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INDIAN CENTRE FOR PLASTICS IN THE ENVIRONMENT (ICPE)
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NEWSLETTER

ECO-Echoes

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January - March 2025

PET RECYCLING IN INDIA: TRENDS, CHALLENGES AND OPPORTUNITIES WITH FOCUS ON B-TO-B RESIN INCLUDING CHEMICAL RECYCLING AND BIO-CHEMICAL RECYCLING

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TO UNDERSTAND THE INDIAN PET INDUSTRY, IT'S CRUCIAL TO LOOK AT ITS RAPID GROWTH – FROM 1.10 MN TPA IN 2020-21 TO 1.9 MN TPA BY 2024-25, GROWING AT 12-14% ANNUALLY.

By Rajesh Kumar Gera

The PET Recycling industry had a turnover of ~Rs 5 K Cr in 20-21, which had increased to Rs 8 K Cr plus in 24-25. India is proud to be having one of the highest PET recycling rates @ 92% & competing with the best globally. The Indian Recycling industry is consisting both of unorganized and organized recyclers. There are Value-added recycled products made from RPET and the Indian PET recycling industry is projected to grow @ 15-20 % p.a. in the coming years.

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PLASTIC WASTE GENERATION IN INDIA

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ICPE assessment: Editor

CPCB issued Standard Operating Procedure (SOP) for Characterization & Assessment of Plastic Waste Generation on June 24, 2024. As per actual assessment conducted by CPCB in 20 select cities across the country in June 2022, it was revealed that average percentage of plastic waste in the total stream of municipal solid waste (MSW) was around 12.2%. The plastic waste percentages in cities ranged from 8% to 17%.

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EDITORIAL

By: T. K. Bandopadhyay

Current edition of ICPE Eco-Echoes Newsletter has focused on an innovative and pioneering research result of manufacture of synthetic aggregates for substituting natural aggregates, a crucial component required for construction activities like roads & buildings, from uncontrolled and inadvertently disposed plastics waste from landfills and bauxite residues from industrial activity. It is hoped that this innovation would lead to a greater achievement of development.

This edition of Newsletter has carried out PET Bottle Recycling process in a comprehensive manner. Historical story of the development of PET Recycling in the country has been described by an expert of a large-scale corporate in the country.

Quantum of plastics recycled in the country has been an ambiguous figure among the policy makers and the industry alike. ICPE, in a joint exercise with Industry Association Apex Body, Plastindia Foundation (PIF), has dwelled on the subject and studied the improved techniques of solid waste collection system and records of Central Pollution Control Board (CPCB) and has analysed the whole process of plastics waste collection system of the central government body to arrive at an authentic figure of plastics waste collection in the country. Readers may like to interact with ICPE on the issue, if they feel so.

It is always a positive signal when general public voluntarily acts on plastics waste management activity on the ground level. A case in reference is the voluntary initiative of the residents of a large residential township complex in Mumbai for the collection of plastics waste accumulated in the waste stream of the township and using it for the construction of a bituminous road within the complex. Team ICPE is happy to have responded to the call of representatives of Indian Navy personnels who reside in the township and provided all technical and other assistance in constructing the bituminised road with waste plastics. A brief story on this has been carried in the Newsletter.

In the FY 2024 – 25, ICPE crossed one lakh attendees in the awareness campaigns organised in schools and colleges throughout the country, both in virtual and physical modes. All India School Contest – 2025 is under progress and preparations are under way to conduct the 2nd event of ICPE Recycle Olympiad 2025. A report has been prepared and included in the Newsletter.

The GoI has implemented the Scheme for Setting up of Plastic Parks at different locations of the country, to support setting up need-based Plastic Industry, with requisite state-of-the-art infrastructure. Ten Plastic Parks have been set up till now, details of which have been reported.

Important information on sector wise global greenhouse gas emissions has been shared in the Data Sheet.

For any clarification, readers may kindly contact the Editor.

Designed & Recreated By: Sudheer Khurana

PET RECYCLING IN INDIA: TRENDS, CHALLENGES AND OPPORTUNITIES WITH FOCUS ON B-TO-B RESIN INCLUDING CHEMICAL RECYCLING AND BIO-CHEMICAL RECYCLING

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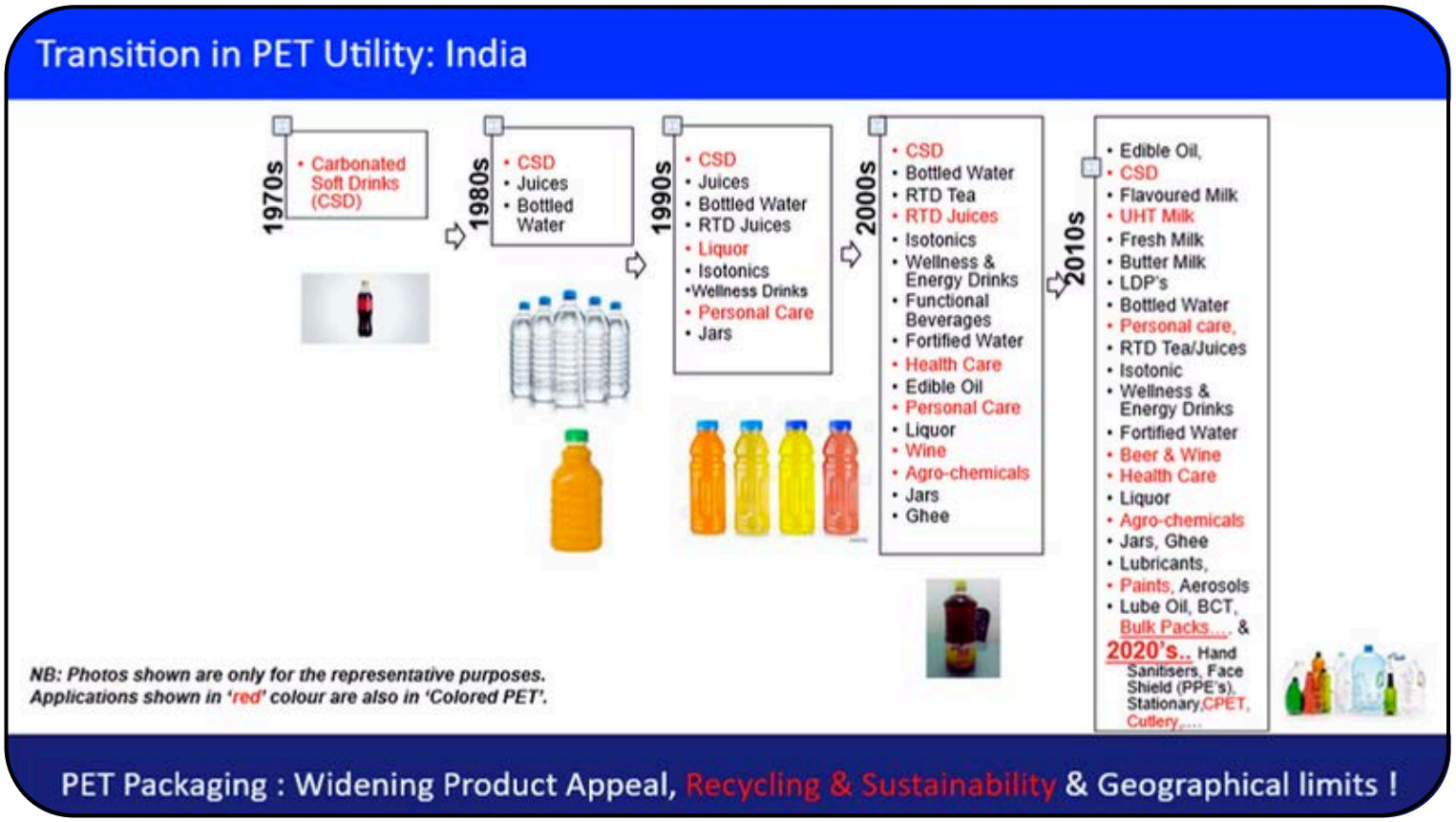
By Rajesh Kumar Gera

>>> EXECUTIVE SUMMARY

The PET Recycling industry had a turnover of ~Rs 5 K Cr in 20-21, which had increased to Rs 8 K Cr plus in 24-25. India is proud to be having one of the highest PET recycling rates @ 92% & competing with the best globally. The Indian Recycling industry is consisting both of unorganized and organized recyclers. There are Value-added recycled products made from RPET and the Indian PET recycling industry is projected to grow @ 15-20 % p.a. in the coming years. It is estimated that the Indian PET recycling industry will have a turnover of Rs 10 K crore plus in the next 2-3 years' time. In addition to the traditional mechanical recycling, there is a growing interest in chemical and bio-chemical (Enzymatic) recycling for the 'difficult to recycle PET Packaging and other polyester materials like textiles'.

