Defossilisation of industry

When we look at all the things we use, we see that most of them have components derived from crude oil or natural gas. This includes everything from the detergent in shampoo or shower gel, the insulation on electrical cables to the dashboards in our cars. Oil and gas are such useful starting points for the chemistry used in manufacture because they contain carbon that is linked together in long chains. All life that has ever existed on this planet is built on a backbone of carbon. Millions of years ago, plants captured sunlight and carbon dioxide so that they could grow. As they died, layers and layers were laid down and compressed, forming coal. Similarly, marine animals died and were converted into crude oil and natural gas. It is these, finite, resources that we have been using as feedstocks for industry. But as they contain carbon dioxide that was captured millions of years ago, when these products come to the end of their useful life and are incinerated or otherwise decay, the carbon dioxide is released back into the atmosphere causing global warming through the greenhouse effect. Approximately 70 % of all greenhouse gas emissions come from fossil fuel use.

Much effort is being put into de-carbonising our lifestyles. If we use alternative ingredients in products that don't rely on fossil carbon, we will reduce the amounts of carbon dioxide released. However, life is based on carbon. It forms the carbon cycle, circulating through the atmosphere, oceans and land. Human activities release about 10 billion tonnes of carbon (mostly as carbon dioxide and methane) into the atmosphere every year and the chemical industry releases lots (Figure 1). Decarbonisation requires that we stop using carbon and use something else.

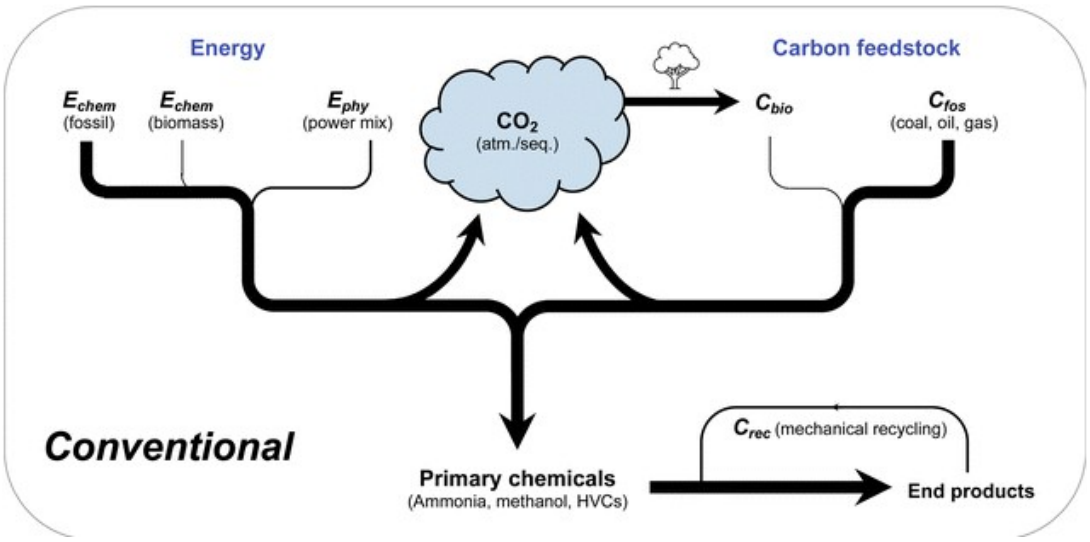

Figure 1. Material and energy flow in the chemical industry – conventional (today). E_{chem} – energy from chemical sources, E_{phys} – energy from physical sources (wind, solar, hydro), C_{bio}, C_{fos} – carbon from biological and fossil sources respectively. (Royal Society of Chemistry)

Unfortunately, there are limited alternatives to using carbon-based raw materials. That means that ‘decarbonisation’ is not possible for the raw materials industry and much of manufacturing. Without conventional, fossil-fuel feedstocks, the chemical industry must change. We could use other resources, such as timber but these could not sustain the planet in the longer term and the processing would be expensive. In the face of these challenges, industry is beginning to look at ‘defossilisation’ as a better way forward. This would be achieved by using renewable carbon, which is obtained from the biosphere, atmosphere or technosphere but not from any fossil source, i.e. the geosphere. Renewable carbon is part of the carbon cycle, circulating between the biosphere, atmosphere or technosphere. Using carbon this way forms a circular economy.

