Flexible Packaging Resource Recovery Update

A Flexible Packaging Association Report

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Contents

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Introduction

The Flexible Packaging Association (FPA) has conducted several studies analyzing the end-of-packaging-use options for flexible packaging in the U.S. with focus on difficult to recycle, often multiple-layer, multi-material packaging structures. The FPA 2014 report, *"The Continuing Evaluation of Existing and Emerging Flexible Packaging Resource Recovery Infrastructure and Processes"* explored the infrastructure and processes needed to enable the viable resource recovery of flexible packaging, both from an economic and technology perspective, including an evaluation of the current and emerging technologies that have the potential to provide positive impacts. The report provided a comprehensive examination of the key challenges that need to be addressed from a full system view that included perspectives from multiple stakeholders such as the community (collection), the material recovery facility (sortation), the re-processor (conversion to a new product), and the end-user (purchase and use of the recovered material), as well as municipalities, NGOs, CPGs, retailers, associations, and government. Dialogue with these key stakeholders was a critical component in compiling such a comprehensive view.

As part of this effort the FPA published *Flexible Packaging Resource Recovery: A Work in Progress* brochure which provides an overview of the key findings. This brochure along with the detailed report can be found on the FPA website: www.fpa.org.

The purpose of this report, *Flexible Packaging Resource Recovery Update* is to provide the most recent research findings, pilots, and other activities related to the resource recovery of flexible packaging. The view is global in scope but with an emphasis on the U.S. and includes examination of recently completed as well as on-going projects. It is intended to capture the latest efforts and key learnings in a single document.

One of the updates addressed by this project is the need to identify and capture the most current information on "who's doing what" and determine how the activities relate to flexibles. This will aid in the efforts to collaborate and to avoid duplication of work. The breadth of work illustrates the growing interest and activity around the recovery of flexible packaging.

I. Collaborative Pilots

There are several new collaborative pilots that have been recently completed or are currently in progress. This discussion will focus on four of these, two from the U.S. and two from Europe.

(1) Citrus Heights "Energy Bag" Collection, Sortation and Processing Pilot (Completed)
(2) UK Curbside Collection, Sortation and Processing Trial (Completed)
(3) REFLEX (Recycling of Flexible Packaging) Project (In progress)
(4) Materials Recovery for the Future (In progress)

In the past many of the pilots that involved flexible packaging focused only on the collection and processing of single-material films whereas the most recent work is focused on multi-material laminates. This is very encouraging in that it illustrates that there is a growing recognition that multi-material laminates as a packaging format will continue to grow and have value, and effort should be made to capture that value. The pilots described below demonstrate a commitment to determine the most effective ways to capture that value.

Citrus Heights "Energy Bag" Collection, Sortation & Processing Pilot

(June 1 – August 31, 2014)

The Energy Bag Pilot was a three month program targeting 27,000 households in Citrus Heights, CA, that tested the feasibility of collecting non-recycled plastics at curbside, sorting them at a material recycling facility (MRF), and delivering them to an energy conversion plant to be converted to oil, all via an existing waste management infrastructure.

During the summer of 2014, households of Citrus Heights, CA were asked to place their non-recycled plastics into a provided bright purple "Energy Bag" and, when full, to put the bag inside their recycling bin at curbside for the regular bi-weekly recycling collection. Sortation took place at Republic Services Newby Island MRF, where the Energy Bags were separated from the regularly recycled items. The bags were bundled and then shipped to Agilyx's pyrolysis facility in Portland where the materials were converted into synthetic oil.

Targeted Material
Flexible packaging currently not recycled in Citrus Heights, CA (both multi-material laminates and non-recycled single-material films) plus plastic utensils.

Instructions provided to households listed the following items for inclusion in the Energy Bag: juice pouches, squeezable pouches, microwavable pouches, frozen fruit & veggie bags, fresh fruit & veggie bags, cereal box liners, laundry pouches, cake mix liners, snack bags, candy wrappers, dog & cat food bags, plastic serving & service ware, straws & stirrers, salad bags, plastic meat & cheese wrap, all other non-recycled plastic bags.

Sponsors/Collaborators
The Dow Chemical Company, Republic Services, Flexible Packaging Association, Agilyx, Reynolds Consumer Products, the American Chemistry Council and the City of Citrus Heights, California

Timing
The pilot itself lasted three months from June-August. Including planning, partner negotiations, promotional efforts, and data analysis the entire program lasted a year. (November 2013 - November 2014)

Location
Citrus Heights, CA

This pilot was very successful. It clearly demonstrated the viability of diverting non-recycled plastics from the landfill and converting them into a valuable end product.

Key Learnings
- Multi-material flexible plastic packaging can be collected at curbside and integrated into an existing recycle program.
- Contamination levels can be controlled providing an acceptable source of plastic for energy conversion.
- The bags can make it through the collection and material handling equipment without high levels of breakage.
- Sorting and consolidating the bags can be efficiently managed at a recycling facility with enough space to accommodate additional manual sorters and temporary storage of the Energy Bags.
- The sorted materials can be transported and are suitable to be converted into a new energy resource.
- A strong partnership among the coalition partners is a critical component of a successful program.
- Based on the results of the post-pilot survey, approximately 33% of targeted households participated at some point during the pilot, with 27% reporting on-going participation at the end of the pilot.

The pilot also revealed some interesting and unexpected learnings. Before running the pilot many consumers in Citrus Heights thought that all plastic was recyclable. The pilot educated them as to what plastics are and what plastics are not recyclable. A positive result of this effort is the MRF should see less contamination from Citrus Heights customers after the pilot than they did before.

In addition, during the interactive communication events no one asked what would happen to the material. They were more interested in the fact that they were now able to put the materials in their recycle bin. This goes counter to the message that many of anti-waste-to-energy folks give lawmakers and provides a different perspective with regard to their constituents' priorities.

Communication, planning, and project management proved to all be critical components of a successful program and the key learnings related to these are explored in much more detail in the full report. This report as well as a documentary on the project can be found at http://www.dow.com/en-us/packaging/sustainability/energy-recovery.

The recommended next step, a scaled-up program targeting a small to medium size city in which key learnings could be applied and broader communication channels utilized is currently being actively pursued.

UK Curbside Collection, Sortation and Processing Trial

(February – November 2015)

A trial to assess the feasibility of including flexible laminated packaging in existing household recycling schemes is currently underway in three different locations in the UK. Varying curbside collection schemes as well as different methods of engaging with residents will be tested to help determine what practices will maximize collection and recovery rates.

This project was funded by the UK government following the successful completion of a scoping study conducted in 2014. The scoping portion of the project also included Tesco as a sponsor.

This project is similar in nature to the Citrus Heights "Energy Bag" Project but from a U.K. system perspective. Comparing results especially in the area of consumer behavior will be interesting and enlightening.

Targeted Material
Laminated flexible packaging

Examples of targeted materials include food and drink pouches, pet food pouches and toothpaste tubes. Residents are being given bags to put these materials in and are being instructed to put the bags out with their regular recyclables.

Project Lead
Anthesis LRS (managing and coordinating trials)

Collection and Sortation
Collection and initial sorting will be done by SUEZ Environnement (formerly SITA UK).

