

The Intel logo, consisting of the word "intel" in a lowercase, sans-serif font, is centered within a dark blue rectangular box. The background of the entire page is a light blue gradient with a repeating pattern of binary code (0s and 1s) and small circular icons containing binary sequences. A stylized illustration of a hand holding a laptop is positioned in the lower-left quadrant, with the laptop screen displaying a bar chart. The overall design is clean and modern, emphasizing technology and data.

# The Intel Sustainable Intelligence Index

Manufacturing



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# Introduction

Artificial intelligence (AI) is transforming the manufacturing sector. Advanced data-driven tools such as digital twins, machine learning (ML), and the Internet of Things (IoT) are revolutionizing the way organizations manage downtime, maintenance, and efficiency. Meanwhile, inventory and production processes are being augmented with computer vision and robotic process automation (RPA).

As the demand for AI continues to soar, so does the need for computing power, often leading to increased emissions. Manufacturing leaders are seeking ways to implement this new technology in a sustainable way, but are they also considering how AI could contribute to their company's broader sustainability goals?

At Intel, we aim to assist manufacturing leaders in implementing AI strategies with sustainability as a guiding principle. By doing this, they can win on two fronts:

## Tech zero\_



Using AI to reduce the carbon footprint of their IT function.

## Tech positive\_



Using AI as a lever for the whole organization to reach its net-zero goals and to have a positive overall impact, driving business growth and accelerating innovation.

Our previous study, *The Sustainable CTO*, identified a Tech Trilemma: knowledge, investment, and innovation. These three areas need board-level attention for organizations to fully leverage technologies for sustainable progress. By measuring sector progress across these pillars, *The Intel Sustainable Intelligence Index* highlights where leaders should be focusing efforts to advance sustainability-related AI, both within their IT function and their wider organization.

By examining the strategies of 'Visionaries' in the manufacturing sector, we can uncover valuable insights and best practices. These industry leaders are paving the way for a more sustainable future by effectively integrating AI into their operations. We are committed to sharing these learnings to help others in the manufacturing sector adopt more sustainable technology practices and reach tech positive.

**Todd Brady**  
Chief Sustainability Officer & Vice President,  
Global Public Affairs, Intel

# About the study

*The Intel Sustainable Intelligence Index* is based on an independent opinion research study carried out in 2024 by Intel, in partnership with Man Bites Dog. The research sample of 2,000 C-suite leaders was made up of 1,500 senior IT decision-makers, 250 CEOs, and 250 Chief Sustainability Officers. Respondents were from organizations across 11 sectors across 22 markets.

More information about the Index can be found in the full report, [found here](#).



## Visionaries\_

Those in the top third of the scoring range (i.e. industry leaders).



## Advancers\_

Those in the middle third of the scoring range.



## Followers\_

Those in the bottom third of the scoring range.

## Key terms

### Tech zero\_



Using AI to reduce the carbon footprint of an organization's IT function.

### Tech positive\_



Using AI as a lever for the whole organization to reach its net-zero goals and to have a positive overall impact, driving business growth and accelerating innovation.



