



NAPCOR

Postconsumer PET Recycling Activity in 2018

December 16, 2019



ACKNOWLEDGEMENTS

2018 marks the twenty-fourth year that the National Association for PET Container Resources (NAPCOR) has issued this report. Information contained in this report was obtained through surveys conducted by NewGen Strategies & Solutions; by More Recycling on behalf of the Association of Plastic Recyclers (APR); and from data generated through internal research conducted by NAPCOR. Support was also provided by Resource Recycling Systems (RRS) and LOM Enterprises. In order to present as accurate a picture of these activities as possible, additional data and information were obtained through discussions with individual collectors, intermediate processors, reclaimers, converters, brokers, exporters, importers, resin producers, bottle manufacturers, public recycling officials, consultants, and other key industry members. We greatly appreciate all contributions.

ABOUT NAPCOR

Founded in 1987, the **National Association for PET Container Resources (NAPCOR)** is the trade association for the PET plastic packaging industry in the United States, Canada and Mexico. NAPCOR is dedicated to promoting the PET package; to overcoming hurdles to the successful recycling of PET; and to communicating the attributes of the PET container as a sustainable package. More at www.napcor.com.

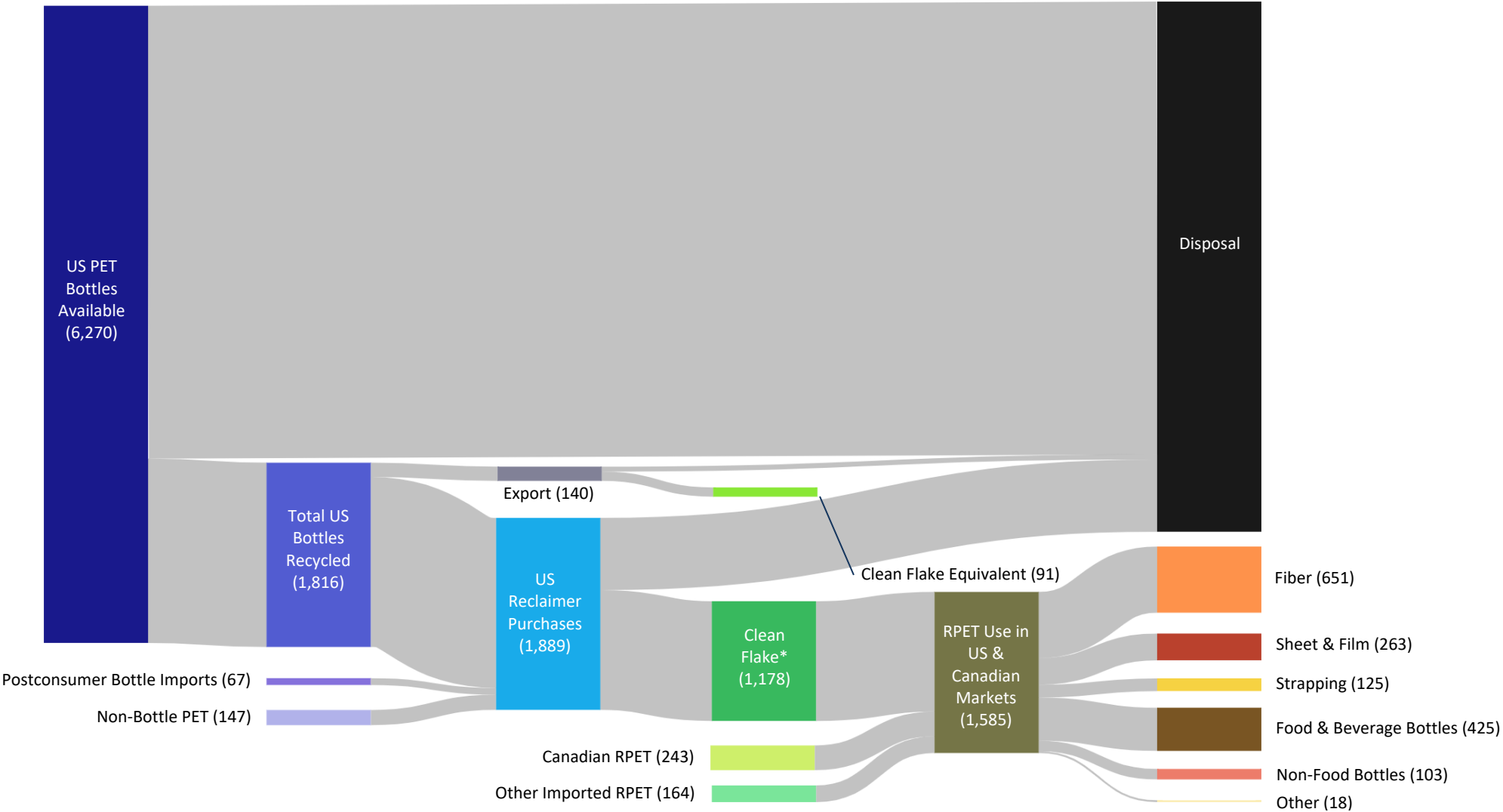
SUMMARY

This report is intended to provide the reader with a detailed overview of the recycling of injection stretch blow molded polyethylene terephthalate (PET) bottles and jars in the United States (US), and a general summary of the recycling of PET thermoforms during 2018.

In 2018, approximately 6,270 million pounds of PET bottles were sold into the marketplace in the US. About 29.0 percent of those – 1,816 million pounds – were collected through recycling programs and sold. With a continued drop in exported bottles, domestic PET reclaimers processed 1,676 million pounds of US material, which is 16 percent higher than domestic reclamation of US bottles in 2017. PET reclaimers in the US supplemented those bottles with imported materials and alternative feedstocks to process a total 1,889 million pounds of PET material. A variety of end users in the US and Canada, led by producers of fiber, consumed the clean RPET flake produced by US and Canadian reclaimers, as well as RPET imported from other countries.

PET material flows in the US are depicted in Figure 1 on the following page. Color coding is used to aid readers in following material flows throughout the report; a color reference guide is provided in Appendix A. Comparative historical data is provided in Appendix B.

