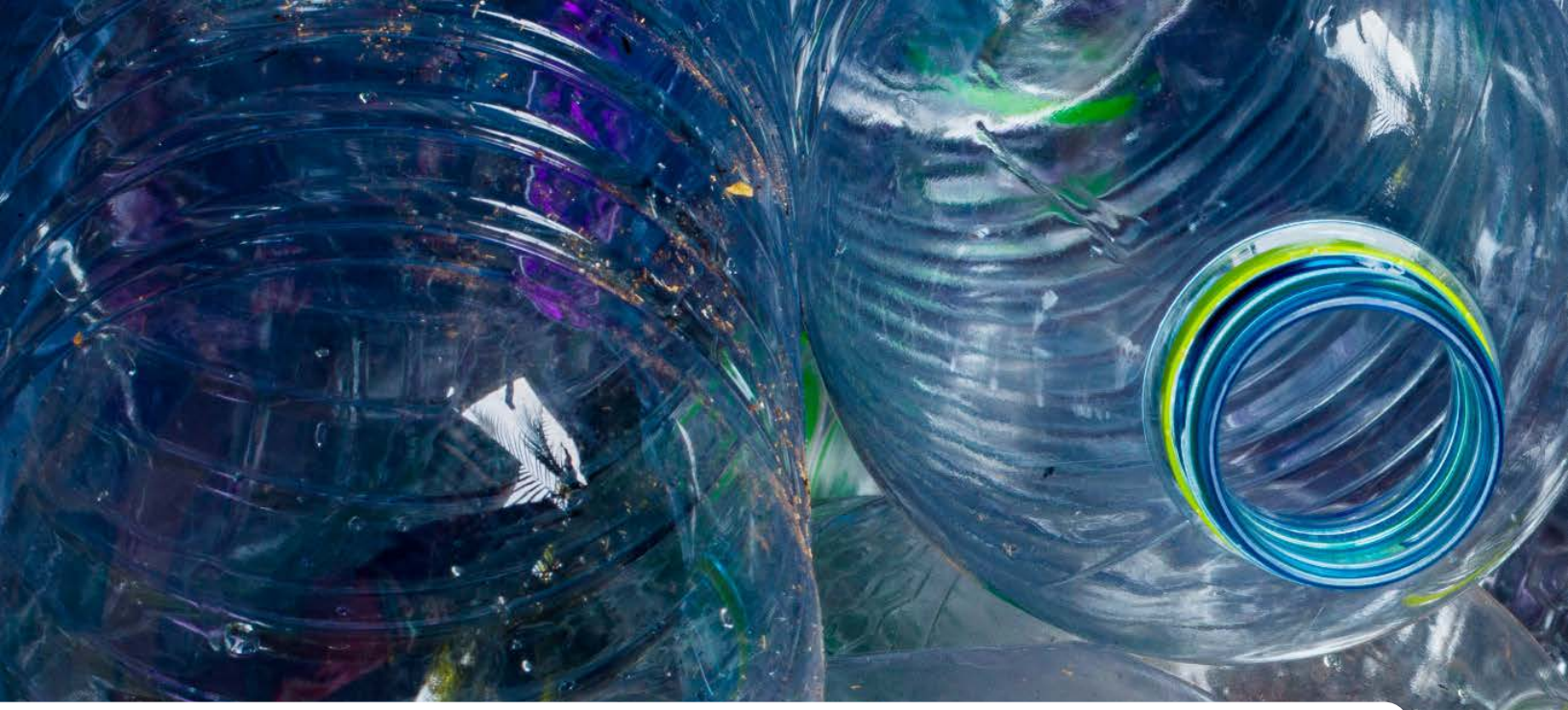

Recycled Content Use in Washington

Assessing Demand, Barriers, and Opportunities

Prepared for the Washington State Department of Ecology

June 1, 2020

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Authors

This report was authored by Cascadia Consulting Group and Full Circle Environmental with support from MORE Recycling. We have taken due care in the preparation of this report to ensure that all facts and analysis presented are as accurate as possible within the scope of the study. However, no guarantee is provided with respect to the information presented, and Cascadia Consulting Group, Full Circle Environmental, and MORE Recycling are not responsible for decisions or actions taken on the basis of the content of this report.

Executive Summary

The Washington State Department of Ecology (Ecology) hired an independent third-party consultant team to study how plastic packaging is managed in Washington and assess various policy options to meet the following goals:

- Packaging sold into the state is 100 percent recyclable, reusable, or compostable by January 1, 2025.
- Packaging sold into the state incorporates at least 20 percent post-consumer recycled content by January 1, 2025.
- Plastic packaging is reduced when possible and optimized to meet the need for it.

This report is focused on the second goal – how to increase the use of post-consumer recycled content in Washington, and is one of several sub-reports that will inform final recommendations to the Washington State Legislature to reduce plastic packaging in the waste stream.

For this report, the consultant team identified and reached out to over 70 plastic converters, manufacturers, fabricators, distributors, and reprocessors in the region to learn about their operations and use of recycled content. While many of these businesses did not respond to requests for information, we interviewed 12 plastic manufacturers and converters and four reprocessors about their ability to market and use post-consumer resin (PCR) in their products, barriers to sourcing or incorporating more post-consumer recycled plastic into their products, and potential solutions to those barriers.

Key barriers cited by manufacturers include:

- **Lack of supply** – the recycling rates for plastics—even the most common and readily recyclable resins such as PET—are too low to produce the quantities of PCR demanded by large consumer packaged goods (CPG) companies. Many previously recyclable rigid packaging formats are also moving to flexible, multi-layer, multi-material packaging that cannot be recycled.

  While temporary, suspension of curbside recycling programs and deposit return systems (DRS) in some states due to COVID-19 has led to even further reductions in material available for reprocessing into PCR.

- **Cost compared to virgin resin** – while PCR may have been more competitive in the past, the low price of oil and the shale gas boom in the U.S. have led to a dramatic reduction in the price of virgin resin, making it virtually impossible for PCR to compete.

- **Material quality** – PCR often requires investments in manufacturing machinery and process adjustments. Material inconsistencies of PCR can make it challenging to work with, compromise product performance, and add costs. Depending on application performance requirements, there are also limitations to the amount of PCR that can be incorporated into products with recycled content.

- **Regulatory requirements** – reprocessors must obtain FDA approval before marketing their PCR for use in food-contact packaging via a letter of no objection (LNO). The limited number of reprocessors with this designation means that the supply of food-grade PCR is even more constrained than PCR overall.

- **Consumer perception** – companies and consumers often perceive recycled content material to be of lower quality than virgin resin, and are unwilling to pay a higher price.

Like the barriers identified, many of the potential solutions to address them are interrelated and mutually reinforcing. The biggest opportunities lie in increasing the volume and the quality of recycled materials for reprocessing into high-quality PCR that can then be used in place of virgin resin in new products and packaging. Options for policy approaches and technological improvements to do this include:

- **Improving collection, sorting, and processing technology** – separate (non-commingled) collection systems, advances in sorting technology at existing materials recovery facilities (MRFs), or investment in secondary processing infrastructure such as a secondary MRF or plastics recovery facility (PRF) could help to increase both the amount of resin recovered and the quality of materials for reprocessing.
- **Increasing collection volumes and quality through policy** – policies such as deposit return systems (DRS) for beverage containers or extended producer responsibility (EPR) for packaging have increased the amount and quality of plastic packaging recovered for reprocessing in places where they have been implemented.
- **Recycled content minimums and design guidelines** – while Washington's recent bill requiring recycled content in plastic beverage containers was vetoed due to COVID-19-related fiscal considerations, other recycled content laws for products such as garbage bags in California have predictably led to an increase in the use of PCR. Design guidelines and incentives that encourage manufacturers and brand owners to use easy-to-recycle packaging could also increase the amount and quality of plastic packaging available for reprocessing.

Other solutions to help drive the market for and use of plastic packaging as PCR include:

- **Procurement requirements** – governments have long used environmentally preferable purchasing requirements for products such as paper and electronics with recycled content, which has driven the market for products with those attributes.
- **R&D and market development support** – research and development support, financial assistance and incentives, and programs to increase data sharing and collaboration among stakeholders across the value chain could help address challenges in a more coordinated way.
- **Consumer education** – education and outreach about proper recycling behavior and the need for recycled content in a closed loop economy can help increase the quantity and quality of recyclable material while driving demand for products with recycled content.
- **Industry initiatives** – partnerships and pilots for design, recycled content, and material recovery challenges can serve as proving grounds for solutions with potential to scale.

Glossary of Key Terms and Acronyms

Blow molding	A plastic production process (commonly used to produce singular, hollow containers such as bottles) whereby a preform plastic tube is heated and filled with air to form a balloon-like shape around which a mold is clamped to shape the final product.
Consumer Packaged Goods (CPG) companies	Also called brand owners or fast-moving consumer goods (FMCG) companies, these companies make consumer products that are sold quickly and at relatively low cost, including packaged foods and beverages, toiletries and personal care items, and other consumables. Some of the largest CPGs include Coca-Cola, Nestlé, Proctor & Gamble, General Mills, Unilever, PepsiCo, AB InBev, Johnson & Johnson, and L'Oréal. (For purposes of packaging regulation in programs around the world, these firms are often considered the producer or manufacturer of both the packaging and product contained in the package.)
Deposit return system (DRS)	Also called container deposit systems or "bottle bills," these laws place a small, refundable deposit on beverage containers which is returned to consumers when they return empty containers to a redemption location. Ten states and one territory (Guam) in the U.S. have DRS programs covering 28 percent of the population. DRS programs account for 47 percent of all beverage containers recycled in the U.S. [1].
Expanded polystyrene (EPS)	A rigid cellular plastic foam found in a multitude of shapes and applications, commonly (though often incorrectly) referred to by the brand name "Styrofoam."
Extended Producer Responsibility (EPR)	A mandatory type of product stewardship that includes, at a minimum, the requirement that the manufacturer's responsibility for its product extends to post-consumer management of that product and its packaging. There are two related features of EPR policy: (1) shifting financial and management responsibility, with government oversight, upstream to the manufacturer and away from the public sector; and (2) providing incentives to manufacturers to incorporate environmental considerations into the design of their products and packaging.

Extrusion	A plastic production process whereby resin is melted and continuously pushed through a die to shape it, then cooled and cut to size. Extrusion can be used for rigid plastics as well as film.
High-density polyethylene (HDPE)	A strong, durable, lightweight, and chemically resistant plastic material popular for a variety of applications, including rigid plastics as well as flexible films. Coded as plastic resin #2.
Injection molding	A plastic production process (commonly used to make solid plastic parts) whereby liquid resin is injected into a mold and then cooled.
Low-density polyethylene (LDPE)	A soft, flexible, lightweight plastic material. It is often used for sandwich bags and cling wrap but can also be used in rigid applications. Coded as plastic resin #4.
Materials recovery facility (MRF)	Also called a processor, an establishment primarily engaged in sorting fully or partially mixed recyclable materials into distinct categories and preparing them for shipment [2].
Letter of no objection (LNO)	Also referred to as a no objection letter (NOL) or a letter of non-objection, this letter is issued by the U.S. FDA and signifies that the agency agrees with a company's finding that a polymer produced through a particular recycling process is safe for food-contact applications. Companies must obtain this regulatory approval before marketing their post-consumer resin for use in food-contact packaging.
Preform	A small plastic bottle, resembling a test tube with threads, that is produced in the first stage of PET bottle manufacturing. PET is injection molded into a preform, which is then reheated, stretched, and blown into its final shape.
Plastic converter	A business that buys raw material and converts it to finished goods. In the case of plastics, converters transform plastic pellets of specific polymers into items such as fibers, films, sheets, and rigid packaging along with semi-durable and durable goods. Converters sell this material to CPGs or other brand owners to use for packaging their products. Many of the plastic manufacturers interviewed for this report are plastic converters.

