

Material Recovery Facilities (MRFs): The Backbone of the Recycling System

A Material Recovery Facility (MRF) is a specialized facility that receives mixed recyclable materials collected from households, businesses, institutions, and drop-off programs and separates them into marketable commodities that can be sold to recycling processors and manufacturers. MRFs serve as the critical link between collection programs and the recycling manufacturing sector. Without MRFs, most recyclables would remain mixed together, making it difficult or impossible to transform them into high-quality feedstocks for new products.

How Materials Reach a MRF

Recyclable materials are collected through a variety of channels:

- Residential curbside recycling programs
- Multi-family residential collection
- Commercial and institutional recycling programs
- Industrial recycling streams
- Construction and demolition recovery programs
- Depot and transfer station collection
- Retail take back and drop-off programs

After collection, materials are transported to a MRF where they undergo sorting and quality control before being marketed as recyclable commodities.

Inside a MRF: The Sorting Process

Step 1: Receiving and Tipping

Collection trucks unload materials onto a tipping floor where operators inspect loads for contamination and large non-recyclable items.

Common contaminants include:

- Plastic bags and film
- Food waste
- Garden hoses
- Textiles
- Batteries
- Electronics

Excessive contamination can reduce commodity value and increase processing costs.

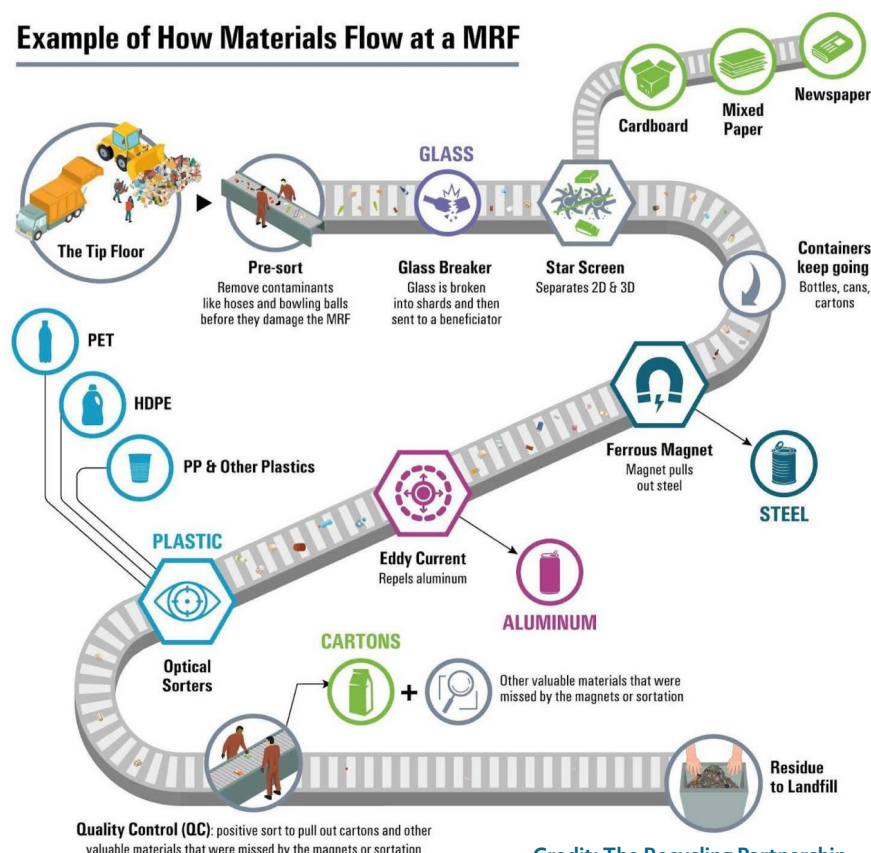
Step 2: Pre-Sorting

Workers remove oversized materials and hazardous items that could damage equipment or pose safety risks.

Examples include:

- Propane tanks
- Lithium batteries
- Tanglers (hoses, cords, chains)
- Large rigid plastics
- Scrap metal

Example of How Materials Flow at a MRF



Credit: The Recycling Partnership

Step 3: Mechanical Separation

Materials move through a series of automated sorting technologies designed to separate recyclables by size, shape, weight, and material type.

Disc Screens

Separate materials by size and shape.

Purpose:

- Remove cardboard from smaller containers
- Separate paper grades

Trommel Screens

Rotating cylinders sort materials based on size.

Purpose:

- Remove broken glass
- Separate fine particles and debris

Ballistic Separators

- Separate materials based on density and movement characteristics.

Outputs:

- Flat materials (paper)
- Rolling containers (plastic bottles, cans)
- Fine particles

Air Classifiers

Use airflow to separate light and heavy materials.