Processing
Enval plans to process the material at their demonstration facility near Huntingdon.

Additional Sponsors/Collaborators
Nestlé UK & Ireland, Coca-Cola Enterprises are responsible for consumer engagement, leveraging their brands to help in getting the message to residents.

Funding
Department for Environment, Food and Rural Affairs (Defra) Action Based Research Program (£188,000)

Timing
Started February 16, 2015 and lasted 9 months.

Location
Up to 260 homes in each of the following three areas: Bracknell Forest, Calderdale, and the London Borough of Hounslow

Project Goals/Desired Outcomes
The project was launched with the following objectives:

- To evaluate the potential to include flexible laminated packaging in mainstream recycling collections in the UK.
- To help determine the collection and communication best practices that would maximize the amount of material collected and recovered.
- To provide insight into how different communications approaches, consumer behavior, and brands influence collection models across different demographics and locations (London, Berkshire, and Yorkshire).
- To demonstrate that Enval can successfully capture and recycle the aluminum, as well as recover the plastics as a fuel oil product.

Results/Key Learnings
As of the time of this report the results of this pilot have not been released.

REFLEX (Recycling of Flexible Packaging) Project
(March 2015 – March 2017)

The collection, sorting, and reprocessing of post-consumer flexible packaging is in its infancy and presents a number of technical and commercial challenges. The REFLEX (Recycling of Flexible Packaging) Project is a UK based effort that was put together to begin to tackle these challenges. It is a two year collaborative R&D project funded by the UK government targeting each step in the supply chain including package design, manufacture, sortation, and reprocessing.

Targeted Material
All flexible packaging

Project Lead
Axion Consulting

Sponsors/Collaborators
Amcor, Dow Chemical, Interflex Group, Nestlé UK, Unilever UK Central Resources, SUEZ Environnement (formerly SITA UK), Tomra Sorting

Funding
A £917,000 grant by the UK government's innovation agency, Innovate UK

Timing
Kicked off in early 2015 and will last 2 years

Location
UK

Project Goals/Desired Outcomes
The goal of this R&D project is to improve the recyclability of flexible packaging by finding new ways of collecting, sorting, and reprocessing it into a high-quality recycled plastic pellet suitable for use in the manufacture of a wide range of products thus driving flexible packaging toward a circular economic model. They have divided this objective into three distinct work streams:

(1) Development of novel new packaging designs that include innovative new inks and barrier polymers

(2) Development of techniques to make blended polymers from flexible packaging which perform in new uses
(3) Improvement in the identification and sorting of recyclable flexible packages from the waste stream

With the backing of brand owner partners Nestlé and Unilever they also hope to develop industry-wide guidelines for recyclable packaging that can be agreed and disseminated.

Current Work

Initial research has focused on exploring and evaluating alternatives to difficult to recycle multi-layer films, which are potentially more suitable for recycling and yet still deliver the performance requirements and technical properties needed for products ranging from confectionery to detergent. The ability to continue to deliver the performance requirements is a key element of this work.

Early work at redesigning these structures using polymers that could potentially be recycled together is showing some early promise on a limited scale.

Another area of focus includes optimization of near infra-red (NIR) sorting technologies to detect and separate mixed polyolefin (Polypropylene and Polyethylene) packaging, such as candy wrappers, chip bags, and bread bags. This would broaden what can be sorted and separated for recycling from mixed post-consumer flexible packaging.

Capturing this mixed polyolefin packaging would divert more of it from landfill, while opening up interesting new options for the types of recycled polymers that could subsequently be made from it.

If and when the appropriate developments occur the team realizes that any new recycling program is a long term effort. It anticipates that the market will follow a similar model to that for plastic bottle recycling taking at least ten years to mature to a point at which more than 50% of flexible packaging is diverted from the waste stream.

Future Work

Further studies will focus on how flexible packaging can be reprocessed into high-quality recycled plastic pellet suitable for use in the manufacture of a wide range of products.

Materials Recovery for the Future

(Phase 1: August 2015 – August 2016, Phase 2 - TBD)

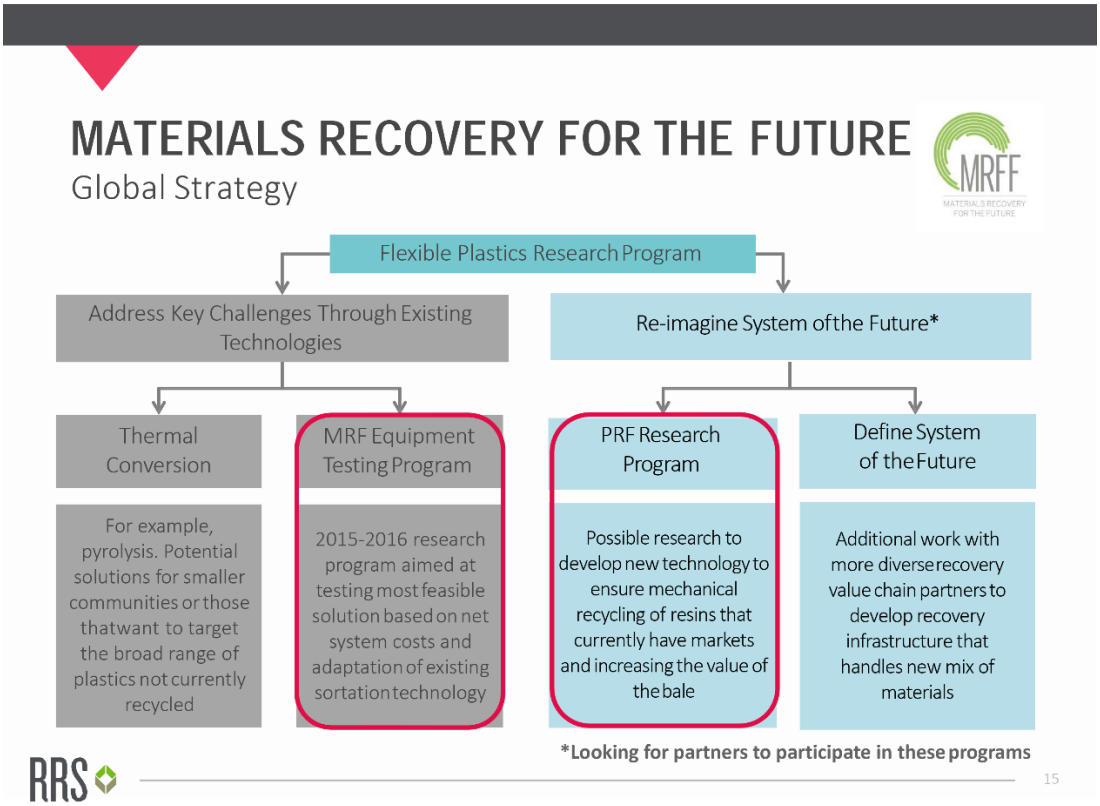
Materials Recovery for the Future is a research project dedicated to advancing the understanding of how flexible packaging can be effectively sorted for recovery. It is hoped that the results will begin to lay the groundwork for the development of an economically viable and national scalable approach that is cost effective for industry and easy for consumers.

