Microsoft Azure

Sustainability within manufacturing

Why manufacturers are uniquely positioned to improve their sustainability efforts using IIoT technology

White Paper

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Manufacturers have been moving into an era of data-driven automation, IoT, machine learning, and artificial intelligence (AI) for years.

In 2020, it was precisely those capabilities, in addition to the resilience of many mission-driven employees, that became critically important to the manufacturing industry's ability to transform in the face of a crisis.

Global impact from the COVID-19 pandemic highlighted how even the most sophisticated supply chains weren't ready for an exponential increase in demand, proving that it was no longer sufficient for manufacturers to adopt new technology but build their own technology to compete, grow, and become sustainable.

Sustainability has been long viewed as a zero-sum contest between economic viability and environmental consideration. Sustainability hasn't traditionally been at the crux of manufacturers' business plans. Previously, the manufacturing space separated sustainability and manufacturing; it didn't understand that sustainability not only trickles down to the manufacturing level, but that it's at the manufacturing level that companies lay the groundwork for improved sustainability.

Achieve a more sustainable solution with Microsoft Cloud

up to **93%** more energy efficient

up to **98%** more carbon efficient

than on-premises solutions

The demand for resources and related environmental pollution that the demand for more resources creates has continued to rise drastically. Therefore, finding solutions focused on more sustainable development of global manufacturing that simultaneously consider the triple bottom line with three dimensions of sustainability—competitiveness, environmental compatibility, and social welfare—is more urgent than ever before.

Manufacturers today face a range of business pressures from consumers, but the demand for increased process and resource transparency has uniquely involved customer and public interest in methods of production and reduction of carbon footprint. To that end, a 2018 study found that using Microsoft Cloud can be up to 93% more energy efficient and 98% more carbon efficient than on-premises solutions[1].

For Azure, energy efficient datacenters and sustainable cloud infrastructure are more than just good business—they provide an incredible opportunity to give back to the communities where they are implemented and operating.

The European Union (EU) Green Deal sees carbon border levy as a matter of survival for the industry. In 2019, carbon taxes were implemented or scheduled for implementation in twenty-five countries. Furthermore, forty-six countries put some form of price on carbon, either through carbon taxes or emissions trading schemes.

The EU Green Deal, and other similar regulations, provide economic incentives and opportunities for manufacturers to switch to a more sustainable end-to-end business model—business models that target improved operational excellence through increased sustainability efforts.

Sustainability is a transferable and applicable approach for all manufacturers. The key to increased energy efficiency is reduced energy consumption—and reducing the amount of time manufacturers spend manufacturing. Improved sustainability efforts also go hand in hand with operational excellence. Furthermore, using Azure services, manufacturers can build solutions with a modern, comprehensive tech stack all underpinned by a common data model, improving time to value, lowering costs, and increasing agility.

"Nearly a third of the world's energy consumption and 36% of carbon dioxide (CO_2) emissions are attributable to manufacturing industries. The large primary materials industries, i.e., chemical petrochemicals, iron and steel, cement, paper and pulp, and other minerals and metals, account for more than two-thirds of this amount."

- **Egbert Schroeer**
  Principal Program Manager
  Azure Manufacturing

Manufacturing accounts for large-scale industrial processes, and as such, manufacturing has a disproportionate influence for improving environmental sustainability while simultaneously improving operational efficiency and brand value.

Green manufacturing as an industry imperative

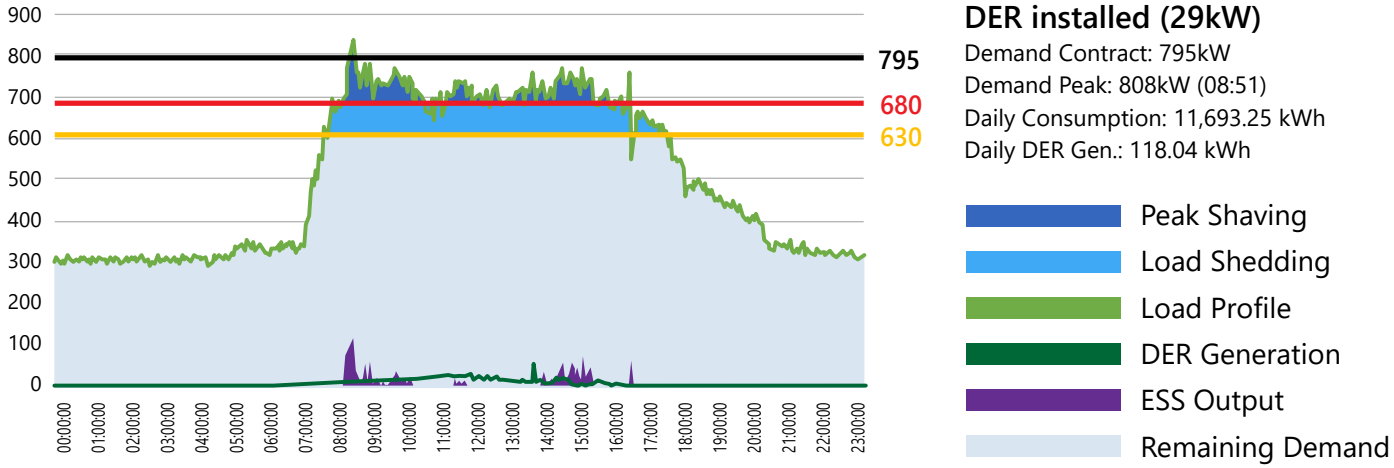
66.6%[1] of all energy (e.g., solar, nuclear, hydro, wind, geothermal, natural gas, coal, biomass, and petroleum) is either used to move energy from residential, commercial, industrial, and transportation sources or is otherwise rejected and considered all but useless. Cost is not the only issue at play when it comes to energy transfer; energy that should have powered electricity too often ends up as waste.

Green manufacturing, which refers to the greening of manufacturing by way of moderating emissions produced during various processes, involves utilizing fewer natural resources and reducing carbon footprint. Green manufacturing is central to the development of most industrial and consumer products, and for that reason, we believe it to be a concrete objective every manufacturer should embrace.

At its core, green manufacturing encourages environmentally friendly manufacturing operations commensurate to less waste, pollution, and harm, and in return, the use of fewer natural resources and the reuse of various materials. Workers within green manufacturers emphasize the importance of drawing energy from renewable sources (e.g., hydropower, solar, wind, etc.), utilizing specific technologies and deploying best practices to ameliorate energy efficiency, reduce greenhouse gases and pollution, and conserve natural resources.

It is through green manufacturing initiatives that companies can gain a strengthened green reputation, tax credits and incentives, increased revenue, and cost savings. Green manufacturing is tantamount to other cross-industry green initiatives and practices such as green chemistry and chemistry 4.1.

Energy Usage Optimization Example



Source: Delta Electronics DeltaGrid® Energy Management

Peak shaving is one example of how to achieve such initiatives. Peak shaving, which helps consumers achieve energy reduction, refers to the process of leveling out apexes in commercial and industrial electricity use. A consumer may decrease their power consumption rapidly over a short period of time (i.e., local shedding) to mitigate a spike in consumption and keep high electric costs at bay. In effect, peak shaving enables grid stability and affects power procurement costs.

To achieve successful peak shaving, manufacturers need to appropriately scale down production, employ stored energy sources, schedule load forecasts, and activate on-site power generation systems—among a host of other strategies. We've observed that as manufacturers incorporate peak shaving and power shaving practices, they'll yield improved cost savings and increased production line flow.

But sustainability isn't just idealistic—as manufacturers continue to emit harmful chemicals into the air, water, and earth, it has become prudent. The example of the 1969 Cuyahoga River fire—one of several fires atop of Cleveland, Ohio's Cuyahoga River—represented a tipping point for Cleveland. The polluted river, and its continuous hazard to those around it, illustrated the environmental price the U.S. was paying at the time for a thriving economy. Ultimately, this forced the country to question whether business as usual was worth the toll it was taking on the environment.

