

SUSTAINABLE MANUFACTURING PRACTICES

Delivering on Carbon Neutral Goals

MAY 2022

Executive Summary

Industrial companies are coming under increasing pressure from regulators, consumers, job seekers, and investors to reduce their heavy carbon footprint. The fact that the sector accounts for more than half of all energy consumption and one-fifth of greenhouse gas emissions globally reveals the enormity of the task. At the same time, making progress holds the promise of a sizeable reward.

To gain a more textured understanding of where industrial companies stand on decarbonization, the Manufacturers Alliance recently partnered with Infosys to take a deep dive into the topic. We surveyed almost 200 companies and conducted one-on-one executive interviews with companies in both the process and product manufacturing sectors.

Our top-level findings reveal that companies are eager to lower their carbon footprint, but many are stalled — unable to move from visibility to transparency and analysis to action. They are actively looking for best practices that can be shared across industries and scaled for a range of company sizes.



Key Findings

- The vast majority of manufacturers we surveyed are already tracking their direct (Scope 1) and indirect (Scope 2) emissions.
- Tracking the enormous category of Scope 3 emissions — those upstream and downstream of the factory gates — is the most difficult area to master, and most have not started. Notable exceptions include the Automotive and Aerospace industries, which are focusing on Scope 1, 2 and 3 emissions, roughly double the rate of the rest of our sample.
- The top three challenges cited as impediments to action included the inability to measure all related factors, the lack of resources to tackle goals, and unclear ownership and roles inside the company.
- Over the next three to five years, the most frequently mentioned projects include improving energy efficiencies (e.g. renewables, lighting), reducing the overall environmental footprint (e.g. energy, packaging, water) and making operational updates (e.g. vehicles, shipping, suppliers, scrap).
- Digital technologies are the key to tracking and reducing carbon emissions due to their inherent ability to increase transparency and accelerate decision making.

This report explores how manufacturing companies are addressing the decarbonization imperative, which programs are on the near-term horizon, where they have surmounted obstacles, and why leaders in this space view sustainability as an enabler of both short- and long-term performance gains.

Sustainability Progress Hinges on Technology, Skillsets, and Collaboration



Manufacturers face an array of challenges these days, including ongoing supply chain disruptions, skilled talent shortages, and historic increases in prices. To these significant operational issues, add the surging attention commanded in boardrooms by corporate Environmental, Social, and Governance (ESG) initiatives.

Sustainable investing is now a \$35 trillion market globally, on track to **reach \$53 trillion** by 2025, according to Bloomberg. Morgan Stanley notes that a **full 79% of investors** are focused on sustainable assets with particular interest expressed by Millennial investors — 99% — an all-time high. Moreover, the U.S. Securities and Exchange Commission is in the process of evaluating new requirements for climate change disclosures as part of its integrated disclosure system. The EU approved disclosure requirements in 2019 through its **Sustainable Finance Disclosure Regulation (SFDR)** as a method of driving capital toward sustainability-oriented investments.

It's not just the investor community that is driving change. Governments worldwide have prioritized climate change. Increasingly, consumers are showing a preference for brands whose products

are better for the planet. Likewise, job seekers are looking for career fulfillment by joining organizations with strong sustainability objectives. Exciting new business models and technologies are making it possible to address climate change while also improving the bottom line. Some companies are achieving this by driving down energy and water use; others are slashing costs through the reuse of materials. And some of the most intriguing examples are pure-play sustainability companies and **well-performing ESG SPACs** (special purpose acquisition companies) that are galvanizing investor attention to new technologies that address the carbon problem.

Manufacturing is under intense pressure to act. Global **manufacturing and production account** for 20% of greenhouse gas emissions and 54% of energy consumption. Last year was one of the **seven warmest years on record**, according to the World Meteorological Organization, even with large swaths of the global economy operating at reduced levels due to the pandemic. As manufacturing reaches pre-pandemic levels of production, all eyes are on industry to make substantial progress.

Sustainable manufacturing today: A mixed bag

To gain a more textured understanding of where manufacturers stand in terms of decarbonization, the Manufacturers Alliance recently surveyed almost 200 companies about where they have made the most progress and where they encounter the toughest challenges. ***Our top-level findings reveal that companies are eager to lower their carbon footprint, but many are stalled — unable to move from visibility to transparency, analysis to action. They are actively looking for best practices that can be shared across industries and scaled for a range of company sizes.***

The purpose of this report is to help manufacturers speed up their progress toward setting and executing on their Scope 1, 2, and 3 emissions goals. We dig into the most promising areas of advancement, identify common challenges, and share advice from manufacturing executives who found early success in meeting specific sustainability targets.

Nearly half of manufacturers responded that they are well on their way with plans to enlarge their sustainability initiatives, such as more detailed measurement of Scopes 1 and 2. Indeed, 28% are expanding efforts beyond their own factories and operations to areas such as tracking Scope 3 upstream and/or downstream emissions.

Companies' current status on carbon footprint initiatives and strategies

We are expanding our initiatives beyond our factories and operations
(e.g., tracking Scope 3 upstream and/or downstream)

28%

We are exploring how to expand our carbon footprint initiatives
(e.g., more detailed measurement of Scope 1 and 2)

45%

We are just getting started with our carbon footprint initiatives
(e.g., less than 2 years measuring footprint)

27%

Defining Scopes 1, 2, and 3

Scope 1: Direct emissions from each company's own operations, such as fuel combustion on-site for gas boilers, fleet vehicles, and air-conditioning leaks

