SENSEYE PREDICTIVE MAINTENANCE

The Challenges of Sustainability in Manufacturing and the Role of Industry 4.0

How AI-powered data analytics helps manufacturers achieve and maintain their sustainability targets.

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Introduction

Today, the most successful manufacturing organizations recognize that sustainability is not only good for business, but is also integral to the way products are marketed, purchased, and operated.

Sustainability needs to be integrated into every aspect of product manufacturing. It should influence all decisions about engineering, operations and maintenance – from machinery selection, maintenance scheduling, process control, materials and component management, to investment planning, and health and safety management.

This report explores the challenges of improving sustainability in manufacturing, the opportunities available, and the bridge built by Industry 4.0 between machine health and sustainability.

We will explore the many ways that real-time data can support business outcomes, leveraging AI-powered industrial analytics to drive the following key sustainability areas with direct reductions in a company's carbon footprint:

1. Reducing spares and material waste.
2. Maximizing the lifespan of legacy assets.
3. Reducing energy consumption in manufacturing processes.
4. Mitigating health and safety risks.

Executive Summary

- Predictive maintenance technology prevents wasted time, energy, and resources by enabling accurately timed and targeted maintenance interventions.
- Replacing components before the end of their useful life is an unseen source of waste in manufacturing with significant sustainability implications. Using fully automated machine health monitoring to schedule the replacement of parts ensures components can operate for their full working life – avoiding the unnecessary consumption of new parts.
- A data-driven approach to component replacement means maintenance departments no longer need to manage vast supply chains of items needing overhauls and spare parts, representing millions of dollars' worth of assets handled unnecessarily, with no consideration of the carbon emissions of consumables, parts and transportation.
- Accurately analyzed real-time data on machine condition enables cost-effective repairs and overhaul to extend machine life (often beyond rated service life). This informs timely investments in new plant and machinery and stretches capital expenditure.
- Healthier machines consume less energy. With energy consumption representing up to a third of overhead costs, manufacturing businesses must continue to prioritize energy efficiency, which directly impacts sustainability.
- Data-driven manufacturing processes offer an exciting opportunity to take energy efficiency a step further by ensuring machines operate at optimum efficiency at all times.
- Providing a safe and healthy working environment is essential for any sustainable business. Remote machine-monitoring and analysis technology minimizes potentially dangerous interactions between people and machines, enabling control, monitoring and diagnosis to be carried out remotely. Machines in good condition are also less likely to experience leakage and risk environmental contamination.
- The era of simply buying carbon credits to offset manufacturing is over. Businesses and consumers are demanding stronger commitments to sustainability.
- Increased sustainability can lead to increased efficiency and profitability, through the appropriate use of Industry 4.0 analytics.

The drive for greater **sustainability in manufacturing**

The importance of minimizing humanity's impact on the environment is widely acknowledged, and energy-intensive industries such as manufacturing have a leading role to play in combating climate change worldwide.

The manufacturing industry is responsible for a high proportion of global greenhouse gas emissions. In the US, it accounts for almost a quarter (23%)[1] of direct carbon emissions , while in Europe, industrial processes and industrial energy use account for 21% (880m tons) of carbon dioxide emissions[2].

Industry 4.0 and its diverse technologies and use-cases now provide manufacturers with more accurate data and insights on their machines and processes than ever before. In this report, we explore the opportunities this presents for manufacturers to address urgent sustainability and environmental priorities, whilst taking business performance to the next level. We examine how manufacturers can improve their sustainability across four key areas – reducing waste, maximizing asset life, reducing energy use, and mitigating safety risks.

