



Let's Recycle Better, Together.

MAKING SENSE OF PLASTICS RECYCLING

WEDNESDAY AUGUST 9TH 1:00PM ET.

Presented by



GREENTHINKING
Webinar Series



Today's Panelists



Nina Butler

Principal & CEO

Stina Inc.



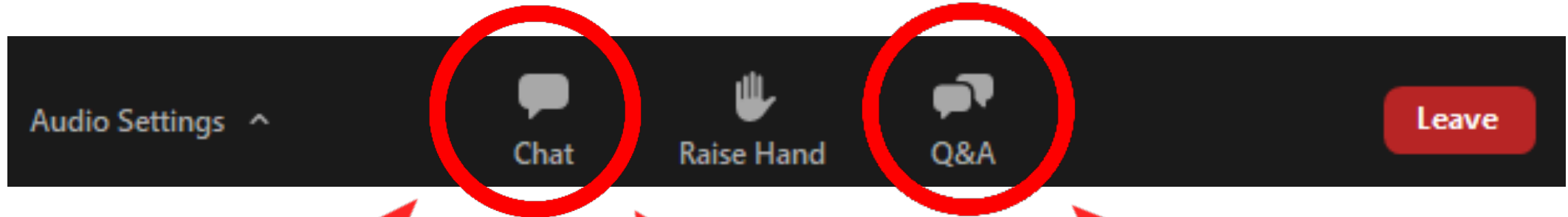
Tonya Randell

*Public / Private
Engagement Manager*

Stina Inc.

Join the Discussion

From your toolbar:



Share your experience & opinions

Look for links to resources

Type direct questions for panelists

Making Sense of Plastics Recycling



Poll

Which of the Following Statements about US National Recycling (as of 2018) is NOT true?

- A 17% of all aluminum is recycled
- B 8% of the plastic you put in your recycling bin is recycled
- C 31% of glass containers is recycled
- D 74% of steel packaging is recycled
- E 21% of paper containers and packaging, excluding corrugated boxes is recycled



Making Sense of Plastic Recycling

Presented By:
Busch Systems Green Thinking Webinar Series

August 9, 2023

Nina Bellucci Butler

Tonya Randell

Harmonizing Human Behavior with the Natural World



STINA™

Research company with tools to support transparency in the plastic recycling value chain



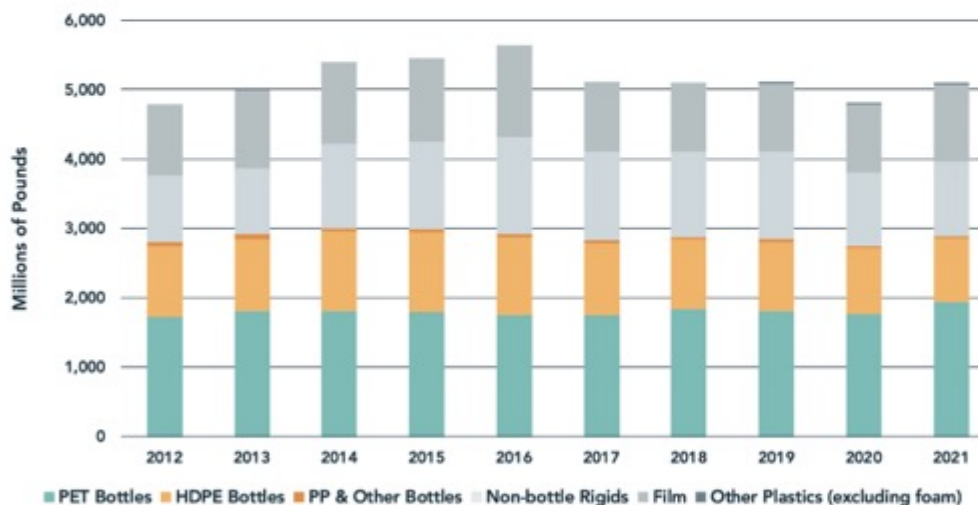
Stina strives to provide data for better decision-making, fosters collaborative problem-solving, and raises awareness through web-based tools.

Latest Figures from Annual Plastic Recycling Study:

Up but Growth in Recycling needed across All categories, especially material suitable for food grade

5.1 Billion lbs. Bottles, Non-bottle Rigid Plastics, Film and Other Plastics (excluding foam)	PET Bottles 1,931.5 Millions of pounds	HDPE Bottles 927.2 Millions of pounds	PP & Other Bottles 28.1 Millions of pounds
	Non-bottle Rigid 1,071.0 Millions of pounds	Film 1,106.2 Millions of pounds	Other Plastics (excluding foam) 20.2 Millions of pounds

U.S. Sourced Post-consumer Plastic Recovered for Recycling by Category (2012-2021)



5.8% Increase Overall



The categories of Bottles, Non-bottle Rigid and Film, tracked in previous years, increased by a 280.3 million pounds in 2021, or 5.8%.

Largest Increase - 9.3% ↑

PET Bottles
163.8
 Million lbs. ↑

Largest Decrease - 1.7% ↓

HDPE Bottles
16.0
 Million lbs. ↓

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




The Association of Plastic Recyclers

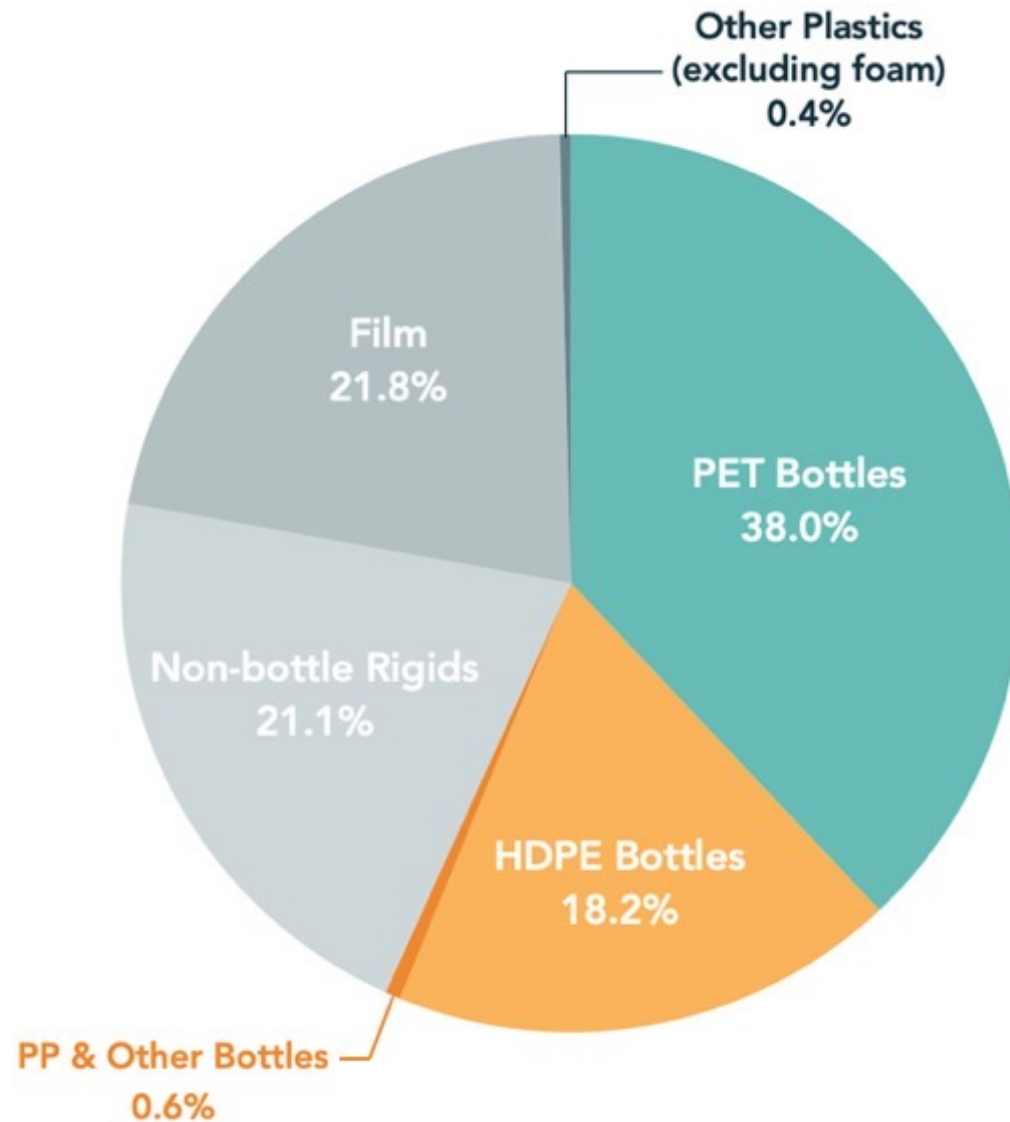


U.S. Sourced Post-consumer Plastic Recovered for Recycling by Category

Plastic Category	Total Recovered for Recycling in 2021 (Millions of Pounds)	Total Percent Change Since 2020	% Acquired by North American Reclaimers
PET Bottles	1,931.5	9.3%	96.9%
HDPE Bottles	927.2	-1.7%	99.2%
PP & Other Bottles	28.1	-15.8%	96.9%
Non-bottle Rigid	1,071.0	1.3%	88.5%
Film	1,106.2	12.2%	83.1%
Other Plastics (excluding foam)	20.2	22.4%	37.2%
Total	5,084.1	5.8%	92.3%

