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Unlocking Sustainable Growth in India's Chemical and Petrochemical Sector: Insights for NCPS 2026

Message from Knowledge Chamber of Commerce and Industry

Shri Durgesh Agarwal

I am pleased to convey my message to the stakeholders of the Chemical and Petrochemical industry. I compliment the Knowledge Chamber of Commerce and Industry (KCCI) for taking the initiative to organise the Chemical & Petrochemical Summit, which provides an important platform for dialogue among industry leaders, policymakers, and experts.

The chemical and petrochemical sector plays a crucial role in India's industrial growth and economic development. It serves as a backbone for several key industries such as pharmaceuticals, textiles, agriculture, plastics, and manufacturing. India has emerged as one of the fastest-growing markets for chemicals, with increasing investments, strong domestic demand, and expanding global trade opportunities.

States like Gujarat have been at the forefront of this growth, contributing significantly through strong industrial infrastructure, world-class ports, petrochemical complexes, and a vibrant manufacturing ecosystem. As India moves toward the vision of Viksit Bharat, the chemical and petrochemical industry will play an even more critical role in driving innovation, sustainability, and global competitiveness.

I am happy to learn that KCCI, in collaboration with ChemAnalyst, is bringing out a research study on the Chemical and Petrochemical sector to mark this summit. Such research-driven insights are extremely valuable for understanding market trends, supply chain dynamics, and emerging opportunities in the sector.

I especially acknowledge the efforts of the KCCI team for conceptualising and organising this important summit and appreciate the ChemAnalyst team for preparing the research study that will contribute meaningfully to industry discussions.

With these words, I wish the Chemical & Petrochemical Summit and the Knowledge Chamber of Commerce and Industry great success.

Durgesh Agarwal
Chairman -Western Region
Knowledge Chamber of Commerce and Industry

Message from Chemanalyst

Mr. Karan Chechi

As India strives towards its ambitious goal of becoming a developed nation by 2047, the chemical and petrochemical industry plays a pivotal role. This sector is not only crucial for economic growth but also for addressing pressing environmental challenges. By prioritizing sustainability and innovation, the industry can align itself with national objectives and global standards.

The chemical sector significantly contributes to India's GDP and employment across various sectors. As demand for chemical products continues to rise, it's imperative that this growth is sustainable. The industry must adopt eco-friendly practices, reduce emissions, and enhance resource efficiency. Sustainability is no longer a choice but a necessity. The global community increasingly prioritizes Environmental, Social, and Governance (ESG) criteria, urging industries to embrace responsible practices.

Resource efficiency is paramount. Implementing practices that minimize waste and optimize resource use can significantly reduce the environmental footprint of chemical production. The adoption of green chemistry principles is equally important, as it leads to the development of safer and more sustainable chemical processes. Transitioning to renewable energy sources is vital for lowering carbon emissions.
Gujarat has emerged as a leader in transforming India's chemical landscape. The state's proactive policies, robust infrastructure, and collaborative ecosystem have positioned it as a leader in sustainable practices within the industry. The Gujarat government has implemented progressive policies that incentivize sustainability and innovation. Research and development in Gujarat are also noteworthy, with significant investments in educational institutions and innovation hubs.

Achieving sustainability and innovation requires united efforts. Collaborations among industry stakeholders, government agencies, and research organizations are vital for driving systemic change. Public-private partnerships can leverage resources, expertise, and technology to accelerate the adoption of sustainable practices. Forming alliances among companies within the sector facilitates knowledge sharing and collective action towards sustainability goals.
A sustainable and innovative chemical sector can contribute to economic growth, job creation, and environmental protection, ultimately enhancing the quality of life for all citizens. A commitment to sustainability and innovation also enhances the global competitiveness of India's chemical sector, positioning it as a preferred partner in international markets.

Karan Chechi
CEO & Founder
ChemAnalyst Data Private Limited

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Executive Summary

India's chemical and petrochemical industry is on the cusp of a transformative journey, crucial to achieving the nation's goal of becoming a developed country by 2047 under the "Viksit Bharat" initiative. The industry, a vital pillar of the economy, has an unprecedented opportunity to lead in sustainability and innovation, driven by global shifts toward greener practices and circular economy principles.

As one of the world's largest producers of chemicals, India must balance its growth ambitions with environmental responsibilities. The industry faces growing pressure to reduce its carbon footprint, manage resources efficiently, and minimize environmental impact. Aligning with the government's commitment to achieving net-zero carbon emissions by 2070, the sector must embrace sustainable production processes, including renewable energy integration, biotechnological innovations, and advanced carbon capture technologies.

Technological innovation will be critical in this transformation. Advanced technologies such as artificial intelligence (AI), machine learning (ML), and the Internet of Things (IoT) will drive efficiency improvements, reduce emissions, and optimize resource utilization. Digitalization, when combined with green technologies, will enable companies to monitor and manage their environmental footprint in real time. These advancements not only contribute to sustainability but also enhance operational competitiveness, making the Indian chemical sector a global leader in sustainable manufacturing.

Gujarat plays a central role in this transformation. The state, which produces over 35% of India's chemical output and 62% of its petrochemical production, has established itself as the country's chemical hub. The Petroleum, Chemical, and Petrochemical Investment Region (PCPIR) in Dahej, Gujarat, is a prime example of how state-level infrastructure and policies can foster industrial growth. With major investments from industry giants like Reliance Industries, ONGC, and BASF, Gujarat is poised to lead India's transition to sustainable industrial practices. The state's chemical sector is already benefiting from its focus on circular economy models, renewable energy adoption, and sustainable infrastructure development. As Gujarat continues to attract global investment and promote green technologies, its leadership will be key in shaping the future of India's chemical and petrochemical industry.

Government policies, including Make in India and AtmaNirbhar Bharat, are paving the way for sustainable growth by promoting green chemistry, enhancing ease of business, and driving investments in cleaner technologies. The National Chemical Policy and Production Linked Incentive (PLI) schemes offer additional support, making India an attractive destination for both domestic and international investment in sustainable chemical production.

The shift toward a circular economy, which emphasizes resource efficiency, waste reduction, and recycling, presents a transformative opportunity for the industry. By adopting circular practices, India's chemical sector can unlock significant environmental and economic benefits, while ensuring resilience in global supply chains.

This shift will require significant investment in infrastructure, technology, and capacity-building, but it holds the potential to position India as a global leader in sustainable manufacturing. Collaboration across sectors will be crucial in realizing this vision. Public-private partnerships, combined with strong ties between government, industry, and academia, will drive research, innovation, and the adoption of green technologies. Gujarat's focus on integrating sustainable practices into its industrial ecosystem offers a model for other regions in India to follow, ensuring that the country's broader economic and environmental goals are met.

In conclusion, India's chemical and petrochemical industry is at a crossroads, with a unique opportunity to lead the global shift toward sustainability. With Gujarat at the forefront of this transformation, and with the support of government policies and technological advancements, the sector can drive India's progress toward becoming a developed nation by 2047. By embracing innovation, fostering collaboration, and prioritizing sustainability, the industry will not only contribute to national economic growth but also ensure a prosperous and sustainable future for generations to come.

Chapter - 1
Introduction

Overview of Sustainability in Industry

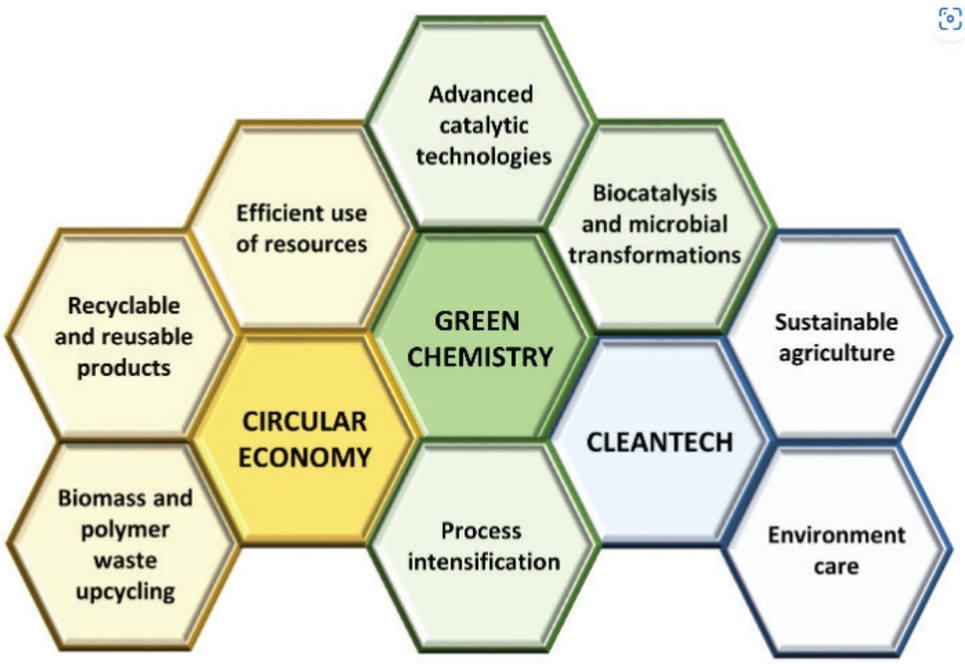
The global chemical and petrochemical industry are a cornerstone of modern economies, producing essential chemicals and materials for diverse applications. It plays a crucial role in sectors such as manufacturing, agriculture, and pharmaceuticals, contributing significantly to GDP worldwide. The industry is driven by technological advancements, including innovations in production processes and sustainable practices aimed at reducing environmental impact. As the chemical and petrochemical industry evolves, focus on sustainability and efficiency are becoming vital for maintaining growth and addressing environmental concerns.

Sustainability in the chemical and petrochemical industry is increasingly vital as the sector strives to balance economic growth with environmental responsibility. The industry faces significant pressure to reduce its carbon footprint, manage resources efficiently, and mitigate environmental impacts. Additionally, the shift towards a circular economy—where waste is minimized, and resources are continuously recycled—plays a crucial role. There is a growing global awareness of the need for sustainable practices across all industries, including chemical manufacturing. However, conventional manufacturing methods have frequently resulted in environmental challenges, such as pollution, waste, and high energy use. In response, the industry is undergoing a major transformation, adopting sustainable practices and pioneering innovative solutions to mitigate these issues.

https://www.scitec.cnr.it/en/research/green-chemistry

The petrochemical industry is a major driver of the global economy, providing essential mate-

Figure 1: Green Chemistry and Sustainability



rials for a broad range of products and sectors. However, it is also a significant source of greenhouse gas emissions. In response, the industry is adopting greener practices and pursuing sustainability through various strategies. One approach involves utilizing renewable energy sources like solar and wind power in production, which lowers both emissions and energy costs. Additionally, companies are incorporating energy-efficient technologies and optimizing operations to cut energy consumption and enhance efficiency. The industry is also focusing on developing sustainable feedstocks, including biobased and renewable alternatives, to decrease reliance on fossil fuels and explore carbon capture technologies. Investments in cleaner production processes, such as catalytic methods and biorefineries, aim to further mitigate emissions and minimize waste[1].

In India the chemical and petrochemical industry plays a crucial role in the social and economic development. As the nation progresses, supported by government policies that enhance business ease, promote self-sufficiency, and increase manufacturing output, the chemical and petrochemical sector is well-positioned to support and drive this growth. Sustainability in the chemical and petrochemical industry of India is becoming increasingly crucial as the sector supports the country's economic growth while facing environmental challenges. The industry is focusing on reducing its carbon footprint and enhancing energy efficiency to align with India's climate goals. The industry is investing in advanced technologies for better water management and exploring biotechnological alternatives to traditional processes. By embracing these sustainability measures, the Indian chemical and petrochemical sector aims to contribute to the country's economic development while addressing environmental concerns and supporting India's broader sustainability objectives.

The Chemical and Petrochemical Industry of India occupies a crucial role in the economy, acting as a backbone for numerous sectors with a diverse range of over 80,000 commercial products. Although the government has made commendable efforts to reduce import dependency, enhance infrastructure, and improve the business environment, a strong emphasis on chemical sustainability needs to be integrated into this growth narrative. The chemical and petrochemical sector is vital for India's economic growth, supporting industries such as textiles, automobiles, and agriculture. Emphasizing sustainability, there is a call for adopting green chemistry principles, reducing carbon footprints, enhancing energy efficiency, implementing circular economy practices, improving water management, and exploring biotechnological alternatives.

In recent years, India has emerged as a competitive and high-quality manufacturing hub on the global stage, drawing significant foreign investment. According to ChemAnalyst, India's chemical and petrochemical (CPC) industry is projected to reach between $383 billion and $450 billion by 2030. The pandemic has driven the global CPC sector to seek more diversified supply chains and invest in regions with favorable business ecosystems and investment policies. India stands out as a major potential investment destination, bolstered by Asia's expanding role in CPC production and sales[2].

The Indian petrochemical industry has experienced significant growth over the years. Building on the earlier momentum, India's chemicals and petrochemicals sector (excluding pharmaceuticals and fertilizers) has further strength-

[1] https://crimsonpublishers.com/pps/fulltext/PPS.000607.php
[2] https://chemicals.gov.in/latest-news/indias-booming-chemical-and-petrochemical-industry-understanding-industry-landscape

ened its role in the national economy, now accounting for approximately 13% to 14% of India's total merchandise exports as of the 2024–25 period. According to the latest reports from the Ministry of Chemicals and Fertilisers, the industry's export value reached an impressive US$ 46.4 billion in the most recent fiscal year, driven largely by a surge in high-value specialty chemicals and favorable trade policies like the China-Plus-One strategy. This steady growth from the 12.4% seen in 2019-20 underscores the sector's evolution into a cornerstone of India's global trade strategy. The sector is anticipated to expand rapidly, driven by the AatmaNirbhar Bharat and Make in India initiatives. Given that the industry is emissions-intensive, adopting technologies that reduce emissions is essential for ensuring sustainable growth[3].

In recent years, global attention is focused on achieving net-zero emissions, with many countries setting timelines for carbon neutrality. At the COP26 Summit in Glasgow in 2021, Indian Prime Minister committed to reaching net zero by 2070. Achieving this goal requires a major shift in India's energy mix, as fossil fuels remain a major part of its energy consumption. The Indian chemical sector, crucial to the nation's economy and energy landscape, is now central to discussions on sustainability and green practices. While it contributes only about 4% of India's greenhouse gas emissions, its role in essential supply chains—such as fertilizers, pharmaceuticals, and polymers—makes its environmental impact significant. The sector, known for its energy-intensive processes, is preparing to implement strategies that align with the national objective of net-zero emissions.

Importance of a Viksit Bharat

The term 'Viksit Bharat' translates to 'Developed India.' Viksit Bharat 2047 embodies the government's vision to elevate the country to a developed status by the centennial of its independence in 2047. The initiative is built on four key pillars: Yuva (Youth), Garib (Poor), Mahilayen (Women), and Annadata (Farmers).
Viksit Bharat 2047 is a vision to transform India into a developed nation by the centennial of its independence in 2047. This vision includes diverse aspects of development, such as economic growth, environmental sustainability, social progress, and good governance, with the goal of achieving a developed status by 2047. For environmental sustainability, the focus is to maintain a clean and green environment to protect its biodiversity and natural resources of the country.

This initiative emphasizes several critical aspects. It seeks to advance the industry by fostering significant growth in production capacities and technological innovations, enhancing the sector's contribution to the national GDP. The initiative also focuses on integrating sustainable practices to minimize environmental impact, such as reducing emissions and adopting green technologies. Additionally, Viksit Bharat promotes the development of advanced infrastructure and efficient supply chains to support the chemical and petrochemical industries. By aligning with Viksit Bharat's goals, the sector is expected to drive industrial growth, create employment opportunities, and bolster India's global competitiveness, ensuring it meets the ambitious development targets set for 2047.
Additionally in July 2024, Minister of Chemicals and Fertilizers of India, called for a unified effort from all stakeholders to drive growth in

[3]https://chemicals.gov.in/sites/default/files/Reports/Chemical%2520and%2520Petrochemical%2520Statistics%2520at%2520a%2520Glance-2019%2520%281%29%5B1%5D.pdf

the chemical and petrochemical sectors, underscoring the government's dedication to these industries as part of India's USD 5 trillion economy goal. This announcement was made during the launch of FICCI's India Chem 2024, a major international expo and conference. Held from October 17–19, 2024, in Mumbai, India Chem 2024 highlighted the Make in India and AtmaNirbhar Bharat initiatives and contributed to the vision of Viksit Bharat 2047. The event will feature the latest technologies, innovations, and products in the chemical and petrochemical industries, while addressing policy issues, regulatory frameworks, and sustainable practices[4].

Objectives & scope of the whitepaper

The primary objective of this whitepaper is to emphasize the critical role of sustainability in India's chemical and petrochemical industry. It seeks to highlight the need for adopting sustainable practices to align the sector with both national goals, such as achieving carbon neutrality by 2070, and global environmental standards. In addition, the whitepaper aims to promote innovation and technological advancement by underscoring the importance of integrating cutting-edge technologies like artificial intelligence, machine learning, and IoT. These technologies are essential for improving operational efficiency, reducing emissions, and optimizing the use of resources across the industry.

Another key objective is to demonstrate how policy alignment can support industry growth while promoting green chemistry and sustainable manufacturing. The whitepaper explores government initiatives such as Make in India and AtmaNirbhar Bharat, illustrating how these frameworks can drive progress within the sector. It also aims to facilitate the industry's transformation toward a circular economy, advocating for a shift away from traditional linear models. By focusing on waste reduction, recycling, and resource efficiency, the paper shows how the chemical and petrochemical industry can achieve long-term economic and environmental benefits.

Collaboration is also a theme of the whitepaper, which aims to encourage stronger ties between the government, industry, academia, and global stakeholders. Through these collaborations, India's chemical and petrochemical sector can enhance its global competitiveness and play a more significant role on the world stage.

The scope of this whitepaper covers a comprehensive analysis of the industry's current state and future potential with a key focus on the state of Gujarat and the developments happening in the state. The whitepaper also examines the technological advancements driving operational improvements and environmental efficiency while exploring the policy frameworks that support sustainable growth. The paper details the economic and environmental benefits of transitioning to a circular economy, supported by case studies that demonstrate successful implementation of sustainable practices. Furthermore, it highlights collaborative strategies among government, industry, and academia that foster innovation and the adoption of greener technologies. Lastly, the whitepaper provides a roadmap for the future growth of the industry, offering recommendations for achieving sustainability targets and positioning India as a leader in the global chemical and petrochemical sector by 2047.

[4]https://www.ibef.org/blogs/mission-net-zero-a-strategic-plan-for-the-indian-chemical-sector#:~:text=The%20sector%20has%20historically%20faced,gases%2C%20contributing%20to%20environmental%20degradation

Chapter - 2
Sustainability

Sustainable Practices and Regulations

Sustainability has become a crucial focus for businesses globally, with stakeholders increasingly demanding greater responsibility for the environmental, social, and economic impacts of industrial operations. According to ChemAnalyst, the global sustainable chemicals market has entered a phase of rapid expansion, reaching a valuation of USD 120.51 billion in 2025. Driven by a robust CAGR of over 10%, the market is now expected to surpass USD 224 billion by 2030. This growth is fueled by a "bio-based revolution," where renewable feedstocks from agricultural waste and biomass are increasingly replacing fossil-based resources. With the Asia-Pacific region emerging as the fastest-growing market due to large-scale demand for bioplastics and biofuels in India and China, the sector is solidifying its role as the backbone of the global green transition.

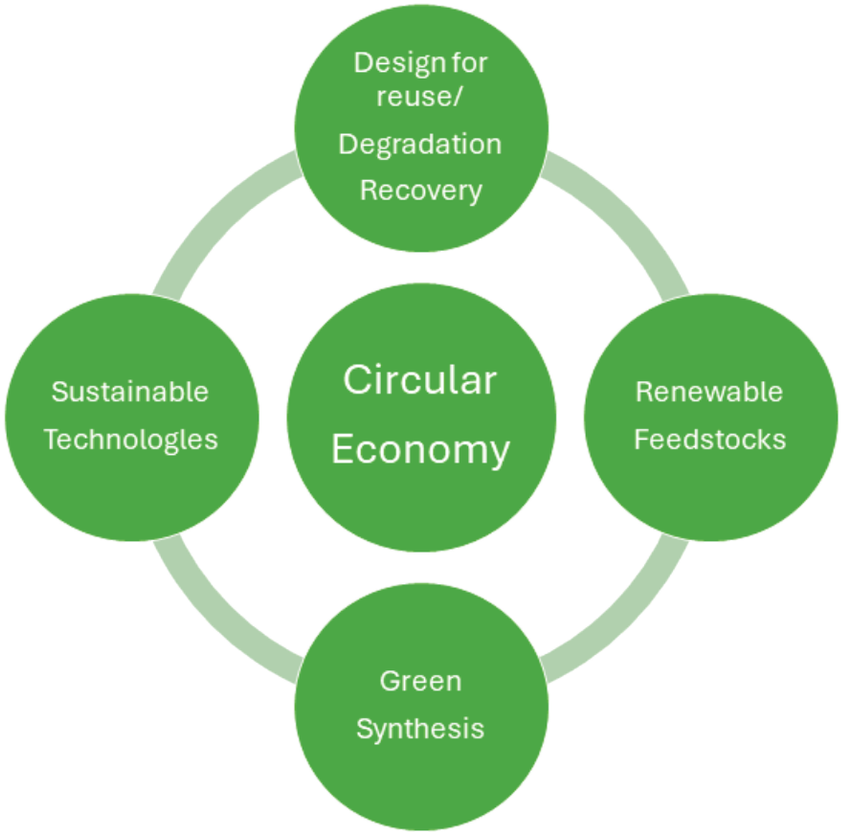
The adoption of sustainable chemicals is anticipated to play a crucial role in driving overall sustainability. By shifting towards more eco-friendly chemical solutions, industries can significantly reduce their environmental impact, lower carbon emissions, and enhance resource efficiency. This transition not only supports the broader goals of sustainability but also fosters innovation and contributes to a more sustainable future for both the environment and society. The chemical industry is no exception, and Indian chemical companies are actively moving towards more sustainable practices.

