Overview of End Market Initiatives

End Markets Industry Leadership Committee

ASTRX Applying Systems Thinking to Recycling

Summary of Current Initiatives

Initiative	Type	Players
Cleaning the rPET Stream	Study	Closed Loop Partners
End Market Demand for Recycled Plastic	Study	More Recycling, Commissioned by SPC, APR and ACC
Film Recycling Investment Report	Study	The Closed Loop Foundation, prepared by RSE USA
MRFF: Flexible Packaging Sortation at Materials Recovery Facilities	Study/Pilot	ACC, prepared by RRS
NEMO: New End Market Opportunities project	Study	Plastics Industry Association (PLASTICS)
Beyond 34: Recycling and Recovery for a New Economy	Pilot	U.S. Chamber of Commerce Foundation, RRS, the City of Orlando and corporate partners
Hefty EnergyBag	Pilot	The Dow Chemical Company and partners
Sustainable Materials Marketplace	Pilot	US and World Business Councils for Sustainable Development (USBCSD, WBCSD) and Corporate Eco Forum (CEF)
APR Recycling Demand Champions Campaign	Collaboration	APR and corporate partners
Circular Economy for Flexible Packaging (CEFLEX)	Collaboration	Sloop Consulting and EU corporate partners
NAPRA: North America Plastic Recycling Alliance	Collaboration	Various industry stakeholders
Plastics-to-Fuel and Petrochemistry Alliance	Collaboration	ACC and various industry partners

