

Cleaning the rPET Stream: How we scale post-consumer recycled PET in the US

A new study by Closed Loop Partners

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Less than 30% of the PET used in bottles and jars is recovered in the US, and just 6% is re-used as rPET in new bottles . Yet PET is the most common resin type used in plastic packaging and the most universally accepted plastic in US municipal recycling programs. Recycling infrastructure for post-consumer PET is also the most mature. How can we address the stark under-performance of PET recycling through investment in solutions that provide long-term benefits to the system overall?

Ideally, demand pull from end users would encourage the recovery and reprocessing of post-consumer recycled PET; yet the market is constrained by the ability of suppliers to offer rPET at prices that can compete with virgin PET resin. If we are ever going to be able to grow the rPET market, we need better solutions that drive efficiencies throughout the process, improve the cost structure of producing rPET, and enhance the material's overall value.

We could increase the recycling rate of PET by 6% and close the loop on nearly 80 million pounds of PET bottles each year – *without putting a single new cart on the street.*

In an analysis conducted by Closed Loop Partners with RRS, we have identified a suite of interventions that would greatly improve the cost structure of rPET and benefit MRFs, reproprocessors, and end-users. If implemented nationally, **we could increase the recycling rate of PET by 6% and close the loop on nearly 80 million pounds of PET bottles each year – without putting a single new cart on the street.**

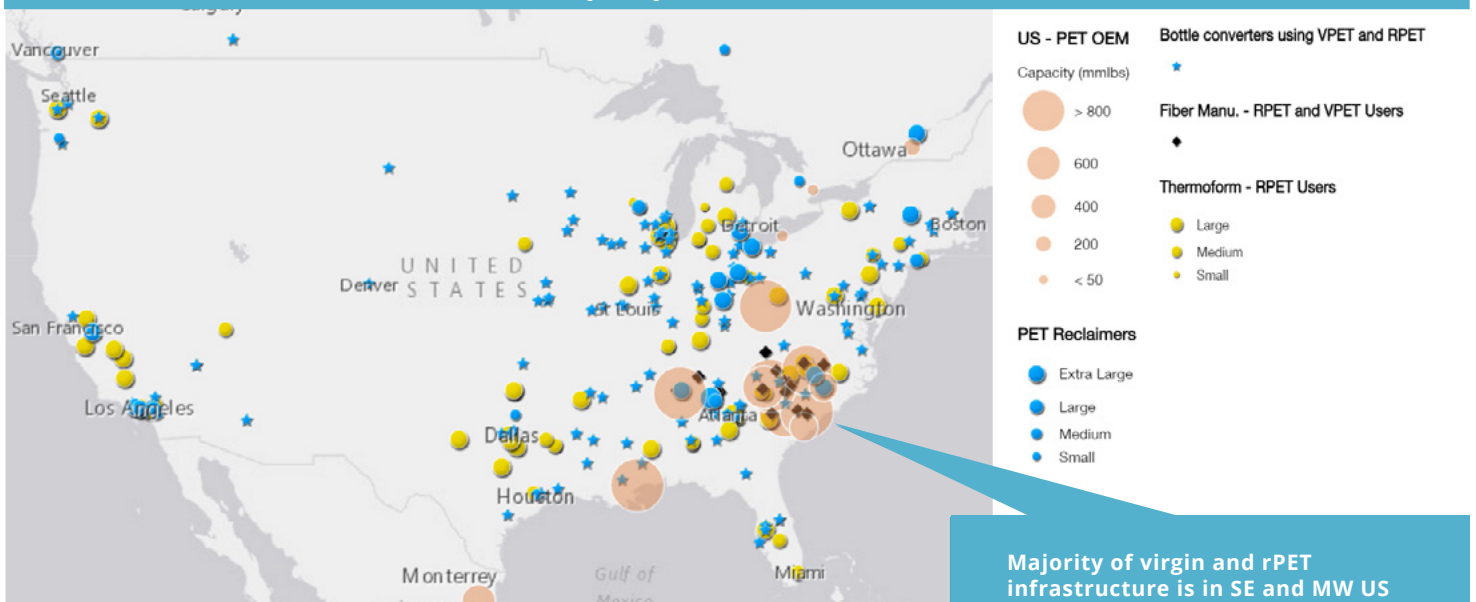
Focusing on bottle-to-bottle processes, we identified several interventions that effectively improve yield from residential curbside collection by more than 20% and lower costs of rPET processing by 10%. By targeting action and investment, MRFs, reclaimers, reproprocessors, and end-users could realize value for themselves and across the system.

