VIEW POINT

ADOPTING A DIGITAL STRATEGY FOR CARBON NEUTRALITY IN THE CHEMICAL INDUSTRY

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1. Introduction

The chemical industry is the cornerstone of the global economy. It provides essential materials, the building block for 95% of all manufactured goods, from automotive, aeronautics and electronics, to pharmaceuticals, agriculture, food, and low-carbon technologies – including renewable energy, housing, and mobility. According to the World Economic Forum, the chemical industry is the largest consumer of the oil and gas and the third highest industry subsector of direct CO_2 emissions, after cement, iron and steel. The sector is classified as 'hard to abate.' However, it is far from 'impossible to abate.' While the chemical industry may find it difficult to avoid carbon, it can use carbon more efficiently.

As Environment, Social, and Governance (ESG) policy has become a corporate priority and regulatory compliance has become mandatory, global enterprises are incorporating environmental sustainability into their economic goals. This shift can partly be attributed to the business and economic benefits that an organization achieves from sustainability investments. Investors are also nudging companies to prioritize sustainability and evaluate ESG data for supporting business decisions. Brand value is another benefit of sustainability programs. Millennial and Gen Z customers will increasingly make purchase and investment decisions based on sustainability policies of brands.

According to the Sustainable Manufacturing Practices for Delivering Carbon Neutral Goals[1] report by Manufacturer Alliance Foundation and Infosys, companies are eager to lower their carbon footprint, but many efforts are stalled — unable to move from visibility to transparency, analysis to action. The report adds that these companies are actively looking to institutionalize best practices that can be shared across industries and scaled across company sizes.

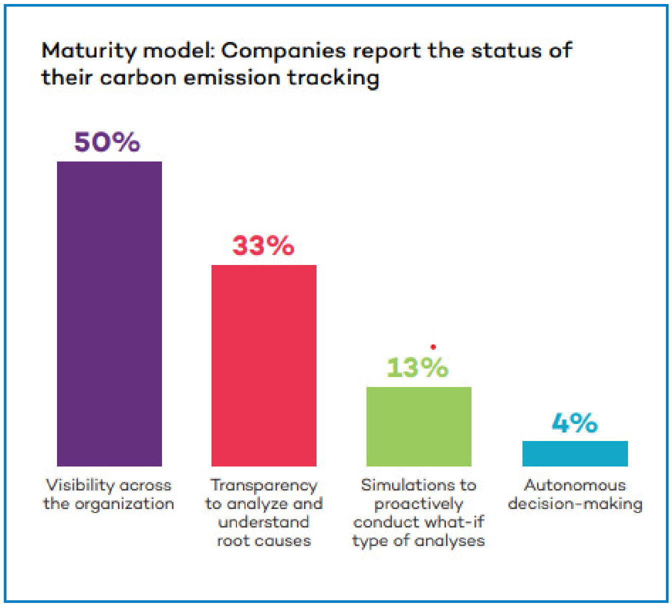

Figure1: Maturity Model

Another key finding is the role of digital technologies: Artificial Intelligence (AI), Big Data, and Industrial Internet of Things (IIoT) enable tracking and reduction of carbon emissions due to their inherent ability to increase transparency and accelerate decision making. The report also assesses the level of maturity for carbon emission tracking among manufacturing companies, as illustrated in Figure 1. The exponential adoption of Industry 4.0 coupled with the big data ecosystem generates actionable insights, which contribute to the emergence of new business models. Infosys proposes a 4-step digital strategy using the maturity model as a reference point.

2. 4-Step Digital Strategy for Achieving Carbon Neutrality

According to a McKinsey Global Survey[3], more than 90% of S&P 500 companies publish ESG reports, which demonstrates that ESG activities generate higher shareholder value. It also provides insights on how technology, when combined with effective leadership and management, enables organizations to achieve sustainability goals.

According to a survey by NTT[4], 44% of 500 global companies have registered an improvement in their bottom line by taking sustainability measures, and 69% of global executives believe that digital innovation is a catalyst to achieve sustainability goals across environmental, social, and governance areas.

33% Experienced reduction in costs due to improved efficiency.

32% Experienced more innovation and new business models.