Phase 1 Objective

- Test the potential of currently available MRF sorting technologies to improve separation of flexible packaging in the existing post-consumer municipal solid waste stream.

Phase 2 Objective

- Define the recovery system of the future through development of Plastics Recovery Facilities (PRFs) that ensure the highest value is achieved from the material mix in each bale.



Source: Materials Recovery for the Future: Flexible Packaging Research Program Presentation - March 15, 2016 www.recycle.com

The team is working toward a future vision where all flexible packaging is recovered and its value is captured.

Targeted Material
All flexible packaging - laminates and films, single material and multi-material

Project Administration/Communication
American Chemistry Council's Research Foundation for Health and Environmental Effects (RFHEE)

Daily Project Management
RRS (managing and coordinating trials)

Sponsors/Collaborators
Dow Chemical, PepsiCo, Procter & Gamble, Nestlé Purina PetCare, Nestlé USA, Sealed Air, SC Johnson, Flexible Packaging Association (FPA), SPI: The Plastics Industry Trade Association (SPI), Association of Plastics Recyclers (APR), Amcor

Timing
Phase 1 was kicked off in August 2015 and is anticipated to last one year. The timing and scope of Phase 2 will be determined after the conclusion of Phase 1.

Phase 1 Project Goals/Desired Outcomes
Test the potential of currently available MRF sorting technologies to improve separation of flexible packaging in the existing post-consumer recycling stream.

- Learn where flexible packaging will end up in the MRF
- Establish a baseline for what portion of flexible packaging can be potentially captured to a target bale
- Gain insight into what sort process modifications could be made to drive more effective recovery at the MRF

Methodology
Conduct a series of iterative tests to determine the potential use of existing MRFsorting technologies to separate flexibles from the stream with a particular focus on disc screens and optical sorters.

The first phase of the research will involve mapping the flow of flexibles through the MRF by adding a representative mix of flexible packaging to the standard incoming single stream material. Then, based on the results engage MRF equipment manufacturers to develop and test options to improve sorting efficiency.

Results of Material Flow Test #1 - November 2015

A baseline material flow test was performed at CP Group's San Diego MRF in November 2015. The flexible packaging seed material was mixed with the single stream feedstock and fed into the MRF. Samples were taken of all the commodity product streams where the seed materials were observed. The samples were then sorted to determine the amount of seed material in each product stream with the following results:

- 63% of the flexible packaging flowed with the old news print (ONP) stream
- 25% of the flexible packaging flowed with the mixed paper stream
- 12% of the flexible packaging flowed with the container stream

As expected the vast majority of the flexible packaging (88%) flowed with the fiber streams (ONP and mixed paper). The optical sorters on these lines were able to extract about half of the flexible packaging from the paper into a relatively clean stream of flexibles but were not able to keep up with the total volume of paper and flexibles at standard throughput speeds. Of the remaining 12% that ended up in the container stream a third of the material (4%) was recovered through a combination of an air drum separator followed by a manual sort. The remainder ended up in the residue stream.

The conclusion drawn from this trial was that with adequate screening and optical sorting capacity on the fiber lines most of the flexible packaging in a single stream MRF could be captured.

The next step will involve both lab and field testing. The MRFF team will work directly with the optical sorter manufacturers to determine the following:

- If specific package forms, resin contents, or ink/coatings cause recognition problems
- If certain forms are difficult to eject
- What optical sorter sizing is needed to maximize recovery at typical throughputs

In addition discussions with disc screen manufacturers are planned to explore if adding flexible packaging to the stream will result in any throughput limitations.

The full test report is expected to be published in fall of 2016.

Current Collaborative Pilots Summarized

A summary of the current flexible packaging focused pilots is found in Table 1 and an expanded list of flexible packaging recovery initiatives can be found in Appendix A.

Table 1: Flexible Packaging Recovery Current Pilot Summary

	Citrus Heights Energy Bag Pilot	UK Curbside Collection Trial	REFLEX Project	Material Recovery for the Future
Location	U.S.	U.K.	U.K.	U.S.
Material	Flexible packaging, plastic utensils	Laminated flexible packaging	Flexible packaging	Flexible packaging
Timing	Jun-Aug 2014	Feb-Nov 2015	Jan 2015 - Jan 2017	Aug 2015 – Aug 2016
Collection component	✓	✓		
Sortation component	✓	✓	✓	✓
Processing component	✓	✓	✓	
Project Goals Desired Outcomes	Demonstrate that multi-material flexible packaging can be collected curbside and integrated into an existing recycling program	Evaluate the potential to include flexible laminated packaging in mainstream recycling collections in the UK	Improve the recyclability of flexible packaging through the creation of innovative inks, new barrier polymers, novel packaging designs and new automated sorting techniques	Test the potential of currently available MRF sorting technologies to separate flexible packaging from the existing stream
Sponsors Collaborators	Dow Chemical, Republic Services, FPA, Agilyx, Reynolds Consumer Products, Citrus Heights, CA	Anthesis LRS, SUEZ environnement (formerly SITA UK), Nestlé UK & Ireland, Coca-Cola, Enval, Defra (UK government agency)	Axion Consulting, Amcor, Dow Chemical, Interflex Group, Nestlé UK, SUEZ environnement, Tomra Sorting, Unilever UK, Innovate UK (UK government innovation Agency)	ACC, RRS, Dow Chemical, PepsiCo, P&G, Nestle Purina, , SC Johnson, Sealed Air, FPA, SPI, APR, Amcor
Updated	5/15/16	5/15/16	5/15/16	5/15/16

Sources: Flexible Packaging Association, direct interviews, company websites, project websites, and press releases

II. Package to Resin Conversion Technologies

There has been increasing interest and press around the desire to use multi-material flexible packaging as feedstock to produce resins that can be manufactured into other products. The **REFLEX** Project in the UK has a workstream dedicated to this.

There are several companies with technologies available or under development that can produce these types of blended resins, but none are practical for use with the material mix that would be collected in a curbside flexibles program. One company that has been doing this for awhile is **TerraCycle** who uses a traditional melt-flow method to create new resins. Another, newcomer **Zzyzx**, uses a novel mechanochemical

compatibilization method based on solid-state shear pulverization. The output of both these processes is a blended polymer that can be used to make other products. The requirement that the incoming feedstock's resin composition be known, consistent, and highly controlled makes it impractical for use with curbside collected materials due to the sheer magnitude of different packaging structures found in a typical household.

The most sought after solution is the development of a process that can separate the individual layers of a multi-material laminate and recycle them back into their original resin types. German company **Saperatech** has come close, developing a micro-emulsion technology that can separate the layers in composite materials such as multi-layer packaging laminates, beverage cartons, and laminated glass, so that the individual components can be recovered. Unfortunately it can only process one specific structure at a time with the need of high volumes to drive efficiencies making it impractical for use with curbside system for the same reason as stated above.

Therefore while each technology can technically recycle or recover multi-material laminated flexible packaging, their limitations currently make them infeasible for use in mixed curbside collected material due to the fact that all of these processes require that the incoming feedstock's resin composition be known, consistent, and controlled. Understanding these limitations are important. These technologies are intriguing. As they advance and improved sortation methods and technologies are developed, these limitations may be able to be overcome.

