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# The Circular Economy and Plastic

Tackling climate change has presented both business opportunities and risks. Money flowed into the sector (e.g. government subsidies [1]) to capitalize on the opportunities and some innovators and investors have done very well out of it. Sometimes unethical entities can adopt counterproductive behaviors to capitalize on market adjustments driven by climate change incentives or penalties. [2]

In just a few months, I have noticed from the media and from talking to businesses how plastic pollution is climbing the environmental agenda and this document is the result of a brief review of the plastic 'economy'.

This review evoked a bit of déjà vu: our plastic problem has many similarities to our greenhouse gas problem. Also, I think that dealing with the issue is going to lead to similar adjustments by governments, businesses and communities and similar sorts of business opportunities and risks. As with the fossil fuel energy sector, this is another instance of the 'circular economy' [3] at work, and we will need to throttle back how we transform raw materials into waste and to deal with the waste we discard into the environment.

This review document explores the plastic cycle in a bit more depth in the following sections:

1. Background
2. The current plastic cycle
3. Economic analysis
4. Conclusion

This review is not intended to be definitively correct, but to present data, ideas and analysis that will be useful in moving the conversation forward and that may help some businesses to think creatively about what they can do in this area to improve their operating procedures or to explore opportunities or avoid risks.

## Background:

In the past few decades we have seen that climate change has resulted in economic developments e.g. governments have subsidized clean energy production and businesses have implemented systems and processes to track their carbon footprint. Acting to tackle climate change has added momentum to the development of new industries such as electric vehicles, and boosted existing ones like the cycle sector (think of the cycle to work scheme).

We can expect a similar swing in business and government schemes to tackle plastic pollution.

Emergence of resolutions in EU parliament to measure environmental impact throughout the supply chain [4], articles on the web for businesses to conduct a plastic audit [5] and the UK government's

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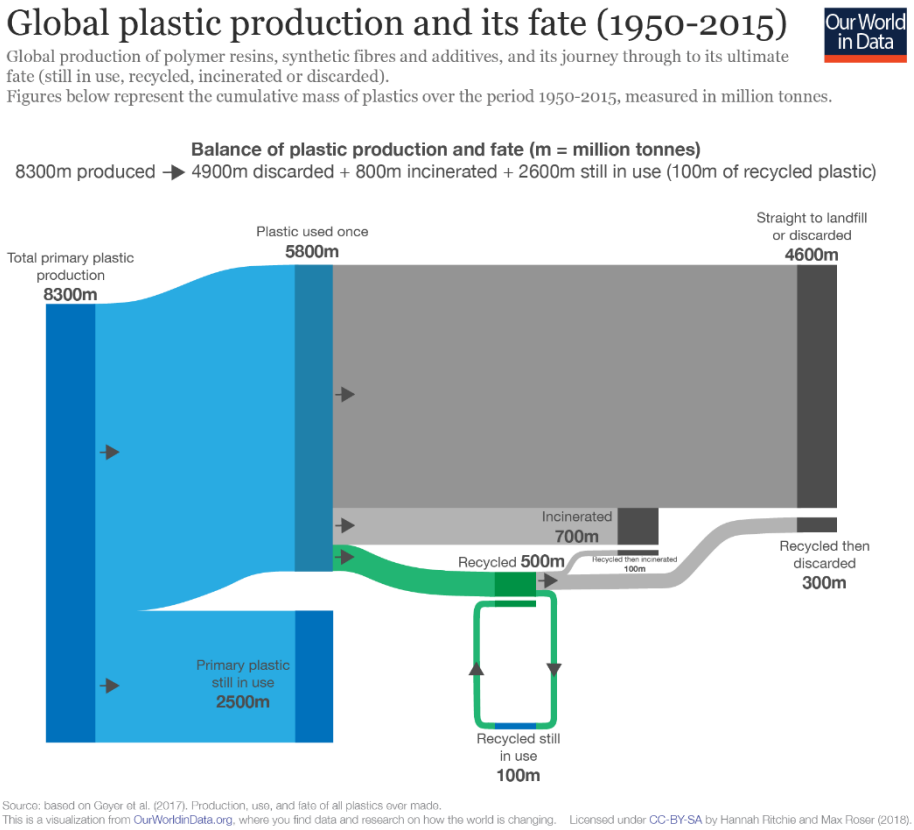
stated intent to eliminate avoidable plastic waste by 2042 are just some indicators of how things will change in the next few decades.