Polyethylene terephthalate (PET)	A clear, strong, and lightweight plastic that is widely used for packaging foods and beverages, especially convenience-sized soft drinks, juices, and water. Coded as plastic resin #1.
Polypropylene (PP)	A thermoplastic used in a variety of applications to include packaging for consumer products, like yogurt pots and margarine containers and many plastic bottle caps. Coded as plastic resin #5.
Polystyrene (PS)	A transparent thermoplastic that is found as both a typical solid plastic and in the form of a rigid foam material. Often used for producing disposable cutlery and dinnerware and coded as plastic resin #6.
Polyvinyl chloride (PVC)	A common thermoplastic used in construction and generally known for its hardness. Coded as plastic resin #3.
Post-consumer resin (PCR)	A type of recycled content that comes from material generated by households or by commercial facilities in their role as end users of a product or package which can no longer be used for its intended purpose. This includes returns of material from the distribution chain [3].
Post-industrial resin (PIR)	Also called pre-consumer resin, this type of recycled content comes from material diverted from the waste stream during the manufacturing process.
Processor	Also called a materials recovery facility (MRF), these companies accept residential and commercial recyclable material and subsequently separate, bale, and sell the material as commodities to reprocessors.
Producer Responsibility Organization (PRO)	The entity (usually a not-for-profit organization) designated by a producer or producers to act on their behalf to administer an EPR or product stewardship program.

Recycling	Transforming or remanufacturing waste materials into usable or marketable materials for use other than landfill disposal or incineration. The term "recycling" as it is commonly used often also refers to the process of collecting and sorting material for reprocessing into feedstock. Where possible, we have tried to use precise language to indicate when we are referring to the process of collecting materials for recycling versus the actual transformation of used products and packaging into feedstock for new materials.
Reprocessor	Also called a reclaimer, these companies purchase post-consumer or post-industrial recycled commodities and process into resin feedstock to sell to manufacturers. For plastics reprocessors, end products include pellet, flake, and other resin products. Some vertically integrated reprocessors also have manufacturing operations and may use the recycled content feedstock that they reprocess in the production of their own products.
Thermoforming	A plastic production process whereby plastic sheets are heated and formed around a mold.

Introduction

Background

In 2019, the Washington Legislature passed the Plastic Packaging Evaluation and Assessment law (Chapter 70.380 RCW), which states that producers of plastic packaging should consider the design and management of their packaging in a manner that ensures minimal environmental impact. Per the law, the Washington State Department of Ecology (Ecology) hired an independent third-party consultant team to study how plastic packaging is managed in Washington and assess various policy options to meet the following goals:

- Packaging sold into the state is 100 percent recyclable, reusable, or compostable by January 1, 2025.
- Packaging sold into the state incorporates at least 20 percent post-consumer recycled content by January 1, 2025.
- Plastic packaging is reduced when possible and optimized to meet the need for it.

The consultant team was tasked with developing options to meet these goals that are capable of being established and implemented by January 1, 2022 for the purposes of legislative consideration.

This report is focused on the second goal – how to increase the use of post-consumer recycled content in Washington. For this report, the consultant team conducted an assessment of businesses in Washington capable of using post-consumer recycled plastic (including both plastics reprocessors as well as companies using recycled content feedstock in their manufacturing), and barriers to using or incorporating more post-consumer recycled plastic into their products. This report, which is one of several task-level sub-reports that will inform final recommendations to the Legislature, also summarizes barriers identified by reprocessors and manufacturers to using or increasing use of post-consumer recycled plastic, and provides a high-level summary of several potential policy and technology options to address these barriers.

Methodology

To gather information about post-consumer recycled content resin (called post-consumer resin, or PCR) use, the team compiled a list of companies that make or sell plastic products in the state of Washington through internet research, review of business lists, and consultation with industry and trade associations to identify relevant members. The team also identified plastic reprocessors in Washington, British Columbia (B.C.), and Oregon. While the geographic scope of the study was limited to Washington, the team recognized that several large plastics reprocessors are located just outside Washington's borders and receive material from the state. Thus, while this list is still not complete, for the sake of providing a more accurate picture of the plastics recycling landscape, we have included a subset of the reprocessors we know to be closely linked to Washington either via purchase of recyclables as feedstock, or through sale of end products.

Through our research we identified 67 companies producing or selling plastic products in Washington, including plastic converters, manufacturers, fabricators, and distributors; this list is included in Appendix A. We determined that several of these firms were fabricators using pre-formed plastic elements or distributors and thus not directly using plastic pellets or flake as a

feedstock in their production.[1] The team contacted each identified manufacturer to ask questions about their operations, production capacity and costs, use and sources of recycled content resins, and barriers to using PCR in their products. We were ultimately able to interview 12 converters and manufacturers.

The team also identified 11 plastic reprocessors in Washington and surrounding states or provinces, contacted nine, and was able to interview four to learn about their operations, production capacity and costs, materials sources and end markets, and challenges with producing and marketing PCR.

Table 1 below shows the number of firms identified during our research.

Table 1 Plastic Companies Identified

Business Type	Identified	Contacted	Unresponsive/ Declined Interview	Interviewed
Plastic Businesses (incl. converters, manufacturers, fabricators, distributors)	67	67	n/a	n/a
Plastic Manufacturers (converters, manufacturers using resin feedstock)	50[2]	50	38	12
Plastic Reprocessors	11	9	5	4

Research Limitations

In the course of our research, the team encountered barriers that precluded us from gathering information related to several of our original research questions, including specific resin quantities, origins of feedstock and destinations of end products, and production capacity and costs. Some companies also had very limited publicly available information; we were not always able to determine whether a company was a primary manufacturer of plastic products using resin pellets or flake as a feedstock, or merely a fabricator using pre-formed plastic materials. Several national or multinational companies producing plastic packaging also have distribution

[1] Though some of the firms included in our list of plastic manufacturers (Table 2 and Table 3) likely are also fabricators or distributors only, we were unable to make contact with them and so could not definitively rule them out as manufacturers able to use PCR feedstock in their production.
[2] This number likely still includes fabricators and distributors due to unresponsiveness.

or sales offices in Washington, but no manufacturing presence. We have done our best to accurately characterize these companies using available information.

Several companies contacted were also unresponsive. Anecdotally, we heard from at least one company that most manufacturers were unlikely to respond to such a request for information since it was not mandatory to disclose and we were not a potential customer.

Of the companies we did interview, several were unable or unwilling to share specific information about their products and operations or whom they buy from or sell to in order to protect supplier/customer relationships. Most manufacturers and reprocessors declined to provide specific cost information citing proprietary information and competition concerns. As such, we noted where we were unable to obtain information or where contacts were unresponsive and provided qualitative and anecdotal information where possible. Appendix A provides the full list of companies contacted through our research as well as a summary of their operations, including those who were deemed to be distributors, secondary manufacturers, or fabricators of plastic products.

Uncertainty From COVID-19

Finally, widespread disruption from the COVID-19 pandemic began just as our work got underway, providing unique complications and considerations for our research. It hindered our ability to connect with manufacturers and reprocessors as some companies were temporarily shuttered or had shifted production to COVID-related personal protective equipment (PPE) and did not have time for an interview. It also caused disruptions in recycling collection and commodities markets. The price of oil—a key factor in the price of virgin resin and already at historic lows due to the shale gas boom in the U.S.—turrned negative for the first time in history in April 2020. Some municipalities in other states also suspended collection of recyclables through curbside or DRS programs and some retailers discontinued their film and bag recycling drop-off programs, though as of the time of writing, there were not significant changes to curbside programs or materials recovery facilities (MRFs) in Washington.

We have noted areas of impact from the virus where possible. In general, it is difficult to predict what long-term impact, if any, COVID-19 will have on the demand for PCR and products made with recycled content, as well as the recycling system and commodities markets in general.

Post-consumer Versus Post-industrial Resin

When referring to plastic with recycled content, there are two main types of resin: **post-consumer resin (PCR)** and **post-industrial resin (PIR)**. As the name implies, post-consumer resin comes from plastics collected after they have been used by consumers or businesses. Post-industrial resin (also called pre-consumer resin) refers to scrap plastic produced in the industrial

manufacturing process. Many manufacturers can reuse this scrap material in their own manufacturing operations or sell it to reprocessors. Post-industrial resin is often free from various types of contamination commonly found in post-consumer plastic. Some reprocessors only accept post-industrial scrap plastic as it is a much cleaner material source.

While both types are technically considered recycled content plastic, the term "recycled content," as it is commonly used and referenced in consumer packaged goods (CPG) companies' recycled content commitments, usually refers to PCR. The Ellen MacArthur Foundation's New Plastics Economy Global Commitment, of which many of the largest CPGs are signatories, explicitly notes that their definition of post-consumer recycled material in a product or packaging "excludes pre-consumer recycled content," and that "transparency on the nature of the recycled content (i.e., post-consumer versus pre-consumer) is to be ensured whenever possible" [4].

Many manufacturers have also questioned the source of recycled content feedstock they buy from reprocessors, noting that they believe some products marketed as PCR are actually PIR. To reduce confusion and substantiate recycled content claims, the Association of Plastics Recyclers (APR) recently developed a post-consumer plastic certification program. This program uses the ISO 14021 standard that requires material to be generated by residential, commercial, industrial, and institutional facilities and excludes scrap material from manufacturing processes [5]. While the program has just recently launched, APR hopes that it will support and increase demand for PCR.

For the purposes of this study, the term "recycled content plastic" means material coming from post-consumer sources unless otherwise noted. Where we have information, we indicated manufacturers who said they used recycled content from post-industrial sources.

Plastic Manufacturers and Reprocessors in Washington

Plastic Manufacturers

The team identified 50 plastic manufacturers[3] across a wide range of sectors in Washington. Table 2 lists identified companies and the sectors in which they operate. Table 3 provides further details on the manufacturers' products, feedstock resins, and ability to use PCR in their operations. Of the twelve we interviewed, half reported currently using PCR, and over 80 percent (10 companies) reported that they wanted to use PCR (for those currently using exclusively virgin resin or PIR) or use more PCR (for those already using some PCR) but have barriers to doing so. These details are included in Table 3.

[3] As previously noted, while the team did not interview companies only fabricating or distributing plastic products, this list of 50 companies likely still includes fabricators and distributors since several companies could not be reached and thus removed from consideration.