Introduction: It is important to first understand the Indian PET Industry and how it has grown. The PET resin consumption was 1.10 Mn TPA in 20-21 and has been growing @ average 12-14 % p.a. The Indian PET Resin consumption of 1.9 million MTPA (24-25) consisted of Bottles: 92%, Sheet: 4 %, Strapping/monofilaments: 2% & Others: 2%. The different applications are enclosed



Recycling Industry in India: The PET bottle usage was 1.9 MMT (24-25) & recycled PET usage was 1.75 MMT (@ 92%). There are 200 plus Collection-cum-Baling Centers in India & are ever growing.There is surely a shift for moving away from the unorganized informal set-up to organised formal recycling setups.It is primarily 'Mechanical Recycling' of PET packs in India. There are 50+ medium-to-large scale manufacturing units using washed flakes of 'Recycled PET'

Process: The PET recycling in India typically starts with a 'waste collector/rag picker' collecting the discarded PET bottles from different sites incl. dump sides. These in turn get sold to the 'Kabadiwallahs' (waste traders), who sort 'PET' from 'Other plastics' & make bales. The baled bottles are transported to 'Recyclers', who do sorting, removal of metals, caps, rings, labels etc. These are shredded, washed, & dried. The dried flakes are sent to the textile spinning units and recycled polyester fiber made is then used to make polyester fabric & for other end-uses. There is a growing interest to make B-to-B resin from recycled PET flakes. It involves special washing process and decontamination along with other standard recycling processes.

Trends in usage of Recycled PET resin in India: The Use of 'Recycled PET' is allowed by BIS for packaging of 'Non-Food Items' in India. The major FMCG producers (non-Food) have started using 'RPET' resin and the initial target is 30% RPET in 25-26. The RPET has been approved byFSSAI for use in direct food contact end-uses. Some of the major brand-owners are already using B-to-B PET resin for packaging of Water, CSD (Carbonated Soft Drinks), Liquor & other products in India. The 'Consistent Availability of Quality RPET resin' is the key. PET is the first material of choice, due to its ease of recyclability & the established PET recycling systems.

Challenges: One of the major challenges is 'Traceability'. One of the key differentiators in recycling ecosystem is the assurance of 'Traceability'. The move is thus towards Digitalization and Block-Chain/AI driven SCM of RPET bottles.The brand-owners & regulatory bodies are now paying far more attention in this regard & it will further improve the Quality of recycled chips. The other major challenge is the availability of consistent quality rPET material. There are concerns on IV & 'Lab' values. It is being addressed by improvising different steps in mechanical recycling; including both the sorting & washing processes.

Applications: The different end-uses of RPET in India include "Fiber Fill, non-Woven, POY, PSF, monofilament, Bottles for Food and non-food applications, Sheets, Strap, Injection moulding, Masterbatches" among others. It has more applications in 'non-Bottle' end-uses, esp. the fiber industry.The polyester fiber is used as a filling material for cushions, pillows and converted to fabrics for use in clothing, upholstery. These products include "T-shirts, caps, jackets, scarfs, carry bags" etc. Just for instance, the Indian cricket team's apparel is made from recycled PET bottles. Some of the other applications in India are for "non-woven (for automobile, carpets, boot liner, Headliner), synthetic leather, fiber filling, spun yarn and textiles''. It is encouraging to note that companies like Adidas, Nike and few others make athletic merchandise from recycled polyester in India. This makes their brand more 'Greener' (Circular) & it helps command a premium over their regular products. In the non-bottle area, RPET sheet usages include 'Blister Packaging of Toothbrushes/Battery cells/Toiletries' etc. both for the domestic as well as for the export markets by major brand-owners. It has been enabled by collaboration between all the stake holders including the major Indian PET raw material manufacturers, sheet suppliers, thermoformers/FFS companies along with the brand-owners & machinery suppliers.

Machinery: As Quality of recycled chips depend on all the process steps, so there is sure shift in the Indian mind-set towards high-end recycling machines for the new recycling projects in India, so as to get further improved Quality of recycled PET chips. Technical alliances both at the Indian & Global level for 'Recycling' machinery are in offing & many such machines are being made in India with foreign collaboration. Ishitva Robotic Systems Pvt. Ltd. have made some significant inroads in sorting machines for handling the mixed plastic waste including PET.

Promotion: There has been quite a spurt in installation of 'Reverse Vending Machines' (RVM) in the last 7-8 years with the concerted efforts of machinery suppliers & PET resin manufacturers. There are 1000 plus RVM machines installed all-over India. The objective has been to sensitize both the public & decision makers on the need for recycling and to create an awareness in the minds of decision makers about the vast recycling ecosystem existing for PET recycling in India.

Regulations: In India, Bureau of Indian Standards (BIS) frames standards for different packaging materials and end-uses including recycled resins. For e.g., IS 14534: 2023 covers guidelines for the recovery & recycling of plastic waste and IS 14535: 1998 is the BIS for using recycled plastics for the manufacturing of different products focusing on non-food sectors. The use of 'RPET' in 'Food and Beverages' end-uses was not allowed till recently in India.

FSSAI had come out with 'Draft Food Safety and Standards Packaging (Amendment) regulations' for use of recycled plastics in '22 as food contact materials based on PWM rules 2021. They have now come out with Guidelines for Acceptance of ''Recycled Polyethylene Terephthalate (PET) as Food contact material (FCM-rPET)". The scope of this guideline pertains only to the recycling process/operation of transforming post-consumer PET used for food applications into recycled PET as Food contact material (FCM-rPET) resins suitable for making food contact materials. It covers the acceptance criteria for using (FCM-rPET) resin in food contact materials. It applies only to the recycling technology approved by FSSAI. It does not apply to production of resins for non-food grade consumer applications.

Thus, approved guidelines & acceptance criteria for use of recycled post-consumer PET for the food contact applications is also being made effective for implementation. The draft amendment regulations are in process of approval by BIS and its notification in the near future. The India's regulatory landscape is evolving to support technologies for production of food – contact grade rPET resins. Under the amended Plastic Waste Management Rules, Producers, Importers, and Brand Owners (PIBOs) are mandated to include a minimum percentage of recycled plastic content in their packaging. For rigid plastic packaging, which includes PET bottles & containers, recycled content requirement is @ 30% for FY 2025–26 & increasing upto 60% by 2028–29. This regulatory push aligns with the capabilities of different technologies & creates a robust market demand for high-quality recycled PET for food-grade applications.

RPET for Food-Contact Packaging (B-to-B resin): Technologies

1. Mechanical Recycling (Super Clean Process)
2. Melt-In Recycling
3. Paste-In Recycling
4. Chemical Recycling &
5. Bio-Chemical Recycling (Enzymatic recycling)

Mechanical Recycling (Super Clean Process)

The mechanical recycling process for rPET for non-bottle uses involves 'Sorting & Washing'. In B-to-B resin, flakes further go through decontamination, SSP & granulation for use in bottles for direct Food Contact applications. The 'Super Clean' rPET process is the conventional recycling process, which has been enhanced with an integrated decontamination step (as specified by FSSAI or any other regulatory body) to remove absorbed contaminants through a combination of surface treatment, high heat, and/or high vacuum in a controlled environment so that the output can be used for direct food contact applications. It has multiple levels of decontamination: Pre-drying/Plasticising/Filtration/Pelletising/Crystallising/Cooling/Bagging. The decontamination process happens in extruder and in SSP. The SSP process is conducted in an inert gas atmosphere.

