

From Waste to Resources: Integrated Approaches for Circular Economy and Low-Carbon Waste Management

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Abstract

The rapid rise in municipal solid waste (MSW), exceeding 2 billion tonnes annually and projected to reach 3.4 billion tonnes by 2050, poses significant risks to environmental quality, public health, and resource security. Addressing this challenge requires a shift from linear disposal practices to Integrated Solid Waste Management (ISWM), which aligns with circular economy principles and sustainability objectives. This paper highlights the pivotal role of ISWM in minimizing waste generation, enhancing material recovery, and promoting recycling. Innovative bio-conversion processes such as composting and anaerobic digestion, alongside thermal technologies including incineration and pyrolysis, are examined for their potential to recover resources and generate energy. These approaches reduce reliance on landfills, mitigate greenhouse gas emissions, and contribute to climate change adaptation and energy security. Furthermore, effective policy frameworks and regulatory support are essential for improving waste segregation, boosting processing efficiency, and stimulating markets for secondary materials. By integrating technological, environmental, and policy dimensions, ISWM provides a pathway toward resilient, low-carbon, and resource-efficient waste management systems.