more than 15 stringent environmental criteria from customers, including the EU's Ecodesign for Sustainable Products Regulation. Reliance on client-specified requirements increased material procurement costs by 10%.

Solution

- FII's AI-powered carbon platform helps SME suppliers calculate emissions, identify decarbonization opportunities and pinpoint emission hotspots – reducing manual reporting time by a supplier from approximately 800 to 24 hours on average.
- FII's eco-design platform integrates 500+ eco-design indicators from more than 15 criteria, providing AI-powered design optimization, shifting the company from passive compliance to proactive, data-driven eco-design.

The digital carbon management platform helped reduce the reporting burden on SME suppliers while empowering them to meet client requirements and unlock benefits from decarbonization initiatives, thereby contributing to the local economy. The in-house-developed product eco-design platform generated a 107% ROI through cost savings and revenue growth.

GHG impact

- The supplier carbon management platform enabled a 37.2% reduction in scope 3 category 1 emissions from 2022 to 2024 by improving data visibility and enabling suppliers to address their emissions hotspots.
- The eco-product design platform enabled a 16.4% reduction in upstream scope 3 emissions from 2022 to 2024 through optimized material usage.

Bottom-line gains

- The proportion of recycled materials used in products increased from 22% to 32%.

Business continuity and resilience

- FII enhanced its supply chain resilience by engaging with and improving the capability of local suppliers, mostly SMEs.

Top-line growth

- 80% of FII's product range is now eco-designed (from 5%), meeting growing environmental criteria required by existing and new customers across different regions.

Key takeaway

Both platforms integrate multiple digital technologies, including analytical AI, machine learning, generative AI, predictive analytics and IoT/IIoT, to create powerful synergies that enable intelligent data processing and forward-looking optimization for sustainable operations.

Source: Forum consultation with Foxconn Industrial Internet (FII), 2026.

The way forward

Industrial decarbonization can ramp up when it is supported by commercially viable business cases, cross-industry collaboration and enabling policy frameworks.

The question posed at the beginning of this paper – whether decarbonization still matters for industry – remains highly pertinent in today’s context of geopolitical fragmentation, economic pressure and policy uncertainty. Decarbonization has proven its relevance not despite these challenges, but because of them. The analysis and case studies presented in this report show that decarbonization need not be traded off against financial performance. When integrated into core business strategy, it can improve efficiency, strengthen resilience and drive growth through innovation and competitive advantage.

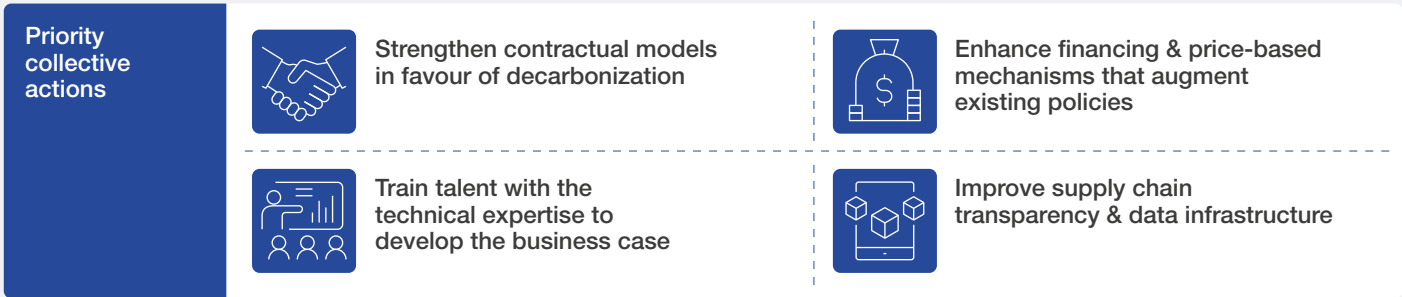
Despite a growing portfolio of deployable solutions, strengthening the business case for decarbonization across industries and regions remains constrained by systemic barriers, shaped by a complex interplay of policy, market and ecosystem factors. For manufacturers operating

across multiple jurisdictions, uneven incentive structures for decarbonization, fragmented value chains and regulatory inconsistencies can limit economies of scale, increase investment uncertainty and complicate the deployment of the solutions outlined in this paper.

