BIOPLASTICS FOR A SUSTAINABLE FUTURE: PRESENT STATUS AND WAY FORWARD

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INTRODUCTION

As concerns about climate change and plastic pollution continue to grow, understanding and promoting sustainable alternatives becomes crucial. The search for alternatives to conventional plastic manufacturing has gained significant momentum globally due to the environmental concerns associated with fossil fuel-based plastics. Building upon this, this paper aims to contribute to the ongoing discourse on sustainable alternatives to conventional plastics and propose thoughtful insights and a road map towards gradually transitioning to bioplastics by critically examining the need, current state, and challenges of the bioplastics industry.

We hope that this paper facilitates informed decision-making, fosters collaboration, and promotes sustainable practices across a diverse range of stakeholders, including plastic industry professionals (manufacturers, suppliers), business leaders, investors, government, and regulatory bodies, think tanks, consumers, etc., each of whom may find specific insights and benefits tailored to their interests and roles.

PLASTIC WASTE POLLUTION

Pollution from conventional plastic waste is one of the major global problems that amply demonstrates the connection between the three planetary crises the world is currently experiencing i.e., pollution, biodiversity loss, and climate change. The extent of the issue is highlighted by the fact that unsustainable techniques used throughout the plastics value chain—primarily post-usage management—directly affect seven of the 17 SDGs (Sustainable Development Goals, Figure 1) [1].

Fig 1. SDG impacted by plastic pollutions

Currently, over 90% of plastics produced globally are derived from virgin fossil feedstocks (a little over 9% originate from recycled plastic and the remaining less than 1% come from other sources), which indicates that the plastic sector is immensely reliant on fossil fuels in several ways (raw material production, energy for manufacturing, end-of-life treatment, etc.) that have ultimately led to severe "carbon lock-in" [2,3].The severity of the problem can be understood by the fact that nearly 79% (6.3 billion tonnes) of the 8.3 billion tonnes of virgin plastics produced globally up until 2016 have been turned into plastic waste and deposited in landfills/open places, while just 9% and 12% had been recycled and incinerated respectively [4].

"IF LEFT UNABATED, THE SHARE OF GHG EMISSIONS FROM PLASTICS WOULD INCREASE ~4X BY 2050 FROM CURRENT LEVELS."

THE RISING PROBLEM OF PLASTIC WASTE IN INDIA

India has seen a significant rise (~23X between 1990 and 2021) in plastic consumption in the last 30 years (Figure 2) [5,6]. As per the Central Pollution Control Board report (2017-18), India generates approximately 9.4 million tonnes per annum of plastic waste, out of which approximately 5.6 million tonnes per annum (60%) is recycled (mainly mechanical recycling) and nearly 3.8 million tonnes per annum (40%) of plastic waste is left uncollected or littered.