Recent trends in rPET capacity in North America

In the past decade, virgin PET consumption has grown, though production has been increasingly consolidated among a few market players (i.e., DAK, Indorama), all privately held companies. The price of rPET closely follows the price of virgin PET, which has seen considerable volatility - as with global oil prices - over the past 10 years. Meanwhile, the national recycling rate for PET has hovered around 30% - largely reflecting an inelastic supply. During this time, capacity for processing post-consumer recycled PET (rPET) has had its ups and downs. The industry recently lost 400 mm lbs of capacity with the closure of some facilities. Capacity is expected to return to roughly 2 billion lbs/year by 2018, with at least 350 million lbs. of new PET processing capacity coming online in the next few years.

Existing facilities that reprocess rPET are operating at ~ 75% capacity. For bottles and containers, end-users can increase the amount of rPET they use, if that material is price-competitive with virgin, and at the appropriate quality specifications. In 2016, just 370 million lbs of rPET was reused for food and beverage bottles, although 1,753 million lbs of PET was recovered for recycling.

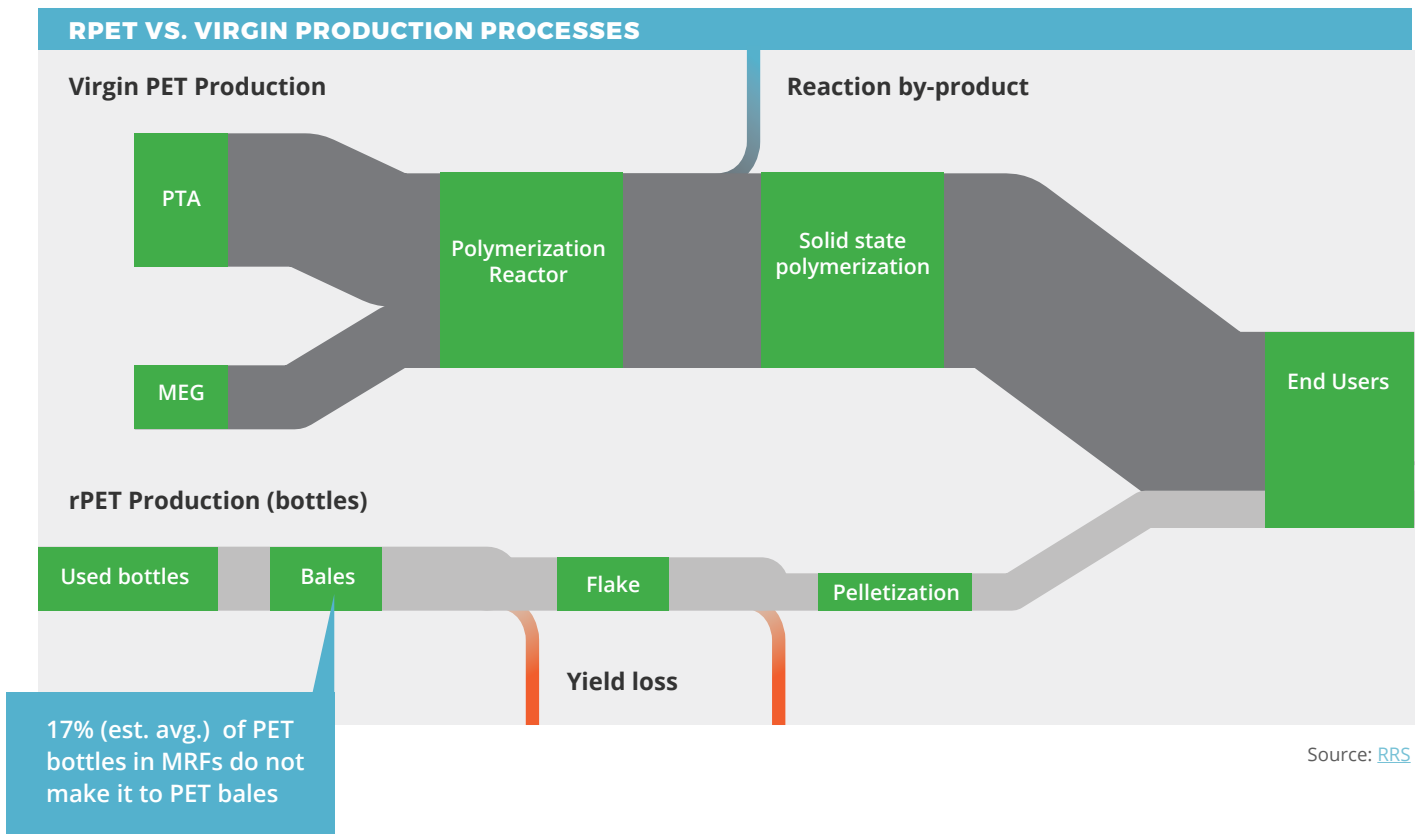
CAPACITY OF U.S. PET INFRASTRUCTURE (2017)