Of all industry using fossil-fuel feedstocks, the plastic industry is the largest. Plastics are everywhere and they are amazing materials that can be used in so many ways. Unfortunately, this leads to release of lots of greenhouse gases and physical pollution of the planet. Europe (and the UK, too) is putting most effort into recycling of waste plastic but such a system is inevitably imperfect with still a lot going to waste. Where carbon dioxide is still being released, carbon capture and storage (CCS) is looked at as a way of removing and burying carbon dioxide. On the other hand, captured carbon is a valuable resource and storing it in the very long term may not be viable. CCS also means that we will have to continue to use fossil fuel as feedstock. Far better would be to use carbon dioxide as a feedstock for industry – carbon capture and utilisation (CCU). Carbon dioxide is already being used to make plastic bottles, methanol and cleaning products.

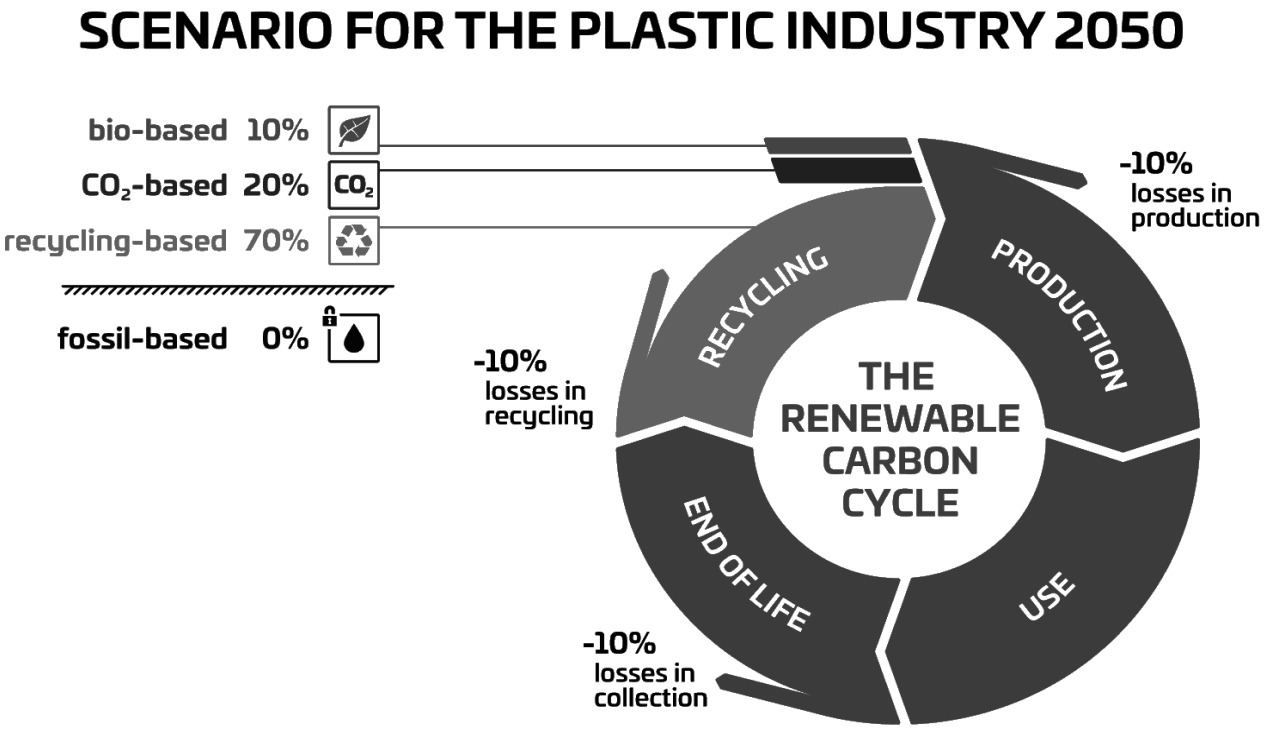

Figure 2. How the plastic industry could defossilise.
(Renewable Carbon Initiative)

In the scenario proposed in Figure 2, by 2050 in the plastics industry, about 70 % of already-existing plastic is recycled into new product, the remaining 30 % comes from captured carbon dioxide and 10 % from biomass, such as culturing algae, food waste, wood pulp etc. with none coming from fossil fuel. The key question then is “Can we actually do this?” At the Renewable Carbon Initiative, they believe it is possible and necessary. The technologies already exist and can be scaled up. However, they are more expensive and not ready to compete with the existing system with its well developed infrastructure and powerful lobbies in the oil and gas industry. Some companies have signed up to such renewable solutions but still face an uphill battle against vested interests. In the medium to long term, the costs of not doing anything will heavily outweigh the costs of implementing these solutions. Already, we see the damage caused by extreme weather events driven by climate change. We hear from island states that they are threatened with flooding from rising sea levels due to the expansion of water as it warms and the increased volumes as polar ice melts. We have seen devastating fires in California, all made worse by climate change.

