SOSA The Open Innovation Company.

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7 technologies manufacturers can *implement today* for a net-zero factory.

→ *In this report, we break down which technologies provide the most efficient way to reduce a factory's carbon footprint, particularly in the processes, tools, and materials used on-site.*

We won't be covering technologies detached from the manufacturing processes (i.e., windmills and solar panels), rather, precisely the technologies you can implement in your existing manufacturing plant today to decrease costs, streamline processes, and reduce your overall C02.

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Introduction

"The perils of climate change are on our doorstep, and as a response, governments, global enterprises, and manufacturers are feeling the pressure to address it."

2021 was a record-breaking year when it comes to climate catastrophes. The "post-pandemic" year saw the most extreme heatwave in modern history, and also mega-disasters costing over $20 billion each, tied with 2017 for the most such disasters on record. The perils of climate change are on our doorstep, and as a response, governments, global enterprises, and manufacturers are feeling the pressure to address it. Europe, for example, is leading the way in taking action by implementing strict regulations such as Corporate Sustainability Reporting standards for polluting enterprises.

While regional regulatory efforts are increasing, environmentally-driven regulations on a global scale are still in development. Conscious business models and corporate responsibility initiatives such as ESG are taking shape, driving industries towards better environmental practices and social and governmental awareness.

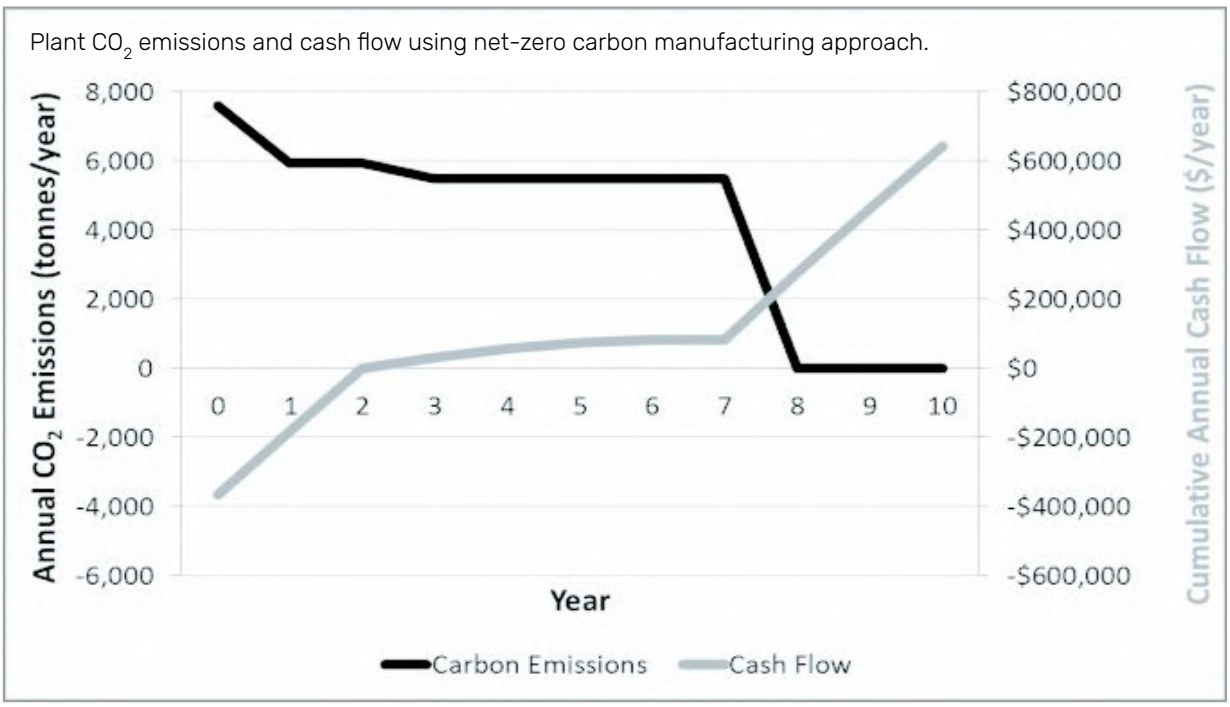
"In Europe alone, the manufacturing sector is responsible for 880 million tonnes of CO2 emissions annually, making it one of the largest single emitters in Europe."