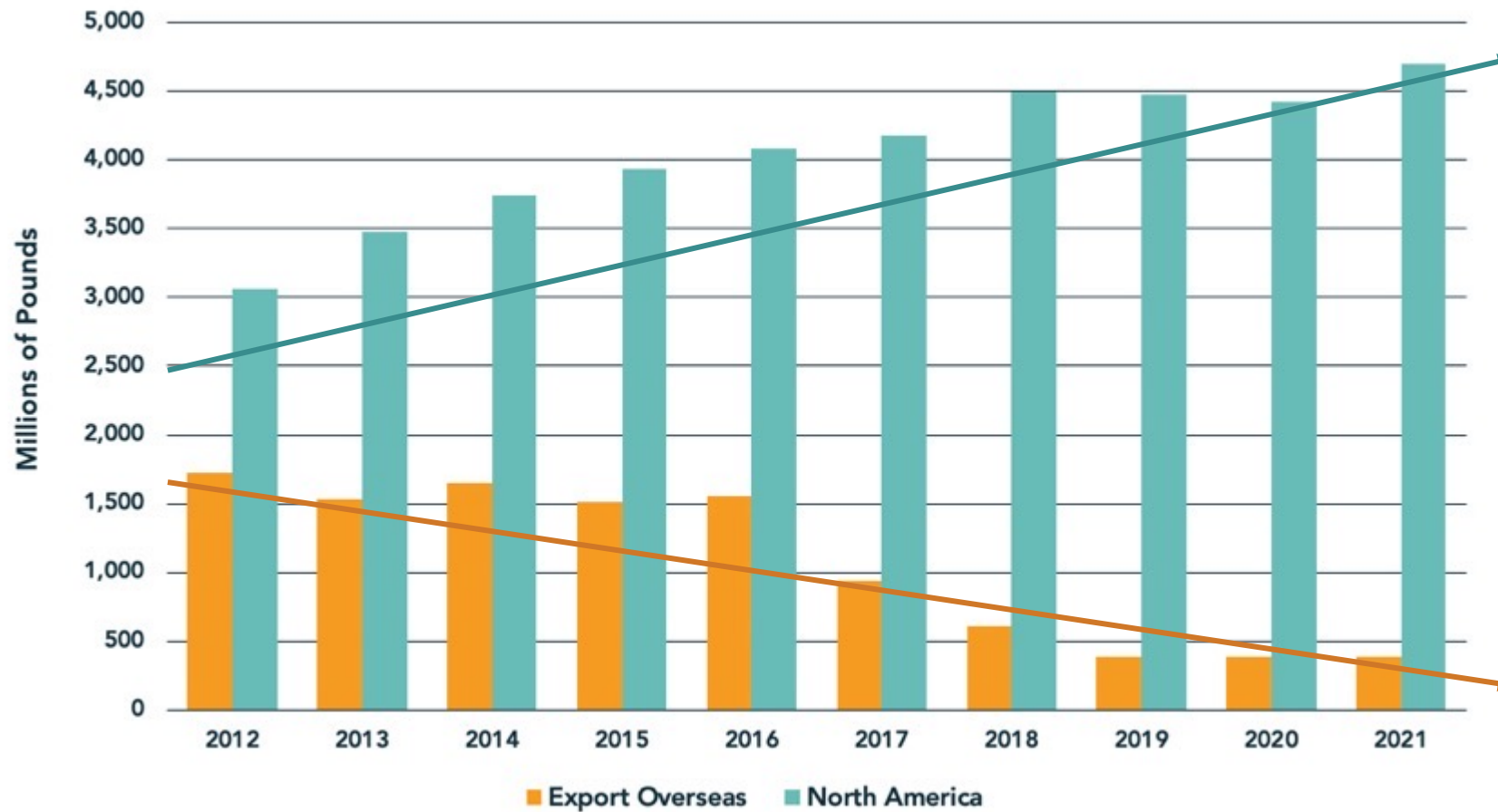
5.8%
Increase
Overall 

U.S. Sourced Post-consumer Plastic Recovered for Recycling by Category



- 56.8 % of Total Post-consumer Plastic Recovered for Recycling is Bottles
- Film surpassed Non-bottle Rigids as the second largest overall category at 21.8% with Non-bottle Rigids following at 21.1%

