National Waste & Recycling Association℠
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Costs and Approaches for Municipal Solid Waste Recycling Programs

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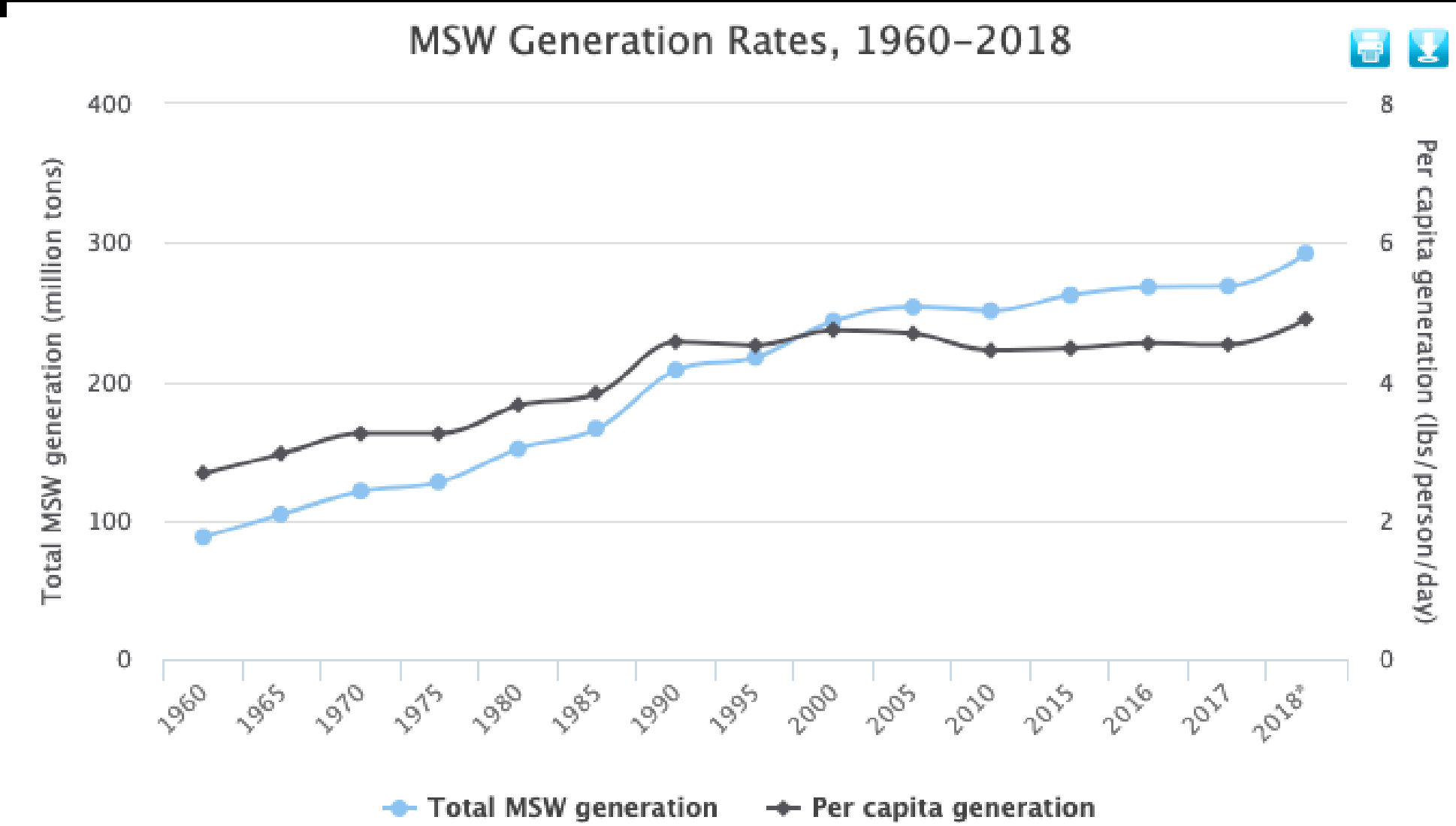
Types of waste generated annually:

- Municipal solid waste – 292 million tons
  - 69 million tons – recycled
  - 43 million tons - composted
  - 35 million tons – WTE
  - 146 million tons – landfilled

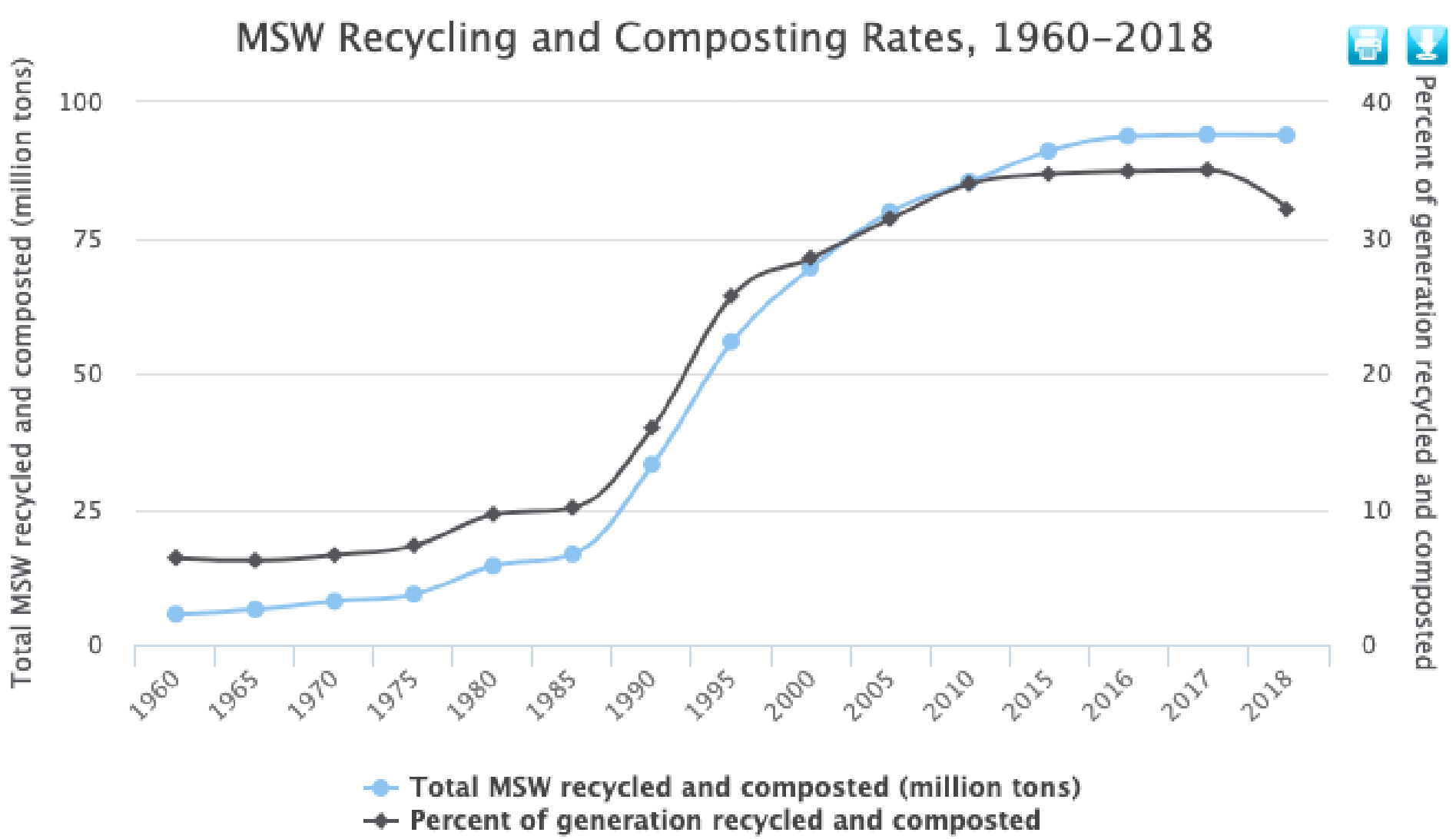
Source: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