In the world of manufacturing, these environmental protocols have become especially important. Given that industry is one of the most polluting sectors globally, and industrial companies account for more than 26% of all global greenhouse gas emissions, manufacturers are pivotal in making a global impact by adopting cleaner processes. In Europe alone, the manufacturing sector is responsible for 880 million tonnes of CO2 emissions annually, making it one of the largest single emitters in Europe.

In the race for sustainable manufacturing, 'net-zero factory' is becoming a coveted achievement. The path to that achievement includes a combination of outsourcing carbon offsetting (off-site) and implementing highly efficient processes in manufacturing (on-site) that are enabled by technologies.

Furthermore, academic research shows that in the course of a year, a small factory's transition to an economic framework based on energy efficiency and renewable energy could lead to net-zero carbon emissions at net-zero costs (see graph below), therefore the benefits are manyfold.

Plant CO_2 emissions and cash flow using net-zero carbon manufacturing approach.



Source: ResearchGate

01

Predictive maintenance

The most obvious place to start when it comes to reducing CO2 is adopting predictive maintenance technologies. These technologies can be applied to any existing machinery, including those from multiple vendors in traditional or modern factories, eliminating the need to acquire more modern machinery.

> *"A recent study surveying 72 major multinational industrial and manufacturing firms discovered that the average cost of an hour's unplanned downtime is $532,000."*

Among the many benefits of predictive maintenance is the primary one: reducing unplanned downtime, a common challenge for industrial manufacturers. A recent study surveying 72 major multinational industrial and manufacturing firms discovered that the average cost of an hour's unplanned downtime is $532,000 USD. With an estimated annual cost of $172 billion USD worth of unplanned downtime for a large plant, the need to reduce downtime in any possible manner is becoming crucial.

To minimize unplanned downtime, a tech-driven approach to predict potential equipment failure has emerged in the past decade. This is made possible through the combination of **IoT-based solutions and machine learning software**, paired to identify usage patterns of such machinery and equipment, which leads to a predictable assessment of a machine's health and maintenance needs.

With the potential to reduce 50% of unplanned downtime, predictive maintenance technologies are being increasingly adopted by large industrial brands. As a result, the fast-growing market for these technologies has been valued at a staggering $6.9 billion USD as of mid-2021.

As mentioned above, these predictive technologies consist of two types:

IoT-based sensors	**Software** (SaaS-based or on-premise application)
These sensors measure machinery output through vibration, sound pressure, motor current, magnetic field, temperature or oil quality. These sensors translate the machine's output into data which can be treated as the "pulse" of the machine, continuously indicating its health state.	These types of software are ideally available via desktop and mobile devices. The software consists of a machine learning mechanism to identify meaningful patterns within the analyzed data. The insights, driven from the processed data, are presented via visual analytics modules of the software, allowing for the ability to set conditions and rules for maintenance based on the machine's behavior, rather than the traditional maintenance schedule defined arbitrarily by the equipment manufacturer.

