



Analysis of Food Grade Recycled PET (rPET) and Recycled HDPE (rHDPE) in the United States

PREPARED BY:



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EXECUTIVE SUMMARY

With aggressive corporate sustainability goals in place, and legislative mandates on the horizon, it is critical to understand the practical limits and challenges to incorporating recycled content in water bottles. This report summarizes the results of a study to model various recycled content scenarios for incorporating recycled polyethylene terephthalate (rPET) and recycled natural high density polyethylene (rNHDPE) into beverage bottles and to identify gaps in supply and other potential challenges to achieving targeted recycled content levels. It also includes a discussion of market dynamics related to each recycled resin that may affect the ability to meet modeled targets.

There are growing voluntary commitments among beverage and water brands to use recycled content, also referred to as post-consumer resin (PCR), in their packaging. This includes the following targets by key beverage brands:

- Nestle Waters North America (NWNNA): 50 percent of their entire portfolio by 2030
- Danone: 50 percent of water and beverage bottles by 2025
- Walmart: 20 percent of all U.S. private brand packaging, including water bottles, by 2025
- Coca-Cola: 50 percent of all packaging by 2030
- PepsiCo: 33 percent of PET beverage bottles by 2025

In addition to voluntary commitments, several states, including California and Washington, are considering policies that would set a minimum recycled content requirement for plastic packaging, including water bottles. Evaluating the impact of these potential mandates requires an understanding of how much material would be required to meet them, and what it would take to recover that much material.

The single serve, gallon, and 2.5-gallon bottled water market uses two types of plastic resin in its packaging: Polyethylene Terephthalate (PET) and Natural High Density Polyethylene (NHDPE). PET represents about 92 percent of the total packaging for bottled water, 1.667 billion lbs, compared to about 8 percent (144 million lbs) of NHDPE.

GLOSSARY

Colored High Density Polyethylene (CHDPE): Pigmented HDPE resin used in applications such as packaging, crates, containers, pipe and composite lumber

Food Grade: Material is suitable for food (and beverage) contact packaging

High Density Polyethylene (HDPE): Plastic resin used in many packaging and non-packaging applications

Letter of Non-Objection (LNO): Determination by the U.S. Food and Drug Administration (FDA) allowing for material to be used for food (and beverage) contact applications

Natural High Density Polyethylene (NHDPE): Colorless HDPE used in applications such as food and beverage packaging

Polyethylene Terephthalate (PET): Plastic resin used in applications such as food and beverage packaging (bottles, jars, clamshells) and fiber (polyester carpet and textiles)

Post-consumer Material: Material that has fulfilled its intended use. May include residential or commercial sources

Recycled HDPE (rHDPE): Plastic resin derived from recycling of HDPE materials from post-consumer sources
Food Grade: Material is suitable for food (and beverage) contact packaging

Recycled PET (rPET): Plastic resin derived from recycling of PET materials from post-consumer sources

Rigid Plastic Packaging (RPPC) Law: Statute in California related to plastic packaging that requires certain conditions for sale in the state, including the use of recycled content in non-food packaging

PET

Supply is the biggest barrier for most rPET content scenarios. Currently bottle-grade rPET is only derived from recovered PET bottles. Gross tonnage recovered of this material has been relatively flat since 2012, and the recycling rate has hovered around 30 percent¹. Based on the most up-to-date data available (2018), this level of recovery supports a rPET recycled content rate of nine percent in beverage bottles. rPET is prominently used in other applications, including fiber (carpet and textiles), sheet (thermoform packaging) and industrial strapping. Fiber is the largest end use of rPET currently (42 percent), followed by bottles (33 percent - 27 percent food / beverage, 6 percent non-food). The use of rPET in bottles will be competing with these other uses into the foreseeable future.

The reclamation infrastructure for bottle grade rPET is most concentrated in the Midwest-East Central region (Michigan, Ohio, Indiana), followed by the South (Georgia, North Carolina) and the Pacific (California) regions. The South also has significant reclamation capacity for fiber grade rPET. California has the most significant sheet end use.

The following table summarizes the results of three different modeled scenarios for rPET use in all beverage containers on national level:

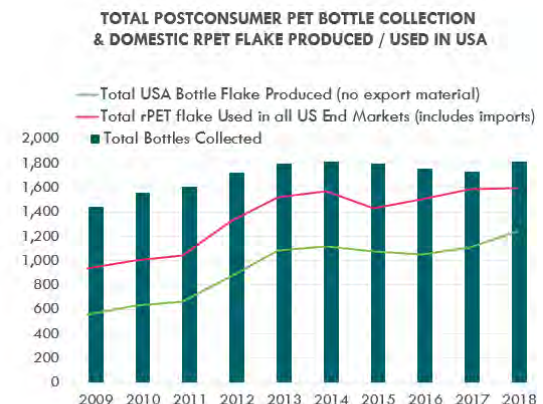
Table 1. rPET Modeled Scenarios

Scenario	Total rPET Demand	rPET Demand for Beverage Bottles	rPET Demand for Other Applications	Additional rPET ² Needed to Meet Target	PET Bottle Recovery Rate to Meet Target	Increase in PET Bottle Recovery Rate
25% by 2025: US	2.8 billion lbs	1.3 billion lbs	1.5 billion lbs	1.2 billion lbs	52%	+23%
50% by 2030: US	4.5 billion lbs	2.8 billion lbs	1.7 billion lbs	2.9 billion lbs	82%	+53%
75% by 2030: US	5.9 billion lbs	4.2 billion lbs	1.7 billion lbs	4.3 billion lbs	110%	+81%

The model predicts that a significant increase in the required use of recycled content for PET bottles on a national level would be very challenging due to supply constraints and competing end uses for recovered PET bottles. Meeting a 25 percent target nationally by 2025 would require the recovery rate and reclamation capacity to nearly double. RRS would expect investment in reclamation infrastructure to be secured if supply and demand align.

¹ Water bottle recovery is 33% according to NAPCOR

² Needed to meet national target while also maintaining competing end uses. This assumes that the rate of growth for US PET bottle sales and end use of rPET remains consistent with historical data between 2010 and 2018



Sources: Report on Postconsumer PET Container Recycling, NAPCOR / APR, 2012-2017, 2018 U.S. National Postconsumer Plastic Bottle Recycling Report, APR / ACC

Figure 1. Historical PET Recovery

Feasibility beyond a 25 percent national target is very uncertain. Achieving a 50 percent rPET target by 2030 would require an 82 percent national recovery rate for PET bottles. A 75 percent target would not be possible using bottle feedstock alone. Expanding the feedstock pool to include polyester fiber from textiles and carpet could shift the dynamic. Emerging chemical recycling technologies have demonstrated promise in unlocking such alternative feedstock channels, but these technologies and business models are not proven on a commercial scale and there are many challenges in the collection and processing of these materials.

HDPE

Supply, cost, and technical constraints impact the potential use of rHDPE. The modeled rHDPE scenarios require less PCR than the PET scenarios. This is because there is far less HDPE used in water bottles, and beverage packaging in general than PET. The relevant fraction of HDPE to consider when looking at rHDPE targets is natural HDPE (NHDPE), a colorless form of the resin, typically used in food contact applications, such as beverage containers. A majority of NHDPE is used in milk jugs, which have typically been excluded from other policies targeting beverage containers, such as container deposit laws. The modeled scenarios do not include PCR targets or mandates related to non-water HDPE bottles. Only about eight percent of all water bottles are made from NHDPE resin.

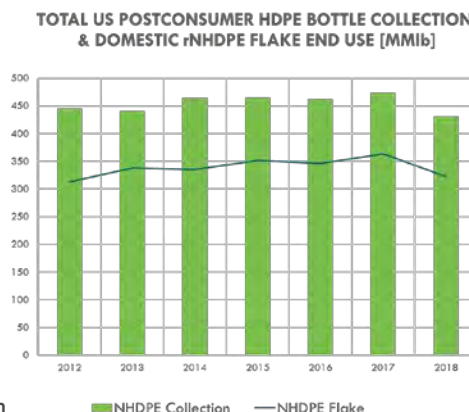


Figure 2. Historical NHDPE Recovery

Currently nearly all rNHDPE goes to non-food bottles with minimal-to-no use in food and beverage containers. There are some inherent technical challenges to using rNHDPE as feedstock for beverage containers, including:

- Stricter input requirements than rPET - only food grade NHDPE can be used as food grade rHDPE
- Low volume - there is only about 1.5 billion lbs of NHDPE bottles sold into the market annually and 431 million lbs of NHDPE bottles collected. This has been relatively flat since 2012 (see Figure 2).
- High cost – rHDPE is consistently priced higher than virgin HDPE and rPET. This is primarily driven by demand for rHDPE created by the California Rigid Plastic Packaging Container (RPPC) Law, which requires non-food HDPE containers to use recycled content.
- Residual odor/ taste may be an issue as recycled content increases beyond 25 percent

The two largest NHDPE reclaimers in the country are located in the Southeast (Alabama, North Carolina). They account for more than 50 percent of rNHDPE resin output.

The following table summarizes the results of three different modeled scenarios for rHDPE on national level:

Table 2. rHDPE Modeled Scenarios

Scenario	Total rHDPE Demand	rHDPE Demand For Water Bottles	rHDPE Demand For Other Applications	Additional rHDPE ³ Needed To Meet Target	HDPE Bottle Recovery Rate To Meet Target	Increase In HDPE Bottle Recovery Rate
25% by 2025 for all states	429 million lbs	43 million lbs	386 million lbs	107 million lbs	38.5%	+9.5%
50% by 2030 for all states	507 million lbs	96 million lbs	411 million lbs	184 million lbs	46%	+17.5%
75% by 2030 for all states	555 million lbs	144 million lbs	411 million lbs	232 million lbs	50.4%	+21.6%

Although the increase in required feedstock for rHDPE targets is not as high as for PET targets, they are still challenging to achieve, due to the technical issues described above. The fact that rHDPE is currently not being used for food grade bottle applications illustrates this point⁴. Consistently higher pricing for rHDPE than rPET, in addition to greater gross supply requirements to meet rPET targets, also suggests that brands with a portfolio target would prioritize rPET over rHDPE.

While there are some HDPE bottles included in deposit-based recovery, such programs typically exclude dairy and juice jugs over 1 liter, which make up most of the stream. This constrains the use of bottle deposits to drive high recovery rates for those materials. Any increase in supply would likely depend on increased access and promotion of curbside collection programs, which have lower recovery potential. There are instances where milk jugs are included in deposit (Alberta, Saskatchewan), but it is the exception to the rule.

CONCLUSION

PCR targets for PET and HDPE water and other beverage bottles on a national scale will require significant efforts along the recycling value chain to increase the supply of recovered feedstock (e.g. greater access and promotion of curbside recycling, efficiently run bottle deposit programs).

To meet any national PET targets, the focus would be primarily on increasing supply through post-consumer recovery activities, with the expectation that reclamation capacity would develop to meet demand as more feedstock becomes available.

Meeting rHDPE demand in all scenarios is as much of an issue of technical feasibility as it is supply quantity issue. These challenges will need to be better understood through product testing, in addition to increasing post-consumer recovery.

³ Needed to meet national target while also maintaining competing end uses. This assumes that the rate of growth for US PET bottle sales and end use of rPET remains consistent with historical data between 2010 and 2018

⁴ A major bottled water company has plans to use rHDPE bottles before the end of 2020



ANALYSIS OF FOOD GRADE RECYCLED PET (rPET) AND RECYCLED HDPE (rHDPE) IN THE UNITED STATES



August 28, 2020





Managing change
in a resource-
constrained world.