FIGURE 1: PET Material Flows in the US (MMlbs)



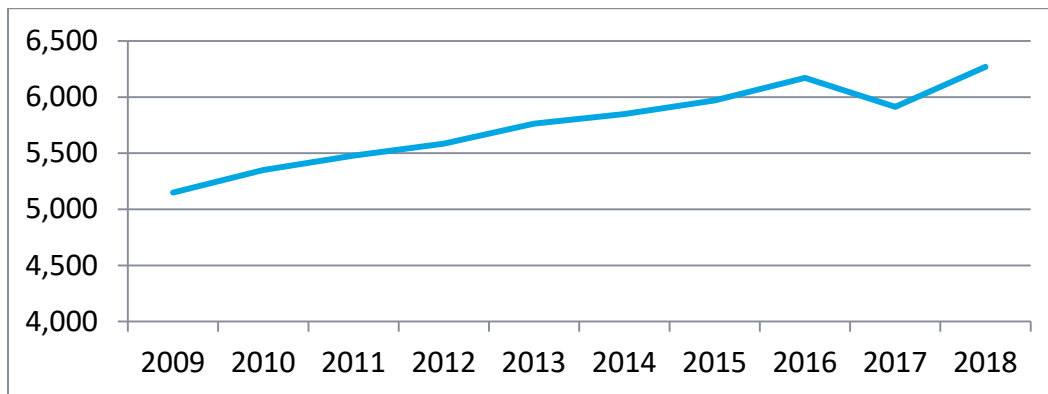
* This total represents all clean flake sold into end markets by US reclaimers. See Figure 7 for detail on total flake produced by US reclaimers from bottles.

PET BOTTLES AVAILABLE FOR COLLECTION

The volume of PET bottles available for recycling in the United States was 6,270 million pounds, representing an increase of six percent from 2017. This number reflects the total amount of PET resin used by US bottle manufacturers from US, foreign, and recycled sources, with adjustments for scrap generated during the manufacturing process and bottles less than eight ounces in size. This total serves as the denominator in this report to determine both the gross and net recycling rates, and includes 480 million pounds of postconsumer PET recycle.

The six percent increase can be partly attributed to tight market conditions for virgin PET resin which occurred following the bankruptcy of M&G Polymers in late 2017, and the resulting closure of their Apple Grove, West Virginia plant. As a result of this closure increased PET resin imports were necessary, but the time it took to qualify and source imports caused a gap until 2018. The 2017 denominator was especially low for this reason, while the 2018 total falls back in line with historical trends (see Figure 2).

Figure 2: Bottles on US Shelves (MMlbs)



POSTCONSUMER PET BOTTLE PURCHASES

The total amount, by weight, of postconsumer PET bottles collected for recycling in the United States and sold to recycling markets in 2018 was 1,816 million pounds. The breakdown of this total, by purchaser, is presented on the following page in Table 1.

TABLE 1: Recycling Rate Numerator (MMlbs)

1,676	Purchased by US Reclaimers
137	Purchased by Export Markets
3	PET bottle component of mixed bales exported
1,816	Total Postconsumer Bottles

This represents an 88 million pound, or five percent, increase in total volume of bottles collected as compared to 2017. As such, volumes of both bottles collected and those available for recycling increased in 2018. Because the increase in the amount of bottles available for recycling was larger than the increase in bottles recycled, the recycling rate decreased very slightly, from 29.2 percent in 2017 to 29.0 percent in 2018.

The increase in collection volumes in 2018 largely reflects a greater amount of PET collected at curbside, though there were also slight increases in volumes returned through the California Redemption Value (CRV) program and other state deposit programs.

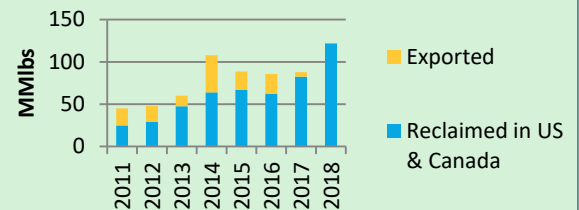
The amount of PET material processed through Material Recovery Facilities (MRFs) increased in 2018, alongside reported increases in the number of households participating in curbside recycling programs. This is an encouraging indicator, especially taking into consideration the challenges faced by domestic MRFs as they adjusted to market disruptions related to China's National Sword policy. If supply from curbside continues to hold or increase, it will buck the trend of the steady decline in PET volumes collected through curbside that began in 2014. For the purposes of this report, MRF volumes are estimated by total reclaimer purchases of PET bales from MRFs, which may not be equivalent to total material collected. As such, it's unclear whether this shift in 2018 occurred at the point of collection or at the point of MRF sortation and processing, or some combination of the two.

PET Thermoform Recycling

In 2018, PET thermoforms collected for recycling in the US and Canada increased substantially from 88 million pounds in 2017 to 122 million pounds. Thermoform exports dropped to practically nothing, while domestic processing increased by nearly 50 percent to make up the difference.

PET thermoform collection volumes are not included in the recycling rate presented in this report, or in the bottle volumes purchased, but are included in total reclaimer PET purchases (page 5) and "flake produced from all sources" total cited on page 10.

Total Thermoform Recovery

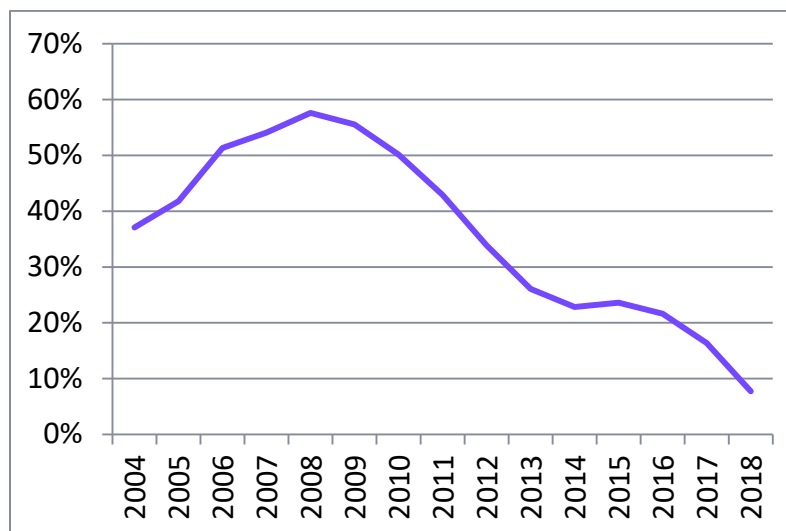


Even with year-over-year growth in domestic processing of PET thermoforms, these packages are still considered non-preferred material by many reclaimers. While PET thermoforms are technically recyclable with PET bottles, they can be problematic from a performance and yield perspective. PET thermoforms bring the potential for "look-alike" contamination from other polymers, and the labels, inks, and adhesives used can affect the quality of recycled materials. In 2018, we saw an increase in activity from brand owners using PET thermoforms towards making packaging more easily recyclable and utilizing recycled content.