Details on each process can be found below.

TerraCycle - Trenton, NJ

Although their process is not new, TerraCycle is continually in the news especially around their ability to recycle hard to recycle materials including laminates, so for clarity sake a brief mention of their process and what they can and cannot do is included here.

TerraCycle is most well known for their "up-cycled" products such as, juice pouch purses and backpacks, although this type of product only represents a small portion of their business. A larger portion is based on the production of customized plastic pellets of various material compositions. In this part of their business they use their in-house R&D team to create new resins by combining incoming feedstock material of a known resin composition with various compatiblizers to create new resins that can be processed through a variety of manufacturing techniques, including injection molding, extrusion molding, and compression molding. These custom formulations are designed to meet a specific customer's specifications.

In order to produce a consistent product they must be able to identify and control the resin make-up of the incoming feedstock. The key to their ability to do this is achieving a very high level of sortation, down to a single product type. They do this through their "brigade" system where they collect materials by having the consumer save specific packages in boxes with only one structure per box (for example drink pouches in one box, coffee bags in another, etc.). The consumer then ships it to TerraCycle when the boxes are full. This gives them a known mix of resins with which to work in each box.

They are very innovative and do great work. Unfortunately this approach would be very difficult to scale on a municipal level. Considering what a challenge it is to get the average consumer to put all recyclable material into a single bin, imagine the participation level if they were asked to separate materials into multiple different boxes! High shipping costs also make this process extremely expensive and would not survive without being subsidized by participating brand owners. So while the resin technology can handle multi-material laminates the level of sortation required would make it impractical and cost prohibitive to apply to mixed curbside collected material.

Zzyzk Polymers - Allentown, PA

Zzyzk Polymers is a relative new comer to this space recently opening a pilot facility in Allentown, PA, that uses a process called "continuous mechanochemical compatibilization" (CMC) to recycle challenging plastics and to create new types of engineered plastic.

CMC is a form of Solid-State Shear Pulverization (SSSP). Unlike melt-mixing, the CMC process cools plastic during processing to maintain a solid state which subjects materials to high shear force. Using this high shear force, polymers are broken apart and then chemically recombined, allowing plastics to bond with other polymers or filler materials. This process allows Zzyzx to compatibilize, encapsulate, and fully disperse just about anything into different types of plastic resins.

Zzyzx feels that their CMC process gives them a competitive advantage by allowing them to recycle materials without extensive cleaning or sorting as their method blends the impurities with the plastic to make a stronger finished product.

In August 2015 they announced the development of a method for blending post-consumer laminated films into an injection grade polymer. As with TerraCycle who has had this ability for several years, the resin make up of the incoming feedstock must be known and controlled which is challenging and expensive for curbside collected material. This challenge would need to be addressed and overcome for this process to be applied broadly to post-consumer laminated flexible packaging.

Saperatech - Bielefeld, Germany

Saperatech, a company located in Bielefeld, Germany, has developed a micro-emulsion technology that can separate the layers in composite materials such as multi-layer packaging laminates, beverage cartons, and laminated glass, so that the individual components can be recovered.

Saperatech's five stage process can be described as follows:

Stage 1 - Crushing
The first stage is to reduce the size of the material to create as much contact surface for the micro-emulsion as possible and to simplify material handling in the process.

Stage 2 - Micro-Emulsion
A highly specialized surfactant based micro-emulsion is created for the specific material being treated to reduce the surface tension between layers. The shredded composite material is added to the micro-emulsion and stirred at a low temperature, around 40°C, until the individual fractions ("products") appear.

Stage 3 - Washing
After the separation of the layers in the composite material is complete the fractions are filtered out and the micro-emulsion is reconditioned. The fractions are then cleaned with washing water and the washing water is also reconditioned.

Stage 4 - Sorting
The now clean products are sorted using conventional procedures such as float-sink, sifting, etc., allowing the individual materials to be captured.

Stage 5 - Drying
A final drying step is performed if it is necessary to make the products saleable.

An industrial pilot plant was commissioned in November 2013 to demonstrate and validate the process for various materials.

In February 2015 Saperatech GMBH announced the establishment of Saperatec Industries Europe, headquartered in Prague, to build and operate industrial scale recycling lines across Europe based on the Saperatech micro-emulsion technology. The units are mainly targeted at transforming used plastics/aluminum laminated beverage cartons and waste associated with the production of packaging materials (post industrial not post consumer) into truly separated marketable raw materials. Specific projects are already being developed and the first recycling facility under this cooperation is anticipated to start operations in 2016.

As with many of the other recycling technologies, Saperatech's technology appears to be impractical for use on mixed post consumer multi-material laminates collected curbside in that the micro-emulsions are currently tailored to a specific composite structure. This means that the curbside collected packaging would need to be separated into "like" structures prior to being put through this process. With the multitude of different laminated packaging structures found in every household this seems implausible. Like structures and large volumes are needed to drive the efficiencies of this process. Both of these challenges must be addressed before Saperatech's technology will become feasible for broad use on post-consumer laminated flexible packaging.

Table 2: Package-to-Resin Conversion Technologies

	TerraCycle	Zzyzx	Saperatech
Location	Trenton, NJ	Allentown, PA	Bielefeld, Germany
Technology	Melt flow	Solid state shear pulverization	Micro-emulsion
Outputs	Blended polymer	Blended polymer	Original resins
Manufacturing Facility	Commercial	Pilot	Pilot
Current Limitations	Need a known highly consistent resin mix Collection process very expensive	Need of a known highly consistent resin mix High volumes of each mix likely required	Can only handle one structure at a time Economics require high volumes of each structure

Sources: Company websites, press releases *November 2015*

III. Waste-to-Energy/Waste-to-Fuel

Waste-to-Energy

Traditional waste-to-energy uses municipal solid waste (MSW) as a fuel to generate electricity. A recent study found the global waste-to-energy (WTE) market to be $25 billion in 2013 and estimated it would reach $37 billion by 2020. Almost half the market in 2013 could be found in Europe where WTE is common and is driven primarily by EU waste legislation. Asia is expected to have the highest growth rate over the time period with China announcing plans to build 300 WTE plants including the world's largest plant which will process 5,000 metric tons of trash per day.

In the U.S. the WTE market has remained static over the last 15 years at roughly 30 million tons of MSW throughput. According to the Energy Recovery Council's 2014 Directory of Waste-to-Energy Plants, there are 84 WTE plants in the U.S., 80 operating

and 4 idle. In 2015 the country's first new plant since 1995 was brought on-line at Florida's Palm Beach Energy Recovery Facility.

The lack of growth in the U.S. can be attributed to the political unpopularity of waste "incineration" at the local and national level. The anti-incineration lobby is very vocal despite the advances in emission control technologies and life cycle studies that show that WTE facilities actually reduce greenhouse gasses by 1 ton of CO2 equivalents for every 1 ton of MSW processed compared to sending it to landfill. Until this attitude changes it is estimated that the traditional WTE market in the U.S. will remain stagnant.