U.S. Sourced Post-consumer Plastic Recovered for Recycling by Destination



Decades Change

2012

35.9%
Export
Overseas

61.4%
North
America

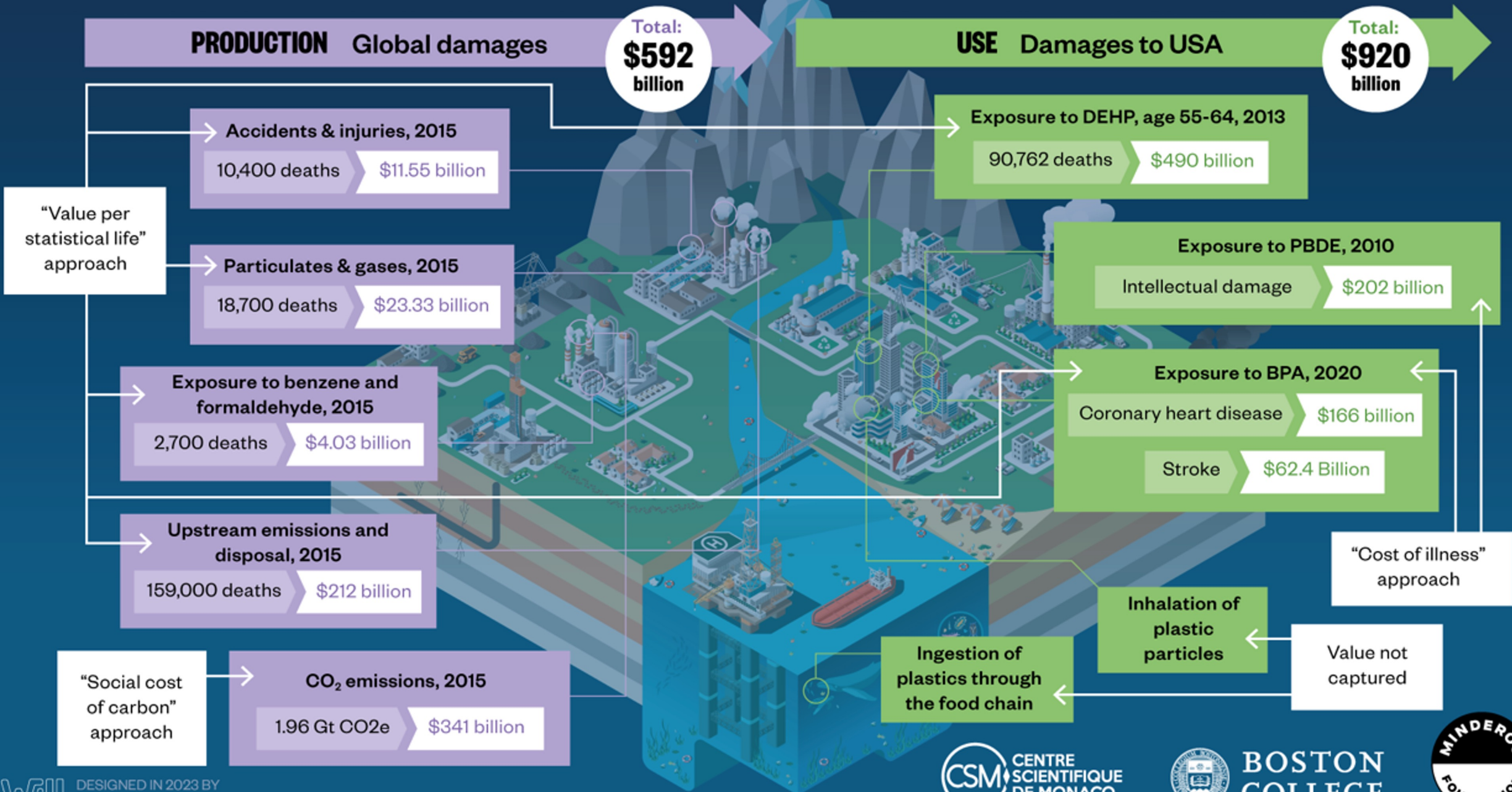
2021

7.7%
Export
Overseas

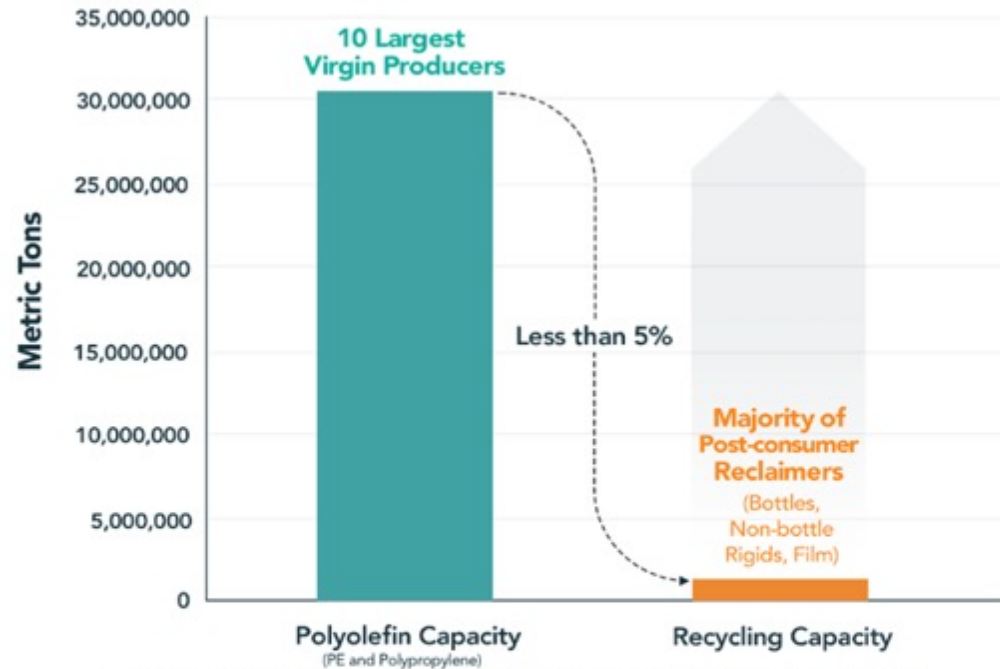
92.3%
North
America

THE HEALTH COSTS OF PLASTIC

ALL COSTS IN 2015 PPP US DOLLARS



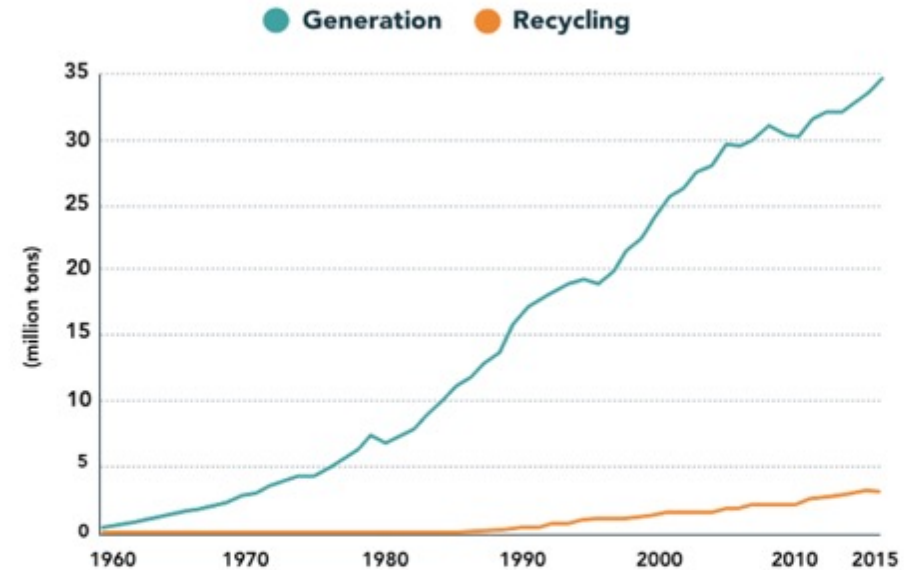
Drastic Action Is Required: The U.S. Plastic Waste Problem Is Growing



Note: Approximate figure includes existing reclamation capacity in 2019. It does not include announced future capacity.

Source: IHS Markit and Stina Inc

Plastics Generation and Recycling, 1960 to 2015



Source: US EPA

Total plastic recycling capacity in 2019 was ~ 3 million tons and capacity to process food grade PCR (polyolefins & PET) is likely < 1 million tons compared to > 55 million tons plastic produced each year.

Resin and plastic products are exported and imported.



MICRO PLASTICS - GLOBAL



BUOY - ALASKA



CROC - USA



WATER BOTTLE
- KOREA



AEROSOL CAN
- PHILIPPINES



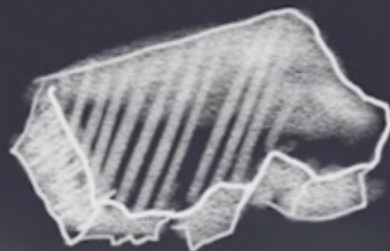
GAS CAN - SRI LANKA



BUOY
VIETNAM



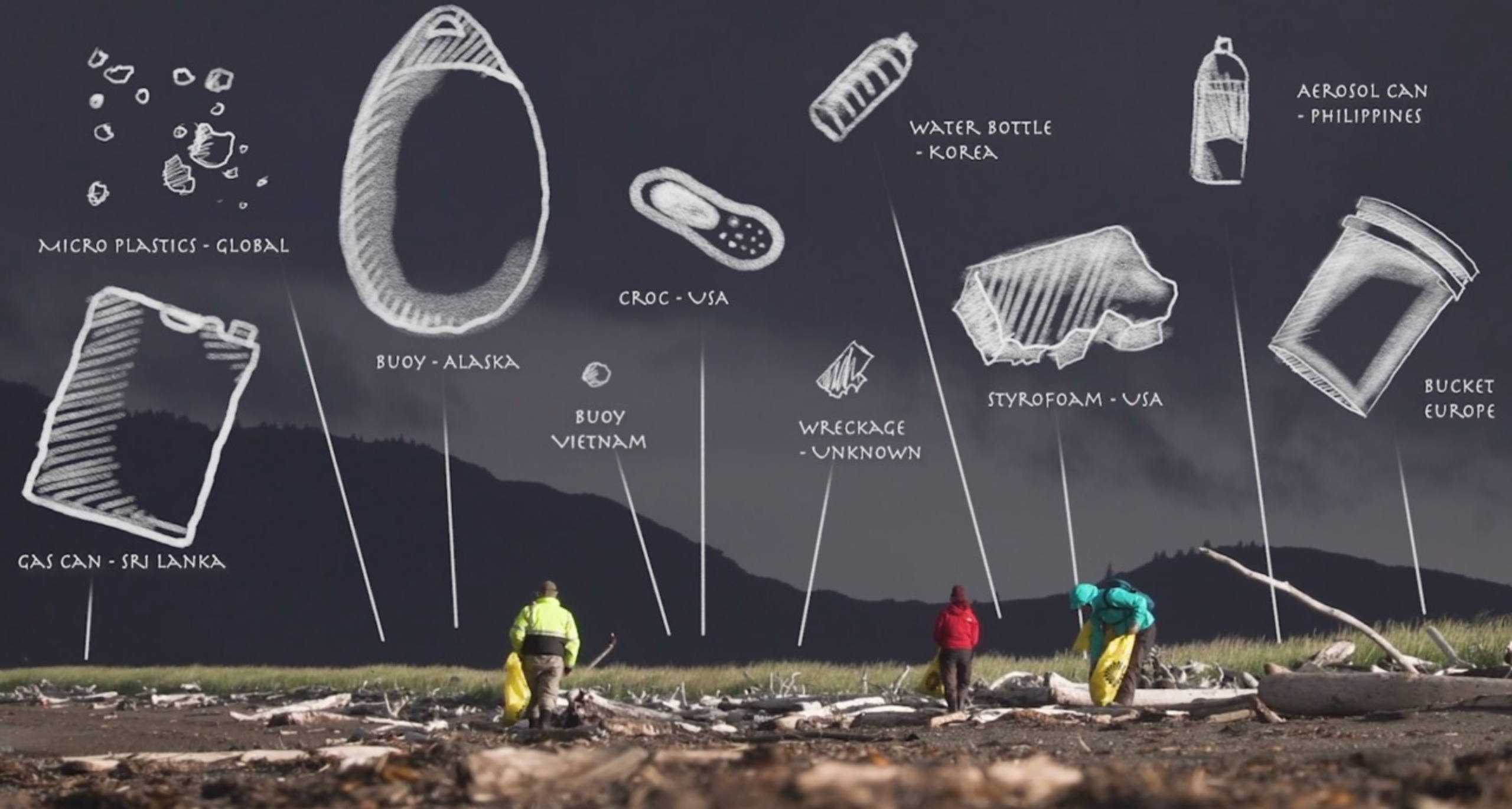
WRECKAGE
- UNKNOWN



STYROFOAM - USA



BUCKET
EUROPE





MONITOR COMPARTMENTS, MITIGATE SECTORS: A Framework to Deconstruct the Complexity of Plastic Pollution



5 GYRES
SCIENCE TO SOLUTIONS

A close-up photograph of a petri dish containing a mixture of white and blue microplastic particles. A blue pipette tip is visible in the foreground, and a metal tool is partially visible in the background.

The purpose of our lab is to investigate plastic pollution through quantifying and identifying characteristics of microplastics in a variety of sample types such as water, sediment, and organismal samples (digestive tracts).



PLASTIC OCEAN PROJECT





Sustainable Use of Resources

Preserve Resources

& Generate Less Waste (in all forms)

Design Products for Efficiency & Regeneration with Lowest Lifecycle Impact (High Circularity Quotient)

Inspire Conscious Consumption

Recover Resources Used

Drive Participation In Recovery

Optimize Recovery Infrastructure

Full Cost Accounting of Overall Impact and Appropriate Offsets

Evaluate Overall Lifecycle Impact for Transparent Accounting

Facilitate Offset System to Give Back to Nature

THE VALUE OF A SINGLE HEALTHY WHALE TO OUR ECOSYSTEM IS **\$2 MILLION**

Source: International Monetary Fund-Finance and Development 12/19



Phytoplankton productivity, which is enhanced by whales, captures **37 Million tons of carbon** per year.