Despite certain challenges, some PET reclaimers continue to process PET thermoforms with their PET bottles. Recycling programs and MRFs interested in marketing PET thermoforms should talk to their buyers about opportunities and best practices. NAPCOR continues its work to better understand and address market concerns, with a goal of overcoming the obstacles preventing large-scale PET thermoform recycling.

There was a large jump in United States reclaimer purchases of US bottles to 1,676 million pounds, compared to 1,445 million pounds in 2017 (a 16 percent increase). US purchases accounted for 92 percent of all US bottles collected, up from 84 percent reported in 2017. US reclaimers also reported supplementing their domestic purchases by importing 67 million pounds of postconsumer bottles or dirty flake, predominantly from Canada and Mexico, as compared to the 61 million pounds imported in 2017. In addition to the bottle volumes presented in Figure 4 on the following page, domestic reclaimers reported buying 147 million pounds of alternative feedstock, including pre-consumer bottles, postconsumer thermoforms and strapping, and sheet. This represents a substantial increase over the 100 million pounds of alternative feedstock purchased in 2017. In total, US reclaimers purchased 1,889 million pounds of PET scrap material.

FIGURE 3: Percentage of US Postconsumer Bottles Purchased by Export Markets



Reclaimers outside of the US purchased a total of 140 million pounds, or eight percent, of total US bottles collected. This is the lowest export percentage of total collections since 2000 (see Figure 3). The purchase of US bottles by Canadian reclaimers increased to 80 million pounds from 72 million in 2017. PET bottle bale exports outside of Canada totaled 57 million pounds, down by more than 145 million pounds as compared to the previous year. The estimated PET bottle fraction of mixed plastic bales exported also continues to decline, down to three million pounds from eight million pounds in 2017. In total, exports to non-Canadian countries made up just three percent of total US PET collection in 2018.

FIGURE 4: Postconsumer Bottles Recycled & Used by Reclaimers

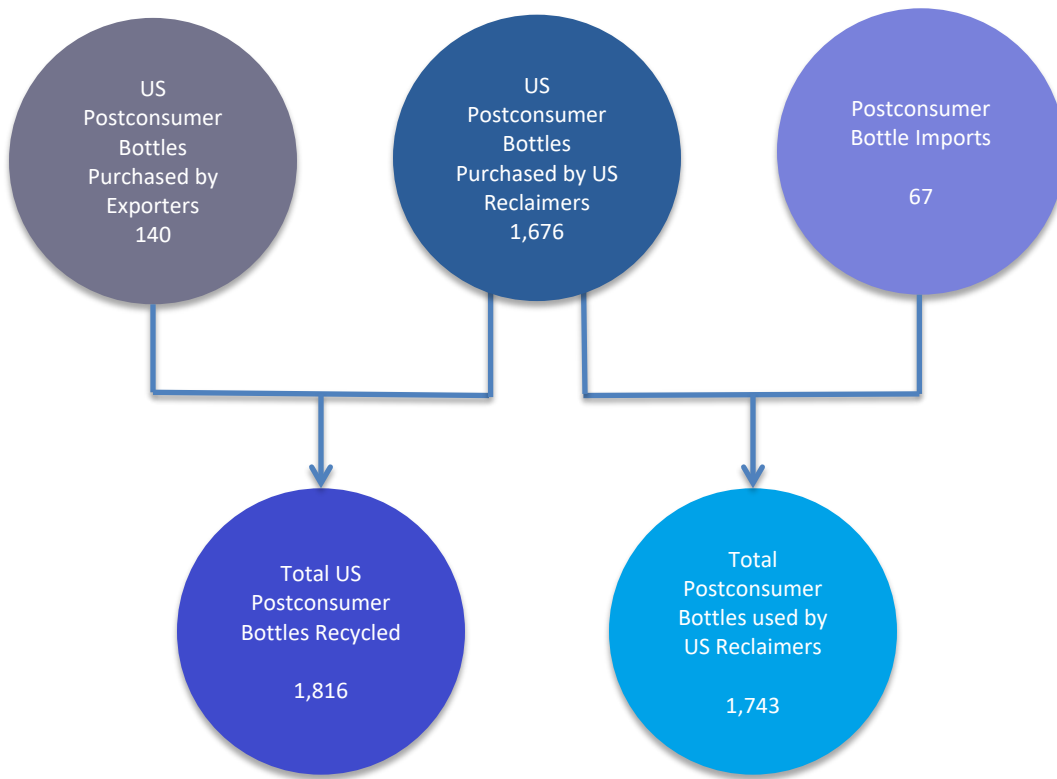
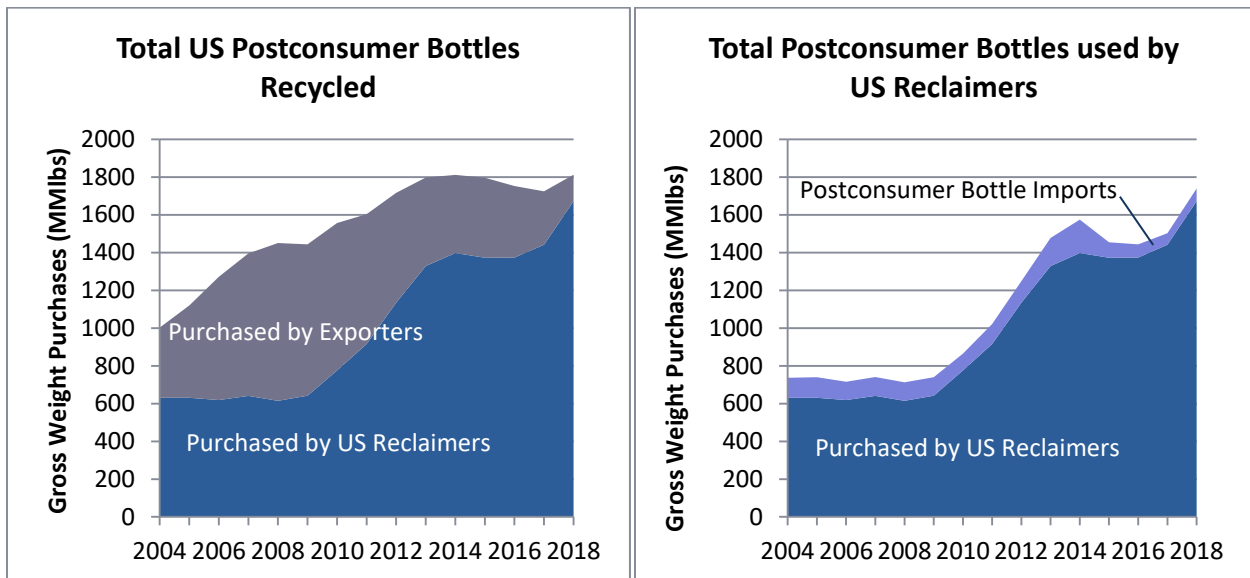