Waste-to-Fuel

The difference between waste to energy and waste to fuel can be explained as follows. In a waste-to-energy plant the waste itself is the fuel that is burned to produce heat which is used to generate electricity. In a waste-to-fuel plant, the waste is a raw material feedstock for a high temperature chemical conversion process which converts the waste into a synthetic crude oil which can then be further processed to create higher value commercial products such as transportation fuels, chemicals, and fertilizers.

A simple way to look at it:

Waste-to-energy: waste is a fuel → output is electricity

Waste-to-fuel: waste is a raw material → output is a synthetic petroleum product

The three most common waste-to-fuel processes are gasification, pyrolysis, and engineered solid fuels. Table 4 illustrates the similarities and differences between these processes.

Table 3: Waste-to-Energy/Waste-to-Fuel Process Comparison

	Traditional Waste-to-Energy	Gasification	Pyrolysis	Engineered Solid Fuel
Type	Waste-to-Energy.	Waste-to-Fuel	Waste-to-Fuel	Waste-to-Fuel
Input	MSW	MSW	Plastics	MSW
Saleable Outputs	Electricity and steam	Synthetic Gas	Synthetic Oil	Fuel Pellets
Conversion Process	Incineration	Chemical conversion	Chemical conversion	Pellet manufacture

Sources: Flexible Packaging Association, company websites, Gasification Technologies Council *November 2015*

Gasification

Gasification is a process that converts carbon-based feedstock materials into a gas by creating a chemical reaction. The high temperature reaction combines the feedstocks

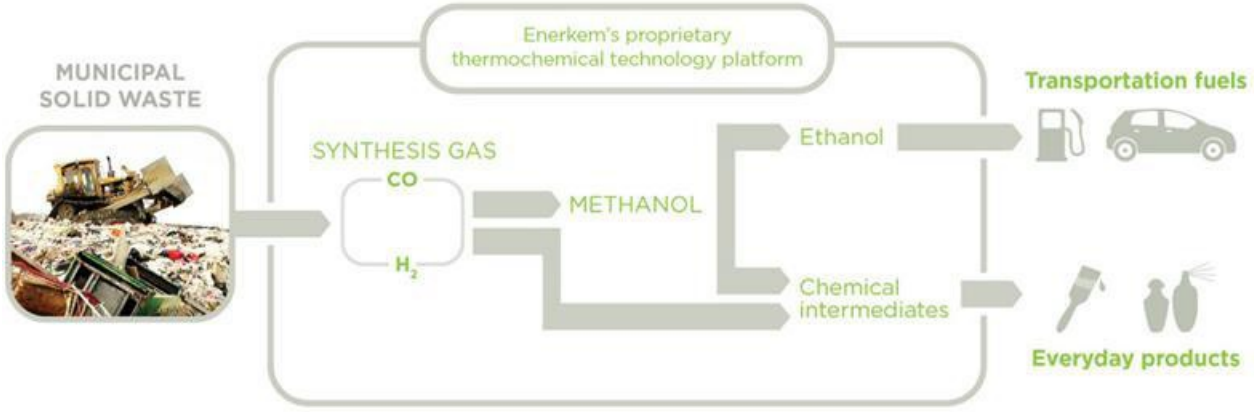
with small amounts of air or oxygen, breaking them down into their simple molecules, primarily a mixture of carbon monoxide and hydrogen, while removing pollutants and impurities. What's left is a clean "synthesis gas" (syngas) that can be converted into electricity and other valuable products.

One of the emerging areas of development in gasification industry is the use of MSW as a feedstock. MSW gasification actually enhances recycling in that prior to feeding into the reactor recyclables, metals, and heavy organics are removed leaving only non-recyclable paper and plastics as the feedstock.

Gasification differs from incineration in that in the gasification process, MSW is not a fuel, but a feedstock for a high temperature chemical conversion process. Instead of making just heat and electricity, as is done in a waste-to-energy plant using incineration, the syngas produced by gasification can be turned into higher value commercial products such as transportation fuels, chemicals, and fertilizers, or used as substitute natural gas. Gasification is also more efficient producing 10 KWh of electricity per ton of MSW vs. 5 KWh per ton of MSW for incineration.

Canadian based Enerkem is one of the emerging leaders in North America for gasification plants that use MSW as feedstock with a 10 million gallon per year plant under construction in Edmonton, Alberta and two under development, including one in Pontotoc, Mississippi. Investors include Waste Management and Valero Oil. Their process is illustrated in Figure 1 below.

Figure 1: Enerkem's Gasification Process



Source: www.enerkem.com

The scale and cost of gasification plants can be quite large as can be the associated tip fees, which is the result of targeting MSW as feedstock instead of just non-recycled plastics as is the case for the smaller scale pyrolysis plants. This is still an excellent

option for flexibles in communities that decide to make the investment in a gasification plant as part of their MSW management strategy.

Pyrolysis

Due to its relatively small scale and capital cost and its ability to use mixed plastics pyrolysis continues to be one of the most promising technologies as an end-of-life option for non-recycled flexible packaging. The pyrolysis technology providers continue to make progress toward commercialization and have begun to refer to their market as Plastics-to-Fuel and Petrochemicals as to better illustrate the scope of what they manufacture.

Many plastics-to-fuel technology providers are targeting densely populated areas that produce a significant amount of non-recycled plastics, especially those that have both landfill problems and a desire to minimize their dependence on landfill. This is where they see potential for developing commercial scale facilities and is an important factor in establishing a solid foothold across the U.S.

All of the leading providers have developed a continuous feed process and have opened, or are working on, commercial scale plants. The recent dramatic decline in the price of oil is putting extreme pressure on the revenue side of the plastics-to fuel business case making the economics of new investment even more challenging than usual. This has slowed the pace of many of the developments that are in the pipeline and in the case of Agilyx has resulted in a change in the short term strategy (details below). It is believed that once oil prices begin to rise above $50/barrel the pace of these projects will again begin to accelerate.

As the interest in this technology has grown, the ACC led Plastics-to-Fuel and Petrochemistry Alliance was launched with a goal of establishing plastics-to-fuel as a strong, viable, alternative energy recovery industry. Since its inception it has attracted new members and is ramping up its efforts. The group recently commissioned and released the 2015 Plastics to Fuel Developer's Guide prepared by the Ocean Recovery Alliance. It includes a "Project Development Guidelines and Recommendations" section designed as a resource for those interested in pursuing the development of a Plastics-to-Fuel system.

An update on the progress of several of the key players follows below and a comparison summary of some of the most active technology providers can be found in Table 4.

Agilyx

One of the early leaders in the plastic-to-fuel market, Agilyx has continued to advance and refine their technology completing the development and commissioning of their first

continuous feed unit, a 50 ton/day Gen 6 demonstration plant in Tigard, OR that was used to successfully convert the material collected in the Citrus Heights "Energy Bag" Pilot into crude oil. However, with oil prices continuing to hover near historic lows, CEO Ross Patten recently announced that Agilyx was planning to modify their Tigard, OR plant to produce styrene monomer from polystyrene products. The polystyrene will be sourced from a variety of sources, including material recovery facilities, municipalities, industrial companies, retailers and even school lunch programs.