There are increasing demands on the Quality of rPET recyclate. The brand-owners demand on AA/Benzene/BPA contents and there are guidelines on material, source and collection system. Capacity of recycling lines vary from 2 to 8 TPH and the delta IV achieved in SSP is in range of 0.16-0.22 dl/g. There are couple of manufacturers of 'B-to-B' PET resin on a pan-India basis and many more new lines are getting commissioned in '25 for the rPET resin suitable for direct food-contact packaging. There is a limited availability of food grade rPET resin and there is a premium for the B-to-B PET resin vs. the virgin PET resin made by the fossil route. The total installed capacity of B-to-B PET resin will be 11 Lac MT plus by 2030 with an estimated investment of Rs 7.5 K CR plus in these recycling systems to make B-to-B PET resins in India.

2. Melt-In Recycling

Virgin PET (vPET) production operation enhanced with the ability of incorporating PET flakes in the molten form. It is decontaminated through a combination of high heat and high vacuum

3. Paste-In Recycling

Virgin PET (vPET) production operation enhanced with the ability of incorporating PET flakes in the paste form, via partial glycolysis. It is equipped with an integrated system of removing absorbed contaminants via chemical distillation, vacuum degassing etc.

Advanced Recycling: The demand for rPET resin in long run can't be met solely by mechanical recycling. There is a growing interest in non-mechanical PET recycling globally & also in India. This includes both chemical recycling & bio-chemical (enzymatic) recycling technology for PET recycling. The chemical recycling is already being done in a small way in India. These recycling processes will help to power both the PET bottle & Textile recycling and circularity.

We will now elaborate more on the **'Chemical and Enzymatic Recycling of Polyesters' covering the Process, Advantages and the Opportunities.**

4. Chemical Recycling

While mechanical recycling remains the most widely adopted method for processing plastic waste, its limitations become apparent, as waste streams grow more complex. Materials such as colored, opaque, multilayer plastics, and polyester-based textiles often fall outside the scope of conventional recycling systems and more often than not, end up in landfills or incinerators. In this context, the chemical recycling emerges as complement to mechanical recycling methods. By breaking down the plastics into their molecular building blocks, it enables the high-quality recovery of materials that would otherwise be lost—particularly for food-grade applications.

Chemical recycling is the broad term used to describe a range of emerging technologies in the waste management industry which allow these plastics to be recycled, which are difficult or uneconomical to recycle mechanically. It's a broader term encompassing various techniques like pyrolysis, gasification, and depolymerization. Chemical recycling transforms PET waste into new raw materials by breaking down the polymer chains, offering a more sustainable alternative to traditional mechanical recycling. This process allows for the recovery of valuable chemicals/ building blocks (monomers). These monomers can then be used as raw materials for the production of new plastics, chemicals, high-quality PET raw material resin, which is suitable for direct food-contact packaging applications or even fuels. These Chemical recycling processes will thus have higher differentiated CAGR for PET/Polyester recycling in the near future.

The Chemical Recycling technology is transforming post-consumer PET waste into high-purity, food-grade rPET resin. Unlike mechanical recycling, which may degrade plastic Quality over time, chemical recycling breaks down PET plastic at the molecular level, restoring it to its original monomers. It allows for repeated recycling without loss of quality, thus ensuring true circularity. It is also called Advanced Recycling, Enhanced Recycling, Conversion or Molecular Recycling. It covers all kinds of recycling technologies that decompose polymers into component monomers, oligomers, or hydrocarbons, using heat, chemical or biological solvents.

Glycolysis Process: The raw material is waste PET bottles flakes. The proprietary two step low temperature glycolysis process involves conversion from solid to liquid phase change & then polyester to ester phase change. A typical chemical recycling process involves depolymerizing the used PET bottles into basic building blocks as BHET (Bis(2-Hydroxyethyl) terephthalate). This process utilizes ethylene glycol (EG) as a key reagent, typically in presence of a catalyst & under specific temperature conditions, usually between 180 to 240 °C. The glycol is finally recovered through distillation. The purified monomers are repolymerized into virgin-equivalent PET, suitable for sensitive applications like food & beverage packs. The Filtration & De-colourisation is a multi-step process to remove all impurities such as glues, dyes, flavour, paper etc..

The recycled esters, equivalent to the esters produced from fossil fuel are produced. IV values up to 1.05 are achieved with Solid State Polymerisation (SSP) process. This method not only enhances material performance but also drastically reduces dependence on fossil fuels and virgin plastic. The chemical recycling process however faces twin challenges of high costs and the need for advanced recycling technologies. There's also a need for increasing the public awareness and support for chemical recycling to drive the demand for chemically recycled materials.

Technology Providers: One of the leading technology suppliers globally for chemical recycling is Axens. One of the most promising technologies in this field is Rewind™ PET, developed by Axens, a solution that is now commercially available and licensed globally by Axens. The Rewind™ PET process is designed to upcycle virtually any PET-based material, including: Transparent, colored, and opaque PET bottles, Mono- and multi-layer PET trays, and Polyester-based textiles.

Additionally, a key differentiator of this technology is its ability to valorize polyester-rich textiles, enabling a true fiber-to-fiber circular solution for the textile industry, an area where recycling rates remain critically low. This technology thus upcycles any PET waste into food grade. It can be integrated either in an existing or in a new PET resin production plant. The amount of recycled material included in the rPET product is adjustable up to 100% depending on market demand. The LCA study results demonstrated a significant reduction in environmental impact, particularly in CO_2 emissions (49% less vs. virgin PET from fossil resources), underscoring the technology's potential to contribute meaningfully to climate change mitigation. There re couple of manufacturers doing Chemical Recycling of rPET in India.

5. Enzymatic Recycling

Executive Summary: Enzymatic recycling is a fast-emerging technology globally with latent potential in India. It allows recycling of Polyester waste, which is largely not recycled. All these wastes could be recycled on a large scale tomorrow & thus potential of these end-of-life materials is enormous in India. It gives scope to leverage on far more economical feedstock, as one can use all types of waste polyester textiles along with the difficult to recycle PET bottles in this process.

Introduction: The PET mechanical recycling industry is fairly well established globally, including India. There is, however, a need for recycling processes for difficult-to-recycle polyester materials. These include colored PET bottles, trays, laminates and polyester rich textiles. Enzymatic recycling is a fast-emerging technology globally with huge latent potential in India. The development of bio-recycling technologies to reinvent the life cycle of PET plastics and polyester textiles is meeting the challenge to move from 'end-of-life' to 'end-of-cycle' models.

It is important to first understand basic principle of enzymatic recycling. The depolymerisation technologies break down plastics like PET into monomers (PTA & MEG), so that they can be transformed back into new plastics (PET resin). This process thus breaks molecular chains & decomposes plastics into monomers and once purified, they can be used to form new high-quality plastics (PET). Enzymatic depolymerisation process is quite promising, as it uses the enzymes, as catalysts to decompose polymers. One of the technology suppliers (Carbios) has done successful alliance of Polymer science and enzymology. The process enables enzymatic recycling of PET and results in virgin-like monomers. It will have high purity and consistent rPET quality allowing for direct food contact applications.