## AI for sustainable manufacturing

# The intention-action gap

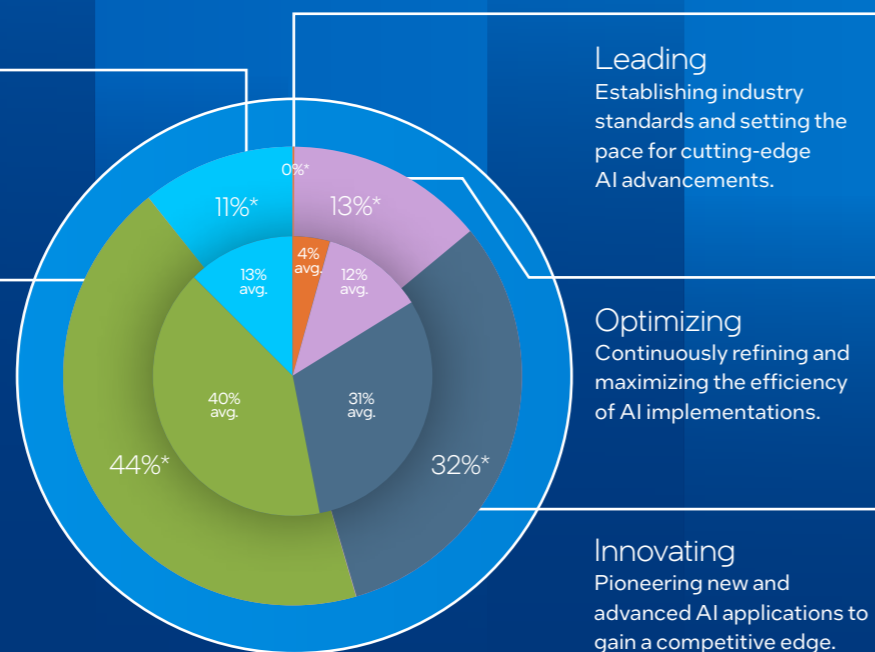
AI creates clear advantages for manufacturing. Big data analytics – fed by IoT devices and interpreted through ML algorithms – can crunch unprecedented volumes of data. Meanwhile, RPA can handle repetitive physical and digital tasks, freeing up human workers for more value-added activities. Implemented widely, AI can save manufacturing businesses significant time, money, and energy by reducing downtime, improving energy efficiency, and limiting waste.

However, many are only just beginning to integrate AI into their operations; 44% of manufacturing leaders in our study report that, when it comes to AI maturity, their organization is at the implementation stage.

### General AI maturity:

**Exploring**  
Beginning to explore AI applications and possibilities.

**Implementing**  
Actively integrating AI solutions into specific processes or functions.



\* of manufacturing businesses



It will be crucial for organizations to evaluate how AI solutions fit into their strategic vision from the exploratory stage to ensure investment is directed toward initiatives that align with overarching goals. Sustainability should be a pivotal component of this evaluation process.

Our research reveals a misalignment between organizations' *intentions* when it comes to using AI to power sustainability strategies and the *action* that is being taken.

While **69%**



of manufacturing leaders believe sustainability-related AI solutions could have a great impact on their business, only 38% report that these solutions are currently being deployed in their organization.

"Manufacturers are under three constant pressures: increasing output, reducing quality issues and lowering overall costs. When it comes to using AI for sustainability, it's important that it measurably connects to at least one of these key challenges.