The Cuyahoga River fire of 1969 sparked the creation of the Environmental Protection Agency (EPA). The creation of EPA would later ignite conversations and raise awareness about irresponsible, inappropriate manufacturing operations, such as excessive greenhouse gas emissions or copious production of the hydrofluorocarbon super-pollutant HFC-23.

> *"The industrial sector is a hard to decarbonize sector. The three gorillas are steel, cement, and chemicals. It's pretty impressive, the level of emissions when we talk about cement and steel. Between them, we're talking about 5-6 gigatons per year of emissions, which is more than 10% of global emissions."*
>
> - **David Danielson, Managing Director Breakthrough Energy Ventures**

How are manufacturers capitalizing on green manufacturing?

The manufacturing industry is best positioned to address the challenges surrounding carbon emissions reduction because it's capable of incorporating or replacing every stage of production with a sustainable solution. This capability isn't just limited to manufacturing; chemistry, mining, and food and agriculture (to name a few) are industries ready-made for more sustainable solutions as well, highlighted by the case studies within this paper.

For manufacturers to make large-scale environmentally conscious changes to their business, they first need to assess their current environmental impact. Once manufacturers have a panoramic view of their energy usage, they can begin to trim it back in areas with the greatest impact. Most manufacturers already have a keen pulse on their energy usage, in part because it's a costly affair for them. But we believe manufacturers should also leverage the expertise of others and leverage tools that democratize expertise to more fully understand how the byproducts they produce affect the environment.

An integral component of green manufacturing is understanding the magnitude in which waste materials cause damage. Waste as a byproduct of a process can signal poor machine operational efficiency or increased downtime. Manufacturers struggle to find the foibles behind increased waste—or they can pinpoint it to, say, extremely complex transitional sequences, but then are unable to solve for it.

Digitalization can help companies track their overall carbon footprint. Industrial IoT (IIoT) also provides a solution for what would otherwise be a stalemate for manufacturers: the ability to monitor and analyze byproduct and waste management, improve resource consumption, and cut down on waste production during the manufacturing process.

We believe that four keys within digitalization enable sustainable environmental performance most: prescriptive maintenance, smart products and connected logistics, precision operations, and operational excellence. Each advanced technology enables manufacturers in different verticals to convert data-driven insights into intelligent action.

Green manufacturing, in this sense, represents a manufacturing engineer's approach to coping with these challenges. The underlying manufacturing technology is developed in the direction of economic competitiveness, environmental compatibility, and social welfare.

Another area in which manufacturers can see improvements in their use of green chemistry is through virtual experiments; that is, reducing the number of costly trial and error lab experiments that involve numerous resources. Instead, sustainable research and development practices can help manufacturers address issues surrounding regulations, product performance, and cost. Mission-driven employees are becoming more prevalent within every industry, making such goals easier to obtain.

Delta Electronics successfully leveraged IIoT technologies to produce in a more sustainable way

Delta Electronics, a world-class corporate citizen driven by the mission "to provide innovative, clean and energy-efficient solutions for a better tomorrow," pledged to achieve 100% renewable electricity and carbon neutrality targets for its global operations by 2030. Delta Electronics is voluntarily internalizing its carbon emissions into economic costs, serving as a tool to support an internal decarbonization strategy. Similarly, Microsoft committed to achieve entirely neutral carbon emissions by 2030.

With Microsoft's help, Delta Electronics could leverage IIoT technologies to produce in a more sustainable way. The difficulty for Delta Electronics lies in understanding how much carbon emissions the company produces, since it produces a plethora of products and is responsible for producing lots of EV charging infrastructure in the world. For instance, Delta Electronics needs to overcome the challenges of different countries' development of renewable energy and supporting regulations since company operations are spread across all five continents.

As part of its efforts to achieve carbon neutrality by 2030, it will focus on its own energy conservation, the use of self-generated solar energy and self-contained power plants, Power Purchase Agreements (PPA), and Renewable Energy Certificates (REC) to achieve the RE100 target. Delta Electronics' board of directors and ESG committee have also set an internal carbon price of USD $300 per metric ton in 2021 for its global operations to further encourage lower carbon emissions. That carbon fee will fund internal energy conservation projects and the procurement of renewable energy.

Delta Electronics has long focused on the development of various international sustainability initiatives and identified topics that match Delta Electronics' ideals to achieve an active response and maximize group strategy effects.

In 2015, Delta Electronics signed the "We Mean Business" initiative. In it, Delta Electronics committed to adopting a science-based target, reporting climate change information in mainstream reports as a fiduciary duty, and engaging in a responsible corporate climate policy. Delta Electronics added the commitment to promote electric vehicles and charging infrastructure in 2018 and committed to 100% renewable energy in 2021.

How IIoT technologies made it possible for Delta Electronics to calculate its carbon footprint

For Delta Electronics to successfully decrease its carbon footprint, it needed a wide-ranging view of both its carbon emissions and its disparate suppliers' carbon emissions. To solve this, DeltaGrid® Energy Management Solution was created to remotely manage EV charging stations and manufacturing plants. To track carbon emissions, Delta Electronics adopted Microsoft's Sustainability Calculator, which calculates insights into carbon emissions data and overall energy usage using Azure services. The Microsoft Sustainability Calculator quantifies Delta Electronics' estimated carbon emissions and Delta Electronics' savings for switching from on-premises computing services to Azure services.

In practice, the calculator prompts Delta Electronics users to select the efficiency of the on-premises datacenter in question. From there, the calculator establishes a baseline starting input (which users can control) to later report on reduced greenhouse gas emissions. Through the calculator, Delta Electronics can filter consumption data by Azure service type. It also allows Delta Electronics to filter its estimated emissions—as well as its suppliers' estimated emissions—by timeframe and region.

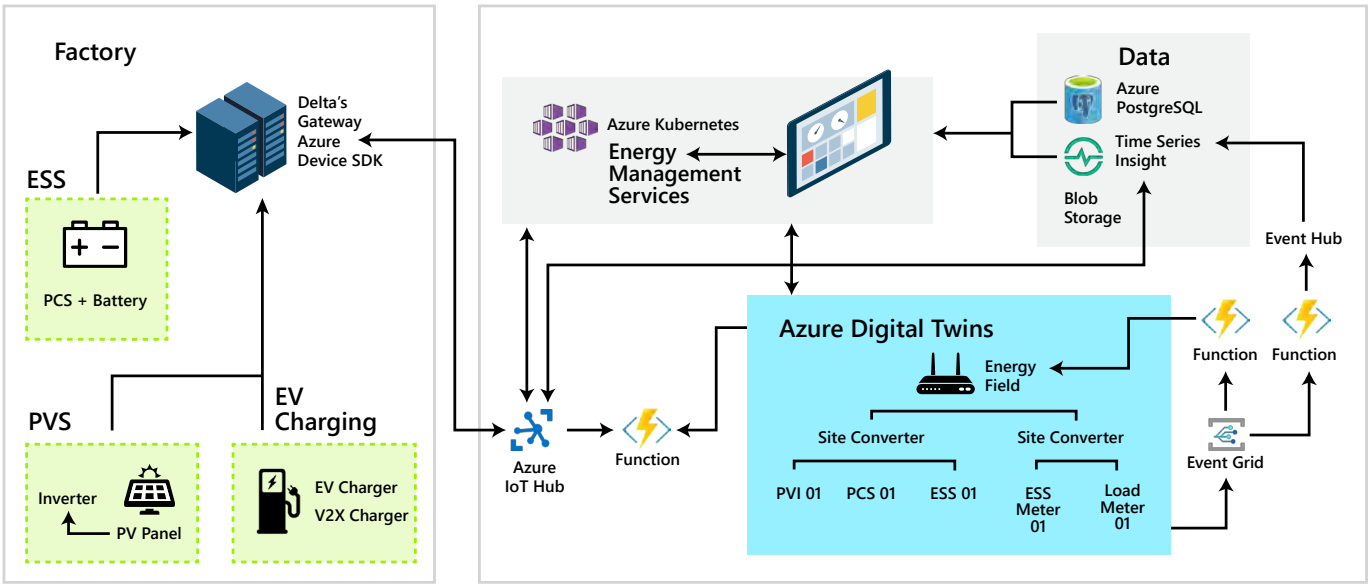


Diagram 1: DeltaGrid® Energy Management Solution Architecture Overview

DeltaGrid® Energy Management Solution can be run in Delta Electronics' factories and office buildings. As Delta Electronics leaned into these digital installations, other companies that lacked these technologies turned to Delta Electronics for hope.

