Material resources, energy, and nutrient recovery from waste: are waste refineries the solution for the future?

Waste refineries focusing on multiple outputs of material resources, energy carriers, and nutrients may potentially provide more sustainable utilization of waste resources than traditional waste technologies. This consequential life cycle assessment (LCA) evaluated the environmental performance of a Danish waste refinery solution against state-of-the-art waste technology alternatives (incineration, mechanical-biological treatment (MBT), and landfilling). In total, 252 scenarios were evaluated, including effects from source-segregation, waste composition, and energy conversion pathway efficiencies. Overall, the waste refinery provided global warming (GW) savings comparable with efficient incineration, MBT, and bioreactor landfilling technologies. The main environmental benefits from waste refining were a potential for improved phosphorus recovery (about 85%) and increased electricity production (by 15-40% compared with incineration), albeit at the potential expense of additional toxic emissions to soil. Society's need for the outputs from waste, i.e., energy products (electricity vs transport fuels) and resources (e.g., phosphorus), and the available waste composition were found decisive for the selection of future technologies. On the basis of the results, it is recommended that a narrow focus on GW aspects should be avoided as most waste technologies may allow comparable performance. Rather, other environmental aspects such as resource recovery and toxic emissions should receive attention in the future.

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