How India can balance growth and sustainability for its Petrochemical industry

Vinod Kumar & Anjali Taneja

At the Asia Petrochemical Industry Conference held in New Delhi in May, the Minister of Petroleum and Natural Gas, Government of India, said that the demand for petrochemicals is expected to nearly triple by 2040 in India.

The Indian petrochemical industry has grown exponentially over the years. According to the Ministry of Chemicals and Fertilisers, Government of India, the share of chemicals and petrochemicals (not including pharmaceutical products and fertilisers) exports in the total national exports increased from 9.2 percent in 2012-13 to 12.4 percent in 2019-20.

Petrochemicals occupy an important place in our everyday lives, in the form of plastics, packaging materials, textiles, paints, detergents, etc. The manufacture of petrochemicals in India is expected to grow rapidly due to the AatmaNirbhar Bharat and Make in India initiatives. Since the sector is an emissions-intensive one, adoption of technologies that reduce emissions from the sector would be key for making this growth sustainable.

Basic building blocks

Ethylene and propylene are considered as important building blocks in the production of plastics and textiles. Ethylene is converted to polyethylene, ethylene oxide, and ethylene dichloride, and these compounds are further processed into useful products, such as plastic bottles, pipes, fittings, coolants, and textiles. Similarly, propylene is used to manufacture polypropylene, propylene oxide, and isopropanol, which are widely used in personal care products and medical applications. Such polymers have undoubtedly played a significant role in managing the COVID-19 pandemic.

Energy-intensive process

Petrochemicals are conventionally produced from fossil fuels through an energy-intensive steam-cracking process. One tonne of ethylene production emits around 1.8 to 2 tonnes of carbon-dioxide emissions. These emissions result when fossil fuels burn to reach the high temperatures needed for cracking. It is evident that decarbonising the sector is crucial to achieve India's net-zero targets. However, unlike the other sectors, decarbonisation of the petrochemical sector is uniquely challenging, primarily due to the sector's reliance on fossil fuels such as naphtha and natural gas—both as feedstock and source of energy.

Decarbonisation strategies

The decarbonisation measures for petrochemicals have traditionally been centred around improvements in energy efficiency, with a view to minimise the demand for process heat. The Perform, Achieve and Trade (PAT) scheme (under the PAT IV notification) mandated by the Bureau of Energy Efficiency (BEE) outlines clear targets for the petrochemical sector towards energy improvement.

Among the recent trends, process electrification (using electricity from renewable sources) has shown promise as a decarbonisation strategy for the sector. A conventional steam cracker uses fossil fuels as a source of energy, resulting in significant carbon-dioxide emissions. An electrified steam

cracker powered by renewable energy can thus be a solution. While companies like BASF, SABIC, and LINDE are jointly working on the world's first electrified steam-cracker demonstration plant in Germany, uninterrupted supply of renewable energy poses a major challenge for this strategy.

Another decarbonisation strategy would be to use low-carbon or green hydrogen produced through renewable electricity as a source of energy for the cracking process. At this juncture, the high cost and availability of green hydrogen could be a barrier in adopting this strategy.

Further, carbon capture and storage is a key technology that can be used for decarbonisation. It involves storing the carbon-dioxide emissions from cracking process deep below the ground. Various post-combustion carbon capture approaches, like solvent-based absorption and membrane separation, are being researched worldwide.

As part of the demand side decarbonisation strategies, circular economy — reduce, reuse, and recycle — needs to be widely promoted to minimise the demand for virgin plastic products. However, the labour-intensive steps involved in the collection and segregation of plastics are a major challenge in recycling.

Way forward

A low-carbon strategy is crucial to make the growth of the Indian petrochemical industry sustainable. The main strategy being adopted at present focusses on improving energy efficiency (based on the PAT scheme), but faster development and adoption of upcoming technologies is vital to ensure an exponential reduction in emissions from the segment.

Moving forward, the sector needs to embrace technological interventions, as well as demand-reduction approaches, to achieve decarbonisation. While efforts for improving energy efficiency should continue, deep decarbonisation technologies (such as carbon capture, process electrification, and green hydrogen) should be adopted in parallel. The potential of alternative feedstocks and reuse of carbon dioxide should also be examined.

From a policy perspective, the provision of subsidies and soft loans can be considered to ease the adoption of capital-intensive decarbonisation technologies such as process electrification and green hydrogen. Additionally, policy support is required for providing uninterrupted renewable electricity at subsidised rates to the petrochemical industries. Also, suitable incentives for recycling plastic waste can help boost collection, segregation, and recycling or repurposing.

Finally, stakeholders' interlinkages and engagements are key to making any policy or strategy sustainable and successful. Government-industry-academia collaborations for research and development initiatives or pilot-plant-driven technological innovations can improve India's technological readiness and enhance its competitiveness at the global level.

[This piece was written by Dr Vinod Vijay Kumar, Senior Associate in the Climate, Environment and Sustainability sector, and Dr Anjali Taneja, Senior Policy Specialist and leads Cross-sectoral Initiatives at the Center for Study of Science, Technology and Policy (CSTEP)]