COUNCIL OF THE GREAT LAKES REGION
Solving for Sustainability®

Circular Great Lakes
FORGING A FUTURE WITHOUT WASTE

Recycling Pathways: Mechanical Recycling, Advanced Recycling, and Waste-to-Energy

Understanding End-of-Life Options for Plastic Materials

As policymakers, businesses, and communities work toward a more circular economy, several pathways exist for managing plastic waste. The waste hierarchy, widely used by government agencies in both the United States and Canada, provides a framework for prioritizing waste management options by emphasizing waste reduction, reuse, and recycling before energy recovery and disposal whenever practical.

Within that framework, mechanical recycling, advanced recycling, and waste-to-energy (WtE) technologies each play distinct roles in recovering value from materials, diverting waste from landfill, reducing the need for virgin raw material extraction, and supporting a more circular materials economy.

Understanding how these approaches differ can help inform policy, infrastructure investments, and end-of-life management decisions.

Source: US EPA
https://www.epa.gov/smm/sustainable-materials-management-non-hazardous-materials-and-waste-management-hierarchy

Mechanical Recycling

Mechanical recycling is the most widely used method of recycling plastics today. Materials are collected, sorted, cleaned, shredded, and remanufactured into new products without fundamentally changing the plastic's chemical structure.

Best suited for:

- Clean, well-sorted plastic streams
- PET (#1) and HDPE (#2) containers
- Rigid plastics collected through established recycling programs

Why choose mechanical recycling?

Mechanical recycling is generally the preferred option when plastics can be effectively collected and sorted. It is a commercially mature technology with well-established collection and processing infrastructure throughout North America. Because the polymer remains intact, it allows materials to stay in circulation and be used to manufacture new products, supporting recycled content goals and broader circular economy objectives.

Advanced Recycling

Advanced recycling, also referred to as chemical recycling, uses thermal, chemical, or solvent-based processes to convert plastics into molecular building blocks that can be used to manufacture new plastics, chemicals, or other products.

Common technologies include:

- Pyrolysis
- Gasification
- Depolymerization
- Solvent-based purification

Best suited for:

- Mixed plastic streams
- Contaminated plastics
- Films, flexible packaging, and other materials that are difficult to recycle mechanically

Why choose advanced recycling?

Advanced recycling can complement mechanical recycling by providing an additional management option for plastics that are difficult to process using conventional recycling methods. Depending on the technology, it can recover value from materials that might otherwise be landfilled or managed through other disposal methods and may produce feedstocks suitable for manufacturing new plastic products.

Waste to Energy (WtE)

Waste-to-Energy (WtE) facilities combust municipal solid waste to generate electricity, steam, or heat while substantially reducing the volume of material requiring disposal.

Best suited for:

- Residual waste that cannot be feasibly reduced, reused, or recycled
- Mixed municipal solid waste
- Communities seeking alternatives to landfill disposal

Why choose waste-to-energy?

Waste-to-Energy provides an end-of-life management option for materials that cannot be practically recovered through recycling. In addition to reducing the volume of waste sent to landfill, modern facilities recover energy that can be used to generate electricity, provide district heating, or support industrial processes. Within many waste management frameworks, Waste-to-Energy is considered a recovery option that follows efforts to reduce, reuse, and recycle materials whenever feasible.

Comparison of Plastic Management Pathways

Metric	Mechanical Recycling	Advanced Recycling	Waste-to-Energy
Circularity Potential	High	Moderate-High	Low
Material Recovery	Produces recycled plastic	Produces feedstocks, chemicals, or plastics	No material recovery
Feedstock Requirements	Clean, sorted materials	Mixed and contaminated plastics possible	Mixed waste streams
Technology Maturity	Mature and widely deployed	Emerging to developing	Mature
Supports Recycled Content Goals	Yes	Potentially	No
Suitable for Flexible Packaging	Limited	Better suited	Accepts but destroys material
Alignment with Circular Economy Principles	Strong	Moderate-Strong	Weak

Key Takeaways

- **Mechanical Recycling:** Generally the preferred recycling pathway for clean, well-sorted plastics that can be efficiently collected and reprocessed into new products.
- **Advanced Recycling:** Can complement mechanical recycling by providing an additional recovery pathway for plastics that are difficult to recycle through conventional mechanical processes.
- **Waste-to-Energy:** Provides an energy recovery option for residual materials that cannot be feasibly reduced, reused, or recycled, helping divert waste from landfill.
- **Invest in Collection and Sorting Infrastructure:** Effective collection, sorting, and contamination reduction are critical to maximizing material recovery, regardless of the end-of-life pathway.
- **Support a Circular Materials Economy:** No single technology can manage every plastic waste stream. A comprehensive materials management system uses multiple recovery pathways to keep materials in productive use whenever practical, reduce landfill disposal, and minimize demand for virgin raw materials.