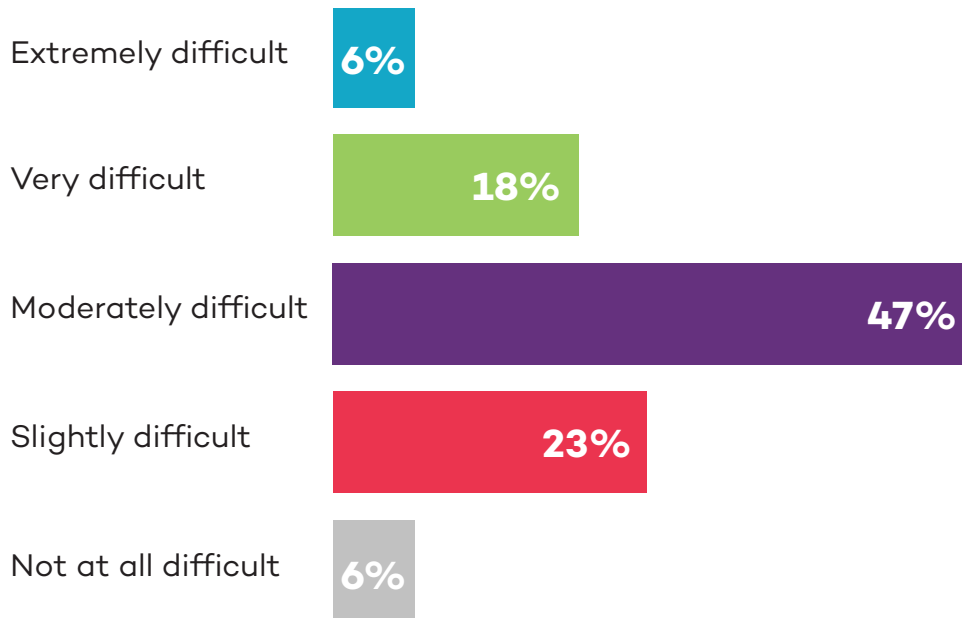
Scope 2: Indirect emissions from energy used by the company, such as heating and cooling for buildings

Scope 3: Indirect emissions in their upstream supply chain as well as the downstream impact of their products

At the same time, even as companies work to gain carbon transparency in their own operations, what happens beyond the factory gates remains opaque to most. This is especially true where indirect downstream activities are concerned, such as transportation, use, and end-of-life treatment of products.

More than 70% said it was moderately or extremely difficult to capture the carbon footprint of the product after it is sold. When it comes to tracking this footprint, 72% acknowledged they have no system in place. Since Scope 3 forms the majority of emissions for most companies, **in some cases 85%-95%**, more progress is urgently needed in this area.

Companies rank difficulty in capturing products' carbon footprint



Game-Changers

Digitalization is rocket fuel for progress. “The game changer in sustainability and cutting greenhouse gas emissions is digital,” according to Katie McGinty, Vice President & Chief Sustainability, Government and Regulatory Affairs Officer at Johnson Controls. McGinty highlighted her company’s strategic partnership with Infosys, which has been in place for more than 20 years.

“Through this 360° partnership, we are able to take even the most efficient piece of equipment and turn it into a powerhouse. The result is a further 50+% reduction in emissions because we are optimizing across the entire system.” Johnson Controls’ decades long focus on sustainability has enabled them to reduce greenhouse gas intensity by 70% and energy intensity by 50%. Sustainability is integrated into the fabric of everything they do and accounts for 75% of all of Johnson Controls’ new product R&D.



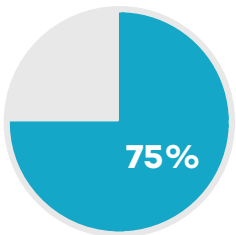


Getting started: How to fast track sustainability

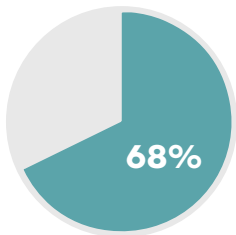
We found widespread agreement with the statement “sustainability goals, including carbon footprint, are part of the company’s culture and best practices.” Significantly, this statement rang true

across all industries and company sizes — a sign that the imperative for sustainable manufacturing has permeated the thinking of industrial companies as a whole.

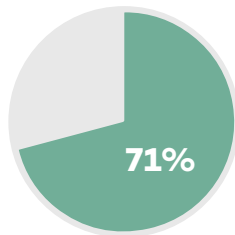
Companies’ current carbon footprint strategy and status



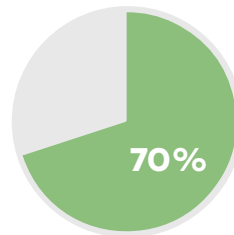
Sustainability goals and carbon footprint are part of the company’s culture and best practices



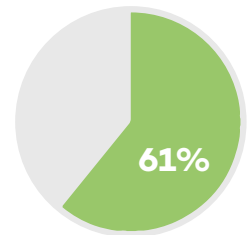
We have enough people and skills to measure, report, and support our sustainability goals



We are confident in the accuracy of our carbon footprint KPIs and metrics



We have a well-defined strategy and metrics for our carbon emission goals



We have all the necessary technology and IT support to measure our emissions

When asked to assess specifics such as technology tools, staffing, and metrics, progress varied. For example, 25% told us they did not possess the necessary technology and IT support to measure their carbon emissions. And in cases where raw data is available, teams often lack the technology to mine it for insights.

Many respondents mentioned insufficient resources and bandwidth to support their company’s sustainability goals as a critical hindrance to progress. The talent shortage in manufacturing has been with us for well over a decade, but in the sustainability space in particular, manufacturers encounter difficulty finding people to measure and report

sustainability KPIs. Even when these functions are staffed, sustainability ownership and roles within the company often lack definition. There is clearly tension between the C-Suite, which sometimes wants to make bold promises, and the operations teams, which seem to lack the staff, budget, and tools to turn those promises into real world progress.

One recurring bright spot amid the challenges is the renewable space. When asked about projects on the horizon, 17% of respondents mentioned adding more renewable energy sources either through purchasing green energy or installing renewables onsite (rooftop solar, fuel cell, cogen, etc.) for near-term progress.

An early leader here is Xylem, which has committed to 100% renewable energy

and 100% process water recycling at its major facilities in its 2025 signature goals. We spoke with Claudia Toussaint, Xylem's Senior Vice President, Chief Human Resources and Sustainability Officer, about the company's approach. "For us, electricity use is the largest contributor to greenhouse gas (GHG) emissions. By reducing energy consumption and increasing investment in renewable energy, we hope to significantly lower our GHG emission intensity levels. We are making good and steady progress, with 10 out of our 22 major facilities now operating on 100% renewable energy," Toussaint said. Xylem was able to achieve this result by doubling down on their commitments and embedding sustainability into the company's business operations and functions.

Top projects to reduce carbon emissions over the next 3 to 5 years

27%

Energy Efficiencies

(Renewable energy, solar power, heating/cooling or lighting upgrades, etc.)

