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Industry Insight - Circular Economy

Can advanced recycling enable a more circular plastics lifecycle over **mechanical recycling?**

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Better recycling

A critical need of the hour towards the goal of sustainability, is better recycling, particularly in higher plastic consumption sectors, including **consumer packaged goods (CPG).** While a large quantum of post-consumer plastics ends up in landfills or leaking into the environment, the ones that do make it to waste collection and recovery facilities do not always end up recycled and reused. Less than 10% gets recycled.

There is a strong move towards a circular economy owing to the increasing pledges and commitments to use recycled material by global CPG companies as well as sustainability targets and regulations set forth by authorities in various regions. These are pushed forward by more sustainable choices from consumers.

The current industry standard for recycling is mechanical recycling, which while simple, does present some challenges. More recently, advanced chemical recycling has been attracting the attention of policymakers as well as industry players and has hence garnered interest across geographies.

We take a look at the two approaches to recycling plastic waste and assess their prospects in a circular future, while also seeing if newer approaches could be in the offing.

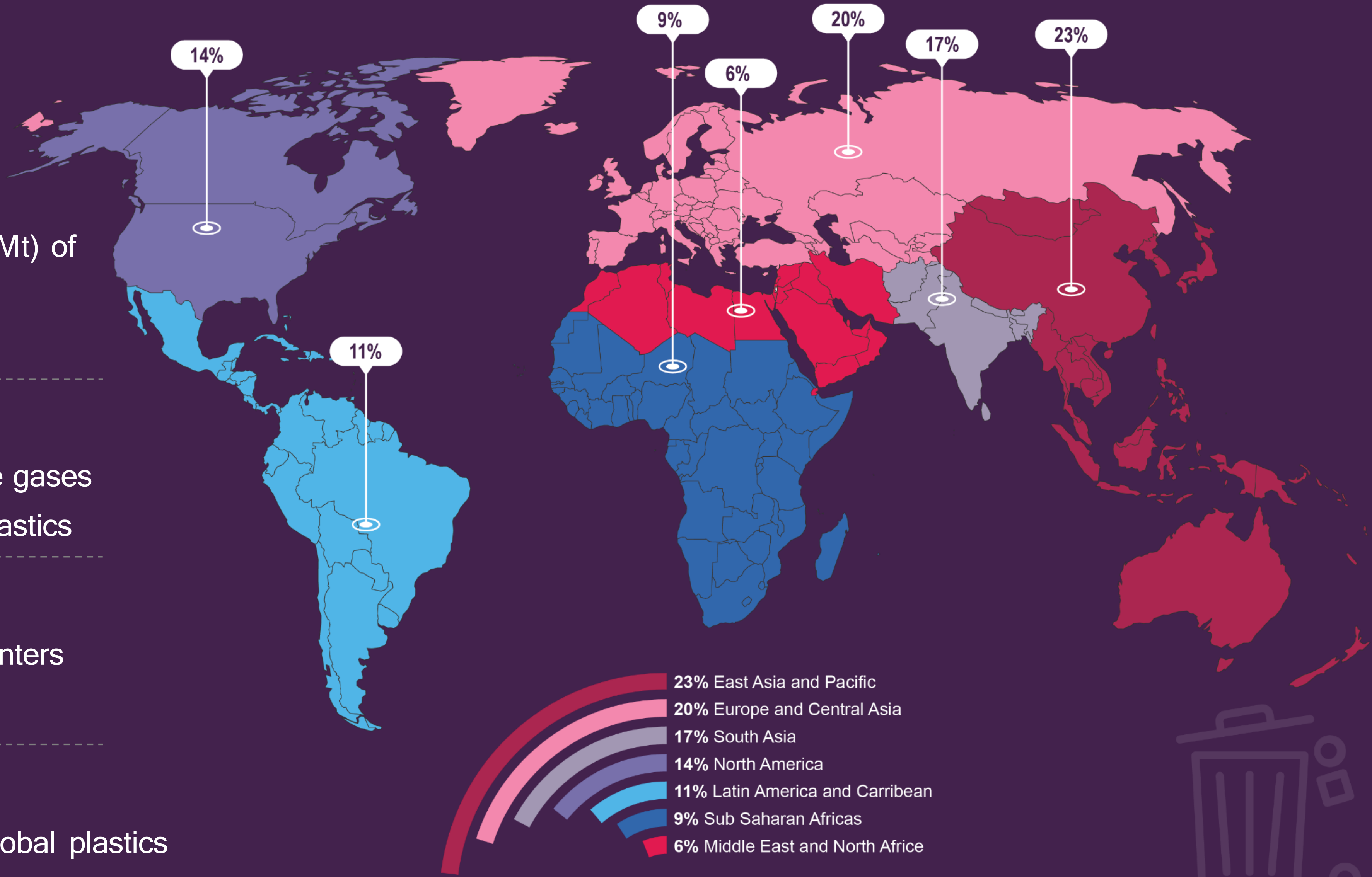
Share of global waste generated by region

