DOWN IN THE DUMPS

An inclusive look at glass recycling in Erie County

By Seth M. Trott

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Introduction

The practice of recycling glass is ingrained in the American psyche. I recall my grandfather lifting his bottle of beer to the light before taking a sip in a ritual stemming from the nightmarish time he found the butt of an old stogie in the bottom of his empty beer bottle. I also remember my grandmother scrubbing the paper labels off of empty glass jars in the glow of her kitchen track light, and hearing the unmistakable middle-of-the-night sound of glass-filled bags clinking together as they were tossed from the curbside into the back of a city garbage truck. And so, when it was announced in January 2019 that glass would no longer be accepted in curbside recycling in Erie, I could not help but ask the question, "What changed?"

The following report gives context to the issue of glass recycling in Erie County and illustrates the complexity of factors at play across our globe, nation, state, and county, as well as some solutions now being explored or introduced to bring glass recycling back to Erie.

The System

The United States has adopted a single-stream recycling system, a process in which all recyclable materials are placed into a single bin that is emptied into the back of a single collection truck. Marissa Begley's article, "How is Glass Recycled," explains that regardless of material type, these recyclables are then hauled off to a materials recovery facility (MRF or "murph") to be separated and sorted by type using heavy machinery, conveyor belts, and human hands. These newly separated materials are shipped to material-specific mills to continue on in their respective recycling processes.

Since the work of physically separating the various types of recyclable materials is completed elsewhere, this process is more convenient for households because they need only to drag a single blue bin out to the curb each week. However, throwing all recyclables together also leads to significant levels of contamination that, according to Mitch Jacoby's article "Why Glass Recycling in the U.S. is Broken," results in only 40 percent of the glass collected ultimately being recycled, whereas the remaining 60 percent of that glass is deemed soiled and heads to the landfill. With a total glass recycling rate of about 33 percent, only about 13 percent of all glass refuse in the United States is truly recycled.

Contamination of recyclables, as described by Jacoby, largely occurs when:

- During the collection process, glass containers are broken and the shards become mixed with other recyclable materials, such as wet paper;

- Consumers mix trash and other non-recyclable materials in with their recyclables;

- Consumers do not sufficiently clean their recyclables of food remnants and other contaminants.

In "Recycling Contamination: Why Glass is Now Deemed Unrecyclable," Dani Fitzgerald concludes that the issue of glass contamination was not as significant in the 1980s and 1990s as it is today. During that time, recycling systems were often multi-stream, a process in which materials were disposed of separately by type. Yet, with efforts aimed to increase customer convenience and lower recycling costs, the industry instituted a single-stream system across most regions of the United States. In contrast to the United States recycling system, Jacoby stated, much of Europe continued to use a multi-stream approach. When coupled with its more

environmentally concerned culture, some parts of Europe are able to boast a glass recycling rate of almost 90 percent today.

It does not appear that the United States will begin to shift back towards this multi-stream recycling approach. Brittany Prischak, former Environmental Sustainability Coordinator for Erie County and current Sustainability Manager for Allegheny County, commented that, to effectively switch systems, municipal waste companies would need to make substantial investments in additional collection trucks, fuel, and other capital adjustments. For this switch to be economical, costs would be passed on to the municipalities they serve, meaning residents of those municipalities would see a much larger, and certainly unpopular, quarterly trash service bill.

Economics

In an already tight recycling market rife with high energy consumption and transportation costs, recyclers need clean, unsoiled products to be profitable, and households are simply not supplying it to them, argues Clare Goldsberry in the article "Recycling is Big Business, but is it profitable?

Then came China's National Sword policy in 2018. In the episode "National Sword," of the 99 percent Invisible podcast, Avery Trufelman reports that since 2001, China has been the largest buyer of recyclable materials. When U.S. recyclers had bales of lower quality, highly soiled product, they could surely bet on China purchasing them. The U.S. and other Western nations have a long history of selling low-quality recyclables and waste to lower-regulated countries, according to Hannah Ellis-Petersen. This practice of "selling" is more akin to simply dumping.