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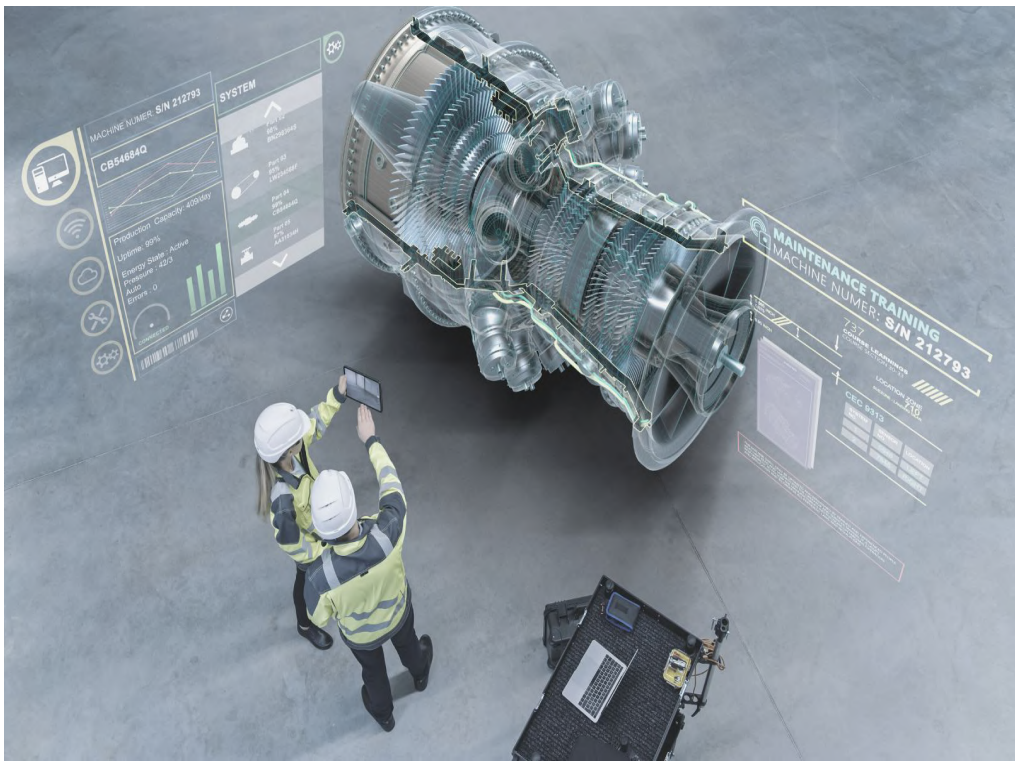

By combining both elements, a standard predictive maintenance solution can utilize historical data to make accurate predictions about a machine's health and the probability of failure of any kind.

The predictions allow maintenance teams to schedule routine inspections, potentially leading to **cost and waste reduction,** both of which contribute to a more sustainable operation.
This occurs through two significant activity changes:

01 Performing necessary actions through planned maintenance, preventing downtime during activity hours.

02 Reducing the need to inspect "healthy" machinery, especially when located at a long distance from the dispatch centers of maintenance personnel.

"The predictions allow maintenance teams to schedule routine inspections, potentially leading to cost and waste reduction, both of which contribute to a more sustainable operation."

KEY INSIGHT

Since many predictive maintenance technologies and startups exist, this creates a competitive landscape with attractive pricing. As a result, manufacturers can get high value from these technologies at a relatively low cost. Couple the price factor with the fact that these technologies are universal and can adapt to any factory or machinery, and predictive maintenance technologies should be first on your list of external technologies to implement. Not only do these technologies provide machine health visibility that can reduce your carbon emissions, but they simultaneously reduce your OPEX.

02

Energy management technology

The need to simultaneously power large machinery is a given for most industrial operations. Manufacturing consumes the most energy out of all major industries (76%), followed by mining (12%), construction (7%), and agriculture (5%).

"In our view, the most pragmatic solution for reducing energy consumption in manufacturing is simply to use energy efficiently."

Traditionally, powering industrial machinery has relied on coal as its primary resource - the non-renewable, highly pollutant king of energy, powering Western civilization from the 18th century to the 1950s. While renewable energy alternatives entered the picture in the 1960s, the global demand for coal is still fairly high today. The good news is it's slowly but surely decreasing.

