# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>3</td>
</tr>
<tr>
<td><strong>1. Introduction</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>2. Finding the Right Partners</strong></td>
<td>5</td>
</tr>
<tr>
<td><strong>3. Pilot Details – Steps to a Successful Program</strong></td>
<td>6</td>
</tr>
<tr>
<td>3.1 Planning</td>
<td>6</td>
</tr>
<tr>
<td>3.1.1 Size, Color, and Quantity</td>
<td>6</td>
</tr>
<tr>
<td>3.2 Communication</td>
<td>8</td>
</tr>
<tr>
<td>3.2.1 Communication Before Pilot</td>
<td>8</td>
</tr>
<tr>
<td>3.2.2 Communication During Pilot</td>
<td>11</td>
</tr>
<tr>
<td>3.2.3 Communication After Pilot</td>
<td>13</td>
</tr>
<tr>
<td>3.3 Collection</td>
<td>14</td>
</tr>
<tr>
<td>3.4 Sortation</td>
<td>14</td>
</tr>
<tr>
<td>3.5 Plastics to What?</td>
<td>14</td>
</tr>
<tr>
<td>3.5.1 Pyrolysis</td>
<td>15</td>
</tr>
<tr>
<td>3.5.2 Agilyx</td>
<td>15</td>
</tr>
<tr>
<td><strong>4. The Collection and Sortation Numbers</strong></td>
<td>16</td>
</tr>
<tr>
<td><strong>5. Energy Recovery Trial</strong></td>
<td>18</td>
</tr>
<tr>
<td>5.1 Material Characterization</td>
<td>18</td>
</tr>
<tr>
<td>5.1.1 Raw Feedstock Characterization</td>
<td>18</td>
</tr>
<tr>
<td>5.1.2 Prepared Feedstock Characterization</td>
<td>19</td>
</tr>
<tr>
<td>5.2 Oil Conversion Efficiency</td>
<td>20</td>
</tr>
<tr>
<td>5.3 Energy Recovery Trial Conclusions</td>
<td>20</td>
</tr>
<tr>
<td><strong>6. Energy Bag Pilot – Best Practices and Key Learnings</strong></td>
<td>21</td>
</tr>
<tr>
<td>6.1 Communication</td>
<td>22</td>
</tr>
<tr>
<td>6.2 Planning and Project Management</td>
<td>24</td>
</tr>
<tr>
<td>6.3 At the Recycling Facility</td>
<td>24</td>
</tr>
<tr>
<td>6.4 The Bag</td>
<td>25</td>
</tr>
<tr>
<td>6.5 The Next Program – Leveraging Key Learnings</td>
<td>25</td>
</tr>
<tr>
<td><strong>7. Conclusion and Next Steps</strong></td>
<td>26</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td>27</td>
</tr>
<tr>
<td>Appendix</td>
<td>27</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Currently, most multi-material flexible plastic packaging and many other types of plastics are difficult to mechanically recycle and end up in landfills. There are, however, emerging technologies that can offer solutions for diverting them from landfills and “recycling” them into feedstocks or valuable energy resources.

During the course of 2014, The Dow Chemical Company, Republic Services, The Flexible Packaging Association, Agilyx, Reynolds Consumer Products, and the city of Citrus Heights, California, collaborated to implement a first-of-its-kind pilot in the United States. The “Energy Bag Pilot” tested the feasibility of collecting households’ non-recycled plastics (NRP) at curbside, sorting the NRP at a material recycling facility (MRF), delivering the desired/sorted-out NRP to an energy conversion facility, and effectively converting that NRP into an energy resource – all via an existing waste management infrastructure.

During this pilot (conducted between June 1-August 31, 2014), citizens of Citrus Heights living in single-family dwellings were asked to place their non-recycled plastics into a provided bright purple bag (called the “Energy Bag”) and, when full, to place the bag inside their recycling bin at curbside for the regular bi-weekly recycling collection.

At the Republic Services Newby Island Resource Recovery Recyclery (the material recycling facility/MRF), Energy Bags were separated from the regularly recycled items, bundled, and shipped to a pyrolysis facility (Agilyx) where these high-energy-content materials were converted into valuable synthetic fuel oil.

The pilot program sought to answer five specific questions:

• Will people participate?

• Will people follow the provided instructions and place the recommended NRP inside the Energy Bag?

• Can the NRP be effectively collected using the existing curbside recycling infrastructure?

• Can the NRP be effectively sorted at the recycling facility?

• Is the NRP collected suitable for pyrolysis?

The answers were encouraging, and a summary is as follows:

• A post-pilot survey reported that 1/3 of targeted households participated at some point during the pilot. The pilot resulted in nearly 8,000 Energy Bags collected totaling approximately three tons of material.

• The majority of participants followed the provided instructions well, resulting in contamination rates comparable to a typical recycling collection cycle. The pilot’s contamination rate was 16.5%.

• Collecting the bags with other recyclables was effective and not disruptive to the haulers’ collection routines. The provided instructions asked that the Energy Bags be placed inside the recycling bin.

• Manually pulling the Energy Bags during the pre-sort phase at the recycling facility was very effective, and only a few bags made it past the pre-sort station. No Energy Bags were found wrapped in the paper screens. The recycling facility management indicated that the pilot ran seamlessly.

• Typical maximum oil conversion efficiencies for pyrolysis are 70-80%. The NRP collected was suitable for pyrolysis and tested at 58% oil conversion efficiency. The Energy Bag Pilot fulfilled its premise through a conversion of 512 gallons of synthetic fuel oil.

The pilot ran for three months; however, the planning, negotiations, pre-production, pre-pilot promotions, and post-pilot data recovery stretched over the course of a year. The planning, implementation and completion of this pilot were possible because of the strong coalition of partners.

The complete results of the Energy Bag Pilot are available in the following report, and the desire is that other municipalities and industry stakeholders will adopt programs like this one to move the potential for large-scale “plastics-to-energy” conversion forward.

As a next step, another pilot program is being planned to validate the findings and assumptions generated by this pilot. Plans anticipate collaborating with brand owners, packaging converters, and industry associations with broad knowledge regarding plastics, sustainability topics, and consumer marketing to help solve issues encountered in this initial pilot.

ITEMS LISTED IN THE PROMOTIONAL LITERATURE AS THINGS TO BE PLACED IN THE ENERGY BAGS

• juice pouches
• squeezable pouches
• microwavable pouches
• frozen fruit & veggie bags
• fresh fruit & veggie bags
• cereal box liners
• laundry pouches
• cake mix pouches
• snack bags
• candy wrappers
• plastic pet food bags
• plastic knives, forks, spoons
• plastic straws & stir sticks
• salad bags
• plastic meat & cheese wrap
• plastic wrap from bulk items
• foam cups
• plastic coffee pouches
• cereal & snack bags
• all non-recycled plastic bags
In the United States today, the average household uses more than 10-thousand kilowatt hours of electricity per year. The average U.S. driver covers nearly 12-thousand miles each year, consuming almost 700 gallons of gasoline. Energy consumption and finding alternative energy sources have been vital topics of discussion for decades. In addition, the efficient use of natural resources to protect the environment from overexploitation continues to be a critical issue. Besides the search for "clean" energy, the need for enhanced recycling efforts, and for finding methods to increase landfill diversion are made all the more relevant as more than half of U.S. municipal solid waste (MSW) ends up in landfills.

Consider, though, if some of that refuse could be captured before it went to landfill. Moreover, what if these materials could be reconstituted into something extremely useful, such as alternative energy resources? Flexible plastic packaging items such as grocery bags made from one single type of plastic – polyethylene (PE) – can and are being recycled through store drop-off programs and in limited communities via curbside collection. This is not the case, however, for flexible plastic packaging that requires several types of plastics layers to meet specific performance requirements, including protecting its contents.

The life cycle cost, performance, and sustainability benefits of flexible plastic packaging are well documented (see case studies at [www.flexpack.org](http://www.flexpack.org) and [www.americanchemistry.com](http://www.americanchemistry.com)). Unfortunately, the many benefits are overlooked or overshadowed, because it is currently difficult to recycle these items in the same manner in which bottles and cans are recycled.

The nature and use of flexible packaging make it challenging to collect and sort. The challenges include its very light weight, the use of different types of plastic layers, and its wide use in food applications that yield high contamination levels. Although these materials still have value, this value is not realized via traditional mechanical recycling. Instead, most of these items end up in landfills, but there are alternatives.

The Energy Bag Pilot sought to complement existing mechanical recycling operations and did not seek to divert materials away from current mechanical recycling programs. Most plastics are made from oil and natural gas. This energy potential is stored in plastic packaging, and it can be recovered. Emerging technologies can turn these non-recycled plastics (NRP) back into oil and natural gas. It’s a different way to divert these items from landfills and recover most of their embedded energy content by converting the plastics into the feedstocks that were used to create them in the first place.

A key challenge has been to develop a viable system to move the raw materials (in this case, currently non-recycled plastic) from the consumer’s garbage bin to this new form of recovery; to change the way households and businesses manage their waste.

During the summer of 2014, the city of Citrus Heights, California, participated in a pilot program to study and better understand the feasibility of collecting NRP from consumers at curbside, sorting the additional materials through an existing material recycling facility (MRF), and converting the collected NRP materials to synthetic fuel oil. The “Energy Bag Pilot” (conducted from June 1-August 31) involved the city’s single-family households on Republic Services’ contracted garbage and recycling routes. A partial list of the plastic items targeted by the Energy Bag Pilot is provided on page 3.

