



ASSOCIATION OF PLASTIC  
**RECYCLERS**

# Packaging Design to Enable Increased Circularity

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Technical Director, APR

April 15, 2024

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# Agenda

- Introduction
  - Me
  - APR
- Current state of US recycling
- Design for Recycling
  - Film Design for recycling
  - Working group projects
- Chemical recycling and potential feedstocks



# Background

## Academic

BS in Materials Science and Engineering - University of Florida

Ph.D. in Macromolecular Science and Engineering - Virginia Tech

# KRATON

- 4 years at Kraton Polymers
  - CARIFLEX™ polyisoprene manufacturing redesign
  - Invented and developed Nexar™ & BIAXAM™ Polymer technologies
  - 2011 US EPA's Presidential Green Chemistry Challenge Award in Greener Reaction

# Milliken

- 14 years at Milliken & Co.
  - Discover through commercialization
  - DeltaMax™ invention & commercialization
  - Technology, Scouting and Acquisition
  - Plastics Additives Global Sustainability Lead

# Current



- Technical Director at APR
  - Lead development and continuous improvement of APR Design® Guide & Testing Protocols
  - APR / RecyClass Harmonization
- Advisory Boards
  - ASU SM<sup>3</sup>
  - BOTTLE Consortium at NREL
  - CPI at University of Delaware
  - Upstate SORBA
  - Conestee Nature Preserve



# Who is APR?

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APR is a US-based international non-profit and the only North American organization focused exclusively on improving recycling for plastics.



# What Do We Do?

Our mission is simple:

**RECYCLE MORE PLASTICS**  
to reduce waste.

# APR Member Sampling

## RECLAIMERS/RECYCLERS



## AFFILIATES



[View all APR Members »](#)

Together, APR's 300+ members span the entire value chain and shape the future of our industry.

- Reclaimers/Recyclers
- Brand Owners
- Retailers
- Converters
- Equipment Manufacturers
- Testing Laboratories
- Certifiers
- Label & Ink Manufacturers
- Resin Manufacturers
- Additives Manufacturers
- Researchers
- Technical Consultants
- And more!



# APR Primary Goals



## Increase Supply

Ensure plastic gets into the recycling system and stays out of landfills and the environment



## Enhance Quality

Guide companies on design and processing to reduce contamination and improve recyclability



## Expand Demand

Identify solutions to expand use of post-consumer recycled content and reduce extraction of natural resources



## Communicate Value

Ensure policy makers and companies recognize the value of recycled content and the recycling process

# Design Guide Training Program Completed

## Packaging Converters

3M

AVERY  
DENNISON

HAVI

PLASTIC  
INGENUITY

Berry

HI·CONE

DART  
DART / SOLO

COMAR™

rieke

SILGAN  
DISPENSING

## Food and Beverage Brands

Coca-Cola

KraftHeinz

CONAGRA™

Keurig  
DrPepper

Nestlé

PEPSICO

General  
Mills

Mondelēz  
International

FERRERO

## Personal Care and Cosmetics Brands

Unilever

ESTÉE LAUDER

Henkel

Edgewell™  
PERSONAL CARE

glanbia

L'ORÉAL

Perrigo

Johnson & Johnson

GOJO

THE BOUNTIFUL  
COMPANY

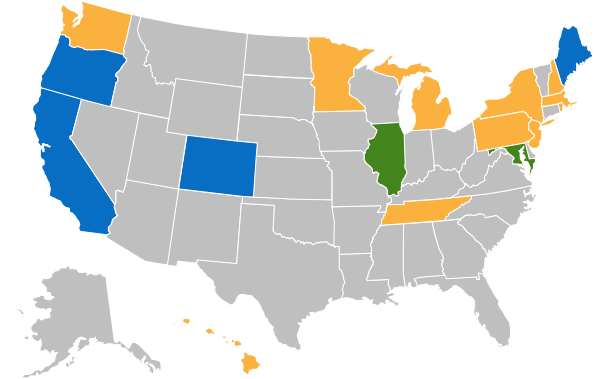
HALEON

scJohnson

COLGATE-PALMOLIVE



# APR's Policy Priorities



## EPR for packaging

Adequate, sustained funding for collecting recyclable materials



## Bottle deposits

Financial incentives for recycling collection of beverage containers



## Recycled content

Requirements to use recycled materials in new products



## Design

Design for circularity standards (inc. APR Design® Guide)



# Policy Key Messages



State, national, and global regulations are rapidly increasing.



EPR, recycled content have strongest momentum.



Lots of details still unfolding.



Differing state and global laws will make compliance challenging.

# Key Policy Hotspots



# U.S. Sourced Post-consumer Plastic Pounds Recovered for Recycling in 2021

|                                                                                                                      |                                                                   |                                                           |                                                                             |
|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------------------------|
| <b>5.1<br/>Billion lbs.</b><br>Bottles, Non-bottle<br>Rigid Plastics, Film and<br>Other Plastics<br>(excluding foam) | <b>PET Bottles</b><br><b>1,931.5</b><br>Millions of pounds        | <b>HDPE Bottles</b><br><b>927.2</b><br>Millions of pounds | <b>PP &amp; Other Bottles</b><br><b>28.1</b><br>Millions of pounds          |
|                                                                                                                      | <b>Non-bottle Rigid</b> s<br><b>1,071.0</b><br>Millions of pounds | <b>Film</b><br><b>1,106.2</b><br>Millions of pounds       | <b>Other Plastics</b> (excluding foam)<br><b>20.2</b><br>Millions of pounds |