ORGANICS
MANAGEMENT



WASTE
RECOVERY



GLOBAL CORPORATE
SUSTAINABILITY

since 1986



SCOPE

1

LANDSCAPE OVERVIEW

- Bottle Recovery Landscape

2

PET

- Recycling fundamentals
- Market fundamentals
- Model results

3

NHDPE

- Recycling fundamentals
- Market fundamentals
- Model results

4

CONCLUSION



GLOSSARY

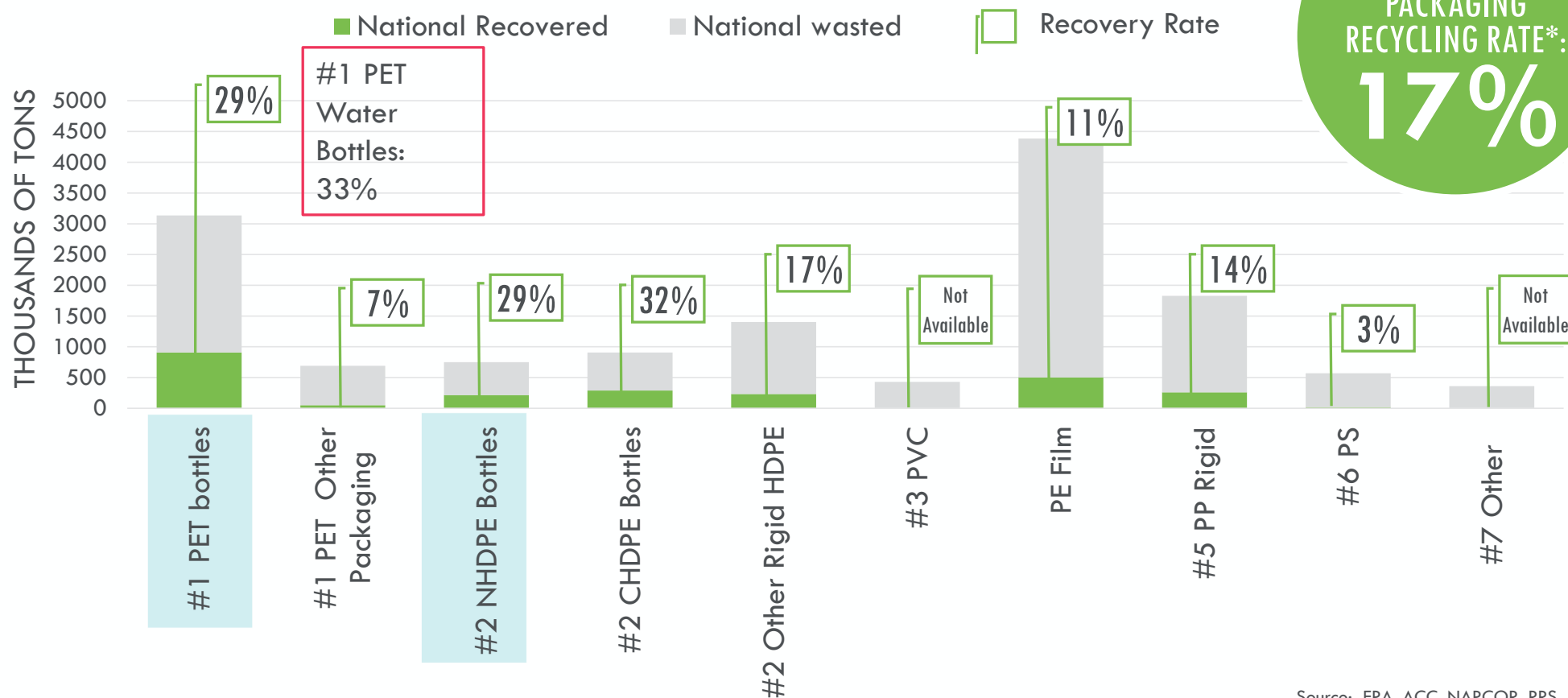
- Colored High Density Polyethylene (CHDPE): Pigmented HDPE resin used in applications such as packaging, crates, containers, pipe and composite lumber
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- Natural High Density Polyethylene (NHDPE): Colorless HDPE used in applications such as food and beverage packaging
- Polyethylene Terephthalate (PET): Plastic resin used in applications such as food and beverage packaging (bottles, jars, clamshells) and fiber (polyester carpet and textiles)
- Post-consumer: Material that has fulfilled its intended use. May include residential or commercial sources
- Recycled HDPE (rHDPE): Plastic resin derived from recycling of HDPE materials from post-consumer sources
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BOTTLE RECOVERY LANDSCAPE

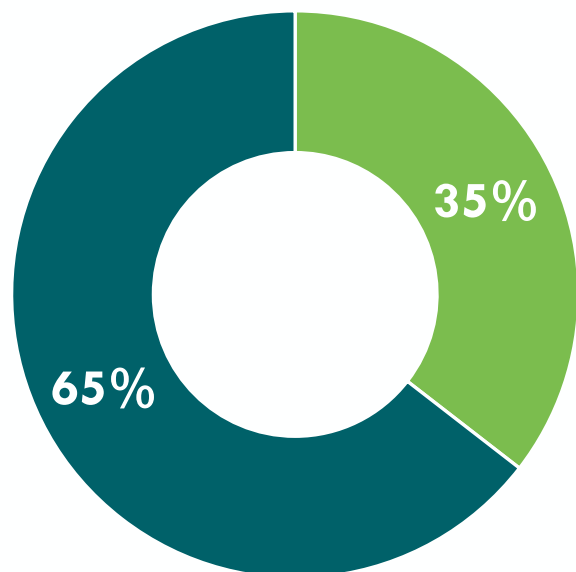
CONTAINERS AND PACKAGING RECOVERY BY RESIN TYPE

2017/2018 SNAPSHOT



WATER BOTTLES VS ALL BOTTLES - MARKET SHARE

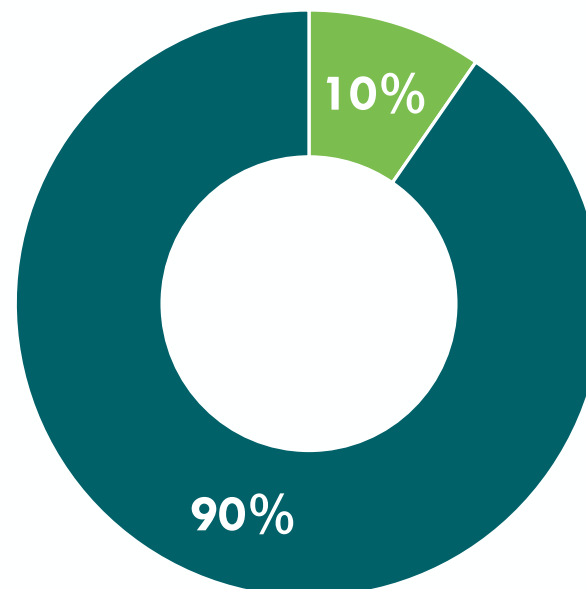
PET BOTTLE MARKET: 4.07 BILLION LBS



■ PET Water Bottles ■ PET Non-Water Bottles

Source: NAPCOR

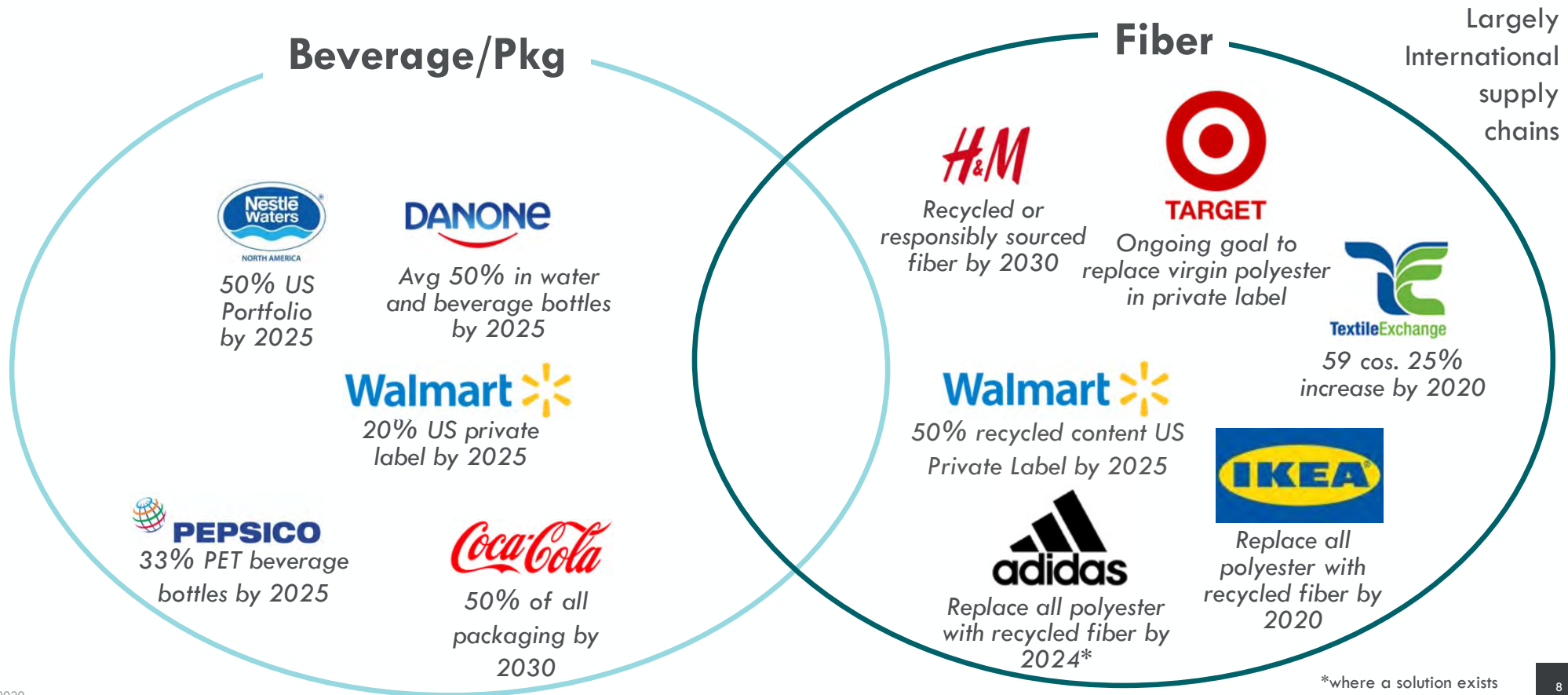
NHDPE BOTTLE MARKET: 1.5 BILLION LBS



■ NHDPE Water Bottles ■ NHDPE Non-Water Bottles

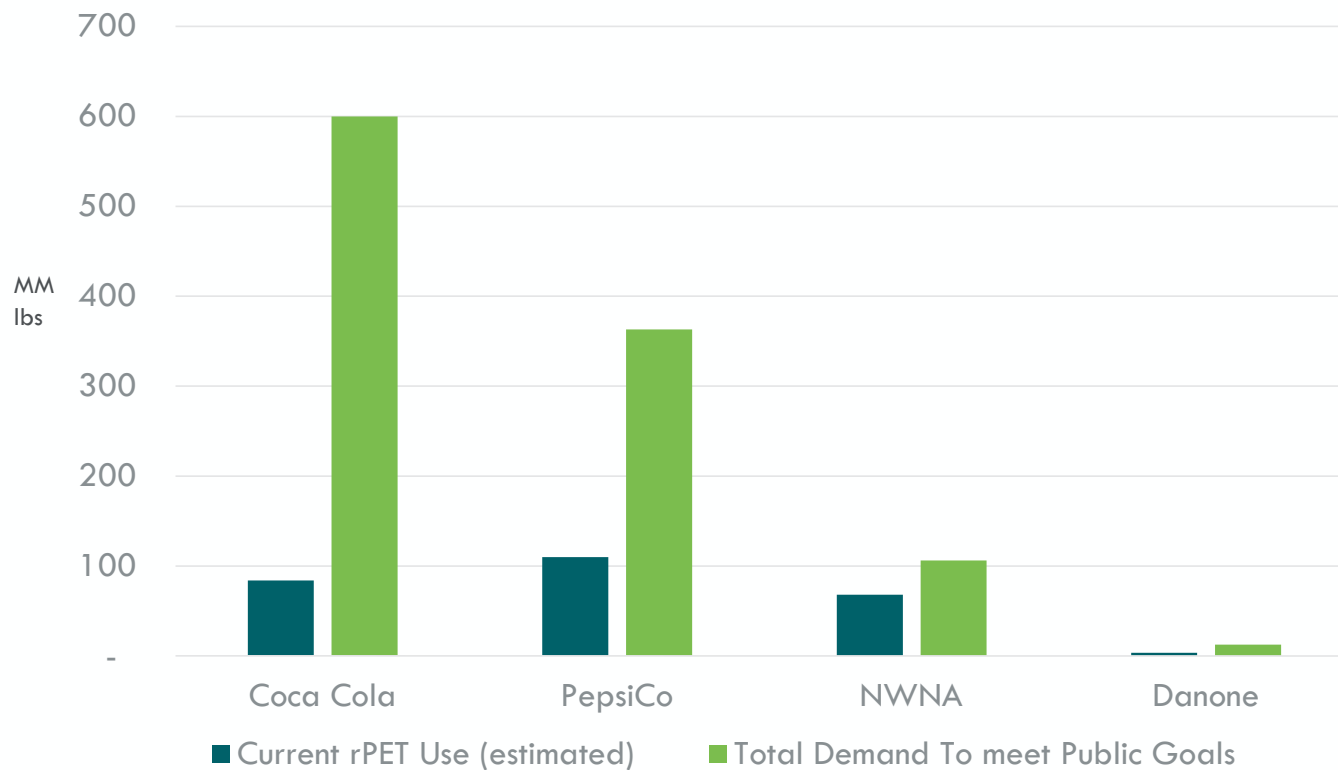
Source: APR/ACC, RRS, IBWA, BMC

PET RECYCLED CONTENT COMMITMENTS



BIG BRAND U.S. rPET GOALS

FOR CONCEPTUAL INTERPRETATION ONLY - PROJECTIONS ARE ESTIMATED.