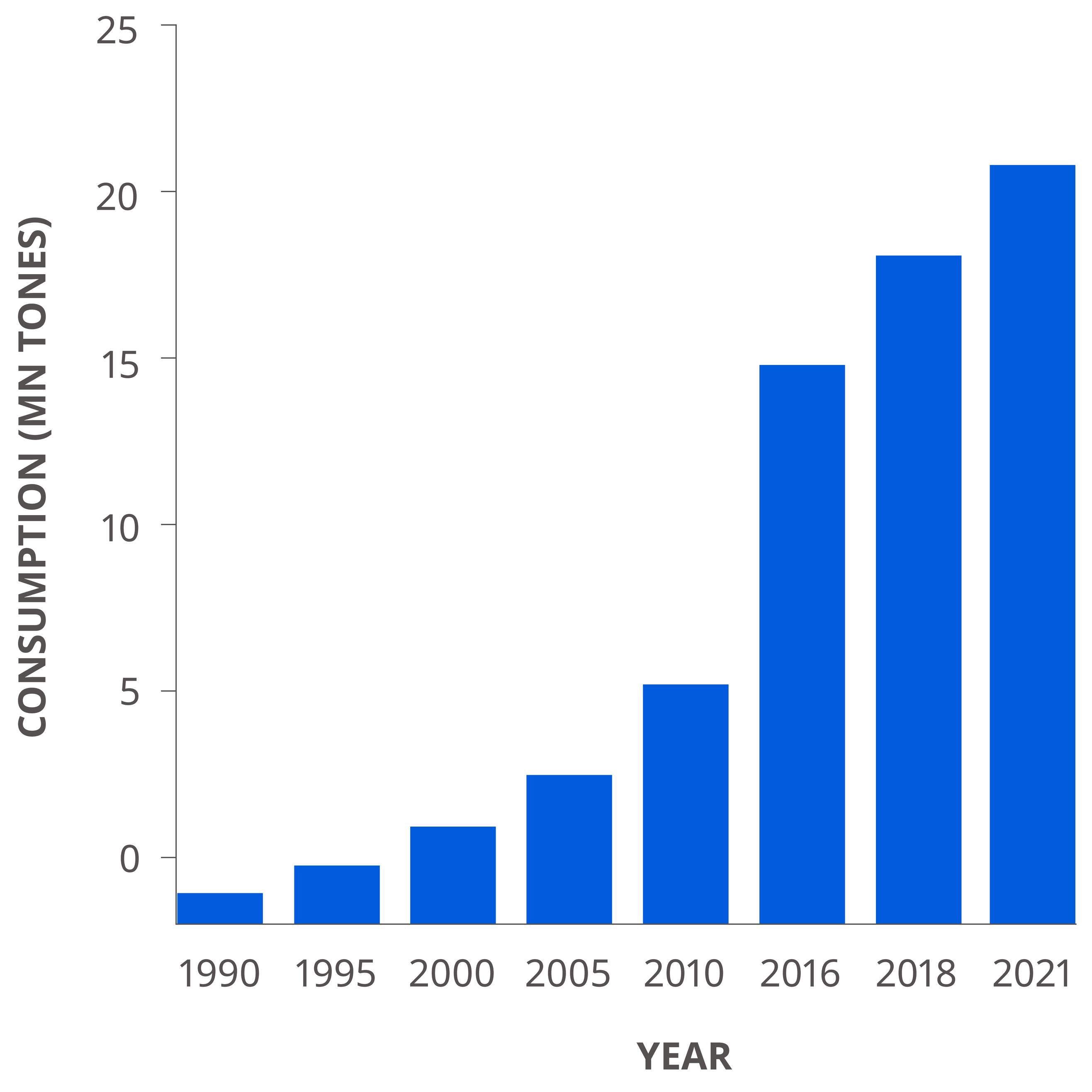


Fig 2. Plastic consumption in India

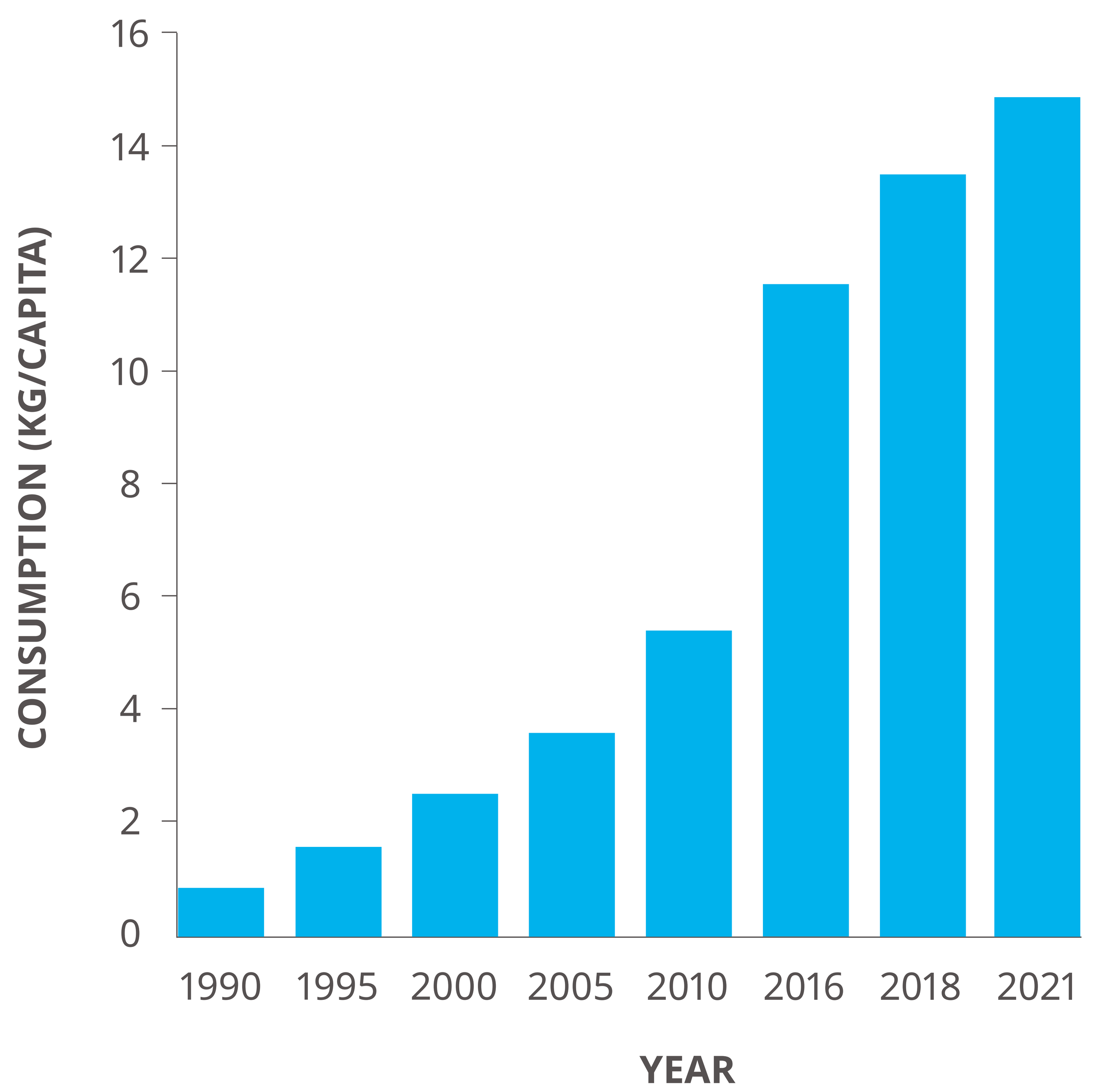


Fig 3. Plastic per capita consumption in India

Though India's per capita plastic consumption in FY 2021-22 was 15 kg, which is significantly lower than many developed and developing countries (e.g., USA-112 kg, Brazil-32 kg, and China-62 kg), it has grown exponentially (~15X) between 1990 to 2021 (Figure 3) [7].