USEPA MSW generation - 1960-2018



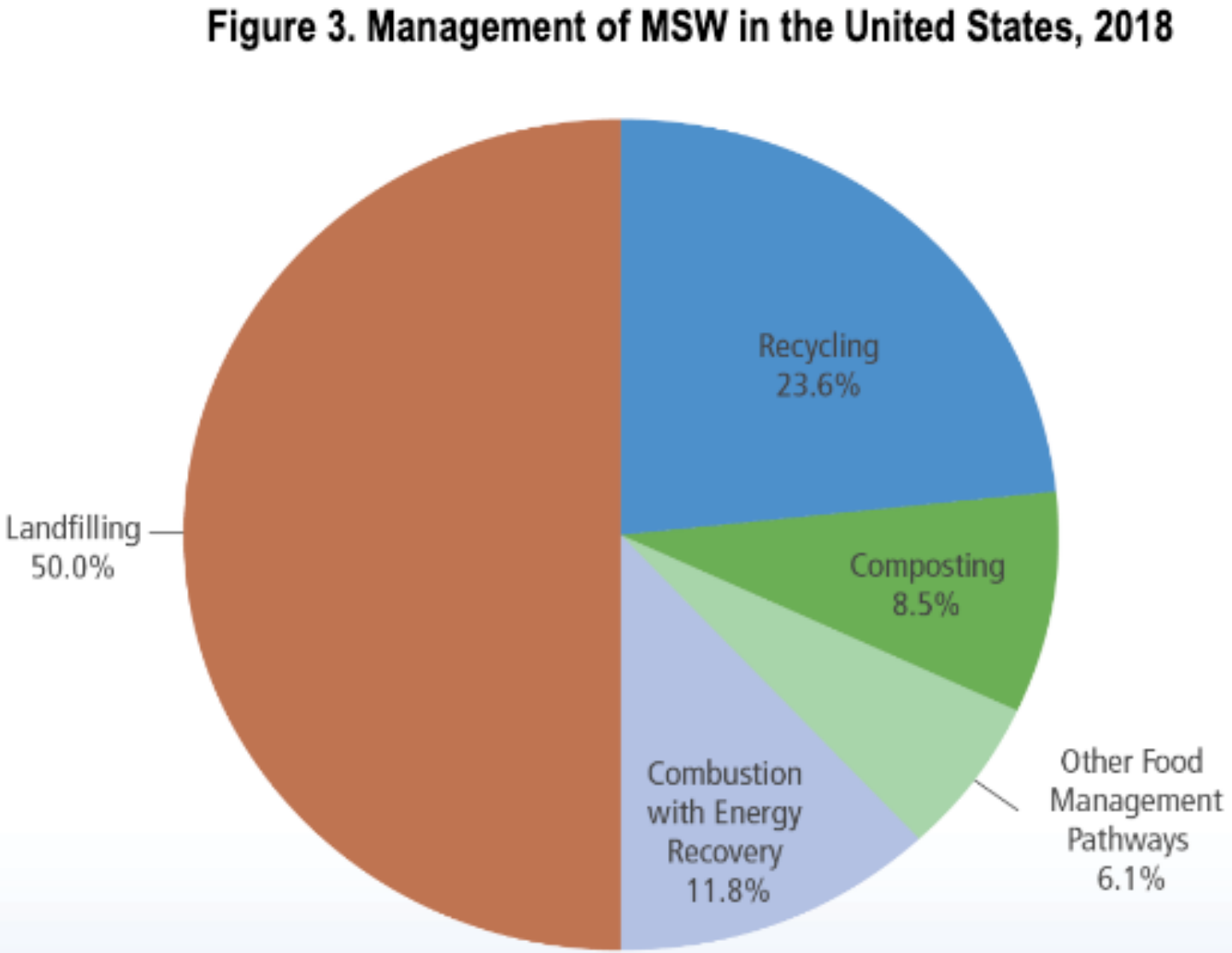
Source: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