Azure's solution architecture helped Delta Electronics maintain utility costs by increasing productivity

Another strategy Delta Electronics employed was to reduce electricity intensity by ramping up efficiency through the adoption of artificial intelligence. However, as productive as the equipment operated, the factories generated an abundance of energy.

Microsoft built a dashboard for DeltaGrid® Energy Management Solution. Through DeltaGrid® Energy Management gateways, collecting energy consumption data from equipment such as energy storage systems, solar systems, EV chargers, HVAC units, and water pumps. With LTE and Ethernet connectivity, data can be integrated into major energy management systems for further analysis as well as remote monitoring and control. Thus, it can centralize energy management in complex systems and realize energy-saving while optimizing energy efficiency.

As part of Delta Electronics' implementation of Azure services, Delta Electronics utilized data from components such as Delta Electronics Gateway, PCS and battery, inverter and PV panel, and an EV charger and V2X charger. Data from these sources then flow into Azure's IoT Hub. From here, data is transferred into one of several services: Core API Service, Time Series Insight, and Azure Digital Twins. Also under the umbrella of the energy field is Delta Electronics Gateway02, which is responsible for transferring data to ESS Meter 01 and Load Meter 01.

The combination of output processes from Delta Electronics Gateway 01 and Delta Electronics Gateway 02 through the Event Grid becomes visible and accessible to Delta Electronics within Time Series Insight and Azure PostgreSQL.

SCG worked together with Microsoft to reduce its out of spec polymers using AI

SCG, a petrochemical company in Thailand and key industry figurehead in Asia, produces an array of plastic grades. The company manages everything from the upstream production of olefins to the downstream production of polyvinyl chloride, polypropylene, and polyethylene. As such, it can be difficult for SCG to achieve optimal operational efficiency within its chemical processes since there are copious amounts of competing goals and priorities.

For SCG to facilitate the production of each grade of polymer, its chemical reactors needed to be precisely calibrated. Previously, SCG struggled to reduce waste and out of spec polymers, since during a grade transition, products that don't meet customer specifications are sometimes produced.

Calibrating chemical reactors is a meticulous, timely art that posed a challenge for even the most seasoned operations. In its previous operations, SCG would spend months, if not years, trialing millions of transitional sequences to no avail. As operators sought to calibrate each reactor to perfection, SCG saw a significant delay in plant performance—resulting in suboptimal machine efficiency and years of downtime.

To improve its process, SCG sought to achieve two objectives: diminish the amount of time it took to optimize each reactor and decrease the amount of out of spec polymer produced during each grade transition.

Autonomous systems offer a potential solution for poor machine efficiency and downtime: AI-equipped technology that can trial transitional sequences and assist, arise, and execute other tests, too. The model informs decisions about production and the designation of set points within the production process.

SCG was no stranger to autonomous systems. Prior to working with Microsoft, SCG developed a digital plant simulator that utilizes simulation modeling to find the most efficient transitional sequence. Despite this technology, the simulation was complex and involved numerous variables. Plus, each operator took a subjective, trial and error approach to find the best grade transition sequence for each new grade pair.

Even with its model, it still cost SCG too much time to explore the millions of simulated scenarios.

AI offered the potential to optimize the duration of grade transition

To help SCG achieve transitional sequences that both yield minimum transition time and waste, Microsoft came up with a long-term solution that combined the knowledge of experienced operators and engineers with the power of AI: Project Bonsai. Project Bonsai is a low-code AI platform designed specifically to speed up AI-powered automation. The platform could trial millions of transitional sequences every day without affecting actual production.

> *"Chemical processing is very complex – everything has to be done carefully and small mistakes can lead to wasted products that no one wants or unnecessary risks. Experience and skills of plant's operators usually determine profit margin and safety level of a plant."*
>
> - **Pitak Jongsuwat**
> **Physics Model Technology Engineer for Chemicals Business**

Together, SCG and Microsoft worked together to train Project Bonsai in a matter of months. Within weeks, it could deliver a set of operational sequences equivalent to highly experienced operator's expertise. True to its potential, the AI safely ran 100,000 simulations each day, trialing millions of transitional scenarios in the process. It proved useful in discovering more optimal paths than experienced operators could ever do by hand, while enabling operators to train AI using their industry expertise.

Between Project Bonsai, knowledgeable operators, and business leaders within SCG, AI allows for a plethora of expertise that was once reliant only on experience and intuitive guesswork. Project Bonsai acts as an interlocutor for manufacturers, guiding them on which areas of the business need extra detail. The user-friendly nature of Project Bonsai alleviates the complexity that AI-powered automation poses by empowering engineers to create and customize AI as a low-code solution.

Today, SCG has deployed the AI in a "human-in-the-loop" mode which enables engineers to apply AI recommendations. Moving forward, SCG hopes to fully integrate AI into its control systems to autonomously operate each transitional sequence.

Thanks to the data readiness of petrochemical companies, IIoT can be used for evaluation and analysis purposes with support from human expertise. For SCG to successfully customize Project Bonsai it needed to work together with Microsoft's Project Bonsai team. The success of Project Bonsai proves that open innovation will become imperative as it will enable companies to accelerate the adoption of Industrial Internet of Things (IIoT) to augment their successes.

ORICA

Orica standardized its operations through Azure infrastructure as a service (IaaS)

Founded in 1874, Orica, a global leader in civil and mining blasting, is the world's largest provider of commercial explosives and innovative blasting systems in the oil and gas, mining, quarrying, and construction markets.

The company has operations in the surface metal, surface coal, underground mining, underground construction, construction, quarrying, and oil and gas markets, boasting 400 sites in more than 100 countries. Orica conducts approximately 1,500 blasts per day on customer sites.

Despite its involved presence across multiple markets, Orica consisted of disparate systems. The company sought to standardize its blasting operations through digitalization to foster a more scalable environment.

To solve this, and to meet regulations that apply to explosive materials and the General Data Protection Regulation (GDPR), Orica posed five goals: reduce ammonium nitrate third party purchase costs, engage in volume leverage and competitive bidding, reduce booster unit cost by maximizing existing assets, reduce freight costs, and shift its on-premises architecture to infrastructure as a service (IaaS).

Orica implemented BlastIQ for more precise, environmentally conscious blasting

In 2000, the mining industry was responsible for 6,477 million tons of waste materials.[2] In over two decades, the mining industry has since adopted new technologies and best practices, leveraging more energy and resulting in more waste. For mining companies to successfully reduce particle size to improve their environmental footprint, they need IIoT technologies to provide them with a tailor-made platform.