Process: Enzymes are currently used in many everyday applications (detergents, biofuels, food, textiles and paper), but using them for the degradation and thus enabling the recycling of both the plastics and textiles for industrial purposes was not considered in the past. These enzymes have been developed to optimize polymer degradation activity. Their activity, including the thermostability, is required for the efficient and competitive implementation in the industrial recycling processes. These optimised enzymes are used in the enzymatic recycling (both for the PET Packaging & for Textiles) & increasing composting efficiency of Biodegradable Plastics (PLA)

The process enables enzymatic recycling of PET & results in virgin- like monomers. It has high purity & constant rPET quality allowing direct food-contact usage. This technology has already matured from demonstration plant stage to industrial scale & is set to enter soon commercial plant stage. The different steps involved in the enzymatic recycling are pre-treatment (including sorting, washing etc.), surface preparation, enzymatic depolymerisation (from polymer to monomers), filtration steps, separation of TA (Terephthalic acid) & MEG (Mono ethylene glycol), followed by purification of TA & MEG. It results in monomers of virgin-like quality. These can be then re-polymerised into PET of a quality equivalent to that of virgin PET, as obtained from the fossil route.

Advantages: Enzymatic depolymerisation recycling process helps to produce high-quality plastics without the use of petroleum. It allows recycling of 'difficult to recycle polyester materials' (both Packaging & Textiles), to produce new materials. It has enhanced circularity (more cycles with constant rPET quality), soft biological process (solvent-free, water-based & low temperature depolymerisation resulting in virgin-like quality) & high-standard LCA (less CO_2 emissions v/s virgin PET resin from fossil fuels). It results in circularity per industry (Packaging to Packaging & Textiles to Textiles) & it gives flexibility to polyester recycling industry to use cheaper feedstocks.

Opportunities: The rPET resin/end-products from the enzymatic recycling process finds applications in the packaging, both for direct food contact and also for non-food contact end-uses. There is also a huge latent potential for the recycling of 'Textiles to Textiles', which is presently not happening in India. The use of this recycled polyester allows the brands to be 'Circular' and it will thus attract a premium over their regular products. A faster market penetration will be thus enabled by the active collaboration between all the stakeholders, including PET and/or Polyester raw material manufacturers, machinery and technology suppliers, along with the brand owners.

Indian Scenario: This technology is now in its production stage globally with a demo plant already working in France. In India many of the major stake-holders in the recycling eocsystem are studying the possibilities for enzymatic recycling process/technology; both for the difficult-to-recycle PET packaging (bottles/sheets)as well as for the recycling of polyester-rich textiles.

Conclusion (Enzymatic): The conversion of plastics waste into resources is one of the main thrusts of the circular economy. Enzymatic recycling is a niche opportunity, as it allows recycling of those 'difficult to recycle polyester waste' which is largely not recycled, such as cosmetic packaging, mixed packs, colored bottles, multi-layer food trays etc. & also polyester textiles. All these wastes could be recycled on a large scale tomorrow & so potential of these end-of-life materials is enormous. These bio-recycling plants need to be multiplied globally under a licensing model to enable local supplies & recycling, including India. It will create a sustainable ecosystem to meet both the consumer demands & strategically contribute to the recycling economy. Plastic and textile waste is thus a precious raw material, enabling the circular economy to become an industrial reality. Partnering at 360° among different stakeholders will lead to faster innovations, unique solutions, enhanced sustainability and creation of value-added businesses in India.

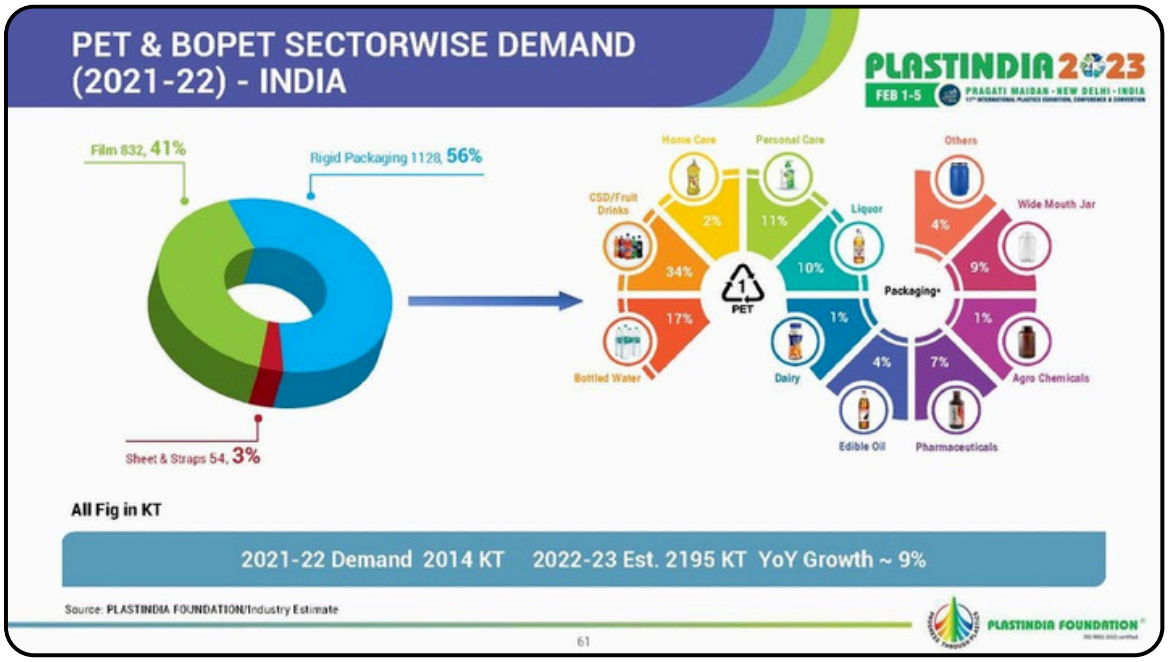
PET Recycling: Indian Ecosystem

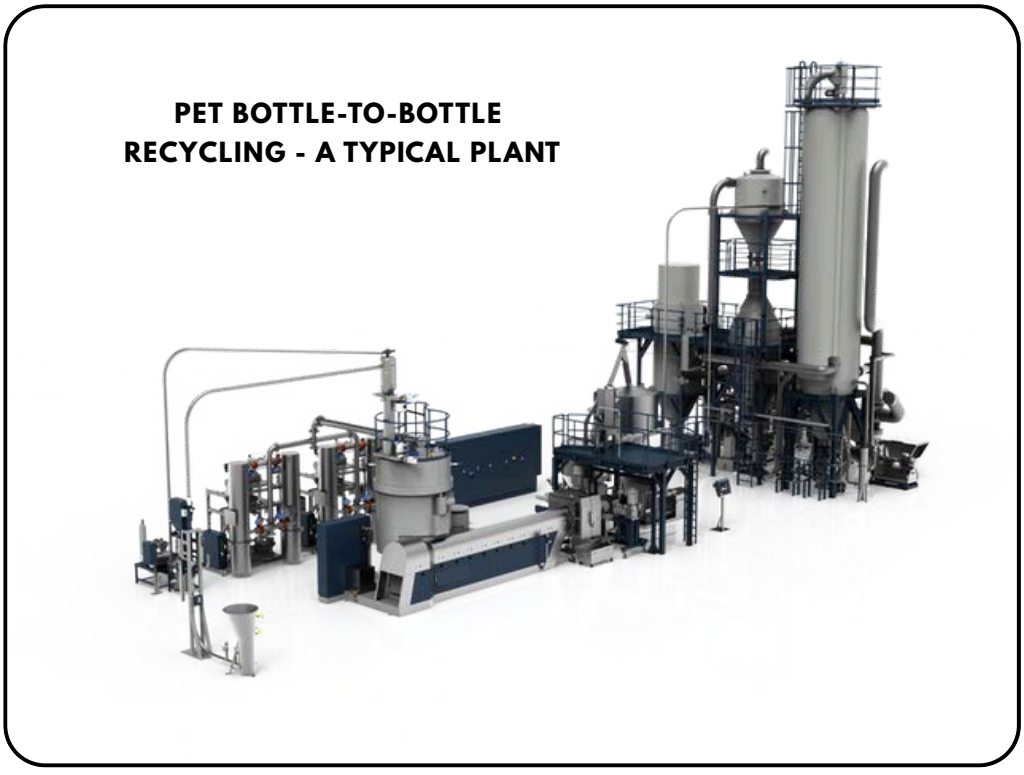
Although PET is a relatively new packaging material, its 'Versatility, Affordability and Convenience' is contributing to its rapid growth in India. It is thus putting an equally increasing pressure on the recycling infrastructure. The Indian societies likewise globally are now on learning curve in their 'Usages, Handling & Disposal' of different types of PET and rPET packaging's.They are benefitting with better management of PET waste, including difficult to recycle PET Packaging / Polyester textile materials through chemical & enzymatic recycling systems. It is also parallelly introducing more RPET items in system including those for direct food-contact applications. The need is to ensure traceability and food safety through FSSAI-compliant processes and thus setting up new benchmarks in the recycled polymer quality.