Patten also made it clear that Agilyx is not giving up on plastics-to-oil. He indicated that they have completed all the commercial drawing and design as well as finished a permitting process for a 50 ton/day Gen 6 plastics-to-oil facility in the Philadelphia area. The company also has an agreement to sell output from the plant to a refinery and has identified a site. Timing of the project is dependent upon improvement in the economic conditions of the oil industry.

PK Clean

A more recent entrant into this market, PK Clean, is making strides in the development of their technology. Their 5 ton/day pilot unit was running at capacity so an upgrade project was launched in January 2015 to increase the capacity to10 tons/day. The upgrade is performing well and PK has now shifted its focus to making a more refined diesel product which is a higher value end product than synthetic crude at current market pricing. Looking to the future PK hopes to deploy its technology in a second location sometime in 2017.

PK has been working very closely with local officials in Salt Lake City where they are located which is a best practice that should be highlighted and replicated. Experience has shown that communication and collaboration with the local community is a key component to successfully developing these types of projects.

Vadxx

Vadxx Energy based in Akron, OH has been working on their technology since 2007 progressing from bench top to a pilot facility. Their first two attempts at commercialization had to be scrapped, the first due to their partner Greenstar Recycling running into financial problems, the second due to site selection issues in Cleveland. Their third attempt has proven successful. After securing 5 acres from the city of Akron and funding from Liberation Capital, Vadxx began construction of a 60 ton/day commercial plant in August 2014. Construction was completed in the summer of 2015 and commissioning and scale up of the facility begun. The first commercial oil production is expected in June of 2016. The plant will include an on-site distillation unit

that will be used to refine the synthetic crude into diesel, home heating fuel, and naphtha (a light fuel used for blending) which will be sold through local distribution. The distillation column is targeted for start-up in late August of this year.

Low oil prices have slowed Vadxx's commercialization efforts. Initially the $20 million plant will run at 25% capacity with plans to scale up to full capacity by early 2017. As other plastic-to-oil industry insiders have, CEO Jim Garrett highlighted $50/barrel as the price at which plastics-to-oil economics become competitive with traditional sources of crude.

In March 2015 Vadxx was cited in a pro-manufacturing speech given in Cleveland by President Obama who posed with a sample of their fuel made from scrap plastic. This type of high profile publicity is important to raising plastic-to-fuel's profile and establishing its position as a viable alternative energy industry.

Cynar

Cynar plc, based in London, has been very active in the European market. They operate a 10 tes/day demonstration plant in Portlaoise, Ireland and have an agreement with Plastic Energy SC to build up to eight 20 te/day commercial facilities in Spain and Portugal. The first Plastic Energy commercial plant located in Almeria, Spain was completed in 2014 and the second commercial plant in Seville, Spain was completed in 2015. A third plant for the Canary Islands has been ordered.

Cynar's plants include secondary distillation on site producing synthetic diesel fuel, synthetic light oil, and synthetic kerosene. Cynar also has an agreement with Plastic Energy Americas SC to evaluate and develop opportunities in the Southeastern U.S., Central and South America, and the Caribbean.

RES Polyflow

RES Polyflow is another Ohio based company that has been active in advancing plastic-to-fuel technology in the U.S. After progressing from a very small pilot unit to building a full scale demonstration unit in North Perry, OH they recently announced their plans to build their first commercial scale plant in Ashley, IN. Groundbreaking is expected in mid-2016. $5.5 million in economic incentives, credits, and grants from state and local government was a critical factor in their decision to build in Indiana. Polyflow plans on spending $90 million to equip the 80 acre site and when at full capacity process 100,000 tons of mixed plastics and rubber.

JBI Plastic2Oil

In January of 2015 JBI Plastic2Oil announced an agreement to partner with EcoNavigation, LLC to develop opportunities for its technology. This represented a shift in strategy from producer and seller of clean fuels to supplier of Plastic2Oil equipment, technology and services. With the signing of the agreement John Bordynuik, the company's controversial founder and Chief of Technology resigned. JBI has also hired the engineering firm of O'Brien & Gere to scale-up their technology into a fully operational manufacturing facility as JBI has only operated a demonstration unit. In March 2016 the partnership was dissolved because it failed to close any deals to build a commercial scale facility. The company is currently evaluating its options which include direct sales or a potential new partnership.

Enval

Enval operates a 5te/day pilot unit in Alconbury, UK and is part of the Defra UK Collection, Sorting and Processing pilot. Their major focus has been the recovery of aluminum from pouches. Although very active on the conference circuit they have been less successful in attracting clients with no commercial facilities announced. They have recently begun to emphasize their environmental technology consultancy offering and have put less focus on the technology and equipment side of the business.

HighWave Energy

In 2014 HighWave Energy (formerly Climax Global Energy) was forced to shut down because they were unable to obtain enough funding to ward off foreclosure by their senior creditor. As a result of the foreclosure, "Highwave Acquisition LLC" took ownership of the HighWave Energy assets and began the search for a new buyer for the assets as a preferred alternative to liquidation. As of the May 2016 an interested buyer has been identified but the transaction process has stalled and the deal has not yet been closed. Once the deal has closed the new buyer plans to evaluate restarting the commercial facility in Blackville, SC which has been idle but maintained since the shutdown in 2014.

GreenMantra Technologies

Greenmantra is a Canadian company that uses a catalytic depolymerization process to convert LDPE and HDPE packaging and containers into waxes, greases, and lubricants. In May 2016 they announced the completion of a 14 te/day commercial facility in Brantford, Ontario. They produce and sell custom wax formulations into a variety of market segments including roofing shingles, rubber, and road asphalt modifiers. Their current technology uses a batch process not continuous feed.

It is included in this report for informational purposes. Although the technology may at some point be able to be modified to use hard to recycle multi-material laminate packaging it currently does not accept them. It uses only "pure" streams of PE. They source this material from MRF's and compete with other processors that use recycled PE.