FIGURE 5: Postconsumer Bottles Recycled & Used by Reclaimers



2018 GROSS RECYCLING RATE

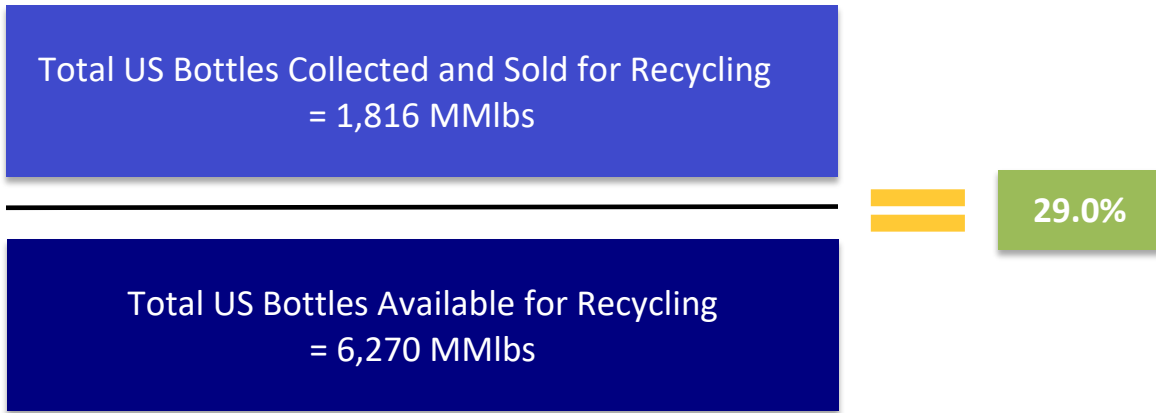


FIGURE 6: Gross Recycling Rates, 2004 – 2018

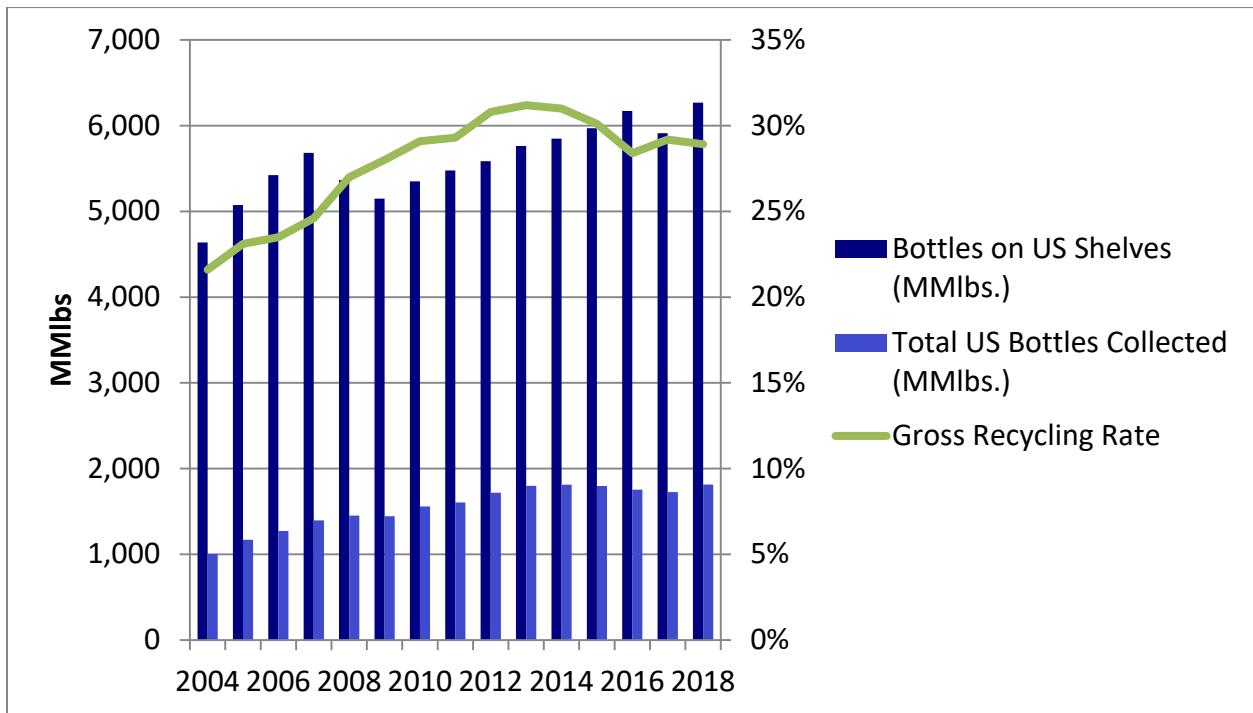


FIGURE 7: PRODUCTION OF PET FLAKE FROM BOTTLES

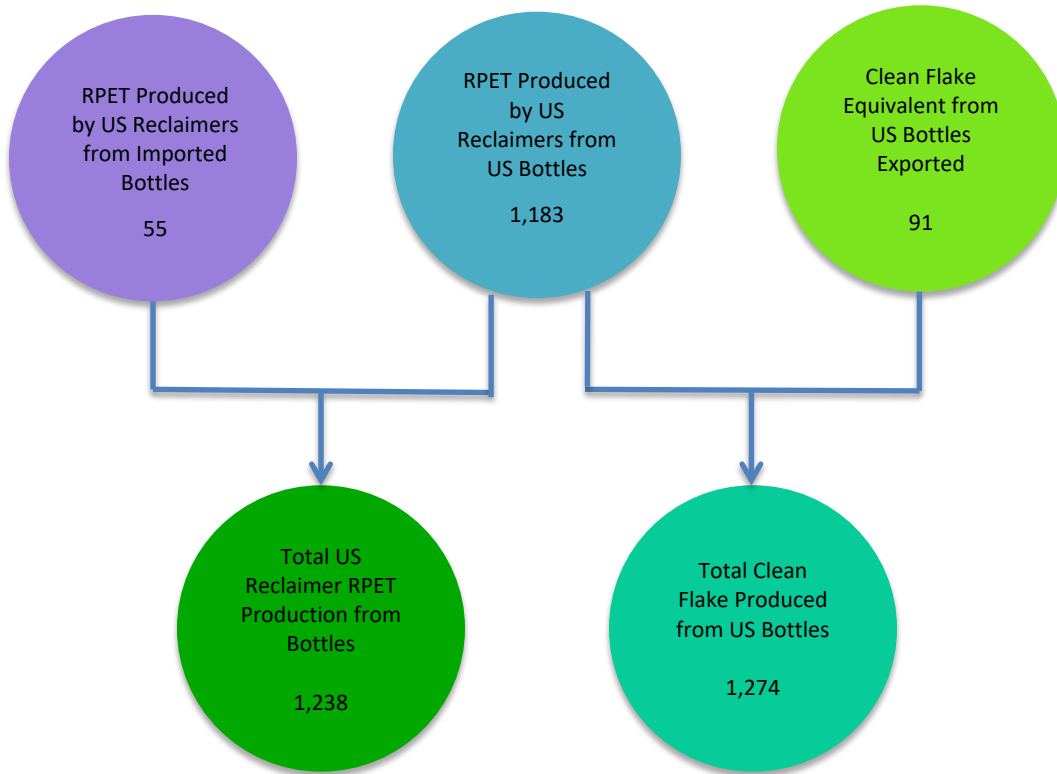
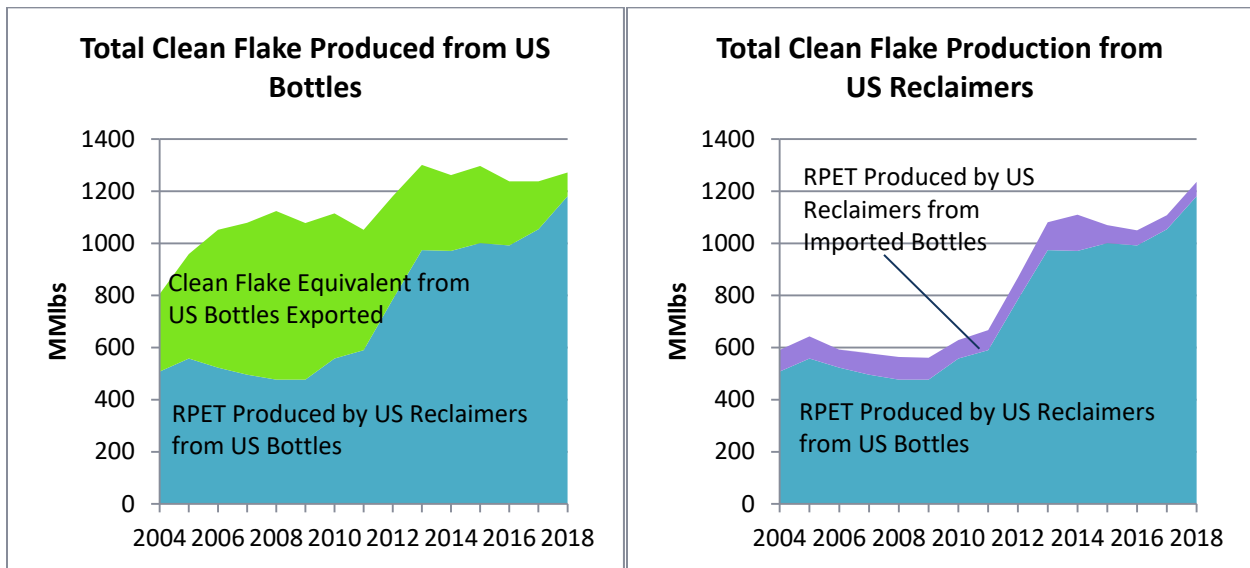


FIGURE 8: Production of PET Flake from Bottles



PET BOTTLE MATERIAL UTILIZATION RATE (NET RECYCLING RATE)

Up to this point in the report, analysis has focused on the ratio of PET bottles collected to the volume of bottles available for recycling, referred to as the gross recycling rate. There is, however, an additional way to conceptualize a rate of PET recycling in the US, which can be thought of as a net recycling rate. The PET bottle material utilization rate compares the amount of usable end product (clean flake) produced from US bottles to the volume of bottles available for recycling. The numerator for the PET bottle material utilization rate is determined by adding the amount of clean flake produced by US reclaimers from US bottle material to the amount of clean flake expected to be produced from exported bottles. That sum is then divided by the total volume of PET bottles available for recycling in the US (the same denominator used in calculating the gross recycling rate). The PET bottle material utilization rate is an expression of material and system efficiency that indicates how much clean flake reclaimers were able to produce from incoming material purchased. It is presented alongside the gross recycling rate, and accounts for process waste and other yield loss trends year-over-year (see Figure 9 on the following page).

