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WHITEPAPER

Towards Carbon-Neutral Manufacturing

with intelligent energy management across the connected enterprise

Executive Summary

Manufacturing businesses are hurtling towards their net-zero obligations rapidly, but few have made progress in this journey so far. As regulators across global markets enact laws for reporting and cutting down GHG emissions, net-zero production is turning into a compliance issue. To get a head start, manufacturers should focus on their energy-linked emissions, which account for **~75%** of all industry-linked GHG emissions.[1]

This makes energy efficiency the foremost lever for attaining carbon neutrality. But one-off efforts towards energy management will not do. What is needed is a reevaluation of every process across all manufacturing value chains, from product development to production, logistics, and consumption.

On the brighter side, the technology for attaining this goal is now readily available. ***The foundational technologies of Industry 4.0 – i.e., cloud computing, AI and ML, IoT, blockchain, and data engineering***, can now be applied to existing enterprise systems to draw granular insights on energy consumption. These insights can be leveraged to recommend preventive and corrective actions, to attain significant reductions in GHG emissions.

Carbon Neutrality Through Energy Management: Challenges and Opportunities

The manufacturing industry is grappling with a series of constraints that are limiting its ability to focus on its net-zero commitments. Rising material costs, supplier constraints, and shrinking margins, are keeping the board relentlessly occupied with short-term actions.

The board may find it difficult to prioritize sustainability amidst these immediate issues. However, it is worth noting that carbon neutrality will not only be essential to stay compliant in highly regulated markets, but also to compete in a sustainability-conscious market. More importantly, the sustainability lever with the highest scope of impact – i.e., energy management, can also drive down energy costs to improve profitability.

Energy efficiency can drive carbon-neutrality across all value chains:

1

Product development & engineering

Here, the focus is to use more energy efficient manufacturing processes and design products that use lesser energy across their life cycle.

2

Manufacturing and production

Optimizing manufacturing process efficiency, HVAC and lighting usage, and consumption at machine tool subsystem level can yield significant energy savings.

3

Logistics and warehousing

Granularly controlling heating, ventilation, cooling, and lighting can help businesses improve the Energy Performance Certificate ratings, which are becoming mandatory in some markets.

4

Suppliers and consumers

Using smart sensors, manufacturers can incentivize customers to adopt energy saving habits, effectively reducing the GHG footprint of their product across the life cycle.

In addition to these actions, energy-linked GHG emissions can also be reduced by monitoring the energy consumed at the plant, BU, and global level from various sources.

Energy monitoring and management:
what makes it difficult?

In order to implement intelligent energy management practices, manufacturers must first have reliable and credible energy monitoring systems in place. This is a key impediment in establishing baselines, and differentiating optimal from sub-optimal consumption.

Here are four key challenges detracting sustainable outcomes from energy management:

01

Manual monitoring of energy and utilities consumption leads to isolated and infrequent readings of electricity, water, and gasoline consumption.

02

Siloed cost, consumption, and production data makes it difficult to understand the causes and impact of energy consumption patterns and trends.

03

Lack of centralized energy consumption tracking makes measurement of energy-linked GHG emissions at plant, BU, and global level unviable.

04

Energy consumption meters and solutions show how much electricity is consumed, but **cannot suggest ways to optimize consumption** because causative factors are outside their scope.

Finally, the lack of a user-centric approach, and absence of a sustainability perspective in energy monitoring and management programs make it difficult to systematically achieve GHG reductions.

Exploiting Industry 4.0 Technologies to Reduce Energy-Linked GHG Emissions

As most businesses have already embarked on their Industry 4.0 journey, they are now well-positioned to apply these technologies to advance their sustainability goals with intelligent energy management. Nearly all manufacturing organizations have already adopted cloud to some extent, and are in the process of advancing their Industry 4.0 maturity.

Here's how Industry 4.0 technologies are be applied to achieve carbon-neutrality through energy-linked GHG reductions:

1. **Cloud computing:** Cloud forms the foundation for centralized energy monitoring and management. Using modern data warehousing, energy consumption data from multiple facilities can be ingested to create global, regional, and plant-level energy consumption dashboards.

