Carbon Tracker Initiative

The Future's Not in Plastics

Why plastics demand won't rescue the oil sector

Analyst Note

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About Carbon Tracker

The Carbon Tracker Initiative is a team of financial specialists making climate risk real in today's capital markets. Our research to date on unburnable carbon and stranded assets has started a new debate on how to align the financial system in the transition to a low carbon economy.

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Executive summary

The future's not in plastics. The oil and petrochemical industries are betting their future growth prospects on demand for plastics. But plastics demand is likely to peak as the world starts to transition from a linear plastic system to a circular one. The implication is peak oil demand and potentially $400bn of stranded petrochemical capex.

Plastics drive growth. As demand growth drivers like transportation have fallen, so plastics make up all the expected growth in oil for petrochemicals, and are the largest driver of expected oil demand, with 95% and 45% of oil demand growth in the central forecasts of BP and the IEA.

Plastics are uniquely vulnerable. Plastics impose a massive untaxed externality upon society of at least $1,000 per tonne ($350bn a year) from carbon dioxide, health costs, collection costs, and ocean pollution. And yet 36% of plastic is used once and thrown away, 40% of plastics ends up in the environment, and less than 10% of plastic is really recycled. Polls by IPSOS indicate that 70-80% of people want radical action to change this.

There are technology solutions. There are three main solutions – reduce demand through better design and regulation; substitute with other products such as paper; and massively increase recycling. A recently published report, "Breaking the Plastic Wave" shows how to implement these solutions to deliver 2040 plastic utility at half the capital cost, half the virgin plastic, 25% less GHG emissions and 700,000 more jobs relative to BAU by 2040.

Why now? Policymakers in Europe and China are implementing much more stringent regulatory regimes using the five key tools of taxation, design rules, bans, targets, and infrastructure. A recent example is the European proposal for a €800/t taxation on unrecycled plastic waste. Meanwhile, the COVID shock is likely to reduce plastic demand by around 4% this year and give policymakers more room to act.

Peak plastics. The solutions put forward in "Breaking the Plastic Wave" would reduce virgin plastic demand growth from 4% a year to under 1%, with a final peak in 2027. Factor in the impact of COVID and that date will be brought forward.

Peak oil demand. If demand for virgin plastic stops rising, the oil industry would lose its primary growth driver. This makes it more likely that 2019 was peak oil demand.

Stranded petrochemical assets. There is a stark contrast between the plans of the petrochemical industry for 4% annual capacity growth and the threat of much lower demand growth. The petrochemical industry already faces huge overcapacity, but is planning to spend a further $400bn on 80 mt of new capacity. Unless stopped, this will result in continued low prices and stranded assets.

$6,000bn of capitalisation in sectors at risk. There are 8 main market sectors at risk from the plastic disruption, with those in the chemicals subsectors most exposed.

Breaking the Plastic Wave

The intersection between plastics, petrochemicals and oil is notoriously complex, and it is often hard to reconcile forecasts from the many parts within it. Some data sources focus on a limited number of plastics, some exclude textiles, and some include all types of plastics. Some data sources look at waste whilst others look at total production. Very little data is available for 2019, and 2020 forecasts are not of much use in light of COVID. Nevertheless, there is a very significant gap between the aspirations of the incumbent players for continued high demand growth and our ability to scale collection and recycling infrastructure quickly enough to avoid plastic in the environment. In light of this gap, the only solution is to significantly reduce the amount of virgin plastic in the system, by shifting to reuse/refill models and to recycled plastic.

Much of the detailed analysis in this report is taken from a recent seminal research report published by SYSTEMIQ and The Pew Charitable Trusts, in collaboration with the University of Oxford, the University of Leeds, the Ellen MacArthur Foundation, and Common Seas, called "Breaking the Plastic Wave",[1] released in July 2020. "Breaking the Plastic Wave" focuses on how to reduce environmental plastic leakage while ensuring a route to Paris Agreement compliance and Sustainable Development Goals more broadly; it concentrates therefore on the areas of plastic most likely to produce leakage, some two thirds of total plastic demand. The analysis in this report seeks to focus on the total system implications of change in the plastic sector, with a focus on oil demand and upstream petrochemical production. We split the report accordingly into three main parts. First we lay out the importance of plastics, the incumbent expectations for business as usual and the inherent weaknesses in this. Then we set out in detail the technological solutions put forward by "Breaking the Plastic Wave" as well as recent political developments. We conclude with what is most likely and the implications of this for incumbents.

[1] To download the full report or for more information on the methodology, please visit https://www.systemiq.earth/breakingtheplasticwave/

The cost of plastics

40%	Share of plastic waste that ends up in the environment	11mt	Annual flow of plastics into the oceans
5-10%	Share of plastics that is really recycled	5t	How much CO_2 is emitted per tonne of plastic
19%	Share of 1.5 degree carbon budget that the plastics industry plans to use by 2040	46kg	Annual plastic usage per person
$1000/t	The externality cost of a tonne of plastic	$350bn	Annual untaxed externality cost of plastics

Why should investors care

3-4%	Incumbent expectations for annual growth in plastic demand in 2020s	0-1%	Plastic demand growth under *Breaking the Plastic Wave*'s System Change Scenario in 2020s
100%	Share of plastic in expected demand growth for oil used by the petchem sector	45-95%	Share of plastic in expected total oil demand growth forecasts of IEA and BP
37mt	Expected overcapacity for ethylene production end 2020	-4%	Expected fall in plastic demand in 2020
$200bn	Capex on upstream plastics overcapacity at the end of 2019	$400bn	Planned capex on expanding upstream plastics production 2020-2024

Solutions

70-80%	Share of people who want radical action to reduce single use plastic usage	€800/t	European planned tax per tonne of unrecycled plastic waste
30%	Share of 2040 plastic functionality from reduction in usage	-50%	Reduction in plastic demand and capital cost by 2040 under the System Change Scenario
22%	Share of 2040 plastic functionality from recycling	16%	Share of 2040 plastic functionality from substitution
2027	When virgin plastic demand peaks under the System Change Scenario		

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1. Why plastics matter

Every year, the world uses 4,500 mt of oil and 1,000 mt of petrochemical feedstocks but only around 350 mt[2] of plastics. Nevertheless, plastics play a key role in the petrochemical and oil industries.

Plastics and petrochemical demand for oil

As set out in the IEA's seminal report on the future of petrochemicals,[3] there are thousands of uses of petrochemicals, in two main areas – plastics and fertilizers. In this note, we focus specifically on the petrochemical demand for oil. We show as below that plastics make up two thirds of demand for oil in the petrochemical sector and all of the growth in demand for oil.

Size

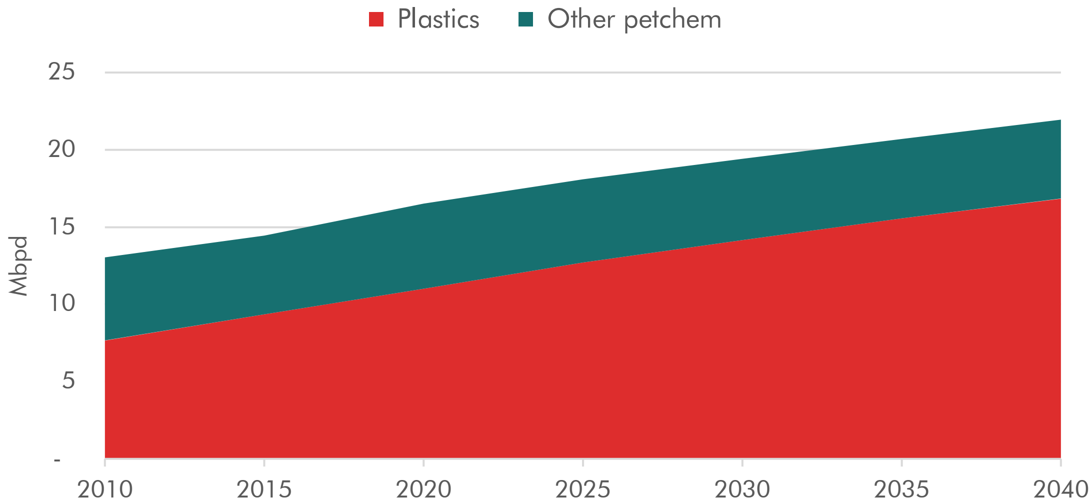
According to BP,[4] single use plastics made up just over a third of total plastics produced in 2017 and required 3.6mbpd of oil. The implication is that the total demand for oil for plastics was around 10 mbpd.[5] BP furthermore states that the total amount of oil used in the petrochemical sector was 15 mbpd.[6] Our conclusion is that oil for plastics is two thirds of total oil demand in the petrochemical sector.[7] Moreover, the data from BP implies that this share will rise over time to 77% in 2040.

Growth

If we make the assumption that single use plastics (where BP does provide forecasts) remain at just over a third of all plastic demand, it is possible to show as below how plastics dominate past and future growth of oil demand in the petrochemical industry.

[2] The size of total plastics demand depends on what is classified as plastics. The IEA calculates demand for thermoplastics in 2017 at 350 mt, with 70 mt of demand for other plastics such as textiles. Geyer includes additives, and so has a slightly higher number. In this report we focus on the 350 mt number which is the most widely starting point for plastics demand.
[3] Source: The future of petrochemicals, IEA, 2018
[4] Source: BP Energy Outlook, BP, 2019
[5] It is possible to cross-check this calculation with the work of Roland Geyer in The Plastic Atlas, 2019. He takes the most comprehensive definition of plastics in 2017 at 438 mt and notes that 93% of finished plastics are from polymers (almost all from feedstocks defined as oil) and 7% from additives. The implication is that total oil used in plastics is 407 mt of oil or 9.7 mbpd.
[6] BP presents data for 2015 and 2020, and we calculate the 2017 number assuming straight line growth
[7] The IEA has a slightly different methodology and does not specify what share of oil ends up in plastics. However, the Sankey flow diagram presented in Mapping global flows of chemicals (2013) by Peter Levi, a key author of the IEA report, also implies that around two thirds of oil in the petrochemical sector ends up in plastics.

FIGURE 1. OIL DEMAND FOR PETROCHEMICALS (MBPD)



Source: BP, Carbon Tracker estimates

Plastics and oil demand

Plastics make up only around 9% of oil demand measured in mbpd (less if measured in tonnes[8]), but are the largest component of oil demand growth.

Size

The IEA[9] notes that petrochemicals made up 14% of oil demand in 2017, of which 13% was petrochemical feedstocks. Assuming as above that 2/3 of petrochemical feedstocks are for plastics, we can calculate that plastics account for around 9% of total oil demand.

Growth

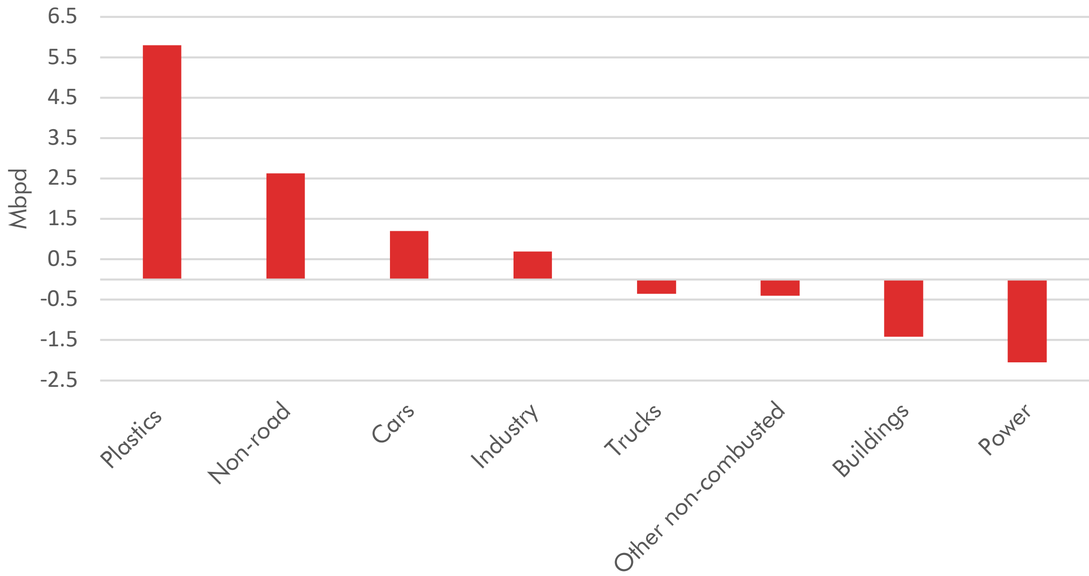
Whilst most commentators have noted that petrochemicals are a major driver of expected oil demand growth, we can go one stage further and demonstrate that it is specifically plastics within petrochemicals that drive the expected growth in oil demand. In the case of the (pre-COVID) BP forecasts, plastics make up 95% of expected net oil demand growth to 2040, and in the case of the IEA they make up 45% of the growth.

BP

In its central scenario,[10] BP forecasts a total growth in oil demand from 2020 to 2040 of 6.2mbpd. If we separate out plastics from petrochemicals as identified above, then plastics is 5.8 mbpd of the growth, or 95% of the total.

[8] Because of the lower density of ethane and other feedstocks for petrochemicals, BP converts 1 mbpd in 2017 into 42 mtoe, as opposed to crude oil where 1mbpd is 50 mtoe.
[9] Source: The future of petrochemicals, IEA, 2018
[10] Source: BP Energy outlook, BP, 2019

FIGURE 2. OIL DEMAND GROWTH 2020-2040 – BP FORECASTS

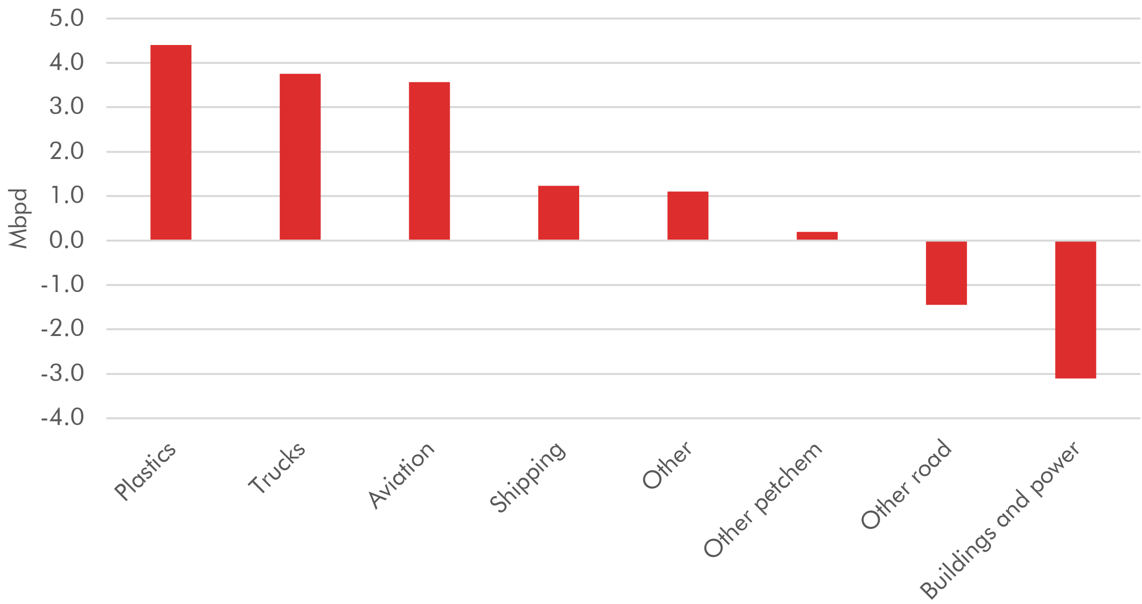


Source: BP, Carbon Tracker estimates

IEA

Plastics are also the largest component of demand growth in the central scenario of the IEA's World Energy Outlook.[11] If we assume that plastics make up two thirds of oil demand for petrochemicals in 2018, we can calculate that plastics will account for 4.4 mbpd of growth in oil demand, making them the largest component of expected oil demand growth, with 45% of the total.