Table 2 Plastic Manufacturers in Washington by Sector

			SECTOR													
#	Company	Location	Food & Beverage	Medical & Pharmaceutical	Building & Construction	Agricultural & Animal Care	Logistics & E-commerce	Industrial & Transportation (Marine & Automotive)	Household & Personal Care	Military & Aerospace	Retail	Electronics	Chemical	Custom	Other
1	**Aaron Packaging**	Sumner	●												
2	**Accel Plastics**	Auburn		●				●		●		●			
3	**Achilles USA**	Everett		●	●			●			●				●
4	**Aero-Plastics, Inc.**	Renton		●						●				●	
5	**Altek Inc.**	Liberty Lake						●		●					
6	**Amcor**	Tumwater, Walla Walla	●												
7	**American Plastic Manufacturing**	Seattle												●	
8	**Amtech Corporation, Inc.**	Wapato												●	
9	**Bainbridge Manufacturing, Inc.**	Waterville			●										
10	**Berry Plastics**	Tacoma, Kent	●	●	●	●		●	●		●				
11	**CFM Consolidated/ Cascade Plastics Co. Inc.**	Fife				●		●							
12	**Conrad Manufacturing Co. Inc.**	Auburn								●					
13	**Dart Container Corp.**	Lacey	●												
14	**Dolco Packaging**	Wenatchee	●	●				●	●						
15	**Elkay Plastics Co., Inc.**	Kent	●	●				●							

#	Company	Location	SECTOR												
			Food & Beverage	Medical & Pharmaceutical	Building & Construction	Agricultural & Animal Care	Logistics & E-commerce	Industrial & Transportation (Marine & Automotive)	Household & Personal Care	Military & Aerospace	Retail	Electronics	Chemical	Custom	Other
16	**Fabriform Plastics Inc.**	Seattle		●				●		●		●			
17	**Fathom**	Seattle						●						●	
18	**General Plastics Manufacturing Company**	Tacoma			●			●		●				●	●
19	**GlobalTech Plastics, LLC**	Fife		●				●		●					
20	**Insulfoam, LLC**	Frederickson			●										
21	**Kaso Plastics**	Vancouver		●	●			●		●		●			●
22	**Mantec Services Inc.**	Seattle												●	●
23	**McConkey Grower Products/Surain Industries**	Sumner				●									
24	**Oldcastle Infrastructure Inc.**	Auburn						●							●
25	**PAC Worldwide**	Redmond					●								
26	**Paragon Films**	Union Gap													●
27	**Pexco**	Tacoma			●			●						●	
28	**Pexco Aerospace**	Union Gap								●					
29	**Piller Aimmco Inc.**	Washougal		●		●		●		●		●			●
30	**Plastic Injection Molding Inc.**	Richland		●		●		●							
31	**Plastic Molded Products**	Tacoma													✶

#	Company	Location	SECTOR												
			Food & Beverage	Medical & Pharmaceutical	Building & Construction	Agricultural & Animal Care	Logistics & E-commerce	Industrial & Transportation (Marine & Automotive)	Household & Personal Care	Military & Aerospace	Retail	Electronics	Chemical	Custom	Other
32	**Plastic Sales & Service**	Lynnwood									●			●	●
33	**Plastics Northwest Inc.**	Vancouver	●	●	●			●		●					●
34	**Plasti-Fab**	Ridgefield			●	●		●					●		●
35	**Polymer Industries – UltraPoly Division**	Tacoma	●	●	●	●		●		●		●	●		●
36	**Pride Polymers LLC**	Yakima					●								●
37	**ProAmpac**	Auburn	●			●			●		●				●
38	**Quanex Building Products (Mikron Industries, Inc.)**	Kent			●										
39	**Rainier Precision**	Seattle												●	
40	**Reality Plastics**	Marysville													✶
41	**Rex Plastics**	Vancouver	●	●								●		●	●
42	**Richards Packaging, Inc.**	Auburn	●	●					●						●
43	**Saint-Gobain Performance Plastics**	Puyallup	●	●	●			●	●	●		●			●
44	**Sea-Lect Plastics**	Everett	●	●				●		●					●
45	**Sealed Air**	Renton	●	●			●		●						
46	**Shields (Novolex)**	Yakima	●											●	●
47	**Smak Plastics Inc.**	Vancouver												●	●
48	**Sonoco Plastics**	Yakima	●												
49	**Vaupell Inc.**	Seattle		●						●					

#	Company	Location	SECTOR													
			Food & Beverage	Medical & Pharmaceutical	Building & Construction	Agricultural & Animal Care	Logistics & E-commerce	Industrial & Transportation (Marine & Automotive)	Household & Personal Care	Military & Aerospace	Retail	Electronics	Chemical	Custom	Other
50	**Yakima Plastics Design & Supply**	Yakima	●			●		●		●				●	

✶*Sector unclear, manufacturer did not have a website and did not respond to interview request.*

Table 3 Plastic Manufacturers in Washington

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
1	**Aaron Packaging**	Bottle and thermoform manufacturer of food service packaging.	PP, HDPE, LLDPE	No information available	No information available
2	**Accel Plastics**	Thermoform manufacturer for transportation, medical, aerospace, and electronics applications.	PE, Polycarbonate (purchase formed sheets, not resin)	Oregon	PCR not compatible with resin needs.
3	**Achilles USA**	Film manufacturer specializing in marine, automotive, graphics, medical and healthcare, industrial, window, stationary, and graphic specialty films.	PE, PVC	No information available	No information available
4	**Aero-Plastics, Inc.**	Injection molding manufacturer for aerospace, medical devices, and high-performance commercial applications.	No information available	No information available	No information available
5	**Altek Inc.**	Contract manufacturer for aerospace, military, and industrial applications.	No information available	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
6	**Amcor**	Multinational packaging manufacturer. WA facilities produce PET preforms and bottles for beverage industry.	PET	Confidential	Currently using some PCR (amounts confidential). PCR use is driven by CPG customer demand, which has increased dramatically over the past few years. Interested in using more PCR but barriers include lack of supply due to LNO requirement and cost.
7	**American Plastic Manufacturing**	Custom plastic bag manufacturer for retail, industrial uses, tradeshows, and restaurant takeout.	HDPE, LDPE	Confidential	Use up to 15% PIR, mainly their own manufacturing waste. Interested in using more PCR but barriers include material quality, lack of supply, and need for equipment upgrades to run PCR.
8	**Amtech Corporation, Inc.**	Custom composite products fabricator.	PVC	No information available	No information available
9	**Bainbridge Manufacturing, Inc.**	Manufacturer of plastic hardware for cabinets, closets, and furniture.	No information available	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
10	**Berry Plastics**	Multinational packaging manufacturer specializing in food and beverage, food service, building and construction, filtration, personal care, medical, industrial and transportation, cannabis, and agriculture applications.	No information available	No information available	No information available
11	**CFM Consolidated/ Cascade Plastics Co., Inc.**	Plastic manufacturer specializing in automotive products as well as hatchery equipment and supplies.	No information available	No information available	No information available
12	**Conrad Manufacturing Co., Inc.**	Manufacturer of aerospace components.	No information available	No information available	No information available
13	**Dart Container Corporation**	Single-use foodservice packaging manufacturer. WA facility produces EPS foam and cups.	PS in WA, PET and PP at other facilities	Confidential	Don't currently use PCR for products made in WA, though their other manufacturing facilities do. Interested in using more PCR but barriers include lack of supply due to LNO requirement or color, poor material quality, and cost.

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
14	**Dolco Packaging**	Subsidiary of Tekni-Plex which manufactures thermoforms for medical and food packaging applications. WA facility produces PS egg cartons, meat trays, apple and pear flats, and takeout containers.	PS in WA	American Styrenics, Total, Plastic Recycling Inc. (for PCR)	Use up to 40% PIR from own operations as well as PCR depending on customer specifications. Interested in using more PCR but barriers include lack of availability due to LNO requirement, poor material quality, and viscosity range variability.
15	**Elkay Plastics Co., Inc.**	Film manufacturer for foodservice, industrial, and healthcare sectors.	HDPE, LDPE	No information available	No information available
16	**Fabriform Plastics Inc.**	Manufacturer and fabricator for aerospace, medical/dental, life sciences, gaming, semiconductor, marine, and transportation sectors.	No information available	No information available	No information available
17	**Fathom**	Injection molding manufacturer for advanced manufacturing applications.	No information available	No information available	No information available
18	**General Plastics Manufacturing Company**	Manufacturer of foam and composite parts for aerospace, building/construction, marine, medical, signage, sports/rec, blast mitigation, and nuclear containment applications.	Polyurethane, Polycarbonate, Acrylic, PVC	No information available	No information available
19	**GlobalTech Plastics, LLC**	Injection molding manufacturer for aerospace, medical, and transportation applications.	No information available	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
20	**Insulfoam, LLC**	Subsidiary of Carlisle Companies, manufacturer of EPS insulation for construction applications.	PS	No information available	No information available
21	**Kaso Plastics**	Injection molding manufacturer for automotive, medical, and residential applications.	ABS, Polycarbonate, Nylon	PolyOne Corporation, Chase, Nexeo, Denton, M. Holland Company, Calsak, others	Currently use 5-15% PCR, interested in using more but barriers include lack of customer demand and material quality/consistency.
22	**Mantec Services Inc.**	Manufacturer of bumper guards and protection products, as well as custom molded rigid foams for aerospace, military, industrial, and automotive applications.	Urethane, PE, PE/EVA copolymers	No information available	No information available
23	**McConkey Grower Products/Surain Industries**	Thermoforming and injection molding manufacturer specializing in agricultural plastic and currently manufacturing face shields in response to COVID-19 from recycled PET.	Post-consumer PP and post-consumer PET	Merlin Plastics (BC), ORPET, Northwest Polymers (OR), Bay Polymer (CA)	~50% PCR and 50% PIR. Interested in using more PCR but barriers include lack of reliable supply, material quality/consistency, and lack of public/private investment in recycling infrastructure to support supply.
24	**Oldcastle Infrastructure Inc.**	Manufacturer specializing in stormwater infrastructure and building materials.	No information available	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
25	**PAC Worldwide**	Film manufacturer for courier, e-commerce, fulfillment, and distribution applications.	HDPE, LDPE	No information available	No information available
26	**Paragon Films**	Film manufacturer of stretch films.	No information available	No information available	No information available
27	**Pexco**	Manufacturer of specialty plastic products. WA facility specializes in traffic safety market products, chain-link fence enhancement products, lighting, and custom plastics.	No information available	No information available	No information available
28	**Pexco Aerospace**	Extrusion manufacturer of aerospace components.	No information available	No information available	No information available
29	**Piller Aimmco Inc.**	Injection molding manufacturer for sports/outdoor rec, automotive/heavy trucking, medical devices/biotech, consumer electronics, industrial, agricultural, and aerospace/military applications.	PP, HDPE	No information available	No information available
30	**Plastic Injection Molding Inc.**	Injection molding manufacturer for small tools, instrumentation, agricultural products, prosthetic components, and consumer products, including packaging.	No information available	No information available	No information available
31	**Plastic Molded Products**	Plastic fabrication company	No information available	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
32	**Plastic Sales & Service**	Manufacturer specializing in envelopes, retail displays, durable menus, cards and badges, lamination, and plastic accessories.	PVC	No information available	No information available
33	**Plastics Northwest Inc.**	Injection molding manufacturer for construction, heavy equipment, aviation, playground equipment, outdoor rec, landscaping, hospital and medical, and food packaging applications.	No information available	No information available	No information available
34	**Plasti-Fab**	Subsidiary of Ershigs, Inc. Manufacturer of water and wastewater treatment and control equipment and structural composite manufacturing for industry applications.	No information available	No information available	No information available
35	**Polymer Industries - UltraPoly Division**	Extrusion and compression molding manufacturer for aerospace, agricultural, automotive, construction, chemical, food and beverage, marine, medical, industrial, sports/rec, transportation, and water/wastewater applications.	No information available	No information available	No information available
36	**Pride Polymers LLC**	Manufacturer of recycled content packaging for shipping and logistics.	Post-consumer PET	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
37	**ProAmpac**	Film manufacturer for frozen food packaging applications.	PE	Dow, Exxon, Chevron, other major PE suppliers	Currently use some PIR (amounts confidential). Interested in using more PCR but barriers include material quality.
38	**Quanex Building Products (Mikron Industries, Inc.)**	Plastic manufacturer for windows and building components.	No information available	No information available	No information available
39	**Rainier Precision**	Custom injection molding manufacturer	No information available	No information available	No information available
40	**Reality Plastics**	Plastic fabricator	No information available	No information available	No information available
41	**Rex Plastics**	Custom injection molding manufacturer	No information available	No information available	No information available
42	**Richards Packaging, Inc.**	Glass and plastic container manufacturer, importer, and distributor for food, health care, and industrial applications. Auburn location supplies glass containers.	No information available	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
43	**Saint-Gobain Performance Plastics**	Multinational plastics manufacturer specializing in high-performance engineered polymers for multiple industries. WA facility manufactures adhesive tapes and films.	Polytetrafluoro-ethylene (PTFE) film	Dupont, Daikin, Gujarat Fluoro-chemicals, Dongyue	Currently 100% virgin material. Interested in using recycled content but barriers include defects from using recycled resin in PTFE processes.
44	**Sea-Lect Plastics**	Injection molding manufacturer for marine, sports/rec, musical instrument, military, beverage, and PPE mask applications.	No information available	No information available	No information available
45	**Sealed Air**	Thermoform, film, and foam manufacturer for food, medical, e-commerce and logistics, and consumer goods applications.	No information available	No information available	No information available
46	**Shields (Novolex)**	Subsidiary of multinational packaging manufacturer Novolex. Shields facility produces film for food and beverage packaging, banking, and custom applications.	HDPE, LDPE	Confidential	Currently using some PCR (amounts confidential).
47	**Smak Plastics Inc./Columbia Manufacturing**	Injection molding manufacturer specializing in bins and storage applications.	No information available	No information available	No information available