32%

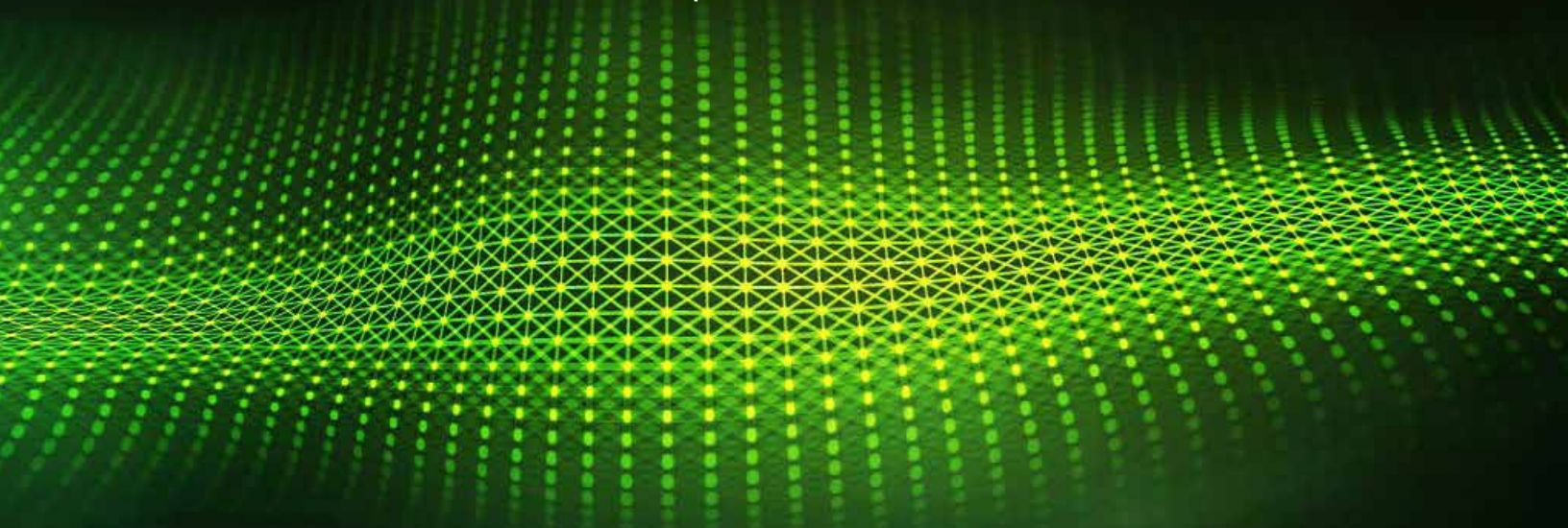
Reducing Overall Footprint

(Reducing fossil fuels, packaging, combustion, waste water, electric consumption, etc.)

27%

Operational Updates

(Updating vehicles, consolidating shipments, optimizing supply chains, reducing scrap in production, etc.)



Dealing with challenges and demolishing impediments

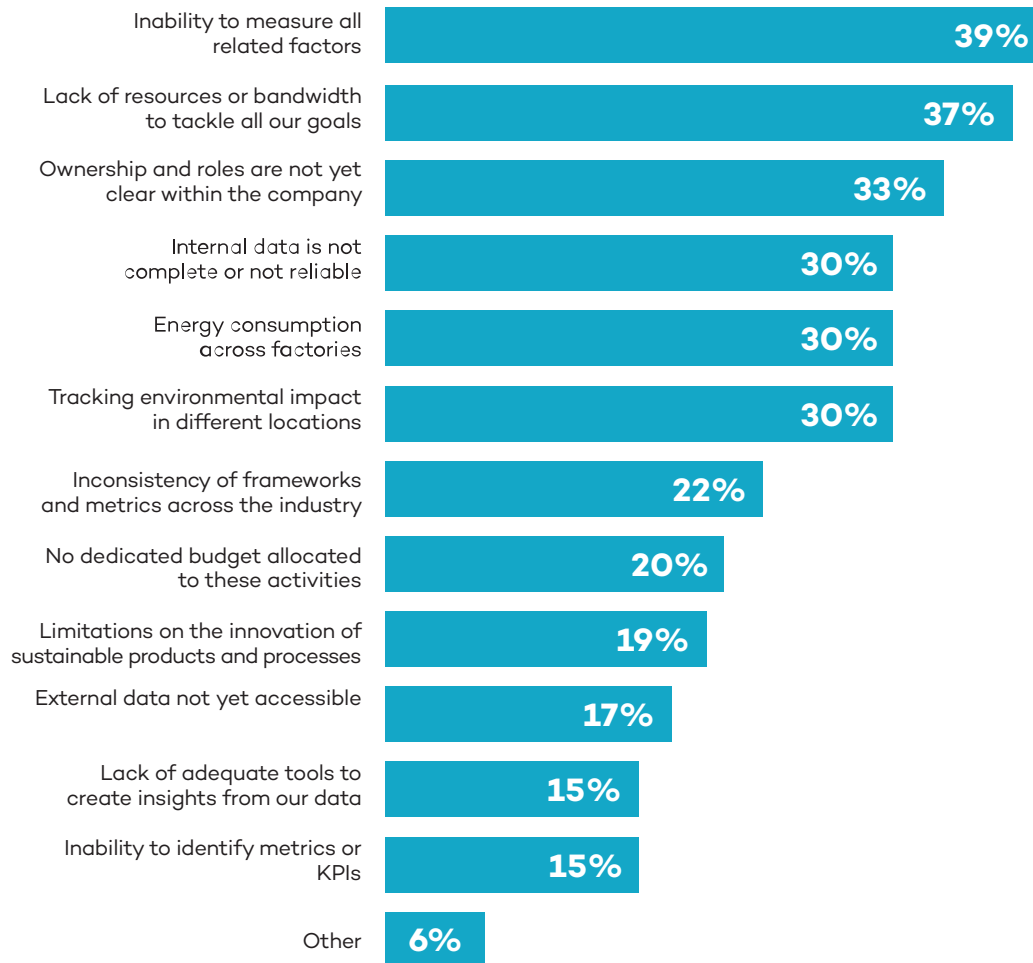
A surprisingly high share of respondents (20%) told us that they had no dedicated budget allocated to activities supporting their company’s sustainability agenda. This may result from the “too many buckets” phenomenon referring to the fact that there is no single, typical organizational unit for sustainability to reside. According to **research Manufacturers Alliance conducted** in late 2021, while almost a third of sustainability functions report to legal, sometimes the role falls under operations (14%), or EHS (11%), each of which approaches the task from a different core function mindset, skillset, and budget.