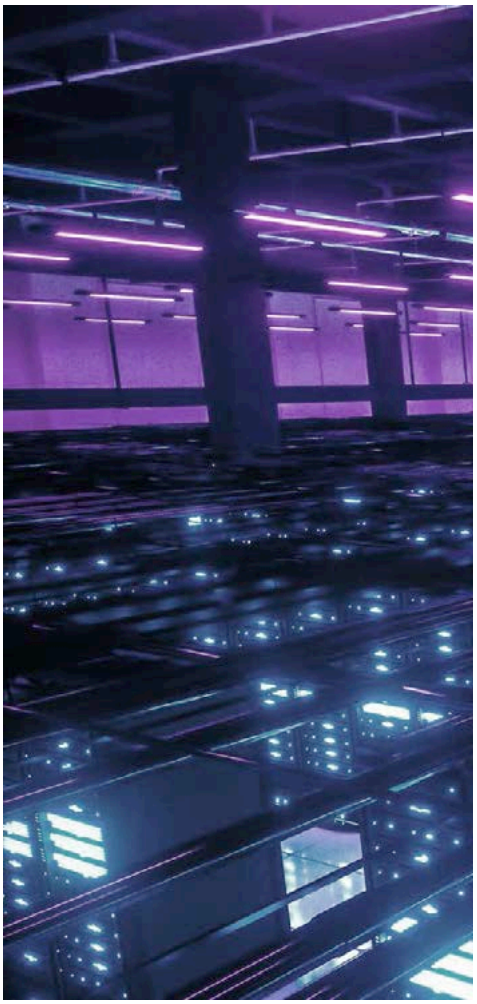
1 Reducing spares and materials waste

Minimizing wasted materials is one of the most significant ways for manufacturing to become more sustainable. Cutting down on waste reduces operational costs at the same time as improving overall business performance.

A substantial cause of waste in manufacturing is processes that drift out of control. This not only wastes raw materials, but also reduces the opportunity to produce (and sell) complete end-products. Batch testing, for example, often results in unnecessary waste due to delays in fault identification. If a fault is detected during batch sampling, the whole batch will need to be examined to determine when production started to shift outside parameters. Any products manufactured after that point are likely to fall outside quality specifications, and will therefore need to be scrapped.

Waste is sometimes caused by a 19th-century approach to manufacturing. This kind of subtractive approach involves starting with a raw material, such as a block of metal, and cutting it down to get the shape you need, creating a lot of waste. An alternative – enabled by new technologies – is additive manufacturing, also known as 3D printing. In this case you build a product by adding material, rather than subtracting it, so there is very little waste. And some automotive manufacturers are moving away from stamping parts out of sheet metal to injecting liquid metal into molds, which is far less wasteful."

Adam Lea-Bischinger, Senior Consultant mcp



Waste is also created by the early replacement of perfectly healthy machinery or components. Traditional maintenance practices involve the preventative replacement of parts to mitigate the risk of failure. This is often justified by the saying that "over maintenance is cheaper than failure". However, the consequence is that components are frequently replaced before the end of their useful life.

Replacing components involves shutting down machines, disrupting production and exposing engineers to potential risks. The discarded component usually ends up being recycled or, worse, in landfill, which is a waste not only of materials, but also of the carbon involved in its production, storage, and transportation. The carbon footprint of the spares supply chain can often be overlooked. Reducing the need for spares and the more effective management of spares demands plays a substantial part in enabling companies to achieve their sustainability goals.

With predictive maintenance, the benefits go even further. The ability to capture early-stage faults enables simple repairs or component replacement, thereby avoiding secondary damage that can result in the scrapping of costly assets. Being able to replace a $50 bearing and avoid the failure of a $50,000 gearbox not only makes good financial sense but eliminates large amounts of waste in saving the gearbox and not needing to expedite a replacement. The majority of the carbon footprint in the management of spares comes from the supply chain, something that's compounded when parts need to be put on special delivery.

Many manufacturers in the CPG and FMCG industries have become adept at recycling waste either within their processes or through their supply chains. Some manufacturing processes generate a lot of heat and steam, for instance, which can be used to provide heat for local homes or businesses.

And carbon dioxide generated in manufacturing processes can be diverted to greenhouses where it's beneficial for vegetable growing. In food manufacturing, many raw materials are delivered along with a considerable amount of soil and stones. These can be separated and sold on as topsoil or aggregates for use in horticulture or construction.

"The drive towards zero-waste manufacturing is being led by highvolume, low-margin processes that are highly optimized. These tend to be continuous operations in plants that have lots of management information to help reduce unnecessary waste. The nirvana of zero waste may ultimately be unachievable, because there will always be faults or issues that cause things to go wrong; but it is certainly possible to minimize waste to the lowest level for the product you are manufacturing."

