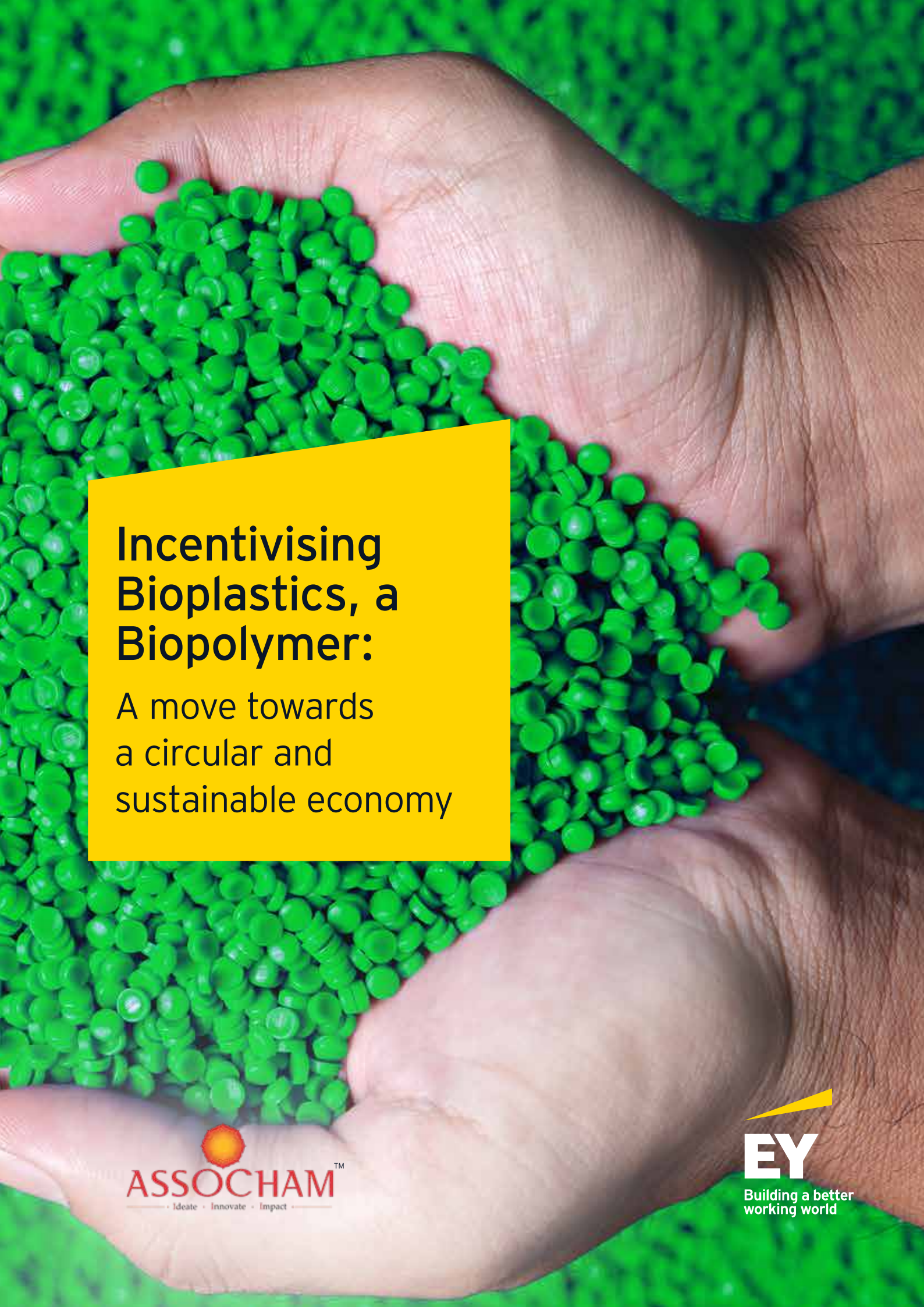

Incentivising Bioplastics, a Biopolymer:

A move towards a circular and sustainable economy

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Contents

1 Introduction

In the present day, conventional plastics has replaced many traditional substances which are used in a vast array of applications, such as everyday single-use items. According to a report by the UN Environment program, if the growth in plastic production continues at the current rate, by 2050 the plastic industry may account for 20% of the world's total oil consumption.[1] A research by the Ellen Macarthur Foundation also states that without any action to mitigate the plastic pollution crisis, there could be more plastic than fish in the oceans by 2050.[2] The high social cost of plastics has led to several initiatives across the globe to curb the issue, such as banning single use plastics (SUPs), plastic recycling and waste management, and pushing for single-use plastic alternatives.[3]

The importance of environmental sustainability has also been recognized by the policymakers with the launch of the latest BioE3 (Biotechnology for Economy, Environment and Employment) policy to foster high performance bio-manufacturing in India. The said policy has been launched with the aim to facilitate a shift from chemical-based industries to sustainable bio-based models, promoting a circular bioeconomy and working towards achieving net-zero carbon emissions. Further, the policy recognizes biopolymers as one of the strategic sectors for sustainable growth which aligns with India's vision of a cleaner, greener, and more prosperous future.[4]

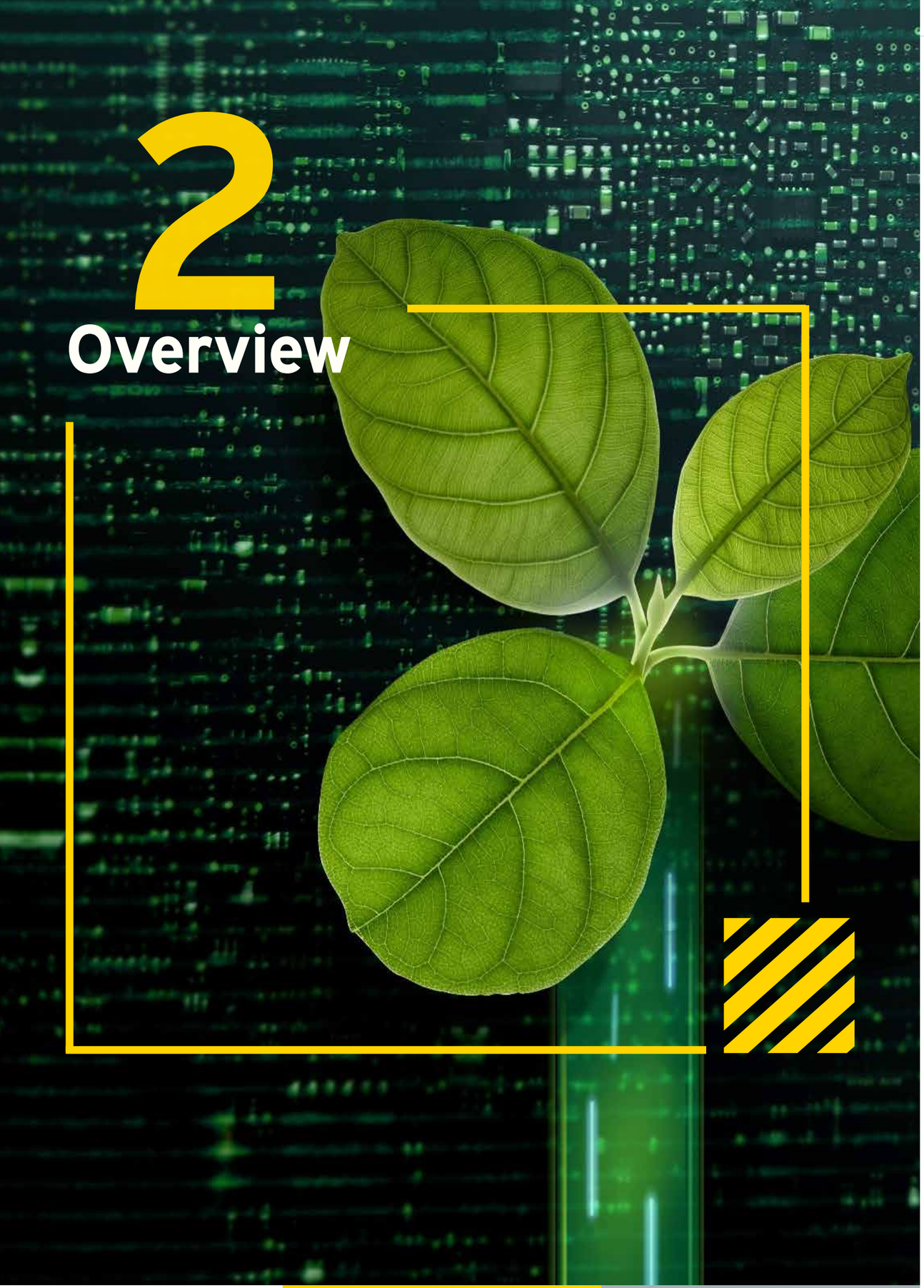
To address environmental concerns associated with conventional plastics and the escalating issue of plastic pollution, the transition to bio-based plastic alternatives that support a circular economy presents a promising and sustainable approach. In the wake of increasing environmental challenges, the advent of bioplastics signifies a revolutionary move in material sciences, aligning perfectly with the idea of de-fossilization and India's ambitious sustainability goals. Bioplastic polymers derived from renewable biomass sources such as, sugarcane, plant oils, starches and cellulose, promise to mitigate the adverse effects of synthetic plastics, including environmental toxicity, persistent pollution and fossil resource depletion. Their biodegradability and potential carbon neutrality position bioplastics as a key component in India's journey towards a circular economy.

Along with various economic and environmental benefits offered by bioplastics, the industry finds its position at a very nascent stage in India. The successful introduction and growth of bioplastics in India requires assertive government intervention. Government-backed financial mechanisms and regulatory policies are paramount in overcoming initial market entry challenges, such as high production costs and competition with established petroleum-based plastics. By allowing tax reliefs, grants and subsidies, the Indian government can incentivize businesses to invest in bioplastic production, research and development. These incentives not only bolster the economic viability of bioplastics but also foster innovation, paving the way for superior and more cost-effective bioplastic products to emerge in the marketplace.

In addition to financial incentives, strong government regulatory support is important. By analyzing global best practices and tailoring them to local contexts, the government can create a regulatory framework that supports the growth of the bioplastics industry, thereby protecting the environment and fostering market development.

Incentives can boost infrastructure development, from manufacturing to disposal facilities, ensuring circular economy in the bioplastic ecosystem.

This report explores the potential of incentivizing the bioplastics industry in India through comprehensive government intervention, and regulatory frameworks to promote the industry.



2 Overview

India is a powerhouse in the plastics industry with a **significant production capacity of approximately**

1.25 crore metric tons

of primary plastic polymer.[5] However, plastics are a prime example of a useful invention that has become troublesome. Initially considered a breakthrough, plastic now poses environmental challenges, impacting marine life and land resources. It has become one of the most produced materials and has been an environmental concern for many years. Despite technological advancements, managing plastic waste effectively remains difficult.

Bio-based plastics are polymers derived from renewable biomass sources such as sugarcane, starch, plant oils and cellulose. Bioplastics act as an alternative for almost every conventional plastic material and corresponding application.

"Compostable plastics"

are 100% biodegradable under specific conditions.

In addition to the fact that bioplastics have similar properties as conventional plastics, it offers additional benefits, such as reduced carbon footprint, better functionalities or additional waste management options, such as organic recycling.[6] Further, bioplastics reduce greenhouse emissions, prevent long-term plastic waste accumulation, and improves soil quality.[7]

Bioplastics encompass a diverse range of materials, each with unique properties and uses. The following section dives deep in the classification of bioplastics and their properties.

As per **ISO 17088-2021 (E), industrial composting** means a composting process performed under controlled conditions on industrial scale with the aim of producing compost for the market.

Compostability describes the property of being biodegradable under industrial or home composting conditions.

Classification of bio-based plastics/bioplastics and their properties

Note
The term 'biodegradable' is often used as an umbrella term[8] which covers all compostable and other biodegradable sources. For our purpose, we have used the term to mean **'compostable'** which refers to the property of being biodegradable in industrial compost or anaerobic digestion facilities producing nutrient rich fertilizer and even biogas.

In India context, the Plastic Waste Management Rules define 'Compostable Plastics' and 'Biodegradable Plastics' as follows:

"Compostable plastics" mean plastic that undergoes degradation by biological processes during composting to yield CO2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable or toxic residue.[9]
Compostable plastics can also be anaerobically digested, to produce biogas and nutrient-rich manure.