[Visit the 2022 Data Dashboard](#)

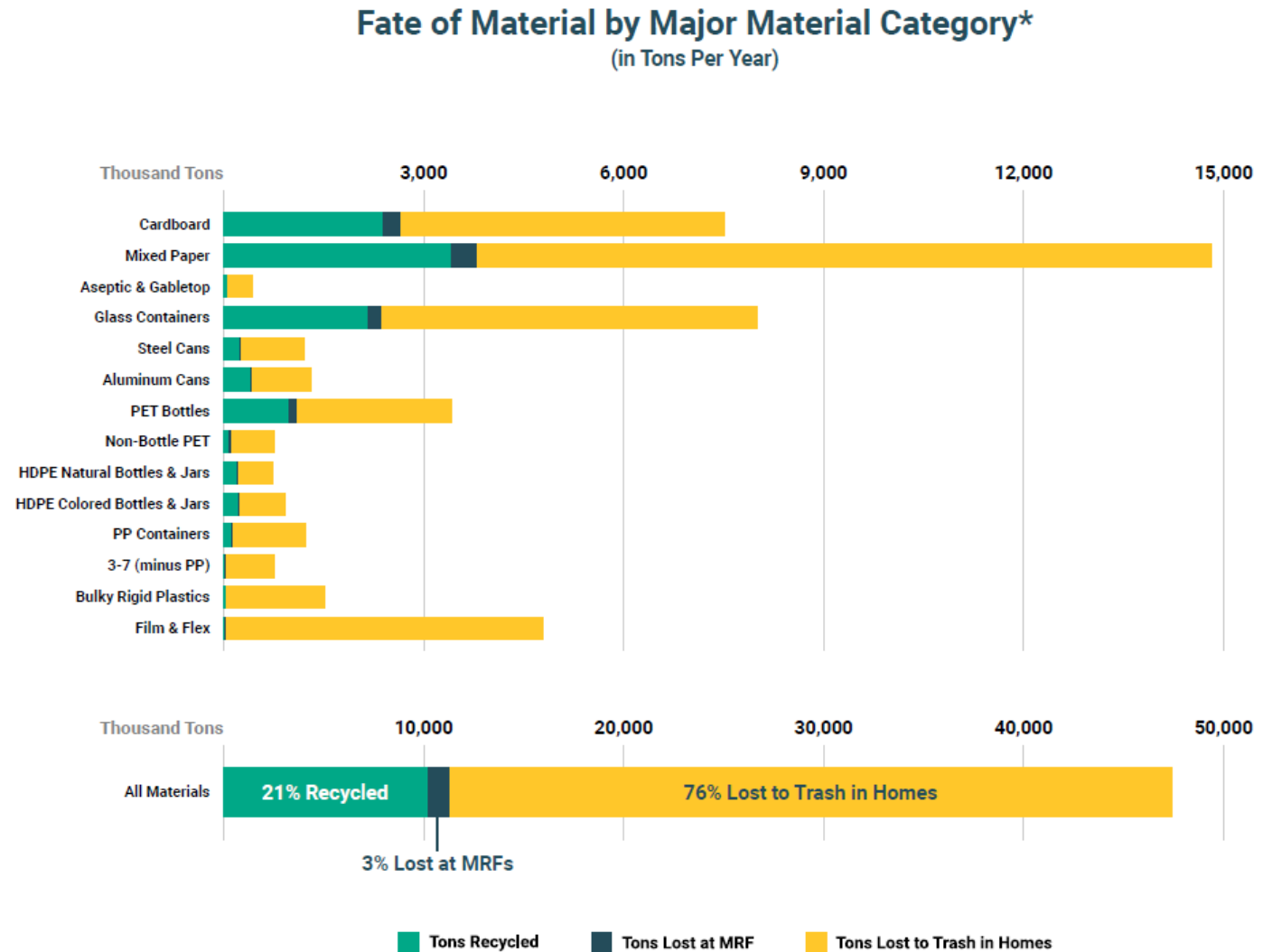


# U.S. Sourced Post-consumer Plastic % Acquired by North American Reclaimers in 2021

|                                  |                                             |                                         |                                                            |
|----------------------------------|---------------------------------------------|-----------------------------------------|------------------------------------------------------------|
| <b>Total</b><br><br><b>92.3%</b> | <b>PET Bottles</b><br><br><b>96.9%</b>      | <b>HDPE Bottles</b><br><br><b>99.2%</b> | <b>PP &amp; Other Bottles</b><br><br><b>96.9%</b>          |
|                                  | <b>Non-bottle Rigid</b><br><br><b>88.5%</b> | <b>Film</b><br><br><b>83.1%</b>         | <b>Other Plastics</b> (excluding foam)<br><br><b>37.2%</b> |



# So Much More Potential Feedstock



# APR Design® Guide for Plastic Packaging



# Is my packaging recyclable?

The **APR Design® Guide** is your tool to ensure a package design is compatible with the North American recycling system.

