The materials ecosystem

Unlocking the value of waste

How connected systems and people are helping plastic waste reach its full potential

CHAPTER 4

Material origins: How inventive recovery technologies are transforming more used plastic into high-value waste

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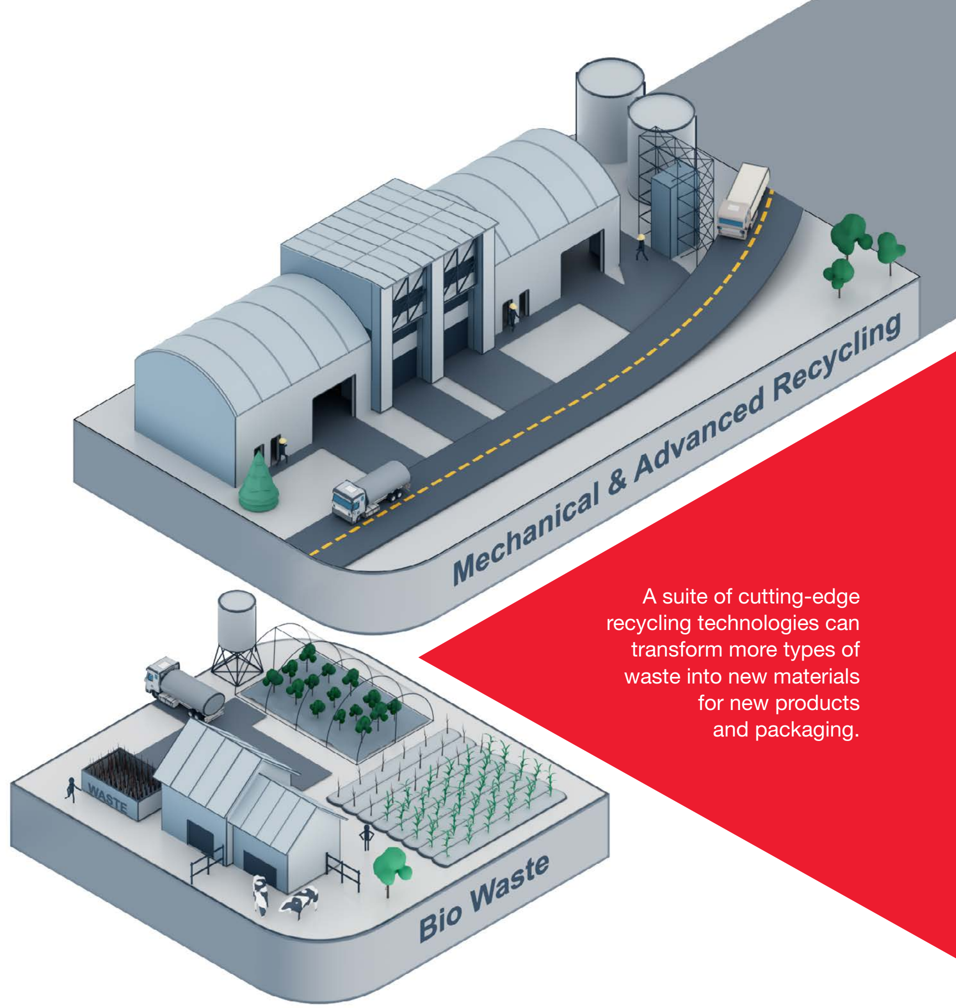

A suite of cutting-edge recycling technologies can transform more types of waste into new materials for new products and packaging.

The present-day goal is to unlock more and more types of waste that can be reintroduced into production as a raw material.

Here, we explore conventional, advanced and emerging technologies at different stages of development and how this diversity in tech must be deployed to make more waste transformation possible.

Connections:

Converging plastic recycling technologies drives increasing value from waste

Recycling technologies are critical components of the continuously improving process of transforming discarded plastic into new products. Advanced and mechanical recycling each have an important role in more efficient processes and increased recycling.

Mechanical recycling is the most commonly used process by which plastic waste is turned into new products without the structure of the material being significantly altered. It uses less energy than other forms of recycling, but it does have limitations. For example, highly regulated plastics such as those used in food packaging currently cannot be produced by mechanical recycling at scale due to quality, performance and safety restrictions.

To enable broader use of recycled plastic, Dow is investing in an innovative technology called chemical recycling, also known as advanced recycling, a complementary technology to mechanical recycling. Advanced recycling offers massive, untapped market potential and the ability to bring sustainability and circularity to previously incompatible areas such as food-grade and medical-grade packaging. Advanced recycling allows the same material to be reused repeatedly while offering the same high-quality plastic.

About nine million tons of polyethylene and polypropylene are currently used in food packaging in the European Union.[20] These materials currently cannot be recycled back into food contact application by mechanical recycling. But by investing in chemical recycling alongside mechanical recycling, we can help improve overall recycling rates and achieve recycled content targets in this sector. Additionally, recent life cycle assessment data produced by the WMG research group at the University of Warwick found that every ton of plastic that is chemically recycled prevents nearly three tons of CO_2 being released through incineration.[21]

Alongside our partner Mura Technology, we are planning and building multiple chemical recycling facilities in the U.S. and Europe, adding as much as 600 kilotons of recycling capacity by 2030. In October 2023, Mura opened the world's first commercial-scale HydroPRS™ (Hydrothermal Plastic Recycling Solution) advanced plastic recycling plant in Teesside, U.K. The purpose-built facility at the Wilton International industrial site will process flexible and rigid mixed plastics, including films, that are currently considered 'unrecyclable'.

