

# SUSTAINABLE OPERATIONS

A comprehensive guide  
for manufacturers



# INTRODUCTION

Sustainability and climate change are top of the global agenda – a critical theme at the heart of key business and political discussions, such as the 2020 WEF at DAVOS,<sup>1</sup> the G20 summits,<sup>2</sup> COP25,<sup>3</sup> the US presidential debates,<sup>4</sup> as well as COP26. The manufacturing sector has also embraced this critical topic and is taking steps to become more sustainable. Today, successful manufacturers understand that environmental responsibility not only meets the needs of the planet and wider society, it is also an integral part of the entire manufacturing value chain and delivers significant business opportunities and benefits.

To understand where the manufacturing sector currently stands in terms of sustainability in operations, we launched a comprehensive research program among large manufacturers, surveying 480 executives from the business-facing side of organizations and 480 executives from sustainability functions. The sub-industries surveyed include

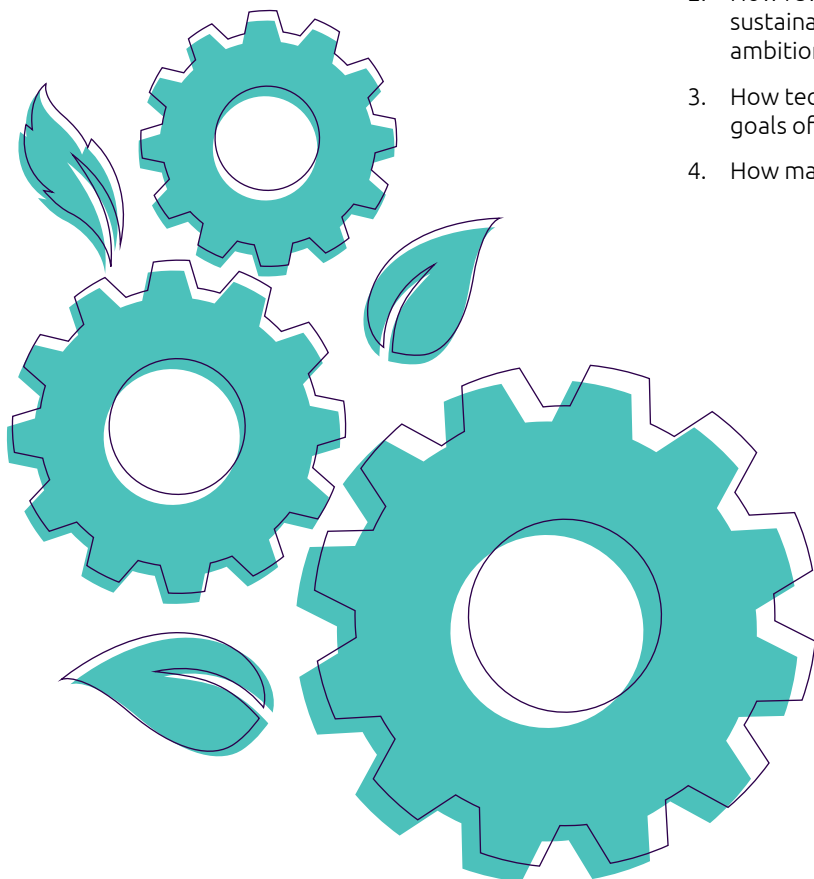
aerospace and defense, automotive, industrial and capital goods, high-tech, consumer products, pharmaceuticals, and medical devices manufacturing. In addition, we conducted one-on-one interviews with a range of sustainability leaders at major manufacturers.

This research focuses on the environmental pillar of sustainability and addresses a number of key questions:

- Are organizations' approaches comprehensive enough, with action across the full value chain from procurement to end of life?
- Are manufacturers embracing all the weapons in the sustainability armory, from reducing waste to re-manufacture?
- How can executives exploit the potential of technology to sustainability progress?

This research report offers answers to these key questions and examines four themes:

1. What "sustainable manufacturing" is and why it constitutes a major opportunity for manufacturers
2. How few organizations are on track to become sustainable manufacturers, despite the sector's high ambitions
3. How technology is helping manufacturers to meet the goals of their sustainability agenda
4. How manufacturers can reach their sustainability goals.



# EXECUTIVE SUMMARY

## – KEY TAKEAWAYS

Growing concerns about climate change, its impact on the planet and its resources raises a crucial question: how do we balance industrial growth and economic prosperity with the environmental impact of manufacturing? This extensive research program examines where the manufacturing sector stands today in terms of sustainable operations and how it can accelerate progress.

### Our key findings include:

#### **Many manufacturers see significant benefits from sustainability.**

- Sustainable manufacturing is about a comprehensive 6R approach that covers a range of areas: Reduce, Recycle, Reuse, Recover, Redesign, and Remanufacture.
- More than eight in ten organizations say that they have enhanced their brand reputation and improved their ESG rating; nearly eight in ten saw an improved efficiency and productivity and more than half reduced packaging costs and increased sales.
- Reducing waste is the biggest environmental priority for manufacturers (71% of respondents), alongside emission footprint (62%).

#### **Manufacturers have set high ambitions but only a few are on track to become sustainable manufacturers.**

- Organizations aim to achieve significant milestones by 2040:
  - 91% aim to achieve 100% renewable electricity and 87% aim to be carbon-neutral.
  - On average, organizations aim to reduce their plastic usage by 55%, while 94% of organizations expect to achieve zero waste for over two-thirds (68%) of their operations by 2040.
- However,
  - Just 51% of organizations aim to align target with the goals of the Paris Agreement.
  - Only 11% of the sustainability initiatives that are launched are actively being scaled across the organization.
  - Only 10% of manufacturers focus on the holistic 6R approach demanded by truly sustainable manufacturing.

#### **Technologies and data are critical to accelerating sustainability agenda.**

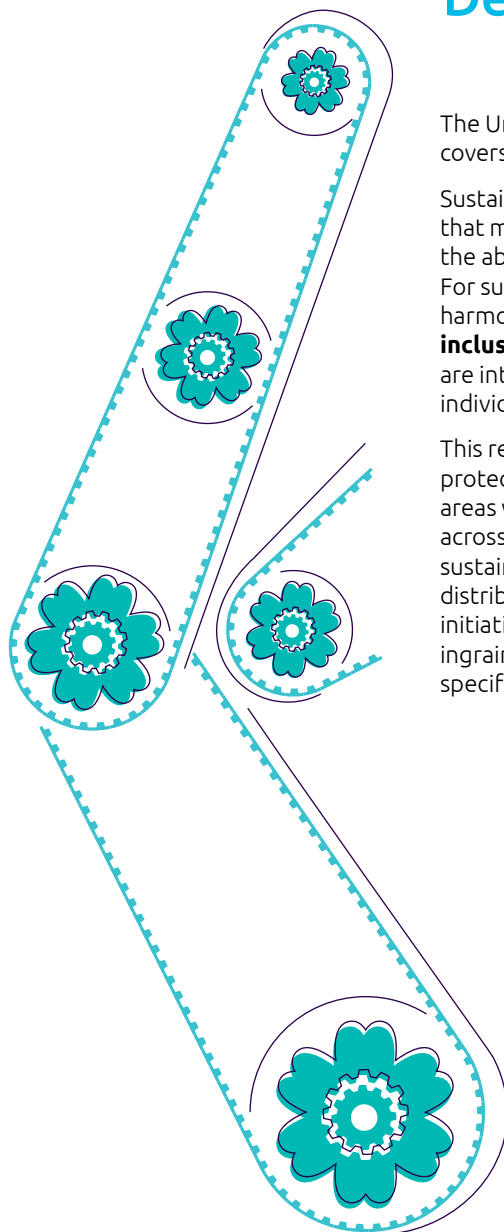
- More than half of the manufacturers have prioritized the deployment of technologies to meet their sustainability agenda and drive economic growth.
- Automation, followed by AI/machine learning and data analytics are the most widely adopted technologies.
- Innovation, driven by technology and data, will help manufacturers in improving sustainability while also ensuring profitable growth.

#### **Based on the analysis, we believe there are five best practices for manufacturers:**

- Align business teams and sustainability executives to explain synergies between performance and sustainability, and anchor the joint agenda.
- Work with customers and suppliers to reduce indirect emissions.
- Build transparency through effective reporting and ensure accountability.
- Incorporate sustainable ways-of-working and operating culture.
- Invest in technology and data-driven innovation to ensure sustainability goes hand in hand with profitability.

# 1. WHAT SUSTAINABLE MANUFACTURING IS AND WHY IT IS A MAJOR OPPORTUNITY FOR ORGANIZATIONS

## Defining sustainable manufacturing

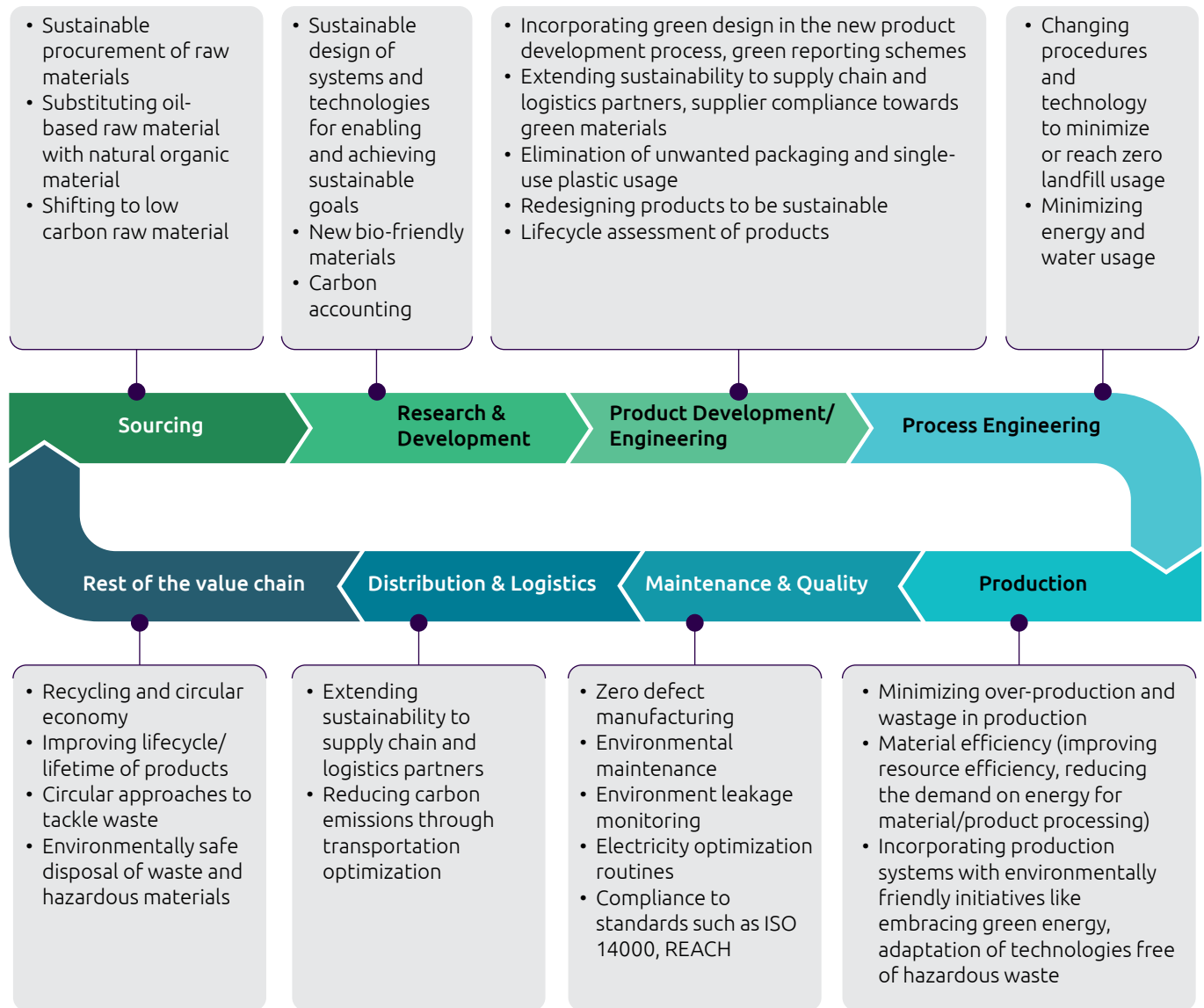


The United Nations definition of sustainable manufacturing covers three important aspects of sustainability:

Sustainable development has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. For sustainable development to be achieved, it is crucial to harmonize three core elements: **economic growth, social inclusion, and environmental protection**. These elements are interconnected, and all are crucial for the well-being of individuals and societies.<sup>5</sup>

This research focuses in particular on the “environmental protection” pillar. As Figure 1 shows, we identified the critical areas where environmental sustainability is implemented across manufacturing operations. These range from sustainable sourcing of raw materials to a sustainable distribution and logistics channel. For a sustainability initiative to deliver maximum rewards, it is important it is ingrained across the entire value chain rather than limited to specific parts.

**Figure 1. Sustainable manufacturing practices across the manufacturing operations value chain**



In the above figure, “Rest of the value chain” covers product usage, disposal, and circular economy components.

Source: Capgemini Research Institute analysis.

Jim Andrew, chief sustainability officer, PepsiCo, outlined how he strives to ensure that sustainability is embedded across all processes in PepsiCo: *“A big focus of the ‘Sustainable from the Start’ program is reducing GHG emissions, sure, but also things like discouraging the use of non-recyclable packaging, because that’s really important. I think that’s one of the real keys to make sustainability work. You got to embed it in the business strategy, the business processes, and the actions everybody takes every day. So, we’re looking at where there are business processes where we can embed sustainability.”*<sup>6</sup>

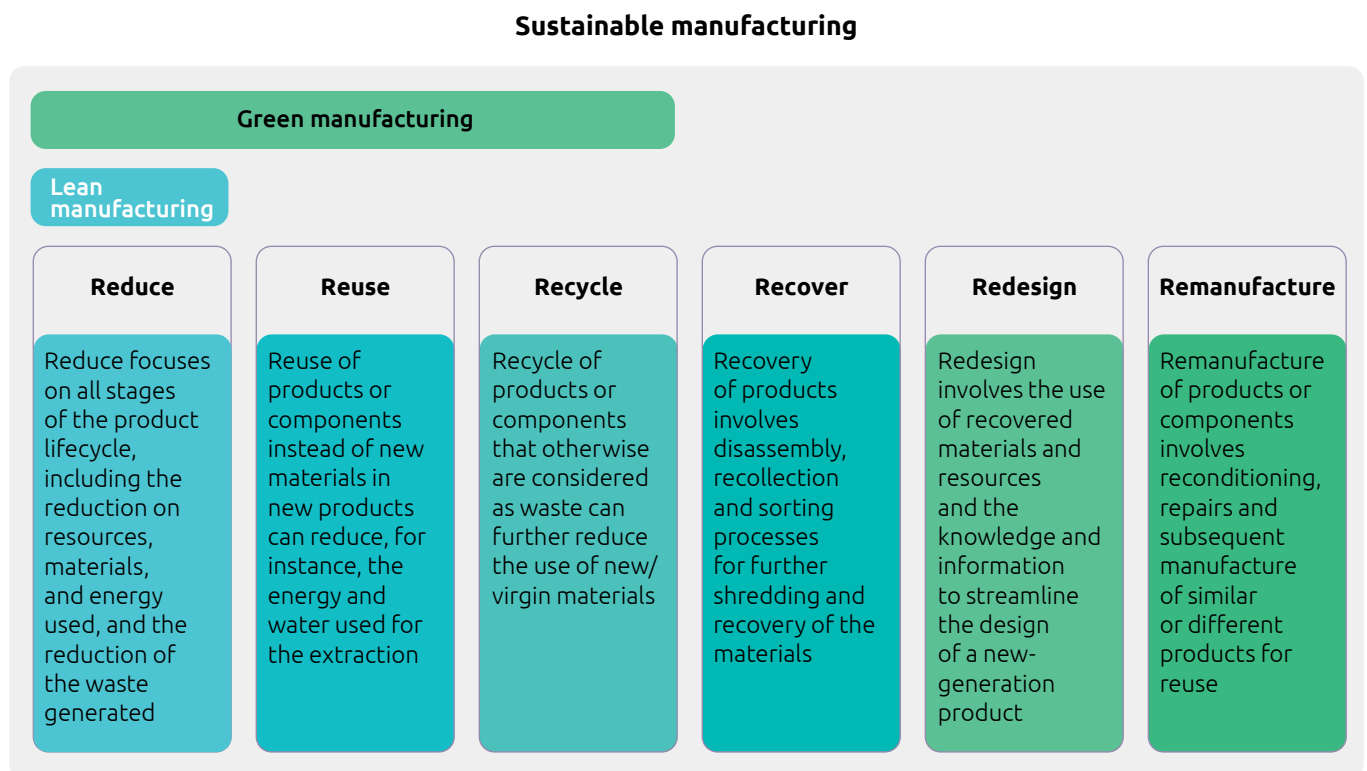
It is also important to note that sustainable manufacturing is different and more comprehensive than traditional manufacturing practices, such as lean or green manufacturing. As Figure 2 shows, sustainable manufacturing takes a comprehensive 6R approach – Reduce, Recycle, Reuse, Recover, Redesign, and Remanufacture – rather than just focusing on “Reduce” (waste elimination) or the three Rs – “Reduce,” “Reuse,” and “Recycle” (commonly referred to as green manufacturing).<sup>7</sup>



*I don't believe you can prioritize any of the 6R's; all of them are equally important. While some R's like reduce, reuse or recycle can still be short-term priorities for organizations, the remaining three R's are very important medium- to long-term priorities."*

**Ramnath Vaidyanathan**  
Head of sustainability at Godrej Industries

**Figure 2. A description of the 6Rs of sustainable manufacturing**



Source: Badurdeen, Fazleena & Jawahir, I.s. (2017). Strategies for Value Creation Through Sustainable Manufacturing.