Overview: Materials Focus of Current Initiatives

PET
- CLF Cleaning rPET

PE

PP
- APR Demand Champions

PS

Films
- CLF Film Recycling
- NEMO

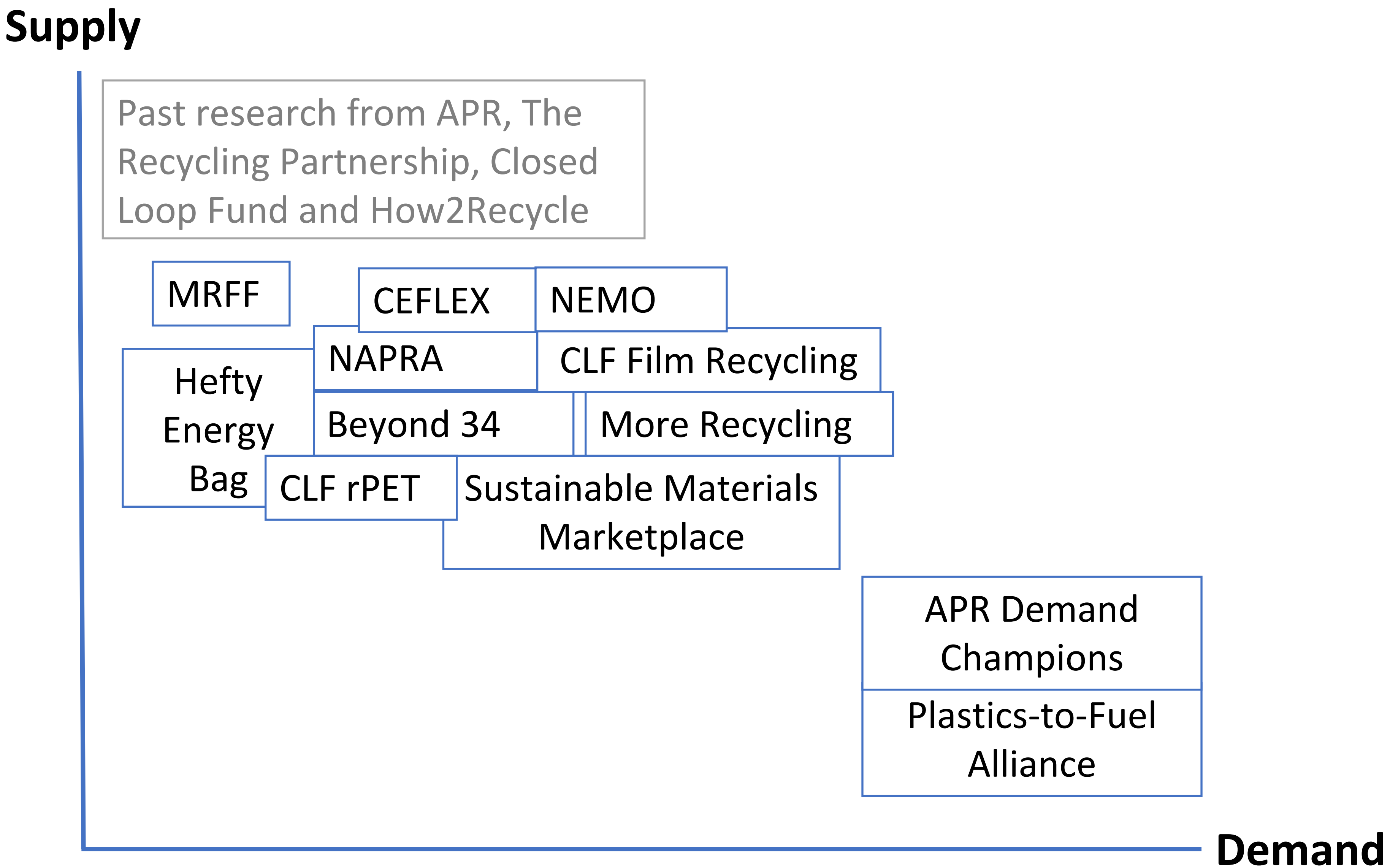
- More Recycling End Market Demand

Multi-Material Flexibles
- MRFF
- Hefty EnergyBag
- CEFLEX
- Plastics-to-Fuel Alliance

- Sustainable Materials Marketplace
- Beyond 34
- NAPRA

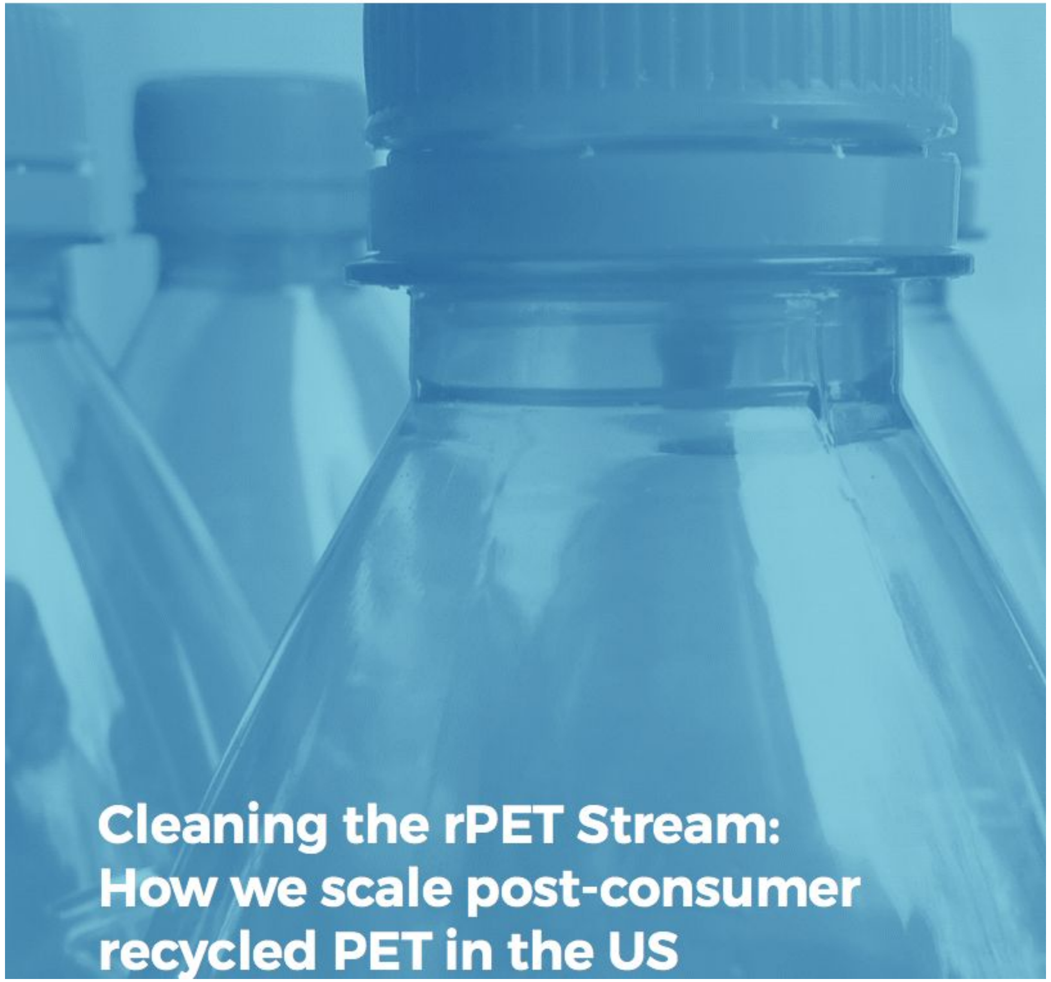
Specific Materials Focus ⟷ Broad Materials Focus