Orica BlastIQ data-enabled intelligent blast management

Improved safety & predictability

Intelligent data & analytics

Reduced overall project cost

Minimized impact on the environment

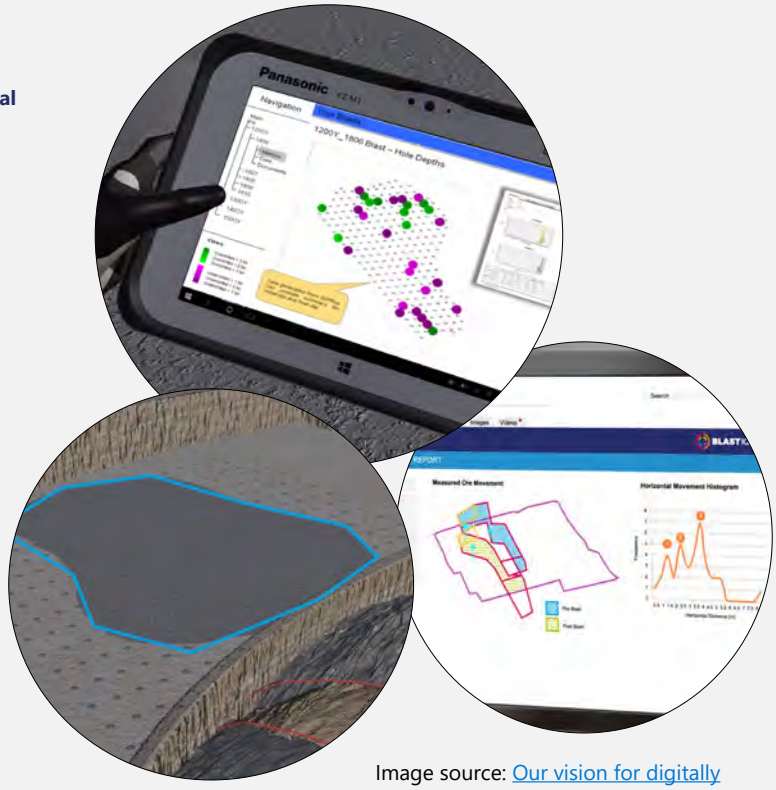


Image source: Our vision for digitally enabled better blasting

In the case of mining, Orica and Microsoft partnered with DataCloud to improve mining productivity and fine-tune blasts through more precise excavation. Through IIoT and collaboration, the three companies sought to reduce waste rock. Orica knew that measuring and optimizing each blast allowed its operators to sort through each load faster to find and rock mechanical data and stream each measurement through Azure Cloud. The BlastIQ platform is hosted on Azure, which allows for automated blasting.

BlastIQ, which was launched in December 2016, assists mine operators by providing a secure, centralized, digital platform for manufacturers to manage drill and blast data and processes. The technology was first trialed in North America and Australia, where remote wireless initiation systems triggered 535 blasts. The operation resulted in zero misfires, proving that remote wireless initiation systems are accurate and boast the potential to increase worker safety, reduce dilution, and increase ore recovery.

BlastIQ operates by coordinating between various IoT technologies: environmental monitoring, blast measurement, reporting and analytics, design and modeling, and hole survey and loading. Within the environmental monitoring facet, BlastIQ consists of nearly 800 monitors. Blast measurement technologies is hosted at six sites globally, and nine customer sites are engaging in BlastIQ's reporting and analytics technology. Hundreds of licenses globally are utilizing BlastIQ's design and modeling platform.

Data-enabled intelligent blasting offers improvements in blast design management, blast assurance management, vibration and air blast measurement, fragmentation measurement, blast data integration, license to operate assurance, blast outcome predictions, and blasting optimization. In addition, BlastIQ provides the capability to collect and interpret data and insights, and as a result, has improved drill and blast processes for Orica significantly.

Beyond that, BlastIQ consolidates and improves data access through SAP S/4HANA on Azure. Within BlastIQ, users can scan through a myriad of data-enabled intelligent blasting technologies: Blast design management, blast assurance management, vibration and air blast measurement, fragmentation measurement, blast data integration, and license to operate assurance.

"For our customers, [we're able to offer] consistency, and it's a guarantee that they know where their rocks are coming from. [Now] the customers and ourselves understand what the real-time, real cost value is on each blast and we can alter the shots to suit the customer's needs."

- **Sean Mclean**
  Huntly Quarry Manager

In short, BlastIQ enables state-of-the-art precision blasts that no longer blast unnecessary rock or materials. Through data driven IIoT technology, Orica improved its operational efficiency and improved upon its sustainability posture in the process.

Orica realized the benefits of cloud-based technology

In theory, BlastIQ was created to predict blast outcomes and streamline each blast for more efficient mine productivity—and that's exactly what it accomplished for Orica. Thanks to BlastIQ, Orica saw its cleanest, most efficient mining operations.

Through Azure cloud, Orica is now able to take the stream rock mass data from the cloud into its cloud blast design and modeling software. This allows Orica to interpret the data and visualize and create blast sequences that'll yield the most optimal outcomes. Using this blast design, in addition to BlastIQ-smart enabled technology, Orica can more accurately blast and predict fragmentation outcomes.

Orica experienced benefits in its downstream process such as reduced energy usage and an increase in its return for its customers. As a result of integrating Azure services, Orica reduced its system's level of complexity from four operating systems to two. Orica replaced all four databases with SAP 4/HANA and Microsoft SQL Service Solutions, and saw benefits in simplified patching, security administration, and overall management.

Now, Azure hosts almost all management, resulting in fewer outsourced providers taking on piecemeal work.

IIoT technology enabled Orica to increase profit and improve its environmental impact. Plus, along with Orica's gains in efficiency and environmental impact, the company now has a reliable foundation for future business system upgrades.

outokumpu

Outokumpu underwent a cultural transformation through piloting a new Azure platform

Based in Helsinki, Finland, Outokumpu is an industry giant in stainless steel manufacturing. Outokumpu has more than 10,500 employees, production in six countries, and operations in over thirty countries worldwide. To further the company's success, Outokumpu embraced end-to-end manufacturing to realize three goals:

- Achieve seamless automation, self-learning, and data-driven production
- Boast zero defects through prescriptive quality management
- Gain real-time insights on overall performance

Within each mill, the process of melting or forging steel requires temperatures up to 1600 degrees Celsius. Throughout the process, Outokumpu uses an extreme amount of electricity. Optimizing furnaces proved to be an excellent long-game strategy for the company, since the benefits of doing so result in greater operational excellence and sustainability.

Outokumpu partnered with Microsoft to construct an industrial digital platform based on Microsoft Azure: Outokumpu Digital Platform (ODP).

To pilot the new business model, Outokumpu tested its largest and most efficient stainless-steel factory in Tornio, Finland. The Tornio factory handles everything from the production of smelting, melting, and mining to hot and cold rolling and finishing of high