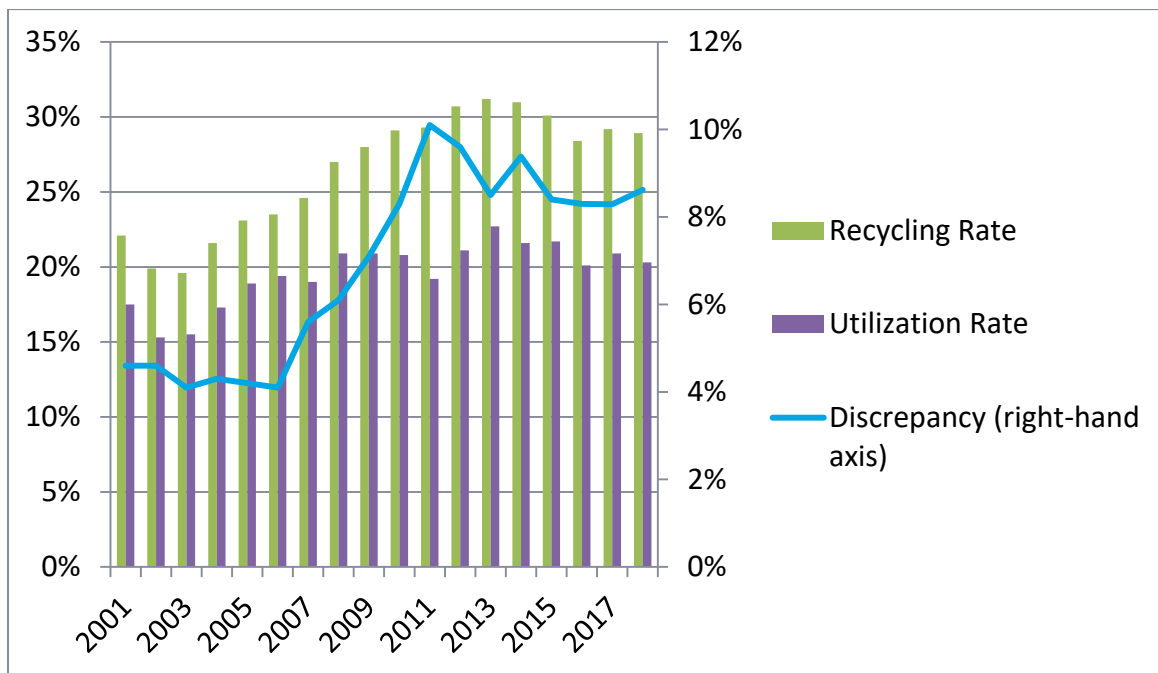
It is important to note that this bottle utilization rate is not a direct reflection of bale yields for a given calendar year for several reasons. First, the report methodology uses survey-derived data of the aggregated amounts of recycled PET bottle material inputs, including both whole bottle bales and dirty flake, at the point of reclaimer purchase for the calendar year. Clean flake production is reported on the basis of flake produced in the calendar year. As a result, the utilization rate could reflect production from materials that were already in inventory as the year began. Second, if reclaimers report higher amounts of dirty flake purchased in a given year, this too can disproportionately affect the utilization rate since dirty flake material generally contains fewer contaminants by weight than do full bottle bales.

PET Bottle Material Utilization Rate Calculation



As diagrammed on the previous page, after applying estimated production rates to the export fractions purchased, NAPCOR determined that the clean flake equivalent of the 140 million pounds of postconsumer PET bottles exported to all locations was 91 million pounds. Adding this to the total flake produced in the US from all sources, the resulting PET utilization rate was 20.3 percent, down slightly from the 20.9 percent reported in 2017.

FIGURE 9: PET Recycling & PET Material Utilization Rates



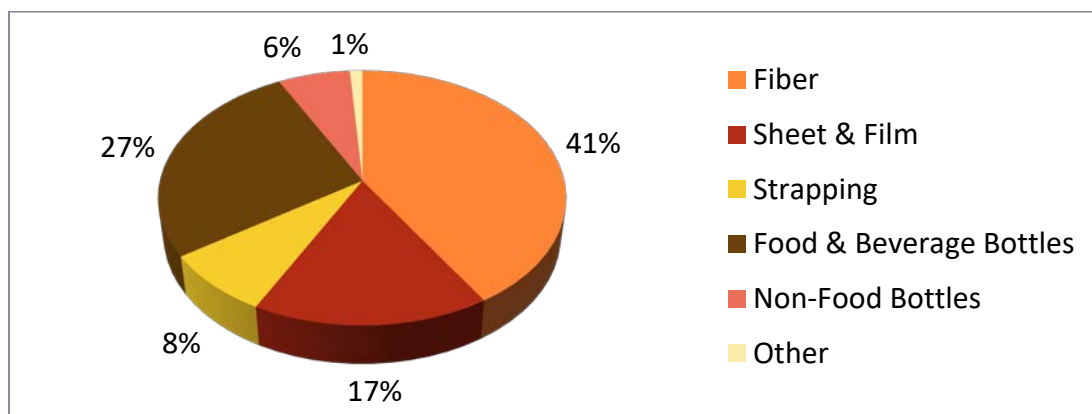
As seen in Figure 9, the discrepancy between the collection rate and the utilization rate began to increase in 2007. At this time, the rate of PET collection increased without a corresponding increase in the rate of clean flake production from collected PET. The most important factor related to this shift is deteriorating bale quality, and resultant low yields for PET reclaimers. Since 2015 the discrepancy between the gross and net recycling rates has held fairly steady, indicating that in recent years there have not been significant gains overcoming this problem. Yield loss can be related to the prevalence of smaller, lighter containers, which require more processing and thus generate higher associated loss per pound of material, as well as ongoing design for recyclability issues creating a greater percentage of less marketable, harder-to-process PET. Design for recyclability concerns include full-wrap, shrink sleeve labels that are difficult to remove or separate from PET, or that block autosort function; barrier layers added to PET to preserve product integrity and extend shelf-life; and metal integrated into PET packages, whether in closures, closure rings, can tops, or pump springs.

2018 RPET END MARKETS

Combined end market totals increased by less than one percent in 2018, with total converter consumption at 1,585 million pounds across all product categories.¹ This figure includes all material sources, with US and Canadian reclaimers supplying about 1,421 million pounds of flake and pellet produced from all sources of feedstock. The remaining 164 million pounds of recycled PET was imported from reclaimers in countries including Indonesia, Ecuador, Mexico, Honduras, Peru, and others. Not counted in these totals, United States and Canadian reclaimers also sold 86 million pounds of PET byproducts to secondary markets.