This report offers details regarding the pilot and may serve as a guide for others seeking to duplicate the process for further study and validation, ultimately helping to recover valuable NRP and reap the sustainability benefits from a full-scale implementation.
2. FINDING THE RIGHT PARTNERS

Gathering the right partners and sharing a common vision are keys to success in any venture. For the Energy Bag Pilot, a number of partners provided both wide-ranging and specialized efforts at various times across the timeline of the program. Those partners included: The Dow Chemical Company (Dow), the Flexible Packaging Association (FPA), The American Chemistry Council (ACC), Republic Services, Reynolds Consumer Products, Agilyx, and the city of Citrus Heights, California, as well as a variety of supporting companies that also provided valuable assistance.

The Dow Chemical Company – The Dow Chemical Company, a large supplier of polyethylene resins and adhesives to the packaging industry, saw a need to explore new end-of-life options for the growing segment of multi-material flexible plastic packaging. As materials science experts, Dow recognizes the untapped value of these non-recycled plastics. The company has been a long-time proponent of resource efficiency and resource recovery (i.e., “energy recovery/plastics-to-energy”). Dow was the primary sponsor of the pilot.

Flexible Package Association – FPA is North America’s oldest and leading advocacy group supporting the flexible packaging industry. FPA has studied and proposed options for end-of-life landfill alternatives for multi-material flexible plastic packaging. FPA was a sponsor of the pilot, contributing financial support and valuable background information concerning resource recovery efforts in the United States. Representatives of FPA also contributed to the assembly of this document.

Republic Services – As an industry leader in U.S. non-hazardous recycling and solid waste, Republic believes in protecting the planet by applying common sense solutions to customers’ waste and recycling challenges. Republic was a sponsor of the pilot and contributed their trucks, drivers, facilities, and customer service and public relations personnel toward the pilot.

Their Newby Island Resource Recovery Recycling can process up to 400,000 tons per year and has the ability to sort a number of wet/dry recyclables, including corrugated boxes, plastics containers, mixed paper, foam packaging, etc. Its set-up allowed the addition of dedicated manual sorters at the front of the recycling line (right after the material comes out of the metering drum) to separate the purple Energy Bags from the other materials as they came through the sorting lines.

Sorting lines like Newby Island’s are common to most MRFs around the country, thus this protocol should be easily duplicated at facilities with adequate space for additional manual sorters before the star screens sortation system.

It should also be noted that Republic Services exhibited a strong “can do attitude” toward this program, which truly helped overcome any challenges that emerged.

Agilyx – Agilyx (www.agilyx.com) based in Beaverton, Oregon, has developed a process to turn non-recycled and low-value plastics into a high-value synthetic fuel oil. While a relatively new technology to North America, a number of companies around the globe have been researching and implementing it for many years. Agilyx is on its sixth generation of their technology and promotes itself as the first company in the world to effectively convert previously non-recycled and low-value plastics into crude oil.

Agilyx was eager to participate in the pilot program to help validate their technology and further promote the concept of municipal resource recovery. According to Jon Angin, Vice President of Business Development for Agilyx, “The key to a successful plastic-to-oil project is a consistent and continuous stream of non-recycled or low-value plastics. We view this project as an indicator that there is still a significant opportunity to capture embodied energy in the form of plastics that are currently moving to landfills.”

Reynolds Consumer Products – Makers of consumer trash bags among other consumer goods, they have a vested interest in the future of plastic packaging as well as consumers’ disposal and recycling behaviors. Reynolds fabricated the Energy Bags and the Energy Bag dispenser box for the pilot.

American Chemistry Council – In conjunction with many advocacy groups, the ACC has sought to promote science-based views on plastics, packaging, recycling, and the environment. The ACC sponsored the post-pilot survey referenced in this report.

Citrus Heights, California – This city northeast of Sacramento has a population of approximately 85,000. The city’s leadership was enthusiastic in their support of participating in the pilot program because they saw the value in the opportunity offered by this program to divert more materials from landfills. They are always looking for creative and cost-effective ways to increase the city’s recycling rate and decrease the amount of material being landfilled.
3. PILOT DETAILS – STEPS TO A SUCCESSFUL PROGRAM

As one looks toward expansion to larger pilots, and ultimately full implementation of an Energy Bag program, it is important to understand the successes and opportunities for improvements found in this initial effort. Below are the steps taken to implement the Citrus Heights Energy Bag Pilot.

3.1 PLANNING

Finding the right partners is critical and can be time consuming. It took several months to finalize all the program details before beginning to implement the Energy Bag Pilot. Aspects such as meetings between potential program partners, defining agreements between actual partners, and the development and consensus for a program identity all needed to be accomplished before more detailed planning and implementation began.

The first meeting between Dow and Republic Services took place almost eight months before the pilot launched. It took four months from then before all partners started to fully engage and move forward at a rapid pace, and it was only through the work of a committed team that the pilot became a reality within that time frame.

Getting the specially created Energy Bags and their dispensing boxes designed, produced, and distributed took four months. Reynolds Consumer Products produced both the bags and the boxes.

Several purple shades were tested, and the darkest shade was selected. The box design saw numerous iterations before the final graphic design was chosen. It took more than a month to get the final print files approved by the companies’ legal departments and other stakeholders. Converting the bags and boxes took another two months, as Reynolds ran both projects within their regular commercial schedule.

3.1.1 SIZE, COLOR, AND QUANTITY

The use of color-coded bags for curbside collection of items such as recyclables and compostables is common in the United States. Of interest to the Energy Bag Pilot Team was a 2012 collection study by the Canadian Plastics Industry Association (CPIA) and Emterra Environmental that assessed the implications of adding recyclable empty plastic bags and overwrap (plastic film), and foam packaging (polystyrene (PS) foam) to an existing curbside recycling program in British Columbia. The program used a dedicated colored bag – a transparent blue one – to collect their targeted materials. A similar dedicated colored bag was chosen for the Energy Bag.

For the Energy Bag Pilot, a non-standard size (8-gallon bag) and an unconventional color (purple) were selected to make the bags distinctive for consumers and easily identifiable at the recycling facility for sorting. A lightweight 1.0 mil film structure was used to provide enough strength to withstand its targeted contents – most of which would be light, flexible packaging that would not cause punctures or breakage.

Use of a standard bag for the Energy Bag Pilot Program was considered; however, the potential for confusion and missed bags during separation/sorting at the material recycling facility (MRF) made a highly distinctive bag preferable. Without an easily identifiable bag, it would be very difficult to distinguish bag types on the sorting lines, in particular for this MRF, because their...
stream accepts regular grocery bags filled with other grocery bags. A translucent bag was selected to make the contents easily visible and identifiable by the manual sorters.

Likewise, the size of the bags was important because the standard 13-gallon trash bag was too big for a two-week collection of non-recycled plastics, and it could have led to people using these bags for their trash instead of their desired use for non-recycled plastics. The 8-gallon bag helped minimize this possible confusion.

Since the pilot was only for a three-month period (six pick-up cycles), it was important to give the residents enough bags for the pilot, but not so many to provide “leftovers” after the pilot was complete. Receiving Energy Bags long after the pilot ended was a main concern of Republic Services, and limiting the number of bags in the box was important to alleviate this valid concern.

FUTURE CONSIDERATIONS...

Anticipate that processes will take longer than expected due to the diversity and magnitude of the coalition. The time required for the decision processes and legal reviews for each partner should not be underestimated.

In hindsight, at least six months are needed between the time all partners give approval and the deadline for the first customer-facing communication in support of the pilot program. This time needs to be spent creating and producing the needed collateral and communication materials to educate the public, the city’s staff, and the hauler/recycler. Allow extra time for the development of the bag and the box graphics and the production of these components.

For the pilot, the Energy Bags were provided to participants free of charge. If the program were to be implemented on an on-going basis, it would need to be determined how the bags would be supplied and who would bear the cost for the development and supply of the collection bags.
3.2 COMMUNICATION

Conveying to our audience how the pilot would work in a simplified way was not an easy task. In fact, as the planning of the communication materials started, it was evident that this would require significant effort and resources to accomplish.

Because the Energy Bag Pilot would be administered to a targeted sub-section of Citrus Heights, which is already a suburban area of a larger city (Sacramento), traditional mass media promotion was deemed inappropriate, as the messages would reach hundreds of thousands of people unable to participate in the pilot. It was decided that direct mail and direct contact would be the promotional avenues, including:

- promotional “bill stuffers” in the customers’ regularly scheduled Republic Services mailings
- a special “Kick-off Event” (co-sponsored by the city) to provide information and generate enthusiasm
- presence and promotional hand-outs at community events
- an online introductory video (posted on YouTube and Citrus Heights’ websites)
- hand-delivered “Energy Bag Kits” for every targeted single-family home

Having a clear, easy-to-understand message for the public is critical to driving both the participation rate and ensuring the right items are placed in the bag. This was difficult because the plastics desired in the Energy Bag constituted a relatively hard-to-explain, diverse category with a potentially endless list of items. It was important to identify groups of non-recycled plastic items that were representative of the majority of plastic packaging not currently recycled in the community (e.g., pouches (juice pouches, squeezeable pouches, microwave pouches, etc.), wrappers (candy wrappers, meat wrappers, cheese wrappers, etc.), plastic serving ware (plastic cups, spoons, forks, knives, plates, etc.). These broad terms were then paired with intuitive “directions,” e.g., If you don’t bin it, bag it; The plastics that don’t go in your bin go in your bag; The Energy Bag is the place for your plastics leftovers.

All communications also included some form of messaging to convey that the Energy Bag program was a way to convert these plastics into an energy resource.

All communication materials were professionally designed and produced. This helped achieve a high level of attention-grabbing consumer appeal and ensured visual and content continuity throughout the program’s “promotional campaign.” Bright colors (purples, blues, and greens primarily) were used to tie into the “purple bag” identification of the Energy Bag and highlight the “blue and green” cues for recycling and environmental action.

