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No time to waste: What plastics recycling could offer

Plastics waste is hurting the chemical industry as well as the environment. By taking the lead on recycling, chemical players could add a new dimension to the industry *and* help solve the problem.

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It's not news that the plastics-waste issue is becoming a crisis and that, in the eyes of the public, the chemical producers that make all those plastics are deeply implicated. The public's concern is already translating into new regulations on plastics in the European Union and elsewhere, and major customers, such as the consumer-packaged-goods (CPG) industry, are ramping up efforts to increase recycled content and reduce their plastics consumption. What is news, however, is that chemical-industry leadership has started to declare that its concept of stewardship and sustainability now extends to dealing with plastics waste. It is also increasingly

acknowledging that the "use once and discard" model, which the plastics industry has grown up with, should be replaced by a new model where plastics are recycled as much as possible.

This marks a watershed moment for the chemical industry, given that more than one-third of the industry's sales are made up of petrochemicals and plastics production and plastics-related products. But as the industry starts to mobilize, there is a lot of uncertainty about what steps represent the best way forward. We believe that the chemical industry has a central role to play in unlocking

many of the challenges of the plastics-waste issue. We also believe there are opportunities to build a new and profitable branch of the industry based on recycled plastics, which our research suggests could represent a profit pool of as much as \$55 billion a year worldwide by 2030.¹

Don't waste all that good plastics waste

Plastics waste washing up on pristine shorelines, from Antarctica to the Arctic, and vast floating islands of plastics waste in the Pacific Ocean have received much media coverage and contributed to the shift in consumer sentiment. Our colleagues have suggested ways that government and industry can stop the flow of waste into the oceans and this tragic environmental degradation.² In this article, we focus on the plastics-waste question from a recycling-potential perspective.

From this perspective, marine plastics pollution may be best understood as the highly visible tip of the iceberg. The majority of used plastics go to landfills and incineration, where materials are lost forever as a resource. Our research shows that currently only 16 percent of plastics waste is reprocessed to make new plastics; the “leakage” into oceans is primarily due to lapses in landfill management or a complete lack of waste-disposal systems (Exhibit 1).

From a resource-efficiency and conservation perspective, this analysis suggests that a huge amount of potential value is currently being lost—value that could instead be captured by better approaches to reusing plastics waste.

An array of policy decisions will be needed at the national and local levels to bring to reality the switch of the plastics-waste flow from landfill and incineration to recycling. But in general terms, for those parts of the world that are not awash in abundant hydrocarbons and where the reuse of

plastics materials makes economic sense, there should be a clear advantage to making this shift.

Beyond the policy decisions that will set the overall direction, let's look in more detail at three areas that will be crucial to making this ramp-up in recycling possible and in which the chemical industry is likely to have a role to play.

Meeting technology needs in recycling

There are three principal approaches to the reuse of plastics: mechanical recycling, chemical recycling, and processing the plastics waste back to basic feedstock. All have suffered from a vicious cycle, where a lack of raw materials due to low rates of recovery of used plastics has limited their growth and dampened interest in their further development and investment; this could now be reversed.

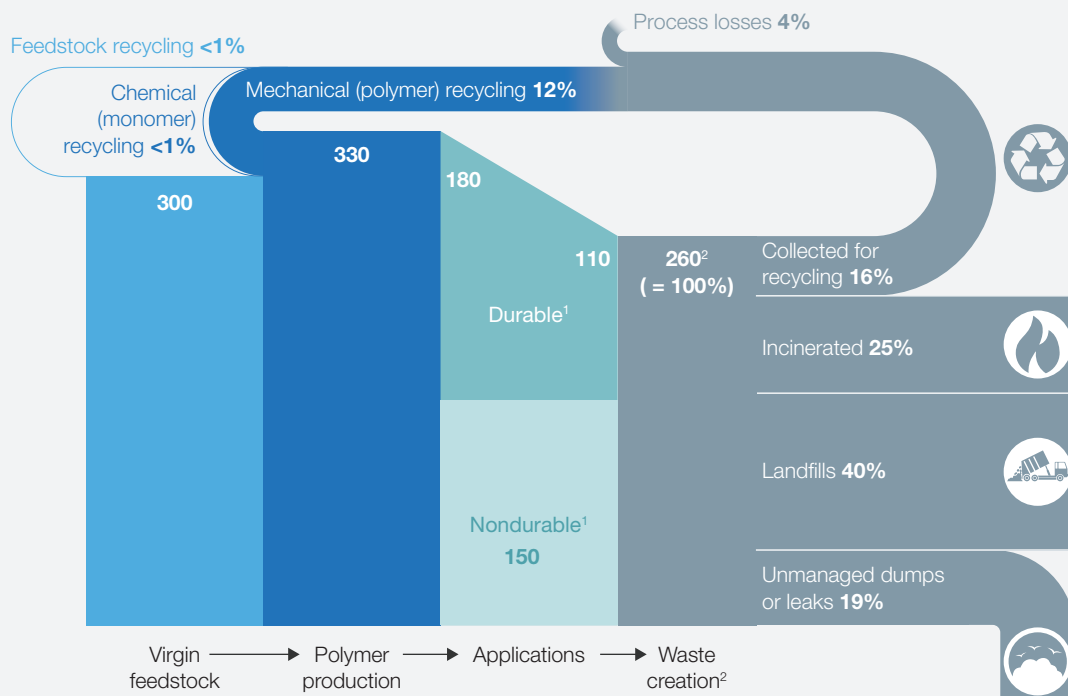
Mechanical recycling takes used plastic and physically processes it back to resin pellets, leaving the polymer chain intact. Recycling of polyethylene terephthalate (PET) and high-density polyethylene has been established as a viable business, but there is room for further process optimization. A key challenge is finding how to preserve the performance quality of resins through recycling steps and avert the deterioration that currently occurs.