Ramnath Vaidyanathan, head of sustainability at Godrej Industries, highlights the importance of embracing a sustainable manufacturing outlook, saying: *"I don't believe you can prioritize any of the 6Rs; all of them are equally important."*

*While some Rs such as reduce, reuse, or recycle can still be short-term priorities for organizations, the remaining three Rs are very important medium- to long-term priorities."*<sup>8</sup>

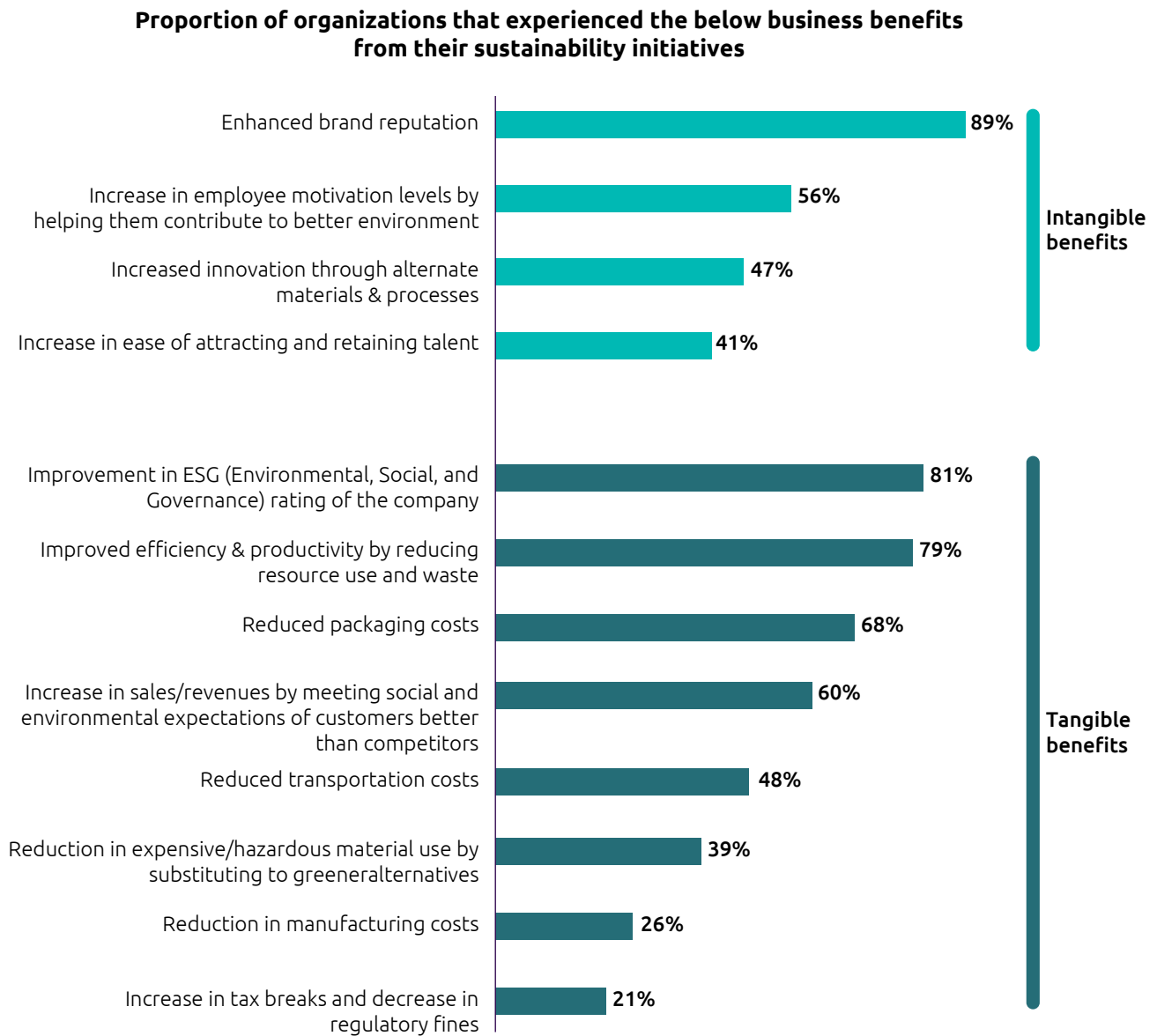
# Sustainability initiatives are driving economic as well as environmental goals

## Business benefits from sustainability

It is a widely held misbelief that implementing sustainability initiatives comes at the cost of profitability. Our research, however, shows that most organizations are seeing monetary and non-monetary benefits from sustainability initiatives (see Figure 3):

- **Enhanced brand reputation and improvement in ESG rating:** More than eight in ten organizations say that they have experienced an enhanced brand reputation and an improvement in the ESG (environmental, social, and governance) rating of the company.
  - A meta-study of 200 academic studies and sources on sustainability by Oxford University and Arabesque Asset Management found a remarkable correlation between sustainability practices and economic performance - 88% of the research shows that solid ESG practices result in better operational performance of firms.<sup>9</sup>
  - Further, a number of third-party rating agencies such as Bloomberg ESG Data Service, Dow Jones Sustainability Index etc. assess organizations on their ESG performance. Institutional investors, financial institutions and other investors are increasingly using these ratings as the basis for informal and shareholder proposal-related investor engagement with these organizations.<sup>10</sup>
- **Reduced cost of capital:** 90% of the reviewed sources on the cost of capital, from the meta-study mentioned above, show that sound sustainability practices lower the cost of capital of companies. For instance, banks such as ING Groep NV have structured loans in a manner which allows borrowers to have a lower interest rate on their loans if they improve their sustainability targets and other metrics.<sup>11</sup>
- **Improved efficiency:** Nearly eight in ten organizations surveyed reported an improved efficiency and productivity.
  - Sky Breathe, a platform that uses Big Data, AI and machine learning, to analyze flight data and identify opportunities for efficiency improvement saved USD 150 million and 590,000 tonnes of CO<sub>2</sub> for Norwegian Airlines, Go Air and others in 2019. Air France, as a part of its aim to reduce the CO<sub>2</sub> emissions by half by 2030, announced the use of this platform and is expecting to reduce its total fuel consumption by up to 5%.<sup>12</sup>
  - Consumer products giant Unilever is making use of digital twins at a facility in Brazil to make production more efficient. The company used the digital twin to set manufacturing parameters; for example, parameters for the temperature at which soap is pushed out before being cut into bars. The project resulted in a savings of \$2.8 million by reducing energy usage and improving productivity by 1% to 3%.<sup>13</sup>
- **Reduced costs:** More than half of the organizations surveyed reduced packaging costs. Allan Dickner, range engineering leader packaging at IKEA, has outlined how the organization has reduced its packaging costs by implementing sustainability initiatives: *"During the last ten years, we have reduced the share of plastic packaging material from 12% to 7%, of the total amount of packing material which is the equivalence of a saving of 60,000 tons a year. If we continue to work the same way as today by replacing the plastic packaging material with more sustainable sources, preferably fiber-based materials, it will help us decrease the amount of plastic packaging material to around 3% by 2030."*<sup>14</sup>
- **Increased sales:** Our research on consumer preferences for sustainability showed that 79% of consumers have either changed or may change their purchase preferences based on the social, economic, or environmental impact.<sup>15</sup> This allows organizations to potentially charge a premium for sustainable products.
- In addition to the above, organizations can also rely on tax incentives from governments for their sustainability projects.

**Figure 3. Proportion of organizations seeing business benefits from their sustainability initiatives**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Business executives survey, February–March 2021, N=480 business executives.



When we looked deeper into what sort of return they delivered, the answer was a significant uptick in performance. For example, organizations that were able to reduce resource waste and usage saw a 6% improvement in productivity and efficiency.

As a result of these strong business benefits, a number of organizations are increasingly focusing on sustainable products and service lines and are also realizing higher growth rates from these. Examples include:

- Consumer products giant Unilever has identified that the seven brands with the highest turnover in the company – Dove, Knorr, Persil/Omo, Rexona, Lipton, Hellmann's, and Wall's – are all "Sustainable Living Brands," which contribute to achieving the company's ambition of halving its environmental footprint by 2030 and increasing its positive social impact. These brands have grown 69% faster than the rest of the business.<sup>16</sup>
- At Philips, the Dutch multinational conglomerate, Green Products and Solutions amounted to 71% of total 2020 revenues, while 15% comes from circular economy products and solutions. Revenues in these two areas have been growing aggressively every year: an increase of 6% YOY compared to 2019 for green products and 15% YOY compared to 2019 for circular products and solutions (circular products are those that meet specific circular economy requirements).<sup>17</sup>
- Danfoss has created the Danfoss Climate Solutions segment, which is a merger of heating and cooling solutions along with technology such as IoT, cloud, and other digital technologies. The aim of this segment is to accelerate climate solutions to urban development, data centers, and industries. This segment today accounts for £2.5 billion in revenues and 43% of Danfoss revenues for the FY2020.<sup>18</sup>
- In 2014, \$2.6 billion of DuPont's annual revenue was from products that create energy efficiency and/or significantly reduce greenhouse gas emissions.<sup>19</sup>

## How innovation is driving sustainability and economic growth

Highlighting the need for innovation to tackle environmental sustainability, John Reilly, co-director, MIT Joint Program on the Science and Policy of Global Change says, *"By this time industries are aware that greenhouse gas emissions that they release are affecting the climate. It will be critical for organizations to think innovatively including with the use of emerging technologies such as AI, to harness their climate actions."*<sup>20</sup>

Digital technologies are driving innovation and bringing benefits to manufacturers across various parts of the value chain:

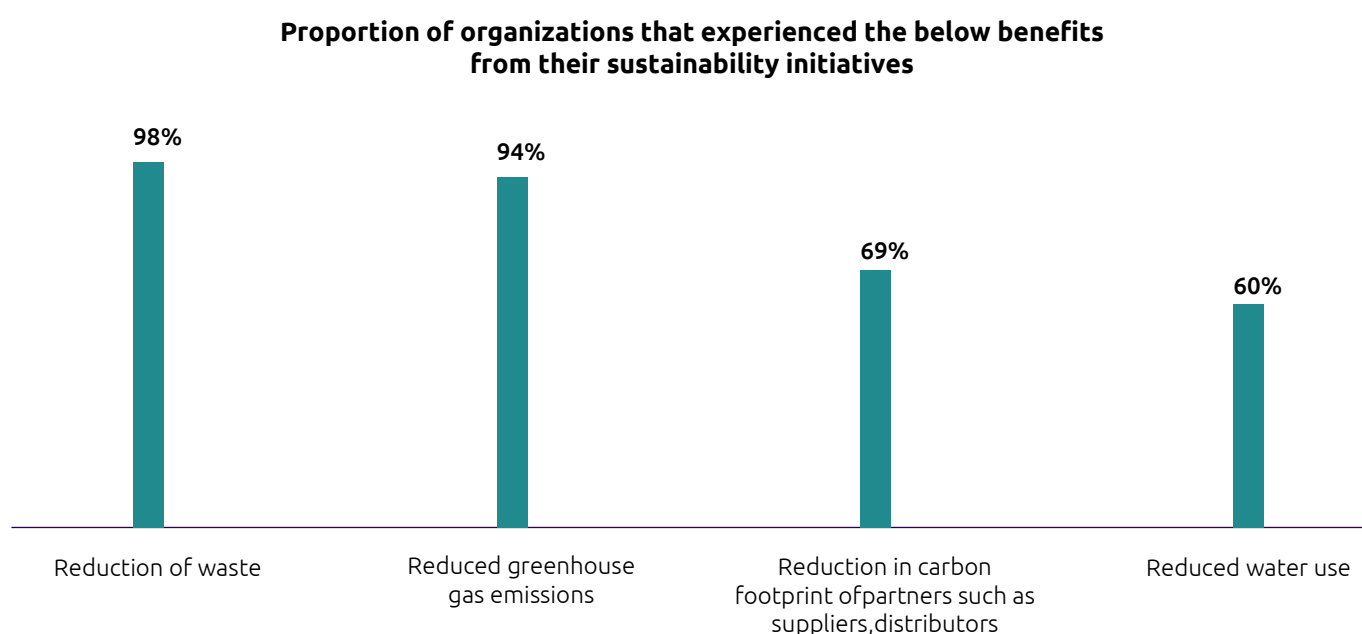
- **Product innovation:**
  - General Motors uses generative design in its product design to explore multiple permutations of a part design so as to arrive at the best possible option. It was found that General Motors was able to achieve a 40% weight reduction on a new seat belt bracket with this approach. Since 2016, GM has launched 14 new vehicle models with a total mass reduction of more than 5,000 lbs resulting in lighter and more efficient cars.<sup>21</sup>
- **Process innovation:**
  - German manufacturing giant Bosch has deployed an AI system for its manufacturing facilities. With the system, an in-house energy platform uses intelligent algorithms to identify deviations in energy consumption. This has enabled some of Bosch's plants to reduce their CO<sub>2</sub> emissions by more than 10 percent over two years.<sup>22</sup>

## Achieving environmental sustainability goals

Our research shows that more than nine in ten organizations have seen a reduction in waste and greenhouse gas emissions

(see Figure 4), while more than one in two has seen a reduction of carbon footprint of their partners and reduction in water use.

**Figure 4. Proportion of organizations that experienced the below benefits from their sustainability initiatives**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, February–March 2021, N=480 sustainability executives.

Many organizations have seen a tremendous improvement in all these parameters in recent years. If we take Philips as an example:

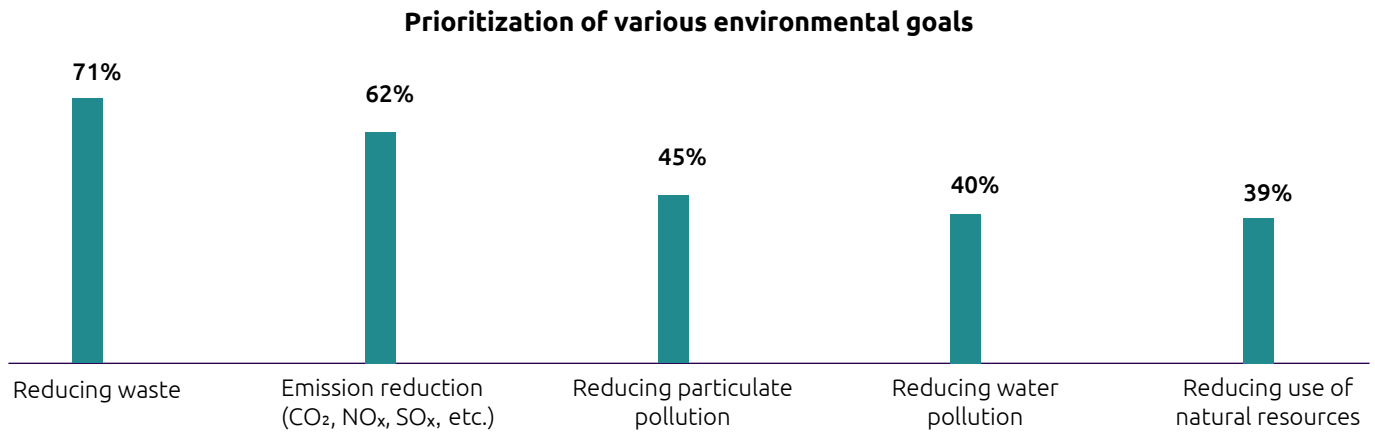
- Compared to 2016, greenhouse gas emissions from manufacturing operations have been cut by 76%.
- Water consumption has been reduced by 20% from 2015 levels.<sup>23</sup>

### Waste reduction and emission reduction are the top environmental priorities

It is perhaps no surprise that reducing waste and emissions reductions are the biggest environmental priorities for organizations (as Figure 5 shows, these are a priority for 71% and 62% respectively):

- The focus on emissions reflects the fact that most large organizations recognize that climate change is a serious threat and are leading the transition to a low-carbon economy.
- Reduction in waste is attractive because it saves costs.