2. **IoT:** Sensor technology enables collection of granular process and machine-level consumption data. Sensor data can also be used to create process maps, which in turn are used to build energy digital twins and energy digital threads.

3. **Advanced analytics:** AI and ML techniques are applied to mine insights from energy consumption and process data, weather data, and other operational parameters. This makes it possible to identify optimization opportunities.

4. **Energy digital twins:** All the above technologies are applied to create a digital replica of a manufacturing organization's real-time energy consumption, requirements, trends, and projections. This is leveraged to track global energy-linked GHG emissions and identify reduction opportunities.

5. **Generative AI:** In advanced energy management, GenAI makes critical insights more discoverable to key decision makers. It enables them to query key energy consumption and GHG metrics, and discover new actions that can drive down energy consumption.

Lastly, Industry 4.0 applications like shop floor automation, autonomous guided vehicles, and AR and VR can also decrease energy requirements across key processes. In addition, increasing energy consumption from renewable sources is essential to achieve a sizable reduction in energy-linked emissions.

Architecting Energy Digital Twins for Intelligent Energy Management

The biggest barrier in achieving GHG reductions from energy consumption at scale, is the absence of a solution that can unify data from multiple systems to identify optimization opportunities at scale. Because solutions like Facility Management Systems and Energy Management Systems (EMS) operate within silos, they fail to drive any significant results.

This makes it essential to devise an overarching EMS that builds a bottom-up view of energy consumption across the organization. Such a solution unifies process, environmental, financial, and compliance data to offer actionable insights to reduce energy-linked GHG emissions. This is the vision that informs an EMS based on energy digital twins and energy digital threads.

Architectural Overview

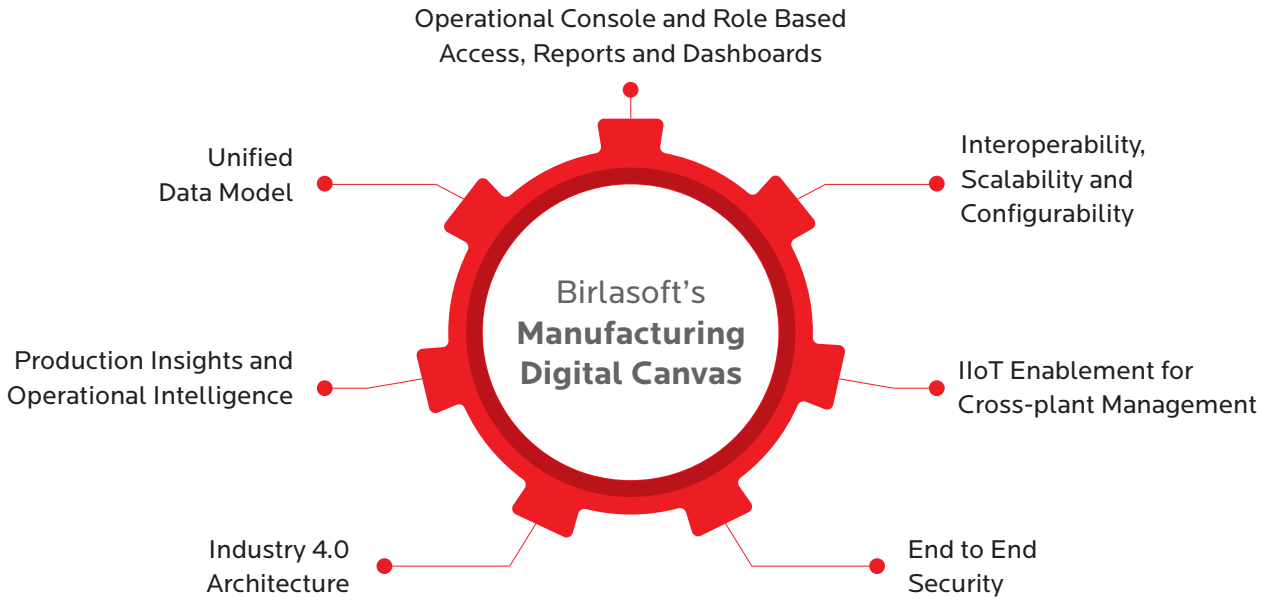

Figure 1 - Birlasoft's Manufacturing Digital Canvas

An enterprise-wide EMS ingests energy data from EMS and BMS systems of all facilities, production data from MES and ERP systems of all business units, environmental data collected through sensors deployed in facilities, and 3rd party weather data. Such an EMS should be based on the industry 4.0 architecture, and leverage unified data models to make data from disparate sources usable.