Overview: Market Focus of Current Initiatives



Key Studies

Cleaning the rPET Stream



Players: Closed Loop Partners

Focus material: PET

Goal:

Address how to improve competitiveness of rPET and how much capital is needed

End Markets Identified:
- Fiber
- Sheet & Film
- Food and beverage bottles
- Non-food bottles

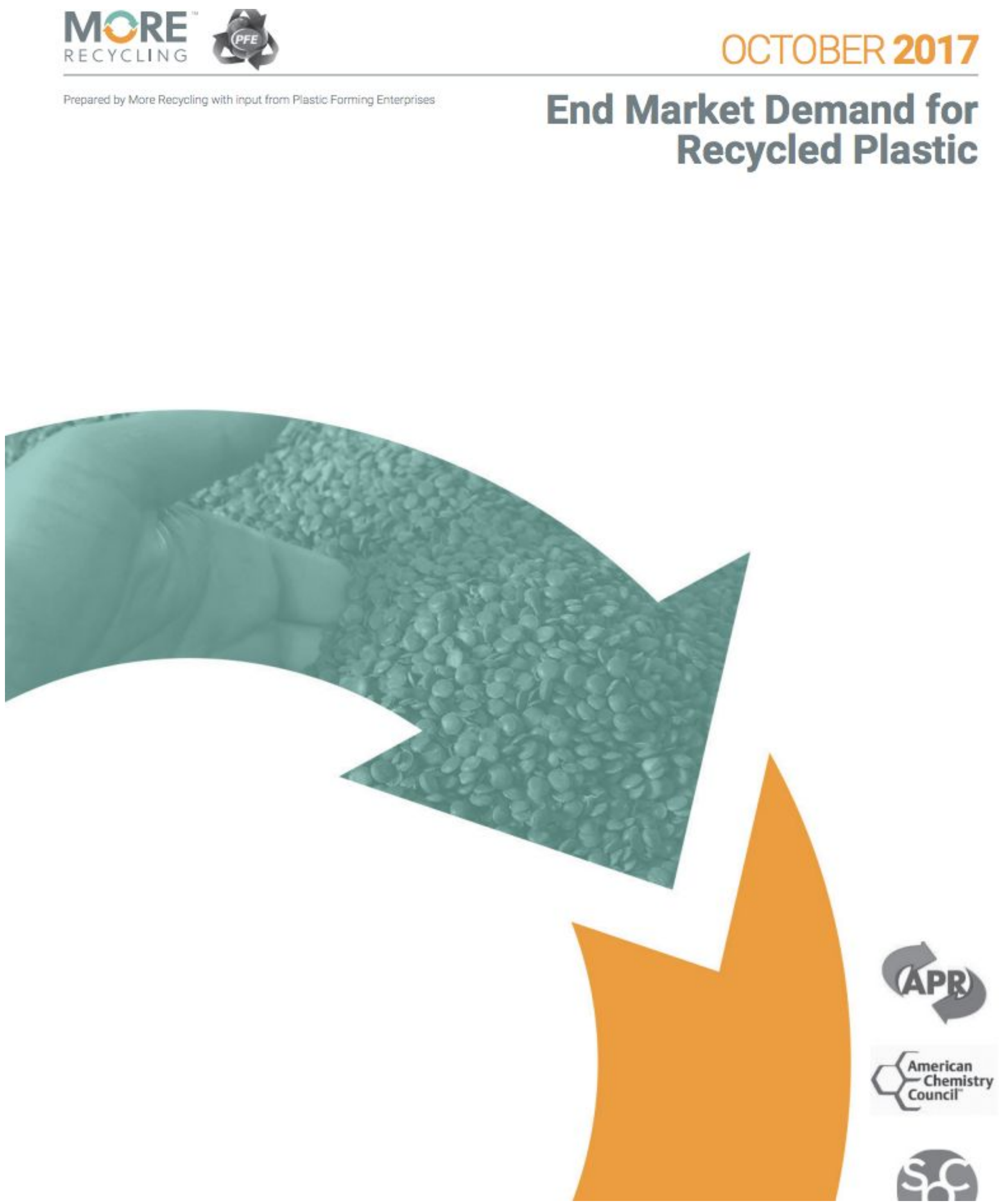
Key Findings:

- The cost structures for producing rPET and PET are very different
- If interventions are implemented together, it can lower costs by 10% & improve yield by 21%
- If implemented at scale, the national recycling rate of PET could increase by 7%
- rPET findings can be instructive for considering solutions for PP and PE

Key Recommendations:

- Technology investments in the form of loans, grants or venture capital should be made to improve MRF Sorting and Quality Control (capture rate)
- Byproduct market development for products like fines, colored PET, and thermoforms should be developed to increase and stabilize MRF revenue streams
- Reprocessors should reduce costs by avoiding pelletization and sending flake directly to resin
- Brands should adopt APR guidelines
- Brands should adopt long-term procurement agreements with suppliers to stabilize market prices
- Investments chemical de-polymerization should be made to prove the technology

End Market Demand for Recycled Plastic



Players:
More Recycling, Commissioned by SPC, APR and ACC

Focus material: PE, PP, PS

Goal: Document the 2016 demand for PCR and shed light on potential challenges or opportunities that may be encountered when stimulating end market demand to meet growing supply of materials for recycling.

End Markets Identified:
Plastic lumber/fencing; Rigid plastic applications (carts, plumbing products); Bottles; Bags

Key Findings:

- Price advantage of virgin resin & limited PCR supply that matches specs are main barriers
- Key equipment needs: vented/vacuum-degassing extruders
- Lumber and fencing had the highest level of PCR content, followed by rigid plastic. Bottles and bags had the lowest level of PCR content
- Total PCR purchases in 2016 were 1.16 billion lbs. For the most part Supply>Demand
    - Capacity to purchase PE: 2,098 million lbs
    - Capacity to purchase PP: 444 million lbs
    - Capacity to purchase PS: 312 million lbs
    - PE: S>D, D>S for material that meet specs
    - PP: S>D, at half capacity for material that meets specs
    - PS: D>S, due to lack of reclaimed PS
- Across material types, most demand is from current PCR users, except for PS

Key Recommendations:

- Industry focus should be on stimulating more demand for recycled content in applications that are more tolerant of the PCR already on the market and packaging that can evolve to embrace PCR
- Governments need to move beyond tonnage based diversion goals
- Rewards and verification for companies that use PCR
- Industry groups should launch and support a “Buy Recycled Campaign”

Film Recycling Investment Report

Players:
The Closed Loop Foundation, prepared by RSE USA

Focus material: Films

Goal:
Explore obstacles and solutions for increasing film recycling at different points in the recycling value chain.

End Markets Identified:

- PE film: trash bags, thicker commercial film, composite lumber products
- Non-PE film: No real end markets, PP film has potential

Key Findings:

- There are several duplicative existing efforts as well as gaps in current efforts
- Reclaimers and markets for non-PE film are virtually non-existent
- Film recycling loans, grants, and venture capital investments are all needed to overcome film recycling obstacles

Key Recommendations:

- A film recycling loan fund would help expand recycling capacity and recycled content product manufacturing, especially for end-user silos, blending and extrusion equipment that enables manufacturers to start using recycled content in products currently made from virgin content

- Grants and venture capital would support R&D for new recycling technology

- Stakeholders need to better coordinate film recycling efforts to avoid duplication

- Film manufacturers must design film products and packages for recycling, including designing products compatible with the polyethylene recycling stream

MRFF: Flexible Packaging Sortation at Materials Recovery Facilities

Players: ACC initiative, prepared by RRS

Focus material: Multi-material/flexibles

Goal: To understand how flexible packaging materials flow in a MRF and what existing technologies can help prepare material for market. To identify and demonstrate end market demand for the recovered multi-laminate and polyethylene films and wraps produced from the project.