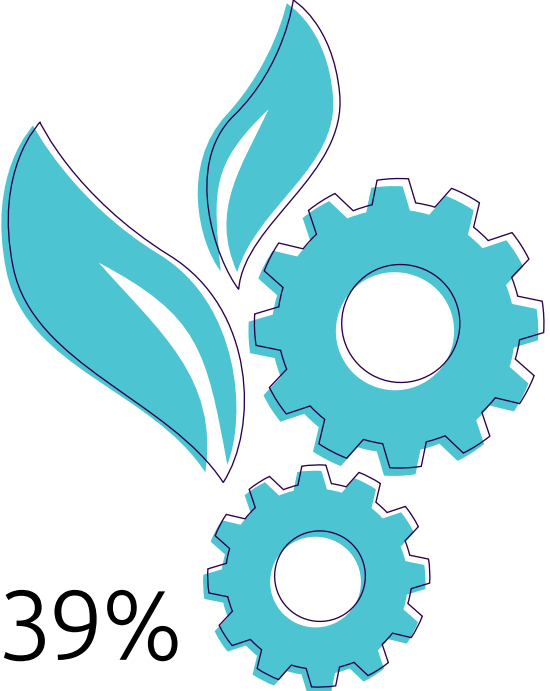
**Figure 5. Prioritization of various environmental goals**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, Business executives survey, February–March 2021, N=480 organizations.

Reducing particulate and water pollution are a priority for 45% and 40% respectively. Air pollution, for example, causes seven million deaths worldwide every year and meeting the goals of the Paris Agreement could save about a million lives a year worldwide by 2050 through reductions in air pollution alone.<sup>24</sup> The relatively fewer proportion for conserving natural resources could be partly explained by the fact that there are no specific financial penalties addressing this area.

It is clear though that these are important initiatives for the world and that the sector is determined to drive improvement. However, in the following section, we look at how many organizations in the sector are not on track to achieve their ambitious goals.

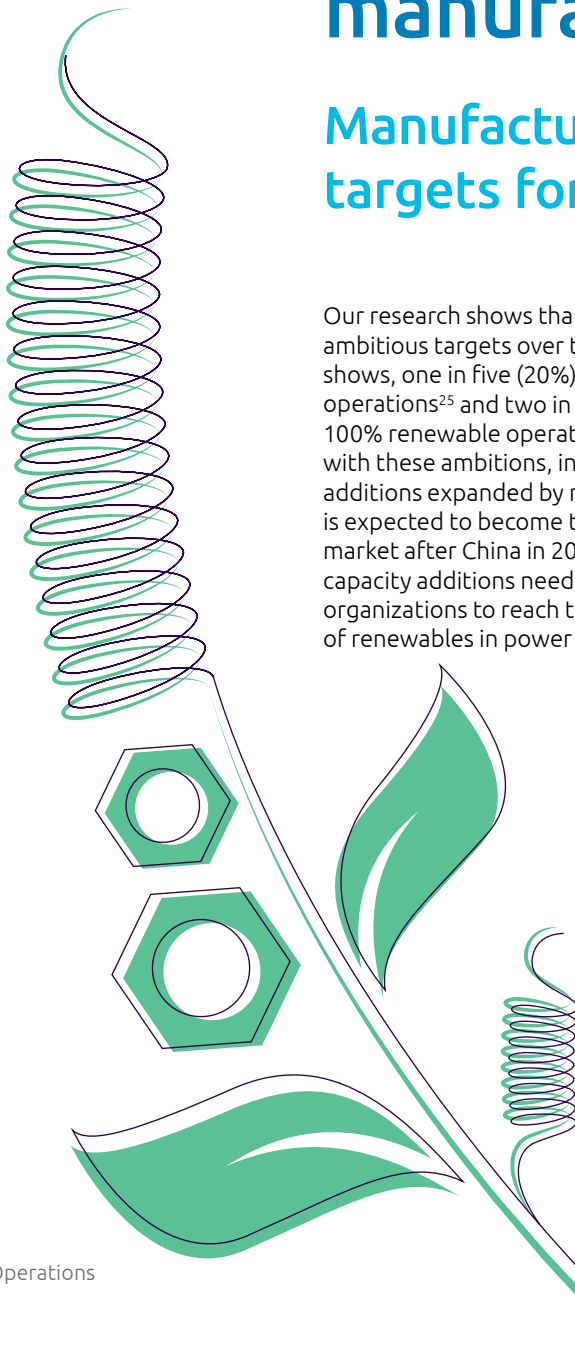


Just **39%**  
of organizations consider reducing  
use of natural resources as an  
environmental priority

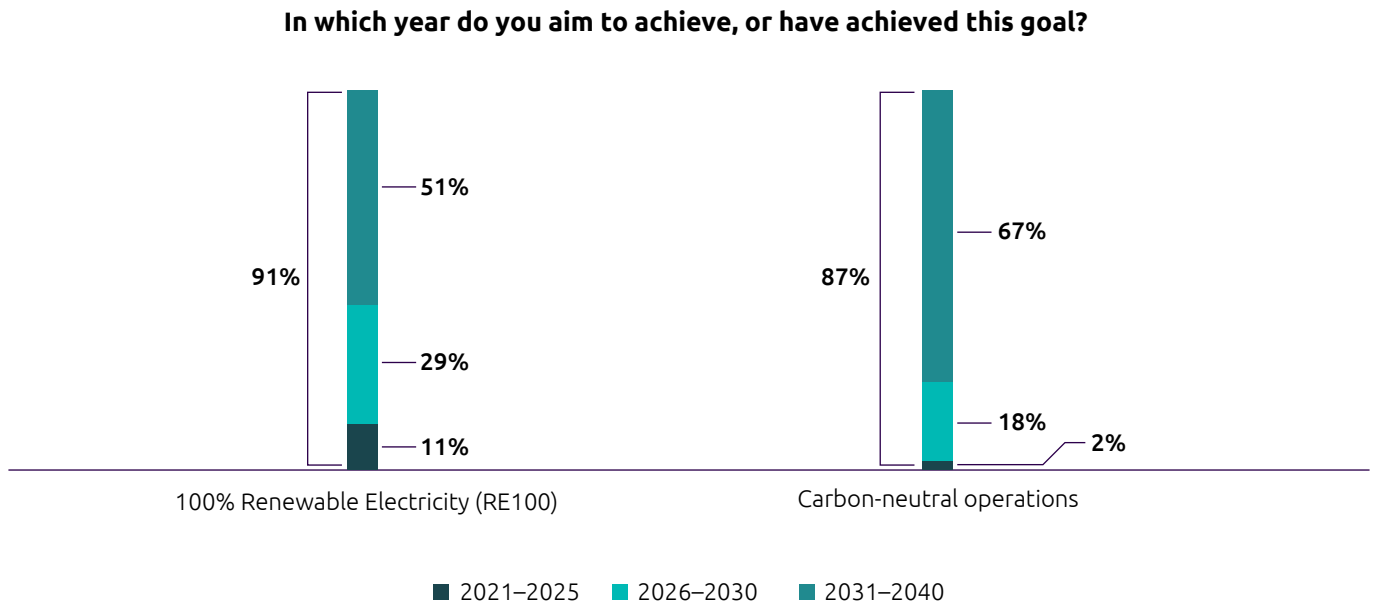
## 2. Despite high ambitions, few organizations are on track to become sustainable manufacturers

### Manufacturers have set ambitious targets for the next decade

Our research shows that manufacturers have aimed for ambitious targets over the coming decade. As Figure 6 shows, one in five (20%) are aiming for carbon-neutral operations<sup>25</sup> and two in five (40%) have set their sights on 100% renewable operations by end of this decade. In line with these ambitions, in 2020, global renewable capacity additions expanded by more than 45% from 2019 and Europe is expected to become the second-largest renewable power market after China in 2021.<sup>26</sup> However, the rate of annual capacity additions needs to grow at a higher pace for the organizations to reach their ambitions considering the share of renewables in power generation is only at 27% for 2019.<sup>27</sup>



**Figure 6. Manufacturing organizations have ambitious sustainable goals**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, February–March 2021, N=480 sustainability executives.

Targets are also ambitious in other areas. By 2040, manufacturers on average aim to reduce their plastic use

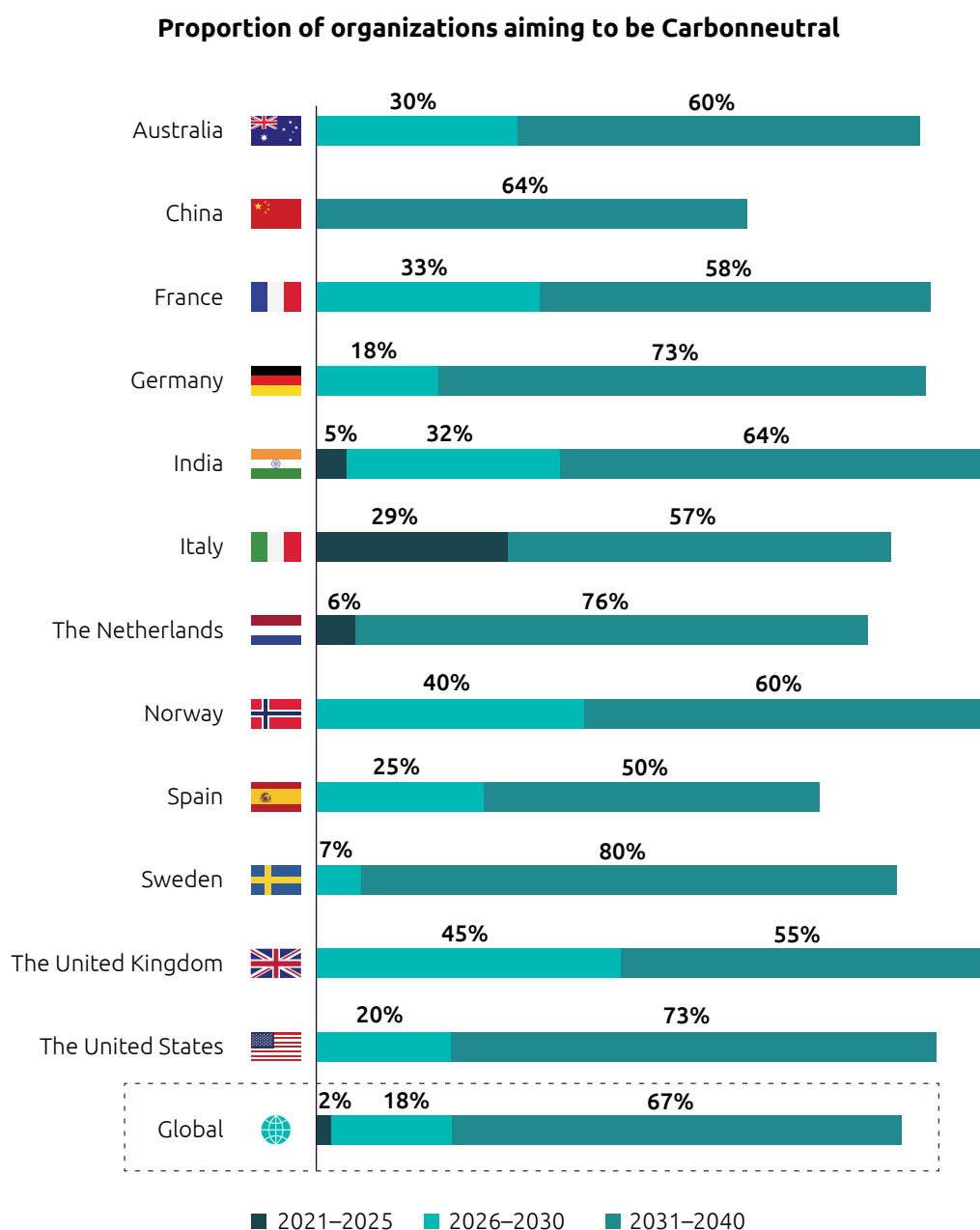
by 55%. Within the same time frame, 94% of organizations expect to achieve zero waste for 68% of their operations

## However, only half of manufacturers aim to align with the Paris Agreement

Aggressive ambitions may be challenged by wider trends and issues. This is clear when we look at goals at a country level. As Figure 7 shows, 29% of Italian manufacturers in our survey want to be carbon neutral before 2025. However, we know that 10% of the carbon footprint comes from power utilization. In 2018, 79% of Italy's grid was still based on carbon-intensive fossil fuels.<sup>28</sup> Therefore, carbon-neutral

operations would require considerable offsetting and effort. As regions such as the EU aim to be carbon-neutral by 2050, organizations as well as governments must take definitive actions (through regulation and legislation aimed at reducing the sector's carbon intensity) towards achieving carbon neutrality.

**Figure 7. Carbon-neutral ambitions by country**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, February–March 2021, N=480 sustainability executives.

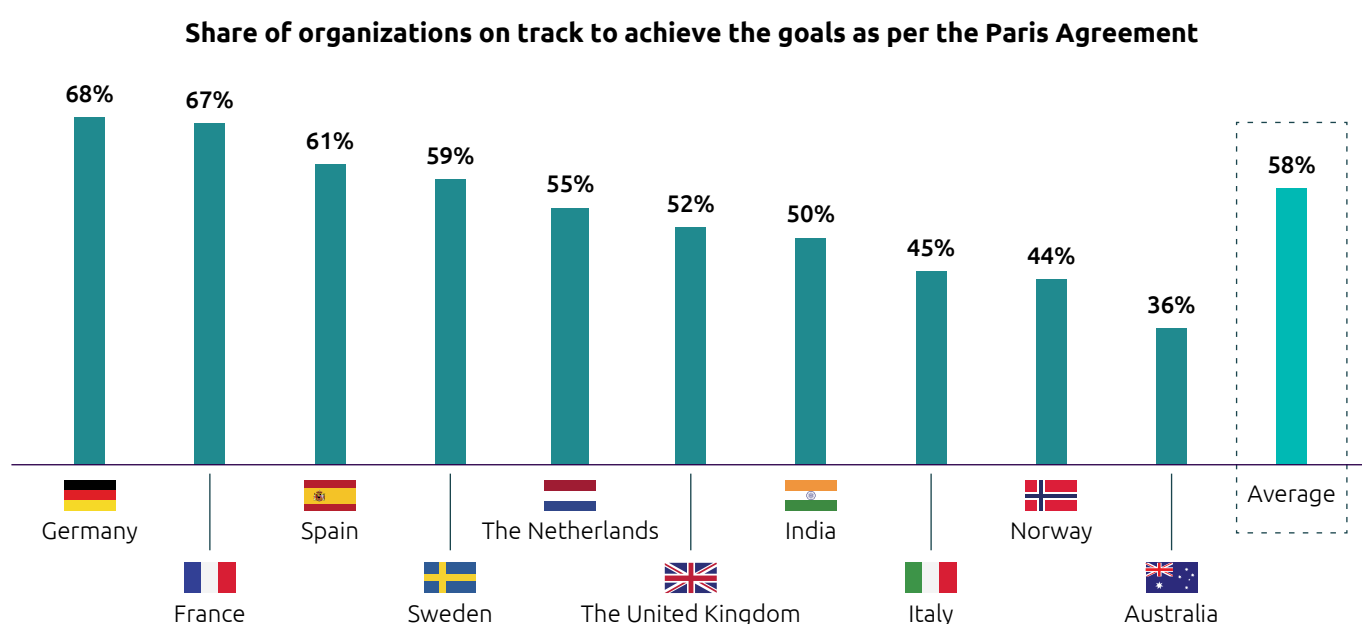
In addition, there is the question of the extent to which companies are aligning with the pathway to tackle climate change that national governments committed to in the Paris Agreement. The agreement aims to limit the global temperature increase in this century to 2°C above pre-industrial levels while pursuing the means to limit this increase to 1.5°C.<sup>29</sup> In our research we found that only 51% of organizations aim to align with the target for the Paris Agreement temperature contribution:

- Within this cohort, 76% of organizations say they are using science-based targets, which is essential and critical to ensure transparency and that carbon accounting standards are followed.
- Our survey also shows that 58% of the aligned organizations are on track to achieve the targets set out in the agreement. Within the EU, Germany (68%) and

France (67%) lead the pack when it comes to achieving the targets (see Figure 8). The European Commission – the executive branch of the European Union – is considering a set of initiatives, under the European Green Deal, with the overarching aim of making Europe climate neutral in 2050. Through regulation and legislation and massive investment, this deal will have overarching targets – a bloc-wide goal of net zero carbon emissions by 2050, and a 50%–55% cut in emissions by 2030 (compared with 1990 levels).<sup>30</sup>

- When we conducted our field research (February–March 2021), none of the organizations in either China or US were looking at achieving alignment with the goals of the Paris Agreement. However, since the US rejoined the agreement in February, we can expect the organizations in the US to reconsider their objectives.

