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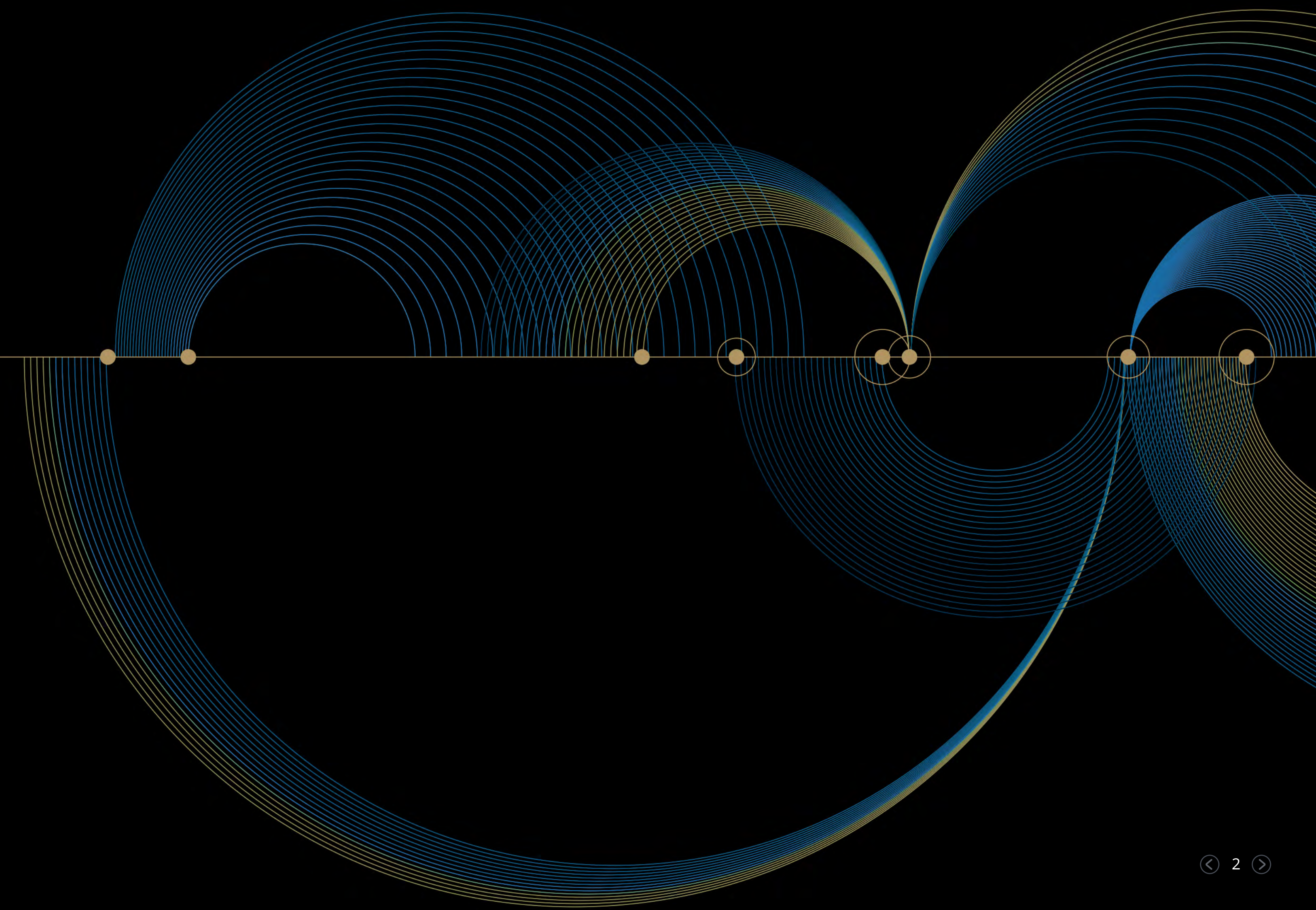
Sustainable manufacturing
From vision to action

Contents



Driving meaningful change

Since the dawn of the industrial age, manufacturers have been evolving and adapting in response to new technological innovations and changing market demands. Today, the industry is moving through another evolution, one that has sustainability at its center.

According to the US Environmental Protection Agency, sustainable manufacturing can be defined as “the creation of manufactured products through economically-sound processes that minimize negative environmental impacts while conserving energy and natural resources.”[1] In this paper, we explore the opportunities that this type of approach presents for manufacturers.

In doing so, we look at five main areas of impact where sustainable practices can drive measurable improvements across the manufacturing value chain:

- **Engineering:** During product design, both small modifications and wholesale reinvention are reducing costs and waste.
- **Sourcing:** The ethical selection and sourcing of sustainable and/or alternative materials has gained importance.
- **Production:** Improved operational efficiency, smart technologies, and green energy are being combined to create the factory of the future.
- **Transportation:** During shipping and delivery, supply chain reconfiguration and decarbonization efforts are rationalizing trade routes and reducing emissions.
- **Aftermarket:** The transition towards a circular economy model promises to change the way products are designed, produced, sold, used, and disposed of.

Along the way, we share real-world stories from manufacturers that are leading the shift towards sustainable practices—as well as strategies organizations can adopt to get started on this journey.

There is little doubt that considerable progress has been made to date. Yet, much more remains to be done, particularly if organizations hope to meet the time limits for achieving net-zero outcomes. In fact, although the 26th UN Climate Change Conference of the Parties (COP26) was rescheduled due to COVID-19, many companies made commitments in 2020 to achieve significant carbon reductions by 2050.[2]

Only through concerted industry efforts, acknowledgment that change is necessary, and a willingness to accept personal responsibility, can manufacturers begin to drive meaningful environmental improvements across the board.

A push and pull towards sustainable manufacturing

The slow but steady move towards sustainable manufacturing has been driven by several forces: a desire to reap the rewards it offers; a need to offset risks and costs; and growing pressure to address stakeholder, shareholder, and customer demands. Underpinning all of these is the growing urgency to address the profound environmental crises, foremost climate change, the impacts of which are becoming more apparent and deleterious .

Benefits

In terms of benefits, manufacturers across the spectrum are leveraging sustainable manufacturing practices to reduce costs and waste, improve operational efficiency, gain competitive advantage, and enhance regulatory compliance. In fact, in Deloitte' survey, 2021 Climate Check: Business' views on environmental sustainability, conducted in January and February 2021,[3] almost half of the 750 executives surveyed reported that their environmental sustainability initiatives measurably boosted their corporate financial performance.