24% Experienced increased growth in revenue

Figure 2: Key Benefits

Figure 3 illustrates the four steps, which begins with defining the GHG scope followed by methodologies for data collection and processing as per GHG accounting protocol[2]. In addition, it is used for metrics and reporting from where insights support decision making and change management to formulate a data driven strategy for chemical companies with complex processes and product portfolios.

GHG Scope Boundary Definition

Scope1: Emissions from

- Chemical reactions such as calcination, hydrofluorocarbon use in production of extruded-polystyrene and polyurethane foam inherent to the chemical industry
- Owned or controlled operating assets such as boilers, furnaces, captive power plant, and production plant logistics

Scope 2: Emissions from use of purchased electricity from steam, heating, cooling, from

- Local governments
- Private service providers

Scope 3: All indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including upstream and downstream emissions:

- Production of purchased products
- Logistics of purchased products
- Use of sold products

Data Collection & Storage

Emissions tracking using IoT devices (telematic devices, sensors and accelerometer) related to emissions due to defective equipment, engine breakdown and improper route planning.

Infra Red (IR) gas sensors for accurate and reliable measurement of CO, CO_2, CH_4 concentration

Modified thermal imagers or CCTV cameras for CO_2 detection and visualization

Tunable diode laser (TDL) spectrometers for atmospheric CO_2 measurement near exhaust vent

Continuous emission monitoring system (CEMS) with cloud, edge and cybersecurity plays a key role for data usage and strategic operational communication within organizations.

Metric & Reporting

GHG protocol product life cycle accounting and reporting standard

GHG Life cycle inventory

International Council of Chemical Association – Life Cycle Assessment

ISO14040: Life Cycle Assessment – Principles and framework

ISO 14044: Life Cycle Assessment – Requirement and regulation

British Standard PAS2050, Life cycle GHG of good and services

ISO/TS 14067 GHG- Carbon footprint of products quantification and communication

ISO/IEC 2011 (IEC: International Electrotechnical Committee)

Japan Chemical Industry Association, avoided CO_2 emission calculation

WRI/WBCSD (World Business Council for Sustainability Development_

End use level

Global Reporting Index 305: Emission

Global Reporting Index 302: Energy

Analytical Decision Making

GHG accounting and reporting helps the organization facilitate decision making about approaches for containing carbon footprint.

Key avenues to invest are:

1) Circular business models for carbon neutrality in chemical industry
2) Carbon market trading

Analytical Capabilities enabled:

1. Net zero scenario simulation
2. Buyer-supplier negotiation
3. CRM analytics
4. Process optimization
5. Cross-collaborative platforms
6. Decisions for VCM and CCM

Figure 3: 4-Step Digital Strategy

In the forthcoming sections, we elaborate on two key avenues such as implementing Circular Business Models for reducing carbon footprint and emphasize the use of Carbon Markets for offsetting the excess carbon emissions. This in turn take us a step ahead in achieving carbon neutrality in the chemical industry.

3. Key Circular Business Models for Carbon Neutrality in Chemical Industry

We have contextualized five circular business models[5] based on the WEF Circular Economy Handbook for the chemicals industry and distilled best practices to reduce the carbon footprint.

3.1 Circular Inputs

This business model focuses on reducing, reusing, and recycling emissions waste by incorporating hydrocarbon supply chain management. These techniques set chemical enterprises on the path to Net Zero while rationalizing green taxes.

- Companies are investing significantly in carbon capture and utilization (CCU)[6] techniques to recycle the waste CO_2 produced along the chemical value chain into methanol, a raw material for building materials, petrol-based chemicals and food processing industry following standardized manufacturing procedures prescribed by the Carbon Recycling International (CRI).
- The biofuel trend in transportation allows chemical companies to reduce their carbon footprint in logistics by establishing Bio-Natural Gas for Vehicles (BNGV) stations where biomass is converted into biomethane[7].
- The Hydrogen Council[8] 2021 Outlook focuses on the fertilizer industry and how ammonia alone contributes 45% to hydrogen offsets globally. Consequently, companies need to prioritize hydrogen supply chain management for renewable and low carbon hydrogen as a source of clean energy for transportation.

3.2 Product-as-a-Service

The chemical leasing[9] program is a flagship global initiative for a performance basis model for sustainable chemicals management. It aims to set a price for expertise and services for using fewer chemicals and focuses on the substitution principle with lesser hazardous chemicals. It has also resulted in an increased rate of substitution and a volatile commodity price in the market. Lesser chemical production avoids potential GHG emissions, thereby reducing the carbon intensity of the chemicals industry. The program also recognizes major contributors by awarding, 'Chemical Leasing Award'. Figure 4 illustrates the chemical leasing concept[10] for the lubrication industry.