**Figure 8. Countries in the EU are leading the way in achieving the Paris Agreement goals**



The above chart lists only those countries with organizations aiming to align with the temperature objective of Paris Agreement. During February–March when we conducted our research, none of the organizations in China and the US were planning to align with the goals of the Paris Agreement.

Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, February–March 2021, N=245 sustainability executives from organizations that aim to align with temperature objective of the Paris Agreement.

## Comprehensive focus on sustainability is lacking, with the majority focusing on lean manufacturing

In this report, we characterize manufacturers' environmental efforts in terms of three types:

- Lean manufacturing (focused on Reduce)
- Green manufacturing (Reduce, Reuse, Recycle)
- Sustainable manufacturing (holistic approach across all six Rs).

As Figure 9 shows, close to two-thirds (64%) pursue lean manufacturing with a focus on waste elimination. Manufacturing has a long focus on reducing use of materials based on lean manufacturing. A good example of this is the Toyota Production Systems and six sigma methodologies for improving product quality and thereby reducing waste.<sup>31</sup> This has been mostly driven by economic considerations and a drive for efficiency.

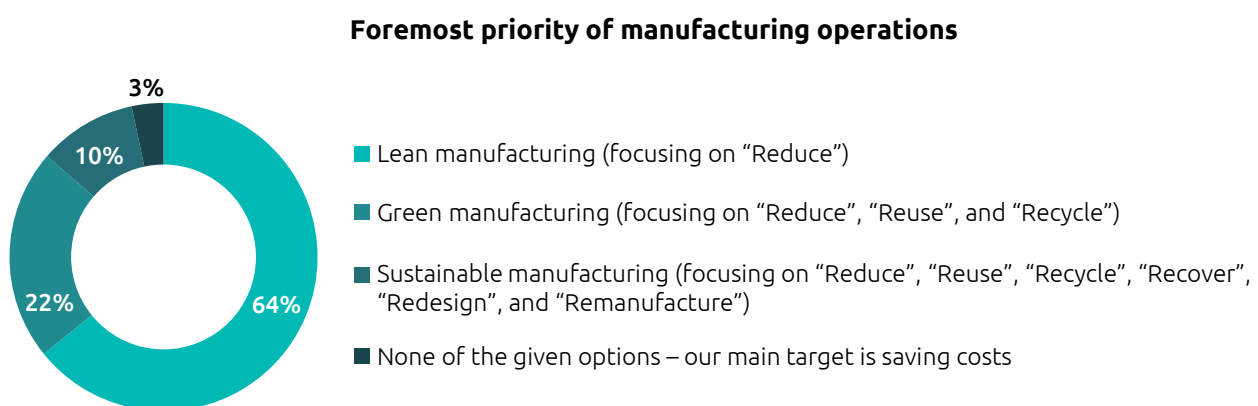
Ahead of this Lean cohort, 22% have incorporated reuse and recycle practices. This incorporates excess by-products and

scraps back into the input cycle. Jaguar Land Rover recycled 300,000 tons of aluminum scrap between September 2013 and January 2019, thereby reducing its virgin aluminum needs. (Virgin aluminum has an exceptionally large footprint due to its power intensive refining process.<sup>32</sup>)

The final cohort (10%) focus on the holistic approach of sustainable manufacturing. This includes incorporating circular economy principles within the manufacturing process, such as Jaguar Land Rover's REALITY aluminum project. The organization reuses and upcycles aluminum from end-of-life products such as cars and household appliances back into their cars. This not only delivers a further 26% reduction in the carbon footprint of aluminum use, it also enables the reduction of landfill waste, thereby closing the circular economy loop.<sup>33</sup>

In "Sustainability in action" we outline a number of initiatives across Recover, Redesign, and Remanufacture.

**Figure 9. Most manufacturers are still focused on traditional lean manufacturing**



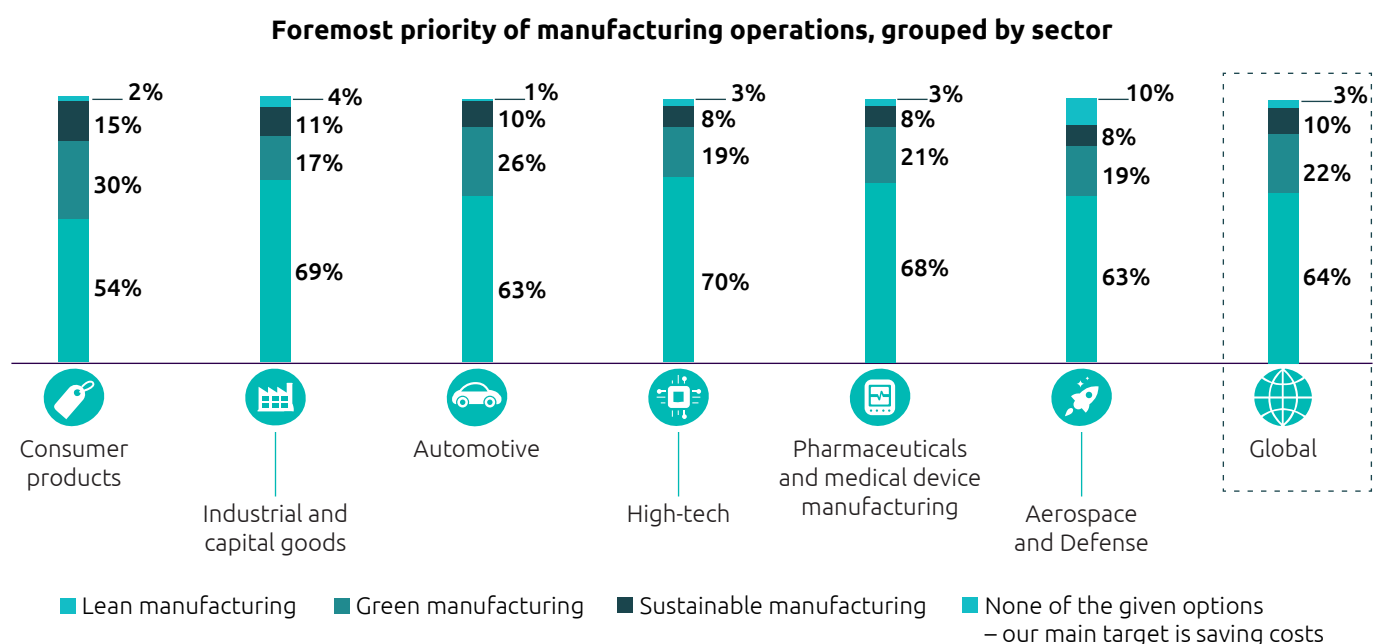
Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, Business executives survey, February–March 2021, N=480 organizations.



As Figure 10 shows, the consumer products sector is the leading adopter of sustainable manufacturing (15% prioritize it), and aerospace and defense are the main laggards (only 8% make it a priority). Overall, only a minority prioritize the

approach, and further, a mere 40% of executives say their initiatives are widespread and encompass all aspects of manufacturing operations.

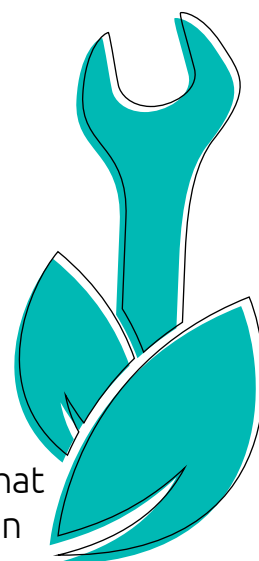
**Figure 10. Organizations that pursue a comprehensive sustainable manufacturing approach are in the minority**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, Business executives survey, February–March 2021, N=480 organizations.

15%

Percentage of consumer products organizations that are holistically focusing on sustainability



# Sustainability in action

## Recover: Sanofi's recovery program

Product recovery ensures that when a product reaches the end of its lifecycle, its disposal does not represent a burden on the environment. Medical wastes can pose a significant threat, not only by degrading the environment but also to people from inadvertently communicating diseases.

To address this issue, Sanofi pursues an ecological alternative to processing end-of-life products that promotes recovery of products and waste:

- It systematically collects many types of waste – such as sharps (any device or object used to puncture or lacerate the skin) or medicines – for recycling or recovery by local waste managers.<sup>34</sup>
- Since many patients self-administer injections and medicines at home, Sanofi promotes proper use of medicines and their safe-disposal techniques. It also participates in unused medicines take-back programs to ensure safety during disposal processes and recovery.
- Sanofi contributes to the protection of natural resources and local ecosystems by providing support for targeted local take-back programs to collect unused medicines. In

France, Sanofi is the largest contributor (€1.8 million in 2018) to an unused medicines collection program called Cyclamed and a major contributor to a DASTRI program for the collection and safe disposal of “sharps” (needle, lancets, infusion sets, etc.) after use by individuals, mainly people with diabetes.<sup>35</sup>

This is part of Sanofi's wider goals as embodied in its “Planet Mobilization” environmental strategy. This has two complementary objectives for 2025: (1) reach a recovery rate greater than 90% and (2) lower the landfill rate to 1%.<sup>36</sup>

This initiative delivers significant benefits. A significant proportion of Sanofi industrial waste (45%) is recycled, representing 119,000 tons in 2018.<sup>37</sup>

Sanofi also recovers and reuses the solvents used in the process of manufacturing their products. In 2019, Sanofi was able to recover and reuse 120,000 tons of solvents.

At the end of 2019, the waste recovery rate reached 75% and landfill rate is 8%. The recovery rate for hazardous waste is 68%.<sup>38</sup>

## Redesign: Nike

It is understood that up to 80% of a product's environmental impact over its lifecycle is determined during the design phase.<sup>39</sup>

Nike has been redesigning its products using materials that mitigate the negative impact on the environment.<sup>40</sup> Almost 70% of its products' environmental impact is due to the materials used in manufacturing. Golnaz Armin, a senior design director at Nike, says: *“That's an end-to-end impact. It's about the water that goes into all the cottons that we grow, that goes into our t-shirts. It's about the energy that it takes to dye fabrics or print on them. Every detail, every aspect of the cycle of the materials, from the raw materials to the finished product matters – and it has a huge impact when you add them up. It is really important to start fundamentally thinking about materials if we really want to make our product better.”*<sup>41</sup>

Nike launched its “Move to Zero” initiative in 2019 to reduce its environmental impact and product design and material usage features heavily in the initiative.<sup>42</sup> In the same year, Nike launched a new design movement named “The Space Hippy.” This is where shoes are designed using fully recycled uppers and soles made from plastic scraps, which are left undyed to further reduce materials use.<sup>43</sup> Nike has developed its own NIKE Materials Sustainability Index (MSI). This allows the company to choose better materials by comparing 57,000 different materials from more than 700 vendors. Moving up the value chain, Nike has a target of sourcing 100% of its material from vendors that meet sustainability criteria.<sup>44</sup>

This initiative has delivered significant results:<sup>45</sup>

- Nike's selective use of material in product design ensured their transition from conventional cotton to sustainable cotton<sup>46</sup> in apparel design. Their sustainable materials strategy is focused on converting the top volume materials to more sustainable options by focusing on maximizing recycled and organic content. Nike sourced 86% of its cotton more sustainably, saving over 53 billion liters of water and used over 200,000 kilograms fewer pesticides than traditionally sourced cotton.
- By 2019, Nike had converted large volumes of key shoe components to 100% sustainable materials. The company is also developing new recycled polyester and leather alternative options that can potentially be incorporated across the product line, including synthetic leathers, socks, laces, linings, and sock liners. Over 28,000 metric tons of carbon were avoided through the use of recycled polyester in Nike footwear. Recycled polyester has a 30% lower carbon footprint than virgin polyester.
- In 2019, Nike has diverted one billion bottles from landfills and waterways by using recycled polyester in their products.

## Remanufacture: Ford's remanufacturing technique

The "Ford Core Recovery Program" oversees collection, remanufacturing, and recycling of damaged parts from Ford vehicles.<sup>47</sup> A new addition to this includes remanufacturing engines. Remanufacturing an engine moves it from single to multiple lifecycles by rebuilding a new engine from reused, repaired, or reused parts. An old engine that might go to scrap or be reused with lower efficiency is remanufactured with specifications similar to the original engine.

Traditional engine remanufacturing techniques are expensive, requiring new parts, intricate machining processes, etc. In 2015, Ford developed Plasma Transferred Wire Arc (PTWA) coating technology to remanufacture engines with a significantly lower economic and environmental cost. The technology applies a spray to the inside of a worn-out engine block and restores it to original factory condition.

*"Traditional engine remanufacturing techniques can be prohibitively expensive, and energy intensive, requiring iron-cast parts and intricate machining processes. The Plasma Transferred Wire Arc coating technology removes the need for additional heavy parts and the processed engine block has a new life as the base of a replacement engine,"* said Mark Silk, supervisor, Powertrain Products, Ford Customer Services Division Europe.<sup>48</sup>

Ford then sells these remanufactured engines through partner dealers and on its online platform, Ford Parts.<sup>49</sup>

The technology saves costs and reduces emissions, providing a range of benefits:

- 50% reduction in CO<sub>2</sub> emissions compared with producing a new engine.<sup>50</sup>
- Increased productivity combined with stronger, lighter, and higher-performing engine blocks.<sup>51</sup>
- Lower vehicle weight: PTWA allows automakers to reduce cylinder block weight and eliminate design restrictions.
- Long-term benefits: PTWA allows automakers to improve durability and ultimately help lower overall costs.