Jim Davison, Regional Director MAKE

Industry 4.0 and predictive maintenance technology has a key role to play in minimizing both material and component waste in manufacturing.

Eliminating waste caused by processes drifting outside parameters can be achieved by having access to real-time data on machine operation and condition. Predictive maintenance technology can analyze that data and create alerts as soon as manufacturing processes are predicted to, or begin to, move outside normal parameters. This allows immediate intervention to adjust settings and bring production back in line, minimizing wasted materials and production time. Without predictive maintenance, these small shifts in machine performance could have gone undetected until a defect was identified in batch testing or a more catastrophic machine failure occurred.

Wasting components through unnecessary early replacement can also be prevented by having access to real-time data on component health. AI-driven machine-health monitoring software can provide this information and identify when components are showing signs of degradation, thus maximizing the lifetime of existing components, and ensuring they are only replaced when necessary. This approach of using continuous monitoring to inform appropriate and opportunistic maintenance can often extend component lifetime by over 50%.
Using technology in this way offers manufacturers enormous potential to run components safely beyond their rated lifetime, avoiding often unnecessary replacement and disposal, and the costs and sustainability impact this entails.

A data-driven approach to component replacement also means maintenance departments no longer need to hold vast stocks of spare parts. Extensive inventories held in storage represent millions of dollars of waste just sitting on shelves. But using predictive maintenance technology ensures that spares can be ordered only when needed – when replacement is imminent.

Minimizing stockholding levels in this way represents a real opportunity for manufacturing firms to become more sustainable. By ensuring that components are only replaced when necessary, predictive maintenance software has been shown to reduce spares consumption by 20%, and to deliver a 40% reduction in inventory and waste.

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There are two use cases around predictive maintenance that jump out at me as win-wins – for the environment and win manufacturers. The first one is around the service process. If you can reduce the truck rolls that have to come out to service your equipment or fix something that's broken, you're reducing your carbon footprint – there's less fossil fuel burned for all those service people coming on site for routine checkups when they're not needed. Anything that can be done to be smarter about how we service those manufacturing facilities and reduce the need to be physically on site is going to help reduce the carbon footprint. And it's probably going to reduce maintenance costs, because they're going to have to pay less for that service.

The other use case is around the parts and the machines themselves. If you can get the machines and part replacements to last longer and not replace parts prematurely, you're saving scarce resources. You're not sending them to the dump and creating pollution and waste. You're getting more reuse out of your machines. Again, it's another win-win with less waste in the world and less use of resources, saving the planet and saving manufacturers money on the expensive parts of machines they may need to replace. These are the two obvious use cases in manufacturing, and they're both sustainable and efficient."

Bill Zujewski, CMO Green Business Bureau

Green Business Bureau

> Industrial machines are a significant expense, with modern facilities representing billions in investment. Many machines may only be rated for 10–15 years. If you can extend that lifespan and stretch the initial capital investment safely, that can be a tremendous saving."
>
> Alexander Hill, Head of Sales, Senseye Predictive Maintenance

2 Maximizing the lifespan of legacy assets

Improving the performance and optimizing the efficiency of legacy plant and machinery not only makes financial sense, it's also far more sustainable than buying new equipment. If the purchase of expensive capital assets can be deferred by extending the life of existing assets, it has a direct impact on cash flow.

However, there comes a point when investing in new equipment is necessary to overcome inefficiencies in existing machinery, or due to a step-change in technology and capability that means new machinery is required to remain competitive.

Working out which assets to replace and when is a complex process involving a thorough life-cycle cost analysis. This needs to consider factors including the purchase price, running costs, output, maintenance costs, energy consumption, and the labor and parts costs of a new machine compared to an existing one. It's rarely as simple as saying that older assets are inefficient and more energy-intensive than more recent models.

To optimize the accuracy and effectiveness of analytics software, real-time data needs to be enriched with data on the maintenance and performance history of equipment. This helps machine learning algorithms make more accurate predictions about how that equipment may perform in the future and how components will degrade – helping to inform decisions on when to invest in new assets.