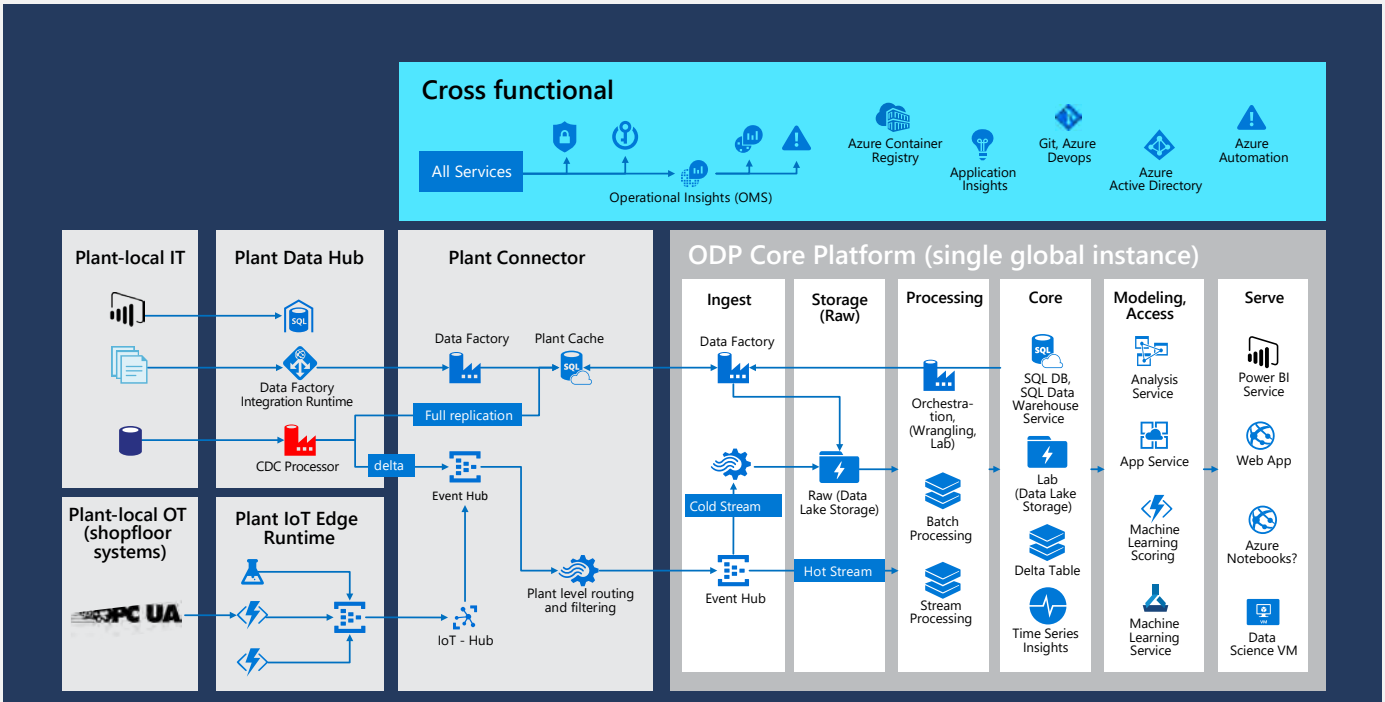


Diagram 2: Outokumpu Digital Platform (ODP) industrial digital platform architecture overview

demanding stainless steel products. Since the Tornio factory was already the epitome of efficiency, it provided Outokumpu the perfect win-win platform to trial ODP.

Knowing the benefits of IIoT technology and industry expertise, Outokumpu wanted to base more decisions on a combination of data analytics and workers' experience. To rewrite the rules of sustainability, Outokumpu knew it needed the power of IIoT to unlock technological benefits, with the added expertise of steel manufacturing experts to guide that technology.

In its shift from experience-driven to data- and experience-driven, Outokumpu onboarded scientists, programmers, and a host of other IIoT experts to boost operational expertise. In its words, "this combination of process, knowledge, computer power, and computer knowledge and data science brings [us] into a new level of the game."

In digitizing Tornio, Outokumpu sought to reduce lead times to customers through step-change improvements in quality, supply chain management, and overall reliability. Outokumpu also wanted to gain up to 100,000 tonnes of freed capability from its existing production asset.

ODP catalyzed differences in the steel melting shop, hot rolling mill, and cold rolling mill

To trial ODP's optimization benefits, Outokumpu trialed ODP in three areas: steel melting shop, hot rolling mill, and cold rolling mill.

Within the steel melting shop, an electric arc furnace worked to optimize casting speed in CCM and optimize AOD treatment time. Meanwhile, continuous casting predicted AI-based refractory consumption, and optimized AI-driven EF melting time. To enhance digital maintenance and repair, continuous casting enabled SMS intralogistics predictive maintenance (PdM). To ensure quality, automatic self-learning QC of slab surface and grinding was integrated via the electric arc furnace.

In the hot rolling mill, a walking beam furnace optimized heating time and automated self-learning quality control with the Tandem mill. An HR Mill deployed predictive maintenance to maintain the Soughing mill, Steckel mill, and Tandem mill.

Within the cold rolling mill, dual annealing/pickling technologies combined with a CR mill ensure continuous rolling-annealing-pickling. Through this,

self-learning quality control is ensured after annealing and pickling and automatic self-learning quality control is ensured after RAPS. These technologies enable RAP 5 PdM and DM10: SZ-mill PdM.

All three infrastructures boast digital coil data and mobile access and real time spare parts track and trace capabilities.

Azure services safeguard ODP

Within ODP, all technology falls under the umbrella of Azure All Services: Security Center, Azure Key Vault, Operational Insights, Log Analytics, and Azure Alert, Azure Container Registry, Application Insights, Git Azure, DevOps, Azure Active Directory, and Azure Automation.

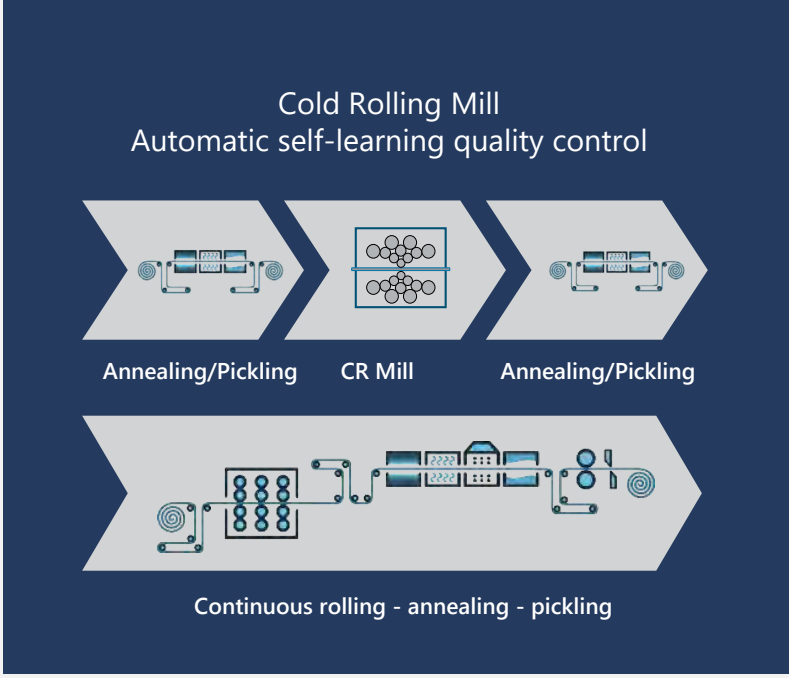
Starting at the shop floor, data is funneled into two entities: plant-local IT and plant-local OT. Within Plant-local IT, Power BI syncs with Plant Local SQL Store within the Plant Data Hub, Static, non-rdbms transfer data into Data Factory Integration Runtime, and RDMBS processes data into CDC Processor.

"It's the speed of changes in digitalization that makes what we have done unique. And how it has impacted our aspirations as a company. It's not just about improving efficiency; it's about changing the entire business concept."

- **Jan Hofmann**
  Executive Vice President
  Business Transformation and IT

Data within Data Factory Integration Runtime transfers to the Data Factory and then Plant Cache. Data from the Data Factory within the IDO core platform, with input from Orchestration Processing flows back and forth between the Plant Cache. Data stored in RDMB5 funnels through the CDC Processor within the Plant Data Hub, before transferring data to the Event Hub.

Back within the Plant-local OT sphere, data from OPC UA transfers to OPC-UA Publisher within the Plant Data



Hub. This data is transferred to the IoT Edge Hub, as well as data from Model Scoring and Actions. From here, data is transferred from the IoT Edge Hub to the IoT-Hub before funneling into the Event Hub altogether.

Data from the Event Hub flows into the plant level routing before transferring from the ODP core platform's Event Hub to ODP's Cold Stream, and then eventually to ODP's raw data lake.

Data from the raw data lake connects into the processing facet of ODP, wherein Batch Processing, Stream Processing, and Orchestration take place. The results of this flow enable the core of ODP (SQL, DB, SQL Data, data lake store, Delta table, and Time Series Insights) to gain visibility to the data as well.