The chronology of the communication program was as follows:

3.2.1 COMMUNICATION BEFORE PILOT

**Bill Insert – Prior to Pilot**

Republic Services mails their service bills every other month. A promotional insert (shown on page 7) was added to all Republic Services bills distributed to the targeted households of Citrus Heights three weeks before the pilot began. It was a short, thought-provoking message that announced that the Energy Bag Pilot was coming soon.

**Launch Event Invitation**

A flier shown on page 7 inviting people to the Energy Bag Pilot “Kick-Off Event” was distributed at city events and neighborhood association meetings. Additionally, a press release was published on the city’s and Republic’s websites days before the event. The planning of the event confirmed how challenging it was going to be to communicate only to the targeted single-family dwellings audience without using broad media outlets.

**Pilot Kick-Off (Launch) Event**

The “family-friendly” launch event took place in the parking lot of Citrus Heights’ City Hall on a Saturday from 11AM to 1PM, two weeks before the pilot was to begin. Large informational banners (shown next page), hand-outs, and representatives from Dow and Republic Services provided background and information concerning the Energy Bag Pilot Program. A representative from Dow and Republic Services, and the Mayor of Citrus Heights spoke as part of the event.

A face painter entertained the kids. A hands-on activity (the Recycling Race) was specially created to demonstrate in a fun way what items went inside
the recycling bin and what could go into the Energy Bag. Additionally, drinks and snacks in packaging like that intended to go into the Energy Bag were provided.

Despite invitations handed out prior to the event and press releases sent to area media outlets, few people attended; however, the local CBS television affiliate did attend, and the news coverage gave the program more visibility and helped offset the limited number in direct attendance. http://sacramento.cbslocal.com/video/10177642-citrus-heights-kicks-off-energy-bag-pilot-program/
**Energy Bag Kit**

The most important communication piece was the “Energy Bag Kit” delivered to every targeted single-family home in Citrus Heights. These kits were packaged in a see-through plastic door-hanger bag and hand delivered by a contracted fleet of workers. The kit included the “branded” Energy Bag box of 10 purple bags, a multi-page educational booklet, and an overview sheet relating the door hanger and its contents to the previous promotional communications the homeowners should have seen (e.g., the Republic Services billing inserts, the news coverage).

The 2.5 x 6.25 inch, 10-page booklet was the most robust piece of education distributed to participants. Its goal was to:

- give an overview of the pilot program, including the desired end result of “plastics-to-energy”
- communicate the reason and importance of the pilot program to Citrus Heights (and the potential benefits from participating in it)
- provide a “how-to” instruction guide for using the Energy Bags correctly (what to put in them and where to place filled bags for pick-up)

In a heavily visual “info-graphic” style, the booklet offered relevant data regarding U.S. municipal solid waste (MSW) landfill use and Citrus-Heights-specific estimates for potential energy that could be captured from these plastics during the pilot program.

The booklet also included a perforated removable reference card listing nearly 20 items and/or categories of suggested items for the purple Energy Bags.

Direct door hangers were selected as the most cost-effective method of distribution. They also achieved a perception beyond “junk mail” that could have been present in a standard mail delivery. The potential for delivering damaged Energy Bag boxes was also higher via standard mail.

It is important to note that the bags were provided at no cost to residents during this 3-month pilot program.

---

*The Energy Bag utilizes technology that converts non-recycled plastics into synthetic fuel oil.*

**YOUR ENERGY BAGS ARE HERE!**

Please place this hanger bag in your new Energy Bag, and let it be your first of many items that will help Citrus Heights generate an alternative energy resource and make this 3-Month Pilot Program a huge success.

---

*Trademark of The Dow Chemical Company*
A WAY TO CONVERT PLASTIC WASTE INTO ENERGY!

THE ENERGY BAG PROGRAM IS A FIRST STEP TOWARD AN IMPORTANT CHANGE IN THE WAY WE HANDLE WASTE.

In the U.S., we create over 250 million tons of trash each year! More than half ends up in landfills, and that’s literally a waste. In many other countries, materials that are hard to recycle are being turned into new energy resources – used to light homes, power TVs, run factories, fuel engines, heat and cool offices … Citrus Heights can do it, too!

135 MILLION TONS OF TOTAL LANDFILL WASTE

In many other countries, materials that are hard to recycle are being turned into new energy resources – used to light homes, power TVs, run factories, fuel engines, heat and cool offices … Citrus Heights can do it, too!

The Energy Bag Program is a three-month summer pilot to test just how well we can collect these different types of household plastics and determine if Citrus Heights can achieve positive long-term environmental and economic results.

During the pilot program, the many types of plastic materials that you would usually throw away in your brown cart will now be collected and converted into energy through the use of plastics-to-energy technologies. And don’t worry – the conversion technologies meet very strict emission control requirements, so your Energy Bags’ contents will be converted through proven, conscientious methods.

4 MILLION TONS OF RECOVERABLE RESOURCES FOR POTENTIAL ENERGY IN THE U.S.A.

3.2.2 COMMUNICATION DURING PILOT

Online Outreach

The city of Citrus Heights has an online presence (http://www.citrusheights.net/), it, together with Republic Services’ customer service phone number, served as the centralized information point for the Energy Bag Pilot. Two weeks after the pilot started, the city launched a dedicated web page for the Energy Bag Pilot on their website. It can be accessed here: http://www.citrusheights.net/295/Energy-Bag-Recycling.

Most of the information contained in the Energy Bag Kit booklet was posted there, as well as a two-minute animated video that clearly described the program. www.youtube.com/watch?v=843Fg1MPg0

The video was posted on YouTube and on the Dow website, as well as the Citrus Heights Energy Bag web page. It received great feedback, and a Facebook page was created to continue to promote the pilot. Directing traffic to the web pages was not easy, however, so a targeted Facebook advertisement was purchased at the beginning of August to further attract participants to the city’s Energy Bag website and its animated video.

https://www.facebook.com/TheDowChemicalCompany/posts/826950067322847
https://www.facebook.com/TheDowChemicalCompany/posts/825504460800741

The animation could have been even more helpful if promoted before the pilot started, as would have the use of targeted internet advertising throughout the pilot period. These are two key learnings from the pilot.
THE ENERGY BAG PILOT PROGRAM IS IN FULL SWING.

We’re almost half way there! From June through August, Citrus Heights is participating in a pilot program to collect non-recycled plastics. We need everyone to participate. The plastics collected will be converted to usable energy resources. You still have time to join in and help Citrus Heights show the world what we can do.

HERE’S A REMINDER OF HOW THE PROGRAM WORKS:

1) Fill your purple Energy Bags with non-recycled plastics. See list below.
2) When full, tie it securely and place it inside your blue recycling cart.
3) Collected Energy Bags will be sorted and sent to Agilyx Corporation to be converted to synthetic fuel oil.

If you don’t bin it, bag it. Check this list for the many things that can be collected in your Energy Bag.

- juice pouches
- frozen vegetable bags
- laundry pouches
- plastic cereal box liners
- snack bags
- candy wrappers
- potato chip wrappers
- plastic pet food bags
- squeezable pouches
- cereal pouches
- plastic cups
- plastic cereal boxes
- snack bags
- plastic serving ware
- plastics
- straws & stirrers
- single-serve coffee pods
- plastic coffee pouches
- disposable cups
- paper coffee cups
- plastic deli meat packaging
- plastic deli meat
- plastic serving ware
- plastic cake mix liners
- toothpaste tubes
- all other non-recycled plastic bags
- condiment packets
- plastic straws & stirrers
- stand-up pouches
- plastic deli meat packaging
- plastic cheese packaging
- disposable cups
- (without the blades)
- toothpaste tubes
- all other non-recycled plastic bags

For more information, or to request additional Energy Bags, please call 916-725-9060. To learn more about the energy conversion process, visit: www.agilyx.com. Watch the Citrus Heights Energy Bag video at: http://youtu.be/843FiG1MPg0
Like us on facebook: www.facebook.com/chenergybag

Together with these, it is important to understand that there is an inevitable delay between people’s feedback and implementing measures based on that feedback.

Bill Insert – During Pilot

With the pilot in process, another promotional flier was included in the regularly scheduled Republic Services bill cycle and distributed in July. This flier reinforced that the Energy Bag Pilot was “in full swing” and asked participants to continue to fill and place the Energy Bags in their bins.

Based on various feedback sources, including comments received during neighborhood association meetings, this flier included clearer instructions with more visuals of specific items that could go in the Energy Bag.

Direct Outreach

The modest attendance at the Kick-Off Event reinforced the belief that it was important to “take the pilot to the community,” rather than thinking the community would come to an event to learn about the pilot. The city’s annual Red, White, and Blue Parade & Festival was identified as an opportunity, and it proved to be a resounding success.

The Energy Bag Pilot Team participated in the parade. Along side a Republic Services truck, team members carried a very-large-scale mock-up of the Energy Bag dispenser box, passed out informational handouts, and interacted with the crowd along the parade route. The recognition of the box was encouraging, as were the responses from the crowd (e.g., “Thank you” or “We participate” or “I want to know more.”) At the parade’s end, the same array of posters, games, and activities from the Kick-off Event were set up, and met – this time – with excellent attendance and engagement.

The Republic Services community outreach representative continued to present the Energy Bag Pilot at city council meetings and neighborhood association meetings in case there were any questions.

Internal/Personnel Communication

Another important part of the pilot’s communications activities was educating the public-facing representatives of the city and Republic Services, e.g., drivers collecting the recyclables in Citrus Heights, customer service group members, office staff answering phone calls, etc.