In many factories, operators, having worked with their machines for a long time, have become accustomed to making decisions about asset replacement based on gut feel. Real-time data analysis technologies overcome any subjectivity in the way machines are operated, and enable asset replacements to be planned more effectively, based on real data rather than instinct.

> This is where Industry 4.0 technology can help. By installing relatively low-cost sensors in the right places on existing machines, you can collect and analyze data on energy efficiency, productivity and predicted maintenance costs. This provides essential information for your cost analysis, helping to inform your investment decisions. Using real-time analytics, machine learning and AI has an important role to play in maximizing the lifespan of legacy assets, and informing the transition to new equipment at the right time."
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> Adam Lea-Bischinger, mcp

By combining and analyzing multiple data feeds, predictive maintenance software helps to build a single version of the truth about each piece of equipment. It enables manufacturers to better understand and optimize performance, as well as accurately predict the remaining useful life of equipment so that its replacement can be planned and budgeted for in a controlled way.

The operational efficiency and targeted maintenance benefits achieved by using predictive maintenance technologies in the manufacturing environment have been found to extend asset lifespan by as much as 50%.

3 **Reducing energy consumption** in manufacturing processes

Manufacturing is inherently energy-intensive, requiring raw materials to be heated, cut, manipulated, and treated in many different ways to transform them into finished products. For some manufacturing businesses, energy represents up to a third of overhead costs.

Consequently, reducing energy consumption has long been a priority for manufacturers. The principal motivation in improving energy efficiency may be cost reduction, but the carbon emissions associated with generating electricity mean that reducing energy use also has significant sustainability benefits.

Beyond that, governments have begun mandating change, and manufacturers are acting. In the UK, the first major economy to pass net-zero emissions legislation, 20% of UK manufacturers had already taken steps towards reaching the netzero target of 2050 within a year of the bill being introduced. A further 20% had considered what action to take.

The shift to Industry 4.0 and the introduction of more data-driven manufacturing processes offers exciting opportunities to take energy efficiency a stage further. Instead of viewing energy consumption at a macro level across a facility, manufacturers can now access more granular data at a machine or even a component level.

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Manufacturers across Europe have been successfully implementing energyefficiency measures for many years, often driven by EU directives. Some of the most successful measures are simple interventions, such as installing LED lighting, ensuring machines are switched off when not in use, and repairing leaks in compressed air systems.

The key to any successful energy reduction program is first understanding the energy footprint of your business. That requires data. Once you understand when and where energy is consumed in your operations, you can intervene effectively to improve efficiencies."

Jim Davison, Regional Director MAKE

> Understanding the way machines are operating provides many benefits, including an understanding of precisely where energy is being consumed. Machines running at the most efficient rate and optimal states consume less energy. There are also impacts related to not having to stop and start production lines unexpectedly. If you can keep those machines running for as long as possible in the best consistent states, you're going to have a direct impact on energy consumption."
>
> Rob Russell, CTO Senseye Predictive Maintenance

Such real-time data shows where most energy is being consumed and highlights potential issues before they cause a problem. This enables timely and targeted maintenance interventions to rectify any fault or adjust control settings before machines start to drift out of optimum performance and consume excess energy.

This constant optimization is an important way of ensuring machinery is always running as energy-efficiently as possible. Predictive maintenance software does this job continuously, providing information to enhance the understanding of machinery performance and providing a base layer of data against which anomalies can be identified.

Targeting maintenance interventions before faults develop not only means maintaining equipment at optimum efficiency, it also prevents sudden and unplanned downtime. Unpredicted downtime is costly and significantly harms sustainability. Energy is consumed whilst nothing is produced, while restarting certain machines and getting equipment to the correct operating temperature can create a further surge in energy consumption.

Using predictive maintenance technology to improve operational efficiencies and minimize downtime can reduce energy usage in manufacturing operations by up to 15%. This equates directly to reduced costs and reduced carbon emissions.

Improving energy efficiency can take manufacturers a long way on their sustainability journey. All manufacturing operations require energy, of course. Once a plant is running as efficiently as possible, the next step is to consider where that energy comes from. Purchasing electricity from carbon-free renewable sources, such as wind and hydropower, is one way to eliminate carbon from energy supplies.