Modeling and assessment technologies, analysis services, App Service, Machine Learning Scoring, and Machine Learning Service compute the data into Power BI Service, Web App, Azure Notebooks, and Data Science VM, allowing Outokumpu full visibility on its assets, processes, and machinery.

Deploying ODP reduced Outokumpu's carbon emissions and brought about change from within

Within the first six months of deploying ODP, Outokumpu saw considerable improvements in machine performance at the Tornio mill. Thanks to a high scrap ratio and continuous development of energy efficiency processes, Outokumpu already boasted the lowest environmental footprint for stainless steel in the industry, but ODP helped reduce its carbon footprint even more.

Through savings in electricity, energy, and operation run times leveraged from data-based decision-making, Outokumpu lowered its CO_2 emissions and increased its output from Tornio by 10–15%. Thanks to ODP's predictive technology capabilities, Outokumpu reduced quality defects by 40%.

From an operational efficiency standpoint, Outokumpu increased its throughput of stainless steel by 54 kt annually, reduced line delays by 60%, gained cost savings up to 5% each year, reduced treatment process time up to 25%, and reduced melting time deviation.

Furthermore, the adoption of ODP led to greater buy-in from the shop floor. Beyond sustainability tracking and routine quality checks, ODP enabled workers on the shop floor to own their projects (triggering a change in status quo). Additionally, the data from ODP allowed Tornio to close the skills gap between new operators and operators that have been involved in steel production for decades.

BÜHLER

Most important of all, because of digitalization, Outokumpu experienced a cultural revolution—for the better. As consumers demand more transparency on the materials they purchase, and as digitalization enables Outokumpu to meet demands of future customers, it has forced the steel industry leader to challenge its age-old processes, habits, and thinking.

Bühler Group implemented cloud based Bühler Insights to target food contamination and waste

Bühler, a family-owned, Swiss company responsible for being the world's leading supplier for solutions in the food processing industry shares a common goal with Microsoft: to make the world a better place. For Bühler's efforts, that starts with the food that people eat.

To date, 70% of the world's water and 30% of the world's energy goes into food production. 30% of all food produced is waste or scattered as it travels across the value chain.[3] With nearly 800 million people around the globe starving each day,[4] solving this predicament with a long-term sustainability fix is in the best interest of every party involved.

65% of the planet's grain processes through Bühler processing machines. Each machine is responsible for keeping food healthy and viable for two billion people each day.[5] With so much waste across its customers' value chains (e.g., flour, grain, rice, and corn mills) Bühler turned to cloud-based software to reduce energy consumption and waste.

Within the food industry, there are two key problems: issues with food contamination and issues with food authenticity, traceability, and lack of transparency.

Working together with Microsoft, Bühler deployed Bühler Insights: a cloud-based platform that combines Bühler thought leadership and industry expertise with Microsoft's knowledge in all things IIoT. Bühler Insights harnesses the power of IoT, AI, and machine learning to increase operational efficacy, improve cost savings, and enable the creation of higher-value products. More impressively, Bühler Insights is the first intelligent cloud-based digital services in the food and feed processing industry.

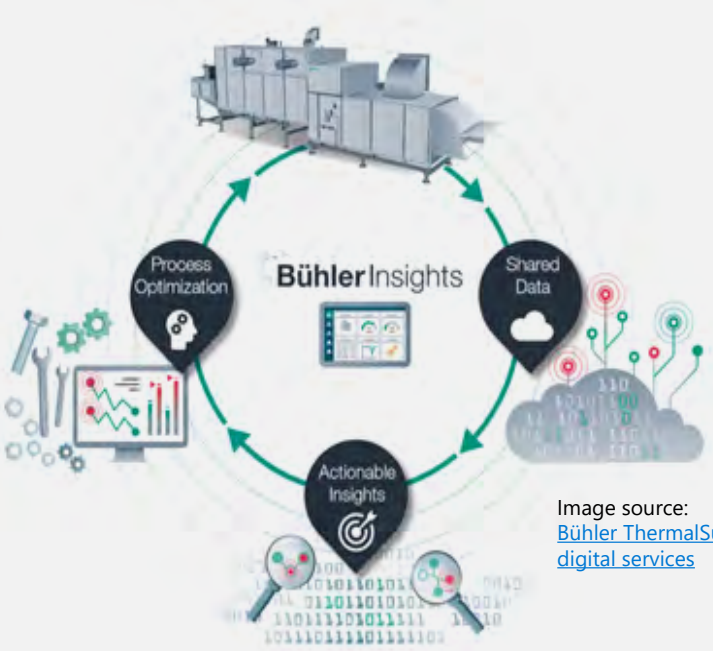


Image source: Bühler ThermalSuite digital services

Diagram 3: Bühler Insights Azure IIoT platform enables food safety insight

Azure IIoT services solve for contamination issues, energy consumption, and food safety outbreaks

The Bühler Insights IoT platform hosts an array of digital services. Blockchain technology works to trace contamination sources to prevent illness, lost food, or weakened brand reputation. MoisturePro™, another digital service powered by the platform, reduces energy consumption for Bühler's industrial drying processes and its customers.

"These problems in the food chain have been with us for some time. But now we have the technology to solve them."

- **Stuart Bashford**
  Digital Officer at the Bühler Group

Bühler's optical sorting technology is another example of IIoT technology—in this case, sensors—targeting food contamination and waste. Using sensors, Bühler's optical sorting technology created a snapshot of every individual grain process. From there, Bühler was able to divide each image into pixels for increased analysis. Bühler deployed image processing techniques and algorithms to determine if the pixel was viable or bad. Using this data, Bühler could then remove the defect grain from the group. Bühler's optical sorting technology handled industrial grade throughputs of fifteen tons per hour.

Furthermore, Bühler drew on smartphone technology to analyze food samples, which allowed its customers to calculate accurate measurements of the materials running on the process line. Bühler also embraced machine learning to provide its customers early intelligence on food safety outbreaks by using aggregate activities from across Bühler's social media channels.

In addition to its efforts with Bühler Insights, Bühler also embraced LumoBision, wherein Azure cloud and AI technology identified corn contaminated with the carcinogen aflatoxin, saving up to 400 tons of crop each day. Lastly, GrainiGo™ for corn and TotalSense™ for rice, are more examples of Azure cloud-based technologies providing Bühler with the tools to provide its customers raw material quality and trends, performance comparatives, and stored data for future traceability and analysis.

Digitalization not only makes food processes safer, but it also allows for increased collaboration and win-

win solutions for all players along the supply chain (e.g., farmers, shopkeepers, haulers, etc.). For instance, blockchain paired with sensor technologies such as IoT and RFID generate a shared data layer that can track multiple parties' asset status as they move across the supply chain. This shared data layer can detect where something originated and what it encountered.

Bühler's success in digitalization benefits all players across the supply chain—including Bühler customers

Microsoft technologies, such as Azure, IIoT, and Azure Blockchain have allowed Bühler to integrate process technologies, solutions, and services to address issues of contamination. For instance, Laatu targets microbial contamination in dry goods by using low-energy electrons to eradicate 99.99% of Salmonella.

Lastly, Mill E3 improves efficiencies within time, energy, and space. This new mill concept can be built more quickly in a small building using fewer costs. Moreover, Mill E3 boasts the potential to consume less energy per ton of processed wheat compared to a conventional mill.

Within Mill E3, sensors rope data into the Bühler Insights platform, helping to guarantee product quality. Blockchain technology offers traceability benefits from the farm to processed flour. Currently, Mill E3 is being created for one of Bühler's valuable customers, Whitworth Bros.