USEPA Recycling/Composting rates - 1960 - 2018

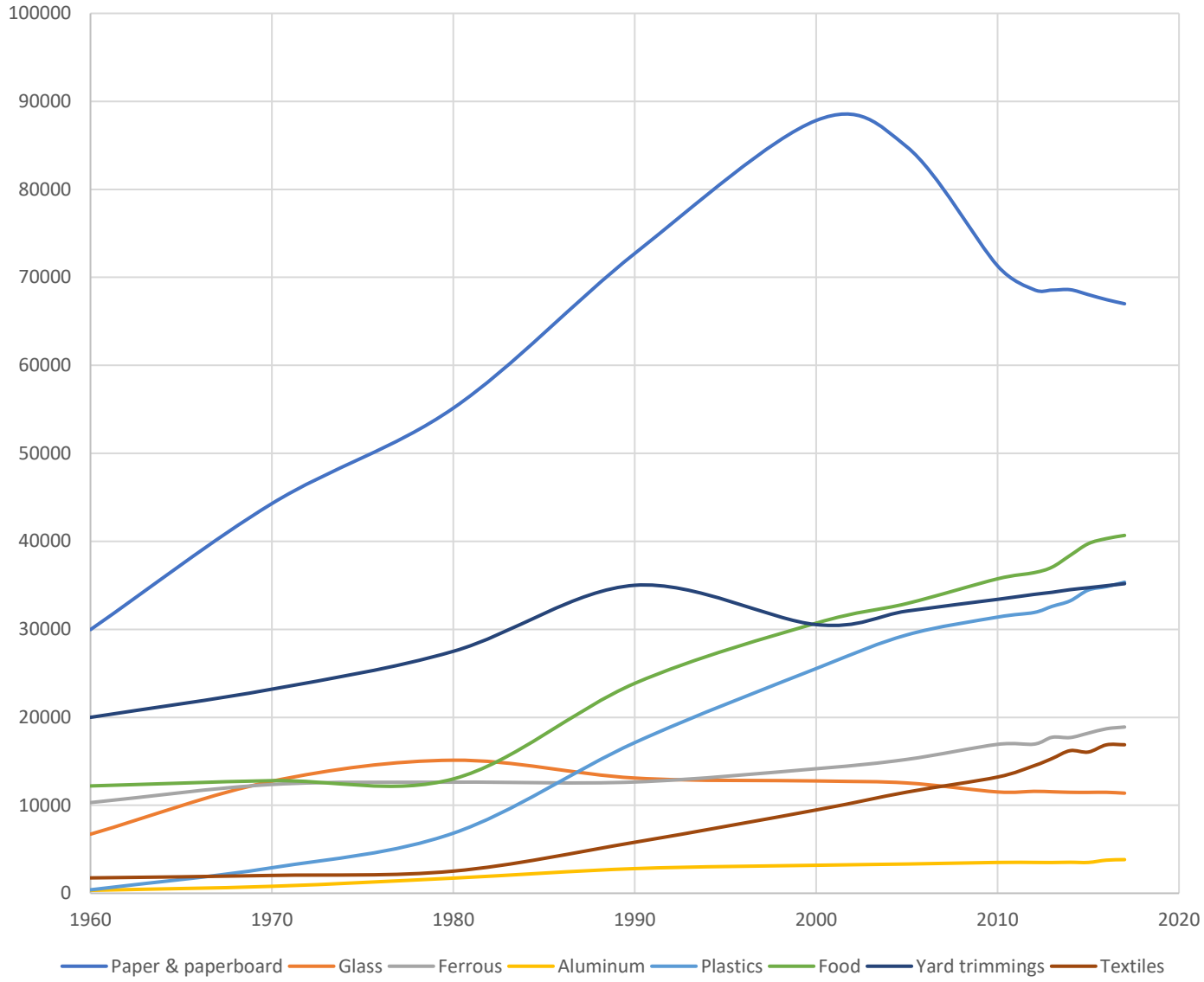


Source: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

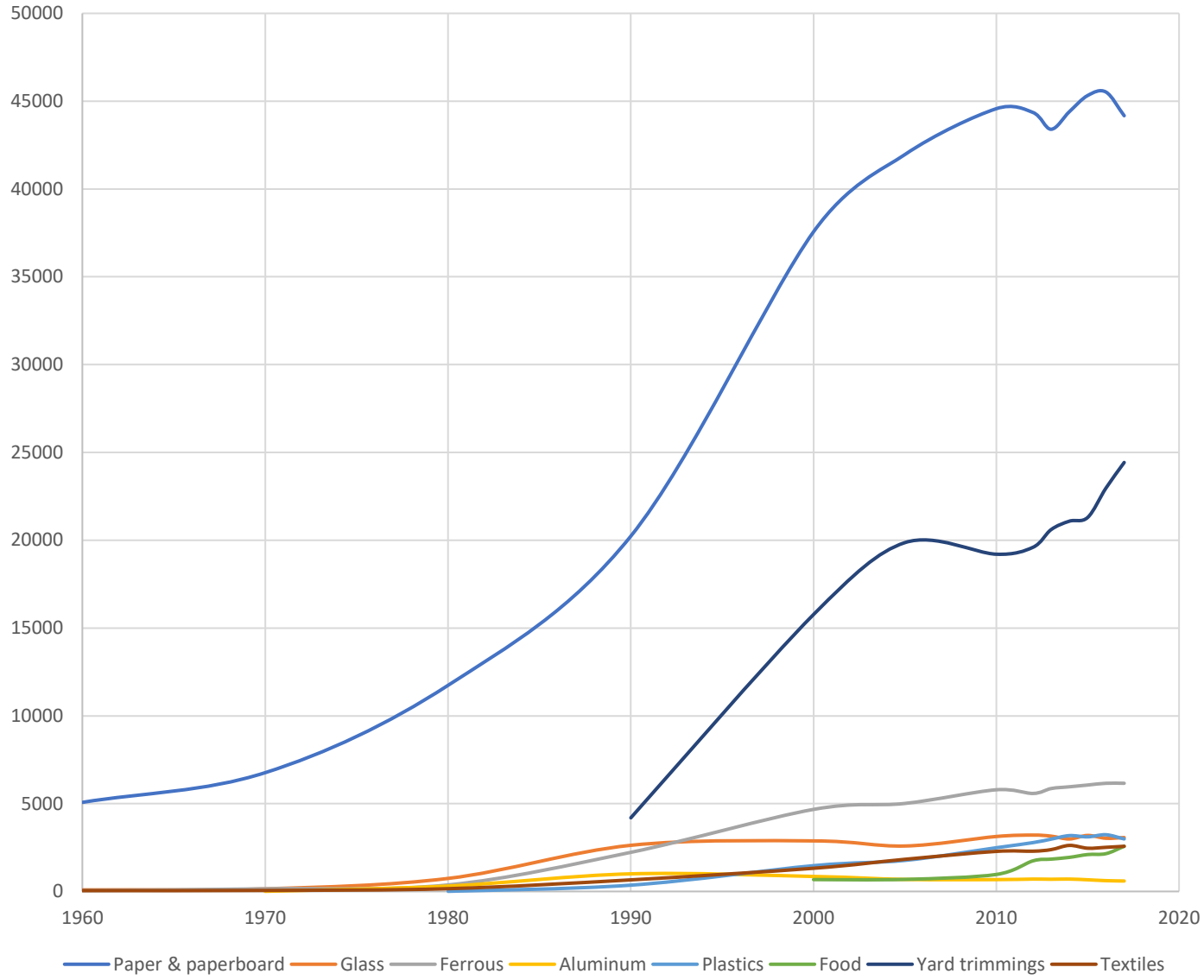
US waste management methodology



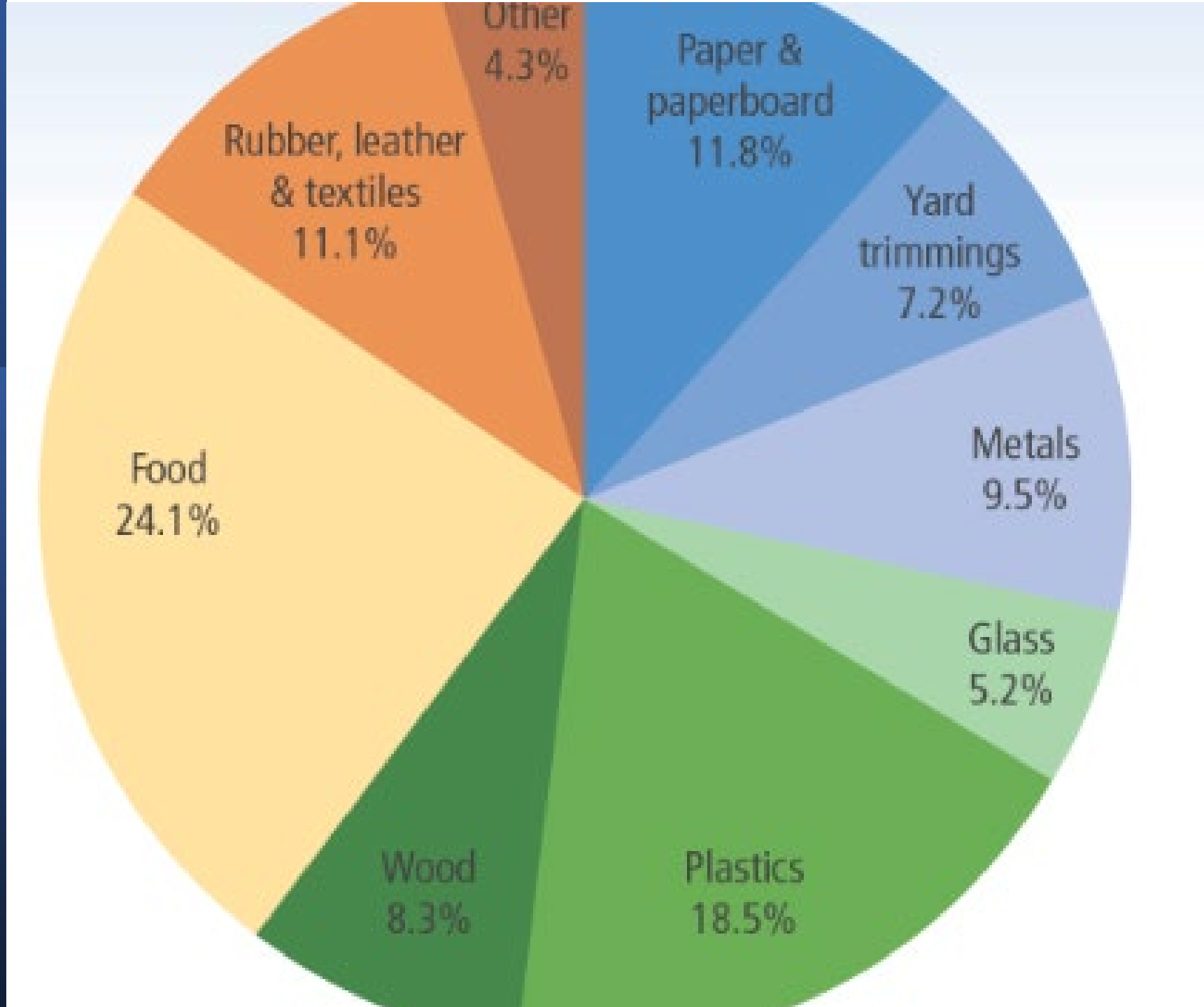
US EPA MSW generation



US EPA MSW recovered



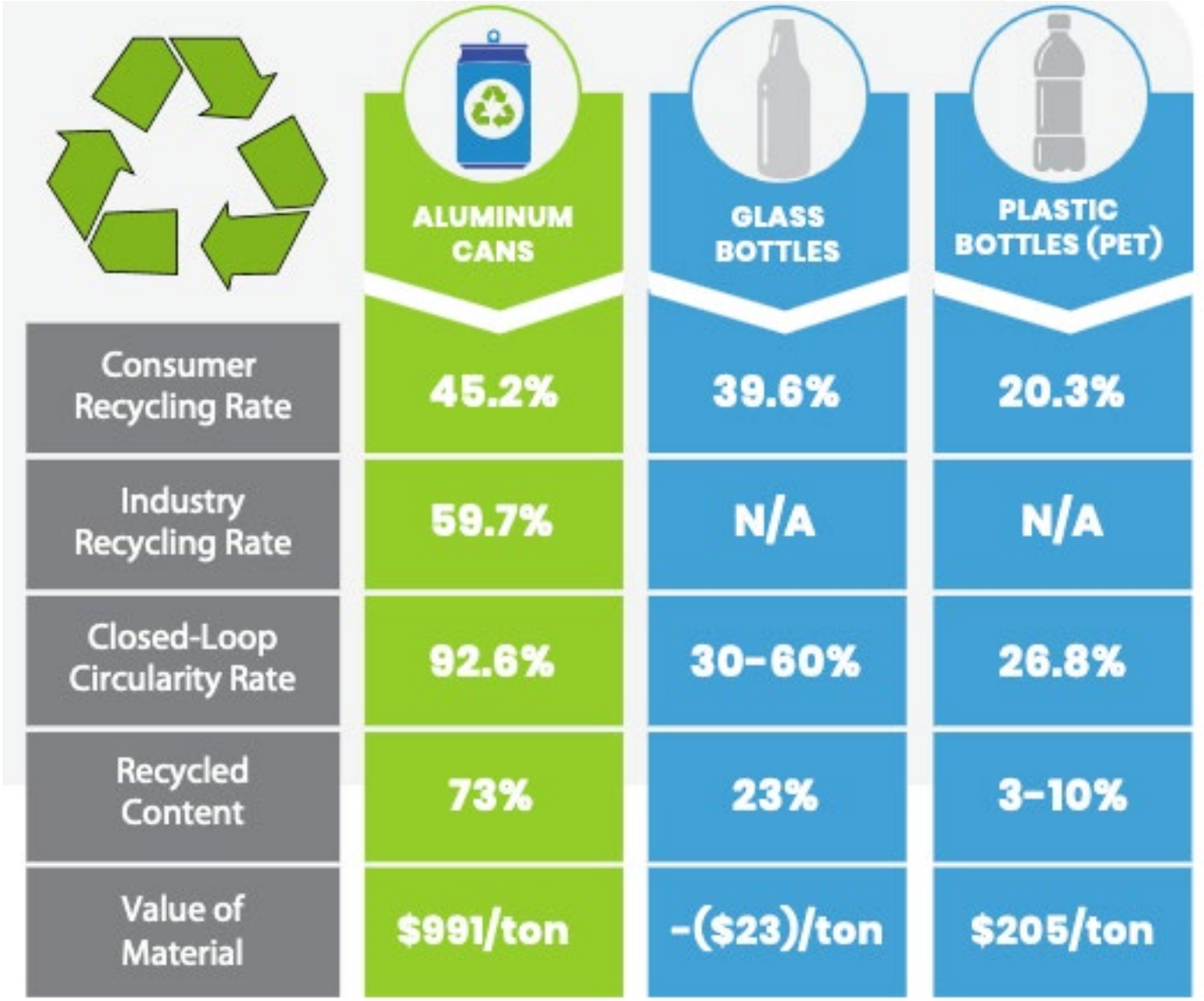
US EPA MSW landfilled by material type



Source: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

What is recyclable at the MRF?

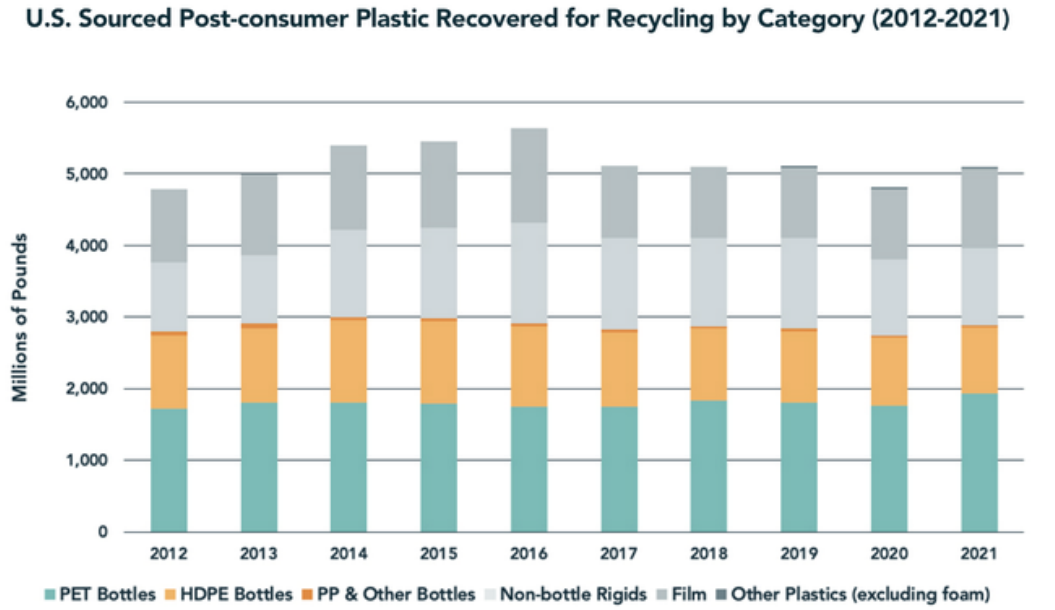
- Cans
- Bottles & jars
- Paper
- Cardboard



	ALUMINUM CANS	GLASS BOTTLES	PLASTIC BOTTLES (PET)
Consumer Recycling Rate	45.2%	39.6%	20.3%
Industry Recycling Rate	59.7%	N/A	N/A
Closed-Loop Circularity Rate	92.6%	30–60%	26.8%
Recycled Content	73%	23%	3–10%
Value of Material	$991/ton	-($23)/ton	$205/ton