- Large beverage companies will likely drive demand
- For rPET, it's important to consider scenarios for all food & beverage bottles

A hand is shown holding a clear PET bottle, tilted as if to pour. Below the hand is a large pile of discarded plastic bottles of various shapes and colors (clear, red, blue). The background is a blurred outdoor scene with warm, golden light, suggesting a sunset or sunrise. A green semi-transparent banner is overlaid on the right side of the image, containing the title text.

PET OVERVIEW & MARKET FUNDAMENTALS



PET MARKET FUNDAMENTALS: SUPPLY

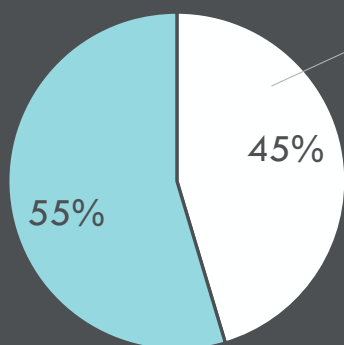
- 60+% of total recovery from curbside collection
- Deposit programs drive high recovery rates
- Bottle grade rPET derived mainly from deposit material, *but not exclusively*
- Recycling rate flat to down in last five years, from 31 to 29%
- Total PET recovered for recycling (gross) also flat, hovering at 1.8 billion pounds since 2013
- Export not a significant factor—8% in 2018 with more than half to Canada; offset by imports
- Full scope of brand commitments cannot be met without increasing supply



PET MARKET FUNDAMENTALS: DEMAND

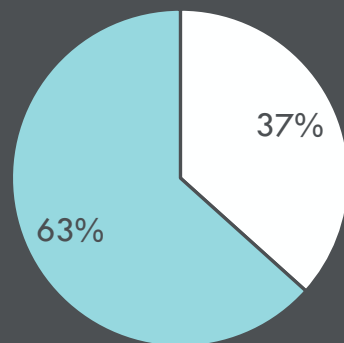
- Current market supports ~7% rPET content in PET bottles
- Fiber is largest rPET end market (42%), followed by bottles (33%)
- Sustained market decline for bales over past 2 years reflects:
 - Low oil / virgin resin prices
 - No significant growth in reclamation operating volumes (competing for bales)
 - Very limited export
- Low bale prices help mitigate rPET / virgin price delta, *but bottle quality rPET is not at parity with virgin and is not likely to be for foreseeable future*

ALL PET BOTTLES: DEPOSIT VS. CURBSIDE



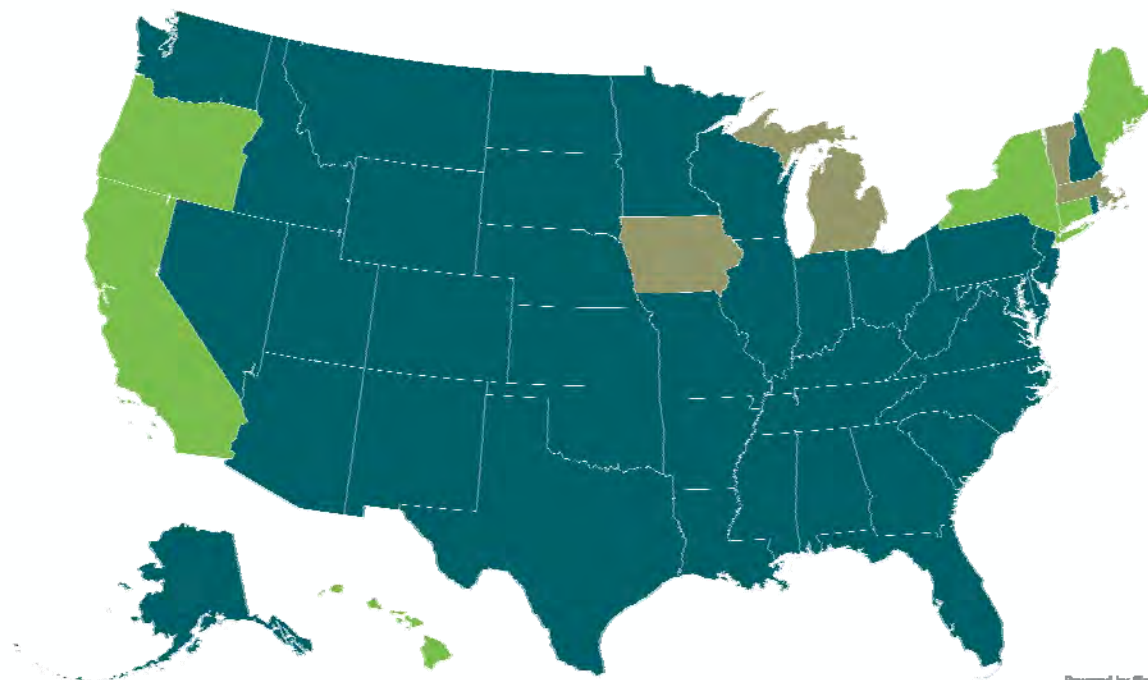
27% OF
POPULATION

- PET From Container Deposit States
- PET From Other States



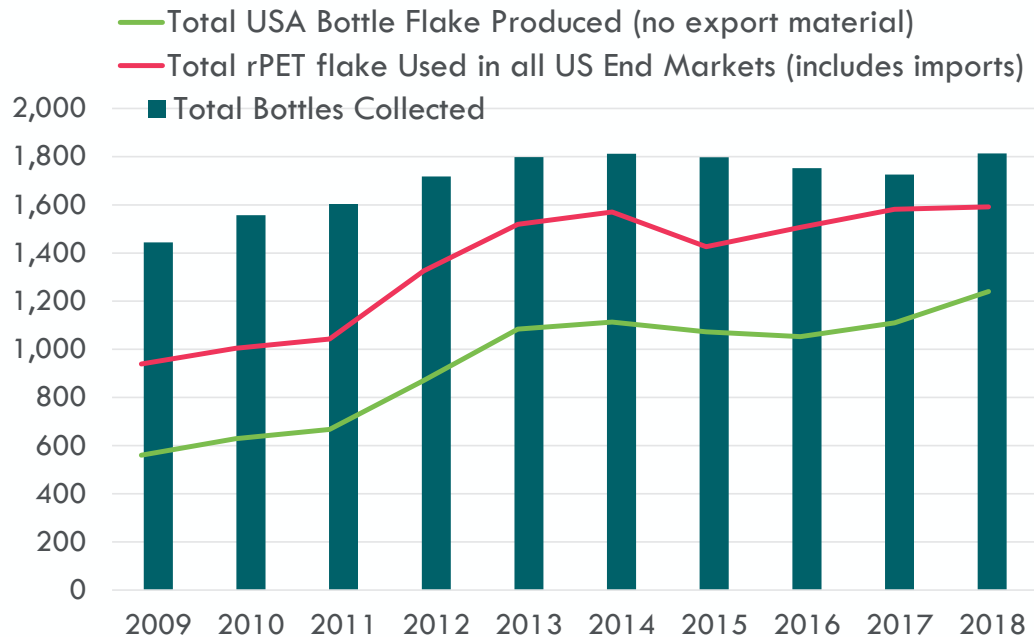
- PET from Container Deposit Programs
- PET from Other Collection methods (e.g. curbside)

BOTTLE DEPOSIT PROGRAMS



Includes Still Water Includes Carbonated Water No Deposit

TOTAL POSTCONSUMER PET BOTTLE COLLECTION & DOMESTIC rPET FLAKE PRODUCED / USED IN USA



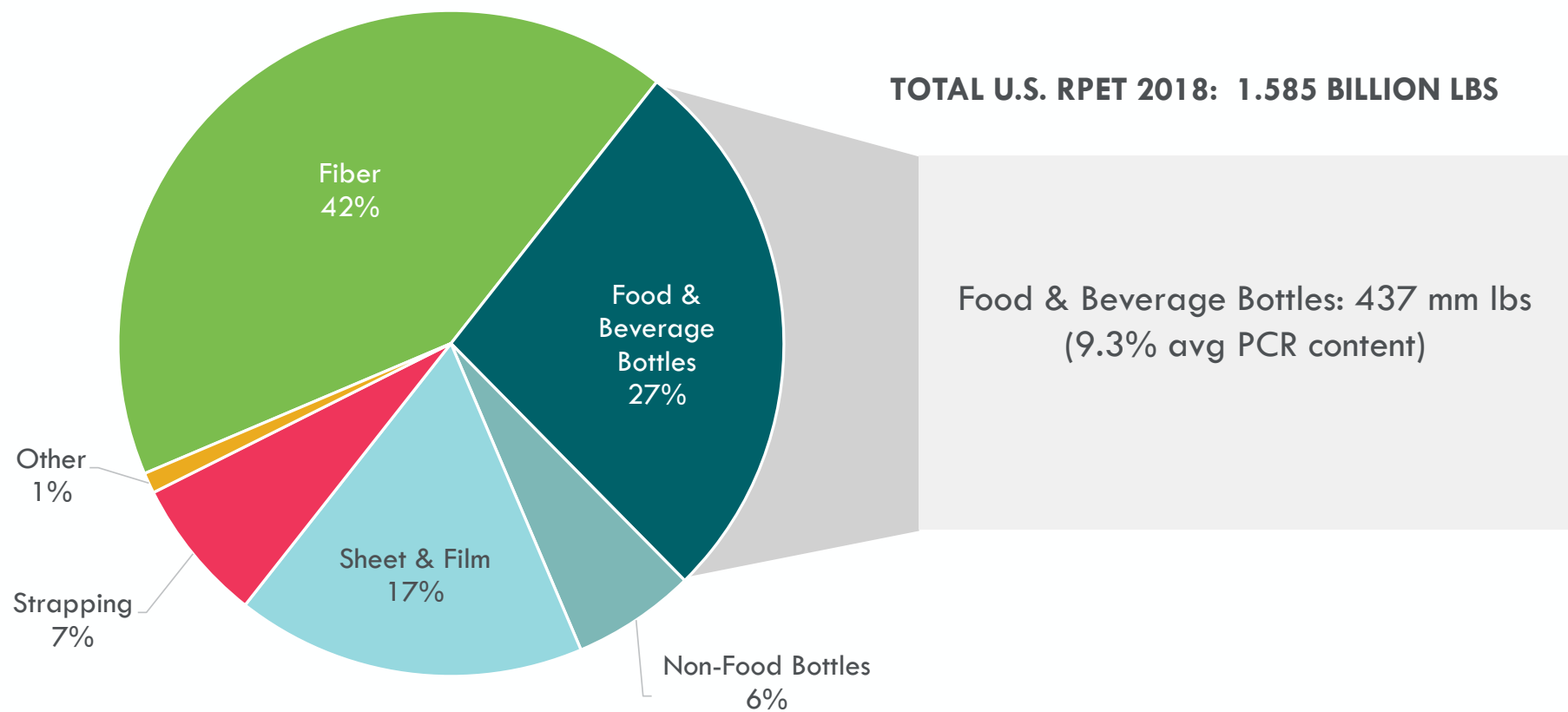
Sources: Report on Postconsumer PET Container Recycling, NAPCOR / APR, 2012-2017,
2018 U.S. National Postconsumer Plastic Bottle Recycling Report, APR / ACC

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POST-CONSUMER BOTTLE COLLECTION & FLAKE GENERATION

- 6.3 billion pounds US PET bottle generation
- Domestic bottle collection flat ~1.8 billion pounds
- US rPET flake production from 1 to 1.2 billion pounds since 2013
- US rPET flake into end markets 1.4 – 1.5 billion since 2013
- Includes non-bottle inputs and rPET imports (mainly to fiber markets)

rPET END USES



Sources: Precise end market shares are calculated for 2018 based on bottle vs. non-bottle split, and on market Report on Postconsumer PET Container Recycling, NAPCOR / APR, 2010-2017.

