FINANCING

Plastics Recycling in the EMEA region

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MUFG Bank Ltd
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Introduction

Plastics have proved hugely valuable to society. Whilst this value is widely accepted, there is an increasing focus on the need to address both carbon emissions from plastic production and the environmental impact of plastic waste.

The move to a sustainable net-zero economy has become increasingly important to the general public, and has become the focus of governments, regulators and investors. The challenge of delivering low carbon and low waste solutions for the plastics industry are significant but the ongoing transformation of other sectors, including the power sector, has demonstrated that significant change is possible to deliver environmental objectives.

Existing technologies and options are available to support the plastics industry's transition to a lower carbon, more circular usage economy. This paper summarises the options around plastic recycling and the ways in which project finance can provide value.

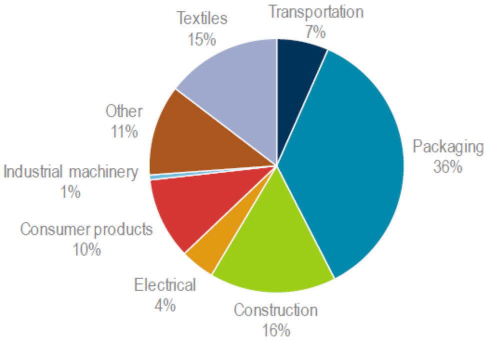
Plastic Production and Usage

Plastics are predominantly produced through steam cracking of naphtha and ethane. The cracking process produces High Value Chemicals (HVCs) which are divided into two main categories; olefins (including ethylene, propylene and butadiene) and aromatics (mainly benzene, toluene, and xylene).

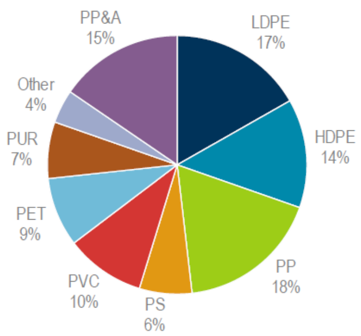
Growth in demand for plastics has historically been driven by economic growth, and has grown faster than any other bulk material, nearly doubling since 2000. Demand is forecast to continue to grow significantly in the coming years. In 2019, global plastics production reached 368 million tonnes (359 million in 2018) and in Europe alone production reached almost 58 million tonnes. [1]

Packaging is the leading end use of plastic consumption globally with construction and textiles also being key consumers of plastics.

Estimated plastic consumption by end use:



Estimated plastic consumption by resin:



[2]

The Environmental Challenge

Plastic pollution has become a pressing environmental issue.

The production of plastic gives rise to on average c. 2.3 tonnes of carbon dioxide for each tonne of end product that is produced (c.1.7 tonnes from refining, steam cracking and polymerisation, and c.0.6 tonnes from upstream emissions from feedstock production and electricity).[3]

The rapidly increasing production of plastics, paired with the fact that a lot of plastics are not biodegradable, has led to the high prominence of the impact of inappropriate disposal of plastics.

China was historically the end destination for a significant volume of plastic waste, however from 2018 China banned imports of various solid wastes including plastics. Effective waste management is, therefore, high up on Government agendas given the environmental impact of improper treatment.

The EU waste policy has for some time been driven around an order of preference for waste management; ‘the waste hierarchy’.

[4]

The waste hierarchy evaluates waste management from most favourable and least favourable for the environment. The preferred option is to encourage buying fewer products with minimal plastic packaging. When waste is created, priority is given to reuse and repair, recycling, energy recovery, through energy from waste (EfW) facilities, and finally disposal which can include landfill. Plastics are, generally speaking, an ideal candidate for recycling.

The waste hierarchy plays a key part in policy makers’ environmental strategies, demonstrated by ambitious targets to encourage movement up the hierarchy. The EU Plan for a Circular Economy has agreed targets of 55% of waste to be recycled, increasing to 60% by 2030, and 65% by 2035, and a maximum of 10% landfilled by 2035.[5]

There are technical and economic challenges with mechanical recycling of plastics and as a result, 32.5% of plastic waste was recycled in Europe in 2018 (42% of plastic packaging waste was recycled in 2018). The remaining plastic waste went to an energy recovery plant (42.6%) or landfill (24.9%).[6]

Mechanical Recycling

Mechanical recycling is the most common form of recycling currently in use. Plastic waste is collected