Another option for large manufacturers is to install renewable generation plant on site. Wind turbines are one option, while factory roofs provide an ideal location for solar panel installations, directly supplying facilities with clean, green, carbon-free energy.

4 Mitigating **health and safety risks**

Maintaining a safe working environment is a critical element of sustainability, and health and safety is a major focus for all responsible manufacturing organizations. But despite significant improvements in health and safety practices, manufacturing still accounts for almost a fifth of all workplace accidents and fatalities.

EU figures show there were 500 fatal accidents in manufacturing environments across its member states in 2018, the last year for which there is full data, and a further 594,000 nonfatal accidents resulting in at least four days of absence from work. In the same year, there were 343 manufacturing fatalities in the US.

Ensuring machinery is maintained and operated efficiently has a direct impact on the health and safety of the workforce. Minimizing direct human contact with operational machinery is a key objective of health and safety policy, alongside ensuring that any essential interventions follow strict safety protocols to protect engineers and the wider workforce from harm.

"Real-time data tools, such as predictive maintenance software, can support high standards of health and safety. By ensuring that wearing parts are replaced in good time, they can prevent catastrophic failure that could lead to fire, explosions, or hazardous chemical leakage. On a daily basis, the technology limits interactions between people and machinery, and ensures that human intervention is only sanctioned when necessary to correct faults or replace parts. Minimizing the number of times an engineer needs to open up a machine is an important way to reduce exposure to potential risks."

Jim Davison, Regional Director MAKE

Predictive maintenance technology helps to mitigate risks by monitoring machinery and supplying real-time information so that operators can make better decisions from afar.
A single piece of equipment can generate multiple data feeds, all of which can be combined and analyzed to support safe and efficient maintenance and operation without the need for personnel to be in the same building as the machine.

The advent of Industry 4.0 means that factories are becoming increasingly automated. As more robotics and greater automation are deployed in manufacturing, fewer humans are required on the factory floor, further reducing exposure to dangerous environments.

Intelligent machine-health monitoring technology further supports the distancing of people from machines. It enables operators to remotely access real-time data on machine performance and condition, and conduct accurate fault diagnosis and inform control setting from a safe distance. The more accurate the remote data analysis, the more targeted interventions can be, reducing the risk of unnecessary human-machine interaction.

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Safety is high on every manufacturer's agenda. With our technology, our knowledge, and our fundamental understanding of the equipment, we reduce the number of maintenance interventions, reduce the risk of people being hurt and injured, and drive more efficiency."

With predictive maintenance technology on the factory floor, manufacturers can achieve greater efficiency and better economic outcomes, as well as providing a minimal-risk manufacturing environment that's as safe as possible for people – creating a highly sustainable way of operating."

Klaus Kruppel, Head of Partners, Senseye Predictive Maintenance

Using predictive maintenance to improve sustainability

The benefits of increasingly data-driven manufacturing for improving environmental performance and sustainability are significant.

Data-driven operational and maintenance activities help to minimize waste, reduce health and safety risks, and extend component life. The more effectively manufacturers maintain and operate their machines and facilities, the greater the carbon emission reductions and associated sustainability benefits.

By enabling plants to run optimally for extended periods without interruption, and helping to ensure machines are operated and maintained efficiently and consistently, Senseye Predictive Maintenance machine reliability and performance solutions help leading industrial organizations worldwide to deploy successful and sustainable maintenance programs.

By way of illustration, the predictive maintenance capabilities enabled by Industry 4.0 and implemented by Senseye Predictive Maintenance clients have demonstrated its ability to deliver:

- An 85% improvement in downtime forecasting accuracy
- A 50% reduction in unplanned machine downtime
- A 55% increase in maintenance staff productivity
- A 50% increase in asset lifespan
- A 40% reduction in maintenance costs
- A 40% reduction in inventory and waste
- A 30% improvement in operational efficiency
- A 20% reduction in spares consumption
- A 15% increase in machinery efficiency leading to decreased energy consumption.

Footnotes:

[1] Source: United States Environmental Protection Agency (EPA)

[2] Source: European Environment Agency, Roland Berger

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