In January 2018, Tom Eng in his article "Could the Chinese National Sword Inspire Global Recycling Innovation, writes that China unexpectedly increased its acceptable quality standards for the recyclable materials that it would purchase from other nations from a 90 to 95 percent purity level to a strict 99.5 percent. This decision effectively banned the country's purchase of international soiled recyclables by increasing the acceptable quality to an economically unreasonable level. China's decision, in other words, was made only after the country reached a level of development and consumption that allowed its recycling industries to survive solely on the materials disposed of domestically (see the documentary "Plastic China" for a harsh depiction of the ecological effects of China's pre-National Sword, "buy it all" mentality).

The West scrambled to cope with plastics trash mounds like this one in China

after the Chinese government banned the importation of most recyclables on Jan.1, 2018. This photograph accompanied an article in the New York Times.

Essentially, China doesn't need the world's refuse anymore. As described in "Piling Up: How China's Ban on Imported Waste Has Stalled Global Recycling," Cheryl Katz notes that prior to this policy decision, about 70 percent of all U.S. recyclables ended up in China. That figure now approaches zero percent. Though China's new policy has directly affected the plastics recycling industry, United States refuse and recyclables processors usually collect and deal in all material types due to the nature of the single-stream system. Therefore, the dip in revenue, increase in costs, and lack of available markets to sell their recyclables has put pressure on small- and mid-sized community recyclers to amend their business models and find alternatives that allow for continued economic viability. Dan Leif, in the article "Glass Is Costing MRFs $150 Million Annually," reports that some communities like Deltona, Fla. were forced to suspend curbside recycling collection altogether while other communities and companies, such as Waste Management – Erie County's primary waste hauler and processor – sought to cut out the weakest links of their recycling and refuse systems.

Enter glass recycling. Aside from single-stream collection and global market pressures, glass is simply expensive to recycle. Due to the sheer weight of the material, the glass recycling process requires large amounts of energy and has other unique costs associated with it, such

as specialized equipment upkeep, additional transportation to move the glass downstream, and tipping fees, or fees paid to dump certain waste into a landfill, according to Leif. The Closed Loop Foundation estimates that the average MRF loses $500,000 per year by accepting glass as a recyclable material. From an entire waste-hauling industry perspective, that figure equates to a loss of $150 million per year in the United States.

The pricing of recycled glass is simply not lucrative enough to counterbalance the high costs associated with its collection and processing. According to a study conducted by Anne Helms and Ahmed Harb, two engineering students at Gannon University under the supervision of Varun Kasaraneni, Ph.D., there is essentially no market for recycled glass that is below 95 percent purity. Of the recycled glass that is marketable, even very finely ground glass with the high purity of 99.8 percent will fetch a modest price of $70 to $100 per metric ton. Shipping costs average about an additional $20 to $30 per metric ton, depending on the distance, with freight shipping across longer distances quoted at upwards of $85 per metric ton. Therefore, if glass is collected from a community without a nearby glass processor or industry, the shipping costs associated with transporting the material alone will often render the process uneconomical, as also explained in David Rue's report, "Cullet Supply Issues and Technologies."

Presently Erie, Pennsylvania's nearest glass processing firm is Dlubak Specialty Glass Corp., 127 miles to the southeast in Natrona Heights, Pa.

The Process

The general glass recycling process, according to Momentum Recycling, is as follows:

Once glass bottles and containers are collected and separated from other materials such as plastic and paper at the MRF, they are typically sold to glass processors, such as Dlubak Specialty Glass Corp., for $40 to $45 per metric ton. Upon delivery, the load of glass is inspected by the processor for contaminants and hazardous materials, such as light bulbs and ceramics, and is then sorted by color. The color-sorted glass is then passed through a hammering machine that breaks the bottles and containers into crude, large pieces for further color sorting. The load of newly crushed glass is then subjected to a revolving cylindrical screen that roughly sorts the glass particles by size and removes paper labels and lids. From here, the glass particles are dried; heated to melt off any sugar, glue, or bacterial remnants; and screen-sorted again by size. Finally, the glass particles are

pulverized to the specifications necessary for the end purchaser.