To be considered recyclable\*, companies must consider all the following criteria:

- Design for recyclability
- Consumer access to recycling
- Acceptance of a package in the recycling stream
- End markets for products made from the recycled plastic



\* For unqualified claims in the U.S., refer to FTC Green Guides



# Each design feature is classified into a recyclability category



- APR Design® Preferred
- Detrimental to Recycling
- Renders the Package Non-Recyclable
- Requires Testing

# Why is APR Preferred design important?

**In a circular economy, consumer product companies are their own material suppliers.**

Companies benefit when their packaging is not only recyclable, but also yields high quality post-consumer resin (PCR). This is why APR distinguishes between **Preferred** and **Detrimental** features.

Companies whose packaging contains **Detrimental** features are reducing and lowering the quality of their own future supply of PCR. Improving features so that the entire packaging achieves **Preferred Design for Recycling** supports a healthy recycling system and increases PCR supply.

**Preferred:**  
recyclable with  
maximum quality  
and yield



**Detrimental:**  
recyclable but  
reduces yield  
and/or quality

# Degradable Additives and Recycling: APR's Position

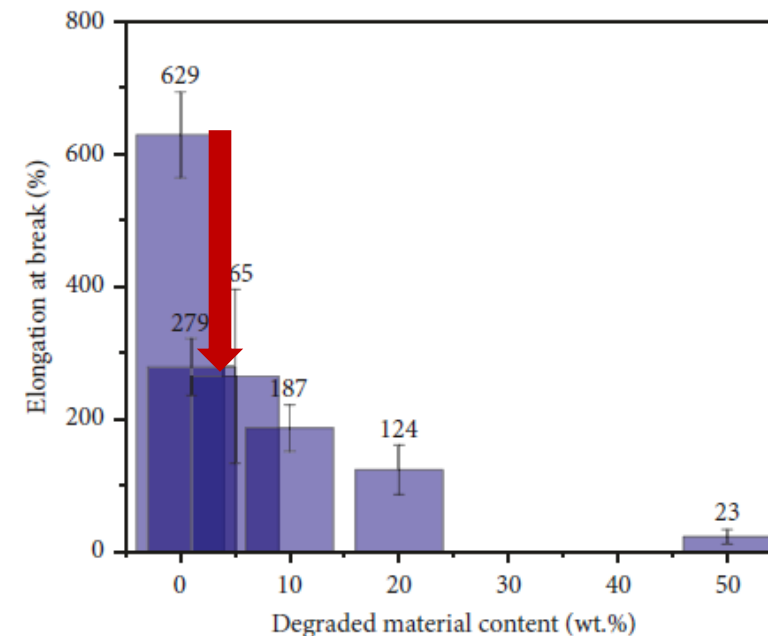
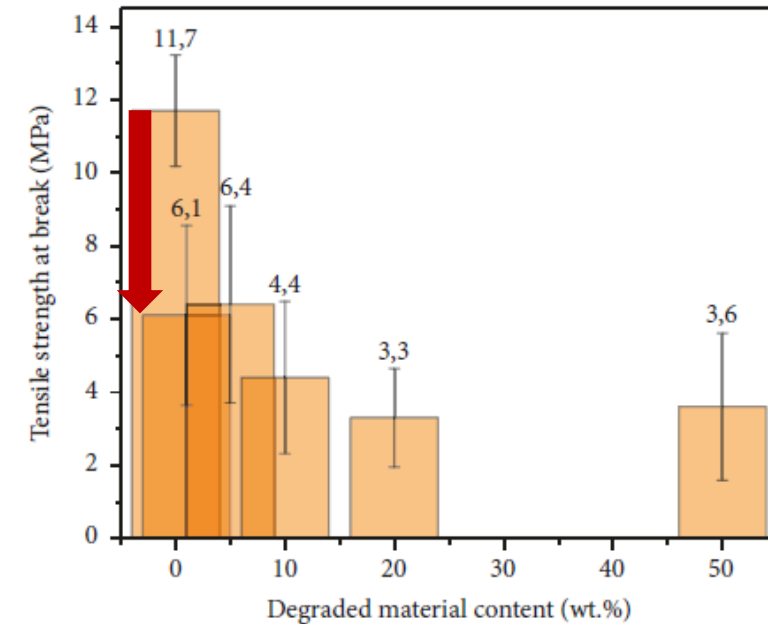
## Degradable Additives Used in Plastic Bottles, Thermoforms, and Films

- As a representative of companies participating in every aspect of the plastic recycling value chain, **APR is concerned that use of degradable additives in plastics collected for recycling may have negative effects** on some products of its members, namely recycled plastic where the secondary use requires demanding physical properties or a long service life.
- Regardless of their mode of action and compatibility in the first use of a plastic product, **degradable additives may present technical challenges for the mechanical recycling process and future uses of the product** produced from that process.

# Effect of the Prodegradant-Additive Plastics Incorporated on the Polyethylene Recycling

- Degradable additive added to LDPE and made 0.3 mm thick film
- LDPE film exposed to UV irradiation per ASTM D5071-06
- Degraded LDPE film introduced to virgin LDPE at 1, 5, 10, 20 & 50%
- Significant decrease in properties at 1% degraded film

International Journal of Polymer Science  
Volume 2018, Article ID 2474176  
<https://doi.org/10.1155/2018/2474176>



