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5.10.P-We469 Enhancing Environmental Sustainability through Industrial Symbiosis in Plastic Waste Recycling

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Plastics, primarily derived from fossil-based feedstocks, face significant end-of-life (EOL) challenges, with a large volume of plastic waste being diverted to linear options such as landfill, incinerators and the environment. European Green Deal's objective for circularity and climate neutrality aims at combining mechanical and chemical recycling, by employing circular economy principles of retaining resources at their highest possible value. This strategy creates a path towards a more sustainable manner for managing plastic waste. This study investigates the environmental benefits of integrating mechanical and chemical recycling methods within a circular economy framework. Two common plastics, low-density polyethylene (LDPE) and polypropylene (PP), were analyzed, using input-output data gathered from the literature, across various EOL scenarios. Life Cycle Assessment (LCA) using SimaPro was applied to analyze the environmental impacts of the two supply chains independently, from monomer production to EOL, across four scenarios: mechanical recycling with incineration or landfill, mechanical and chemical recycling, and the fourth being a replica of the third with the incorporation of industrial symbiosis between the two supply chains.

Largest environmental impacts from human health and ecosystem were witnessed in the scenario that combined mechanical recycling and incineration. Processing of the polymer accounted for the largest share in each process (for human health 34-46% for PP waste, 32-43% for LDPE waste, and for ecosystems 26-39% for PP waste and 37-51% for LDPE waste). Pyrolysis products led to avoided impacts of 14% for propylene from wPP and 9% for ethylene from wLDPE, due to the reduced virgin feedstock reliance. Industrial symbiosis achieved the lowest impacts in all the impact categories chosen, leveraging waste pyrolysis and material exchange to minimize resource extraction and environmental burdens. Integrating industrial symbiosis with mechanical and chemical recycling maximizes environmental benefits by reducing resource impacts and dependence on virgin materials, highlighting its potential for enhancing circularity in plastic waste management. This framework can guide policymakers and industries toward sustainable plastic waste management strategies.