It would be natural to think that not using coal is the ideal solution. However, it is technically difficult to run a self-sustained factory with renewable energy alone (solar panels and windmills require very particular weather conditions). Even with these challenges, more than 200 companies, including manufacturers, have already pledged to honor commitments to reach net-zero by 2040 (10 years earlier than anticipated by the United Nations) through the Climate Pledge. These commitments would obviously involve installing renewable energy generation technologies for their assets along with reducing reliance on fossil fuels.

In our view, the most pragmatic solution for reducing energy consumption in manufacturing is simply to use energy efficiently. Saving energy (i.e., not turning on machines when they are not needed, or replacing machinery that is not energy efficient enough), not only reduces a site's carbon footprint but also its OPEX.

Ensuring efficient energy use within a production site is easy with the right technology and consists of three key steps:

Collect →	**Monitor** →	**Act**
Collect historic and real-time operating data that reflects the energy usage of a site's assets.	Monitor the behavior, patterns, and trends of energy usage, while analyzing the data to gain a better understanding of the bigger picture.	Act upon insights made to improve overall performance and reduce energy consumption where possible.

For each type of factory, the actionable insights will be different. For example, based on common issues found using energy management technologies, one can expect to initiate machinery inspection when energy consumption is relatively high or improve environmental conditions such as better ventilation or insulation.

KEY INSIGHT

Energy management technologies are a must-have for reducing your overall carbon emissions and costs. This should be on the top of your list, given the ease of implementing these technologies. As an added benefit, energy management technologies also improve worker safety by ensuring that your machinery doesn't become a hazard. For example, better energy management can prevent machines from overheating and ensure necessary repairs before a system malfunctions or an inadequate power backup leads to an accident.

03

Industrial product management software

"One could simulate a material switch by choosing a different material on the platform and seeing how it will affect the carbon footprint without actually implementing it."

Industrial product management software allows for micro and macro understanding of a product's carbon footprint and a combined view of a product portfolio information regarding compliance, sustainability, and costs. **Think software where manufacturers can add all of their raw material components and see the environmental effects of each of these.**

Whether it's through a standalone software or as an add-on to industry-standard CAD environments, manufacturers can utilize data such as Product Lifecycle Management (PLM), Computer-Aided Design (CAD), and Enterprise Resource Planning (ERP) systems and upload them to a cloud-based platform. Once the data is imported, manufacturers can instantly analyze details relating to manufacturing as specific as individual material components. For example, one could simulate a material switch by choosing a different material on the platform and seeing how it will affect the carbon footprint without actually implementing it.

KEY INSIGHT

Industrial product management software is one of the most resource-efficient ways to instantly get a better picture of the projected carbon emissions from your manufacturing. The opportunity to create savings and carbon reductions before any machine starts working is substantial and, therefore, a must-have for every industrial product design.

04

Water treatment machinery

"A by-product of the chemical process used in anaerobic water treatment creates biogas, which can be used as a source of renewable energy in factories."

Introducing water treatment technologies into the manufacturing process could tremendously contribute to reducing carbon emissions primarily in two ways; **reducing water consumption and harvesting energy.**

A typical water treatment process takes the water used in the course of production and processes it to be reused again, thereby reducing water consumption. The water can then be reused for the manufacturing process itself or other tasks (such as irrigation, cleaning, and toilet flushing).

The second way water treatment technologies can benefit manufacturers is by being a source for energy harvesting. For example, a by-product of the chemical process used in anaerobic water treatment creates biogas, which can be used as a source of renewable energy in factories, a technology currently in use by manufacturers across verticals.

KEY INSIGHT

Water treatment machinery is probably the hardest to implement among all the suggested solutions in this report. We identified more presence of such technology providers in Europe, so for manufacturers with activities in this region looking for a quick win, this would be the place to plan a pilot.

05

Innovative recycled packaging

"For manufacturers, building partnerships with sustainable packaging startups can reduce carbon emissions from the get-go, rather than later having to rely on external companies for offsetting."