End Markets Identified: Plastic Lumber, Films, Durable Products, Building Products, Intermediates, Energy & Fuel

Key Findings:

- Loose, automated collection could be more scalable and cost effective than bagged collection, especially in large MRFs

- Optical sorters show promise as a sorting mechanism for flexible films, however, there is wide cost variability in MRFs for optical sorters

- Single and mixed resin films with limited contamination can go towards markets for mechanically recycled materials, others go towards fuel pellet market or WTE

- The most promising markets for growth are in durable products and intermediates, pellets, engineered fuel pellets, building products, and cement kilns, with limited growth potential for film and lumber/extruded applications and pyrolysis
- Key concerns for end markets include cleanliness of films and 1% or less PVC

*Ongoing testing for additional end markets

Key Recommendations:

- Further equipment testing for MRFs is needed, especially for optical sorters and air flow control
- End market assessments are needed to identify large-scale consumers for multi-resin materials and to estimate markets for end products produced using new technologies
- Economic analyses of MRFs that measures net system costs for processing is needed
- Economic feasibility of secondary processing studies is needed for each end market
- A Community MRF demonstration pilot for curbside film collection should be conducted

New End Market Opportunities Project (NEMO)

Players: Plastics Industry Association (PLASTICS)

Focus material: PE films

Goal: Identify new end markets for return-to-retail film in NA with minimal added processing costs; Measure the market opportunity, communicate to the plastics recycling value chain and ensure appropriate processing methods are put into place for targeted end market applications.

End Markets Identified: Film products (beige, gray, colored or darker applications); Plastic lumber

Key Findings:

- Processed 400 pounds of material and got 250 pounds of pellets
- Resulting pellets were not as dark as expected so could go into some colored applications
- Not suitable for blown film applications, but can work for cast film used for injection molding
- Had some success shopping pellets around to potential end users

*Study ongoing, will also produce mapping end markets roadmap tool & literature review on films use in novel applications

Key Pilot Projects

Beyond 34: Recycling and Recovery for a New Economy

Focus material: Multiple

Goal:

Increase the current 34% recycling rate in the U.S. by providing a scalable model for improving recycling and recovery rates. The City of Orlando has been chosen to serve as the pilot city. The plan will also identify greater economic reuse opportunities for material generated from commercial, industrial, and residential sources. The long-term goal is to scale the project nationally.

Players:

- U.S. Chamber of Commerce Foundation
- RRS
- The Orlando Regional Chamber of Commerce, and the City of Orlando.
- The Dow Chemical Company
- Republic Services
- Target
- Walgreens Boots Alliance
- The Walmart Foundation.

The Hefty EnergyBag

Focus material: Multimaterial/flexibles
Type: Pilot

Goal:
Collects previously non-recycled plastics – like the candy wrappers and juice pouches always thrown away – at curbside and converts them into energy resources. The program is complimentary to mechanical recycling.

Players:

- Dow Chemical Company
- Republic Services
- Flexible Packaging Association (FPA)
- Agilyx
- Reynolds Consumer Products
- ACC
- City of Citrus Heights, CA
- Omaha Hefty® EnergyBag™ Program Partners
- First Star Recycling,
- Conagra Brands,
- Systech Enviro Corp.,
- Recyclebank

End Markets Identified:

- Plastics-to-Fuel
- Cement Kilns/Energy

Key Findings:

- Multi-materials flexible plastic packaging and miscellaneous non-recyclable plastic items can be collected at curbside and integrated into an existing recycling program
- Contamination levels can be controlled in a curbside collection program
- Colored bags are easy to sort and did not create contamination at the MRF
- Communication, planning and project management are critical components of a successful program

Sustainable Materials Marketplace

Focus material: Multiple
Type: Pilot

Goal:
Create an expanded U.S. materials marketplace for companies to reuse material on a secure cloud-based marketplace software platform. Project members share materials data, review recommended materials, negotiate trades, and receive notifications of potential obstacles. The platform also enables companies to brainstorm ways to reuse ubiquitous materials, fix wasted transport and logistics space.

