VIEW POINT

HOW CHEMICAL MANUFACTURING CAN NAVIGATE A CLEAN ENERGY TRANSITION

Clean energy transition is now a global movement. The United Nations Intergovernmental Panel on Climate Change (IPCC) and World Economic Forum (WEF) highlight the imperative for accelerated decarbonization to mitigate global warming. The Green Claims Directive and Corporate Sustainability Reporting Directive of the European Union make sustainability reporting and emissions accounting documentation a mandatory requirement. In addition, the U.S. Securities and Exchange Commission (SEC) has drafted rules of climate-related financial disclosure for public listed companies.

Consequently, industries and economies are taking affirmative action. Enterprises and governments have pledged to transition from coal, oil and gas. Programs to achieve net zero CO2 emissions while ensuring universal energy access are being implemented to comply with the 2015 Paris Climate Agreement adopted at the United Nations Framework Convention on Climate Change.

The energy transition imperative

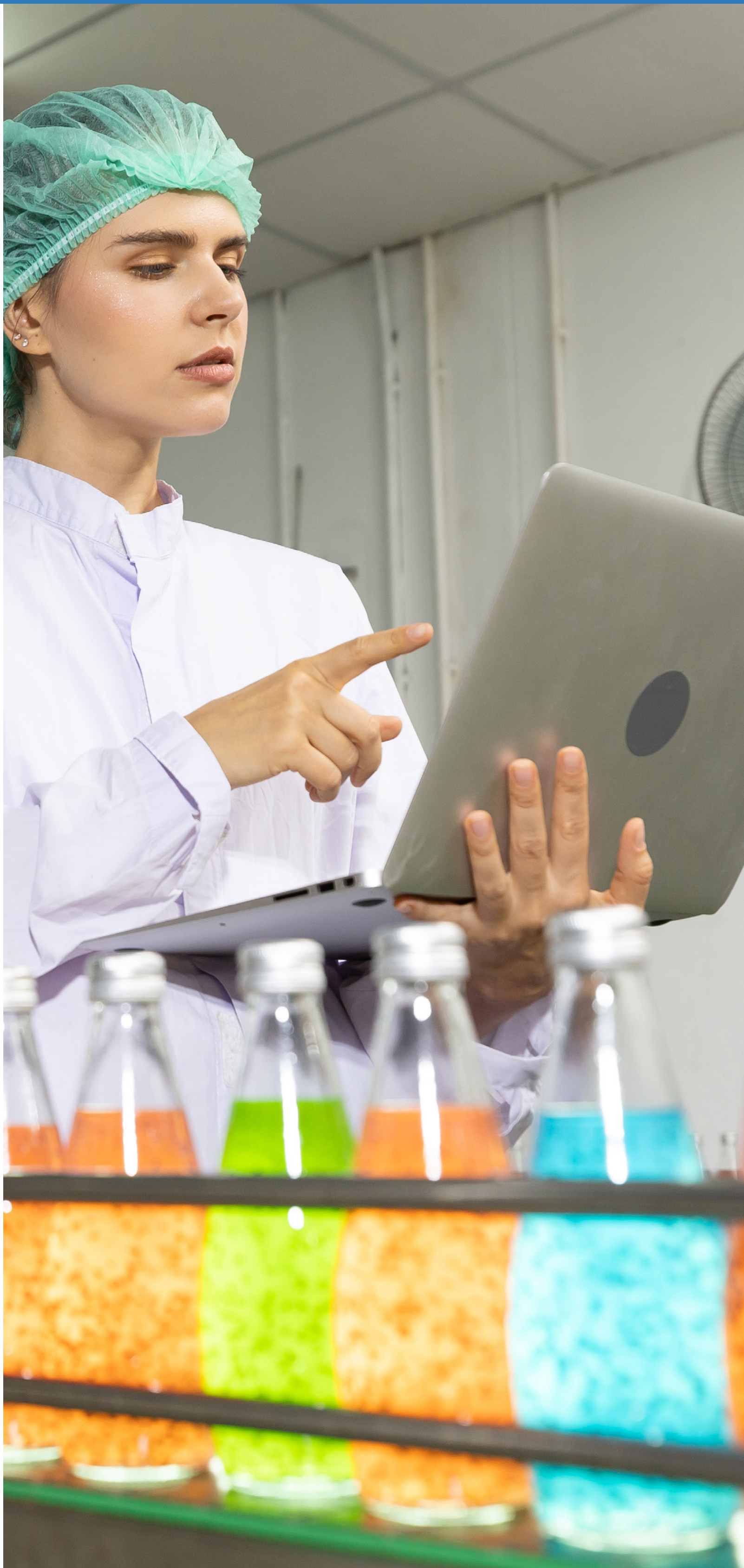
The implementation of clean energy technology to reduce energy consumption and carbon emissions varies from industry to industry. While the automotive industry is a front-runner, mining characterized by a sizeable scope 3 emissions footprint is challenged to prioritize the sustainability agenda. Being among the largest consumers of energy, chemical and adjoining industries are on the radar for their carbon-intensive manufacturing practices.