For manufacturers, building partnerships with sustainable packaging startups can reduce carbon emissions from the get-go, rather than later having to rely on external companies for offsetting. Manufacturers, particularly those with consumer-facing brands, need to partner with fully sustainable packaging technologies to cater to environmental and consumer demand. The innovative recycled packaging technologies offer both functional (external/shipping packaging) and consumer-oriented packaging solutions.

More importantly, these technologies focus on the ecological impact of their materials and the ecological impact of the ***processes*** used to make them. For example, in terms of finished packaging - sustainable packaging startups can utilize recovered paper containing valuable fibers, which can be reused a few times in the production of each packaging sheet. In terms of the process, packaging companies can convert their wastewater into renewable energy, as mentioned in the water treatment section of this report.

KEY INSIGHT

When it comes to eco-friendly packaging for consumer goods, we're witnessing a growing consumer demand (with 50% of the consumers willing to pay more for sustainable packaging and delivery) and a clash between the incumbents and newcomer packaging producers. While today, recyclable packaging is a "nice to have" it will soon be a "must-have" due to government regulations and fines such as The European Packaging and packaging waste directive (PPWD) 94/62/EC (newly updated in 2018) and increasing consumer pressure.

06

Tech-driven raw materials

"In this way, startups are becoming the new raw material suppliers, offering patented innovations that lower a manufacturer's overall carbon footprint."

Nearly all manufacturers heavily rely on raw material suppliers for their manufacturing processes and finished goods, and sourcing materials that comply with the requirements dictated by the product's engineers is an art of its own. Add to that the fact that procurement departments have to build and maintain long-standing relationships with suppliers, and you've got another challenge. When sustainability enters the equation, it complicates the process even further, as material vendors must pass demanding standard qualifications to prove their sustainable practices, such as supplying recyclable or biodegradable materials. All this without mentioning the many challenges COVID-19 added to the supply chain, including delayed and increased shipment costs and unexpected disruptions and shortages.

Today's consumer brand manufacturers prioritize sustainability by sourcing biodegradable materials as well as considering the environmental impact related to the processes their raw materials undergo. For example, are materials being synthesized through a highly polluting process? Were they made using waste? These are questions that lead to implementing solutions with a more impactful carbon footprint reduction. ***That's where tech-driven raw materials come in.***

Startups entering the market utilize technologies to process and recycle materials in a way that simply wasn't possible before. These technologies focus on creating new sustainable raw materials, but also creating them with low environmental impact.

"Tech-driven raw materials include an alternative plastic material made entirely from processed household waste; or bio-based materials such as pineapple textile made from waste pineapple leaf."

In this way, startups are becoming the new raw material suppliers, offering patented innovations that lower a manufacturer's overall carbon footprint.

Tech-driven raw materials include an alternative plastic material made entirely from processed household waste; or bio-based materials such as pineapple textile made from waste pineapple leaf. For manufacturers, working with such external technologies allows a stable supply of raw materials. As an added value, some raw material providers can potentially handle a manufacturing plant's waste to create new material. In addition, these innovations often consider the environmental impact of shipping heavy materials, resulting in lighter materials being developed (that are also cheaper to ship).

KEY INSIGHT

If you can become a design partner for early-stage raw material tech companies, you may gain a competitive advantage by being early to the game and getting better terms with new tech-driven suppliers. Alternatively, planning the design around tech-driven raw materials may take up to a year for large manufacturers, so if you're a factory, consider these opportunities now.

07

Infrastructure for fossil-fuel-free equipment

"Hydrogen-based forklifts take as little as three minutes to change tanks, while the electric alternative requires 20 minutes to replace a battery and 8 hours to recharge it."

One of the C02 polluters often ignored in manufacturing facilities is the emissions from equipment on-site. This includes the different types of tools and vehicles used for material handlings, such as forklifts, tow tractors, and industrial trucks. The C02 emissions from these, although less obvious and less substantial than waste, for example, shouldn't be an afterthought.