Andreas Müller, Group CEO of Georg Fischer—a global industrial manufacturer that *The Wall Street Journal* recently ranked as one of the ten most sustainable companies in the world—agrees. "Sustainability is definitely a driver for economic success," he noted in an interview with Deloitte Switzerland. "Solutions addressing the sustainability needs of our society become more important and carry more weight in the market. Demand for such products is high. Also these products are often in the early stages of their lifecycle and therefore can deliver higher margins."[4]

Rising risks

Yet the advantages alone are not the only motivating factors. The shift towards sustainable manufacturing is also an effort by many companies to mitigate a range of risks. These cannot be underestimated, and in fact may be more of a motivation than the potential benefits.

For instance, major corporate purchasers are increasingly imposing rules on their downstream suppliers to meet certain sustainability thresholds. In one example, supply chain members of the Carbon Disclosure Project (CDP) now regularly ask their key suppliers to disclose detailed environmental performance data. With over US$5.5 trillion in purchasing power,[5] the initiative's 200-plus global members are seeking greater transparency from companies across the manufacturing supply chain. Manufacturers that fail to comply with these requests may find themselves at risk of losing their preferred supplier status.

Regulatory mandates, too, are becoming more stringent, just as compliance is becoming more complex. National, regional, and global regulations and voluntary standards have placed manufacturers under pressure to improve their energy efficiency, reduce carbon emissions, limit their water usage, minimize waste generation, and disclose their environmental performance.

External pressures

Investors are also weighing in. Gone are the days when manufacturers could only report progress towards sustainability in their corporate disclosures. Instead, companies are now typically expected to deliver year over year progress on their sustainability objectives. Also, conscious consumers in many countries are paying closer attention to the working conditions, material inputs, and waste disposal methods employed by manufacturers of everything from electronics and apparel to food products and household goods. Beyond consumers shifting their purchasing habits, many are also funneling their investment dollars into sustainable funds (see figure 1).

Like various other movements that have rapidly gained momentum, the demand for sustainable manufacturing is poised to increase in the face of rising concerns around climate change. Between 2000 and 2020, CO_2 emissions released by global fossil fuel combustion and industrial processes rose by roughly 35%, to 34.07 billion metric tons.[7] As the impact of climate change continues, governments, communities, and concerned citizens around the world will likely be looking for meaningful change from businesses in every sector, including manufacturing.

Figure 1: Sustainable fund flows, Q4 2020[6]

Flows into sustainable funds, in billions of U.S. dollars

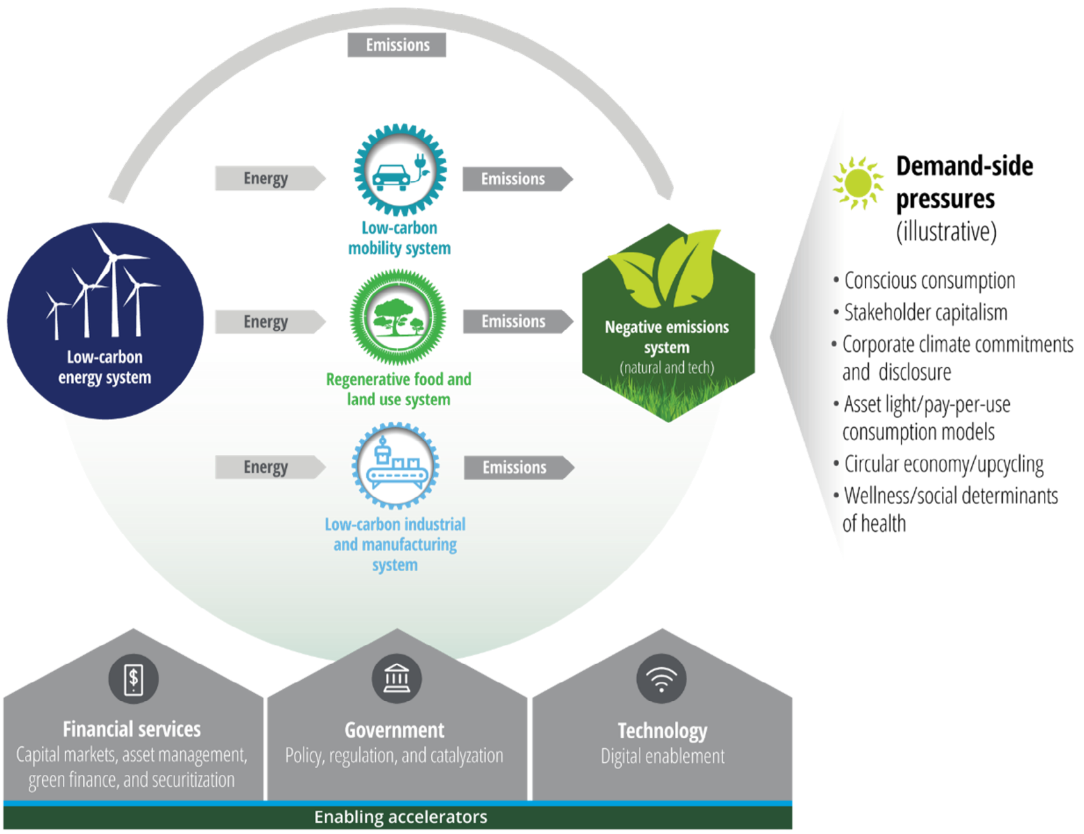
Europe	120.8
United States	20.5
Asia (excluding Japan)	5
Japan	3.7
Australia and New Zealand	1.2
Canada	1.2

Source: Morningstar

As evidence, simply consider the resources being proposed or directed towards the low carbon transition. By 2030, €1 trillion (approximately US$1.18 trillion) in public and private investments are expected to be deployed under the EU's Green New Deal[8]; the US commitment proposed in the Climate and Environmental Justice plan anticipates total spending of US$5 trillion by 2050[9]; and China has already spent billions of dollars[10] in its quest to achieve carbon neutrality by 2060 and has made major commitments to future spending as well.

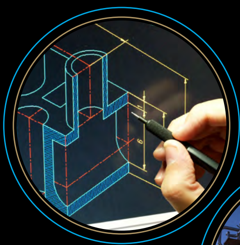
These combined drivers could ultimately require the transformation of the entire manufacturing and industrial system, forcing manufacturers to look at how they design, source, manufacture, deliver, and service all their products (see figure 2). A low-carbon manufacturing and industrials system will likely see changes in every sector and along nearly every step of the value chain, many complementing and accelerating the broader shifts toward smart factories and digital supply networks already underway.[11] Significant change is afoot and it necessitates bigger thinking. Manufacturers prepared to embrace the change may find themselves unlocking the floodgates of unprecedented innovation. Those unprepared may find themselves being left behind.