In addition to Mill E3, Bühler's success has led Whitworth Bros to implement Microsoft Azure Blockchain Workbench to digitize Whitworth Bros once manual, pen and paper-based process of grain transportation. Much like Bühler Insights's

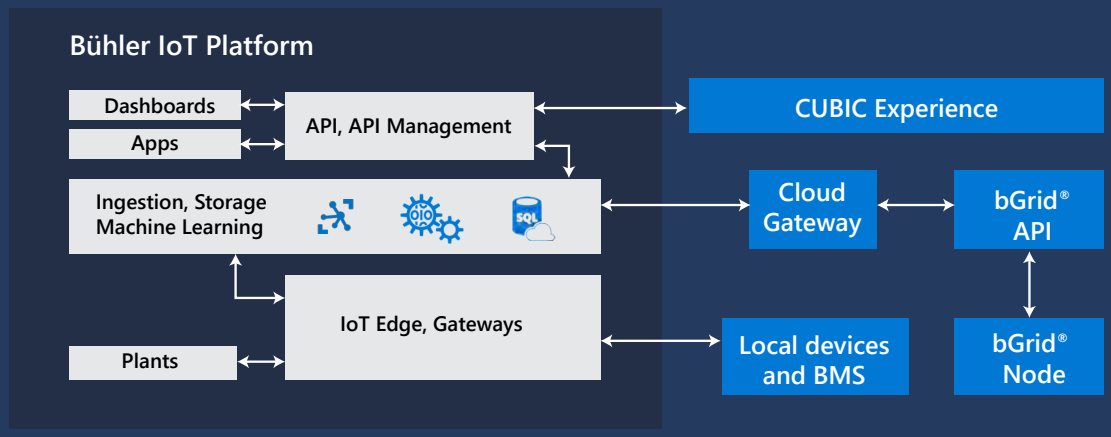


Diagram 4: Microsoft's CUBIC integrated IoT systems architecture

Laatu deployed 80%[6] less energy than comparative conventional microbial elimination technologies.

Another example is a Tubex Pro: a self-optimizing scale system that provides insights on real-time production data through Bühler Insights. Tubex Pro provides unmarked transparency and traceability along the value chain.

Tubex Pro is a smart, self-optimizing, scale system for the food industry that provides a constant flow of real-time production data. It enables improvements in efficiency and yield and provides a new level of transparency and traceability along the value chain. The data can also be seamlessly integrated into Bühler's Yield Management System.

early success as the first cloud services in the food and feed processing industry, Whitworth Brother's implementation of blockchain is the first instance of a company deploying blockchain to specifically analyze grain and maize.

Through full value chain solutions, Bühler, in partnership with the Norwegian coffee producer Jon. Johannson Kaffe constructed the first plant that uses 85% less CO_2 compared to traditional coffee production facilities. The plant achieved high productivity with low greenhouse gas emissions through processing technology Bühler supplied. Bühler combined Joh. Johannson Kaffe's green coffee

preheating unit with a state-of-the-art energy recovery system and energy-efficient emission control system to revolutionize the roasting process.

Excess energy is used to power laboratories and offices, meanwhile the rest of the plant's exhaust gases burn off organic matter, rendering them harmless.

With Bühler Insights, Bühler is proving itself not only a leader in the food processing industry, but a thought leader in the agriculture industry, too. Bühler Insights has led to new offerings, increased revenue, and a guarantee of crop safety along the supply chain.

Bühler enjoys energy benefits from Microsoft's Smart Building CUBIC Experience

Combining efforts with partners in the Smart Building and IoT environment, Microsoft joined forces with Codit and bGrid to provide a smart building for Bühler that would connect buildings and devices using sensors. In doing so, Bühler would gain real-time performance data, enable efficient resource management and predictive maintenance capabilities using building performance telemetric data, and manage building management from mobile devices.

CUBIC Experience Vision provides a digital platform for visitor management, smart lobby experience, meeting room management, access management, indoor navigation, digital signage, conferring and collaboration capabilities, smart meeting temperature/lighting control, smart workplace, people finder, AR experience, occupancy analysis, and sustainable eSmart building benefits.

CUBIC Experience offers Bühler the benefits of efficiency, sustainability, and management that technology provides, without any technical barriers to entry.

Smart building solution accelerators for Access Management include an IoT-based Access management system, a smart lobby and visitor management system, and on-site service. EEnergy management that provides sustainable solutions for the innovation center, meeting room experience technologies, occupancy analysis, indoor navigation, digital signage, and smart space booking pave the way for greater technology-enabled interaction and collaboration.

Energy management systems use IoT sensors, weather forecasts, and more to optimize energy usage within each building. Through CUBIC Experience, Bühler can be proactive about their proactive energy management thanks to daily end-to-end insights. Based on energy consumption, CUBIC can command any room or space to adjust or shut down equipment such as lights, heaters, and more.

The Energy System Module learns as it goes, drawing on real usage to optimize its decisions and drive higher cost savings. As a result, Bühler can more easily decrease energy costs, increase sustainability, and learn and accrue more cost savings.

Microsoft's CUBIC integrated IoT systems are comprised of three parts: CUBIC Experience, CUBIC

IoT, and CUBIC Infrastructure. Within the CUBIC Experience, occupancy analytics, light management, building analytics, and smart cleaning provide facility and real estate management solutions.

A myriad of solutions such as indoor positioning and navigation, CUBIC AR Tour, LinkedIn Wall, cashless payment, visitor management, AV Experience meeting rooms, and more pave the way for a better working experience for both Bühler and its clients.

CUBIC IoT consists of storage, machine learning, and ingestion capabilities. Dashboards and apps allow Bühler to monitor its store, machine learning, ingestion, IoT Edge and Gateways data, and Cloud Gateway and bGrid API data.

Lastly, within CUBIC Infrastructure, lighting, ventilation, heating and cooling, blinds, phones, and more work to connect with other IoT devices within the building thorough iBeacon, positioning technologies, and asset tracking.

CUBIC's bGrid Smart Building network utilizes IoT Edge and Gateways technology that use sensors and temperature and location data to ensure long-term sustainability. IoT Edge and Gateways data provides secure direct access to plants, enhancing operational efficiency there too.

As a result of energy management solutions, Bühler can assess its building's power usage, water usage, and overall health consumption on any personal device. This same data can also be accessible on Digital Signage screens or staccato (FM) screens.

Bühler implements SageGlass to reduce energy usage on its Uzwil Campus

Bühler partnered with Saint-Gobain SageGlass to create and implement smart glass into its CUBIC innovation campus in Uzwil, Switzerland. The smart glass, dubbed SageGlass, is useful for office buildings, hospitals, stores, and other large buildings in reducing temperature costs, since it controls the amount of sunlight passing through each piece of glass. Increased sunlight has proven to increase overall workplace satisfaction, relieve stress, and stimulate productivity (among other benefits), however, more sunlight can lead to increased energy consumption.

To address this, SageGlass is equipped with software and sensors capable of adjusting tint and blocking and filtering sunlight based on outside temperature and solar radiation. As advanced as it sounds, the basic principles of SageGlass have been around since 1960. The glass is made up of atoms or molecules that can transform their optical properties using a flow of electricity.

The process involved lithium ions and electrons. Lithium-ions implant into the storage layer of the glass. Once voltage (solar radiation, in this instance) contacts these ions, the lithium-ions shoot through the electrolyte to the electrochromic layer, which darkens the glass. Counter voltage causes the lithium-ions to funnel back into the storage layer, allowing the electrochromic glass to become transparent once again.

Buildings that utilize SageGlass require 35% less energy, resulting in a 10% reduction of CO_2.[7] Through the nanometer-thin coating in SageGlass, Bühler's Uzwil campus is now more temperature efficient, which has resulted in dramatic energy reduction and cost savings. Additionally, SageGlass's upfront costs pay off over time. According to Bühler, "SageGlass calculates a return on investment of less than ten years, based on energy savings alone."

Soon enough, SageGlass will make shades, blinds, curtains, and overly steep energy bills seem all but archaic.