"PLASTICS USED FOR THE PACKAGING ALONE CONTRIBUTE TO NEARLY 60% OF THE TOTAL DEMAND IN INDIA."

Landfilling and incineration are two of the most popular methods of disposing of or treating plastic waste in India. Both practices adversely impact the air, water, and soil, making them unsustainable and contrary to the circular economy. If this trend continues, the issue of plastic waste will only get more intense over time. Estimates suggest that if sustainable alternatives are not implemented immediately, India›s plastic waste might increase by 4.5 times by 2050, compared to current levels [8].

CAN PLASTIC WASTE RECYCLING ADDRESS THE CHALLENGE?

Plastic recycling is an important step towards reducing the adverse impact on the environment and health, but our recycling capacity is currently unable to handle the amount and types of plastic we are discarding each day. The majority of recycling today (more than 99%) is through mechanical recycling wherein the waste can only be recycled a few times before losing necessary properties. Hence, recycling results in a downgraded material that cannot be used for the same purpose and is ultimately discarded or incinerated [9]. Moreover, virgin plastics produced from fossil fuels are typically cheaper to produce than recycled plastics due to multiple reasons including transportation costs and limited infrastructure to handle recycled plastics. To enable infinite recycling, **advanced recycling** techniques need to be adopted; chemical recycling will enable the waste to be converted to Its basic chemicals, while retaining all the virgin properties. The following highlights the above two routes for plastic recycling:

Mechanical recycling, the more established route, does not match the substantial amount of plastic that's being produced, evident from the fact that only 9% of all the plastic waste produced globally is recycled [4]. The key reasons are that only selected types of plastics can be recycled, which does not eliminate the plastic waste but just prolongs the waste disposal. Additionally, due to a lack of recycling infrastructure globally, landfills have been the primary destination for plastic waste

Chemical recycling, one of the advanced recycling methods, is now picking up speed. Chemical recycling methods convert the waste back into its monomeric form through depolymerisation, or to alternate feedstocks from which these monomers other intermediates can then be produced and repolymerised to form virgin-grade plastics. There are however a few limitations to chemical recycling. For example, not all plastics can be processed through chemical recycling plants (e.g. PVC), and the feedstock quality/ sorting requirements and scale of recycling today are challenging

Among the array of other sustainable options, material downgauging emerges as a promising strategy. This approach involves the thinning of the gauge of plastic materials, thereby advancing sustainability efforts through reduced feedstock requirements, waste volume, energy consumption, and greenhouse gas emissions—all while upholding product quality standards.

Similarly, **Design for Recycling (DfR)** stands out as a pivotal concept in fostering recyclability. DfR entails crafting products with recycling in mind, steering clear of non-standard materials that could impede recycling processes and ensuring alignment with established recycling protocols. To aid in this endeavour, valuable resources such as RecyClass, established by the European Plastics Recycling and Recovery Organisation, and the APR Recycling Guidelines offer guidelines and tools to assess the recycling compatibility of specific products and packaging.

While above mentioned approaches are crucial in managing/reducing plastic waste as well as decreasing reliance on virgin feedstock, it is imperative to explore additional avenues. One such option is the integration of bio-based feedstock and alternatives into conventional plastics. The bio-based alternatives could present a promising avenue for addressing both the reduction of plastic waste (through biodegradability) and fostering sustainability by utilising renewable feedstocks in manufacturing processes.

BIOPLASTICS: A POTENTIAL ALTERNATIVE TO CONVENTIONAL PLASTICS

Bioplastics are bio-based products that are wholly or partly derived from materials of biological origin, excluding materials embedded in geological formations and/or fossilised. Depending on the biodegradability and biobased content, bioplastics are broadly divided into three categories[10].

- **Biobased or partially biobased and non-biodegradable**, such as bio-based polyethylene (PE), bio-based polypropylene (PP), or bio-based polyethylene terephthalate (PET) – so-called drop-ins – and technical performance polymers, such as numerous bio-based polyamides (PA), polytrimethylene terephthalate (PTT) or new polymers, such as polyethylene furanoate (PEF).

- **Biobased and biodegradable**, such as polylactic acid (PLA), polyhydroxyalkanaoates (PHAs), polybutylene succinate (PBS), or different starch blends.
- **Fossil-based and biodegradable**, such as polybutylene adipate terephthalate (PBAT), that may well be produced at least partly from bio-based feedstock in the future and some cases already are

As bioplastics continue to advance, their versatility expands, enabling their utilisation across a broad spectrum of applications. These include packaging, agricultural films, horticultural products, disposable utensils, toys, textiles, cling film, food containers, and more. With ongoing development, bioplastics are proving to be increasingly adaptable to diverse needs and industries.

