



**Building a Smart, Sustainable
Factory:** 5 Considerations to Achieve
Corporate Decarbonization Objectives

SIEMENS



Introduction

Highly autonomous and energy efficient factories underpinned by digitalization, IIoT, and distributed energy sources represent the future of manufacturing. However, developing such a facility is a complex undertaking that requires careful planning, investment, and coordination between stakeholders from the earliest phases of the project lifecycle.

Most manufacturers today recognize the importance of embracing smart concepts, such as automation, advanced data analytics, artificial intelligence (AI), digital twins, and others. The advantage these technologies provide in terms of reduced costs, improved safety, higher throughput, and increased efficiency is no longer in question. What is less clear for many industrial organizations is how smart technologies can be leveraged to achieve corporate sustainability objectives and decarbonize their factories.

As a global leader in the development of smart, sustainable solutions for manufacturing and an early adopter of these technologies within our own facilities, Siemens has a unique understanding of the challenges that industrial organizations face in today's business environment. Drawing on in-depth interviews with three of our customers (Deloitte, Forge Nano, and KORE Power), this white paper provides five important considerations when building a smart, sustainable factory.

The Journey to a **Smart, Sustainable** Factory

On the path to building a factory of the future, it is important to first recognize that no two situations are the same. Every organization is at a different point on the digitalization and decarbonization journey. Factors such as geography, financial resources, the product being manufactured, whether it is a brownfield or greenfield site, and others will all play a role in determining the optimal approach.

Nonetheless, there are steps any organization can take early on to increase the probability of success. These actions aim to promote thinking about factory development holistically, which is important to maximize return on an investment in technology and to lower the facility's total cost of ownership (TCO).



#1: Define sustainability targets and ensure alignment with stakeholders

Setting sustainability targets provides a clear strategic direction for the project. It helps to define a long-term vision that aligns with broader corporate sustainability goals. By establishing these targets first, manufacturers can ensure that their action plan is geared towards achieving specific, measurable outcomes rather than vague, unquantifiable objectives.

Establishing clear sustainability targets also aids in effective risk management. By identifying specific environmental and social risks and setting targets to mitigate these risks, companies can avoid potential future liabilities. For instance, targets related to reducing carbon emissions can help companies anticipate and adapt to regulatory changes aimed at combating climate change.

Additionally, establishing sustainability targets is important for transparent and effective stakeholder engagement. It enables companies to communicate their commitment to sustainability in a quantifiable manner, making it easier for investors,

customers, and employees to understand and support the company's environmental and social initiatives. Transparency also enhances the company's reputation, making it more likely to attract sustainability-minded investors and customers, and improve employee retention by aligning corporate values with those of its stakeholders.

For brownfields, manufacturers need to first quantify their starting point to determine if sustainability goals are even realistic. This requires a comprehensive energy audit to develop a baseline assessment of the plant's building envelope, including an evaluation of all existing infrastructure, such as local utilities, building and automation systems, production equipment, etc. Once sustainability targets have been established, leaders can then begin thinking about what technologies, methodologies, and concepts they can employ to drive their initiative(s).



The first step in any sustainable manufacturing initiative is to gain an understanding of the factory's energy usage, and to do this, you need visibility. If you can't measure the consumption of electricity, water, and gas, then there is no way to assess progress towards established goals or be transparent with leadership. And it is not just enough to collect usage data for the entire facility. You need granularity into individual systems and equipment so that opportunities for reduction and optimization can be identified and addressed in a strategic manner."

Ric Bravo
Senior Controls Engineer
KORE Power



Power is an important factor to consider when evaluating a greenfield factory's location, as many plants can require tens or even hundreds of megawatts of electricity. In many areas where existing transmission infrastructure does not exist, this level of power is simply not available from the utility, and the process to bring it in can be lengthy. **The cost of power is also critical.** The higher the facility's energy demand, the more important it is to invest in smart technologies that can reduce electricity consumption and maximize plant efficiency."

Don Kaiser

COO, Forge Nano & Forge Battery

#2: Identify any site limitations, particularly related to power

Location and geography play a critical role in facility development. In addition to supply chain considerations, a key variable that manufacturers must consider is power.

Many regions across the U.S. and abroad are constrained in their electricity supply. If there is a power deficit, plant capacity could be restricted. Additionally, the location may require new substations to be built, which can introduce possible delays due to the long lead times for critical electrical equipment. Lead times for a large transformer, for example, can be up to 50 - 120 weeks, depending on its design.