With funding in short supply, it should come as little surprise that transparency often suffers. Respondents said it is challenging to track energy consumption and environmental impact across factories and locations. In many cases, this means that internal data is incomplete, unreliable, or both, according to 30% of respondents.

Beware of low-hanging fruit

When it comes to finding a budget to support sustainability activities, Jim Ego, Head of EHS at Plexus, shared an important lesson learned: Be strategic about the sequencing of projects. “Don’t go after all the low-hanging fruit at once. It’s really tempting to run out there and try to do all the projects that have an easy ROI first. But in your next phase, your projects don’t have any ROI anymore and can be harder to justify. Save some of those easier ones and bundle them together with the more capital-neutral/capital-intensive projects.”

Challenges to advancing carbon footprint goals

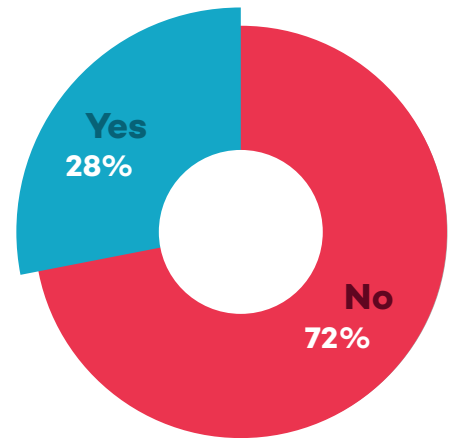


Scope 1, 2, 3: What is and isn't being tracked

The vast majority of manufacturers we surveyed are already tracking their direct (Scope 1) and indirect (Scope 2) emissions. The methods by which they track these emissions vary significantly including manual tracking (e.g., spreadsheets), third-party software, or, as most respondents indicated, a combination of the two.

When it comes to Scope 3 emissions, both upstream and downstream, respondents generally told us that tracking is much more difficult if not impossible right now. Most have not started — with some significant exceptions in Automotive and Aerospace (see below).

Do companies have a system in place to track the carbon footprint of their products?



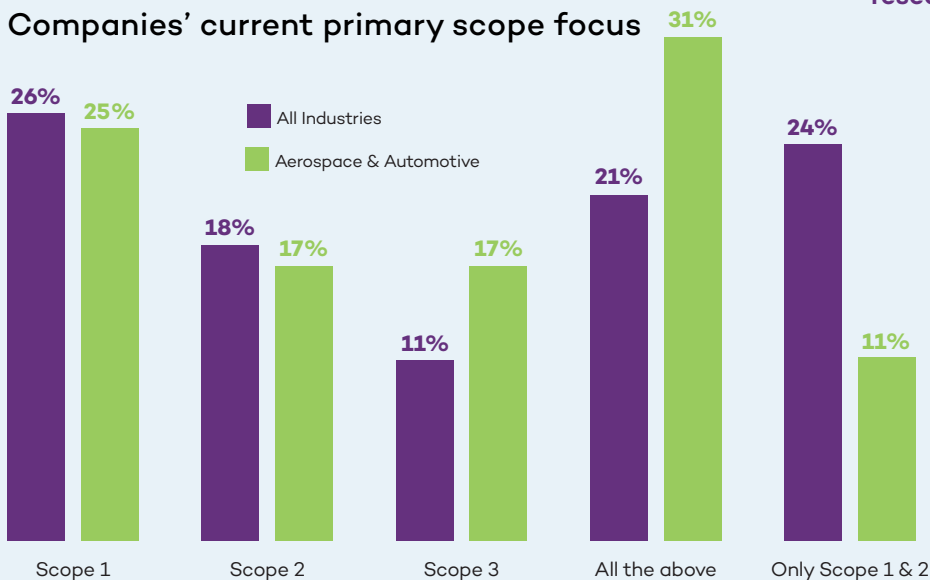
Automotive & aerospace — Ahead of the pack on Scope 3

Automotive and aerospace are great examples of sectors that have offered such transparency. They have also made significant strides in measuring Scope 3 emissions. Unlike other manufacturers that have focused strictly on Scope 1 and Scope 2, more than 30% of automotive and aerospace companies told us they're focusing on all three, roughly double the rate of the rest of our sample.



This is good news since road and aviation mobility accounts for some 88% of all mobility emissions according to **recent research** from McKinsey.