Cullet is the end product of glass processing plants. Photo is from the Tennessee Municipal League.

The final product of this process is called cullet and can resemble small glass beads or even sand, depending on what glass product that batch of cullet is to be transformed into next.

Opportunity Cost

Glass is the gold standard of recyclable material because it is 100 percent recyclable, explained Jacoby, meaning that the same bottle can theoretically be crushed, melted, reshaped, and recycled an infinite number of times without suffering a reduction in quality. Compare this to paper's ability to be recycled only five to seven times due to the paper fiber's tendency to become shorter, more rigid, and less usable with every cycle as a result of the chemicals and cutting involved in the paper recycling process, according to C. Claiborne Ray's article, "Through the Mill."

Glass manufacturers prefer to use cullet as an ingredient in their manufacturing recipe. Jacoby goes on to report that some of the benefits gained from a manufacturer's use of cullet in place of raw materials are as follows:

- Given that glass is largely made up of silica (sand), soda ash, and limestone, using cullet reduces the amount of raw materials necessary to produce "virgin" glass by about 20 percent – every one kilogram of cullet introduced to the recipe can replace 1.2

kilograms of raw materials.

- Cullet melts at a lower temperature than the raw materials involved in glassmaking. Therefore, manufacturers pay for and consume less energy to heat their furnaces to a high temperature. Every additional 10 percent of cullet used in the glass manufacturing recipe reduces the necessary temperature of the furnace by about 3 percent. This reduction in temperature also contributes to lower furnace maintenance costs and a longer furnace lifespan.

- Cullet produces a higher quality of glass. When raw materials are melted together to create a new glass product, carbon dioxide is released and can get trapped in the molten glass mixture, resulting in unwanted bubbles in the finished glass product. The melting of raw materials can also form crystals, streaks, and other imperfections in virgin glass, all of which are reduced or completely avoided through the use of cullet.

- Because carbon dioxide is released in the raw materials melting process but not in the melting process of cullet, for every six metric tons of cullet substituted in the glass recipe, one metric ton of carbon dioxide being emitted into the Earth's atmosphere is avoided. Thus, the use of cullet is also eco-friendly.

The difficulty with cullet, however, is that there is simply not enough to go around. Clean, high-quality cullet requires significant levels of processing. Lucrative cullet processing requires an economy of scale now unachievable given current glass recycling rates and contamination levels. In short, because households are not recycling glass or cleaning the glass that they are recycling, recyclers are not receiving enough high purity glass to make cullet, and, therefore, glass manufacturers cannot use as much cullet as they would prefer. This directly increases manufacturing costs, the price of glass products, and levels of CO2 emissions. Indirectly, glass manufacturers must use more energy to heat their furnaces, which could create additional CO_2 emissions on the back end, depending on how that energy to heat the furnace is produced at the power plant.

On the demand side, glass manufacturers are not the only users of cullet. Although the best use of recycled glass is arguably to make new glass bottles and containers, Karyn Maier, in the article "Uses for Recycled Glass," describes how cullet can be used to make fiberglass, tile, flooring, bricks, match heads, reflective paint, gravel, the base surface of roads and airport runways ("glassphalt"), abrasives, sand-blasting material, glass

mulch for landscaping, concrete, and even beach sand.

A close-up shows the very fine glass particles mixed with beach sand at Hanapepe on the island of Kauai in Hawaii. This sand additive could cut the cost of sand replenishment, a typical challenge at Presque Isle State Park beaches and elsewhere.