The Renewable Carbon Initiative (RCI) aims ‘to support and speed the transition away from fossil carbon use to renewable carbon for all organic chemicals and materials.’ They are working not only with the plastics industry but right across manufacturing to find best solutions. Companies are signing up to learn from the work of the RCI. They include well-known giants such as Michelin, Lego, IKEA and smaller ones too. The RCI wants all our energy to come from renewables – solar, wind and hydro – and industry to use only renewable carbon from carbon capture, biomass and recycling (Figure 3).

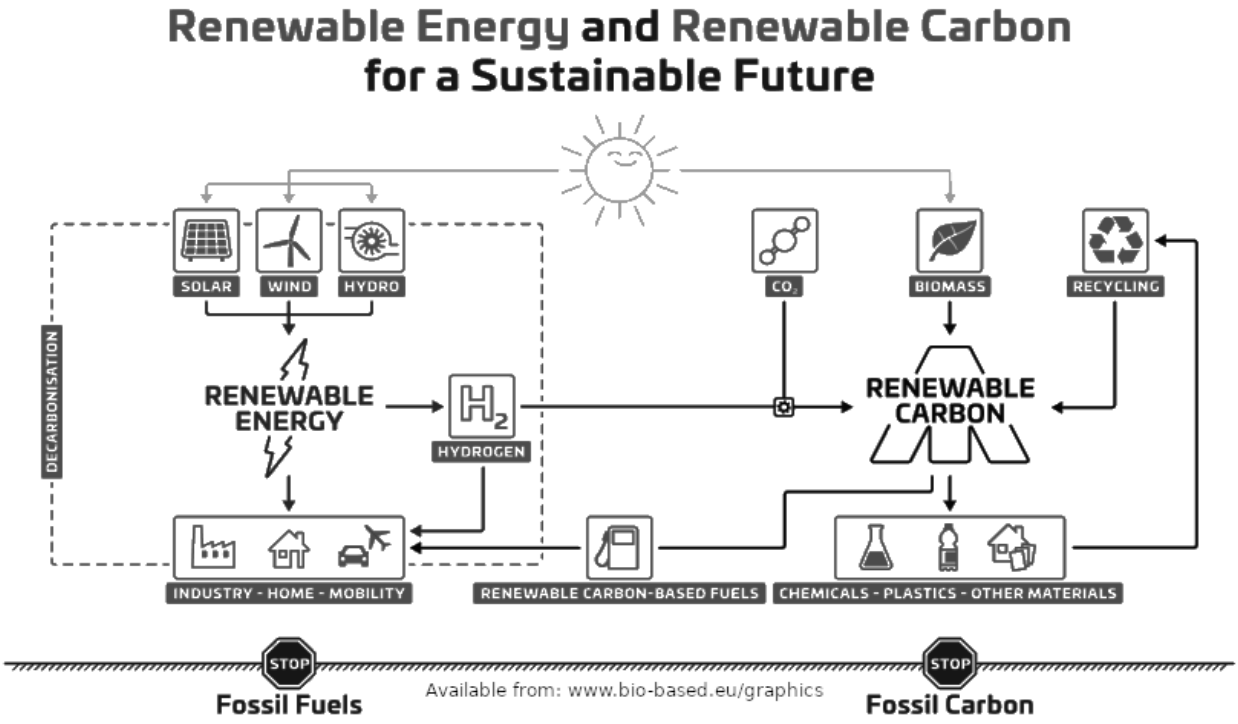

Figure 3. Renewable Carbon Initiative proposal for defossilisation of chemical production

Royal Society of Chemistry:
https://pubs.rsc.org/en/content/articlehtml/2025/su/d4su00601a
Renewable Carbon Initiative: https://renewable-carbon-initiative.com/

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