India's chemical industry is rapidly expanding, with a compound annual growth rate (CAGR) of around 8-10%, largely driven by the increasing demand for eco-friendly and sustainable products. The growth of the green chemicals market is bolstered by various government initiatives, such as the Green Chemistry Initiative launched by the Ministry of Chemicals and Fertilizers, which encourages the adoption of green technologies and processes. Supportive policies, including the National Chemical Policy, foster sustainable development and innovation, creating a favourable environment for international investment. Additionally, India benefits from abundant and diverse feedstock sources—such as biomass, agricultural residues, and renewable energy—which ensure a stable supply chain for green chemical production. Growing environmental awareness among Indian consumers is further fuelling demand for sustainable products across sectors like agriculture, textiles, and packaging. This dynamic landscape presents lucrative investment opportunities, with a supportive regulatory framework and potential for joint ventures, strategic partnerships, and technology transfers to capitalize on the burgeoning green chemicals market in India[5].

India has also made significant progress to become the sixth-largest global economy in chemical sales. Its key advantage lies in its demographic dividend and a rapidly expanding middle class with increasing purchasing power, positioning it as a consumption-driven economy. Despite the challenges of doing business in India, the government has implemented numerous structural reforms to create a more favourable environment for foreign investment. Initiatives such as 'Make in India' are aimed at enhancing the competitiveness of domestic manufacturing, attracting investment, and boosting exports, thereby supporting the industry's growth. On the other hand, petrochemical industry is also increasingly adopting greener practices and promoting sustainability through

[5] https://www.eai.in/blog/2024/03/why-is-the-indian-green-chemicals-market-an-attractive-destination-for-international-investment.html#:~:text=Government%20Initiatives%3A%20The%20Indian%20government,of%20green%20technologies%20and%20processes.

Figure 2: Circular Economy & Sustainability



several strategies. One approach involves using renewable energy sources, such as solar and wind power, in production processes to cut greenhouse gas emissions and lower energy costs. Additionally, companies are incorporating energy-efficient technologies and optimizing operations to decrease energy consumption and enhance overall efficiency.

The EU has recently led the charge in sustainability with its 'Chemicals Strategy for Sustainability,' outlining a long-term vision for its chemicals policy. This initiative, coupled with growing consumer environmental awareness, has driven key sectors to innovate and develop sustainable chemical solutions. The chemical industry, by interacting with other sectors, has the potential to influence them towards greener product portfolios and eco-friendly practices. Adopting natural ingredients, ener-

gy-efficient technologies, low-carbon products, and substantial R&D investments can enhance the competitiveness of Indian goods on the global stage. Additionally, businesses can refine their branding and marketing to emphasize sustainability, potentially commanding premium returns[6].

Collective adoption of sustainable chemical manufacturing practices is crucial for achieving global environmental goals and aligns with major international agreements and initiatives:
- Paris Agreement: This landmark accord aims to limit global warming to well below 2 degrees Celsius above pre-industrial levels. Sustainable practices in the chemical industry, such as reducing greenhouse gas emissions and enhancing energy efficiency, support these climate goals.
- Sustainable Development Goals (SDGs): The UN's SDGs address various global challenges, including those related to sustainable consumption and production (Goal 12) and climate action (Goal 13). The chemical industry's sustainability efforts contribute significantly to these goals.
- Circular Economy Initiatives: Promoted by organizations like the Ellen MacArthur Foundation, these initiatives advocate for reusing, recycling, or repurposing products and materials. Sustainable chemical practices, such as recycling and resource efficiency, are essential to these principles.
- Chemical Leasing: Encouraged by the UNIDO, this model involves paying for the service provided by chemicals rather than purchasing and disposing of them. This approach reduces chemical waste and supports sustainability objectives.
- REACH Regulation: The EU's REACH regulation focuses on the safe use of chemicals and promotes substituting hazardous substances with safer alternatives, enhancing industry safety and sustainability.
- Toxic Substances Control Act (TSCA): In the US, the TSCA regulates chemical use to protect human health and the environment. Recent amendments have strengthened safety and sustainability measures.
- Chemical Footprint Project: This initiative encourages companies to measure and report their chemical footprints, fostering transparency and reducing hazardous chemical use.
- Global Reporting Initiative (GRI): GRI provides a framework for sustainability reporting, including chemical management. Many companies now use these guidelines to report their sustainability efforts.

[6] https://economictimes.indiatimes.com/small-biz/trade/exports/insights/why-specialty-chemicals-and-sustainable-solutions-will-be-the-way-forward-for-indian-exporters/articleshow/99508617.cms?from=mdr

Importance of ESG & Circular Economy in Shaping the Future of the Chemical and Petrochemical (C&P) Industry

Sustainability is increasingly at the forefront of both societal and business priorities, driven by conscious consumer demand, heightened investor awareness, and more stringent regulations. This shift is intensifying the focus on environmental, social, and governance (ESG) factors within the chemical industry, which has traditionally faced scrutiny for its environmental impact due to energy-intensive processes, significant greenhouse gas emissions, and inadequate waste management.

The chemical and petrochemical industries play a crucial role in advancing sustainability efforts. Companies are increasingly prioritizing Environmental, Social, and Governance (ESG) criteria, responding to stakeholder demands for a clear and strategic focus on these standards. Success and value in the chemical sector are now judged not only by financial performance or innovative products but also by how sustainably these goals are achieved. This involves adopting the cleanest technologies with minimal emissions, ensuring safety, and fulfilling broader social responsibilities. Key issues such as greenhouse gas emissions, carbon footprint, and transparency in accounting and disclosure are becoming critical areas of compliance and scrutiny[7].

According to the Global Carbon Atlas, India ranks as the third largest emitter of carbon dioxide (CO2) worldwide, accounting for 7.2% of global emissions. The carbon emissions in India rose from 1,677 million metric tons in 2010 to 2,830 million metric tons in 2022. As India aims to become a major manufacturing hub and a leading economic power, the demand for raw materials and associated emissions are projected to rise significantly. This positions India in a critical role to embrace sustainable practices and play a substantial part in mitigating climate change.

Sustainable regulations have evolved globally, with governments increasingly mandating ESG elements that were previously voluntary. ESG disclosures have become mandatory in major markets worldwide. In India, the Securities and Exchange Board of India (SEBI) has introduced new sustainability reporting requirements for the top 1000 listed companies. The new reporting requirements in India encourage transparent and standardized disclosures on ESG parameters and sustainability-related risks and opportunities for listed companies. This framework will enable companies to more effectively showcase their sustainability goals, positions, and performance to the market. As a result, it will foster long-term value creation and enhance investors' ability to make informed decisions regarding ESG factors[8].

The circular economy is crucial for transforming the Chemical and Petrochemical (C&P) industry towards a more sustainable future. This approach focuses on closing the loop of product lifecycles through greater resource efficiency and waste minimization. For the C&P sector, it means redesigning processes to reduce material consumption, enhance recycling, and promote the use of renewable resources. Adopting circular economy principles enables companies to lower production costs, reduce environmental impact, and comply with tightening regulations. It also drives innovation in product

[7] https://www.indianchemicalcouncil.com/docs/ERM-ICC-Knowledge-papers-10-12-21.pdf
[8] https://www.mayerbrown.com/en/insights/blogs/2021/06/india-imposes-new-esg-reporting-requirements-on-top-1000-listed-companies

development and operational practices. By embracing these principles, the C&P industry can achieve long-term economic and environmental benefits, ensuring its growth and sustainability in a rapidly evolving market.

According to the Economic Advisory Council to the Prime Minister of India (EAC-PM), India's transition to a circular economy is projected to create an annual value of USD 218 billion (INR 14 lakh crores) by 2030 and USD 624 billion (INR 40 lakh crores) by 2050. These savings are anticipated to represent 11% of India's current GDP, increasing to 30% by 2050. However, successfully implementing a circular economy in India requires an effective ecosystem to foster the identification and adoption of sustainable and circular business models.

In India, the chemical industry, a major contributor to carbon emissions, has recognized the urgent need to address sustainability challenges. Leading companies in the sector are actively working to reduce their environmental impact and adopt sustainable practices. To combat climate change and reduce their carbon footprint, several major Indian chemical and petrochemical companies are setting ambitious net-zero goals and implementing various initiatives. These efforts underscore their commitment to sustainability and their proactive stance on reducing emissions. By setting net-zero targets, investing in renewable energy, and adopting carbon reduction strategies, these companies are contributing to the global sustainability agenda. Embracing sustainability not only enhances environmental performance but also boosts market competitiveness, attracts investment, and builds a positive brand image.
Recognizing the urgency of sustainable practices, the Indian chemical industry is driving the transition toward a greener future through continued efforts and collaboration. Various companies in the country have taken certain initiatives strengthening their move towards sustainability. For instance,

- Reliance Industries Limited (RIL), one of India's largest conglomerates, has committed to achieving net-zero carbon emissions by 2035. The company plans to utilize renewable energy sources, enhance energy efficiency, and adopt carbon capture technologies. RIL is investing USD 10 billion in its 'Green Energy Plan' to reach its sustainability objectives.

- Tata Chemicals is focusing to reducing its absolute emissions by 30%. In the 2023 financial year, scope 1 emissions of Tata Chemicals Limited amounted to appro ximately 4,423.6 metric kilotons of carbon dioxide equivalent (CO_2e). The company has developed a comprehensive roadmap to address Scope 1, Scope 2, and Scope 3 emissions. It is actively investing in renewable energy projects, energy-efficient technologies, and exploring carbon offsetting solutions, all aimed at transitioning to a low-carbon economy.

- Aditya Birla Chemicals has set a goal to cut its carbon emissions intensity by 35% by 2030, compared to the 2018 baseline, and to achieve net-zero emissions by 2050. The company is investing in energy-efficient processes, exploring renewable energy options, and adopting circular economy principles to minimize its environmental impact[9].

Transitioning from a linear to a circular economy presents significant challenges, but the ben-

[9] https://ficci.in/api/pdf1/EMP?fileID=23807&fileName=y1lwgHhLVPUTF2lGVKmxvS1Li4q1f8hgbu8Vljkl.pdf

efits are substantial. This shift promises to drive accelerated economic growth while enhancing environmental conservation for future generations. Embracing a circular economy can generate economic value and contribute to a sustainable world for those to come. By establishing an integrated network of circular business models, companies can effectively foster a circular economy. With a system-wide approach and supportive economic conditions, India has the potential to emerge as a leading hub for sustainable manufacturing.

Reshaping and Fostering Sustainable Manufacturing

The chemical and petrochemical sectors are increasingly prioritizing sustainable manufacturing practices to tackle environmental and social issues. Companies are adopting advanced green technologies, such as bio-based chemicals and renewable energy sources, including green hydrogen. These efforts are complemented by cleaner production processes that reduce waste and lower energy consumption. Investment in energy-efficient technologies and optimized operations aims to cut greenhouse gas emissions and improve overall efficiency. Adhering to evolving regulations and standards drives further advancements, while cross-sector collaboration fosters innovation and enhances sustainability across the value chain. These initiatives not only align with global sustainability goals but also bolster the industry's competitive edge and resilience in the marketplace.

In an era where the future of the planet is at stake, sustainable manufacturing and production have become critical challenges. For India Inc., embracing sustainable practices is no longer an option but a necessary step to align national objectives with global environmental targets. India's commitment to sustainability is clear through its ambitious targets under the Paris Agreement: a 50% reduction in carbon emissions by 2030 and achieving net-zero emissions by 2070. The nation has already made significant strides, surpassing its initial goal with a 24% reduction in emissions between 2005 and 2020. India's drive towards sustainable manufacturing is supported by strategic policies such as the National Action Plan on Climate Change (NAPCC), which outlines a path for sustainable industrial growth. Additionally, initiatives like the Zero Effect Zero Defect (ZED) certification enhance efficiency in smaller enterprises, while Renewable Energy Certificates (RECs) facilitate access to green energy.

Accounting for approximately 14% to 17% of the GDP and supporting a growing workforce of roughly 68.5 million, India's manufacturing sector remains a cornerstone of its economic strategy. The government has refined its vision through the Viksit Bharat 2047 initiative, maintaining the ambitious target to increase the sector's contribution to 25% of GDP while shifting focus toward high-tech manufacturing and sustainable industrial growth. [SB4.1]As India navigates this growth trajectory, balancing economic ambitions with environmental stewardship is essential. Sustainable manufacturing practices will play a key role in establishing India as a leader in responsible global industrialization.

Environmental, Social, and Governance (ESG) practices are transforming India's manufacturing sector by promoting cleaner energy use, resource efficiency, and waste reduction. Industry leaders are pioneering this shift with innovative

approaches. For instance, Mahindra & Mahindra aims for carbon neutrality by 2040, a full three decades ahead of India's collective target. Similarly, Godrej & Boyce exemplifies successful ESG implementation with nearly complete waste diversion from landfills, demonstrating that circular economy principles can be effectively applied in practice[10].

The chemical industry is pivotal in advancing sustainability through various measures. These include adopting green molecules (bio-based chemicals), utilizing renewable energy and green hydrogen, and developing cleaner, more efficient production processes that minimize waste and energy consumption via sustainable technologies. Although total carbon elimination is unattainable, significant reductions in greenhouse gas (GHG) emissions are achievable through current industry practices. Examples include:

- Agrochemicals: Indian agrochemical firms are implementing eco-friendly practices, such as zero-discharge solutions, recovering over 80% of water, and significantly reducing total dissolved solids (TDS) and chemical oxygen demand (COD) levels.

- Petrochemicals: This sector is embracing circular economy principles, renewable energy use, and decarbonization efforts to support sustainable growth.

- Chlor-Alkali Chemicals: Indian chlor-alkali plants predominantly use green membrane technology. By-products like hydrogen are repurposed for flakes plants and boilers, while fly ash and brine sludge are utilized in coal-based power plants and construction materials. The industry is also advancing towards zero effluent discharge and recycling liquid effluents within plants.

Achieving New Heights: Opportunity to Boost Exports

India has consistently ranked third in chemical imports and fourth in exports over the past five years, demonstrating its significant role in global trade. The percentage share of India's chemical exports has steadily increased, driven by economic growth and rising domestic consumerism, which is expected to enhance per capita chemical usage. India has cemented its position as a reliable global supplier of dyes, dye intermediates, basic chemicals, agrochemicals, cosmetics, toiletries, and castor oils. The sector's growth is attributed to efforts by the Department of Commerce & Industry, CHEMEXCIL, and Indian exporters, despite challenges such as high freight rates and container shortages. Key states like Gujarat, Maharashtra, Karnataka, Tamil Nadu, and Andhra Pradesh have seen significant benefits. This growth is driven by increased exports of organic and inorganic chemicals, agrochemicals, dyes, and specialty chemicals.

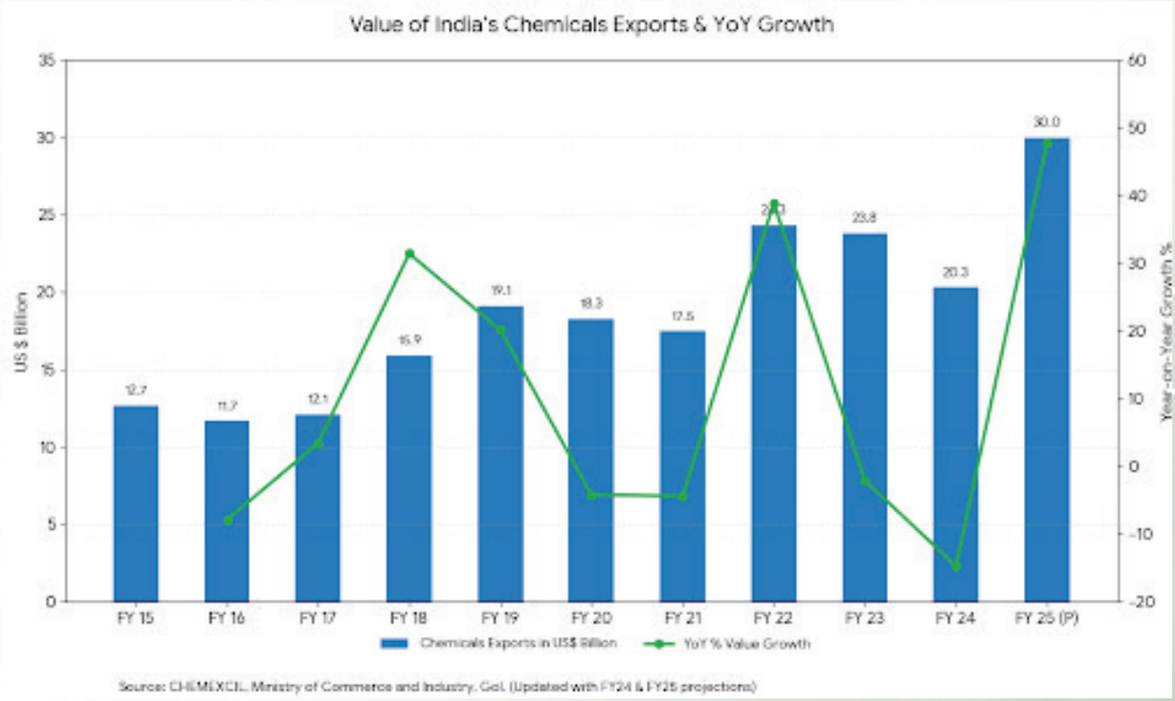
India ranks among the world's top chemical exporters, dealing in inorganic and organic chemicals, dyes, agrochemicals, plastics, synthetic rubber, and filaments. According to the latest data from the Ministry of Chemicals and Fertilisers, India's chemical and petrochemical exports (excluding pharmaceuticals and fertilizers) reached USD 20.3 billion for the full FY24. This followed a high of USD 23.8 billion in FY23 and a record-breaking USD 24.31 billion in FY22, which had marked a massive 38.67% year-over-year increase. While global demand

[10] hhttps://etedge-insights.com/industry/manufacturing/driving-sustainable-manufacturing-practices-a-must-for-reinforcing-india-incs-commitment-to-environmental-responsibility/

fluctuations led to a slight cooling in 2024, early figures for FY25 suggest a recovery, with projections trending toward USD 21.1 billion as India continues to solidify its position as a global hub for specialty chemicals.

India exports chemicals and chemical products to over 175 countries, with major destinations including China, the USA, Brazil, the Netherlands, Saudi Arabia, Indonesia, the UAE, Japan, and Germany. The industry has also expanded its reach to markets such as Turkey, Russia, and Northeast Asia, including Hong Kong, Japan, South Korea, Taiwan, Macao, and Mongolia. According to the latest data from the Ministry of Chemicals and Fertilisers and IBEF, the USA and Brazil have maintained their positions as critical trade partners for India's chemical sector. In FY25, the USA remained the top importer of Indian chemicals with shipments valued at USD 3.05 billion. Brazil followed as the second-largest destination with imports of USD 1.59 billion, while exports to China were valued at USD 1.48 billion during the same period. This shift reflects a slight normalization in global demand compared to the record highs of 2022–23, while highlighting India's growing role as a key supplier of specialty chemicals and agrochemicals to Western markets.

Figure 3: Value of Chemicals Exported from India from Financial Year 2011 to 2023(in billion INR)



Government Policies to Enhance Chemical Manufacturing:

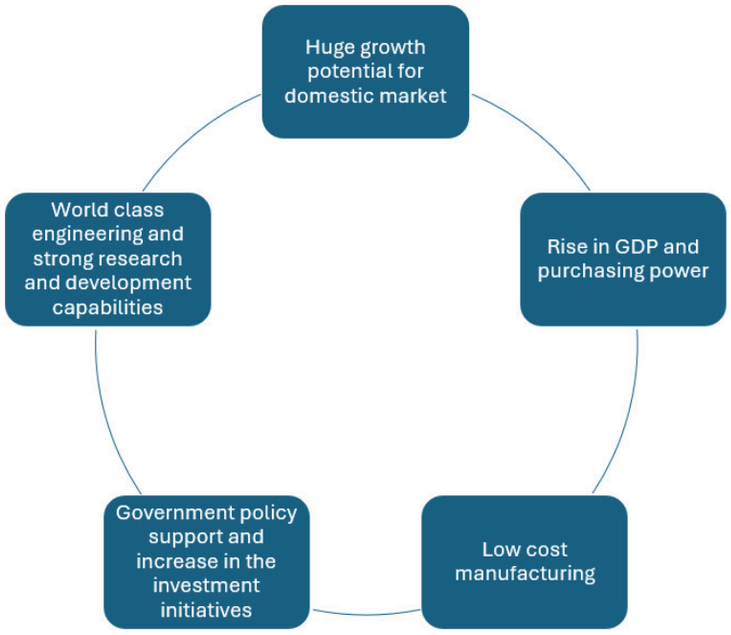
- In the Union Budget for 2025–26, the central government increased the allocation for the Department of Chemicals and Petrochemicals to ₹194.05 crore (approximately USD 22.4 million), representing a 36.7% rise over the previous year's revised estimates. Beyond this departmental funding, the 2026–27 Budget introduced a major ₹600 crore (USD 69.3 million) initial allocation for a new Chemical Parks Scheme to build dedicated industrial hubs. Additionally, a massive ₹20,000 crore (USD 2.3 billion) fund was announced to support decarbonization and carbon capture technologies across the sector over the next five years, signaling a shift toward sustainable high-tech manufacturing, highlighting its commitment to advancing the chemical sector.

- To boost domestic production, cut imports, and attract investments, the government has introduced a Vision 2034 for the chemicals and petrochemicals industry.

- The government plans to implement a Production Linked Incentive (PLI) scheme for agrochemicals, offering 10-20% output incentives to encourage production.

- The Production Linked Incentive (PLI) Scheme for Bulk Drugs has successfully moved into a high-production phase, with 34 out of 48 approved projects already commissioned and producing 25 critical bulk drugs as of late 2025. While the total financial outlay remains ₹6,940 crore, the in-

Figure 4: Opportunities in Chemical Manufacturing Industries



dustry has already exceeded initial expectations by investing ₹4,814 crore, surpassing the committed target for the entire six-year period. These efforts have generated cumulative sales of ₹2,720 crore and successfully replaced imports worth over ₹2,192 crore, significantly reducing India's dependence on external sources for life-saving medications.

- The chemical manufacturing sector in India continues to benefit from 100% Foreign Direct Investment (FDI) permitted under the automatic route. As of September 2024, the sector has attracted a total of USD 22.15 billion in cumulative FDI equity inflows since April 2000. This represents an increase of over USD 2 billion since mid-2022, underscoring the sustained global confidence in India's role as a major manufacturing hub for specialty and industrial chemicals.

