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## Sustainability's future in manufacturing: What to expect

Technologies such as AI and digital twins are critical to success to be sure, but so are tried-and-true techniques such as circularity and the “R-strategies” in reducing waste.

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### What you'll learn:

- Industrial waste is at an all-time high, and only 7.2% of materials used worldwide were recycled in 2023.
- Circularity also helps address resource scarcity by ensuring the availability of essential materials.
- By leveraging lifecycle assessments, simulating R-strategies and connecting designs to supply chains, businesses can optimize resources and reduce waste.

**Editor's note:** This is the first part of a two-part series on sustainability in manufacturing and its role in digital transformation. The second part will [appear here](#).

Throughout the years, sustainability has been a challenging topic for companies as it constantly shifts in and out of organizational and political focus. While there have been periods of intense progress, there also have been times when industries struggle to adapt to new regulations and regional differences. One thing that has become clear to us, however, is that sustainability is a driver for growth and profitability.

See also: [AI brought closer to sources of data generation](#)

We have seen first-hand how businesses that prioritize sustainability are positioning themselves for long-term success. With pressing challenges like climate change, evolving geopolitical regulations, and increasing consumer demand for eco-friendly products, organizations must adopt sustainable practices to not only remain relevant but also to truly thrive.

With this in mind, let's take a look at the trends, innovations, and forward-thinking companies shaping the future of sustainability.

### **Circularity: The new standard**

Industrial waste is at an all-time high, and only 7.2% of materials used worldwide were recycled in 2023. This presents a huge opportunity for organizations to save both costs and resources by embracing circularity.

The Circularity Gap Report highlights that companies can reduce CO2 emissions by over 39% by focusing on recovering and reusing resources throughout the entire product lifecycle, including within supply chains.

Circularity also helps address resource scarcity by ensuring the availability of essential materials. A circular economy operates on a framework of "R-strategies," which guide circular design and manufacturing to maximize resource use and minimize waste.

**Podcast:** [The Art of the Practical in digital transformation](#)

These "R-strategies" include: reducing; repairing; refurbishing; remanufacturing, and recycling.

Transitioning from a linear economy to a circular economy starts with design as research shows that 80% of a product's environmental impact is determined in the design phase. The digital twin—a digital representation of a physical asset or process based on powerful physics-based simulation—is a crucial tool in creating smarter, more efficient machines, products and processes. It allows engineers to design sustainably from the start, instead of trying to add it on later.

The digital twin helps define and optimize products and production systems, thus significantly reducing the need for physical prototypes before investing in physical assets and contributing to saving valuable resources.

Creating a digital twin and leveraging tools like design and simulation software enables companies to embed circularity into every stage of the product lifecycle—from design and manufacturing to use and through end-of-life.

**Podcast:** [Data management in a digital manufacturing world](#)

The digital twin can also be used to understand cause and effect in the supply chain. By creating a virtual replica of real-world networks and processes, digital twins enable users to simulate disruptions and changes in advance, evaluate their impact using real data, and make more informed decisions with transparency.

By leveraging lifecycle assessments, simulating R-strategies and connecting designs to supply chains, businesses can optimize resources and reduce waste. Digital technologies like the digital twin, AI and IT/OT convergence also can improve production efficiency, with automation and predictive maintenance extending machine life, reducing downtime, and minimizing resource use.

Once products are in use, tools like asset management software work to ensure optimal resource efficiency and enable informed maintenance. Additionally, as innovations like the battery passport, which functions as a digital record for individual batteries by documenting their entire lifecycle become more widespread, reuse and recycling will be further enhanced.

**See also:** [Unifying IT and OT in U.S. manufacturing](#)

Circularity also tracks a product to its end-of-life. Using advanced recycling technologies, supported by automation, companies can reclaim old materials for future use. Circular alternatives like biodegradable plastics benefit from flexible production systems that adapt to new processes, driving the zero-waste economy forward.