In Citrus Heights, Republic’s drivers are active and well regarded. They seem sincerely respected and are often asked questions by their customers. The drivers were identified early on as the potential “first line” representatives for the Energy Bag.

The drivers’ manager was contacted early in the pilot planning process to get his feedback on the potential issues of adding the bags. As the pilot started, a meeting was held with all the Citrus Heights recycling collection drivers to explain the pilot, to tell them why it was being done, and what was expected of residents. As the program progressed, the drivers were invaluable in disseminating information and providing important observations to the Energy Bag Pilot Team. For example, they saw some residents taping the bags to the side of the bin; thus, the instructions in follow-up literature were modified to stress “inside” the bin, and more clear graphics depicting the bag inside the bin were used.

Republic’s customer service manager communicated with his team about the pilot and the potential questions they could get. The same conversation took place with the city employees involved in the pilot, so residents calling City Hall would get timely and correct answers.
Several meetings were also held with the material recycling facility (MRF) managers prior to the start of the pilot to fine tune the sortation process and audit details. As a result, dedicated sorters were added exclusively to remove the purple Energy Bags, and once the pilot began, additional adjustments were made based on employee feedback.

### 3.2.3 COMMUNICATION AFTER PILOT

#### Bill Insert – After Pilot

A third and final bill insert was mailed with the September billing cycle. It was a simple “thank you for your support” that also asked the recipients to stop using the Energy Bags. The insert also promised follow-up information and directed them to the Citrus Heights website for the final results of the pilot.

**Internal/Personnel Communication**

The same “thank you” message was directly communicated to the truck drivers, customer service representatives, MRF managers, and the city’s personnel. The public-facing representatives were encouraged to thank their customers and/or those calling about waste management issues.

The preliminary results of the pilot were shared with the mayor and vice mayor, as well as with the city council. This report and the documentary video about the Energy Bag Pilot will be available on the city’s website for Citrus Heights residents to access.

**Documentary Video**

A set of documentary videos was created to capture the “making of the Energy Bag Pilot.” A promotional “trailer” premiered at Pack Expo-Chicago, North America’s largest packaging exposition, before an audience of plastics packaging industry professionals.

To generate anticipation of the longer, more in-depth documentary, the four-minute trailer video provided an overview of the pilot but did not offer results.

As the editing of the video progressed, it was decided to create two versions of the follow-up documentary. The originally planned, longer, in-depth documentary meant for industry professionals interested in pursuing an Energy Bag Pilot would serve as a companion piece to this report. A shorter version would essentially “complete the trailer” by simply answering the question posed at the end of the trailer (i.e., revealing the results). This shorter version will serve as a public-oriented, general information video and be available via YouTube and the program partners’ websites.

---

**FUTURE CONSIDERATIONS...**

Communication before, during, and after the program’s time frame is essential to engage, initiate, and maintain interest and action throughout the program. Use as many media options as possible, and engage participants through direct contact at community events.

Make sure that all customer-facing employees are fully informed and trained to respond to customer questions prior to any external communications. In Citrus Heights, the meeting with the truck drivers should have taken place before the pre-pilot communications were distributed, as some drivers received questions for which they had no answers.

The Citrus Heights pilot’s media outreach was limited; additional types and frequency of communication would likely result in increased participation rates.

The animation could have been even more effective if promoted before the pilot started. Targeted internet advertising throughout the pilot period could have increased awareness and/or participation.

It is important to understand that there is an inevitable delay between people’s feedback and implementing measures based on that feedback.

---

**THANK YOU FOR YOUR SUPPORT**

The three-month Energy Bag Pilot program has concluded, and we thank everyone in Citrus Heights who participated. You were challenged to change the way you think about waste, and you proved that non-recycled plastics can be collected and recovered for energy.

**PROGRAM RESULTS WILL BE SHARED SOON.**

We are in the process of sorting and distributing the last collection cycle, and we will soon begin evaluating the results of the pilot program. Please visit the City of Citrus Heights website (www.citrusheights.net) in the coming weeks for information on the program’s final results.

**PLEASE STOP USING THE ENERGY BAGS.**

The pilot program is complete, and we can no longer accept any Energy Bags in your recycling cart or bin. Please remove the purple Energy Bags from your recycling bin. You can dispose of your remaining purple bags at plastic bag drop-offs located at local grocery stores.

**THANK YOU!**

Together, we made the Energy Bag program a success, and we should be very proud. You, the citizens of Citrus Heights, have changed the way we as a society think about waste. We are in the process of sorting and distributing the last collection cycle, and we will soon begin evaluating the results of the pilot program. Please visit the City of Citrus Heights website (www.citrusheights.net) in the coming weeks for information on the program’s final results.

**Sponsored by:**

* Energy Bag uses a technology that converts non-recycled plastics to synthetic fuel oil.

**Trademark of The Dow Chemical Company**
3.3 COLLECTION

Once the Energy Bag Pilot Program’s various components were ready and the pilot began, the collection of the Energy Bags was virtually seamless. The majority of participants in Citrus Heights simply added the purple bags to their existing blue roller bins per the instructions provided in the promotional materials. The trucks from Republic Services collected the recycling every two weeks.

FUTURE CONSIDERATIONS...

Visual representation of what should go in the Energy Bag and where the bag should be placed for pick-up (inside the recycling bin) was needed to reinforce directions after the original instructions were provided. Pictures were found to be more effective than words.

3.4 SORTATION

Effectively separating the Energy Bags from the other recyclables as they entered the recycling facility was a key area of focus for the pilot. Efficient removal and storage is one of the challenges that any new material faces when it is introduced into a recycling facility.

Prior to the pilot’s commencement, it was decided to add dedicated sorters (aka pickers) to the pre-sort line, right after the metering drum. The sorters only job was to manually remove the Energy Bags as they passed by. Initial staffing was set at three per shift. This turned out to be more than needed for the volume of bags collected. Staff adjustments were made as the pilot progressed.

At the transfer station located in Rancho Cordova, a loading tag system was set up to identify which loads leaving for the recycling facility contained Energy Bags. This system worked very well and helped to ensure that the additional staff were on the sorting line at the right times. This information aided in the planning process and enabled the Energy Bag sortation to be consolidated into one shift and resulted in labor savings. If the program were to expand to all households, this step would no longer be necessary, as all loads arriving at the recycling facility would potentially contain Energy Bags.

Manually pulling the bags at pre-sort was very effective. Just a few bags were missed. Those that made it through were caught and pulled during the downstream quality control process. The color of the bags helped tremendously, making them easy to identify and remove. Some operators commented that if the bags were slightly more opaque, the job would have been even easier.

With Newby Island’s metering system, only 1% of the bags were broken before they made it to the manual sorters. Even more importantly, no bags were found wrapped in the paper screens. A random minimum of 10% of the bags pulled each day was set aside for material characterization. A total of 13.7% of the incoming material was audited throughout the pilot. For consistency, this procedure and the characterization audit were carried out by the same employee during the entire program. The average contamination level throughout the pilot was 16.5%, which according to Enrique Castillo, operations manager at the Republic Services Newby Island MRF, is a very typical contamination level for all recycling activities at this location.

The ability to estimate the capacity of a picker to remove Energy Bags based on actual data is one of the key take-aways from the pilot. Republic Services observed that each picker can remove 40-50 Energy Bags per minute. At 45 bags per minute and 6.75 hours of run time per eight-hour shift, this equates to roughly 18,000 bags per shift per sorter. Based on the pilot’s average material weight per bag (0.7 lbs.), each picker can remove 6.3 tons of material per shift.

If the program were to be scaled and participation rates and volumes increased, the manual sortation would need to transition to automated sortation, although based on the numbers above, most programs could utilize manual sortation for quite some time.

The recycling facility management felt that the pilot ran seamlessly.

FUTURE CONSIDERATIONS...

Having a distinctive, colored bag helped tremendously during sorting. The Energy Bags were easy to identify and remove. Having a slightly more opaque bag (or one with identifying graphics) could make the process even easier for manual sortation.

3.5 PLASTICS TO WHAT?

During the Red, White and Blue Parade & Festival, Citrus Heights residents were surveyed and asked: What is the preferred way of referring to what happens to the plastics during the conversion process? There were four options:

1. Plastics to Energy
2. Plastics to Fuel
3. Plastics to Oil
4. Return to Fuel

67% of the respondents selected “Plastics to Energy.” None chose “Plastics to Oil” or “Return to Fuel.”
This supports the choice of using the “Energy Bag” terminology, but further questioning suggested how the process should be referenced in promotional materials. When asked why they preferred “Plastics to Energy,” most said something like “Because energy is something that people can easily relate to,” or “Everybody needs energy.”

A post-pilot survey reinforced these responses. When given a choice of reasons for participating, “Creating alternative energy” was a leading response (82%).

3.5.1 PYROLYSIS

Pyrolysis is a resource recovery technology that uses heat in the absence of oxygen to chemically transform plastic into end products that include synthetic crude oil, synthetic wax, and syngas.

The crude oil can be further refined and made into valuable products for everyday use such as gasoline, diesel fuel, jet fuel, fuel oil, lubricants, and can even be transformed back into plastic. The waxes are applicable to the industrial wax, lubricant, and diesel markets. The syngas, which is typically only 10-15% of the output, can be reused directly in the pyrolysis plant to generate heat.

Pyrolysis plants use hard-to-recycle mixed, unsorted plastic resins as feedstock, including multi-material flexible plastic packaging and metalized/coated films. The process can tolerate some levels of contamination. Most operators will accept up to 5% PVC, although they prefer not to have any, as chlorine levels in the finished product should be kept to a minimum. They also try to limit the amount of PET because it negatively affects oil conversion efficiencies and ultimate yields, which drive program economics.