Companies' current primary scope focus



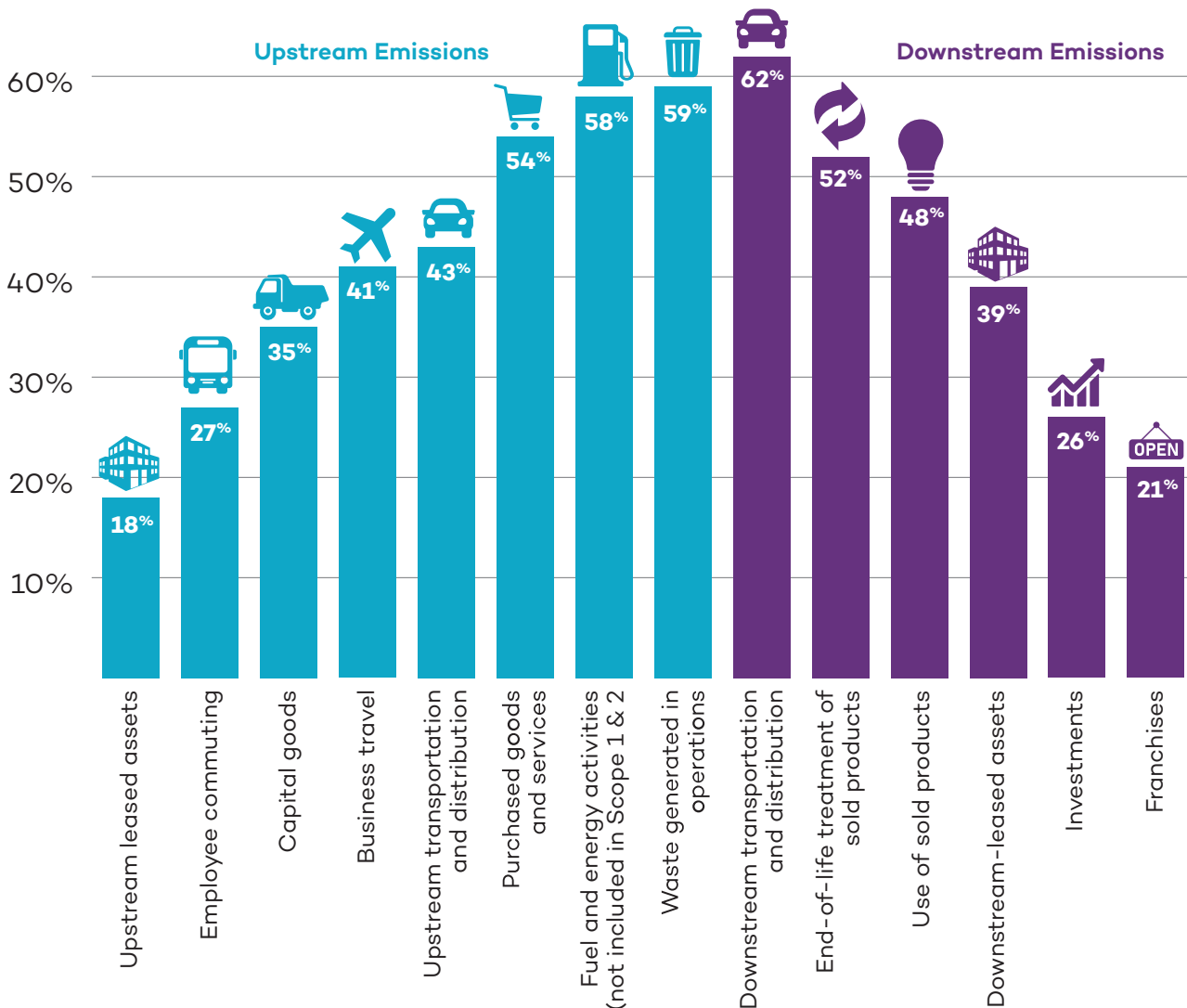
Commonly tracked Scope 3 areas were downstream transportation (62%), waste generated in operations (59%), fuel and energy related activities (58%), and purchased goods and services (54%). But companies have made less progress in other Scope 3 areas. This is due in part to the complexity of the task, murky definitions, and fragmented sustainability reporting frameworks. As one EHS director quipped in an interview, “I’m a Pareto chart kind of guy. I’d rather spend more time on the big things than worry about where one bolt came from.”

At the same time, respondents clearly know that the pressure is on to start tracking Scope 3. As Jim Ego at Plexus told us, to get Scope 3 right, “we all have to

work together to figure out where to draw the lines and determine which company is responsible for a particular piece of a product’s carbon footprint.” It will take a high degree of collaboration to avoid massive double counting of emissions.

As prices of rare materials soar, the focus on use of sold products and end-of-life treatment will gain steam. An example is lithium, used in electric vehicles, which saw a **500% price increase** between 2021 and 2022. As this case makes clear, getting more granular about Scope 3 can sometimes be a sustainability project that not only sells itself, it can also help fund other items on the decarbonization to-do list.

Scope 3 downstream and upstream emissions — what is being measured





Plexus: From pilot to global rollout

The Plexus experience with reducing GHG makes one thing very clear: It all starts with transparency. We spoke with Jim Ego at Plexus about his company's approach. Plexus's **enterprise-level sustainability objectives** aim to decrease energy and resource consumption, limit greenhouse gas emissions, conserve water, and reduce waste.

To gain a better understanding of its current Scope 2 emissions, Plexus is installing an energy submetering system throughout its plants worldwide, a \$1.2M investment in 2022. "These systems allow us to see energy utilization down to the equipment level," Ego explained. "With this technology, I can look at a wave solder machine, see exactly how much energy it's using and compare it against another wave solder machine nearby." If one is using more energy than the other, that indicates the need to do maintenance or replace a machine. These insights help Plexus reduce its energy consumption while also providing actionable data that can be used to prevent unplanned downtime in the event of machine failure.

Plexus is basing this global initiative on a pilot project started in 2020 in Kelso, Scotland, which yielded a 20% reduction in energy use. As Ego pointed out, the submetering project gave Plexus a full picture of its energy usage. "We didn't need to adjust the thermostat by a degree or make major capital investments. We just needed to have a better understanding of where and how we use energy to reduce it by 20%," Ego explained. This same technology is giving Plexus a clearer picture into its natural gas and water usage as well.

Plexus is proactively thinking about ways to design its customers' products to improve sustainability. Can something be manufactured with materials that make it a better candidate for reuse (versus recycling or landfill)? These are the types of considerations that Plexus can offer its customers as options during the product design phase. As more companies express the desire for more sustainable products, this proactive approach can be a triple win, for Plexus, its customers, and the environment.



Gaining ground: Pull ahead of the rest and learn from the best

What is driving success? A few key areas stood out. The most common practice cited by 63% of companies is defining metrics, milestones, and KPIs. It is also important to check in regularly with internal stakeholders. According to 55% of respondents, the key is to consistently evaluate metrics with these stakeholders to make sure programs stay on track.

The materiality assessment can play a critical role here. David Harvey, EHS Director at The Greenbrier Companies, stressed that a materiality assessment can assist in reconciling perspectives from internal and external stakeholders, including Greenbrier leadership, customers, suppliers, and community leaders, to determine the most relevant topics to address in Greenbrier's ESG program. As a result of this approach, Greenbrier has been able to increase recycled steel content 4 percentage points in a one-year span, from 47%

in 2020 to 51% in 2021. Steel is the company's largest natural resource usage and its most energy-intensive upstream input. Growing recycled steel content is an identified focus area in Greenbrier's ESG strategy.