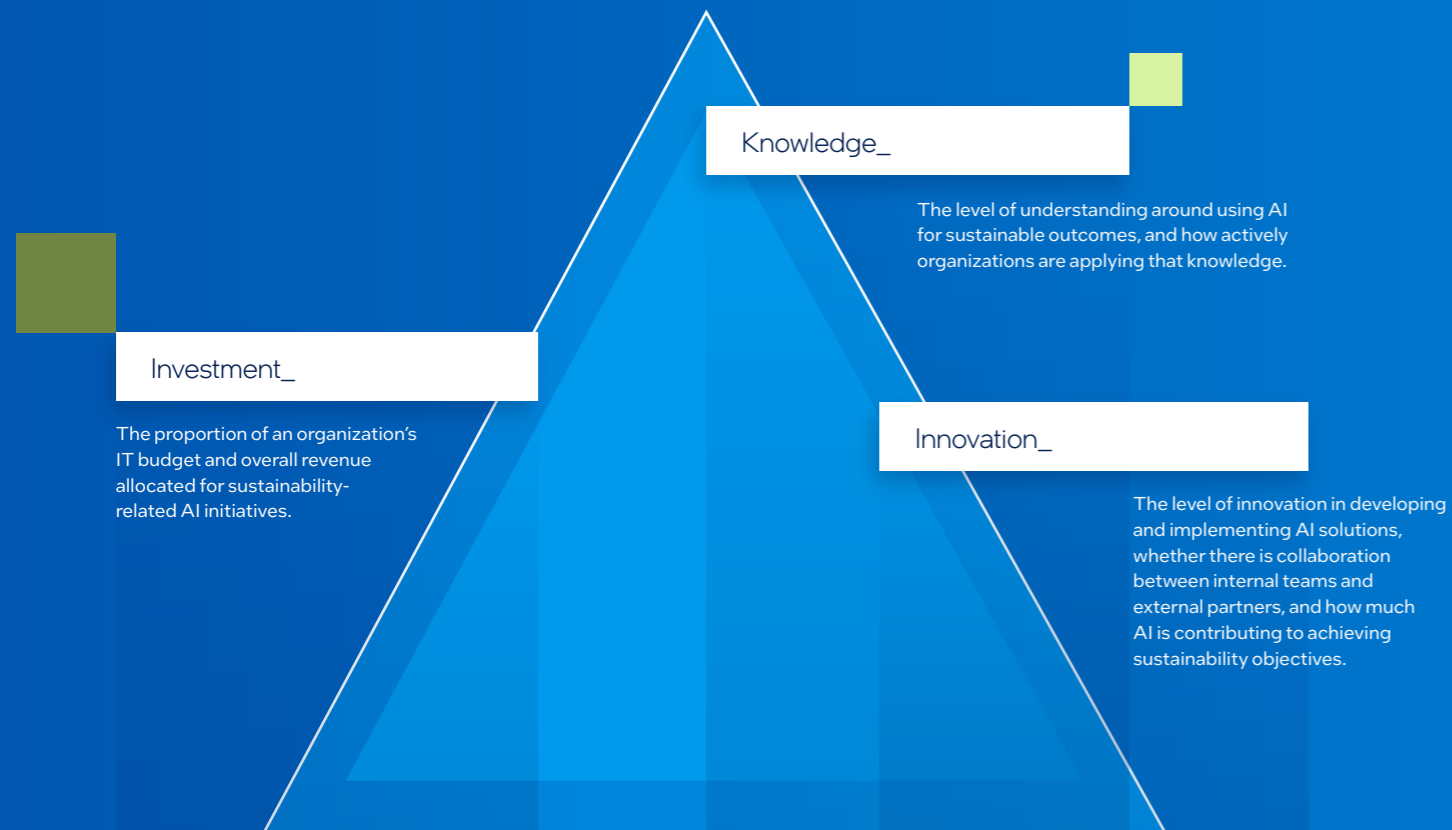
"At the moment, we're seeing this in a few ways. For example, it's easy to see how automating monitoring processes, advanced process control and Computer Vision lead to improved quality and efficiency, picking up the work of a person – or several people – that can now be moved into a more valuable role. More advanced enterprises are using Retrieval-Augmented Generation (RAG) applications, to support and speed up incident investigation and analysis.

"AI is a huge opportunity for the manufacturing sector. Most businesses aren't going to be upgrading their equipment every few years to keep up with technology leaps, but successfully introducing AI into processes acts as a 'wrapper', improving the functionality of existing machinery and increasing its lifespan."

**Jose Ramirez**  
General Manager, Manufacturing Global Solution Sales and Center of Excellence, Intel

# The Intel Sustainable Intelligence Index

The Intel Sustainable Intelligence Index ranks key sectors on their **use of AI to drive sustainability**. Sector performance is scored across three pillars:



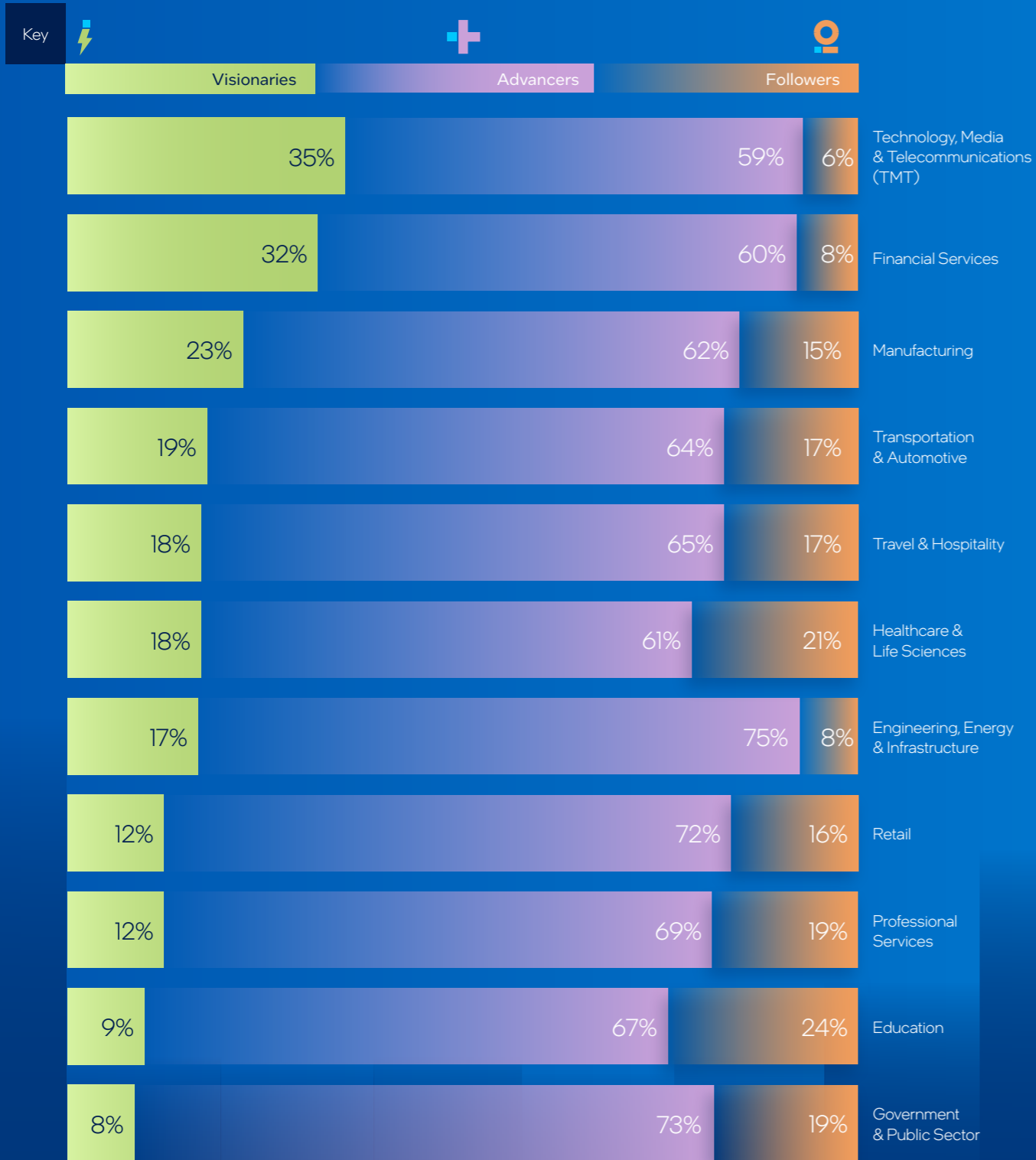
Organizations are divided into three groups based on their scores:

-  **Visionaries\_**  
The companies blazing a trail in sustainability-related AI (i.e. in the top third of the scoring range).
-  **Advancers\_**  
The companies making headway in this space (i.e. in the middle third of the scoring range).
-  **Followers\_**  
The companies at risk of falling behind the curve (i.e. in the bottom third of the scoring range).

