

CHEMICAL REACTIONS

The Challenge with Plastics in the Circular Economy

When the winner of the Tour de France has #PassOnPlastic emblazoned on his kit, it is clear that the problem of waste plastics is now part of public debate. In David Attenborough's Blue Planet 2, the image of plastic bags floating in the ocean and his chilling statement that “the future of all life now depends on us” has helped to change the global narrative on plastic pollution. Whilst plastic is an incredibly versatile material providing many benefits, including for the environment, it is estimated that approximately 50% of plastic produced falls into the “single-use” category; the idea of plastics within a Circular Economy is a creditable aim but cannot be achieved by recycling alone. We explore both economic and business opportunities and challenges for the management of plastic waste.

PLASTICS HAVE CHANGED THE WORLD BUT...

There are enormous benefits of using plastics to enhance society and the environment. They help save energy, are light, easily shaped, strong and inexpensive. Plastic packaging specifically helps reduce damage to goods, increase shelf-life, reduce food waste and saves energy. The benefits of using plastic are seemingly boundless but we may have neglected the end of life consequences of their use.

There is increasing public concern about the environmental impact of plastic waste:

- Litter – bags, films and bottles;
- Landfill – ‘leakage’ of uncontrolled waste;
- Marine litter – ocean plastic soup;
- Micro-plastics – from cosmetics and the possible decomposition of plastics products.

MARINE LITTER MAINLY FROM ASIA

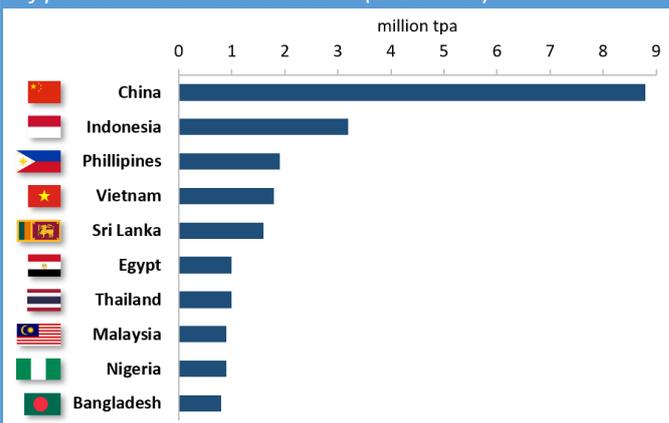
The current debate is being led by concern of the impact of plastics on the oceans. When plastic waste is discarded as litter in the environment it will mostly end up in the world’s rivers, seas and oceans. This amounts to eight million tonnes of plastic per year; according to the World Economic Forum (WEF) and Ellen McArthur Foundation the oceans may contain more plastic than fish by weight in 2050 unless positive action is taken.

Eight of the 10 largest polluting countries are in developing Asia, collectively accounting for 75% of plastic waste washed into the oceans. India, despite its population of 1.3bn, falls outside the top ten thanks to armies of rag pickers (although some commentators challenge this low statistic).

In the developed world there is a well established waste collection system. Growing public awareness and legislation has also increased the amount of recycling (not just plastics) and is reducing the amount of plastic waste that leaks into the environment.

Unfortunately, in the developing world, the lack of waste collection and processing infrastructure in many countries leads to mountains of plastic waste that ultimately ends up in the world’s oceans.

Figure 1. Top 10 countries contributing an estimated 85% of plastic waste into the oceans (2010 data)