Disruptions in the supply chain in China have created significant opportunities for the Indian chemical manufacturing sector. China's anti-pollution measures are likely to benefit Indian chemical producers. The Petroleum, Chemicals, and Petrochemicals Investment Regions (PCPIR) policy is anticipated to draw investments totaling USD 280 billion by 2035. Special incentives provided through PCPIRs or Special Economic Zones (SEZs) are expected to stimulate the growth of downstream units, further advancing the chemical industry[11].

Two key government initiatives, 'Make in India' and 'Atmanirbhar Bharat,' are designed to support the growth of the chemicals and petrochemicals sector. To leverage these initiatives, the industry must scale up through ecosystem development, including establishing Petroleum, Chemicals, and Petrochemicals Investment Regions (PCPIRs) nationwide, creating infrastructure linkages for a hub-and-spoke model, and integrating value chains. India's appeal as a manufacturing destination has grown due to competitive labor costs, cost-effective manufacturing, and recent corporate tax reforms. Indian specialty chemical companies have developed unique capabilities and established global supply relationships. Despite specific industry challenges, long-term prospects for the Indian chemical sector look promising. Rising domestic demand in key end-use sectors such as agriculture, consumer goods, infrastructure, automotive, electronics, and healthcare is expected to drive significant growth, with chemicals playing a vital role.

For 'Make in India' to succeed, structural changes are essential. While the 'China+1' strategy is still evolving, India's competitors are advancing rapidly. China, having been the dominant manufacturing hub, is now facing challenges. As industries like cosmetics, fashion, and FMCG experience growth, India can capitalize on its strengths in sectors such as perfumery, essential oils, and packaging-related chemicals.
The industry must focus on exploring and diversifying its value chain rather than concentrating on a single segment. Success in 'Atmanirbhar Bharat' hinges on developing comprehensive capabilities across the value chain to reduce import dependence, mitigate supply chain risks, and strengthen the economy. As the government prioritizes electronics, semiconductors, renewable energy, and pharmaceuticals, the chemicals and petrochemicals sector will evolve, positioning itself as a crucial element in India's global manufacturing strategy.
India's allowance of 100% FDI in chemicals and the introduction of Production Linked In-

[11] https://www.solutionbuggy.com/blog/opportunities-in-chemical-manufacturing-industry-in-2023

centive schemes are reinforcing its status as a preferred manufacturing hub. With increasing domestic consumption, sectors such as agrochemicals and specialty chemicals are poised for growth. Additionally, the trend towards distributed manufacturing systems—moving from single-country operations to multi-country setups—could help Indian specialty chemicals players navigate global supply chain risks and political uncertainties, positioning them for international success[12].

Recognizing the industry's potential, the Indian government has introduced Vision 2034 for the Chemicals and Petrochemicals sector to enhance domestic production, reduce imports, and attract investments. The plan includes a proposed production-linked incentive scheme to stimulate domestic manufacturing. Additionally, India's 'Make in India' policy continues to support the sector by fostering growth and innovation.

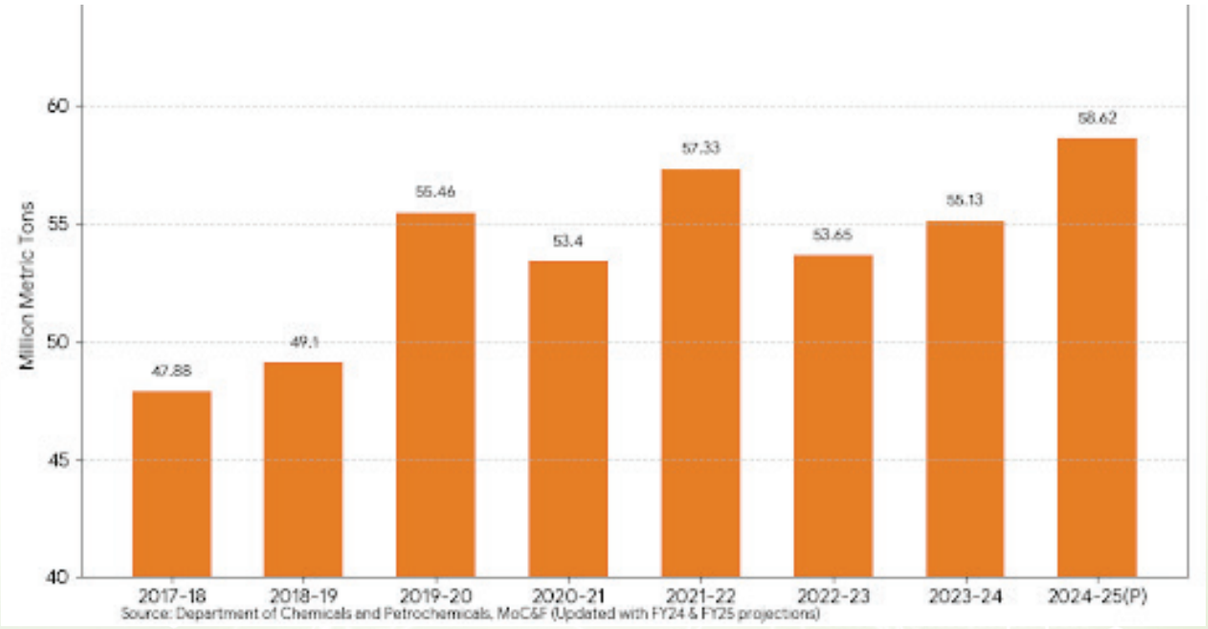
To achieve net-zero emissions by 2070, Indian companies must align their strategies with the transition to a low-carbon economy, which requires significant investments in new technologies and skilled labour. The Indian government has introduced several measures to address environmental challenges and support growth in the chemical sector. Key actions include:

1. The Indian chemical sector continues to attract significant global capital, permitted by a liberalized policy allowing 100% FDI under the automatic route. Following a landmark 91% surge in FY 2023, the sector has seen cumulative investments reach USD 22.15 billion as of late 2024. Global investors are increasingly leveraging India's "China Plus One" strategy and domestic PLI schemes, resulting in a projected recovery to USD 1.06 billion in FDI for the most recent fiscal period.[SB6.1] This influx of global expertise brings advanced technologies and sustainable practices, enhancing sector efficiency and aligning with environmental goals.
2. Boosting Non-Hazardous Chemical Production: The deregulation of non-hazardous chemical production and anti-dumping duties on substandard imports aim to support domestic producers and enhance industry scale and profitability[13].
3. Upcoming Initiatives: The government plans to revise the 2007 Petroleum, Chemicals & Petrochemical Investment Regions (PCPIRs) policy to establish integrated chemical complexes with shared infrastructure. Additionally, it encourages the development of plastic parks and chemical manufacturing units in various regions, including SEZs and underdeveloped areas. A Production Linked Incentive (PLI) scheme is also being developed to improve cost competitiveness in sectors like agrochemical and pharmaceutical intermediates.

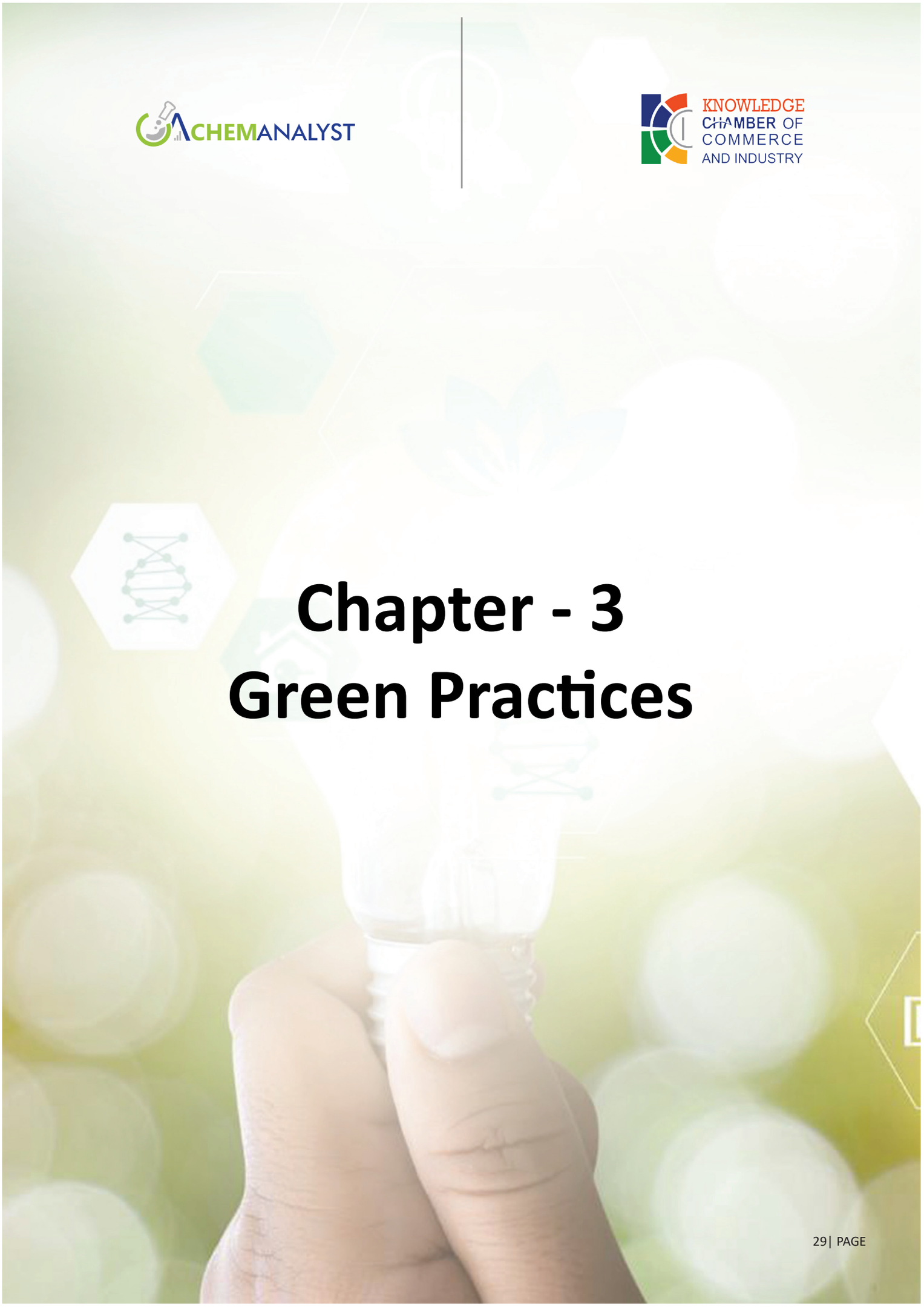
The Indian chemical sector is vigorously pursuing a strategic plan to achieve net-zero emissions, driven by government initiatives such as increased foreign direct investment (FDI), enhanced skill development, and efforts to regulate substandard imports. Proposed reforms, including a revamp of the Petroleum, Chemicals, and Petrochemical Investment Regions (PCPIRs) and new incentives for chemical manufacturing units, highlight a commitment to sector growth. The industry's shift towards responsible investing and ESG-focused funding indicates a positive outlook for its path to net-zero emissions. Nevertheless, challenges like policy alignment, capital investment, and cost implications must be addressed for a successful transition.

[12]https://timesofindia.indiatimes.com/blogs/voices/indias-chemical-industry-unleashing-the-next-wave-of-growth/
[13] https://www.ibef.org/blogs/mission-net-zero-a-strategic-plan-for-the-indian-chemical-sector

Figure 5: India's Basic Chemicals and Petrochemical Productions (MMT)



Source: Department of Chemicals and Petrochemicals, MoC&F (Updated with FY24 & FY25 projections)



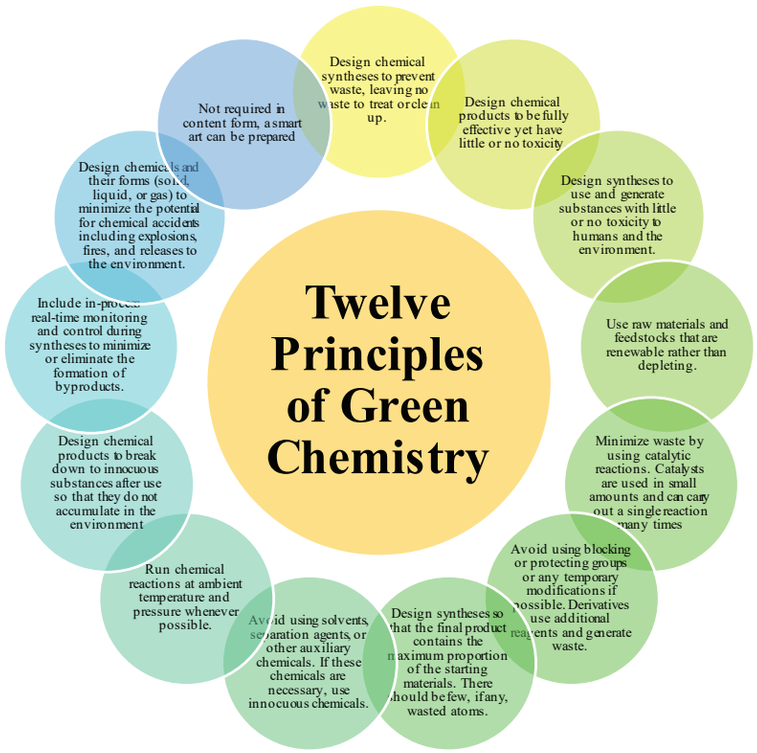
Chapter - 3
Green Practices

Green Principles and Life Cycle Assessment

Green chemistry has become a crucial driver for sustainable development and environmental stewardship within the chemical industry. India is well-positioned to become a leading player in the global green chemistry arena, given the growing interest and alignment with sustainability goals.

The Indian government is actively supporting green chemistry through various initiatives. Additionally, policies and regulations, including the National Chemical Policy, are designed to support the growth of the green chemicals market and attract international investment. India benefits from abundant and diverse feedstock for green chemical production, such as biomass, agricultural residues, and re-

Figure 6: Twelve Principles of Green Chemistry



newable energy sources, ensuring a stable supply chain for green chemical manufacturers.

Tata Chemicals, a key player in the Tata Group's diverse portfolio, is integrating green chemistry principles into all its new products. As the world's second-largest soda ash producer with operations spanning India, Europe, North America, and Africa, the company is prioritizing carbon reduction and sustainability, with 70% of its capacity sourced from natural origins. Tata Chemicals is heavily investing in technological innovation, including transforming its 80-year-old Mithapur plant into a smart factory. The plant now employs advanced technologies like analytics, IoT, artificial intelligence, and

digital twins to monitor emissions, enhance operational efficiency, and reduce environmental impact. Additionally, Tata Chemicals has launched the UK's first carbon capture plant, utilizing amine-based technology to capture up to 40,000 tonnes of CO2 annually—equivalent to removing 20,000 cars from the road—and convert it into sodium bicarbonate. The company is also concentrating on decarbonization, redesign, circular design principles, and sustainable renewable solutions through its R&D efforts[14].

Figure 7: Key Indian Players in Green Chemicals Market

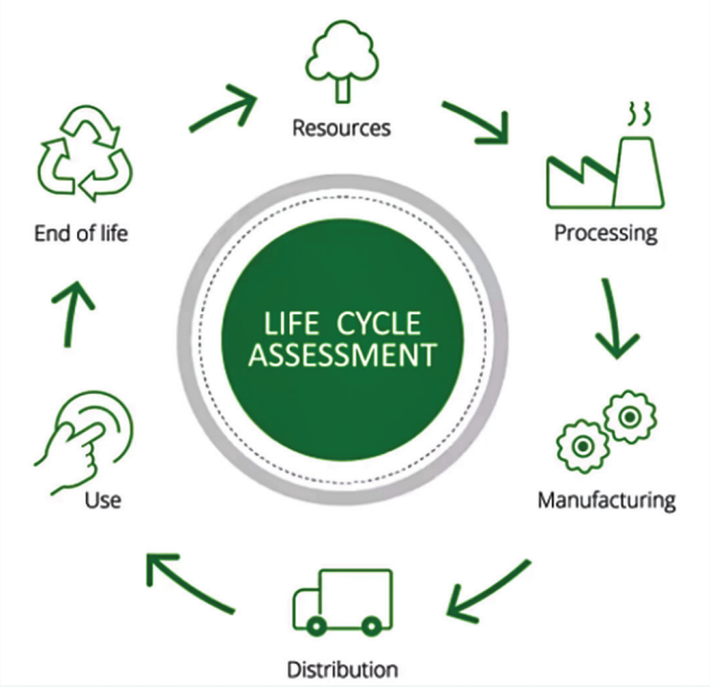
Green Chemistry Initiative:

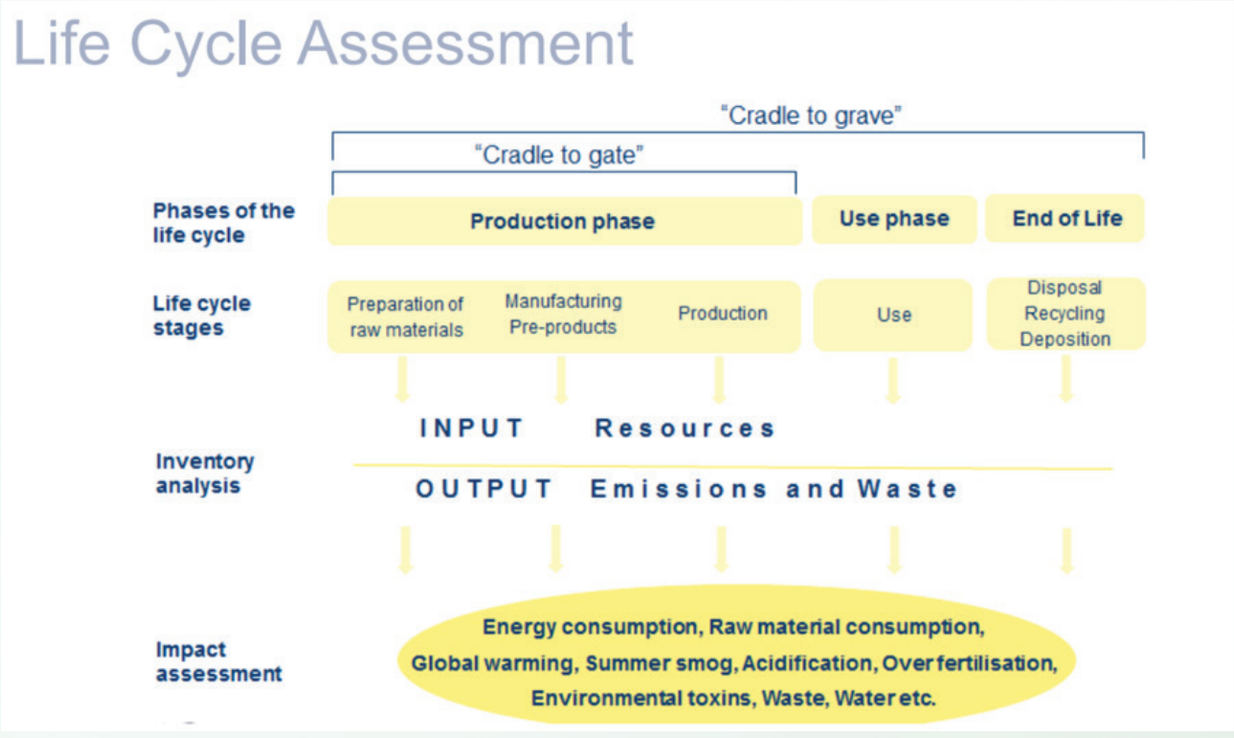
The Ministry of Chemicals and Fertilizers has introduced the Green Chemistry Initiative to advance the use of green technologies and processes within the chemical industry. This initiative seeks to lessen the environmental footprint of chemical manufacturing by promoting the use of renewable feedstocks, reducing waste generation, and fostering the development of eco-friendly products and processes[15].

As sustainability becomes a central focus, designing chemical products, processes, and supply chains with environmental considerations is increasing. For over two decades, environmental assessment has been a key component of chemical process design. Various performance indicators and metrics have been developed to evaluate environmental impacts during process design. These metrics often include assessments of acute toxicity, biodegradability, and ozone depletion potential as part of hazard evaluations related to environment, health, and safety. However, these metrics are frequently limited by data availability and regulatory scope, focusing primarily on the process in question. To fully address sustainability, it is necessary to extend the assessment beyond individual processes and consider potential trade-offs throughout the entire life cycle. This broader perspective is particularly relevant to advancing chemical and petrochemical sustainability in India.

[14] https://www.businesstoday.in/industry/story/new-products-are-focused-on-green-chemistry-principles-says-richard-lobo-of-tata-chemicals-384258-2023-06-05
[15]https://www.eai.in/blog/2024/03/why-is-the-indian-green-chemicals-market-an-attractive-destination-for-international-investment.html#:~:text=Green%20Chemistry%20Initiative%3A&text=The%20initiative%20aims%20to%20reduce,eco%2Dfriendly%20products%20and%20processes.