Source: https://www.cancentral.com/wp-content/uploads/2023/01/CMI-Recycling-Primer-Roadmap.pdf

Trend Chart



In 2021, 5,084.1 million pounds of post-consumer plastic material sourced in the U.S. was recovered for recycling in the categories of Bottles, Non-bottle Rigids, Film, and Other Plastics (excluding foam).

Bottle Recycling Rates

All Bottle Recycling Rate

28.2%

Up 1.0 percentage points since 2020

PET Bottle Recycling Rate

28.7%

Up 1.6 percentage points since 2020

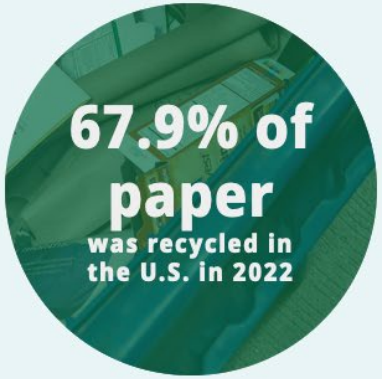
HDPE Bottle Recycling Rate

28.9%

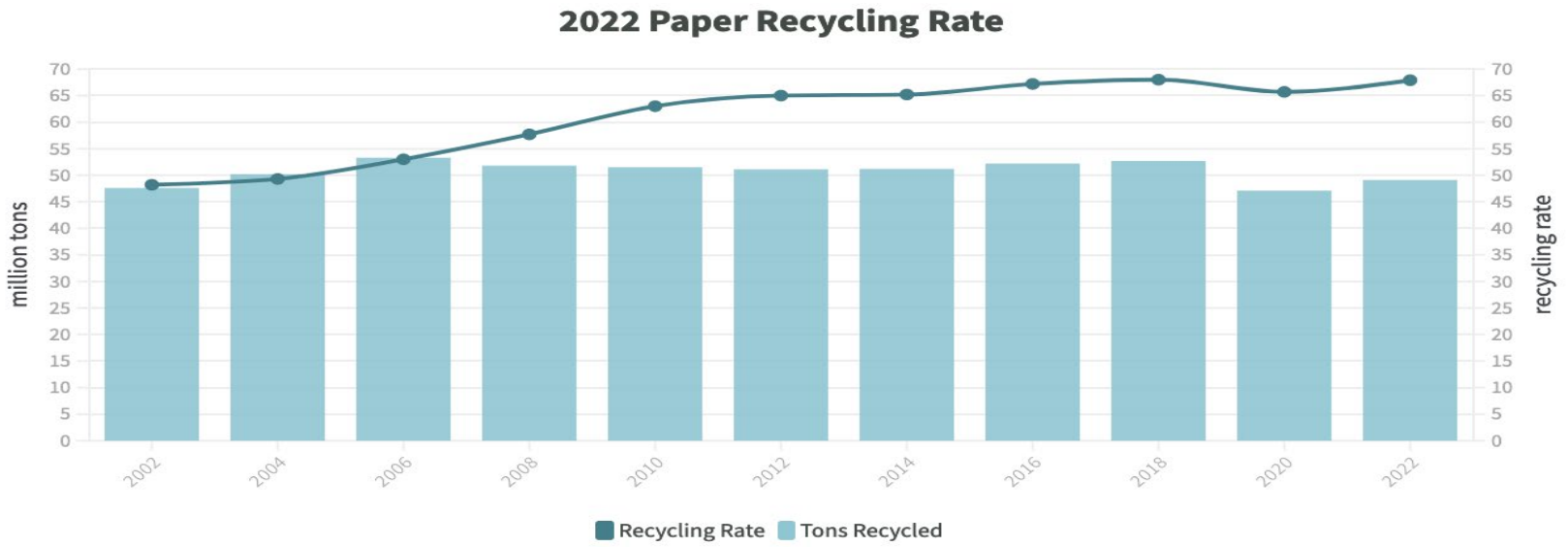
Up 0.1 percentage points since 2020

Source:
https://circularityinaction.com/2021PlasticRecyclingData

94% of Americans have access to community paper recycling programs. Paper recycling is a success story and paper products are part of the recycling solution.