## APR's Position is In-line with Other Organizations

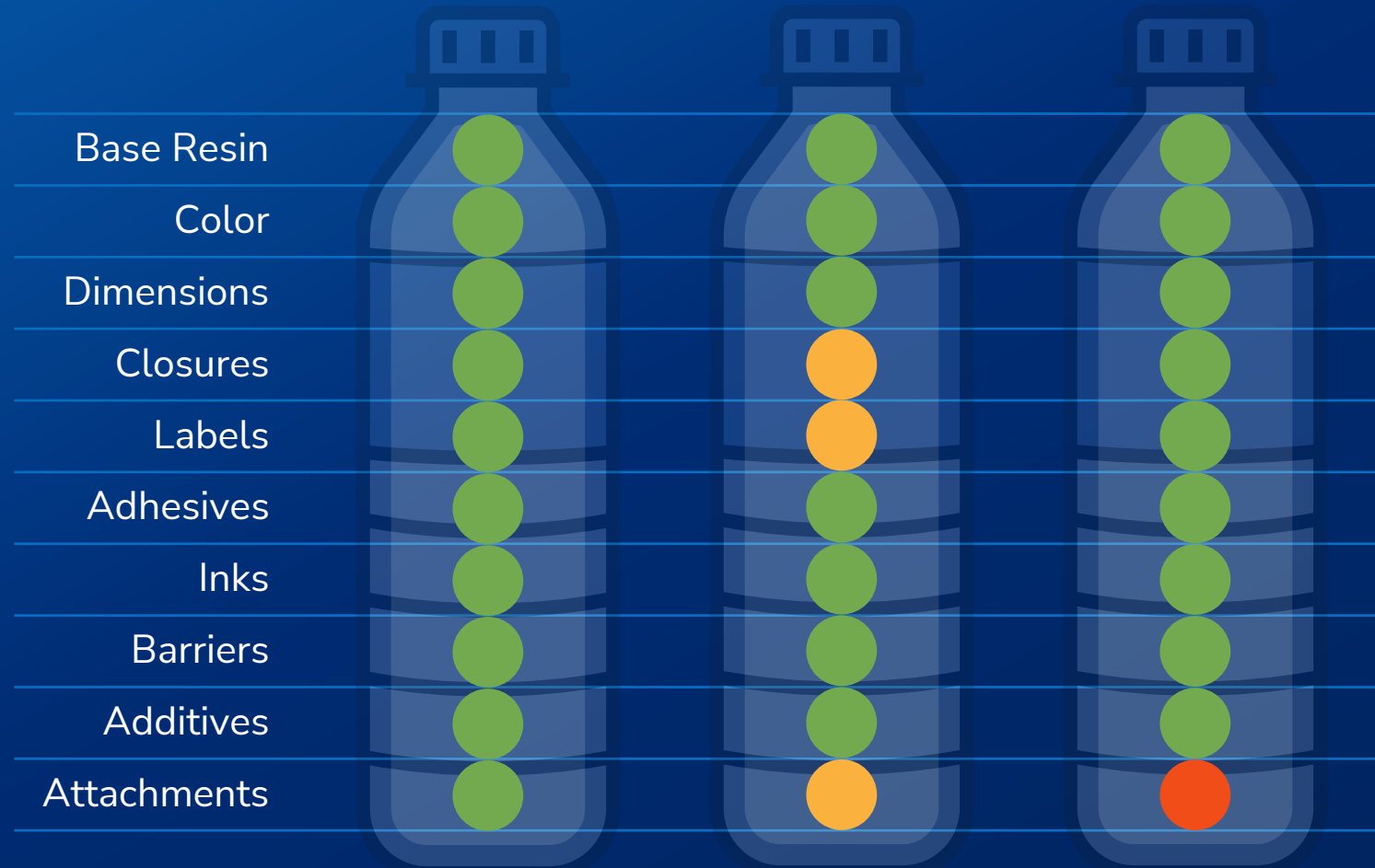
- [CEFLEX](#) - Oxo-degradable or similar (e.g. enzyme-based) additives are Not Permitted and Not compatible with PE or PP recycling
- [Ellen MacArthur Foundation](#) – Oxo-degradable plastic packaging is not a solution to plastic pollution and does not fit in a circular economy
- [EU Single Use Plastic Directive](#) - The following SUP products cannot be placed on the market: products made from oxo-degradable plastic
- [NAPCOR](#) - Degradable Additives to Plastic Packaging: A Threat to Plastic Recycling
- [RecyClass](#) - Oxo- and bio-degradable plastics consist of polymers that are incompatible with today's conventional plastic polymers. That hence cannot be mixed with standard polymers because they have a strong negative impact on the recycled plastic properties.
- [SPC](#) - does not support the use of any kind of degradability additives in packaging, including additives that seek to make packaging more degradable in landfills, marine environments, or open environments (e.g., as litter)
- [US Plastics Pact](#) - Problematic and Unnecessary Materials
- [Walmart Recycling Playbook](#) – Materials to avoid: “degradable additives or biodegradability additives” for all plastic packaging
- [WWF](#) - does not support the use of oxo-degradable materials, as they do not result in better environmental outcomes and contribute to microplastic pollution



# Design Features Drive Whole Package Assessment

## Design Features

Design features are classified according to the APR Recyclability Categories or test results where testing is required.



## Whole Package Assessment



# APR Assessment of Whole Package

## Preferred Design for Recycling



All design features are Preferred or have passed testing.

## Tolerated but Needs Improvement



Any design feature is Detrimental, AND no feature is Non-Recyclable.

## Non-Recyclable



Any design feature Renders the Package Non-Recyclable.

