Measuring recycled content: why Mass Balance Accounting matters for plastics

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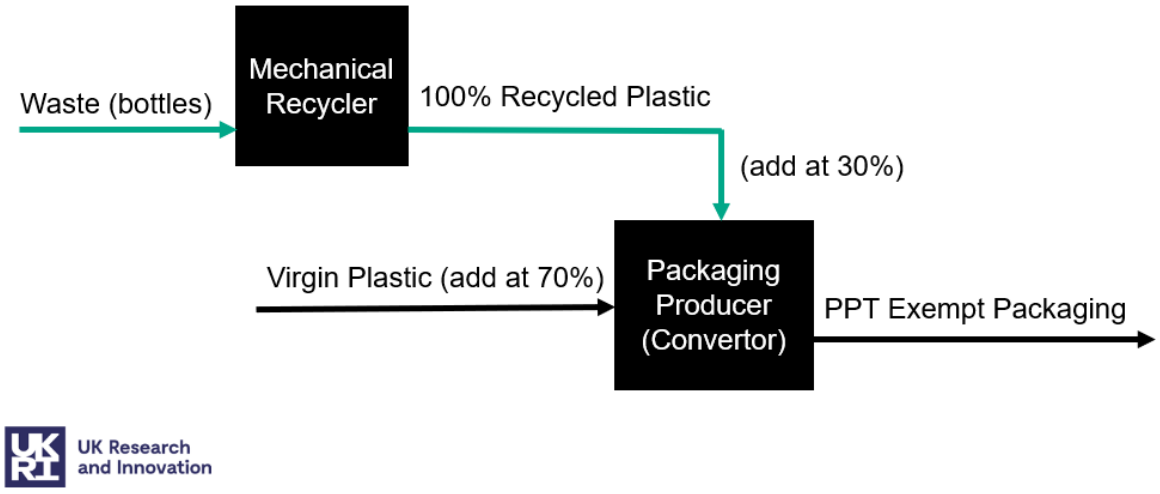
As the UK Plastics Tax goes live and the European Commission deliberates on an EU-wide recycled content target for plastics packaging, the question of how to accurately measure and provide an audit trail for recycled content derived from the chemical recycling of plastics has become the subject of much debate.

Conventional mechanical plastics recycling typically produces recycled feedstock of a single polymer type (e.g. PET) destined for use as a feedstock by a particular packaging producer (convertor). As Figure 1 shows, it is a discrete circular loop that makes accounting for and auditing the recycled content relatively easy.

Figure 1: Tracking feedstock from mechanical recycling is relatively easy



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For chemical recycling routes, however, recycled plastic is taken back to the basic building blocks (oligomers, monomers, etc) for polymer manufacturing. Where the recycled feedstock is a pyrolysis oil (pyrolysis being the most advanced technology in terms of commercial development at present), it enters the petrochemical supply chain much earlier in the production cycle (and often intermittently) as a bulk raw material (pyrolysis oil). It is then mixed with virgin feedstock (naphtha) before being piped, potentially over long distances, to the cracker. The cracker then converts the combined feedstocks into a number of outputs, the predominant one being ethylene.

Ethylene is a fundamental building block for a wide range of chemicals including polymers and plastics, and ethylene pipelines are commonly used to distribute large quantities of ethylene across and often between countries. These can be 100s of kilometres long, with multiple input and offtake points, and as Figures 2 and 3 show, there is no way of tracking and auditing the destination of ‘recycled’ molecules that are indistinguishable from other molecules through these long and complex supply pipelines.