Plastic is incredibly useful, and would not easily be substituted in electrical insulation, food wrapping, lightweight components in cars, planes and vehicles for space exploration, to name just a few uses. But it is so cheap that we have no qualms about manufacturing single use items like plastic bags and bottles, nor of throwing these away without a thought. This is a problem.




Between 1950 and 2015, about 8.3bn metric tons of plastic were produced, of which by 2015 about 56% had been discarded into the environment as waste, 30% remained in use, 8% had been incinerated and only 6% had been recycled [6].

Plastic does not readily biodegrade or decompose – it can take 500 years. It does, however, fragment into smaller and smaller 'microplastics' which enter the air, water and food chain. We now exist in a 'plastic soup' [7] and microplastics are found in the tissues of many living things including humans. It is fortunate that the chemical inertness of plastic reduces its toxicity, although perhaps this has not yet been properly measured. Also, the concentration of plastic particles in our environment and our bodies will increase in the next few years and this may cause the physiological effects to become more noticeable.

Clearly, something has to be done.

Our way of life is dependent on this wonder material, but discounting its impact on our environment is no longer possible. The plastic we throw away does not just disappear – it is causing problems, and we need to think about how we can create a circular economy, where what we produce and use is recycled back into use or is disposed of in an environmentally friendly way.

Although some change and discussions of change on this issue are happening, we are still in the early stages of adjustment and it is easy to foresee that acceleration of change is possible and likely. Change is essential and is going to be both a necessity and an opportunity for businesses. It is probable that businesses do not want to change yet because in the short term their margins will reduce, but it is also possible that businesses may be able to adapt now to secure assets and

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opportunities which will rise steeply in cost as demand for them increases in future when change is more urgent.

Let us look at how the cycle of plastic manufacture, use and disposal works at the moment.

**The current plastic cycle:**

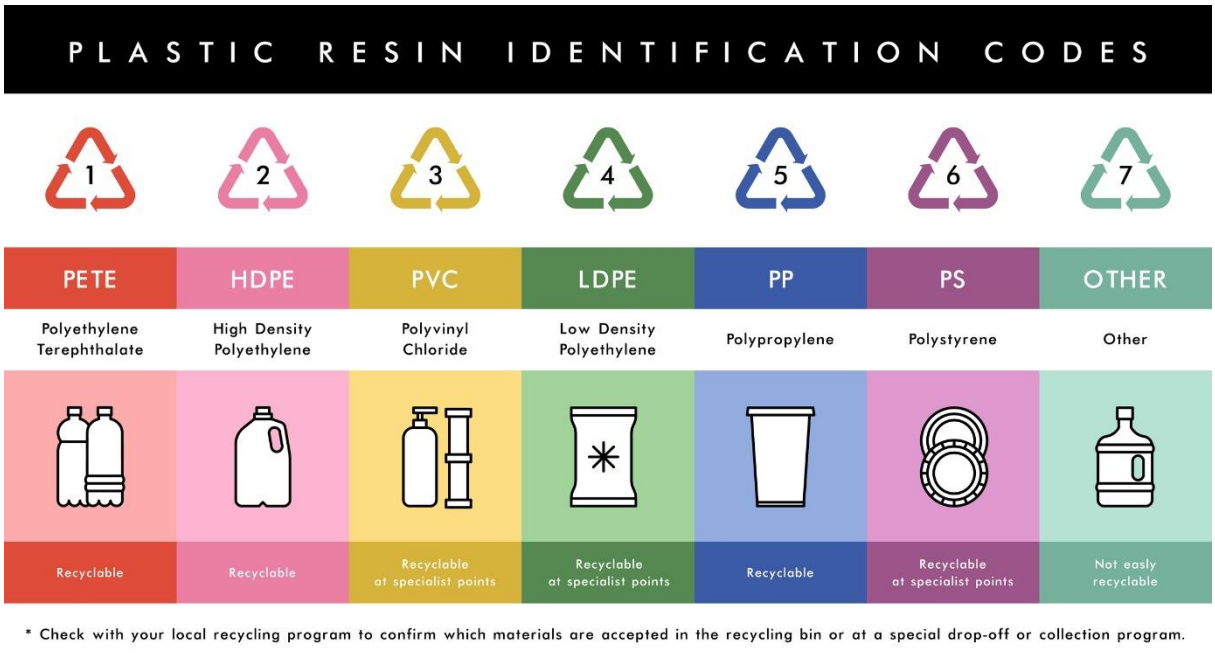
*Production:*

Plastics are produced either from crude oil refining [8], recycling [9], or biological processes [10].