Processible by the recycling system

High Quality  
PCR

Low Quality or Yield  
PCR

Landfill



# APR Alignment with Other North American Organizations



Pathway to circularity



Recyclable



Recyclable by California Law



Widely recycled

Check locally

Not Yet Recycled

PREFERRED DESIGN

TOLERATED BUT NEEDS IMPROVEMENT

NON-RECYCLABLE

# APR Guidance Covers Entire Recycling Process: Collection to Pellets (Flexible Edition)



# Two Different Recycling Process for Flexibles: Wet & Dry

Since it's not possible to predict the type of reclaimer we must design packaging to effectively pass through both types of processes.

- Each process has different limitations
  - Dry process
    - Paper labels
    - Metal removal by magnets
  - Wet process
    - Metals removed by sink/float
    - Paper labels (with properly designed adhesive) removed by wet grinder
- Both utilize devolatilizing extruders and melt filtration for ink and non-melt removal

# Film Design

## Design Generalizations

- Color: All colors allowed
- Composition > 90% **PE** including all components i.e.. paper labels
- Must float
- Metallization allowed if:
  - Below coverage guidance ([APR-RES-SORT-04 Metal Decoration Resource](#))
  - Passes metal detection test ([APR SORT-B-03 Metal Sortation Protocol](#))
- Other layers/additives require testing

## Current APR Working Groups

- Laminating adhesives
- Inks
- Clean & Dry
- PP Flexible

# APR Design® for Recyclability Recognition

## *Critical Guidance Path*

### WHY IT'S IMPORTANT



Provides 3rd party validation that a design feature is compatible with the recycling system and meets APR Design® Guide standards



Provides a path for testing the impact of innovative packaging design features on the recycling system, when a testing protocol exists



Recognition makes a design feature eligible to be included in packaging assessed as Preferred Design for Recycling



Provides credibility and rewards the investment required to solve recycling challenges

### HOW IT WORKS

The program has four steps and generally is completed within 3-6 months:

1. Conduct testing with an independent third-party lab.
2. Submit non-proprietary, non confidential results demonstrating the component meets APR's testing criteria and pay program fee on APR website.
3. After successfully completing an APR member webinar, technical panel review and stakeholder discussion of results, APR will issue recognition.
4. APR provides logo and recognition letter, promotes item across all media channels and lists item on website.

NOTE: If the item will remain in recycled pellets at the end of the testing process, companies should conduct **APR Application Guidance** testing as well.



**Component Manufacturers:** Get started now by contacting [rebecca@plasticsrecycling.org](mailto:rebecca@plasticsrecycling.org)