[1] *Plastics the facts 2020, Market Research Group (PEMRG) and Conversion Market & Strategy GmbH*
[2] *Adapted from Production, use, and gate of all plastics ever made, Geyer R JR Jambeck and KL Law*
[3] *Industrial Transformation 2050 – Pathways to Net-Zero Emissions from EU Heavy Industry, Material Economics (2019),*
[4] *Waste Hierarchy Guidance, sourced from the UK Government website*
[5] *EU Circular Economy Package, sourced from European Union website*
[6] *Plastics the facts 2020, Market Research Group (PEMRG) and Conversion Market & Strategy GmbH*

and sorted, cleaned, cut into chips, and re-melted for moulding. Mechanical recycling is commercially focussed on PET, HDPE and polypropylene. It is possible for other polymers, such as LDPE, but this business has not grown due to constraints in collection.[7]

The process requires a high-quality flow of sorted plastic waste, meaning that both the quality of sourcing and nature of the sorting are important. This can be technically difficult and costly. There could be increased capacity for mechanical recycling with greater investment in collection and sorting, and there is great potential for future technologies such as AI to deliver higher quality washing systems that could improve sorting and the quality of recycled materials.[8]

Even if there was an increase in capacity, some technological challenges can remain. For example, some impurities remain after cleaning, including some additives used in virgin plastics to make them yield certain properties. The presence of these additives can mean that the final product is contaminated, which downgrades the quality of the produced products or results in the need to use virgin materials. This restricts use of recycled plastics for things such as food packaging. In short, plastic recycling has clear government support, but delivering a useful end product has a complicated value chain in between.

Incineration

Mixed with other materials, plastics can be processed in an incinerator in order to generate heat, electricity, and hot water in EfW facilities. The remaining bottom ash from the process is either recycled, for example it can be used in roads, or sent for disposal. Flue gas is also produced during the process and cleaning systems are used to remove harmful substances and then is released into the atmosphere.

EfW is interesting from a carbon perspective. When approached from the perspective of waste disposal, there are significant CO2 benefits from landfill emissions avoided, and waste ultimately needs to be disposed of in one form another.[9]

However, when approached purely as a power source, it performs relatively poorly compared to other forms of power generation. A technical study for Zero Waste Scotland reports that burning waste in EfW plants in 2018 had an average carbon intensity of 509 g CO2/khW, nearly twice the carbon intensity of the UK marginal electricity grid average (270 g CO2/Kwh in 2018).[10] Although there is generally debate in the industry around how best to measure CO2 outputs and savings.

The point remains that EfW plants and mechanical recycling are seen as having complementary roles, as EfW facilities process the waste that remains after recycling, for example mixed stream plastics or plastics such as polystyrene or polypropylene. Innovation should be encouraged to move up the waste hierarchy for plastics, but in the meantime EfW plants offer an environmentally beneficial alternative to landfill and as such have been seen as a key part of the solution in reducing landfill.

Government policy has greatly incentivised the migration away from landfill to more environmentally sustainable waste treatment options. The UK Government has implemented a landfill tax (£94.15/tonne of waste in 2020)[11], which has seen an increase in the levels of waste processed in EfW plants and a large reduction of waste going to landfill. In 2019 a total of 12.6Mt of residual waste was processed, an increase of 9.9% on 2018. Based on facilities in construction, by 2024 it is estimated that inputs could rise to 18.0Mt. [12] At the end of 2020 there were 53 EfW plants in the UK and 11 more in construction.

At the same time, there is an increasing push as part of the EU circular economy package to increase household recycling (which includes plastics), and there has been robust debate around ensuring that plastics that could be recycled do not get incinerated or end up in landfill. The EU is targeting a requirement to recycle 65% of municipal waste by 2035.

The UK will largely follow suit in terms of a target and whilst recycling has increased and improved over time in the UK, it has proven increasingly difficult to lift rates above c. 45%. It is a complex area – and we are stuck at the level partly because: (i) public attitudes show a mismatch between a willingness to recycle and the actual level of participation in recycling; (ii) a political reluctance to consider direct charging for household waste collection; and (iii) public sector austerity – which in recent years has

[7] *Recycling and the future of the plastics industry (2018), McKinsey, Thomas Hundertmark, Mirjam Mayer, Chris McNally, Theo Jan Simons, and Christof Witte*
[8] *The European Recycling Landscape – the quiet before the storm? (2020), McKinsey, Mikhail Kirilyuk, Mirjam Mayer, Theo Jan Simons, and Christof Witte*
[9] *Exploration chemical recycling – Extended summary, CE Delft (2020)*
[10] *The climate change impact of burning municipal waste in Scotland (2020), Kimberly Pratt and Michael Lenaghan, Zero Waste Scotland*
[11] *HM Revenue and Customs, Landfill Tax rates, updated 30 October 2018*
[12] *Tolvik Consulting, Climate Change and Energy from Waste, December 2020*

restricted the roll out of any new household waste recycling schemes.