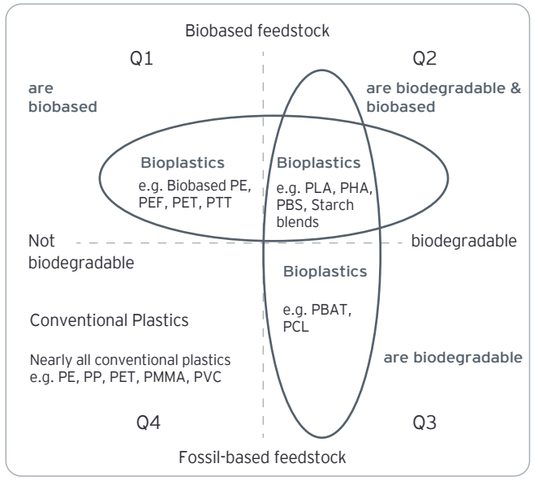
"Biodegradable plastics" means plastics, other than compostable plastics, which undergoes degradation by biological processes in specific environment such as soil, landfill, sewage sludge, fresh water, marine, without leaving any micro plastics or visible or distinguishable or toxic residue, which has adverse environment impact".[10]

Bioplastics can be broadly classified in three major categories:

01 Bio-based, non-biodegradable (Q1) – PE, PET, PP, PA

02 Bio-based, biodegradable (Q2) – PLA, PHA, PBS, Starch blends

03 Fossil-based, biodegradable (Q3) – PBAT, PCL



Source: European bioplastics

The residuary category – **fossil based, non-biodegradable (Q4)** represents conventional/traditional plastics (PE, PP, PET, PA). These are primarily derived from non-renewable resources like petroleum and are highly durable and **resistant to degradation.** Generally **non-biodegradable,** these plastics can persist for hundreds of years, leading to massive plastic waste accumulation in oceans, soils and ecosystems, harming marine and terrestrial life.[11]

1

Bio-based, non-biodegradable plastics (Q1)

- These plastics are biologically derived but are not biodegradable. Bio-based bioplastics are 100% mechanically recyclable through present methods of recycling used plastics. In other words, they can be mechanically recycled in accordance with existing recycling streams.[12]
- These materials possess properties that are identical to their conventional versions (PE, PP, PET, PA) and they can help to reduce a product's carbon footprint through recycling.[13]

Examples	Uses
Bio-PET (Bio-based Polyethylene Terephthalate): Similar in properties to conventional PET used in bottles and textile fibers but partially made from renewable raw materials like sugarcane.[14]	Used in foils/bags, bottles, clothing, textile and other packaging.[15] Since PET is the largest polyester used for fibers (65%)[16], bio-PET offers a bio-based alternative in this sector.[17]
Bio-PE (Bio-based Polyethylene): Also similar to its fossil-based counterpart but produced from ethanol, derived from crops like sugarcane or corn.[18]	Used in many applications such as thin films, packaging, plastic containers, bottles, bags, plastic toys, wire and cable insulations, medical tubing, and injection moulding, among others[19].

Examples	Uses
Bio-PA (Bio-based Polyamides/ Nylons): Produced from vegetable oil, these plastics retain the desirable properties, such as flexible to rigid and food safe.[20]	Used in a wide range of industrial applications in sectors including automotive, electrical, textile and medical industries[21]

2

Bio-based, biodegradable plastics (Q2)

- These plastics are made from renewable biological sources, such as starch, cellulose and proteins. Some of these materials biodegrade predominately under composting conditions, while others in less controlled environments.[22]

Examples	Uses
PLA (Polylactic Acid): Polylactic acid (PLA) is a biodegradable as well as recyclable polyester made from renewable feedstock. Lactic acid as the raw material is produced by fermentation of glucose or sucrose and is refined to a high purity.[23]	PLA is better than other plastics in thermostability and it is the best in terms of 'hardness', 'mechanical strength' and 'transmittance'. As per production cost, PLA has the lowest production cost of rigid material.
PHA (Polyhydroxyalkanoates): Produced by microorganisms, PHAs are biodegradable and are extracted from bacterial fermentation processes.[24]	PHA plastic is good at film forming and hydrolysis resistance and is therefore best to package water but is also used for general packaging purposes.[25]
PBS (Polybutylene Succinate): PBS is one of the most important biodegradable polyesters synthesized by polycondensation between succinic acid and butanediol.[26]	Its high flexibility guarantees its use in many applications involving film production. To boost its properties for different purposes, PBS can be modified.[27]
Biodegradable/compostable starch blends: These are fully biodegradable plastics made from starch-rich plants like potatoes, wheat or corn.[28] These are mixtures of starch with other biodegradable materials to enhance its properties for various applications.[29]	Starch-based bioplastics can be used to create agricultural mulch films, which help suppress weeds and retain moisture in the soil.[30] With the ability to blend with other polymers, starch blend bioplastics are commonly used in packaging materials such as trays, loose fill foams, cups, plates and cutlery. They can also be used to create biodegradable films for food packaging.[31]

3

Fossil-based, biodegradable plastics (Q3)

- These are biodegradable plastics but are produced from fossil-based resources such as PBAT and PCL.[32]

Examples	Uses
Polybutylene Adipate Terephthalate (PBAT): It is a type of thermoplastic polymer known for its biodegradability. It is derived from It is derived from common petrochemicals– purified terephthalic acid (PTA), butanediol and adipic acid.[33]	PBAT's hydrolysis resistance makes it the best to package food and other snacks/cereals.[34] It is also used for the production of shopping and express bags, packaging films and 3D printing material[35]
Polycaprolactone (PCL): PCL is a synthetic, semi-crystalline, biodegradable polyester with a melting point of only 60°C, which means it can be shaped by hand after a few minutes in hot water.[36]	PCL has numerous applications in packaging, scaffolds, prosthetics, sutures, drug delivery, films, carry bags, pouches, trays, reusable dishes, membranes and other fields.[37]

Properties of key bioplastic materials

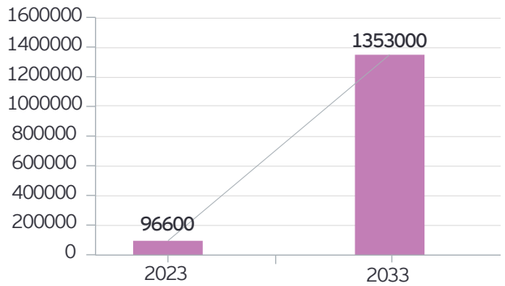
Further, each category of bioplastics (discussed above) contain distinct materials based on certain properties, as depicted in the table[38] below:

Basis of distinction	Starch blends	PLA	PHA	PBS/ PBSA	PBAT
Thermostability	0	++	+++	+++	+++
Film-forming	++	--	++	++	++
Hardness	0	+++	-	0	-
Mechanical strength	+	++	+++	+++	+++
Hydrolysis resistance	+	-	+++	+++	+++
Transmittance	-	+++	-	-	-
Production cost	lowest	lowest	highest	higher	lowest
+++best|++better|+medium|0 not good|-bad|--worse					

Global outlook

- Globally, the bioplastics **market stood at US$96,600 million in 2023.** It is projected to surge to a staggering **US$13,53,000 million by 2033,** reflecting a compound annual growth rate **(CAGR) of 30.2%.**[39]
- Bioplastics production currently represent roughly **0.5%** of the over 400 million tons of plastic produced annually.[40]
- This accelerated growth indicates that by the decade's end in 2030, bioplastics are expected to constitute a significant **40%** of the total global plastics market[41], marking a shift towards sustainable materials.

Figure 1: Global value forecast (in US$ million)

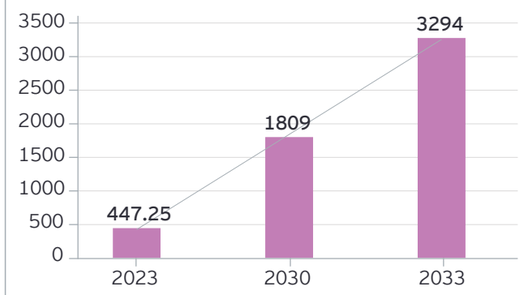


Source: Statista

Indian outlook
Market size and forecast

- Starting at **US$447.25 million in 2023,** India's bioplastics market is expected to grow at **22.1%**[42] **annual rate,** reaching **US$1,809.51 million by 2030**[43], and **US$3,294 million by 2033,** assuming a continued application of the 22.1% growth rate annually[44].
- This demonstrates the market's strong economic potential and its importance for sustainable industrial growth.
- Despite the considerable potential that bioplastics hold, India currently represents a very minute fraction of the global market, with **only a 0.46% share**[45], considering the immense scale of the worldwide bioplastics industry which boasts a market value of US$96,600 million.[46]
- The disparity highlights the vast untapped potential for growth and expansion in the Indian bioplastics sector, presenting an array of opportunities for innovation, investment and development.

Figure 2: Indian value forecast (in US $ million)



Source: India bioplastics market: Environmental awareness, Maximize market research

India's Imports

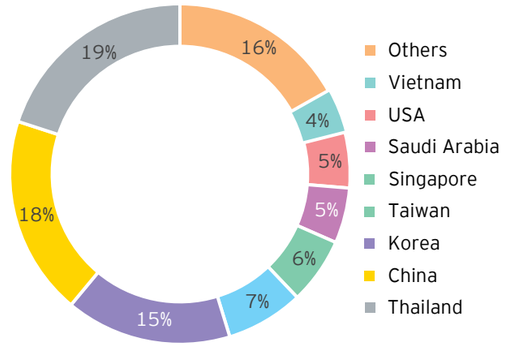
Product	HSN	2019-20	2020-21	2021-22	2022-23	2023-24 (Apr-Jan)
PBT	39079920	29.80	-	-	-	-
PLA	39077000	2.86	2.69	3.99	10.49	10.19
Other bioplastics	3907	1,752.70	1,580.68	2,486.58	2,503.19	2,090.01
Total bioplastics*	**3907**	**1,785.36**	**1,583.37**	**2,490.57**	**2,513.68**	**2,100.20**

Figure _ Source: Ministry of Commerce. GoI

*Note: For the purpose of this report, we have considered bioplastics covered under HSN 3907

- Imports of PLA (polylactic acid), under the HSN code 39077000 have witnessed an increase over the last five years, signifying a boost in demand for PLA.
- During the fiscal year 2022-23, India's import for bioplastics was significantly shaped by three leading countries:[47]
  - **Thailand** emerged as the top exporter to India, contributing 19% of the imports, amounting to US$481 million.
  - **China** was the second-largest exporter to India with an 18% share, equivalent to US$462 million.
  - **Korea** accounted for 15% of the imports, amounting to US$386 million.
- Thus, we may infer that most of India's imports of bioplastics are sourced from the Asia-Pacific region.