KEY BENEFITS OF BIOPLASTICS OVER CONVENTIONAL PLASTICS

- **Lower overall GHG emissions:** Substituting the annual global demand for fossil-based polyethylene with bio-based PE could save more than 42 million tonnes of CO_2 emission[7]. From a cradle-to-gate perspective, the Global Warming Potential (GWP) of PLA was estimated to be 501 gm CO_2 eq/kg PLA (considering the uptake of CO_2 in the PLA molecule) which is roughly a 75-80% reduction in carbon footprint in comparison to most traditional plastics. By taking several innovative measures, including the use of renewable energy in the feedstock conversion process, the CO_2 footprint of PLA could be further reduced from 501 to minus 909 gm CO_2 eq/kg PLA [11], i.e. ~280% reduction in CO_2 footprint.
- **Reduced dependency on crude oil imports:** Self-reliance in energy security is crucial for India to minimise vulnerability to global disruptions, ensure economic stability, and achieve long-term sustainability. India, the world's third-largest consumer and importer of crude oil, has been consistently importing more than 80% of its oil needs every year from overseas; for instance, in 2022-23, India imported ~ 88% of its oil (Ministry of Petroleum and Natural Gas, Govt. of India). There is a substantial amount of crude oil that India uses for the production of polymers. However, utilising the huge volume of agricultural waste that India produces every year (~230 MMT)[12], the amount of crude oil consumed might be decreased significantly, potentially reducing the nation›s dependency on oil imports.

  For example, India had around 6 million metric tonnes (MMT) and 10 MMT of excess sugar and maize respectively in the year 2019-20 [13]. A high-level estimate suggests that if 10% of the ~ 18 MMT of plastic consumed during the year 2019-20 (Figure 2) was replaced with bioplastics, India could have saved nearly $2 billion on petroleum imports consuming nearly either 3 MMT of sugar or 4.5 MMT of maize —far less than the surplus quantity available.

"BY PRIORITISING DOMESTIC ENERGY DEVELOPMENT, INDIA CAN BUILD RESILIENCE AGAINST EXTERNAL SHOCKS AND CONTRIBUTE TO A MORE SECURE, SUSTAINABLE ENERGY FUTURE."

- **The flexibility of employing an extensive range of feedstock:** an extensive array of feedstock (biomass) alternatives, including both 2G and 3G feedstock, can be used to make bioplastics. These alternatives offer a sustainable and distinct application for India's plentiful agricultural waste while also lessening competition with food crops.

FEEDSTOCK FOR BIOPLASTIC PRODUCTION

The feedstocks employed in bioplastic manufacturing can be categorised into three generations : First generation (1G) – consisting of edible crops like corn, sugarcane, wheat, and vegetable oils; Second generation (2G) – encompassing non-edible biomass sources such as agricultural residues (e.g., straw, corn stover, sugarcane bagasse), forestry residues, and dedicated energy crops; and Third generation (3G) – which explores unconventional sources like algae and other microorganisms for bioplastic production.

Among these three types, 1G feed are commonly used for producing biofuels/biochemicals due to their wide availability, technology maturity, lower production cost and high yield (for example, the two largest producers of bioethanol in the world, Brazil and the US, manufacture bioethanol from sugarcane juice and maize, respectively). However, the utilisation of 1G feedstocks for energy purposes, particularly in the production of biofuels and bio-based products has resulted in food-versus-fuel debate due to various concerns including food insecurity, risk of driving up food prices, risk of land use change/deforestation, adverse impact on biodiversity and ecosystem services.

While the use of 3G feedstock for bioplastics is still in its infancy, the 2G feedstocks are often seen as a promising alternative to 1G for balancing sustainability, environmental impact, and cost-effectiveness. With India's substantial agricultural waste (~230 MMTPA)[12], 2G feedstocks offer notable advantages over 1G and 3G counterparts such as extensive availability, non-edible and no competition with food crops and can replace 1G feedstocks once the 2G technologies are more established.

- **New job opportunities in the domestic market:** Growth in the bioplastic industry will lead to new employment opportunities in a vast range of sectors (agricultural, R&D, manufacturing and processing, supply chain management, waste management, recycling, retail, and sales, etc.) as businesses expand to serve growing markets and to meet new clean and sustainable energy requirements and mandates.

BIOPLASTICS: GLOBAL STATUS AND RECENT DEVELOPMENTS

Bioplastics are still at an emerging stage and the production of bioplastics accounted for less than 1% (~ 2.2 MMT) of the 390 MMT of plastics produced globally during the year 2022 [14]. In that same year, Asia emerged as the global leader in the production of bioplastics, accounting for ~ 45% of the total, followed by Europe with ~ 29% [15]. However, owing to the increase in overall demand combined with the emergence of more diverse products and applications, the global bioplastics production capacity is set to increase significantly from around 2.2 MMT in 2022 to approximately 6.3 MMT (~ 3X) in 2027 (Figure 4) [16].