#	Company	Description	Resin Type	Material Origin	Current PCR Use & Potential Use (tons/year)
48	**Sonoco Plastics**	Multinational packaging manufacturer. WA facility manufactures PET thermoform clamshell packaging for produce (blueberries, strawberries lettuce, etc.).	PET	Suppliers confidential but WA facility sources from West Coast suppliers.	Currently using some PCR (amounts confidential). Interested in using more but barriers include cost, material quality, and lack of supply due to LNO requirement.
49	**Vaupell Inc.**	Injection molding manufacturer for aerospace, military, and medical applications.	No information available	No information available	No information available
50	**Yakima Plastics Design & Supply**	Injection molding manufacturer specializing in custom-machined parts for agribusiness, animal husbandry, food processing, aerospace, manufacturing, conveyor systems, off-road vehicles, and marine applications.	ABS, Acrylic, HDPE, PS, Nylon, Polycarbonate, PVC, PTFE, Urethane, etc.	No information available	No information available

Plastic Reprocessors

The team also identified 11 plastic reprocessors in Washington and the surrounding region that process material from or sell into the state, though as previously noted, this is not a complete list (there are 32 reprocessors on the West Coast, including Washington, Oregon, California, and British Columbia). Table 4 below includes information about these reprocessors and the materials they process.

Table 4 Plastic Reprocessors in Washington and Surrounding Region

#	Company	Location	Description	Materials Processed
1	**Agilyx**	Tigard, OR	Chemical recycler turning mixed plastics and discrete polymers into custom petrochemical products.	PS (R&D underway for other plastics)
2	**Agri-Plas**	Brooks, OR	Agricultural plastics reprocessor collecting, sorting, and processing plastic crop containers from Oregon, Washington, Idaho, and Utah.	Baling twine, chemical jugs and drums, buckets, greenhouse film, LDPE foam and shrink wrap, trays and crates.
3	**Dart Container Corporation**	Lacey, WA	Food and beverage packaging manufacturer that also collects and recycles/resells EPS to manufacturers of other products.	EPS
4	**Denton Plastics**	Portland, OR	Post-consumer plastics reprocessor recycling plastics, making custom compounds, and distributing PCR and virgin pellets and powder.	PET, HDPE, PVC, LDPE/LLDPE, PP, PS/EPS, ABS
5	**Fraser Plastics**	Maple Ridge, B.C., Canada	Post-consumer and post-industrial reprocessor that recycles colored and natural HDPE into PCR pellets and flake.	HDPE
6	**Merlin Plastics**	Delta, B.C., Canada	Post-consumer plastic reprocessor turning plastic container packaging into pellet and flake.	PET, HDPE, LDPE, PP
7	**Northwest Polymers**	Molalla, OR	Post-industrial plastic reprocessor buying material from the western U.S. and Canada.	No information available

#	Company	Location	Description	Materials Processed
8	**Pride Polymers**	Yakima, WA	Post-industrial and post-consumer plastic reprocessor that also manufactures packaging for logistics and shipping applications.	PET, HDPE, PP
9	**Rainier Plastics, Inc.**	Yakima, WA	Post-industrial plastics reprocessor baling, shredding, grinding, densifying, pelletizing, and blending raw materials for the plastics industry.	LDPE, HDPE, PP, ABS, Polycarbonate, Acrylic, bags, sheets, rollstock
10	**Styro Recycle LLC**	Kent, WA	EPS reprocessor, LDPE film consolidator.	EPS
11	**Westcoast Plastic Recycling Inc.**	Langley City, B.C., Canada	Post-consumer film reprocessor and broker of other recycled materials.	LDPE film

Barriers to Recycled Content Use

Some of the key barriers to using or increasing the use of PCR shared by the manufacturers and reprocessors interviewed are summarized in this section. While some plastic manufacturers did note that they use recycled content plastic in their manufacturing, some indicated that the plastic was from post-industrial sources rather than post-consumer. For manufacturers in Washington and elsewhere, several challenges often prevent PCR from being a financially or technologically feasible option under current conditions. Often these barriers are outside of their control, and many expressed concern that Chapter 70.380 RCW will begin to force manufacturers to use a material source that does not yet exist at a viable scale or cost.

The plastic manufacturers interviewed often expressed similar barriers to using recycled materials for their products made or sold in Washington. All these barriers—a lack of supply, relative cost, material quality, regulatory hurdles, and consumer perception—are interrelated and, therefore, must be considered and addressed collectively.

Supply Side Barriers

Lack of Supply

One of the key barriers to using PCR, even by manufacturers who are willing and able to use it, is a lack of supply that meets their specifications. The desired supply ultimately hinges on a combination of factors discussed below, including regulatory hurdles, demand from consumers, and demand from CPG companies. Even manufacturers currently using a small amount of PCR stated that their ability to increase use depends on the available supply. They noted that the supply of desirable PCR that meets their packaging specifications is even more constrained than the overall supply of PCR, especially for food-grade packaging.

Of the approved materials, an even smaller portion meets the strict requirements of CPG companies that buy packaging materials to use for their products. Packaging appearance is important to brand owners, and thus CPGs often want clear, "natural," or white resin for their packaging, but much of the PCR available is gray or black (though smaller, more expensive quantities of natural PCR are available). One manufacturer explained that this is partially caused by the direct application of ink by brand owners on clear packaging, such as bottles, which changes the color of the material when it is reprocessed.

Some manufacturers and reprocessors cited concerns about recent or expanding material bans—such as those for plastic bags and EPS—directly harming their business but also reducing the supply of high-quality material for recycled content plastic. California, for example, has seen a reduction in store drop-off locations for film following the statewide bag ban.[4] Material substitutes in response to bans can also lead to material stream contamination during reprocessing, highlighting the need to identify preferable alternatives before instituting a ban.

One reprocessor noted that some manufacturers have switched to polypropylene or other mixed plastic products from polystyrene in anticipation of bans or in response to negative consumer perception. Some of this material still resembling polystyrene (foam trays, for

[4] Though as a majority of reclaimed PE film currently comes from industrial or commercial sources, rather than residential, this does not necessarily significantly reduce the supply of film for reprocessing. Demand for reclaimed PE film is also currently very weak and heavily reliant on Trex, a composite lumber manufacturer. If the price for PE film were higher, there would be greater incentive to capture film through reverse logistics (including drop-off programs) for reprocessing.

example) makes it into PS batches for reprocessing and can ruin the entire batch, causing otherwise pure recycled content material to go to landfill.

Many of the largest CPG companies made ambitious recycled content pledges decades ago that they have still not been able to meet. With renewed or updated pledges and commitments, demand for PCR supply appears to be increasing. One packaging manufacturer interviewed noted that they had seen an "exponential increase" in requests for recycled content material from their customers (brand owners), as well as greater acceptance of the higher costs.

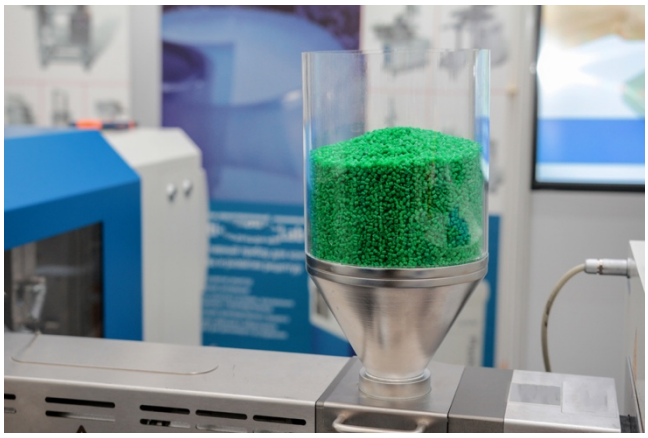
According to a recent report from the National Association for PET Container Resources (NAPCOR), the trade association for the PET packaging industry in North America, there is not enough recycled PET supply or processing capacity in the U.S. to meet brand owners' stated commitments. The report states that current collection volumes could only support a ten percent recycled content commitment by CPGs [6], though many companies have pledged to meet much higher targets in the next few years. One plastics recycling expert estimates that the U.S. would need a PET recycling rate of at least 70 percent to meet future demand [7], though according to NAPCOR's 2018 PET Recycling Report, it currently sits at just 28.9 percent [8]. In the ten states that have DRS programs for beverage containers, recovery rates range from 65 to 95 percent [7]. While the recovery rate for PET containers (63.1 percent in 2017) is lower than those for glass and aluminum in U.S. states with DRS programs (68.4 percent and 82.2 percent respectively), it is significantly higher than PET bottles recovered from states without DRS programs (16.6 percent in 2017) [1]. Manufacturers echoed this challenge, noting that there simply is not enough PET being collected to meet recycled content demand, especially after accounting for yield loss during processing to obtain food-grade quality resin.

Supply concerns related to the COVID-19 pandemic have also been raised by manufacturers and industry groups, who have requested that Congress include up to $1 billion in recycling infrastructure funding in future COVID-19 relief legislation [9]. The suspension of recycling collection in many municipalities and suspension of enforcement of DRS programs due to the pandemic has led to a reduction in recycled PET for manufacturing feedstock. Even several states with ongoing DRS programs have seen a decrease in material; according to NAPCOR, PET bottles from Michigan's system are "nonexistent" and volumes in California have decreased 60 to 70 percent [10].

NAPCOR and several other packaging materials groups have recently issued a statement calling on states to protect DRS programs, noting that these systems provide higher quality material streams with higher recycling rates than curbside systems [10]. According to NAPCOR Executive Director Darrel Collier, "beverage container deposit programs are essential to preserve the supply of post-consumer recycled PET. By incorporating post-consumer recycled PET in the production of new bottles, significant environmental savings are achieved, while continuing to work toward achieving content commitments by leading brand owners." [11]. In interviews,

several manufacturers confirmed that they prefer PCR sourced from deposit programs over PCR from materials that were collected from curbside recycling programs.

Material Quality



Another concern regarding PCR is the need to meet customer expectations by maintaining similar levels of quality compared to products manufactured from virgin material. Many manufacturers underscored the inconsistent quality of post-consumer material. Recycled content resin feedstock is often a mix of resins with the same Resin Identification Code (RIC) but actually has slight design variations (within the RIC designation). Recycled content resins, unless they have been stripped of additives and stabilized, often do not match well with virgin specifications. One packaging manufacturer noted challenges arising from variability in material viscosity. PCR with similar viscosity ranges to virgin resin make it easier for manufacturers to commingle the two feedstocks. With drastic discrepancies in viscosity levels for recycled versus virgin resins, manufacturers can only mix in a small amount of PCR.

Depending on application performance requirements, there are also limitations to the amount of PCR that can be incorporated into products with recycled content. For example, some applications such as the thin film used to package raw meat have both practical and technical challenges in achieving 100% PCR content without chemical recycling. Food-grade resin is particularly limited, since reprocessors need to know whether the original resin source application was food-grade and handled such that no new contaminants were absorbed during storage or shipment. Few reprocessors have FDA-approved recycling processes for food-grade resin, and having these capabilities adds costs to the process. PET generally has fewer issues for use in food contact applications than other resins because of the solid stating process in reclamation, but there are limits to the number of heat cycles a resin can tolerate due to polymer degradation. This degradation restricts the applications for which a recycled resin can be used.