Top importing countries for bioplastics in 2022-23 (HSN 3907)

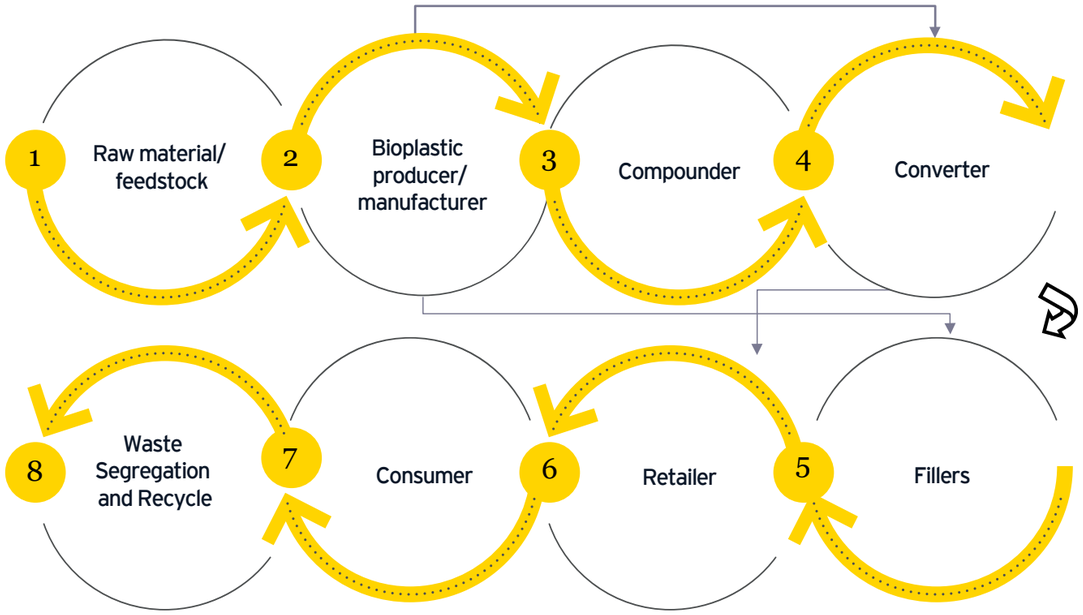


Source: Trade statistics, Ministry of Commerce

Bioplastics value chain

- The value chain for bioplastics includes several essential stages, from sourcing raw materials to producing bioplastic resins and converting them into finished products. **The typical value chain for bioplastics involves the following steps:**

Figure 3: Bioplastics value chain



Raw Material or Feedstock

- Bioplastics are mostly made of carbohydrate-rich plants, such as corn or sugar cane, which is known as first-generation feedstock.[48]
- First-generation feedstock is currently the most efficient to produce bioplastics, as it requires the least amount of land to grow and produces the highest yields.[49]
- The sustainable sourcing of feedstock is a prerequisite for more sustainable products. Negative impacts like deforestation of protected areas and environmental damage caused by bad agricultural practice must be avoided.[50]

Bioplastics Manufacturing and Production

- The feedstock is further processed to extract monomers.[51] Monomers can be defined as an individual network of atom/s or some discrete molecule/s united together chemically to analogous monomers to form a polymer.[52] Monomers can be considered as the building blocks for bioplastics, most of these building blocks (monomers) are derived from sugars. Some examples are lactic acid, succinic acid, bio-ethylene glycol, bio-ethylene, furan dicarboxylic acid and isosorbide.[53]
- The extracted monomers are then polymerized into bioplastics.[54]
- The polymers are processed into resin pellets, which are the base form of plastics used for manufacturing products.[55]
- These bioplastic resin pellets are then sent to compounders/ converters.

Conversion, Compounding and Additives/Fillers

Additives/Fillers

- As bioplastics have lower tensile properties (i.e., capability of being drawn out or stretched) than traditional plastics, fillers are used to increase the strength of bioplastics. These are also used to reduce plastic cost, shrinkage during the setting process, and to improve tensile strength and hardness.[56]

Compounders

- Compounding refers to blending compostable bioplastic polymers with other compostable polymers or blending two kinds of compostable bioplastic polymers to make compostable compounds which are used for different purposes.[57]
- One popular blend is PLA+PBAT which results in a transparent compound.[58]

Converters

- The compound or resins are melted and formed into final products through processes like extrusion, injection molding, blow molding or thermoforming.
- This stage may involve the manufacturing of a wide variety of items, including disposable cutlery, bags, textiles, automotive parts and more.[59]
- This stage employs the most number of people in the entire value chain.

Retailers and Consumers

- **Retailers:** Bioplastic products are packaged, transported and distributed to retailers.
- **Consumers:** The products are then used for their intended purpose, replacing traditional fossil fuel-based plastics.

Waste segregation and recycling

- Compostable bioplastics offer all end-of-life options, including large-scale composting, mechanical recycling, chemical recycling, organic recycling and anaerobic composting to produce biogas.
- Compostable bioplastics first disintegrate and fragment due to heat and humidity, then fully biodegrade into CO2, water and methane.[60]
- This methane and CO2 can be converted into biofuels, potentially reducing fossil fuel reliance and greenhouse gas emissions. Composting bioplastics like PLA (Polylactic Acid) also produces nutrient-rich organic manure, enhancing soil health and reducing the need for energy intensive fossil based chemical fertilizers.[61]

3 Need for bioplastics

The widespread use of disposable packaging through of **Single Use Plastics (SUPs)** is not just bad for the environment but a threat to human health as well. SUPs are problematic due to their non-recyclable design and the lack of a dedicated waste management system, leading to substantial environmental plastic waste accumulation. Furthermore, even when recycled, fossil-based SUPs leave behind **microplastics and toxic chemicals.** An **average human inhales and estimated 1019 meters of microplastic** over a lifetime,[62] which may result in various diseases such as cancer, tuberculosis and **infertility.**

The waste plastic material is either buried or disposed of on land,[63] resulting in burden on the landfills and poor socio-economic conditions of the waste pickers, mostly women.[64] Since plastic waste is combined with municipal solid refuse and spread out across a large area, both humans and animals have suffered because of improper plastic garbage disposal.[65]

As per OECD global plastics outlook database, global plastic leakage to the environment (terrestrial and aquatic) was estimated at **22 Mt in 2019.** However, this value could double, reaching **44 Mt by 2060.**[66]

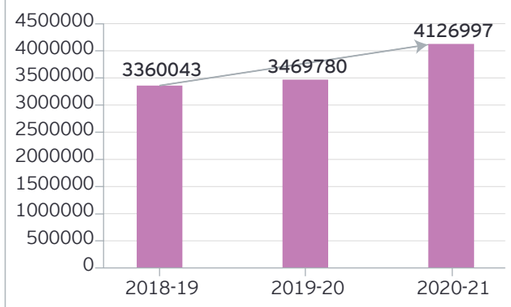
The persistent use of SUPs remains a critical environmental concern, highlighting the immediate necessity for eco-friendly substitutes such as bioplastics. These alternatives not only support recyclability but also play a significant role in lowering carbon emissions. The following sections will examine India's present situation and its environmental repercussions; explore viable sustainable alternatives to SUPs; assess the potential advantages of adopting bioplastics; and discuss the challenges currently perceived by the bioplastics industry.

India's plastic waste crisis: mismanagement and environmental impact

Current state

- Plastic waste generation reflects an upward trend since 2018-19 [67] with India generating 41,26,997 tons of plastic waste [68] in 2020-21 which is 1.2% of the globally generated plastic waste (367 million metric tons).[69]

Figure 4: Plastic waste generated in India (tonnes)



Source: Trends in Plastic waste generated, PIB

- In India, there are around **4,953 registered units** engaged with plastic across 30 states/Union territories in India. While there are only **823 unregistered plastic manufacturing/recycling units** in nine states/UTs. [70]
- As per the Centre for International Environmental Law (CIEL), **emissions from plastic production could severely diminish India's remaining carbon budget, leaving only 10-13% for all other global activities.**[71]
- As per a report by Earth Action, Switzerland; India ranks third in total plastic waste generated in the world and currently ranks at the **lowest of 180 nations** evaluated with an Environment Performance Index (EPI) of 1**8.90.**[72]

Environmental impact

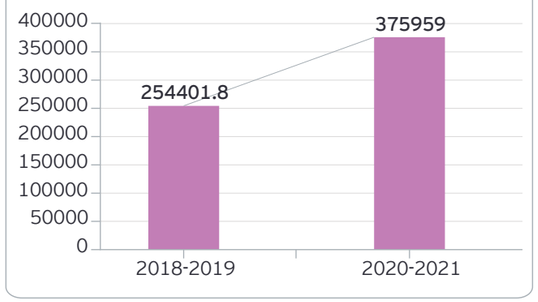
- As per UNDP, India generates **15 million tons of plastic waste every year but only one fourth of this is recycled due to lack of a functioning solid waste management system. This leads to burden on the landfills and poor socio-economic conditions of the waste pickers, mostly women.**[73]
- Around 30–40% of plastics is let into the environment either as mixed waste, or it is economically not feasible to segregate and collect lightweight materials for further recycling (therefore effectively **downcycled**). Although, regulations in India are in place for implementing segregated collection of plastic waste and recycling, their strict implementation and monitoring is lacking.[74]
- As per a research article on 'Greenhouse Gas Emissions from Landfills' by International Online Medical Council (IOMC), Methane (CH4) emission from landfill is estimated to account for 3% - 19% of the anthropogenic sources in the world.[75] India, one of the **world's largest emitter of CH_4 from landfills,** currently produces about 16 tons of CO2 equivalent per year which is predicted to increase to almost 20 tons of CO2 equivalent per year by 2020[76]. CH4 alone constitutes about 29% of the total GHG emissions in India which is nearly twice the worldwide average of 15%.[77]

- Fossil-based polymers in rivers like the Ganga, Brahmaputra and Alaknanda have been causing severe consequences, including the extinction of species like the Gangetic River Dolphins. Addressing plastic pollution is crucial to preserve biodiversity and protect freshwater ecosystems.[78]

Case study – Uttar Pradesh

*Further the impact of plastic waste on freshwater ecosystems in India, particularly Uttar Pradesh is a matter of grave concern as the state is ranked by the Central Pollution Control Board (CPCB) at **33rd position out of 35 regions** in environmental performance.*[79]

Figure 5: Production of plastic waste in Uttar Pradesh (tonnes)



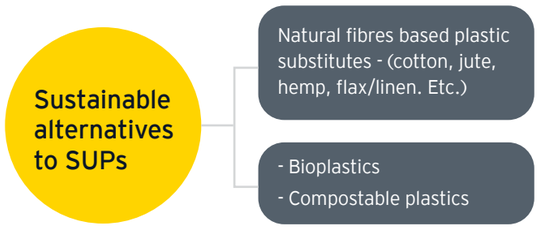
- In 2018-2019, the state produced 254,401.8 tons of plastic waste, which decreased to 161,148 tons in 2019-2020 but surged to 375,959 tons in 2020-2021. Despite this staggering volume, less than 10% of plastic waste is effectively utilized, leading to detrimental environmental consequences as the majority finds its way to landfills and dump yards.[80]
- ***The limited capacity to treat plastic waste in Uttar Pradesh with only 13 recycling units, four compostable plastic units and 82 landfills, further exacerbates the challenge of growing waste management.***[81]

Less 10% of plastic waste is effectively recycled.

The escalating plastic waste crisis and inadequate recycling underscore the urgent need for sustainable alternatives to single-use plastics. The environmental toll is significant, with detrimental effects on our ecosystems and contribution to climate change through CO_2 emissions from traditional plastic production. Bioplastics offer a promising path forward, aligning with de-fossilization and decarbonization goals.[82]

Sustainable alternatives to Single Use Plastics (SUPs)

In response, industries have begun to explore alternatives such as:[83]



Among the above-mentioned alternatives, Bioplastics may emerge as a promising solution to fill the packaging material gap post the ban on identified SUPs. Embracing sustainable material solutions—such as bio-based polymers, substituting virgin polymers with recycled ones, and reducing the material use in plastic products[84] —will significantly advance India's sustainability goals.

Currently, common commercially produced biodegradable/ compostable bioplastics include Polylactic Acid (PLA), PBAT, PBS, and Poly(hydroxyalkanoates) (PHA). Among these, PBAT, PLA, and their composites are considered the best-performing and most economically viable biodegradable/ compostable plastics available.[85]

Benefits of bioplastics

Bioplastics have several advantages over traditional plastics in terms of low carbon footprint, energy efficiency, biodegradability and versatility as discussed below. Despite representing a small portion of the market, they are revolutionizing many application fields due to their following benefits:

Environmental benefits

Reduction in plastic pollution

- Bioplastics provide a compostable alternative to conventional plastics, such as SUPs, significantly reducing plastic pollution. By breaking down naturally, bioplastics help mitigate the long-term environmental impact of plastic waste.[86]

Reduced carbon footprint

- As per research (Loughlin & others, 2023) it is estimated that production of PLA plastics only requires 1.8kg carbon emissions of bioplastics as compared to 3.1kg of emissions produced by conventional plastics.
- As per research (Suarez & others, 2022), it is estimated that the use of poly-lactic acids (PLA) for textiles can offer a carbon footprint reduction of up to 80%.

Decreased dependence on fossil fuels

- Bioplastics contribute to a reduction in fossil fuel consumption by using renewable biomass resources. This shift supports India's transition to a more sustainable and low-carbon economy, aligning with global efforts to combat climate change.

Waste management

- Efficient waste management is the key to reduce the negative impacts on the environment due to plastic pollution. Every year, an estimated 11.2 billion tons of solid waste is collected worldwide and decay of the organic proportion of solid waste is contributing about 5% of global greenhouse gas emissions.[87] If this waste is composted and managed properly, the released greenhouse gases can be controlled and further utilized for the purposes of bio-gas and methane production through the implementation of the following:

Composting

Certain types of bioplastics can be composted along with organic waste. This process contributes to the production of nutrient-rich compost, which can be used in agriculture, thereby closing the loop in the waste management cycle and enhancing soil health.