FIGURE 3. OIL DEMAND GROWTH 2018-2040 – IEA FORECASTS



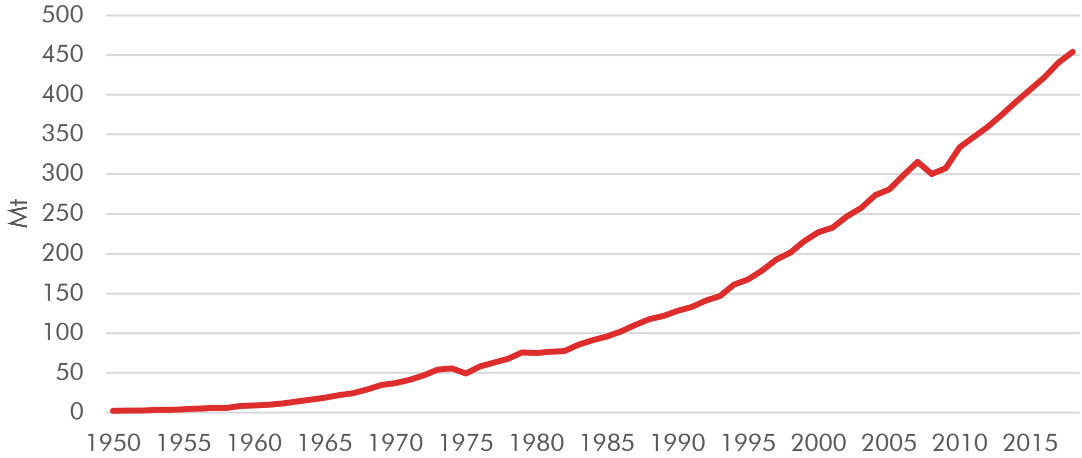
Source: IEA NPS scenario, Carbon Tracker estimates

[11] World Energy Outlook, IEA, 2019

2. Incumbent expectations for Business as usual (BAU)

According to the authoritative study by Geyer,[12] plastics production has been rising rapidly for decades. Since 2010, the growth rate has slowed to 4% a year.

FIGURE 4. GLOBAL PLASTICS PRODUCTION (MT)



Source: Geyer. Note this includes additives and textiles.

As we set out below, most incumbents expect this growth rate will continue, driven largely by emerging market demand for plastics. The IEA and BP are more cautious, expecting 2% annual growth rates for plastic demand, whilst industry forecasts are for 4-7% growth in ethylene[13] capacity. At its May 2020 investor day, Exxon noted the expectation for robust long-term demand growth for key chemical products of around 4% a year.

3%-4% annual growth means a doubling of demand in 18-24 years, and this appears to be what the industry is tooling up for.

IEA and BP

BP notes that the rate of growth of plastics demand would be 3% a year under business as usual. However, in its primary Evolving Transition (ET) scenario, it assumes that this falls to 2% a year as a result of regulatory pressure on plastics.

In its central NPS scenario, the IEA forecasts that the rate of growth of plastics demand will be 2% a year to 2040, rising from 350 mt of thermoplastics to 540 mt in 2040. It is notable that in this scenario it does not foresee a material increase in the recycling rate[14] or much regulatory or technology change.

[12] Source: Production, use and fate of all plastic ever made, Geyer, 2017
[13] Ethylene is the largest intermediary chemical between oil and gas feedstocks and plastic resins. As such it serves as a proxy for industry expectations for the sector as a whole
[14] The IEA forecasts three aspects of the recycling rate. Two of them see no change, and the collection rate increases only marginally, from 15% in 2017 to 18% in 2050.

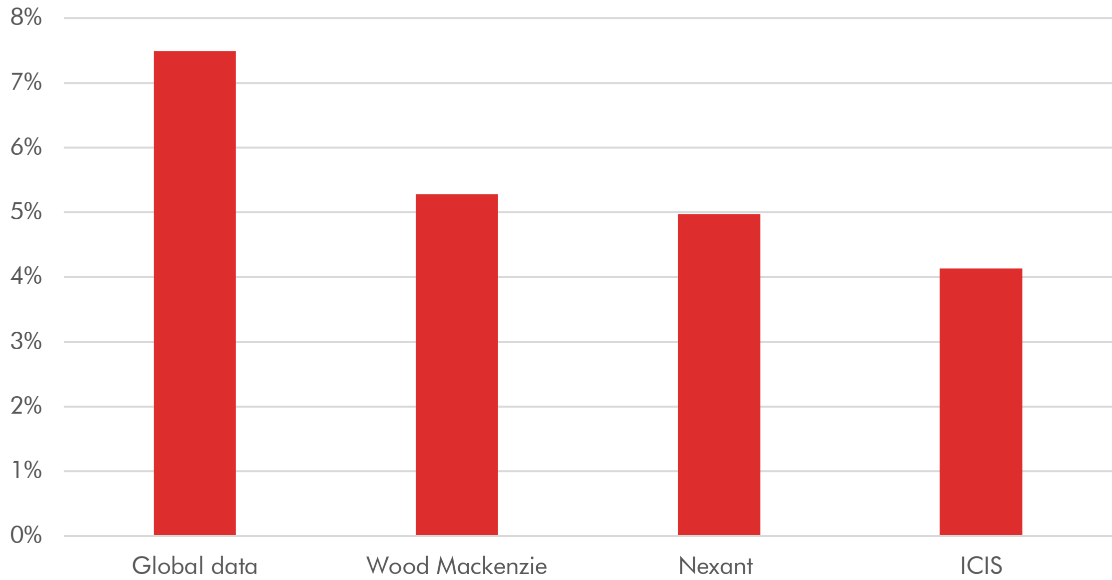
Capital expenditure

Low prices for US ethane have driven a huge boom in capital expenditure in the petrochemicals industry, mainly to convert this ethane into plastic.[15] The American Chemistry Council noted in 2020 that $205bn had been invested in the US petrochemicals sector.

At the same time, global oil companies noted that plastics was one of the few bright spots of demand growth, and elected to invest more capital into the sector.[16] National Oil Companies made a similar decision, electing to invest into the petrochemicals sector in an attempt to diversify their economies.[17] The Guardian reported plans to invest a further $100bn in Saudi Arabia and $140bn in China.[18]

Industry research groups do not tend to forecast plastics demand, but they do forecast capacity for ethylene, which is the largest intermediary chemical in the production process of plastic. Before COVID, they were forecasting annual growth rates of ethylene capacity of between 4% and 7% in the period 2019-2024.

FIGURE 5. EXPECTED ANNUAL GROWTH RATE OF ETHYLENE DEMAND 2019-2024



Source: Wood Mackenzie, BNEF, Global data, ICIS

[15] Source: How fracked gas is driving the plastics boom, CIEL, 2017
[16] Source: The Long View: There will be blood - the oil companies are becoming an existential threat to the petrochemicals companies, Alliance, 2020
[17] *See for example the Guardian in 2017.*
[18] https://www.theguardian.com/environment/2017/dec/26/180bn-investment-in-plastic-factories-feeds-global-packaging-binge

3. Problems with the Business as Usual (BAU) view

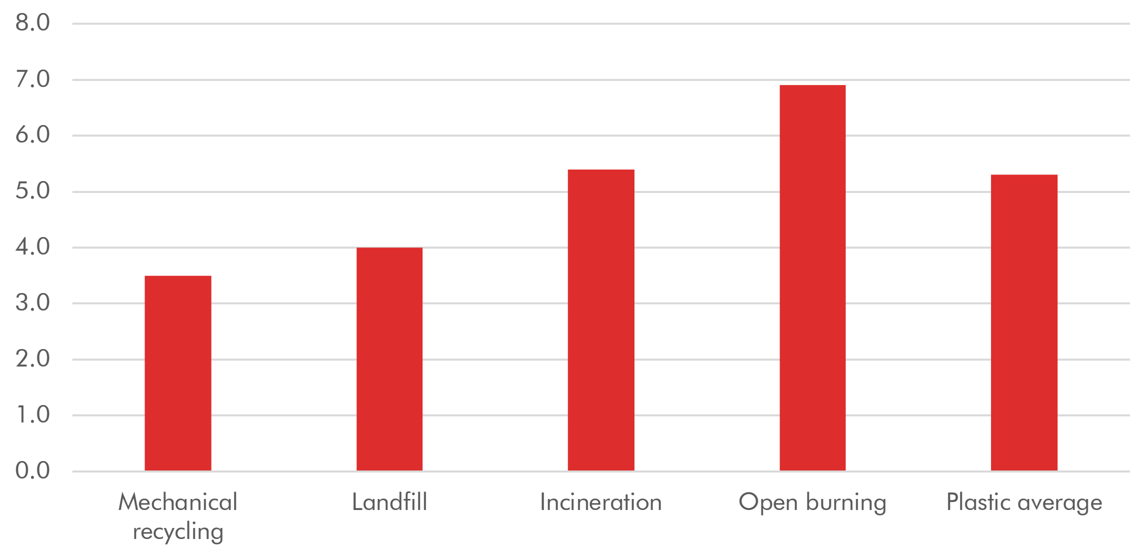
There are four immediate problems with the BAU view that the plastics industry of the future will be the same as the plastics industry of the past: the doubling of carbon emissions from plastics at a time when the Paris Agreement implies that emissions need to trend towards zero; the untaxed externality of plastics of at least $1,000 per tonne; the huge amounts of waste in the plastic system, much of which leaks to the environment; and the new attitude of consumers and voters who want change from a linear system to a circular one because of the unsustainable amount of virgin materials that a linear system requires.

In addition to this, we note that plastic demand is no longer rising in the OECD markets which make up nearly half of demand, and that the emerging markets also want to curtain plastic usage. Finally, there is a slightly more technical issue – the growth in so-called oil demand for plastics is in fact growth in natural gas liquids (NGL) demand.

Carbon dioxide

Carbon is produced at each stage of the plastic value chain: to produce oil; to convert into resins; and at the end of life when plastic is burnt, buried or recycled. A very detailed analysis of the issue by Zheng et al in Nature Climate Change in 2019[19] suggested that the total carbon footprint of plastics was 4.4 tonnes of CO2 per tonne of plastics. "Breaking the Plastic Wave" estimates the carbon footprint per tonne based on its final disposal method as below; if we multiply this by the share of plastic ending up in each area, it averages out a little higher at just over 5 tonnes of CO2 per tonne of plastics. In any event, a good rule of thumb number is likely to be 5 tonnes of CO2 per tonne of plastic. To put this into context, the World Energy Outlook in 2019 notes that the CO2 emissions of the 4,500 mt of oil used in 2018 were 11,500 mt, or 2.6 tonnes of CO2 per tonne of oil; so plastic is responsible for roughly twice as much carbon dioxide per tonne as oil.

FIGURE 6. CO2 PER TONNE OF PLASTIC DEPENDENT ON ITS DISPOSAL METHOD



Source: Breaking the Plastic Wave

[19] Source: Strategies to reduce the global carbon footprint of plastics, Zheng, Nature climate change, 2019

If we assume 350 mt of plastic demand with a total carbon footprint of around 5 tonnes of CO2 per tonne of plastic, that implies annual emissions of 1.75 Gt of CO2. Continuation of current growth rates would see the carbon footprint of plastics double by the middle of century to around 3.5 Gt.

Meanwhile, the Paris Agreement implies that in order to get to 1.5 degrees, global CO2 emissions (33 Gt from the energy sector in 2018) will have to halve by 2030 and get to zero by the middle of the century. "Breaking the Plastic Wave" estimates that the plastic sector alone would therefore use up 19% of the entire global carbon budget if it continued to grow under business as usual.

To have one sector planning on doubling its carbon footprint while the rest of the world plans to phase out emissions clearly makes no sense. This provides a clear driver for policymakers to take action.

Externalities

How big are the externalities of plastic

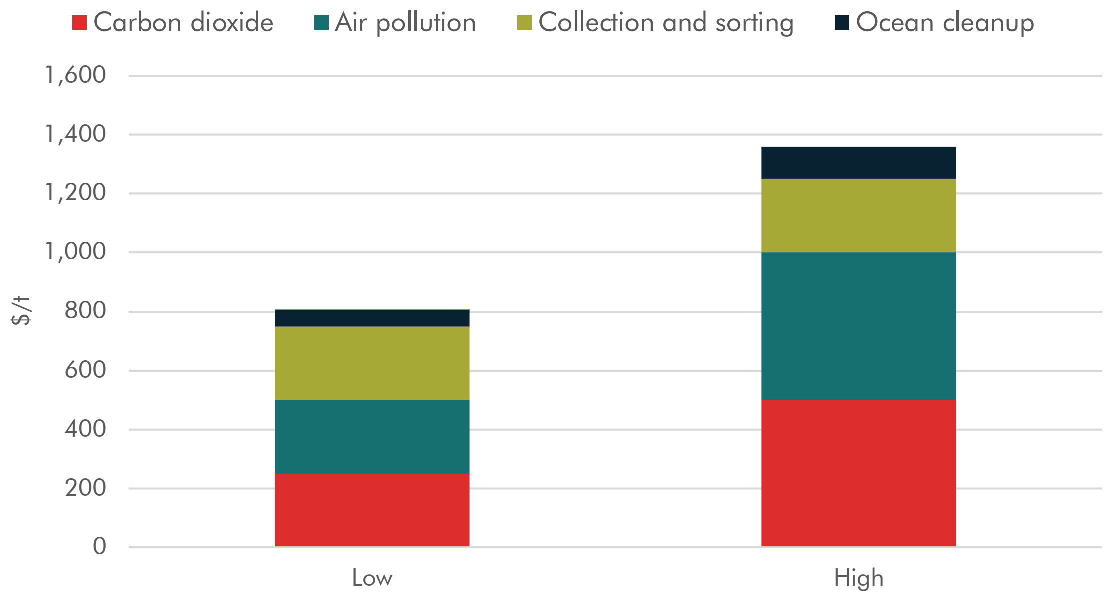
The externality cost of plastic is of course a controversial issue. In 2014, Trucost calculated a $75bn externality from 80 mt of consumer goods, implying an externality cost per tonne of $938 in 2014 dollars.[20] Other research from CIEL[21] or Lancet[22] has identified very significant costs of the plastic externality.