Figure 2: The building blocks of the low-carbon ecomony



Source: Deloitte analysis

Product design with sustainability in mind



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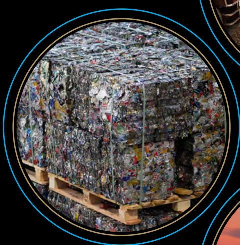
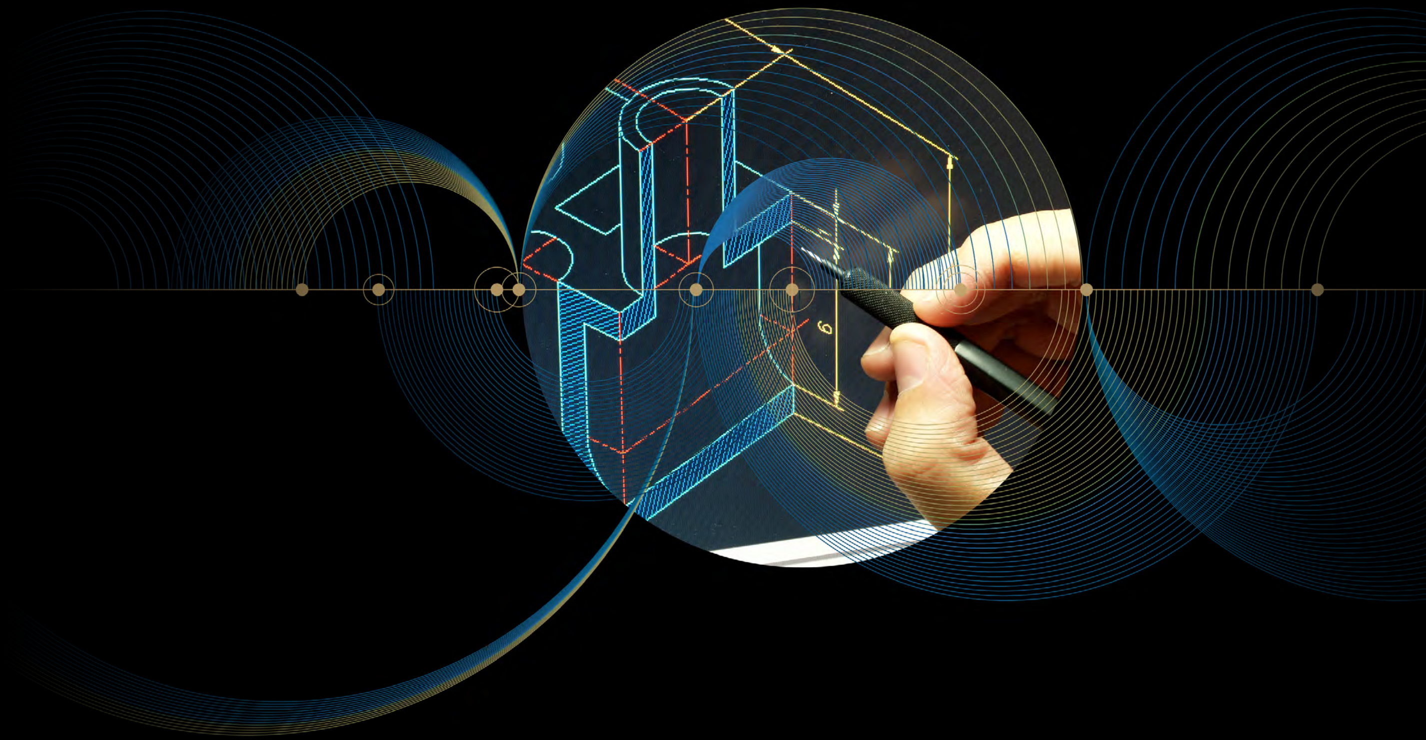


The journey towards sustainable manufacturing



Product design with sustainability in mind

In many ways, sustainability begins at the product design stage. With rapid prototyping and additive manufacturing (AM) vastly enhancing research and development (R&D), companies can often realize sustainability benefits by modifying existing products. Beyond generating less material waste, AM can help manufacturers reduce reliance on environmentally-detrimental materials such as caustic cutting fluids. The lighter weight of many AM-produced parts can also help save fuel and energy.[12]

There are many examples of new product formulations. Over the past few decades, for instance, automotive manufacturers have largely switched to waterborne paints and coatings, vastly cutting down the emission of volatile organic compounds (VOCs).[13] Beyond reducing human health hazards, this switch can yield considerable environmental benefits.

By thinking through the entire lifecycle use of products, many manufacturers are also reducing disposal and waste by making their products available for lease or rent rather than selling them outright so that they can ensure proper product maintenance and extend the product life-span. In addition to incenting manufacturers to improve production quality in an effort to extend product life, this approach can open the doors to new streams of revenue through service and support contracts. One example of this is Mitsubishi Electric Group's M-Use® elevator leasing model which, in addition to allowing customers to manage their total investment, supports the circular use of raw materials to cut down on energy consumption.[14]

One key to realizing these benefits is to approach product design with sustainability in mind. This could involve redesigning individual elements of specific products to improve environmental performance, looking for opportunities to reduce disposal costs and improve raw material utilization, finding ways to extend product lifecycles, or designing with the ultimate intent to reuse, refurbish, or remanufacture (see: The case for a circular economy).