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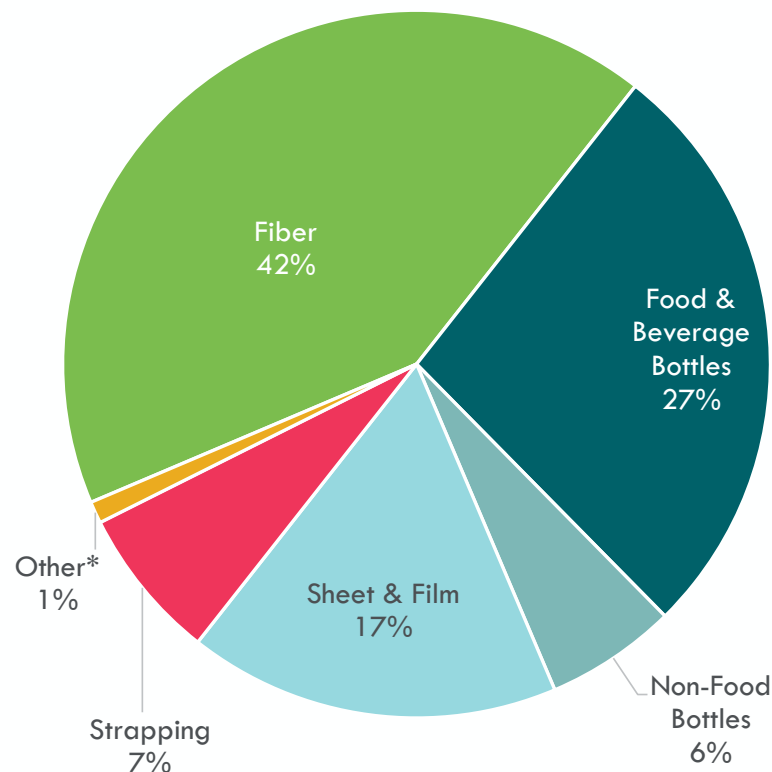
USE OF rPET IN BEVERAGE BOTTLES COMPETES WITH OTHER ESTABLISHED rPET END MARKETS

Non-Food Bottles: Smaller, less high-profile application for PET over the years than food/beverage. RPET usage volumes have ranged between 50 and 64 million pounds for the last 10 years, and averaged 53 million pounds for the last 20

Food & Beverage Bottles: RPET use in food and beverage has increased year-over-year for 20 years. Some flattening from 2014 - 2016

Strapping: Long-time market for green PET bottle stream

Other: Car interiors, other specialty

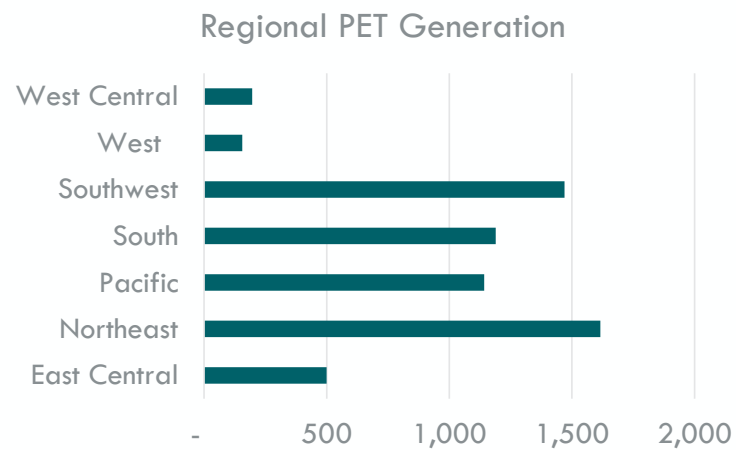
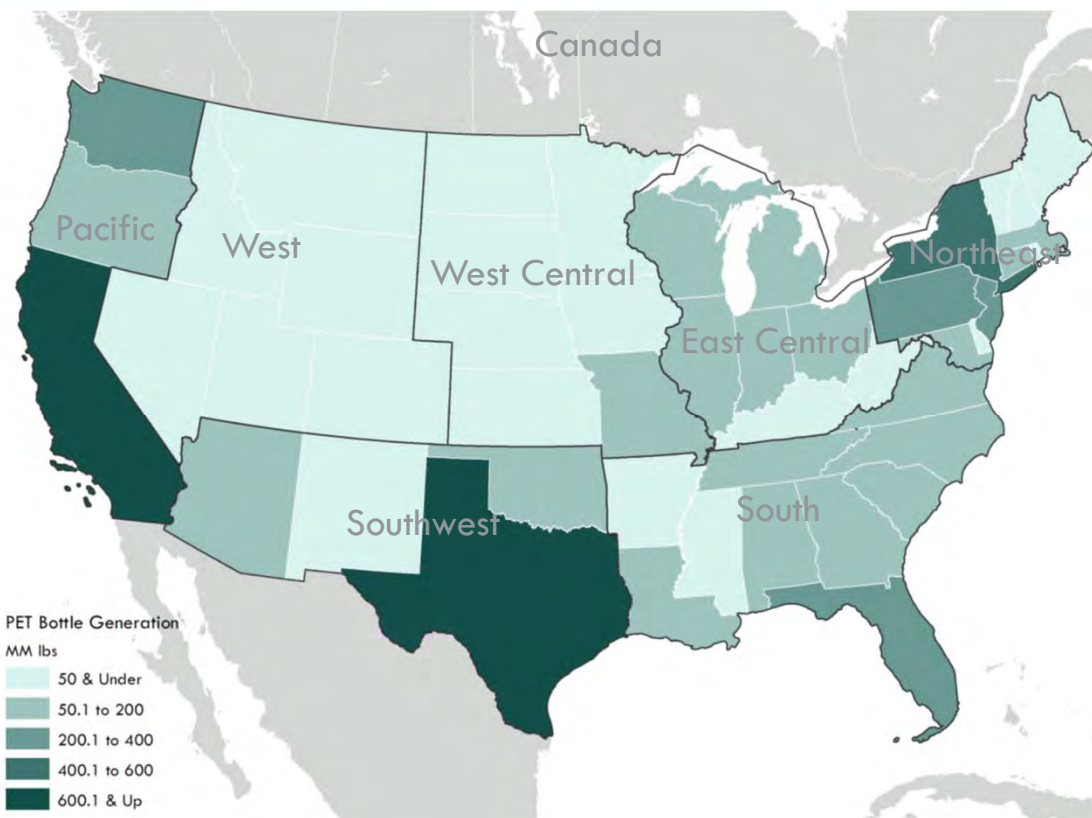


Fiber: Southeast US carpet producers still reliant on PET bottle bales for raw material supply at ~460 million "pounds in" capacity. No anticipated change to PET bottle bale buying patterns:

- Established system; economics tolerant of bale quality and price variation
- Recycled content offsets end-of-life challenges for PET carpet

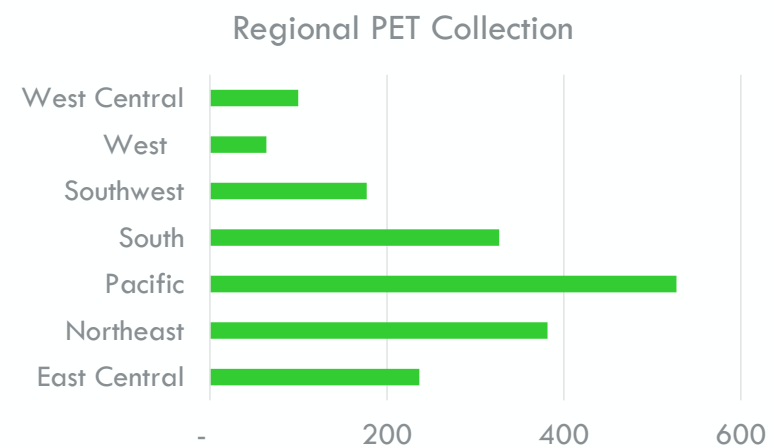
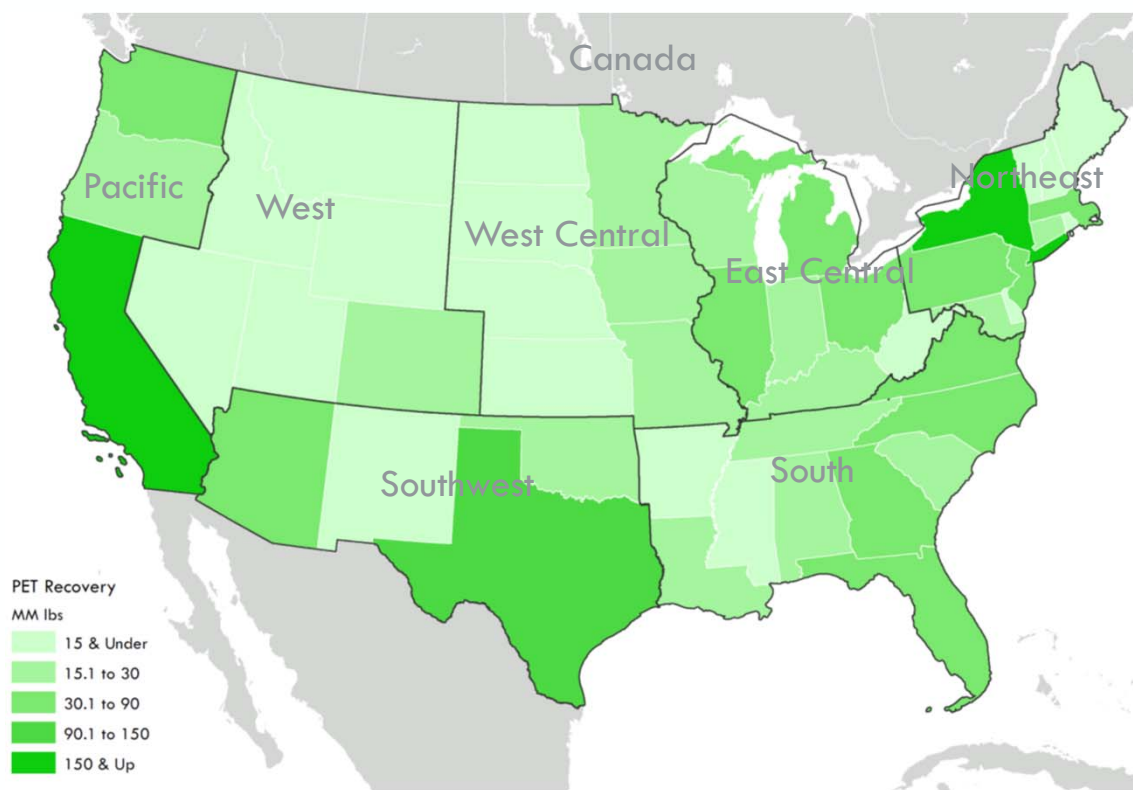
Sheet: Big growth market over last 10 years. Good vehicle for rPET content, and generally more price sensitive than bottle market, but part of brand commitment in some markets and/or offset for environmental scrutiny. The other primary rPET market in California.