We set out below a summary of the externality costs associated with plastics, and this gives a range of between $800 and $1400 per tonne of plastics. Although there are a number of assumptions to be made, and the range is quite wide, we believe it is reasonable to suggest that plastic imposes externalities upon society of at least $1,000 per tonne of plastic.[23] As a matter of note, this externality cost is around the same as the cost of most plastics, which is typically $1000-1500 per tonne.

There are four aspects of the externality cost which we can quantify: carbon dioxide; air pollution; collection costs; and ocean clean-up costs. Other areas which are harder to quantify include the cost of litter on land, the cost of microplastics, and the health costs to workers in petrochemical plants.

[20] Source: Valuing Plastic, UNEP and Trucost, 2014.
[21] Source: Plastic and climate, CIEL, 2019
[22] Source: The impact of petrochemical industrialisation on health, 2018
[23] Note this is similar to the €800 per tonne that the European Union is suggesting should be the levy on non-recycled plastic waste

FIGURE 7. PLASTIC EXTERNALITIES PER TONNE $



Source: EPA, CREA, WHO, UNEP, CT estimates, Breaking the Plastic Wave

Carbon dioxide

As is well appreciated, carbon dioxide imposes a cost on society through global warming. The cost per tonne is known as the social cost of carbon, the SCC. The SCC was calculated under the Obama administration in 2020 terms at $50 per tonne, and most estimates of the cost are higher than this. The US EPA released a report in 2020[24] on the cost of the SCC around the world, which noted that it was calculated to be over $200 per tonne in Germany, $103 in France and $93 in the UK.[25] The difference arises because of the scope of the analysis and the discount rates used.

If we assume an SCC of $50-100, then the cost of carbon dioxide from plastic is $250-500 per tonne.

Air pollution

Each stage of the production of plastic produces pollutants such as PM 2.5, SOX and NOX which are harmful to human health. It is especially concerning that 22% of plastic is openly burned and another 13% is incinerated.

The World Health Organization,[26] the World Bank,[27] the IMF,[28] and CREA[29] (Centre for Research on Energy and Clean Air) have done extensive analysis of the consequences and costs of these pollutants. CREA estimates that the pollutants from fossil fuels cause 4.5 million deaths a year from conditions such as asthma and heart failure. The estimated cost of the pollution is highly dependent on the value placed on a human life, but is of the same order of magnitude as the cost of global

[24] Source: The social cost of carbon, EPA, 2020
[25] The difference between the numbers depends on the cost of capital and the boundaries of the damage estimates.
[26] Source: Ambient air pollution: a global assessment of exposure and burden of disease, WHO, 2016
[27] Source: The cost of air pollution, World Bank, 2016
[28] Source: How large are fossil fuel subsidies, IMF, 2019
[29] Source: Quantifying the Economic Costs of Air Pollution from Fossil Fuels, CREA, 2020

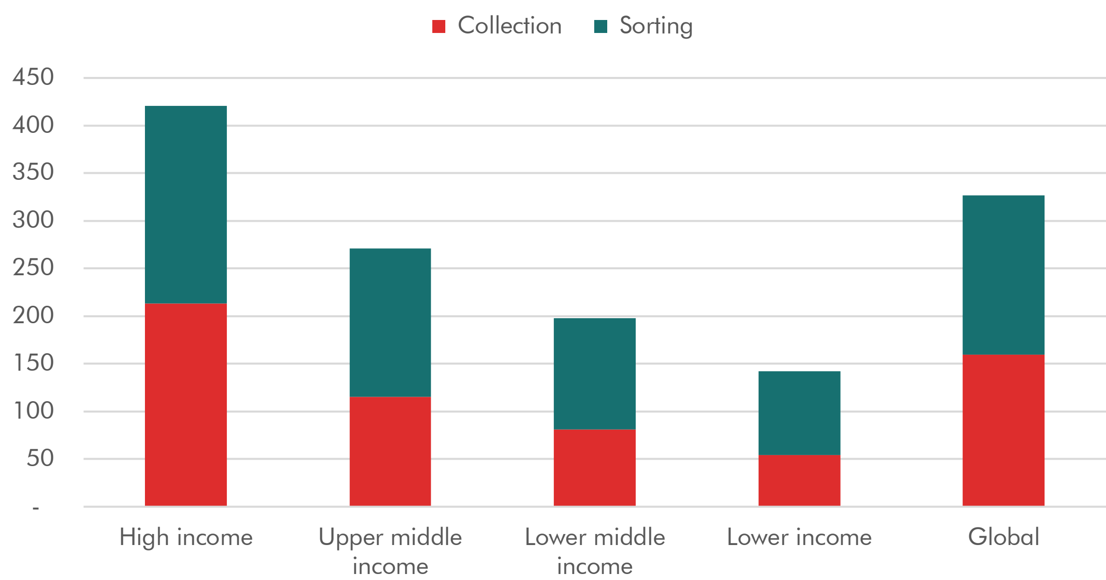
warming. CREA for example calculates the health cost at $2.9tn which is around $90 per tonne of CO_2 released by the energy sector. This puts the cost at the top end of the $50-100 range that we identified above for the social cost of carbon. The IMF has a similar conclusion.

We are not aware of a detailed study of the costs of the pollution specifically from the plastics value chain, but we believe it is reasonable to make the simplifying assumption, as elsewhere in the fossil fuel sector, that the healthcare costs are comparable to the costs of carbon dioxide. That implies costs of $250-500 per tonne of plastic.

Collection and sorting

Plastic waste is expensive to pick up, transport and sort. "Breaking the Plastic Wave" estimates the costs to collect and sort plastic waste for the four main income groups as below, for urban and for rural environments. On a weighted basis, the average cost is $159 per tonne for collection and $167 for sorting, making a total cost of $327 per tonne.

FIGURE 8. COLLECTION AND SORTING COSTS $ PER TONNE



Source: Breaking the Plastic Wave

There is then a question of how to allocate this cost across the plastic system, given that much plastic is not collected and much of the collected waste is not sorted. However, there is a relatively elegant solution to this, which is to assume that the collection and sorting cost is an approximation of the uncounted negative externality costs that we identify below. This implies that we can take this cost across the entire plastic sector. For our low end estimate we note that only around 75% of plastic produced in a year becomes waste, and we take therefore 75% of the total. For the high end estimate we note that all plastic will eventually end up as waste and so we give full cost allocation. Costs therefore range from $245 per tonne to $327 per tonne.

Ocean plastic

11 mt of plastic ends up in the ocean every year, and there are 150 mt of plastic in the sea. According to a UNEP study[30] the cost of the plastic in the sea is $13bn a year from clean-up costs,

[30] Source: Valuing plastic, UNEP, 2014

reduced fish catches and physical damage to ships. A study by Forrest et al in 2019[31] suggested that the cost of ocean plastic was 100 times higher at $1,500bn, and a recent article in Marine Pollution Bulletin argued that the cost is $500-2,500bn per annum.[32] The UNEP analysis was done in 2014, and the true cost is likely to be higher than this, but we will take it as a starting point.

The calculation of the ocean clean-up cost per tonne of plastic produced is not quite so simple as it seems because the cost of the plastic in the ocean relates to the total stock of plastic in the ocean of 150 mt. Moreover, the 11 mt of plastic which enters the ocean this year is likely to stay there causing damage for decades (or more), so the costs need to be capitalised. We also need to decide whether to allocate the cost over all plastic production of 350 mt or over just the plastic analysed by Breaking the Plastic Wave of around 215 mt. Because we are looking for a holistic system cost, we choose to allocate over all plastic production.

The calculation is then pretty simple. $13bn for 150 mt of plastic implies an annual cost per tonne of plastic in the sea of $87. This needs to be capitalised[33] and we choose 20 years for a low-end cost and 40 years for a high-end cost to give a cost per new tonne of plastic entering the sea of between $1,700 and $3,400. If we multiply by 11 mt and divide by the 350 mt of total plastic produced that gives a cost per tonne of plastic produced of between $54 and $109. So a range of $50-100 is appropriate.

Microplastics

Microplastics pollute waters and seas. However, the costs of this are not yet calculated with sufficient rigour for us to be able to include them into the analysis.

Rubbish

14% of the plastic ends up in terrestrial leakage. This also has costs in terms of picking it up or dealing with it. We have not seen an analysis of these costs, although they are likely to be material.

Are the externalities priced in?

We set out below an overview of the subsidies and taxes we can find in the plastics system. Although we are obliged to make a number of assumptions, the main point simply is that the subsidies are higher than the taxes. This means that all of the externalities of the sector are effectively untaxed.

Subsidy

Some countries pay subsidies to companies to build plastic plants. But the most notable amount of subsidy is from subsides to the oil sector, calculated by the IEA in 2018 as $150bn[34], or $33 per tonne of oil. Since it takes about 1 tonne of oil to make a tonne of plastic,[35] that implies a subsidy to the plastics sector of around $33 per tonne or $12bn in total.

[31] Source: Eliminating plastic pollution, Forrest et al, Frontiers in marine science, 2019.
[32] Source: Global ecological, social and economic impacts of marine plastic, Marine Pollution Bulletin, Beaumont et al, 2019.
[33] The plastic is likely to cause damage for many decades, but the cost of money means that you still need a lower capitalisation rate
[34] Source: Fossil fuel subsidies, IEA, 2019
[35] The calculation of the amount of oil required per tonne of plastic depends of course on the type of plastic and whether you include in the calculation only directly used feedstock or oil from co-products. It takes around 1.5 tonnes of oil equivalent to make 1 tonne of ethylene, but less than one tonne of ethylene to make one tonne of plastic products as there are other additives. If we take the widest possible definition of inputs from BP of 419 mt of oil inputs into the plastics sector and the widest possible definition of plastic from the IEA at 420 mt, the ratio is 1:1.

In the context of the plastics sector, this is not in fact a very large amount, but it is worth bearing it in mind, because it is almost certainly larger than the taxation on plastics.

Taxation

The preferred solution to tax plastics for governments at present is to implement 'extended producer responsibility' (EPR) schemes. The idea is that these schemes raise money from producers in order to pay for the costs of cleaning up the wate from their product, on the polluter pays principle. Europe is the leading region at implementing these schemes, and the issue was examined in some detail recently by the European Academies' Science Advisory Council (EASAC)[36]. They concluded that even in Europe the EPR schemes were not fit for purpose. On the one hand the total tax levied varies between €200 per tonne in Austria[37] and €15 per tonne in the UK. On the other hand, the amounts levied did not even cover the cost of collection and sorting, let alone the carbon and health externalities identified above.

We are not aware of an analysis of the total amount levied under the EPR schemes, but it is possible to put a ceiling level on the total European EPR payments. Total European plastic use is around 50 mt, of which 40% is packaging, implying 20 mt of packaging usage. On the highly optimistic assumption that the EPR per tonne averages €100, the total EPR payment would then be €2bn. In reality, it will be less. In any event €2bn is considerably less than the $12bn subsidy that we noted above.

Untaxed externality

The conclusion is that the untaxed externality on plastic is in the region of $1,000 per tonne of plastic produced. Which is $1 per kg, or $350bn a year. This sounds like a large number until we calculate what it means per person or per item of plastic used.

- The average person uses 46 kg of plastic a year, so the total externality cost is $46 per person, or 0.5% of global per capita GDP.
- The cost per item is extremely low. If a sandwich wrapper weighs 10 grams for example, then the externality cost is 1 cent.

The reason for these calculations is to show that the imposition of a plastics tax would not have a major impact on consumer prices. However, what it would do is force producers to be less profligate with plastics and to search for solutions to reduce usage.

Who pays for the externalities

Given that the externalities are not priced in, it is worth asking who pays for them. And the answer is overwhelmingly the poor and those living in poor countries. These are the people who live beside the plants burning toxic plastics and the people living in poor fishing communities in seas churning with plastic litter. Moreover, a major finding of the IPCC's report on the impacts of global warming of 1.5 degrees is that many of the impacts are not burdened equally across society and fall disproportionately on the poor and vulnerable.

Who benefits from untaxed externalities

If the impact on consumers of paying for externalities is low, it follows that the benefit to them from failing to tax the externality is also low. How many of us would object to paying one cent extra for a sandwich in order to keep the streets clean?

[36] Source: Packaging plastics in the circular economy, EASAC, 2020
[37] As a matter of note some EPR costs in Germany are €350 per tonne

The primary beneficiary of low taxation is therefore the producer. The average cost of a tonne of plastic is $1,000 - 1,500, and the externality, as we have seen, is in the region of $1,000. So the subsidy from the rest of society to the plastics industry is only a little less than the total sales value of the industry.

It is possible to go one stage further in our analysis of the costs and benefits of the failure to tax externalities. Because there are lots of companies that want to produce plastics, capacity expansion is huge. And overcapacity leads to low prices and low returns for incumbents. Paradoxically we may therefore be in a position where even the industry itself fails to generate returns out of covering the planet in plastic waste. This is a bizarre situation, and a significant regulatory failure.

Waste

The plastic system is characterised by extraordinary levels of waste. Four aspects of this are worth noting: the large amount of single use plastic (36% of all plastic produced); the huge amounts of mismanaged waste (40% of all plastic waste is mismanaged); the feeble amounts of recycling compared to other industries (theoretical recycling rates are 20% but in practice they are closer to 5%); and the poor design of plastic products (almost anything goes).

Single use plastic (SUP)

Extremely high levels of plastic are used only once. According to Geyer,[38] 36% of plastics are used in packaging, almost all of it single use packaging. A sandwich wrapper is used once and tossed away to pollute the environment for a thousand years. Packaging is vulnerable to political action because the pollution is so visible, and we show below it is notable that nearly three quarters of people surveyed by IPSOS in 2019[39] want to see SUP bans.

Mismanaged waste

According to "Breaking the Plastic Wave", 40% of municipal solid plastic waste is mismanaged and ends up in the environment. 5% ends up in ocean leakage, 22% in open burning, and 14% in terrestrial leakage. And this waste is extremely unpleasant and visible.

Recycling

Recycling levels in the plastics industry are shockingly low. According to "Breaking the Plastic Wave", 20% of plastic waste is sent for recycling, but this is not the end of the story. Around 5% is rejected immediately, and most of the rest is downcycled into lower quality products such as carpets or park benches which are not recycled at the end of their life. "Breaking the Plastic Wave" calculates that only 5% of used plastic actually substitutes virgin plastic. Ellen MacArthur has a similarly low number; it calculates that only 14% of plastics is collected for recycling; of this 4% is rejected at once, 8% is downcycled into lower value products, and only 2% is in fact recycled into similar products.[40]

Contrast this low real recycling rate with the 60-80% recycling rates that are seen for steel, aluminium, or paper. There are of course reasons why recycling rates are so low, as we examine in more detail below. But the starting point needs to be that the amount of plastic that is actually recycled is shamefully low, meaning that there is a lot of low-hanging fruit as society seeks to address the problem.