Anaerobic Digestion

Treating bioplastics via anaerobic digestion to produce biogas as well as nutrient rich compost, this presents a promising avenue for the development of an integrated circular economy. This process ensures the optimal use of resources, converting waste into valuable energy and manure.

Economic benefits

Employment opportunities

- The bioplastics industry creates employment opportunities across the entire value chain, from agriculture (for biomass feedstock production) to manufacturing and waste management. This sector supports job creation and economic diversification. A complete substitution of petroleum-based plastic with **biobased plastics would create 18 million jobs globally.**[88] For instance, in 2013, the bioplastics industry has contributed to approximately **23,000 jobs in Europe.** Further, it is estimated that the bio-plastics industry could account for about **300,000 high-skilled jobs** in the EU bioplastics sector.[89]

Support to MSME sector

- Compounders, convertors, etc. who are part of conventional plastic value chain majorly belongs to MSME sector who invest in machines and equipment required for various processes.
- Incorporating bioplastics into the production process can be achieved without negating the investments made by MSMEs in machinery and equipment, as many existing machines are capable of processing bioplastics like Polylactic Acid (PLA).
- By leveraging current infrastructure of MSMEs, the transition to bioplastics production can be facilitated with minimal disruption, fostering stability and reducing potential resistance within the sector to embrace bioplastics[90].

Boost to agriculture

- Increased demand for biomass feedstock

The production of bioplastics requires biomass feedstock, stimulating demand for certain agricultural products. This demand can provide additional income opportunities for farmers, enhancing their livelihoods.

It is noteworthy that India is the largest sugar producing country in the world, with an impressive production of 34,300,000 tonnes followed by Brazil with 27,732,026 tonnes of sugar production and Thailand with that of 14,866,800 tonnes.[91]
Now one of the bioplastics, PLA is a polyester made from renewable biomass, typically from fermented plant starch like corn, cassava, sugarcane or sugar beet pulp. Therefore, India holds immense biomass potential required for the production of bioplastics even greater than that of Thailand.[92]
If all plastic and chemicals were to be made from bio-mass, it would account for approximatley 1.7%-2.3% of the total bio-mass available globally.[93] India has a competitive advantage as it is rich in bio-mass.

- Efficient use of arable landThe production of bioplastics

Bioplastics can be produced from renewable feedstock that requires only a minuscule portion of arable land for cultivation. This efficient use of land ensures that food production is not compromised, supporting sustainable agricultural practices. As per a EU bioplastics report growth of renewable feed stock for bioplastics require very less arable land. **For example,** in 2022 about **0.015%** of the global land was used to produce **2.2M tons** of bioplastics.[94]

Hence, development of the bioplastics industry could open new economic avenues, particularly for the agriculture sector, which can supply the raw materials needed. This growth could contribute positively to India's GDP, create jobs and position India as a frontrunner in the rapidly growing global bioplastics market.

Challenges perceived by the industry

Despite the aforementioned benefits, the bioplastics industry faces a myriad of challenges that hinder its growth and widespread adoption in India. These challenges include, limited availability of raw materials, price competition with traditional plastics, and other concerns as discussed below in detail:

1 Price competition from traditional plastics

Producing biobased bioplastics usually costs more than producing petrochemical plastics. This is due to the more complex process of converting bioplastic resins from sources like sugarcane and cassava, along with the significant investments required for research and development. Furthermore, the cost competitiveness of fossil-based bioplastics is heavily dependent on the fluctuating prices of oil and gas as they are derived from petrochemicals, which are influenced by supply and demand dynamics, extraction and production costs, and political events and crises.[95]

The stark price difference between traditional fossil-based polymers and bioplastics is indicative of a significant market challenge that bioplastics face in gaining wider acceptance and usage.

For instance, the cost of conventional polymers such as PE/PP and PET (traditional plastics) stand at approximately INR120/Kg and INR140/Kg (US$1-1.3)[96], respectively, which is significantly lower compared to the price range of INR250/Kg–INR280/Kg (US$2.4-2.8)[97] for PLA, a common type of bioplastic. This notable price disparity raises the question whether the consumers and industries are likely to opt for the more expensive bioplastics like PLA.

Factors increasing cost of bioplastics

- Less optimized production processes
- Small scale operations
- Lack of innovative technology
- Limited availability and high cost of raw materials

- Possible solution: economies of scale

Economies of scale is a concept that means, increase in quantity of production causes the cost of the product to decrease. Basically, increase in production quantity is directly proportional to decrease in cost. The production cost of bioplastics, specifically PLA, is higher (INR 250-280/kg) than traditional polymers (INR 120-140/kg). Economies of scale can reduce PLA's cost through increased output, achieved by bulk purchases or managerial/technological efficiencies. A case study on cement industry in Asia shows scaling up production from 50,000 to 900,000 tons reduces costs by 39%.

It is imperative to note that the average production capacity of conventional plastic manufacturing unit in India is 300,000 tons, while the larger production units has a capacity ranging between 600,000-900,000 tons.[98] While a production plant for PLA (a popular bioplastic) in India is being setup with a mere production capacity 75,000 tons. The government incentives will act as a boon to bioplastics production in India as it will lead to increase in the production capacity and may help in reduction of the overall current cost substantially.

2 Limited production capacity

According to the industry association, European Bioplastics, bioplastics make up about 0.5% of the over 400 million tons of the total annual plastic production globally, representing a small portion of the market.[99]

The current capacity for bioplastic production in India is notably constrained and very limited, in part due to the limited availability of specialized machinery and equipment[100] for bioplastic processing and extrusion. This limited supply makes it difficult to meet potential demand and compete with the readily available and abundant traditional plastics.

3 Import reliance

India's net import position for bioplastics under the HSN code 3907 *(Polyacetals, other polyethers and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallylesters and other polyesters, in primary forms)* **exposes a widening trade deficit over the recent years.**

Net Import [Import - Export] (in US$ million)[101]

Product	HSN	2019-20	2020-21	2021-22	2022-23	2023-24 (Apr-Jan)
PBT	39079920	28.72	-	-	-	-
PLA	39077000	2.48	1.00	3.42	9.04	7.05
Other bioplastics	3907	622.80	703.63	1081.97	1396.27	1495.35
Total bioplastics*	**3907**	**654.00**	**704.63**	**1,085.39**	**1,405.31**	**1,502.40**

Figure 6: Import reliance, Source: GOVERNMENT OF INDIA Ministry of Commerce

- In the fiscal years from 2019-20 to 2023-24, the net foreign exchange (Forex) deficit due to bioplastics significantly increased, indicating a growing reliance on imports. The deficit rose from US$654.00 million in 2019-20 to US$1,502.40 million from April to January in 2023-24.
- Specifically, PBT recorded a net Forex deficit of $28.72 million in 2019-20 with no subsequent records of imports or exports, while PLA showed a persistent import reliance with the deficit growing from US$2.48 million in 2019-20 to $10.05 million in the 2023-24 period.

These numbers reflect India's growing reliance on bioplastics imports. The persistent increase in net Forex year over year highlights the urgency for India to develop a more robust bioplastics industry to improve self-sufficiency and address the trade imbalance.

4 End of life challenges

Bioplastics present a sustainable alternative to traditional plastics, decomposing into CO2 and H2O within 20–45 days under suitable conditions.[102] The primary end-of-life options for compostable plastics include biological waste treatment (composting and anaerobic digestion), recycling or reprocessing, incineration with energy recovery, chemical recycling and landfilling.[103]

Further, the introduction of compostable bioplastics will be more beneficial if the generated biomass is transported efficiently to the composting or biogas facilities as this will reduce GHG emissions and allow for lower fossil based energy generation.

However, most bioplastics end up in landfills and incinerators due to littering, incorrect sorting, lack of composting infrastructure, rejection at composting facilities due to their similarity with conventional plastics, consumer knowledge gaps, costly infrastructure and inconsistent degradation rates compared to other compostable wastes.[104]

This mismanagement leaves bioplastics potentially less hazardous to the environment as compared to conventional plastics. Therefore, end-of-life utilization poses a significant challenge to the bioplastics industry as well.

With the right set of policy measures, the above challenges can be overcome, and bioplastics can emerge as an alternative to traditional plastics. India is well-positioned to capitalize on this growing market. By investing in research, development, and infrastructure for domestic bioplastics production, India can become a leader in the bioplastic's revolution, promoting a more circular and environmentally conscious future.

With this background, the next chapter emphasizes on certain initiatives taken by the Indian government in this regard.

4

Existing government policies/ benefits for bioplastics

India has been active in combating plastic pollution with a series of legislative and innovative measures since a few decades. With the vision to tackle plastic waste management, Government of India has from time to time notified several rules and guidelines on this issue including manufacturing, stocking, sale and use of plastic.

In 2019, India piloted a resolution on addressing single-use plastic products pollution, recognizing the urgent need for the global community to focus on this very important issue, at the United Nations Environmental Assembly.[105] Followed by this, on July 1, 2022, India banned the manufacture, import, and use of certain identified single-use plastic items, targeting the adverse environmental, economic, and social ramifications of such materials.[106] Further, the following initiatives have been undertaken by the Indian government for resolving the plastic waste issue:

Focused initiatives:

- Plastic Waste Management Rules
- Extended Producer Responsibility
- Schemes by Department of Chemicals and Petro chemicals
- Regional Initiatives
- Setting of Indian Standards

Other supportive measures:

Atmarnirbhar Bharat 2020

To make India self-reliant in all aspects including replacing imports by domestic production with globally competitive quality and quantity

Source: PIB

India's climate action plan 2008

Plan envisages reducing carbon emissions by 1 bn tonnes by 2030; reducing carbon intensity in the economy by 45% by 2030 over 2005 levels; achieving target of net-zero emissions by 2070, etc

Source: PIB

Swachh Bharat Mission – Urban 2.0 - 2022

Focus on source segregation of solid waste, utilizing the principles of reduce, reuse, recycle, scientific processing of all types of municipal solid waste, etc.

Source: PIB

Circular Economy Roadmap 2021

Aims to foster research and industry partnerships between India and Australia and co-develop a roadmap for India's transition to a circular economy in the Plastics sector.

Source: PIB

Interim Budget Speech 2024

Proposal to launch a new scheme for promoting bio-manufacturing and bio-foundry specifically catering to environment friendly alternatives such as biodegradable polymers, bioplastics.

Source: Interim Budget Speech 2024

Pradhan Mantri Annadata Aay SanraksHan Abhiyan (PM-AASHA) 2018

An umbrella scheme to ensure Minimum Support Price (MSP) to farmers via Price Support Scheme (PSS) or Price Deficiency Payment Scheme (PDPS).

Source: PIB

G20 summit to create a sustainable & resilient future 2023

Aiming to focus on promotion of sustainable and climate resilient blue economy (including reduction of marine plastic litter), promotion of circular economy.

Source: PIB

Niti Aayog

Niti Aayog has reported vide a detailed study on plastic alternatives and alternative technologies, with an emphasis to encourage usage of alternatives to plastic.

Source: PIB

1 Plastic waste management rules

Superseding the earlier Plastic Waste (Management and Handling) Rules, 2011, the Ministry of Environment, Forest and Climate Change (MoEFCC) notified **the Plastic Waste Management Rules, 2016, as amended from time to time,** introducing [107] several key provisions in the regulatory framework for management of plastic waste generated in the country. The important aims of the said rules, as amended from time to time, are as follows:

- Mandated increased responsibilities for producers, importers and generators of plastic waste, emphasizing the need for a collect-back system through the concept of extended producer responsibility (EPR).
- Segregation of plastic waste at the source, payment of user fees, and the collection and recycling of plastic sheets and carry bags with a minimum thickness of 50 microns. Stipulated specific conditions for manufacture, importer stocking, distribution, sale and use of carry bags, plastic sheets and multilayered packaging.
- Prohibition on manufacture, import, stocking, distribution, sale and use of certain single use plastics commodities, including polystyrene and expanded polystyrene, such as ear buds, plastics sticks for ballons, plates, cutlery, straws, trays, etc.[108]
- Defined two key provisions, namely, **"compostable plastics"** and **"biodegradable plastics"** as follows:

"Biodegradable plastics" means plastics, other than compostable plastics, which undergoes degradation by biological processes in specific environment such as soil, landfill, sewage sludge, fresh water, marine, without leaving any micro plastics or visible or distinguishable or toxic residue, which has adverse environment impact". [109]

"Compostable plastics" mean plastic that undergoes degradation by biological processes during composting to yield CO2, water, inorganic compounds, and biomass at a rate consistent with other known compostable materials, excluding conventional petro-based plastics, and does not leave visible, distinguishable, or toxic residue.[110]
Compostable plastics can also be anaerobically digested, to produce biogas and nutrient-rich manure.