Figure 8: Life Cycle Assessment

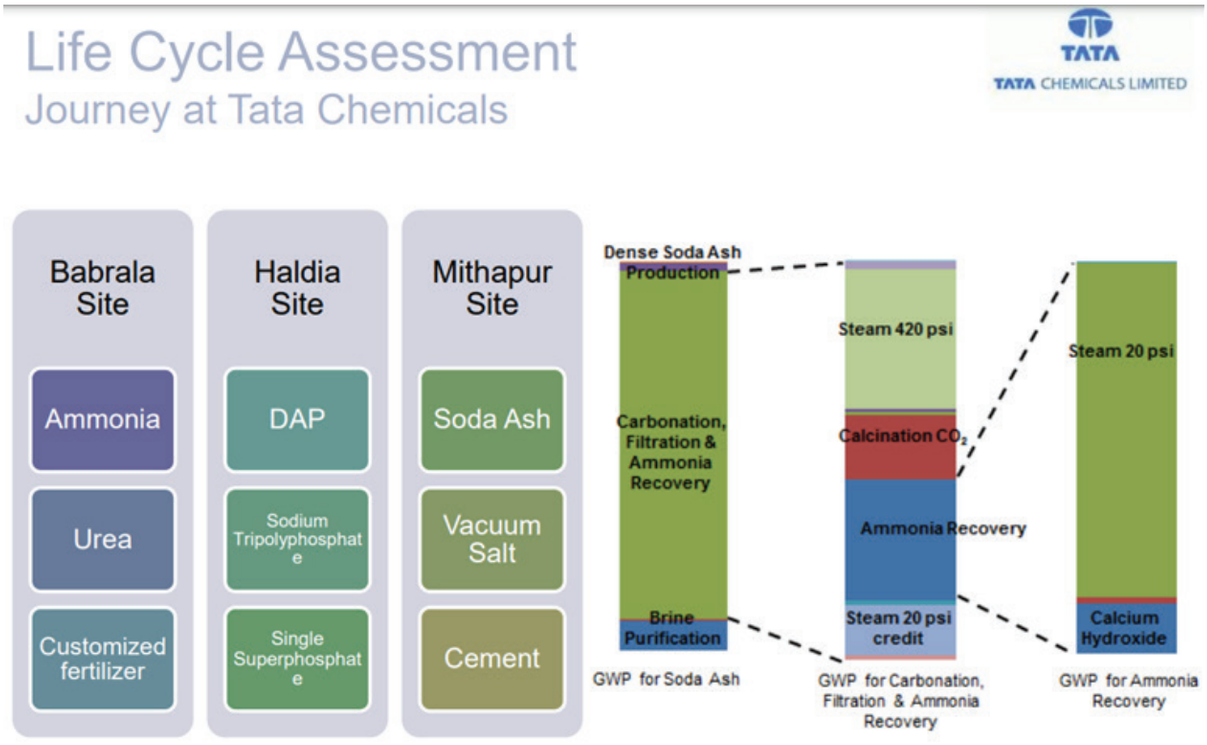




Life Cycle Assessment

The life cycle assessment (LCA) of bioethanol and other products is increasingly gaining attention as industries and consumers seek more sustainable options. According to ChemAnalyst, India Bioethanol market is anticipated to grow at an impressive CAGR of 17.44% to reach at USD 10644.31 million by 2027. As demand for sustainable solutions rises, companies are focusing on LCAs to identify opportunities for improving environmental performance, optimizing resource use, and minimizing waste.

India Glycols Limited, a prominent publicly traded company based in India, exports chemical products to over 40 countries globally. The company has benefited from the UNEP/SETAC Life Cycle Initiative program, receiving guidance and support from life cycle management (LCM) affiliated with the Federation of Indian Chambers of Commerce & Industry (FICCI). The life cycle assessment concluded that using renewable-based raw materials for manufacturing monoethylene glycol (MEG) is preferable to traditional petrochemical methods in India, the US, and Europe. India Glycols Limited also conducted life cycle assessments for various products including bio-ethanol, bio-ethylene oxide, bio-glycols, bio-glycol ethers, and bio-polyethylene glycols. These assessments revealed new business and growth opportunities through improved life cycle capabilities[16].



[16] https://www.lifecycleinitiative.org/case-study-india-glycols-ltd-believes-in-green/
[17] https://www.greenco.in/casestudy/Life%20Cycle%20Assessment%20in%20India%20by%20Dr.%20Rajesh%20Kumar%20Singh-2014.pdf

Role of Green Hydrogen

The advancement of sustainable energy sources is a significant challenge for society. Green hydrogen, generated by electrolyzing water with renewable energy, presents a promising solution for decreasing reliance on fossil fuels.
In recent years, the rise in energy consumption has been influenced by a combination of factors, such as industrial growth, urbanization, and greater electricity access in developing regions. Global energy consumption has continued to climb, rising from 13,647 Mtoe in 2015 to approximately 14,950 Mtoe by the end of 2023, according to the latest IEA and Energy Institute data.

Similarly, global electricity demand has surged from 23,127 TWh in 2015 to a record 29,471 TWh in 2023, with 2024 estimates pushing this figure beyond 30,700 TWh. This growth is increasingly driven by rapid electrification, the expansion of data centers for AI, and robust industrial activity in emerging economies. Green hydrogen is emerging as a promising technology, gaining momentum in recent years as a viable solution for addressing the challenges of transitioning to a sustainable energy future[18].

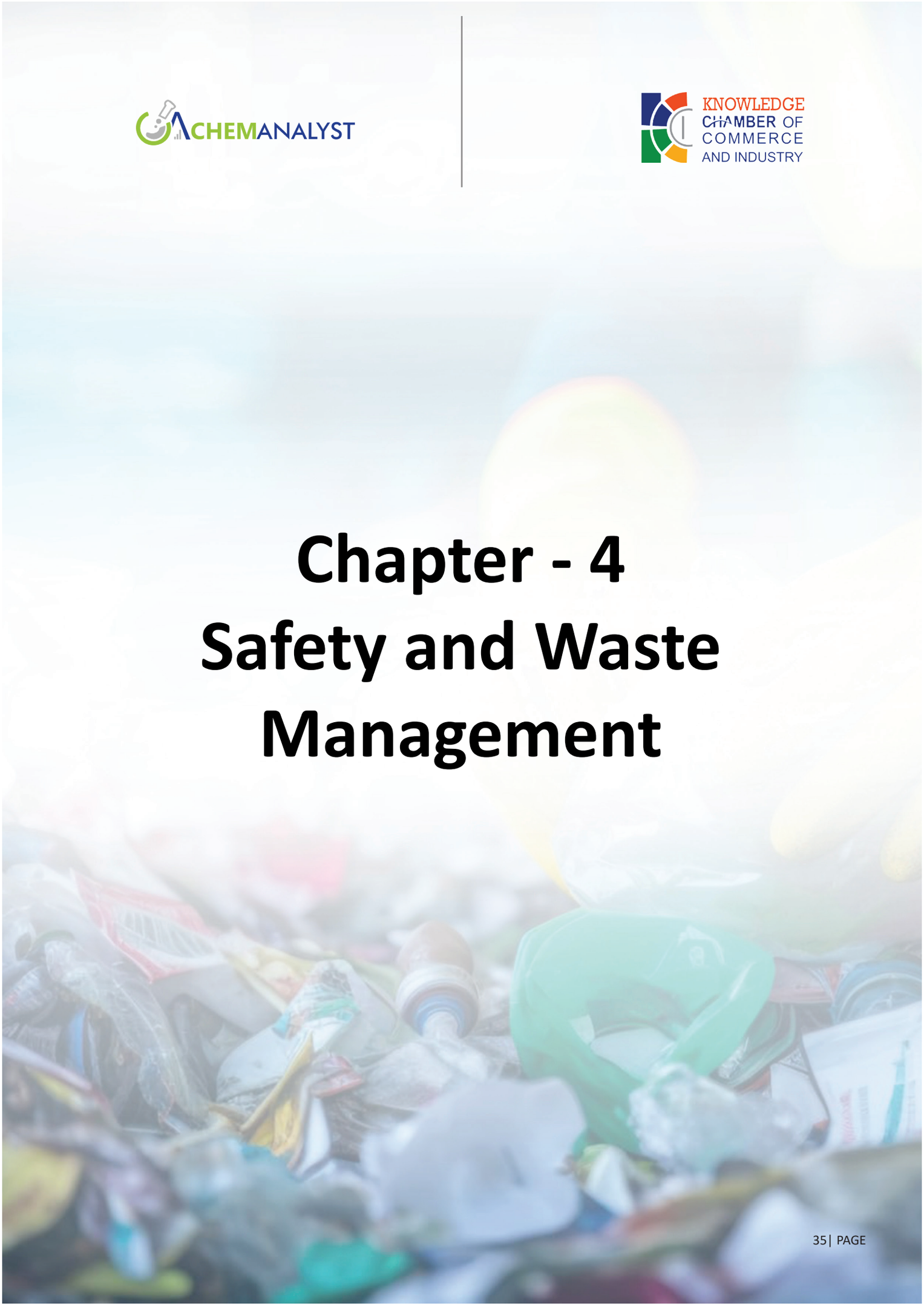
According to ChemAnalsyt, the global Green Ammonia Market is expected to reach USD 7676.47 Million by 2032 with a CAGR of 39.16% during the forecast period. Green hydrogen is pivotal for addressing India's energy security and cutting emissions in challenging sectors such as steel, fertilizers, refining, cement, and mobility. In early 2023, the Indian government launched the 'National Green Hydrogen Mission' to support this goal. India's abundant renewable energy potential can drive Green Hydrogen growth, but rapid capacity expansion is necessary.

To facilitate this, the government has introduced several Production Linked Incentive (PLI) schemes to boost renewable energy capacity across various sectors, including solar, onshore and offshore wind, biomass, hydro, pumped storage, and battery energy storage systems (BESS) for round-the-clock renewable energy. Pilot projects for hydrogen use in steel, shipping, and mobility sectors have already been initiated, with more planned for the future.

India also made a significant advance in fostering demand for Green Hydrogen and its derivatives with a key initiative. The Solar Energy Corporation of India (SECI) issued a Request for Selection (RfS) to identify Green Ammonia Producers. This initiative aims to facilitate the production of Green Ammonia through cost-based competitive bidding under Mode 2A of the Strategic Interventions for Green Hydrogen Transition (SIGHT) Programme, which is part of the National Green Hydrogen Mission managed by the Ministry of New & Renewable Energy (MNRE).

[18] https://www.sciencedirect.com/science/article/abs/pii/S0360319923045056

Chapter - 4
Safety and Waste Management



Handling Dangerous Materials and Ensuring Safety

In India, the surge in industrialization and technological progress has led to a rise in the use of chemicals and hazardous materials, necessitating strong legal and administrative frameworks to manage associated risks. As India's economy positions itself as a manufacturing hub, it is crucial to balance industrial growth with sustainable practices that address resource constraints.

The concept of a Circular Economy aims to enhance resource sustainability by keeping materials in use for as long as possible, maximizing their value, and then recovering and regenerating them at the end of their life. Managing toxic and hazardous industrial waste is a priority to protect health and the environment and is central to advancing a resource-efficient economy.

India faces a growing challenge with hazardous waste, which increases by 2% to 5% annually, with about 10% to 15% of industrial waste classified as hazardous. Developing Circular Economy solutions for treating industrial waste can foster innovative approaches to utilizing discarded materials. The Indian government is actively working to transition towards a Circular Economy, with NITI Aayog identifying 11 focus areas and delegating them to relevant ministries.

The Department for Chemicals and Petrochemicals (DCPC) has been assigned the management of toxic and hazardous industrial waste in India. DCPC has submitted a report and action plan to NITI Aayog outlining strategies to limit hazardous waste in the economy.

The plan includes identifying areas for sustainable reutilization and recycling of hazardous wastes, developing standard operating procedures (SOPs) and technologies in collaboration with academic and research institutions. It also emphasizes promoting circular processes through viable business models and funding incentives. Regular workshops, seminars, and awareness programs on Green Chemistry and Circular Economy are being organized, and industries generating hazardous waste are being geographically mapped for better data analysis and waste management. The implementation of these action plans is underway, with ongoing monitoring of progress by the Department.

Effective Waste Management Practices

The Indian chemicals and petrochemicals industry is undergoing a significant transformation, driven by policy reforms that are accelerating growth. The key challenge, however, is achieving this growth in a sustainable and responsible manner. Globally, major chemical and petrochemical companies are achieving their sustainability goals by streamlining their portfolios. Indian companies, however, lack the option to follow this approach and instead develop effective strategies for chemical waste management, recycling, and the circular economy.

Many multinational chemical companies have launched sustainability-focused initiatives. Indian companies should consider adopting similar practices, such as process optimization and cleaner production, to reduce waste generation. Establishing recycling facilities or partnering with specialized waste management firms can help convert waste into valuable resources. Rather than viewing waste as a burden, companies are exploring opportunities for resource recovery and implement Extended Producer Responsibility (EPR) programs to manage the waste from their products throughout their lifecycle. Investing in research and innovation is crucial for developing eco-friendly products, processes, and technologies. This includes creating bio-based alternatives, environmentally friendly chemicals, and advanced recycling techniques that support the circular economy. By embracing these strategies, Indian chemical companies can minimize their environmental impact, conserve resources, and drive the industry's shift towards a more sustainable and circular economy.

Figure 12: Hazardous Waste Management Practices

Chemical Regulations

There is currently no REACH-like or TSCA-like regulations for chemicals in India. There is no national chemical inventory or any chemical registration requirement either. However, India is developing its own REACH-like regulation.

Overview of Chemical Regulations in India

The following 2 chemical regulations are the most important ones in force in India.

- Manufacture, Storage And Import Of Hazardous Chemical (Amendment) Rules, 1989, 1994, 2000
- Ozone Depleting Substance (R&C) Rules (2000)

Manufacture, Storage And Import Of Hazardous Chemical (Amendment) Rules, 1989

The regulation was firstly enacted in 1989 by the Ministry of Environment & Forests (MoEF) and later amended in 1994 and 2000. It regulates the manufacture, storage and import of hazardous chemicals in India. The transport of hazardous chemicals must meet the provisions of the Motor Vehicles Act, 1988.

"Hazardous Chemicals" includes 3 schedules. Regulatory requirements are different for each schedule.

1. any chemical which satisfies any of the criteria laid down in Part I of Schedule 1 or listed in Part II of this Schedule 1 ;
2. any chemical listed in Column 2 of Schedule 2;
3. any chemical listed in Column 2 of Schedule 3;

Regulations on Schedule 1 Hazardous Chemicals

Schedule 1 consists of two parts: (1) any hazardous chemicals that meet one of the following criteria and (2) 684 named chemical substances listed in Schedule 1.

- Toxic chemicals: oral LD50 <200mg/kg, or dermal LD50 <2,000mg/kg or inhalation LC50 < 10mg/L
- Flammable gases: i.,e gases that are ignitable when in a mixture of 13 percent or less by volume with air
- Flammable liquids: liquids with flash points below than 90 celcius degress
- Explosives
- For hazardous chemicals covered in schedule 1, site owners must meet the following obligations:
- identify hazards associated with industrial activity and take adequate steps for prevention and control
- provide relevant information to persons liable to be affected by a major accident
- notify the concerned authorities within 48 hours of the occurrence of a major accident
- provide safety data sheets and label every container of hazardous chemicals.

In addition, any person responsible for import-

ing Schedule 1 hazardous chemicals in India shall provide [before 30 days or as reasonably possible but not later than] the date of import to the Chief Controller Imports & Exports with the information below:

i. the name and address of the person receiving the consignment in India;
ii. the port of entry in India;
iii. mode of transport from the exporting country to India;
iv. the quantity of chemical (s) being imported; and
v. complete product safety information

Schedule 2 and Schedule 3 Hazardous Chemicals

Schedule 2 and schedule 3 are some hazardous chemicals with assigned threshold quantities. When a site handles a hazardous chemical more than the thresholds, the site will be regarded as major accident hazards (MAH) installations and subject to reporting, safety audit and contingency plan requirements.

Ozone Depleting Substance (R&C) Rules (2000)

This regulation strictly controls the production, import and use of ozone depleting substances (ODCs) in India. Most of ODCs are banned in India.

In Aug 2020, Indian Draft Chemicals (Management and Safety) Rules was published. These Rules provide for Notification, Registration and Restrictions, or prohibitions, as well as labelling and packaging requirements related to the Use of Substances, Substances in Mixtures, Substances in Articles and Intermediates Placed or intended to be Placed in Indian Territory and introduce REACH-like registration requirements to certain priority substances. The rules are also known as **"India REACH"[19].**

The Indian Department of Chemicals and Petrochemicals has introduced additional Quality Control Orders (QCOs) for various chemical compounds. These new regulations are designed to enhance safety in the handling of these chemicals, benefiting both human health and the environment. GPQI is assisting the German industry by submitting feedback on the draft regulations to the appropriate Indian regulatory bodies.

India is seeing a rise in technical regulations, which often mandate certification according to specific Indian Standards. These measures aim to improve product safety and quality in the Indian market. In mid-November of 2021, the Department of Chemicals and Petrochemicals released eight draft QCOs for chemical products. Industry stakeholders have a 60-day period to review and comment on these drafts. Following this, the Department will consider the feedback and issue the final QCOs. Once finalized, these QCOs will require affected chemicals to obtain a mandatory standard mark under the Bureau of Indian Standards (BIS) certification schemes, based on the Indian Standards referenced in the regulations. The new rules may introduce

[19] https://www.chemsafetypro.com/Topics/India/Overview_of_Chemical_Regulations_in_India.html

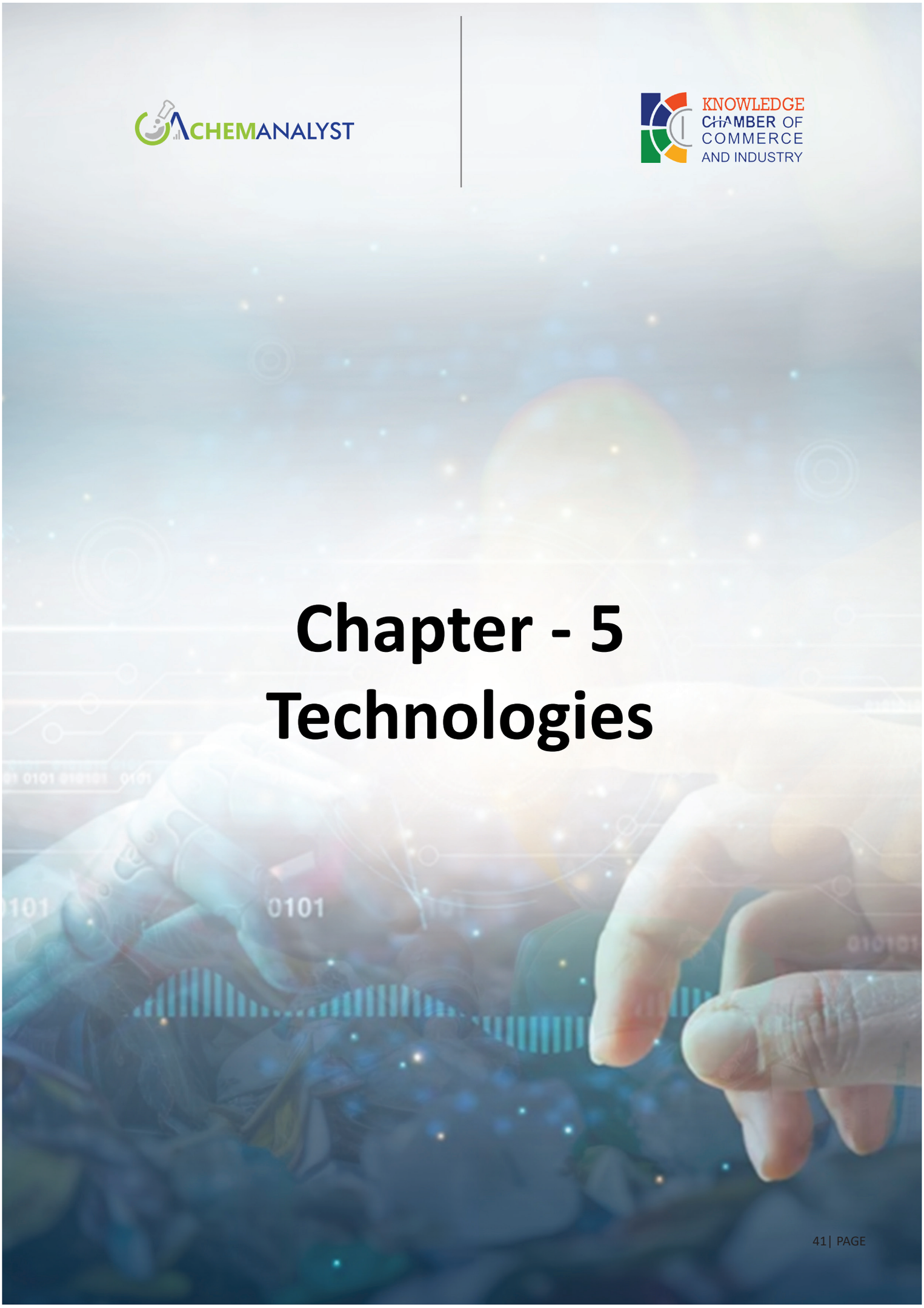
technical market access challenges. Economic operators have until mid-January 2022 to submit their comments on the draft regulations.

List of notified chemicals

Product category	Indian Standard
Lauric Acid	IS 10931:1984
Acid Oil	IS 12029:1986
Palm Fatty Acids	IS 12067:1987
Rice Bran Fatty Acids	IS 12068:1987
Coconut Fatty Acids	IS 12069:1987
Rubber seed Fatty Acids	IS 12124:1987
Hydrogenated Rice Bran Fatty Acids	IS 12361:1988
1,3 Phenylenediamine	IS 17450:2020

[19]

[20] https://www.gpqi.org/news_en-details/india-announces-new-regulations-for-chemicals.html



Chapter - 5
Technologies

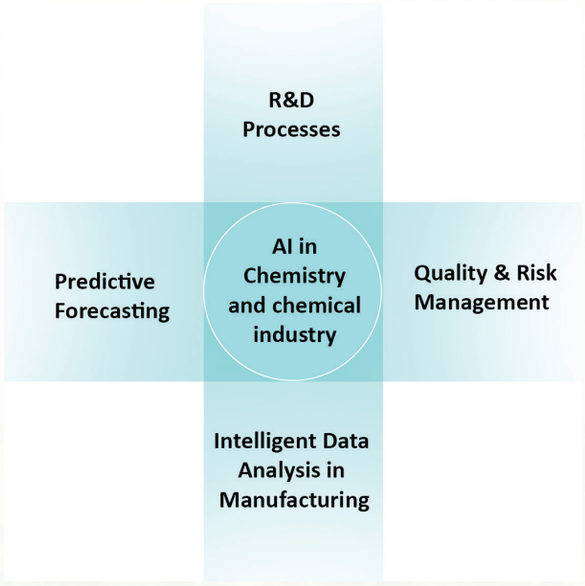
AI and Digitalization for Sustainability

Alongside advancements in green technology, digitalization is reshaping the chemicals and petrochemicals industry. Technologies such as artificial intelligence (AI), the Internet of Things (IoT), and advanced analytics are being used to optimize processes, boost productivity, and facilitate predictive maintenance. These innovations support real-time monitoring, data-driven decision-making, and automation, resulting in enhanced operational efficiency and reduced resource consumption. Digitalization also promotes greater transparency and traceability throughout the value chain. Blockchain technology, for instance, helps track raw materials, ensuring their sustainable sourcing and mitigating the risk of unethical practices. Digital platforms and collaborative tools enhance communication and cooperation among stakeholders, fostering the development of sustainable supply chains and sharing best practices.

The integration of greentech and digitalization provides synergistic benefits to the industry. Digital tools facilitate the monitoring and optimization of greentech initiatives, offering real-time insights into energy use, emissions, and waste. By employing these tools, companies can identify improvement areas, adopt sustainable practices, and better track progress toward environmental goals.