[38] Source: Production, use and fate of all plastics ever made, Geyer, 2017
[39] Source: A throwaway world, IPSOS 2019
[40] Source: New plastics economy, rethinking the future of plastics, Ellen MacArthur, 2016

Design

What lies behind this waste and limited recycling is poor design. Thanks to regulatory capture, idleness or ignorance, the plastics industry has been able to deploy its products with impunity. Look carefully at the back of the plastic products you use in your everyday life, and you will see a worrying number of pieces of packaging which are for whatever reason not recyclable. In some countries it is legal to put toxic dyes and colours into packaging, which mean that it cannot be recycled.[41] It is legal to combine two types of packaging in one product so that the whole product cannot be recycled (e.g. plastic bonded onto the inside of disposable coffee cups preventing both the plastic and the cardboard from being recycled). It is legal to fill magazines with sachets of sample products, even if few of them are used. It is legal to use plastic for pretty much anything, regardless of the cost to others.

The plastics industry responds to this criticism in a time-honoured manner. Rather than addressing the question of why my sandwich wrapper is non-recyclable or why the industry does not have to pay for the pollution that it causes, the industry persuades regulators to focus on areas of relatively small plastic demand like plastic bags, commissions studies to show that plastic is less environmentally damaging than glass, and focuses on areas where plastic is indeed invaluable, like PPE material in the fight against COVID.

This approach has served the industry well, but it also creates a spectacular amount of fragility as society wakes up to the size of the externality. This is not an industry which has focussed at all on efficiency or maximising utility. It is a bloated behemoth, ripe for disruption.

Under current designs, only 21% of plastic has enough value to be collected economically. "Breaking the Plastic Wave" has shown that this could be increased to 54% without compromising the quality or the services that we get from the plastic. A near tripling of the amount of valuable plastics would have a transformative impact on the economics of the entire recycling supply chain. "Breaking the Plastic Wave" for example calculates that it would increase the value per tonne of recycled plastics by $180, which would be enough in many areas to make recycled plastic more economically attractive than virgin plastic.

Society

Society has finally woken up to the problems imposed by the current energy and plastics system and wants solutions. We set out the main areas of concern and summarise some recent polls suggesting that people want action to curb plastic usage.

Areas of concern

Society has especial concerns about global warming and ocean plastic, and expectations for continued growth in plastic demand run directly contrary to both of these.

- Global warming. As we have seen, the necessity to curtail global warming requires carbon emissions to halve by 2030 and get to net zero by the middle of the century. It is simply delusional for investors in the plastics sector to believe that the sector will be immune from attempts to resolve this issue.
- Ocean plastic. According to "Breaking the Plastic Wave", there are 150 mt of plastic in the ocean. And we add 11 mt a year. Under BAU we will add 29 mt a year by 2040, and there is forecast to be 646 mt of plastic in the sea under this scenario, similar to the weight of all

[41] For more on this see Waste Only, Intercept, 2019

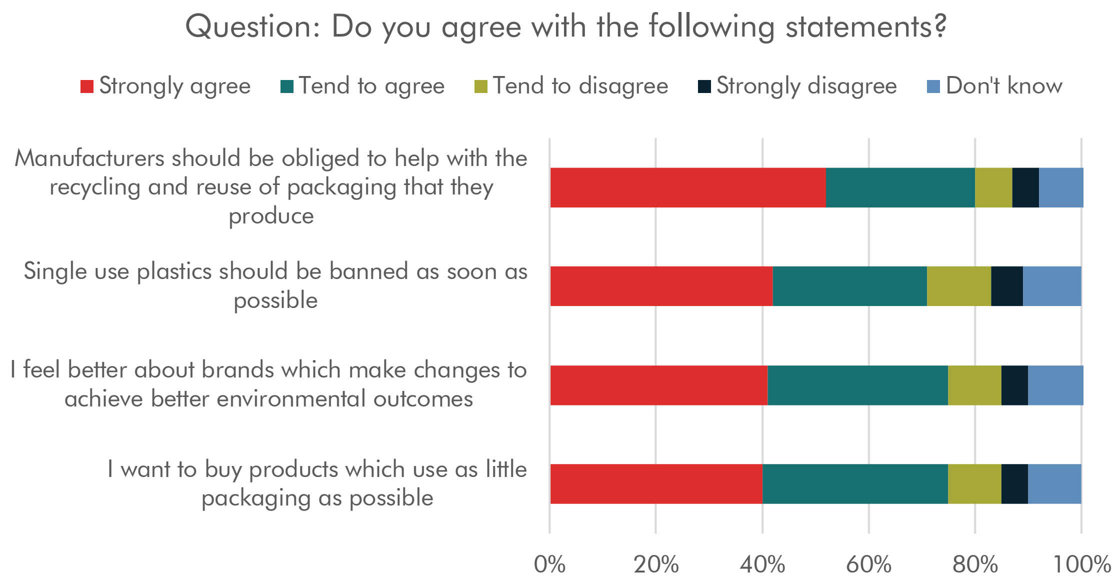
the fish in the sea.[42] As shown by the popularity of programmes like David Attenborough's Blue Planet, society is outraged by the mess, and anxious for solutions.

Opinion polls

Consumers are looking for ways to reduce plastic use and are putting pressure on governments to find solutions. For example, according to Google trends, searches for 'Circular economy' have tripled in the last five years.

We show below the result of some polls carried out by IPSOS in 2019 which looked at consumer attitudes to packaging and single use plastics. The results are pretty stark. 70-80% of those polled wanted action in the shape of a ban on single use plastics as soon as possible and forcing manufacturers to pay for recycling costs. And those in favour of action were around 5 times the number of those opposed.

FIGURE 9. IPSOS POLLS 2019



Source: IPSOS (19,515 online adults under the age of 75 surveyed across 28 countries. Fieldwork dates: July 26th – Aug. 9th, 2019)

How about the useful aspects of plastic?

Plastic usage is extremely useful in certain areas such as healthcare and in other areas such as packaging or automotive it reduces total emissions by reducing waste or weight. Set against this, one can raise the question of plastic waste and the use of plastic in areas with doubtful utility such as the famous example of the McDonald's ready meal plastic toys.

At the outset it is worth noting that the amount of plastic used in PPE equipment is very low and not sufficient to outweigh falling plastic demand elsewhere as a result of the economic shock of COVID. In their analysis of the global plastics market[43] in 2020, Wood Mackenzie is for example forecasting a 4% fall in global plastic demand this year in spite of rising demand for PPE. Simply put, a car uses

[42] Source: New plastics economy: rethinking the future of plastics, Ellen MacArthur, 2016
[43] Source: Commodities in distress; what about chemicals, Wood Mackenzie, 2020

a lot more plastic than a mask or even a thousand masks, and the economic shock of COVID means we are buying a lot fewer cars.

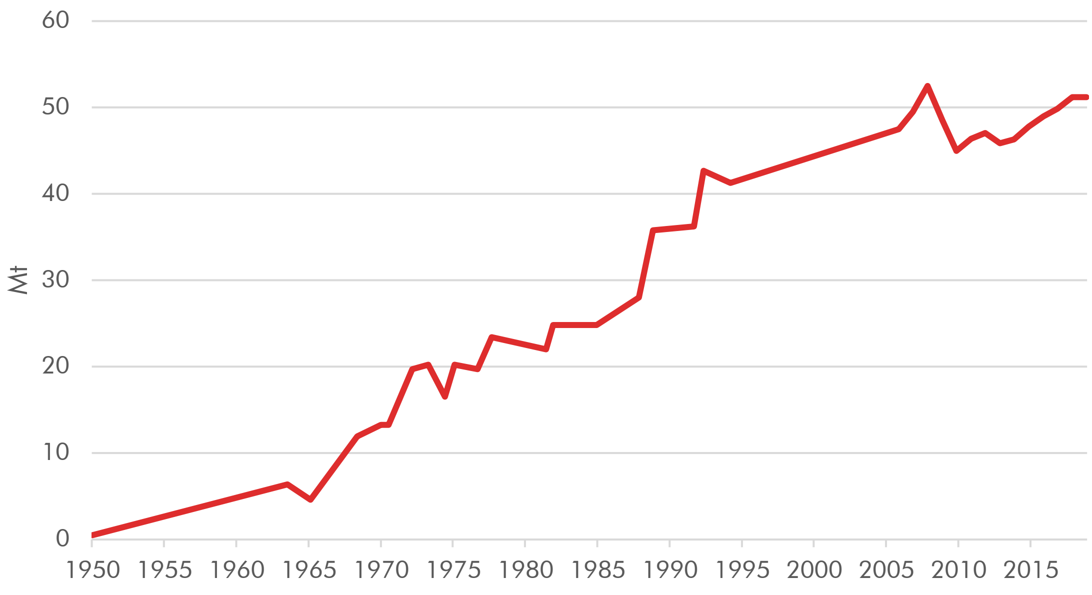
The optimal amount of plastic will then lie in the middle between these two extremes. And this is precisely why it is so important to tax plastic for its externality, and then let the market figure out which areas are most important and are prepared to pay their way.

It is worth emphasising again a point we have made many times at Carbon Tracker:[44] in order to disrupt an industry, it is not necessary to reduce demand to zero. Instead disruption often comes at or shortly before the moment of peak demand. The point then is that we can all continue to enjoy the benefits of plastics in many areas of our lives; but if we start to make changes at the margin and curb demand growth from 4% to 1%, then the implications for the industry will be significant.

Developed market saturation

There is increasing evidence that demand for plastics has peaked in the OECD. For example, the IEA cites an analysis by METI[45] on the demand for plastic, which shows that in Japan, Europe and the US, plastic demand has stopped rising with GDP growth. Plastic demand in Europe rose rapidly until 1990, slowly until 2007, and since then has been stagnant for over a decade, and is still below its peak. Initiatives such as the Plastics Pact, led by the Ellen MacArthur Institute, are doing remarkable work to reduce the usage of plastics.

Figure 10. European plastic demand Mt



Source: European Plastics Association

Given that the OECD makes up nearly half of global plastic demand, that implies that demand is no longer rising in half of the world. So, as in many areas of the energy sector, all demand growth will be driven by China and the rest of the emerging markets.

[44] See for example: 2020 Vision, Carbon Tracker, 2018
[45] Source: The future of petrochemicals, IEA, 2018 cites data from METI, Future supply and demand trend of petrochemical products worldwide, 2016

Emerging market leapfrog

The core argument of the plastics industry is that the emerging markets will copy the profligate and wasteful habits of the leaders of the OECD, and use plastic with impunity. However, this is unlikely given that there are already moves in these countries to reduce plastic demand. Why would the leaders of India or Uganda want to make the same mistakes we did after all? President Modi of India has been outspoken in his desire to ban single use plastics. And many initiatives are underway in Africa to curtail plastic usage.[46]

In short, nobody likes plastic waste, and as solutions to curtail usage and waste are found by Europe, China and other innovators they are likely to be adopted elsewhere.

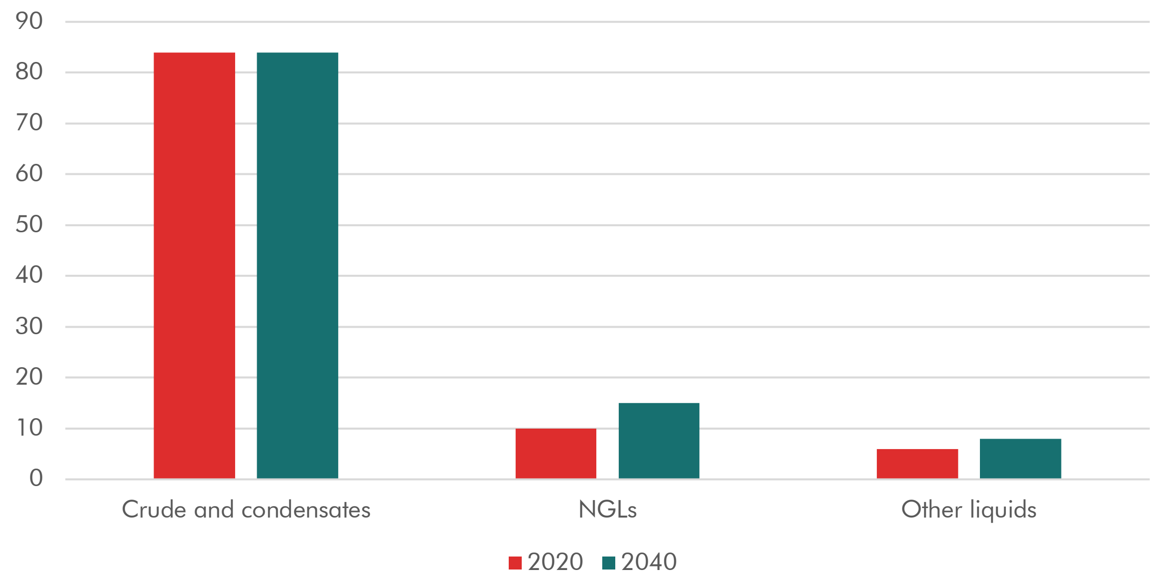
Gas supply not oil supply

The feedstock which is driving supply growth for plastics (and thus oil) is in fact NGLs (mainly ethane and propane). NGLs are classified by the IEA and BP as oil, but are in fact a gas at standard temperature and pressure, and trade at a lower price than oil.

Of the total of 7 mbpd of oil supply growth forecast by BP from 2020 to 2040,[47] NGLs make up 5 mbpd. Of this, 3 mbpd is from the US and 2 from the Middle East. 5 mbpd of new NGL supply almost perfectly matches the expected 5.8 mbpd of plastics demand growth expected by BP in the period to 2040.

The reason that this matters is that plastics demand growth, even if it should materialise, will drive NGL demand not oil demand. The largest component of oil demand growth is not therefore in fact for oil at all.

Figure 11. Liquid supply 2020 and 2040 (Mbpd)



Source: BP

[46] See for example '34 plastic bans in Africa, a reality check', Greenpeace, 2020
[47] Source: BP Energy Outlook 2019, BP

4. Technology solutions

There are many technology solutions to curtail demand for virgin plastics, and people have been advocating them in various forms for many years. The major contribution to the debate by "Breaking the Plastic Wave" is that it has calculated how to reduce demand in detail, and costed it. As a result, in this section we specifically focus on the solutions described in the System Change Scenario of "Breaking the Plastic Wave". The reduction in virgin plastic and total plastic in "Breaking the Plastic Wave" is not built on an anti-plastic sentiment but on the simple fact that it is unlikely that collection and recycling infrastructure can scale enough to deal with plastic waste volumes by 2040, especially in the Global South. Hence, if humanity is determined to protect the ocean and other eco-systems, the System Change Scenario presents a plausible roadmap to achieve it

In reality, as in any transition, some solutions will be more successful than others, and technology will make possible other solutions that we cannot foresee today. As governments put into place more appropriate tax and regulatory structures, so innovators and companies will figure out superior answers. The reason to present the list is simply to show that there are solutions, today, which can have a material impact on demand for plastic in the 2020s. Other forecasters focus on different issues and forecast for example a lesser[48] or greater[49] role for chemical recycling, but that is a separate debate.