Here's why.

Vehicles like forklifts and industrial trucks traditionally have fuel and diesel-based engines and, in most cases, require a fueling station on-site or nearby to keep all vehicles operational. The greener alternatives popping up are electric vehicles (EV) or hydrogen-based vehicles, each holding benefits and obstacles for factories looking to integrate them.

Let's look at charging forklifts. Hydrogen-based forklifts take as little as three minutes to change tanks, while the electric alternative requires 20 minutes to replace a battery and 8 hours to recharge it. When you rely on battery-operated EVs, this also means allocating storage space to extra batteries. Meanwhile, hydrogen storage and recharging equipment take up less space.

"hydrogen-energy tech companies jumped from 44 investments in 2019, gaining a total of almost $900M, to a total of $5.5B in 2020, with over 66 deals"

In terms of overall costs, battery-operated forklifts used to be almost the only alternative to diesel-powered vehicles, as handling hydrogen storage on-site used to be difficult and expensive. However, EV batteries, which are also costly and difficult to dispose of once depleted, are currently going through a slow tech development. In addition, tech companies are currently redesigning how batteries are built, making them more efficient and eventually more affordable.

On the other hand, hydrogen-energy tech companies have been flourishing since 2020, jumping from 44 investments in 2019, gaining a total of almost $900M, to a total of $5.5B in 2020, with over 66 deals throughout the year. The peak maintained height also in 2021, gaining $5B worth of investments over 69 deals.

KEY INSIGHT

Both battery and hydrogen-operated vehicles will need an on-site, reliable charging infrastructure. As a result, factory managers should consider the investment they're willing to make to power their material handling equipment.
The good news is that serious investment is going into tech companies creating the charging infrastructure for electric batteries and hydrogen tanks. This growing demand is a response to increasing market adoption. In other words, the tech is moving fast.
Whichever energy storage system you decide to adopt, ensure your tech provider can also anticipate offering on-site energy generation solutions. These on-site energy generation solutions are currently integrated only within massive, highly innovative manufacturers. However, once the charging infrastructure technology is further validated, therefore becoming more common and affordable, mid-tier manufacturers will also be able to acquire them, reducing costs and carbon emissions significantly across the board.

Taking carbon-neutral steps forward

“Adopting external technologies to reduce a factory's carbon footprint is a pressing environmental issue as it is a cost-effective one.”

Adopting external technologies to reduce a factory's carbon footprint is a pressing environmental issue as it is a cost-effective one. These costs refer to production costs themselves, and emerging costs associated with not being "green enough." In Europe, carbon permit prices are rising (up 5.7%). Costs like loss of insurance, government fines, and negative consumer perceptions, the latter of which hits particularly close to home for CPG manufacturers, are all adding up.

The urgency to get to net-zero factories is therefore twofold. However, the path to net-zero manufacturing will not always be linear. Instead, it will require a combination of the technologies in this report and a cultural shift of adopting open innovation and the ability to implement external technologies. In this way, manufacturers can stop relying on others to offset CO2 off-site and take control of the processes, costs, and emissions on-site.

Ready to discover technologies to reduce your factory's carbon footprint? Book a consultation with a SOSA innovation expert here.

ABOUT SOSA

SOSA is an open innovation company. We work with innovation teams and business units in corporations (like HP, Schneider Electric, RBC, Swiss Re), and governments (like Australia, Brazil, Canada and Taiwan).

We scout and validate startups and technologies in order to bring our clients the solutions they need to solve use cases, identify opportunities, or build new products.
Think noise-canceling headphones for the endless supply of startups.

Since 2014, we've literally been in the room facilitating discussions between large organizations and tech companies. From the first touchpoint all the way to pilots, implementations, and investments, we bring our clients precisely the technologies they need to advance innovation.