REGIONAL PET SUPPLY



Source: RRS Calculation based on national resin sales numbers (ACC/APR, 2018) and regional gallonage (BMC, 2018)

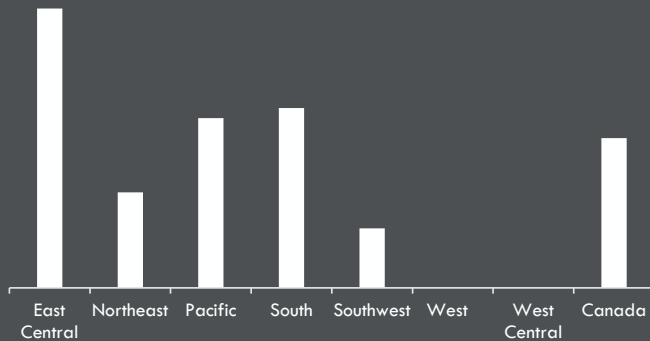
REGIONAL PET COLLECTION



Source: RRS Calculation based on national recovery (NAPCOR) and RRS state recovery share (RRS)

PET RECLAIMERS

Regional Food Grade PET Reclamation*



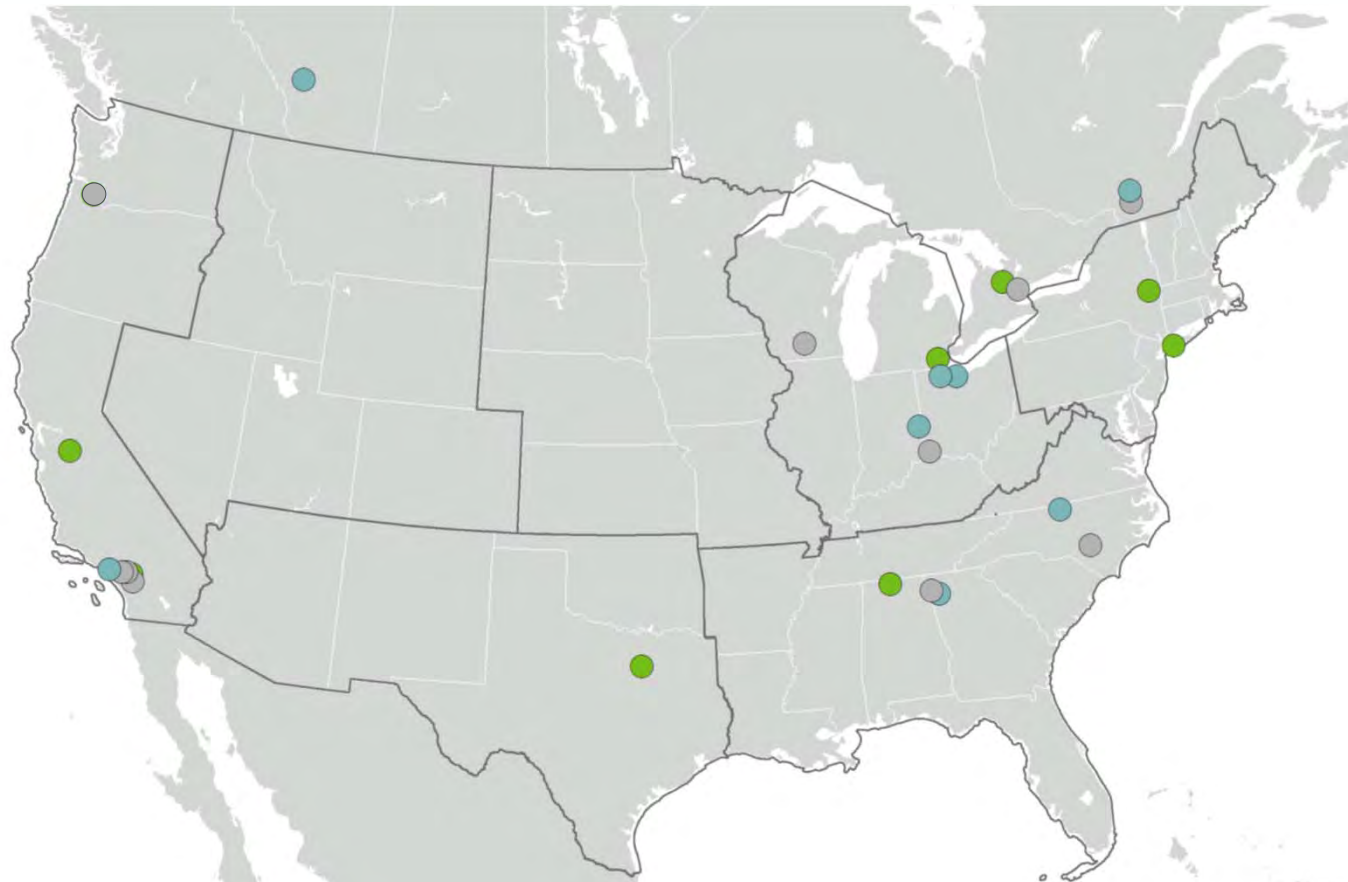
South Primarily Bottle and Fiber

East Central Primarily Bottle

CA Primarily Bottle and Sheet

* Based on tonnage processed by primary and partially bottle grade reclaimers

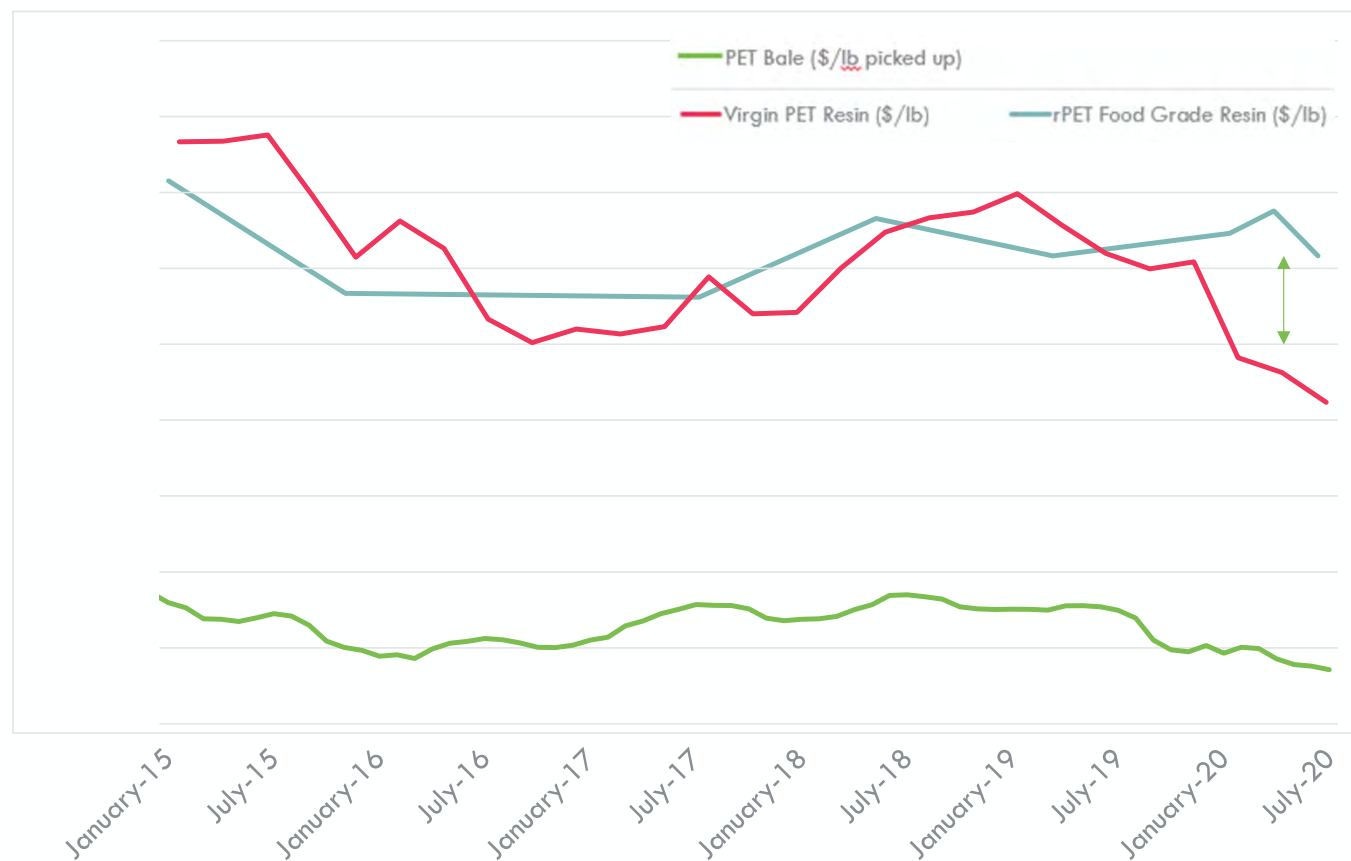
- Primary Bottle Grade
- Partially Bottle Grade
- Non-Bottle Grade



Over 170 Letters of Non-Objection (LNO) for food contact PET, based mainly on process technology. 21 of 26 PET reclaimers have food contact rPET capability for bottle or sheet; 16 for bottle. One add'l (bottle) with CarbonLite Pennsylvania plant coming on line in 2020.

PET MARKET FUNDAMENTALS: MARKET PRICING

- Food Grade rPET Resin historically tracks closely with Virgin
- Brand commitments are now resulting in price premium for food grade rPET over virgin (\$.20-\$.25 / lb in 2020)
- Bale pricing is currently below historical averages – due to non-food dynamics lower end uses (fiber and sheet)



A photograph showing a hand holding a clear plastic bottle, tilted as if pouring. Below the hand is a large pile of discarded plastic bottles of various shapes and colors (clear, red, blue). The background is a blurred outdoor scene with sunlight. A green rectangular box is overlaid on the right side of the image, containing white text.

PET GAP MODEL RESULTS: SELECT SCENARIOS



MODEL ASSUMPTIONS

- Baseline data sources include National Association for PET Container Resources (NAPCOR), The Association of Plastic Recyclers (APR), American Chemistry Council (ACC), and Beverage Marketing Corporation (BMC) – most recent year data available from each is 2018
- Yield factors based on industry interviews and RRS analysis
- Geographic bottle sales based on per capita
- Geographic recycling data based on academic research and internal RRS calculations considering several factors
- Growth over time (bottle sales; PCR* usage) based on historical growth patterns (mostly 2010-2018)

*Post-Consumer Resin

SCENARIO 1: 25% RECYCLED CONTENT (RC) TARGET BY 2025 FOR ALL STATES

PRIMARY OUTPUTS: BEVERAGE BOTTLE TARGET (million lbs)

rPET needed to meet Bev Target	rPET needed to Meet Bev Target and Maintain other End Uses	Additional rPET needed to Meet Bev Target and Maintain other End uses	PET collection needed to Meet PET Bev Bottle Target	PET collection needed to meet Bev Target and Maintain other End Uses	Additional PET Collection needed to meet Bev Target and Maintain other End Uses	Increase in PET Recycle Rate to meet Scenario Target
1,311	2,808	1,223	1,956	3,639	1,826	23%

Current PET Bottle Recovery:

28.9%

PET Bottle Recovery Rate Needed To Meet Target:

52%



SCENARIO 2: 50% RC TARGET BY 2030 FOR ALL STATES

PRIMARY OUTPUTS: BEVERAGE BOTTLE TARGET (million lbs)

rPET needed to meet Bev Target	rPET needed to Meet Bev Target and Maintain other End Uses	Additional rPET needed to Meet Bev Target and Maintain other End uses	PET collection needed to Meet PET Bev Bottle Target	PET collection needed to meet Bev Target and Maintain other End Uses	Additional PET Collection needed to meet Bev Target and Maintain other End Uses	Increase in PET Recycle Rate to meet Scenario Target
2,820	4,519	2,934	4,210	6,192	4,379	53%

Current PET Bottle
Recovery:

28.9%

PET Bottle Recovery Rate
Needed To Meet Target:

82%



SCENARIO 3: 75% RC TARGET BY 2030 FOR ALL STATES

PRIMARY OUTPUTS: BEVERAGE BOTTLE TARGET (millions of lbs)

rPET needed to meet Bev Target	rPET needed to Meet Bev Target and Maintain other End Uses	Additional rPET needed to Meet Bev Target and Maintain other End uses	PET collection needed to Meet PET Bev Bottle Target	PET collection needed to meet Bev Target and Maintain other End Uses	Additional PET Collection needed to meet Bev Target and Maintain other End Uses	Increase in PET Recycle Rate to meet Scenario Target
4,231	5,929	4,344	6,314	8,297	6,484	81%

Current PET Bottle
Recovery:

28.9%

PET Bottle Recovery Rate
Needed To Meet Target:

110%



The image features three white, opaque high-density polyethylene (HDPE) jugs standing on a rustic wooden plank surface. The jug on the left has a yellow cap, while the two jugs on the right have purple caps. A semi-transparent green rectangular box is positioned in the center, containing the title text. In the top-left corner, there is a small red triangle pointing downwards.