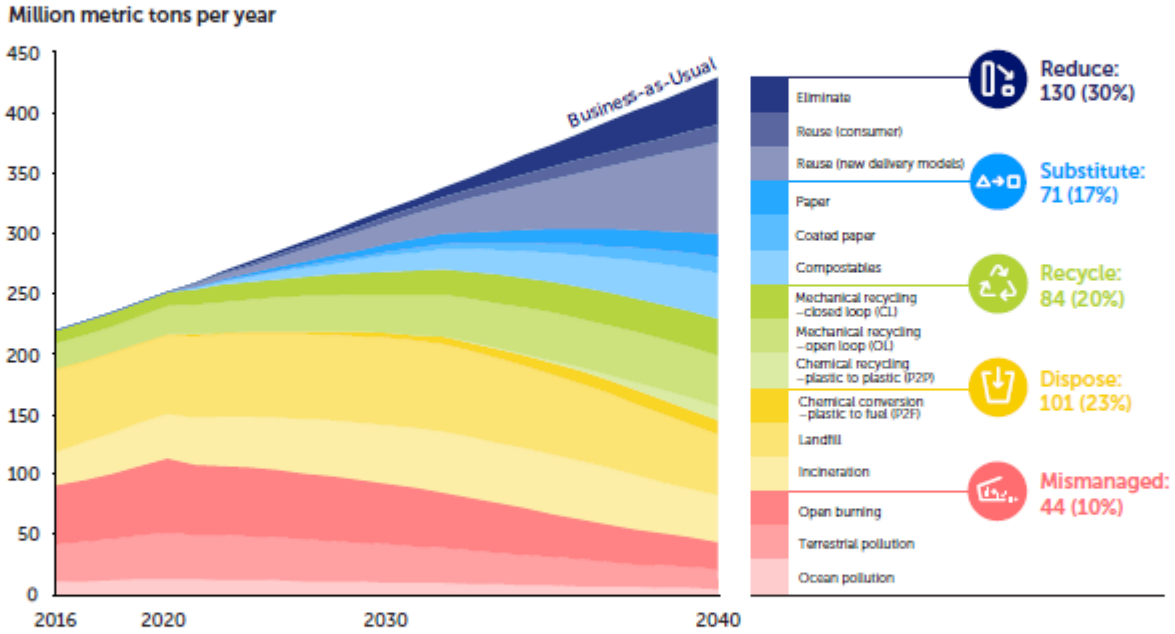
How to reduce plastic demand

Solutions to the plastic problem can be divided into upstream and downstream. Upstream solutions are ways to reduce the amount of plastic that is used; there are two main upstream solutions – reduce demand and substitute other materials for plastic. Downstream solutions are ways to recycle the plastic you have so as to reduce demand for virgin plastics; there are two main solutions – mechanical recycling and chemical recycling.

"Breaking the Plastic Wave" notes that the plastics problem is so large that we are going to have to use all the solutions in order to address it. Without significant action, the plastic growth projections of industry cannot be reconciled with the goal to reduce the flow of plastics into the ocean. Simply expanding waste collection, landfill, incineration and recycling is a false hope – the only way to meaningfully reduce plastic pollution to the environment is to combine these downstream measures with absolute reduction of plastic in the system.

[48] Source: Plastics and climate, CIEL, 2019
[49] Source: How plastics waste recycling could transform the chemical industry, McKinsey, 2018

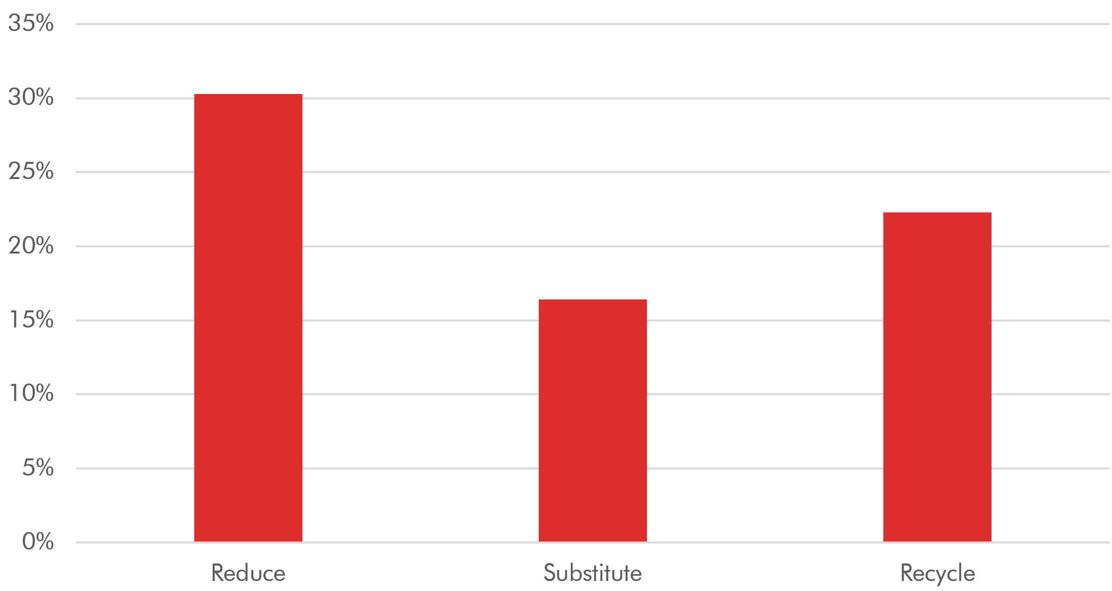
Figure 12. How to solve the plastic problem (Mt)



Source: Breaking the Plastic Wave

We summarise the solutions with regard to the share of 2040 plastic utility that they provide. Reducing demand is the most important solution, followed by recycling and then substitution.

Figure 13. Share of 2040 utility by Wedge



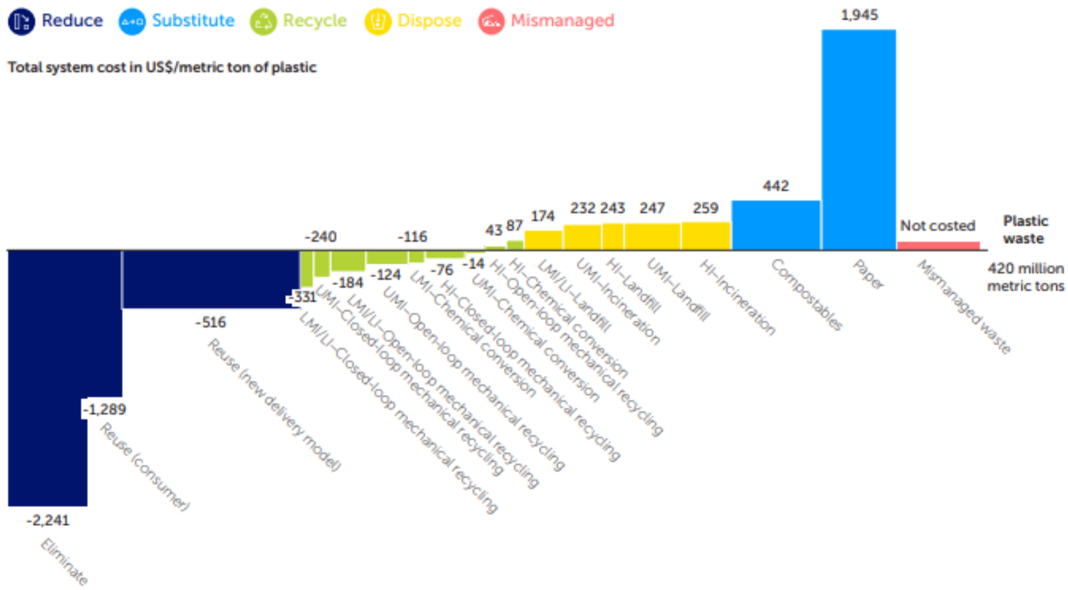
Source: Breaking the Plastic Wave

Low-hanging fruit

One useful way to chart the most likely initial solutions is to look at the marginal abatement cost curve (MACC). But it is worth bearing in mind that the MACC itself changes over time. And it is unnecessary to worry excessively about the possibly high costs of solutions at the top end of the cost curve when we are surrounded by the low hanging fruit of solutions at the bottom end.

As would be expected, solutions which reduce demand are in fact profitable as are many of the recycling options. The most expensive options are the substitution ones.

FIGURE 14. MARGINAL ABATEMENT COST CURVE PER TREATMENT TYPE IN THE SYSTEM CHANGE SCENARIO, 2040 ($/T)



Source: Breaking the Plastic Wave

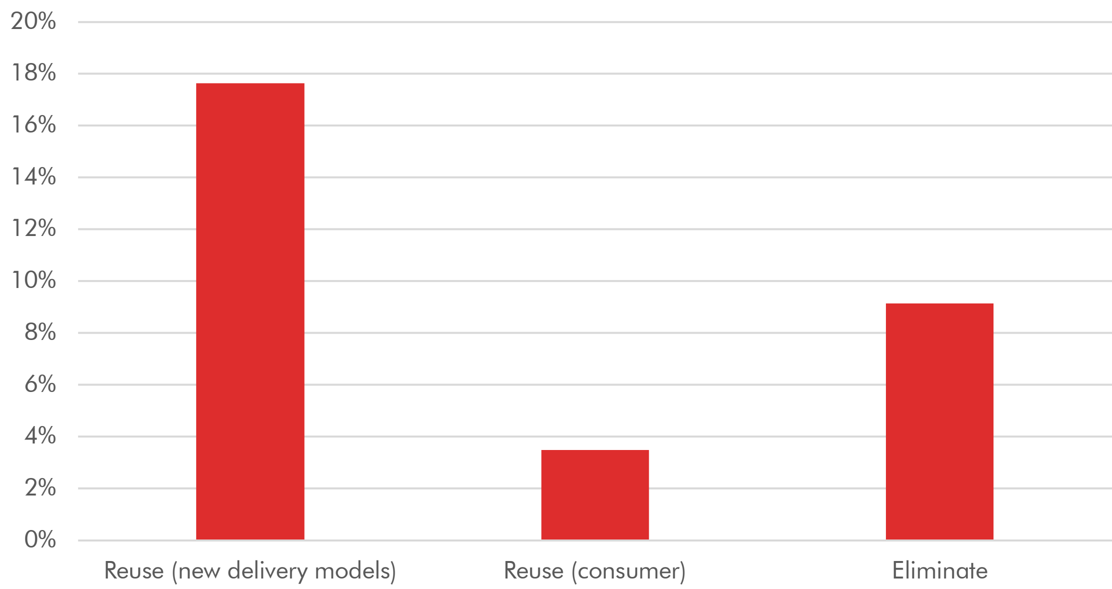
Timing

"Breaking the Plastic Wave" identifies three timeframes: the 2020-2022 period with immediate solutions including reducing excess packaging and new design; the period to 2025 which is characterised by catalysing solutions like targets and investment in waste systems; and the period to 2030 which requires breakthrough solutions such as system innovation. As in other areas of the energy transition, it is not necessary to do everything at once in order to drive change.

Reduce

There are three main ways to reduce demand. Of these, the new delivery models are by far the most important.

FIGURE 15. REDUCE SOLUTIONS SHARE OF 2040 UTILITY



Source: Breaking the Plastic Wave

Eliminate demand

For example, redesign overpackaging to remove double wrapping in plastic, reduce the number of plastic bags that are used and disposed, extend the lifetime of household goods.

Consumer reuse

Reusables owned by consumers such as water bottles or owned by institutions such as plastic pallets.

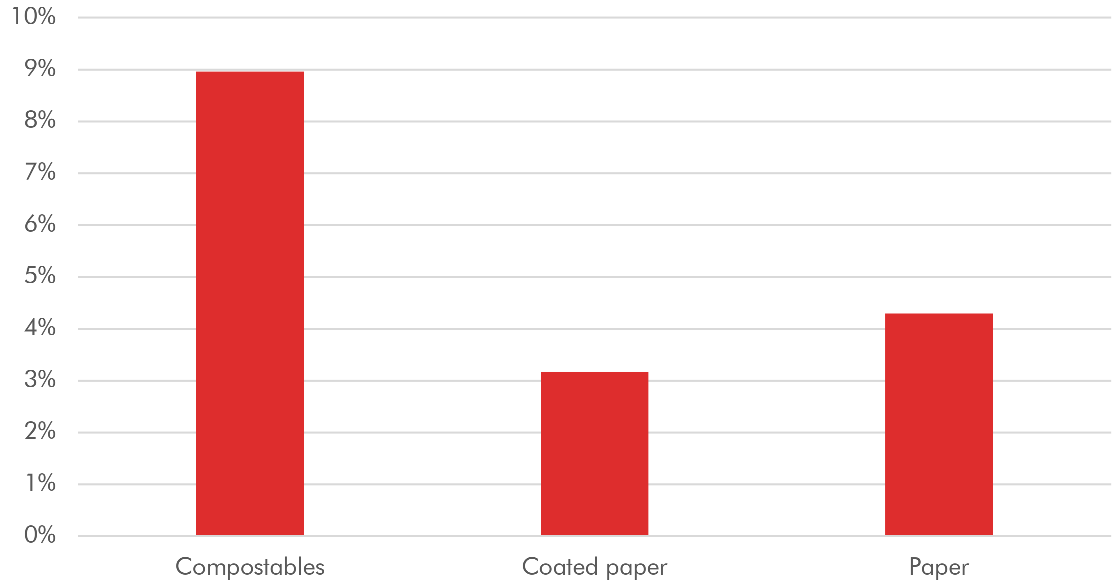
New delivery models

For example, refill from dispensers, concentrated capsules, subscription services, take-back services, shared ownership.

Substitute

There are three main substitution tools: Of these, compostables are the most important.

FIGURE 16. SUBSTITUTE SOLUTIONS SHARE OF 2040 UTILITY



Source: Breaking the Plastic Wave

Paper

Replace plastic food punnets with paper ones, and introduce paper based food service items.

Coated paper

Replace confectionery wrappers and sachets.