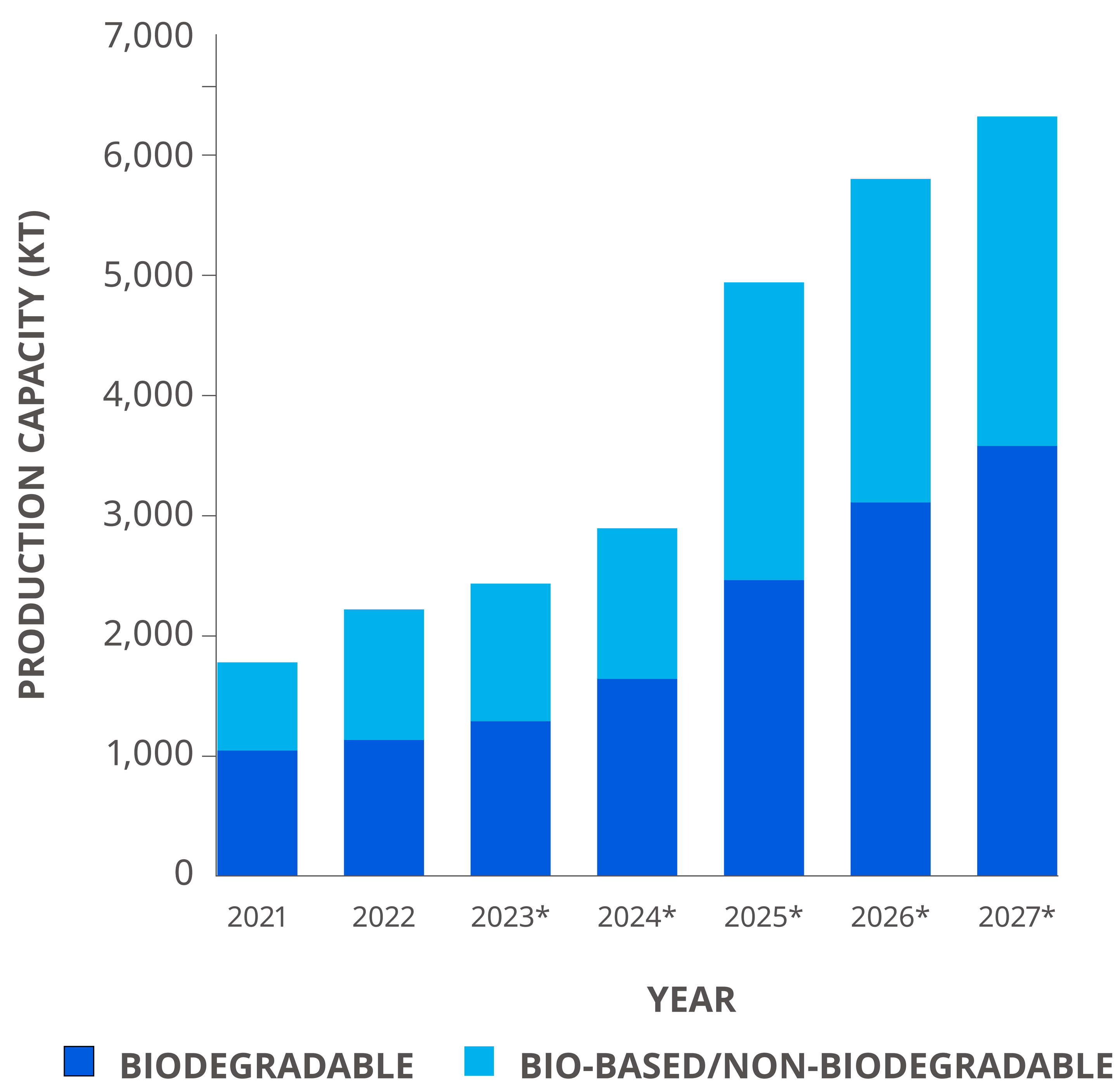


Fig 4. Global production of bioplastics

Notable multinational companies across various sectors have diversified their product portfolio and incorporated bioplastic in their product to cut down their carbon footprint. These companies are from diverse sectors including supermarkets (Walmart, Tesco, Carrefour, Sainsbury, Billa, Spar, and Hofer), electronics (Fujitsu, Samsung), automotive (Toyota, Mercedes, Ford), and food and beverages (McDonald, Coca-Cola, and Heinz)[11].

BIOPLASTICS SCENARIO IN INDIA

In India, bioplastics are still in their nascent stage with very few players operating in this segment. Although some companies do have processing facilities to make bioplastic-based items, such as trays, plant pots, cutlery, and tableware, there are negligible industrial manufacturing facilities for producing the raw materials (PBAT, PBS, PLA, and PHA). This, as a result, leaves India reliant on imports for raw bioplastic material leading to higher prices (1.5-4 times more expensive than their fossil-based counterpart, depending on the bioplastic type)[13].

MARKET POTENTIAL

In 2021, the Indian bioplastics market was estimated at $515 million, up from $325 million in 2020, according to the BIRAC (Biotechnology Industry Research Assistance Council) “India Bioeconomy Report 2022” (a rise of 58% over 2020 levels in comparison). With a compound annual growth rate (CAGR) of 24–25%, the bioplastics market in India is expected to reach $755-800 million by 2025[17]. While the market shows a positive trend, with no dominant player at present, the Indian bioplastics market is still very much up for grabs.

RECENT DEVELOPMENTS AIMING TO ESTABLISH BIOPLASTIC MARKET IN INDIA

The Indian government intends to promote biodegradable plastics in the country, as evident by the Plastic Waste Management (2nd Amendment) Rules, 2023. To create a sustainable bioplastic ecosystem in India, this rule not only helps establish a regime for the promotion of bioplastics in India but also guarantees the product’s legitimacy, producer accountability, and environmentally sound end-of-life treatment of biodegradable plastics. Some of the highlights are:

- **Dedicated category for biodegradable plastics:** A separate category is introduced for biodegradable plastics. The provision of thickness is not applicable to carry bags and commodities made up of biodegradable plastics.
- **Color-coded differentiation:** BIS will prescribe separate colour/marking for plastic packaging and commodities made from biodegradable plastics based upon end-of-life environmental media/site for biodegradation.
- **Regulated EPR (Extended Producer Responsibility) fees:** Manufacturers of biodegradable plastics need to fulfill their EPR obligations by obtaining EPR certificates generated by local authorities based upon mutually agreed modalities.
- **Clear labels on biodegradable plastics:** Plastic packaging or commodities made from biodegradable plastic would bear a label that indicates how long a product made of biodegradable plastic would take to degrade under particular environmental conditions (such as land, landfill, water, etc.).