# Impact of Paper Labels → Always Detrimental

Wet process example



In dry process label fiber ends up in recycled flake

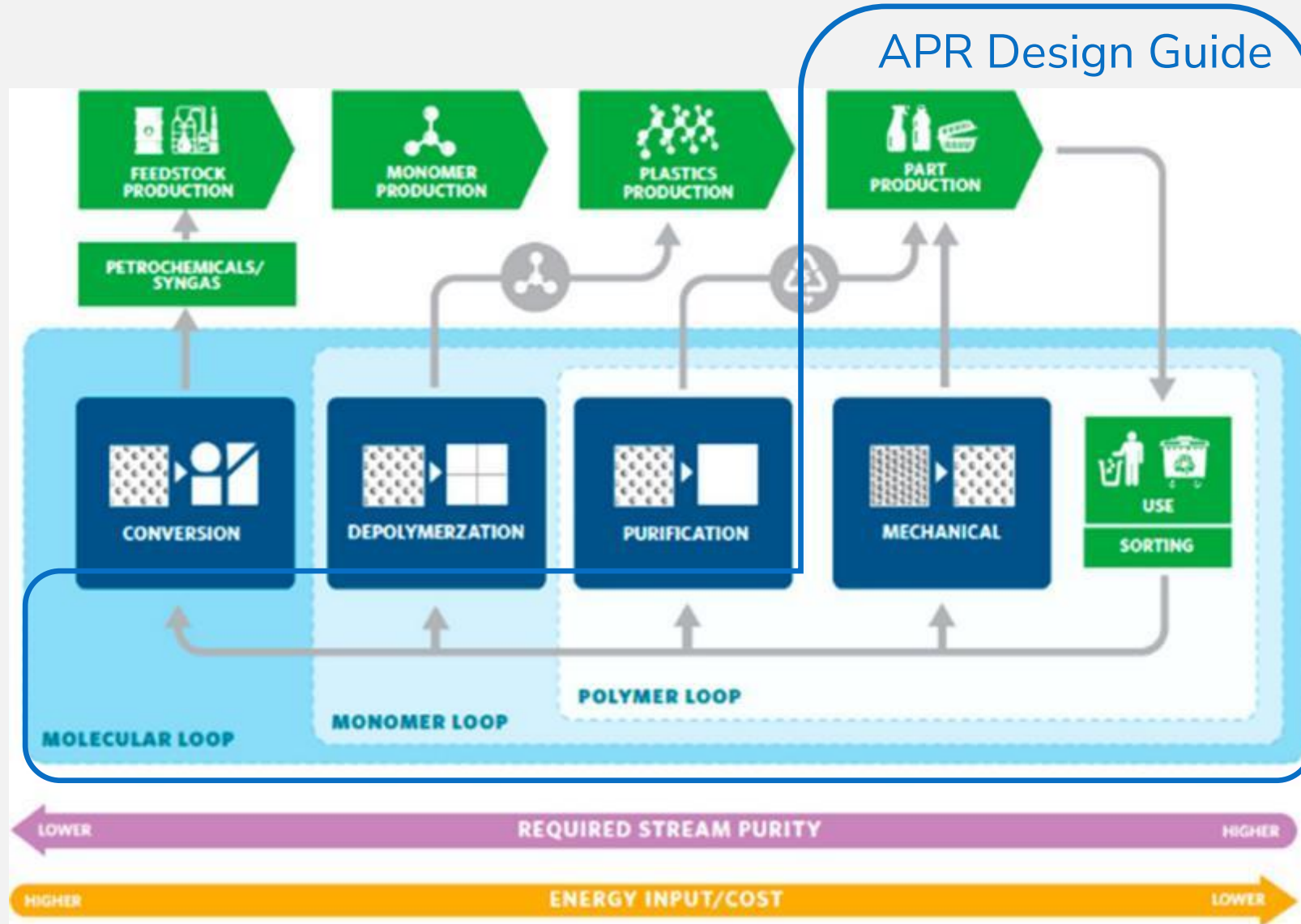


# Potential Challenges with Pouches

- Muti-material
- Metalizing
  - Limitation for dry recyclers
- Heavy fillers
  - Limitation for wet recyclers
- Pouches bring non expected contaminates
  - Equipment is designed for paper and heavies, not foodstuff, straws, dispensers etc.
- Water treatment!
  - Systems are designed for paper and dirt, not foodstuff



# Advancing Plastic Circularity



Source: [ACS Macro Lett. 2020, 9, 9, 1376-1390](#)



# Chemical Recycling

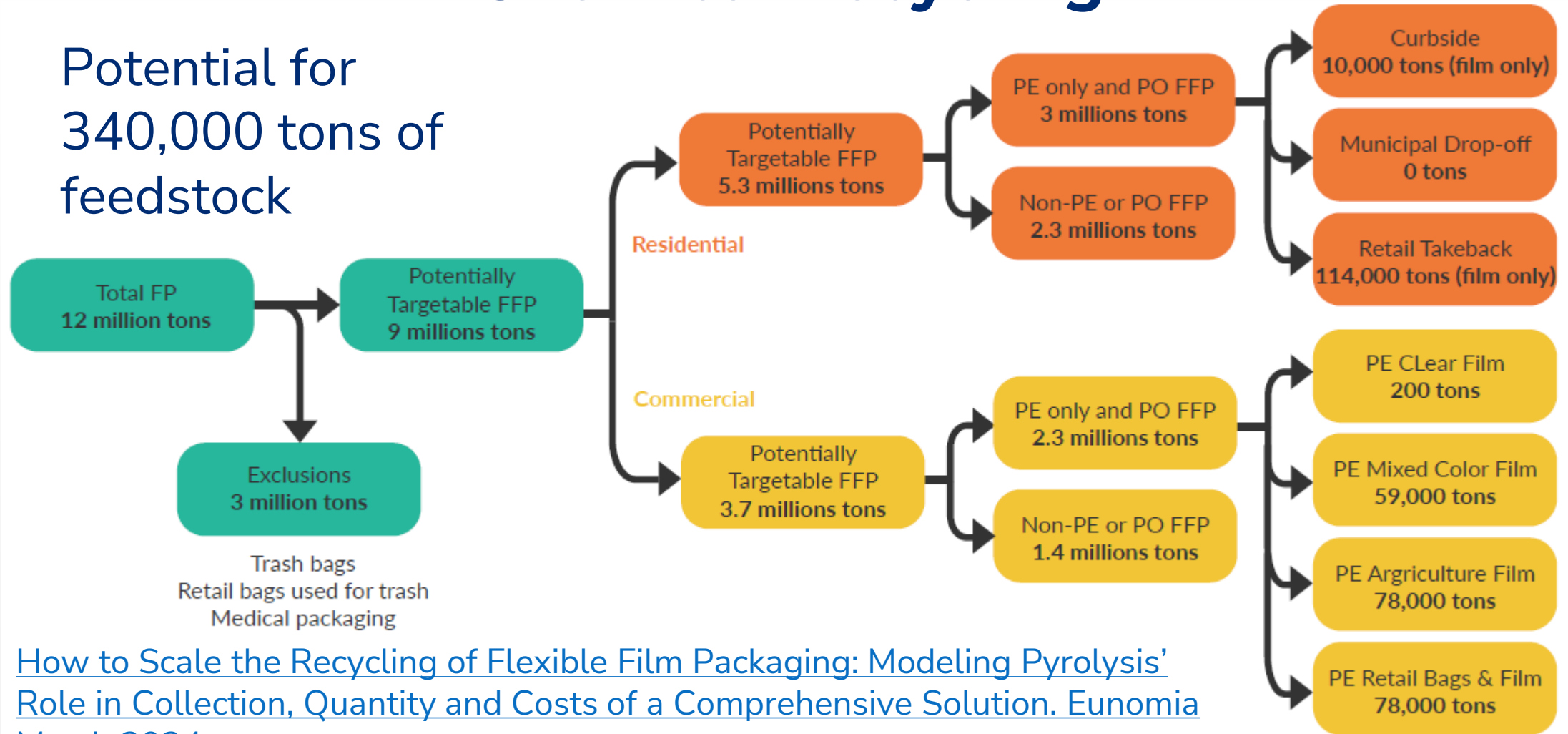
*Complimentary to Mechanical Recycling*

- Can process complicated packaging that mechanical recycling can't – multilayer etc.
- Can produce very pure material
- Business models target large volumes of cheap feed streams i.e. carpet fiber
- Many technology providers with varying process limitations

The Challenge for consumer packaging: How to isolate, collect and direct complicated packaging at an acceptable price and meet process specifications.