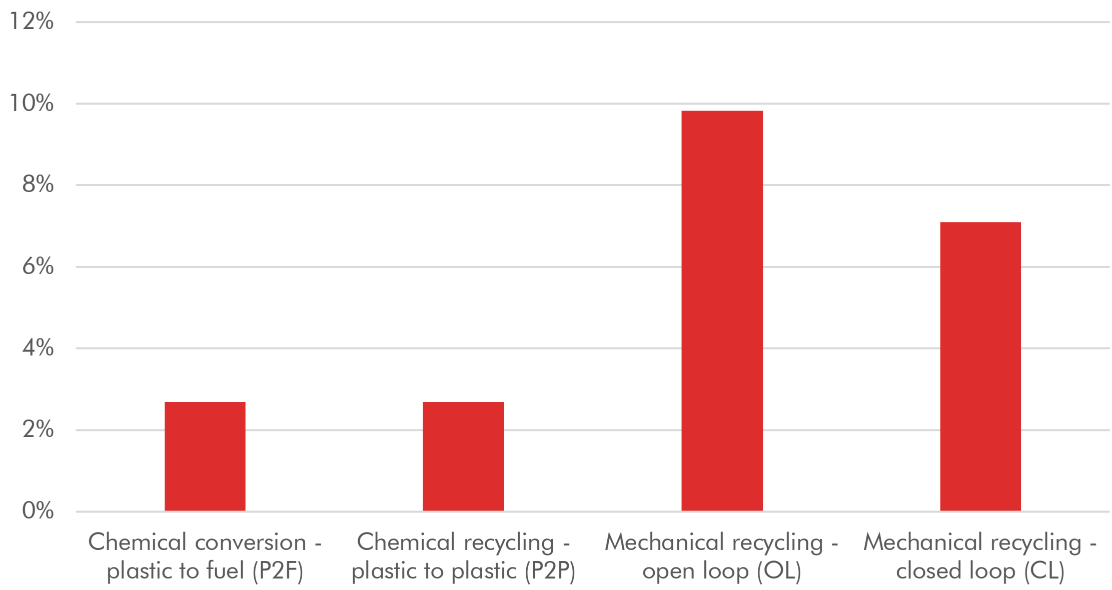
Compostable

Compostable chip packets and tea bags and banana leaves for takeaway food.

Recycle

There are four main downstream solutions. Of these an expansion of open loop mechanical recycling is the most important.

FIGURE 17. RECYCLE SOLUTIONS SHARE OF 2040 UTILITY



Source: Breaking the Plastic Wave

Mechanical recycling

Opportunities include: increasing demand for recycled plastics by setting targets; increasing the value of recyclates through design; increasing the recycling infrastructure size; forcing changes in design. All of these can increase the value of the recycling system.

Chemical recycling

Chemical recycling tends to be highly controversial,[50] with some seeing it as a silver bullet to transform the industry, and others concerned about the continued high carbon footprint of the technology, the health impacts and the risks of perpetuating the current system. "Breaking the Plastic Wave" tends to use it quite sparingly in their analysis, and opportunities include: expanding chemical recycling infrastructure, increasing research into reducing costs, and improving the legislative environment.

[50] See for example Plastics and climate, CIEL, 2019

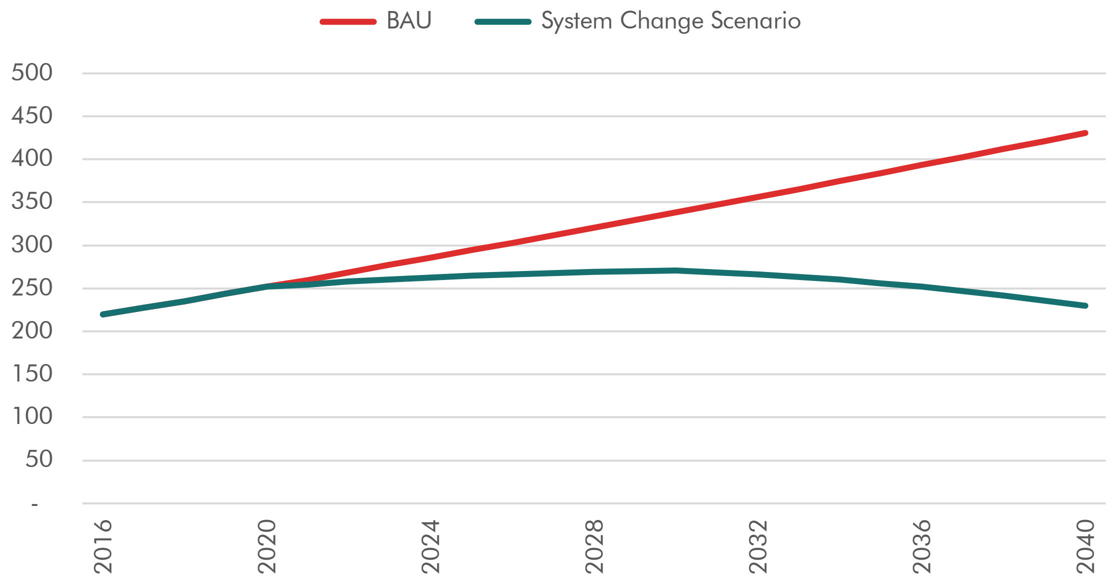
The gap between System Change Scenario and BAU

The alternate view set out by "Breaking the Plastic Wave" for the future of plastics is called the System Change Scenario (SCS) and we summarise below the key ways in which this differs from Business As Usual. The SCS has a near-term peak in plastic demand, lower capital expenditure, and more jobs.

Total demand

Under SCS, plastics demand (for the two thirds of total demand that is covered) reaches a plateau after 2020 and peaks in 2030, a major contrast to BAU demand (they assume 3% annual growth in demand which seems close to the consensus views outlined above) which rises inexorably.

FIGURE 18. DEMAND FOR PLASTIC (MT)



Source: Breaking the Plastic Wave

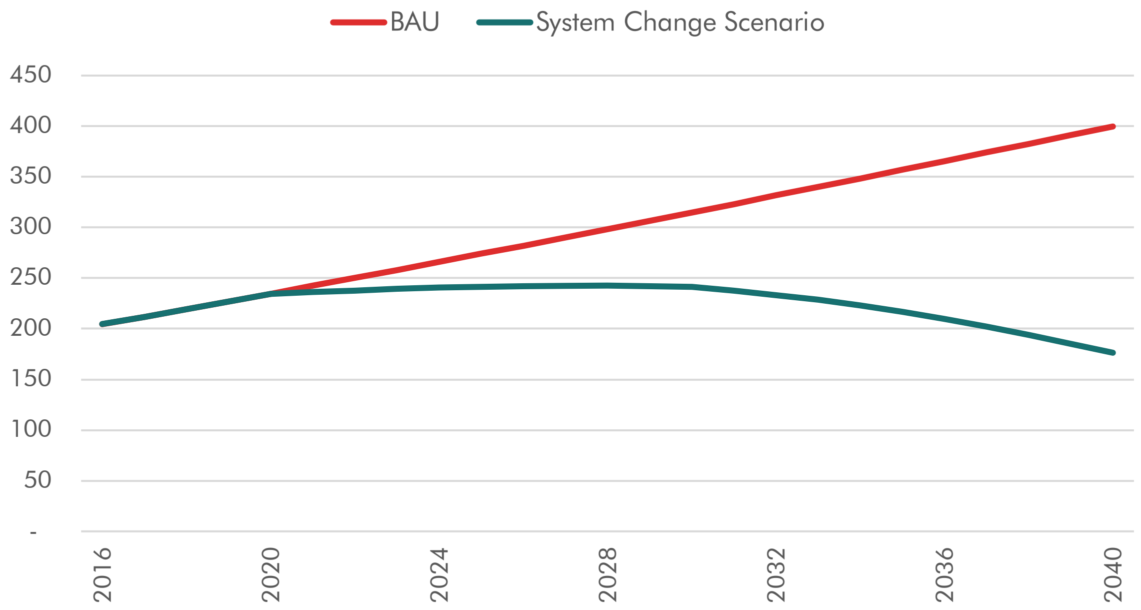
Demand for virgin feedstock

Because recycling is higher, demand for virgin feedstock peaks even sooner, in 2027. In fact the picture is even more stark than this. In the "Breaking the Plastic Wave" model, written before the effects of COVID, virgin plastic demand growth falls from 4% a year before 2020 to below 1% a year between 2020-2027. So 2020 is a watershed year. The total (not the annual) growth in expected demand for virgin plastic from 2020 to 2027 is only 3%.

The impact of COVID in many areas is to pull forward peak demand, as we noted with regard to the oil sector.[51] Wood Mackenzie forecast a 4% fall in plastic demand in 2020 for example. The implication is that if the Breaking the Plastic Wave assumptions are put into place and applied in the rest of the plastics system, then 2019 would be peak demand for plastics.

[51] Source: Was 2019 the peak of the fossil fuel era, Carbon Tracker, 2020

FIGURE 19. DEMAND FOR VIRGIN PLASTIC (MT)

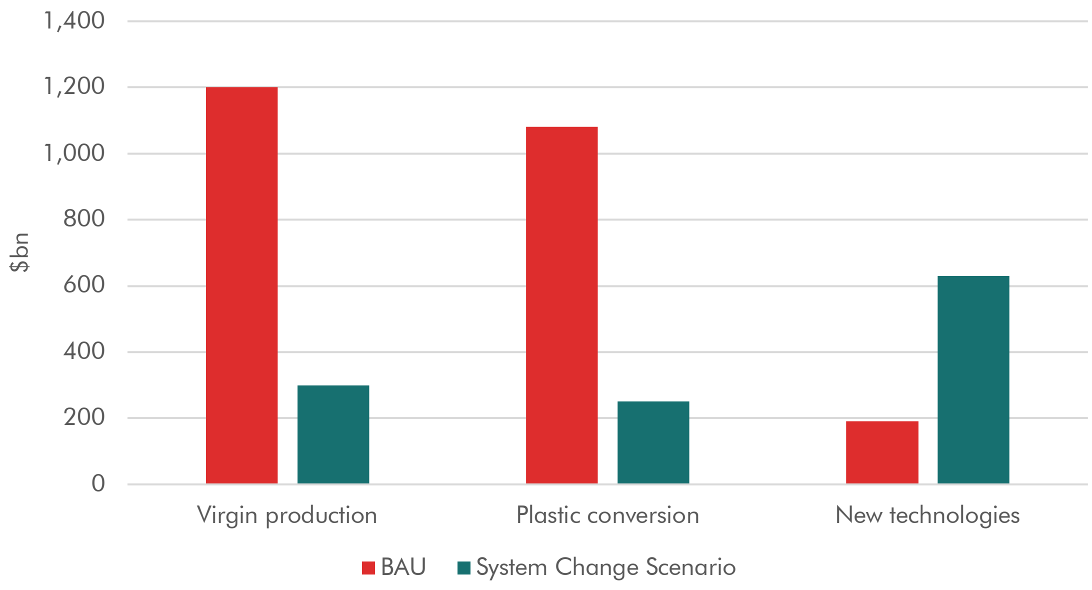


Source: Breaking the Plastic Wave

Capital expenditure

BAU requires $2,500bn to be spent on mature technologies between 2021 and 2040, including $1,200bn to be spend on new upstream facilities for virgin plastic production. SCS requires money to be spent on recycling, with only $300bn spent on virgin plastic production in the same timeframe. This is perhaps the most notable gap between the two scenarios from the perspective of the investor. Under SCS, the total capex on virgin plastic production is $900bn lower, only 25% of the capex required under BAU.

FIGURE 20. CAPEX REQUIRED BETWEEN 2021-2040 UNDER BAU AND SYSTEM CHANGE



Source: Breaking the Plastic Wave

Cost to governments

"Breaking the Plastic Wave" calculates that the cost to governments of the business as usual paradigm of littering and trying to pick it all up is $670bn, which is $70bn more than under the System Change Scenario.

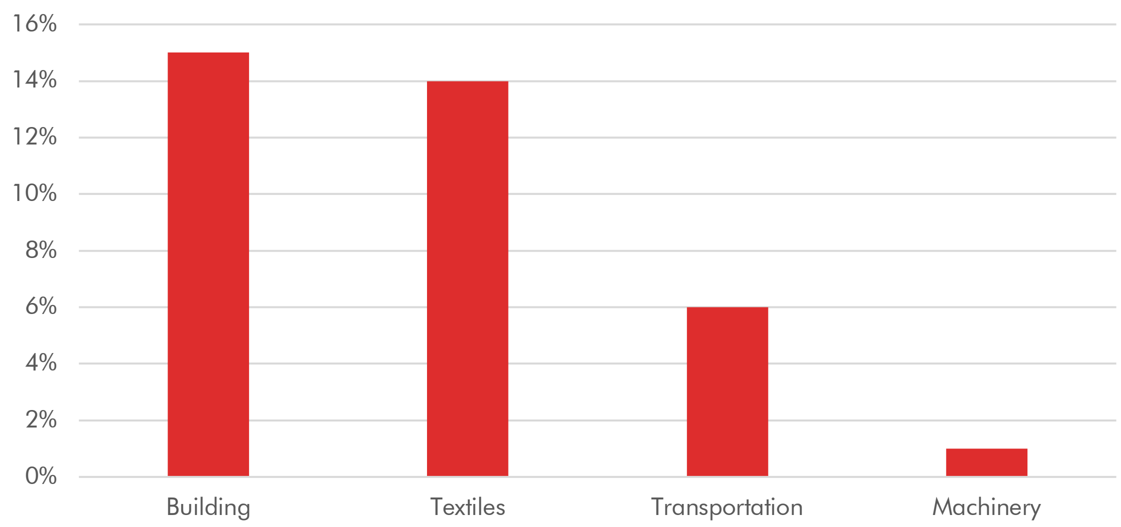
Jobs

"Breaking the Plastic Wave" calculates that a System Change Scenario would need 12 million jobs, 0.7m more than under Business As Usual.

Areas not covered by Breaking the Plastic Wave

"Breaking the Plastic Wave" covers around two thirds of total plastic demand in its analysis, and it does not consider in detail three main sectors: construction, textiles, and transportation.

FIGURE 21. SHARE OF TOTAL PLASTICS DEMAND FROM SECTORS UNCOVERED BY BREAKING THE PLASTIC WAVE



Source: Breaking the Plastic Wave

The question to be asked therefore is whether growth in these sectors could be large enough to drive rapid growth in the entire plastics value chain. As we set out below, we doubt that they can do so.

Similar historical growth rates

According to Geyer, these sectors of plastics demand have had similar growth rates to the areas on which Breaking the Plastic Wave focusses.

Similar issues

The other sectors face broadly similar drivers. They also have large amounts of untaxed externality and large amounts of waste. And demand therefore is also susceptible to the three areas of technological solutions set out by "Breaking the Plastic Wave" – reduce, substitute and recycle.

Not big enough to drive significant growth

Areas covering one third of the market are simply not large enough to drive high systemic growth by themselves, if the rest of the market is no longer growing. The maths of this observation is pretty obvious. If "Breaking the Plastic Wave" is right, and demand growth for virgin plastic for two thirds of plastics demand can be constrained to zero, then it will be hard for the remaining one third to drive much system growth.