The Final word: Way Forward!

'Design for Recycling' is the new Key for a product launch in India & globally. The regulatory support being extended by FSSAI and BIS will further expand the scope of RPET in India including difficult-to-recycle rPET items (both for Packaging & Textiles). It will help to open up new avenues for all in the value-chain in the recycling ecosystem. The Sustained mantra of 'Reduce & Reuse' & Technologies for 'Mechanical, B-to-B PET resins, Chemical & Enzymatic Recycling' will help to establish a robust 'Recycling & Sustainability' Eco-system for all.

There is a 30% mandatory recycled content regulation for rigid plastics in FY 2025-26 & all these technologies have to work hand-in hand for same. A similar trend is seen globally. Investments by large players in mechanical recycling & depolymerization technologies is on the horizon. 'Design for Sustainability' & 'Ease of Recycling' is now in vogue. Countries have benefited from 'Circularity of Plastics' for better management of waste & so will India. Versatility, Affordability, Convenience & Recyclability will continue to contribute to the growth of rPET industry!





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AGGREGATES FROM WASTE LANDFILL PLASTICS AND BAUXITE RESIDUES FOR SUSTAINABLE INFRASTRUCTURE DEVELOPMENT

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The growing number of infrastructure projects has led to a significant rise in the demand for one of the most critical resources in the construction industry, i.e., natural aggregates. To meet this demand, unregulated and excessive mining activities that result in adverse impacts on ecosystems, biodiversity, and natural landscapes is very common. On the other hand, because of the urbanization and industrialization, there is a huge accumulation of waste plastic in landfills, and the generation of bauxite residue (commonly known as red mud), a by-product from the alumina refineries, poses serious challenges related to disposal, environmental pollution, and the formation of micro- and nano-plastics. To overcome these concerns, manmade aggregates (refer to the Figure below) from the unsegregated and untreated mixed plastics from the landfill (M/S Antony Lara Enviro Solutions Private Limited, Mumbai, India) and bauxite residues (supplied by M/S Hindalco Industries Ltd., India) were synthesized. These aggregates reduce dependence on the natural aggregates and promote the beneficial reuse of industrial and municipal waste materials. The synthesized aggregates were comprehensively characterized for their physical, morphological, chemical, thermal, and mechanical properties and benchmarked against natural aggregates. The results indicate that these artificial aggregates hold promising potential as a sustainable and viable alternative for the natural aggregates for infrastructure development, addressing the critical issues like resource conservation, waste reduction, and circular economy and the Sustainable Development Goals (SDGs).

Aggregates synthesized using landfill plastics and bauxite residues

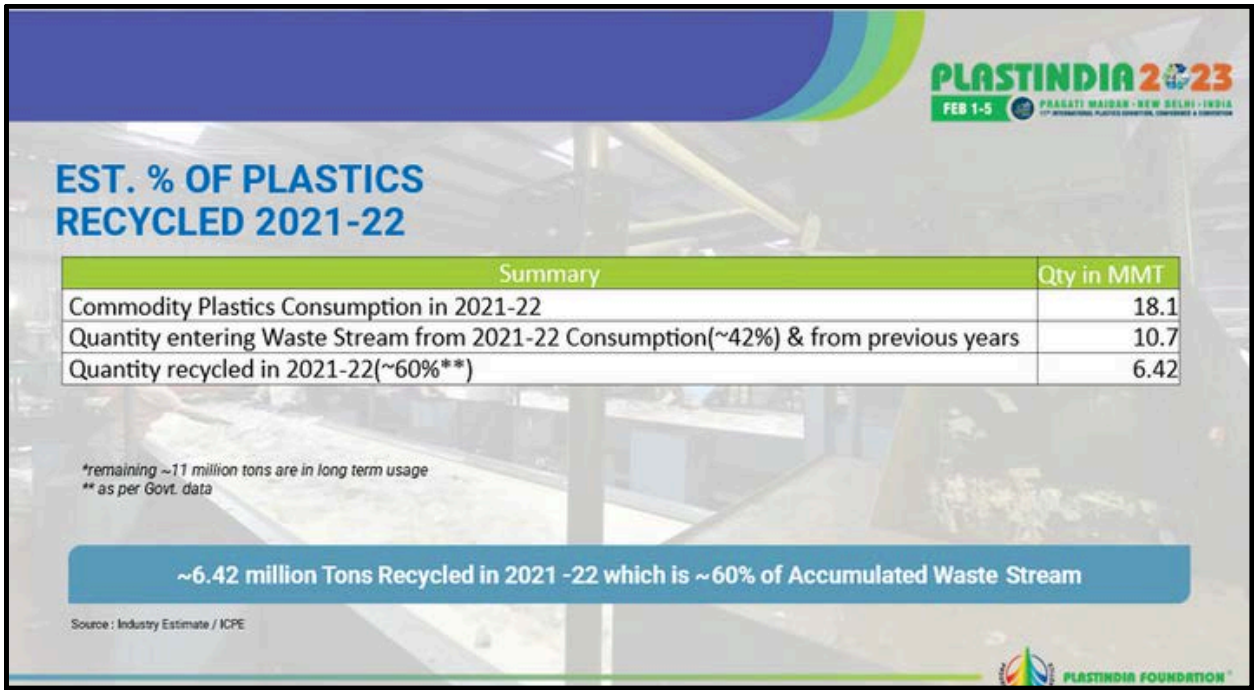
PLASTIC WASTE GENERATION IN INDIA
ICPE ASSESSMENT: EDITOR

CPCB issued Standard Operating Procedure (SOP) for Characterization & Assessment of Plastic Waste Generation on June 24, 2024. As per actual assessment conducted by CPCB in 20 select cities across the country in June 2022, it was revealed that average percentage of plastic waste in the total stream of municipal solid waste (MSW) was around 12.2%. The plastic waste percentages in cities ranged from 8% to 17%.

Extrapolating the result for the whole country, which generates about 60 Mn T of MSW, the average generation of plastic waste in the country is estimated to be 7.32 Mn T.

Again, according to CPCB, India recycles 60% plastic waste it generates. Accordingly, it is estimated that about 4.392 Mn T of plastic waste was recycled in India in 2022.

Plastic Industry and ICPE estimation of India's plastic recycling quantum in 2021 – 22 at about 6.42 Mn T.



Unlike in many other countries including some developed countries, rigid plastics waste does not pose any waste management issues in India. All rigid plastics waste is readily collected from the waste stream sooner it reaches there, by the informal waste collectors and forward it to the recyclers and earn their livelihood. Value of rigid plastics waste is remunerative. However, flexible plastics waste mostly remain unattended except for one or two types of flexible plastic waste, due to its non-remunerative values. India needs more attention for managing unattended flexible plastics by adopting appropriate methodology.