Figure 2: Tracking feedstock from chemical recycling is more difficult

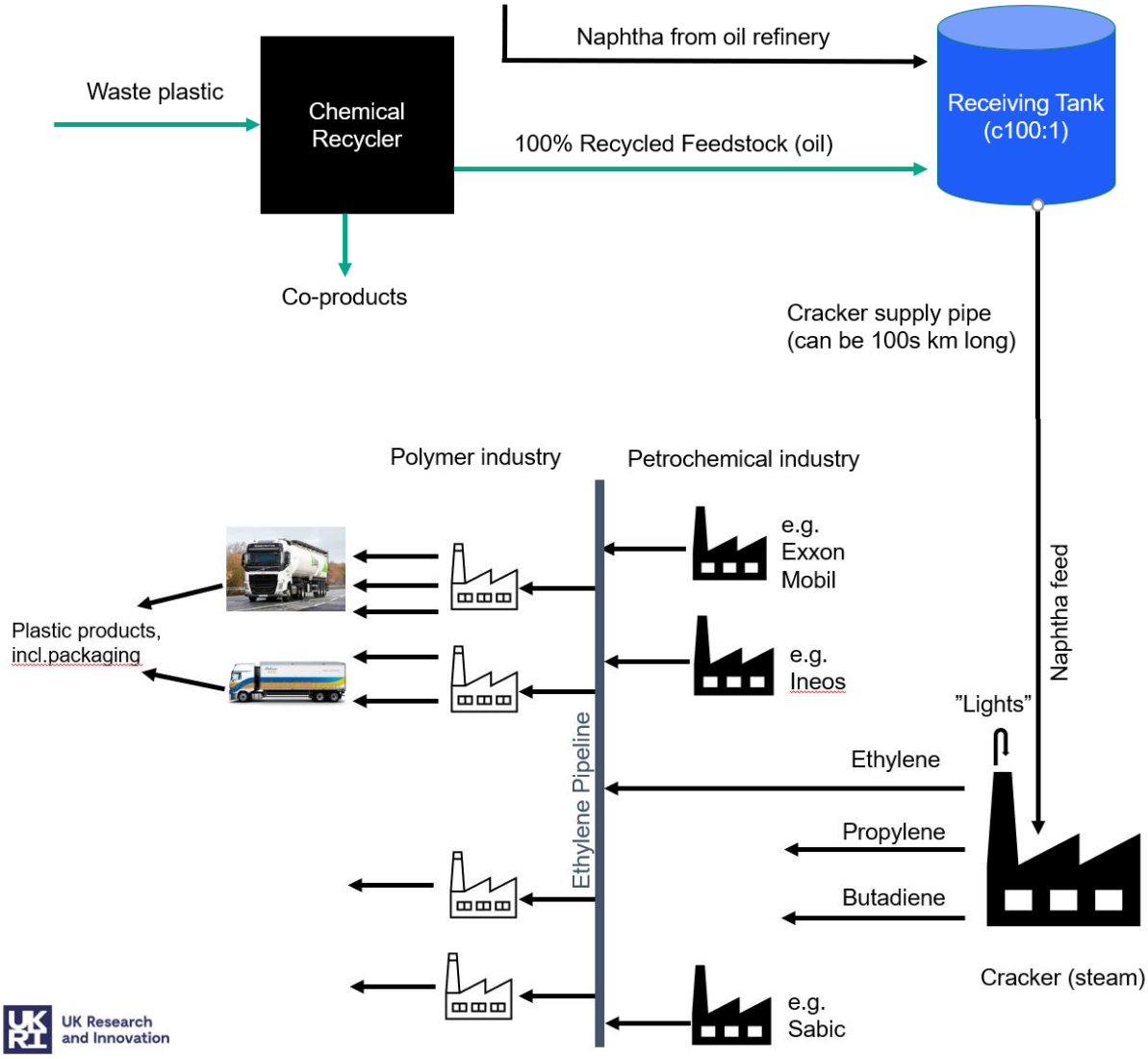

Figure 3: European ethylene pipeline

This is where the challenge lies. The opportunity that chemical recycling technologies offer is that they can produce virgin-grade feedstock from plastic waste streams that are not suitable for mechanical recycling (see '**Competing or complementary: the relationship between mechanical and chemical recycling of plastics' article** which is also available to download). But to do so in a cost

effective way, and maximise the overall environmental benefits, the recycled feedstock needs to feed into the existing polymer manufacturing infrastructure and be blended with virgin feedstock, making it impossible to physically follow through the system to final product.

That is why there is growing discussion about the use of Mass Balance Accounting (MBA) – a chain of custody framework – as a way of measuring and auditing the feedstocks from chemical recycling, as well as other alternative feedstocks such as bio-derived materials. Because it provides a methodology to 'allocate' recycled content in systems where recycled and virgin material are mixed together, MBA is already established as an approach in other complex supply chains where there is a need to accurately demonstrate recycled content, for example the Forest Stewardship Council and Better Cotton Initiative.