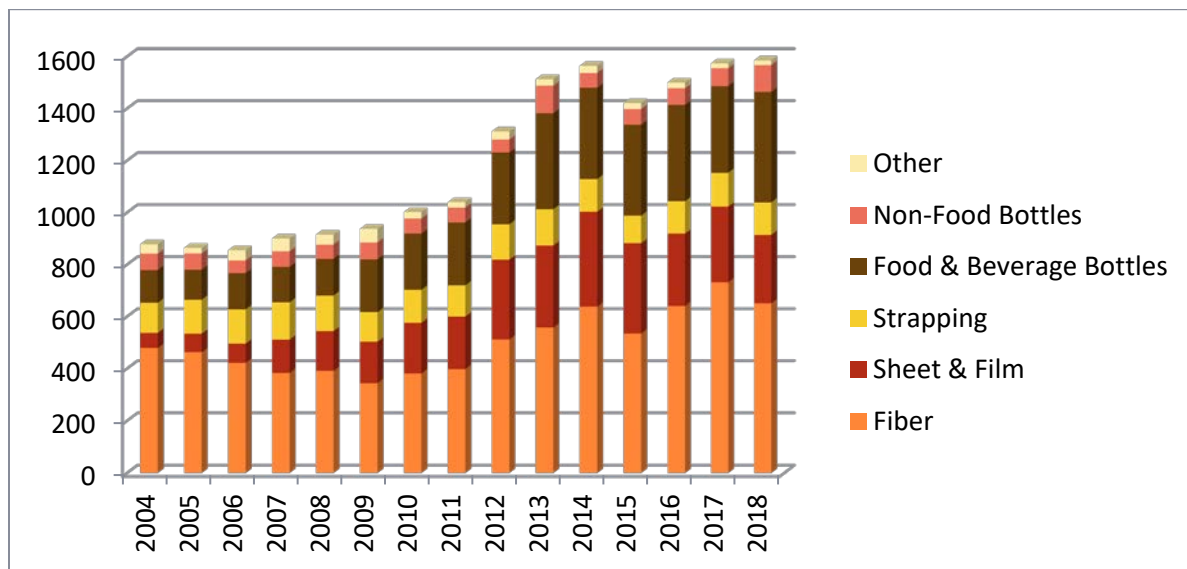
Looking at total use of RPET in specific domestic market segments – both domestically produced and imported – the most striking change from 2017 was an increase of more than 30 percent in the amount of RPET being used in new bottles. Food and beverage bottle usage was up by 91 million pounds while non-food and -beverage bottle usage rose by 34 million pounds, bringing the combined total for RPET usage in bottles to 528 million pounds. RPET use in the film and sheet category was down by about ten percent at 263 million pounds, resulting in total RPET usage in all packaging applications at 791 million pounds (97 million pounds greater than that of 2017). Both fiber and strapping sectors contracted, down by 11 and four percent, respectively, over 2017. Decline in fiber sector usage is attributable to market dynamics rendering domestically produced RPET too expensive for staple markets, and a slowdown in demand for polyester carpet. US RPET sales to domestic converters totaled 1,178 million pounds, up by 103 million pounds over 2017. Total Canadian RPET sales were up very slightly to 243 million pounds from 241 in 2017.

FIGURE 10: RPET End Use by Product Category in 2018



¹ Since the 2009 report, the RPET end-use data shown in Figures 10 and 11 has reflected RPET consumption by converters in both the US and Canada.

FIGURE 11: Historical RPET End Use by Product Category (MMlbs)



CONCLUSION

The results of China's National Sword policy taking effect at the start of 2018 can be clearly seen in postconsumer PET recycling data for that year, as export volumes outside of Canada continued to plummet to a new low of just three percent of total collection. Domestic processing was up by 16 percent to compensate for the lack of exports, and reclamation plant utilization increased to 80 percent in the US (further discussion in the following section). Especially impressive in this context was the increase in curbside PET collection, given that domestic MRFs had to navigate this large disruption until markets rebalanced.

Another notable shift in 2018 was bottle end use of RPET beginning to take share away from non-bottle end use applications – most notably the fiber sector, which used 81 million fewer pounds of RPET versus 2017. Meanwhile, RPET usage in bottles grew by 126 million pounds, or 31 percent. This is likely tied to a wave of recycled content commitments announced by consumer packaged goods companies beginning in early 2018. We can expect to see more of this trend going forward, as the list of such commitments continued to grow in 2019.

Although the analysis in this report primarily focuses on PET bottles, the continued increase in PET thermoform recovery is worth noting. Thermoform recycling in the US and Canada increased 48 percent over 2017, with only one tenth of one percent of the total going to export markets in 2018. Simultaneously, there was a decline in RPET usage within the sheet and film end use market. In order for thermoforms to enjoy the







benefits of a closed-loop recycling story in the same way as bottles, it is imperative that the hurdles to incorporating recycled PET thermoform content into new packaging be overcome.

Appendix A – Color Reference

Used in Material Flow Diagram






	US Bottles Available for Recycling (Denominator)
	Total US Bottles Recycled (Numerator)
	Postconsumer Bottle Imports
	Non-Bottle PET Imports
	US Postconsumer Bottles Purchased by Exporters
	Total Postconsumer Bottles used by US Reclaimers
	Clean Flake Equivalent from Exports
	Clean Flake*
	Canadian RPET
	Other Imported RPET
	RPET Use in Domestic Markets
	Disposal

End Markets

	Fiber
	Sheet & Film
	Strapping
	Food & Beverage Bottles
	Non-Food Bottles
	Other

* This total represents all clean flake sold into end markets by US reclaimers. See figure 7 for detail on total flake produced by US reclaimers from bottles.

Other

	US Postconsumer Bottles Purchased by US Reclaimers		Total US Reclaimer RPET Production from Bottles
	RPET Produced by US Reclaimers from Imported Bottles		Total Clean Flake Produced from US Bottles
	RPET Produced by US Reclaimers from US Bottles		

Appendix B – Data Tables

TABLE 2: Postconsumer Bottles Recycled / Used by Reclaimers
Gross Weight Purchases (MMlbs)

A. Purchased by US Reclaimers

B. Purchased by Exporters*

C. Total US Material Recycled (A+B)

D. Postconsumer Bottle Imports

E. Total Postconsumer Bottles used by US Reclaimers (A+D)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
A.	605	549	580	656	588	599	600	522	520	631	681	619	641	615	642	776	916	1,135	1,329	1,398	1,373	1,374	1,445	1,676
B.	170	148	111	89	183	170	234	275	321	372	489	653	755	836	802	781	688	582	469	414	424	379	283	140
C.	775	697	691	745	771	769	834	797	841	1,003	1,170	1,272	1,396	1,451	1,444	1,557	1,604	1,718	1,798	1,812	1,797	1,753	1,728	1,816
D.	46	87	66	101	60	69	70	57	62	106	109	97	100	98	98	89	106	114	149	177	82	70	61	67
E.	651	636	646	757	648	668	670	579	582	737	790	716	741	713	740	865	1,022	1,249	1,478	1,575	1,455	1,444	1,506	1,743

* As of 2005, this number includes the amount of PET sold in mixed bottle bale shipments.