Successful adoption of greentech and digitalization requires collaboration among stakeholders, including governments, industry associations, research institutions, and companies. Joint efforts are essential to develop supportive policies, advance research and development, and create knowledge-sharing platforms. Cross-sector partnerships are crucial to leveraging diverse expertise and accelerating the implementation of innovative solutions.

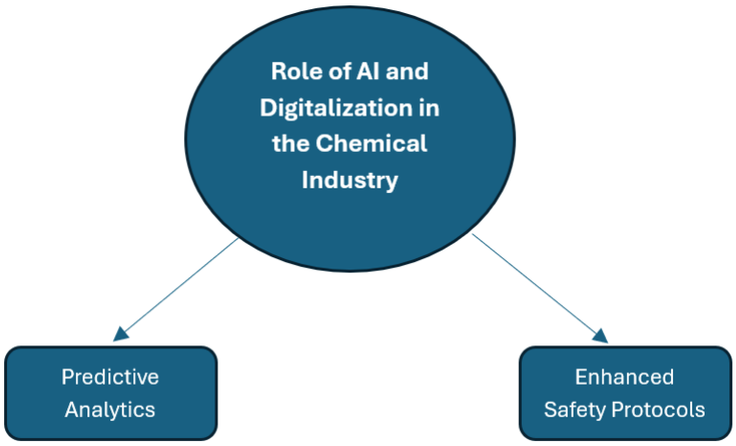
Figure 13: AI in Chemistry & Chemical Industry



The chemicals and petrochemicals industry is undergoing a significant transformation towards sustainability, driven by the dual forces of greentech and digitalization. Embracing greener alternatives, optimizing energy use, and leveraging digital technologies will allow the sector to reduce its environmental impact while remaining economically viable. This transition demands collaboration, innovation, and a long-term commitment, ultimately benefiting both the environment and the industry's future viability.

Artificial Intelligence (AI) is emerging as a pivotal force in transforming chemistry towards a more sustainable and eco-friendly future, spearheading the sustainability revolution. The integration of AI with green chemistry is more than an academic exercise—it's a groundbreaking business initiative that is deploying scalable, real-time solutions to significantly reduce environmental impacts on a global scale. Artificial Intelligence (AI) plays a crucial role in advancing green chemistry through the development of innovative, sustainable materials. A notable example is IBM Research's use of AI to discover a new range of recyclable and self-healing polymers. AI algorithms accelerate the discovery of new materials by employing predictive analytics to analyze vast chemical datasets and forecast the properties of potential materials, ensuring environmental compliance.

Figure 14: Role of AI in Digitalization and Chemical Industry



AI is also revolutionizing chemical production by optimizing energy consumption. For instance, BASF, a leading global chemical company, has implemented AI-driven processes to enhance energy efficiency. Through machine learning algorithms, BASF can predict and adjust energy usage in real time, resulting in substantial reductions in carbon emissions and energy costs. The integration of AI with green chemistry marks the beginning of a new era in sustainability. AI's advanced applications and real-world industry implementations are significantly speeding up the shift towards greener chemical processes. This transition is crucial for ensuring a healthier planet for future generations and achieving global sustainability goals. Although still in its

early stages, AI's impact on green chemistry is already substantial and represents a critical step towards a more sustainable future.

Digitalization and the integration of AI/ML are revolutionizing the chemical industry in India, bringing significant benefits such as increased efficiency, improved safety, and enhanced sustainability. Nonetheless, challenges including high initial costs, data privacy issues, and skill shortages must be overcome to fully realize the potential of these technologies.

As India's chemical sector advances in its digital journey, the collaborative efforts of industry leaders, policymakers, and technology innovators will be crucial in shaping a resilient and competitive future. Embracing digitalization and AI/ML will not only boost the industry's global standing but also contribute significantly to the nation's economic growth and sustainable development. The transformative potential of these technologies heralds a future where innovation and efficiency are intertwined, driving India towards the vision of Viksit Atmanirbhar Bharat.

The chemical industry, long considered a pillar of modern industrialization, has experienced a significant transformation with the advent of digitalization and the integration of Artificial Intelligence (AI) and Machine Learning (ML). In India, this shift is more than a passing trend; it represents a fundamental change that promises to improve efficiency, safety, and innovation. Digitalization involves incorporating digital technologies to reshape business models, optimize processes, and enhance productivity. In the chemical sector, this transformation encompasses a range of technologies, including the Internet of Things (IoT), big data analytics, cloud computing, and AI/ML.

As a major player in the global market, India's chemical industry is adopting these advancements to address longstanding issues such as operational inefficiencies, safety concerns, and

Figure 15: Advantages of Digitalization in Chemical Industry

environmental sustainability. The integration of AI and ML is particularly transformative, offering revolutionary improvements to traditional practices. Several Indian chemical companies have effectively adopted digitalization and AI/ML, demonstrating the transformative power of these technologies.

- **Reliance Industries Limited (RIL)** : Reliance Industries Limited, a major player in the chemical sector, has been a leader in digitalization. RIL has implemented AI-driven predictive maintenance across its refineries and petrochemical facilities. By utilizing real-time data and machine learning algorithms, RIL has significantly reduced unplanned downtime and maintenance costs.

- **Tata Chemicals** : Tata Chemicals has embraced digitalization to improve its manufacturing processes. The company employs IoT sensors and AI analytics to monitor and optimize production in real-time, leading to increased operational efficiency, reduced energy consumption, and enhanced product quality. Tata Chemicals' commitment to sustainability is further supported by AI-driven initiatives designed to minimize environmental impact.

Building Leadership in R&D, Innovation, and Digitalization

As the global landscape rapidly evolves due to technological advancements and sustainability pressures, the Indian petrochemicals sector is focusing more to rely on research and development (R&D) to remain competitive and address future needs. The Ministry of Chemicals and Fertilizers has introduced several initiatives, such as the Petroleum, Chemicals, and Petrochemicals Investment Regions (PCPIRs) and plastic parks, but there is a pressing need to accelerate these efforts.

The industry needs to focus on domestic requirements, as India imports a significant amount of chemicals. The government has identified around 500 chemicals that should be produced domestically to conserve foreign reserves and enhance self-reliance. The national petrochemicals policy, established in 2007, led to the creation of PCPIRs, with three currently operational. Additionally, the policy called for the establishment of Centers of Excellence (CoEs), resulting in 13 such centers being set up. The Central Institute of Plastics Engineering and Technology (CIPET) operates three CoEs dedicated to green transportation, sustainable materials, and 3D printing for biomedical applications. CIPET also boasts three world-class R&D centers in Bhubaneswar, Chennai, and Bengaluru.

Indian chemical companies have significantly ramped up their innovation efforts, with total R&D expenditure for major firms reaching ₹8.4 billion in FY24, up from ₹5.9 billion in FY22. The sector's R&D investment is now growing at a 15% CAGR, consistently outstripping revenue growth as companies pivot toward high-margin specialty chemicals. While the historical average spend was 0.6% of revenue, the latest figures show a shift toward higher intensity, with average allocations reaching 1.2% and top-tier specialty players investing up to 5% to stay competitive in the global market. The journey of digitalization and AI/ML in India's chemical industry is still in its early stages, with a promising future full of potential advancements and innovations.

- **Autonomous Chemical Plants :** The idea of autonomous chemical plants, where AI systems manage and optimize all production aspects with minimal human intervention, is gaining momentum. These plants would rely on AI for decision-making, process control, and safety management, offering benefits such as increased efficiency, fewer human errors, and enhanced safety.

- **Digital Twins :** Digital twin technology, which involves creating virtual replicas of physical systems, is poised to transform the chemical industry. Digital twins allow for real-time monitoring, simulation, and optimization of chemical processes. This technology facilitates predictive maintenance, process optimization, and scenario analysis, leading to improved performance and reduced operational risks.

- **Collaboration and Innovation :** The future success of digitalization and AI/ML in the chemical industry will hinge on collaboration among industry stakeholders, academia, and technology providers. Open innovation platforms, joint research efforts, and knowledge sharing will drive the advancement and adoption of these technologies[21].

According to ChemAnalyst, the global Carbon Capture Utilization and Storage Market is expected to reach USD 4.72 Billion by 2029. The increasing adoption of Carbon Capture, Utilization, and Storage (CCUS) in the chemical and petrochemical industries is becoming more pronounced as these sectors seek to address their environmental impact. This shift is driven by the need to reduce greenhouse gas emissions and comply with stringent climate regulations.

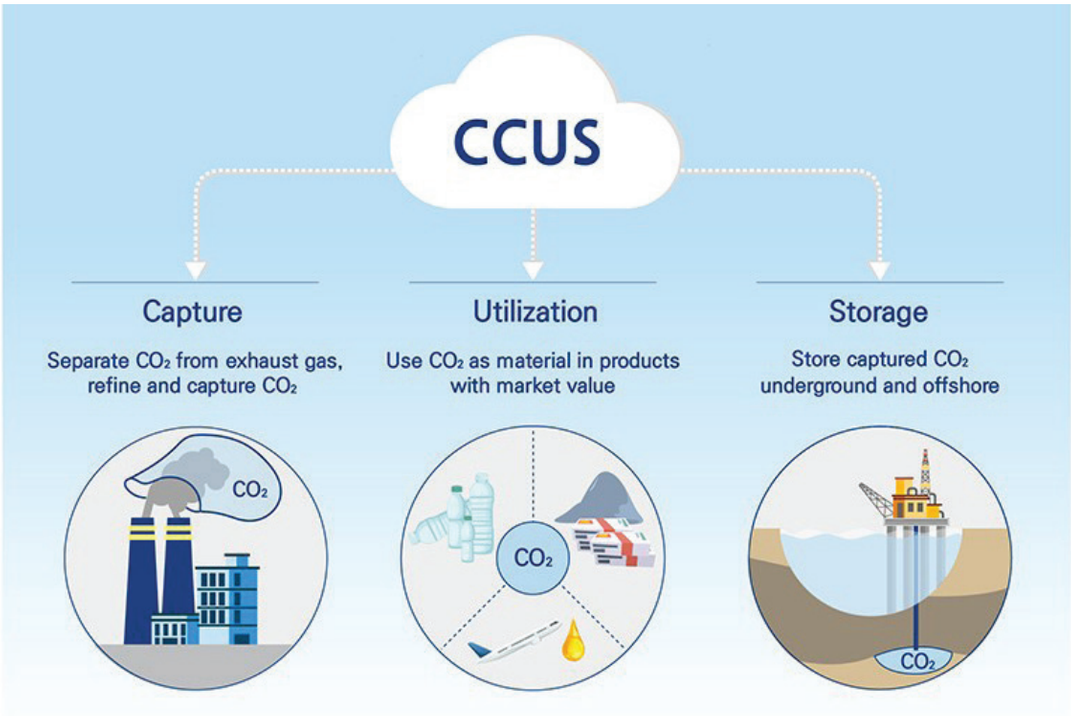
The adoption of Carbon Capture, Utilization, and Storage (CCUS) in India's chemical and petrochemical industries is increasingly becoming a pivotal strategy for mitigating carbon emissions and addressing climate change. These sectors, known fors their substantial greenhouse gas emissions, are under growing pressure to implement sustainable practices. In response, there has been a notable rise in the integration of CCUS technologies, driven by a combination of governmental support, industry investment, and technological advancements. The Indian government has played a significant role by establishing supportive policy frameworks and financial incentives, as well as creating roadmaps such as the '2030 Roadmap for CCUS,' which guides and encourages the adoption of these technologies.

Additionally, increasing industry awareness and the need to comply with global environmental standards have accelerated the implementation of CCUS solutions. This collective effort is not only aiding in reducing emissions but also fostering innovation and positioning India's chemical and petrochemical industries as leaders in sustainable practices.

The Ministry of Petroleum and Natural Gas, Government of India, has launched initiatives to foster collaboration and knowledge sharing within the industry, aiming to develop and implement a unified and practical strategy for Carbon Capture, Utilization, and Storage (CCUS) and Carbon Capture and Storage (CCS) techniques in the oil and gas sector. To this end, a task force named 'Upstream for CCS/CCUS' (UFCC) is working on the '2030 Roadmap for CCUS,' which will provide essential guidance and direction for oil and gas companies to advance and expand CCS/CCUS technologies.

[21] https://www.indianchemicalnews.com/opinion/digitalisation-and-use-of-aiml-in-indian-chemical-industry-advantages-and-shortcomings-shrey-b-patel-founder-angiras-rasayan-22690

Figure 16: Carbon Capture, Utilization, and Storage (CCUS) in the Chemical and Petrochemical Industries



Initially centered on refining, the partnership between TCS and TotalEnergies is leveraging digital technologies to enhance collective knowledge and advance various aspects of refining, including production units, processes, the supply chain, and petroleum product markets. This effort aims to improve refinery performance and promote sustainability in the oil and gas industry. The 'entrepreneurship-in-residence' model allows TotalEnergies to work closely with TCS's technology and domain experts, with TCS contributing its expertise in structured co-innovation approaches. While the innovation center initially focused on the refinery sector, its scope has broadened to encompass other areas and related industries, including exploration and production, renewable gas, and power[22].

Implementation Challenges

Cyber threats are increasingly posing significant challenges and obstacles to the growth of the chemical sector. As the industry becomes more reliant on digital technologies across various sectors, the frequency and severity of cyberattacks are leading to substantial financial losses and infrastructural damage. This situation is driving companies to invest heavily in advanced cybersecurity systems to safeguard their operations and ensure data privacy.

[22] https://www.tcs.com/what-we-do/pace-innovation/article/sustainability-oil-gas-iot-energy

Chapter - 6
Regional Contributions

Gujarat's Role in Sustainable Development

According to the final data from CHEMEXCIL and the Ministry of Commerce for FY24, the USA has solidified its position as the primary destination for Indian chemicals, while trade dynamics with China and Brazil have shifted slightly.

Exports to the USA reached approximately $3.05 billion in the latest fiscal period. While the sector saw a record 59% surge in FY22 (reaching $3.6 billion), the recent figures reflect a normalization of global demand and a strategic shift toward high-value specialty chemicals. The USA remains the top importer with a market share of roughly 15.1%, followed by Brazil at 7.8% and China at 7.3%. Notably, while bulk exports to China have moderated, India's "China Plus One" strategy has led to increased export footprints in emerging markets like Turkey and the Netherlands.

India ranks among the top three global producers of basic chemicals. According To ChemAnalyst country's chemical market is currently valued at approximately USD230 billion and is projected to grow to between USD858 billion and USD1.12 trillion by 2040. Micro, Small, and Medium Enterprises (MSMEs), which make up 28-30% of the sector, play a vital role in achieving these growth targets and meeting rising demand. The industry provides employment to around two million people in India. The Indian chemical industry, which represents 3.4% of the global market, is primarily concentrated in Maharashtra and Gujarat, with significant production also occurring in West Bengal and Tamil Nadu.

Gujarat produces 35% of India's chemical output, establishing itself as a leader in the country's chemical manufacturing sector. The state's chemicals are exported to 175 countries, with the US, China, Brazil, the UAE, Germany, Indonesia, the UK, the Netherlands, South Africa, and Belgium being the top destinations.

Gujarat, a Western Indian state renowned for hosting major petrochemical and chemical industry giants like Reliance, has seen its chemical sector become the largest and fastest-growing segment of its economy. Despite its business-friendly policies and robust infrastructure, a recent Tata Strategic Management Group report emphasizes the need for Gujarat to benchmark itself against international examples for integrated development, which is crucial for strengthening its position as a key chemical hub.

As Eastern countries gain prominence in the global chemical market, Gujarat's role will become increasingly significant. It suggests that drawing comparisons with global leaders like Jurong Island in Singapore—home to major companies such as BASF, ExxonMobil, DowDuPont, Mitsui Chemicals, Shell, and Singapore Petroleum Company—and ensuring seamless coordination between State and Central departments will be essential for achieving integrated development. Gujarat stands at the forefront of India's chemical industry, further solidifying its reputation as the 'Petrochemical and Chemical Capital of India.' The state contributes 62% of India's petrochemical production, 53% of its chemical production, and 45% of its pharmaceutical production.

Gujarat is the top exporter of various chemi-

cal sub-sectors, including inorganic chemicals, organic chemicals, petrochemicals, plastics, rubber, man-made filaments, and man-made fibers, contributing 41% to India's national chemicals and petrochemical exports. Currently, Gujarat accounts for 14% of India's specialty chemicals production and aims to increase this share to 40% by 2047.

The state's advanced chemical sector infrastructure and skilled workforce are expected to attract further investment in specialty chemicals and related products.

The chemical industry in Gujarat is valued at USD 31.5 billion, while the coke and petroleum industry is valued at USD 50.8 billion. Gujarat accounts for 41% of India's total chemical and petrochemical exports, representing 5% of the country's overall exports and 27% of the state's total exports. The state hosts four refining complexes with a combined capacity of 102 MMTPA, which constitutes 41% of India's total refining capacity.

Gujarat is the leading exporter in India for chemical and petrochemical products, including inorganic chemicals, organic chemicals, plastics, rubber, man-made filaments, man-made fibers, and miscellaneous chemicals. The top ten export destinations for these products are the USA, China, Brazil, the UAE, Germany, Indonesia, the UK, the Netherlands, South Africa, and Belgium[23].

Four industries have signed Memorandums of Understanding (MoUs) committing a total investment of ₹1,401 crores in the chemical sector. These industries will establish their units at Saykha and Dahej GIDC in Bharuch district, creating 2,285 potential jobs. During two phases of the MoU signing program, a total of 10 MoUs with investments amounting to ₹2,761 crores have been signed to establish various industries. These new projects are expected to generate over 5,000 potential jobs.

According to the MoUs signed on August 2, by 2024-25-26, Gujarat Fluorochemicals will invest ₹50 crores to set up a facility at Dahej-2 in Saykha and Dahej GIDC for producing lithium hexafluorophosphate, a key chemical for electric vehicle batteries. Additionally, Savita Green Tech Limited will invest ₹493 crores in Saykha GIDC to initiate a plastic bottle recycling project. Harcros Chemicals Pvt. Ltd. will establish a specialty chemicals plant at Dahej-1 with an investment of ₹300 crores, and Ashu Organic (India) Pvt. Ltd. will launch a manufacturing plant for dyes and pigment intermediates in Dahej-3 with an investment of ₹108 crores[24].

[23] https://www.tcs.com/what-we-do/pace-innovation/article/sustainability-oil-gas-iot-energy
[24] https://www.indianchemicalnews.com/chemical/gujarat-signs-4-mous-worth-rs-1401-crore-in-chemicals-sector-18431

Successful Case Studies

Case Study 1: Tata Chemicals' Green Chemistry Initiatives

Tata Chemicals, headquartered in Mumbai, India, and part of the Tata Group, stands as one of the largest chemical companies in the country, specializing in chemicals, crop nutrition, and consumer products. The company has taken a pioneering role in sustainable practices by implementing green chemistry principles, notably developing a process to produce sodium bicarbonate using carbon capture technology, which captures carbon dioxide from its own operations and reuses it as a raw material, thus reducing CO2 emissions.

This initiative has notably diminished the company's carbon footprint and resulted in a more environmentally friendly product, while economically it has opened new markets for eco-friendly goods and socially it has strengthened Tata Chemicals' reputation as a leader in sustainability. However, the project faced significant challenges, particularly the substantial initial investment required for the carbon capture technology; Tata Chemicals overcame this by leveraging government incentives and forming partnerships with technology providers. The case illustrates the critical role of innovation and collaboration in achieving sustainability goals and demonstrates that investment in green technologies can lead to considerable long-term economic benefits.

Case Study 2: Reliance Industries' Circular Economy Model

Reliance Industries Limited, headquartered in Mumbai, stands as the largest private sector corporation in India. It operates across various sectors, including petrochemicals, refining, and telecommunications. As part of its commitment to sustainability, Reliance Industries has embraced a circular economy model within its petrochemical business. Reliance Industries Limited has become the first Indian company to chemically recycle plastic waste-derived pyrolysis oil into Circular Polymers certified by the International Sustainability & Carbon Certification (ISCC)-Plus.

It has not only contributed to environmental conservation but also created economic value by transforming waste into valuable resources and generating employment opportunities in recycling units. However, the company faced challenges, primarily in ensuring that the quality of the recycled products met industry standards. To overcome this, Reliance invested in advanced recycling technologies and implemented stringent quality control processes. From this experience, it is evident that circular economy practices hold substantial potential for improving waste management and creating economic benefits. Additionally, the case highlights the crucial role of technological investment in maintaining product quality and achieving sustainability goals.

Case Study 3: Godrej Industries' Renewable Energy Adoption

Godrej Industries, part of the Godrej Group and based in Mumbai, operates across various sectors such as chemicals, consumer goods, and real estate. To enhance sustainability, the company has invested in renewable energy sources, including solar and wind power, installing solar panels at its manufacturing sites and supporting wind energy projects. This shift has reduced

reliance on fossil fuels, decreased greenhouse gas emissions, and led to cost savings and improved energy security. A significant challenge was the high initial cost of renewable energy installations, which Godrej addressed through government subsidies and long-term power purchase agreements. This experience underscores the economic and environmental advantages of adopting renewable energy and the critical role of strategic planning and financial incentives in overcoming investment hurdles.

Case Study 4: Bharat Petroleum's Green Hydrogen Initiative

Bharat Petroleum Corporation Limited (BPCL), headquartered in Mumbai, is a leading oil and gas company in India. To support India's clean energy transition, BPCL has invested in producing green hydrogen using renewable energy, aiming to reduce carbon emissions. This initiative has had several impacts: environmentally, it has decreased carbon emissions and promoted clean energy; economically, it has created potential new revenue streams from hydrogen markets; and socially, it has contributed to national energy security and sustainability goals. A significant challenge faced was the high cost of electrolysis technology, which BPCL tackled by collaborating with international partners to share technology and expertise. This initiative highlights the importance of partnerships in advancing innovative technologies and demonstrates the potential of hydrogen as a clean energy source.