Table 4: Selected Pyrolysis Technology Providers

	Agilyx	Cynar plc	PK Clean	Vadxx	RES Polyflow
Location	Portland, OR	London, U.K.	Salt Lake City, UT	Cleveland, OH	Akron, OH
Website	www.agilyx.com	www.cynarplc.com	www.pkclean.com	www.vadxx.com	www.respolyflow.com
Technology	Thermal pyrolysis	Thermal pyrolysis	Catalytic pyrolysis	Thermal pyrolysis	Thermal pyrolysis
Feed	Continuous feed	Continuous feed	Continuous feed	Continuous feed	Continuous feed
Outputs[1]	Synthetic crude oil	Synthetic diesel, oil, and kerosene	Synthetic crude oil	Synthetic crude oil	Synthetic crude oil
End Markets	Transportation fuels	Diesel fuel Transportation fuels Kerosene	Transportation fuels	Diesel fuel Naphtha Heating fuel	Diesel fuel Octane enhancers Fuel blend stocks
On-site Refining	No	Yes	No	Yes	No
Module Size	50 tons/day	20 tons/day	10 tons/day	60 tons/day	60 tons/day
Feedstock	Waste Plastic	Waste Plastic	Waste Plastic	Waste Plastic Carpet & Roofing	Waste Plastic Rubber & Carpet
Feedstock Limitations	Will accept up to 5-10% PET and PVC combined. Nylon in trace amounts	Will not accept PVC or Nylon PET must be <2%	Will accept up to 40% PET and PVC combined	Will only accept PET, PVC, and nylon in trace amounts	Rubber, carpeting and PVC limited to 10% of feed
Business Model	Own and operate, JV, Sales & Service, License	License and royalty	JV, client owned and operated	Own and operate License & royalty	Own and operate License
Pilot/Demo Facility	Tigard, OR[4] 50 ton/day unit	Portlaoise, Ireland 10 ton/day unit	Salt Lake City, UT 10 ton/day unit	Akron, OH 1 ton/day unit	Perry, OH 60 ton/day unit
Commercial Plants	Construction of a Gen 6 unit in Pennsylvania is in the planning stages **Waste Management**[2] Portland, OR **Rational Energies**[3] Plymouth, MN **GenAgain**[3] Atlanta, GA	Cynar plans to build 8 plants in Spain & Portugal for Plastic Energy SC **Plastic Energy SC** Almeria, Spain 20 te/day **Plastic Energy SC** Seville, Spain 20 te/day	No plans for a client owned commercial unit as of yet	Vadxx Owned Akron, OH 60 tons/day unit scheduled to begin commercial production in June 2016 On-site distillation expected to start in August 2016	Construction of the first 60 ton/day unit in Ashley, IN scheduled to begin mid-2016 Current plans call for the construction of a total of five 60 ton/day vessels on site
Updated	5/15/2016	5/15/2016	5/15/2016	5/15/2016	5/15/2016

Sources: Flexible Packaging Association, direct interviews, company websites, and press releases
2015 Plastics-to-Fuel Project Developer's Guide, prepared for the ACC by the Ocean Recovery Alliance, June 2015

1 - In addition to combustible gases and char which are common to all pyrolysis processes.
2 - Agilyx is taking over ownership of Waste Management's Portland, OR unit and plans to convert it to Gen 6 technology.
3 - Client owned and operated Agilyx Gen 5, 12 ton/day, 4-vessel batch unit. Current operating status is unknown.
4 - Currently being modified to process polystyrene to styrene monomer

Engineered Solid Fuels

This technology is designed to recover the energy imbedded in MSW headed to the landfill by using it as a feedstock to create fuel pellets. The process takes in MSW removes the recyclables, metals, and heavy organics leaving non-recycled paper and plastics which are then shredded, mixed, dried, pelletized and shipped to the customer to use as a fuel in industrial boilers and kilns replacing other solid fuels such as coal, wood, and petroleum coke.

Waste Management has invested heavily in this technology developing a product called SpecFUEL™ in house. Waste Management describes SpecFUEL as "a highly engineered fuel made through a 13-step process involving mechanical and sophisticated optical sorting equipment. The system removes recyclable metals, organics, PVC, and inert materials unsuitable for fuel. The remaining paper and plastic materials are manufactured into a uniform, high quality, high-energy content fuel." The first SpecFUEL™ plant opened in San Antonio, Texas in 2012 and a second in Philadelphia opened in 2014.

The Dongara engineered solid fuel facility in Canada at which the FPA conducted trials in 2011 has discontinued operations.

IV. Industry Work Groups

There are multiple industry work groups that are focused on improving the recovery of flexible packaging. A list can be found in Table 5. Several of these groups have been active for many years and represent a cross section of industry and value chain players. Although a few of the groups are focused specifically on PE bag and film recovery, several of the groups are taking a broader view to include other types of packaging including multi-material laminates. Although each has a slightly different focus, taken together they represent a solid level of effort and resource aimed at flexible packaging recovery.

The list of groups has grown over the past couple of years. A few of the newer additions are summarized below.

Association of Plastics Recyclers Film Reclamation Committee

The Association of Plastics Recyclers' (APR) formed the Film Reclamation Committee August of 2015 to help in the on-going efforts to boost polyethylene film recovery and markets. They plan to bring the recycling industry's perspective to this work by collaborating with several of the existing work groups that are focused on PE film

recovery, including ACC's Flexible Film Recycling Group (FFRG) and the Sustainable Packaging Coalition's (SPC) How2Recycle label.

The key message they wish to communicate and reinforce that plastic film is recyclable, regardless of the specific collection scheme.

The Committee will also work on ensuring that APR's existing technical tools, such as the *Design Guide*™ for Plastics Recyclability and bale specifications, are current with regard to film recycling, adaptable to changes in collection schemes and markets, and easily accessible.

The committee plans to continue to study the issue of film impact to curbside collection and MRFs, as well as participate in partnerships to expand retail PE film collection.

American Chemistry Council Plastics-to-Fuel & Petrochemistry Alliance

The ACC led Plastics-to-Oil Technologies Alliance formed in 2014 to increase the awareness of the benefits of plastics-to-fuel technologies in the hope of building plastics-to-fuel into a strong, viable, alternative energy industry.

In 2015 the group added Vadxx as a new core technology provider member joining founding members Agilyx, RES Polyflow, and Cynar. Associate members include Sealed Air, Americas Styrenics, Tetra Tech, and Trex.

Recently the group changed its name to the Plastics-to-Fuel and Petrochemistry Alliance (PFPA) to reflect the fact that the group's members produce a variety of different end products, rather than just oil. These include liquid fuels such as diesel, naphtha, and synthetic crude oil for conversion to fuels or chemicals, as well as waxes, lubricants and other products.

The group has released several fact sheets and reports relating to the technology and a short educational video that explains the process and its benefits in easy to understand terms.

Sustainable Packaging Coalition Multi-Laminate Recovery Industry Leaders Committee

Due to high member interest, the SPC has reestablished its Industry Leadership Committee focused on the recovery of multi-material laminates. The committee's goal will be to provide information and resources to their members to help improve the recovery of multi-material laminate flexible packaging.

The initial efforts will focus on the following two areas.

- Maintaining a publicly available database outlining the key flexible packaging recovery initiatives and the organizations driving them.
- Pulling together a list of existing end markets for multi-material laminate packaging to include locations, processing technologies, acceptable inputs, and end product outputs as a resource for companies wishing to recover hard to recycle materials.

They want to use a collaborative approach to build upon existing work including that of the Flexible Packaging Association.

Healthcare Plastics Recycling Council

The Healthcare Plastics Recycling Council (HPRC) is focused on increasing the recovery of plastics in clinical settings such as hospitals and other medical facilities. They have sponsored several studies and conducted small scale recycling pilots. They recently announced an effort they call the "100 Tons Project" which builds upon recycling successes they have seen at single hospitals by expanding the best practices to multiple facilities within a geographic area.

The project targets four participating Chicago area hospitals where both rigid and flexible non-infectious plastic packaging and other products including PP and PE sterilization wrap, as well as bottles, basins, pitchers, trays, and Tyvek® peel packs will be collected and sent out for recycling.