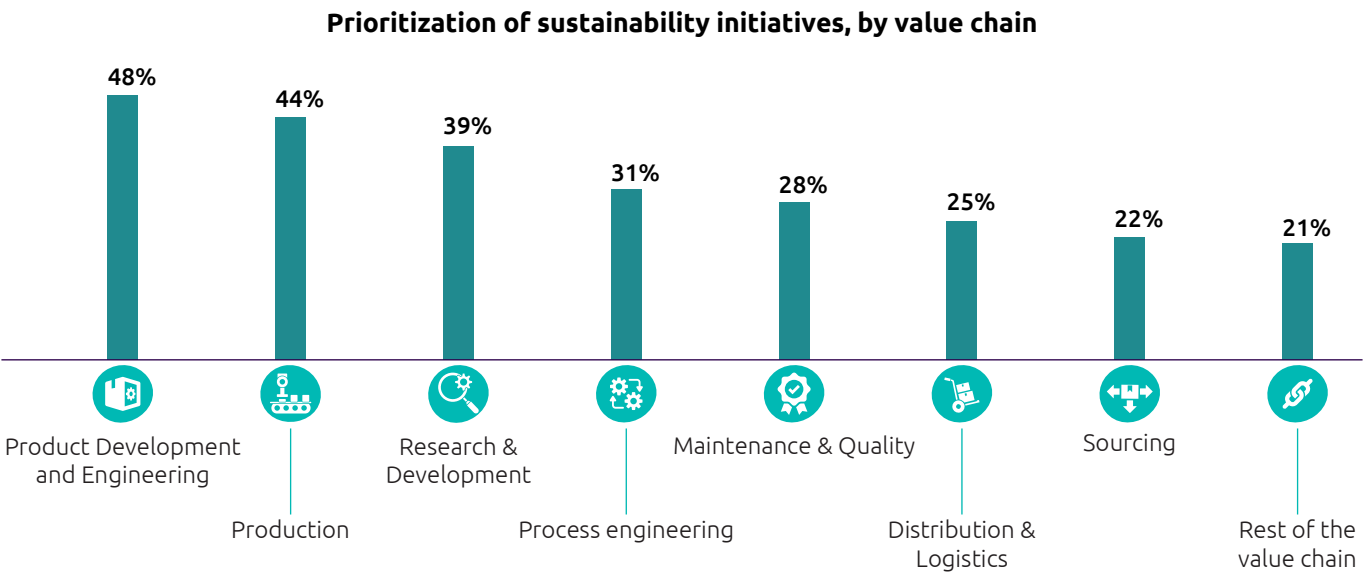
Focusing on sustainability as a core part of business strategy, Ford is also investigating a wide range of renewable materials as potential raw material for its automotive vehicles' components. Among them is a shrub called Guayule, found in Arizona, which is being investigated there for its potential to reduce the amount of rubber that is imported for use in auto production. Further plant-based rubber alternatives Ford is looking into include dandelions, sunflowers, and sugarcane.<sup>52</sup>

# Maturity of sustainability practices across the value chain is low

We asked business executives about how they prioritize sustainability in terms of different functions. As Figure 11 shows, the product development and engineering function

gets the most attention when it comes to sustainability initiatives, followed by production (44% make this area a priority).

**Figure 11. Product development and production are the foremost priority for sustainable initiatives for manufacturing organizations**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Business executives survey, February–March 2021, N=480 business executives.

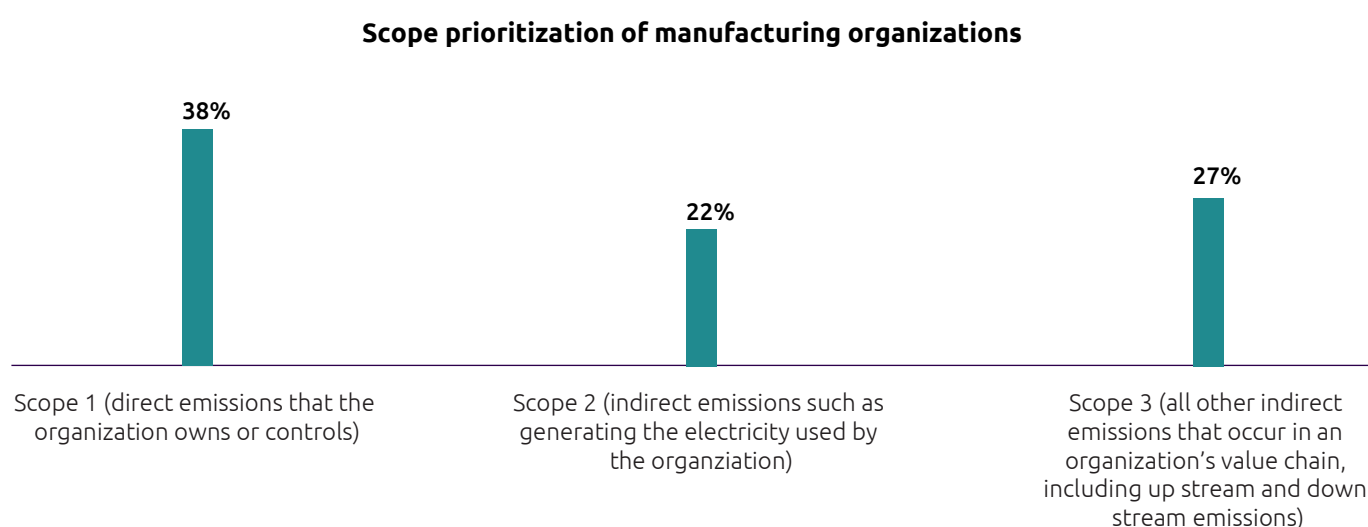


Only **11%**  
of sustainability initiatives that are launched are actively being scaled across the organizations, on average.

Merely prioritizing sustainability initiatives does not, of course, equate to success and progress on critical sustainability challenges. Firstly, we found that only 11% of the sustainability initiatives that are launched are actively being scaled across the organization. Secondly, as Figure 12 shows, most emphasis is given to scope 1 emissions (direct emissions that the organization owns or controls) but less attention is given to scope 2 (indirect emissions

such as generating the electricity used by the organization) and scope 3 (all other indirect emissions that occur in an organization's value chain, including upstream and downstream emissions).<sup>53</sup> Further, only 31% of business executives believe that sustainability is fully integrated into the manufacturing strategy.

**Figure 12. Scope 1 is the main priority for manufacturing organizations**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Business executives survey, February–March 2021, N=480 business executives.

Focusing on scope 1 is mostly driven by organizational goals of carbon neutrality. However, much of the carbon footprint of manufacturing organizations is in the domains of scopes 2/3. For example, in 2020, US tech company Dell Technologies had ~98% of emissions from scope 3 and ~1.5% from scope 2. Scope 1 overall accounts for ~0.4% of its carbon footprint.<sup>54</sup> This holds true for most discrete manufacturers. This is why the emphasis on scope 1 emissions, while enabling organizational sustainability, does not support wider global sustainability.

Most organizations do not have reliable scope 3 emission data. *"I think you also need to have data to analyze where you have opportunities,"* explains the head of sustainability at a home appliance manufacturer. *"Only then can you need to drill down to see what the drivers are for your carbon footprint. And if you look beyond your scope 1 and 2 you will conclude that scope 3 – and maybe end-user consumption – are your main carbon drivers."*<sup>55</sup>

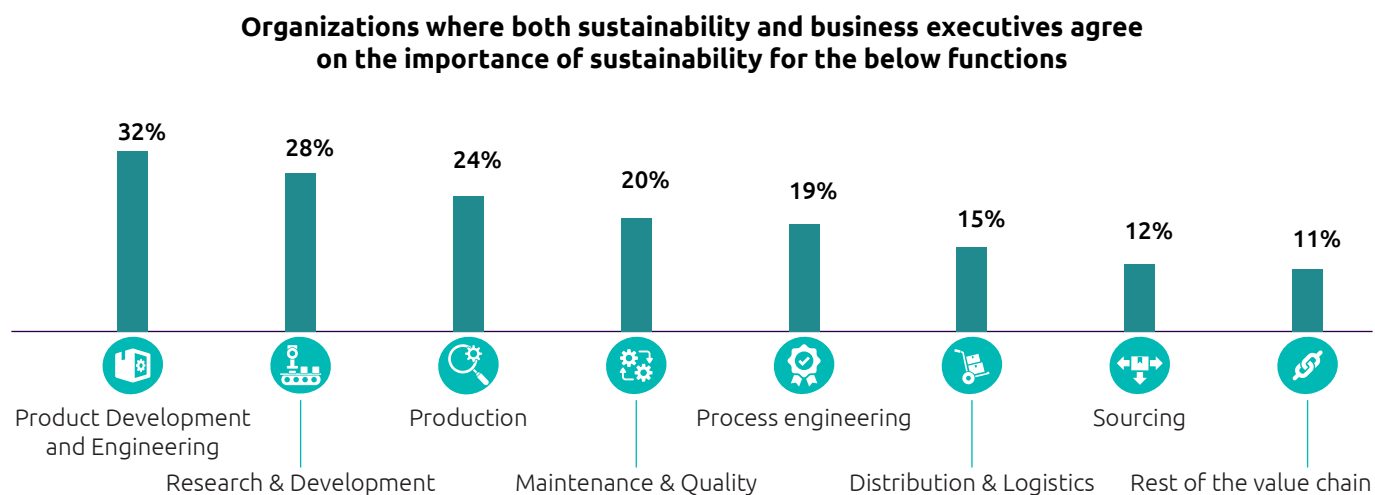
## Lack of alignment between business and sustainability executives hinders progress

Alignment is an issue across the environmental agenda. Only one in five organizations agree that sustainability is fully integrated into the manufacturing strategy.

However, it is also an issue between stakeholders within an organization. In our research, we examined the extent to which business-facing executives and their sustainability peers are aligned on key areas of sustainability. We found a lack of alignment was an issue at both an objective level and in terms of the importance of sustainability for different functions:

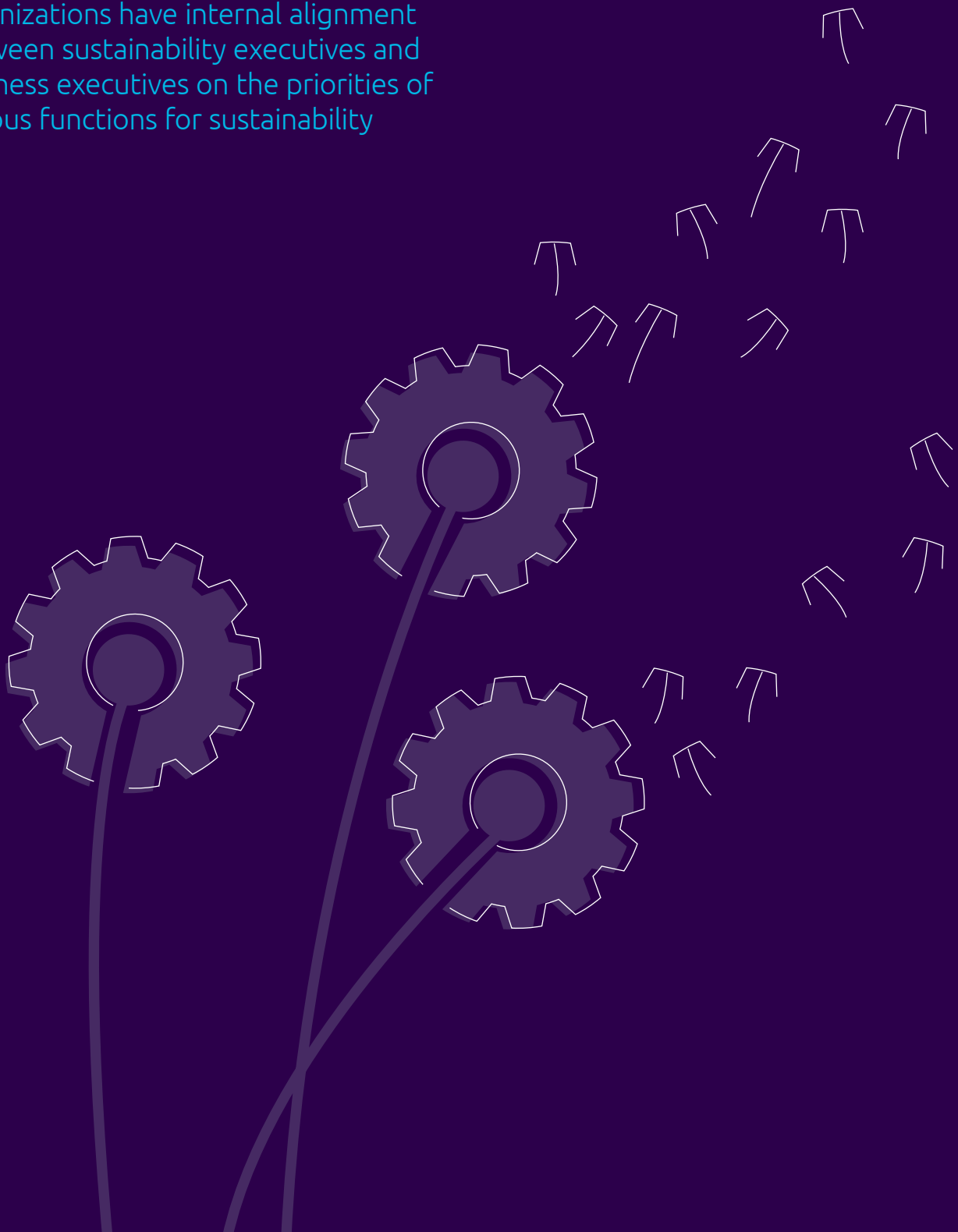
- Objective level: Business and sustainability executives are aligned on reducing particulate pollution in only 31% of organizations, and the same is true for reducing water pollution (29%) and reducing use of natural resources (27%).
- Functional level: As Figure 13 shows, only a minority of organizations are aligned on key issues. For example, we found that business and sustainability execs were aligned on the importance of sustainability in process engineering in only 19% of organizations. While prioritizing product development and/or production is important, this should not be at the cost of the rest of the value chain functions.

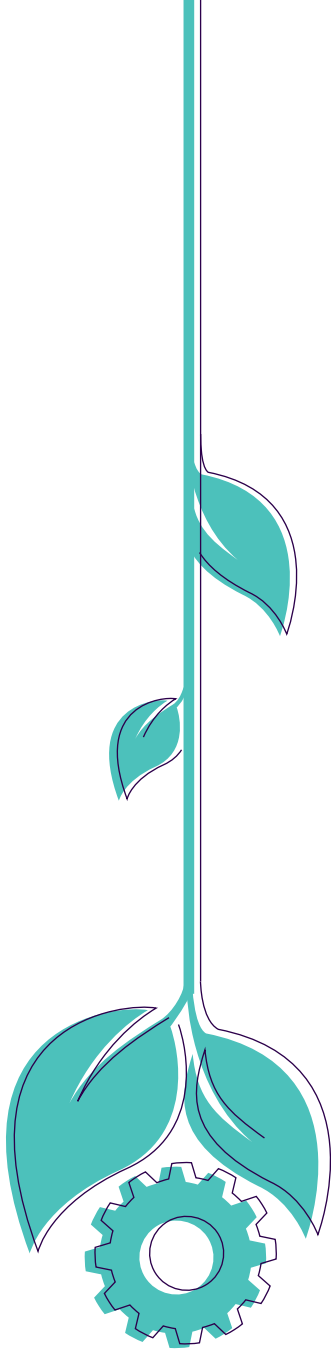
**Figure 13. Less than one in three manufacturing organizations have alignment between sustainability executives and business executives on the priorities**



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, Business executives survey, February–March 2021, N=480 organizations.