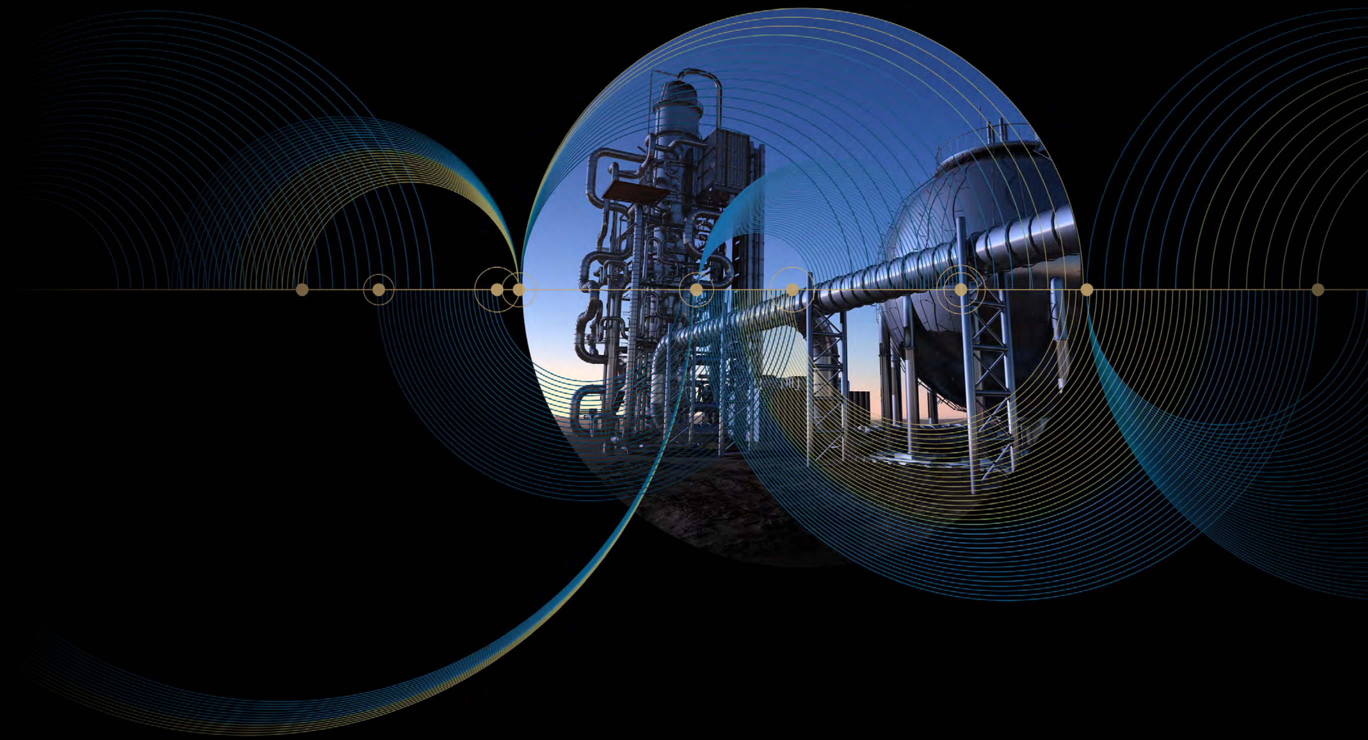
From redesign to reinvention

While green design principles can help manufacturers reduce their environmental impact, those seeking to create, transform, and protect long-term value are increasingly engaging in more divergent thinking. This has seen companies ushering in unprecedented product innovation to realize outsized results.

Unilever provides a powerful case in point. In 2010, when it launched the Unilever Sustainable Living Plan (USLP), its stated aim was to decouple its growth from its environmental impact to enhance its social impact. Within 10 years, the company had reduced its total product waste footprint per consumer by 32%, lowered its manufacturing-related greenhouse gas emissions by 65%, and achieved zero waste and 100% renewable grid electricity across all its sites.[15] Today, the company's sustainable living brands—including Seventh Generation, Dove, and Pukka Herbs—account for 70% of its turnover growth.[16]

Germany's Siemens AG also provides a story of reinvention. In response to global shifts towards renewable energy, the company spun off its gas and power division in 2020 to redirect focus towards its digital industries and smart infrastructure businesses.[17] The spun-off division—now known as Siemens Energy Global—has become a major supplier of renewable power. In fact, Siemens Energy Global's 67% stake in Siemens Gamesa Renewable Energy[18] makes it one of the largest wind turbine manufacturers in the world.

As disruptive forces continue to change operational realities across manufacturing sectors, companies looking to achieve competitive advantage may need to allocate more resources towards product innovation. Those prepared to act quickly could stand to benefit the most. After all, product reinvention requires that proper scientific and technical underpinnings be in place in advance. The manufacturers farthest along this path could conceivably become the next "big" sustainable brands in 5 to 10 years' time.



Material selection and ethical sourcing

Another important element in driving sustainable manufacturing revolves around material selection and sourcing. At its most fundamental level, this begins by reducing raw material inputs, replacing potentially toxic materials with those less harmful to the environment, selecting new material technologies that replace those that are not green, and using processes such as additive manufacturing to shorten supply chains and cut down on the amount of material required to produce components.

In many ways, however, these are only first steps. To meet environmental, social, and governance (ESG) mandates and avoid backlash from consumers, investors, and regulators, manufacturers may increasingly need to demonstrate provenance of their raw inputs.

Tracing origins

Although early demands for provenance were likely sparked by the need to eliminate conflict minerals from supply chains, social expectations around ethical sourcing have burgeoned. With each passing year, a growing number of upstream suppliers, consumer and industrial brands, and technology giants are paying closer attention to the origin of the raw materials they source and sell—putting manufacturers under greater pressure to improve product traceability and disclose the carbon footprint associated with their process manufacturing.

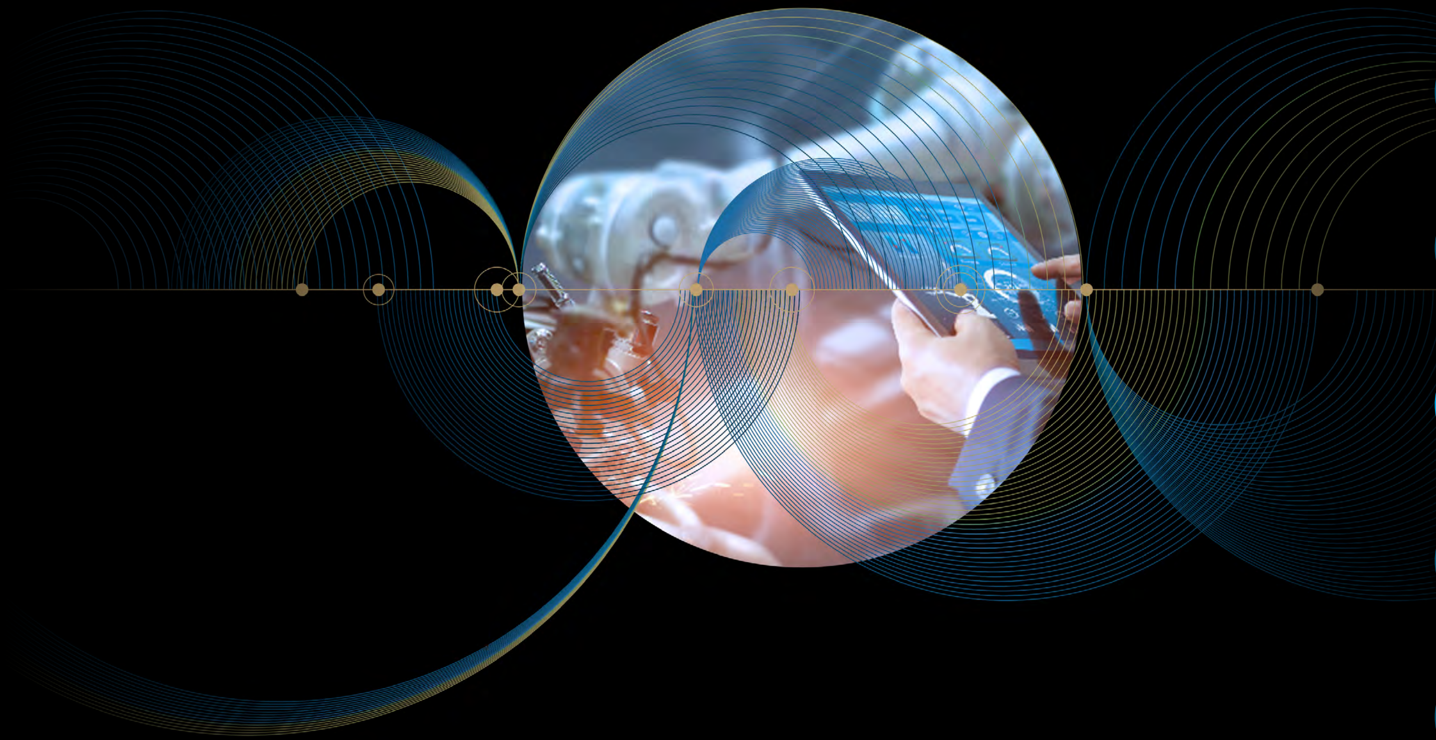
Proposed regulations, such as Switzerland's Responsible Business Initiative, make it clear that expectations are increasing. Under the proposal, which was defeated in a November 2020 referendum, Swiss-based multinational companies would have been required to regularly report on a range of non-financial issues related to their carbon emissions, social and employee policies, and human rights performance. A counter-proposal is already in the works to increase corporate reporting and due diligence requirements.[19]