Players:

- US BCSD
- WBCSD
- The CEF

End Markets Identified:

- Cartons - ceiling products/other packaging
- Drums/Totes - Reconditioning of used containers if direct reuse is not an option
- Additional markets for related products identified include cement kiln co-processing, aluminium and chemical recovery
- Market depends on specific product.

Key Findings:

- There is a need for personalized user support so they better understand how the marketplace works and what sorts of materials can be uploaded
- There is a need for technical help uploading data into the platform
- There is a need for expert assistance to assess the feasibility of potential transactions and help in facilitation

Key Collaborations

APR Recycling Demand Champions Campaign

Focus material: PE, PP
Type: Collaboration

Goal:
Champions commit to purchase “works in process” (WIP) durable goods, creating consistent, reliable demand for mixed residential, recycled plastics

Players:

- APR
- Berry Global
- Campbells Soup
- Coca-Cola North America
- Envision Plastics
- Keurig Green Mountain
- KW Plastics
- Merlin Plastics
- Plastipak/Clean Tech Inc.
- P & G
- Target

End Markets Identified:

- “WIP” items used in manufacturing, e.g. crates, totes, cans, pails, drums, recycling bins, pallets, transport packaging, and other items.

Circular Economy for Flexible Packaging (CEFLEX)

Focus material: Multimaterial/Flexibles
Type: Collaboration

Goal:

A new initiative by a broad consortium of European companies aiming to advance better system design solutions for a variety of flexible packaging, including multi-materials films. Working towards the development of collection, sorting and reprocessing infrastructure for post consumer flexible packaging across Europe by 2025. Work includes the development of robust Design Guidelines for both flexible packaging and the end of the cycle infrastructure by 2020. There is also a workstream for sustainable end markets.

Players:

- Managed by Sloop Consulting
- Additional partners include: Amcor, Attero, APK Aluminium, Barilla Group, Borealis, Constantia Flexibles, Dow Europe, DSD-Duales System Holding, DuPont, Erema Group, EXPRA, Flexible Packaging Europe, Henkel, Hills Pet Nutrition, Huhtamaki, Hydro, Aluminium Rolled Products, Immer Group, Jindal Films Europe, mtm Plastics, Mondi Consumer Packaging, Nestlé, PepsiCo, pladis, PlasticsEurope, Plastotecnica, Polypouch, Pyral, Procter & Gamble, Robert Bosch Packaging Technology, Sappi Packaging and Specialty Papers, Sealed Air Siegwek, Suez, Tomra Sorting, Tonsmeir Wertstoffe, Unilever, Wipack

North America Plastic Recycling Alliance (NAPRA)

Focus material: Multimaterial/Flexibles
Type: Collaboration

Goal:
Increase collaboration between trade associations working on efforts to drive the recovery of plastic products. Work to identify common issues and opportunities and leverage their collective expertise and member networks to expand recovery opportunities. Define 'driving new end market opportunities for recycled plastics' as a key focus area for the group moving forward, emphasizing the importance of recycled content.

Players:
- ACC
- The Recycling Partnership
- Canadian Plastics Industry Association
- The Vinyl Institute
- FPI
- PLASTICS
- APR
- National Waste & Recycling Association
- ISRI
- Keep America Beautiful
- PAC
- SPC
- AG Container Recycling Council
- Carpet America Recovery Effort

Plastics-to-Fuel and Petrochemistry Alliance

Focus material: Multimaterial/Flexibles
Type: Collaboration

Goal:
The newly established Plastics-to-Fuel and Petrochemistry Alliance will work to increase awareness of the benefits of plastics-to-oil technologies, enhance the industry's voice through expanded membership and demonstrate broad support for plastics-to-oil technologies through an expanding network of allies.

Players:

- ACC initiative
- Members: Agilyx, Plastic Energy, Renewlogy, RES Polyflow, VADXX, Americas Styrenics LLC, Tetra Tech

End Markets Identified:
Pellets for fuel and petrochemicals

ASTRX

Applying Systems Thinking to Recycling

SUSTAINABLE PACKAGING COALITION®

THE RECYCLING PARTNERSHIP™