2022 PAPER RECYCLING RATE



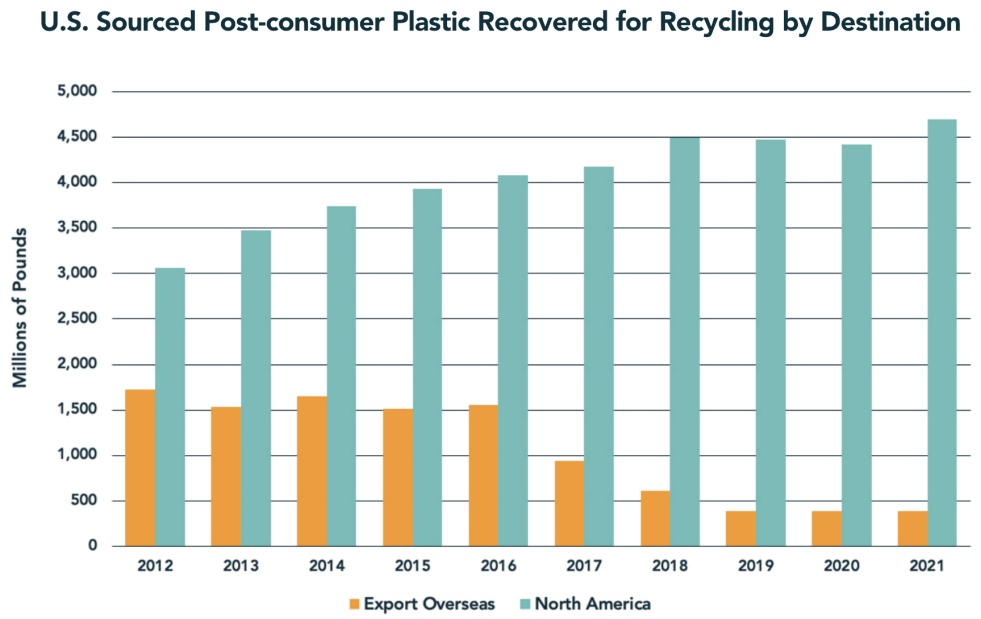
Source: AF&PA Statistics

American Forest & Paper Association

Where do our plastics go?

Total	PET Bottles	HDPE Bottles	PP & Other Bottles
92.3%	96.9%	99.2%	96.9%
	Non-bottle Rigids	Film	Other Plastics (excluding foam)
	88.5%	83.1%	37.2%

Trend Chart



4,693 Million lbs. Reclaimed in the North America

Decades Change

2012

35.9% Export Overseas | 61.4% North America

2021

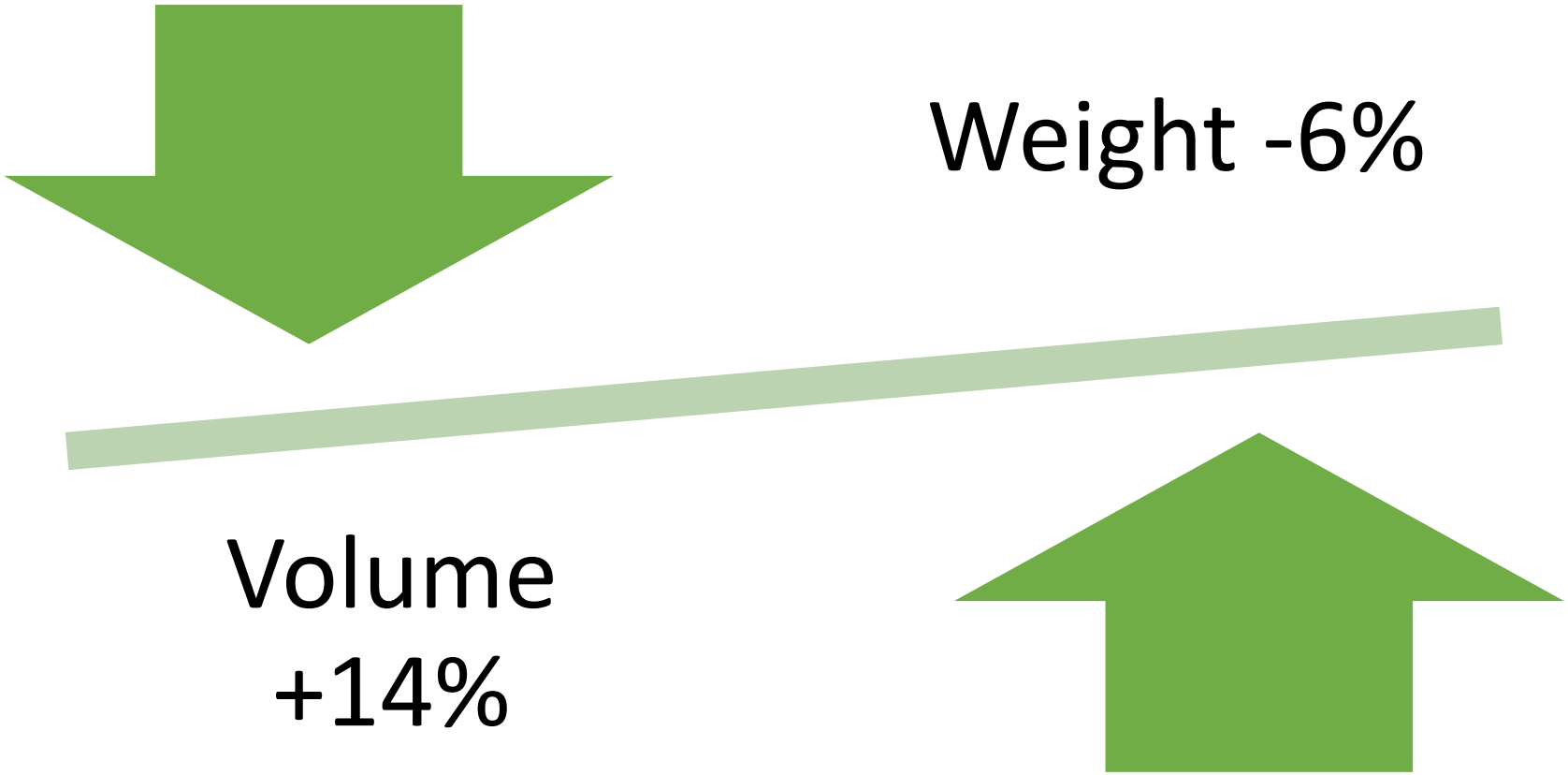
7.7% Export Overseas | 92.3% North America

Source: https://circularityinaction.com/2021PlasticRecyclingData

How should it be prepared?