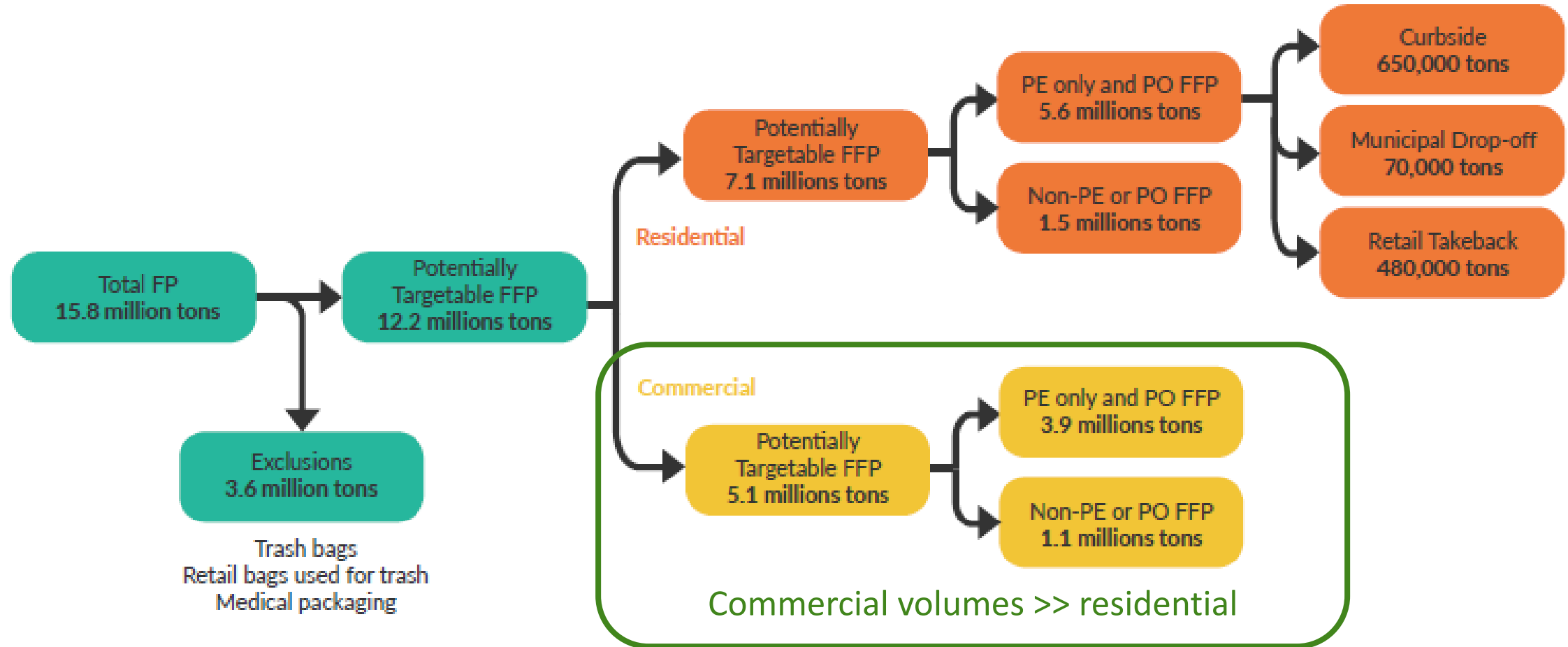
# Potential Flexible Packaging Volume for Chemical Recycling

Potential for  
340,000 tons of  
feedstock



[How to Scale the Recycling of Flexible Film Packaging: Modeling Pyrolysis' Role in Collection, Quantity and Costs of a Comprehensive Solution. Eunomia](#)  
March 2024