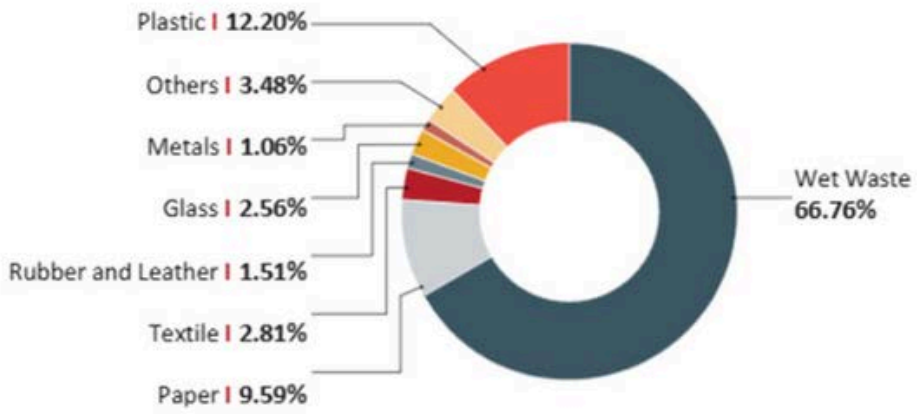
Government of India's implementation of EPR regulations for the stake holders (Producers, Importers, Brand Owners and the Processors) for ensuring recycling of the plastics packaging waste within stipulated time, is a positive step to achieve Plastics Waste Management goals.

Mechanical Recycling is the most opted processing method while Chemical Recycling (Pyrolysis) is gaining interest in urban areas. More than 100 KT was recycled through pyrolysis method in 2022.

Table 8: Average municipal waste composition in 20 cities

Component	Range (%)	Average (%)
Wet Waste	53-80	66.76
Dry Waste	20-47	33.36
Paper	4.8-20.7	9.59
Textile	1.1-4.7	2.81
Rubber and Leather	0.2-3.5	1.51
Glass	1-6.3	2.56
Metals	0.3-3.3	1.06
Others	2-5.6	3.48
Plastic	8-17	12.20

Figure 8: Average Municipal waste composition



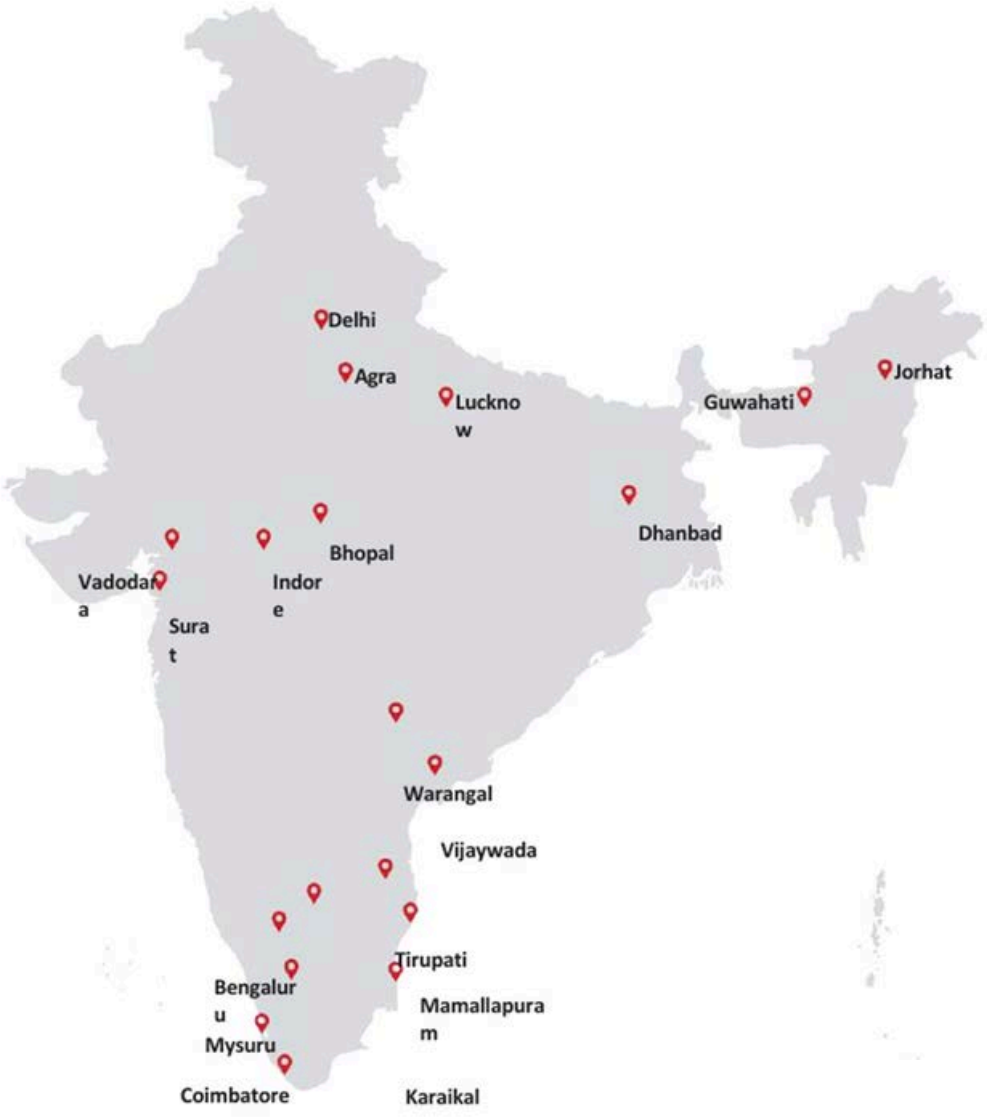
3.1.1 Selection of Cities

The study was done in 20 cities across 11 states, with diversity in location, population, waste generation quantity and current waste management practices. The selected cities are given in Table 6 and shown in MAP 1 below. The selection of the 20 cities was done at three levels:

1. Stratification of the cities to ensure best representation of the country, and to best capture the diversity (hill, plain, tourist, capitals, etc.).
2. Stratification in terms of population, waste management practice, Swachh Sarvekshan ranking, and quantum of waste generation.
3. Lastly, cities with better waste data collection were selected to cross-check the inventory results and thus establish the robustness of the methodology.

1. Delhi •South Delhi Municipal Corporation 2. Uttar Pradesh •Agra •Lucknow	1. Karnataka •Mysuru •Bengaluru 2. Kerala •Alappuzha •Thiruvananthapuram 3. Andhra Pradesh •Tirupati •Vijayawada 4. Telangana •Warangal 5. Tamil Nadu •Coimbatore •Mamallapuram 6. Puducherry •Karaikal	1. Jharkhand •Dhanbad	1. Gujarat •Surat •Vadodara	1. Madhya Pradesh •Bhopal •Indore	1. Assam •Guwahati •Jorhat

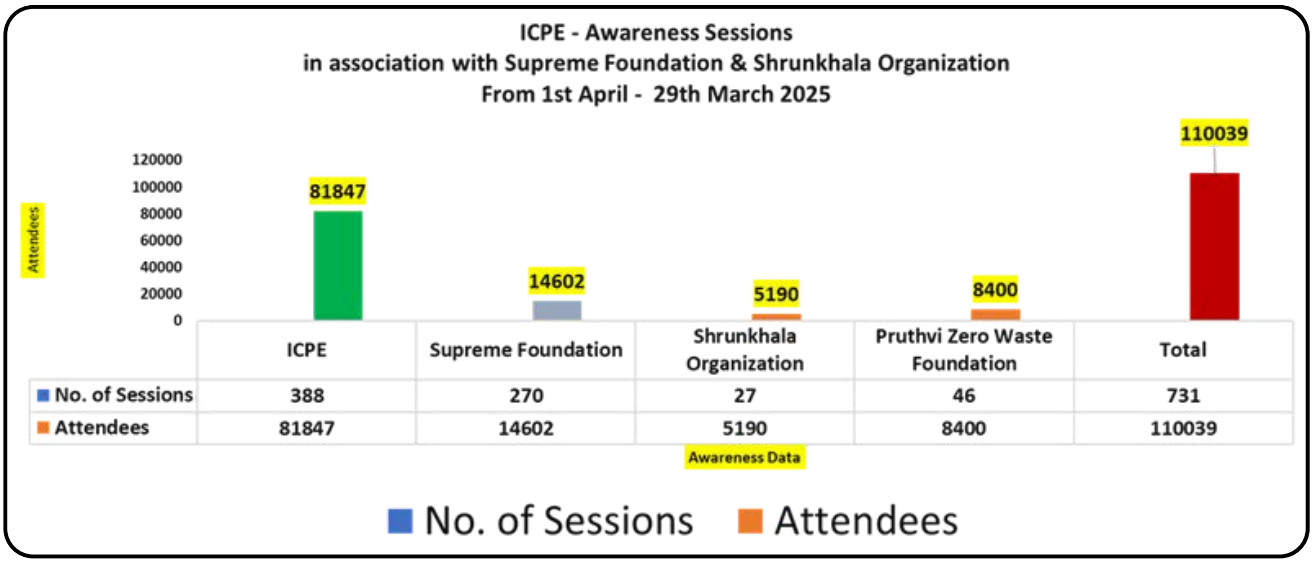
Map 1: Cities selected for the survey



Map disclaimer: The geographical map is for informational purposes only and does not constitute recognition of international boundaries or regions. GIZ and SIA makes no claims concerning the validity, accuracy or completeness of the map nor assumes any liability resulting from the use of the information therein.