- Clean
- Loose
- Empty
- Caps on plastic containers
- Dry

Recycling - 2000-2015



Collection vs. processing costs

Lightweighting

- Less material in same packaging (less noticeable):
  - Lighter glass bottles
  - Lighter cans
  - Lighter plastic water bottles
- Change in packaging type to make it lighter:
  - Laundry detergent from rigid plastic bottle to pods in a pouch
  - Tuna fish from cans to flexible pouches
  - Costco rotisserie chicken from domed rigid plastic to flexible plastic bags
- Changes are continuing:
  - Sustainable wine roundtable will reduce the average bottle weight of a 750 ml bottle from 550 g to 420 g by end of 2026
  - Crown will reduce aluminum in 12 oz cans by 10% by 2030

Material – complexity

- Multiple materials on packaging
  - Bottle
  - Cap
  - Label
- Multi-layer materials
  - Cartons - Plastic/paper/metal/plastic
  - Coffee cup – plastic/paper
  - Coffee pods – coffee/fiber/plastic/metal
- Progress
  - Tubes

HDPE Generation & Recovery

National HDPE Generation and Recovery

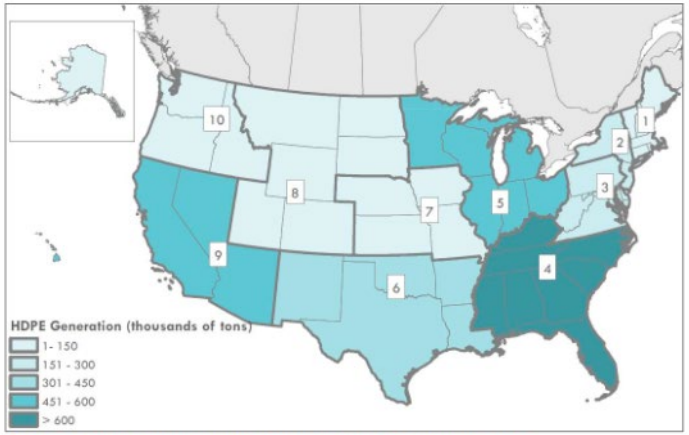


Figure 4. HDPE Generation (in thousands of tons) by Region, 2018
Source: RRS

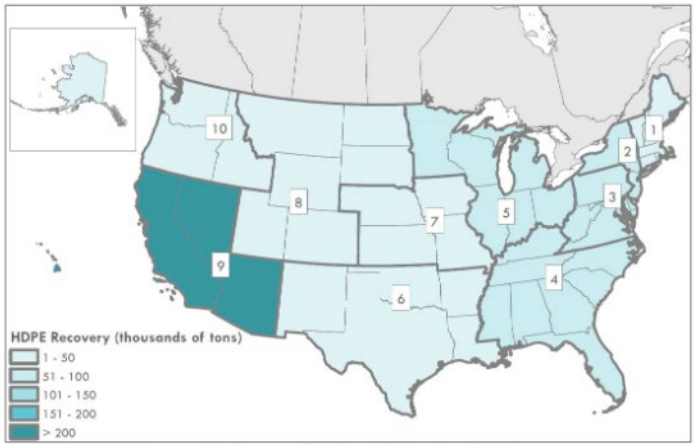


Figure 5. HDPE Recovery (in thousands of tons) by Region, 2018
Source: RRS

National PET Generation and Recovery

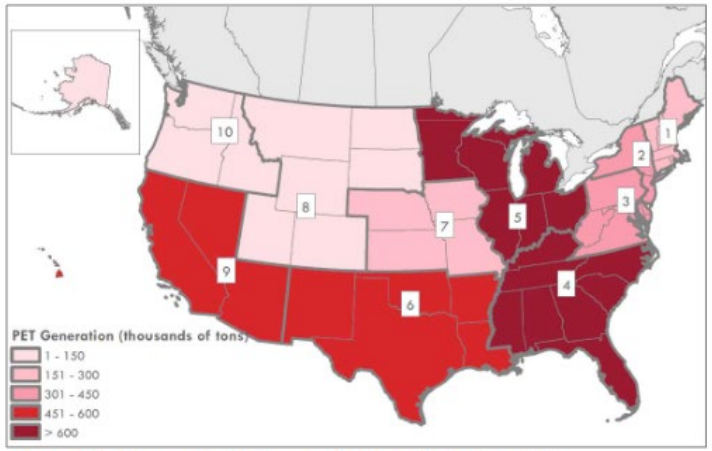


Figure 2. PET Generation (in thousands of tons) by Region, 2018
Source: RRS

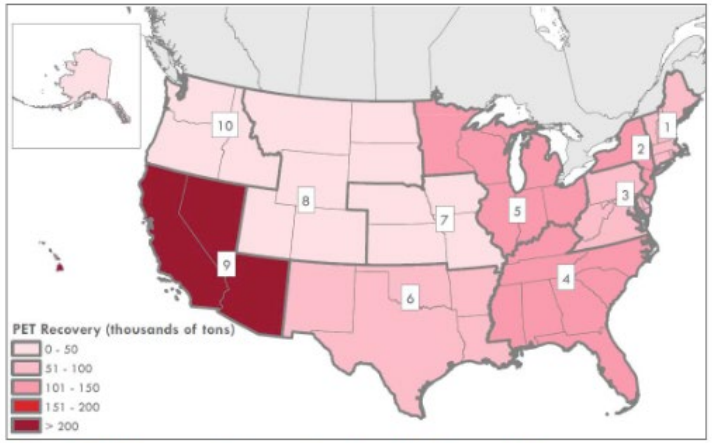
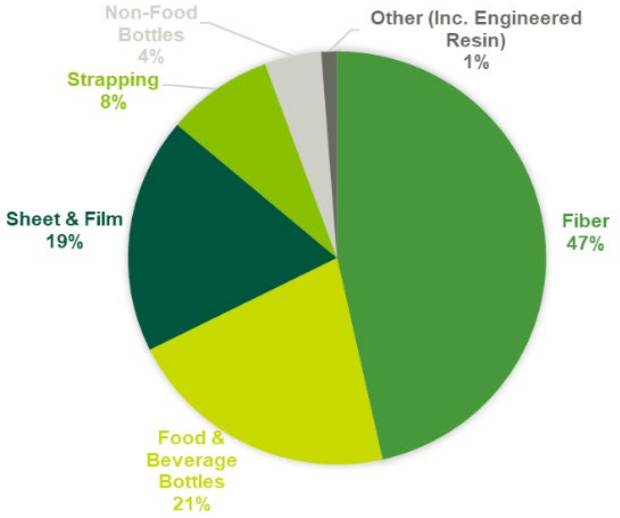


Figure 3. PET Recovery (in thousands of tons) by Region, 2018
Source: RRS

Source: https://www.republicservices.com/cms/documents/sustainability_reports/Plastics-Recovery-Program-Review2020.pdf

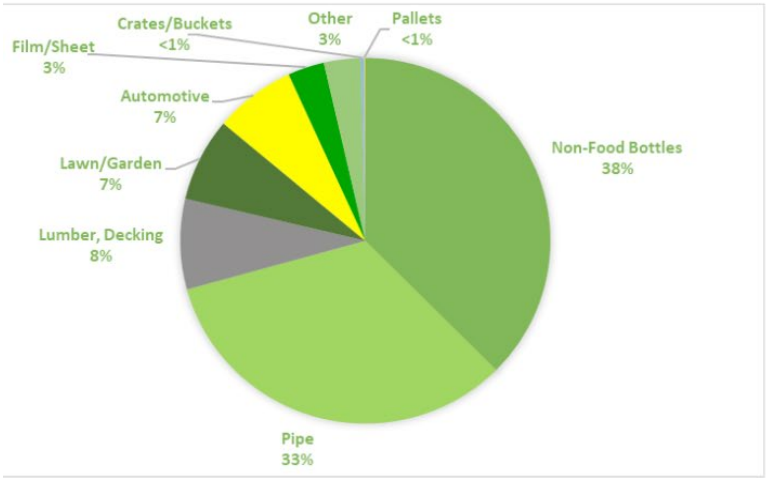
PET & HDPE end use

Table 6: PET End Uses



End Use	%	'000 Tons
Fiber	47%	447
Food & Beverage Bottles	21%	203
Sheet & Film	19%	178
Strapping	8%	79
Non-Food Bottles	4%	42
Other (Inc. Engineered Resin)	1%	12
Total	100%	961

Figure 9: HDPE End Uses



End Use	%	'000 Tons
Non-Food Bottles	37.4%	249
Pipe	33.2%	221
Lumber, Decking	8%	53
Lawn/Garden	7.4%	49
Automotive	7.1%	47
Film/Sheet	3.2%	21
Other	3.2%	21
Crates/Buckets	0.30%	2
Pallets	0.10%	1
Total	100%	666

Source: https://sustainability.wm.com/downloads/WM_Report_on_Recycling.pdf

EPR

Extended Producer Responsibility for Packaging Outcomes

Environmental outcomes often associated with Extended Producer Responsibility (EPR) include: 1) increases in recycling rates, 2) increases in recycled content usage, 3) increases in design-for-recycling practices, and 4) increases in the market value of collected packaging waste. These four outcomes are interrelated. For instance, it is reasonable to assume that increases in design-for-recycling practices (outcome 3) will facilitate increases in recycling rates (outcome 1), which should increase the supply of recycled content, thereby facilitating producers' usage of recycled content (outcome 2), which in turn can be linked to the market value of collected packaging waste (outcome 4). Given these interrelations, EPR programs vary in the directness with which they intend to address each outcome. Some programs may have elements directly aimed at improving several of these outcomes, while other programs may intend for these outcomes to be indirectly addressed via the interrelations.