Mandated labelling requirements for:

- **Recycled plastic** packaging or commodity: "recycled having [-----specify percentage-----] of recycled plastic" and marking for HDPE, PET, LDPE, etc as the case may be
- Plastic packaging or commodity made from compostable plastics: "compostable only under industrial composting"
- Plastic packaging or commodity made from biodegradable plastic: "Biodegradable in [--- specify number of days ---] only in the [---specify recipient environment such as soil, landfill, water etc.---]"

2 Extended producer responsibility for plastic packaging

- The Ministry of Environment, Forest and Climate Change (MoEFCC) notified Guidelines on Extended Producer Responsibility (EPR) for plastic packaging vide Plastic Waste Management (Amendment) Rules, 2022, on 16th February 2022.
- These guidelines stipulate mandatory targets on EPR, recycling of plastic packaging waste, reuse of rigid plastic packaging and use of recycled plastic content.
- The guidelines provide for moving towards sustainable plastic packaging and reducing the plastic footprint of plastic packaging.
- EPR guidelines targets both pre-consumer plastic packaging waste, which is the waste produced during the manufacturing and packaging stages before reaching the consumer, and post-consumer plastic packaging waste, which is the waste consumers generate after the packaging's intended use is fulfilled. This system ensures that all participants in the plastic supply chain are accountable for environmental stewardship.[111]

3 Schemes by Department of Chemicals and Petrochemicals

The Department of Chemicals and Petrochemicals has launched a Scheme for setting up Centers of Excellence'[112], this initiative is aimed at enhancing research and development in areas such as biopolymers and eco-friendly polymers, refining recycling technologies, and advancing innovative methods for the collection, sorting, purification and production of recycled items, among other objectives. Centers of excellence have been set up under this scheme.[113]

4 Regional initiatives

New Delhi: The Department of Environment (NCT Delhi) has acknowledged the importance of bioplastics as an alternative to identified single-use plastic items and thereby recommends, amongst other recommendations, that suppliers of alternatives to single-use plastics (SUPs) could be incentivized at a rate of 5-10 paisa per unit of sales in the Delhi region to support the procurement of these alternatives.[114]

Tripura: The Tripura State Pollution Control Board has released a report titled "Bioplastics: An Alternative to Conventional Plastics," which underscores the need for regulatory support to boost bioplastics production in Tripura.[115]

5 Setting of Indian standards on sustainable packaging

Due to urgent need of Indian Standard for implementation of PWM Rules, the Bureau of Indian Standards (BIS) decided to formulate a comprehensive indigenous Indian Standard for biodegradable plastic. The BIS has in its Handbook on Indian Standards on Sustainable Packaging, discusses the tentative Indian Standard for "assessment of biodegradability of plastics in varied conditions" (IS 17899 T : 2022).[116]

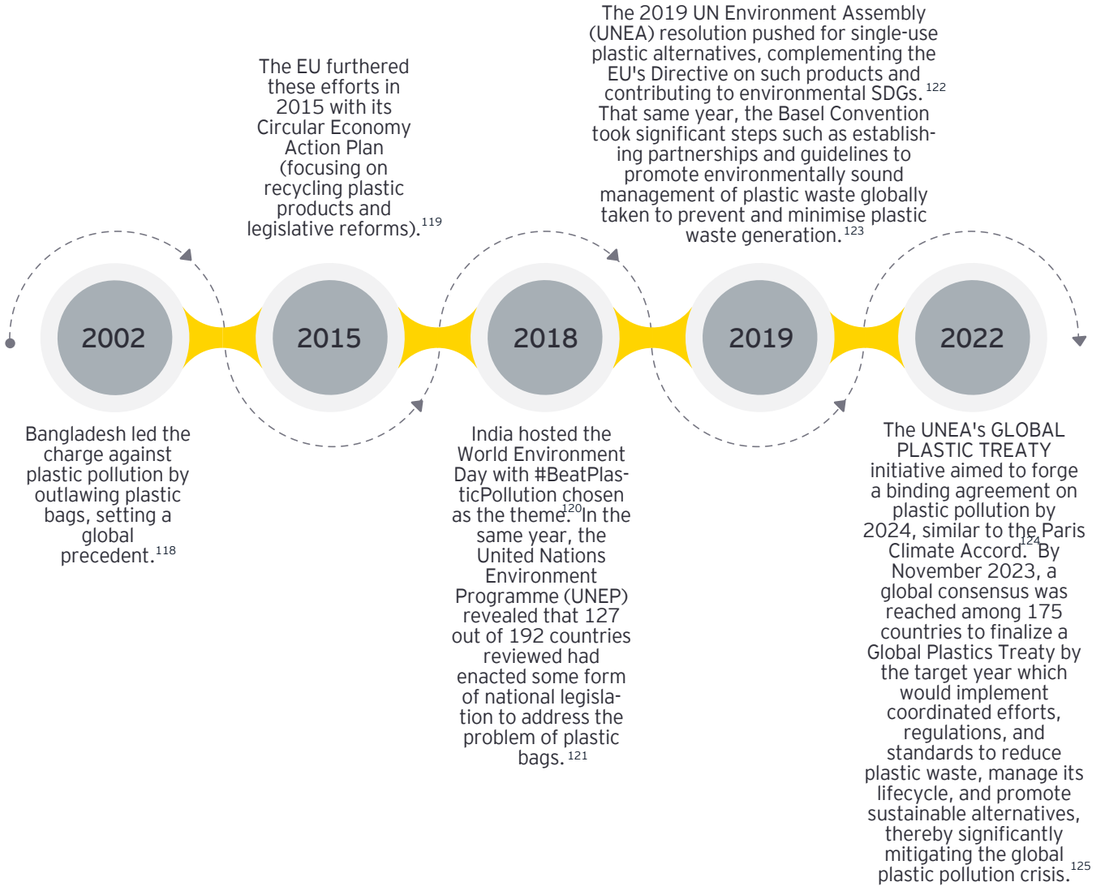
In addition to the above, there are several supporting measures such as 'Atmarnirbhar Bharat,[117] which is India's clarion call for self-reliance and production of high-quality, competitive domestic goods.

However, there is no specific scheme yet for incentivizing bioplastic production and disposal in the country. Incentivizing bioplastic production is not merely an option but a necessity for achieving global prominence and transitioning into a robust circular economy.

For this industry to flourish, it is essential to draw inspiration from global incentives and policies that have catalyzed the bioplastic sectors in other countries. The next chapter discusses in detail the initiatives/incentives provided by major countries in the global value chain, which is a major step towards development of a circular economy.

5 Global best practices

Bioplastics represent a significant global opportunity due to several key developments globally against plastics that have set the stage for the bioplastics industry at the international level:



Thailand

Background: Thailand is well-positioned to become a **global bioplastics hub** due to its leading production of raw materials, advanced technology, and technical expertise across the supply chain. The country's production capacity is **95,000 tons a year** and manufacturers plan to increase the volume by 75,000 tons a year. In the year, 2023, Thailand was the **world's second-largest producer** of bioplastic products trailing only the United States of America.[126]

Its strategic location in Southeast Asia offers broad market access, and robust government incentives fuels sector growth. These factors collectively underscore Thailand's readiness to emerge as a global leader in bioplastics.

Policy measures

Thailand's approach offers significant incentives, such as: [127]

Tax incentives
- Corporate Income Tax Exemption for 3-8 years
- Exemption of import duty

Non-tax incentives
- Permit to bring in expatriates.
- Permit to own land.
- No restriction on foreign currency

Note: To promote bioplastics packaging, Thailand cabinet offered a tax deduction up to 125% to companies that purchase and use bioplastics for their products (From January 2019 to December 2021).

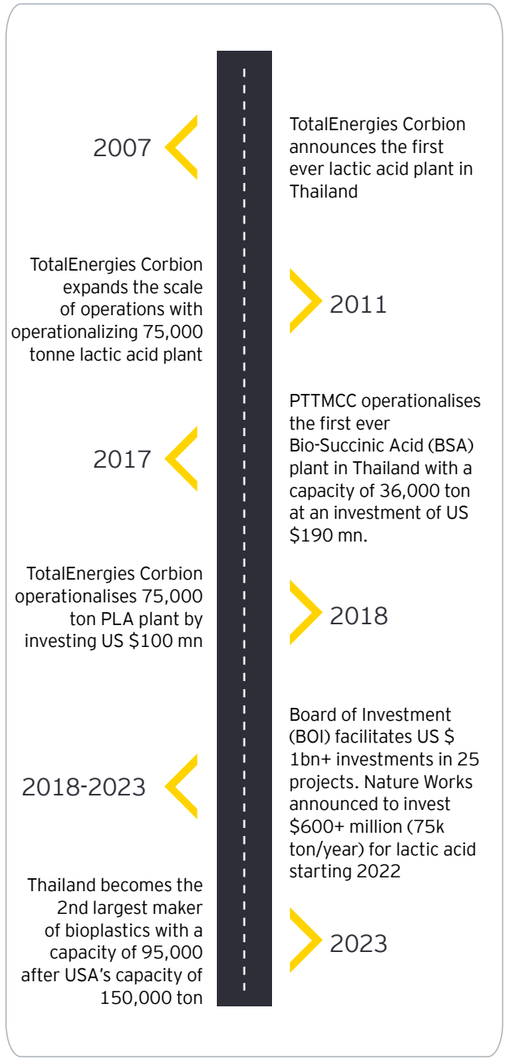
Case Study - Thailand

The bioplastic industry in Thailand has experienced significant growth, marking a crucial step towards a circular and sustainable economy.

Key milestones
- 2007: Corbion announced the first-ever lactic acid plant in Thailand, setting the foundation for bioplastic advancements.[128] This marked a significant investment in the country's bioplastics infrastructure, setting the stage for further advancements in the industry.
- Expansion: Corbion commissioned a lactic acid plant and in 2016 TotalEnergies Corbion constructed a PLA plant, boosting production capacity.[129] It demonstrates a strong commitment to increasing production capacity and meeting the growing demand for bioplastics.

Diversification and innovation
- PTTMCC: It is a strategic joint venture between PTT Public Company Limited (PTT) and Mitsubishi Chemical Corporation (MCC) which launched Thailand's first Bio Succinic Acid (BSA) plant with a capacity of 36,000 tons[130], further diversifying the bioplastics portfolio.[131]
- Board of Investment (BOI): The support from the BOI has been instrumental in facilitating over investment worth US$1billion across 24 projects in the bioplastics sector. This support has helped attract both local and international investors, driving the industry's expansion and creating new opportunities for sustainable development.[132]

Global standing
- 2023: Thailand became the second largest bioplastics producer with a capacity of 95,000, following the capacity of 1,50,000 ton of the USA.[133] This achievement highlights the country's commitment to sustainability and environmental stewardship, showcasing its potential to drive positive changes in the global plastic industry.



Further, Braskem (Brazil based company), the world's largest biopolymer producer, along with SCG Chemicals Plc (SCGC) has decided to build a new plant in Thailand producing bio-based polyethylene with a production capacity of 2,00,000 tonnes per annum.[134]

Overall, the growth of bioplastic industry in Thailand reflects a strategic shift towards a more sustainable and circular economy. With continued investments, innovations, and support from the government agencies, Thailand is poised to further strengthen its position as a key player in the global bioplastics industry.

Malaysia

Background: The 12th Malaysia Plan (12MP) identifies the Biomass Sector as a key industry for economic growth. Malaysia is focusing on biomass in plantation, forestry, agriculture, livestock, and fisheries, per the National Biomass Action Plan 2023-2030 to promote sustainability, a low-carbon economy, and job creation.[135]

Policy measures[136]

Green Technology Financing Scheme 4.0 – Financing scheme to the producers/users of green technology and energy service company.
- Financing size – RM 50- RM 100 million
- Financing tenure – Up to 10-15 years
- Incentive period – First 7 years

Govt Incentive –
- 60%-80% Government Guarantee and
- 1.5% Rebate on Interest Rate

Malaysian Investment Development Authority (MIDA) incentives: utilisation of Oil Palm biomass to produce bioplastics (amongst other products)
- Income tax exemption between 70%-100% of statutory income for a period of 5-10 years[136]
- Investment Tax Allowance: Between 60%-100% of qualifying capital expenditure incurred within a period of 5 years.

