SCIENCE FOR ENVIRONMENT POLICY

Study highlights best EU initiatives for achieving material circularity for three types of plastic

Global annual production of plastic, primarily from fossil fuels, exceeds 300 megatonnes (Mt) a year. A study compares European initiatives to improve recycling of three widely used plastics — polyethylene (PE), polypropylene (PP), and polyethylene terephthalate (PET) — to achieve policy targets for reducing virgin plastic production. The material flow of these plastics in Europe — lifetimes, demand growth rates and quality reductions of recycled plastic — are considered over a 50-year timeframe.

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Reducing virgin production of plastics is vital to. reduce plastic production, ease dependence on fossil fuels and reduce the release of fossil CO_2 into our atmosphere. The EU aims to transition to a circular economy, a strategy for a cleaner, more competitive Europe that recirculates materials into society as much as possible. Circular activities include recycling plastics and designing plastic products with durability and reuse in mind (see the European Strategy for Plastics in a Circular Economy).

At present, polyethylene (PE) and polypropylene (PP) account for around 50% of Europe's plastic production, and polyethylene terephthalate (PET) 8%. However, unlike PE and PP, PET's chemical properties allow it to be recycled in a way that maintains its food-grade quality. Collectively, these three plastics represent over 85% of the plastic packaging produced in Europe, and up to 67% of the plastic produced in other sectors. Currently, 70% of European plastic waste is incinerated, landfilled or exported. However, the EU aims to encourage reutilisation of plastic waste, and has adopted a target of 55% recycling by 2030 for household plastic waste, supported by voluntary commitments from the plastic industry to recycle 70% (plastic packaging) and 50% (plastic waste) by 2040.

To help achieve these plastic recycling goals, this study assesses the effectiveness of different initiative scenarios to close the plastic loop in Europe. Six individual prospective scenarios represented the main circularity-enhancing initiatives covering: maintaining constant plastic consumption, managing waste plastic exports in the EU, design-for-recycling initiatives, improved

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Study highlights best EU initiatives for achieving material circularity for three types of plastic (continued)

collection and recovery and reprocessing — with a baseline scenario of 2016 conditions. The researchers applied a dynamic material flow analysis model to evaluate the potential circularity of PET, PE and PP in Europe, incorporating product lifetimes, demand growth rates and the quality reductions of recycled plastic. The analysis covered the UK, Norway, Switzerland and the EU's 27 Member States over a 50-year period.

Four evaluation indicators were applied, including:

- the **recycling rate** (RR), expressing the percentage of plastic waste effectively recycled;
- the **circular material-reuse rate** (CMUR), expressing the percentage of total plastic demand (across all sectors) covered by recycled plastic;
- the **closed-loop circularity rate** (CLCR), expressing the percentage of plastic demand covered by recycled plastic from the same sector and product group;
- the **virgin material consumption** (VMC) indicator, expressing the absolute quantities of virgin plastic needed to meet the total annual demand — on top of recycled plastic.

The baseline scenario analysis showed low recycling rates of 13–20%, with virgin plastic providing 85–90% of the plastic demand after 50 years. Individual scenarios led to a maximum RR of 35% — insufficient to comply with EU recycling targets. However, the analysis showed that RRs of above 55%, where 75–90% was recycled in a closed loop, could be achieved by combining all the initiative scenarios including: change of framework conditions (constant demand, no export of waste), design for recycling (monopolymer design, alignment of rigid packaging), increased collection and advanced end-of-life technology. Moreover, 46–60% of the annual demand after 50 years could be covered by recycled plastic.

The researchers posit that closing plastic material loops and moving away from virgin plastic production cannot be achieved solely by technological improvement — demand must also be stabilised; and they note that this was not reflected in the RR. Presently, the RR is the only indicator converted into mandatory targets for EU Member States; the researchers suggest that their results indicate that this indicator alone is insufficient as a measure of plastic circularity. They conclude that RR should be supplemented with indicators that focus on plastic demand, aspects of functionality, and the quality of recycled plastic materials (such as CLCR and CMUR).