Purpose:

- Remove lightweight contaminants
- Improve paper quality

Magnets

Remove ferrous metals such as:

- **Steel food cans**
- **Aerosol cans**

Eddy Current Separators

Use magnetic fields to eject non-ferrous metals such as:

- Aluminum beverage cans

Optical Sorters

Near-infrared (NIR) scanners identify materials based on their chemical composition.

Commonly sort:

- PET (#1)
- HDPE (#2)
- PP (#5)
- Cartons
- Paper grades

Modern MRFs increasingly rely on optical sorting systems to improve recovery rates and material purity.



Step 4: Quality Control

Employees conduct final inspections and remove remaining contaminants.

This step is critical because manufacturers often require:

- 95–99% purity specifications
- Consistent bale composition
- Low moisture content

Higher quality materials command higher market prices.

Step 5: Baling

Separated materials are compressed into dense bales for transportation.

Typical bale commodities include:

Commodity	Typical End Market
OCC (Cardboard)	Paper mills
Mixed Paper	Tissue and packaging
PET Bottles	Fiber and new bottles
HDPE Bottles	Containers and pipe
Aluminum Cans	New aluminum products
Steel Cans	New steel products
Cartons	Fiber recovery facilities



What Happens After the MRF?

A MRF is not the final destination for recyclable materials.

Once sorted and baled, materials generally follow one of several pathways.

Pathway 1: Mechanical Recycling

The most common pathway for paper, metals, glass, and many plastics.

Typical Plastic Recycling Process

1. Bales arrive at a plastics processor.
2. Materials are sorted again if necessary.
3. Plastics are shredded into flakes.
4. Flakes are washed to remove labels and contaminants.
5. Material is melted and filtered.
6. Plastic is pelletized.
7. Pellets are sold to manufacturers.

These pellets can be used to produce:

- Packaging
- Containers
- Film products
- Construction materials
- Automotive components

Mechanical recycling remains the dominant recycling pathway globally due to its relatively low cost and lower environmental footprint compared to alternative technologies.

Pathway 2: Secondary Sortation

Secondary sortation facilities process materials after they leave a traditional MRF.

These facilities use advanced sorting technologies to recover materials that would otherwise be lost.

Benefits

- Increases recovery rates
- Captures smaller plastic fractions
- Improves bale purity
- Recovers materials from residue streams

Commonly Recovered Materials

- Polyethylene (PE) film
- Polypropylene (PP)
- Small-format plastics
- Mixed rigid plastics

Secondary sortation is increasingly viewed as a strategy for improving recycling system performance without requiring major changes to consumer behavior.

Pathway 3: Chemical Recycling

Some plastics that cannot be mechanically recycled may be sent to chemical recycling facilities.

Processes may include:

- Pyrolysis
- Gasification
- Solvolysis
- Depolymerization

These technologies break plastics down into:

- Monomers
- Hydrocarbons
- Chemical feedstocks

Potential applications include:

- New plastics manufacturing
- Chemical production
- Fuel production

While chemical recycling can expand the range of recoverable materials, questions remain regarding economics, energy use, and long-term scalability.





Pathway 4: Export Markets

Historically, many recyclables were exported for processing.

The 2018 implementation of China's National Sword Policy dramatically reduced imports of mixed recyclables and forced North American recycling systems to improve material quality and develop domestic processing capacity.

The policy highlighted the importance of:

- Lower contamination rates
- Domestic recycling infrastructure
- Strong end-market development

Pathway 5: Residual Disposal

Not all materials entering a MRF are successfully recycled.

Residual materials may include:

- Contaminated recyclables
- Composite materials
- Non-recyclable packaging
- Broken materials

These materials are typically sent to:

- Landfills
- Waste-to-energy facilities

Residual rates vary but often range from 10–30% depending on incoming material quality and facility technology.

Key Challenges Facing MRFs Today

Contamination- Food waste, plastic bags, and non-recyclables increase processing costs and reduce commodity value.

Flexible Packaging- Films, pouches, and multilayer packaging are difficult to sort using conventional equipment.

Commodity Market Volatility- Prices for recyclable commodities fluctuate significantly based on global demand and supply conditions.
Infrastructure Gaps- Many regions lack local processing capacity for recovered materials.

Packaging Complexity- Modern packaging often contains multiple materials that are difficult to separate and recycle.

Key Takeaways for Policymakers

Infrastructure Matters — MRFs are essential recycling infrastructure that connect collection programs with end markets.

Quality Drives Value — Cleaner material streams generate higher-value commodities and improve recycling outcomes.

End Markets Are Critical — Recycling only works when there is demand for recovered materials.

Secondary Sortation Can Improve Recovery — Advanced sorting technologies can significantly increase capture rates for hard-to-recycle plastics.

Design for Recycling Matters — Packaging designed with recyclability in mind reduces costs and improves system performance.

Recycling Is a System — Collection, sorting, processing, manufacturing, and end-market development must work together to achieve circular economy goals.