European policy has referenced EPR as a mechanism to implement the polluter pays principle since the introduction of the Waste Framework Directive (2008/98/EC). While EPR has been required in Europe for some materials, EPR was not required for packaging until 2018, when Directive 2018/852, amending Article 7 of the Packaging and Packaging Waste Directive. However, a number of countries implemented EPR for packaging long before this requirement. The most established programs are found in Germany, France and Italy and it is these programs for which secondary research has been carried out to provide a view on the extent to which EPR has contributed to the four outcomes above.

Outcome 1: Increases in Recycling Rate

Conclusion: EPR setting material specific targets will likely increase recycling rates.

Outcome 2: Increases in Recycled Content

Conclusion: There is no evidence that EPR, as currently designed and implemented, has led to the use of more recycled content. Eco-modulation has been introduced to drive the outcome towards greater recycled content, but it is too early to determine any results.

Outcome 3: Increases in design-for-recycling practices

Conclusion: France introduced eco-modulation to support design for recyclability and its recycling rate has steadily increased since it was introduced compared to Germany's. However, Italy's rate has increased by more than France's without eco-modulation. There is no definitive data that shows that EPR results in increased design-for-recycling of packaging.

Outcome 4: Increases in the market value of collected packaging waste

Conclusion: Evidence could not be found linking EPR to increased end market values for packaging waste.

Conclusion

EPR in Europe to date has not traditionally been designed to drive use of recycled content or design for recyclability. Although as noted by the OECD, "the impact of EPR on eco-design has been less than originally hoped for," substantial attempts to focus EPR programs on this priority have been limited. Efforts to improve recycled content, design-for-recycling and end market values need to be specifically considered if these outcomes are to be achieved. For these measures, especially recycled content, separate legislation may be more effective in ensuring that targets are transparently met and monitored than if included as optional through eco-modulated fees under EPR. EPR on its own may provide the funding necessary to financially support recycling.

Contamination	17-23%

Lithium batteries: What's the problem?

Lithium-Ion Batteries & Products

Lithium Battery Waste Projections (Australia)

LIB waste is growing at a rate of 20% per year

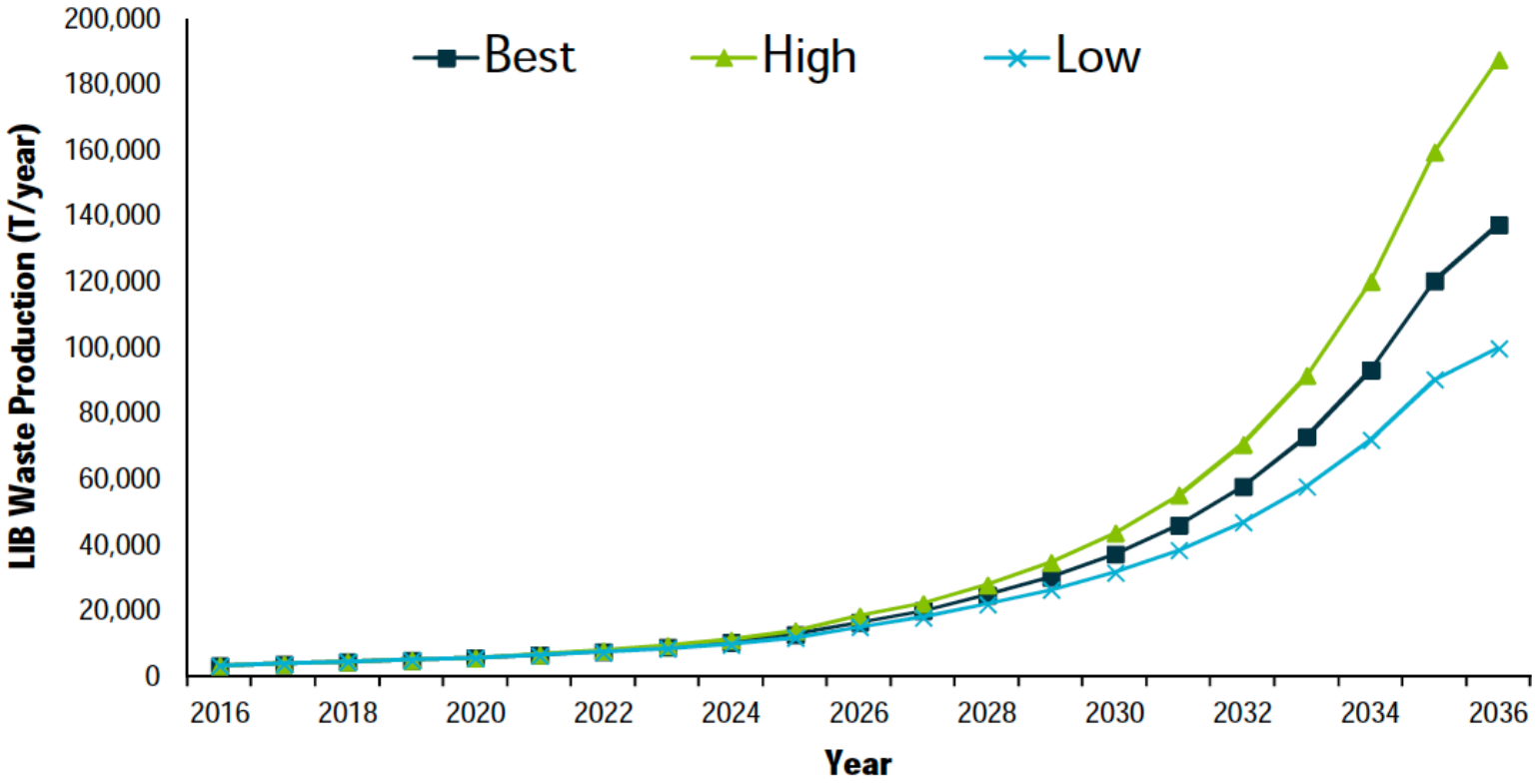


Figure 7 Projected LIB waste production from 2016 to 2036 (modified from Randell et al., 2016).

Source: https://www.csiro.au/-/media/EF/Files/Lithium-battery-recycling-in-Australia.PDF&ved=2ahUKEwjY04KyrcWFAxUcElkFHRaIA2YQFnoECBYQAQ&usg=AOvVaw0GvdgQI6wmtG0JGTcKRYUS

MRF Fires

Tulsa's only recycling facility, Mr. Murph caught fire in April 2021

Reyclables from Tulsa were sent to the WTE facility for 11 months while it was rebuilt

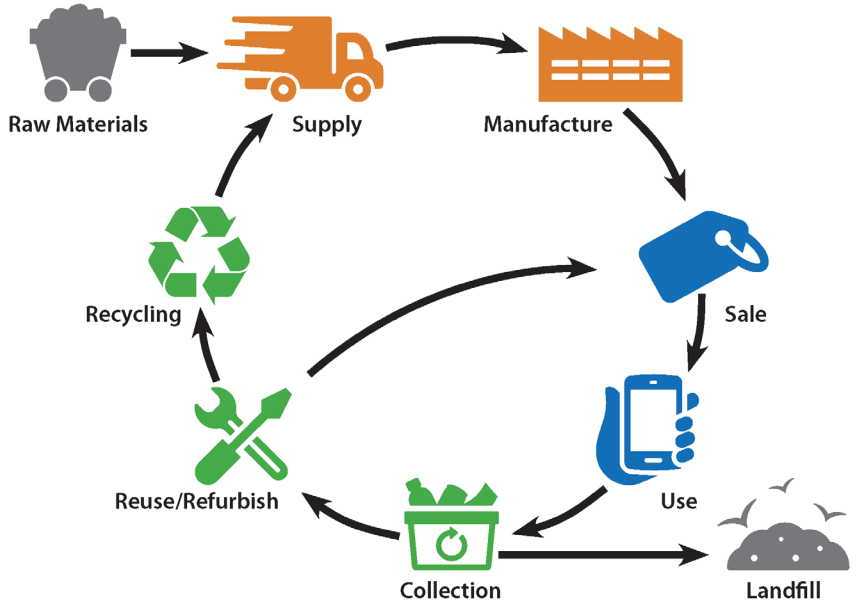
EPA
United States
Environmental Protection
Agency