Uncertainty about availability, consistency, and quality of PCR from suppliers is another challenge. One manufacturer noted that they cannot definitively verify the quality and composition of purchased PCR until actually beginning their manufacturing process.

One reprocessor noted that part of the problem also comes from CPGs themselves and the types of packaging they use for their products. Many products once packaged in a rigid format made from readily recyclable materials are moving to flexible packaging formats. The proliferation of multi-layer, multi-material packaging—much of which is not recyclable—is diminishing the availability of high-quality material to use in PCR and eventually in new packaging and products.

Regulatory Requirements

Depending on the resin, regulations further limit availability of high-quality PCR. For products that will be used in food-contact applications, recycled plastic must meet the same regulatory requirements for safety as virgin material. Though the FDA does not require that all food-contact plastic packaging products undergo regulatory review, companies may request one for marketing purposes. To demonstrate safety, plastics reprocessors can independently evaluate their recycled resin and submit this assessment to the FDA. The assessment must contain a description of the recycling process, steps taken to prevent both physical and chemical contamination, data to show that the recycling process removes contaminants, and the proposed conditions for use of the recycled plastic. If the FDA approves the safety of PCR for food-contact applications, they will issue a letter of no objection (LNO) [12].

In 2019 Washington passed a law requiring that no manufacturer or supplier may sell, offer for sale, or distribute for use in the state a plastic product that is labeled with the term "biodegradable," "degradable," "decomposable," "oxo-degradable," or any similar term, or in any way imply that the plastic product will break down, fragment, biodegrade, or decompose in a landfill or other environment unless it meets the requirements in Chapter 70.360 RCW. To discourage greenwashing and reduce consumer confusion, this law allows only compostable packaging to have green or brown tints. One manufacturer who produces plastic bags voiced concern about the mismatch between these restrictions and the limited availability of post-consumer content in the appropriate colors, noting that much of the feedstock for post-consumer material from recycled film is brown.

Demand Side Barriers

Cost

Manufacturers that intend to begin using or expand use of PCR are likely to bear additional costs related to process defects and new technology, particularly given current market conditions and virgin resin subsidies. Efforts to compete with virgin resin in terms of quality and performance may also require higher handling and processing costs [13]. Using PCR typically requires manufacturers to retool their machinery and alter existing processes; one manufacturer

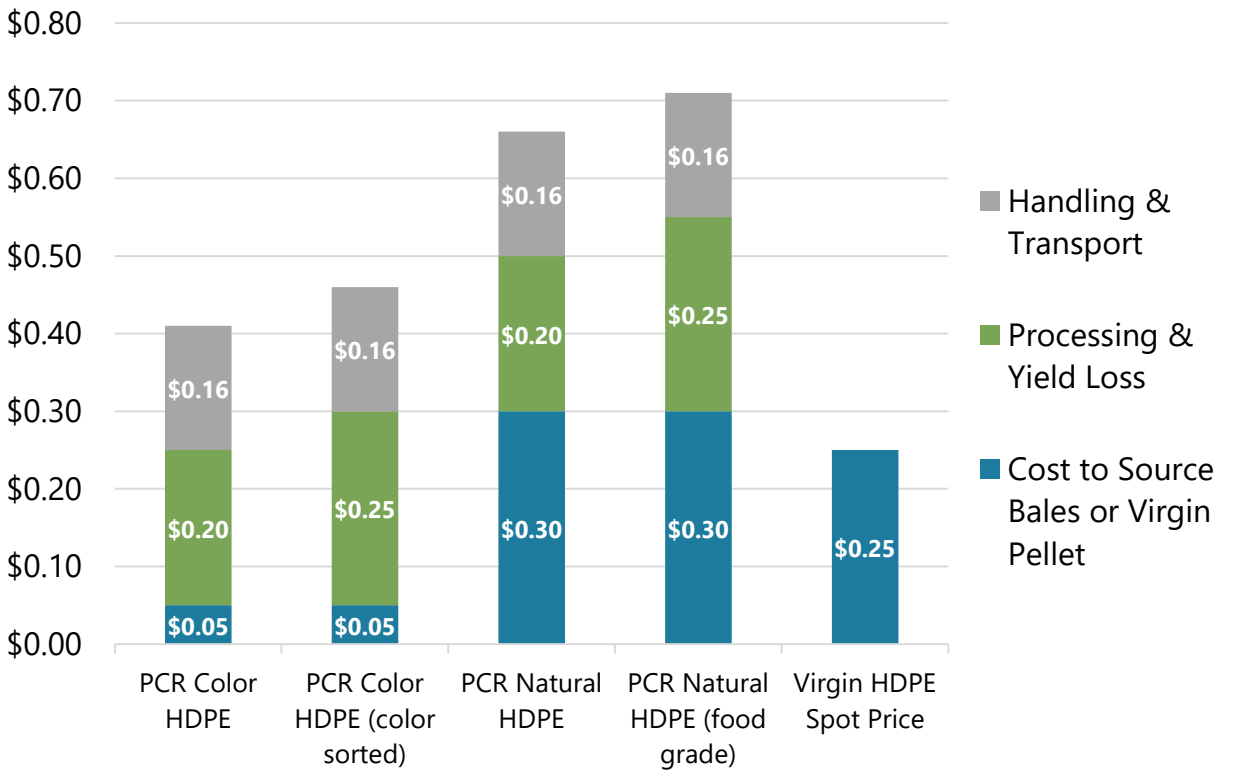
noted that incorporation of recycled content material requires process expertise and machine settings that are sensitive to resin variability.

Plastic extruders, for example, must have adequate venting. When running PCR, there is a higher chance of moisture presence and volatiles from paper residue, so the extruder must be able to vacuum vent to remove moisture and contaminants or risk gelling and development of holes during the blowing process. Due to inconsistencies in plastic quality and lack of a universal process, the only way to learn is through trial and error. For some companies, this expenditure on technology and processing changes could be a risky investment. One plastic bag manufacturer stated that investing in new technology after Washington State's recent single-use plastic bag ban would not be a smart business decision.

PCR is also often more expensive than virgin resin (especially now with oil prices at historic lows, and even recently below zero), as pricing of virgin resin has never captured externalities associated with virgin plastic. This can feel counterintuitive; several manufacturers noted that their customers expect recycled content resin to cost less than virgin, both due to PCR being comparatively cheaper in the past, and also because of perceptions about the material quality being slightly lower.

In the past, many types of PCR were less expensive than virgin resin, but the shale gas boom in the U.S. has dramatically expanded the availability of virgin plastic and thus led to a drop in its price. In a 2017 survey and study done by MORE Recycling about end market demand for recycled plastic, respondents cited "not enough price advantage over virgin resin" as the most common barrier to using PCR [14]. Figure 1 illustrates the price differential between various types of PCR HDPE compared with virgin HDPE, including the breakdown of total costs associated with processing the PCR.

Figure 1 Comparison of PCR and Virgin HDPE Resin Prices



Source: *MORE Recycling & RecyclingMarkets.net. Resin prices are from April 2020. Variation in PCR pricing can occur across the industry based on quality and processing levels.*

The price differential also depends on disruptions to virgin resin markets, which are highly influenced by oil prices. In recent months, the COVID-19 pandemic and price wars between oil-producing countries led to a drastic drop in oil prices, which—as a key component of virgin plastic—decreased the price of virgin resin even further [15]. The price drop for virgin resin may attract more buyers in the coming months, inevitably pulling them away from the market for recycled resin. At the end of 2019, the opposite was true but with the same result: more companies demanded PCR, which drove up its price due to lack of supply [16]. Such frequent price and demand fluctuations can deter manufacturers eager to avoid uncertainty and who may already be on the fence about using PCR.

Consumer Perception

The impact of consumer perception on PCR use includes two aspects: consumers' thoughts on the value and efficacy of recycled plastic, and their willingness to buy products made with recycled content plastic. Further up the value chain, some reprocessors noted manufacturer suspicion about PCR quality compared with virgin resin as part of their reluctance to use it.

In terms of consumer perception about the value of recycling, a 2020 study funded by the Hi-Cone division of Illinois Tool Works Inc. found that only a quarter of Americans recycled their plastic waste and that only three percent of the total respondents surveyed in the U.S., Mexico, the United Kingdom, and Spain believed all the plastic they put in their bins ended up being recycled [17]. Another survey from 2019 by Accenture reported that, despite 83 percent of respondents claiming that the reuse or recycling of products was important, quality and price had greater impacts in consumers' decision-making [18] [19]. These findings are likely a result of limited understanding and trust, arising from conflicting reports and news in the past few years after global import restrictions exposed many of the flaws in the recycling system.

Opportunities

Several opportunities already exist for increasing recovery of plastic packaging in Washington and expanding use of recycled content material, and new opportunities can be created and supported. In discussing these opportunities, it is worth bearing in mind three interrelated realities of the current situation and the path ahead:

- The barriers identified by stakeholders, and discussed above, are very real and must be addressed.
- The goals established by the Legislature for this report set the intention for plastic packaging in Washington to have high recycled content, and to be highly recycled, reused, or composted.[5]

[5] The authorizing legislation for this study also clearly emphasizes that plastic packaging management strategies should prioritize prevention, waste prevention, and source reduction, and further states that, through design and innovation, industry should reduce plastic packaging when possible. Given the barriers to using recycled content feedstock, source reduction is an important strategy for reducing plastic packaging in the waste stream. While this will be explored further in future reports, this task-level sub-report focuses on recovery and recycled content feedstock availability in order to expand its use in packaging and products made or sold in Washington.

- Notable progress toward recovery and market utilization, beyond Washington's current levels, has already been made in other parts of the world.

Opportunities to expand plastic packaging recovery and use of PCR in Washington fall into two categories: technical advances and policy advances. Some barriers described by manufacturers and reprocessors are purely technical in nature and could be addressed with advances in equipment or processing. For example, continued developments in optical sorting equipment will improve the quality, and therefore marketability, of specific plastic resins and colors, which can then be utilized for production of PCR for use in packaging and other applications.

Other opportunities for advancing recovery and use of PCR are not limited by technical barriers, but rather are impeded by existing policies, or the absence of supportive policies. For example, U.S. oil and gas subsidies keep the market price of virgin resins artificially low compared to PCR, thereby making the latter less competitive.

Many barriers combine both technical and policy elements; for example, recovered HDPE can technically be recycled, but current curbside recycling programs—due to a combination of improper recycling behaviors and the inherent challenges of single-stream recycling—result in a sub-optimal material stream in terms of volume, sortation, purity, and contamination. These barriers also differ in whether they are better addressed by local, state, federal, corporate, or legislative intervention.

This section presents technical and policy opportunities to increase use of PCR. In practice, the separation between these two types is used for illustrative purposes and any options to pursue will require a blend of mutually reinforcing technical and policy adjustments.

Technical Advances

Increase Quality

Several manfucturers noted that making products using PCR presents challenges compared with more predictable characteristics of virgin feedstock. The inconsistent nature of PCR was often traced back to concerns with collection and processing. While advances have been made in sorting and cleaning technology, there is still room for improvement if PCR, even those resins in highest demand, are to be more cost-competitive with virgin resin. Improvements can also be made during packaging design to use more easily recycled resins, and avoid resin combinations that are problematic for recycling at end of life. For example, harmonizing resin types for specific packaging types can improve recovery yields and quality.

Increase Recovery and Yield

Once plastic packaging has been successfully recovered and sorted, some reprocessors noted that processing challenges still exist for maximizing recovery and yield when producing PCR for use in new products and packaging. These are challenges which likely could be addressed and overcome, but many in the industry do not have a financial interest in addressing these barriers due to current market conditions, the low comparative cost of virgin resin (often due to subsidies), lack of demand for recycled content products, and other factors.