Green Investment tax allowance (GITA)
- Tax Allowance of 100% of the qualifying capital expenditure incurred on a green technology project from 2013 until 2026.
- Allowance can be offset against 70% of the statutory income in the year of assessment.
- Unutilised allowances allowed to be carried forward.

Green Income Tax Exemption (GITE)
- Green technology services related to renewable energy, energy efficiency, electric vehicle, green building, green data centre, green certification and verification and green township qualify for this tax incentive.

Incentive - 100% exemption applied to statutory income from 2013 till 2026.

Incentives for BioNexus Status Companies
- Biomass companies undertaking bio-conversion technologies such as biofuel, bioenergy, biomaterials, and bioremediation from various sectors, i.e., plantation, agriculture, livestock and aquaculture are eligible to apply for investment incentives under BioNexus Status granted by Malaysian Bioeconomy Development Corporation (Bioeconomy Corporation).

Incentives – 100% tax exemption for 10 years; Import duty waived on imported raw materials and machineries for 10 years.

Taiwan

Background: Taiwan offers tax incentives and subsidies to boost R&D, smart machinery investments, and attract foreign professionals. Companies can deduct significant portions of R&D and investment costs from taxes, while eligible foreign professionals enjoy reduced income tax. Subsidies, like the Global R&D Innovation Partner Program promotes innovation and economic growth.

Policy measures[137]

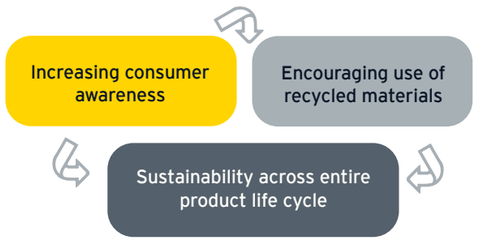
Tax incentives
- Up to 15% of the company's R&D expenditures may be deducted from its profit-seeking enterprise income tax for current year or up to 10% of such expenditures may be credited over three years against the profit-seeking enterprise income tax payable by the company.
- Waiver of import duties for machinery and equipment not manufactured in Taiwan.
- Investment in smart machinery: For investments of no less than NT$1 million and no more than NT$1 billion, either "5% of investment spending deducted from profit-seeking enterprise income tax (current FY)" or "3% of investment spending deducted from profit-seeking enterprise income tax, if total spending spread over three years" may be selected, but the total amount deducted may not exceed 30% of corporate income tax that year.
- Foreign Special Professionals: Foreign special professionals who meet criteria are eligible for a 50% deduction of total income tax for amounts exceeding NT$3 million.

Subsidies:
- Global R&D Innovation Partner Program: Foreign Company after gaining approval from the Ministry of Economic Affairs (MOEA), will be eligible for subsidies of up to 50% of total R&D expenditures.
- Programme for development of pioneering companies: Program funding of up to 50% of total expenditures may be granted for any project that has been approved by the MOEA

United States of America

Background:

- The US bioplastics market had total revenue of $1.2 billion in 2022, representing a compound annual growth rate (CAGR) of 10.0% between 2017 and 2022.[138]
- Market consumption volume increased with a CAGR of 11.4% between 2017 and 2022, to reach a total of 278.9 thousand tonnes in 2022.[139]
- The US market accounted for 12.9% of the global bioplastic market and 62.9% of the North American market. The market kept expanding rapidly, largely due to the rising demand for applications of sustainable packaging in consumer goods.[140]
- The U.S. bioplastics market size was estimated at USD 3.07 billion in 2023 and is expected to grow at a compound annual growth rate (CAGR) of 19.3% from 2024 to 2030.[141]



Policy measures[142]

- The United States presents a multi-faceted model, combining R&D investment, taxation strategies to discourage the use of virgin plastic, and the USDA BioPreferred Program, which mandates federal purchase of biobased products. The program makes it mandatory for federal bodies and agencies to purchase and use bio-based products such as bioplastics.
- Under the USDA BioPreferred Program, federal purchase preference in case of certain categories of products should have a minimum of 25% of biobased content.[143]
- USDA's goal is to make it easy for consumers to identify biobased products. There are currently more than 4,500 USDA Certified Biobased Products labelled as "USDA certified biobased product."

Japan

Background:

- The government of Japan has implemented The Resource Circulation Strategy for Plastics to introduce the maximum number of bio-based plastics (approximately 2 million tons) by 2030.[144]
- The government therein aims to incentivize local governments to start using bio-based plastics in waste collection bags for household and commercial waste treatment.[145]
- Regulations are in place to ensure the establishment of fair and equitable recycling systems that promote the use of bioplastics. This includes measures to stimulate demand for bio-based products and improve reliability related to marine biodegradability.[146]

To achieve the targets outlined in the Resource Circulation Strategy for Plastics is to adopt biomass plastics and materials recycled from waste plastic based on the 'mass balance approach'. The proportion of biomaterials in the raw input is attributed to the final product, allowing products made from mixed materials to be labelled as "100% biomass" based on the certified bio content purchased. This approach ensures even products containing petrochemical components can be certified as sustainable, enhancing the use of bio resources in plastics.[147]

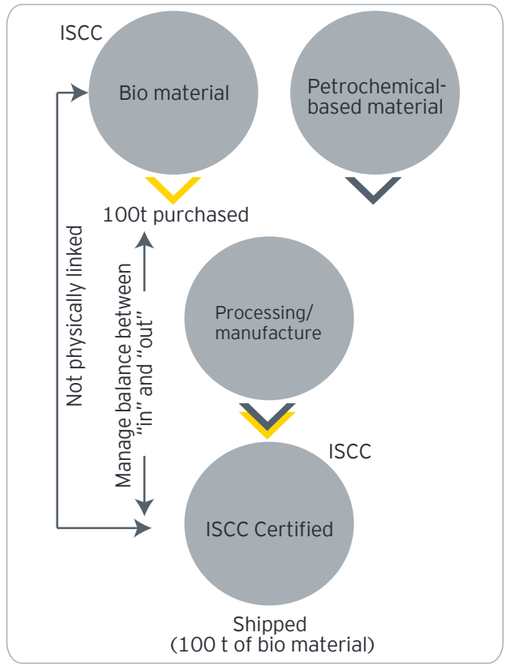
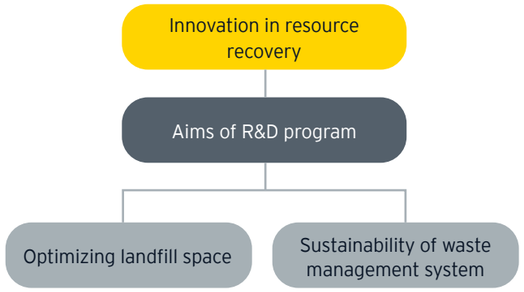


Figure 5: Mass balance approach to promote the use of Biomass, Source: Iwatani [148]

Policy measures

- Japanese Ministry of Environment announced 6.2 billion yen in the 2019 budget for the development of products made from biodegradable bioplastics and subsidise companies that produces paper alternatives to plastic.[149] [150]
- The Japanese Ministry of Environment plans to support corporate investments in equipment intended to boost production of plastic alternatives with subsidies covering between 33% to 50% of the price of the equipment. [151]
- Enactment of the "The Plastic Resource Circulation Act" which was promulgated in June 2021 and went into effect in April of 2022. This law includes a "Design for the environments by manufacturers," a "Reduction of single-use plastics by retailers and service providers," and a "Separation,collection and recycling of plastic waste by municipalities and private sectors". [152]
- "Roadmap for Bioplastics Introduction" was formulated in January 2021. The roadmap calls for raising the amount of bio-based plastic products introduced into Japan from the current 50,000 tons to 2 million tons by 2030.[153] [154]
- In 2019, at the G20 Osaka Summit, Japan proposed the "Osaka Blue Ocean Vision" aiming to reduce additional pollution from marine plastic litter to zero by 2050, which was shared among the global leaders. In May 2019, a corresponding "Roadmap for the Development and Implementation of Marine Biodegradable Plastics" was formulated.[155]



South Korea

Background:

- South Korea Biodegradable polymer demand stood at 50.72 thousand Tonnes in 2020 and is forecast to reach 93.95 thousand Tonnes by 2030, growing at a healthy CAGR of 6.27% until 2030. [156]
- Demand for biodegradable polymers in the packaging sector is set to grow during the forecast period owing to rising e-commerce activities in the region. [157]
- Besides, various government initiatives are supporting the use of Biodegradable Polymers in place of non-biodegradable plastics to curb plastic pollution. [158]
- Increasing demand for biodegradable polymers from other sectors such as consumer goods, textiles, and pharmaceuticals sector is increasing the demand for biodegradable polymers. [159]

Policy measures

In South Korea, the government provides incentives to promote bioplastics through various policies and regulations.

- One such initiative is the ISCC (International Sustainability and Carbon Certification) PLUS Scheme, which supports the use of biobased, renewable, and circular raw materials. The scheme aligns with the European Commission's Renewable Energy Directive (RED II) and encourages the transition to a circular economy by avoiding incineration and landfill and adopts recycling and reusing materials and components. [160]
- Additionally, the government offers support for organizations and raw material suppliers dealing with agricultural and forestry biomass, bio-based waste, and residues. [161]
- South Korea's Biomass Plastic Certification program, aimed at validating and promoting products with significant biomass-derived content, could inspire similar certification systems in India, ensuring quality and promoting consumer trust and understanding of bioplastic products. This certificate program gives the manufacturers a certification which helps in getting access to credits and loans and improve ESG ratings on the Korean stock market which subsequently helps in attracting more investors. [162]

India, with its vast biomass potential, is well-positioned to lead the bioplastics revolution in Asia. Drawing inspiration from global best practices, including robust policies and incentives from countries like Thailand, the USA, Japan, and South Korea, India can drive innovation and sustainability in the bioplastics sector, fostering economic growth and environmental stewardship.

6 India incentives benchmarking

As the world pivots towards sustainable solutions by adopting bioplatics which serves as a substitute to conventional plastics, there is a pressing need for the Indian government to proactively support the establisment and growth of this sector. The same will not only enable India to fight the platic pollution menace but will also help India secure a significant position in the global bioplastics value chain, tapping into an industry that not only promises environmental benefits but also offers substantial economic opportunities. The adoption of bioplastics aligns with India's commitment to environmental stewardship and its pledge to reduce its carbon footprint. Government intervention in the form of policy incentives, research and development support, and public-private partnerships is essential to stimulate the bioplastics market.

In the past also, both Central and State Government have contibuted to the development of various sector by notifuing sectoral policies for extending fiscal and non-fiscal/ regulatory measure to support the industry. The below tables provides a snapshot of the incentives offered by Central Government as well as various state governments to promote sectoral development and growth.

1 Fiscal Incentives

Central level schemes

- Central Government have always been at the forefront for promoting industrial development and increasing manufacturing in the country. Various sector specific schemes have been notified by the Central Government which provides incentives in the form of Capital subsidy, interest subvention etc. Last 4 years saw the advent of large number of Production Linked Incentives (PLIs) being notified which helped boost domestic manufacturing.

Nature of incentive	Indicative Scheme	Quantum of incentive
Capital Subsidy	SPECS – Electronics sector [163]	25% of capex
	ATMP/OSAT facility [164]	50% of capex
	M-SIPS – Electronics (*discontinued, but was available for promoting electronics) [165]	25% of capex (Non-SEZ)
Interest Subvention	Animal Husbandry Infrastructure development fund [166]	3% p.a. for 8 years
	Scheme for financial assistance to sugar mills for augmentation of ethanol production capacity [167]	6% p.a. or 50% of interest rate, whichever is lower; 5 years.
	New Central Sector Scheme for industrial development of J&K [168]	6% for 7years (Loan <500 Cr)

State level schemes

- State Governments have also been issuing various general and sector specific incentive scheme to attract investment in their areas in order to foster growth and development. The sectoral scheme are notified keeping in mind the need of the state and the potential of sector growth. Similar to the Central Government, state governments also grant fiscal incentives in the nature of capital subsidy, net SGST reimbursement, interest subvention along with other state specific exemptions such as stamp duty exemption, electricity duty exemption etc. Another interesting feature of the state policy is the option of dovetailing the best suited incentives available in any other state incentive policies or provides the option of formulating customised incentive packages depending on the size of the project and the quantum of investment.