353 million tonnes (Mt) of global plastic waste generated in 2019

3.4%
of global greenhouse gases (GHG) come from plastics

Only 2%
of this waste even enters closed-loop recycling

$44.1 billion
was the estimated global plastics recycling market size in 2021



Source: Evalueserve Insights; OECD; Research and Markets

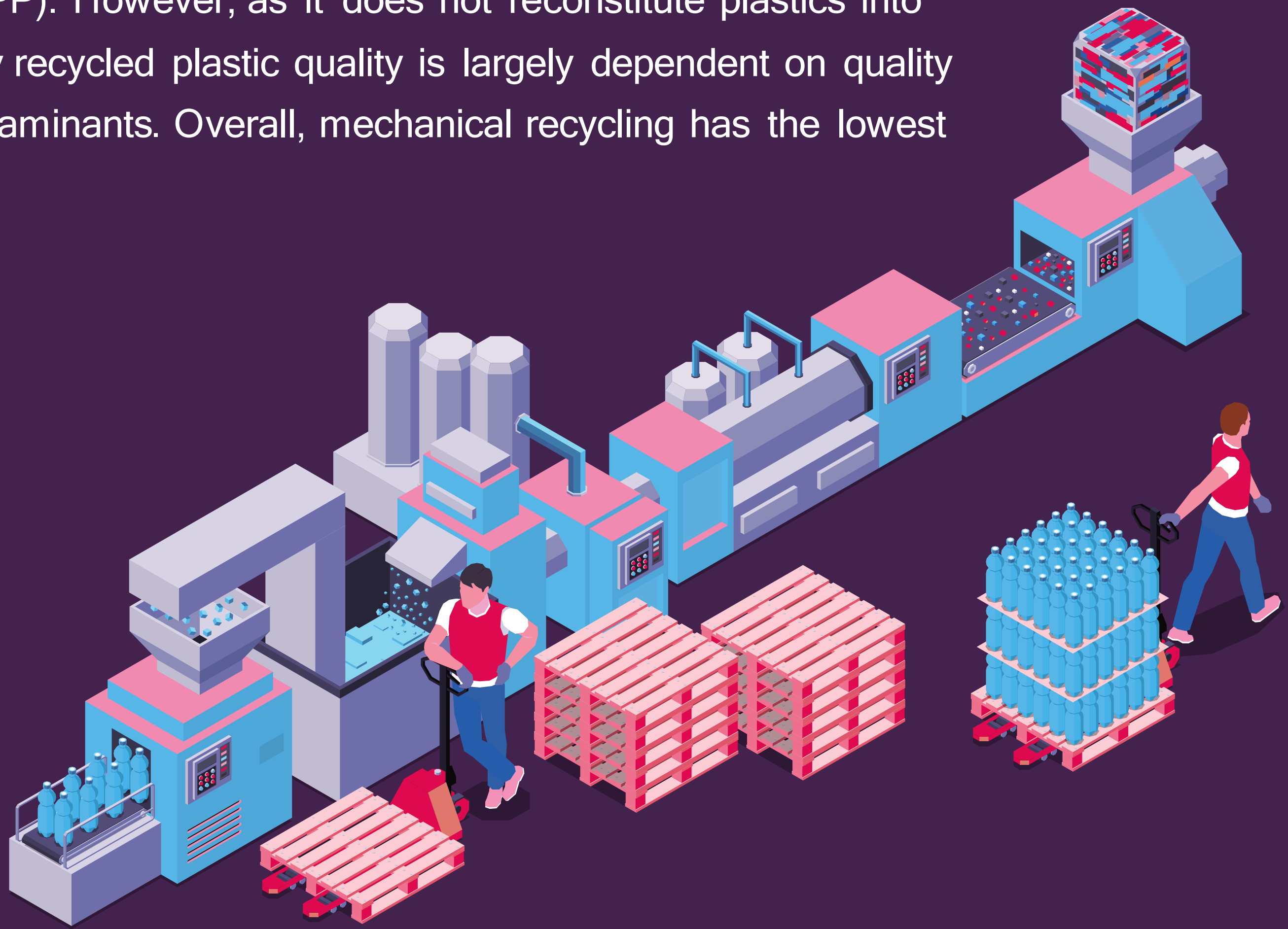
Mechanical recycling

What is it?

This, the most commonly used recycling process, relies on sorting, crushing and melting of plastics into reusable pellet, granulate, or recyclate form of polyethylene terephthalate (PET), polyethylene (PE) and polypropylene (PP). However, as it does not reconstitute plastics into their chemical monomers, mechanically recycled plastic quality is largely dependent on quality of the original plastic and level of contaminants. Overall, mechanical recycling has the lowest carbon footprint.

Mechanical recycling stages:

- Waste collection
- Sorting
- Shredding
- Washing and drying
- Melting into mouldable pellets



99% of currently recycled plastics undergo mechanical recycling.

PET bottles, particularly the clear variety, can be directly mechanically recycled into new PET bottles. This is an ideal example of **closed-loop recycling** in which a product is recycled into the same product for the same use. In this case, it is referred to as bottle-to-bottle recycling.