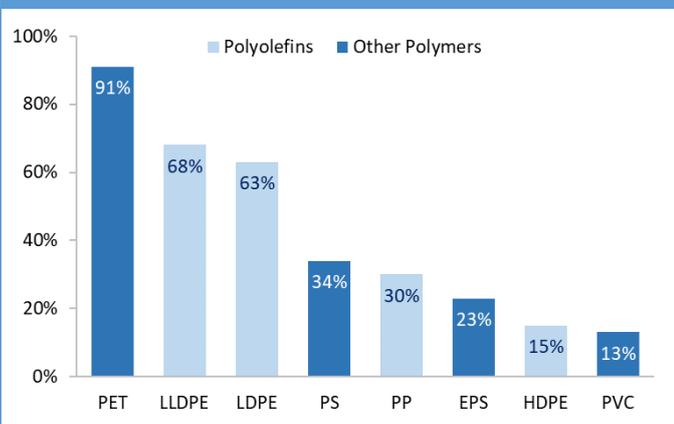
Source: Georgia University / WSJ 2015

THE MAIN FOCUS OF PLASTIC WASTE IS ON PACKAGING

Approximately 50% of plastics are used once, mainly in packaging (44%). Applications in building & construction, consumer electronics and other sectors pose problems at their end of life but are less likely to cause littering and end up in the oceans. The automotive industry introduced recycling 30 years ago and has forced much of the development work on its suppliers including plastic producers.

The key polymers in single-use plastics are PET, Polyethylene, Polystyrene and Polypropylene (see Figure 2 below). Other polymers like PVC were used in the past in packaging but have been replaced in many areas, whilst polyamide has specific barrier properties ideal for certain niche applications.

Figure 2. Amount of polymers used as plastic packaging in Europe, as % of production



Source: ICIS 2017

CONSUMER SENTIMENT DRIVES CHANGE

Every year, four trillion plastic bags are used throughout the world and only 1% are returned for recycling. Consumer pressure has encouraged legislation that has led to the charging for, or banning outright of, single-use plastic bags in many western countries.

The fast food restaurant chains McDonalds and Starbucks, along with other companies, announced that they were going to end the use of plastic straws in their outlets. Whilst this is a popular move, it will make a minor contribution to stopping littering.

Plastic packaging makes a valuable contribution to reducing food waste and ensures goods are protected in transit. Consumer sentiment has led to some companies, such as Amazon, opting for cardboard packaging over plastic. But plastic packaging has an advantage in food packaging. It can significantly reduce the wastage of food. For example, selectively porous membranes are particularly effective at controlling the natural chemicals that help to ripen fruit such as ethylene.

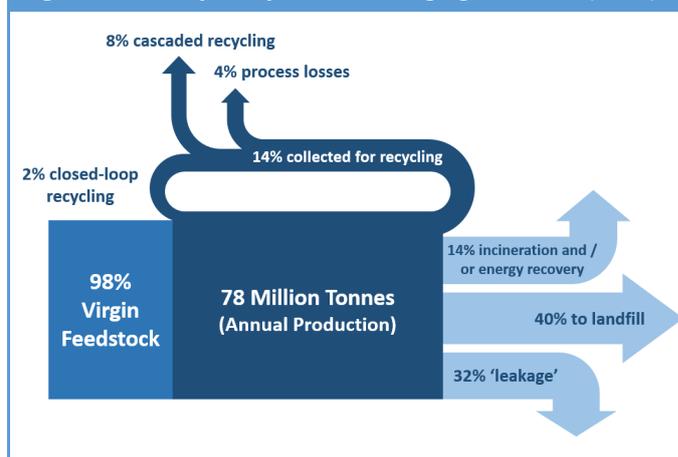
WHERE DOES THE PLASTIC WASTE GO?

Plastic packaging can include a number of polymer types to improve performance, such as multi-layer films used for the storage and transportation of foodstuffs. As a result, they are more difficult to recycle. Even a single polymer like polypropylene has many grades that reduce recyclability.

27.1m tonnes of post-consumer plastic waste was collected in Europe in 2016. This was more than half of the 50m tonnes of plastics produced. Of this plastics waste 31% was recycled, 42% was incinerated with energy recovery and 27% was sent to landfill. Looking specifically at packaging, 41% of plastic packaging waste (16.7m) was recycled.

The global picture is more worrying. We produce 78m tonnes of packaging waste and 32% of this is leaked into the environment, as seen in Figure 3.