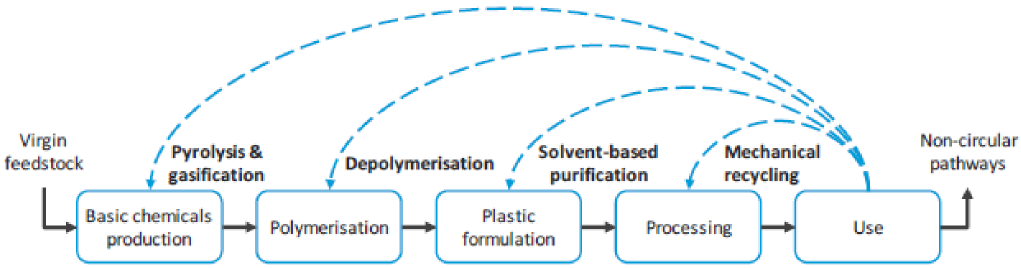
Chemical Recycling

Chemical recycling can also be seen as complementary to mechanical recycling, as it enables the further extraction of value from plastics that have exhausted their economic potential for mechanical processing. Waste plastics are broken down into very basic materials, so a wide range of new plastics (or other products) can be created. There are four main chemical recycling types: depolymerisation, solvent based purification, pyrolysis, and gasification. Within these types, different technologies are being developed which focus on specific inputs / outputs or chemical processes. The below chart demonstrates the different processes used in recycling, and at what stage plastic production these processes recycle polymers.

Pyrolysis

Pyrolysis is the process of thermally breaking down plastics, with temperatures between 400-1000c, without oxygen, resulting in a range of hydrocarbon products. This process allows for the treatment of mixed, unwashed plastics waste.

Pyrolosis is a versatile process suitable for the production of an array of products. For example, pyrolysis of waste polyolefin under different conditions can yield hydrocarbon wax and oils, BTX aromatics, olefin gases. The latter two groups of chemicals comprise the 6 base chemicals used as starting feedstocks in the synthesis of an array of chemicals. The process works best with polyolefins such as polypropylene and polyethylene. There have been issues with processing polymers such as PVC, which breaks down to give chlorine during pyrolysis which can result in lower quality products and damage to the treatment plant.



Based on Crippa et al. (2019).

Depolymerisation

Depolymerisation breaks down a polymer into its raw materials for conversion into new polymers. This process is restricted in its application to condensation type polymers such as PET and polyamide, and compared to the traditional production of these polymers is profitable due to the avoidance of capital investments in steam crackers as well as the cost of plants required to make PET and polyamide intermediates.

Purification

Solvent based purification is a process in which polymers are dissolved in a selected solvent so the polymer can be separated from any contamination before being precipitated back out and reused as a polymer. Dissolution does not affect the chemical composition of the polymer. The plastics that can be fed into this process are PE, PP, PVC, and PS.

This is a relatively new technology, and needs to scale up to become commercially viable. As most plastic waste is collected as mixed polymers, one of the key challenges is the separation and recycling of the waste components separately.

There are already commercial scale facilities carrying out pyrolysis of waste plastic, but this is mainly for the production of fuel which is the less environmentally friendly route. The decision on which to use the plant for largely depends on the demand dynamics in the locations where the plant operates.

Gasification

Gasification is a partial combustion of a feedstock and oxidising agent (air, oxygen, steam) which are fed into a chamber operating between 900-1400 C to produce a mixture of gases called Syngas, which include carbon monoxide, carbon dioxide, hydrogen, water, and methane. The decomposition reaction also produced carbon char, which is oxidised during the reaction and provides heat required to achieve the high temperatures. Incomplete oxidation leads to the formation of tars, which need to be removed from the syngas as they foul catalyst surfaces used for subsequent processing. The Syngas is then cleaned to remove entrained tar and other contaminants (eg. hydrogen chloride or sulphur oxides) the amount of gas cleaning required depends on the levels of these contaminants. The resulting Syngas can be burnt for energy or used in the production of new hydrocarbons.

Gasification is less limited by heating rate than pyrolysis, as heat can be supplied by oxygen, air, and steam. Both require large amounts of energy in order to convert the plastic waste compared to depolymerisation, purification, and mechanical recycling.

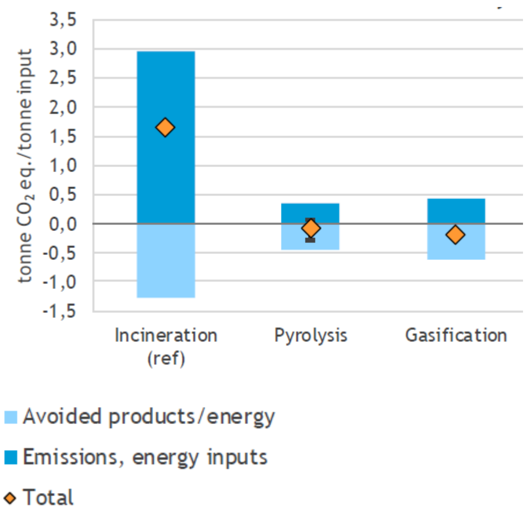
Considerations and Financing

Some research suggests that pyrolysis and gasification could have a smaller carbon footprint than EfW. The research considers:

1) The emissions and energy inputs from the process (i.e direct process emissions and emissions linked to the production and supply of energy for the process); and

2) The “avoided products” from pursuing a certain technology (i.e in the case of incineration with energy recovery this process generates electricity, which means that less needs to be generated in conventional power plans, thus the avoided emissions are credited to the waste treatment process.)