State level schemes

- As mentioned earlier, Bioplastic polymers are derived from renewable biomass sources such as sugarcane, plant oils, starches, and cellulose. Herein, one of the major sugar producing mills in the country has indicated its interest to set up a PLA plant produced from sugarcane in the state of UP. The state of **Uttar Pradesh** is apt for the said activity as **it ranked 1 in sugarcane cultivation area and production for 2022-23** season.[169] UP stands as the country's leading sugarcane, sugar, and ethanol producer boasting a total of 118 sugar mills in FY 2022-23.[170] This milestone highlights the state's potential in the agricultural and agro-based industries with well-structured state policies driving substantial economic growth and development. Moreover, the GOI is also commited to transform the nation's sugarcane belts into energy belts.[171]
- Given the said background, for the purpose of benchmarking various State sectoral incentives, the below table provides a snippet of the policies (indicative list) notified by the state of Uttar Pradesh which may form the basis to incentivise the bioplastics sector in the state.

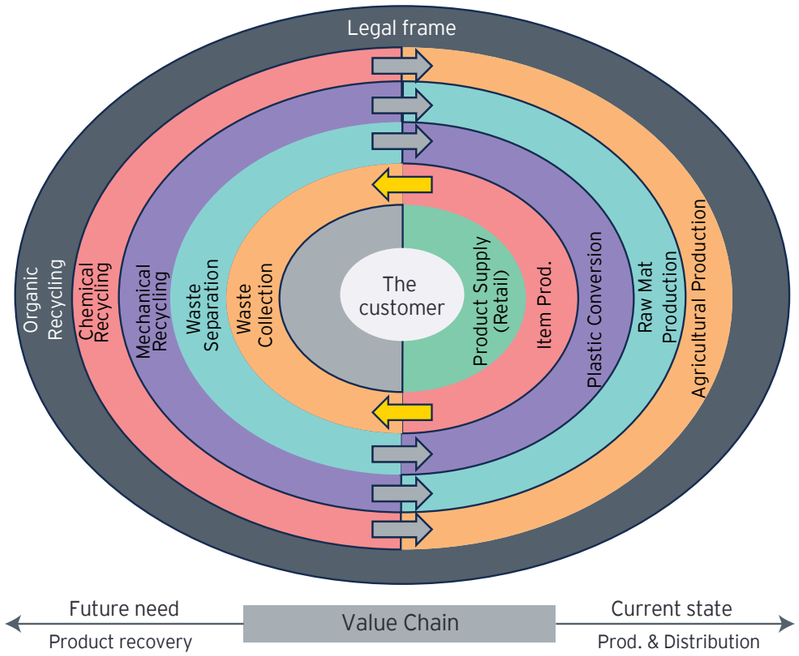
Nature of incentive	IIEPP (2022)	Fortune 500	Green Hydrogen (2024)	Semiconductor (2024)	Pharma 2023)	Food Processing (2023)
Capital Subsidy	22% of ECI, 15 yrs (upto 12% additional boosters)	30% of ECI over 7 yrs	60% to 20% of cost of electrolyser	50%	15% of P&M, 5 years upto 200 Crs.	35% of P&M, upto 5 Crs.
Net SGST Reimbursement	200% of ECI, 14 yrs	Upto 100% of ECI over 10 yrs	100%	-	-	-
PLI Top-up	30% of PLI upto 100% of ECI	-	-	-	-	-
Stamp duty exemption	75%	75%	100%	100%	100%	100%
Electricity Duty exemption	-	100% for 5 yrs	-	100%, 10 yrs	100%, 10 yrs	-
Interest subsidy	-	-	-	5% p.a, 7 yrs, upto 1 Cr p.a. upto 1 Cr p.a.	5% p.a., 5 yrs, upto 1 Cr p.a.	
Front end land subsidy	-	75% cost reimbursement				
Dovetailing with other state policies	Silent	Silent	Yes	No	Silent	Silent
Customised package incentives	Yes (Ultra mega project of special importance)	No	No	No	No	No

- In furtherance to the above, a comparison of the state sectoral policies notified by the state of UP with the sectoral policies notified by other states also provides an indicative quantum of incentives being notified in various jurisdictions to promote sector-specific development:

Nature of incentive	Incentives available in other states	Quantum of incentive
Capital Subsidy	U.P. Green Hydrogen[172]	60-20% (Cost of electrolyser)
	TN Industrial Policy[173]	40% (Flex subsidy)
	Rajasthan Investment Scheme[174]	35% over 10 years (Cost of P&M)
	Odisha IPR[175]	30% over 5 years (Cost of P&M)
Interest Subvention	Chhattisgarh Agro & Food Process. Policy[176]	50% of ECI1* (Loan < 80% of ECI)
	Aatmanirbhar Gujarat Scheme[177]	7% for 10 years 1 (Up to 1.2% of ECI p.a.) (Above incentive is in addition to the SGST reimbursement provided under the Policy)
	J&K New Central Sector Scheme[178]	6% for 7 years 1* (Loan <500 crores)
	Gujarat Textile Scheme[179]	6% for 5 years (Up to 20 crores. p.a.)
	Gujarat Bio-technology Policy[180]	10% over 5 years (Up to 20 crores. p.a.) (Above incentive is in addition to the capital subsidy provided under the Policy)
Net SGST reimbursement	J&K New Central Sector Scheme[181]	Up to 300%
	Odisha IPR[182]	Up to 200%
	IIEEP of U.P.[183]	Up to 200%
	MH Package Scheme of Incentives[184]	Gross SGST
Power Tariff exemption	Odisha IPR[185]	INR 2 for 10 years
	Gujarat Semi-conductor Policy[186]	INR 2 for 10 years
	MP IT, ITeS & ESDM Policy[187]	INR 2 for 10 years
Electricity Duty exemption	Chhattisgarh Agro & Food Processing Policy[188]	100% - 15 years
	MP Defence[189] & Chhattisgarh IT/ITes[190]	100% - 12 years
	Punjab Integrated Logistics Policy[191]	100% - 10 years
	Rajasthan Solar Policy[192]	100% - 10 years
	FDI Policy of U.P.[193]	100% - 5 years
Land Subsidy	FDI Policy of U.P.[194]	75% of cost

2 Cluster Schemes

- To support the circular economy in case of bioplastics, development of clusters plays an integral part. Development of clusters help in capacity building through formation of clusters to cater to the needs of an industry. The same also helps in promoting circular economy which benefits the environment. The below diagram depicts an overview of the circular value chain.
- Typically, attention is predominantly directed towards the production and distribution phases of products, as denoted by the green segment on the right. However, it's crucial not to overlook the product recovery phase, highlighted by the blue segment on the left. Emphasizing this phase is imperative for fostering a truly circular economic model.



- Development of various components required for promotions of circular economy is a crucial part w.r.t incentivizing the bioplastic manufacturing in India. Herein, in the past, to promote sectoral development, the Government of India has introduced various cluster schemes (as tabulated below on an illustrative basis) which have catalysed creation of ecosystems that not only drive innovation and skill development but also attract investment and generate employment in the given sector:

Scheme	Objective	Benefits under the Scheme
PM MITRA Scheme [195]	Strengthen Indian textile industry by enabling scale of operations, reduce logistics cost by housing entire value chain at one location, attract investment, generate employment & augment export potential.	▸ Development Capital Support (DCS) up to INR 500 crore per park to Park SPV. In two phases: ▸ Phase 1: INR 300 Cr for Greenfield Park and INR 100 Cr for Brownfield Park. Concession period will be 25 years till completion of Phase 1 ▸ Phase 2: INR 200 Cr for Greenfield Park and INR 100 Cr for Brownfield Park. ▸ Competitive Incentive Support (CIS) up to INR 300 crore per park to the units to incentivise speedy implementation.
Pradhan Mantri Matsya Sampada Yojana (PMMSY) [196]	Overall development of aquaculture sector through: ▸ Development of hatcheries, construction of grow-out and rearing ponds, ponds for aquaculture ▸ Construction of fish retail markets, fish feed mills, storage units etc. ▸ Construction of quality testing labs and diagnostic labs	▸ Investment of INR 20,050 crore in all the States and Union Territories ▸ Financial assistance ranging from 40-100% of the project cost from Central/State government depending upon the type of scheme under the Yojana.
Mega Food Parks Scheme (MFPS) [197]	Creation of processing infrastructure near the farm, transportation, logistics and centralized processing centres.	Scheme provides a capital grant at the rate of 50-75 % of the eligible project cost subject to a maximum of INR 50 crore per project.
Scheme for Setting up of Plastic Parks [198]	State of the art infrastructure and enabling common facilities to assist the sector move up the value chain and contribute to the economy more effectively.	Grant funding up to 50% of the project cost subject to a ceiling of INR 40 crore per project by Central Government. The remaining contribution to the project is done by the State Government or the State Industrial Development Corporation or similar agencies of the state.
Micro and Small Enterprises – Cluster Development Programme (MSE-CDP) [199]	Boost the productivity and competitiveness of Micro and Small Enterprises (MSEs) by adopting a cluster approach. This involves providing financial assistance from the Government of India for setting up Common Facility Centers (CFCs) in existing clusters and for establishing or upgrading Industrial Areas, Estates, and Flatted Factory Complexes.	▸ Common Facility Centres: Construction of "tangible assets" such as Processing Centre, Testing Facilities, Design Centres, including Plug & Play Facilities. GOI Assistance: up to 80% of the Project cost of maximum INR 30 crores. ▸ Infrastructure Development: Development of drainage, power distribution, roads etc. in existing / new industrial estates / areas / Flatted Factory Complex. GOI Assistance: up to 70% of the Project cost of maximum INR 15 crores. [200]

With the growing need of usage of alternatives to conventional plastics and the growth of bioplastic industry at a global front – wherein global economies are incentivizing the companies to set up bioplastic manufacturing, India also has the opportunity to mark its presence on the global value chain by creating demand for use of bioplastics and promote its manufacturing. The said goal also aligns with India's objective of creating sustainable solutions and reduce carbon footprints. Further, as seen from the above tables, Indian Government (federal as well as state) have always extended their support in providing fiscal incentives to enable the industry grow. Similarly, with the right set of incentives being offered to the bioplastic sector, this sector has the potential of showing an exponential growth.

7 Policy Recommendations

The analysis in the above chapters underscores India's significant role and potential in the plastics industry, highlighting its vast market size and production capacity alongside the environmental challenges posed by traditional plastics. Bioplastics have emerged as a promising solution to the plastic waste problem, offering renewable alternatives capable of mitigating environmental concerns. Projections for the global and Indian bioplastics markets indicate substantial growth opportunities. Developing a robust value chain for bioplastics, from sustainable sourcing to waste management, is essential for India's transition. Strategic investments in research, development, and infrastructure can position India as a leader in the bioplastic's revolution, aligning with sustainability goals.

Despite the initiatives undertaken by the government against plastic pollution, a dedicated focus on bioplastics policies is imperative. Drawing insights from global best practices, particularly from countries like Thailand, Malaysia, Taiwan, USA, Japan, and South Korea, India can foster a thriving bioplastics industry.

In light of the above, the following section provides the policy recommendations which may be adopted by Central Government and state governments to contribute towards creation of bioplastics sector and promotion of circular economy:

- Reduce Import Dependency: Currently, India is the net importer of bioplastics and development of this sector will result into reducing import dependency.
- Cleaner Environment: Bioplastics are bio-degradable and compostable resulting into a cleaner environment
- Drastic Reduction of GHG emissions therefore contributing net zero by 2070 mission
- MSW Management: Development of bioplastics will help resolve the issue of plastic waste management
- Employment Generation: With manufacturing plants being set up, the opportunities are also created for more employment generation
- Additional Income to Farmers: By using agricultural produce like sugarcane for generation of bioplastics, agricultural produce can fetch additional income for farmers. Thus conversion of agricultural produce into bioplastics can help the farmers.

In nutshell, a robust 'National Bio-plastics Policy' will serve as a critical instrument in addressing the escalating issue of conventional plastic waste, thereby supporting the government's commitment to achieving its sustainability objectives, including the 'Net Zero' target by 2070. Thus, the right set of incentive structures and subsidies could be considered to offset the higher costs and encourage widespread adoption. This strategic move would not only enhance India's Environmental Performance Index (EPI) ranking but also contribute to the nation's long-term economic and environmental resilience.