Forge Nano is currently in the process of developing a lithium-ion battery manufacturing facility in North Carolina under their newly formed subsidiary, Forge Battery.

In some cases, the delays and power challenges may be so pronounced that it becomes more advantageous to modernize a brownfield site where most of the electrical transmission and distribution infrastructure is already in place. If there are plans to expand the facility in the future, and power needs increase, you can expect more complexity for your electrical infrastructure.

Manufacturers also must consider the source of utility power and how the grid will evolve as the energy transition progresses. Increasing penetration from renewables like wind and solar can be attractive, as it reduces the facility's carbon footprint. However, the intermittency of these sources can have implications for future grid stability and reliability of electricity supply.

In certain cases, facilities may wish to implement their own onsite power source as part of a microgrid, which is independent of the public utility. The microgrid could consist of a conventional power generation source or a hybrid system with dedicated renewables and battery energy storage.

This is the strategy that smart manufacturing leader Deloitte has employed at its Smart Factory in Wichita, Kansas. The Smart Factory by Deloitte @ Wichita assembles a first-of-its-kind ecosystem of more than 20 world-renowned solution providers and technology innovators (including Siemens) to

help solve the toughest challenges in manufacturing. The factory manufactures and donates Smart Rover STEM education kits.

In addition to its fully functioning manufacturing production line that combines cutting-edge technologies, including AI, machine learning, robotics, vision solutions and more, the 60,000 square foot facility features its own dedicated microgrid comprising solar panels, wind turbines, and battery back-up. The zero-emissions electricity provided by the renewables-based microgrid is used to power the production process and greatly reduces the facility's carbon footprint.

Depending on the market, factories with microgrids may be able to capitalize on an additional revenue stream by participating in demand-side management (i.e., feeding any excess energy back to the grid during high demand). In this way, operators can transform their facility from a mere power consumer into a flexible asset with a dispatchable source of energy.



Deloitte's approach at The Smart Factory in Wichita is an example of how smart manufacturing and sustainability efforts are converging. The microgrid is producing clean electricity for the factory. At the same time, we are leveraging a BMS and other tools to capture our consumption data so that can we optimize how that energy is used. **Having control and visibility over both sides allows us to adopt a truly holistic approach to energy management."**

Tim Gaus
Principal, Smart Manufacturing Leader
Deloitte Smart Factory

Other benefits of microgrids include lower energy bills by avoiding congestion charges. Additionally, they ensure increased protection from losing power during natural disasters, as they don't rely on power supply being fed through miles of above-ground wires and assets that require maintenance and repair.

Regardless of the factory's plans or aspirations, it is beneficial for organizations to engage with an electrical solutions provider very early on in the project timeline to evaluate all current and future power needs, as well as external factors related to the grid, to determine the optimal electrification strategy.



#3: Approach digital transformation from a factory lifecycle perspective

In the context of digital transformation, manufacturers often focus narrowly on how advanced technologies can be applied to enhance their facility *after* it is in operation. While this is an important aspect of sustainability, the goal of a modern smart factory is to have all building systems work in unison to reduce not only electricity usage, but also the consumption of other utilities, like water and gas.

Leveraging the digital twin early in the design phase supports these goals. At the same time, it can help expedite the development process and reduce risk by identifying potential issues in the design before any construction takes place. The digital twin supports and drives the digital transformation of the factory by facilitating a seamless transition as the project progresses through the various stages of its lifecycle.

“The digital twin is an immensely valuable tool in that it allows manufacturers to simulate, test, and learn in a completely virtual environment,” added Tim Gaus.

“For greenfields, these capabilities can be leveraged during the design and construction phase to effectively

de-risk the factory’s build out. Keeping the digital twin evergreen facilitates a seamless flow of information as the project moves through the various stage gates. This ultimately supports decision making and enables manufacturers to continuously optimize the built environment with substantially lower risk.”

Once the facility is in operation, the focus can then shift to total energy management, which involves employing dedicated efficiency measures, analytics, and services to help ensure that the factory consumes only the energy that it absolutely needs. When derived from the right data and applied correctly, building analyses provide unprecedented transparency and granularity of information about the facility and equipment performance. This enables smarter decisions, whether it be identifying and optimizing big energy users, adopting energy procurement strategies that reduce energy price and risks, or building the business case for onsite power generation.



#4: Understand change management and workforce implications

The implementation of smart technologies and sustainable concepts will inevitably result in changes to traditional ways of working. This may lead to corresponding changes in the roles and responsibilities of personnel. In certain areas, skills gaps could emerge that need to be addressed. Manufacturers need to think about the implications that adopting a smart, sustainable manufacturing approach and how technology can be leveraged to enhance their workforce.