*Crude oil refining:* About 15% of crude oil is naphtha, a combination of diverse hydrocarbons which needs further processing to be used. Naphtha can be processed to produce a mix of products such as hydrogen gas, ammonia fertilizer, solvents (ethane, propane, butane, benzene, paraffins) [11], and the chemicals that can be polymerized to create plastics (ethylene and propylene).

The processing can be varied to change how much of the different products is produced, and there are various processes specifically designed to produce the inputs needed for making plastic [12, 13]. Presumably, weighting the mix of products in one way or another is not driven solely because this is the only way to produce certain products, but because this is how to maximise the margins from the available inputs.

The initial raw polymers (e.g. pellets of polyethylene or polypropylene) are sent to factories to be further processed either by physical processes, or the addition of additives, or both into 7 major types of plastic [8] from which physical products (plastic wrapping film, bottles, etc.) are made.




*Recycling:* Currently, recycling is predominantly physical in nature [9]. I.e., plastic waste is sorted into different types, then the uniform waste is washed, shredded, melted and reconstituted as a new product. Chemical recycling (pyrolysis) is increasingly touted as a way to take waste plastic and convert it into raw solvents such as ethylene and propylene, and then to process these as per normal (see above) into plastics once again [14].

However, pyrolysis is an endothermic process and presumably requires even more energy than cracking, so is probably lower margin than cracking. I.e. companies would find it more profitable to produce plastics from primary resources (oil) than from recycled plastic. Also, its environmental friendliness is contested [15], and it would still require the cost of accumulating and sorting Municipal Solid Waste [MSW].

*Biological processes:* Oil is biological material that has been processed by geochemical processes, and plastic is obtained by processing components of this. So, it is not too surprising that some biological processes should themselves be capable of producing substances that can be used to make polymers. Among the ways to produce 'bioplastics' is to further process agricultural products such as ethanol from soybeans, sugar, corn starch, or palm oil (see Table 1.2 of note [10]). Although some very useful and biodegradable biological plastics can be made, not all biological plastics are more biodegradable than non-biological plastics. Also, there can be significant cost to the ecosystem of replacing large swathes of farmland with crops that are used to make plastics.

*Use:*

In 2015, 322 million tons of plastic were produced [16] and of this is increasing each year.

In Western Europe, about 92 kg per capita of plastic are used per annum [17], and worldwide the figure is 35 kg per capita (this could be as high as 136 kg per capita for Western Europe and 45 kg per capita worldwide [18]). Approximately one third of plastic produced is for packaging (mostly single use), which means that Europeans put 30 kg of plastic waste into the environment each year, and the figure is about 10 kg for each person on the planet each year.

Construction uses another 15% to 20% and textiles a similar amount. Automobiles use a lot of plastic, and up to 16% of a car's mass may be plastic.

To find substitutes for plastic will not be easy.

Given the fact that plastic products are more a feature of developed nations and economies, it seems that the demand for such products is going to increase as emerging nations raise the standard of living of their citizens.

Also, as manufacture of appliances and products occurs across the globe, regulating the use of plastic in manufacture will not be easy.

*Disposal and recovery:*

The process of recycling and incineration has been discussed above. However, for these processes to be used, plastic waste must find its way to these facilities. This does not happen at the moment.

Most plastic that is disposed of goes into the environment as landfill or as uncontrolled waste. Some people question whether landfill is a problem [19].

The problem with landfill is that it is not always done properly, and this is more a feature of less developed nations, similarly as for recycling and incineration.

There are somewhere between 150,000 and 500,000 landfill sites in Europe alone (most of which are inactive), and these represent an immense repository of concentrated resources – metal, glass and plastic. An organization - European Enhanced Landfill Mining Consortium (EURELCO -

https://eurelco.org) is actively investigating how to recover these [20]. The potential is obviously much greater when looked at from a worldwide perspective.

Uncontrolled plastic waste can enter rivers and streams and be carried out to sea. Reclamation of plastic from the environment is not easy and it becomes more difficult as plastic breaks down into microplastics, although technologies are forthcoming which may enable this [21].

Plastic needs to be isolated as a form of waste, and it must be prevented from entering the environment.