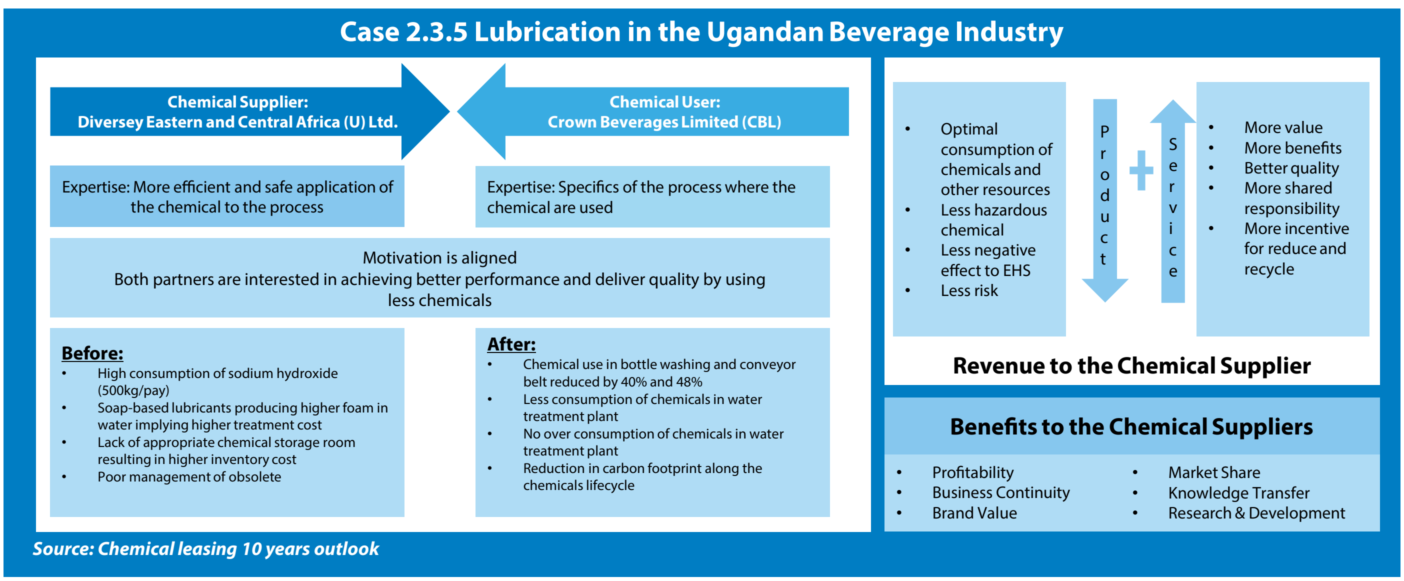

Figure 4: Chemical Leasing Concept

3.3 Product Use Extension

Product Lifecycle Assessment (LCA) adopts a closed loop approach to facilitate resource efficiency by reusing[11] the final product, thereby limiting the carbon footprint associated with end-of-life and post-recycling emissions. In the chemicals industry, the scope should cover consumable and durable products.

The fastmoving consumer goods (FMCG) industry presents a challenge in waste management. In this business, developing a circular loop via touchpoints with customers and collection agents at the bottom of the marketing pyramid demands moving the supply chain closer to customers for efficient reverse logistics and procurement, which in turn reduces supply chain costs and minimizes GHG emissions.

Customer relationship management programs drive product use extension, as mentioned below:

- Initiatives such as pay per fills rather than pay/units sold is now common in the FMCG business. For paints, it significantly reduces raw material cost downstream as well as upstream, thereby ensuring lesser usage of chemicals. In this scenario, the plastic can, tank, and container manufacturers need to adopt a value-based model for more durable products.
- The apparel, toy, furniture, and automotive industry produces a significant amount of hard-to-recycle waste. The downstream segment needs to engage with customers for repair, remanufacture and refabricate products. The upstream chemical producers should adopt a value-based model to produce more durable and eco-friendly chemicals.