Fishing industry is estimated at over **\$150 Billion**. Whales contribute to the food web chain and increased fish stocks.



Whale watching industry estimated at **\$2 Billion** globally.



Each whale sequesters **33 tons of carbon** on average when it dies and sinks to the ocean floor.

A Reminder of the Benefits...

**REDUCTION
IN ENERGY
CONSUMPTION**
WHEN DISPLACING
VIRGIN PLASTIC WITH
POST-CONSUMER
RECYCLED PLASTIC



**PET 79%
HDPE 88%
PP 88%**

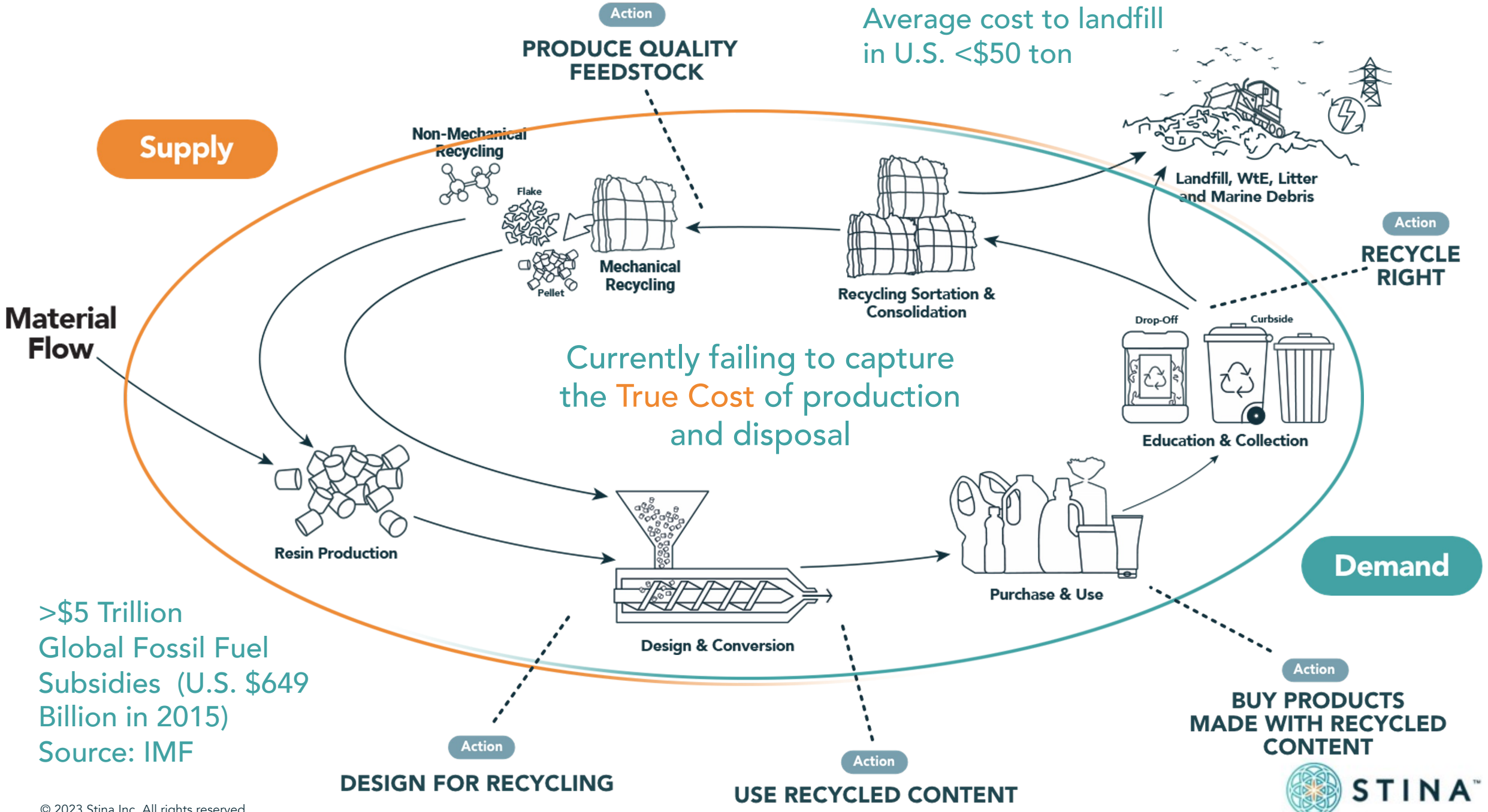
Source: APR Life Cycle Inventory Analysis



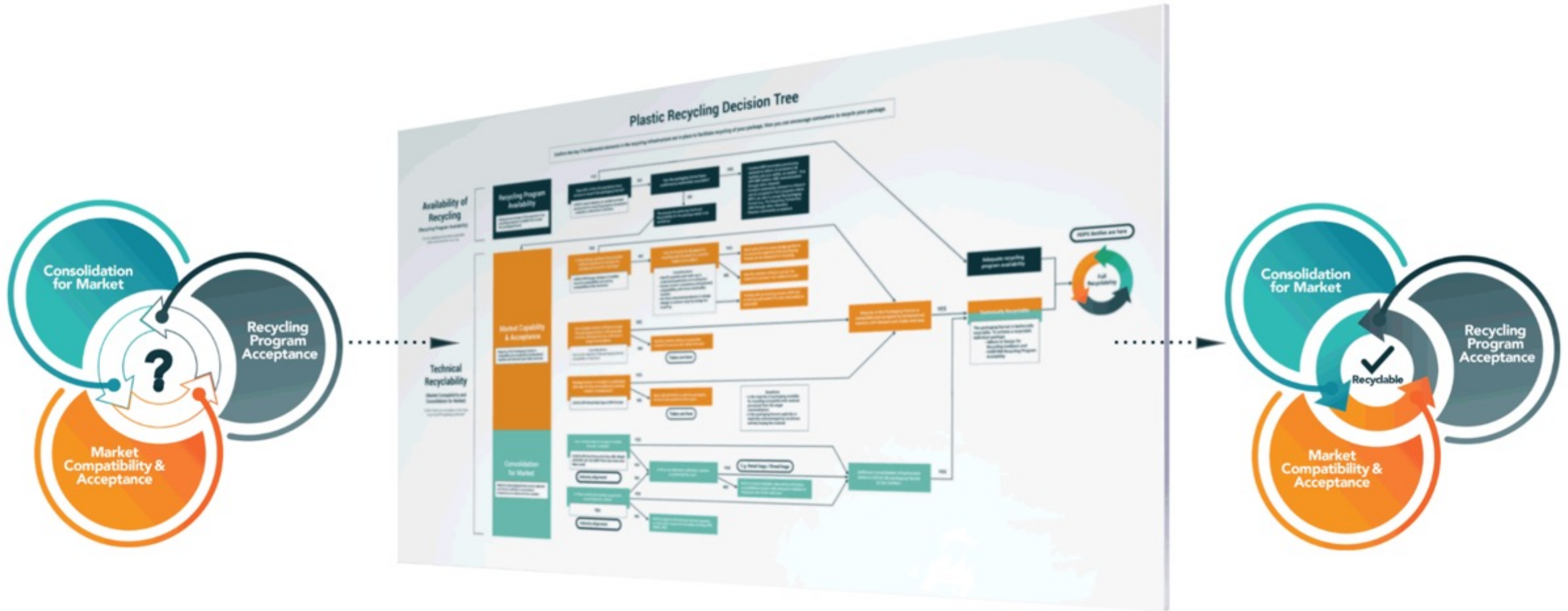
That's big energy savings. Greenhouse gas emissions drop significantly too. Read more about it.