# 2030 Volume Potentially Scales with EPR to 6.2 Million tons of Feedstock

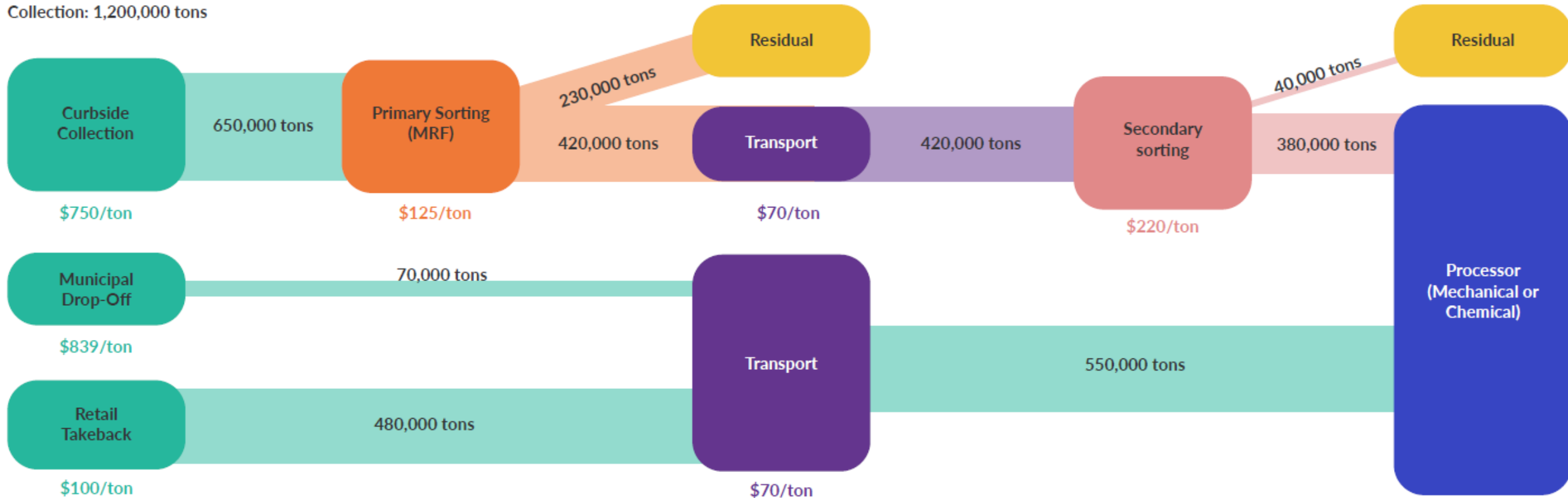


How to Scale the Recycling of Flexible Film Packaging: Modeling Pyrolysis' Role in Collection, Quantity and Costs of a Comprehensive Solution. Eunomia March 2024



# Residential Collections Come with a Weighted Cost of \$889/ton

Collection: 1,200,000 tons

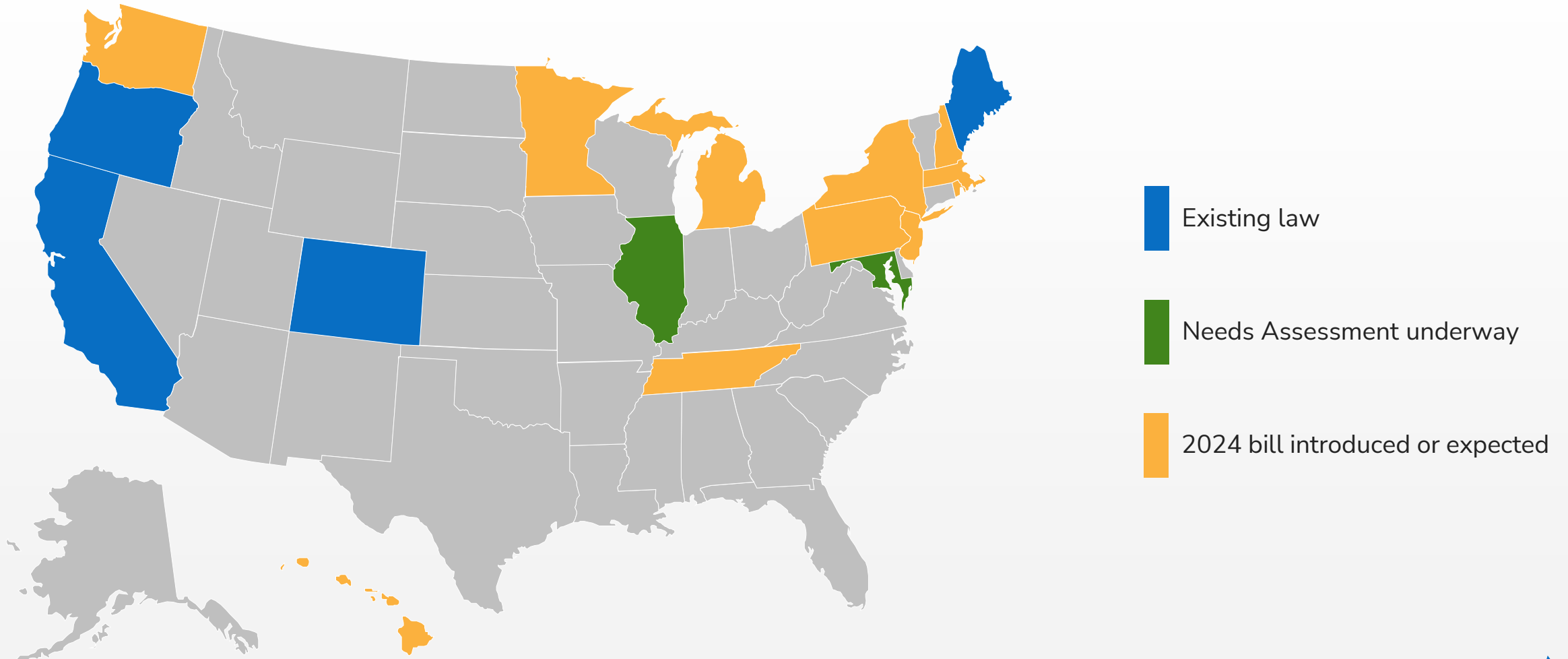


How to Scale the Recycling of Flexible Film Packaging: Modeling Pyrolysis' Role in Collection, Quantity and Costs of a Comprehensive Solution Eunomia March 2024



# EPR FOR PACKAGING IN US

March 2024



Map by PresentationGO.com



# APR Programs Are Circular by Design®

Together, we can reduce plastic waste and move towards a circular economy



# RECYCLING WORKS



when we all work together





ASSOCIATION OF PLASTIC  
**RECYCLERS**



# Thank you!



**Scott Trenor**

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