TABLE 3: Gross Recycling Rates, 1995 – 2018

Year	Total US Bottles Collected (MMlbs)	Bottles on US Shelves (MMlbs)	Gross Recycling Rate
1995	775	1,950	39.7%
1996	697	2,198	31.7%
1997	691	2,551	27.1%
1998	745	3,006	24.8%
1999	771	3,250	23.7%
2000	769	3,445	22.3%
2001	834	3,768	22.1%
2002	797	4,007	19.9%
2003	841	4,292	19.6%
2004	1,003	4,637	21.6%
2005	1,170	5,075	23.1%
2006	1,272	5,424	23.5%
2007	1,396	5,683	24.6%
2008	1,451	5,366	27.0%
2009	1,444	5,149	28.0%
2010	1,557	5,350	29.1%
2011	1,604	5,478	29.3%
2012	1,718	5,586	30.8%
2013	1,798	5,764	31.2%
2014	1,812	5,849	31.0%
2015	1,797	5,971	30.1%
2016	1,753	6,172	28.4%
2017	1,728	5,913	29.2%
2018	1,816	6,270	29.0%

TABLE 4: East Coast, Non-Deposit PET Bottle Bale Prices – Average High / Low
(Picked Up, Truckload Quantities, Seller's Dock)

2018	<i>LOW</i>	<i>HIGH</i>
JANUARY	\$0.130 / lb	\$0.150 / lb
FEBRUARY	0.130	0.150
MARCH	0.140	0.160
APRIL	0.150	0.160
MAY	0.155	0.165
JUNE	0.165	0.175
JULY	0.165	0.175
AUGUST	0.165	0.175
SEPTEMBER	0.160	0.170
OCTOBER	0.160	0.170
NOVEMBER	0.160	0.170
DECEMBER	0.160	0.170

TABLE 5: Production of PET Flake from Bottles
Recycled PET (RPET) Production Summary (MMlbs)

- A. RPET Produced by US Reclaimers from US Bottles
- B. RPET Produced by US Reclaimers from Imported Bottles
- C. Total RPET Production US Reclaimers (A+B)**
- D. Clean Flake Equivalent from US Bottles Exported
- E. Total Clean Flake Produced from US Bottles (A+D)**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
A.	496	438	486	513	457	476	476	401	412	505	558	523	496	477	477	558	590	785	974	971	1,001	992	1,055	1,183
B.	38	70	55	75	47	51	44	46	49	83	85	69	82	87	84	71	77	84	107	139	69	58	54	55
C.	534	508	541	588	504	527	520	447	461	588	643	592	578	564	561	629	667	869	1,081	1,110	1,070	1,050	1,109	1,238
D.	153	134	92	75	154	143	184	212	255	298	401	529	583	647	601	557	462	396	327	291	296	246	184	91
E.	622	572	578	588	611	619	660	613	667	803	959	1,052	1,079	1,124	1,078	1,115	1,052	1,181	1,301	1,262	1,297	1,238	1,239	1,274

TABLE 6: PET Utilization Rate

Year	Clean Flake Equivalent from Bottle Material (MMlbs)	Bottles on US Shelves (MMlbs)	Utilization Rate
1995	622	1,950	31.9%
1996	572	2,198	26.0%
1997	578	2,551	22.7%
1998	588	3,006	19.6%
1999	611	3,250	18.8%
2000	619	3,445	18.0%
2001	660	3,768	17.5%
2002	613	4,007	15.3%
2003	667	4,292	15.5%
2004	803	4,637	17.3%
2005	959	5,075	18.9%
2006	1,052	5,424	19.4%
2007	1,079	5,683	19.0%
2008	1,124	5,366	20.9%
2009	1,078	5,149	20.9%
2010	1,115	5,350	20.8%
2011	1,052	5,478	19.2%
2012	1,181	5,586	21.1%
2013	1,301	5,764	22.6%
2014	1,262	5,849	21.6%
2015	1,297	5,971	21.7%
2016	1,238	6,172	20.1%
2017	1,239	5,913	20.9%
2018	1,274	6,270	20.3%

TABLE 7: RPET used by Product Category (MMlbs)

Product Category	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011 ¹	2012	2013 ²	2014	2015	2016	2017	2018
Fiber	292	320	415	417	452	435	344	296	479	463	422	383	391	344	381	398	512	558	638	535	642	732	651
Sheet & Film	69	71	89	68	65	37	18	32	58	71	74	128	153	159	195	202	307	315	365	347	278	291	263
Strapping	66	58	67	80	101	82	83	77	116	131	132	144	137	114	127	120	136	140	126	106	125	130	125
Engineered Resin	24	26	30	26	27	24	10	10	12	8	9	11	7	10	9	See Other	See Other	See Other	See Other	See Other	See Other	See Other	See Other
Food & Beverage Bottles	24	41	52	68	54	77	86	106	126	115	139	136	141	203	216	242	276	425	351	350	370	333	425
Non-Food Bottles	71	53	47	50	40	44	43	24	63	63	49	60	55	65	58	57	50	50	57	60	64	69	103
Other	1	1	7	9	5	2	4	7	24	13	30	38	31	42	16	21	31	25	27	23	22	19	18
TOTAL CONVERTER CONSUMPTION	547	570	707	718	744	701	588	552	878	864	855	900	915	937	1,002	1,040	1,312	1,513	1,564	1,421	1,501	1,575	1,585

¹ The Engineered Resins category was folded into “Other” as there was insufficient survey response in this category to meet standard confidentiality guidelines.

² The Food & Beverage and Non-Food Bottles converter consumption volume splits for 2013 have been corrected to reflect a data error discovered in 2014. Total converter consumption volume for 2013 was not affected.

US Regional PET Collection Estimates

US Census Divisions:

- New England: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
- Middle Atlantic: New Jersey, New York, Pennsylvania
- East North Central: Indiana, Illinois, Michigan, Ohio, Wisconsin
- West North Central: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
- South Atlantic: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia
- East South Central: Alabama, Kentucky, Mississippi, Tennessee
- West South Central: Arkansas, Louisiana, Oklahoma, Texas
- Mountain: Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Nevada, Wyoming
- Pacific: Alaska, California, Hawaii, Oregon, Washington

Table 8: PET Collection in 2018 by US Census Division

Region	Population	Curbside Collection (MMlbs)	Curbside Collection (lbs/cap)	Deposit Collection (MMlbs)	Total Collection (MMlbs)	Total Collection (lbs/cap)
New England	14,853,290	68	4.57	33	101	6.81
Middle Atlantic	41,257,789	223	5.41	98	321	7.77
East North Central	46,931,883	221	4.70	36	257	5.47
West North Central	21,376,861	91	4.27	10	102	4.75
South Atlantic	65,322,408	249	3.81	0	249	3.81
East South Central	19,112,813	41	2.15	0	41	2.15
West South Central	40,318,727	109	2.71	0	109	2.71
Mountain	24,552,385	58	2.37	0	58	2.37
Pacific	53,441,278	149	2.78	429	578	10.81
TOTAL	327,167,434	1,209	3.70	607	1,816	5.55