STINA™



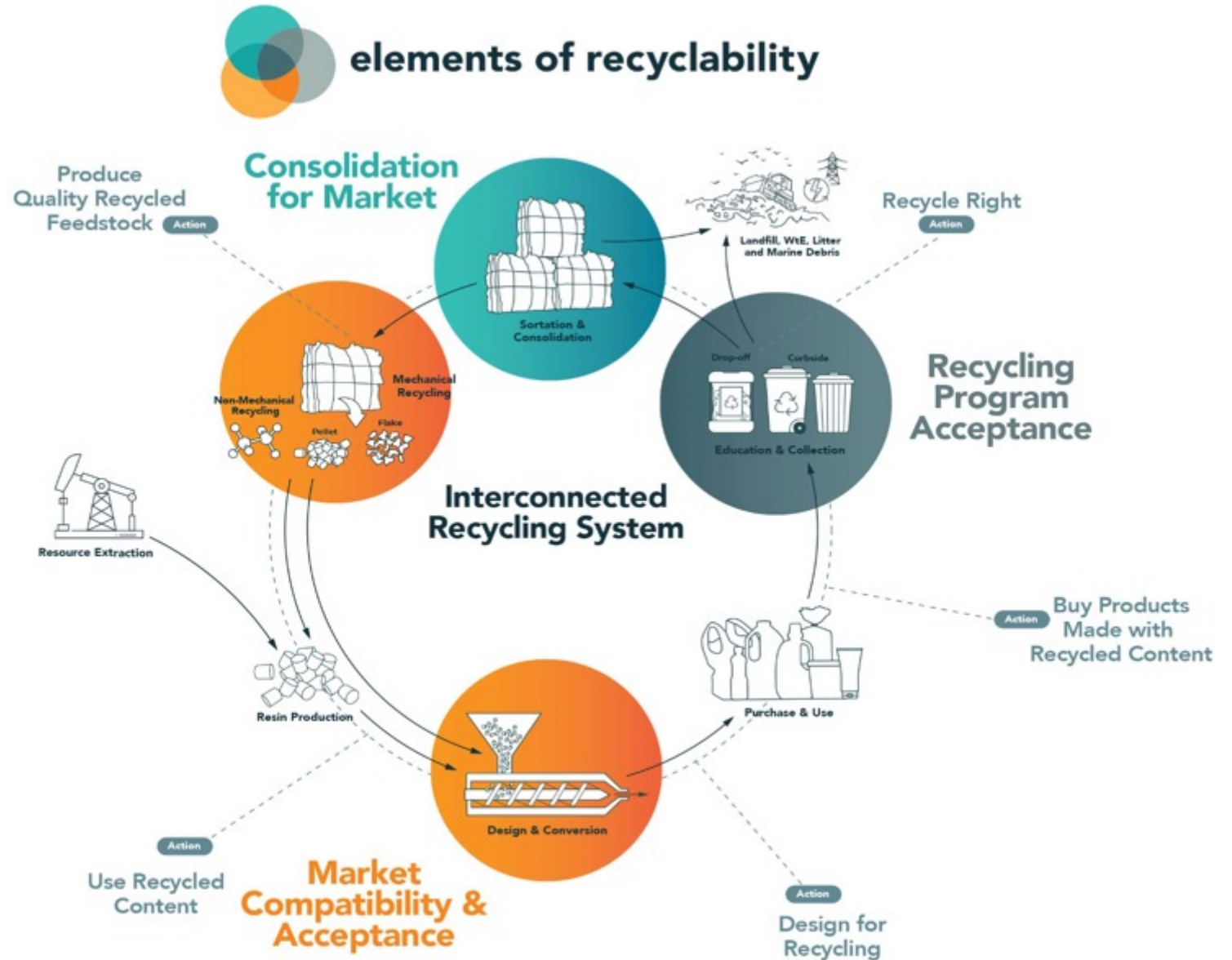
Plastic Recycling Decision Tree: Roadmap to Recyclability



Source: Stina Inc

The Decision Tree lays out the Elements of Recyclability requirements for a package or product:

- Majority of the packaging format is compatible with and accepted by recycling markets that can process them into recycled feedstock
 - Design for Recycling is critical
- Majority of packaging format can be captured, and there is sufficient consolidation infrastructure to deliver it to the markets.
- There are recycling programs accepting and collecting the packaging format for recycling.



Containers & Packaging Recycling Rates (EPA 2018)















- Plastic Containers & Packaging – **13.6%**
 - Plastic Containers & Packaging, excluding Bags, Sacks and Wraps – **15.1%**
 - PET, HDPE & PP Bottles, Containers, and Packaging, excluding Bags, Sacks and Wrap – **20.6%**
 - PET, HDPE & PP Bottles & Jars – **29.5%**
- Paper Containers and Packaging, excluding Corrugated Boxes – **20.8%**
- Glass containers – **31.3%**
- Aluminum beer and soft drink cans – **50.4%**
- Total Aluminum packaging – **34.9%**
- Steel Packaging – **73.8%**

2020 from annual study notes
PET, HDPE, PP Bottles recycling
rate – **27.4%**

Plastic is a diverse material and that complicates recycling

- Not only are there many different types of plastics; there are several types of manufacturing processes that influence how recyclable an item is.
- For example, most beverage and food bottles are blow molded and have different properties from thermoformed containers or injection molded buckets.

Plastic Resin Identification Codes

 PETE	 HDPE	 PVC	 LDPE	 PP	 PS	 OTHER
Polyethylene Terephthalate	High-Density Polyethylene	Polyvinyl Chloride	Low-Density Polyethylene	Polypropylene	Polystyrene	Other
<p>Common products: to-go containers, cups, jars, trays, soda & water bottles</p> <p>Recycled products: clothing, carpet, clamshells, soda & water bottles</p> 	<p>Common products: grocery bags, milk jugs, flower pots, detergent & shampoo bottles</p> <p>Recycled products: detergent bottles, flower pots, crates, pipe, decking</p> 	<p>Common products: pipe, pool liners, siding, automotive product bottles, sheeting</p> <p>Recycled products: pipe, siding, binders, carpet backing, flooring</p> 	<p>Common products: bread bags, paper towel overwrap, squeeze bottles, trash bags</p> <p>Recycled products: trash bags, decking, furniture, shipping envelopes, compost bins</p> 	<p>Common products: yogurt tubs, cups, twine, straws, hangers, shipping bags, non-woven bags</p> <p>Recycled products: paint cans, speed bumps, auto parts, hangers, plant pots, toothbrush handles</p> 	<p>Common products: to-go containers, razor handles, flatware, CD cases, hot & cold cups, foam packing, trays, egg cartons</p> <p>Recycled products: picture frames, crown molding, rulers, flower pots, hangers, toys, tape dispensers</p> 	<p>Common types & products: polycarbonate, nylon, ABS, acrylic, PLA; multi-layer packaging, bottles, safety glasses, CDs, lenses, pouches</p> <p>Recycled products: electronic housings, auto parts</p> 

Markets should drive program acceptance



Model Bale Specification: PET Bottles with PET Thermoforms

This model specification provides industry-developed guidelines for recycling market acceptance of this baled commodity. It is not intended to replace the specifications of individual buyers that may allow or prohibit different contents or bale sizes. It provides a benchmark for sellers for producing quality recycled plastic baled commodities.

Any whole polyethylene terephthalate (PET) postconsumer bottle or jar with a screw-neck top that contains the ASTM D7611 "#1, PET or PETE" resin identification code and that is clear, transparent green, or transparent light blue. All bottles should be free of contents or free flowing liquids. Closures (caps, lids, rings and labels) may be left on bottles.

This specification allows inclusion of PET thermoforms of more than two percent, but not to exceed 10 percent of bale, by weight. PET thermoforms are defined as any whole, extrusion grade, clear polyethylene terephthalate (PET) package labeled with the ASTM D7611 "#1, PET or PETE" resin identification code, including and not limited to egg cartons, baskets, clamshell containers, cups, lids, blister pack without paperboard backing, tubs, deli containers, trays and folded PET.

Grade C



The Association of Plastic Recyclers

Model Bale Specifications: HDPE Colored Bottles

This model specification provides industry-developed guidelines for recycling market acceptance of this baled commodity. It is not intended to replace the specifications of individual buyers that may allow or prohibit different contents or bale sizes. It provides a benchmark for sellers for producing quality recycled plastic baled commodities.

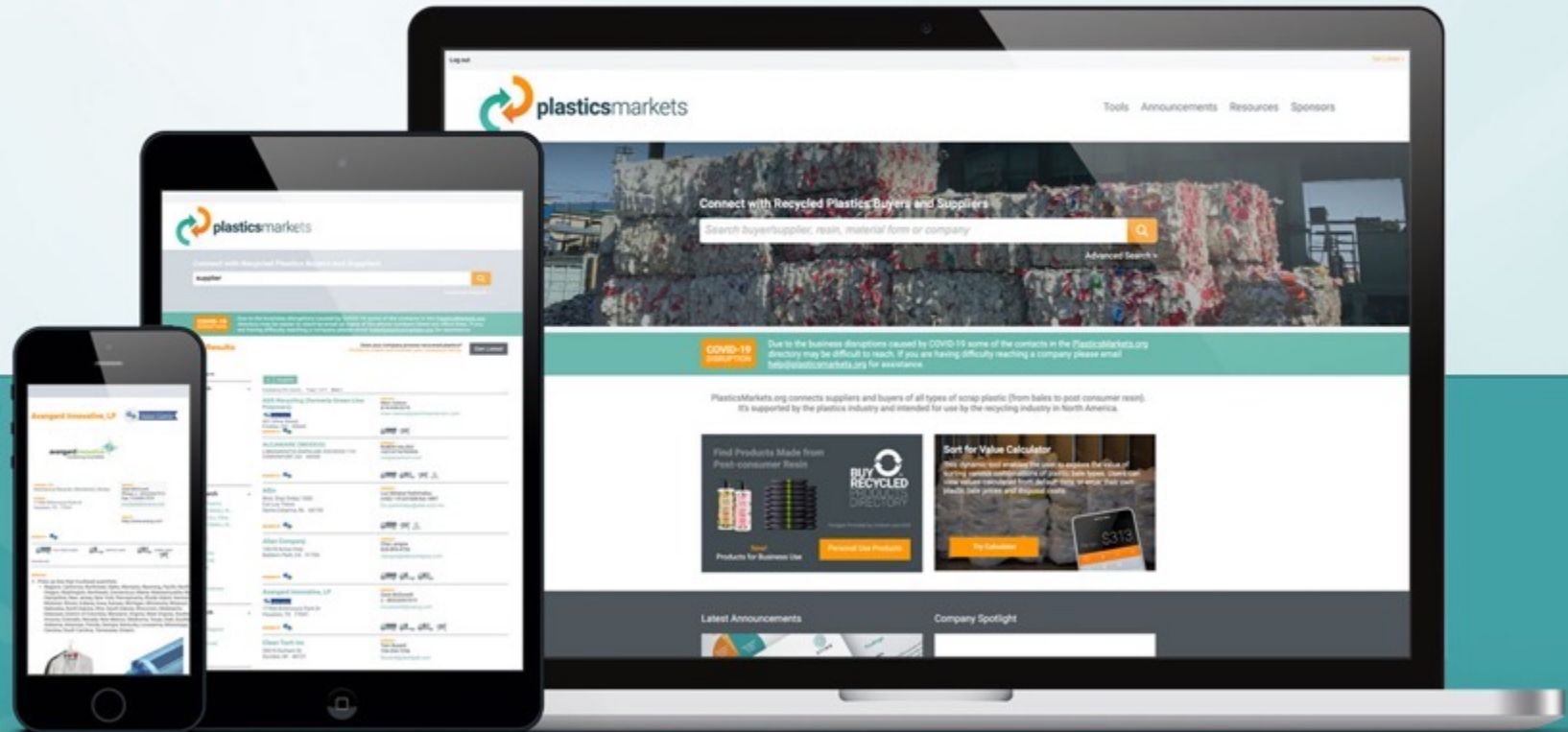
Any whole, blow-molded, high density polyethylene (HDPE) bottle containing the ASTM D7611 "#2, HDPE" resin identification code that is pigmented and opaque, and was generated from a curbside, drop-off, or other public or private recycling collection program. Bottles are defined as containers that have a neck or mouth that is smaller than the base.