An Analysis of Lithium-ion Battery Fires in Waste Management and Recycling

July 2021
Office of Resource Conservation and Recovery
EPA 530-R-21-002

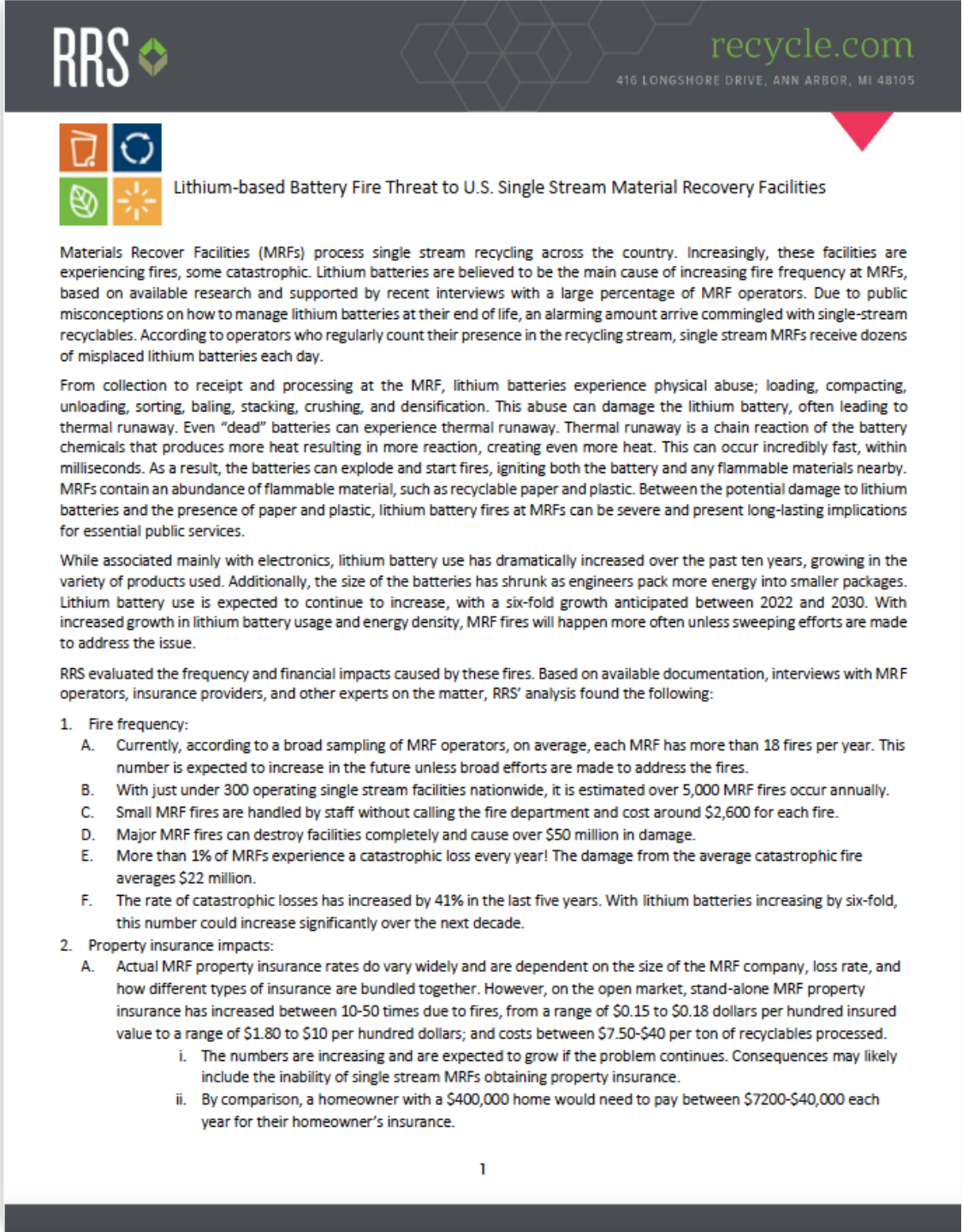
EPA's analysis

"*This problem is only going to get worse in future years.*"



MRF fires

- 18 fires/year/facility
- 1% of MRFs experience catastrophic loss every year
- Insurance costs are now:
  - $1.80-$10/$100 insured
  - $7.50-$40/ton of recyclables



RRS recycle.com
416 LONGSHORE DRIVE, ANN ARBOR, MI 48105

Lithium-based Battery Fire Threat to U.S. Single Stream Material Recovery Facilities

Materials Recover Facilities (MRFs) process single stream recycling across the country. Increasingly, these facilities are experiencing fires, some catastrophic. Lithium batteries are believed to be the main cause of increasing fire frequency at MRFs, based on available research and supported by recent interviews with a large percentage of MRF operators. Due to public misconceptions on how to manage lithium batteries at their end of life, an alarming amount arrive commingled with single-stream recyclables. According to operators who regularly count their presence in the recycling stream, single stream MRFs receive dozens of misplaced lithium batteries each day.

From collection to receipt and processing at the MRF, lithium batteries experience physical abuse; loading, compacting, unloading, sorting, baling, stacking, crushing, and densification. This abuse can damage the lithium battery, often leading to thermal runaway. Even "dead" batteries can experience thermal runaway. Thermal runaway is a chain reaction of the battery chemicals that produces more heat resulting in more reaction, creating even more heat. This can occur incredibly fast, within milliseconds. As a result, the batteries can explode and start fires, igniting both the battery and any flammable materials nearby. MRFs contain an abundance of flammable material, such as recyclable paper and plastic. Between the potential damage to lithium batteries and the presence of paper and plastic, lithium battery fires at MRFs can be severe and present long-lasting implications for essential public services.

While associated mainly with electronics, lithium battery use has dramatically increased over the past ten years, growing in the variety of products used. Additionally, the size of the batteries has shrunk as engineers pack more energy into smaller packages. Lithium battery use is expected to continue to increase, with a six-fold growth anticipated between 2022 and 2030. With increased growth in lithium battery usage and energy density, MRF fires will happen more often unless sweeping efforts are made to address the issue.

RRS evaluated the frequency and financial impacts caused by these fires. Based on available documentation, interviews with MRF operators, insurance providers, and other experts on the matter, RRS' analysis found the following:

1. Fire frequency:
   A. Currently, according to a broad sampling of MRF operators, on average, each MRF has more than 18 fires per year. This number is expected to increase in the future unless broad efforts are made to address the fires.
   B. With just under 300 operating single stream facilities nationwide, it is estimated over 5,000 MRF fires occur annually.
   C. Small MRF fires are handled by staff without calling the fire department and cost around $2,600 for each fire.
   D. Major MRF fires can destroy facilities completely and cause over $50 million in damage.
   E. More than 1% of MRFs experience a catastrophic loss every year! The damage from the average catastrophic fire averages $22 million.
   F. The rate of catastrophic losses has increased by 41% in the last five years. With lithium batteries increasing by six-fold, this number could increase significantly over the next decade.
2. Property insurance impacts:
   A. Actual MRF property insurance rates do vary widely and are dependent on the size of the MRF company, loss rate, and how different types of insurance are bundled together. However, on the open market, stand-alone MRF property insurance has increased between 10-50 times due to fires, from a range of $0.15 to $0.18 dollars per hundred insured value to a range of $1.80 to $10 per hundred dollars; and costs between $7.50-$40 per ton of recyclables processed.
      i. The numbers are increasing and are expected to grow if the problem continues. Consequences may likely include the inability of single stream MRFs obtaining property insurance.
      ii. By comparison, a homeowner with a $400,000 home would need to pay between $7200-$40,000 each year for their homeowner's insurance.