“Be thoughtful with your rollout strategies to leaders. Your goals impact their business. Get third party verifications of carbon metrics early on. It's difficult to tell leaders that your historical data is wrong.”

— *Survey respondent*

As Greenbrier and other companies made clear, getting away from any type of manual tracking is a must. That includes adopting analytics tools to improve the accuracy of metrics, investing in technology to help track emissions, and engaging external consultants for best practices and resources.

Having these tools and resources in place also makes companies more accountable and transparent. As Scott Tew, Managing Director of the Center for Energy Efficiency and Sustainability at Trane Technologies told us, accountability to track metrics and becoming more transparent are great ways to make progress. “Deciding to be more transparent by sharing where you are is a great step toward engaging other companies who may be doing better than you. You can’t really have those conversations until you’re willing to say where you are,” Tew said.



39%

Importance of Strategy & Buy-In

When asked about lessons learned, 39% of respondents gave answers that related to strategy and buy-in, including creating a strategic plan, measuring successes, aligning the project for proper support in the organization, being persistent and flexible, and highlighting the value — importance not dollars — of the on-going work.

Practices companies are implementing to support carbon emission goals

63%	Define metrics, milestones, and KPIs	34%	Engage with an external consultant for best practices and resources
60%	Define a plan and strategy with short and long-term deadlines	29%	Collaborate with a third party (e.g., distributors) to get access to external data
55%	Consistently evaluate metrics with internal stakeholders	27%	Consistently evaluate metrics with external stakeholders
51%	Educate employees on the practices and importance of sustainability goals	27%	Dedicate resources in product development (e.g., invest in sustainable raw materials)
46%	Allocate budget to continue to move forward with goals	24%	Increase the number of FTEs dedicated to tracking and reporting sustainability activities
38%	Invest in analytics tools to improve the accuracy of metrics	18%	Partnering with education programs
37%	Invest in technology to help track emissions	3%	Other



The path to Net Zero is bold, collaborative, and digital

Smart companies are viewing sustainability targets not as a burden but as an opportunity. Take Caterpillar, for example, which produces diesel engines and might be expected to have a tough slog in a world that is decarbonizing. But as **Caterpillar's CFO Andrew Bonfield** put it recently, "If you think about the commodities that need to be produced to drive electric batteries, that's an opportunity for us within our mining business... [Also], we are an integrator of technologies... We move dirt and moving dirt requires a lot of other things."

Trane Technologies has turned decarbonization into a pureplay business. According to Scott Tew at Trane Technologies, it all starts with an "essential understanding that sustainability provides a new lens to think about how to provide customer solutions differently." Gone is the strict focus on equipment and components. A full picture must include new types of sensors and monitors, data analytics, servicing, managing, and maintaining equipment. "All of those things together create a sort of exponential growth and efficiency for reducing emissions," Tew said.

One critical success factor for Trane Technologies has been integrating sustainability into existing processes, especially product development. "If you want to change your future product

offerings, how they are built, and how they operate, you have to first work on changing the product design process," Tew said. That means putting aside existing process tools, checklists, stopgaps, and information.

The way a company interacts with its supply chain is also essential for success, according to Tew. Trane Technologies views its entire value chain as its responsibility. It all starts with a clear view of who can be a supplier. Preferred suppliers must accept the same ambitious operations targets set by Trane Technologies. When a smaller partner has difficulty meeting some of these, such as the energy reduction targets, Trane Technologies provides resources, partnerships, and quarterly webinars to help them figure out how to improve.

Several executives mentioned the power of industrial companies starting to act as an ecosystem moving toward the goal of decarbonization. Sameer Ralhan, Senior Vice President, Chief Financial Officer of The Chemours Company, underscored this point. "We believe the majority of suppliers, especially the large suppliers, are in a similar boat. So, actually it's a very constructive dialogue," he said. "The sooner our suppliers can move, the better it is for us and the industry. We're spending a lot of time with our supply chain partners on this question."

CONCLUSION

Investment in Digital Technologies Will Increase Sustainability and Competitiveness



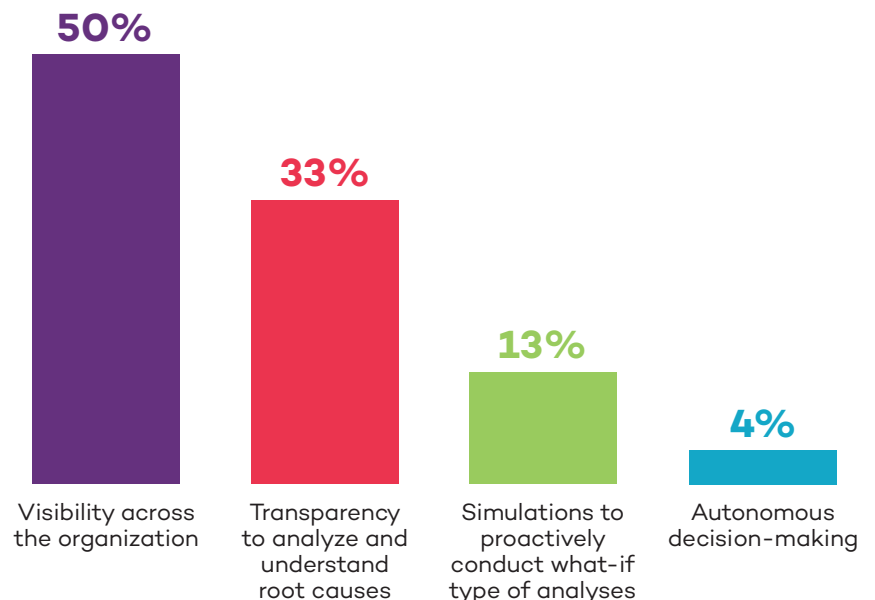
As the body of evidence from our survey and interviews makes clear, digital technologies are the key to tracking and reducing carbon emissions. These technologies give manufacturing real-time **visibility** into what is happening on the plant floor. They also provide **transparency** at the operational level, turning data into knowledge and explaining why something is happening. The next step is performing **simulations** as well as “what-if” analyses, testing ways to reduce a company’s carbon footprint in the virtual world before taking action in the physical world. Ultimately, companies can combine these technologies with AI to enable **autonomous decision making** in an environment where human intervention may be needed only rarely.