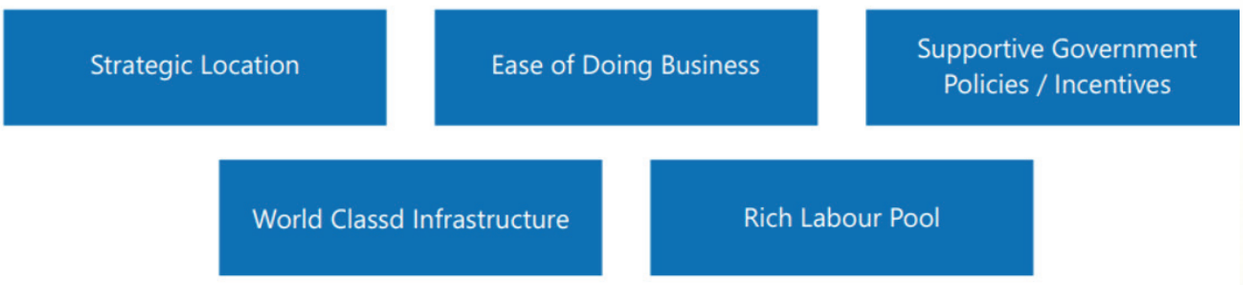
The Pivotal Role of Gujarat PCPIR in Driving Inclusive Growth

In May 2007, the Government of India introduced a Policy Resolution aimed at fostering the development of Petroleum, Chemicals, and Petrochemical Investment Regions (PCPIRs). This initiative draws inspiration from successful chemical and petrochemical hubs in the Middle East, Southeast Asia, and Europe, which have significantly advanced their sectors and spurred regional growth.

The policy aims to encourage investment in the petroleum and petrochemical industries by establishing an effective regulatory framework and state-of-the-art infrastructure. It provides broad guidelines and sets minimum standards for developing PCPIRs, while also detailing the roles of both the Central and State Governments in terms of budget and institutional support.

The Gujarat Government, through its nodal agency, the Gujarat Industrial Development

Figure 17: Key Investment Drivers

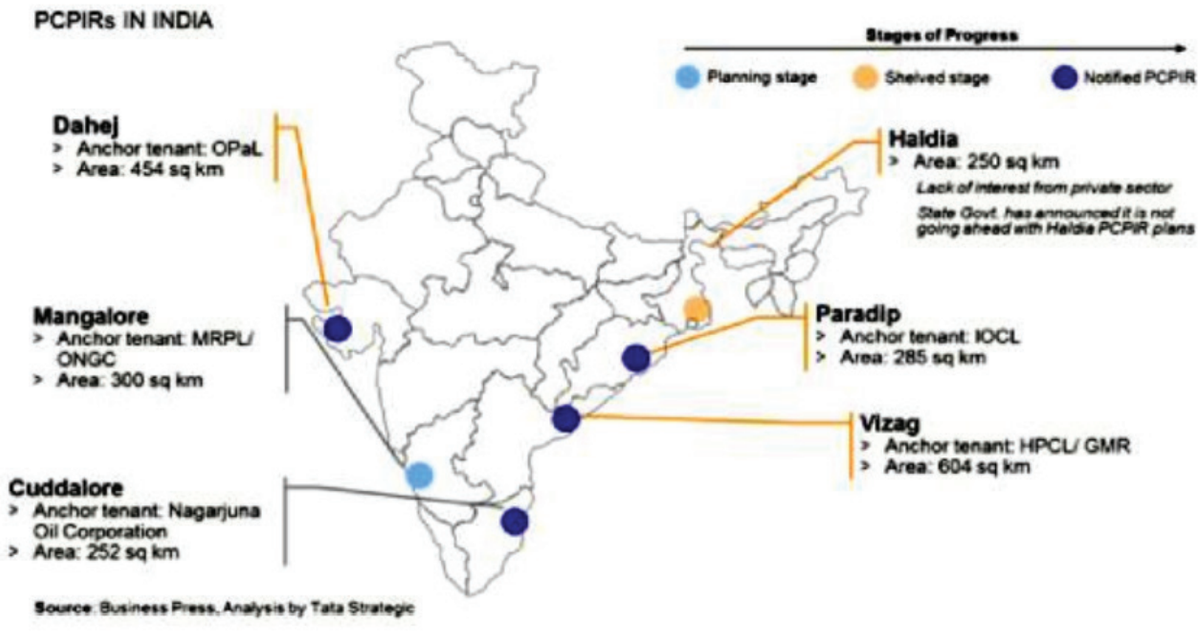


Corporation (GIDC), sought to capitalize on this opportunity and engaged Mott MacDonald Private Limited (referred to as Consultants) to prepare the application for Gujarat. Based on this application, a 453 sq. km area in Bharuch District, Gujarat, was approved as one of the first three PCPIRs in India, alongside the PCPIRs in Andhra Pradesh and West Bengal. ONGC Petro Additions Ltd (OPaL), a joint venture between Oil and Natural Gas Commission (ONGC) and Gujarat State Petroleum Corporation (GSPC), has been designated as the 'lead anchor' for promoting the Gujarat PCPIR.

The establishment of PCPIRs is crucial for the chemical industry, as this policy is anticipated to draw significant investments from both domestic and international sources. Currently, three PCPIRs have been announced: Dahej, Paradip, and Vizag. Additionally, several SEZs, including those in Mangalore and Dahej, host petrochemical complexes. These SEZs are dedicated to becoming net foreign exchange earners, thereby intensifying their focus on penetrating export markets.

India has identified six PCPIRs, with four having received final notification. The Haldia PCPIR plan has been discontinued due to lack of support from the new West Bengal government. In contrast, there has been no opposition to the other four PCPIRs, and their development is expected to proceed as planned. Among them, Vizag, Paradip, and Dahej have seen some progress, while the Cuddalore PCPIR was recently approved in August 2012. In Dahej, total committed investment has reached Rs 128,441 crore, with the anchor tenant ONGC-OPaL investing Rs 8,707 crore as of May 2012. NEERI has been assigned the EIA study and environmental management plan. The Gujarat government is working on expanding the Bharuch to Dahej stretch to six lanes. However, since the anchor tenant is located within the SEZ, its activities will primarily focus on export.

Figure III 6: PCPIRs in India



[25] https://ficci.in/public/storage/events/21293/ISP/Gujarat-Specilty-Chemicals-Conclave-2013-Background-Paper-Final.pdf

With companies such as Reliance, Shell, ONGC, and others already established in Gujarat, the state is poised to become a leader in the chemicals and petrochemicals sector. The Petroleum, Chemicals, and Petrochemicals Investment Region (PCPIR) at Dahej in Gujarat's Bharuch district is one of the four PCPIRs designated by the Centre under the PCPIR Policy 2007. Covering an area of 452.98 square kilometers, the Gujarat PCPIR boasts excellent connectivity through road, rail, port, and air.

The ONGC Petro Additions Limited (OPaL) facility within the PCPIR is one of South Asia's largest petrochemical complexes. Spanning 5 square kilometers, OPaL has the capacity to produce 1.4 million tons of polymers and 500,000 tons of chemicals annually. Besides OPaL, the PCPIR also hosts manufacturing and processing facilities for major companies including BASF, ONGC, Reliance Industries (RIL), Welspun, Pidilite, and GNFC.

Reliance Industries Ltd's (RIL) Jamnagar refinery is the world's largest and most intricate single-site refinery, with a crude processing capacity of 1.4 million barrels per day (MMBPD). According to RIL's official website, the Jamnagar refinery complex features some of the globe's largest units, including those for fluidized catalytic cracking, coking, alkylation, paraxylene production, polypropylene, refinery off-gas cracking, and petcoke gasification.

Dahej is a prominent investment hub with a robust industrial base spanning sectors such as chemicals and petrochemicals, textiles, pharmaceuticals, and ports and shipbuilding. The development of the GPCPSIR, the Dahej SEZ, and its proximity to the Delhi-Mumbai Industrial Corridor (DMIC) is expected to further drive industrial and economic growth in the district. Dahej has successfully attracted significant investments into the PCPIR, totaling approximately US$ 13.6 billion. This includes US$ 2.4 billion allocated for infrastructure development in the PCPIR region by the Gujarat Infrastructure Development Corporation (GIDC), and a major investment of US$ 4.0 billion from OPaL. Key investors in the region include Reliance, BASF, Aditya Birla, Welspun, GACL, Adani, SRF, GSPL, Torrent, and Lanxess. Additionally, various projects by Nayara Energy, Godrej Agrovet, Polyplastics, Thermax, Astral Pipes, Neogen Chemicals, and others are currently under development.

Chapter - 7
Collaboration between Industry, Government, and Academia

Collaboration between Industry, Government, and Academia

1. SCG Chemicals (SCGC), a prominent integrated chemical company, has partnered with the Synchrotron Light Research Institute (SLRI), which operates under the Ministry of Higher Education, Science, Research, and Innovation. This collaboration aims to advance academic research focused on polymer and chemical innovations. Recently, the two organizations signed a Memorandum of Understanding and Service Agreement to jointly develop polymer and chemical innovations targeting decarbonization, circular economy principles, and future industrial applications.

2. GreenLine unveiled its first partnership in the Chemical Industry with GHCL Limited, marking a significant milestone in its commitment to sustainability. This collaboration is a crucial step toward decarbonization and the reduction of Scope 3 emissions, highlighting GHCL's strong dedication to fostering a greener future. Together, it aims to drive innovative solutions that contribute to a more sustainable and eco-friendly chemical industry.

3. Arete Group has announced a major transaction involving the acquisition of 35 acres of prime industrial land at Payal Industrial Park (PIP) in Dahej, Gujarat, by Silox India. Silox India, a Belgium-based manufacturer of inorganic chemicals, is entering this strategic partnership to drive growth, innovation, and sustainability in the chemical manufacturing sector. PIP, developed and promoted by Arete Group, is India's largest privately integrated industrial park, strategically positioned within the Gujarat PCPIR (Petroleum, Chemicals, and Petrochemicals Investment Region). Endorsed by the Gujarat government, PIP provides world-class infrastructure and facilities, making it an ideal location for manufacturing plants and large-scale industries. Spanning over 3,500 acres and planned by CH2M Hill, the park is designed to meet the needs of water-intensive and polluting industries.

4. Godrej Locks & Architectural Fittings and Systems-At its eco-friendly manufacturing facility in Goa, Godrej Locks & Architectural Fittings and Systems has embraced green chemistry for the production of locks. The plant employs an ion exchange process for the selective removal of heavy metals, enhancing energy efficiency. It also features an automated online effluent treatment plant that has replaced eco-hazardous materials with more bio-friendly alternatives. The green chemistry approach uses trivalent chrome, a non-cyanide-based option, instead of the environmentally harmful hexavalent chromium. Similarly, the plating process employs an alkaline copper system in place of hazardous cyanide copper. Additionally, the company prioritizes the use of recycled materials, such as brass and Mazak, and ensures that processed scrap is sent back to the smelter to be converted into raw material for reuse.

5. Swedish Steel India is advancing its green manufacturing initiative through the HYBRIT project, which aims to replace coking coke with hydrogen in the steel production process. The steel industry is one of the largest contributors to global carbon

dioxide emissions, accounting for 7% of the total. The HYBRIT (Hydrogen Breakthrough Ironmaking Technology) project seeks to replace coal with hydrogen in steelmaking, replacing the traditional blast furnace method. Currently, coke is used to convert iron ore to iron, but the new process will use hydrogen gas, produced from fossil-free energy sources, instead. The by-product will be water, which can be recovered and used to produce more hydrogen gas. According to the company, reduction reactions in ironmaking account for approximately 85-90% of the total carbon dioxide emissions in ore-based steelmaking. HYBRIT's method will significantly reduce these emissions by using hydrogen gas as the primary reductant.

Roadmap for Sustainability

The Indian chemical industry is currently grappling with several sustainability challenges. First, the sector is highly energy-intensive, consuming approximately 12-15% of the country's total energy. This substantial energy use leads to significant greenhouse gas emissions, contributing to climate change.

Second, the chemical industry is one of the largest consumers of water in India, accounting for around 20% of total industrial water usage. This high level of water consumption strains limited water resources, exacerbating water scarcity in certain regions.

Third, the industry generates considerable amounts of hazardous waste and emissions, which can pose serious environmental and health risks if not managed effectively. It is also susceptible to accidents such as leaks, spills, and explosions, which can result in severe environmental damage and harm to human health. Lastly, the chemical industry faces social sustainability issues, including poor working conditions, low wages, and human rights violations, especially among contract workers.

The sustainability roadmap for Indian Chemical Industries emphasizes the need for the sector to transition to more sustainable practices to minimize its environmental and societal impact. It outlines a framework for adopting sustainable practices throughout the entire value chain, including raw material sourcing, production, transportation, distribution, and disposal. A major takeaway from the roadmap is the necessity for Indian Chemical Industries to implement cleaner production methods and technologies to lower greenhouse gas emissions, energy consumption, and waste generation. This can be achieved through the adoption of energy-efficient technologies, renewable energy sources, and circular economy principles.

Another critical step for the industry to adopt responsible sourcing practices to ensure that raw materials are sustainably obtained and do not contribute to deforestation or other forms of environmental degradation. Additionally, there is a call for reducing water consumption and enhancing water use efficiency. Overall, the sustainability roadmap offers a comprehensive and actionable framework for Indian Chemical Industries to embrace sustainable practices, supporting a more sustainable future for both India and the global community[26].

[26] https://www.indianchemicalnews.com/opinion/sustainability-roadmap-for-indian-chemical-industry-18525#:~:text=One%20of%20the%20key%20conclusions,energy%20consumption%2C%20and%20waste%20generation.


Five Conversion Strategies To Transition the Chemical Industry Toward Sustainability
Energy Conversion
The industry should minimize its process energy requirements and transition from fossil fuels to renewables.
Feedstock Substitution
The industry should sharply reduce fossil fuel use for feedstocks in the production of chemicals, while building supplies of alternative sustainable, renewable feedstocks.
Molecular Redesign
The industry should develop innovative, new platform and tunable chemistries based on the principles of green chemistry and engineering.
Production Process Redesign
Chemical manufacturing processes should be redesigned to use renewable feedstocks, minimize adverse impacts, and work within more flexible, distributed, and resilient manufacturing operations.
Downstream Product Redesign
Product design and delivery should be reimagined so that products are more circular, use safer chemistries, and have lower adverse impacts through their lifecycle.

Chapter - 8
Policy Framework

Overview of Government Policies Supporting the Chemical and Petrochemical Industries

Overview of Government Policies Supporting the Chemical and Petrochemical Industries

The Government of India (GoI) aims to position India as a leading hub for CPC (Chemicals, Petrochemicals, and Pharmaceuticals) manufacturing through various initiatives and policy reforms designed to foster a more business-friendly environment for both domestic and international investors. India's Ease of Doing Business (EoDB) ranking has significantly improved from 142 in 2014 to 63 in 2019. The government is also advancing bold reforms, including the Chemical (Management and Safety) Rules (CMSR), Extended Producer Responsibility (EPR) regulations, and the rationalization of basic customs duties on raw materials for domestic manufacturers. The focus is on addressing anomalies and challenges in the indirect tax regime, particularly the inverted duty structure that hampers the Make in India initiative.

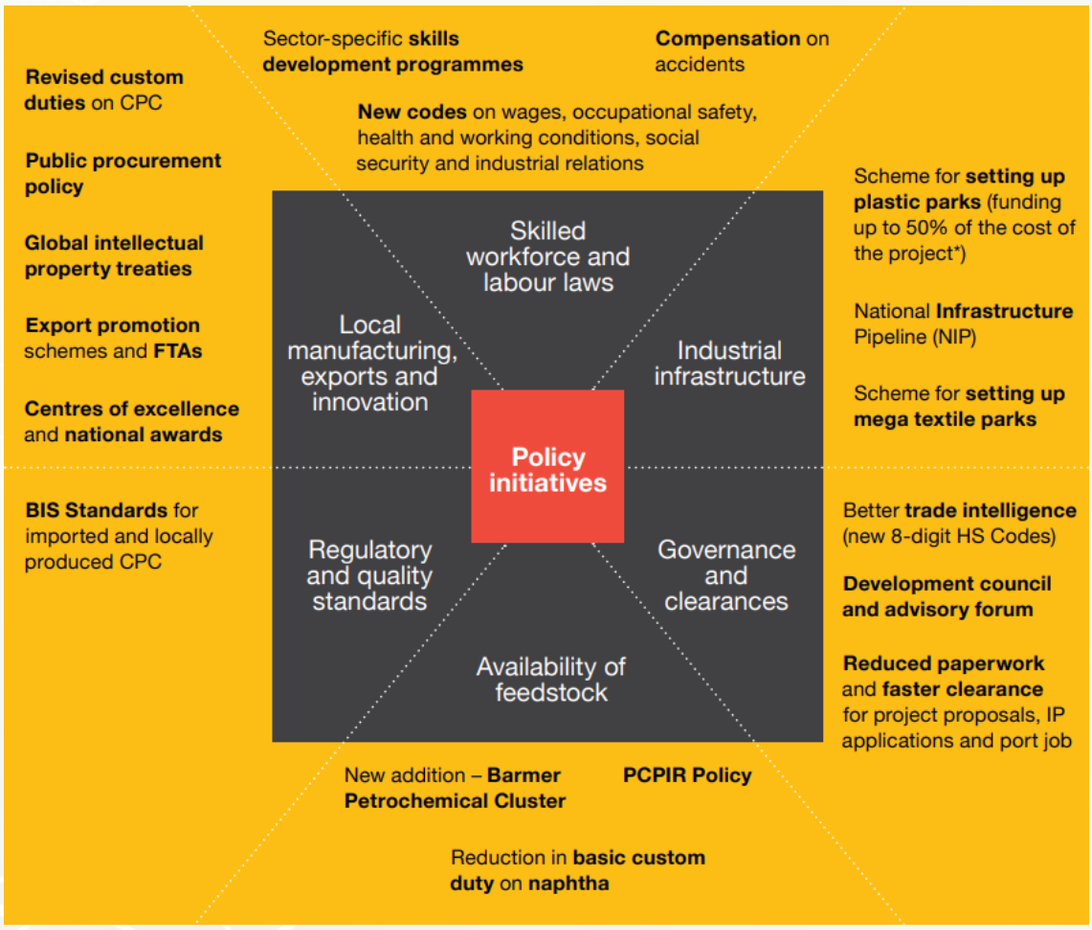
To further enhance the domestic manufacturing sector, the GoI has announced multiple economic stimulus packages to revitalize the COVID-affected economy, introduced the Production Linked Incentive (PLI) Scheme across 13 sectors, and implemented various tax and labour reforms. Additionally, the National Infrastructure Pipeline (NIP) has been established, and several sector-specific policies and schemes, including public procurement policies, have been developed. The government has also set mandatory Bureau of Indian Standards (BIS) regulations, launched skill development programs, and renewed the PCPIR policy to support CPC sector growth.

The PLI Scheme, with a total allocation of USD 28 billion, has been extended to cover 13 sectors. This initiative aims to achieve a minimum production output of approximately USD 500 billion over the next five years. The scheme offers cashback and incentives ranging from 2-20% of incremental sales revenue and incremental export revenue, depending on the sector.

The Government of India introduced the PCPIR Policy in 2007 to attract investment and create employment opportunities within the Petroleum, Chemical, and Petrochemical Investment Regions (PCPIRs). This policy aims to foster the growth of the Chemical and Petrochemical sectors in an integrated, large-scale, and environmentally friendly manner.

The Government of India (GOI) reviews all applications for establishing PCPIRs (Petroleum, Chemical, and Petrochemical Investment Regions) under this policy and approve feasible proposals promptly. A High Powered Committee ensures effective coordination among central ministries and state governments, and to oversee the progress of environmental and other clearances as well as the development of the PCPIRs at necessary intervals. The GOI also ensure that external physical infrastructure linkages, including rail, road (national highways), ports, airports, and telecommunications, are provided to the PCPIRs in a timely manner. These infrastructures will be created or upgraded through Public-Private Partnerships (PPPs) wherever possible, with the Central Government providing necessary viability gap funding through existing schemes. Budgetary provisions for infrastructure creation through the public sector will also be made where needed. Additionally, the GOI will support state governments and their agencies in promoting domestic and global investment in the PCPIRs by disseminating relevant information.

Figure 19: Policy Initiatives



The State Government play a central role in establishing the PCPIR. Responsibilities include identifying a suitable site, preparing and seeking approval for the proposal, notifying the PCPIR area under the relevant Act, and acquiring or assisting in acquiring the necessary land for infrastructure and processing areas. Land acquisition must comply with legal requirements and include rehabilitation provisions as per established norms, avoiding agricultural land where possible.

Once the area is notified, the State Government ensure that all physical infrastructure and utility linkages within its jurisdiction are provided within a specified timeframe. A nodal department will be designated to coordinate these linkages, and this department, along with relevant authorities, facilitate all required state-level clearances.

Specifically, the State Government is responsible for:

I. Ensuring reliable power connectivity and availability, including open access as per state electricity regulations.

II. Providing bulk water supplies.

[27] https://www.pwc.in/assets/pdfs/industries/oil-and-gas/publications/evolving-horizons-indian-chemical-and-petrochemical-industry.pdf

III. Ensuring road connectivity through state roads.

IV. Facilitating sewerage and effluent treatment from the PCPIR to final disposal sites.

V. Developing infrastructure to address health, safety, and environmental concerns.

The State Government may also offer additional incentives for the development of the PCPIR. Additionally, a Management Board will be established to oversee the development and management of the PCPIR, which may be constituted under an existing state Act or a new Act if necessary[28].

Strategic Initiatives for Sector Growth

Government initiatives such as the "Make in India" and "Atmanirbhar Bharat" campaigns have significantly advanced India's petroleum industry by providing crucial support and fostering sector growth. Alongside technical assistance, substantial government investments have played a pivotal role in enhancing the industry's development. In addition to these programs, several other initiatives have further strengthened the sector, including the National Petrochemical Policy of 2007, Hydrocarbon Vision 2030 of 2016, Skill India, automatic approval for 100% FDI in the petrochemical industry, and the Production Linked Incentive Scheme 2021. These efforts have collectively provided an unparalleled boost to the petroleum sector in India.

National Policy on Petrochemicals

I. Establishment of Plastic Parks

This initiative aims to create state-of-the-art plastic parks through a cluster development model, consolidating and enhancing the capabilities of the domestic downstream plastic processing industry. The objective is to boost sectoral investment, production, and exports while generating employment opportunities. The scheme has approved ten Plastic Parks across various states including Madhya Pradesh (two), Odisha, Jharkhand, Tamil Nadu, Uttarakhand, Chhattisgarh, Assam, Uttar Pradesh, and Karnataka.