Less than **1 in 3** manufacturing organizations have internal alignment between sustainability executives and business executives on the priorities of various functions for sustainability

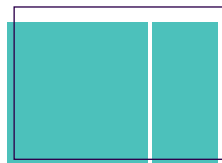
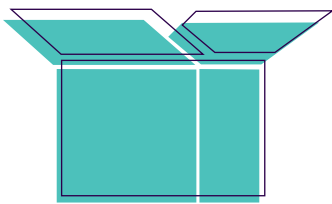




### 03. How technology is helping manufacturers to achieve the goals of their sustainability agenda

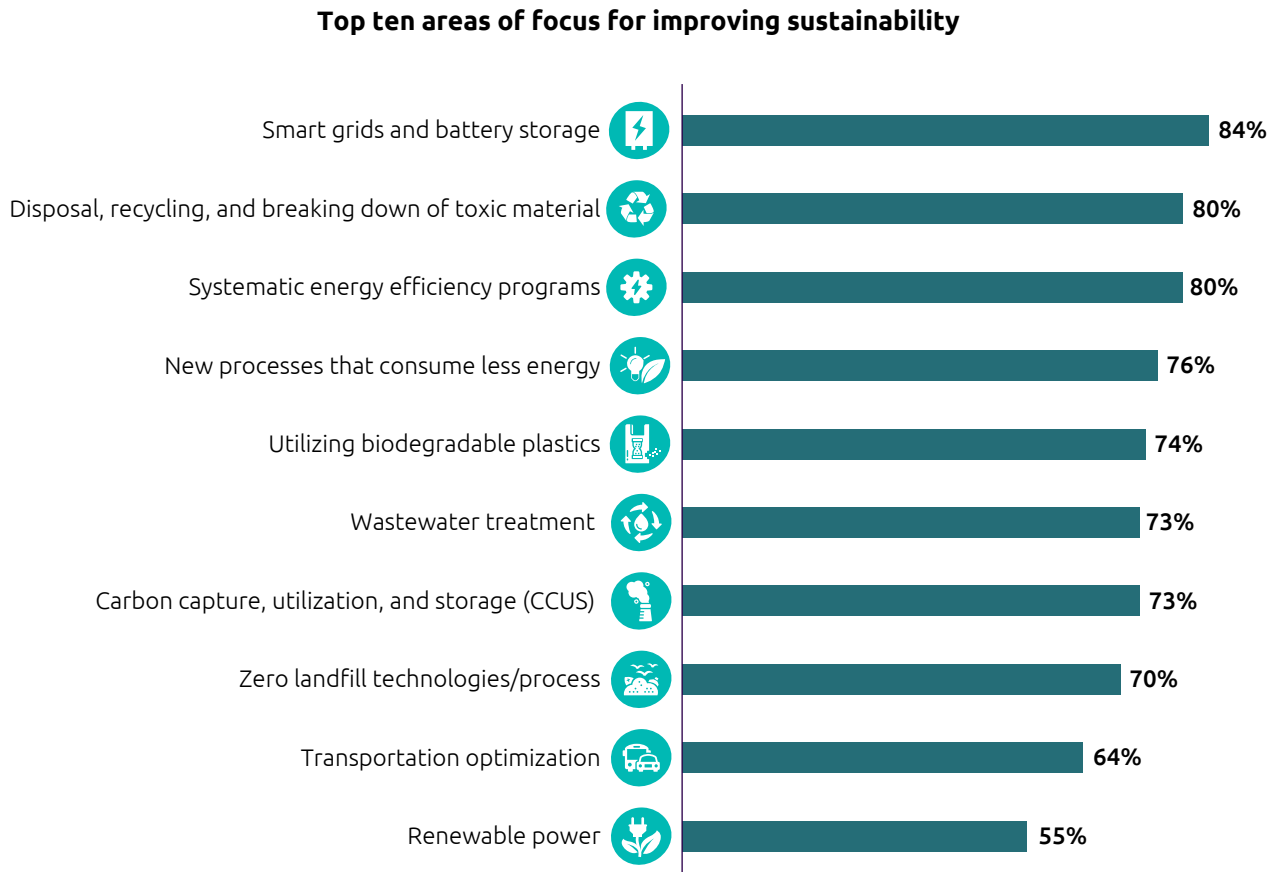
Technology is playing a key role in sustainability initiatives

Manufacturers have wide-ranging sustainability agendas. As Figure 14 shows, for example, 84% have smart grids and battery storage on the agenda. Similarly, 73% are focusing on wastewater treatment as well as CCUS (carbon capture, utilization, and storage) which helps in mitigating the CO<sub>2</sub> emissions. For instance, Mitsubishi Heavy Industries (MHI), together with Kansai Electric Power company, developed its own CO<sub>2</sub> capture technology. This technology which helps in energy savings has been adopted for 13 of MHI's plants as of February, 2019.<sup>56</sup>





**Figure 14. Top initiatives on the manufacturing sustainability agenda**

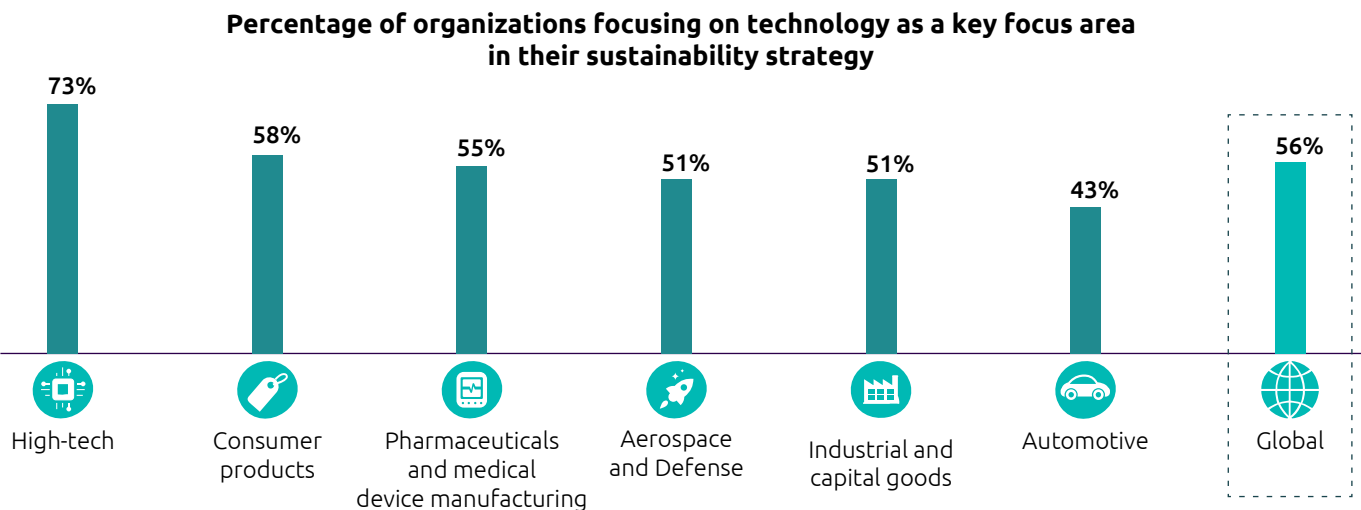


Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, February–March 2021, N=480 sustainability executives.

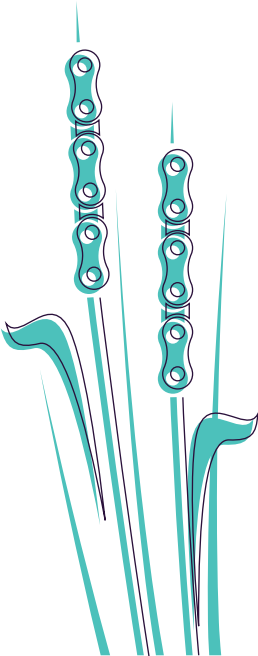
Technology will be key to driving progress across the agenda. Our research shows that more than half of the organizations say technology for sustainability is a core focus of their sustainability strategy. High-tech industry leads the way, with three in four organizations using technology for their sustainability strategy (see Figure 15). A key reason is this

sector's experience in using technology. As Adam Schaefer, director of supply chain sustainability and Peter Schmutzer, director of purchasing at Intel Corp, explains: *"We may be closer to the core technology that's going to enable it. Thus, when we think about sustainability overall – we think of technology."*<sup>57</sup>

Figure 15. Technology is a key focus area for manufacturing's sustainability strategy



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Business executives survey, February–March 2021, N=480 business executives.



73%

Percentage of organizations adopting automation for driving sustainability in their operations

## Digital technologies for sustainability are adopted by many and deliver significant

Our research shows significant adoption of key technologies to drive sustainability in manufacturing operations:

- 73% are adopting automation
- 68% AI/machine learning
- 60% data analytics.

This take-up reflects the potential of these technologies. As Figure 16 shows, for example, scaled use of technologies has resulted in a 15% reduction in waste, on average, over the past two years and another 20% reduction over the next five years.



“We may be closer to the core technology that’s going to enable it. Thus, when we think about sustainability overall – we think of technology.”

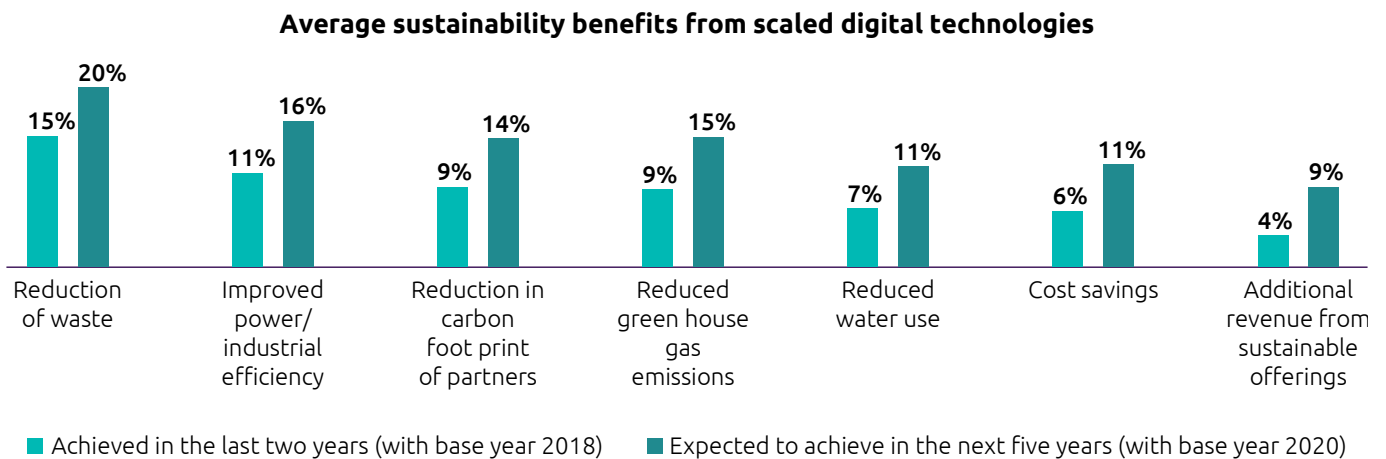


**Adam Schaefer**  
Director of supply chain sustainability at Intel



**Peter Schmutzer**  
Director of purchasing at Intel

**Figure 16. Digital technologies enable numerous sustainable benefits**



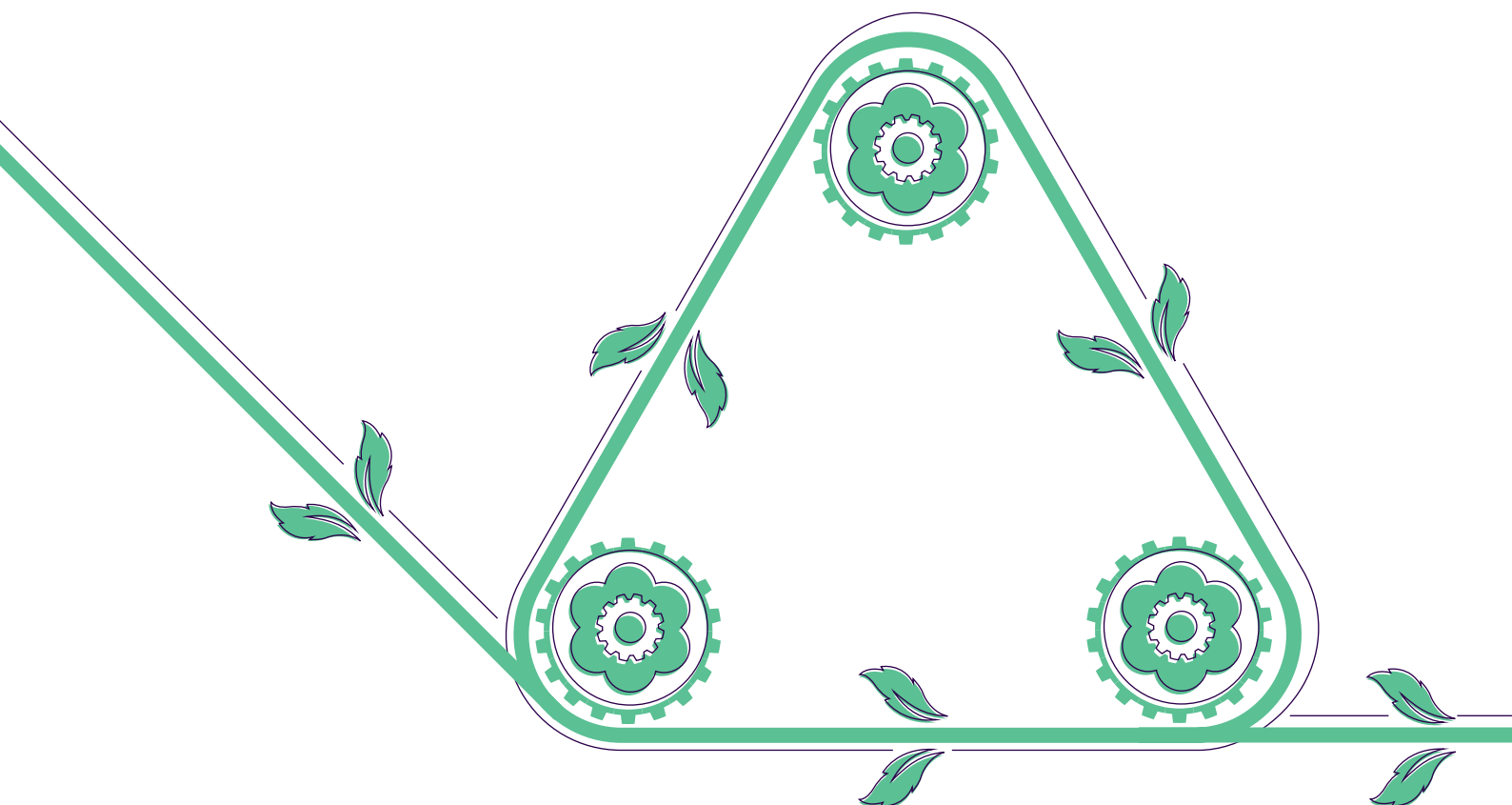
Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Business executives survey, February–March 2021, N=480 business executives.

Our research found digital technologies have enabled considerable advantages to manufacturers and continue to do so. As Nanna Aage Lundsgaard, senior director of engineering at Danfoss Climate Solutions, explains: *“You have to look at technology and sustainability going hand in hand, and see it as an opportunity. The fact that you can bring much more than the product to the market. You can make it a service model by combining it with software and IoT at site. I think that this is truly a factor that manufacturers need to start realizing and thereby really start embarking on.”*<sup>58</sup>

Innovation, driven by technology and data, can help manufacturers address both sustainability and economic concerns simultaneously. Budgetary constraints often seen for sustainability initiatives can be resolved by routing the benefits realized from using digital technologies into sustainability programs. Further, these technologies not only allow designing for sustainability ahead of manufacturing but also enable a feedback loop from operations to design, thereby allowing manufacturers to become an intelligent industry.<sup>59</sup> Overall, this will help manufacturers reconcile economic growth with environmental sustainability.

## 4. How can manufacturers reach their sustainability goals?

Based on our analysis of manufacturers' responses, and drawing on our experience working with major players in this area, we have identified the top sustainable practices/applications within each of the 6R areas, from Reduce to Remanufacture (see Figure 17). These applications have been selected because they deliver the greatest benefits, according to both our survey and the testimony of Capgemini's subject matter experts. By focusing on these applications across the 6Rs, manufacturers can ensure their approach is comprehensive and delivers maximum benefits.



**Figure 17. Top applications that deliver the greatest benefits**

Type	Top applications
 Reduce	<ul style="list-style-type: none"> <li>• Reducing carbon footprint of operations through green hydrogen and renewable power</li> <li>• Improving material utilization through additive manufacturing and precision manufacturing in metal fabrication</li> <li>• Reducing transport carbon footprint by environmentally focused inventory management.</li> <li>• Reducing composite plastics and non-recyclable materials</li> </ul>
 Reuse	<ul style="list-style-type: none"> <li>• Reusable transport packaging by constructing durable materials using metal, plastic, and wood that is designed to achieve multiple uses</li> <li>• Use of returnable/reusable plastic boxes and shipping containers</li> <li>• Building rainwater harvesting reservoirs or replenishing underground water reserves.</li> </ul>
 Recycle	<ul style="list-style-type: none"> <li>• Using recyclable packaging material</li> <li>• Collecting and recycling scrap from customer processes</li> <li>• Recycling wastewater</li> <li>• Recycling process waste heat for environmental heating</li> </ul>
 Redesign	<ul style="list-style-type: none"> <li>• Incorporating green chemistry in product safety</li> <li>• Incorporating environmentally oriented materials selection and sourcing sustainable materials</li> <li>• Redesigning products to remove fossil fuel feedstock sources (such as plastics)</li> <li>• New transportation networks supported by network design technologies and use of alternate transport methods</li> <li>• Redesigning systems using simulation platforms and data collected along the full life cycle to optimize direct and indirect impacts</li> <li>• Designing products in such a way that they can be remanufactured and incorporate lifetime-extension services</li> <li>• Implementing functional approach and embracing the opportunity to change the business model to improve the environmental impact and at the same time, taking the opportunity to identify new innovative products and services</li> </ul>
 Recover	<ul style="list-style-type: none"> <li>• Being part of industrial waste exchanges that recover waste from a given industry to provide material of value to another industry</li> <li>• Collaborating with third-party vendors to recover as much waste as possible from site locations</li> <li>• Recovering the energy stored in residual material by turning waste into a fuel for manufacturing processes or equipment designed to produce energy</li> </ul>
 Remanufacture	<ul style="list-style-type: none"> <li>• Reclamation of used durable materials, such as steels, and products that can be reused in future manufacturing processes</li> <li>• Taking back end-of-life products from customers so as to disassemble and use them in the remanufacturing process</li> <li>• Offering repurposed/reused products as a service offering</li> <li>• Building retrofitting service lines for extending the usable lifetime of products.</li> </ul>

Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, February–March 2021, N=480 sustainability executives along with Capgemini expert analysis.