The complex web that stems from simple household recycling decisions is vast and can affect everyone from glass manufacturers to state transportation departments, sandblasting firms, and American beaches. The cost of recycling is significant, but the opportunity cost of not recycling can be huge.

Across the Nation

Recyclers across the nation are cutting glass from their collection programs and struggling to turn a profit. Some are literally paying to get rid of the recyclables that they are contractually obligated to collect while attempting to renegotiate their no-longer-economical contracts with the municipalities they serve. From incineration to "Glass is Trash" slogans, Mary Esch, in her article "Once Easily Saved, America's Recycling Industry Now in the Dumps," states that communities are racing to find new ways of waste disposal, recycling, and citizen education.

The irony is that the demand for recycled glass exceeds the supply, yet

glass recycling facilities are shutting down. Recycling Today reported that "in 2017, the Northeastern U.S. consisted of six glass manufacturers and 10 glass processing facilities. In 2018, the last glass container manufacturer and MRF glass processors closed."

Although the issue permeates across the United States, for all of the reasons previously noted, some cities have tailored their own solutions to the glass dilemma. Some factors that are specific to location and must be taken into account include the contract terms between a municipality and recycler; the proximity of the city to a glass recycling facility because of shipping costs; and local arguments, such as citizens' unwillingness to pay higher refuse bills or participate in a glass drop-off program.

Following are examples of how some cities have reacted to glass being eliminated as a recyclable material:

- Houston partnered with a regional glass mill, Strategic Materials, to develop a glass drop-off program but halted that development when a U.K.-based firm decided to build a glass-processing MRF in the city, according to Recycling Today. As a result, Houston will likely return to curbside glass collection and recycling in 2020.

- Gilford, N.H. is upgrading its public recycling center and has opted to institute a dual-stream recycling system that would keep glass separate from other mixed recyclable materials, according to Kelly Maile of Recycling Today.

- Tacoma, Wash., is considering a shift towards a single-stream recycling system to save money on labor and other costs related to the collection process. Though Tacoma would be following the lead of many other cities in the region, Candice Ruud of Tacoma News Tribune reported that opponents point to the trouble of material contamination as a reason to stick with the current multi-stream system.

- Kansas City, Mo.'s brewer, Boulevard Brewing, started a glass recycling facility, Ripple Glass, to promote glass recycling and keep millions of beer bottles from entering local landfills. Boulevard Brewing helps to collect the bottles by placing drop-off locations throughout the city, and Ripple Glass processes those bottles into cullet, selling the majority of the cullet to a local fiberglass manufacturer.

Across Pennsylvania

The Pennsylvania Resource Council (PRC) – the commonwealth's oldest grassroots environmental organization – explained in the article "Glass Recycling" that Pennsylvania is home to three glass mills that depend on recycled glass bottles and jars as the raw material to produce new glass containers. Several other glass mills operate in neighboring Midwestern states, resulting in one of the strongest markets for glass recycling in North America. Regardless, glass curbside collection is disappearing from many larger communities across Pennsylvania. Some communities, such as Lancaster, have decided to continue to recycle glass because of the material's economic demand and recyclability, according to Ad Crable of Lancaster Online. To give recyclers some financial breathing room, local government has chosen to eliminate paper and most plastic products from its recycling programs. This similar practice is commonly seen in the eastern half of Pennsylvania.

Allegheny County official Prischak noted that the vast majority of government's decision-making power on the topic of glass recycling and refuse processing generally rests at the state level. Though individual Pennsylvania municipalities can bid their own contracts to waste haulers, the content of those contracts must adhere to Pennsylvania regulations and mandates. Individual counties play a minor role in the process through their control over "solid waste flow ordinances" that designate which landfills accept waste from which municipalities. This designation is based on the capacity of the landfill to which the waste travels. For example, if a landfill closes or reaches the maximum capacity allowed by law, the county decides where else to send the refuse. Additionally, the county receives and prepares reports on local recycling figures to be distributed and used by other governments and organizations. The federal government has little to no direct power over local recycling because of the need to customize and fit each recycling program to the unique needs of individual states, counties, and municipalities.