II. Creation of Centres of Excellence in Polymer Technology

The goal of this scheme is to advance petrochemical technology and research, as well as to support the development of new polymer and plastic applications. During Phase I (2013-2017), the Government[25] of India provided financial support covering up to 50% of the project cost, with a maximum limit of (Rs. 6 crore) over three years. The government has expanded the Centres of Excellence (CoE) in Polymer Technology scheme, with 15 centers now operational across India's top research and educational institutions. Under the latest guidelines for the 2021–2026 period, financial support has been increased to a maximum of ₹10 crore per project to better support the commercialization of homegrown technologies. Current research is heavily focused on sustainability, with these centers leading the development of biodegradable plastics, advanced medical materials, and circular economy solutions to reduce the environmental footprint of the petrochemical setor.

[28] https://chemicals.gov.in/sites/default/files/Policies/PCPIRPolicy.pdf

Petrochemicals Research & Innovation Commendation Scheme 2023

The scheme for establishing Plastic Parks, Centres of Excellence, and the National Petrochemicals Awards has been reviewed and renamed the Petrochemicals Research & Innovation Commendation Scheme, effective January 2023. This new framework aims to foster R&D and human resource development in the petrochemicals sector, institutionalizing the commendation scheme to achieve these objectives.

Revised Petroleum, Chemical, and Petrochemical Investment Regions (PCPIRs) Policy (2020-35)

Under the PCPIR Policy of 2007, four PCPIRs are being developed in Andhra Pradesh (Visakhapatnam), Gujarat (Dahej), Odisha (Paradeep), and Tamil Nadu (Cuddalore and Nagapattinam) to encourage investment and industrial growth. The revamped PCPIR Policy 2020-35 targets attracting a total investment of USD 142 billion (Rs. 10 lakh crore) by 2025, USD 213 billion (Rs. 15 lakh crore) by 2030, and USD 284 billion (Rs. 20 lakh crore) by 2035. The updated policy will reduce the size of each region from 250 to 50 square kilometers, using a specialized cluster integration approach. The Centre will provide Viability Gap Funding (VGF) of up to 20% for infrastructure projects in these regions. The PCPIRs are designed to promote the petroleum, chemical, and petrochemical sectors on a large scale in an integrated and environmentally friendly manner. They are expected to create approximately 33.83 lakh jobs, with around 4.21 lakh people already employed in related activities. The PCPIR initiative is projected to attract around USD 276.46 billion (Rs. 20 lakh crore) in investment by 2035.

Chemical (Management and Safety) Rules (CMSR)

The fifth draft of the Chemical (Management and Safety) Rules (CMSR) has been released, which will replace the Manufacture, Storage, and Import of Hazardous Chemicals Rules (1989) and the Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules (1996). This regulation requires manufacturers, importers, or Authorized Representatives to register chemicals that need to be registered when they are produced, imported, or placed in Indian territory.

Extended Producer Responsibility (EPR)

Extended Producer Responsibility (EPR) requires producers (including brand owners and importers) to manage their products in an environmentally sound manner throughout their lifecycle. This policy is a step towards more sustainable waste management. The Indian government has introduced an EPR Policy to support this approach.

Additional Measures

The government has allowed 100% Foreign Direct Investment (FDI) in the petrochemical sector through the automatic route. Additionally, various tax benefits have been granted to the petrochemical industry, including exemptions or reduced rates for excise duty, customs duty, and value-added tax (VAT) on specific petrochemical products such as polymers, plastics, and synthetic fibers[29].

[29] https://www.ibef.org/blogs/expansion-opportunities-for-petrochemicals-in-india

Chapter - 9
Micro, Small, and Medium Enterprises (MSMEs)

Contribution of MSMEs in the Chemical Industry

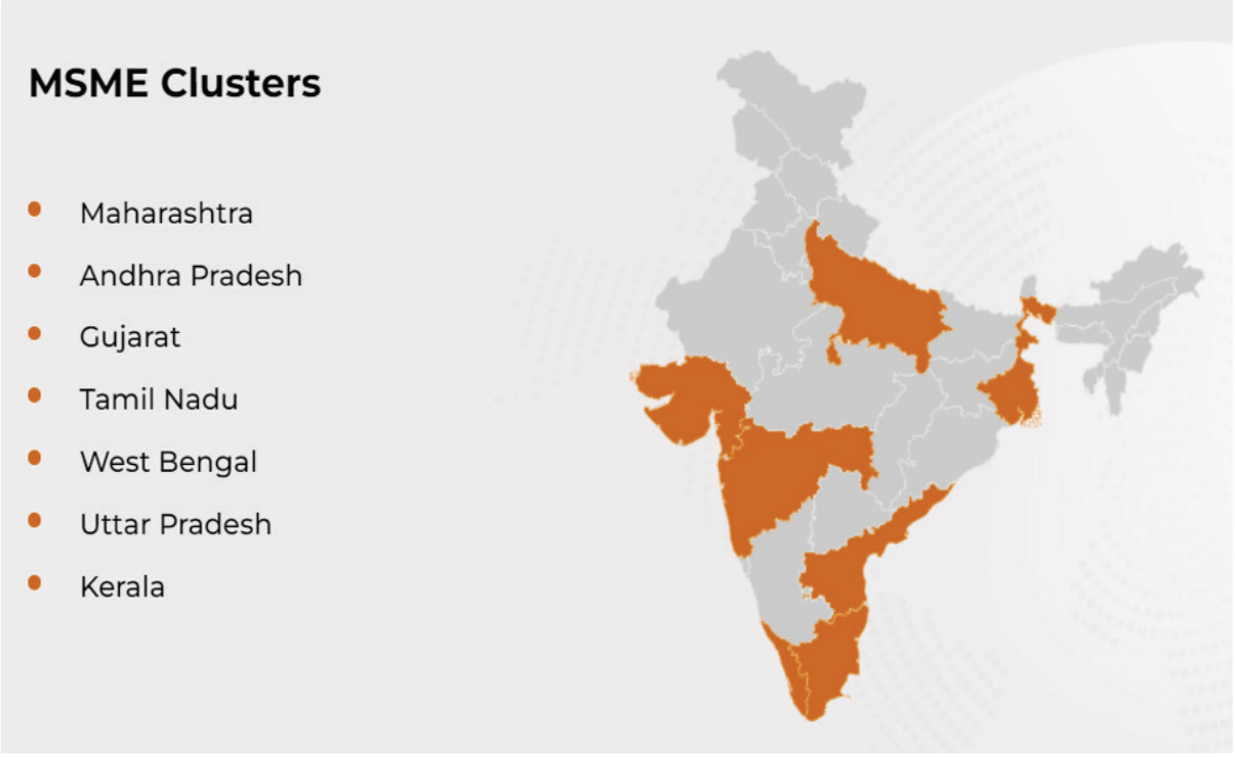
With its 42 ports, 18 domestic airports, and one international airport, Gujarat has become a prominent center of industrial activity. The state hosts 106 product clusters and 60 designated special economic zones (SEZs), drawing significant investments in sectors such as petrochemicals, chemicals, pharmaceuticals, minerals, ceramics, dairy, gems and jewellery, textiles, automotive and engineering, IT, power, and ports.

Gujarat's strategic location has made it a key player in exports of chemicals, textiles, processed foods, and agricultural products. The state is rapidly evolving into a manufacturing hub, attracting numerous global healthcare companies eager to invest.

As a result, Gujarat is solidifying its position as India's manufacturing capital. The state has also prioritized the development of small and medium enterprises (SMEs) through various policy initiatives, including interest subsidies, venture capital support, and quality certification programs. These efforts empower many MSMEs in Gujarat to undertake new initiatives, bolstering the economy.

MSMEs are vital to Gujarat's economy, providing employment for both unskilled and skilled workers and significantly contributing to the

Figure 21: MSME Clusters in India



nation's economic growth. The Gujarat government is dedicated to enhancing the quality of life and prosperity in the state by fostering a business-friendly environment, simplifying the ease of doing business, and encouraging entrepreneurship among youth. The MSME sector is pivotal in the chemical manufacturing industry value chain.

On one hand, it contributes by producing low value-added products, performing job work for larger domestic players, and carrying out processes such as purification and blending. On the other hand, MSMEs also serve niche markets by providing high-quality specialty ingredients, where the market size is smaller but competition is limited due to the high standards required. MSMEs in Gujarat play a vital role in the state's development and significantly contribute to India's socio-economic growth. According to data presented by the Union government, Gujarat ranks as the fourth largest state for MSMEs, following Maharashtra, Tamil Nadu, and Uttar Pradesh.

Gujarat is home to approximately 11.26 lakh registered MSMEs, representing 7.5% of the total 1.48 crore MSMEs registered nationwide. This highlights the state's robust entrepreneurial spirit and has fostered a dynamic business environment. Gujarat is rapidly evolving into a major Multi-Product MSME hub, offering substantial economic opportunities for its residents.

India's chemical sector is both diverse and robust, with Micro, Small, and Medium Enterprises (MSMEs) playing a vital role. Data from the Ministry of Chemicals & Petrochemicals shows that MSMEs make up approximately 30% of the domestic chemical industry.

Major clusters of these enterprises are located in Thane, Mumbai, and Ahmedabad. About half of these MSMEs are involved in organic manufacturing, while the remainder specialize in producing dyes, pigments, soaps, detergents, and agrochemicals.

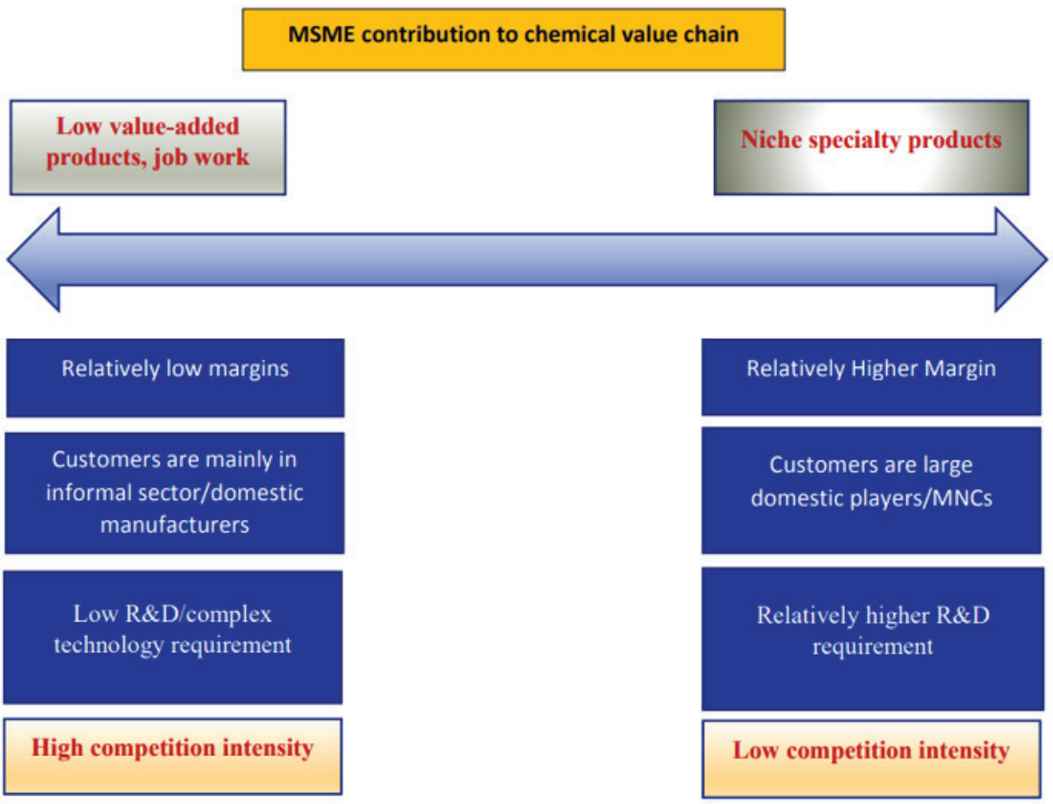
Although the chemical sector is dominated by large players, the MSME (Micro, Small, and Medium Enterprises) segment is estimated to represent approximately 25-30% of the industry. This segment is vital for domestic chemical manufacturing and job creation. MSMEs typically focus on areas where scale is less critical and R&D requirements are minimal, but they also have a significant presence in niche specialty chemical sectors.

Enhancing MSME Capabilities and Competitiveness

With the implementation of the "Make in India" initiative, investment in the manufacturing sector has become more appealing. This has provided the chemical and petrochemical industries with global exposure, driving expansion, job creation, and establishing a competitive edge. In the realm of research and development, the government offers a 200% tax deduction under Section 35 (2AB) of the Income Tax Act for both capital and revenue expenditures related to scientific R&D.

Additionally, the new "59-minute loan" scheme for MSMEs allows for loans up to ₹1 crore, supporting industry growth and enhancement. India benefits from lower pharmaceutical production costs compared to the US and significantly lower than in the UK.

Figure 22: MSME's Contribution to Chemical Value Chain



Despite the accelerated growth and government incentives, the industry faces several challenges. There is often a lack of understanding in structuring innovation, marketing, sales, manufacturing, and portfolio management. Experienced chemical consultants can assist by analyzing a company's market position and guiding it towards progress.

Compliance with government policies is another major challenge for the chemical industry. Companies frequently struggle with low profit margins due to government pricing policies. Pharmaceutical and chemical consultants can alleviate these challenges by ensuring compliance with regulations, staying updated on policy changes, and helping companies take advantage of available benefits.

The Micro, Small, and Medium Enterprises (MSMEs) sector plays a crucial role in the socio-economic development of India. This sector is vital for the country's Gross Domestic Product (GDP) and export performance. It also significantly contributes to entrepreneurship development, particularly in semi-urban and rural areas.

On May 13, 2020, a revision in the definition of MSMEs was announced under the Aatmanirbhar Bharat Abhiyaan Scheme. The Ministry of

[30] https://energy.economictimes.indiatimes.com/files/cp/800/cdoc-1632303852-ICRA%20White%20Paper%20on%20Chemical%20and%20Plastic%20Industry%20-%20Final%20-%20Sep%202021.pdf

Micro, Small, and Medium Enterprises issued a gazette notification on June 1, 2020, which introduced updated definitions and criteria for MSMEs. These new classifications took effect on July 1, 2020. Under the revised Aatmanirbhar Bharat Abhiyaan Scheme, MSMEs are now classified based on investment in plant and machinery and turnover criteria.

The Gujarat Government launched the 'Aatmanirbhar Gujarat' scheme to advance the manufacturing sector by offering various forms of support and incentives. This initiative aligns with Prime Minister's vision of 'Aatmanirbhar Bharat' and underscores Gujarat's reputation as a leading hub for entrepreneurs and industry in India. The scheme provides substantial support for MSMEs in Gujarat, including a capital subsidy of up to Rs 35 lakh for micro industries, an annual interest subsidy of up to Rs 35 lakh for up to 7 years, and a 10-year Employees' Provident Fund (EPF) reimbursement. Additional benefits are available for women, young entrepreneurs, startups, and differently-abled entrepreneurs. Launched on October 5, 2022, the scheme will remain in effect for five years.

The number of MSMEs in the country is projected to increase from 6.3 crore to approximately 7.5 crore in the near future, growing at a compound annual growth rate (CAGR) of 2.5%. As of March 2024, the number of MSMEs registered on the Udyam portal, including the Udyam Assist Platform (UAP), has reached 4,00,42,875. In October 2023, gross bank credit extended to MSMEs under priority sector lending totalled USD 279.18 billion. This represents a 22.8% increase from the previous year and an 11.8% rise from September 2023, according to the latest RBI data on sectoral credit deployment.

Table 2: Criteria for Classification of Industries Based on Turnover and Investment

Criteria	Manufacturing Enterprises and Enterprises rendering Services (Revised classification with effect from July 1, 2020)	
	Turnover	Investment
Micro	Rs. 5 crore (US$ 610,000)	Less than Rs. 1 crore (US$ 120,000)
Small	Rs. 50 crore (US$ 6.1 million)	More than Rs. 1 crore (US$ 120,000) but less than Rs. 10 crore (US$ 1.2 million)
Medium	Rs. 250 crore (US$ 30.4 million)	More than Rs. 10 crore (US$ 1.2 million), but less than Rs. 50 crore (US$ 6.1 million)

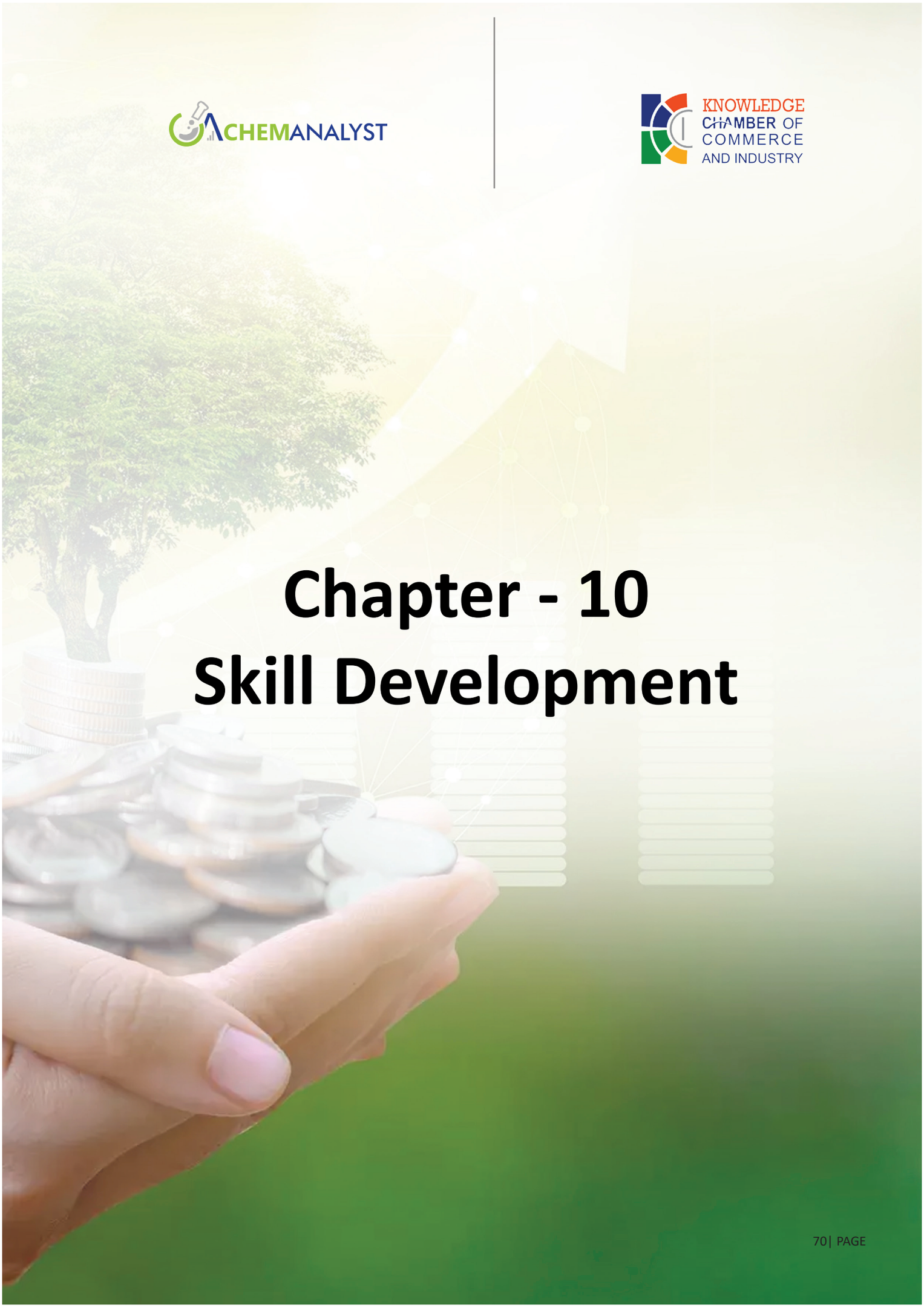
[31] https://www.ibef.org/industry/msme

Support and Incentives for MSMEs

Gujarat leads India's chemical industry, housing over 11,000 chemical units. The state produces more than half of the country's major chemicals. Gujarat is a key center for manufacturing fertilizers, pharmaceuticals, dyes, and pigments, and is home to numerous MSMEs in these sectors. The state also boasts several research and development centers and institutes focused on advancing chemical technology. The Gujarat government supports the chemical industry with initiatives such as investment incentives, infrastructure improvements, and access to skilled labor.

- The Self-Reliant India (SRI) fund, with a total corpus of ₹50,000 crore (US$6 billion), has allocated ₹7,593 crore (US$910 million) to 425 MSMEs. This investment, made under the Aatmanirbhar Bharat package, supports various sectors including agriculture, pharmaceuticals, automotive, and chemicals.

- On December 15, 2023, DCM Shriram Ltd announced its entry into the "Advanced Materials" sector within its Chemicals business. As of November 30, 2023, the Self-Reliant India (SRI) Fund, established by the government in May 2020 and managed by SBICAP Ventures, has invested ₹6,448 crore (US$777.62 million) in MSMEs, with a 15-year period for equity infusion.

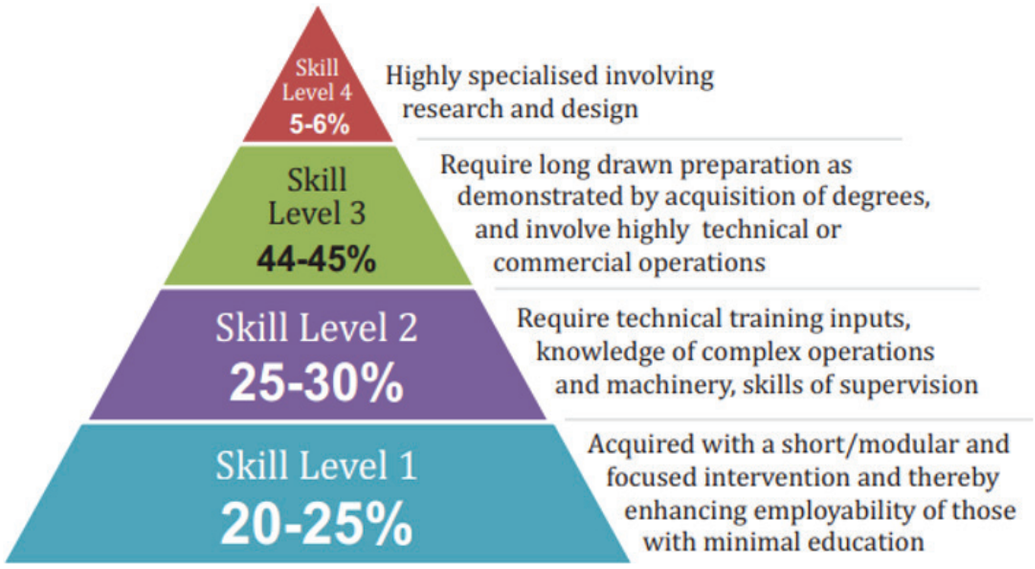


Chapter - 10
Skill Development

Addressing the Skill Gap in the Chemical and Petrochemical Industry

The Rubber, Chemical, and Petrochemical Sector Skill Development Council (RCPSDC), formerly known as RSDC, is dedicated to enhancing skills within India's rubber, chemical, and petrochemical industries. The plastic industry, in particular, offers substantial employment opportunities and entrepreneurial potential. RCPSDC, in collaboration with the Central Institute of Petrochemicals Engineering & Technology (CIPET), provides skill development training programs aimed at unemployed youth, including those from SC/ST/OBC/EWS/BPL categories. These initiatives offer young people the chance to enhance their skills and secure positions within the industry.