The global economy is increasingly dependent on the bulk chemical industry for diverse products, including plastics and primary chemicals. The chemical industry converts resources into essential raw materials and intermediates for core sectors as well as end industrial and consumer products. Be it fertilizers to boost agriculture output or HDPE bags to pack fertilizers, chemical products are always in demand. It is estimated that 95%+ of all manufactured goods comprise chemical products.

Case in point: scaling up renewable energy capacity has increased the demand for wind turbines. Wind turbine blades are made of advanced chemicals such as fiberglass-reinforced resins, high-strength carbon composites, epoxy resins, and specialty alloys. In addition, the turbines require corrosion-resistant coatings, additives, and a range of polymers.

Innovation in core industries drives growth in chemical manufacturing. However, the ensuing energy consumption and direct as well as indirect CO2 emissions counteract progress. Direct emissions from production is ~ 1.3 t CO2 per ton of primary chemicals (ethylene, propylene, benzene, toluene, mixed xylenes, ammonia, and methanol), according to the International Energy Agency (IEA) Tracking Clean Energy Progress (TCEP) 2023 assessment.

Chemical leaders, including BASF and SABIC, have established the Global Impact Coalition to reduce emissions and advance circularity. The industry-wide collaboration develops proof-of-concept pilots and establishes R&D hubs to accelerate technology solutions for reducing process emissions, enabling energy transition, and promoting circularity of polymers.



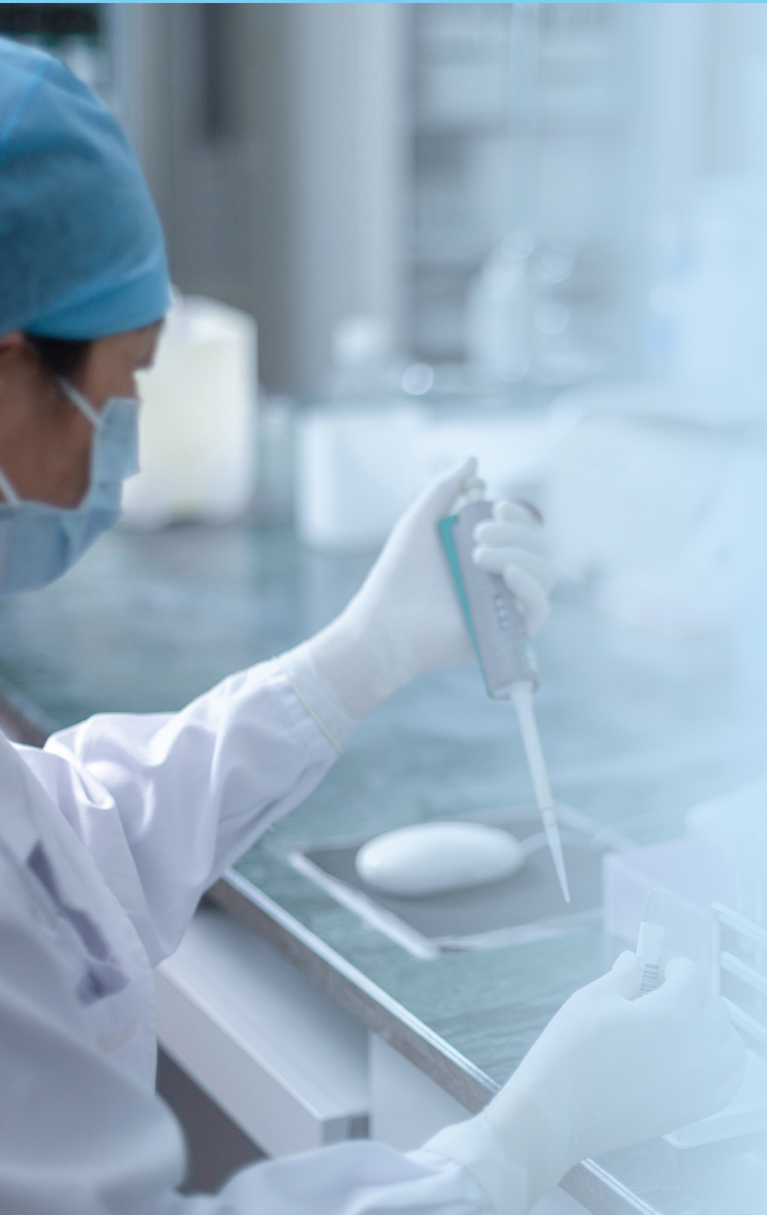
Reducing carbon intensity of operations

Large-scale processes at bulk and specialty chemical plants consume megawatts of electric power. The chemical industry consumes fossil fuels as fuel as well as feedstock. Fossil fuels are the base material to produce fertilizers, plastic and other chemical compounds. It is also used as fuel in machinery and furnaces; heating, ventilation and air conditioning (HVAC) and lighting systems; and to power synthesis and cooling processes. Emissions from the use and disposal of chemical products further magnify the carbon footprint of chemical operations.

