# Overview of Pyrolysis and Gasification Technologies for Chemical Recycling of Mixed Plastic and other Waste

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## Abstract

Chemical recycling (CR) – also referred to as feedstock or advanced recycling – has elicited increasing global interest mainly because of its potential to complement mechanical recycling in promoting the circularity of plastic waste which are currently incinerated or landfilled. However, its applicability extends beyond "*Plastics-to-Plastics*". With its potential to recirculate other heterogenous and contaminated carbonaceous waste (e.g. mixed plastic and other composite waste, MSW, agricultural waste, …) as secondary carbon feedstock for chemical production, CR also holds the promise to support the transformation to a resource efficient, circular and net zero society by reducing the chemical industry's demand for primary carbon resources as well as avoiding carbon leakages via international supply chains.

In recent years, dynamic CR developments in terms of R&D and project deployments are observable worldwide. A review of over 50 CR technologies is conducted to enable a state-of-the-art overview of current CR developments. The review focused on pyrolysis and gasification technologies to enable an evaluation of their suitability for mixed plastic waste and other inhomogeneous and/or contaminated carbonaceous waste materials, as well as technological challenges for their deployment and/or upscaling. Key evaluation criteria include technology readiness level (TRL), reactor type, realized capacity, scale-up potential, feedstock specifications and products,

For waste pyrolysis, even though a large variety of reactor types with different process configurations is available, similar feedstock specifications, realized capacity and scale-up potential are observed. While feedstock flexibility beyond mixed plastic waste is offered by a few technologies, these tend to feature a lower TRL compared to those focusing purely on mixed plastics. Common technological challenges of waste pyrolysis range from formation of coke and agglomerates, heat transfer limitations to product upgrading for integration into existing chemical production.

For waste gasification, recent developments have focused especially on fixed-bed and fluidized-bed reactors. Gasification processes are offered by fewer technology providers than pyrolysis, but feature comparatively larger reactor capacities and scale-up potential. Compared to waste pyrolysis, waste gasification generally exhibits greater feedstock flexibility and tolerance for contaminants. Technological challenges include syngas quality for chemical synthesis, carbon conversion and the treatment of solid residues.