Table 5: Flexible Packaging Recovery Industry Work Groups

Sponsor	Work Group	Focus/Goal
ACC	Flexible Film Recycling Group	To increase the recycling rate of PE bags & film
ACC	Plastics-to-Fuel and Petrochemistry Alliance	To increase awareness of the benefits of technologies that convert hard to recycle plastics to fuel and other valuable products, enhance the industry's voice and build a network of allies
AMERIPEN	Packaging Recovery and Recycling Advocate	Material neutral approach to advancing the recovery of packaging with a focus on policy and best practice
APR	Film Reclamation Committee	To boost PE film recovery and markets
CPIA	Film Recovery Working Group	To increase the diversion of plastic film from landfills through recycling and recovery (PE bags & film)
FPA	Flexible Packaging Resource Recovery Task Group	To facilitate the advancement of flexible packaging recovery with a focus on hard to recycle materials
FPI	Plastic Recovery Group Paper Recovery Group	Create solutions for the recovery of plastic and paper foodservice packaging in the U.S. and Canada (flexible and rigid)
HPRC	Healthcare Plastics Recycling Council	To enable the healthcare community to implement sustainable, cost-effective recycling solutions for clean plastic products and materials used in the delivery of healthcare.
pacNEXT	Material Optimization Committee	To improve recovery of high impact materials, to increase the value and utility of recovered materials
SPC	Multi-Material Laminate Recovery ILC	Provide information and resources to their members to help improve the recovery of multi-material laminate flexible packaging
SPI	American Progressive Bag Alliance	To defend against plastic bag bans and taxes while proactively promoting the positives of bags

November 2015

Table 6: Index of Organizations

Acronym	Organization
ACC	American Chemistry Council
AMERIPEN	American Institute for Packaging and the Environment
APR	Association of Postconsumer Plastics Recyclers
CPIA	Canadian Plastics Industry Association
FPA	Flexible Packaging Association
FPI	Foodservice Packaging Institute
HPRC	Healthcare Plastics Recycling Council
PFPA	Plastics-to-Fuel and Petrochemistry Alliance
SPC	Sustainable Packaging Coalition
SPI	SPI: The Plastics Industry Trade Association

V. Conclusion

Since the release of the Flexible Packaging Association's "*The Continuing Evaluation of Existing and Emerging Flexible Packaging Resource Recovery Infrastructure and Processes"* report last year, there has been steady progress in the journey toward a future where flexible packaging is recovered and its value is captured.

The report recommended that the next steps include the development of collaborative pilots that would demonstrate the behavior of multi-material laminates at key points in the recovery value chain.

The pilots outlined in this report certainly do that both here in the U.S. and in Europe. Each phase of research has informed the next. Recovery technologies such as waste-to-fuel are being seen as complementary to traditional recycling, and there is recognition that all of these technologies are evolving and what may be most beneficial today could change over time.

These pilots are focused on multi-material laminates and they are looking at them at all points of the value chain. Cumulatively the pilots are testing a variety of collection schemes, evaluating the performance of several different sortation methods and technologies, and looking at multiple recovery options.

The results of projects currently underway and outlined in these pages are eagerly awaited as they will provide the foundation for developments that will take the recovery of flexible packaging to the next level.

Appendix A: "Who's Doing What"

Table 7: Flexible Packaging Recovery Initiative Summary

Group	Initiative	Focus/Goal
Collaborative Pilots/Trials		
Dow, PepsiCo, P&G, Nestle Purina, SC Johnson, Sealed Air, FPA, SPI, APR, ACC, Amcor	Materials Recovery for the Future (MRFF)	Phase 1 - MRF Equipment Testing Program - Test the potential to auto-sort flexible packaging in the MRF utilizing existing sortation technologies (Aug 2015 - Aug 2016)
Nestle, Coca-Cola, SUEZ environnement, Enval, Anthesis LRS	UK Curbside Collection, Sortation & Processing Pilot	Assess the feasibility of including flexible laminated packaging in existing household recycling schemes (Feb-Nov 2015)
Dow, Republic Services, Agilyx, Reynolds, FPA, ACC and Citrus Heights, CA	Energy Bag Collection, Sortation & Processing Pilot	Test feasibility of collecting non-recycled flexible plastics curbside, manually sorting them at the MRF and converting them to synthetic oil using pyrolysis (Jun-Aug 2014)
HPRC	Health Care plastics recycling pilots	Collect and analyze data related to materials, types, volumes and sources of plastic waste generated within healthcare facilities. Document best practices as they relate to in-hospital mixed-plastics recycling programs (2013)
FPA	FPW Alternative to Landfill Pilot Trials	Run both pre and post consumer FPW through pyrolysis and engineered solid fuel processes to determine their suitability as a feedstock (2011)
Projects		
ACC	W.R.A.P Recycling Action Program	Web based tool to enable recycling of bags and film with the goal of doubling film recycling to 2B lbs. by 2020 Plasticfilmrecycling.org
FPA	FPW Resource Recovery Project	Evaluating the technology and economic challenges to the viable recovery of FPW (ongoing)
APR	Design-for-recycling guidelines for film	20 APR members drafting design-for-recycling guidelines for film including 10 separate draft bale specifications
American Progressive Bag Alliance	A Bag's Life - Reduce, Reuse, Recycle	Public educational campaign in FL, PA, GA, NY, NC, TX, VA, LA promoting the 3 "R's" as they relate to bags and films. Includes a zip code recycle center locator
SPC	Physically mapping end markets for flexible packaging	Provide information about end markets for multi-material laminate flexible packaging to improve recovery.
State Work Groups		
WI	WI Council on Recycling Plastics Recycling	To develop recommendations to spur economic growth and jobs in WI through increased plastics recycling
OR	Oregon DEQ plastics recovery workgroup	Developing a long-term strategy for increased plastics recovery in Oregon
WI DNR, ACC, SPC	Wisconsin W.R.A.P	Recycling plastic film beyond bags, leverages Plasticfilmrecycling.org (Launched Feb 2013)
High Profile Municipal Collection Programs		
NYC	New York City Solid Waste Management Plan	Expanded recycling program to include all rigid plastics, program does not include flexibles (no bags, film, or laminates)
Seattle	Seattle Recycling Program	City of Seattle accepts PE bags curbside (it does not accept laminates), King County does not accept bags or laminates
San Francisco	San Francisco's Zero Waste Program	Mandatory recycling and composting. Do not accept any flexibles (no bags, films, or laminates)
Alternative Collection/Recovery Models		
Carton Council	Carton Recycling Program	Facilitates the recycling of cartons by providing optical sorters to MRFs, marketing materials/collection tools to communities, and providing a stable end market for the recovered material
Tetra-Pak	Experimentation in Coalition Building: Increasing Recovery	Develop customized action plans for targeted communities in TN and NC to address the key barriers to recovery performance (2013)
SERDC	SERDC 120: Increasing Recycling Rates	Develop plan to apply collection best practice to targeted cities to increase recycling in the SE region (flexibles not included in this phase) Resulted in the creation of The Recycling Partnership (Jan-Jul 2014)
TerraCycle	Brigades® collection program	Individuals and groups collect and ship material to TerraCycle for recycling, cost is subsidized by participating brand owners

May 2016