Decarbonization of organic and inorganic chemical processes demands a multi-pronged strategy to boost the efficiency of energy and materials. In this regard, global regulation is accelerating the transformation to a low-carbon and circular chemical industry landscape. Environmental regulation such as the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), Packaging and Packaging Waste Directive, and the Circular Economy Action Plan in the European Union links material usage, recycling, waste management, and plastic pollution. In the United States, regulations such as the Resource Conservation and Recovery Act (RCRA), Toxic Substances Control Act (TSCA), National Emissions Standards for Hazardous Air Pollutants (NESHAP) of the Clean Air Act (CAA), and California Proposition 65 or the Safe Drinking Water and Toxic Enforcement Act govern sustainability practices in the chemical industry.

These regulations drive policy measures to produce sustainable materials, use chemical output more efficiently, reduce the use of single-use plastics, and explore possibilities to reuse and recycle products. Recycling offsets the need for primary production and reduces waste, while meeting the demand for chemicals. For instance, innovation in materials, such as bio-based plastics, is redefining the sustainability standards for wind turbines.

Technological interventions enhance sustainability in chemical manufacturing. Take for example, simulation tools that allow manufacturers to explore feedstock substitution (bioethanol), and optimize processes to increase the recovery rate of steam and heat from flue gas generated at combustion units. Similarly, advanced automation and integration of sensors and Internet of Things (IoT) technology offer opportunities to improve process efficiencies and reduce energy required for purifying products and byproducts.



Pivoting to clean energy

Chemical manufacturers should transition from fossil fuels for circularity and decarbonization. Migration to renewable energy helps enterprises reduce emissions from operations (Scope 1 and 2), and significantly reduce the carbon footprint. Notably, innovation in energy production, transmission and storage is facilitating the transition to low-carbon electricity.

Sun Cable, the renewable energy developer, is set to generate solar energy at a 12,400-hectare farm in the Northern Territory, Australia, and transmit it to Singapore. The Australia-Asia PowerLink project will transport electricity via 800 km overhead transmission lines to Darwin and 4,300 km of subsea cables to Singapore. This intercontinental network will be the world's largest renewable energy and transmission project commissioning 17-20GW solar capacity and up to 42GWh of energy storage.

Singapore is a pioneer in renewable energy infrastructure. Jurong Island, the petrochemical hub, is becoming a testbed for sustainable energy technologies. A strategic partnership between the Energy Market Authority (EMA) and JTC, a consortium consisting of VFlowTech, CBE Eco-Solutions, Rolls-Royce, Nanyang Technological University, Advario, and Infosys, is setting the direction for energy transition in carbon-intensive industries.

In a pilot project, the storage terminal of Advario Singapore Chemical in Jurong Island is being used for the deployment of Vanadium Redox Flow Battery energy storage system (VRFB-ESS). Existing chemical storage tanks will be used to store ESS electrolyte, which is synthesized using recycled vanadium ions from industrial waste in Jurong Island. The GWh-scale energy storage project is powered by solar photovoltaic systems and adopts a cloud-based smart energy management system for operations.

A roadmap for sustainable chemical manufacturing

Innovations in storage technology, such as gravity-based energy storage and megapack battery energy storage system (BESS), enable the chemical industry to accelerate the transition to renewable energy. Further, the application of carbon capture, utilization and storage (CCUS) technologies complements the capacity of forests, wetlands and the ocean to absorb carbon generated by industrial activity and offset global warming.

Renewable energy, from onsite installations or shared facilities, combined with fleet electrification and energy efficiency programs can minimize the carbon footprint of operations significantly.

Global manufacturers, including BASF, Dow Chemicals and Orica, have reduced the carbon intensity of their supply chains by pivoting to renewable energy.

Energy-efficient equipment, smart buildings with sensor-based energy management systems, and process optimization decrease power consumption per unit of chemical production. In addition, smart management of energy supply and consumption allow chemical plants, the backbone of global industrial and economic ecosystems, to operate with a modest environment footprint.

Infosys, a digital energy orchestrator, develops bespoke tools for a seamless transition from non-renewable to renewable energy sources. Our AI solutions ensure a robust structure for diversified energy supply, while our data-driven approach helps prioritize clean energy investments.

About the Author

Ram Ramachandran

Head of Sales for Chemicals, Agriculture, Metals & Mining industries at Infosys

He has helped many large corporations with transformation strategies including energy transition, responsible AI & automation and human experience based digital solutions.