All bottles should be free of contents or free flowing liquids and direction should be provided to consumers to empty and rinse containers. While including closures (caps, lids, and rings) on bottles is acceptable, removal of closures is also acceptable. Loose caps and closures should not be added to the bale.

WORK WITH YOUR BUYER(S) as to their allowances for:



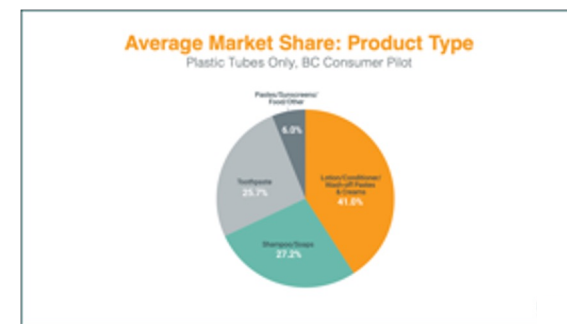
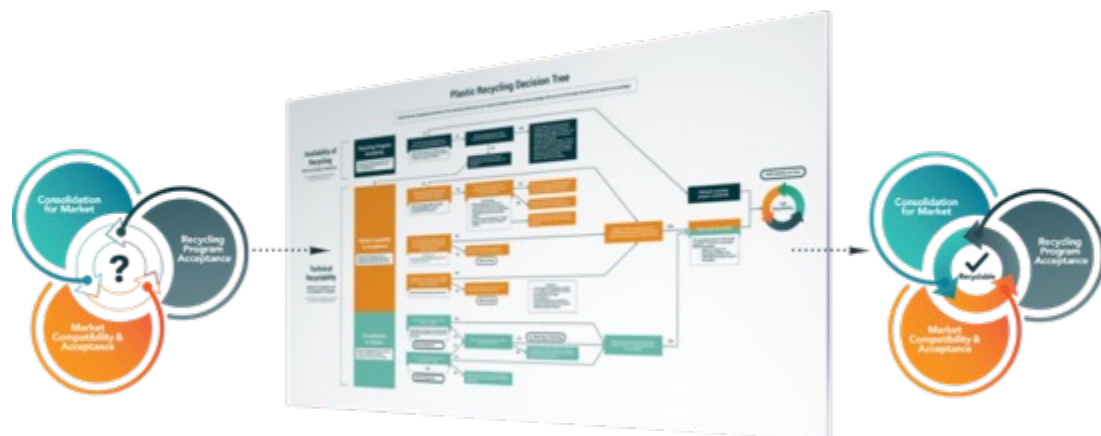
Connecting Buyers and Suppliers of Recovered Plastics



Plastic Squeeze Tube Project – Ongoing Journey To Recyclability through Collaboration

Data about things like market share, compatibility with the colored HDPE bottle stream, and sortability have been needed to answer specific questions of what is needed to take a format like tubes to recyclability.

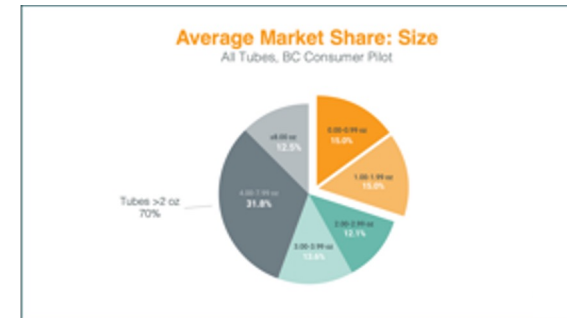
Plastic Recycling Decision Tree: Roadmap to Recyclability



HDPE Compatibility Testing

Estimation Process Data	0% Control	25% Tubes	Pellet Testing	0% Control	25% Tubes
Melt Temp (°F)	412	414	AVG. Melt Flow Rate (g/10 min)	0.494	0.437
Pressure (psi)	2100	2400	AVG. Density (g/cm³)	0.942	0.941
			AVG. Wastage % at 180 °C	0.0074	0.0072

Properties for ASTM Parts	0% Control	0% Tubes	10% Tubes	25% Tubes
AVG. Melt Flow Rate	0.501	0.489	0.472	0.451
AVG. Pressure Modulus (psi)	147,487	153,721	148,300	144,727
AVG. Neck Load (N/Aksi)	15.30	9.89	9.25	7.86
AVG. Tensile @ Yield (psi)	3681	3761	3750	3686
AVG. % Elongation at Break	458	318	300	325



Consolidation for Market

Test whether it can flow through to the desired commodity, and general size and shape realities

Initial collection of tubes from 5 of the 6 MRFs

- tubes collected made it to and were picked from the container line – 4 of 5 was assumed potential issue

Sonoco MRF Flow Study

- Intention: test tube flow through MRF to the container line (includes fiber sorting)
- 4 tubes tested (2 over 3 oz, 2 < 1 oz)
- Confirmed flow to container line >3 oz, no optical at facility

Recycle BC ORF Flow Study

- Intention: test broad array of tubes from brands to further confirm general size/shape issues at the screen, and to verify optical read to HD line
- 14 passed >85% to plastic container line (1-6oz)
- To HD line - 3 >80%, 3 >80-90%, 4 >60-70%
- Confirmed < 1 oz likely won't sort past screens, 1-2 oz may or may not pass depending on shape of tube