Source: [RRS](#)

rPET vs. Virgin Production Processes

Virgin material is produced at scale by combining raw material inputs (PTA, MEG) in a polymerization process. In contrast, post-consumer recycled PET must travel from consumer to MRF to reclaimer/ reprocessor to end user – at each stage there is potential for yield loss and inefficiency. Two very different processes result in very different cost structures. At the time of the study, the estimated average cost to produce virgin PET was \$0.52-0.56 per pound, while the cost to process and produce rPET was estimated at \$0.60-0.65 per pound. It is no wonder that end users have chosen virgin PET. **If rPET is ever going to be competitive with virgin at scale, we have to find ways to make improvements across the system.**



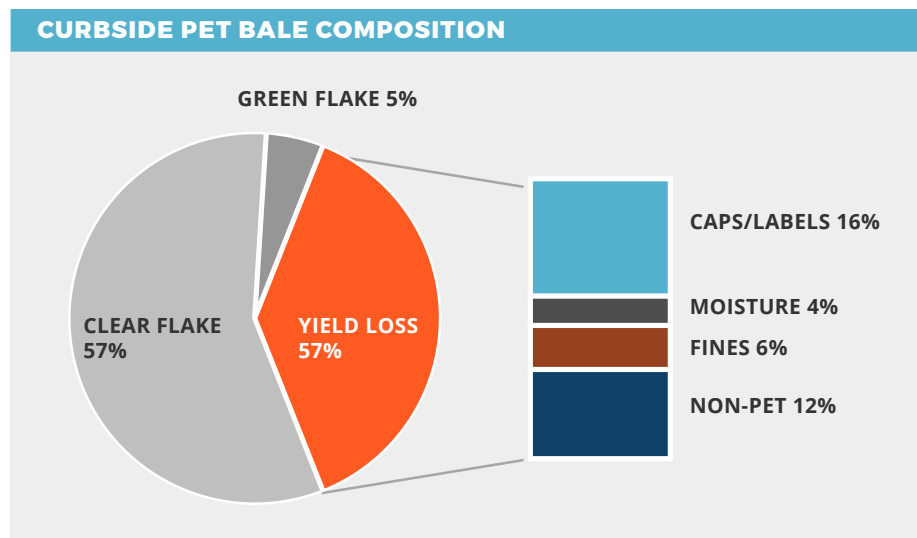
If rPET is ever going to be competitive with virgin at scale, we have to find ways to make improvements across the system.

QUANTITY (VOLUME)

Consumer access to, and participation in, convenient recycling determines supply of PET. Supply is not influenced by price or demand; rather, supply is a function of municipal and state policies that determine material recovery, and consumer behavior. Collections infrastructure and policies influence how much material is available for reprocessing.

QUALITY AND YIELD OF PET BALES

In non-Bottle Bill states where PET is generally recovered through curbside collection, PET bales out of MRFs have sold for, on average, ~\$0.17 per pound, national average (picked up). Bottle Bill bales typically command a premium of \$.05 to \$.15 per pound over curbside. **The estimated average yield of PET in a curbside bale is 62%; there is potential to recover more PET than is collected today.** Furthermore, it is estimated that another 17% of PET that travels through a MRF is not captured in the PET bale. For the reclaimer, the adjusted yield price is \$0.31 per pound – a difference of at least \$0.07 per pound (not including transportation). Contributors to yield loss include caps and labels, non-PET material, fines and moisture, as illustrated.