Typical maximum oil conversion efficiencies for pyrolysis are 70-80% but vary depending on the nature of the plastic feedstock. At these rates, one ton of packaging waste typically yields five to six barrels of oil. In other words, it takes roughly 8-10 pounds of non-recycled plastic to make one gallon of synthetic crude oil.

This process carries a carbon impact that is lower than coal and crude oil extraction. Moreover, since plastics have a high embedded energy content – closer to oil and more than coal – the paradox of plastics disposal in landfills while our energy demands continue to increase becomes clear.

Additional advantages of the pyrolysis process include that it generates very few emissions, it has a small footprint, and its modular design allows units to be located on space-restricted sites. Pyrolysis is smaller in scale and lower in capital costs than a typical gasification or an engineered solid fuel plant, making it an attractive option for the recovery of lower-volume materials such as flexible packaging.

At present, there are several companies offering pyrolysis technology in varying stages of development, and the market continues to advance down the path of commercialization. At the end of 2014, there were four commissioned commercial-scale plants operating in the U.S. with more planned. There are also numerous plants outside the U.S. The recent launches of the ACC-sponsored Plastics Energy Recovery Team (PERT) and Plastics-to-Oil Technologies Alliance are another step in the process of building a solid foundation for the growth of this market. The members are working together to build credibility, remove barriers at the state and local levels, and expand the use of this technology in the U.S.

It is important to note that pyrolysis is a technology that complements rather than competes with mechanical recycling, as it targets hard-to-recycle plastics that are otherwise destined for the landfill. Mechanical recycling of materials like plastic bottles will continue to be the preferred recovery method for high-volume packaging made from single materials.

3.5.2 AGILYX

Agilyx was one of the key members of the collaborative coalition of partners that made the Energy Bag Pilot a success. A leader in the emerging plastics-to-oil market, Agilyx operates three North American commercial pyrolysis facilities. Their technology is a patented thermal pyrolysis process that is clean and energy efficient, returning at least five times more energy than it uses in the production process. It is designed to use co-mingled hard-to-recycle plastics (types 1-7) that would otherwise be destined for the landfill.

For the Energy Bag Pilot, Agilyx converted the collected non-recycled plastics from Citrus Heights into synthetic fuel oil. Additionally, Agilyx staff performed several tests to determine material characterization and oil conversion efficiencies. The testing and conversion processes are detailed in the Energy Recovery Trial section.

FUTURE CONSIDERATIONS...

Positioning of future programs should be based around the opportunity to turn plastics to energy (as opposed to oil or fuel). Citrus Heights survey respondents overwhelmingly chose “Creating alternative energy” as their reason for participating in the pilot (82%). 67% of the respondents selected “Plastics to Energy” as their choice for an over-arching title for the process.
4. THE COLLECTION AND SORATION NUMBERS

The material characterization audit results are provided in Table 1. The data were collected via audits of one of every seven bags collected at the MRF each day of a collection week, totaling 13.7% of all material collected being audited. Table 1 represents the average from these collective results over six recycling collection cycles at the Newby Island MRF (collections occurring every other week).

As an added data point, it was decided to track the mono-material films that could have been recycled through grocery store drop-off programs (Table 1, Bags/Wraps). If these materials are clean and dry, recycling them is a preferred end-of-life alternative; however, since they are made mostly of PE, they are also a perfect feedstock for the pyrolysis process, which is a preferred end-of-life alternative to landfills.

An overview of the collection and sortation data is provided below. More detailed data on the six collection cycles can be found in the Appendix.

Table 1 clearly shows the predominance of non-recycled flexible plastic at 33.4% and scrap rigid plastic at 16.5%, PET and HDPE bottles accounted for 4.4% of the collected material (and mostly PET bottles that have a better value in the mechanical recycling market).

Primary plastics resins found in the Energy Bags included #2 HDPE, #4 LDPE/LDPE, #5 PP, and #6 PS. The #3-#7 rigid plastics subcategory consisted mostly of PE and PP yogurt cups and trays and PET clamshells. PE and PP are very suitable for pyrolysis, but PET clamshells are not, as PET reduces production yields. If the MRF does not find an economically advantageous recycling market for these materials, they are a perfect feedstock for plastics-to-energy after PET is removed.

The types of contamination received in the Energy Bag contents as compared to the contamination found on a typical recycling cycle proved interesting. In regular recycling processes, food contamination is very visible; however, this was not the case for the pilot where 8.2% out of 16.5% contamination was comprised of paper. The average contamination level throughout the pilot was 16.5% – typical of all recycling activities at Republic's Newby Island facility. It is important to note that continuous education could reduce contamination levels. In addition, the results obtained from the audit might be skewed toward the higher values due to outliers such as entire bags filled with newspapers or shredded paper, or bags of clothing for example.

Figure 1 and Table 2 show the collection cycle trends of the audit's major categories. It can be observed that the quality of the materials improved during the last two collection cycles. This might be a result of the second promotional bill insert that visually demonstrated and reinforced the types of materials that could go inside the Energy Bag.

Overall, the breakdown stayed very constant throughout the three months. It was clear during the audits that residents who participated did an excellent job choosing appropriate materials and removing residue from their plastics resulting in Energy Bags filled with clean suitable material. More than 70% of the materials collected through the Energy Bag Pilot were suitable for pyrolysis and provided a high yield (explained in the "Trial Results" section).

Table 1: Total Characterization Audit Results (%)

<table>
<thead>
<tr>
<th>Major Category</th>
<th>Subcategory</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible Plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENERGY BAGS</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>Bags/Wraps</td>
<td>19.2</td>
</tr>
<tr>
<td></td>
<td>Other Flexibles</td>
<td>33.4</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>#3-7</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td>PET/HDPE Bottles</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>Scrap Rigid/Food Service/EPS</td>
<td>16.5</td>
</tr>
<tr>
<td>Other Contamination</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paper</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td>Trash</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Table 2: Cycle Trends Characterization Audit Results (%)

<table>
<thead>
<tr>
<th>Collection Cycle</th>
<th>Flexible Plastic</th>
<th>Rigid Plastic</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Flexible Plastic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENERGY BAGS</td>
<td>60.1%</td>
<td>56.2%</td>
<td>50.5%</td>
</tr>
<tr>
<td>Bags/Wraps</td>
<td>5.9%</td>
<td>6.3%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Other Flexibles</td>
<td>21.0%</td>
<td>24.4%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3-7</td>
<td>21.6%</td>
<td>20.9%</td>
<td>24.9%</td>
</tr>
<tr>
<td>PET/HDPE Bottles</td>
<td>1.6%</td>
<td>2.6%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Scrap Rigid/Food Service/EPS</td>
<td>14.8%</td>
<td>21.0%</td>
<td>12.3%</td>
</tr>
<tr>
<td>Other Contamination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td>18.2%</td>
<td>14.9%</td>
<td>24.6%</td>
</tr>
<tr>
<td>Trash</td>
<td>5.9%</td>
<td>9.3%</td>
<td>10.8%</td>
</tr>
</tbody>
</table>
The Energy Bag Kits were distributed to a total of 26,000 homes, but there were delivery issues reaching approximately 1,000 homes (mostly in gated communities). These households received the Energy Bag Kits three weeks after the pilot started, and this could have discouraged them from participating.

There was no tracking of individual households (i.e., if and/or how often each participated), therefore to calculate the participation rate, two scenarios were postulated (presented on Table 3): Scenario 1 assumes that each participating home contributed one Energy Bag every collection cycle; Scenario 2 assumes that each participating home contributed one Energy Bag every other collection cycle.

The actual participation rate likely lies somewhere in between these two assumptions, with an average of the two offered as a potential estimated participation rate. It is important to note that the values offered in this section are different from the participation rate reported in the post-pilot survey, in which 1/3 said they had participated in the program at some point. The values in this section attempt to find a value for the scenario of an on-going participation by the same household.

What do the numbers for Scenario 1 and Scenario 2 tell us? On average, each collected Energy Bag in Citrus Heights weighed less than one pound. A full scale, economically viable conversion technology plant needs roughly 100,000 pounds (50 tons) of plastic each day to run efficiently. If the facility operates five days a week (~20 days per month), it will require ~2,000,000 pounds of plastic during the month. Assuming the plant is supplied only with material collected from residential participants, this equates to 1.4 million households participating regularly in an Energy Bag program to meet this need. Thus, a city like Los Angeles could supply the needed material. In fact, if the greater Los Angeles metropolitan area is considered, there could be enough material for three plants, assuming significant participation. The use of other sources of feedstock could reduce the number of participating households needed to supply a commercial scale pyrolysis plant.

**Table 3: Participation Rate Estimates**

| Total Number of Participating Households | 26,000 |
| Number of Bags Collected | 7,977 |

<table>
<thead>
<tr>
<th>Participation Scenarios</th>
<th>One Bag/Household Every Collection Cycle</th>
<th>One Bag/Household Every Other Collection Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential Number of Bags for the Three Months</td>
<td>156,000</td>
<td>78,000</td>
</tr>
<tr>
<td>Participation Rate</td>
<td>5.1%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Average Potential Number of Bags for Three Months</td>
<td>117,000</td>
<td></td>
</tr>
<tr>
<td>Average Participation Rate</td>
<td>7.7%</td>
<td></td>
</tr>
</tbody>
</table>

What do the numbers for Scenario 1 and Scenario 2 tell us? On average, each collected Energy Bag in Citrus Heights weighed less than one pound. A full scale, economically viable conversion technology plant needs roughly 100,000 pounds (50 tons) of plastic each day to run efficiently. If the facility operates five days a week (~20 days per month), it will require ~2,000,000 pounds of plastic during the month. Assuming the plant is supplied only with material collected from residential participants, this equates to 1.4 million households participating regularly in an Energy Bag program to meet this need. Thus, a city like Los Angeles could supply the needed material. In fact, if the greater Los Angeles metropolitan area is considered, there could be enough material for three plants, assuming significant participation. The use of other sources of feedstock could reduce the number of participating households needed to supply a commercial scale pyrolysis plant.