Figure 23: Skill Pyramid for the Chemicals Industry



The chemical industry is encountering significant difficulties in sourcing skilled and employable personnel to meet its workforce needs. New employees primarily acquire skills through on-the-job training (OJT). This shortage of skilled workers could hinder the industry's growth. Therefore, it is crucial to identify skill gaps, assess the demand for various skill sets, and develop a skilled workforce. Addressing these issues will require a collaborative effort from all stakeholders involved.

As one of the fastest-growing sectors, the chemical industry presents significant opportunities for youth across a range of skill levels, from high school graduates to Ph.D. and M.Tech. holders. Approximately 20-25% of roles in the industry require skills that can be acquired through short or modular training programs, thus improving employability for individuals with minimal education. Additionally, various companies, including public sector units, offer apprenticeship training in diverse areas such as industrial chemical analysis, QA/QC of pesticides and formulations, hazardous chemical handling, industrial and chemical safety, process and plant operations, and chemical packaging and labeling.

[32] https://facilities.aicte-india.org/KARMA/ssc-documents/Rubber,%20Chemical%20&%20Petrochemical%20Skill%20Development%20Council.pdf

Training Programs to Enhance Workforce Capabilities

The National Employability Enhancement Mission (NEEM) aims to address the issue of unemployment by equipping millions of job-seeking youths with essential skills for various industries. Many traditionally educated individuals lack the specific skills required for employment, and the NEEM scheme addresses this gap by offering skill development training through apprenticeships. This initiative seeks to tackle both the challenges of unemployment and the shortage of skilled workers in the country.

National Apprenticeship Promotion Scheme (NAPS)
The National Apprenticeship Promotion Scheme (NAPS), launched by the Government of India in 2016, aims to incentivize industries and enhance apprenticeship opportunities. The scheme's primary objective is to encourage apprenticeship training across the country by partnering with employers who wish to take on apprentices, aligning with the Skill India vision and mission.

Major Benefits:

- Access to pre-approved courses on the apprenticeship portal, with the option for industries to customize courses according to their specific needs.
- Flexible training durations, ranging from 6 to 24 months, as determined by industry preferences.
- Training is conducted on the industry premises, tailored to the organization's requirements.
- Financial support of up to 25% of the prescribed stipend, with a maximum of Rs. 1,500 per month per apprentice.
- No obligation for industries to retain apprentices after their training is completed.
- Industries can use their CSR funds to provide additional "skill training" beyond the minimum requirements set by the Apprenticeship Act (2.5% of the workforce).

RPL- Recognition of Prior Learning

Recognition of Prior Learning (RPL) is an assessment process designed to evaluate an individual's existing skills, knowledge, and experience acquired through formal, non-formal, or informal learning and certification.

Major Benefits:

- Aligns the competencies of the unregulated workforce with the standardized National Skills Qualification Framework (NSQF).
- Enhances employability opportunities for individuals and offers alternative pathways to higher education.
- Provides opportunities to address and reduce inequalities by valuing diverse forms of knowledge.

- Connects with the extensive uncertified workforce nationwide through direct collaborations with industry.

Short Term Training (STT)

The Short-Term Training offered at approved Training Centres (ICs) aims to assist Indian nationals who are either school or college dropouts or unemployed. In addition to providing training aligned with the National Skills Qualification Framework (NSQF), these centres also cover Soft Skills, Entrepreneurship, and Financial and Digital Literacy. The training duration varies by job role, ranging from 240 to 500 hours. Upon successful completion of the assessment, candidates receive placement assistance from Training Partners (TPs).

Benefits to Corporates:

- Access to skilled manpower for their operations.
- Ability to develop a new workforce tailored to their specific needs.
- Opportunities to re-skill and certify existing employees.
- Option to integrate CSR initiatives for skill development aligned with RCPSDC job roles.
- Support for TPs by offering their facilities for practical training under CSR.
- Contribution to building a more skilled workforce nationwide.

Placement Portal

RCPSDC has launched a dedicated placement portal to cater to the hiring needs of the Rubber, Chemical, and Petrochemical industries. This platform allows candidates from across the country to apply directly for job opportunities offered by employers. The portal features advanced filtration tools that enable both employers and job seekers to refine their searches based on interests, location, skills, and more[33].

Capacity-building initiatives by Research and Development (R&D) institutions are crucial for shaping the future of the global chemical industry. These efforts encompass a broad range of activities aimed at enhancing the skills, capabilities, and resources of professionals and organizations within the sector. Key initiatives include:

- **Research Collaboration:** R&D institutions facilitate partnerships between academia, industry, and government agencies to advance scientific knowledge, develop innovative technologies, and tackle industry challenges. Collaborative projects offer opportunities for knowledge exchange and interdisciplinary work.

- **Technology Transfer and Licensing:** Institutions support the dissemination of cutting-edge research, patents, and technologies through licensing agreements. This helps industry players

[33] https://facilities.aicte-india.org/KARMA/ssc-documents/Rubber,%20Chemical%20&%20Petrochemical%20Skill%20Development%20Council.pdf

adopt new technologies, accelerate product development, and gain a competitive edge.

- **Training and Workshops:** By organizing programs on topics such as chemical process optimization, sustainability, regulatory compliance, and emerging trends, R&D institutions enhance the skills and capabilities of chemical industry professionals, empowering them to address complex challenges and drive innovation.

- **Incubation and Start-up Support:** Many institutions operate incubators, accelerators, and technology parks to support start-ups and small businesses in the chemical sector. These initiatives provide access to infrastructure, funding, mentorship, and networking opportunities.

- **Education and Training Programs:** Institutions collaborate with universities and technical schools to offer specialized degree programs, courses, and certifications in fields like chemical engineering, polymer science, materials science, and nanotechnology, creating a skilled workforce for the industry.

- **Open Innovation Platforms:** R&D institutions establish platforms for industry stakeholders to collaborate on pre-competitive research projects, share resources, and address common challenges, fostering a culture of collaboration and co-innovation.

- **Policy Advocacy and Advisory Services:** Institutions engage in advocacy and provide advisory services on research funding, intellectual property rights, environmental regulations, and technology standards, helping shape a supportive regulatory environment.

- **Global Networking and Partnerships:** By forming strategic partnerships and participating in international research consortia, R&D institutions enhance their visibility and impact, promoting cross-cultural collaboration and knowledge exchange.

Overall, these capacity-building initiatives are vital for driving innovation, competitiveness, and sustainability in the global chemical industry. By promoting collaboration, facilitating technology transfer, providing education and training, and advocating for supportive policies, R&D institutions contribute significantly to the advancement of science and technology and the growth of the chemical sector worldwide.

In the Indian chemical industry, training and capacity building are essential for fostering growth, innovation, and sustainability. Companies that invest in their workforce can overcome challenges, seize opportunities, and establish themselves as leaders in a competitive market. With strategic planning, collaboration, and a focus on continuous learning, the Indian chemical industry can unlock its full potential and contribute to national economic prosperity and industrial development.

Partnerships with Educational Institutions for Skill Development

Human resources are crucial for the growth of the Indian Chemical Industry, which is currently facing a significant challenge in attracting world-class talent. To address this issue and draw skilled professionals to the sector, it is essential to enhance technical education and establish new institutions with state-of-the-art facilities. According to the National Skills Development Corporation (NSDC) report on Human Resource and Skills Requirement for the Chemicals and Pharmaceutical Sector 2022, the industry will need approximately 1 million skilled workers by 2022. Currently, the chemical industry employs around 800,000 people, with an additional 200,000 needed by 2022. Major challenges include inadequate quality education and insufficient investment in skill development. Therefore, a substantial policy focus on skill development is necessary to meet these demands.

- On July 9, 2015, the Ministry of Chemicals and Fertilizers and the Ministry of Skill Development and Entrepreneurship signed three memorandums of understanding (MoUs) to address the need for skilled manpower in the industry. These MoUs aim to collaboratively meet the growing demand for skilled workers in the fertilizer, pharmaceutical, and chemicals & petrochemical sectors. The agreements include setting standards and quality assurance processes to support the implementation of various projects. The three departments within the Ministry of Chemicals and Fertilizers will coordinate their budgets under existing or new schemes to execute the initiatives outlined in the MoUs. This coordination will encompass advocacy, marketing, training, certification, and, if necessary, the establishment of a project management unit.

- BASF, in partnership with Somaiya Vidyavihar (SVV) and the Indian Chemical Council (ICC), is celebrating the success of the inaugural batch of the We-Chemie program—Women Enabled for Careers in Chemistry. This initiative recognizes the achievements of students who have completed the training. With women representing less than 30% of the global chemical sector, and likely even fewer in India, BASF leads this CSR effort alongside SVV and ICC to address the gender imbalance in the industry. The We-Chemie program aims to build a pipeline of skilled female graduates and postgraduates from underprivileged backgrounds, equipping them to embark on successful careers in the chemical industry. The program offers participants vital knowledge, skills, and a supportive mindset through a combination of industry visits, mentorship, and self-development activities.

Chapter - 11
Conclusion

Summary Of Key Insights

India's chemical and petrochemical industry is entering a critical phase in its evolution, marked by a growing recognition of the need for sustainability, innovation, and global competitiveness. As the country aims to achieve its Viksit Bharat 2047 vision, the sector must undergo a transformative shift to remain a cornerstone of India's economic growth while aligning with global environmental standards. Several key insights underscore the urgency and potential of this transformation.

1. Sustainability is No Longer Optional – It is Imperative

The chemical and petrochemical industry is one of the most resource-intensive sectors in the global economy. Historically, the sector has been associated with high levels of greenhouse gas emissions, energy consumption, and waste production. However, the pressure to mitigate climate change, reduce environmental impact, and improve resource efficiency has never been more significant. India's commitment to achieving net-zero emissions by 2070 has placed sustainability at the forefront of industrial strategy, and the chemical industry is at the heart of this transformation.

As one of the world's leading chemical producers, India is uniquely positioned to take advantage of the global push for greener industrial practices. To remain competitive, Indian chemical companies must adopt sustainable production processes, including renewable energy, biotechnological alternatives to fossil fuel-based feedstocks, and advanced carbon capture technologies. Sustainability must be integrated into every aspect of the business model, from production to supply chain management.

2. Technological Innovation is Key to the Industry's Future

The adoption of advanced technologies is reshaping the chemical and petrochemical industry. Artificial intelligence (AI), machine learning (ML), the Internet of Things (IoT), and blockchain are transforming how companies monitor, optimize, and control their operations. These technologies offer real-time insights into energy consumption, emissions levels, and production efficiencies, enabling businesses to make informed decisions that reduce their environmental impact. For instance, AI can predict equipment failures and suggest optimizations that reduce energy consumption, while blockchain ensures transparency in supply chains by tracking raw materials from their source to their final use.

Indian companies must invest heavily in these technologies to drive both sustainability and competitiveness. Digitalization is no longer a luxury but a necessity for companies that want to operate at peak efficiency, minimize waste, and reduce costs. By leveraging these advancements, Indian chemical firms can improve their environmental performance while increasing operational efficiency and productivity.

3. Gujarat as the Pioneering Hub for Sustainable Growth

Gujarat's chemical and petrochemical industry plays a central role in India's industrial landscape. The state contributes over 35% of the nation's chemical output and 62% of its petrochemical production. Gujarat's leadership in the sector is exemplified by the Petroleum, Chemical, and Petrochemical Investment Region (PCPIR) at Dahej, which has attracted major investments from leading global corporations such as Reliance Industries, ONGC, and BASF.

Gujarat's focus on infrastructure, industry-friendly policies, and a commitment to sustainability has made it the chemical hub of India. The state has set an example by integrating renewable energy sources, adopting circular economy practices, and fostering sustainable development across its industrial zones. Its role as a frontrunner in the sector is expected to grow, further positioning Gujarat as a critical player in India's journey toward achieving its sustainability and industrial goals.

4. Government Policies as Catalysts for Sustainable Development

India's government has introduced several key policies and initiatives aimed at accelerating the growth and sustainability of the chemical and petrochemical industry. Initiatives such as Make in India and AtmaNirbhar Bharat focus on reducing import dependency, enhancing domestic production, and promoting India as a global manufacturing hub. These programs are complemented by the National Chemical Policy and Production Linked Incentive (PLI) schemes, which provide financial incentives for companies that invest in clean technologies and sustainable manufacturing processes.

The government's focus on improving the ease of doing business, coupled with policies designed to attract foreign direct investment (FDI), creates an ideal environment for the sector's growth. However, for these policies to succeed, companies must embrace innovation, sustainability, and new business models that prioritize environmental stewardship. As the regulatory landscape continues to evolve, companies that are early adopters of green technologies and sustainable practices will be well-positioned to benefit from both government incentives and global demand for sustainable products.

5. The Circular Economy is the Future of Sustainable Industry

The transition to a circular economy is one of the most significant opportunities for the Indian chemical and petrochemical industry. Unlike the traditional linear model of "take, make, dispose," the circular economy focuses on designing products and processes that maximize resource efficiency, minimize waste, and promote the recycling and reuse of materials. This approach not only reduces environmental impact but also creates new economic opportunities by turning waste into valuable resources.

By embracing circular economy principles, the Indian chemical industry can reduce its reliance on finite natural resources, lower production costs, and improve the sustainability of its supply chains. Companies that invest in recycling

technologies, waste-to-energy solutions, and resource-efficient manufacturing processes will be able to differentiate themselves in an increasingly competitive global market. The circular economy also offers a path toward greater resilience by reducing dependence on volatile global supply chains and ensuring more sustainable production systems.

6. Collaboration and Partnerships are Essential for Success

Collaboration across sectors and industries is vital to achieving the sustainability and innovation goals of India's chemical and petrochemical sector. Public-private partnerships (PPPs) must be strengthened to foster the development and scaling of clean technologies and sustainable practices. By working together, government agencies, industry leaders, academic institutions, and research organizations can accelerate innovation, reduce costs, and share best practices.

Gujarat's example shows the importance of collaboration between state governments and industry leaders in driving industrial growth and sustainability. Other regions in India can follow suit by fostering similar collaborations that align with national policies and global sustainability standards. Cross-sector partnerships that prioritize sustainability and innovation will not only help the industry meet its economic and environmental goals but will also attract greater investment from both domestic and international sources.

7. A Global Outlook is Critical for India's Competitiveness

To remain competitive on the world stage, India's chemical and petrochemical industry must align with international environmental, social, and governance (ESG) standards. Global investors and consumers are increasingly demanding that companies demonstrate responsible business practices, particularly around sustainability. Indian companies that meet or exceed these global standards will gain access to new markets, attract foreign investment, and strengthen their position as leaders in sustainable manufacturing.

Gujarat's robust chemical sector, combined with India's growing policy support, positions the country to play a leading role in global supply chains. As international trade shifts toward more sustainable models, companies that prioritize ESG performance will enjoy a competitive edge. Furthermore, India's participation in global environmental agreements and trade deals will provide additional opportunities for the industry to grow while contributing to global sustainability goals.

8. Workforce Transformation and Upskilling Will Drive the Industry Forward

As the chemical and petrochemical industry embraces digitalization and sustainability, a skilled workforce will be essential to implement and manage these advanced technologies. Companies must invest in upskilling their employees, ensuring they are equipped with the necessary knowledge and expertise to operate in a more complex, technologically-driven environment. Collaboration with educational institutions and training organizations will be key to building a talent pipeline that can support the sector's long-term growth.

The shift toward sustainable production processes will also create new job opportunities, particularly in areas such as clean energy, circular economy practices, and digitalization. Companies that invest in workforce development will be better positioned to attract and retain top talent while maintaining their competitive edge in an increasingly dynamic global marketplace.

In conclusion, India's chemical and petrochemical industry is at a pivotal moment, with the potential to lead the global shift toward sustainability and innovation. By embracing advanced technologies, aligning with government policies, fostering collaboration, and focusing on the circular economy, the sector can not only drive economic growth but also ensure a sustainable and prosperous future for India. With Gujarat as a leading example, and with collective action from all stakeholders, India is well-positioned to achieve its goal of becoming a developed nation by 2047.

Future Directions And Recommendations

The future of India's chemical and petrochemical industry lies in its ability to embrace sustainability, innovation, and global competitiveness. As the sector transitions toward a more sustainable model, key future directions will shape its growth and ensure it aligns with India's broader vision of becoming a developed nation by 2047. One of the most critical future **directions is the decarbonization of the industry.** To meet India's target of achieving net-zero emissions by 2070, the industry must adopt greener production processes, including the use of renewable energy sources such as wind and solar power. Investing in carbon capture technologies and energy-efficient systems will be essential to reducing the sector's carbon footprint. The **shift to biotechnological alternatives** and sustainable feedstocks will also be vital in reducing reliance on fossil fuels, supporting the industry's move towards cleaner, low-emission practices.

Embracing digitalization and advanced technologies is another key direction for the industry's future. Artificial intelligence (AI), machine learning (ML), and IoT will continue to revolutionize operations, enhancing predictive maintenance, optimizing processes, and reducing resource consumption. These technologies enable real-time monitoring of emissions and resource use, facilitating the industry's commitment to sustainability goals. **Incorporating blockchain for supply chain transparency will** also ensure responsible sourcing and promote ethical practices throughout the production cycle.

The transition to a **circular economy** will play a crucial role in ensuring sustainable growth. The industry must focus on reducing waste, improving recycling processes, and enhancing resource efficiency across the value chain. By adopting circular economy principles, such as reusing materials and designing products for longevity, the chemical and petrochemical sector can unlock significant environmental and economic benefits. Collaboration across industries to create integrated circular systems will be necessary to close the loop on production processes and optimize resource utilization.
Government policies and incentives will continue to shape the industry's growth trajectory. The government should further enhance policy frameworks that encourage investments in clean technologies and sustainable practices,

particularly through financial incentives, tax benefits, and subsidies for adopting green technologies. Strengthening regulatory frameworks such as the National Chemical Policy and expanding the scope of the Production Linked Incentive (PLI) schemes will drive innovation and encourage industries to pursue sustainable development. The government must also focus on **upskilling the workforce** to manage and implement these advanced technologies effectively.

Collaboration between government, industry, and academia must be reinforced to foster innovation and accelerate the transition towards sustainability. Public-private partnerships should focus on research and development (R&D) in areas such as green chemistry, sustainable manufacturing practices, and resource-efficient technologies. Knowledge-sharing platforms should be established to promote best practices and facilitate the scaling of successful innovations across the sector.

To succeed on the global stage, **India must enhance its global competitiveness** by aligning with international sustainability standards and ensuring that Indian companies meet global ESG (Environmental, Social, and Governance) criteria. By positioning itself as a leader in sustainable chemical production, India can attract more foreign investment and expand its influence in global markets. Participation in global trade and environmental agreements will further support the country's goal of becoming a responsible leader in the global chemical industry.

In conclusion, the future of India's chemical and petrochemical industry will be defined by its commitment to sustainability, innovation, and global competitiveness. By embracing advanced technologies, transitioning to a circular economy, and fostering collaboration, the sector can lead India toward its goal of becoming a developed nation by 2047, while contributing to both economic growth and environmental stewardship. The successful realization of these goals will require collective efforts, visionary leadership, and a long-term commitment to driving responsible industrialization.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KNOWLEDGE CHAMBER OF COMMERCE AND INDUSTRY

About KCCI

The Knowledge Chamber of Commerce and Industry is an emerging industry body committed to strengthening the knowledge-driven economic ecosystem by fostering collaboration between businesses, academia, policymakers, and innovators. In today's rapidly evolving global landscape , organisations like KCCI play a crucial role in promoting sustainable growth, encouraging entrepreneurship, and enabling industries to adapt to technological transformation.

KCCI works as a dynamic platform that connects industry stakeholders across multiple sectors, helping them access actionable insights, policy guidance, market intelligence, and strategic networking opportunities. By bringing together startups, MSMEs, large enterprises, research institutions, and independent professionals, the Chamber aims to create a holistic environment where innovation and knowledge exchange can thrive.

One of the key priorities of KCCI is to promote digital transformation and skill development. With industries increasingly relying on advanced technologies such as artificial intelligence, data analytics, and automation, KCCI focuses on organizing workshops, seminars, and training programmes that enhance workforce capabilities. These initiatives empower professionals and entrepreneurs to stay competitive in the global market while contributing to national economic progress.

In addition to technology and innovation, KCCI places strong emphasis on entrepreneurship development . The Chamber supports budding entrepreneurs by facilitating mentorship programmes, incubation support, funding awareness sessions, and industry exposure opportunities. By nurturing startups and encouraging business leadership, KCCI contributes to job creation and economic diversification.

KCCI also actively engages with government agencies, regulatory bodies, and international institutions to represent industry concerns and provide constructive feedback on policy matters. Through research publications, white papers, and industry reports, the Chamber helps shape discussions around economic reforms, sustainable development, trade expansion, and investment promotion.

Knowledge Chamber of Commerce & Industry

The Emporio, 607/608, Mahavirnagar, Harikurpa Society, Chandkheda, Ahmedabad, Gujarat 382424

About Chemanalyst

Welcome to ChemAnalyst, your definitive source for comprehensive market analysis and pricing intelligence across the global chemical and petrochemical sectors. Our platform equips companies with critical, up-to-date information on market trends, news, and deals that shape the chemical industry worldwide.
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We take pride in our achievements and are honored to have been awarded 'The Product Innovator of the Year, 2023' and to be recognized among the "Top 100 Digital Procurement Solutions." These accolades reflect our commitment to innovation and excellence in serving the chemical sector.

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