KEY CHALLENGES IN ADOPTING BIOPLASTICS

The bioplastic industry faces several significant challenges that impede its widespread adoption and market competitiveness. The following are some of the persistent barriers preventing the bioplastics market from growing:

- **Higher production cost than conventional plastics**: Bioplastics are still 1.5–4 times more expensive than conventional plastics due to their lower scale of production, evolving technology, and feedstock pricing mainly due to reliance on imported feed.
- **Technology not matured:** As many of the technologies are still in their early stages, with only a few technologies reaching beyond technology readiness level (TRL) 7, the technology landscape is evolving, which is necessary to achieve better products at relatively lower cost.
- **Limited policy support:** Though the Indian government has recently taken considerable steps to promote bioplastics, the industry still needs assistance, including adequate legislative and regulatory measures to encourage and generate demand.
- **Lack of feedstock collection scheme:** The bioplastic industry faces a significant challenge of absence of a reliable feedstock collection system. Potential approach to improve feedstock availability could be through fostering partnerships among stakeholders (such as farmers and biofuel manufacturers), upgrading supply chain infrastructure, and implementing logistical improvements like centralised feedstock collection points.
- **Lack of standards and awareness:** The benefits of bioplastics are unclear to consumers and plastic converters due to unclear/no labelling, conflicting life cycle assessments, and in some cases, potential greenwashing. It is necessary to create uniform standards and a better information distribution system.

POTENTIAL TRANSITION PATHWAYS

The plastics production and demand will continue to grow and there are huge production capacities for conventional plastics that have been set up, both globally and in India, that will continue to operate for many years. Hence, we envisage two parallel approaches and potential steps in the near and long-term to transition from conventional pathways to low- carbon/alternate feedstock-based production:

GRADUAL DECARBONISATION OF FOSSIL FUEL-BASED PLANTS IN THE NEAR- MEDIUM TERM (1 TO 5 YEARS)

POTENTIAL STEPS	
Use of bio-based feedstocks	• Partially blending bio-based monomers can offer a transitional solution that would be more readily accepted by industries and consumers accustomed to traditional plastic properties. • Several companies in Europe and the US are already producing aromatics and olefins from bio-naphtha. Incorporating bio-based monomers diversifies the feedstock for plastic production, reducing dependence on fossil fuel resources.
Enhance energy efficiency and widen RE use	• Upgrade and retrofit existing production facilities and implement energy-efficient manufacturing process to improve energy efficiency. • Implement measures to widen RE use e.g., electrification of steam crackers to replace fossil fuels.
Improve circularity	• Promote the adoption of closed-loop systems through measures, such as chemical recycling, to reduce the demand for virgin raw materials. • A circular economy approach for plastics is being developed by many companies in Europe, US, and China to convert plastic waste into oil that can replace virgin crude.
Carbon capture utilisation and storage (CCUS)	• CCUS is also being explored by petrochemical industry players to reduce net CO_2 emissions. Various countries such as the US, Europe, and China are exploring CCUS routes to decarbonise petrochemical plants.

ESTABLISHING BIOPLASTICS AS AN ALTERNATIVE TO CONVENTIONAL PLASTICS IN THE LONG TERM (> 5 YEARS)

POTENTIAL STEPS	
Demand creation	• Public procurement or mandates for the use of bioplastics can create significant demand and help reduce costs through economies of scale. • Initiatives such as the Bio-preferred Program in the US give preference to the biobased products through mandatory purchasing requirements. Similarly, other initiatives such as Japan's Biotechnology Strategic Scheme and the EU's Recyclate Component Law have time-bound targets to increase either recycled content or alternate plastics use.

Affordable finance, and tax incentives	• Bioplastics is an emerging market in India and low-cost funding is needed to help this sector grow and improve commercial viability. Getting financial support from the Green Climate Fund (GCF), Global Environment Facility (GEF), etc. needs to be explored. • Direct and indirect measures, such as financial and tax incentives are needed to increase private sector investment. Tax exemptions, reductions/ waivers of import duties on raw materials and machinery are required to reduce the production cost of bioplastics in the domestic market.
Alternative feedstock	• Ensuring a consistent supply of biomass is essential to accelerate the transition from fossil-based plastics to bioplastics. Thus, in addition to traditional 1G (first generation) feedstocks, such as maize and sugarcane, it is also necessary to investigate 2G (second generation) feedstock alternatives that are abundant in India (~230 MMT/year).
Innovation and R&D	• Further work is required to improve the cost of production, biodegradability, and carbon footprint of the bioplastics. Industry-academia collaboration is required to demonstrate and scale key technologies developed. • Identification of key R&D centers, and focused research to develop processes to use locally available bio-based materials to maximise the use.
Infrastructure development	• The availability of a well-established infrastructure would promote innovation, efficiency, and sustainability, all of which help foster the growth of the bioplastics sector. • Improving biomass collection and transportation infrastructure, and expanding and upgrading the testing facilities are needed to expand the use of bioplastics.
Collaborations and partnerships	• Academic institutions, industries, and government agencies need to work together on joint projects/establishment of bioplastics facilities. In addition to the fundamental research, such collaborations also need to be established in scale-up, pilot, and demonstration projects. • The Indian stakeholders in the bioplastics space need to engage with international counterparts to facilitate technology transfer, knowledge exchange, and gain access to the international market.