Figure 3. Global flow of Plastic Packaging Materials (2013)



Source: New Plastics Economy, WEF / Ellen McArthur Foundation 2016

THE CIRCULAR ECONOMY

The vision of the circular plastics economy has two important legs:

- Reduction of plastics entering the natural environment; and
- Decoupling of the plastic production process from hydrocarbon feedstock
 - Recognising that plastic waste is in effect an unused feedstock
 - Growing use of renewables as feedstock, albeit from a low base

HOW TO CLOSE THE LOOP?

A recent study from December 2017 showed that 30% of all packaging is difficult to recycle (Wageningen University (NL), Dec 2017).

The push for a more Circular Economy of plastics has so far been aimed at plastics that can be either reused or

recycled. Conversion technologies are also required that complement recycling and allow the recovery of energy or petrochemical feedstocks from plastics.

Recent thinking has pushed for the inclusion of methods such as chemical recycling and incineration to be part of the loop in order to make use of polymers that are too complex to recycle by conventional means.

Polymer recycling is ideal for single types of waste, e.g. production scrap. The plastics are mechanically processed, compounded and then extruded. Post-consumer PET bottles are also suitable due to limited range of polymer grades. With advanced technology it is possible, but more expensive, to process mixed waste that has limited contamination. Other post-consumer waste poses a much greater challenge.

As the need for more effective recycling grows, plastic producers and processors will have to reconsider the optimum performance of packaging materials with respect to how easily they can be recycled.

Feedstock recycling requires chemical processing. Some pre-sorted plastics like PET can be depolymerised. For other polymers, such as the polyolefins, pyrolysis can reduce the plastics to precursors or oil. A number of companies are developing ‘plastics-to-fuels’ processes or ‘plastics-to-chemicals’ via gasification of mixed plastics or municipal solid waste – this can be used as an alternative to incineration.

Incineration / Energy Recovery – plastics are the equivalent of “stored energy”. Incineration with energy recovery should become an option for managing post-consumer waste that is difficult to separate.

As a result, thermal treatment of plastics can be considered part of the Circular Economy provided the energy returned may be utilised such that other fuel reserves may be conserved. One challenge of burning waste is the impurities that are either picked up during their use or are contained in certain plastics (like polyamide and PVC); these can lead to hazardous emissions being released into the environment. This can be mitigated by using high temperatures and emission scrubbing.

Biodegradable polymers are being promoted for certain single-use applications. **Oxo-biodegradable plastics** are ideal in areas of high littering and where heat and sunlight speed their degradation, e.g. Middle East and Africa.

Disposing of waste is expensive and recycling is often uneconomic. To build a successful Circular Economy must be a collective effort:

- **Politicians** must use a combination of legislation, taxation and subsidy

- **Consumers** must recognise that they have a responsibility for the waste that they create. They must avoid littering and pay to have waste removed and processed
- **Retailers** must facilitate the responsible disposal of plastic waste
- **Brand owners, OEMs and plastics producers** must work together to develop material solutions that meet the need for recycling; they must also produce recycled grades that meet prime specifications.

In time, **recycled materials need to be priced** as different to virgin polymer. Consumer pressure and legislation, helped by labelling, should ensure strong demand for their reuse. As an example, legislation requiring the partial blending of biofuels has encouraged investment in that industry. Plastic products are more complicated (food packaging need different standards to drain pipes) so targets for the use of recycled materials are more difficult to set.

[EU DIRECTIVE 2030](#)

Following on from public call for action, the EU issued a directive on plastic waste in January 2018. Under the new strategy, the European Union will:

- **Make recycling profitable for business:** New rules on packaging will be developed to improve the recyclability of plastics used on the market and increase the demand for recycled plastic content;
- **Curb plastic waste:** Becoming effective for packaging, new plans will now turn to other single-use plastics and fishing gear as well as restricting the use of micro-plastics in products;
- **Stop littering at sea:** New rules on port reception facilities will tackle marine litter;
- **Drive investment and innovation:** Invest an additional €100m to finance the development of smarter and more recyclable plastic materials, making recycling processes more efficient, and tracing and removing hazardous substances and contaminants;
- **Spur change across the world:** Continued support of other developing nations.