Additional brand flow testing also had positive results



Drop-off Directory

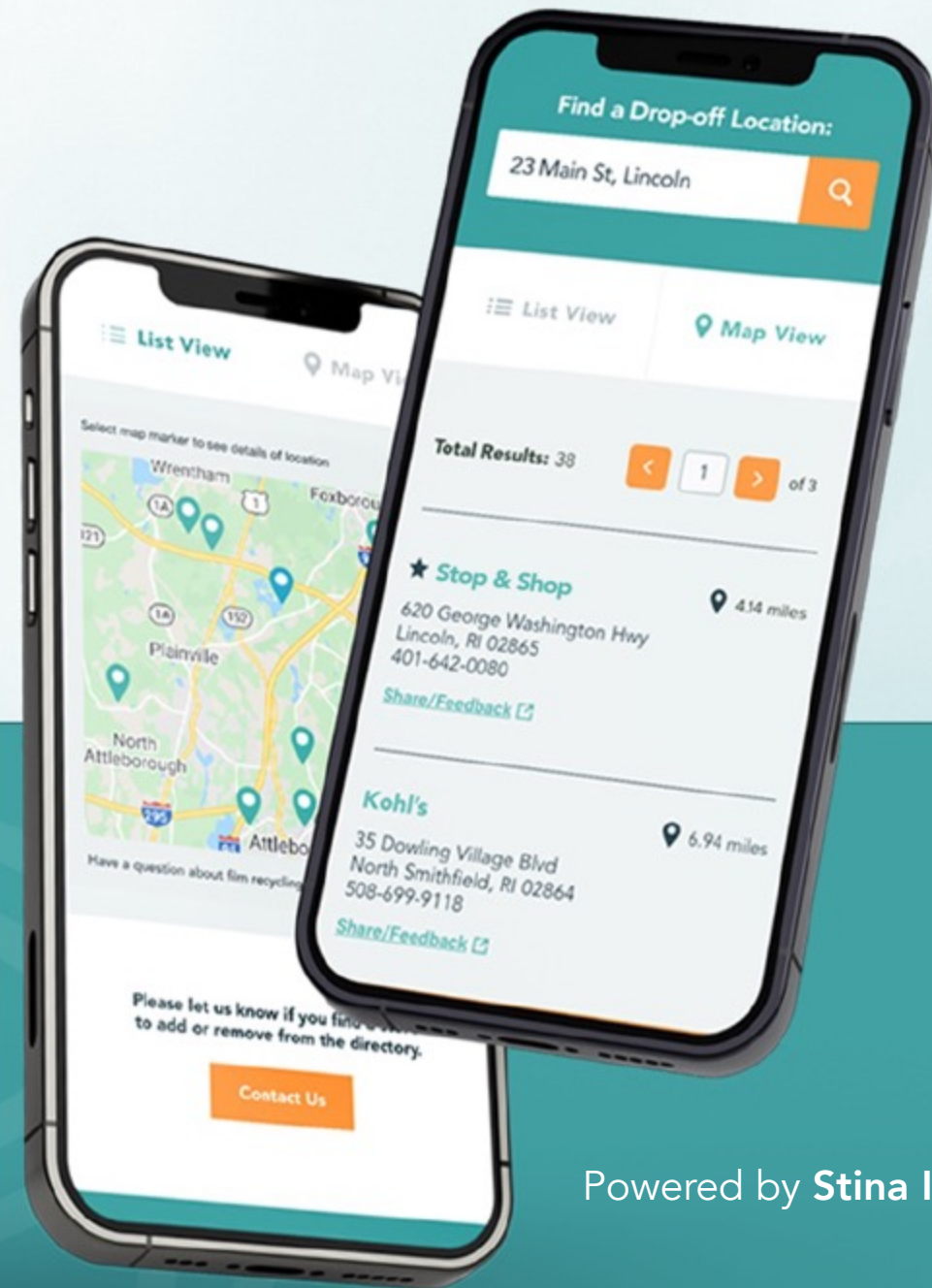
Recycle your plastic bags, film & wrap



Available on

BagandFilmRecycling.org

A searchable drop-off directory of locations that accept bags, film and wraps, housed on a website to support the responsible handling of post-consumer film and bags.



Powered by **Stina Inc.**

U.S. Sourced Post-consumer Film Recovered for Recycling by Category (2021)

Film Category	Total Recovered for Recycling in 2021 (Millions of Pounds)	Total Percent Change Since 2020	% Acquired by North American Reclaimers
PE Clear Film	439.5	4.6%	84.0%
PE Mixed Color Film	188.8	48.2%	79.8%
PE Agricultural Film	154.2	-1.3%	89.5%
PE Retail Bags & Film	264.2	7.9%	88.8%
Other Film	59.5	60.9%	44.9%
Total	1,106.2	12.2%	83.1%

**12.2%
Increase
Overall**



Educate with Clear, Concise Language and Images

- SAY and SHOW what you accept and don't accept
- Make your list and flyer easy to find on your webpage
- Focus on the most volume to accept and most problematic contaminants to exclude
- Reiterate that Resin ID Codes are NOT recycling symbols
- Messaging about Reusable bottles or bags; signing up to limit junk mail.



DON'T TANGLE OR CONTAMINATE
RECYCLE MORE
FOR A GREENER STATE

PLASTIC
Bottles, tubs, jugs and jars
No pumps
Empty and rinse

METAL
All cans
Empty and rinse

GLASS
Bottles and jars
Empty and rinse

PAPER
Paper, cartons and cardboard
Flatten cardboard

KEEP THESE OUT!

- ⊗ All batteries (car, lithium, etc.)
- ⊗ Electronics
- ⊗ Shredded paper
- ⊗ Ceramic items
- ⊗ Food-tainted items
- ⊗ Styrofoam/peanuts
- ⊗ Clothing or textiles
- ⊗ Household glass
- ⊗ Tangles (cords, hoses, wires, etc.)
- ⊗ Diapers
- ⊗ Medical waste
- ⊗ Tires
- ⊗ Disposable cups (plastic and paper)
- ⊗ Hazardous waste
- ⊗ Toys
- ⊗ Plastic bags/wrap
- ⊗ Scrap metal/wood

PLEASE DON'T BAG YOUR RECYCLABLES!

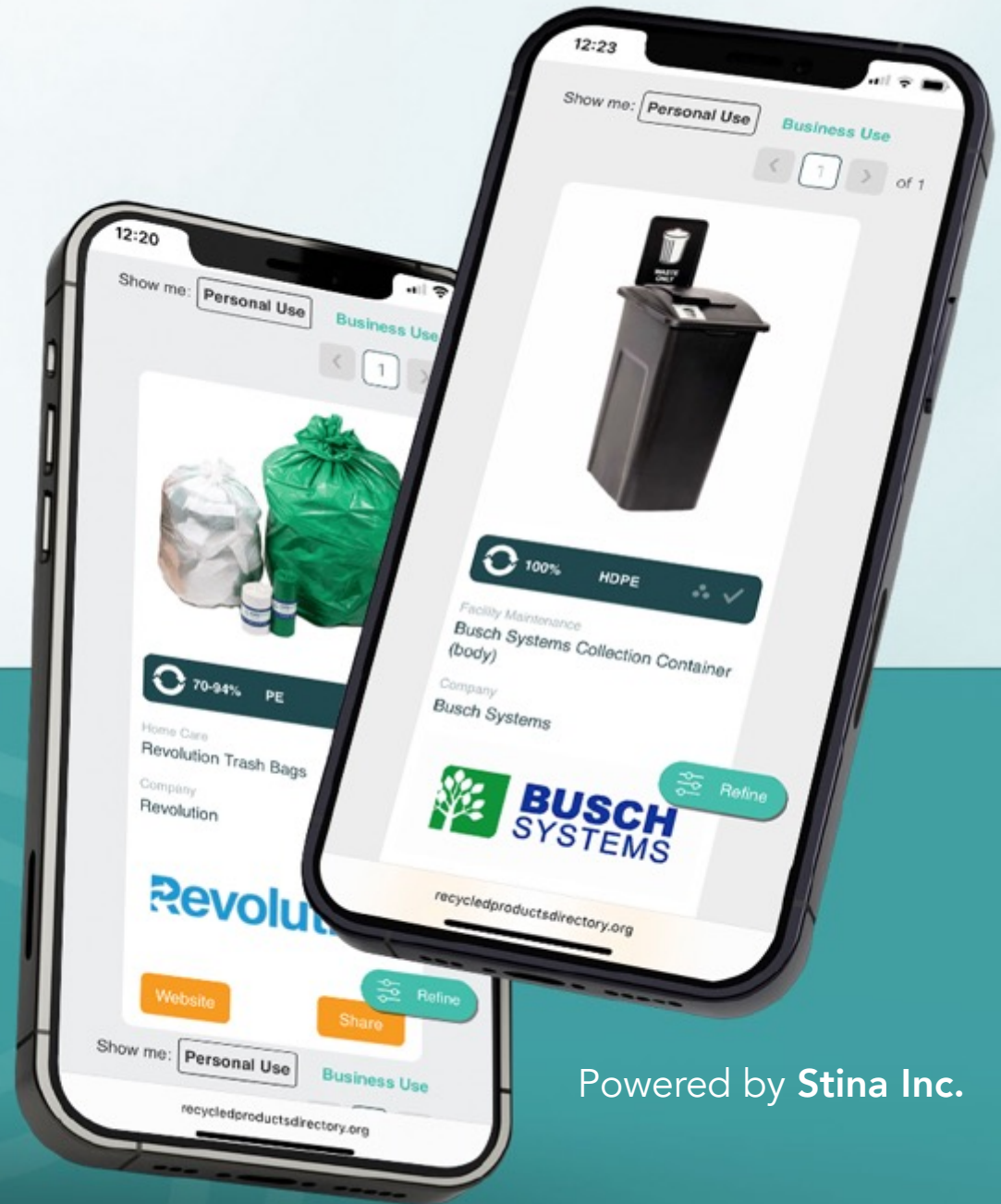
The N.C. Division of Environmental Assistance and Customer Service (DEACS) is a non-regulatory division of N.C. DEQ offering technical and financial assistance to businesses, manufacturers, local governments, institutions, economic developers and citizens in environmental management. For questions, call 1-877-623-6748. www.recyclenc.org





BUY RECYCLED PRODUCTS DIRECTORY

A directory of products made using post-consumer resin (PCR) to help consumers and businesses make environmentally friendly choices.



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Plastic in Our Homes

Home Structure & Function



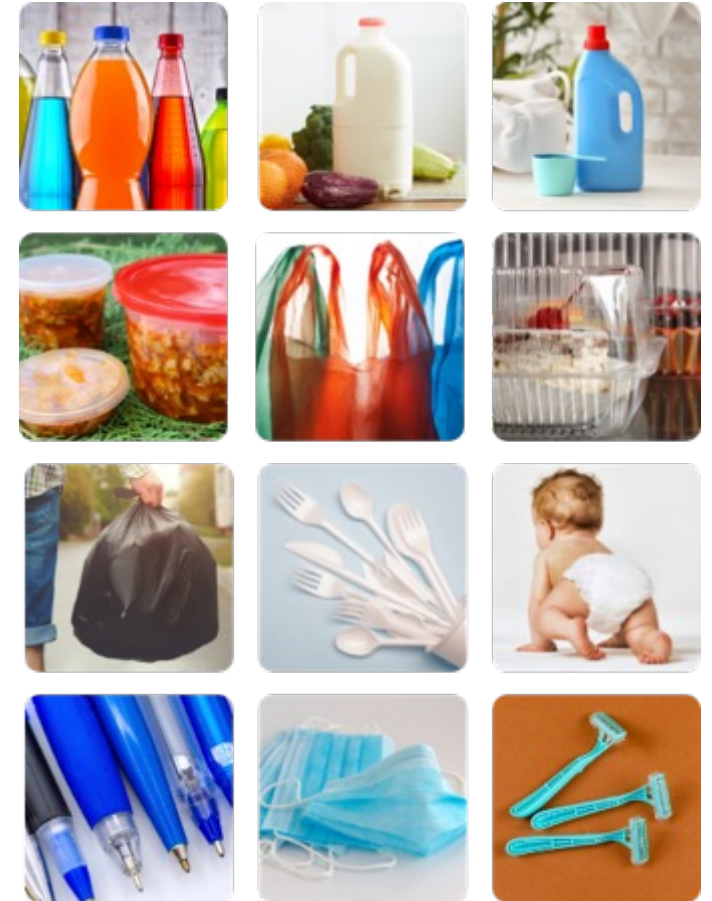
Vehicles



Durable & Reusable Items



Non-Durable Items (Non-Packaging & Packaging)



Let us spotlight how your company's value chain is helping to close the loop

Connect with Us if you want
to help Close the Loop.