“THIS APPROACH ALLOWS FOR A SMOOTH TRANSITION, MINIMISING POTENTIAL DISRUPTIONS, WHILE ENCOURAGING A SHIFT TOWARD MORE SUSTAINABLE ALTERNATIVES LIKE BIOPLASTICS. THIS WOULD ALSO ALLOW INDUSTRIES AND CONSUMERS TIME TO ADAPT, WHILE CONTRIBUTING TO A MORE SUSTAINABLE AND CIRCULAR ECONOMY.”

TECHNIP ENERGIES: SETTING THE BENCHMARK IN SUSTAINABLE PLASTICS SPACE

Technip Energies is a leading technology and engineering company with project capabilities and a rich legacy of projects across the globe including a strong presence In India. As a key player in the energy transition, supporting customers achieve their Net Zero trajectory, Technip Energies has multiple offerings for a stage-wise and asset-wise approach to decarbonising the polymer/petrochemicals space:

A. Polymer Technologies: Low “C” footprint technologies and solutions to decarbonise existing assets.

B. Circular Technologies: Advanced recycling technologies to help achieve “true” circularity.

C. Sustainable Chemistry Technologies: Bio-monomers and biopolymers to produce more sustainable plastics - either novel or drop-in plastics.

Below is an overview of some of Technip Energies’ endeavors in the sustainable plastics space:

- **PBAT & PBS:** Technip Energies’ polybutylene adipate terephthalate (PBAT) and polybutylene succinate (PBS) are biodegradable polyesters according to EN 13432 which solve environmental pollution problems caused by plastic products mostly made of polyethylene, polypropylene, and polystyrene. Their hydrolysis-sensitive ester bonds lead to decomposition by microorganisms and at the same time, their semi-crystalline structure provides flexible mechanical properties, e.g., for the usage of packaging, mulch films, bags, and cutlery. PBAT/PBS swing plants can adapt easily to the market demands and accommodate the arrival of new bio-feedstocks, e.g., **bio-succinic acid offered by Technip Energies as well**. This helps to improve carbon efficiency by the integration of the full value chain for sustainable monomer and polymer production.
- **Bio-ethylene:** Technip Energies’ Hummingbird® technology is the industry-leading solution for the conversion of bioethanol to polymer-grade bio-ethylene with over 99% selectivity through a simple low-cost and low-temperature dehydration process using a proprietary catalyst. Hummingbird® is a drop-in technology for the ethylene value chain, providing on-demand production capacity. This can be fed to any existing polyethylene facility to produce bio-polyethylene.
- **Polylactic Acid (PLA):** Technip Energies and Sulzer offer end-to-end PLA technology called PLAnet™. Lactic acid (LA) is produced by fermentation of sugars and then purified by centrifugation, filtration, and evaporation to obtain polymer-grade LA. Pure LA is polymerised into Polylactic Acid (PLA). The process involves the production of food grade and non-GMP PLA products - a variety

of grades (and easy production switchover between grades) for various applications. The PLA waste can be recycled back to virgin LA with the LOOPLA technology.