Too often, organizational change is viewed as a top-down exercise, with “lower level” employees feeling left out or minimally involved. This can lead to undesirable outcomes, such as apprehensions about the change or indifference to it, both of which threaten the success of the initiative. To avoid problems, project leaders and executives should promote transparency and clearly communicate the value of their strategy to leverage digitalization and improve sustainability.

Involving factory personnel in the process makes it more likely that they will prioritize energy management (if they aren’t already) and be open to using all available tools and technology to achieve established sustainability goals or outcomes.

“The return on investment from smart technologies is severely diminished if the factory’s workforce isn’t aware of how new tools can be leveraged to drive efficiency and make their jobs easier,” said, Ric Bravo. **“The ultimate goal with digitalization is to work smarter, not harder. To this end, leaders need to ensure that their engineers and technicians are educated and trained to use smart technologies. Technicians can also play a role in helping leaders decide what specific technologies to employ by communicating the challenges they face in their day-to-day activities.”**

Tim Gaus added: **“One of the biggest pain points for manufacturers today is getting access to skilled labor. Greenfields have the unique opportunity to address this by taking advantage of advanced techniques to enable the convergence of IT and OT and get closer to software-defined manufacturing from day one. A simple example would be the use of modern communications protocols.”**

#5: Consider alternative options for project financing

Financing remains one of the key barriers to sustainable factory investments. This is compounded by the fact that infrastructure upgrades tend to be reported as CAPEX, with amortization costs weighing heavily on balance sheets and financial ratios.

Flexible financing models can address this challenge and alleviate the need for upfront investments. Factory performance improvements can be paid for by the savings achieved over the term of the contract, or financed through a Private-Public Partnership (PPP). They can even be delivered as a service, providing a systematic, OPEX-based way to improve building performance, ensure compliance, and manage risks.

In such cases, reductions in buildings' energy use and operating costs are achieved without the need for additional capital. The building systems contractor identifies and implements strategies to achieve pre-agreed savings targets over the term of the contract. In return, customers pay a service fee based on these savings. The main automation contractor takes responsibility for the risks and costs of implementing measures to meet the contractual performance targets, including the repair, replacement and insurance of technical equipment.

Private financing options may also be available. As an example, Siemens Financial Services was the lead investor on the initial \$75 million tranche of private financing for KORE's Power Inc.'s 12-GWh lithium-ion battery cell production facility in Arizona, known as "KOREplex." As part of the project, Siemens Smart Infrastructure is providing critical electrical infrastructure and energy management solutions that automate and digitalize building operations.

"The economics of utilizing green concepts, like renewables-based microgrids is becoming more attractive. This trend will likely continue on the heels of legislation like the Inflation Reduction Act (IRA), which incentivizes the adoption of sustainable technologies", said Tim Gaus. **"Many of our customers are finding that there is an easier payback approval process with sustainability-focused projects. They are willing to tolerate a longer payback period than otherwise might be the case if the investment allows them to achieve meaningful progress towards corporate ESG goals."**





Conclusion

Despite 50 years of offshoring, the U.S. manufacturing industry remains a key part of the economic growth, employing more than 12 million people and adding some \$2.5 trillion annually to gross domestic product (GDP)¹. It is also a significant contributor to the country's environmental footprint, accounting for an estimated 17% of direct carbon emissions and 7.6 billion tons of industrial solid waste².

Like every industrial sector, there is an increasing impetus within the manufacturing industry on decarbonization and autonomous operations. Smart factories built on digital foundations and distributed energy resources are undoubtedly the future. In a recent survey from the National Association of Manufacturers (NAM), over half of manufacturing executive respondents said sustainability is essential to their future competitiveness. More than two-thirds said they are implementing extensive, corporate-wide sustainability strategies³.

Organizations need to begin making plans now to modernize and transform their facilities or risk becoming uncompetitive. When evaluating strategic partners for a project, manufacturers should prioritize real-world experience, as this is often needed to translate high-level emission abatement plans into actionable next steps. Early engagement with vendors and solutions providers is also crucial and can help de-risk facility development by ensuring that technology and digitalization are leveraged to the greatest possible extent.

¹ [United States Manufacturing Facts](#), National Association of Manufacturers

² [Manufacturing Waste Management Trend](#), U.S. EPA, November 1, 2023

³ [National Association of Manufacturers \(NAM\)](#)

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