HDPE OVERVIEW & MARKET FUNDAMENTALS



HDPE MARKET FUNDAMENTALS: SUPPLY

- Postconsumer recovery split between Natural (NHDPE) and Pigmented HDPE (CHDPE), 431 and 576 million pounds, respectively, in 2018
- NHDPE recovery volumes grew gradually from 434 to 473 million pounds from 2010-2017; dropped back to 431 in 2018
- HDPE has second highest recovery tonnage for plastic resin, behind PET and roughly equivalent recycle rate to PET
- Postconsumer material flows primarily through MRFs (milk containers make up large part of NHDPE bale supply)
- Only NHDPE is potentially suitable for food/beverage recycled content use
- Unlike PET, not all virgin NHDPE material produced is food grade
- Anecdotal reports of increasing import of NHDPE bales from Mexico (not reflected in available data used in this project)



HDPE MARKET FUNDAMENTALS: DEMAND

- Strong demand for NHDPE with June per pound bale price ~6X that of CHDPE. This reflects:
 - California's Rigid Plastic Packaging Container (RPPC) law:
 - Creates baseline inelastic demand
 - Decouples rNHDPE from virgin resin pricing
 - Color flexibility of Natural HD – can be colored to brand specs
 - Quality and performance of rNHDPE vs rCHDPE supports its preference – increasing use in premium consumer products
- 18 FDA “Letters of No Objection” for HDPE for food grade use
- Of these 18 only two reclaimers are actively producing the majority of Food Grade rNHDPE - Envision, KW
- Market indicates potential increased interest – equipment provider EREMA has LNO on their tech; recent reports of several sales
- Currently, rNHDPE goes primarily to non-food bottles
- Minimal use of rNHPDE in food/beverage, e.g., for caps (no bottles)

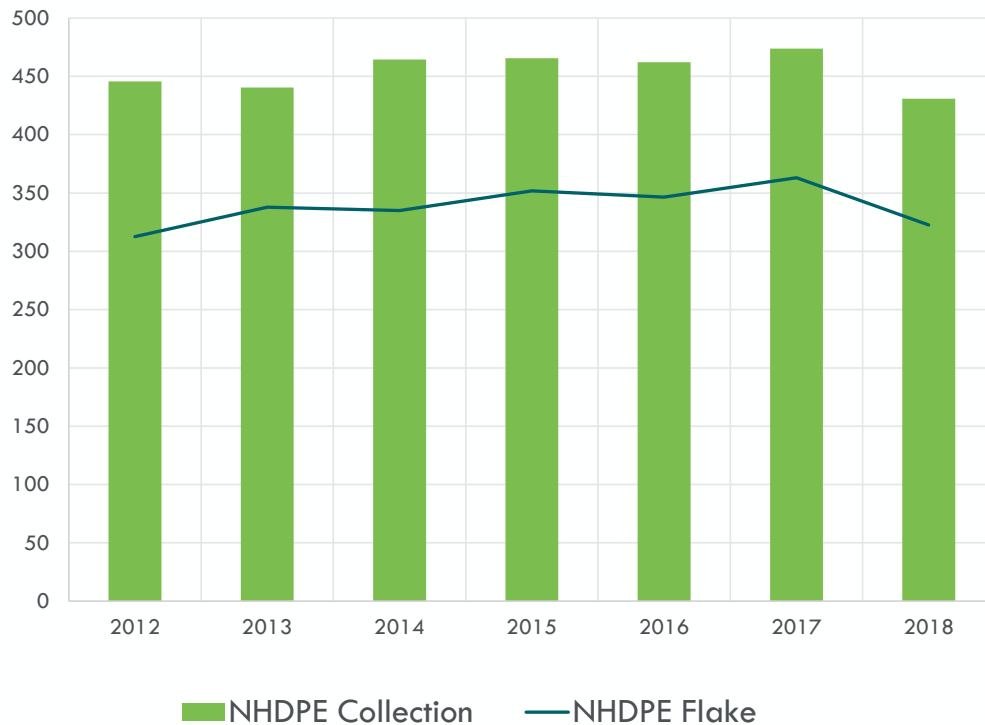


HDPE MARKET FUNDAMENTALS: CHALLENGES

HDPE beverage content mandates would be challenging:

- Low volume, high cost raw material; inelastic market
- Management of input stream integrity (for food / beverage grade)
- LNO has very specific conditions for container use and sourcing requirements
- Non-food grade (mainly color) not currently allowed as feedstock for food grade
- May be technically feasible, would need FDA to change requirements for LNO
- Odor/taste becomes an issue as recycled content increases (>25%)

TOTAL US POSTCONSUMER HDPE BOTTLE COLLECTION & DOMESTIC rNHDPE FLAKE END USE [MMlb]



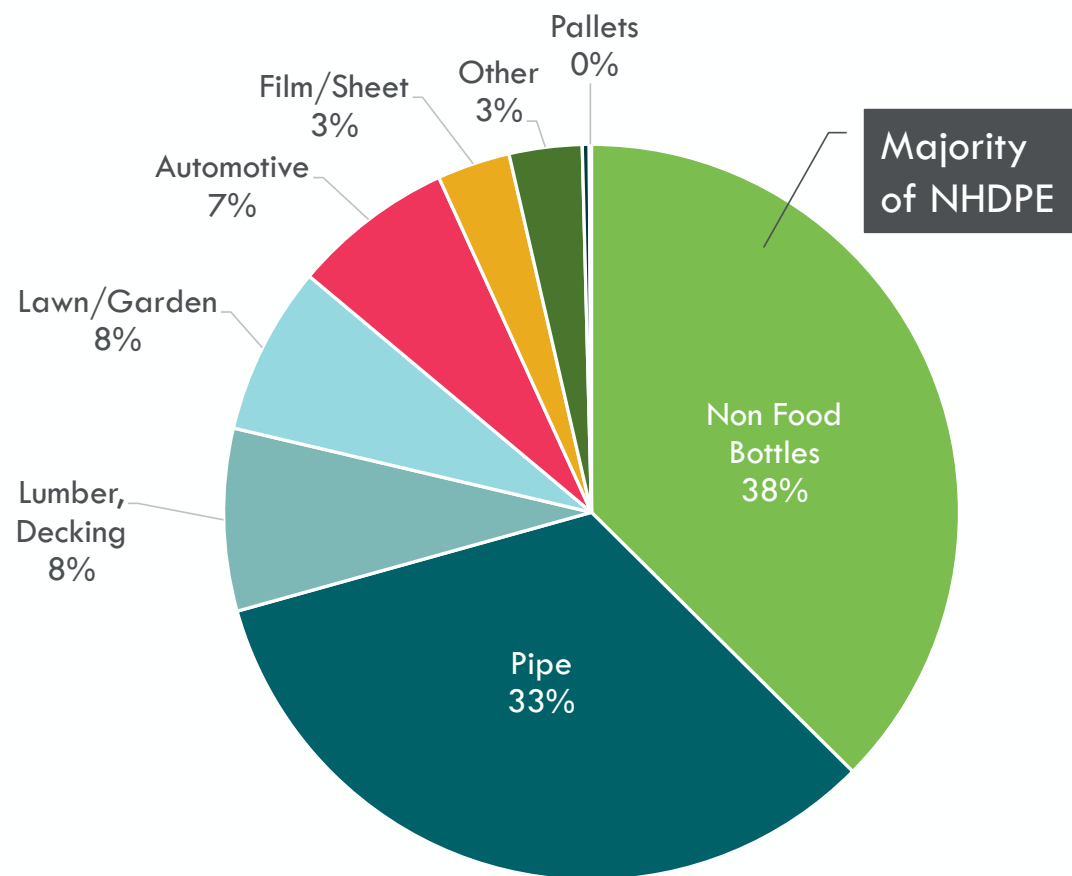
Source: Report on Postconsumer PET Container Recycling, NAPCOR / APR, 2012-2017, 2018 U.S. National Postconsumer Plastic Bottle Recycling Report, APR / ACC

POST-CONSUMER HDPE BOTTLE RECOVERY & FLAKE PRODUCTION

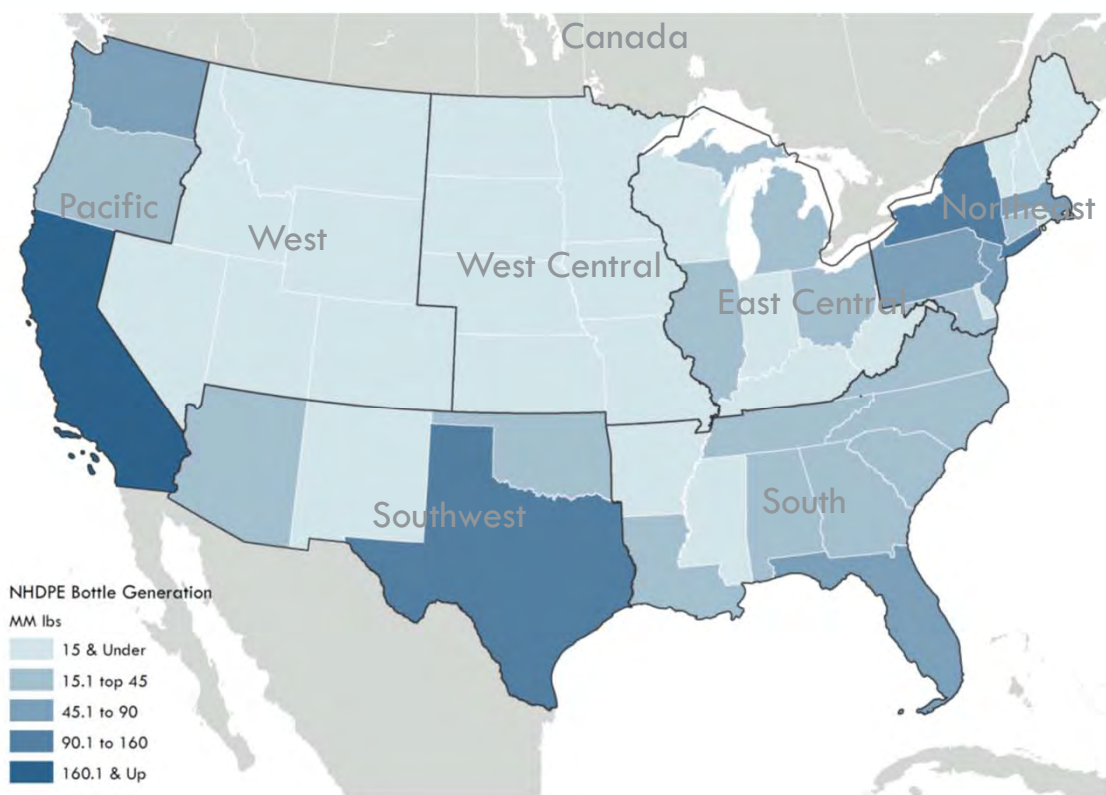
- 3.3 billion pounds US HDPE bottle generation
- 1.5 billion pounds of this is Natural HDPE
- NHDPE collection 431 million pounds in 2018
- US NHDPE flake processed, ~323 million pounds in 2018

rHDPE End Uses

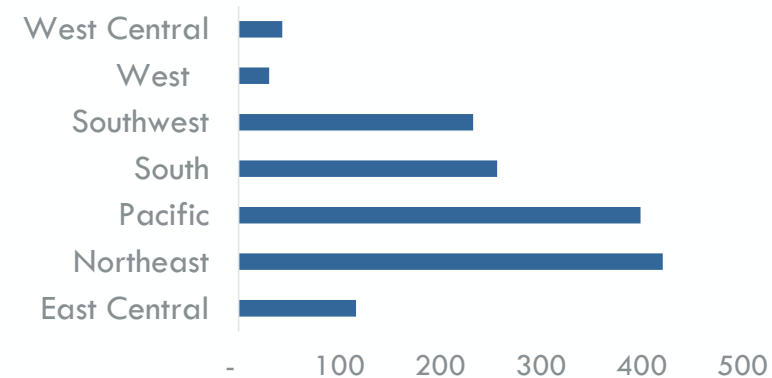
- Chart includes rCHDPE and rNHDPE
- NHDPE primarily for non-food bottles (though not exclusively) — market largely driven by the CA RPPC law and decoupled from virgin
- CHDPE applications focused on non-rigid packaging — low cost alternative to virgin. Market highly affected by low oil / natural gas prices