Nearly 50% of recycled plastics in the UK (in 2018), for example, went towards building and construction materials, which amounts to **open-loop recycling**, also referred to as **downcycling**. Downcycling is when a product is recycled into a product for a different use. However, considering the longer-term use in this case, it could be considered beneficial downcycling.

Advantages and limitations

Source: Evalueserve Insights; RSC

Material degradation is a real concern in mechanical recycling. Recycled plastics, with each cycle, end up with slightly worse quality than virgin plastics. Hence food-grade plastics cannot be produced from this process.

Sorting of collected plastic waste can be a big challenge and currently serves as a major concern in the quality of recycled plastics. While near-infrared (NIR) spectroscopy sorting exists, many materials recovery facilities (MRFs) still rely on manual sorting, which can result in human error. Even with NIR, the sorting takes place basis wavelength signatures, which means it cannot effectively sort darker or black plastics.

Crude oil prices determine the pricing for plastics making, as the latter are petroleum based. At present, this seems more of a con given current oil prices. But in the future when fossil fuels eventually lose favour to cleaner fuel sources, the pricing of plastics too could improve with some incentivisation for recycling.

Source: Evalueserve Insights; RSC

Chemical recycling

What is it?

Advanced or chemical recycling transforms plastic waste back into its base chemicals and hydrocarbon feedstock or monomers using chemical agents. This process is particularly useful for recycling of plastics that are challenging or economically unviable to recycle mechanically. This can help reduce the diversion of plastic waste to incineration and landfills.

Chemical recycling categories and feedstock:

- **Feedstock recycling** - pyrolysis, gasification, hydrothermal treatment
  - PE, PP, PB, PS, PMMA, PET, CFRP, circuit boards and others
- **Purification**
  - PVC, PSD, PE and PP
- **Depolymerisation**
  - PET, PA and PU

- **Hydrocarbon recovery** is possible for various plastic types with advanced recycling making it more lucrative. It can also address recycling of multi-material, multi-layered plastic packaging.

- **Recycling rates** can improve significantly with advanced recycling as it is a viable complement for polymer streams for which extraction of further value via mechanical recycling is not possible.

- **Virgin quality** raw materials can be re-introduced to the plastics supply chain, which can enable food-grade plastics to be produced from post-consumer waste.

- **Problematic CO2 gas** emissions are higher while using some of the chemical recycling processes and their finished products, than mechanical recycling, making it a challenge to justify some streams of chemical recycling.

- **Costs** are much higher for setting up highly specialised advanced recycling plants, running into multiples of tens compared to those for setting up simple mechanical recycling plants. The cost disadvantage may even out over time as more investments and efficiency progresses are made.

Advantages and limitations

Source: Evalueserve Insights

From concern over the lifecycle of plastics, a thorough look shows that the application of their second or further life stages through recycling is also a concern. We re-emphasise that plastic waste is not a problem that can be wished away. However, there are finer points to consider and opportunities to explore:

Most major governments and industry bodies are pledging or aiming to introduce between 30% and 50% of recycled plastics into their overall plastic supply chains by 2030. Hence, the growth potential for plastics recycling in this decade appears to be massive, in multiple times over the current recycling rate of under 10%.

At present, neither mechanical nor chemical recycling are end-all processes towards to a completely circular or closed loop plastics value chain. Having said that, a hybrid solution of the two complementary processes is right in front of everyone to see.

Established mechanical recycling processes can reduce recovered plastics to a basic material. Advanced recycling processes can further enhance the purity of these erstwhile non-viable for recycling plastics for use in more categories including as food-grade plastics, a feat no recycled plastics other than PET bottles have achieved.

Circular way forward

Speaking of PET, the focus needs to be on closing the loop as far as possible. Recently, a report by Eunomia suggests that the PET bottle recycling rate in 2020 was 61%. Recyclers of other polymer streams should study this value chain as an example to achieve their targets - from both, material as well as incentivised material recovery process perspectives.

One critical need of the hour and what accounts for a preventable loss to plastics recycling is waste management optimisation. If more plastics are prevented from leaking into the environment, sorted properly into their respective categories, and cleared of contaminants, the quality and quantum of recycled plastics will automatically improve significantly.

In the absence of a fail-proof closed loop value chain, not all open-loop or downcycling activities should be ignored. As mentioned earlier, harder to recycle plastics may simply be kept from landfills and incineration by incorporating them into longer-term use such as infrastructure applications and others through a hybrid of advanced plus mechanical recycling processes, taking into account GHG emissions.

Some processes, particularly advanced chemical recycling, will need to be funded and developed further so as not to add to carbon emissions for the sake of reducing plastic waste. Studying the impact of each recycling activity, analysing and comparing product carbon footprint (PCF) will be essential. The end goal is fewer carbon emissions, after all.

In the end, there needs to be greater onus on the consumers, whether through better education material or incentivising the habit of not littering, collecting and sorting their plastic waste as also through programs to sensitise them towards to outcomes of their consumption habits.

A circular economy will require all stakeholders, as all points on a circle, to hold their sustainability spots equally.

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