Or consider the following example: currently, companies ranging from BMW Group, Daimler, and Ford to Microsoft and Tiffany & Co. all police their mineral supply chains through membership in the Initiative for Responsible Mining Assurance (IRMA). The organization assesses industrial-scale mines to determine if they adhere to specific standards around business integrity, social responsibility, and environmental performance.[20] As demand for sustainable products grows, sourcing practices across the manufacturing industry will likely come under greater scrutiny.

Immutable proof

One way to deliver this level of transparency is through the adoption of immutable ledger technologies, such as blockchain. In the diamond industry, for instance, De Beers developed a blockchain platform called Tracr to digitally track diamonds from the mine to retailers. Mined diamonds are assigned a global diamond ID, which records their individual characteristics, such as carat, clarity, and color—designed to allow consumers to confirm that registered diamonds are natural and conflict-free.[21]

These technological advancements are already influencing the ways in which many manufacturers select and source their materials. In 2018, for instance, Walmart famously asked its lettuce suppliers to use the company blockchain to trace their products back to the farm in a bid to enhance food safety.[22] By tracking and tracing individual materials, component parts, and even finished products, immutable ledgers can help manufacturers enhance product quality, accelerate product recalls, and reduce tampering—all while providing transparency into the sustainability of their supply chain networks, from product production and distribution to purchase and disposal.



Forging the factory of the future

In considering ways to reap the rewards of sustainability within the manufacturing sector, another critical focal area is on the factory floor. This often begins with automation and integration.

In recent years, manufacturers have implemented lean processes as well as digital capabilities to boost productivity, create safer workplaces, and reduce costs. By providing manufacturers integrated and complimentary capabilities, they can gain greater visibility into their production processes, equipment wear-and-tear, and energy usage. These capabilities can empower organizations to optimize production, improve predictive maintenance, and minimize material waste.

Alternative energy options

Currently, manufacturing processes use roughly one-quarter of the energy in the United States and one-third of the world's energy.[23] Even in lower-intensity sectors, energy often represents a significant cost—which only stands to rise as global energy prices increase. By reducing waste and water usage, adjusting energy loads, lowering heating requirements, and even embracing carbon-neutral manufacturing, the factories of the future have the potential to drive measurable sustainability outcomes as well as reduced costs. This is particularly salient given that these energy efficiency improvements are increasingly mandated by licensing authorities at the outset or review of operations.

One approach for making this happen may be by increasing reliance on the increasingly competitive renewable energy sources. Through power purchasing agreements (PPAs), manufacturers can lock in fixed prices for the supply of renewable energy, sometimes for as long as 15 or 20 years.[24]

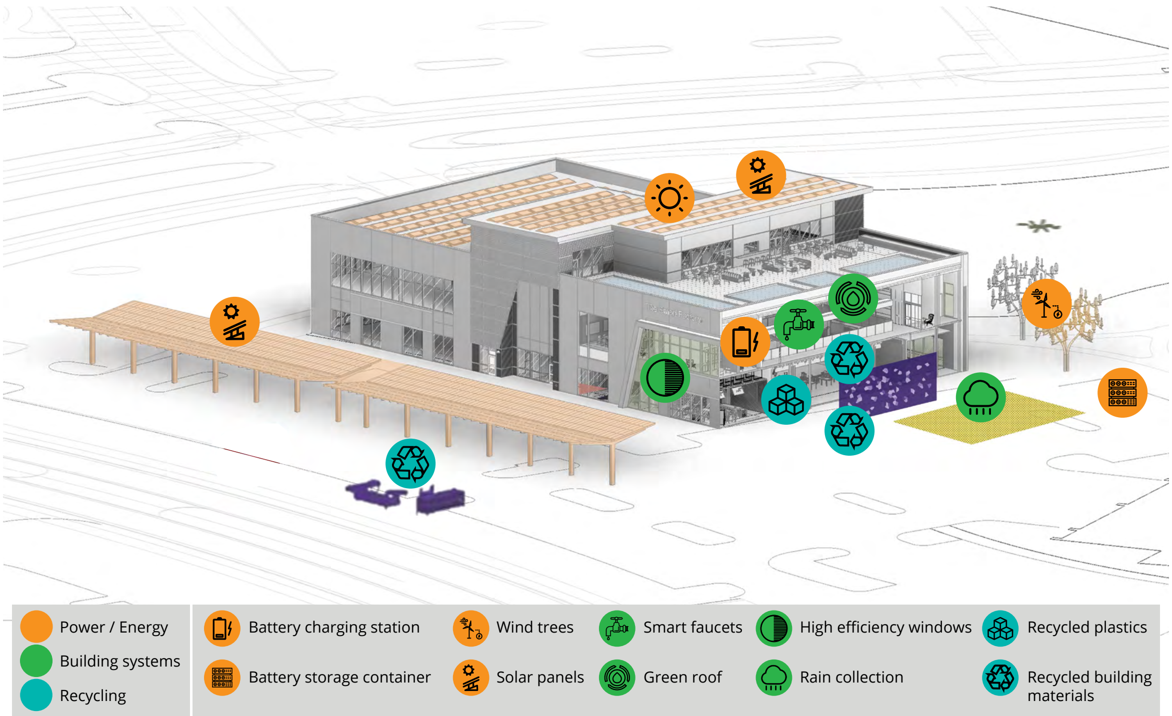
Several manufacturers with large campuses have even begun investing in on-site generation, using solar panels, wind turbines, and geothermal pumps to power their own facilities. Given the upfront costs associated with renewable energy generation, however, governmental incentives will likely be required before this approach gains widespread traction.