These issues are often best addressed at the design stage, when resin selections are being made for specific packaging applications. Such decisions are often driven by marketing considerations, as negative price signals from the material value in the recovery phase do not make their way back to the brand owner or packaging manufacturer. There is also ongoing research and development to develop new polymers, though it is highly dependent on resin type and application. In general, it is very difficult to introduce new polymers given the strong market hold of incumbents.

Improve Production Tolerances

Some manufacturers noted that their technology is simply not ready to use PCR for their production application. Getting to that point would require substantial investment and several years. Without baseline regulatory support to level the playing field for such an undertaking, or assurances of a market for their eventual product, such investments are unlikely. This is particularly true for packaging products intended for food contact, which must demonstrate greater levels of purity in order to receive an LNO from the FDA.

Secondary MRF or Plastics Recovery Facility (PRF)

The issues of quality, recovery, and yield are all dependent on the packaging materials recovered from the recycling stream. Aside from considerations around resin selection or packaging design, there are collection and sorting technology changes that could increase value and recovery. One manufacturer noted that despite technical challenges in manufacturing high recycled content packaging, the real long-term challenge is creating a reliable supply of recovered packaging for use as feedstock.

The current recovery system in Washington is often dependent on single-stream recycling collection followed by general purpose materials recovery facilities (MRFs) that include some level of product and/or resin identification. The quantity and quality of output could be greatly supported by investments in additional sorting infrastructure, such as the establishment of a dedicated, regional plastics recovery facility (PRF) or a secondary MRF. Though issues of volume, flow control, the need for long-term purchasing contracts to ensure financial viability, and other

system design considerations would need to be resolved, additional sorting infrastructure could help further refine the output of recovered plastic packaging, and prepare it for higher value end use through a number of possible configurations.

For example, a PRF could be used to sort all regional plastic containers, whether collected separately or mixed (rather than having existing MRFs sort any plastics). A secondary MRF could sort and recover mixed plastics remaining in primary MRF residuals, enabling primary MRFs to focus on improving the quality of commodity bales with the highest volume and value, such as PET and HDPE bottles. Additional sorting dedicated to plastics could also help address the issue of color sortation to allow production of color-specific PCR. Ultimately, financial and other incentives for manufacturers and MRFs to invest in this type of sorting technology and infrastructure could increase the quality and quantity of plastics recovered for recycling and the viability of their use as PCR in the future.

Research and Development Support

Many of the technical issues raised above require research and development support. Such support could take the form of grants, loans, academic research, access to financing, and other public and private intervention. The recently launched Washington State Recycling Development Center could play a role in identifying needs and ranking high-return opportunities. The University of Washington and Washington State University could collaborate with industry in public-private partnerships to help cover the costs of research and development while leveraging private investment toward the public good. Additionally, many producer respsonbility organizations (PROs) operating within mandatory extended producer responsibility (EPR) systems direct funds toward R&D and other technical support to help drive the collection, processing, and recovery advances needed to achieve the mandated recovery levels or recycling rates set by the regulatory authority as part of EPR laws.

Recovery for Fuel and Chemical Recycling

Chemical recycling, including both polymer-to-monomer and polymer-to-fuel recycling, may also have a role in managing fractions of residual and contaminated plastic waste (especially small format and multi-material flexible packaging) in the future. There is debate about whether polymer-to-fuel chemical recycling can be truly considered recycling rather than waste-to-energy, however we have included it for the sake of completeness, and use the term “chemical recycling” as it is a commonly used and recognized term. These options should be given secondary consideration following higher value capture and utilization of recovered plastic. The Legislature, in directing this study, emphasized the importance of recycled content, which is only achievable if resins are preserved, isolated, and repurposed as feedstock for new products and packaging. Even if chemical recycling proves viable in certain applications, this approach would

still face all the operational and cost challenges of collection, transport, sorting, and processing faced by current recycling operations.

Chemical recycling is also much more energy intensive, so policies should create incentives for high-quality scrap plastic to be mechanically recycled and less readily-recyclable (or non-recyclable) materials to be diverted for chemical recycling. Many chemical recycling enterprises are also currently looking to source high-quality scrap as feedstock as yields are usually higher.

Policy Advances

Increase Supply

Many of the technical contamination and yield challenges discussed in the previous section can also be addressed through policy tools. Several manufacturers pointed out the positive impacts on quality and quantity for recovered packaging in DRS programs and other segregated collection channels. (Furthermore, such systems generate funds that can be used to support continued research and development, technology support, or loan and grant programs.) Policies and regulations (e.g., flow control and others) that would facilitate construction of a PRF could also help increase supply of recovered materials.

Increase Quality

Improving quality by reducing contamination boosts opportunities for use of PCR in new products and packaging. Contamination takes many forms, including co-collected products made from unwanted resins, or single products containing multiple resins that are not easily separated, or even simply contamination from food, dirt, liquid, and mold. Quality and contamination issues were also ranked highly as a key opportunity to boost statewide recycling in the recently issued report from the Responsible Recycling Task Force [20]. The State is currently addressing quality and contamination issues by developing a statewide Contamination Reduction and Outreach Plan (CROP), with local CROPs required by June 2021.

One operational approach to improving material quality is to move away from the existing reliance on single-stream systems for residential and commercial recycling collection. Options to split the stream vary, from glass-on-the-side, to containers versus fiber, to deposit return systems. In each case, these approaches keep valuable resins separate at the point of collection, making them more efficiently (and profitably) sortable during processing. Deposit return systems are particularly effective at maintaining quality of recovered materials; the Container Recycling Institute notes that PET plastic from container deposit programs typically sells for 40 percent more than PET from curbside recycling collection programs [1].

Recycled Content Requirements

HB 2722 Concerning minimum recycled content requirements (2019-20) would have required manufacturers to meet progressively higher recycled content minimums in plastic bottles. It would have been the first law of its kind in the U.S., but was vetoed due to COVID-19-related fiscal considerations. Washington has prioritized environmentally preferable purchasing in government procurement for many years (Chapter 43.19A RCW and 39.26.255 RCW). More recently, additional environmentally preferable purchasing guidelines were established by Governor Inslee's Executive Order for State Efficiency and Environmental Performance (SEEP). Federally, recycled content guidelines have been established for electronic products via the Environmentally Preferable Electronics Assessment Tool (EPEAT).

One respondent referred to the Clinton-era recycled paper Executive Orders for purchasing and noted their effectiveness in setting market expectations and in leveling the playing field on the production side. While industry at the time, including the respondent's own company, "claimed that the requirements were going to kill industry," the regulations instead provided the "necessary nudge" to spur recycled content paper production. Similar market floors can help level the playing field for plastic packaging, and drive new entry to market for PCR by removing the economic advantage held by companies who stick with long-standing, efficient, often subsidized virgin resin.

Recycled content requirements for garbage bags provide a useful example of how mandates can drive the market. Approximately six billion pounds of PE resin are used to produce garbage bags in the U.S. annually. In California, garbage bags are required to have 10 percent recycled content. According to recycling industry representatives, these requirements have been vital drivers of demand for recycled plastic film. "Seventy percent of our customers are supplying the California marketplace…" said Eadaoin Quinn, director of business development and procurement with EFS-plastics, a leading North American plastics recycler and compounder. "If another area were to enact legislation similar to California, that would be the exact signal that we and our competitors need in order to invest in additional infrastructure" [21]. One company, Revolution Bag, has a product line featuring 97 percent PCR. Table 5 below shows the potential impact of using different levels of PCR in garbage bag production in the U.S.

Table 5 Impacts of Increasing PCR in Garbage Bags

PCR Level	Pounds of Recycled PE Resin Needed	Portion of Total Volume of PE Currently Reclaimed in U.S.	Metric Tons of CO_2e Avoided
10%	600 million	32%	**270,276** (equal to emissions of roughly 58,000 cars in one year)
30%	1.8 billion	95%	**810,828** (equal to 173,000 cars)
70%	4.2 billion	222%	**1,891,831** (equal to 403,000 cars)
97%	5.8 billion	308%	**2,621,277** (equal to 558,000 cars)

Source: *MORE Recycling. Numbers were tabulated using information from several private reports as well as the U.S. EPA's WARM calculator and extrapolation of California's most recent waste characterization study.*

Given these market realities, and given recent expanded industry support for recycled content goals, a level playing field solution might require formalization (through rules and regulations) of recycled content metrics that carefully establish standards by product type, packaging type, and resin (though manufacturers and reprocessors cautioned against setting standards blindly or broadly, and encouraged identification and avoidance of unintended consequences). For example, considerable volumes of plastic packaging were (and to some extent still are) shipped abroad for recycling, making this material less available for use in domestic production of new packaging. Coupled with the very low cost of virgin resin, businesses are incentivized to use

virgin feedstock. This does not mean solutions do not exist (or cannot be developed) to expand recycled content use through legislated phase-ins that initially focus on high-volume packaging, readily available resins, or simpler packaging formats, and which respond to adjusted market availability over time. Furthermore, China and other countries' import restrictions are increasingly keeping this potential feedstock in the U.S. and therefore more readily available for use as feedstock.

Research and Development Support

As with opportunities for technical support in driving expanded recovery and use of recycled content, research and development, both publicly and privately funded, also play a role in creating policy solutions. For example, business school case studies exploring plastic wastesheds could help pave the way for a new PRF by identifying optimal locations. Similarly, government or academic institutions could gather data to help prioritize policy targets, perhaps by clarifying the existing and potential market for recycled content PP use, to attract private investment in expanded sorting and recovery infrastructure. Regarding this opportunity, one respondent noted that legislation, policies, and regulations have a role to play in "getting data so we can make decisions." Research and development support, financial and otherwise, can also be incorporated into the funding structure of an EPR system, with specified funds being dedicated to solving processing or other technical challenges.

It is also the case, according to some stakeholders, that manufacturers often stick with the specifications they have for the resins they already use, and rarely take the time to revisit formulations or talk to their suppliers and vendors about reformulating with recycled content. R&D could help identify opportunities for substitution, and share information with targeted industry sectors regarding resins and packaging types. Specification data and substitution opportunities could be developed in technical papers for use by companies either willing to consider PCR, or required to do so through recycled content mandates. At the national level, the National Institute of Standards and Technology (NIST) is beginning to engage in this area.

One recent industry-funded example of R&D is the Pacific Northwest Secondary Sorting Demonstration Project, a 60-day pilot led by the Plastics Industry Association in partnership with the American Chemistry Council, AmSty, Berry Global, the Carton Council, LyondellBasell, Portland Metro Regional Government (Metro), and Milliken [22]. This project involved using a portable secondary MRF, operated by Titus MRF Services, in Portland to sort material from four MRFs in Oregon and Washington. The goal was to demonstrate the value that could still be extracted from landfill-bound or low-value mixed materials that have already been sorted at a primary MRF.

Market Development Support

Though similar to R&D support, market development support often focuses more on financial and economic tools to expand opportunities. Washington's new Recycling Development Center and the Washington State Department of Commerce have particular roles to play. Opportunities for specific investment can be identified, for example, by establishing information clearinghouses to track resin quantities, resin applications, and technical constraints. Based on such data, investment could take the form of loans, grants, temporary price supports, economic development zones, recycling market development zones, and other fiscal tools. This data can also be used to set required targets for industry with regard to recovery, processing, recycled content, and other metrics.

On the demand side, market development support could help identify priority products and resins for establishing feasible recycled content goals and requirements. Market development support could provide independent, third-party assessment of resin suitability for various applications.

Design Requirements

One industry trade association noted that new packaging is consistently entering the market and can present challenges for collection, sorting, processing, and manufacturing. Multi-layer, multi-material flexible packaging, which is not readily recyclable, has proliferated in the marketplace—particulary for e-commerce and food and beverage packaging—and therefore in the waste stream.[6] This raises opportunities for packaging redesign with recyclability in mind. Guidelines governing removable labels, water solubility for inks, and other attributes that impact the cost-effectiveness of plastic packaging recovery are ripe for policy solutions.