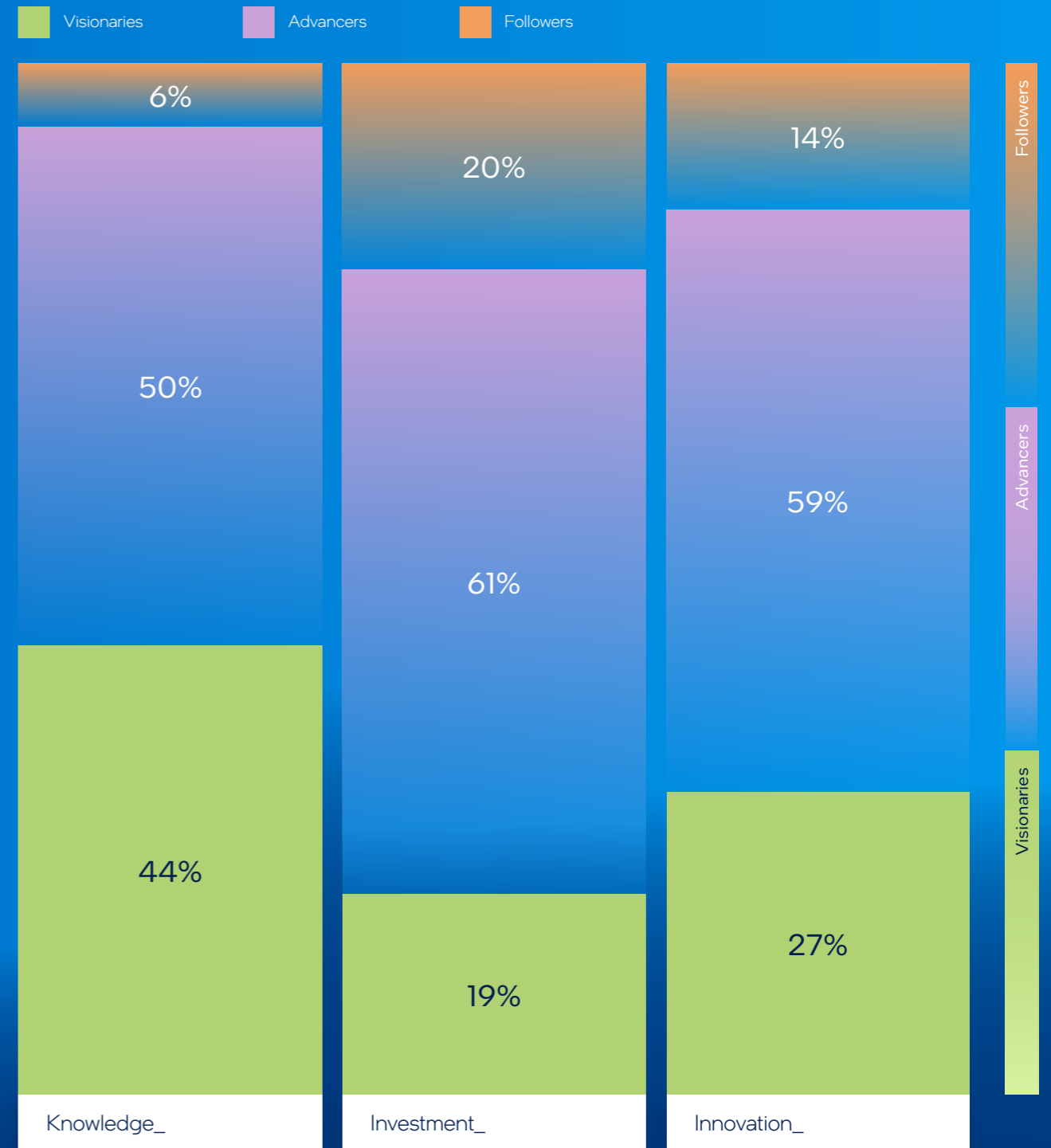
When it comes to leveraging AI for sustainability, manufacturing ranks third out of the 11 sectors represented in the study, behind only technology, media, and telecommunications (TMT) and financial services. The sector scores highest in the knowledge pillar, with 44% of organizations in the Visionaries category. Meanwhile, investment is the biggest challenge, with a fifth of organizations in the Followers category.



Overall sector performance



Overall pillar scores for the Manufacturing sector:



## Tech zero vs. tech positive

The Index also examines sector progress through the lenses of tech zero and tech positive – i.e. AI for sustainable IT, and AI for sustainable organizations.

### Tech zero\_

# 66%

of leaders in manufacturing say their organization is utilizing AI to reduce the carbon footprint of the IT function.

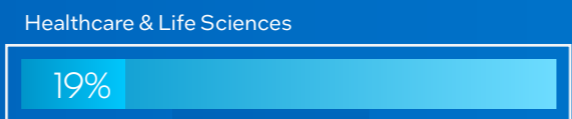
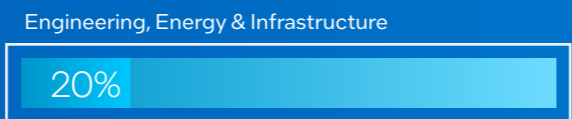
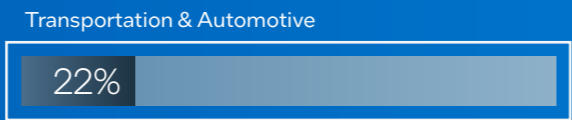
### Tech positive\_