The historic growth rates of these sectors has been around 4%. Let us assume that the kind of solutions suggested by "Breaking the Plastic Wave" can bring that down to 2-3% growth. If only one third of the system is growing, then the total system growth is simply one third of the growth rate of the growing part. So even a 3% growth rate in these areas would mean only 1% growth rate for the system as a whole.

5. Political solutions

We set out below why politicians are likely to act, what politicians can do, and what they are doing, before considering how COVID impacts the debate.

Why politicians are likely to act

The theory

When you enumerate them, there are a surprisingly large number of reasons why politicians are likely to act to reduce demand for virgin plastic imported from abroad.

Popular choice

As we have seen in the IPSOS polls, consumers are anxious to reduce plastic pollution.

More jobs

There are 0.7m more jobs in the new waste management industries than in a system that relies on constantly producing plastic from imported virgin feedstock. And countries that seize the opportunity can gain technology leadership. Moreover, recycling jobs are local jobs effectively producing local plastic, whereas the import of plastics from abroad depends on oil extraction and conversion in other countries.

New solutions

There are technology solutions which enable change to happen. This is a combination of the regulatory frameworks being pioneered by Europe and China and the superior technology solutions which emerge from that.

Limited costs for voters

The cost for consumers of higher regulation on plastics is low. As we noted above, the entire externality cost of $1,000 per tonne is only $46 per annum per person. Since politicians are likely to introduce taxes at much lower rates, the overall consumer impact is minimal. Moreover the overall cost of the circular solution is lower.

More revenue, less cost

Governments need new tax revenues and a tax on plastics can provide them. Moreover, less waste plastics means lower collection costs.

Reduce oil import dependency

For those countries that import oil, plastic is in effect an oil import. Therefore, a reduction in plastics usage ties in with the more nationalist agendas that we see in this age of uncertainty.

Why COVID speeds up change

In the very short term, plastics lobbyists have been able to overturn plastic bag bans and to trumpet the benefits of PPE. Moreover, waste systems are in disarray, and the low price of oil has meant that virgin plastic is cheaper than recycled plastic.

However, in the longer term, COVID is likely to speed up change. Reasons for this include:

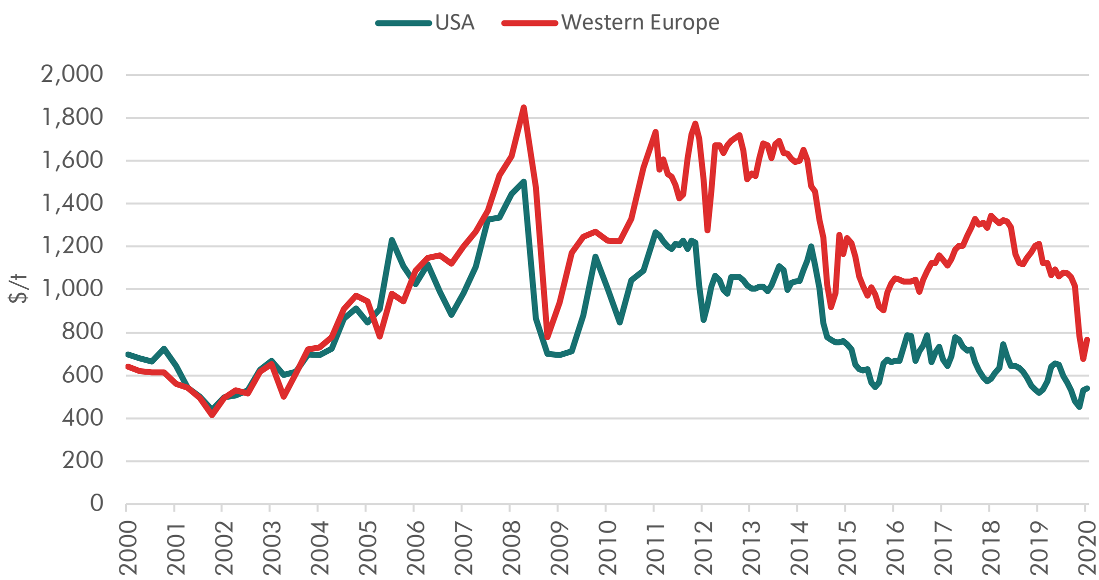
Need for money

A tax on plastics can raise useful funds at this time of fiscal stress, and could be a rare example of a popular tax. There is no need to plunge in immediately with the full externality cost, and a sliding scale could phase taxation in. Given the 350 mt of plastics used per annum, a tax at $100 per tonne would raise $35bn a year, rising to $175bn at $500 per tonne.

Weaker incumbency

One explanation for the extraordinary ability of the plastics sector to avoid paying for its externality costs must be strong political leverage. At this time of weaker incumbency and with petrochemical commodity prices at low levels, governments have the ability to step in with tax wedges. With ethylene prices at their lowest level since 2003 there has not been a better time for governments to step in and levy the savings as taxation.

FIGURE 22. THE PRICE OF ETHYLENE IN $ PER TONNE (NOMINAL)



Source: Bloomberg

Appetite for change

We live in a febrile world, where the Overton window of opportunity has been opened for change. Some politicians are taking it. A parallel can be drawn with the actions of politicians after the oil shock in 1973. At that stage they significantly increased the taxation on oil and took measures to increase efficiency. They missed out on plastics which at the time was a tiny industry. They should not make that mistake again.

What are politicians doing

We first set out what politicians can do and then what they are doing. Politicians in Europe are leading the way as we set out below. We see signs that the Chinese government will adopt its own set of policies to address the issue. And once these two major regions have set the scene, the successful innovations that they develop are likely to be copied by many other counties, especially by those which import their oil.

The opportunity set

We focus on five areas where politicians can act: tax, design, targets, bans and infrastructure.

Taxation

When you buy petrol you pay tax on the oil at an average level of €80 per tonne of CO2 globally,[52] and more in most of Europe. That tax goes a long way to paying for the externality cost of the oil, widely reckoned to be over €100 per tonne of CO2. However, when you buy plastic you do not pay for the externality cost. This gives politicians an easy and legitimate opportunity to introduce taxation to make polluters pay.

Regulation of design

Most countries have done little to stop companies from putting toxins into plastics, selling non-recyclable plastic and combining dozens of types of plastic in a single product. That simply will have to stop. Governments can be much more prescriptive about what is allowed and what is not.

Targets

Governments can set targets for the share of recycled plastic that is used in products and for the share of all plastics that must be recycled and collected.

Bans

Governments can ban outright certain products, such as plastic straws or plastic cutlery or plastic that is not reusable or recyclable into products of equal value.

Infrastructure

Governments can take the money raised from paying for externalities in order to build recycling systems fit for purpose.

Europe

Europe has taken the lead in driving change from a linear plastic system to a circular one. The circular economy action plan was set out in 2018[53] and was further fleshed out by the European Parliament Directive on single use plastics in 2019[54] and latest plans set out in July 2020.[55] A lot of the detailed regulation is still being written today, and will come into force in the early 2020s. To read these documents with their attention to detail is to be reminded of the difficulty of action in the face of decades of untrammelled plastic usage. Change is hard, and regulatory flexibility and innovation will be needed.

Notable aspects of the European plan include:

- Design. All plastic packaging must be able to be recycled after 2030. Beverage container caps should be integrated into products to stop the loss of caps.
- Taxation. The prices paid under the Extended Producer Responsibility will increase to cover the total cost of waste management and clean-up of litter as well as consumer education. The proposal is for a tax (technically a 'levy') of €800 per tonne from January 2021 on waste plastic that is not recycled.

[52] Source: Taxing energy use, OECD, 2019
[53] Source: A European Strategy for plastics in a circular economy, 2018
[54] Source: Directive on the impact of certain plastic products on the environment, June 2019
[55] Source: Special meeting of the European Council, July 2020

- Targets. Minimum collection targets of plastic bottles and for the share of recycled plastic in PET bottles (25% by 2025).
- Bans. Various plastic products have been banned such as the wide use of expanded polystyrene.
- Infrastructure. The amount of infrastructure for recycling is to be increased fourfold by 2030.
- Labelling. There are as ever detailed provisions for classification and labelling of plastic products such as wet wipes.
- Reporting. Each country will have to report back progress.

Some have argued that a tax of €800 per tonne on non-recycled plastic waste still covers only a portion of total European plastics usage, and implied that the consequences will therefore be limited. In light of the analysis we have presented above about the externality costs and societal attitudes to plastic, we look at this in a different light. The taxes which apply to certain areas of plastic today in one region are surely likely to apply to a growing number of areas in a rising number of regions.

Meanwhile, Europe is something of a testbed for new policies. Certain countries like Denmark and Germany have high recycling rates and can be copied by those with low recycling rates such as Finland or Cyprus. And we see evidence that much more assertive policies for making polluters pay are likely to come into place. For example, EASAC[56] notes that the Italian taxation scheme on packaging due to come into force this year will introduce four categories of packaging, with tax rates of up to €546 per tonne for packaging which is not sortable or recyclable with current technologies. The UK consultation on reforming the UK packaging producer responsibility system in 2019 noted that under the UK system only 10% of packaging waste costs were covered and examined ways to resolve that.[57].

Moreover, as Europe succeeds in the curtailment of plastic demand in one area, we should expect the focus of policymakers to move to other areas which are causing issues such as the textiles sector, which is the subject of a forthcoming piece by Planet Tracker.

For these reasons, we believe it is a mistake to do what some petrochemical analysts have done and to add up the impact of the total known legislation today, arguing that it is not going to have much of an impact because the total amount of plastic used by plastic bags and straws is very small.[58] This approach is to apply a pedestrian and backward looking framework to a dynamic situation. The goal of the legislation is to move plastic demand from linear to circular, and it is highly likely to be tightened up over time.

As the European Union succeeds in driving change, we can expect to see other countries adopting their successful policies. This incidentally is what also happened in the electricity sector. Innovators like Germany or Denmark led the way, paving the path for other counties to follow.

China

China has similar aspirations to Europe, to reduce plastic waste and pollution. It has an especial desire to reduce its dependency on oil and gas given rising geopolitical tensions with the US. Moreover, China is one of the world's largest contributors to ocean pollution, and its people suffer from that as the shores of the South China Sea are littered with plastic pollution.

[56] Source: Packaging plastics in the circular economy, EASAC, 2020.
[57] Source: Consolation on reforming the UK packaging producer responsibility system, UK government, 2019
[58] See for example The plastics paradox, Goldman Sachs, 2019

As ever, the actual plans for reducing plastic pollution in China are a little uncertain and there is tension between the centre and the provinces. However, we are confident that change is coming.

The first indicator of major change came in 2018 when China largely closed down its industry for the importing and processing of foreign plastic waste. As China was the world's largest plastic waste importer this immediately caused major issues worldwide, and is forcing countries to put more effort into recycling their own waste.

In January 2020, the National Development and Reform Commission and the Ministry of Ecology set out a piece named 'Opinions on further strengthening the treatment of plastic pollution'. Zhou Hongchun, a researcher at the social development research department of the State Council, was reported as noting that solving the "white pollution" problem will not only improve the global environment, in particular the marine environment, but also play a positive role in transforming China's economic development mode and enhancing its international influence.[59]

The plan has three main vectors.

- By region. Prefecture level cities, country level cities. Provincial capitals, provincial level cities, and country.
- By time. With targets for 2020, 2022, and 2025.
- By area of focus. The first area of focus will be plastic bags, to be followed by a focus on SUP alternatives, more regulation of recycling, higher recycled content and rules on monitoring.

We expect to see much more detail on this plan and further developments over the course of the year.

US

Even if the current Federal government is seeking to expand plastic usage, there are many regional and local initiatives in the United States which are seeking to curtail it. Notable initiatives from the US include the Break Free From Plastic Pollution Act and the Zero Waste Act. If Biden wins the Presidency in November, we are likely to see a very different attitude from the US.

[59] Source: State Council, People's Republic of China.
http://english.www.gov.cn/policies/policywatch/202005/11/content_WS5eb88dd4c6d0b3f0e94975b3.html

6. What is likely

Plastics is a sector which imposes large externalities upon a society which is no longer prepared to tolerate them. There are technology solutions which would curtail these externalities, and evidence that politicians are starting to set up the necessary regulatory frameworks. The implication therefore is that change is more likely. At present, this sector in particular is dependent at present on regulatory leadership which is subject to the vagaries of the electoral cycle. However, as regulatory clarity emerges we are likely to see the appearance of superior and cheaper technology solutions, which will over time be able to drive change regardless of the political process.

We consider below how this is similar to the electricity sector 15 years ago and think through the regional aspects of change. Our conclusion is that there will be a large gap between the growth hoped for by the industry and that which is likely to materialise.

Similar to other areas of the energy complex

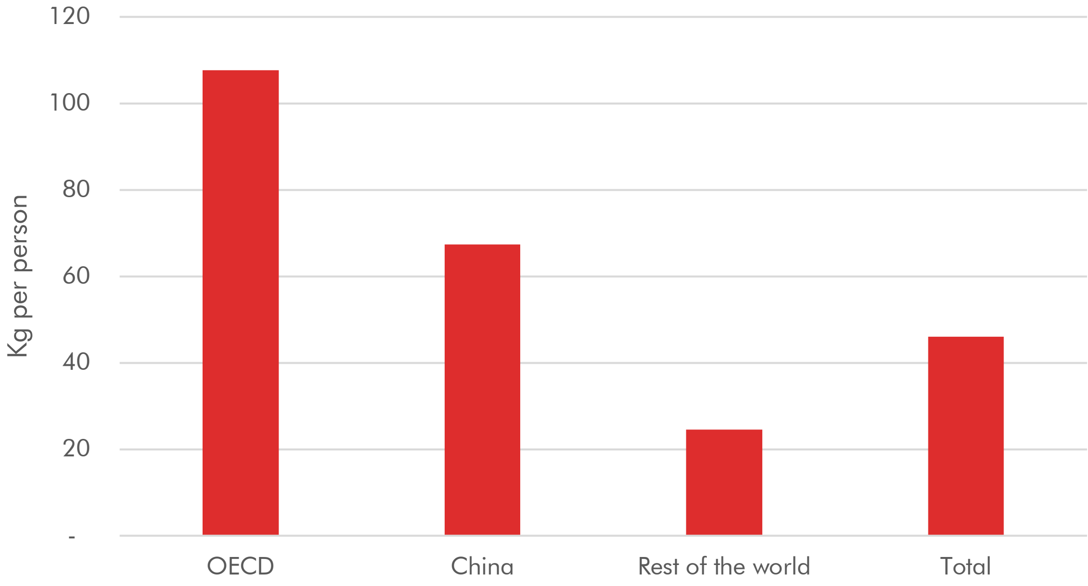
The plastic problem looks a lot like the fossil fuel electricity problem 15 years ago. Policymakers in 2005 were keen to find solutions to decarbonise electricity, and at the time the solutions were expensive and seemed unfeasibly difficult. Wind electricity cost over $100 per MWh, solar cost over $400 per MWh and grid operators argued that solar and wind could never supply more than 2% of the system. The situation looked hopeless until it was solved by a combination of regulatory pressure and technological innovation.