[PLASTIC PRODUCERS ARE RESPONDING](#)

Leading polymer producers are investing in recycling:

- **LyondellBasell** and **Suez** acquired **QCP** in November 2017; based in the Netherlands, QCP’s focus is on PP and HDPE, aiming for high quality recycled products, with an initial capacity of 35ktpa.
- **Borealis** acquired **mtm plastics** in June 2016; based in Germany, it is a leading European producer of post-consumer recycled polyolefin products.

- **Borealis** acquired **Ecoplast** in July 2018, an Austrian plastics recycler. It processes around 35kt of post-consumer plastic waste, turning it into LDPE and HDPE recyclates for films.
- **Imerys Group** acquired **Regain Polymers** in September 2016; UK-based processor and recycler of hard plastics (including HDPE, PP and PS).

Complexity and proliferation of materials are a hurdle for the Circular Economy. Polymer producers, packaging companies and brand owners recognise the need to 'design for recycling': while the plastic products must be fit for purpose, there must be added consideration on the reuse and recyclability of plastic.

PET a Winner: Most Recycled Plastic Packaging Material in Europe

PET resin is a very effective material for recycling with 1.9m tonnes of PET bottles collected for recycling representing a recycling rate of nearly 60% in 2016.

The key to the success of PET is that there are limited grades which ensures standardisation of material to allow near homogeneous input streams. There are also some very effective end markets for R-PET:

- Textile applications: 24% (2011: 39%)
- Thermoforming sheet: now major market, 38%
- Bottle-to bottle applications: 26% (2011: 25%)

The average recycled content in PET bottles in Europe is now 11%.

NEGATIVE IMPACT ON DEMAND

The move to the Circular Economy will reduce demand for certain plastics, particularly for packaging materials.

In the developed world, the use of reusable containers will continue to grow as will the switch to non-plastic carrier bags, bottles, food containers or general packaging. Some applications can be replaced immediately, while others will take longer for suitable alternatives to emerge, particularly where they lead to a negative economic impact by increasing waste and reducing shelf life.

Global plastic production grew on average 3.8% from 245 to 335m metric tonnes per annum from 2008 to 2016, a significant premium to GDP. Our expectation is that global plastics demand will grow at a slower rate in

the long-term, probably below GDP, as the Circular Economy is embraced.

IMPACT ON MERGERS AND ACQUISITIONS (M&A)

The plastics industry has seen extensive M&A both amongst plastic producers and plastic processors (compounders, extruders, etc).

The Circular Economy will bring winners and losers. Companies with polymers related to packaging such as the **polyolefins could see further consolidation** as the smaller weaker players exit. Amongst the plastic processors, the large **compounding and masterbatch companies** are diversified across several end markets and may see this as an opportunity to consolidate smaller players with exposure to packaging.

Investment in mechanical and chemical recycling is still modest and we expect it will grow strongly. There are few companies with commercial scale and profitable businesses. Various start-up companies are developing innovative ways to process plastic waste and are hungry for capital to build commercial scale plants. They are looking for investors that bring funds and expertise in waste management and polymers. Founders have high expectations of their value to new investors. **We expect plastic producers with separate Venture Funds to target these start-up technologies.**

Companies developing **biodegradable plastics** are also hungry for capital. As the sector expands the companies that attract investors are likely to act as consolidators of businesses with complementary technologies.

A long-term concern for investors in the plastics industry is **the possible risk of "Superfund" legislation being applied to the oceans.** This is a US federal government program designed to fund the clean-up of sites contaminated with hazardous substances. It was established as the **Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA).**

A test case in 2014 looked to establish **Tern Island** (near Hawaii) as a Superfund site for plastics. This has not progressed but it is a warning. If Governments coordinate legislation on plastic waste then producers, brand owners and OEMs could become liable for the partial clean-up of the plastics already in the oceans.

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