REGIONAL HDPE SUPPLY

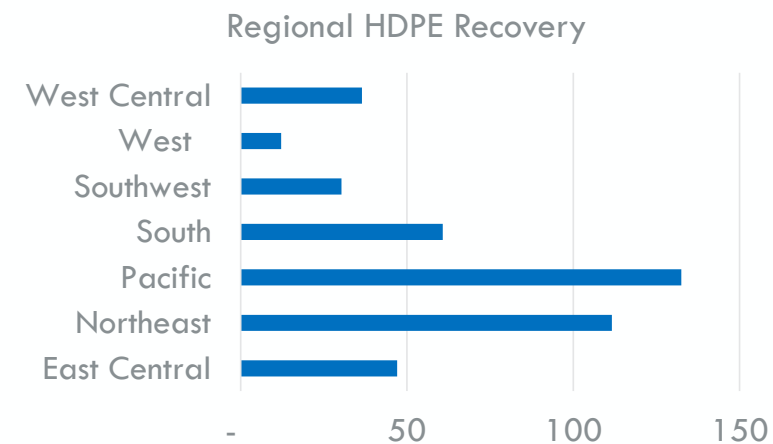
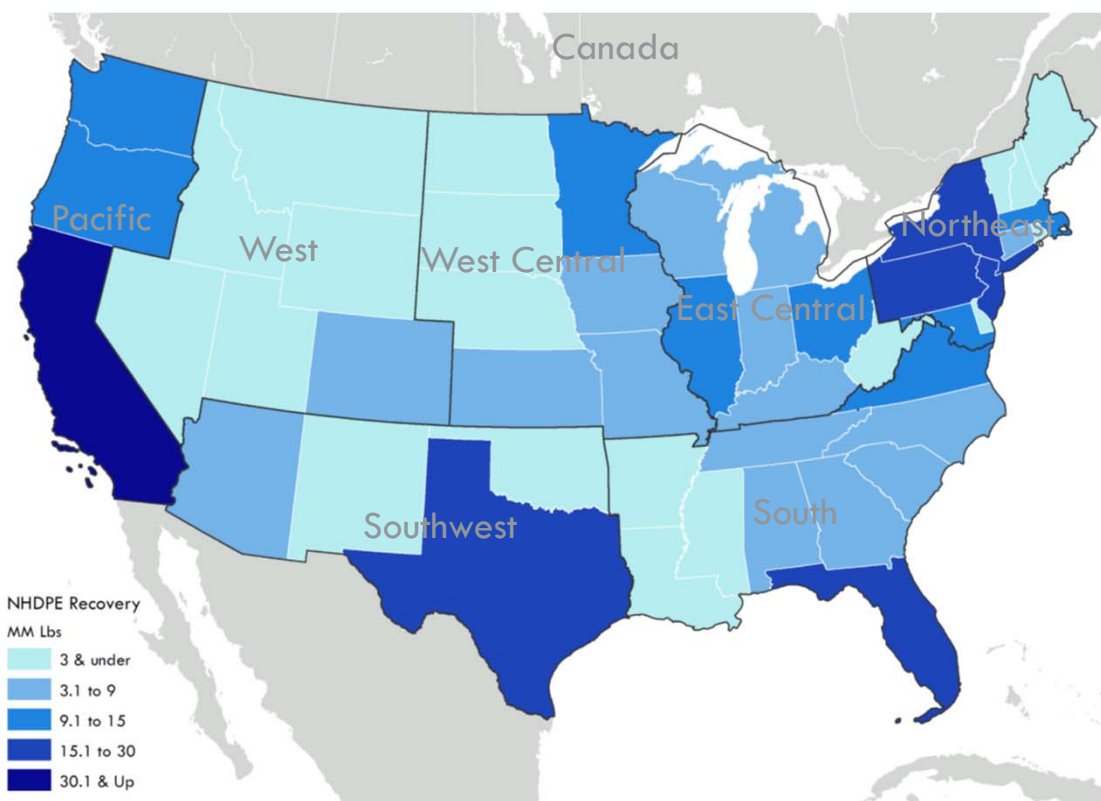


Regional HDPE Generation



Source: RRS Calculation based on national resin sales numbers (ACC/APR, 2018) and regional gallonage (BMC, 2018)

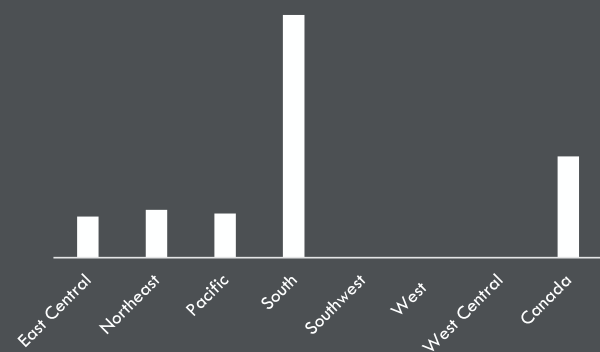
REGIONAL rHDPE SUPPLY



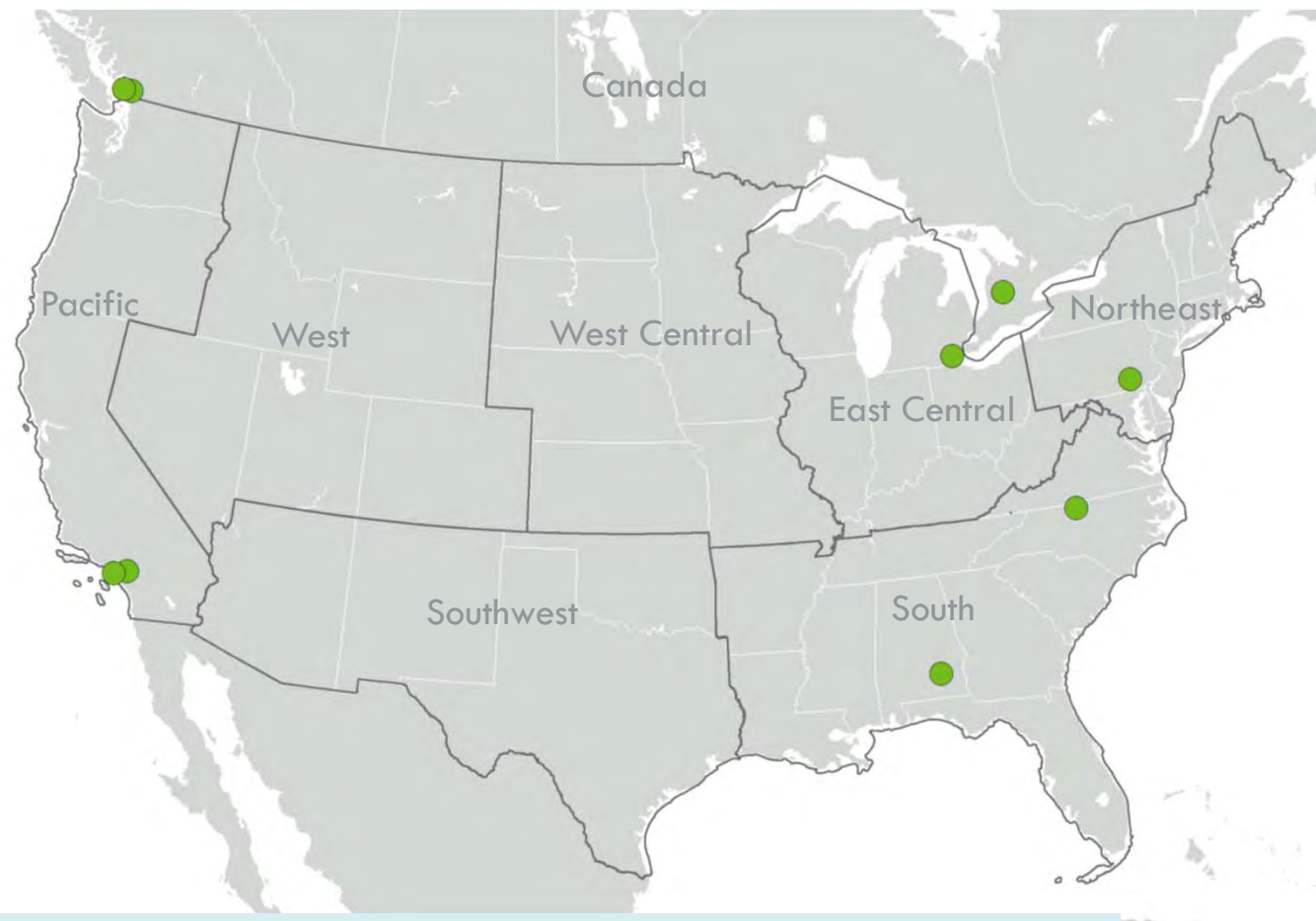
Source: RRS Calculation based on national recovery (APR/ACC, 2018) and State plastic recovery rate (Themelis and Mussche, 2014)

NHDPE RECLAIMERS

Regional NHDPE Reclamation

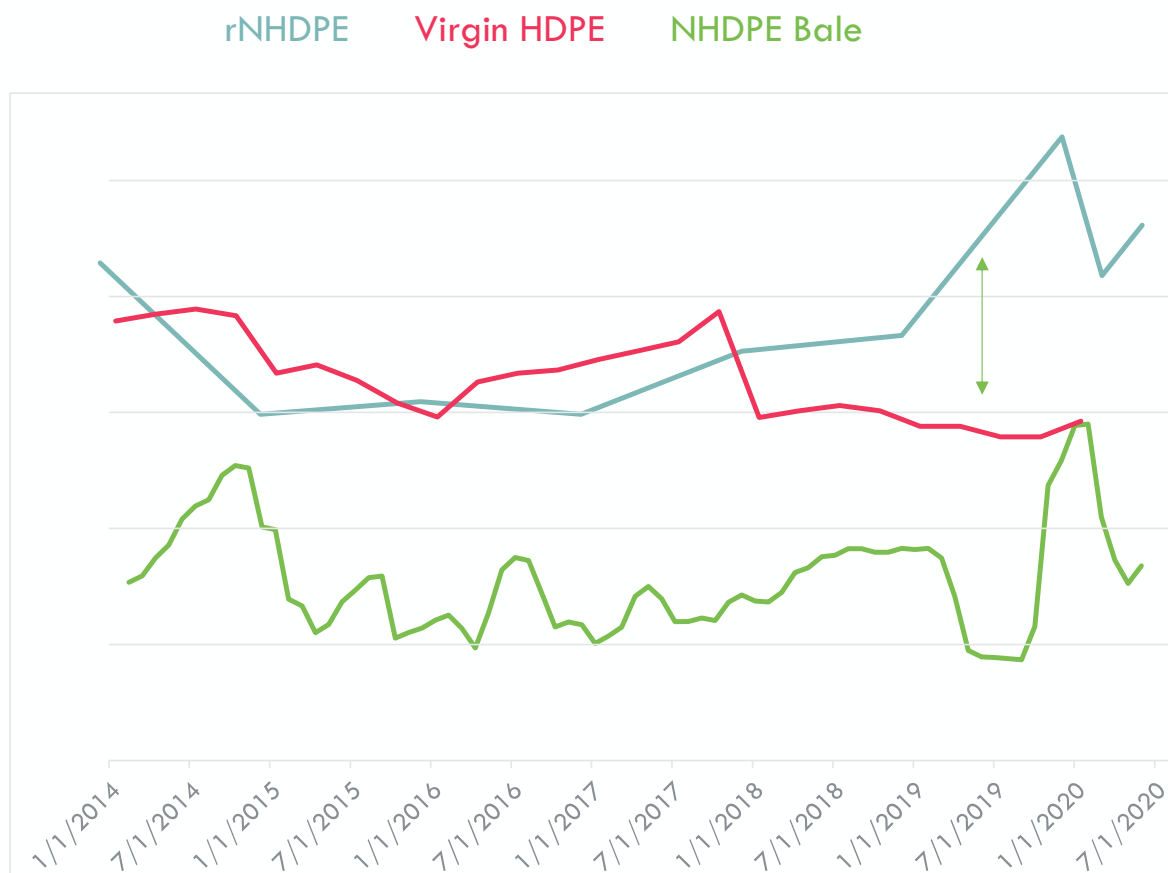


Largest NHDPE Reclaimers located in the South




18 Letters of Non-Objection (LNO) for food contact HDPE, nine since 2016. LNO based on controlled feedstock (food grade HDPE) and process technology. Two reclaimers above have food contact HDPE LNOs: Envision and KW.

HDPE MARKET FUNDAMENTALS: MARKET PRICES



- Decoupling of Virgin and PCR due to policy and scarcity
- NHDPE Bale average is \$.30/lb more than CHDPE
- MRFs and new recyclers starting to sort more natural from color due to large difference in price – Z-Bales leaving the market
 - Z-bales are mixed Natural and Colored HDPE

The image features three white, high-density polyethylene (HDPE) jugs standing on a rustic wooden plank surface. The jug on the left has a yellow cap, while the two jugs on the right have purple caps. A semi-transparent green rectangular box is positioned in the center, containing the title text. In the top-left corner, there is a small red triangle pointing downwards.