AWARENESS PROGRAMMES IN SCHOOLS & COLLEGES

In the FY 2024 – 25, ICPE crossed one lakh attendees in the awareness campaigns organised throughout the country both in virtual and physical modes. Actual number of attendees was 110039 in total number of 731 sessions in more than 500 schools, covered by ICPE and its partner organisations. Details have been reflected in the bar chart given below.



AWARENESS PROGRAMMES....CONT...

ALL INDIA SCHOOL CONTEST – 2025

ICPE continues organising All India School Contests among the young generation inviting ideas for addressing the issues of plastics in the environment in the country. Theme questions for this year's

'All India School Contest – 2025' being conducted during the period 1st June to 31st August 2025 are:

- **Primary Category Students (Class I to Class IV)**

  What are some important uses of plastics that have made life more convenient?

- **Junior Category Students (Class V to Class VIII)**

  How does using plastics in packaging keep food fresh and safe?

- **Senior Category Students (Class IX to Class XII)**

  Plastics are sustainable material – elaborate.

The process of receiving the entries from the students is under progress. Evaluation and declaration of winners of the contest will follow.

ICPE - PLASTICS RECYCLE OLYMPIAD 2025

After warm welcome of the 1st ever effort to conduct the ICPE Recycle Olympiad in 2024, 2nd edition of the event is scheduled from 20 to 22 October 2025. While in the 1st event 119 schools had registered with about 17000 students, about 600 schools with more than 72000 students have already registered. ICPE is gearing up to conduct the event efficiently.

Questions on issues of plastics in general and plastics waste collection and recycling in particular have been set as the awareness package for the young students, glimpses of which were shared in the last ICPE Eco- Echoes Newsletter which could be traced back to ICPE website.

BITUMEN ROAD WITH PLASTICS WASTE CONSTRUCTED AT NAVY NAGAR, COLABA, MUMBAI

In an encouraging awaken initiative, residents of Navy Nagar, the township complex of Indian Navy personnel at Colaba, Mumbai, demonstrated a unique responsible behavior towards upkeeping the environmental cleanliness effort of surrounding area adding value to the township road infrastructure. Cdr. Sowjanya Shree Gutta of Indian Navy and Col. Shikha Yadav, Head of the EME Services of the Navy Complex decided to collect the plastics waste generated in the sprawling township and use it for constructing bituminized road within the township. They sought ICPE's technical guidance and assistance to construct a bitumen road with plastics waste in the township. (Reference for ICPE activity was sourced from ENVIS website of MoEF & CC, GoI). ICPE readily agreed and provided necessary on the field services to Indian Navy.

Accumulated plastics waste, as collected by the residents of Navy Nagar, was properly ground to proper size as per Indian Road Congress Standard specification. Mixing of plastics waste with hot aggregates and molten bitumen was carried out in a continuous mixing plant at Navi Mumbai. The road was laid in Navy Nagar Township on 25th January 2025. The total surface area of the road was about 850 sq metres spanning about 150 metres long road.

The construction activity went well. ICPE will monitor the condition of the road from time to time for the next few seasons.

The waste plastic conforming to the size passing 2.36 mm sieve and retained on 600-micron sieve was used (Reference Indian Road Congress specification: IRC – SP: 98 – 2013 / IRC – SP: 98 - 2019). Dry Mixing Process of bitumen with plastics waste was adopted.

BITUMEN ROAD WITH PLASTICS WASTE CONT...

R to L: Indian Navy officers: Cdr. Sowjanya Shree Gutta; Col. Shikha Yadav; ICPE team: Sh. Tushar K Bandopadhyay; Ms. Neha Maurya

Bituminous Road with Plastics Waste being constructed at Navy Nagar Township, Colaba, Mumbai

TEAM, ICPE

CONSTRUCTED ROAD

SHREDDING & SIEVING OF FLEXIBLE PLASTICS WASTE AS PER IRC SPECIFICATIONS
COURTESY: THE SHAKTI PLASTIC INDUSTRY, MANOR, PALGHAR.

MINISTRY OF CHEMICALS AND FERTILIZERS

PLASTIC PARKS IN INDIA

ACCELERATING GROWTH OF THE POLYMER-BASED INDUSTRIAL ECOSYSTEM

POSTED ON: 11 APR 2025 1:03PM BY PIB DELHI

INTRODUCTION

The Department of Chemicals and Petro-Chemicals is implementing the **Scheme for Setting up of Plastic Parks** under the umbrella scheme of New Scheme of Petrochemicals, to support setting up **need-based Plastic Parks,** with requisite **state-of-the-art infrastructure**, enabling common facilities through **cluster development approach,** to consolidate the capacities of the **domestic downstream plastic processing industry.** The objective is to **consolidate** and **synergize** the **capacities** of **downstream plastic processing industry** to help **increase investment, production** and **export** in the sector as well as **generate employment.** Under the scheme, the government of India provides grant funding **up to 50%** of the project cost subject to a **ceiling of Rs.40 crore per project.**

A plastic park is an industrial zone specifically designed for plastic-related businesses and industries. It aims to consolidate and synergize the capacities of the plastic processing industry, promoting investment, production, and exports while generating employment. These parks also focus on achieving environmentally sustainable growth through waste management and recycling initiatives.

Plastic Parks have emerged as an integral part of India's strategy for managing plastic waste, promoting recycling, and supporting the chemical industry. **10 Plastic Parks** have been approved so far in different States. Details of funds released to these Plastic Parks during the **last five years are:**