Incentive support - Central Government

1 Formulation of 'National Bio-plastics Policy'

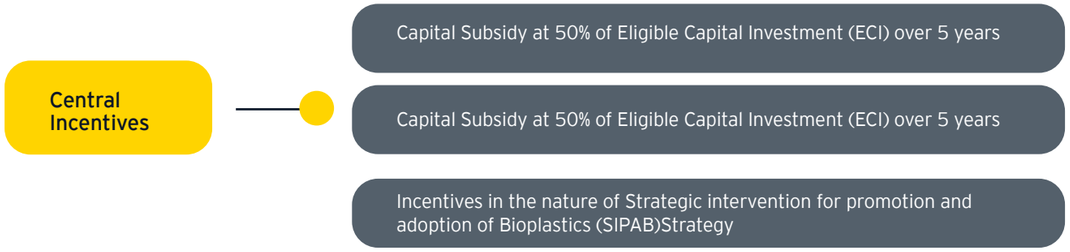
The Central Government may consider to develop and implement a 'National Bio-plastics Policy' with the strategic objective of establishing India as a leading global centre for bio-plastics manufacturing. This policy should encompass initiatives to stimulate domestic capabilities in the production, application, and recycling of bioplastics. The policy should also focus on enabling segregation of conventional plastic waste from the compostable plastic waste and establish a mechanism to undertake composting process at each municipal corporation level. By fostering innovation and investment in this sector, the policy can facilitate a competitive edge in the international market with the main objectives to:

Target Objective

By the year 2040, goal should be to achieve a transformation in India's consumption patterns by replacing 50% of single-use plastics with compostable alternatives, thereby significantly reducing the environmental footprint and fostering a positive global ecological

2 Fiscal Incentives

- To support the circular economy in case of bioplastics, development of clusters plays an integral part. Development of clusters help in capacity building through formation of clusters to cater to the needs of an industry. The same also helps in promoting circular economy which benefits the environment. The below diagram depicts an overview of the circular value chain.
- Typically, attention is predominantly directed towards the production and distribution phases of products, as denoted by the green segment on the right. However, it's crucial not to overlook the product recovery phase, highlighted by the blue segment on the left. Emphasizing this phase is imperative for fostering a truly circular economic model.



3 Establishment of Regulatory Framework

- Dedicated regulatory framework for the bioplastics industry is crucial as it ensures environmental sustainability, consumer safety by setting standards for compostable materials, fosters innovation and market confidence by providing clear guidelines for production and usage, thereby facilitating industry growth and competitiveness in the global market.

A. Market Development		
A1.	Mandating use of Bioplastics	▸ Adoption of bioplastics in a phased manner (Like phased elimination of single-use plastics in India vide Plastic Waste Mngt. Rules[201] and acceptance of bioplastics in other countries such as Japan, USA etc.) ▸ To be included as one of the objectives under India's Plastic Pact[202] ▸ Imposition of sector-related restrictions on use of single-use plastics and replace the same with bioplastics (In 2020, Bangladesh imposed a ban on all single-use plastics in coastal hotels & restaurants)[203]
A2.	Set-up of special regulatory committees for monitoring growth of bioplastic industry	▸ Special committee / task forces to be set up at national level to regulate & monitor appropriate adoption of bioplastics & related norms (like special task forces established at central & state levels for elimination of single-use plastics & effective implementation of waste management rules)[204]
A. Market Development		
A3.	Amendment to Plastic Waste Management Rules, 2023 to include bioplastics for use by manufacturers and importers	▸ Suitable amendment in the plastic waste management rules mandating the manufacturers/importers of plastic raw material for **use of recycled plastic content** to include within its scope bioplastics as well.
B. Protection to Domestic Bioplastic Industry		
B1.	QCO issuance with respect to BIS standards on bioplastics	▸ Notification QCO for bioplastics (Like standards for Solar DC Cable, reusable sanitary napkin, etc., QCO has been imposed on aluminum, footwear[205] etc.)
B2.	Imposition of quota restrictions on imports	▸ Imposition of restriction on imports by way of quotas i.e., quantitative restriction on imports
B3.	Levy of higher customs duty on imports of bioplastics	▸ Higher custom duty on import of bioplastics
B4.	GST rate rationalisation on supply of bioplastics	Reduce the current GST rate of any polymer under HSN 3907 which is either bio-based or compostable or both from 18% to 12% to encourage usage bio-based plastics. ▸ The same would be in line with the measures taken by the Government in the past to stimulate sectors that utilize bio-based or agricultural materials in their production processes by tax rate rationalization. For instance: ▸ The GST rate on boards including bagasse-based boards and board made from agricultural residue from reduced from 28% to 12% (14th GST Council Meeting and 15th GST Council Meeting) ▸ Considering the positive impact of 'biodiesel' as well as 'biopesticides' on the environment, GST rate was reduced on these goods from 18% to 12% (25th GST Council Meeting). ▸ GST rate was rationalized to 5% from 28% on molasses to increase the liquidity with mills and enable faster clearance of dues to sugarcane farmers.

C. GST rate rationalisation on supply of bioplastics Public Awareness		
C1.	Campaigns with respect to bioplastics & correct waste disposal	▸ Carrying out various campaigns with respect to benefits & correct waste disposal requirements of bioplastics (including setting-up of dedicated webpage / online platforms)
C2.	Fund allocation under Swachh Bharat Mission	▸ Allocation of funds under Swachh Bharat Mission Urban 2.0 for awareness with respect to bio-plastics promotion
C3.	Labelling & Certifications	▸ Imposition of restriction on imports by way of quotas i.e., quantitative restriction on imports

4 Cluster Development

Establishment of a 'bioplastics cluster' with the aim to redirect focus towards the product recovery phase of the bioplastics end of life value chain segment, ensuring that the industry operates within a circular framework.

To facilitate cluster development in this industry, the government must provide comprehensive support in several key areas. Firstly, the focus should be on enhancing **know-how and technology** through funding research and development initiatives, facilitating partnerships between academic institutions and industry players, and providing incentives for the adoption of cutting-edge bioplastic technologies.

Secondly, the government must invest in the necessary **infrastructure** that enables the production, processing, and distribution of bioplastics, ensuring that these facilities are both environmentally sound and economically viable. Lastly, **job creation** is crucial; the government should implement policies that encourage the industry's expansion, such as training programs to develop a skilled workforce specialized in bioplastics, and tax benefits for companies that create new employment opportunities.

The creation of a bioplastics cluster is set to offer substantial benefits, aiding not just the prominent industry participants directly involved in bioplastics production but also the Micro, Small and Medium Enterprises (MSMEs) like converters, compounders, and others who are vital to the overall bioplastics value chain...

By addressing these areas, the central government can catalyse the growth of the bioplastics industry, driving innovation and sustainability while bolstering the economy.

Required Support from the Government		Partners and Value Chain which shall be covered
Know-How & Technology	▸ Knowhow creation through collaboration by all partners in the value chain ▸ Holistic interdisciplinarity brainpower at minimal cost - setting up research centres / COEs*, centers for testing, designing, etc. ▸ Connecting with universities & government institutions	All partners and entire value chain will be covered

Required Support from the Government		Partners and Value Chain which shall be covered	
Infrastructure	▸ Land allotment at concessional rates ▸ Common facilities & equipment free / under PPP model: - industrial composting & biogas facilities - conversion of bioplastics - analytics of bioplastics - testing of compostable bioplastics - recycle systems, etc.	Agricultural Producers, Compounders & Converters, Organic Recycling	Brand Owners, Recycling, Waste Management
Job Creation	▸ Creation of jobs outside & within the bioplastic cluster, mainly including: - labor intensive sectors of plastic conversion – for compounders & converters - brand owners (at item production level) - waste management (especially organic recycling)	Compounders & Converters, Brand Owners, Organic & Mechanical Recycling, Waste Management	Raw Material Producers, Retailers, Chemical Recycling

● High Importance ○ Moderate Importance

Incentive support - State Government

Sector specific scheme for Bioplastics

▸ Dedicated Sector Specific Scheme to be notified by the State Government extending the following fiscal benefits

State Incentives

- Capital Subsidy at 50% of Eligible Capital Investment (ECI) over 5
- Interest Subvention at 7% for 7 years
- Power Rebate at INR 2/Unit along with Electricity Duty Exemption
- SGST Reimbursement capped at 200% of ECI for 14 years.
- Land Subsidy at 75% Cost

With the above incentives, the State governments to also give the option of allowing dovetailing between various sectoral policies issued with the state as well as the option of creating a customized policy for investment crossing a defined threshold.

By implementing some/all of the recommendations put forth in this report, India can move towards integrating bioplastics into broader environmental and economic strategies, leveraging India's biomass potential and sugar production leadership. Establishing supportive policy frameworks, incentivizing production of bioplastics and adopting a cluster-based methodology can prove to be vital in India's journey in becoming a robust circular economy.

Glossary of Terms

Particulars	Description
UN	United Nations
SUP	Single Use Plastic
ISO	International Standards Organisation
CAGR	Compounded Annual Growth Rate
HSN	Harmonized System of Nomenclature
OECD	Organisation for Economic Corporation and Development
UT/UTs	Union Territories
CO2/CO2/CO2	Carbon Dioxide
GHG	Greenhouse Gases
EU	European Union
MSME	Micro, Small and Medium Enterprises
GDP	Gross Domestic Product
INR	Indian National Rupee
US	United States of America
H2O	Water
PIB	Press Information Bureau, India
NCT Delhi	National Capital Territory, New Delhi
PWM Rules	Plastic Waste Management Rules
SDG/SDGs	Sustainable Development Goals
RM	Ringgit Malaysian
FY	Financial Year
USDA	United States Department of Agriculture
ISCC	International Sustainability and Carbon Certification
ESG	Environment Sustainability Goals
SPECS	Scheme for Promotion of Manufacturing and Electronic Components
ATMP	Assembly, Testing, Marking, and Packaging
OSAT	Outsourced Semi-conductor Assembly and test
M-SIPS	Modified Special Incentive Package Scheme
J&K	Jammu and Kashmir
SGST	State Goods and Service Tax
CGST	Central Goods and Service Tax
GST	Goods and Service Tax
UP	Uttar Pradesh

Glossary of Terms

Particulars	Description
ECI	Eligible Capital Investment
P&M	Plant and Machinery
TN	Tamil Nadu
IPR	Intellectual Property Rights
SPV	Special Purpose Vehicle
GOI	Government of India
MSW	Municipal Solid Waste
QCO	Quality Control Order
COE	Centres of Excellence
PE	Polyethylene
PP	Polypropylene or Polypropene
PET	Polyethylene Terephthalate
PA	Polyamides/Nylons
HDPE	High Density Polyethylene
PLA	Polylactic acid
PHA	Polyhydroxyalkanoates
PBS	Polybutylene Succinate
PBAT	Polybutylene Adipate Terephthalate
PCL	Polycaprolactone
MOEA	Ministry of Economic Affairs
CIEL	Centre for International Environmental Law
EPI	Environment Performance Index
CH4	Methane
IOMC	International Online Medical Council
CPCB	Central Pollution Control Board
MSP	Minimum Support Price
PSS	Price Support Scheme
PDPS	Price Deficiency Payment Scheme
MoEFCC	Ministry of Environment, Forest, and Climate Change
EPR	Extender Producer Responsibility
LDPE	Low-Density Polyethylene
BIS	Bureau of Indian Standards
UNEP	United Nations Environment Programme

Glossary of Terms

Particulars	Description
UNEA	United Nations Environment Assembly
PTT	Public company Limited
BSA	Bio Succinic Acid
MCC	Mitsubishi Chemical Corporation
BOI	Board of Investment
SCGC	Standing Committee on Government Guarantees
MIDA	Malaysian Investment Development Authorities
MP	Malaysia Plan
GITA	Green Investment Tax Allowance
GITE	Green Income Tax Exemption
R&D	Research and Development
PLUS Scheme	Pooled Livelihoods and Upskilling Support
RED	Renewable Energy Directive
PLIs	Production Linked Incentives
IIEEP	International Institute for Educational Planning
ESDM	Electronics System Design Manufacturing
MITRA	Mega Integrated Textile Region and Apparel
DCS	Development Capital Support
CIS	Competitive Incentive Support
PMMSY	Pradhan Mantri Matsya Sampada Yojna
MFPS	Mega Food Parks Scheme
MSE-CDP	Micro and Small Enterprises Cluster Development Programme
CFC	Common Facility Centers
GHG	Greenhouse Gas
SIPAB	Strategic Intervention for Promotion and Adoption of Bioplastics

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