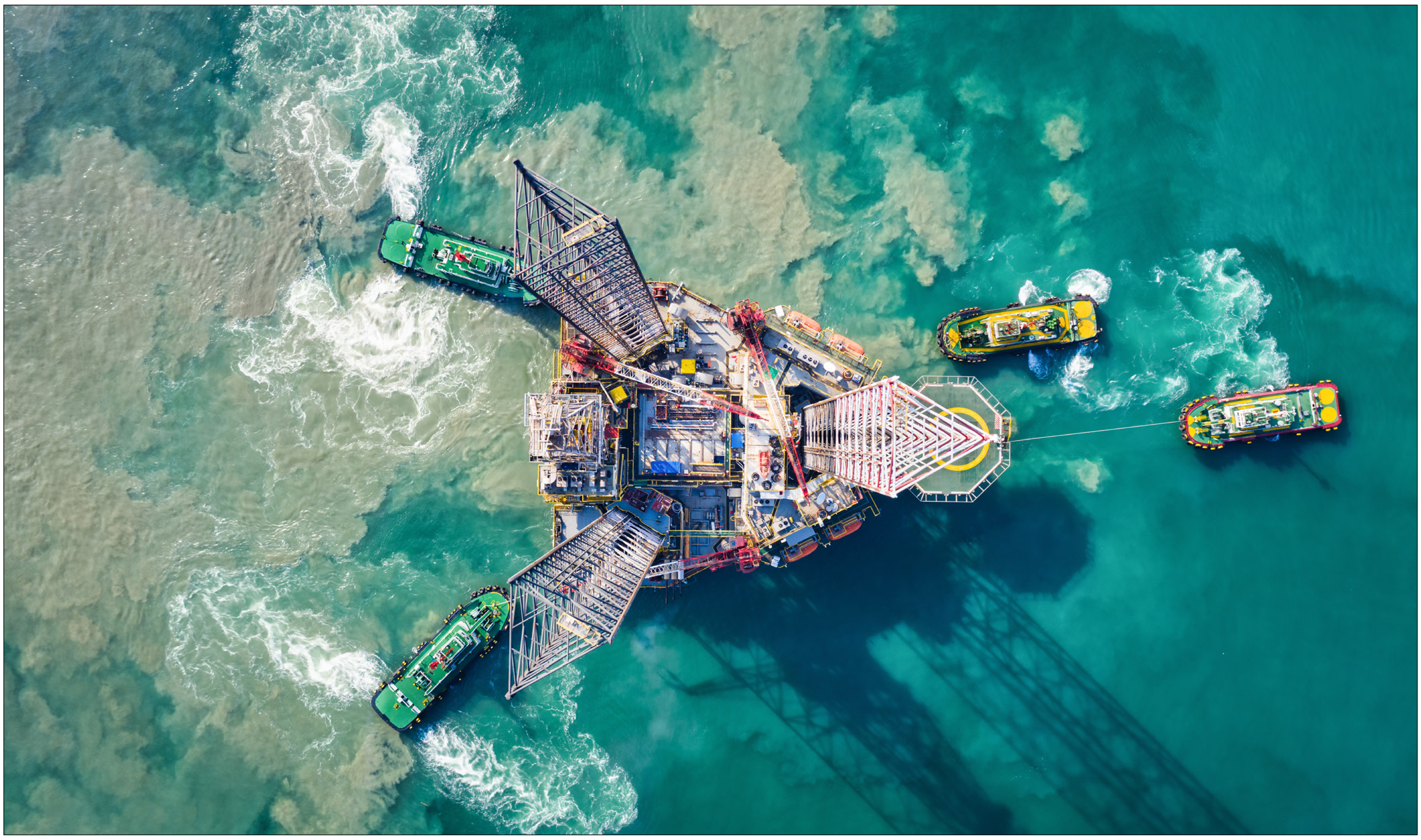
- **FDCA and Bio-MEG:** Leveraging Technip Energies' prior experience in FDCA (Furan di-carboxylic acid) and bio-MEG (mono-ethylene glycol) through collaboration will help relevant bioplastic players in expediting innovation, shortening time to market, and facilitating knowledge exchange.

CONCLUSION

The demand for bioplastics is poised to grow in the near future as businesses are encouraged to achieve "carbon neutrality" at the global level. The use of sustainable measures such as bioplastic production, circularity, and more efficient technologies (across the landscape) holds significant potential to reduce GHG emissions and limit dependency on fossil fuels in the polymers space.

India, with a large domestic market, huge oil import dependency and significant growth potential for plastics, is well positioned to demonstrate and scale cost-effective bioplastics and circular plastics production to replace conventional plastics. The government, through various initiatives, has already indicated its long-term plans to include wider adoption of bioplastics.

There cannot be a better time for stakeholders across the bioplastics value chain to come together to identify innovative pathways and expedite wider adoption of bioplastics in the near to medium term. Organisations with an early head start will certainly have an edge going forward.



For technology references and Technip Energies' complete portfolio, please refer to www.ten.com or Technology Handbook

To further support the development of the bioplastics sector, Technip Energies' leading engineering teams support organisations, R&D firms, Institutes, and start-ups to engineer, scale, and commercialise technology rapidly with end-to-end support along the process.

ABOUT TECHNIP ENERGIES

Technip Energies is a leading Engineering & Technology company for the energy transition, with leadership positions in LNG, hydrogen and ethylene as well as growing market positions in blue and green hydrogen, sustainable chemistry and CO2 management. The Company benefits from its robust project delivery model supported by an extensive technology, products and services offering.

Operating in 34 countries, our 15,000 people are fully committed to bringing our clients' innovative projects to life, breaking boundaries to accelerate the energy transition for a better tomorrow.

Technip Energies shares are listed on Euronext Paris. In addition, Technip Energies has a Level 1 sponsored American Depositary Receipts ("ADR") program, with its ADRs trading over the counter.

For further information: www.ten.com

ABOUT XYNTEO

Xynteo partners with the world's largest organisations to unlock people and planet-positive growth. From embracing the opportunity of net zero and the circular economy to creating socially inclusive opportunities and reshaping an equitable stakeholder ecosystem, we bring a new approach to how your business can think, lead, partner, and act.

We operate at the intersection of positive impact and value creation to turn your most complex challenges into opportunities for Good Growth by transforming leaders, organisations, and the interconnected systems they are a part of. We partner with you to co-design and implement future fit models of business and the leaders, organisations, and partnerships to deliver them.

ABOUT VIKAASA

Vikaasa is a coalition of purpose driven, forward leaning organisations, collaborating to accelerate India's progress on the UN Sustainable Development Goals by designing, incubating, and piloting new growth models, enabling scale and creating material impact. The coalition was launched in March 2017, by the then President of India, Late Shri Pranab Mukherjee, who praised this initiative as "the need of the hour". This business-led sustainable livelihood, healthcare, and waste management. Our coalition partners include Hindustan Unilever, Hindalco -an Aditya Birla Group Company, Technip Energies, Shell, State Bank of India, Tata Trusts, Cyient and WPP.

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