**FUTURE CONSIDERATIONS...**

Having the same characterization methods, as well as having the same personnel running the characterizations throughout the pilot was helpful for data consistency. It is important to utilize the same weighing equipment and to have dedicated space to run the characterizations.
5. ENERGY RECOVERY TRIAL

The Energy Bag Pilot pyrolysis trial ran smoothly. Approximately three tons of collected materials were sent as “energy bales” from Republic Services to Agilyx. The conversion process, simplified for this document, was accomplished as follows:

- The Energy Bags’ contents, together with the Energy Bags themselves, were prepped then shredded.
- The shredded material was moved to the Gen 6 pilot plant material staging area in preparation for the pyrolysis trial run.
- The material was next loaded into the automatic feeding system and carried to the feed hopper of the Gen 6 material reclamation unit.
- The material was then “densified” to form a vacuum plug that was fed into the thermal reclamation unit (a self-cleaning, multi-zone-heated, dual-screw unit) in which the plastic was heated and converted first into a liquid, and then into a hydro-carbon gas.
- The hydro carbon gases were transferred to a condensing tower, part of a proprietary system, where they were condensed back into a liquid.
- The resulting oil/water emulsion then moved to a separation unit where the synthetic fuel oil was removed and conditioned before being sent to storage to await shipment to the refinery.

5.1 MATERIAL CHARACTERIZATION

The Energy Bag material was characterized at Agilyx both before and after shredding to determine the relative resin percentages. These are referred to as “raw feedstock characterization” and “prepared feedstock characterization” respectively. It is important to note that these characterizations are in addition to those done each collection cycle at the Newby Island Resource Recovery Recyclery (as explained in Section 4).

5.1.1 RAW FEEDSTOCK CHARACTERIZATION

A 13-pound “grab sample” was selected at random from the incoming raw feedstock (sent by Republic). The sample was first sorted by material type to determine the basic characterization (Figure 2). The rigid plastics, film plastics, and foam materials were then sorted by resin type – either by their SPI Resin Identification Code if they were labeled, or by near-infrared (NIR) spectroscopy if not labeled – to determine the detailed characterization of the sample (Figure 3).
The raw feedstock contained over 55% of high-oil-yielding plastics (PE, PP, and PS) but also included relatively high levels of low-oil-yielding plastics (PET and PVC) and non-plastics such as fiber.

5.1.2 PREPARED FEEDSTOCK CHARACTERIZATION

An analysis of the feedstock was also completed after it had passed through the Feedstock Preparation System. This system shreds the material and runs it through a cross-belt magnet (to remove metal) and a wind sifter (to remove heavy contaminants such as large pieces of aggregate, glass, and metal). Material was collected at regular intervals during this process to make up the sample. Figures 4 and 5 present the basic and detailed characterization results for the prepared feedstock respectively.

The prepared feedstock contained over 45% of high-oil-yielding plastics (PE, PP, and PS), but as with the raw feedstock sample, it also included relatively high levels of low-oil-yielding plastics (PET and PVC) and non-plastics such as fiber.

The compositional variations are likely due to the complex composition nature of multi-layer laminates and the limitations of using NIR spectroscopy to identify different plastics in the these types of structures. The PET values are high, and the PE and OPP numbers are lower than expected because each material was characterized based only on its outer layer, which did not account for the relative resin make-up of the multi-material laminates in the mix. Taking this into account, these figures can still be considered an accurate representation.

The PET number was higher than is ideal due to the number of PET clamshells that were included in the sample. PET has an oil yield of around 15% compared to PE and OPP, which is close to 90%. If a program were implemented on a larger scale, discussions concerning whether or not to include PET clamshells in the Energy Bag would be prudent. In some communities, these materials can be placed in the recycling bin and would not need to be included in the Energy Bag. The result of that could be a more optimal categorization to achieve the highest and best use of the material and increase commodity revenues for the program.

FUTURE CONSIDERATIONS...

Participants followed instructions very well regarding what materials should go into the Energy Bags. The inclusion of PET clamshell packaging, however, likely diminished the end quality of the conversion feedstock, and thus the conversion efficiency. Future programs should consider if and how to reduce the number of PET clamshells received.

Figure 3 – Detailed Characterization of Raw Feedstock

Figure 4 – Basic Characterization of Prepared Feedstock

Figure 5 – Detailed Characterization of Prepared Feedstock
5.2 OIL CONVERSION EFFICIENCY

Oil conversion efficiency is the measure that drives the economics of the pyrolysis process. A few percentage points over the life of the asset can make a huge difference in the level of profits for a given program. This makes the material mix of the feedstock extremely important. Table 4 shows the acceptability, tolerance, and oil yield related to the various resins found in the waste stream.

An oil conversion efficiency of 75-80% is considered robust. To estimate the expected oil yield of the Energy Bag materials, a sample of prepared feedstock was processed through a bench scale pyrolysis system. The material processed well, and the resulting oil conversion efficiency was 58%. This was expected based on the relatively high levels of PET and fiber found in the sample.

Based upon the 58% conversion efficiency, Citrus Heights’ three tons of collected non-recycled plastics yielded 512 gallons of synthetic fuel oil. That is nearly 12 barrels of oil recovered.

Considering the negative effect of the PET and fiber materials and the potential for improving the feedstock, an increase toward 600 gallons is plausible in a similar pilot scenario – even at identical participation. With this in mind, the Energy Bag Pilot Program shows it is very promising for this type of residential recovery system to succeed.

### Table 4 – Conversion Efficiencies by Materials

<table>
<thead>
<tr>
<th>Type</th>
<th>Acceptability</th>
<th>Tolerance</th>
<th>Oil Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 PET</td>
<td>&lt;5%</td>
<td>Tolerated</td>
<td>~15%</td>
</tr>
<tr>
<td>#2 HDPE</td>
<td>100%</td>
<td>Desired</td>
<td>~90%</td>
</tr>
<tr>
<td>#3 PVC</td>
<td>&lt;3%</td>
<td>Tolerated</td>
<td>~35%</td>
</tr>
<tr>
<td>#4 LDPE</td>
<td>100%</td>
<td>Desired</td>
<td>~90%</td>
</tr>
<tr>
<td>#5 PP</td>
<td>100%</td>
<td>Desired</td>
<td>~90%</td>
</tr>
<tr>
<td>#6 PS</td>
<td>100%</td>
<td>Desired</td>
<td>~80%</td>
</tr>
<tr>
<td>#7 Other</td>
<td>&lt;75%</td>
<td>Desired</td>
<td>~70%</td>
</tr>
</tbody>
</table>

5.3 ENERGY RECOVERY TRIAL CONCLUSIONS

The Energy Bag contents ran through the system with no problems and processed well, but the feedstock quality was not as robust as desired, as it contained relatively high levels of PET and fiber that negatively impacted oil yield. Knowing this is helpful, however, as it demonstrates the need to address the issue in a scaled-up program.

The Energy Bag feedstock provided a conversion efficiency of 58%, equating to a total yield of 512 gallons of synthetic fuel oil (12 barrels) via 6,000 pounds of collected materials.

There are a few specific actions that could be implemented in future programs to potentially improve the quality of the feedstock and thus the oil yields:

- A continuing education program aimed at the participants in the collection program reinforcing the types of materials that should and should not go into the Energy Bags could reduce the amount of fiber put into the bags.
- In areas that have MRFs with the ability to sort them, PET clamshells could move from the Energy Bag to the curbside bin.
- Pre-sorting could be added to the pyrolysis feedstock preparation system to remove low-oil-yielding materials. Targeting just PET and fiber-heavy materials should result in a solid improvement in conversion efficiency.

Overall, the Energy Bag Pilot was considered a success and has provided several useful insights applicable to future programs.
The following section outlines the best practices and key learnings from the Energy Bag Pilot. These insights provide valuable lessons that can be leveraged in future pilots, as well as on-going community programs.

One of the key factors contributing to the success of the pilot was the effective collaboration between the members of the stakeholder coalition:
- the community (Citrus Heights)
- the waste hauler and resource recovery recyclery (Republic Services)
- the recovered material processor (Agilyx)
- the industry representatives (Dow, Reynolds Consumer Products, FPA, ACC)

Building this type of coalition should be the first step taken in any program.

The pilot was initiated to address several key questions regarding this specific type of resource recovery system. Having a set of similar objectives would be important for future programs. The questions presented by this stakeholder coalition and the discovered answers are below:

**Will people participate?**

Although the pilot time was short and the communication channels limited, people did participate. 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. While this is an excellent number, further efforts will need to focus on increasing participation.

**Will people follow the provided instructions and place the recommended non-recycled plastics inside the bag?**

The majority of participants followed instructions well, collecting the correct types of materials, as well as rinsing/cleaning packaging prior to disposal. The pilot saw contamination rates that were no different than what a recycling facility typically sees with more established materials. It is important to note, however, that the source of contamination for the Energy Bags was different from typical recycling facility contamination, presenting an overall cleaner material with little food residue.

**Can the material be effectively collected using the existing curbside recycling infrastructure?**

Collecting the bags with the current recyclables proved to be simple, effective, and not disruptive to haulers’ routines. The pilot netted nearly 8,000 Energy Bags totaling approximately three tons of material.