Act 101 is Pennsylvania's recycling law, formally titled the "Municipal Waste Planning Recycling and Waste Reduction Act." The act was signed into law in 1988 but has minimal enforcement procedures. Aside from the stipulations and mandates listed below, the law simply requires larger communities to have residential and commercial recycling programs in place, as well as leaf collection procedures. These larger municipalities are defined in the Act as those that exhibit a population of 10,000 or more.

The lack of glass recycling in Erie County can be directly tied to Act 101's hands-off approach. The Act presents a list of items that can be recycled, and individual municipalities are required to choose three items from that list to include in their recycling program. So, if a municipality

wants to recycle only newspapers, paper, and shredded paper, their state recycling requirement is technically fulfilled – no municipality is forced to recycle glass. In contrast, New York requires municipalities to recycle glass by prohibiting its disposal into landfills.

New York has also implemented a "bottle bill" that requires consumers to pay a deposit on their glass bottle purchases that is then recouped when the bottle is recycled. Because of this stance on glass recycling, New York's glass bottle recycling rate is about 90 percent. As recently as October 7, 2019, a bottle bill was introduced in the Pennsylvania House of Representatives. House Bill 1322 would allow Pennsylvanians to receive "five cents for every plastic, aluminum, or glass bottle or can they return. Distributors would be allowed to add the deposit to the cost of the drinks," reported Matt Heckel of ABC-27 News in Harrisburg. A similar bill, SB 588, was introduced in the Pennsylvania Senate in 2009 but died shortly thereafter.

The Pennsylvania Department of Environmental Protection delineates other key mandates in Act 101 as follows:

- Each county must develop plans to manage its own wastes and assure a minimum of 10 years of disposal capacity;

- Counties must report countywide municipal waste generation and recycling data to the Pa. Department of Environmental Protection annually;

- Counties must submit a new county plan to the Pa. DEP for approval once its landfill has an anticipated three years left until it reaches its disposal capacity;

- A $2-per-ton fee is placed on all waste disposed of at municipal waste landfills and, on the contrary, waste-to-energy facilities are provided grants for local collection programs, public education, and materials processing, as well as composting facilities, equipment, and technical training.

Act 101 is often discussed in the state Legislature, sometimes amended, but never overhauled. However, glass recycling is a finicky challenge. For it to be economical, all of the pieces of the industry must be within a physical distance that allows for profit margins to not be entirely consumed by transportation costs. So, by giving large municipalities the choice of materials to recycle, Pennsylvania government walks a fine line between promoting localized, efficient solutions and mandating a beneficial process regardless of profitability.

If the state were to mandate that all municipalities recycle glass, the municipal waste landscape may look quite different: waste and recycling firms' profits may further plummet, doors shutter, and quarterly refuse bills be substantially higher. Conversely, a glass recycling mandate may incentivize Pennsylvania waste firms to adopt a multi-stream or dual-stream recycling system, leading to the creation of new recycling firms, job growth, and a more prosperous glass industry across the commonwealth due to the spike in supply of high-quality recyclable glass. Pennsylvania could also experience a reduction in greenhouse gas emissions.

According to L. Binda's article "Glass Recycling Returns to Harrisburg," that city lost its glass recycling materials pickup in 2015 and has since taken the lead on reinstating glass recycling by announcing a partnership with the Mount Pleasant, Pa.-based glass recycling mill, CAP Glass, to pilot a glass recyclables drop-off program. Harrisburg's city government purchased recycling bins and placed them at strategic locations across the city. Residents can drop off their glass bottles and jars and CAP Glass will collect, transport, and recycle the glass, free of charge. As a result, recyclable material averts the trash stream; residents can recycle their glass containers again; and CAP Glass receives a significant supply of clean, quality glass, simply for the cost of collection and transportation. The program was put into effect in April 2018.