Mura's innovative HydroPRS™ process uses supercritical steam (water at high temperature and pressure) to convert plastics to their original materials and oils. The HydroPRS™ process complements mechanical recycling and enables a circular plastics economy through the production of recycled plastic feedstock for the manufacturing of new plastic. In the coming years, Mura plans to have 1 million tons of HydroPRS plastic recycling capacity in operation or development.[22] This process will be fundamental in closing the loop on plastic waste and keeping it within the circular economy. Crucially, it allows hard-to-recycle plastics to be recycled.

Valoregen, a Dow partner, is building France's most significant single hybrid recycling site, combining mechanical and advanced recycling technologies under one roof. Valoregen will be able to reduce the overall carbon emissions produced from these processes as it strives to limit the transportation of waste products to different sites. The ultimate goal: a systems approach capable of recycling all plastic waste in one place.

To achieve progress we must create a viable marketplace for varied recycling technologies and waste materials. There is no single solution, but a combination of new partnerships and innovative technologies is driving a systems evolution.

Influences:

How mass balance creates more certainty for circular plastics

Mass balance rules for measuring recycled content are vital to the growth and sustainability of industry. This is particularly true in the plastics sector, where mandatory recycled content targets are increasingly seen as a viable method for replacing fossil-based materials with sustainable alternatives.

While recycled content policies provide the regulatory certainty necessary for business investments, there's a critical need for effective methods to measure and validate the recycled content of plastics. Here, mass balance becomes pivotal, allowing tracking and communicating the use of materials derived from advanced recycling methods in their finished products.

A mass balance approach has many benefits. In the plastics industry, it addresses concerns from brand owners about recycled content at product level and credible on-product claims to be communicated to consumers for food contact applications. The audited process also enables traceability throughout the supply chain and can measure the credibility of sustainability claims. This empowers consumers to drive a change in the packaging value chain in a credible manner, prevent greenwashing and allow the scale-up of circular solutions.

If we want to tackle the plastics problem effectively, mass balance accounting is an essential piece of the puzzle. The risks of not recognizing this process can create confusion for consumers. Brands and retailers will struggle to meet legal requirements on recycled content and consumers' expectations of meaningful recycled content targets.

Dow shares more on its chemical recycling (also known as advanced recycling) and mass balance accounting perspective in a recent BusinessGreen article.[23]

Businesses and consumers alike want change. To meet that, we've dramatically increased the amount of circular and renewable feedstocks going into our production lines. By mass balancing this way (rather than creating dedicated lines for producing bio-based or circular polymers), we're reducing the environmental impact of our process and ensuring the world gets bio-based products in the most cost-efficient way.

Gaps:

Diversifying sources of more sustainable content for new plastics

To produce new plastic materials that are more sustainable — and reduce the use of traditional fossil feedstocks and the carbon footprint associated with them — it will take a combination of feedstocks produced from recycled plastic waste and bio-based materials.

Bio-based describes materials derived from organic materials available continuously (i.e., renewable) from agricultural, plant and fungal sources living in a natural environment. Dow focuses on non-edible renewable resources. Advances in bio-based sources remain a catalyst for scaling alternative feedstock adoption.

Used cooking grease from animal fats has been effective in renewable plastic production for years, in addition to tall oil from the paper industry. Recently, Dow and New Energy Blue announced a long-term supply agreement in North America in which New Energy Blue will create bio-based ethylene from agricultural residues for plastics production.

Dow's agreement with New Energy Blue, staffed by experts with deep experience in bio-conversion ventures, is the first agreement in North America to generate plastic source materials from corn stover (stalks and leaves). This is also Dow's first agreement in North America to utilize agriculture residues for plastic production. This agreement would play a pivotal role in Dow's approach to building material ecosystems that value, source and transform waste into circular products.

On top of expanding the use of recycled waste feedstocks, the use of renewable bio-based feedstocks and carbon capture technologies will need to increase to enable manufacturing processes that are more energy-efficient and less carbon-intensive.

Key takeaways

- Making every plastic recyclable will entail complementary technologies in varied stages of maturity and adoption — including mechanical, advanced, hybrid and emerging innovation — to unlock more raw materials and waste for circular feedstocks.
- While recycled content policies provide the regulatory certainty needed for business investments, we need ways to measure and validate the sustainable content of plastics. The globally accepted practice of mass balance accounting, which recognizes materials entering and leaving systems, is used to determine the amount of recycled content in the production process and to track the progress of circularity.
- To produce new plastic materials that are more sustainable, it will take a combination of feedstocks produced from recycled plastic waste and bio-based materials.

UNLOCKING the value of waste

Redefining what high-quality washing means for plastics circularity

To transform recyclable plastics that are difficult to recycle, like film plastics from discarded food packaging, mechanical recyclers need detergents and antifoam agents to improve the quality and consistency of post-consumer recycling (PCR) streams. These agents remove surface contaminants such as adhesives and control foaming to enable greater water circularity. Innovative products like EVOWASH™ detergents and antifoams improve the quality of recycled plastic while maximizing the reuse of processed water.

Sources

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