Source: [RRS](#)

CLEANING AND SORTING

Mechanical processing of the PET bale, and the subsequent conversion to flake, drives costs by an estimated average of \$0.19 per pound. The many contamination / yield issues are partly a result of MRF inefficiencies in sorting, but also partly result from design decisions made by brand owners that are counter-productive to the recycling process.

CONVERSION OF FLAKE TO PELLET

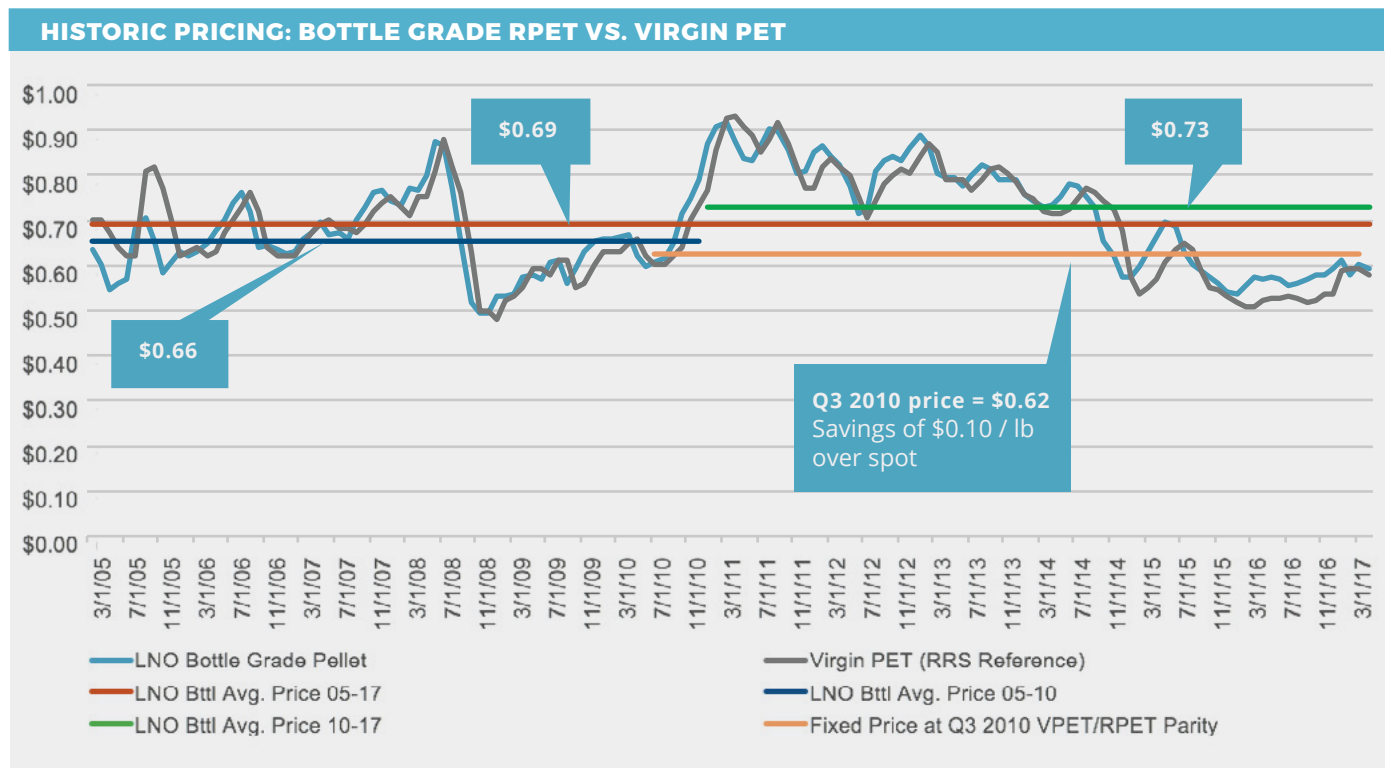
The estimated average cost of this process is \$0.10 per pound.

INCONSISTENCY OF SUPPLY

In addition to inelastic (i.e., not effected by pricing) volume of material collected, the quality of rPET can vary with little warning. The variability can make it difficult for end users to maintain a consistent quality specification without adapting the process or blend of materials being used.