**Economic Analysis:**

From the above analysis, it is clear that the current economic forces of prices and margins often work in ways that are not aligned with the forces that would promote a circular economy for plastic.

Also, there is an increasing pressure to implement the latter, which implies that some feedback and change will affect the current economic setup.

However, there are core market inefficiencies hampering the circular economy of plastic and these are some of the core areas where economics will need to change:

1) Plastic – especially single use plastic – is far too cheap. This encourages a whole slew of wasteful behaviours, including:
    1. Overuse of single use plastics in the supply chain;
    2. No attempt made to introduce trade-in or plastic recovery programs that would reimburse consumers for used plastics;
    3. No financial reason for consumers to not throw away used packaging;
    4. Too little investment in recovery and recycling of plastic from waste;
    5. Too little investment in development of plastic alternatives and no market for more expensive alternatives.

2) Margins from producing plastic from crude oil byproducts are too high:

The incentive to produce plastics from primary resources must reduce.

The relative margin for plastic waste as a raw material for the manufacture of plastic is uneconomical compared to the margin to be made from converting oil industry byproducts into plastics.

The margins for plastic from oil are high enough to forego alternative byproducts such as solvents, hydrogen or ammonia fertilizer and to even invest further to increase the mix of ethylene and propylene that is obtained from naphtha.


If the aim is to reduce the production of plastics from the oil refining sector, then measures to reduce this might be to apply tariffs to refineries which do produce plastics,

or to subsidize investment in refinery infrastructure that would produce alternatives rather than plastics.

3) Margins from producing plastics from crops are relatively too high:

The must be reduced unless the plastics produced are proven to be biodegradable and not harmful to the environment.

4) Whilst making plastic more expensive and reducing the supply from primary raw materials would both help to reduce waste, subsidies and grants could also be applied to:

    1. R&D in developing biodegradable plastic alternatives;
    2. Subsidisation of plant and machinery that will recover waste plastic from the environment;
    3. Subsidies for plastic manufacture which is proportionate to the amount of recycled plastic that is used;
    4. Subsidisation of the building of more recycling and incineration plants which can handle all sorts of plastic waste;
    5. Subsidisation of equipment and systems that allow plastic to be tracked throughout the supply chain.

5) Global cooperation to improve the reclamation, recycling and incineration facilities in less developed or financially well-off nations.

6) Global cooperation so that no nations or firms are incentivized to produce plastic products in countries where it is a cheap commodity and sell them into countries where plastic has been made more expensive.

These economic / regulatory measures could result in shifting the balance of plastic manufacture and use to a cyclical flow, which actually consumes the waste in the environment instead of increasing it.

As mentioned above, dealing with plastic pollution has risen in priority for the environmental objectives of many governments. The 2017 G20 '2030 Agenda: Climate & Finance, Trade & Investment' looked at how to tackle this on a number of fronts including innovation, consumption, waste management and worldwide collaboration [22].

As in the case of the carbon market and the changes feeding into trade and commerce, businesses will seek out ways to profit from the delivery of innovations and services that enable a transition to a circular economy for plastic. Quite possibly it will be the firms in developed nations, with their access to skills, infrastructure and funding sources who are the first to make significant strides in this sector.

If the carbon market is an indicator of whether it is possible for growth to be decoupled from pollution (CO2 emissions in the case of the carbon market), then the change to a circular economy of plastic can also be achieved without too detrimental effect on a country's growth [23].

There may be differences in this instance, because the CO2 market has so far simply comprised a shift in how energy is produced rather than the rehabilitation of an environment which suffered the effects of its increased concentration, whereas plastic recovery from the environment is likely to be costly and time consuming.

**Conclusion:**

There are strong similarities in the way that plastic pollution will be tackled in the coming decades and the way that the reduction in greenhouse gases from fossil fuels has and continues to be tackled.

This is going to mean the promotion of innovation in the sector, and investment in facilities to extract waste plastic from landfills and the general environment. Plastic use will be something that companies will need to measure throughout the supply chain. Production of plastic from primary sources such as crude oil and crops will be reduced, and measures will be applied to swing the market to a more sustainable, lower polluting 'circular economy'.

Some companies and their investors will do very well out of this, and others will need to adapt and change to retain their levels of activity and growth. Overall, it seems likely that the economy will find a new balance which allows for growth with a more environmentally sound way of operation.

**Notes:**

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