This data is ingested into a data lake built on a public or private cloud (depending on the compliance requirements of the organization). Ultimately, it is harmonized to track KPIs like purchased electricity, composition of renewable and non-renewable energy consumed, diesel used in generated electricity, and highest-energy-consuming processes.

Lastly, the data is used to establish demand trends, plant level consumption in MMBTUs, and energy-linked GHG emissions (total, per plant, or per unit of production). Such trends and insights are made available through dashboards and reports that are customized for relevant roles.

Energy management doesn't end with reporting. Instead, Industrial IoT networks are also deployed as control systems that automatically act to reduce energy consumption by limiting wastage and optimizing energy usage. This IIoT enablement can work across plants, and orchestrated centrally by exploiting cloud computing.

EMS systems should be secured end-to-end using advanced techniques like network isolation and encryption, as they interact with mission-critical industrial control systems, enterprise applications, and IT systems.

Click here for learn more about Birlasoft's Manufacturing Digital Canvas that enhances efficiency by real-time monitoring.

Manufacturing Digital Canvas

Use Cases and Possibilities

An enterprise-wide EMS that adopts an energy digital threads approach can help organizations meet their GHG reduction targets and comply with regulatory reporting requirements in sustainability-first legislations. Creation of industry standard reports such as GRI (Global Reporting Initiative), CDP (Carbon Disclosure Project), TCFD (Task Force on Climate-Related Financial Disclosures), CASB (Cloud Access Security Broker) for energy and utility metrics, monitoring and analysis. Tracking risk weekly and monthly for carbon footprint reductions. **Here are some ways in which such a solution can enable these outcomes:**

01

Optimizing HVAC or heating system control based on the weather data and activity levels inside the perimeters of a facility or a cold-chain system.

02

Alerting specific plants before they are about to exceed their GHG emissions, and facilitating the switch to clean energy grids for meeting electricity requirements.

03

Accounting for energy consumption in the production process to **inform product design and engineering decisions.**

04

Reporting metrics like **GHG emissions per unit produced**, or GHG emissions on a plant level to the regulators in that geography.

05

Identifying opportunities to **reduce energy consumption across industrial processes** using process digital twins.

06

Arming plant managers and sustainability officers with **plant and regional-level views that break down energy consumption by source, GHG emissions**, and key influences causing consumption variance.

07

Automatically monitoring sub-meters to **identify machines and processes that consume the highest amount of energy.**

08

Identifying idle machines, which typically consume approximately 50% of the power that they consume compared to when they are in use.[2]

Key Outcomes of Intelligent Energy Management at Scale

Implemented at an enterprise-wide level, an intelligent energy management solution can drive holistic outcomes for the organization:

Next Steps

Industrial energy consumption accounts for over a third of global energy use, making energy efficiency a significant avenue for achieving GHG reductions in manufacturing.[3] While energy management has been facilitated by point solutions so far, scaling the wins in a systematic fashion call for an enterprise-wide solution that can build a detailed view of energy consumption in real time and drive optimization.

This paradigm shift in energy management will be a key aspect in the transition to Industry 5.0, where ecosystem strategies will systemically drive down energy consumption across the industry. This human-centric and sustainable future of the manufacturing sector requires manufacturing organizations to treat energy-linked GHG emissions as a currency to be preserved.

This is the rationale behind the application of energy digital twins for GHG tracking and reduction. By contextualizing energy consumption data with plant-wide process data, environment data, cost, and weather data, manufacturers can unlock valuable insights to drive down energy linked GHG emissions. This will be the first significant step towards carbon-neutral production.

References

1 https://www.energystar.gov/industrial_plants/decarbonizing_industry/sources_industrial_greenhouse_emissions

2 https://www.sciencedirect.com/science/article/pii/S2212827113003144

3 https://www.iea.org/energy-system/industry

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