HDPE GAP MODEL RESULTS: SELECT SCENARIOS

SCENARIO 1: 25% RECYCLED CONTENT (RC) TARGET BY 2025 FOR ALL STATES

PRIMARY OUTPUTS: WATER BOTTLE TARGET (million lbs)

rNHDPE Needed To Meet Water Bottle Target	rNHDPE Needed To Meet Water Bottle Target And Maintain Other End Uses	Additional rNHDPE Needed To Meet Water Bottle Target And Maintain Other End Uses	NHDPE Collection Needed To Meet Water Bottle Target	NHDPE Collection Needed To Meet Water Bottle Target And Maintain Other End Uses	Additional NHDPE Collection Needed To Meet Water Bottle Target And Maintain Other End Uses	Increase In NHDPE Recycle Rate To Meet Scenario Target
43	429	106	51	557	127	10%

Current NHDPE Bottle Recovery:

29%

NHDPE Bottle Recovery Rate Needed To Meet Target:

38.5%



SCENARIO 2: 50% RC TARGET BY 2030 FOR ALL STATES

PRIMARY OUTPUTS: WATER BOTTLE TARGET (million lbs)

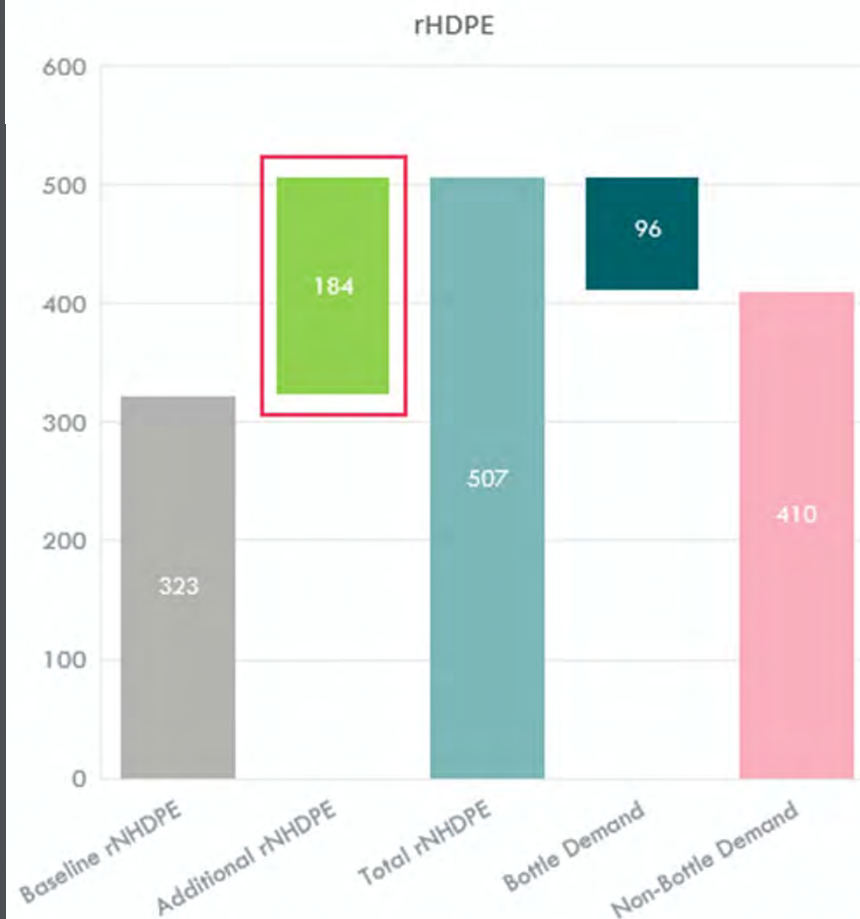
rNHDPE Needed To Meet Water Bottle Target	rNHDPE Needed To Meet Water Bottle Target And Maintain Other End Uses	Additional rNHDPE Needed To Meet Water Bottle Target And Maintain Other End Uses	NHDPE Collection Needed To Water Bottle Target	NHDPE Collection Needed To Meet Water Bottle Target And Maintain Other End Uses	Additional NHDPE Collection Needed To Meet Water Bottle Target And Maintain Other End Uses	Increase In NHDPE Recycle Rate To Meet Scenario Target
96	507	184	115	649	219	17.5%

Current NHDPE
Bottle Recovery:

29%

NHDPE Bottle Recovery
Rate Needed To Meet
Target:

46%



SCENARIO 3: 75% RC TARGET BY 2030 FOR ALL STATES

PRIMARY OUTPUTS: WATER BOTTLE TARGET (million lbs)

rNHDPE Needed To Meet Water Bottle Target	rNHDPE Needed To Meet Water Bottle Target And Maintain Other End Uses	Additional rNHDPE Needed To Meet Water Bottle Target And Maintain Other End Uses	NHDPE Collection Needed To Water Bottle Target	NHDPE Collection Needed To Meet Water Bottle Target And Maintain Other End Uses	Additional NHDPE Collection Needed To Water Bottle Target And Maintain Other End Uses	Increase In NHDPE Recycle Rate To Meet Scenario Target
144	555	232	172	707	276	21.6%

Current NHDPE
Bottle Recovery:

29%

NHDPE Bottle Recovery
Rate Needed To Meet
Target:

50.4%





KEY TAKEAWAYS




KEY TAKEAWAYS

- rPET has more significant implications for bottled water companies
- Supply is biggest barrier for PET content scenarios – flat collection and quality concerns
- Existing bottle grade rPET production capacity in the USA is underutilized
- rNHDPE food grade applications are nascent and present challenges related to technical feasibility, supply availability and cost



KEY TAKEAWAYS

- All PCR content growth scenarios are challenging
- Difficult to see pathway for $> 25\%$
- Bottle grade rPET end uses compete with fiber and sheet end markets
- Commitments for polyester textiles may exacerbate demand gap
- Advanced recycling of non-bottle PET and textiles present additional opportunity but are unproven at scale

A photograph showing a hand holding a clear plastic bottle, tilted as if pouring. Below the hand is a large pile of discarded plastic bottles of various shapes and colors (clear, blue, red). The background is a blurred outdoor scene with sunlight. A green rectangular box with white text is overlaid on the right side of the image.

SYSTEM REQUIREMENTS AND COST FACTORS

IN ORDER TO MEET 25% RECYCLED CONTENT (RC) TARGET BY 2025 FOR PET



On average every person in the US must recycle **273** bottles per year. This would require...



Strong policy intervention:

- Optimized container deposit
- Mandatory recycling and automatic curbside / parallel access



Significant infrastructure:

- Collection best practices (e.g., carts, auto subscription)
- Deposit redemption (reverse vending, bottle drop)
- MRF upgrades
- Doubling of reclamation capacity

HYPOTHETICAL COLLECTION COSTS FOR ADDITIONAL PET REQUIRED TO MEET TARGETS — LBS/\$1.00



Type of System	Expected lbs/\$	Cost for 25%	Cost for 50% by 2030	Cost for 75% by 2030
Average Curbside	.3	\$8B	\$19B	\$28B
High cost deposit	.60	\$4B	\$9.5B	\$14B
Optimized deposit	5.85	\$425M	\$1B	\$1.45B

Note: Costs include estimate of scrap value based on 2018 National scrap value averages; represents full system cost (not distributor cost), does not include infrastructure investment costs for reclamation



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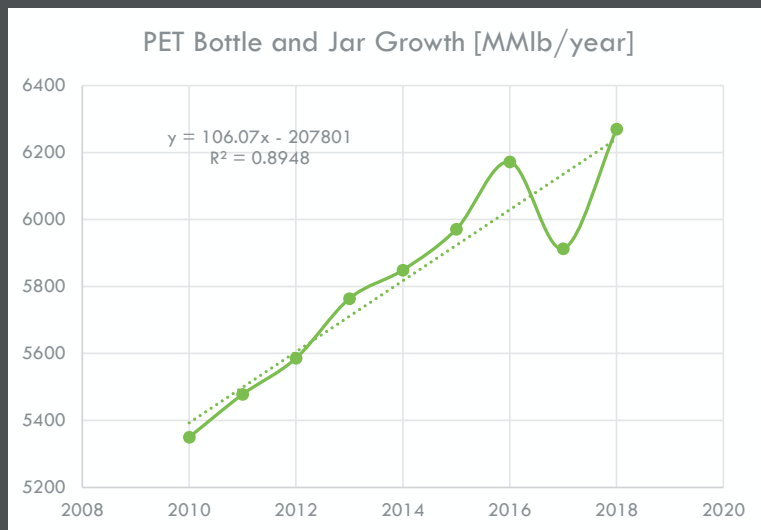


STAFF MEMBER	PROJECT ROLE	YEARS OF EXPERIENCE
Resa Dimino	Project Director / Research and Analysis	28
Kate Eagles	Project Advisor / Research and Analysis	28
Bryce Hesterman	Project Manager / Research and Analysis	16
Holly Halliwill	Project Administrator / Research and Analysis	3
Erin Grimm	Graphic Design, Map Design	11

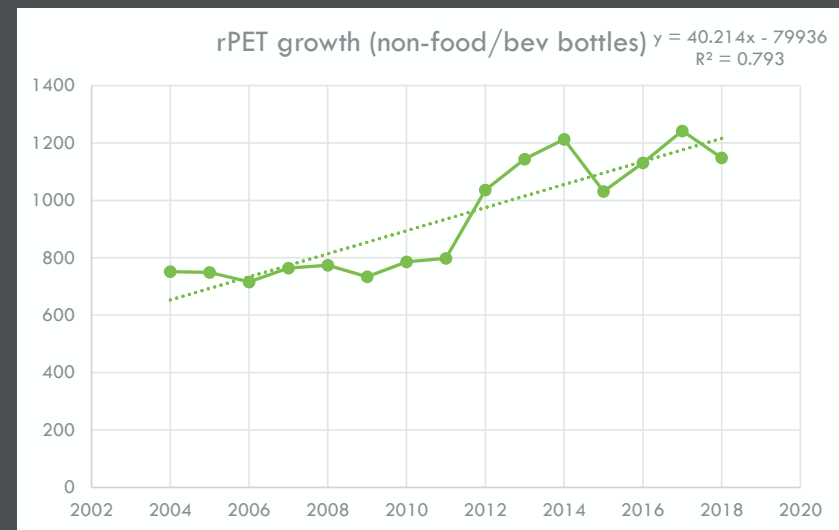


APPENDIX

GROWTH RATE ASSUMPTIONS

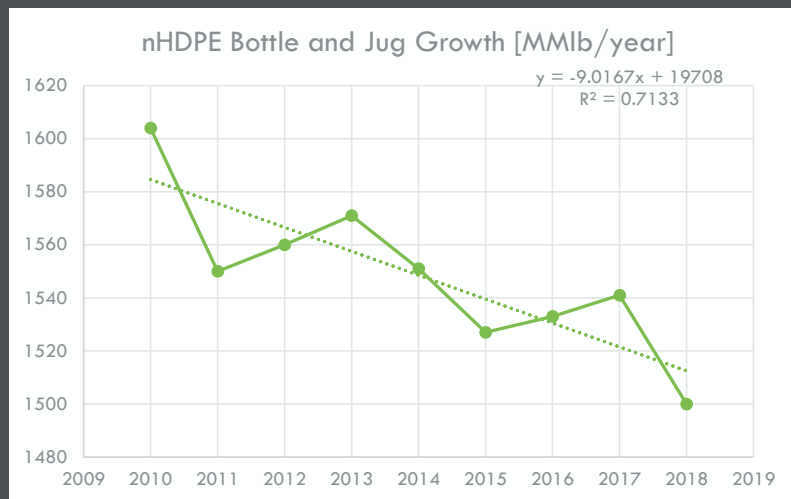


Source: NAPCOR Post Consumer Bottle Recycling Rate Reports

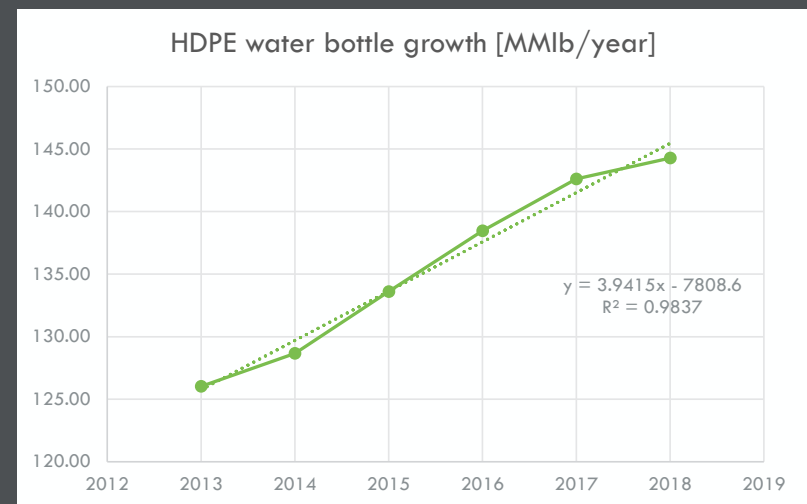


Source: NAPCOR Post Consumer Bottle Recycling Rate Reports

GROWTH RATE ASSUMPTIONS



Source: ACC/APR Post Consumer Bottle Recycling Rate Reports



Source: BMC gallonage and RRS/IBWA sampled and measured bottle weights