Chemical recycling, also referred to as monomer recycling, puts used plastics through a chemical process that breaks them back down to their monomers. Such an approach is only feasible for condensation-type polymers that can be re-monomerized, such as polyesters (notably PET) and polyamides, but this still represents substantial volumes, and there remains considerable scope for process improvements.

Processing back to feedstock requires breaking polymer chains down to hydrocarbon fractions through catalytic or thermal processing. A number

Exhibit 1 The majority of plastics waste currently goes to landfills and incineration.

Global polymer flows, millions of metric tons per annum, 2016



¹ Durable applications with an average lifetime >1 year will end up as waste only in later years; nondurable applications go straight to waste.

² 150 million metric tons of mixed plastic waste from nondurable applications that end up as waste in same year, plus 110 million metric tons of mixed plastic waste from production in previous years.

Source: McKinsey analysis

of technologies are under development. Among these, pyrolysis may offer the biggest potential, because it should be able to process a wide range of low-quality mixed-plastics-waste streams. This could be particularly useful for processing flexible packaging, a major portion of the waste stream, which today's mechanical recycling processes cannot handle well.

Strengthening the waste-management chain

Our projections suggest that the volume of plastics going to recycling could increase fivefold by 2030,

to 220 million metric tons per year, if current flows to landfill and incineration are redirected and recycling capture improves. The waste-management industry that collects plastics waste and does preliminary processing has its own set of challenges—notably a lack of scale even now—and these will need to be addressed if it is going to be able to handle these massive new flows.

In developed economies, the industry tends to have high costs due to small scale and lack of efficient

collection and sorting processes, with so far limited application of automation. In emerging economies, plastics waste is typically processed through informal systems—individual workers picking through waste dumps, with hand sorting at collection points and landfill sites—and this represents a processing structure that cannot easily be scaled up.

In our view, the chemical industry could have at least a temporary role in supporting the plastics-waste-management sector as it ramps up its operations. In industries such as aluminum and paper, where recycling has become part of the industry's structure, producers played an important role in getting recycling established, including making investments in and having ownership of recycling infrastructure.

A seat at the table

There has been confusion on the part of all stakeholders—which, besides the chemical industry, include policy makers, consumers, the waste-management industry, OEMs, and others—about who is responsible for managing plastics waste. Customers and consumers have been so happy with the versatility, convenience, and low cost of plastics that they have accepted the downsides linked to plastics' ubiquity and durability, such as pollution. But the history of the chemical industry has many examples where public opinion has ultimately reversed its view on such trade-offs: from lead paint to chlorinated fluorocarbons to chlorinated solvents, and so on.

The chemical industry is increasingly aware that it's at another of these transition points. It's therefore important for the chemical industry to be at the table with all stakeholders, and to come with clear points of view on how to solve the problems. But the industry is also increasingly recognizing that to be a credible participant, it needs to start making meaningful and bold moves right away.

From waste to resource: Adding a new branch to the chemical industry

If all these factors can be aligned, chemical companies can help to solve the plastics-waste problem. Less recognized is the potential within this for chemical-industry players to build new kinds of profitable businesses, which, as noted above, could represent a profit pool of \$55 billion per year by 2030.

Under a scenario where much larger quantities of plastics waste are routed for reuse instead of going to landfill and incineration, we see a potential for chemical companies to transform two areas: polymers produced from mechanical recycling, and the whole field of pyrolysis and chemical recycling of used plastics. Projecting a step further, it's possible to imagine a wholly new configuration of petrochemical and plastics plants.

First, petrochemical and plastics companies are strongly placed to advance the development of improved technologies for mechanical recycling and the markets for polymers made from mechanical recycling. Some companies have started to make moves in this area—for example Borealis and LyondellBasell have recently acquired polymer-recycling companies in Europe—but there is clearly scope to develop this area further in view of the much increased used-plastic volumes that could become available.

Second, in pyrolysis and chemical recycling, petrochemical and plastics companies are arguably ideal candidates to work on technology enhancements that will be needed to make those processes work better and capture higher margins. Some companies, including, for example, SABIC, are already active in development work, but these are still early days. The focus will be on process scale, output quality, and new technologies that can deal with the lower-value end of the spectrum of plastics waste—a large part of the pie. In addition to their own work, chemical companies

can back small start-up companies active in this area with promising technology offerings.