Sustainability

is a transferable and applicable approach for all manufacturers.

Sustainability is the key to improved operational efficiency

Optimization is integral to manufacturing success, and since automation is paramount to achieving optimization, it has proven to be a major development in the industry. Even still, manufacturers understand the limits of AI; namely that AI offers only limited flexibility and requires consistent, precise operating conditions to yield desired results.

As most manufacturers seek to realize sustainable manufacturing (e.g.,100% renewable energy usage, 60% reduction in carbon footprint, etc.), there are four preliminary gaps to acknowledge:

- Shortage of recorded and standardized carbon transparency
- Fixed versus dynamic balance between supply and demand
- Incapacity to counter to dynamic line rearrangements
- Dependency on costly consultancy service

Microsoft applies an end-to-end approach to sustainability, accounting for every aspect of its device value chain (i.e., resourcing sourcing to production to delivery), which is important since the shift to going green involves wholehearted changes to measurement key performance indicators (KPIs), carbon footprint evaluation, and infrastructure.

Azure IIoT services allow companies to keep a pulse on each metric, which leads to increased understanding of the economic value that each operational integration brings.

The shift from on-premises to cloud computing

Through cloud computing, manufacturers can collect, analyze, and store data, reduce cost of IT ownership, and become more agile as a company.

In shifting from on-premises to cloud computing, manufacturers will use fewer large datacenters, and in return, reduce overall IT consumption of energy and related carbon emissions.

Four Microsoft applications within Microsoft Cloud that are comparable to their on-premises equivalents are Microsoft Azure Compute, Microsoft Exchange Online, Microsoft Azure Storage, and Microsoft SharePoint Online. Each application boasts extreme efficiency, which translates into both energy and carbon savings.

Other drivers that contribute to Microsoft Cloud applications' top-notch operational efficiency are IT operational efficiency, IT equipment efficiency, datacenter infrastructure efficiency, and the purchase of renewable energy to power datacenters, campuses, and more.

Here's where we can help

The dogma of green manufacturing is success achieved through digitalization, but increased security concerns and digitalization are warring entities in the green manufacturing realm.

Through IIoT technologies, companies can circumvent problems and inefficiencies that once proved to be stalemates for businesses. Azure services can bring manufacturers unflappable confidence to know that just as they are digitally transforming their operations, their data remains secure.

Most conventional security measures like service, network, compute, and storage layers are applicable to cloud security, too. These security measures, while built into the cloud, are audited by third party IT security providers. Through capitalizing on customization features available on Azure Cloud, all hosted applications will be protected.

> At Microsoft, we believe the science on climate change, and we support reaching net zero emissions.

Azure's platform provides a secure foundation for companies to augment their workforce, trial IIoT technologies, and become greener—even if operators aren't well-versed in IIoT.

For instance, the food and agriculture industry represent roughly 6.5% of global GDP and nearly a third of the entire world's workforce. There are more than 570 million farms in the world, and over 90% of them are family operated.

Technology development and deployment in agriculture has historically lagged other sectors, creating significant opportunity for tech-driven gains. Azure's management system (MS) is well-positioned to address five technology gaps within the developing and developed world, such as high-cost solutions, lack of return on investment (ROI), low cost of manual labor discouraging tech adoption, fragmented farm ownership, and lack of adopting existing best practices.

In the livestock industry, IIoT technology provides value chain analysis of selected crop and geography markets to identify key stakeholders. Internal MS capabilities assessments and partner identification and competitive landscape assessments provide strategic options to develop minimum viable products to service specific unmet needs.

Through MS AGTech, Microsoft can fill end-to-end gaps and unmet needs in key markets. Through successful production and distribution plans, Microsoft can solve the key end-to-end gaps in the target market.

Microsoft supports broader innovation, net zero emissions goals, and sustainability-driven policies

At Microsoft, we believe the science on climate change, and we support reaching net zero emissions. In addition to empowering our customers, we've committed to becoming more sustainable. We're investing in broader innovation, we're supporting government action that drives sustainability efforts, and we're committed to becoming carbon neutral by 2030 by shifting to 100% renewable energy. By 2050, we hope to remove the company's historical carbon emissions altogether.

To achieve this, we're laying groundwork using the best available science and math. We've invested $1 billion in climate innovation funds for negative emission technology, we support suppliers and customers with sustainably conscious tools, provide advance transparency, enlist employees to contribute to the effort, and use our voice to speak on carbon-related policy issues.

Several standards, including Microsoft Supplier Code of Conduct, Microsoft Supplier Social & Environmental Accountability, Environmental Requirements for Cloud Hardware Transparent Packaging, Restricted Substances for Hardware Products, and Restricted Substances Control System for Hardware Products enable the following services:

- Disclosure of accurate greenhouse gas emission data (Microsoft Supplier Code of Conduct)
- Sustainability metrics for baselining and benchmarking environmental impacts related to the performance of services for Microsoft (Microsoft Supplier Social & Environmental Accountability)
- Environmental requirements for transport packaging for cloud service hardware equipment (Environmental Requirements for Cloud Hardware Transparent Packaging)
- Identification of restricted or banned substances and materials for hardware (Restricted Substances for Hardware Products)
- Enforced supplier reporting on equipment materials, substances, and lab reports (Restricted Substances Control System for Hardware Products)

Become more sustainable with Azure IIoT, IT, and OT

Microsoft has a long history of helping and consulting chemical, mining, farming, and food manufacturers (among others) across all markets to understand complex issues at the intersection of farm operations, technology, investing, land ownership, and environmental stewardship.

As your business moves to increase sustainability and improve operational excellence, Azure services can provide a safeguarded platform for you to trial new initiatives, no matter how small-scale those efforts may be.

In being green through IT, cloud computing can provide strong improvements to less efficient, less secure on-premises infrastructures. IT allows manufacturers a platform to host, store, and analyze real-time data. This leads to improved business intelligence, management, and collaboration solutions.

OT optimizes operations, paving the way for increased revenue and more sustainable business practices as a result. OT also secures data across the value chain, which optimizes collaboration and protects against data security risks.

What's holding you back from sustainable solutions—and how can we help?

Sustainability has been clarified as an imperative for all companies, but it's also an increasingly emerging topic. Increased sustainability is a long-term play; one that lacks barriers to entry—especially for manufacturers—but one that requires investment and adoption.

To that end, how prepared is your company to adopt and invest in sustainability-supporting technology?

Read more:

Microsoft sustainability

Environmental Sustainability | Microsoft CSR

Azure Sustainability

AI for Earth

The Carbon Benefits of Cloud Computing: a Study of the Microsoft Cloud White Paper

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[1] Microsoft Azure Online, "Azure Sustainability." https://azure.microsoft.com/en-us/global-infrastructure/sustainability/

[2] While 2005 data is available, this analysis used 2000 data to stay consistent with the 2000 data presented in the Energy and Environmental Profile of the U.S. Mining Industry. After new data is presented in the E&E Profile, this bandwidth analysis will be updated to reflect the latest industry data. According to NMA and USGS Commodity Summaries (metals and industrial minerals selected based on DOE Mining Annual Report of 2004), production in 2005 was: coal – 1,131 M tons; metals – 62.3 M tons; and industrial minerals – 3,491M tons.

[3] Microsoft online, "Bühler is working with Microsoft to make food safer."

[4/5] "Bühler will track crops from farm to fork using blockchain technology," Microsoft online, September 25, 2018, https://cloudblogs.microsoft.com/industry-blog/manufacturing/2018/09/25/buhler-will-track-crops-from-farm-to-fork-using-blockchain-technology/

[6] LinkedIn, Egbert Schröer, "Industrial IoT and AI - How they shape the future"

[7] Bühler online, "Joh. Johannson Kaffe saves 85% CO_2 with new plant"

Microsoft