A detailed 2019 White Paper published by the Ellen MacArthur Foundation's (EMF) CE100 Network (Enabling a circular economy for chemicals with the mass balance approach) noted that:
"Provided the right conditions in terms of traceability, validation and acceptance are met, the mass balance approach could be among the key levers to meet the challenge of increasing recycled content and making plastic pollution a thing of the past."

Over the past 20 years or so, a number of standards and certification frameworks have been developed around the world to verify recycled content in plastics and a 2021 report by Eunomia Research & Consulting and the Circular Innovation Council provides a useful assessment of the current landscape. The approach around which the petrochemical industry is currently coalescing is the International Sustainability & Carbon Certification (ISCC) Plus MBA, which embraces the concepts outlined in the EMF White Paper and is already being used by a number of the major players including Dow, Sabic, Exxon Mobil and Plastic Energy.

It is becoming the preferred system at least in part because it allows for free allocation of recycled content across products at a group level – a workable allocation methodology to measure and audit chemically recycled feedstocks used in the existing, complex plastic production supply chain where direct physical traceability is not possible. This provides a way to verify performance against one important objective; from a feedstock perspective, every tonne of pyrolysis oil means one tonne less of virgin naphtha, delivering technology-dependent benefits from a resource, carbon, and energy perspective (according to a soon-to-be-published LCA from one of the technology providers currently moving towards commercial-scale operation, less energy is required to produce pyrolysis oil than virgin naphtha).

Some stakeholders argue, however, that the free allocation approach does not provide sufficient rigour in terms of being able to accurately attribute recycled content to specific outputs, which are important considerations both for recycled content targets and taxes, and for supply chain and consumer confidence. However, unless parallel polymer manufacturing infrastructure is developed to use the recycled feedstock or existing crackers use solely recycled feedstock – neither of which is feasible from an investment perspective or desirable from an environmental one – then some form of flexible allocation system is likely to be needed.

In developing a robust approach to verifying recycled content, therefore, the pertinent question may not be "is free allocation suitable?" but rather "under which circumstances is free allocation suitable?". The challenge for the polymer manufacturing industry is to implement it in a sufficiently robust and transparent way to provide confidence to policy makers, regulators, and society that the promised environmental benefits will be delivered, that recycled content claims can be evidenced and trusted, and we are not just being greenwashed.

Working towards getting agreement on an accounting methodology for the chemical recycling of plastic is critical from a number of perspectives. For the purposes of policy and fiscal measures designed to stimulate the uptake of recycled content (such as the UK Plastic Packaging Tax) and other policy measures and voluntary commitments (such as the UK Plastics Pact), auditability is essential to demonstrate that the desired outcomes are being achieved, to ensure a level playing field for different technology solutions, and to provide supply chain confidence in recycled content claims. It also underpins the business case for chemical recycling; developing a credible and recognised method of capturing and demonstrating the value of recycled content derived from chemical recycling will be necessary to justify the higher investment and operational costs involved for these technologies.

It is also important in the context of ensuring that sufficient recycled content is available in the future. While growing demand for recyclate is only one of key factors, industry sources are reporting that prices are almost double those in the same period in 2021 for some polymer grades. As recycled content targets become a more widely used approach, the pressure on availability and price will grow. This in turn means that additional recycling capacity will be needed, particularly for plastic waste streams such as mixed plastics and food-contaminated films and flexibles that are unsuitable for mechanical recycling (see '**Competing or complementary: the relationship between mechanical and chemical recycling of plastics' article** which is also available to download). The drive to collect more of these waste streams through more consistent household collections will also add to pressure for appropriate recycling infrastructure.

In addition, chemical recycling is likely to have an key role to play in boosting the production of food grade recyclate that meets the stringent regulatory requirements that apply for this type of material, and in helping to put a stop to the UK's export of plastic waste, a move most recently called for by the Environment Agency's Chief Executive Sir James Bevan (inews.co.uk: 'UK must stop dumping plastic food wrappers and drinks bottles in poor countries, Environment Agency boss says').

At present, the way forward on an accounting methodology for recycled content derived from chemical recycling for the purposes of the UK Plastic Packaging Tax is unclear, although the use of MBA is under consideration. What is clear, however, is that delays in agreeing a way forward will diminish the investment case for chemical recycling at a critical time.

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