Thinking big and bold

Beyond this, there's scope for chemical companies to think big and bold about what would be possible with a massively increased flow of plastics waste ready for reuse. In a scenario where pyrolysis technology matures and offers low-cost economics in large-scale plants, it is possible to imagine a new type of fully integrated plant configuration, able to accept used plastics as well as traditional feedstocks. Our research suggests that the economics of such plastics waste-based feedstocks could be highly competitive with oil refinery-based feedstocks at crude-oil prices of \$75 per barrel and still competitive at a level of \$65 per barrel.

Petrochemical and plastics companies would be well placed to invest in new feedstock units based

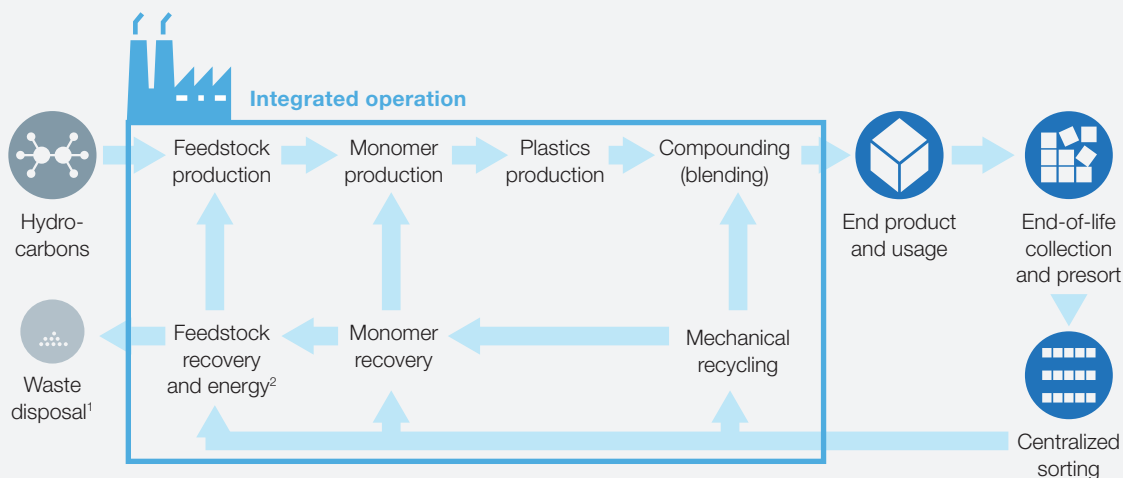
on pyrolysis-treated waste from the large volume of newly available waste plastics that could be coming into the market, alongside the naphtha or natural-gas-liquids feeds they have traditionally been using (Exhibit 2).

This is the kind of investment that petrochemical companies are well used to making—involving large investment sums and requiring the building of large-scale plants, and taking risks where future oil prices are a key component of the equation for value creation.

Established plastics producers would also be in a strong position to invest in mechanical recycling on a large scale—a much larger scale than what has been tried to date due to the constraints of plastics-waste supply. They would also be able to make these large-scale mechanical recycling units part of their integrated production sites.

Exhibit 2 How plastics waste could feed into an integrated petrochemicals complex.

Product flows



¹ To treatment plant for disposal of final residue.

² Processing of plastics waste to convert it to chemical feedstock, along with waste-to-energy units to supply energy requirements.

Source: McKinsey analysis

Working with other stakeholders

Finally, there's a clear role for chemical companies to get involved with and work alongside other stakeholders. The waste-management sector will be the one to take the lead on expanding its operations, which should be helped by a new virtuous circle of much higher plastics-waste volumes to handle, and this should attract more investment and technology development, particularly in areas such as automation. But chemical companies can help in improving the operations of plastics-waste collection and sorting by contributing new technology in areas such as better solvents and additives for washing plastics as well as tracing materials that can be added to plastics to facilitate automated infrared sorting.

At the same time, chemical companies building large-scale pyrolysis facilities may consider partnering with or investing in waste companies as a way to ensure the supply of large quantities of plastics waste that they will need, at least in the early days, in a pattern not dissimilar to the aluminum and paper industries.

As the makers of plastic resin, chemical companies are also strongly placed to move thinking forward about how to optimize the design of plastic packaging for ease of recycling. Besides working with CPG companies, chemical companies will have an important role to play in discussions with consumer organizations and regulators. Clearly this is an area where some companies are already active, but there is plenty of scope to do more.



A clear change is under way in the business and societal environments in which the chemical industry is operating, with consumer sentiment about plastics-waste pollution on the rise, regulators imposing new requirements, and a wider embrace of circular-economy thinking in the business community. Leaders in the chemical industry clearly recognize this and want to act. Producers face a mix of challenges and opportunities, but it's clear that the industry can make a significant contribution to resolving those challenges and to also build a new recycling-based dimension to the plastics business. ■

¹ Our forthcoming report, *The circular economy in petrochemicals: Plastics recycling*, will present additional and more detailed findings.

² See "Saving the ocean from plastic waste," November 2015, McKinsey.com.

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