The Smart Factory @ Wichita

One of the best ways to understand the benefits conferred by the factory of the future is through personal experience. As an example, Deloitte is currently building a net-zero building called The Smart Factory @ Wichita, which was created to bring to life leading practices and real-world proof points to show manufacturers the art of the possible. The building is 60,000 square feet—with the manufacturing site comprising roughly one-third of that space. This allows the smart factory to generate sufficient energy on-site to power operations. It does so using a range of best-of-breed technology from around the world—including solar panels on the roof and carports, next-generation wind trees, and lithium-ion (Li-ion) battery stacks to achieve utility-grade storage. Microgrid control units monitor energy flows to ensure consistent loads, relying on advanced analytics to improve demand management. Excess power is also stored for later use. While the site features a generator to meet peak loads, the ability to store dense, renewable energy in-situ allows for the creation of a sustainable smart grid and supports the net-zero vision for the factory of the future (see figure 3).

The Smart Factory @ Wichita also brings together a wide range of leading vendors, who are collaborating to deliver technological interoperability. The aim is to build a sustainability ecosystem that allows the smart factory to integrate multiple technology platforms—whether manufacturers choose to build a greenfield factory or, the more-likely scenario, retrofit a brownfield site. Manufacturers who visit the site will have the opportunity to explore various use cases to see some of the benefits of a smart factory in action. Also, to further enhance sustainability, The Smart Factory @ Wichita is working towards becoming a zero-waste facility.

Figure 3: The Smart Factory @ Wichita sustainability overview | Key net-zero components



Source: The Smart Factory @ Wichita

Streamlining shipping and distribution

Beyond product development and production, manufacturers serious about realizing sustainable development goals should look at the impact of their distribution practices. This can be particularly critical given the industry's heavy reliance on both shipping and road freight.

To put this in context, the shipping industry currently accounts for approximately 2.7% of global CO_2 emissions, with particular geographic concentration across East-West trade routes.[25] Bulk carriers, oil tankers, and container ships account for around 85% of all shipping activity.[26] For its part, road freight accounts for around 9% of global CO_2 emissions, with the United States, Europe, China, and India responsible for more than half of that total.[27]

To truly support global decarbonization efforts, manufacturers should think through a wide range of factors in relation to their supply chains, such as distance traveled, geographic coverage, the predictability and repeatability of their routes, and (for road freight particularly) the number and length of breaks. This can position the sector to make progress in specific areas rather than waiting for a solution that's optimal across the board.

Taking enlightened action

There are a range of strategies manufacturers can consider to drive ongoing progress in this regard. From a road freight perspective, companies could use digital technologies and data analytics to optimize their loads. Currently, the largest opportunity for most organizations is in domestic transport and developing markets where empty miles are often twice as high as on international routes in developed markets.[28]

One example of data analysis in action is UPS's ORION (On-Road Integrated Optimization and Navigation) technology. First deployed in 2012, the system's algorithm optimizes delivery routes to reduce fuel consumption. One way it does this is by minimizing left-hand turns, which increase idling. Between 2012 and 2020, UPS estimates that ORION has saved its driver approximately 100 million miles, translating into 10 million gallons of fuel savings per year.[29]

Fleet owners can also take steps to enhance the efficiency of the trucks themselves through low-friction tires and lubricants, improved aerodynamics, and driver assistance devices. Notably, driver training can play a key role too, potentially helping to improve fuel efficiency by as much as 20% to 30%.[30]

Opportunities also exist to run pilot projects focused on new fuels and other emission-reducing technologies along selected routes (see example 1).

Example 1: Shifting to fossil free transport

Scania, a global provider of transport solutions, recently partnered with Norwegian wholesaler ASKO to explore low-emission alternatives for long haulage. After putting four hydrogen gas trucks into operation in January 2020, the partners added two battery electric distribution trucks to the mix one month later. By 2022, ASKO hopes to have a fleet of 75 battery electric trucks, with an aim to run emission-free by 2026.[31]

In the wake of the COVID-19 pandemic, reshoring is another strategy whose time may have come—at least for those manufacturers whose end markets support it (see example 2). While far-flung supply chains played a role in reducing expenses in recent years, localizing supply networks may help to offset higher labor costs, while simultaneously positioning manufacturers to respond quicker to local demand. Additive manufacturing can make this approach more viable by enabling production closer to the point of consumption—which can also serve to markedly reduce shipping and freight costs.

Example 2: The case for reshoring

To keep manufacturing costs under control, back in 2016 trucking technology company TruckLabs began sourcing parts for its aerodynamic panels in low-cost countries around the world, including Mexico, China, and Taiwan. When the trade war between the United States and China broke out in 2018, however, the company began to reconsider its strategy.

After comparing international labor costs, materials costs, shipping, operational complexities, and the risk of business disruptions within various jurisdictions, the company decided to reshore 60% of its production to the United States. Despite the complexities, this shift has already enabled TruckLabs to reduce its materials costs by roughly 20%, cut lead times from eight to four weeks, and lower its carbon footprint by reducing reliance on international freight.[32]

Yet another way to move the needle around shipping and distribution is by implementing initiatives to support "green transport" through long-term contracts, committing to volume on selected routes, and incorporating emissions targets in tender criteria. Sectors under regulatory pressure, like automotive, or those with high consumer visibility, such as fast-moving consumer goods or apparel, could be prime candidates for these types of programs.

To be effective, however, both ship and fleet operators would need to play a role by sharing emissions data more openly or improving monitoring technologies to help manufacturers make informed decisions and verify performance. Although challenges exist, this solution could make ship and fleet operators more confident that green investments will pay off, while perhaps generating higher margins for green products—creating an additional source of funding for the transition to low-emission fuels.

The case for a circular economy

When walking the path towards sustainable manufacturing, an additional consideration revolves around what happens to products once they're in a consumer's hands. While the extent to which manufacturers are responsible for the in-field performance of their products (e.g., their energy intensity or carbon outputs) is unclear, there is no question that the imperative to reduce waste is growing.

Each year, over two billion tons of waste is sent to landfills around the world[33] and that amount is expected to rise in tandem with a growing global population. At the same time, roughly 10% of the garbage collected around the world is estimated to end up in the oceans.[34] Add in concerns around the potential toxicity of electronic waste, landfill-generated air and water pollution, and the strain on limited natural resources required as inputs for countless products, and the case for recycling, reuse, and refurbishment further strengthens.