**Can the material be effectively sorted at the recycling facility?**

Manually pulling the bags at pre-sort was very effective. The purple color of the bags helped tremendously, making them easy to identify and pull. Almost all the bags were captured at pre-sort, and the manual sorters could have handled many more bags than were seen during the pilot. Only a few bags made it past the pre-sort station, but those that did were pulled during downstream quality control. No bags were found wrapped in the paper screens. This is a very important result and a learning that will be of much interest at a recycling facility.

**Is the material suitable for pyrolysis?**

The material collected during this pilot was definitely suitable for pyrolysis and ran well through the process. The PET levels were higher than ideal, primarily from PET clamshells. Contamination from other materials was well within acceptable ranges. The oil conversion efficiency tested at 58%, which is very promising for future pilots, as both the PET and contamination concerns could be easily addressed.

The pilot also revealed some interesting and unexpected learnings:

- Despite being highly aware of environmental issues, many consumers in Citrus Heights thought that all plastic formats could be recycled in their blue recycling bin. The pilot served to bring a better understanding to the residents of Citrus Heights as to which plastics are and are not currently recyclable. Two positive results of the pilot should be their greater awareness of the value of materials currently going to landfills, hence the need for programs such as the Energy Bag; and the recycling facility should receive less contamination from Citrus Heights customers in the future.

- None of the participants asked what would happen to the collected material; they were more interested in the fact that they were now able to recycle the materials. Consumers seemed most interested in knowing that the materials would not end up in the landfill, and survey results showed they believed that using the materials as an energy resource is a positive outcome, one much preferred to landfill.

- While the concept of “plastics/waste-to-energy” was highly regarded, the message of “landfill diversion” and “protecting the environment for future generations” was also a primary driver toward participation for many of the surveyed participants (38%).

- Community pride can be an important factor. In Citrus Heights, the idea that their city would be recognized as an innovator and national leader in conservation/environmental efforts was the highest-ranking motivator for participation in the post-pilot survey (71%) - above the actual environmental advantages listed.
COMMUNICATION

Communication with the consumer is a critical component of a successful program. It drives both the volume of material collected (through household participation) and the quality of the material collected (by getting the consumer to put the right materials into the bag).

The key take-away from the Citrus Heights Energy Bag Pilot is to communicate early and often through multiple channels, including direct media, mass media, social media, and through personal community outreach. Communication before, during, and after the program’s time frame is essential to engage, initiate, and maintain interest and action. Additional types and frequency of communication are likely to result in increased participation rates, which is important to both future pilot programs and permanent implementation programs.

Community outreach was paramount in Citrus Heights. Face-to-face interaction with Q&A opportunities demonstrated positive outcomes, with residents gaining greater understanding and willingness to participate.

In Citrus Heights, the “branding” of the program (i.e., Energy Bag) and the distinctive purple bag itself proved to be an effective communication tool as it resonated with the customers, enhanced understanding, and gave the community something to rally around.

The messaging of the communications was also important. Highlighting that the Energy Bag does not compete with recycling, it complements it, was an important factor in gaining community buy-in. The how’s and why’s and the potential benefits of the program were consistently and repeatedly a part of that same message.

Overall there was a positive response by citizens. Very few residents were skeptical, and the communication program was a key part of that.

What Worked Well

- Grass roots efforts with face-to-face interactions explaining the program were very effective. The ability to ask questions was important to consumer understanding. Having a presence at local community events and neighborhood association meetings to pass out fliers and answer questions was a big help.
- Social media posts promoting Energy Bags were also effective, allowing on-going and immediate feedback and interaction; however, the Citrus Heights social media efforts were not launched until after the middle of the pilot. Future programs should start this process as part of a “pre-program launch” and continue it throughout.
- The animated video that described the program was a very effective communication tool, but it was not available until two weeks after the pilot started. Using this as a pre-launch educational tool could have been very helpful.
- The bill/statement stuffers mailed directly to Republic Services customers before, during, and after the pilot were effective. More than 25% of respondents in a post-pilot survey recalled receiving/reading the promotional materials. These also did double-duty, serving as handouts at some community events, thus increasing potential impressions with the audience.
- The hand-delivered Energy Bag Kits also performed as planned. 50% of survey respondents recalled the kit, and – obviously – everyone who participated used the Energy Bags provided in the kit.

What Was Challenging

- Limiting the Energy Bag Pilot to a relatively small segment of a relatively small suburban community made the use of mass media communication impractical for communicating to such a targeted audience. While press releases were distributed to area radio, TV, and newspaper outlets, few responded with coverage and the “free advertising” desired. Conducting the pilot in a larger metropolitan area with a much larger targeted participation would afford access to mass media advertising and promotions (e.g., local news broadcasts, local morning shows, local TV, radio and newspapers ads, etc.) that would cost-effectively touch the desired audience without wasting advertising dollars or confusing large numbers of consumers residing in non-participating areas.
- The pilot’s tight time schedule proved challenging, especially as it related to communication planning. Media such as outdoor advertising, out-of-home efforts such as mall kiosks or bus stands, and local or regional magazine advertising require contracts months in advance of placement. Future programs should set time aside well in advance of the program’s initiation for an upfront analysis of the targeted community to determine the most effective communication channels.
• Summer was not the ideal time to conduct the pilot. Residents taking vacations could have reduced participation. People spending less time indoors and more time away from the home could have reduced recycle content. A launch during the school year could have used schools to help communicate the program and leverage young people’s enthusiasm for recycling.

• Although listed as a positive above, the use of bill inserts as a primary communication vehicle also posed concerns. The area included a number of rented homes, and if the landlord received the bill, the renters were left unaware of the program. Also, many consumers now use auto-pay programs and may never open their standard billing statement.

**What to Do Differently Next Time**

• Leave plenty of time for the planning process.

• Identify the best communication channels for a specific community as part of the up-front planning process.

• Develop and promote a dedicated website for the program and have it online prior to launch.

• Use a video prior to the launch to help with education and building anticipation.

• Expand the use of targeted internet marketing (highly visited web pages in a specific geographic area), including social marketing.

• Educate collection drivers prior to the launch so they are well equipped to answer consumer questions and become true ambassadors for the program.

• Launch the program during the school year so students can learn about and promote the program. If they are actively engaged, they can influence parents, relatives, and peers. Identify strategies to engage students early in the process.

• Engage in more community and club events (Optimists, Lions, Kiwanis, Chamber of Commerce, etc.) with a prepared presentation.

**Themes to Highlight**

The Energy Bag Program:

• does not compete with recycling, it complements it

• targets items that cannot currently be mechanically recycled

• diverts material from the landfill

• helps protect the environment for future generations

• produces alternative energy

• turns waste into energy/oil

• results in needing less new fossil fuel being extracted from the ground

**General:**

• Plastics are a valuable resource that should not be wasted.

• Considering the entire lifecycle of a product, optimized plastic packaging, including multi-material laminates, have a smaller environmental footprint.

• Collaboration is critical to driving change.

**Additional Learnings to Leverage**

• Active and timely stakeholder participation and support and effective coordination among the partners are important factors in executing a successful program.

• Tapping into existing community events is preferred (as opposed to creating an independent event), because there is an established audience. Citrus Heights’ Red, White and Blue Parade & Festival, for example, was a great event for promoting the pilot among residents already attending the event.

• Hand delivering the box of 10 bags directly to consumers was an effective way to kick off the program as it allowed the consumers to ask questions (if they were home), and it ensured that the majority of the community received their bags on time.

• Utilizing Citrus Heights’ and Republic’s established communication channels to consumers was an efficient way to reach the consumer.

• The majority of Energy Bag promotional literature, including the program’s kick-off details, was delivered via an insert in Republic Services’ bi-monthly billing statements. With the emergence of auto-pay programs, many consumers no longer look at their paper bills, so many customers may not have seen the fliers introducing and/or further promoting the pilot program. Future programs should consider this trend. Also, renters may not see the bill inserts since the property owner – and not the resident – may receive the billing statement.

• In an increasingly visual populace and growing elderly communities, the need to graphically portray the story and instructions is imperative. Although detailed instructions were provided in all promotional material, it was suggested that pictures would have been better understood by a broader range of consumers.
6.2 PLANNING AND PROJECT MANAGEMENT

In a project as complex as the Energy Bag Pilot Program, which involved multiple stakeholders, including the consumer, planning and program management becomes critical.

Buy-in and engagement from all stakeholders both local and regional, as well as the application of solid project management principles and strong project leadership are key components of success.

The tight time schedule of the pilot clearly highlighted the need to build in plenty of time for the up-front planning process and training. Involving all the key partners in the development of a comprehensive program plan that captures the key activities and clearly defines the roles and responsibilities of each partner will build a solid foundation on which to execute the program.

Key Learnings to Leverage

• Clearly defined goals, roles, and responsibilities and a program strategy план that is agreed upon by all partners up front are critical components of success.
• Ensure that all key stakeholders have representatives involved in the early planning stages to streamline communications and build alignment and buy-in up front.
• Obtain buy-in from the city, as it is a critical component to the success of a pilot.
• A strong program manager is needed to drive the program and overcome challenges; persistence in moving the program forward and overcoming challenges helped make the Citrus Heights program successful.
• Effective program management is critical:
  - Name an overall program leader and a project lead from each collaborating partner.
  - Set clear expectations for all the key partners.
  - Clearly define the roles and responsibilities of each partner and team member.
  - Apply solid project planning and project management practices to the program.
  - Develop a comprehensive program plan that includes a detailed communication plan and is agreed upon by all parties prior to the start of the program.
• Build in plenty of time for planning and preparation:
  - Don’t underestimate the time it will take to finalize all the agreements and legal considerations when dealing with multiple stakeholders and multiple legal departments.
  - From this experience, the lead time to convert custom bags and boxes was four months.
  - Allow time to communicate to all parties (internal personnel and targeted participants) prior to the program launch.
• Active participation from all collaborative partners is a key to success.