VOLATILITY OF COMMODITY PRICES

RPET is typically purchased on the spot market. Price volatility prevents suppliers from being able to invest in capital expense to keep up with the latest technology or expand capacity. Were long-term contracts more common in the industry, buyers and suppliers would have benefitted from pricing at roughly \$0.62-0.73 per pound over certain periods, based on historic pricing data.



(1) Price of VPET increased in Q3; Source: [RRS](#)



What interventions would have the greatest impact on the cost structure of producing rPET? We looked at a wide range of investments, policies, and actions across the system, with an eye toward impacting a bottle-to-bottle process.

We prioritized interventions based on the following criteria:

1. Impact on the system
2. Feasibility to implement
3. History of commercialization/proof of concept
4. Level of investment required
5. Impact on cost reduction/value enhancement.

Although we did not focus on the effect of improving collections infrastructure on increasing supply, this study showed the impact of interventions led by MRFs, reclaimers, reproducers, producers and end-users. Key interventions are summarized on the following page.

Interventions that work

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INTERVENTION	IMPACT ON rPET SYSTEM	CAPITAL EXPENDITURE (Type of Capital)	PROOF OF CONCEPT	TIMELINE
MRF sorting and quality control , incl. installing optical sorters and robotics equipment, and implementing best management practices	10+% capture rate increase at MRF; 5% yield increase at reprocessor; 10% savings from lower operating & disposal costs	\$0.5MM, avg. per MRF (Equipment loan)	Widely deployed	1-5 years
Flake to Resin , i.e., installing equipment that would bypass the pellet stage, going from flake directly to blend with virgin resin.	15% cost savings vs. PCR pellet; 10% flake content to reactor would increase rPET to bottle markets from ~23% to 30%; better quality product (less discoloration)	\$2-3MM per 25MM lbs. (Equipment loan)	In production at both DAK & Indorama	1-5 years
Flake to Preform , i.e., installing equipment that can bypass the pellet stage, going from flake directly to preform.	15% cost savings vs. PCR pellet; allows high % of food grade recycled flake (up to 100%); better quality product (less discoloration)	\$1.3MM per 80 mm lbs. (Equipment loan)	8 locations worldwide; 1 in development in CA	1-3 years
Brand Commitment to APR Design Guidelines , implemented by end users/brand owners	5% yield increase at reprocessor	NA	Already in the market	1-3 years
Brand Procurement Strategies , incl. pricing to minimize volatility and long-term purchase agreements, negotiated between the end-user and reprocessor	Increased stability, access to financing for reprocessor; potential stabilizing effects further upstream	NA (Contract)	Already exists in the market for virgin and other PCR commodities (e.g., paper); less so for rPET	1-3 years
Chemical Depolymerization , i.e., installing / operating a new plant to produce like-virgin PTA and MEG monomers	Minimal cost savings (est.)	NOT MODELED (Incl. venture capital, equipment loans)	Very early; Loop Industries pilot completed and first commercial scale facility in development	2-5 years
Byproduct Market Development , for non-PET materials (e.g., PP, PE) would incentivize MRFs to improve quality of PET bales, and other commodities	Reduces yield loss; improves and diversifies MRF revenues	NOT MODELED (Could include contracts, venture capital, equipment loans)	Recent example: APR Demand Champions initiative	1-5 years

Where APR's Design Guides Can Have the Greatest Impact



DESIGN GUIDE TOPIC

APR GUIDANCE

Metal closures and lidding

Avoid using metal with PET packaging.

Pressure sensitive film labels

Employ labels that meet APR Critical Guidance Test Criteria, including use of conforming substrates, adhesives, and inks.

Shrink sleeve labels

Employ labels that meet APR Critical Guidance Test Criteria, or which have been evaluated within APR's Responsible Innovation Program.

Paper labels

Avoid use of paper labels. If used, conduct lab testing to select paper labels that have negligible impact on color and haze of recycled PET.

Blow molded PETG containers

Avoid using PETG in packaging.

Based on our criteria, we saw the greatest potential in implementing a suite of interventions all together, including those implemented by MRFs, reclaimers/reprocessors, brand owners or end users, and producers. Investments made at each stage in the process can also generate value throughout the system.