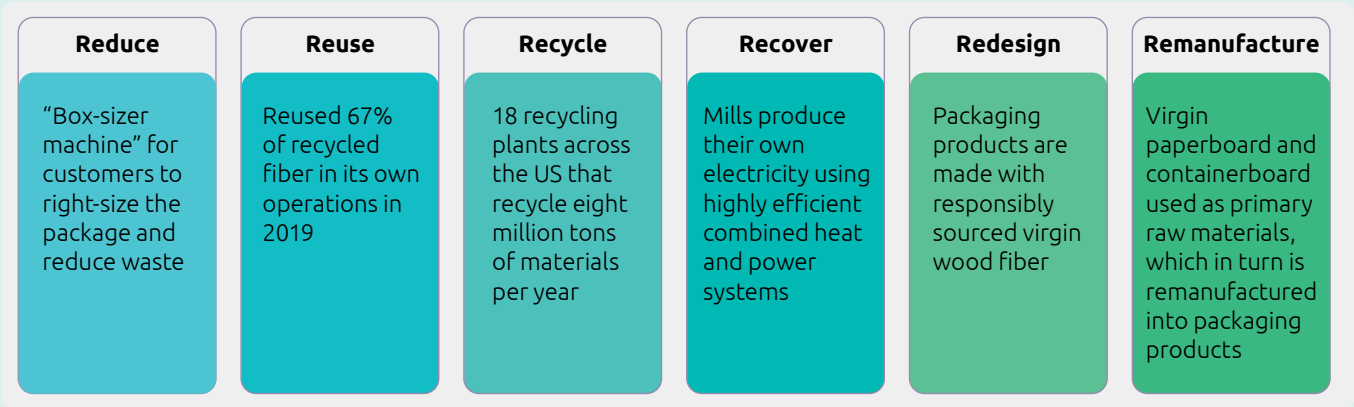
# How WestRock is taking a comprehensive, cross-functional approach to sustainability

WestRock – an American corrugated packaging company – started evolving its sustainability approach at a rapid pace back in 2015 when it set some ambitious sustainability goals. Brandi Colander, chief sustainability officer at WestRock, outlines the basis of their comprehensive approach: *“Here at WestRock, sustainability is not about compliance or reducing our impact. It’s how we do business – and why. The foundation*

*of our sustainability commitment is built on three pillars: people and communities, bettering the planet, and innovating for our customers and their customers – working together to imagine and deliver on the promise of a sustainable future.”*<sup>60</sup>

WestRock has embraced all the six Rs of sustainability, as Figure 18 shows:

Figure 18. WestRock’s comprehensive approach to sustainability



Source: Capgemini Research Institute analysis.

# 18



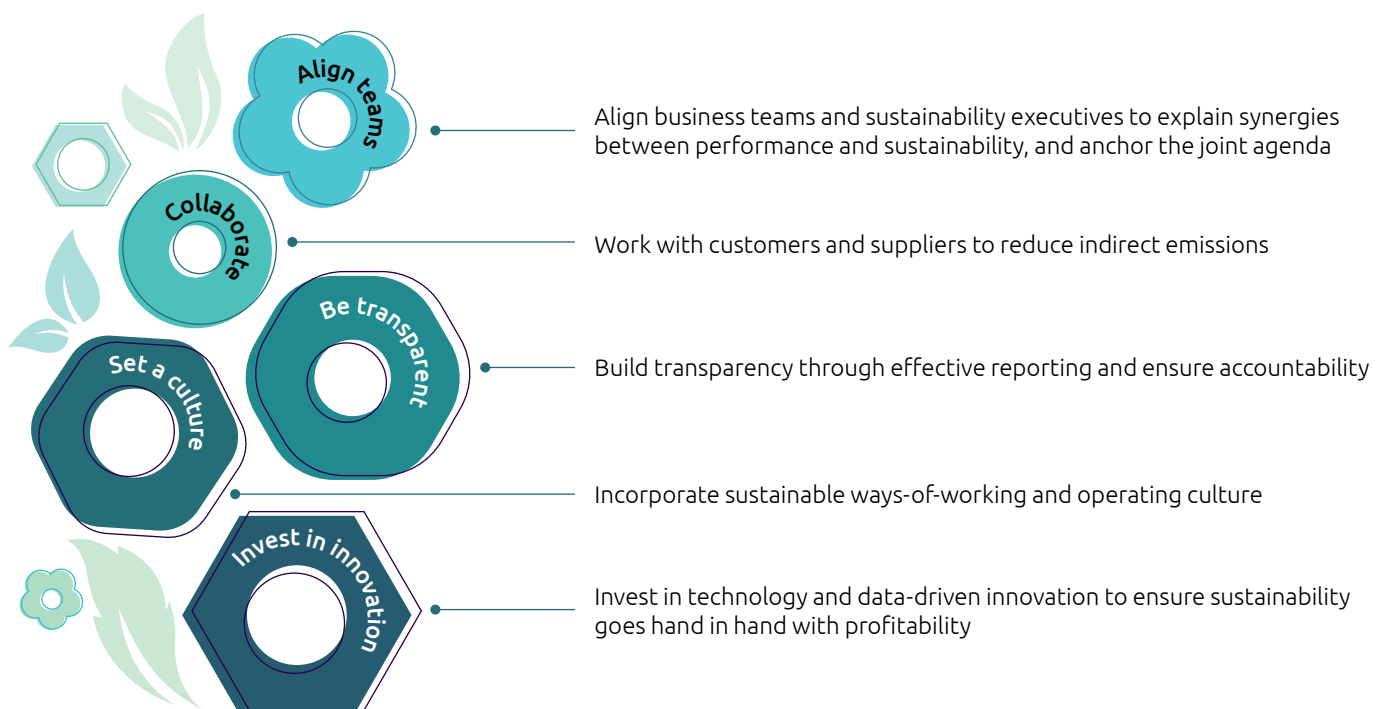
recycling plants of WestRock  
across the US recycle eight  
million tons of materials per year

- **Reduce:** WestRock uses its “box-sizer machine” for customers to right-size the package and virtually reduce waste. Smaller packaging helps WestRock’s postal and delivery workers to fit more packages on its trucks, which in turn reduces carbon emissions from gas and saves time.<sup>61</sup>
- **Reuse:** In 2019, 67% of the recycled fiber was reused in WestRock’s own operations while the remainder was sold to other organizations.
- **Recycle:** WestRock has 18 recycling plants across the US that recycle eight million tons of materials per year. It is also working to increase the awareness of recyclability and educate its consumers through a partnership with The Recycling Partnership.<sup>62</sup>
- **Redesign:** WestRock’s paper-based packaging products are made with responsibly sourced virgin wood fiber. The organization makes sure that its wood suppliers adhere to its environmental, social, and legal standards, ensuring that the fiber it uses is responsibly sourced.<sup>63</sup>
- **Recover:** WestRock’s largest mills self-generate virtually all of the steam needed for their operations using renewable biomass, and they produce their own electricity using highly efficient combined heat and power (CHP) systems. On an intensity basis, WestRock’s energy efficiency, measured as million BTU’s consumed per ton of production, increased by approximately 3% during the period 2015 to 2019.
- **Remanufacture:** WestRock uses recycled and virgin paperboard and containerboard as its primary raw materials. It then remanufactures these materials into a variety of packaging products, including corrugated boxes, folding cartons, partitions, and point-of-purchase/merchandising displays.<sup>64</sup>

## Key success factors

To maximize the results from these applications, and drive the sustainability agenda, five success factors are critical, as Figure 19 shows.

**Figure 19. Five success factors for achieving sustainability goals**



Source: Capgemini Research Institute analysis.

- **Align business teams and sustainability executives to explain synergies between performance and sustainability, and anchor the joint agenda**

There is a tendency for sustainability executives and their teams to be compartmentalized as a separate department or to find themselves operating in silos, when the need is for them to be an important part of strategic decision making. Business-facing teams need to work in alignment

and collaboration with sustainability teams, but this will only happen if organizations take two steps:

- Ensure that the chief sustainability officer is empowered – involving them in strategic decision making and backing them with a dedicated budget allocation for sustainability.
- Make business teams and sustainability teams accountable for both financial KPIs (such as cost reductions) as well as sustainability KPIs (such as emissions reduction) thereby driving the collaboration between the teams



Vinicius Cataldi – head of sustainability LATAM at Sika AG, a Swiss multinational specialty chemical company – outlines how sustainability is championed from the top: *“At Sika AG, the discussions around sustainability are pushed from the top, by the CEO. As sustainability executives, we are not just responsible for creating the sustainability roadmap, but also to clearly communicate this to everyone in the organization and get them involved. We make sure everyone knows the sustainability plans, what activities are supposed to take place and that everyone is engaged in working towards sustainability.”*<sup>65</sup>

Other organizations are taking conscious steps to align business teams and sustainability executives:

- In the process of setting long-term goals to improve environmental performance for carbon dioxide emissions, energy, waste, and water, Alcoa – a global leader in aluminum – has linked up to one-fifth of the employee compensation – from production managers to the chief executive – to achieving these goals. It has also invested into the research and development of products that reduce costs (such as fuel costs) to create a win-win strategy that not only reduces emissions but also improves the company’s competitiveness.<sup>66</sup>
- Health products giant, Johnson & Johnson, has implemented a flexible budget within the organization to encourage investment in sustainability projects. By increasing capital for greenhouse-gas reduction initiatives such as solar installations, the company saves money through reduced energy costs. It can then use these

savings to help finance similar projects. The company also reduced the rate of return required for these emissions-reduction projects to reflect their lower risk. This is helping the company reach its greenhouse gas reduction goals while the projects themselves are showing an average return around 19%.<sup>67</sup>

- Another organization actively using environmental metrics is Natura, the Brazil-based, multinational cosmetics company. The company works with its suppliers to track and price externalities such as carbon dioxide emissions, water use, and waste generation. Natura, in turn, uses a shadow price for these factors to select suppliers with the lightest footprint, which will also create financial benefits.<sup>68</sup>

In addition to aligning the teams, it is important to break down the long-term sustainability targets into clear, measurable metrics. This allows organizations and the teams to monitor and adjust their actions on time. In line with this philosophy, Mickael Aubry, global innovation program manager at Faurecia, explains how their organization breaks down broad sustainability goals into specific targets: *“At Faurecia, we do divide up the long-term target of emission reduction and set internal milestones on that basis. So, this long-term target has been segregated into two different work packages and each one is linked to a specific target within the overall goal of emission reduction.”*<sup>69</sup>



At Sika AG, the discussions around sustainability are pushed from the top, by the CEO. As sustainability executives, we are not just responsible for creating the sustainability roadmap, but also to clearly communicate this to everyone in the organization and get them involved...”

**Vinicius Cataldi**

Head of sustainability LATAM at Sika AG

## • Work with customers and suppliers to reduce indirect emissions

Organizations should consider performing a Life Cycle Analysis (LCA) of a specific scope (e.g., a product range) in order to analyze the environmental impact across all steps of the life cycle. The result will help in prioritization of impact reduction, according to company objectives. Large part of this impact reduction involves working with partners. Today, many organizations require their suppliers to adhere to a set of standards that ensure that their activities and processes are in line with the client company's environmental aims. For instance, Unilever's Responsible Sourcing Policy (RSP) includes a set of mandatory requirements that all its suppliers need to meet to be able to do business with the company. Compliance with these requirements is assessed through a variety of means, from online assessments to third-party audits for designated high-risk countries and supplier types.<sup>70</sup>

Organizations can ask their suppliers for information on environmental audits and details of their practices and processes. This is an effective way to monitor what a supplier is doing to reduce indirect emissions and drive sustainability. However, we recommend that organizations go a step further: proactively collaborating with their suppliers on sustainable initiatives and practices. This means more than just monitoring the raw materials an organization might source from suppliers. Instead, it is about providing suppliers with resources – such as technologies – that could help improve sustainability or allow the two organizations to jointly develop sustainable products.

While a number of studies have shown that monitoring alone has no direct effect on supplier performance, joint and collaborative efforts have a significant effect on environmental performance.<sup>71</sup> As Intel's Adam Schafer says: *"No matter what industry – whether it's technology, semiconductors, automotive, aerospace, or agriculture – industry consortiums enable sustainability. There are other companies that are working towards these common goals as well. Consortium spaces are really where it's coming together and really driving sustainability."* This collaboration is the basis for more impactful initiatives, such as circular economy programs. Suppliers and consumers can enable manufactures to develop and implement closed-loop resource operations.

A number of organizations have put collaboration at the heart of their approach, recognizing that they are working to drive the greater good of the sector as a whole. Marco Philippi, head of procurement strategy at Audi, says: *"We interact with more than 14,000 direct suppliers from more than 60 countries. That adds up to a large responsibility, but at the same time it offers enormous potential. If we succeed in steering the network in the right direction, then this not only has a positive effect on Audi, but also on our entire sector."* Audi launched an Audi CO<sub>2</sub> program in the supply chain in 2018, working with suppliers to identify measures for reducing CO<sub>2</sub> emissions.<sup>72</sup>

Organizations also need to educate and empower consumers. Consumer behavior can have a significant impact on how products affect the environment and sustainability is not something that ends at the four walls of the organization. Instead, it needs to extend from organization to suppliers to consumers. Educating consumers about sustainable choices works as a virtuous cycle: it ensures that consumers expect and demand sustainable products and practices from organizations and choose sustainable companies and products over unsustainable ones. In turn, this will incentivize organizations to invest in sustainable products and practices.

Levi Strauss & Co., for instance, has launched a program called "Care Tag for Our Planet." It puts concise instructions on all of the company's products so that consumers can learn sustainable ways to launder and care for their clothing. The organization encourages its consumers to "wash less, wash in cold, line dry, and donate when no longer needed."<sup>73</sup>

FMCG giant PepsiCo has launched its own recycling program – PepsiCo Recycling – which has already worked with more than 4,000 schools and with numerous college and university campuses and local communities in the US to boost recycling and raise awareness of the importance of recycling. Since 2010, in schools alone, some 93 million cans and bottles have been recycled through PepsiCo Recycling.<sup>74</sup> Along similar lines, the Coca-Cola Company has also expanded recycling awareness through key partnerships with three key nonprofit organizations.<sup>75</sup> It has also launched a marketing campaign named Round in Circles aimed at encouraging people to recycle.<sup>76</sup>



“At Faurecia, we do divide up the long-term target of emission reduction and set internal milestones on that basis. So, this long-term target has been segregated into two different work packages and each one is linked to a specific target within the overall goal of emission reduction.”

**Mickael Aubry**

Global innovation program manager  
at Faurecia

• **Build transparency through effective reporting and ensure accountability**

One of the main challenges that stands in the way of driving sustainable practices is the need for a robust and credible way of measuring, managing, and disclosing sustainability performance. The ideal goal is sustainability reporting that has the credibility and comparability of financial reporting.

Effective sustainability reporting offers a range of benefits:

- Internally, it can become the thread that educates the wider organization about sustainability plans and aligns them behind the overall sustainability vision. Effective reporting also identifies gaps in existing sustainability practices, ensuring that senior management is aware. Philips, for instance, has a Sustainability Board to oversee its sustainability initiatives, which is chaired by the head of Group Innovation and Strategy along with three other Executive Committee members. They join the sector and functional leaders four times a year to define sustainability programs and monitor progress. Philips uses the benchmark information and research of external indices to strengthen its sustainability reporting and the top leadership makes sure that sustainability is embedded in all aspects of product creation.<sup>77</sup>
- Externally, it helps meet the expectations and scrutiny of external stakeholders – from consumers to investors – and enhances reputation and brand value.
- It can also play a key role in building reputation among customers and the wider ecosystems. Customers can use environmental disclosures (especially product usage) to ensure that they can make sustainable choices and help them improve their sustainability ratings. Based on initiatives, consumers can also play a key in various aspects such as circular economy and sustainability-as-a-service offerings.