Drop-off
Directory



Help consumers
find Drop-off
locations to recycle
their bags, film
and wrap



close the loop



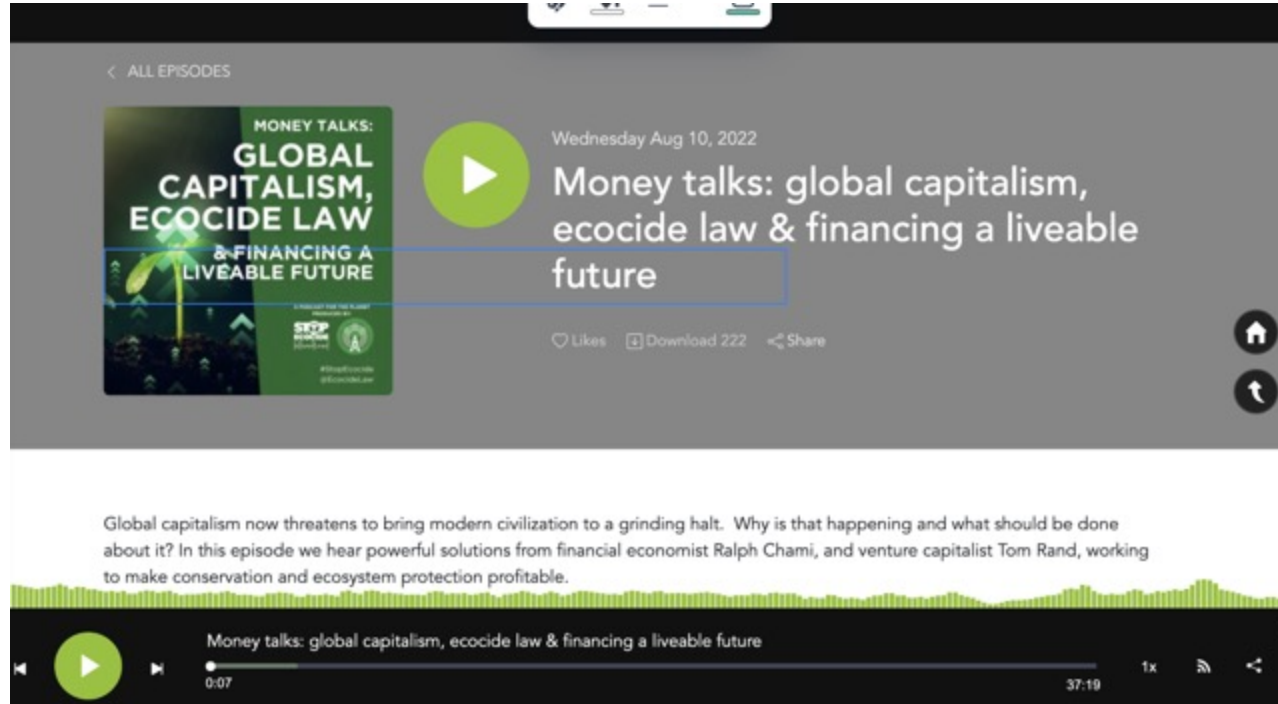
Bring together
makers of
products made
with recycled
content with
consumers
looking to
buy them



Connect
buyers and
suppliers of
post-consumer
recycled
material



More Inspiration to Drive a Circular Economy



<https://podcastsfortheplanet.podbean.com/e/money-talks-global-capitalism-ecocide-law-financing-a-liveable-future/>



(Kim Stanley Robinson inset photo: [Gage Skidmore](#))

<https://www.thegreatsimplication.com/episode/66-kim-stanley-robinson>

Resources & Awesome Video Short



Plastic Recycling Data Dashboard
<https://circularityinaction.com/2021PlasticRecyclingData>



Plastics Markets
<https://plasticmarkets.org/>



Bag and Film Recycling
<https://BagandFilmRecycling.org>



Buy Recycled Products Directory
<https://recycledproductsdirectory.org/>



Info Exchange
<https://www.stinainc.com/RecyclingSupport/#>

Assessing the State of Food Grade Recycled Resin in the Canada & the United States
https://www.plasticmarkets.org/jsfcontent/ECCC_Food_Grade_Report_Oct_2021_jsf_1.pdf



Life Cycle Impacts for Postconsumer Recycled Resins: PET, HDPE and PP
<https://plasticsrecycling.org/images/library/2018-APR-LCI-report.pdf>

Model Bale Specifications
<https://plasticsrecycling.org/model-bale-specifications>



Upstream (Reuse)
<https://upstreamolutions.org/>



TRUE Zero Waste Certification
<https://true.gbci.org/>

If You Give a Beach a Bottle

Short film by Max ROMEY & OPR

<https://www.pbs.org/video/if-you-give-a-beach-a-bottle-8jrjcg/>



Publications on Plastics

Reckoning with the U.S. Role in Global Ocean Plastic Waste

<https://nap.nationalacademies.org/catalog/26132/reckoning-with-the-us-role-in-global-ocean-plastic-waste>

The Emergence of Microplastics: Charting the Path from Research to Regulations

<https://pubs.rsc.org/en/content/articlepdf/2023/va/d2va00275b>

Plastics and the Limits of U.S. Environmental Law

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4058628

Minderoo-Monaco Commission on Plastics and Human Health Report

<https://annalsofglobalhealth.org/articles/10.5334/aogh.4056>

Food Additives and Child Health

<https://publications.aap.org/pediatrics/article/142/2/e20181408/37584/Food-Additives-and-Child-Health?autologincheck=redirected>

The CLARITY-BPA Core Study: A Perinatal and Chronic Extended-Dose- Range Study of Bisphenol A in Rats

<https://ntp.niehs.nih.gov/whatwestudy/topics/bpa>

An Overview of Chemical Additives Present in Plastics: Migration, Release, Fate and Environmental Impact During Their Use, Disposal and Recycling

<https://www.sciencedirect.com/science/article/pii/S030438941730763X>

Operating Space of the Planetary Boundary for Novel Entities

<https://pubs.acs.org/doi/10.1021/acs.est.1c04158>

GCSE 2022 Plastic Legal Summary: Comparative Law Analysis and Recommendations Regarding Plastic Waste: France and the United States.

<https://www.gcseglobal.org/sites/default/files/inline-files/GCSE%20French%20American%20Comparative%20Law%20of%20Plastic%20Pollution%20March%2015%202022.pdf>



STINA™

Harmonizing Human Behavior with the Natural World

"The potential for innovation through inspiration from nature is as great as the risk we face by ignoring nature's signals. We want to help unlock that innovation."

Nina Butler

Nina@Stinalnc.com

Next Up...



**MAKING THE CASE
FOR REUSE &
WASTE PREVENTION**

WEDNESDAY SEPTEMBER 6TH 1:00PM ET.

Presented by  **BUSCH**
SYSTEMS | **GREENTHINKING**
Webinar Series

Presenters:

- Kelley Dennings, *Center for Biological Diversity*
- Macy Zander, *Upstream*
- Dr. Dagny Tucker, *Perpetual*

Today's Resources Online



- Info Exchange
- Tubes Project Details
- + more**

Visit: stinainc.com

Additional Resources

- Today's presentation & recording
- APR life cycle study of plastics
- LCA studies on plastics recycling
- US EPA Draft National Strategy to Prevent Plastic Pollution

+ more

Visit: buschsystems.com/blog



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SYSTEMS

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Archived Webinar Recordings

- *Food organics collections*
- *Public space recycling*
- *Strategic planning*
- *Special event waste reduction*

+ more

Webinars on the Horizon

- Centralized collections arrangements
- Waste reduction in Healthcare

Visit: buschsystems.com/blog



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Let's Recycle Better, Together.





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SYSTEMS



CarbonGraph

**BUSCH SYSTEMS IS PROUD TO HAVE PARTNERED WITH CARBONGRAPH
TO MAP OUT THE CARBON FOOTPRINT OF OUR PRODUCTS.**

STAY TUNED!

MORE UPDATES TO COME SOON!

Thank You to Our Panelists



Nina Butler

Principal & CEO

Stina Inc.



Tonya Randell

*Public / Private
Engagement Manager*

Stina Inc.