6.3 AT THE RECYCLING FACILITY

Handling material in the recycling facility is a crucial step in the process. Effectively and efficiently removing and storing the Energy Bags is one of the key challenges that a program of this nature faces. Leveraging what was learned during the Energy Bag Pilot is the key to expanding the program to larger communities.

Key Learnings to Leverage

• The training of the staff prior to the pilot is very important to ensure broad awareness of the pilot.
• The drop-off loading tag system which identified loads with the Energy Bags worked well and ensured efficient staffing for manually sorting the Energy Bags.
• Ideally, more space to segregate and stage the material would be preferable. This would allow all material to run at once. If the program were expanded to all households, this step would no longer be necessary, as all loads would contain Energy Bags.
• The data collection process could be simplified if arriving material could be processed sooner.
• The color of the bags helped tremendously and made them easy to identify and pull at pre-sort.
• Energy Bags that did pass pre-sort were easily pulled downstream. Very few bags made it through this step.
• No bags were found wrapped in the paper screens, meaning that manually picking the Energy Bags at pre-sort was effective.
• The 1.0 mil bag performed well, withstanding considerable abuse; only 1% (approximately) was damaged.
• For the number of bags collected, three pickers per shift were more than needed for this pilot (estimated that each picker can remove 40-50 Energy Bags per minute, or 18,000 bags/shift – more than enough for the quantities collected).
• Characterization audits for the pilot were very detailed and thus time consuming. A full-time program could scale back to normal levels and not be overly burdensome.
• For larger programs, a separate storage area for the Energy Bag contents would be necessary.

6.4 THE BAG
The purple Energy Bag itself was an important component of this program. From a community perspective, the branding of the program and the bag itself proved to be an effective communication tool. It resonated with the customer and enhanced understanding, as well as giving the community a program identity to rally around – the Energy Bag.

From a recycling facility perspective, the distinctive color enabled the bag to be easily recognized and removed at pre-sort, increasing the number of bags each manual_picker could remove and decreasing the number of bags that were missed during this process.

Some considerations for future programs:
• Standard grocery bags should not be substituted as an “Energy Bag.” They are too hard to see on the line, and they often contain trash or recyclables, thus limiting the effectiveness of identifying and pulling them at pre-sort.
• Fewer broken bags were encountered than expected (~1%); for this pilot, a 1-mil bag was adequate; however, it is important to understand the abuse the bag will need to withstand based on the specific recycling facility (e.g., metering drum).
• Increase the opaqueness (or color intensity) to make the material collection bags easier to see.
• Add printed instructions (or graphic instructions) directly on the bag.
• The use of a drawstring or other easy-to-close style bag to make closure easier could be considered.

6.5 THE NEXT PROGRAM – LEVERAGING KEY LEARNINGS
When developing future pilots, as well as on-going community programs, the following critical learnings from the Citrus Heights Energy Bag Pilot should be considered:
• Build a stakeholder coalition that includes participants from different parts of the value chain, such as the community, waste haulers, recycling facility operators, recovered material processors, and various parties from the plastics industry.
• Buy-in and engagement from all stakeholders both local and regional, as well as the application of solid project management principles and strong program leadership, are critical components of success.
• Target a community that is large enough to take advantage of mass media and to generate enough material to maximize the added waste management labor utilization (i.e., pickers).
• Leave plenty of time for the up-front planning process and training.
• Involve all partners in the development of a comprehensive program plan outlining the key steps and clearly defining the roles and responsibilities of each partner.
• Communicate to the participants often, interactively, and through multiple channels including mass media and social media. Community outreach is paramount.
• Highlight that the program does not compete with mechanical recycling but complements it.
• Launch during the school year to leverage students and their enthusiasm for recycling.
• Use the Energy Bag name (or similarly “branded” identification) and keep it consistent across communities and programs. The name and marketing of the bag resonated with consumers.
• Use a distinctive bag. The color made it very easy to spot and remove manually at pre-sort, increasing the capacity (the number of bags that could be handled by each picker) and the effectiveness (the percentage of bags removed during pre-sort) of the sorting process.
• Consider using a slightly more opaque drawstring bag with the instructions printed directly on the bag.
• Review potential challenges with specific sorting systems.
The Citrus Heights Energy Bag Pilot sought to demonstrate the viability of a curbside municipal resource recovery system for currently non-recycled plastics using an existing waste management infrastructure. Ultimately, the collected materials were used as feedstock for conversion into synthetic fuel oil, thus “closing the loop” of the plastics’ life cycle.

The targeted plastics covered a wide range of items, but multi-material plastic packaging (e.g., pouches for food and beverage packaging applications) represented a large percentage. Current estimates by the U.S. EPA suggest these types of plastic packages not targeted for recycling account for about 5MM of 250MM tons or 2% of all municipal solid waste.1

Critics argue that turning plastics and other organics into energy or fuel destroys valuable resources and may reduce incentives for mechanical recycling. Countries in Europe, however, have some of the highest recycling rates in the world (up to 70%), yet also turn their residual waste, including a lot of flexible packaging, to energy and avoid landfilling.

In addition, recent North American research has documented that the states with relatively high recycling rates for plastics are also the ones with the most waste-to-energy capacity.2

This shows that there is great opportunity before us – that different options for landfill diversion are already being embraced, and programs being tested, such as this Energy Bag Pilot, could offer another valuable method to make the most out of these resources and protect our environment.

This pilot was successful because it answered all the questions posed and clearly demonstrated the viability of an alternative municipal waste management program to divert NRPs from the landfill and convert them into a valuable resource. Specifically, it showed:

- Multi-material flexible plastic packaging and miscellaneous non-recycled plastic items can be collected at curbside and integrated into an existing recycle program.
- The public can follow instructions and provide a good source of plastics for energy conversion.
- Contamination levels can be controlled.
- The bags can make it through the collection and material handling equipment.
- Sorting out 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.
- Sorted materials can be transported and are suitable to be converted into a new energy resource.
- A strong partnership among the coalition partners ensures all aspects of the program are successful.

Moving forward, it is important to continue to prove the viability of recycling non-recycled flexible packaging and plastics into energy resources. Therefore, a long-term pilot program needs to be undertaken to increase participation rates and to generate the volume of plastic required to justify the operation of a conversion technology facility.

In the long term, it may not fall entirely on Energy Bag content to support the conversion facilities. Recycling facilities sell a significant amount of their collected materials such as paper, metal, aluminum, recycled plastics, etc. to recyclers, but there are currently no resale markets for these non-recycled plastics. Many recycling facilities already have many types of non-recycled plastics going down their lines that would likely be intentionally collected if a profit could be made. Capturing a portion of this existing material, along with the NRP collected through the Energy Bags, could help fill the needs of a conversion technology plant like Agilyx.

Looking to the future as the supply of collected plastics grows and the ability of recycling facilities to sort and market more specific types of plastic develops, conversion technologies could expand and evolve to provide additional outlets for resource recovery of a wider range of plastics.

As a next step, another pilot is being planned to validate the assumption that improved communication will drive higher participation rates and higher quality of material collected for conversion. Plans anticipate partnering with brand owners with a great understanding of consumer marketing, packaging converters, and industry associations with knowledge regarding plastics, sustainability topics, and complementing strategies to help solve issues encountered in this initial pilot. Any subsequent pilots will continue to be implemented by a broad coalition of industry players to ensure success and continue to drive change.

The Energy Bag Pilot was, and continues to be, a story about the power of collaboration – how companies, communities, organizations, and everyday people can work together to make the changes that the world wants to see.

---

2 Themelis, Castaldi, Bhatti, & Arsova, 2011
ACKNOWLEDGMENTS

This program could not have happened without the dedication of the following people:

**REPUBLIC SERVICES**
Russ Knocke – Director of Field Communications and Public Affairs
Ryan Byrd – Operations Manager
Johnnise Foster-Downs – Municipal Services Manager
Kevin Hoover – Operations Manager
Brett Schreiner – Customer Service Supervisor
Brian J. Ezyk – Assistant General Manager
Enrique Castillo – Operations Manager
Henry Haas – Onsite Manager (contracting)
Citrus Heights Recycling Route Truck Drivers

**CITY OF CITRUS HEIGHTS**
Mayor Mel Turner
Vice Mayor Sue Frost
Mary Poole – Operations Manager General Services Department
Freida Morales – Program Assistant General Services Department

**THE DOW CHEMICAL COMPANY**
Jeff Wooster – Global Sustainability Director
Becky Zavala – Senior Communications Manager
Erica Ocampo – Sustainability Manager
Ira Shaughnessy – Sustainability Manager

**FLEXIBLE PACKAGING ASSOCIATION**
Marla Donahue – President
Ram Singhal – Vice President
Peter Hunderup – Consultant

**AMERICAN CHEMISTRY COUNCIL**
Jennifer Killinger – Senior Director of Sustainability and Public Outreach, Plastics Division
Craig Cookson – Director, Sustainability & Recycling

**DOW 2020 VIDEO TEAM**
Christopher Frederick
Matt Gewirtz
Kenneth Crawford

**THE SCOTT & MILLER GROUP**
Rusty Beckham
David Dutton
Vogue Nowels

**TKINGSBURY CONSULTING**
Tony Kingsbury

APPENDIX

Below are listed additional resources and some of the comprehensive work containing materials used in the production of this report. They can be accessed via the Energy Bag website at: http://www.dow.com-packaging/sustainability/energy-recovery.htm

- Examples of promotional materials
- Box layout for Energy Bags
- Collection details
- Agilyx report
- ACC survey