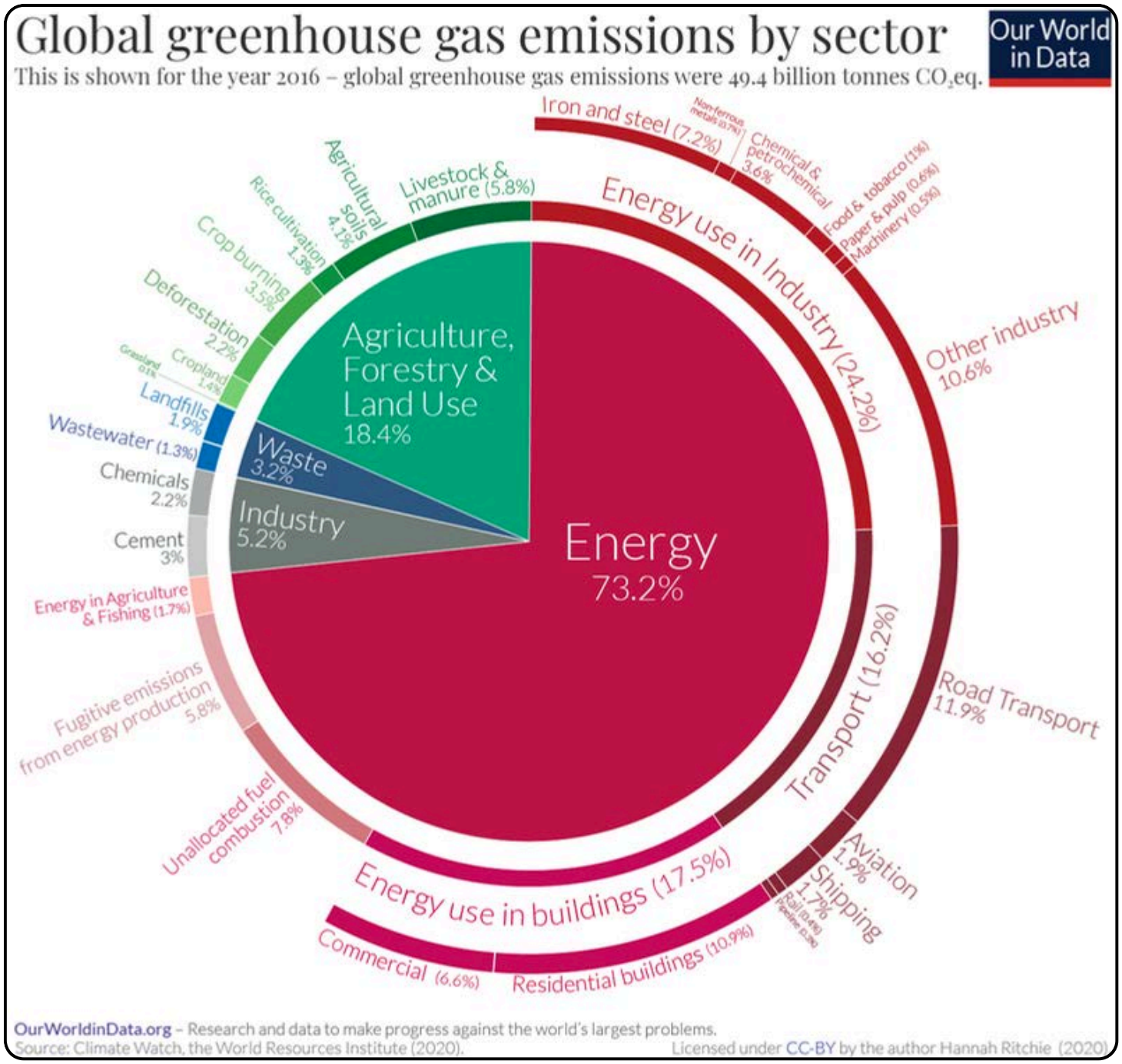
Plastic Park Location	Approval Year	Total Project Cost (₹ crore)	Approved Grant-in-aid (₹ crore)	Amount Released (₹ crore)
Tamot, Madhya Pradesh	2013	108.00	40.00	36.00
Jagatsinghpur, Odisha	2013	106.78	40.00	36.00
Tinsukia, Assam	2014	93.65	40.00	35.73
Bilaua, Madhya Pradesh	2018	68.72	34.36	30.92
Deoghar, Jharkhand	2018	67.33	33.67	30.30
Tiruvallur, Tamil Nadu	2019	216.92	40.00	22.00
Sitarganj, Uttarakhand	2020	67.73	33.93	30.51
Raipur, Chhattisgarh	2021	42.09	21.04	11.57
Ganjimutt, Karnataka	2022	62.77	31.38	6.28
Gorakhpur, Uttar Pradesh	2022	69.58	34.79	19.13

For complete report, Click here

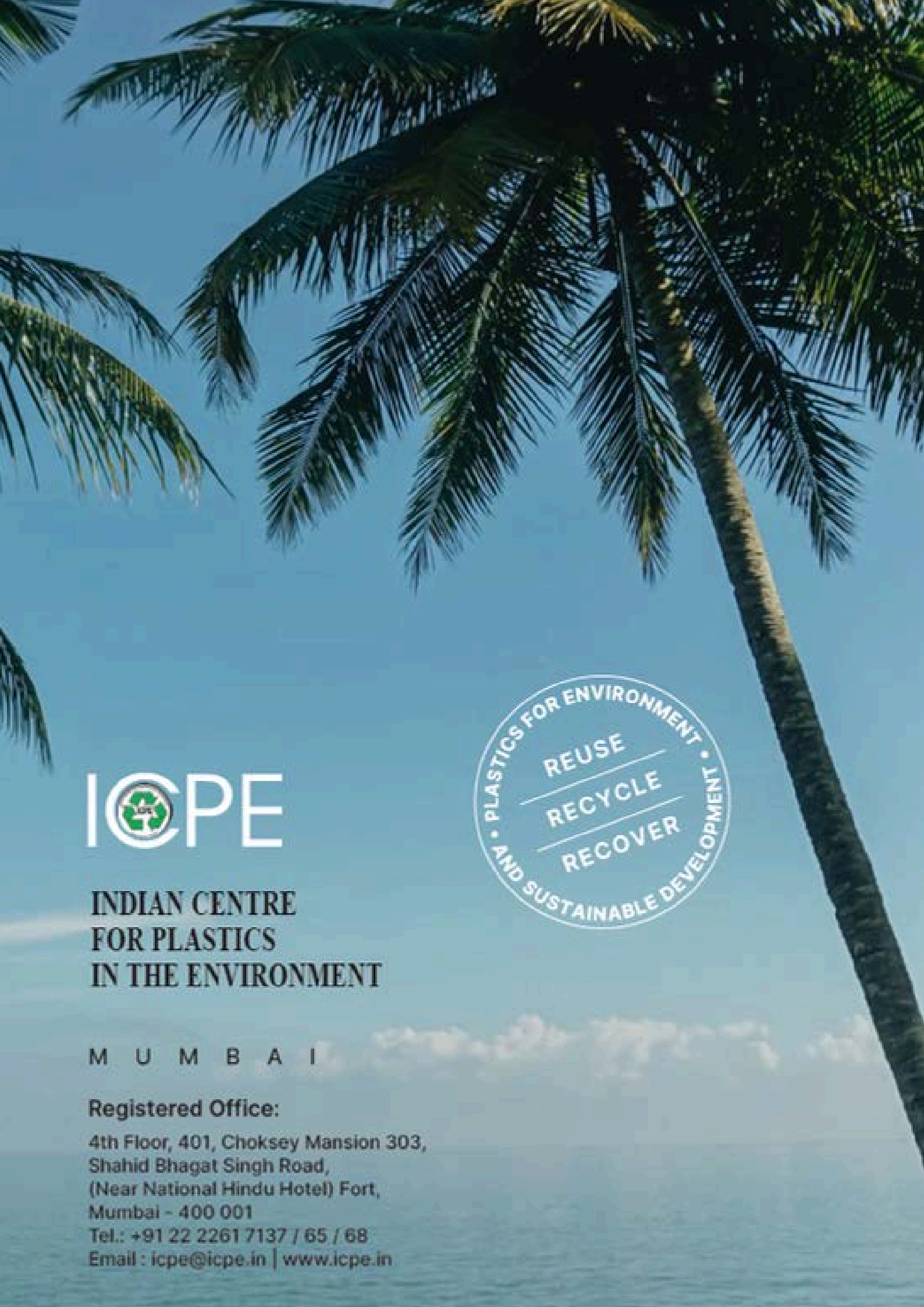
DATA SHEET

SECTOR BY SECTOR: WHERE DO GLOBAL GREENHOUSE GAS EMISSIONS COME FROM?

GLOBALLY, WE EMIT AROUND 50 BILLION TONNES OF GREENHOUSE GASES YEARLY. WHERE DO THESE EMISSIONS COME FROM? WE TAKE A LOOK, SECTOR-BY-SECTOR.



Source: Hannah Ritchie (2020) - “Sector by sector: where do global greenhouse gas emissions come from?” Published online at OurWorldinData.org. Retrieved from: 'https://ourworldindata.org/ghg-emissions-by-sector' [Online Resource]



ICPE

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