Implementing circularity is a long-term solution that empowers businesses to achieve greater results with fewer resources, which can help protect the environment, as well as the bottom line.

### **Fürth and Spinnova show how progress can be made**

Siemens' electronics plant in Fürth, Germany—which recently received the Sustainability Lighthouse award from the World Economic Forum for being a leader in the

field of energy efficiency, CO2 reduction and resource conservation—demonstrates how sustainable outcomes equate to a more profitable business. It has experienced cost-efficient benefits, including:

- 64% energy saving per throughput
- 72% reduction in greenhouse gas emissions per throughput
- 47% less waste per throughput
- 145% increase in production throughput

These achievements are a direct result of their focus on a circular economy. By tracking its products throughout their lifecycle, Fürth uses spare parts and repairs to extend the lifecycle of products to avoid emissions that would otherwise be generated during production, scrapping and recycling.

**Podcast:** [Easier-to-accomplish automation projects that bring real ROI](#)

Through a long-life repair service, the plant offers an extended service on selected products. There are already over 300 long-life repair cases in the beginning of 2025, and that number is expected to increase to 2,000 by 2026.

Additionally, by building on its substantial energy savings, Fürth is striving to achieve CO2 neutrality by 2026. While the target may seem ambitious, the plant's dedication to sustainable practices and circularity provides a clear path to turning this vision into reality.

Like the Fürth plant, Spinnova is using circular models to redefine sustainability in the textile industry. The fashion industry generates over 90 million tons of waste per year and consumes even more water. That is why Spinnova's mission is to make the textiles industry a sustainable one.

Spinnova's technology makes it possible for raw material producers, fiber producers and others in the industry to produce fibers from a variety of cellulosic raw materials through a mechanical process that mimics how spiders spin their webs.

**See also:** [Toyota weaves the city of its future](#)

This one-of-a-kind production process creates materials that look and feel like cotton and linen. Using Siemens technology to enable their innovation and design, Spin-

nova has managed to make a sustainable impact on a historically wasteful industry.

### Optimizing sustainability with AI

AI is another digital tool that has the potential to further enable circularity as well as overall sustainability efforts. Although AI has been a widely discussed topic across industries and consumers, its potential for sustainability is just beginning to be uncovered.

It will, however, require strategic implantation and scalability, which is only possible with industrial-grade AI. This classification is used only for AI that meets the levels of quality, security and reliability necessary to tackle the requirements and standards of even the most demanding environments.

AI's advantage lies in its ability to process large amounts of data and identify hidden patterns. Not only does this power help companies accelerate digital transformation by identifying inefficiencies to lower emissions, but it also enables circularity within the digital enterprise.

**Crystal Ball 2025:** [Emphasize companywide technology investments](#)

But what does this look like in a real-world scenario? As a sustainable digital enterprise, Siemens' electronics factory in Erlangen, Germany, has been using industrial AI to collect, connect and understand data to accelerate sustainability—and the benefits have not gone unnoticed. For example, the factory has seen improvements such as:

- Reducing its energy consumption by 25% and its net carbon footprint by 50%.
- Targeted improvements to production efficiency have helped reduce the energy used to produce each product by 50%.
- Production hall ventilation power consumption is down by 70%

Additionally, Erlangen employs robotics to handle their printed circuit board (PCB) components with incredible accuracy. With the increased precision of the now automated fitting process, Erlangen has been able to reduce wasted material and energy significantly, making the factory more efficient.

**See also:** [OT cybersecurity challenges: Q&A with Rob Larsen](#)

Since the smart robotics no longer require extra pre-sorted parts, the plastic inlays that were once required to organize sorted parts are not necessary. The result is the elimination of thousands of plastic pieces that ultimately end up as waste. These environmental and cost savings would not be possible without AI.

The future of sustainability is one of opportunity and transformation. As circularity and AI become essential to success, businesses can move beyond compliance to generate real value through cutting costs, driving efficiency, and reducing waste. With new and ongoing innovations and advancements, sustainability soon will become inseparable from profitability and success.

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