# 67%

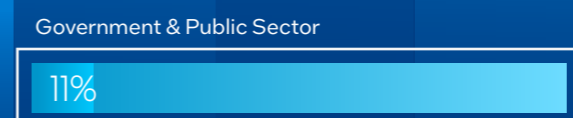
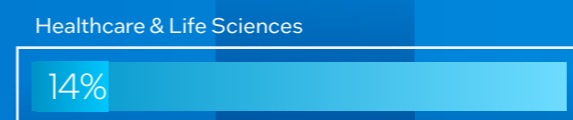
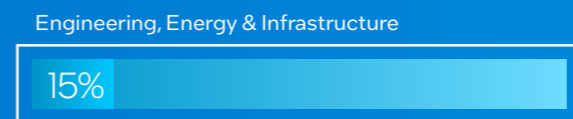
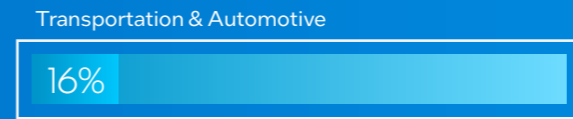
of leaders say their organization is using AI as a lever for the whole organization to reach its net-zero goals and to have a positive impact.



### Tech zero\_

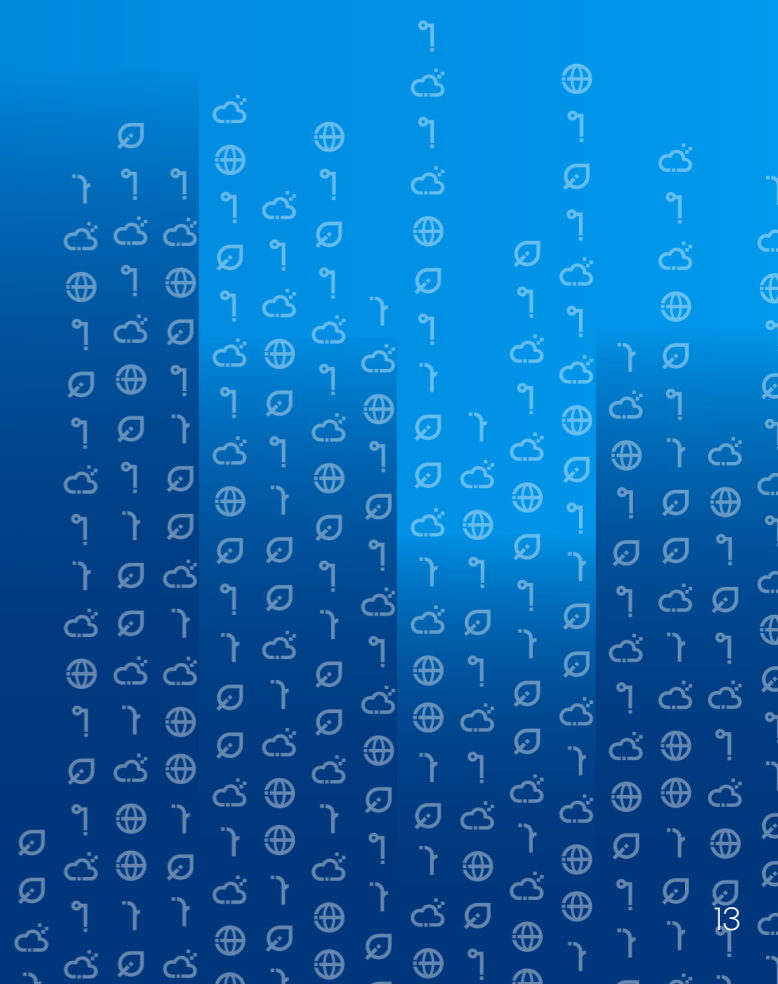


### Tech positive\_



With 19% of organizations in the Visionaries group for tech-zero and tech-positive indicators, organizations in the manufacturing sector appear to be deploying AI solutions to improve the sustainability of their IT function and as a lever for sustainability across the wider business. However, while the manufacturing sector ranks fifth for tech zero, it cracks the top three for tech positive, where progress is slower.

These results may reflect the pressure on the sector as one of today's biggest contributors to direct carbon emissions. More than this, sustainability is good for business. Greater efficiency reduces waste and energy use, cutting costs, and sustainable practices attract eco-conscious consumers and investors, boosting sales and investment. The clear link between sustainability and profitability in manufacturing is a strong incentive for industry change.