FOR MRFS

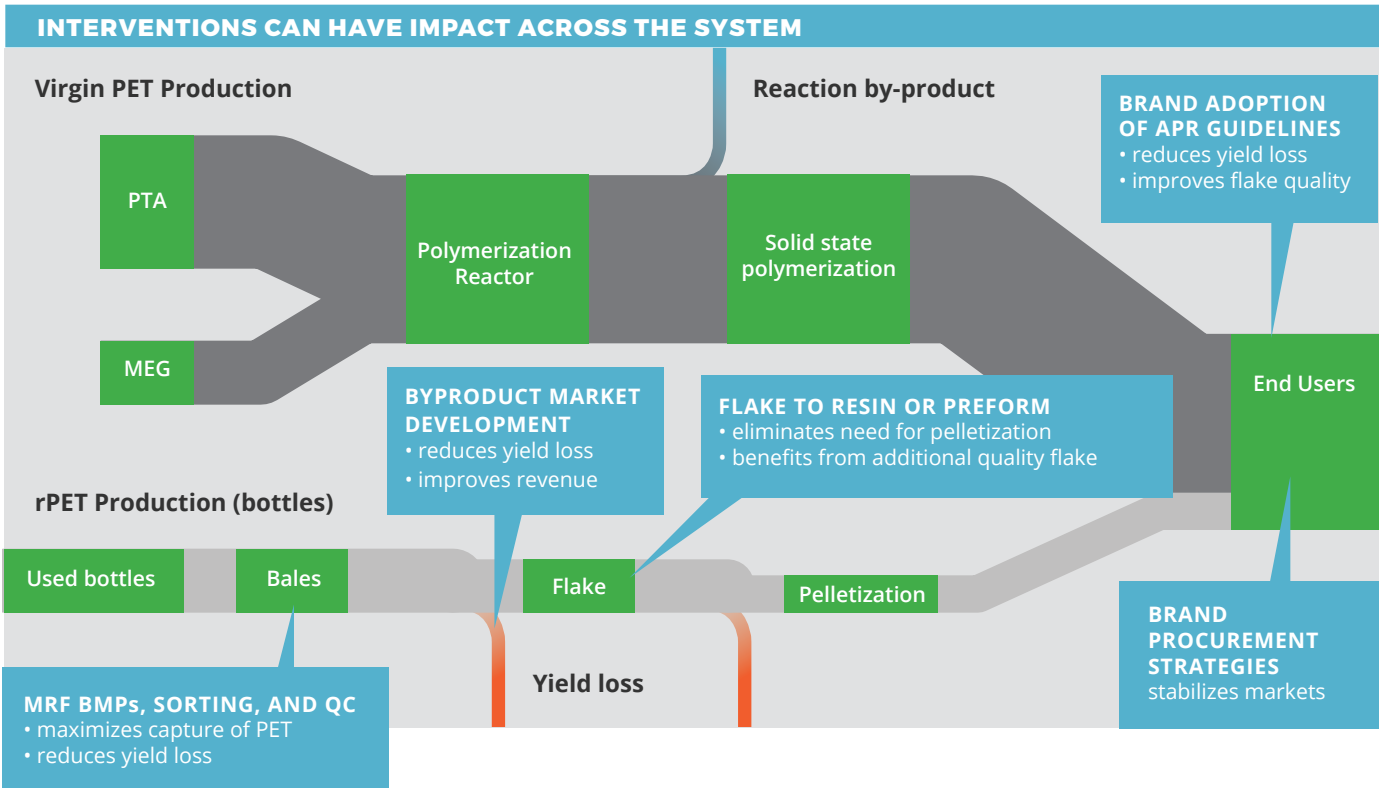
Yield improvement (10+%) and additional capture/yield improvements for other material types; increased cost savings and revenue opportunities

FOR REPROCESSORS

Yield improvement (21+%, incl. yield improvement at MRF); cost savings (10+); reduced exposure to price volatility and commodity risks

FOR BRAND OWNERS/END-USERS

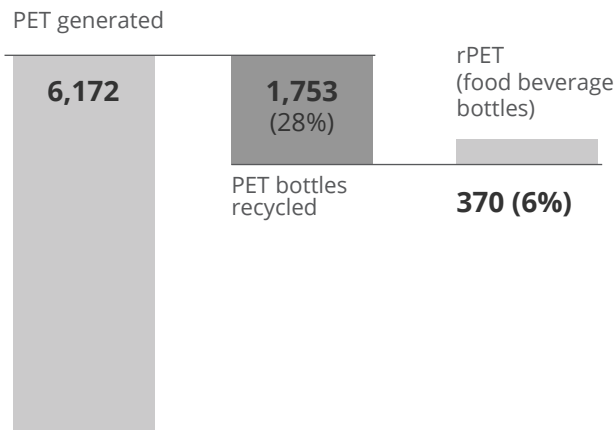
Increased volume of higher quality of RPET at lower cost; greater flexibility in end uses of material; less volatility in price