The below chart is sourced from a study focused in the Netherlands. The research demonstrates that pyrolysis and gasification generate less CO2 emissions that incineration.[13]



Gasification has, however, had a patchy track record in the UK (although has performed better in Europe) – and there are a number of schemes that have either run into difficulty or performed below their intended levels.

McKinsey forecast, assuming USD 75 a barrel oil price, that that mechanical recovery rates will increase from 12% to 15-20% by 2030. This increase will be driven by improvements in the efficiency of technology for some polymers, and improvements in the collection and sorting of plastic waste. However, at lower oil prices, the economics for mechanical recovery become more challenging compared to virgin plastics, as the cost of producing virgin plastics decreases. Depolymerisation and purification can have similar economic benefits to mechanical, as they avoid capital investments needed for other technologies. McKinsey indicate pyrolysis remains profitable at USD 50 a barrel.[14]

McKinsey project a scenario in which plastic recycling could rise by up to 50% by 2030 assuming an oil price of USD 75 a barrel, a supportive regulatory environment, and supportive behaviour from consumers and industry stakeholders. They estimate that this would require investment of c. USD 15-20bn a year.

Given the requirements of certain waste streams to accommodate recycling, in order to improve levels of recycling there needs to be investment in both waste collection and sorting, and government support for recycling plant operators to encourage further investment. This could take the form of direct investment, subsidies, and/or a taxing regime that favours recycling processes over landfill or incineration.

There are examples of chemical Recycling plants that are built or being developed, but this is not a recycling solution that is fully scaled yet and the plants are part of pilot programmes usually with Government support. For example, the Government research body, UK Research and Investment (“UKRI”), has recently announced an investment of GBP 20 million in chemical recycling technology:

- A consortium led by Veolia, and consisting of Unilever, Charpack and HSSMI are developing the UK’s first facility capable of recycling 100% of clear PET plastics.

- ReNew ELP will set up a Catalytic Hydrothermal Reactor which is planned to convert 20,000 tonnes per annum (increasing to 80,000tpa on completion of the site) into chemicals and oils for production to new virgin grade plastics.

[13] *Exploration chemical recycling – Extended summary, CE Delft (2020)*
[14] *How plastic waste recycling could transform the chemical industry by Thomas Hundertmark, Mirjam Mayer, Chris McNally, Tho Jan Simons, Christof Witte*

- A consortium of Neste, Recycling Technologies, and Unilever are collaborating to build a pyrolysis plant project in Scotland which will recycle plastic waste unfit for mechanical recycling. Deals have already been struck with Scottish local authorities for plastic waste feedstock.

Plastic Energy, which currently operates commercial scale plastic chemical recycling plants in Seville and Almeria in Spain, is working with ExxonMobil to construct a chemical plant in France be adjacent to ExxonMobil's petrochemical complex. The plant will have initial capacity to process 25,000 tonnes of plastic a year with plans to scale up to 33,000 tonnes. The project has received financial support from the French Government as part of their Plan de Relance and Regional Planning Grant Scheme.

This is an area that should attract further interest and involvement from both Investors and Government. The potential ESG benefits are very high. As ever with areas that have high potential environmental benefit, they may come with revenue models that are slightly more speculative and that is an area where Government could potentially focus its support. There is no shortage of "green" money willing to be deployed.

Outlook

The political and regulatory environment is supportive of increasing recycling of plastics. Existing technologies are available to achieve this objective and a range of emerging technologies are currently under development.

The long term potential for new technologies is positive given these technologies' contribution to recycling rates possible CO_2 emission savings. These technologies are, however, still in the relatively early stages of development and in order to be supported by finance providers, there will have to be sufficient due diligence and a proven track record to demonstrate that the plants will operate as expected.

Irrespective of technology type for projects to be financeable, banks need to have comfort in the feedstock supply, which could take the form of long term take or pay waste contracts in place at financing as is seen now on EfW project financings, and the product offtake. Many projects have already been financed on this basis and the potential commercial arrangements are well understood.

The ingredients are in place to deliver a strong pipeline of recycling projects over the coming years and commercial bank financing has been deployed extensively on a range of precedent projects.

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