“As a manufacturer, Intel has many years of experience using technology to drive manufacturing efficiency while reducing our overall costs and environmental footprint by using fewer resources. Taking into account how AI solutions impact sustainability targets is critically important for businesses to succeed. Manufacturers should embrace these new solutions, while optimizing how much compute is truly needed. Doing so balances needed investment to better the business while keeping sustainability in clear focus.”

**Todd Brady**  
Chief Sustainability Officer & Vice President, Global Public Affairs, Intel



Pillar 1

# Knowledge



When it comes to AI knowledge, Visionary organizations are those that understand how AI can be used for sustainable outcomes and are actively implementing this knowledge to help achieve sustainability targets.

They carry out regular training for the IT function and across the wider workforce and have – or are actively recruiting for – roles that focus on AI throughout the business.

This is the strength of the manufacturing sector; seven in 10 manufacturing leaders believe their organization actively promotes knowledge-sharing in sustainability, and the same proportion say their organization is actively incorporating AI expertise to drive sustainability initiatives. By supporting employees' learning and growth, manufacturing organizations can stay competitive in an increasingly digital landscape and prepare for future advancements in the field.

Two-thirds of manufacturing leaders say their organization boasts a highly skilled AI workforce. Of all sectors in our study, businesses in manufacturing are the most likely to have a Chief AI Officer in place (49%), and three-quarters either have an AI trainer already in position within their IT team (38%) or are actively recruiting for one (36%).

While half of manufacturing organizations are considered Visionaries for knowledge-based tech-positive indicators, this is compared with 34% for tech-zero indicators. This relationship between tech zero and tech positive in manufacturing suggests that sector leaders are prioritizing AI benefits for the production line, potentially at the long-term expense of progress in other departments – and the business as a whole. Without a strategic, holistic approach to the relationship between AI and sustainability, manufacturing leaders may find their rush to efficiency obstructs their future progress.



## Tech zero: AI for green data management

Within the manufacturing sector, AI technologies can be deployed in a variety of ways to reduce the carbon footprint of the IT function while improving operational efficiency and sustainability.

### AI-powered demand prediction

AI algorithms can predict IT workload demand by analyzing historical data and usage patterns. By forecasting peak and off-peak times in the manufacturing process, AI can dynamically allocate resources and adjust power settings accordingly. During low-demand periods, AI can power down or put idle servers into energy-saving modes, significantly reducing energy consumption.

### Load balancing

AI can distribute workloads across servers and data centers in a way that maximizes energy efficiency for production lines. By ensuring that servers operate closer to their optimal capacity, AI minimizes the energy wasted on underutilized resources. This not only saves energy but also extends the lifespan of IT equipment.

Pillar 2

# Investment

When it comes to investment, Visionary organizations are allocating a substantial proportion of both their IT budget and annual revenue to sustainability-related AI research and development. They already have a range of AI technology deployed within their IT function and across the business, with more applications under development.

However, despite 65% of manufacturing leaders saying their organization's current AI strategy is *aligned* with its broader net-zero objectives, our research reveals that businesses are failing to fully leverage AI to enable real sustainability progress. Three-quarters of leaders (74%) anticipate their organization's overall investment in AI is set to triple in the next 12 months. However, a closer look at how their *sustainability-related* AI budget will change reveals that, although 72% of leaders expect it to increase in the next 12 months, they predict it will rise by an average of only 7%.

This missed opportunity would be huge. By investing in AI for sustainability, leaders could see improved efficiencies across their organization – resulting in annual savings of up to \$36m.

The ROI of AI in manufacturing:

**\$10.9m**

Average annual cost savings per company

**\$36m**

Maximum annual savings per company

The top AI use cases manufacturing organizations are currently deploying for tech zero and tech positive:

**Tech zero:**

- 1 Regulatory compliance
- 2 Cloud computing optimization
- 3 Computer vision for improved quality or reduced waste

**Tech positive:**

- 1 Energy consumption optimization
- 2 Process automation
- 3 Predictive analytics



Pillar 3

# Innovation

To be a Visionary organization in the innovation pillar requires high levels of collaboration among internal teams and external partners to share ideas and best practice around the use of AI for sustainability. Visionary innovators might also have filed successful patents for sustainability-related AI tools or solutions in the last 12 months, and will be seeing AI solutions contributing towards their organization's sustainability goals.