These four stages can form the basis for a sustainability **maturity model** similar to those created for digitalization, such as the one developed by Infosys **for Industry 4.0**. The connection between digitalization and sustainability should not be surprising given the increases in productivity and circularity inherent digital technologies.

The good news is, many companies in our sample are making progress in exactly these areas. Already, 45% of the companies we surveyed are mining the vast quantities of manufacturing data at their fingertips to track and monitor

their emissions, using Internet of Things technology to measure key parameters (34%) and tapping AI and machine learning to advance autonomous decision making (26%). Some are using digital twin software to create virtual replicas of physical systems and perform simulations (16%). For those that have not yet implemented any of these approaches (38%), investment in digital will be critical to avoid missing out on these vital sustainability and performance gains.

Maturity model: Companies report the status of their carbon emission tracking



Sustainability is the wave of the future for manufacturing. The industry is making bold, significant advances to reduce their carbon emissions with many making commitments to Net Zero. Manufacturers have been reporting on their progress without well-defined external guidance or strategies and formalized frameworks. The **SEC's proposed climate disclosure rule**, announced in March 2022, will require companies to disclose climate-related risks and GHG emissions in their financial statements. Such a requirement will provide further impetus for manufacturers to invest in technologies to address the issue.

Technologies to decarbonize and track sustainability data can do double duty to boost productivity and performance overall. Modernizing for sustainability starts to look less like a drag on operations and more like a competitive enhancer. The old thinking that environmental responsibility is at odds

“I think we were like a lot of manufacturing companies in the beginning. We were always thinking incrementally — how can I do 3% better than last year? It’s hard to break out of incremental thinking. We learned that setting big, bold commitments engages your employees unlike anything else. They begin to rally behind the commitment. Behaviors change.”

— *Scott Tew, Trane Technologies*

with productivity and competitiveness is being replaced by an awareness that strong sustainability performance is not only good for the planet, but also good for the bottom line.

Recommendations for Action



Design clear metrics, milestones, and KPIs. Perform a materiality assessment to serve as a baseline upon which to measure progress.



Align with your most important stakeholders. Involve them in the development of your roll-out strategy. Check in with them often to maintain buy-in.



Recalibrate your focus to view your business through a sustainability lens and gain new perspectives on your culture, portfolio, product development, supply chain, product end-of life, etc.



Get away from manual tracking and invest in digital technologies that allow you to progress from visibility, to transparency, to simulation, and to autonomous decision making.



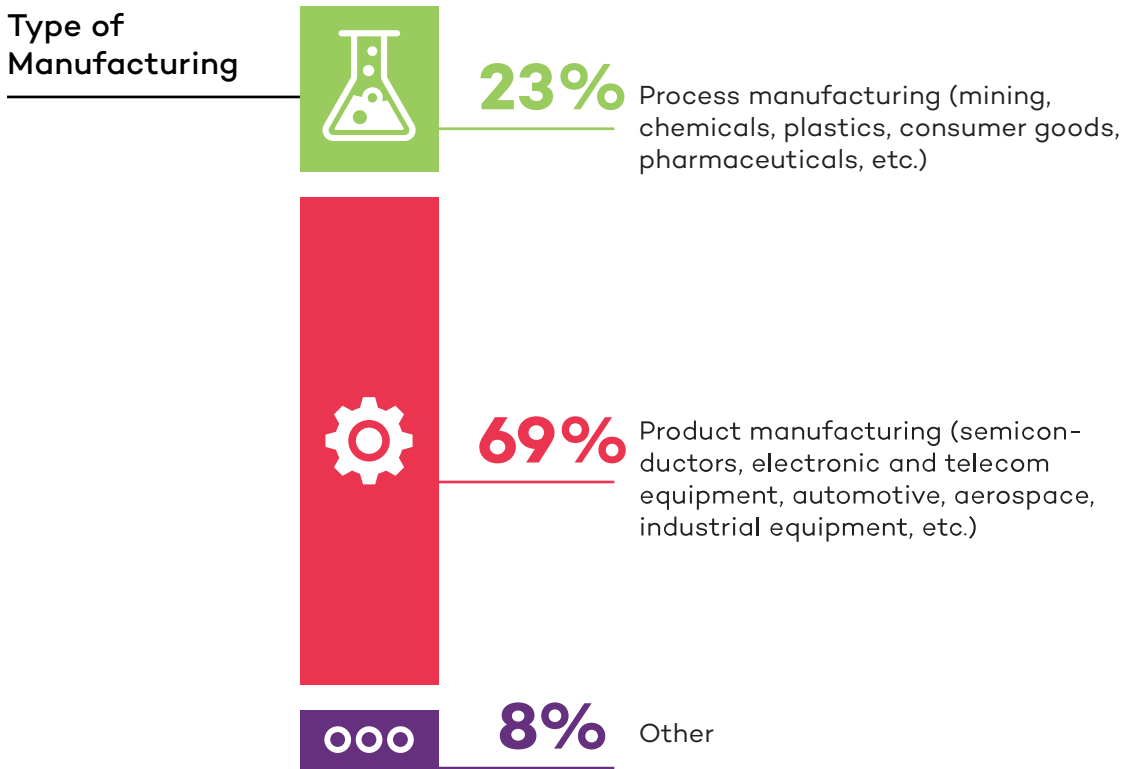
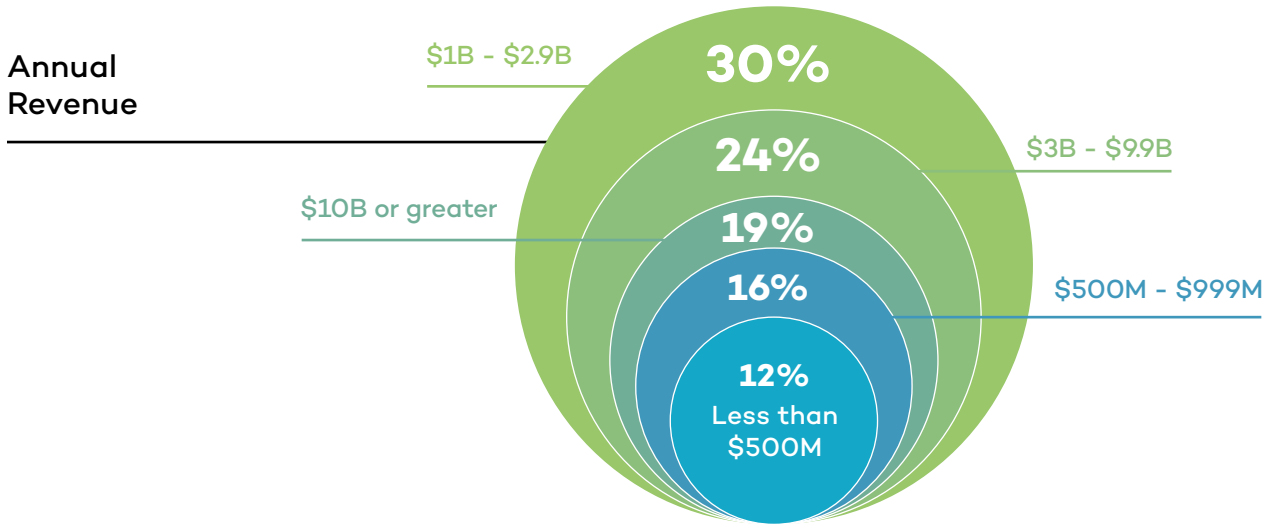
Embrace transparency and collaboration throughout your supply chain by sharing your best practices and discussing your challenges so that you can teach and learn from others.