An oft-cited dynamic is that a first mover toward new packaging is at an economic disadvantage, yet if framing regulations are put in place to guide the market, then innovators and first movers can be economically rewarded.

A common counterargument is that consumers are not demanding products with recycled content, recyclability, or other environmental attributes, which is why the marketplace has not responded. The reality is more nuanced, and includes the notion that it is solely lack of information that prevents consumers from making informed decisions or requests. Toxics in packaging provide a useful example; cadmium, lead, and other toxics were long used to provide bright colorants for use in labeling. Consumers were motivated by the packaging appearance to

[6] From a lifecycle perspective, flexible packaging has environmental benefits despite its end-of-life management challenges. Flexible packaging reduces the amount of material used as well as the weight, and thus the greenhouse gas impacts associated with production and transportation.

buy the products, but did not know that the packaging contained toxics and carcinogens; they did not have sufficient information to demand changes in the market. Legislation prohibiting the use of toxics in packaging had to be passed to benefit society at large—the burden was not on consumers to demand these changes. Once regulated to do so, most manufacturers removed the restricted toxics from their packaging.

Similar baseline legislation could prove effective in driving design changes and use of recycled content. Modulated fees assessed to manufacturers or brand owners—that differentially reward more or less environmentally harmful packaging—can also help drive innovative, beneficial private sector decision-making against the backdrop of a level playing field. While such action typically requires baseline legislation to avoid freeriding, there are examples of movement in this direction, including The Recycling Partnership's recently launched Polypropylene Recycling Coalition, which is bringing together brand owners, converters, and resin producers to discuss how to recycle packaging applications that are not currently being recycled.

Federal Solutions

Some opportunities lend themselves to local action, and others to federal intervention. The federal subsidies for virgin material use, many of which were established for raw material use and industry sectors in their infancy, should be revisited and eliminated or shifted to their recycled content counterparts. Purchasing requirements supporting recycled content use could also be productively applied at a national level through federal purchasing. A national DRS or EPR program for packaging could also be established at the federal level, such as is proposed in H.R. 5845, the Break Free From Plastic Pollution Act of 2020 introduced by Senator Tom Udall (D-NM) and Representative Alan Lowenthal (D-CA).

Education Regarding Consumer Perception and Behavior

Education and outreach about proper recycling behavior and the need for recycled content in a closed loop economy can help increase quantity and quality of recyclable material while driving demand for products with recycled content. Education and awareness campaigns, complete with metrics tracking awareness, are often components of municipal recycling service contracts and EPR programs. Demand for recycled content products and packaging can also be driven through consumer education designed to influence perception and change behavior. Despite the comparatively larger impact of systemic changes like recycled content mandates, DRS, design guidelines, modulated fees, and other interventions, consumer education still remains an important and necessary element for building acceptance of recycled content in packaging.

Many brands are already touting their use of recycled content in products and packaging and using it as a marketing strategy rather than trying to compensate for perceptions of lower quality. While some apparel brands have been advertising their use of recycled content plastic in

their clothing and accessories for years, large CPGs are following suit. For example, Head & Shoulders launched the recyclable Beach Bottle in 2017 made from plastic collected from European beaches, and is working to introduce recycled content packaging across its other hair care brands [23]. Customer awareness of and comfort with recycled content products can help drive demand, which in turn helps drive production, boosting margins and allowing for greater investment in recovery technology and infrastructure.

Industry Initiatives

Industry-originated initiatives to address design, recycled content, and material recovery concerns often serve as proving grounds and incubators for useful technical and policy advances in managing plastic packaging. Such initiatives serve an invaluable role and demonstrate industry's ability to innovate and move quickly. An example of such an initiative would be to establish a partnership between key supply chain stakeholders to align incentives and create a value loop. For example, a large retailer like Amazon with sophisticated logistics operations could develop a collection and reverse supply chain system in partnership with a packaging manufacturer, providing them with a consistent, high-volume, and high-quality material supply to go back into the manufacturing of their shipping products.

While intertia and the economic disadvantage to first movers on such initiatives often slows industry action, properly structured baseline regulation can pave the way for spurring quick industry entry into market.

A key challenge in relying on this approach to comprehensively address existing challenges with plastic packaging recovery and use of PCR is the structural barrier preventing scalability. Even as first-mover companies make strides, their competitors often do not join them, and some of these innovator companies fall short of their declared goals. Recycled content goals for PET bottles provide just one example of industry statements repeatedly declared and missed since the early 1990s.

In light of such missed goals, manufacturers and brand owners often point to the limits of addressing such macroeconomic issues on a state by state basis. Packaging is often not produced where it is sold, recovered, or discarded, which can make closed loop systems difficult to achieve under current economic realities. However, in the absence of a federal system, and with many waste decisions left to state and local governments, states find themselves in a position where they need to act. If manufacturers and brand owners can collaborate—under a regulatory structure—and meet or exceed local requirements, that will go a long way toward establishing a consistent, comprehensive, nationwide system, which is something producers, and other industry players in the supply chain—from manufacturers and brand owners to MRF operators and reprocessors—would like to see.

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Appendix A. Plastic Companies Identified

Table A 1 Plastic Manufacturers, Converters, Fabricators, and Distributors

#	Company	Description	City	Notes	Phone	Website
1	**Aaron Packaging**	Bottle and thermoform manufacturer of food service packaging.	Sumner	Did not respond to interview request.	(360) 889-0152 x710	www.aaronpackaging.com
2	**Accel Plastics**	Thermoform manufacturer for transportation, medical, aerospace, and electronics applications.	Woodland	Interviewed	(253) 854-0034	www.accelplastics.com
3	**Achilles USA**	Film manufacturer specializing in marine, automotive, graphics, medical and healthcare, industrial, window, stationary, and graphic specialty films.	Everett	Did not respond to interview request.	(425) 347-5785	www.achillesusa.com
4	**Aero-Plastics, Inc.**	Injection molding manufacturer for aerospace, medical devices, and high-performance commercial applications.	Renton	Did not respond to interview request.	(425) 226-3400	www.aero-plastics.com

#	Company	Description	City	Notes	Phone	Website
5	**Alpha Packaging**	Bottle and thermoform manufacturer for the nutritional, pharmaceutical, personal care, housewares, consumer chemical and niche food and beverage applications.	Surrey, B.C., Canada	Not located in WA. Did not respond to interview request.	(604) 538-4088 (B.C.)	www.alphap.com
6	**Altek Inc.**	Contract manufacturer for aerospace, military, and industrial applications.	Liberty Lake	Did not respond to interview request.	(509) 924-3731	altek-inc.com
7	**Amcor**	Multinational packaging manufacturer. WA facilities produce PET preforms and bottles for beverage industry.	Tumwater, Walla Walla	Interviewed	(360) 943-2527 (509) 525-0230	www.amcor.com
8	**American Plastic Manufacturing**	Custom plastic bag manufacturer for retail, industrial uses, tradeshows, and restaurant takeout.	Seattle	Interviewed	(206) 763-1055	www.apmbags.com
9	**Amtech Corporation, Inc.**	Custom composite products fabricator.	Wapato	Did not respond to interview request.	(509) 877-2228	www.amtechcorp.com
10	**Bagcraft Packaging (Novolex)**	Subsidiary of multinational packaging manufacturer Novolex. Bagcraft facility produces paper and polycoated paper for food and beverage packaging.	Vancouver	Interviewed. Bagcraft facility produces mainly paper products.	(360) 695-7771	novolex.com

#	Company	Description	City	Notes	Phone	Website
11	**Bainbridge Manufacturing, Inc.**	Manufacturer of plastic hardware for cabinets, closets, and furniture.	Waterville	Did not respond to interview request.	(509) 745-9555	www.bainbridgemfg.com
12	**Berry Plastics**	Multinational packaging manufacturer specializing in food and beverage, food service, building and construction, filtration, personal care, medical, industrial and transportation, cannabis, and agriculture applications.	Tacoma	Declined interview request due to COVID-related time constraints.	(812) 424-2904	www.berryglobal.com/home
13	**Calsak Corporation**	Importer of multiple types of plastic products, including plastic sheets, rods, and tubes (no manufacturing in WA).	Kirkland	WA facility does not manufacture plastics.	(425) 285-5812	www.calsak.com
14	**CFM Consolidated/Cascade Plastics Co Inc**	Plastic manufacturer specializing in automotive products as well as hatchery equipment and supplies.	Fife	Did not respond to interview request.	(253) 922-3460	www.cfmconsolidated.com
15	**Clear Cut Plastics**	Custom plastic fabricator of acrylic and other various types of rigid plastics	Seattle	WA facility does not manufacture plastics.	(206) 545-9131	www.clearcutplastics.com
16	**Commercial Plastics Corp**	Custom fabricator of retail displays, industrial products, and marine products.	Seattle	WA facility does not manufacture plastics.	(206) 682-4832	www.commercialplasticscorp.com

#	Company	Description	City	Notes	Phone	Website
17	**Conrad Manufacturing Co. Inc.**	Manufacturer of aerospace components.	Auburn	Did not respond to interview request.	(206) 504-2126	www.conradmfg.com
18	**Curbell Plastics Inc.**	Distributor of plastic sheets, rods, tubes, films, and related products for aerospace, marine, manufacturing, signage, and other applications.	Fife	WA facility does not manufacture plastics.	(888) 501-4463	www.curbellplastics.com/Discover-Curbell/Locations-Nationwide/Seattle
19	**DACO Corporation**	Distributor of material handling equipment, including plastic containers and pallets, storage, dock equipment, packaging equipment, and supplies.	Kent	WA facility does not manufacture plastics.	(425) 656-4504 (425) 264-4832	www.dacocorp.com
20	**Dart Container Corporation**	Single-use foodservice packaging manufacturer. WA facility produces EPS foam and cups.	Tumwater (Distribution) Lacey (Manufacturing)	Interviewed	(360) 352-7045	www.dartcontainer.com/home
21	**Dolco Packaging**	Subsidiary of Tekni-Plex which manufactures thermoforms for medical and food packaging applications. WA facility produces PS egg cartons, meat trays, apple and pear flats, and takeout containers.	Wenatchee	Interviewed	(509) 663-8541	www.tekni-plex.com/our-businesses/dolco/dolco-contact

#	Company	Description	City	Notes	Phone	Website
22	**Elkay Plastics Co., Inc.**	Film manufacturer for foodservice, industrial, and healthcare sectors.	Kent	Did not respond to interview request.	(425) 656-8822	www.lkpkg.com
23	**Fabriform Plastics Inc.**	Manufacturer and fabricator for aerospace, medical/dental, life sciences, gaming, semiconductor, marine, and transportation sectors.	Seattle	Declined interview request.	(206) 587-5303	www.fabrifi.com
24	**Fathom**	Injection molding manufacturer for advanced manufacturing applications.	Seattle	Did not respond to interview request.	(510) 281-9000	studiofathom.com
25	**General Plastics Manufacturing Company**	Manufacturer of foam and composite parts for aerospace, building/construction, marine, medical, signage, sports/rec, blast mitigation, and nuclear containment applications.	Tacoma	Declined interview request.	(888) 852-8509	www.generalplastics.com
26	**GlobalTech Plastics, LLC**	Injection molding manufacturer for aerospace, medical, and transportation applications.	Fife	Did not respond to interview request.	(253) 327-1333	www.globaltechplastics.com