3.4 Resource Recovery

The Alliance to End Plastic Waste (AEPW)[12], a 65-member cross value chain collaboration alliance, addresses challenges and develops best practices for efficient recycling of hard-to-recycle plastics such as plastic packaging, polyethylene terephthalate (PET), and high density polyethylene (HDPE) bottles and resin. The goal is to achieve carbon neutrality by reducing the potential GHG emission, post-disposal.

Challenges:

1. An integrated sorting, processing, and manufacturing facility is critical to improve operational efficiency and lower recycling costs.
2. Creating value for hard-to-recycle plastic waste by converting into a material for a variety of useful applications.
3. Evaluate localized recycling technologies to produce the raw material building blocks for new plastics.

Best Practices:

1. R&D and pilot projects to augment the body of knowledge is required to reuse or recycle the waste into a minimum economic product.
2. Renewable energy powered production processes and reutilization of process utilities such as water and air to minimize carbon footprint.
3. Accreditation with the Plastic Credit Exchange (PCX), a plastic market offset to target 100% recyclability and benchmarking,

3.5 Sharing Economy Concept

Sharing economy concept is a platform supporting business enterprises to be circular-first organically or transition to the circular economy or become early adopters and share innovations via several mediums:

- Voice of Customer (VoC)
- Awareness campaigns
- Cross-collaboration among SMEs and industry bodies to share industry knowledge for implementation
- Voluntary standardizing platform
- Audit reporting
- Chemical leasing
- Plastic leasing

4. Carbon Markets: Approach to Net Zero

The role of carbon markets is critical to achieve Net Zero GHG emissions. An efficient carbon markets ecosystem is imperative to meet the target of restricting global warming within 1.5 ° C. The carbon credit market is expected to grow at a CAGR of nearly 31% from 2020 through 2027, with a value reaching $2.4 trillion[13]. Currently, enterprises have two avenues to trade carbon credits: Compliance Carbon Market (CCM) and Voluntary Carbon Market (VCM)[14].

Standards for Carbon Offsets[15]

Lack of transparency and monitoring of carbon markets can be mitigated with rigorous standards for carbon offsets. Standards developed by independent third-party bodies and government regulated standards help monitor projects and mitigate the risk of invalid creation of carbon offsets. The Climate Action Reserve (CAR), Gold Standard and Verified Carbon Standard (VERRA) set standards to support voluntary carbon markets (VCMs) while ISO 14064 is government regulated and applicable to CCMs.

Market mechanisms are fundamentally different for both markets, which necessitates a different lens to explore each market.

Key Characteristics

	Nature of credits	Liquidity	Market value potential	Market dynamics and regulations
Compliance Carbon Markets (CCM)	Credits obtained by regulated entities to meet predetermined regulatory targets. Credits are mainly available under **cap-and-trade schemes from both primary and secondary markets**	Relatively **high liquidity** with direct relationship with volatile power, gas and coal prices.	**Large market value** (e.g., ~$260bn in 2020 with ~$30bn from Europe and ~$25bn from North America)	**Highly regulated,** With robust monitoring, reporting and clear quality verification standards
Voluntary Carbon Markets (VCM)	Credits voluntarily purchased by companies and individuals (purchased funds are used for project development) Credits are mainly available from **private project developers and OTC brokers.**	**Low liquidity** with limited trading potential in secondary markets where most buyers surrender and use the credit.	**Limited market value in current status with strong growth potential** (i.e., ~$300m in 2020, est. ~15x growth potential to reach $5bh-$180bn by 2030 depending on scenarios materializing)	**Fragmented and complex market with low to no regulation,** different accounting methodologies with varying degrees of rigor and a variety of industry-created standards.

Compliance and voluntary carbon markets operate largely independently with limited overlaps existing within and across markets (e.g., certain compliance markets allow the use of a small % of voluntary credits to meet compliance targets)

Figure 5: Carbon Market Types[14]

5. Summary

Chemicals are ubiquitous due to consumption, which contributes to the rapid growth in product portfolios. It demands that the chemicals industry become more responsible with its carbon footprint and sustainability measures. The four-step digital strategy discussed in the present study supports the transition to Net Zero by leveraging technologies such as IIoT, data analytics, cybersecurity and cloud for accurate and transparent carbon reduction. It will enable enterprises to adopt circular business models and carbon markets, and accelerate their journey to meet Net Zero targets.

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