Priority collective actions

To advance industrial decarbonization at the speed and scale required, it is critical to address perceived commercial risks and build stronger business cases. Drawing on consultations with more than 50 senior industry champions, this report identifies four collective actions needed to address commonly shared gaps (see Figure 4):

FIGURE 4 Four priority collective actions



Action 1 Strengthen contractual models in favour of decarbonization

Manufacturers, suppliers, logistics providers and energy providers need collaborative contractual models that reduce risks and support long-term low-carbon investments. While supply chain engagement is improving collaboration (see [Solution 8](#)), broader innovation in commercial and contractual arrangements remains limited.

For example, virtual power purchase agreements (VPPAs) are a type of contractual arrangement that can provide long-term revenue certainty for renewable energy developers, yet they remain unavailable in many regulated electricity markets and underutilized even where market liberalization has enabled their adoption.

equivalent volume of renewable electricity is supplied to the grid for its vehicle-charging needs, while maintaining greater flexibility in how and where renewable energy is sourced.⁶⁴



Enhance financing and price-based mechanisms that augment existing policies

For example, in the case of fuel switching (see [Solution 3](#)), Australia's Green Iron Investment Fund is helping de-risk early capital investments in manufacturing low-emissions iron using renewable hydrogen.⁶⁵ By supporting Australia's nascent green iron industry, the initiative has the potential to significantly increase the value derived from the country's iron ore resources, while reducing emissions across the steel value chain.

Strengthening financing and price-based mechanisms – including carbon pricing, emissions trading systems, green public procurement and targeted financial and investment incentives – can reduce investment risk, improve project economics and accelerate the deployment of solutions. Stable and predictable policy frameworks play a critical role in creating the long-term investment confidence needed to scale up emerging technologies.





Action 3

Train talent with the technical expertise to develop the business case

Ramping up industrial decarbonization requires technical capabilities and skilled talent able to translate opportunities into business cases that demonstrate financial value. Proficiency in this area is increasingly important as demand for green skills outpaces supply, creating workforce constraints that could slow the adoption of low-carbon technologies and industrial transformation.⁶⁶ Investing in developing talent with the right technical expertise can help companies assess technology options,

quantify costs and benefits, reduce execution risks and develop more investable projects.

For example, the Climate Investment Funds' \$1 billion industry decarbonization investment programme supports emerging economies such as Brazil, Mexico and Egypt in developing the capabilities needed for a just transition in hard-to-abate industries, while promoting inclusive participation in the growing green economy.⁶⁷



Action 4

Improve supply chain transparency and data infrastructure

Limited supply chain transparency and inconsistent emissions data weaken the business case for industrial decarbonization by making emissions reductions difficult to measure, verify and monetize. Without reliable, granular and comparable data, organizations face challenges in identifying emissions hotspots, assessing the impact of capital-intensive abatement measures (see Solutions 2, 3, 4 and 7) and prioritizing investments across their operations and value chains.

Strengthening data infrastructure is a critical enabler to prove the commercial viability of decarbonization solutions. Standardized emissions accounting frameworks, interoperable digital platforms (see [Solution 10](#)) and product-level traceability can support more targeted capital allocation, ROI measurement and stronger accountability for progress.

Addressing these four collective actions will require collaboration across industry, governments, financial institutions and other ecosystem partners, underpinned by stable and consistent long-term policy frameworks. Together, these efforts can strengthen the business case for decarbonization and position it as a driver of long-term growth.

Building on this paper, the World Economic Forum will continue supporting this shift from ambition to implementation by providing CXOs with practical guidance on business cases

and proven pathways, showcasing successful real-world initiatives by leading companies to enable fast followers to replicate best practice and collaborate globally.

Looking ahead, decarbonization will remain a defining feature of the evolving industrial landscape. As the link between economic resilience and environmental sustainability strengthens, organizations must turn ambition into action, supported by collaboration and – above all – grounded in a robust business case.

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