Harness sustainability goals to energize your employer branding, increase competitiveness, and improve productivity.

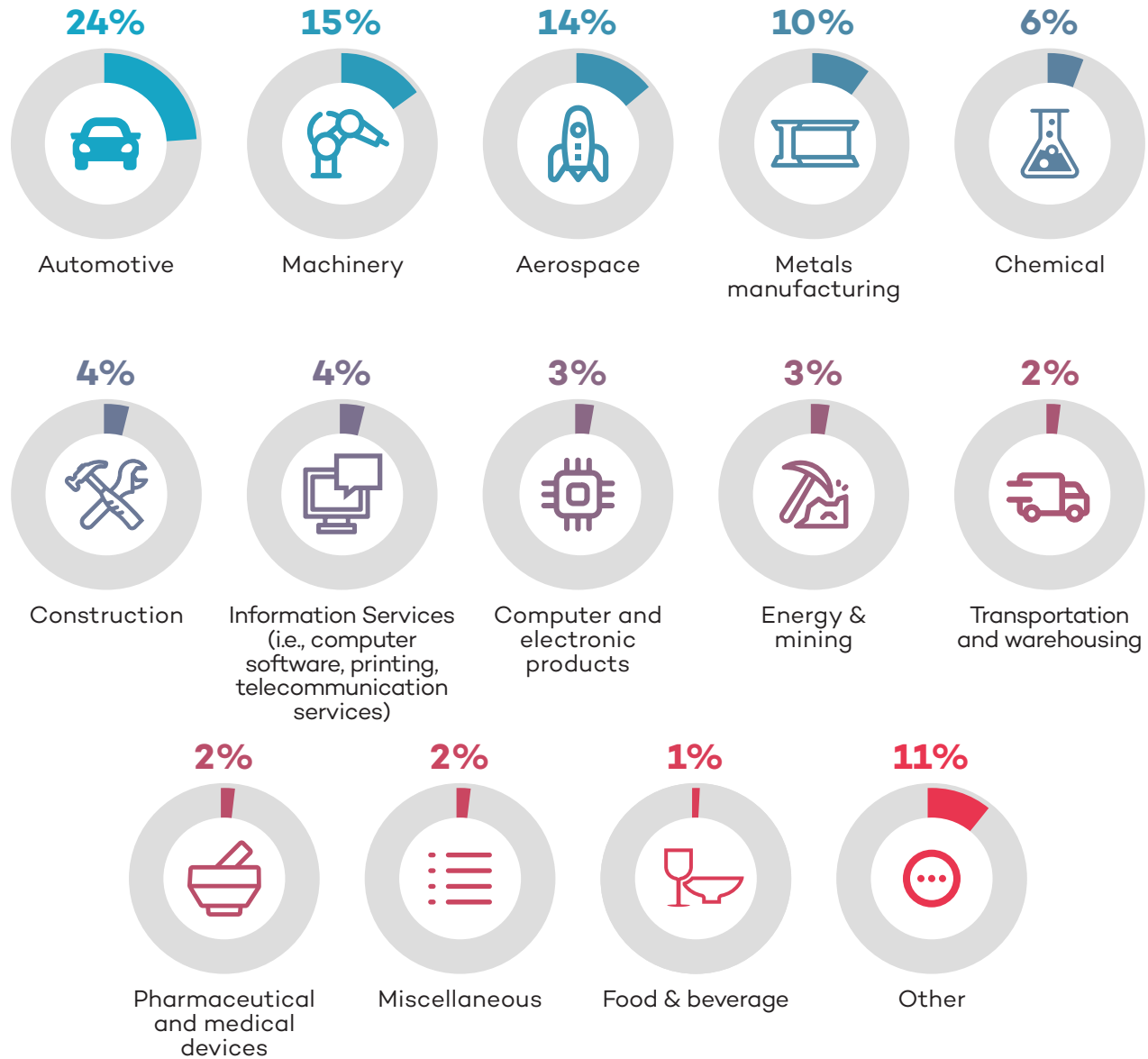
About the Survey

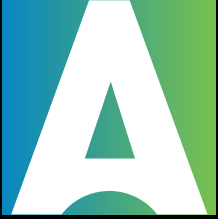
Manufacturers Alliance and Infosys surveyed almost 200 leaders in manufacturing to better understand their carbon footprint strategies, tactics, and best practices to measure scopes 1, 2, and 3. The Alliance has highlighted some statistics about the companies surveyed.



About the Survey

Primary Industry





Manufacturers Alliance Foundation is the 501(c)(3) partner of Manufacturers Alliance. The Alliance Foundation provides educational opportunities for the manufacturing community and its stakeholders through insights, events, and tools for today's most critical business decisions. The Alliance Foundation focuses on talent, technology, digital transformation, and competitiveness. For more information, visit ManufacturersAlliance.org/foundation.

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