There is also a growing movement to hold companies accountable for all their product lifecycle emissions. These are defined as "... all the emissions associated with the production and use of a specific product, from cradle to grave, including emissions from raw materials, manufacture, transport, storage, sale, use and disposal."[35] While these standards are currently voluntary, ongoing stakeholder pressure around the world will likely continue to push these issues higher up the corporate agenda.

Thinking in loops

In response to these concerns, many manufacturers have begun to consider the viability of circular economies. Beyond its potential to promote sustainable production and consumption, a circular economy model can drive both environmental and financial benefits. The Ellen MacArthur Foundation estimates that circular economy activities could contribute as much as US$700 million in annual material cost savings to consumer goods production, along with a 48% reduction in carbon dioxide emissions by 2030.[36]

Loosely defined, a circular economy is a closed-loop system designed to replace end-of-life waste disposal with material reduction, reuse, recycling, and recovery (see figure 4). As this definition makes clear, the circular economy model extends well beyond recycling. Its broader focus actually aims to keep resources within the product lifecycle for as long as possible by:

- **Closing the loop:** reintegrating waste or production by-products back into the manufacture of new products (see example 3).
- **Slowing the loop:** extending product life and slowing the resource transition to waste or resource recapture (see example 4).
- **Narrowing the loop:** reducing resource and material intensity requirements during production, use, or disposal.

Figure 4: R hierarchy: Value retention options in a circular economy[37]

Value retention option	Consumer	Producer
R0: Refuse	• Choice to buy/consume less • Reject packaging waste	• No use of hazardous materials (or virgin materials) for products of production processes • Production processes designed to avoid waste
R1: Reduce	• Less frequent use of goods • Longer and more careful use of goods	• Explicit step in product design: less material per production unit > dematerialization • Design long-lasting goods
R2: Resell/Reuse	• Buy second-hand goods • Resell unused products • Consumer-to-consumer auctions	• Reuse in fabrication • Use of existing waste streams as inputs • Direct reuse as economic activity via collectors and retailers • Multiple use of (transport) packaging • Reselling unused, unsold products or products with slight defects (e.g., packaging)
R3: Repair	• Repair by consumer at their place or a repair center • Repair by a third-party company (organized by the consumer)	• Enable (easy) repair and maintenance of goods through product design • Collect defective products in repair centers controlled by the manufacturer or a third party • Distinguish planned repair as a part of a long-term maintenance plan from ad-hoc repair • Use modular designs, facilitate disassembly

Value retention option	Consumer	Producer
R4: Refurbish	n/a	• Replace or repair components with overall structure still intact, resulting in improved product quality • Use modular designs, facilitate disassembly
R5: Remanufacture	n/a	• Disassembly of overall structure, checking, cleaning and potentially repairing components • Retention of original product quality • Use modular designs, facilitate disassembly
R6: Repurpose	n/a	• Use discarded components adapted for another function
R7: Recycle	• Correct disposal of goods: separate waste streams/ materials	• Process streams of post-consumer products • Ensure further use of recycled raw materials (own use, brokerage) • Use modular designs
R8: Recover	n/a	• Capture energy embodied in waste (incineration, use of biomass)
R9: Re-mine	n/a	• Retrieve materials in landfills, urban mining/landfill mining

The R hierarchy is a widely used framework to rank value retention options. Different versions with varying granularity are in use, with many of the Rs being conceptually related or even overlapping. Depending on the value retention option, there is a consumer and a manufacturer perspective. For options like recycling, there is even a potential governmental perspective to be considered.

Source: *A circular transition*, Deloitte

Example 3: Reverse logistics in action[38]

After introducing a new product to market, a global consumer electronics company began seeing a high rate of returns. This raised an ancillary concern: what was happening with the products that weren't being returned? If they weren't being disposed of responsibly, the company was at risk of facing fines under local extended producer responsibility (EPR) regulations.

To address these dual challenges, the company decided to implement a reverse logistics program designed to achieve two goals: to conduct a failure analysis on returned products and enhance its sustainability objectives through 100% recycling of returned products.

To achieve these goals, the company set up regional return hubs around the world—shortening return streams for quicker inspection results and disposal. With greater access to robust end-of-life data, the company's engineering and design teams were able to improve device reliability, extend product life, reduce discards, while simultaneously introducing a sustainable disposal process for product dismantling, reuse, and recycling.

Example 4: Cradle to cradle carpet design

In a bid to reduce waste, promote material reuse, and enhance its sustainability outcomes, global carpet manufacturer Desso pioneered a "cradle to cradle" program designed to transition the company to a circular business model. In addition to designing its carpets with recyclable yarn that can be separated from the backing and continuously reused, the company also introduced a take-back program to prevent its products from landing in landfills.[39] Additionally, the company's growing reliance on renewable energy to power its manufacturing has seen it reduce carbon emissions by 50%.[40]

Unlocking the benefits

Critically, studies suggest that up to 80% of a product's circularity may already be determined at its design stage.[41] Transitioning to a circular economy consequently requires fundamental changes not only to the ways that materials are sourced but also to the ways in which products are designed, produced, sold, used, and disposed of. It also requires collaboration among multiple actors across the supply network.

Given the variability of business models and operational realities, there is no one-size-fits-all solution to establishing a circular economy or embracing reverse logistics. What works in consumer goods may not work in industrial products.

Despite this, it remains important to consider the available options so that manufacturers can identify opportunities within their unique value chains.

In addition to reducing the environmental impact of their products, this type of strategy can unlock a range of ancillary benefits. These extend from lower costs for materials, waste management, and energy to enhanced compliance with the growing number of regulations that now mandate a move towards responsible disposal practices (such as the EU Green Deal and the Swiss Responsible Business Initiative). It also holds the potential to generate new streams of revenue (e.g., by leasing equipment versus selling it outright).

The journey towards sustainable manufacturing

Whether prompted by stakeholder demands, regulatory mandates, a concern for the environment, or pure financial motives, one thing is clear: the sustainability imperative appears to be growing. Manufacturers can no longer confine sustainability to a reporting activity by simply publishing aspirational targets in their annual reports. To make the progress necessary to shift the dial, they will instead need to commit to clear action.

Here are some ways to consider getting started:

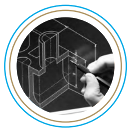
Plan

- **Assess your current state.** As a first step, it's important to measure your facilities' current carbon profiles, as well as your products' in-field performance, to build a baseline of your environmental footprint or the output of your current processes. Examples include utility monitoring to measure water and power consumption; analytics to help you identify areas to reduce waste across your manufacturing processes; deploying route optimization software to monitor your distribution practices; or using intelligent tires to measure fuel consumption and tire wear. This exercise should help you determine where to best focus your energies to make the biggest impact.