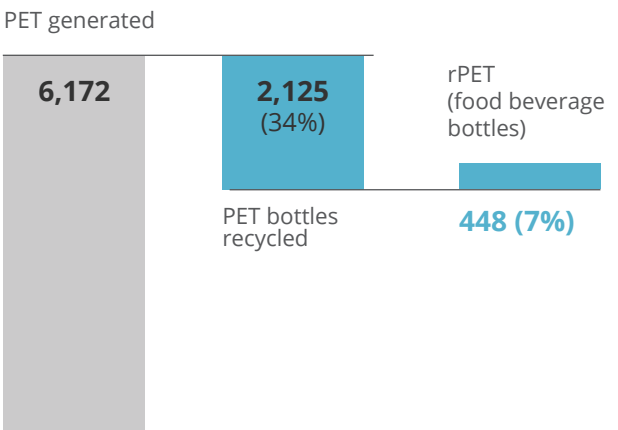


With more than 6 billion pound of PET bottles and containers generated each year, *these interventions have the potential to increase the domestic supply of rPET for bottles and other uses by 6% or more over time.*

BASELINE YIELD FOR CONTAINERS (2016)
million lbs



YIELD WITH INTERVENTIONS
million lbs



ABOUT US

Research and analysis for Cleaning the rPET Stream was provided by RRS, with input from the Association of Plastics Recyclers (APR) and NAPCOR.

Closed Loop Partners invests in sustainable consumer goods, advanced recycling technologies, and the development of the circular economy using a variety of investment approaches. The business was launched in 2014 with the creation of our unique project finance vehicle, Closed Loop Fund, which was later complemented by both philanthropic and growth equity funds on the Closed Loop platform.

Offering below market rate loans to municipalities and private recycling companies in North America, Closed Loop Fund plans to invest \$100 million by 2025 to scale recycling infrastructure and create more circular supply chains for consumer products and packaging, focusing on recyclable commodities in plastics, glass, paper and metal. As of June 2017, the Fund's initial investments have diverted more than 80 million pounds of post-consumer plastics, including PET. The Fund's investors include the world's largest retailer and consumer brands: Walmart Foundation, 3M, Coca-Cola, Colgate-Palmolive, Dr. Pepper Snapple Group, Johnson & Johnson, Keurig Green Mountain, Nestlé Waters North America, Pepsi, Procter & Gamble, and Unilever. For more information, visit closedlooppartners.com.

From an investor's point of view, there are opportunities to strengthen the rPET market through project financing and venture capital, but other supports are needed (e.g., adoption of APR design guidelines, negotiation of long-term contracts) too. We are seeing investors come to the table (e.g., recent investments in new capacity under companies such as rPlanetEarth and Carbonlite), but more capital is needed if we are to close the loop on post-consumer recycled PET bottles and containers. For example, an additional \$125 million in capital investment could support the upgrade of 250 MRFs across the continental US. If this investment were made, the system would see an additional 80 million lbs. of PET per year.

Improving infrastructure for rPET production can benefit PET end uses beyond packaging, as well as other resin types. HDPE, PP are growing PCR materials. The interventions recommended here for PET – in particular at the MRF – would have a “halo” effect on other materials. Post-consumer recycled production of these other resin types should be studied further to understand the cost implications and impact potential in detail.

See below for all source references.

1. NAPCOR, and The Association of Plastics Recyclers. “2005-2015 Reports on Postconsumer PET Container Recycling Activity.” Recycling Rate Reports. N.p., n.d. Web. Apr. 2017.
2. “CPI News Releases.” U.S. Bureau of Labor Statistics. U.S. Bureau of Labor Statistics, n.d. Web. Apr. 2017.
3. NAPET Conference, 2015
4. OESA Conference, 2016
5. The Packaging Conference, 2015
6. Americas Polyester Industry Conference, 2015
7. Confidential interviews with industry experts, 2017
8. All data from RRS, unless otherwise noted.

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