#	Company	Description	City	Notes	Phone	Website
27	**Insulfoam, LLC**	Subsidiary of Carlisle Companies, manufacturer of EPS insulation for construction applications.	Frederickson	Office closed due to COVID-19, did not respond to interview request.	(253) 271-3056	www.insulfoam.com
28	**Interstate Plastics**	Fabricator, converter, and distributor of plastic sheet, rod, tube, film, and associated products.	Kent	WA facility does not manufacture plastics.	(253) 395-4885	www.interstateplastics.com
29	**Kaso Plastics**	Injection molding manufacturer for automotive, medical, and residential applications.	Vancouver	Interviewed	(360) 254-3980 (503) 227-3064	www.kaso.com
30	**Laird Plastics Inc**	Distributor of plastic sheets, rods, and films.	Renton, Spokane	WA facility does not manufacture plastics.	(206) 623-4900 (509) 535-2006	www.lairdplastics.com seattle.lairdplastics.com spokane.lairdplastics.com
31	**Mantec Services Inc.**	Manufacturer of bumper guards and protection products, as well as custom molded rigid foams for aerospace, military, industrial, and automotive applications.	Seattle	Did not respond to interview request.	(206) 207-7335	www.mantecservicesinc.com/

#	Company	Description	City	Notes	Phone	Website
32	**McConkey Grower Products/Surain Industries**	Thermoforming and injection molding manufacturer specializing in agricultural plastic and currently manufacturing face shields in response to COVID-19 from recycled PET.	Sumner	Interviewed	(253) 863-8111	https://mcconkeyco.com/pages/locations
33	**Multi-Craft Plastics**	Plastic fabricator specializing in signs and graphics, retail displays, accessories and supplies, and custom fabrication.	Kent	WA facility does not manufacture plastics.	(425) 656-3600	www.multicraftplastics.com
34	**Multifab Packaging**	Bottle and thermoform manufacturer for food and beverage, aerospace, agricultural, pharmaceutical, construction, high-tech, logistics, fabrication, storage, and timber applications. WA facility is distributor only.	Spokane	WA facility does not manufacture plastics.	(800) 435-8210	multifabpackaging.com
35	**Oldcastle Infrastructure Inc.**	Manufacturer specializing in stormwater infrastructure and building materials.	Auburn	Did not respond to interview request.	(253) 839-3500	oldcastleinfrastructure.com
36	**PAC Worldwide**	Film manufacturer for courier, e-commerce, fulfillment, and distribution applications.	Redmond	Did not respond to interview request.	(800) 535-0039	www.pac.com

#	Company	Description	City	Notes	Phone	Website
37	**Paragon Films**	Film manufacturer of stretch films.	Union Gap	Did not respond to interview request.	(509) 424-3700 (Union Gap) (949) 355-6052	www.paragonfilms.com
38	**Pexco**	Manufacturer of specialty plastic products. WA facility specializes in traffic safety market products, chain-link fence enhancement products, lighting, and custom plastics.	Tacoma	Declined interview request.	(253) 284-8000	www.pexco.com/locations/tacoma-wa
39	**Pexco Aerospace**	Extrusion manufacturer of aerospace components.	Union Gap	Did not respond to interview request.	(509) 248-9166	www.pexcoaerospace.com
40	**Piller Aimmco Inc.**	Injection molding manufacturer for sports/outdoor rec, automotive/heavy trucking, medical devices/biotech, consumer electronics, industrial, agricultural, and aerospace/military applications.	Washougal	Declined interview request due to COVID-related time constraints.	(360) 835-2103	pilleraimmco.com
41	**Plastic Injection Molding Inc.**	Injection molding manufacturer for small tools, instrumentation, agricultural products, prosthetic components, and consumer products, including packaging.	Richland	Did not respond to interview request.	(509) 375-4260	www.qualityplasticparts.com

#	Company	Description	City	Notes	Phone	Website
42	**Plastic Molded Products**	Plastic fabrication company	Tacoma	Did not respond to interview request.	(253) 473-2740	No website
43	**Plastic Sales & Service**	Manufacturer specializing in envelopes, retail displays, durable menus, cards and badges, lamination, and plastic accessories.	Lynnwood	Declined interview request.	(206) 524-8312	www.plasticsales.com
44	**Plastics Northwest Inc.**	Injection molding manufacturer for construction, heavy equipment, aviation, playground equipment, outdoor rec, landscaping, hospital and medical, and food packaging applications.	Vancouver	Did not respond to interview request.	(360) 823-0505	plasticsnw.com
45	**Plasti-Fab**	Subsidiary of Ershigs, Inc. Manufacturer of water and wastewater treatment and control equipment and structural composite manufacturing for industry applications.	Ridgefield	Did not respond to interview request.	(360) 887-3580	www.plasti-fab.com

#	Company	Description	City	Notes	Phone	Website
46	**Polymer Industries - UltraPoly Division**	Extrusion and compression molding manufacturer for aerospace, agricultural, automotive, construction, chemical, food and beverage, marine, medical, industrial, sports/rec, transportation, and water/wastewater applications.	Tacoma	Declined interview request.	(253) 272-1217	polymerindustries.com/wp
47	**Polymershapes**	Fabricator, converter, and distributor of plastic sheet, rod, tube, film, and associated products.	Seattle	WA facility does not manufacture plastics.	(206) 575-1462	www.polymershapes.com www.polymershapes.com/locations/seattle
48	**Pride Polymers LLC**	Manufacturer of recycled content packaging for shipping and logistics.	Yakima	Did not respond to interview request.	(509) 452-3330	www.pridepolymers.com
49	**ProAmpac**	Film manufacturer for frozen food packaging applications.	Auburn	Interviewed	(253) 939-8206	www.proampac.com/en-us
50	**Professional Plastics, Inc.**	Distributor of plastic sheets, rods, tubing, and films.	Tukwila	WA facility does not manufacture plastics.	(253) 872-7430	www.professionalplastics.com
51	**Quanex Building Products (Mikron Industries, Inc.)**	Plastic manufacturer for windows and building components.	Kent	Did not respond to interview request.	(253) 854-8020	www.quanex.com
52	**Rainier Precision**	Custom injection molding manufacturer	Seattle	Declined interview request.	(206) 624-8258	www.rainierprecision.com/home.html

#	Company	Description	City	Notes	Phone	Website
53	**Reality Plastics**	Plastic fabricator	Marysville	Did not respond to interview request.	(360) 653-3949	No website
54	**Rex Plastics**	Custom injection molding manufacturer	Vancouver	Did not respond to interview request.	(800) 839-0366	rexplastics.com
55	**Richards Packaging, Inc.**	Glass and plastic container manufacturer, importer, and distributor for food, health care, and industrial applications. Auburn location supplies glass containers.	Auburn	Did not respond to interview request.	(253) 872-2848	www.richardspackaging.com
56	**Saint-Gobain Performance Plastics**	Multinational plastics manufacturer specializing in high-performance engineered polymers for multiple industries. WA facility manufactures adhesive tapes and films.	Puyallup	Interviewed	(253) 841-8512	www.plastics.saint-gobain.com/ www.sheergard.com
57	**Sea-Lect Plastics**	Injection molding manufacturer for marine, sports/rec, musical instrument, military, beverage, and PPE mask applications.	Everett	Did not respond to interview request.	(425) 339-1345	sealectplastics.com
58	**Sealed Air**	Thermoform, film, and foam manufacturer for food, medical, e-commerce and logistics, and consumer goods applications.	Renton	Did not respond to interview request.	(425) 203-1620	sealedair.com

#	Company	Description	City	Notes	Phone	Website
59	**Shields (Novolex)**	Subsidiary of multinational packaging manufacturer Novolex. Shields facility produces film for food and beverage packaging, banking, and custom applications.	Yakima	Interviewed	(800) 541-8630	www.shieldsbag.com
60	**Smak Plastics Inc./Columbia Manufacturing**	Injection molding manufacturer specializing in bins and storage applications.	Vancouver	Did not respond to interview request.	(360) 882-0410	www.smakplastics.com
61	**Sonoco Plastics**	Multinational packaging manufacturer. WA facility manufactures PET thermoform clamshell packaging for produce (blueberries, strawberries lettuce, etc.).	Yakima	Interviewed	(509) 575-5341	www.sonoco.com
62	**TAP Plastics**	Plastic fabricator for custom plastic panels, rods, tubes, window films, epoxy resins, fiberglass fabrics, adhesives, casting products, and signage.	Seattle	WA facility does not manufacture plastics.	(206) 389-5900	www.tapplastics.com
63	**Toolless Plastic Solutions Inc.**	Custom plastic enclosure fabricator	Everett	WA facility does not manufacture plastics.	(425) 493-1223	www.toollessplasticenclosures.com
64	**Vaupell Inc.**	Injection molding manufacturer for aerospace, military, and medical applications.	Seattle	Did not respond to interview request.	(206) 784-9050	www.vaupell.com

#	Company	Description	City	Notes	Phone	Website
65	**Visual Options Inc.**	Custom plastic fabricator for retail and graphic applications.	Tacoma	WA facility does not manufacture plastics.	(253) 472-1440	visualoptions.net
66	**Yakima Plastics Design & Supply**	Injection molding manufacturer specializing in custom-machined parts for agribusiness, animal husbandry, food processing, aerospace, manufacturing, conveyor systems, off-road vehicles, and marine applications.	Yakima	Did not respond to interview request.	(509) 248-6020	www.yakimaplastics.com
67	**Zumar Industries, Inc.**	Plastic fabricator specializing in signs and traffic safety products.	Tacoma	WA facility does not manufacture plastics.	(253) 536-7740	www.zumar.com

Table A 2 Plastic Reprocessors in Washington and Surrounding Region

#	Company	Description	City	Notes	Phone	Website
1	**Agilyx**	Chemical recycler turning mixed plastics and discrete polymers into custom petrochemical products.	Tigard, OR	Did not respond to interview request.	(503) 217-3160	www.agilyx.com
2	**Agri-Plas**	Agricultural plastics reprocessor collecting, sorting, and processing plastic crop containers from Oregon, Washington, Idaho, and Utah.	Brooks, OR	Did not respond to interview request.	(503) 390-2381	www.agriplasinc.com/index.html
3	**Dart Container Corporation**	Food and beverage packaging manufacturer that also collects and recycles/resells EPS to manufacturers of other products.	Lacey, WA	Interviewed	(360) 352-7045	www.dartcontainer.com/home
4	**Denton Plastics**	Post-consumer plastics reprocessor recycling plastics, making custom compounds, and distributing PCR and virgin pellets and powder.	Portland, OR	Did not respond to interview request.	(503) 257-9945	www.dentonplastics.com
5	**Fraser Plastics**	Post-consumer and post-industrial reprocessor that recycles colored and natural HDPE into PCR pellets and flake.	Maple Ridge, B.C., Canada	Did not contact	(604) 814-5042	fraserplastics.com/index.html
6	**Merlin Plastics**	Post-consumer plastic reprocessor turning plastic container packaging into pellet and flake.	Delta, BC, Canada	Interviewed	(604) 522-6799	merlinplastics.com

#	Company	Description	City	Notes	Phone	Website
7	**Northwest Polymers**	Post-industrial plastic reprocessor buying material from the western US and Canada.	Molalla, OR	Interviewed	(503) 829-3550	nwpoly.com
8	**Pride Polymers**	Post-industrial and post-consumer plastic reprocessor that also manufactures packaging for logistics and shipping applications.	Yakima, WA	Did not respond to interview request.	(509) 452-3330	www.pridepolymers.com
9	**Rainier Plastics, Inc.**	Post-industrial plastics reprocessor baling, shredding, grinding, densifying, pelletizing, and blending raw materials for the plastics industry.	Yakima, WA	Did not respond to interview request.	(509) 248-1473	www.rainierplastics.com
10	**Styro Recycle LLC**	EPS reprocessor, LDPE film consolidator.	Kent, WA	Interviewed	(253) 838-9555	www.styrorecycle.com
11	**Westcoast Plastic Recycling, Inc.**	Post-consumer film reprocessor and broker of other recycled materials.	Langley City, B.C., Canada	Did not contact	(604) 247-1664	www.westcoastplasticrecycling.com