A critical first step is to select what reporting standard to use, such as GRI, Sustainability Accounting Standards Board, and the ISO Standard 26000 on Social Responsibility.

SIKA AG's Vinicius Cataldi outlines how critical it is for sustainability reporting data to be integrated with advanced ERP systems: *“It is important for sustainability to be part of a larger ERP system. This means you have everything integrated, making it possible to collect all sustainability-related information and support effective reporting. So, the most important factor in credible sustainability reporting is how you're collecting data and whether you have access to reliable sustainability information internally. For this to happen, the ERP system must be integrated”*<sup>78</sup>

## • Incorporate sustainable ways-of-working and operating culture

Historically, most organizations have focused their operations on driving economic efficiencies. These highly tuned and efficient ways of working are designed to reduce costs and improve operational efficiencies. However, the COVID-19 pandemic has shown that this way of working and operations is not always resilient. Take, as an example, how global supply chains – which were designed to maximize economic efficiency – have been shown to be vulnerable. Any variation or shock in the supply chain has brought it to close collapse as shown by the Suez shipping crisis,<sup>79</sup> the ongoing semiconductor shortage, and overall COVID-19 supply chain constraints.<sup>80</sup> With supply chains becoming the stress point of the global economy,<sup>81</sup> nearshoring and onshoring efforts have intensified.

As organizations reimagine their supply chains, it is also an opportunity to address sustainability issues. Traditional globalized just-in-time (JIT) supply chains need to be reconsidered. While this could mean an increase in inventory and warehousing costs, there are also opportunities for better peak-pricing, unused return capacity, bulk purchase and shipping, and the overall economic opportunity of improved resilience. A comprehensive view of the supply chain costs that considers not just financial KPIs but also sustainability KPIs and circular economy principles will help organizations in being more resilient and sustainable.

There are also similar opportunities beyond the supply chain:

- Sustainable ways of working: The constraints of social distancing and the need for reduced workforce numbers on the factory floor have shown the power of digital innovations. For example, carrying out specialized maintenance and operations remotely, reduces the carbon cost of traveling while also shortening the lead-time for diagnosis and improving uptime. Control towers and digital twins can be effective in plant monitoring and simulations. However, organizations must note that these investments in technology also have an associated carbon cost and should determine the net effect from these initiatives.
- Communicating with and educating employees: Sustainability requires the contribution of the shop floor workforce, who are at the heart of driving change in environmental practices. Introducing technology in isolation will have little impact unless it is allied to the necessary cultural and behavioral change (digital initiatives can often fail because people resist and insist on doing things the old way because that is “how it is done”). New technologies and ways of working will only achieve scale if they have the backing of the shopfloor workforce. A dedicated internal communication campaign, along with workforce education, are critical aspects of any sustainability initiative.



“You have to look at technology and sustainability going hand in hand, and see it as an opportunity. The fact that you can bring much more than the product to the market. You can make it a service model by combining it with software and IoT at site. I think that this is truly a factor that manufacturers need to start realizing and thereby really start embarking on.”

### **Nanna Aage Lundsgaard**

Senior director of engineering at Danfoss Climate Solutions



“We started building solutions for precision farming which would allow us to significantly reduce our end users’ environmental footprint. For example, the use of pesticides, fertilizers and other chemical products for weed control is reduced by collecting data and using advanced analytics, machine learning, and artificial intelligence. This helps us to support farmers to reduce consumption of chemicals...”

**Peter Ommeslag**

Program manager at CNH Industrials

### • Invest in technology and data-driven innovation to ensure sustainability goes hand in hand with profitability

To drive the sustainable manufacturing agenda, organizations need to invest in innovation leveraging digital technologies such as AI/machine learning, process automation, analytics, and digital twins as well as the right data.

- BMW opened a new automotive plant in Mexico. The plant director, Hermann Bohrer says, *“The plant was designed from the start to allow us to respond quickly and flexibly to future model variants and production volumes. We use innovative Industry 4.0 technologies, including new automation solutions and modern assistance systems. Sustainability was also a major focus from the beginning - and we are setting new standards in this area.”* By reconditioning and reusing water required for the painting process, this plant will be the group’s first paint shop to generate no process wastewater at all. Through on-site solar energy plant and the use of renewable energy sources, the plant will be supplied with 100% CO<sub>2</sub>-free electricity in future.<sup>82</sup>
- A climate modelling exercise we conducted with a climate change startup estimates that, by 2030, AI-enabled use cases have the potential to help organizations fulfill 11%–45% of the “Economic Emission Intensity” targets of the Paris Agreement, depending on the scale of AI adoption across sectors. For instance, for the automotive sector, AI-enabled use cases have the potential to deliver eight percentage points of the 37% reduction (more than one-fifth) required by 2030. In the future, AI is expected to reduce GHG emissions by 16% and improve power efficiency by 15% in the next three to five years.<sup>83</sup>
- Our survey found that more than half of the manufacturing organizations are deploying AI/VR and RFID in the next one to three years to boost their sustainability initiatives.<sup>84</sup>

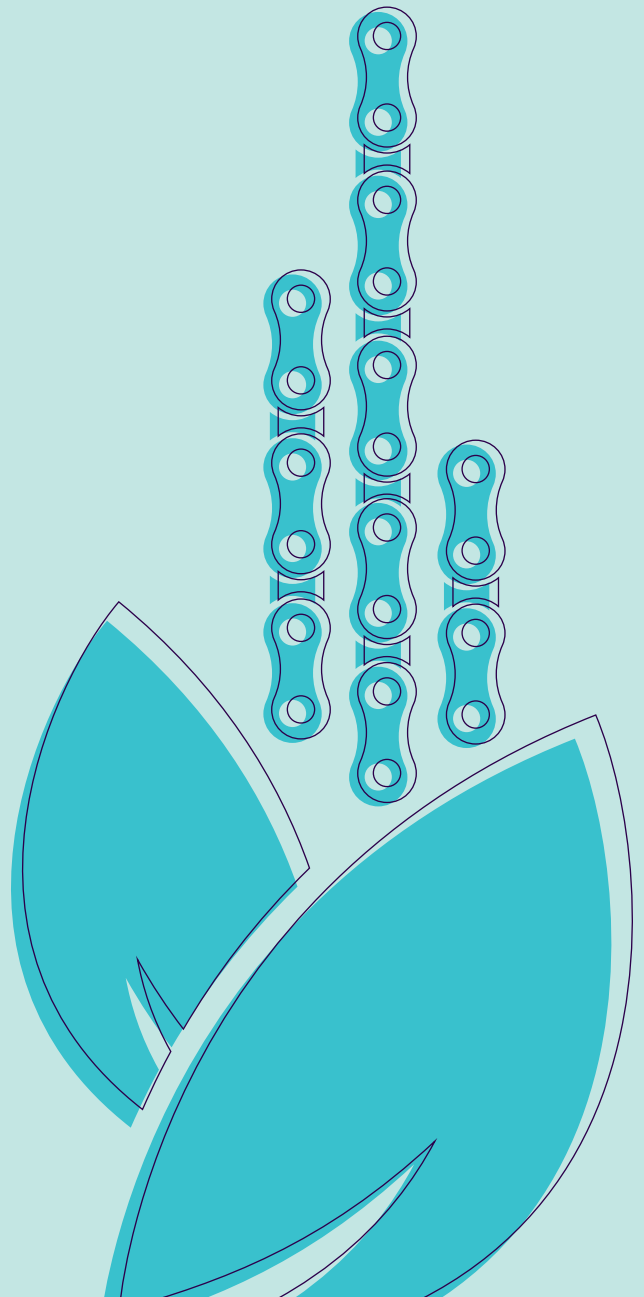
Innovation can also transform the environmental impact of how consumers use products. Most discrete products create a considerable environment footprint once they leave the factory. However, technology can play a critical role in addressing this. For example, Peter Ommeslag, program manager of manufacturing engineering and footprint industry 4.0 at CNH Industrials, explains how CNH Industrials tackled the footprint of their end users in the agriculture space: *“We started building solutions for precision farming which would allow us to significantly reduce our end users’ environmental footprint. For example, the use of pesticides, fertilizers and other chemical products for weed control is reduced by collecting data and using advanced analytics, machine learning, and artificial intelligence. This helps us to support farmers to reduce consumption of chemicals to actually what is needed based on the crop they are growing.”*<sup>85</sup>

Various technologies – such as 3D printing, digital twins, and IoT – can enable considerable improvement in sustainability. However, they also come with a carbon and economic cost that has to be analyzed. Managing all this means understanding the direct and indirect consequences. For example, you might have an initiative that reduces internal emissions but inadvertently pushes those emissions and the associated environmental degradation to other parts of the supply chain. Therefore, incorporating technology should consider the rest of the value chain, the long-term environmental effects, and the social cost.

# CONCLUSION

Sustainability could not be more important in manufacturing operations, given the resources consumed, and the day-to-day emissions and the waste generated. A comprehensive sustainable manufacturing implementation delivers significant environmental and economic benefits: improved ESG rating, transforming efficiency, and reducing costs. Despite this, few manufacturing organizations are on track to become sustainable manufacturers and achieve their targets. Our research showed that two-thirds of manufacturers (64%) still focus only on waste elimination (lean) and only around a quarter focus on indirect emissions. While sustainability also means economic and social inclusion, even within the environmental pillar, the majority of organizations are not looking at conserving natural resources or even reducing water and particulate pollution.

To accelerate performance, organizations need to take a more comprehensive approach across the six Rs of sustainable manufacturing, exploit the power of innovation, and drive scaled solutions. Progress will require that manufacturers align business-facing teams and those executives leading sustainability initiatives, work with customers and suppliers to reduce indirect emissions, build transparency through credible reporting, incorporate sustainable ways of working and invest in technology and data-driven innovation to ensure sustainability goes hand in hand with profitability.



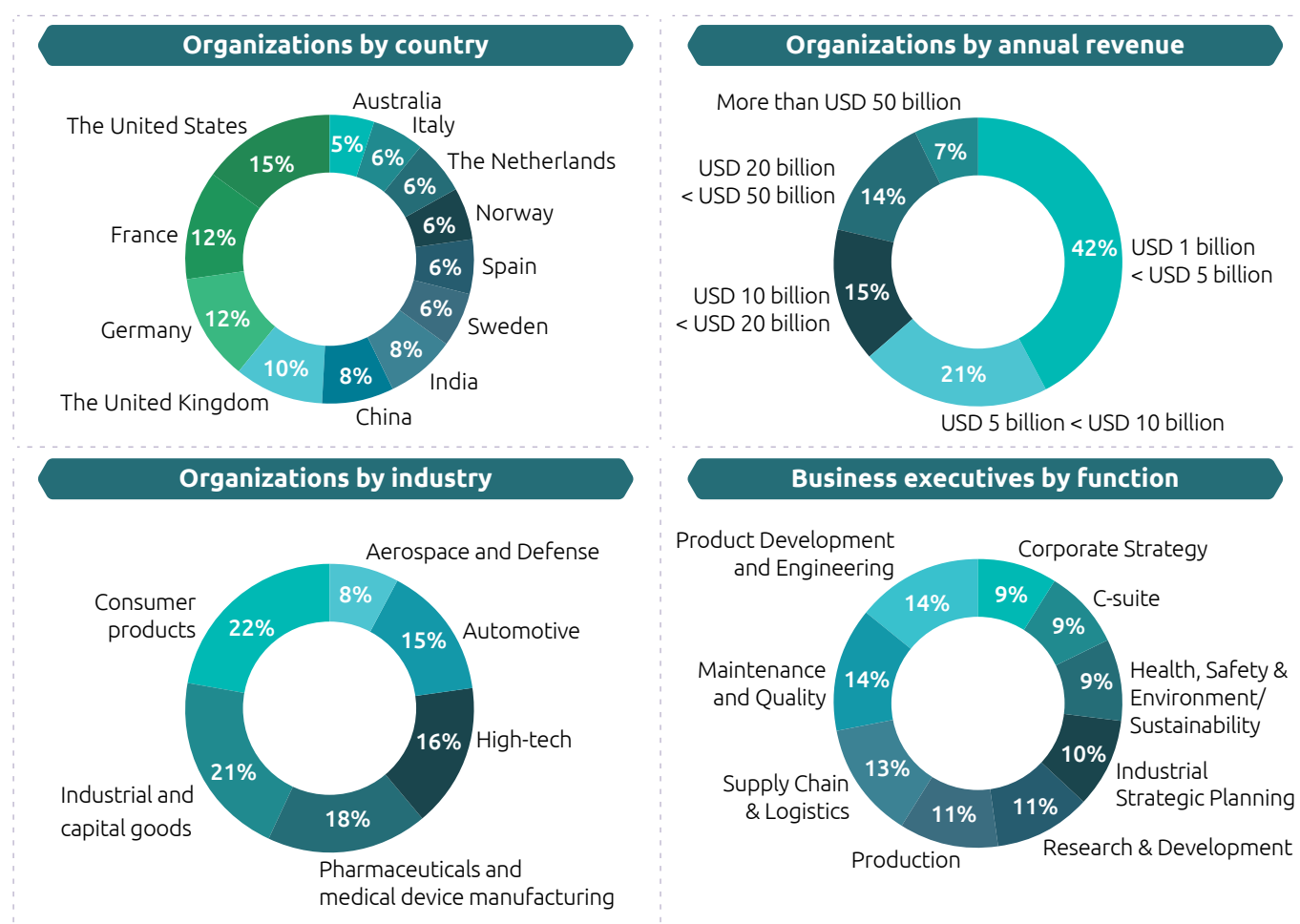
# RESEARCH METHODOLOGY

We carried out an extensive research with qualitative and quantitative components. We conducted two executive surveys of business and sustainability professionals – both

from the same organization. Our focus was on the experience and priorities of both these executives.

## Executive Survey

We surveyed 1,000 executives from large manufacturers. Out of these, 480 organizations surveyed were represented by an executive from the business-facing side and one from sustainability functions.



Source: Capgemini Research Institute, Sustainability in Manufacturing Operations, Sustainability executives survey, Business executives survey, February–March 2021, N=480 organizations.

## In-depth interviews

We conducted 15 in-depth interviews with senior sustainability executives from various organizations. These were experts in the field of manufacturing and sustainability.



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The authors would like to especially thank Paul Hermelin, Florent Andrillon, Reinhold Pfeiffer, Volker Darius, Jean Pierre Petit, Ralph Schneider-Maul, Sanjay Salunkhe, Vera Schneemann, Sylvie Cabral, Jacques Mezrahi, James Robey, Clement Falquet, Walid Negm, Jeff Larsen, Rainer Mehl, Diederik Veleers, Pierre Bagnon, Sebastien Neyme, Sanjeev Gupta, Manuel Chareyre, Julian Relph, Ramon Angel Antelo Reguengo, Damien Dieryck, Susan Beeston, Vikas Kumar, Jean Luc Chabaudie, Anne-Laure Cadene, Nicolas Bonneau, Sascha Kaus, Philipp Gehrmann, Mark Fischer, Konstantin Bergmann, Subhankar Pal, Dominik Nostadt, Maxime Wyka, Katharina Schuback, Valerie Lavaste, Nicolas Bontikous, Deniz Rall and Andrew Hill for their contribution to this research.

The authors would also like to thank Vivek Kotru, Frédéric Arquier, Emmanuel Lochon, Dan Chamberlain, Ralf Bus, Dan Brennan, Arthi Singh, Maria Adolf, Yi Liu, Chitty Cao, Florian Baars, Amol Khadikar, Nancy Manchanda, Amrita Sengupta, Gaurav Aggarwal, Tarun Kumar, Megha Gandhi, Ankita Fanje, and Soumik Das for their contribution to this research.

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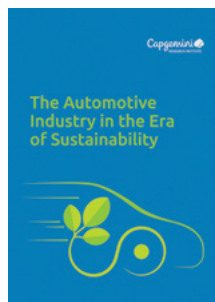
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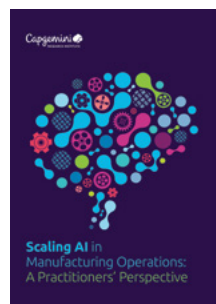
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