- **Refresh your strategy.** Ensure you have made explicit, systemic choices underpinning your strategy, from your winning aspiration through where to play, how to win, and the capabilities and management systems you need to execute effectively. From there, create a roadmap to hit your end goal and define what levers you can pull. This may include reallocating spend into new markets where you are best able to differentiate, identifying strategic acquisitions, pursuing accretive partnerships, and/or redesigning processes and operating models to put sustainability at the heart of your decision-making. The best strategies in the face of uncertainty – which is the condition inherent to a decarbonizing future – are generally built on scenario planning. These take into account multiple, equally plausible but divergent futures and identify both 'no regrets' actions that would be resilient under any scenario as well as signposts and leading indicators which you can monitor to determine how the relative likelihood of each scenario shifts as the future plays out.
- **Set targets and define priorities.** Built on your strategy, this includes identifying program milestones, building out viable use cases, and using lessons from elsewhere – not just best practices but interesting analogues from different settings – to enhance your odds of success at creating lasting advantage. Beyond considering your end customers' priorities and expectations, this should also see you gaining a stronger understanding of the range of decarbonization pathways available to you. Project multiple different options for what those pathways might look like, based on shifting assumptions around demand conditions, policy moves, and technology development curves. Ideally, use tools which can map down to asset-level projections which you can roll up for a company-wide pathway rather than top down target-setting, which all too often misses the practical realities of what can be achieved, and dynamically shift your planned path forward as uncertainties resolve into trends.
- **Consider funding and tax implications.** Review your capital allocation process to bring carbon into the equation. Look at alternative funding mechanisms, too, such as green bonds, ESG investment funds, available tax incentives, carbon trading schemes, private equity funding, and partnerships/joint ventures.
- **Address cultural imperatives.** Sustainable manufacturing can only be achieved by setting the right tone from the top, gaining buy-in, and considering the change management implications. This means determining what priority sustainability holds within your corporate agenda—and how that aligns with your broader strategy. Experiential training is also typically key to gain buy-in for the move towards improved sustainability outcomes. Similarly, executive support is critical to drive meaningful change. One way to tackle this is by linking sustainability KPIs to executive remuneration.

Execute

- **Define necessary roles and responsibilities.** This may include appointing people to new roles (such as a chief sustainability officer) to lead these initiatives at a strategic level. The key here is to demonstrably make sustainability a corporate priority by securing senior leadership buy-in, rather than relegating it to a "nice-to-have" initiative that languishes on the corporate backburners.






- **Make careful investment decisions.** Questions to ask in this regard include: What sustainability metrics is the company under pressure to deliver on? Is there a convincing and supported business opportunity to address those expectations? Which areas should you best focus on to leverage your core strengths and realize measurable financial returns? What capabilities are required to deliver on this strategy—and will you build them internally or partner/invest to acquire them? Have you considered all viable technical alternatives? How much of your internal rate of return (IRR) is driven by grants, subsidies, incentives, or tax benefits? If regulations change, how significantly may this affect your business case?
- **Form structured ecosystems to overcome potential barriers.** Although the case for sustainable manufacturing is growing stronger, significant barriers persist. Regulatory constraints, such as a lack of government incentives to make alternative energy more affordable, make it economically challenging for many manufacturers to pursue this path. Uncertainty around market mechanisms can stymie action (e.g., which comes first: EVs or the power grid?). Obstacles around financing and customer acceptance of unprecedented designs also frequently lead to inaction. And cultural impediments persist—from short-term thinking and difficulty measuring environmental impacts to concern about alienating a subset of customers or employees by taking a stance.

  This all speaks to the imperative of forming structured ecosystems to bring partners together—including manufacturers, industry associations, third-party providers, and regulators. To truly move the needle on sustainability outcomes, a coordinated approach is necessary—one that creates a virtuous circle, where all participants up the game (see example 5). Complexities unquestionably exist around how manufacturers can work together to address sustainability concerns. Yet the time for best efforts is now—before the manufacturing sector finds itself facing the type of existential threat that forced industries such as mining and oil and gas to explore collaborative solutions to their collective problems.

Example 5: Partnering to succeed

As part of its commitment to eco design—an approach that has seen it adopt energy-efficient solutions and make smarter material design choices—in 2020, Philips reportedly achieved its goal to become 100% carbon neutral. With sustainability as a key priority, the company also sources 100% of its electricity from renewable sources.

Not content to rest there, the company is looking for ways to collaborate with its suppliers and customers to magnify its impact. This includes working with customers to reduce emissions during product use, collaborating with suppliers to reduce emissions across the supply chain, and exploring ways to adopt circular economy principles. Philips is orchestrating local material use across its production sites, has embedded emissions in its material selections, and has shifted the conversation from waste management to resource management.

Looking forward, Philips hopes to drive systemic transformation towards a circular economy by stimulating the behavior of end consumers as well—and is already taking steps to inject greater rigor into the identification of functional metrics to track its progress. By adopting a transparent approach and prioritizing data reliability, the company hopes to drive industry-wide change across the ESG spectrum.

Reflect

- **Measure progress and create a clear market narrative.** With robust and accurate measurement systems, manufacturers can do more than simply measure the progress of their sustainability initiatives. They can also use those outputs to create a clear market narrative around the positive impacts they are driving—painting a powerful picture for investors and consumers alike, all the while improving transparency to stakeholders.
- **Play a role in shaping the dialogue.** Although some companies may be tempted to take a wait and see attitude around sustainability, this stance could be risky. Rather than waiting for public opinion to settle against you, it may make sense to work proactively with associations to develop an industry point of view that helps shape opinion.
- **Think through unintended consequences.** In the quest to improve environmental performance, it's important to examine the downside implications of your decisions as well. For instance, while EVs have the potential to reduce automotive emissions, the benefits may be diminished by the environmental impacts associated with the mining and manufacture of battery minerals. True progress mandates the adoption of a lifecycle approach.

  Better yet, identify the future in which you hold advantage and act quickly to catalyze outcomes that increase the likelihood of that future coming true. In the face of uncertainty, the best leaders understand that the instinct should not be to analyze more (by definition, a retrospective exercise) but rather to act faster and in smaller increments.

By focusing on long-term outcomes, working collaboratively with industry stakeholders, and adopting a deliberate and coordinated approach, manufacturers have the capacity to realize significant benefits on the road towards sustainability. These extend from improved competitiveness and efficiency, to reduced costs and risks. Yet the true measures of success will pervade well beyond the shop floor. By driving measurable sustainability outcomes, manufacturers also have the power to create lasting social value.

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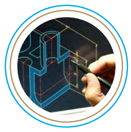




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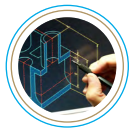




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