Regional differences

It is possible to split the world into three main regions for the purpose of this analysis: the OECD, China and the rest of the world (RoW). Although the data sources differ as to the split of plastic usage between these three regions,[60] the rough split is likely to be 40-45% OECD, 20-30% China and 30-35% the rest of the world. If we take 40% OECD, 25% China, 35% the rest of the world as a starting point, then per capita consumption in the OECD is a little over 100 kg, in China is around 70 kg and in the rest of the world is just 25 kg.

[60] For example Material Economics in 'The circular economy', 2018, estimates that China in 2015 was 15% of global demand for plastics while IHS in 'Population growth and materials demand study,' 2019 estimates it to be 31% in 2019 and the China National bureau of statistics to be 29% in 2019.

FIGURE 23. PLASTIC DEMAND PER PERSON 2017 KG PER PERSON



Source: Material Economics, IHS, China National bureau of statistics, Carbon Tracker estimates

In popular perception, plastic is associated with the film The Graduate, which was released in 1967. In the film the protagonist is advised that 'there's a great future in plastics'. When The Graduate was released, global plastic demand was 23 million tonnes, 7 kg per person. Today it is 350 mt, 46 kg per person; so the film got it right. That said, we are not notably happier as a result of the torrent of plastic. That helps perhaps as a framing within which to think about plastic demand per capita:

- OECD demand for plastic is likely to fall as governments respond to the desire of their citizens to tackle the plastics problem. If the average person is using nearly twice their bodyweight in plastic every year, it is fair to say there are a few savings that can be made.
- The Chinese government has started to tackle plastic consumption. Given that China is a major importer of oil and has significant pollution issues, this would seem to be a very fruitful area. Moreover, this analysis would indicate that Chinese plastic consumption per capita is not that far away from the OECD average. So it is feasible that Chinese plastic demand will soon stop growing.
- Non-OECD demand is likely to continue to rise from a relatively low level. But the question is how much plastic is necessary for the good life. If the old thinking was that the whole world would rise to OECD levels, it may well be that the OECD levels themselves fall very considerably as people figure out new ways to get plastic utility without plastic externality. So the level of non-OECD growth may turn out to be much lower.

The net impact of this is that plastics will replay the same debate we see in many other areas of fossil fuel demand: falling demand in the OECD, rising demand in the non-OECD, and China as a key swing factor. In the coal sector, this has already led to peak demand for coal. In the automotive sector it has also led to peak demand for ICE cars and oil demand for cars.

Peak demand for plastics is then simply a question of the assumptions that are made for these three areas. In order to get to 4% growth, you need 2% growth in the OECD, 4% growth in China and 6% growth in the rest of the world. However, if growth in the OECD is -2%, flat in China and 2% in the rest of the world, then total plastic demand growth would be zero.

7. Implications of change

The implications of the change from high growth to low growth or decline is disruption for incumbents, as we have seen elsewhere in the energy complex. However, the impact is likely to be especially disruptive in the plastics sector because it has tooled up for so much growth. We summarise the implications for plastics and oil if growth in demand sees a dramatic slowdown and then consider the financial market consequences.

Plastics

As noted above, companies active in the oil and petrochemical sector have identified plastics as a key vector of growth, and have massively increased capacity as a result. There are three immediate and obvious implications for the plastic sector if that growth does not materialise: overcapacity; low prices; and stranded assets.

Overcapacity

We summarise the issue of overcapacity in the ethylene sector, and then calculate the implications for the upstream petrochemical sector as a whole.

Ethylene

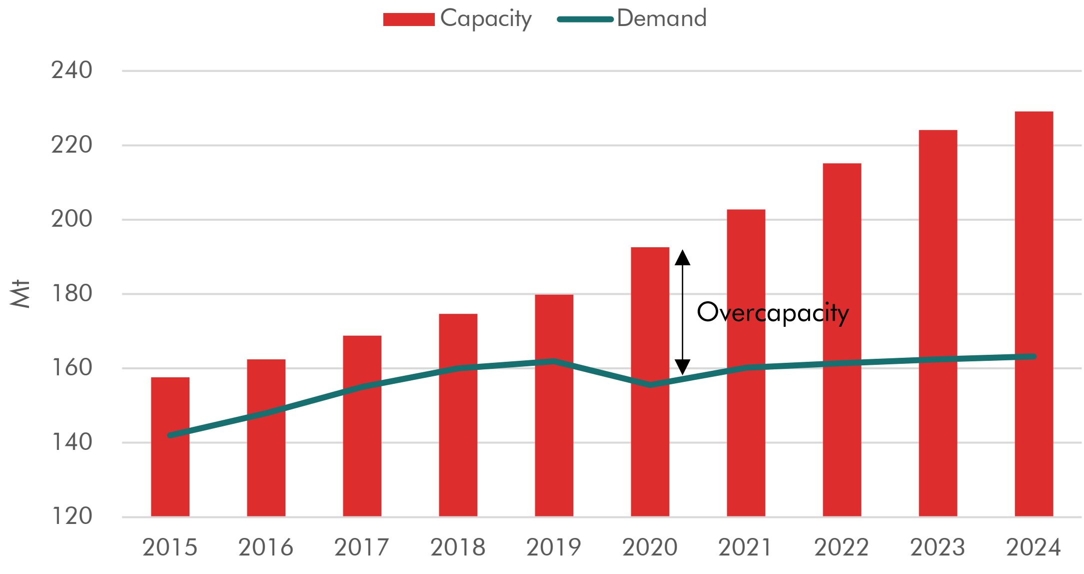
According to Wood Mackenzie, global demand for ethylene in 2019 was 162 mt, whilst data from Nexant estimates total capacity in 2019 was 180 mt. This implies the industry was running at 90% capacity, which is perhaps fair enough given rising demand and some outages.

Moreover, Bloomberg states the planned ethylene capacity expansion in 2020 is 13 mt, and the total planned capacity growth over the five years to 2024 is 49 mt.

Wood Mackenzie forecasts a fall in polymer demand in 2020 by 4%. If this applies to ethylene as well, then the combination of rapidly rising supply and falling demand means that overcapacity at the end of 2020 will be 37 mt.

Unless the industry changes its expansion plans, overcapacity will only grow. We set out the implications of this in the chart below, which contrasts the industry plans for rising capacity with the implied levels of demand if plastics bounces back in 2021 and then grows in line with "Breaking the Plastic Wave" forecasts.

FIGURE 24. GLOBAL ETHYLENE CAPACITY AND POTENTIAL DEMAND (MT)



Source: Wood Mackenzie, Nexant via Bloomberg, "Breaking the Plastic Wave", Carbon Tracker

Upstream petrochemicals

The upstream petrochemical sector is extremely complex. However, the primary intermediate chemicals in the production of plastics are ethylene and propylene. It follows that if we can calculate expected developments in these two areas then we can infer the implications for the sector as a whole.

Ethylene and propylene capacity versus demand

Total capacity in 2019 for ethylene and propylene production was 311 mt versus demand of 272 mt, implying overcapacity of 39 mt.

According to Nexant, the total capacity increase for these two key intermediary chemicals planned from 2019 to 2024 is 83 mt. Meanwhile, BloombergNEF identified 81 specific new petrochemical facilities which are planning to increase capacity by 77 mt in the period 2020 to 2025.[61] Of these, 40% are in China, 18% in North America and 15% in the Middle East. Our conclusion is that 80 mt is a good approximation for planned new capacity expansion.

FIGURE 25. ETHYLENE AND PROPYLENE CAPACITY (MT)

Area	Demand 2019	Capacity 2019	Overcapacity 2019	Capacity 2024	Increase in capacity 2019-2024
Ethylene	162	180	18	229	49
Propylene	110	132	22	166	34
Total	**272**	**311**	**39**	**395**	**83**

Source: Wood Mackenzie, Nexant via Bloomberg, Carbon Tracker

What is the cost of capacity

The cost of an ethane cracker according to the IEA is $2,000 per tonne. However, this does not include other steps in the plastics process such as polymerisation. We can identify two data points to help us calculate the entire cost of the process to turn feedstock into plastic resins based on an

[61] Source: Oil refinery and petrochemical projects, BloombergNEF, 2020

IEEFA report on the Shell petrochemical plant in the US.[62] According to IEEFA, the cost of the plant was $10bn for 1.6 mt of capacity, so a cost per tonne of $6,250, although they note that there is some dispute in the calculation of this figure, with some suggesting the total cost is $6bn, or $3,750 per tonne. They also note that a Sasol plant cost $13bn for 1.8 mt of capacity, so $7,000 per tonne. Meanwhile, the detailed calculations of "Breaking the Plastic Wave" imply a cost of $6,750 per tonne for the production of resins from feedstocks and a further $4,500 per tonne for the production of plastic products from resins.

In order to be conservative, we take an average cost of $5,000 per tonne for the process from steam cracking to polymerisation.

Total cost

If we combine these two numbers, we can make the following observations.

- At the end of 2019, the petrochemical industry had already invested around $200bn (39 mt times $5,000 per tonne) in upstream plastic production capacity that was greater than demand.
- The intention is to invest a further $400bn (80 mt times $5,000 per tonne) in additional upstream plastics capacity in the next five years to 2024. Into a market where demand has been damaged by COVID and which faces additional threats as we have noted from technology and policy.

Low prices

The implication of overcapacity is of course that prices will remain low. We have already seen record low ethylene prices at the start of the year.

Stranded assets

This will lead to stranded assets as the companies at the top end of the cost curve have to close down. But it will also lead to much lower returns across the plastics complex as even low cost companies see a significant fall in profitability. This will mean that the huge amounts of new capacity constructed over the last few years will not earn the returns that were expected.

The special case of the US petrochemical industry

The focus of this piece is the impact of slowing growth for plastics on incumbents. However, the US ethane based petrochemical sector will of course also be impacted by the additional factor that their expected cost advantage over oil based petrochemicals is being eroded by the rapid fall in oil prices. This will cut expected returns further as has been noted by Wood Mackenzie and others.

No need for new capex

If the plastics sector faces overcapacity today and limited demand growth, the implication is that no new capacity need to be built for the creation of plastics feedstocks. We have already started to see companies cancel their plans to build new capacity and we expect many more cancellations.

Opportunity in new areas

As the world shifts from the linear model to the circular model, it creates huge amounts of opportunity right across the value chain – from consumer facing business which can develop reuse

[62] Source: Shell's Pennsylvania petrochemical complex, IEEFA, 2020

strategies, to recycling businesses which can challenge the petrochemical giants. The European Union, for example, anticipates a 4-fold increase in recycling capacity.

Oil

We focus on two main consequences of the slowing of plastic demand for the oil sector – the loss of its key growth driver, and the impact on the peak oil demand argument.

Loss of the key pillar of oil demand growth

If demand for plastics stops growing rapidly, then oil will lose its main pillar for the expected growth in demand.

Peak demand

According to the IEA, the impact of COVID will be to reduce oil demand in 2020 by 8%, with an uncertain bounce-back in 2021 and then a return to low growth. As we noted in May 2020,[63] the implication of this was that oil demand might have peaked in 2019 because of the rising challenges from renewables and efficiency.

The likely weakness in plastics demand only adds to the pressure. Five years ago, the oil forecasting industry had four pillars of oil demand growth: cars, trucks, planes, and petrochemicals. As electric vehicles have grown in popularity, so the forecasters stopped expecting growth to come from the car sector. COVID has significantly damaged airline demand for oil, and it is uncertain when if ever it will return to its 2019 levels. The success of electric vehicles in cars has meant that some forecasters now expect trucking demand for oil to peak in the near term. That leaves the oil sector, as we have seen, dangerously dependent on plastics. Remove that pillar and peak oil demand becomes ever more likely.

Financial markets

We conclude with a brief overview of the impact of slowing demand growth for plastics on financial markets.

What stocks are in the space

The story of disruption spans oil, petrochemicals and plastics. We believe there are 8 subsectors exposed to the risk based on the MSCI global industry classification system (GICS), with a total of 3,700 companies. The total capitalisation of these companies is $6,269bn, and they are trading at a price to book (PB) of 1.3 times. Half the companies are from the integrated oil and gas sector, and 30% are from the three chemicals subsectors. Of course, some stocks will be in areas which are not impacted by the plastics story (like fertiliser) and some like LG Chem have been able to move into new areas such as batteries. Nevertheless, it is notable that there are many companies whose fortunes will be impacted by this story. We summarise the key sector valuations below.

[63] Source: Was 2019 the peak of the fossil fuel era?, Carbon Tracker, 2020

FIGURE 26. VALUATIONS IN RELATED SECTORS

Sector	Market cap $bn	PB	YTD performance	Market cap split
Integrated Oil & Gas	3,203	1.4	-25%	51%
Specialty Chemicals	914	2.1	9%	15%
Commodity Chemicals	777	1.6	8%	12%
Oil & Gas Refining & Marketing	512	1.3	2%	8%
Oil & Gas Exploration & Production	478	0.7	-45%	8%
Diversified Chemicals	203	0.8	-12%	3%
Oil & Gas Equipment & Services	167	0.7	-36%	3%
Oil & Gas Drilling	16	0.2	-48%	0%
Total	**6,269**	**1.3**	**-11%**	**100%**

Source: Bloomberg, priced as of 28th August 2020

What is at risk

As noted in our Decline and Fall report, the risk facing these companies is not simply one of stranded assets, because plastics production capacity and oil extraction capacity is greater than demand. They also face the prospect of lower prices for long periods and the threat of disruption from newer, nimbler competition. Moreover, investors are well aware of the risks to companies of peaking demand, and tend to sell shares before the peak.

The risk from the plastic story is likely to be felt most by the 30% of the stocks in the chemicals sectors, and most notably those which are exposed only to plastic related petrochemicals. This is because plastics make up all the expected demand growth for oil in the petrochemical industry but only half of the oil sector.

What should investors do

Investors can reasonably make some changes to the standard way in which they look at companies in the oil and petrochemical sectors. For example, they should now factor in:

- Continued low prices for key petrochemical feedstocks for the foreseeable future.
- Lower prices for oil. Oil prices of course have many drivers.
- Higher levels of taxation for plastics.
- Lower levels of demand for plastics.
- Higher levels of risk.
- Lower or zero terminal values for production assets.
- Higher clean-up costs.
- Sector restructuring as weaker players are unable to survive a more rigorous environment.

And in turn investors should be sceptical about plans for capacity expansion. With such high levels of capacity and the prospect of limited demand growth, the business case will look extremely weak. A move into petrochemicals therefore is not in fact the diversification it is claimed to be, but a doubling down on the current fossil fuel system.

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