Although only 57% believe their organization is either fairly innovative or extremely innovative in terms of using AI as a lever for the whole organization to reach its net-zero goals and have a positive impact, manufacturing sector leaders are collaborating to make the most out of AI solutions.

# 74%

say their organization actively engages with stakeholders to gather input on how AI investments can enhance sustainability – the highest of all sectors in our study – and the same proportion of organizations have a roadmap or specific goals for further deploying AI technologies to enhance environmental sustainability.



## Tech positive: Machine vision for quality and reduced waste

*Machine vision*, a subset of artificial intelligence, can significantly enhance quality control and reduce waste in manufacturing organizations through the following key applications:

### Automated inspection

AI-powered vision systems are used to inspect products for defects with high precision in real-time. These systems use machine learning algorithms to analyze images and detect inconsistencies or defects that human inspectors might miss, ensuring higher accuracy and consistency.

### Predictive quality analytics

Machine learning models predict potential quality issues before they occur by analyzing historical data and identifying patterns associated with defects. This predictive capability helps manufacturers address issues proactively, improving overall product quality.

### Process optimization

AI helps to optimize manufacturing processes by analyzing data to find the best operational settings and conditions. This optimization ensures that the production process consistently produces high-quality products while minimizing waste and inefficiencies.

### Defect classification

AI systems can classify different types of defects by learning from a database of defect images and descriptions. This classification helps in identifying root causes and implementing specific solutions to address each type of defect.

### Case study

*[Axiomtek Detects 99.9 Percent of Soldering Defects with AI](#)*

Axiomtek\* built an automated optical inspection solution to detect defects during circuit board assembly. Deep learning and edge computing has allowed them to reduce latency and optimize for cost and power efficiency.



## Conclusion

# Closing the intention-action gap for manufacturing

AI offers the manufacturing sector disruptive value, and organizations are taking a proactive approach to embedding AI solutions beyond their IT team. However, this may have more to do with the direct link between production efficiencies and profit than a strategic approach to sustainability.

To drive meaningful long-term sustainability and further their tech-positive progress, manufacturing C-suite leaders need to view AI as an opportunity to drive sustainability across the whole business and stay alert to the carbon implications of rapidly deploying AI at scale.

Done right, AI can be a lever that enables lagging enterprises and legacy machinery to rapidly reach industry 4.0. But for this technology to succeed in helping manufacturing goals and driving efficiency, organizations must start with mature, standardized infrastructure, data and processes across their operations.

Leaders should consider that, although production lines have historically been the sector's biggest carbon emitter, this will rapidly be outstripped by the computing power demanded by AI. As a result, the sustainability of IT functions should be given

as much attention as the factory floor, with Chief Technology Officers and Chief Sustainability Officers working closely together. Collaboration across industry stakeholders – including governments, businesses, and technology providers, such as Intel – will be crucial to building a sustainable ecosystem of responsible manufacturing that is supported by AI.

AI is the key to bridging the gap between digitalization and sustainability in the manufacturing sector. However, this will require bold leadership, strategic vision, and a commitment to collaboration and responsible innovation. By viewing AI and sustainability as complementary forces, manufacturing leaders can harness technology as a powerful catalyst for sustainable growth, transforming the industry for a greener future.



# Disclaimer, authorship, and acknowledgments

The concept development and research design for this report were carried out by Intel and thought leadership consultancy, Man Bites Dog. The opinion research fieldwork was conducted in January and February 2024.

## Resources

For more information about Intel's sustainability goals and progress please visit: [www.intel.com/sustainability](http://www.intel.com/sustainability)

## About Intel

Intel (Nasdaq: INTC) is an industry leader, creating world-changing technology that enables global progress and enriches lives. Inspired by Moore's Law, we continuously work to advance the design and manufacturing of semiconductors to help address our customers' greatest challenges. By embedding intelligence in the cloud, network, edge and every kind of computing device, we unleash the potential of data to transform business and society for the better. To learn more about Intel's innovations, go to [newsroom.intel.com](http://newsroom.intel.com) and [intel.com](http://intel.com).

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