Similarly, the Pittsburgh area Pennsylvania Resource Council launched a network of pop-up glass recycling events in March 2019. On weekends, the PRC sets up collection bins at different Pittsburgh locations, such as in the parking lots of schools and municipal buildings, and allows residents to drop off their glass bottles and containers, whereupon the material is given to CAP Glass for further processing and recycling.

These examples are just two of many across Pennsylvania that illustrate how individual communities are facing the loss of curbside glass pickup and are working to develop localized solutions to a national issue.

Erie County

Erie County is primarily served by two waste processing firms: Waste Management and Pro Waste Services. Brittany Prischak said that, of the two, Waste Management is the key player in recycling, as Pro Waste largely deals with commercial waste, recycling, and dumpster rentals. Advanced Disposal currently serves Millcreek and Corry and collects glass in curbside recyclables, at which point the glass is taken to a MRF

in Buffalo, N.Y., where it is separated and recycled into road aggregate. According to a Reuters report, Advanced Disposal announced its acquisition by Waste Management in April 2019 and the firm expects the deal to close sometime during 2020.

As noted earlier, Waste Management decided in January 2019 that it could no longer accept glass in Erie County at curbside for economic reasons.

For each of Erie County's 38 municipalities, only six are deemed to be large municipalities and mandated to follow Act 101 rules – City of Erie, Millcreek Township, Fairview Township, Harborcreek Township, Borough of Edinboro, and City of Corry. The remaining 32 municipalities can voluntarily choose whether to have recycling procedures in place, but many opt to forgo pickup because of the cost of the contract: with a low population density and a wide geographic area, waste haulers spend a large amount on transportation while collecting little product and thus, the hauler must charge the municipality more for the contract, though most waste haulers choose simply not to bid on a contract. Each municipality in Erie County has a separate contract for waste collection, with each contract having its own associated costs and stipulations, according to Prischak.

Erie County government recently hired Nestor Resources to conduct a study to identify gaps in recycling services for residents in rural municipalities and to discover ways to improve and fund the county's recycling processes, according to the Erie County Department of Planning and Community Development. This information will be used to develop a five-year strategic plan that will assist Erie County in outlining:

- County policies that require recycling services to be offered to any resident or business interested in such services, with special consideration to the cost of recycling in rural communities;

- Alternative collection programs for municipalities to encourage more recycling and to decrease trash disposal;

- Recommendations for new recycling collection programs, including potential infrastructure and equipment purchases;

- Discussions with local waste hauling companies concerning consistent recycling education.

Prischak also stated that Erie is the only municipality in the county that collects its own waste and recyclable. City employees drive city-owned

garbage trucks every night and collect the trash from the curbsides.

When the City of Erie collects its recyclables, the trucks are emptied at one of two waste transfer stations: Waste Management's West 14th and Raspberry St. station (for the city's west side) and Pro Waste's East 18th and Buffalo Road station (for the city's east side). Due to Pro Waste's focus on commercial waste, the remainder of this discussion will focus on Waste Management. The recyclables are then driven to Pittsburgh to Waste Management's nearest MRF, where the materials are sorted into paper, plastic, metal, glass, and trash, and then each heads to its respective post-sorting processing centers or landfills. This Pittsburgh-based Waste Management MRF at Neville Island ultimately controls the decisions of Waste Management's recycling program in Erie County. It was this MRF that calculated that glass was no longer economical for it to recycle, leading to the phase out of glass collection in Erie County.

Millcreek and Corry continue to have glass recycling through their contracts with Advanced Disposal. Upon the anticipated acquisition deal between Waste Management and Advanced Disposal, Waste Management will assume Advanced Disposal's municipal contracts and will be obligated to fulfill them. This means that Waste Management will continue to collect and recycle glass in Millcreek and Corry by transporting the glass to its Pittsburgh MRF until the terms of the municipal agreements expire. Millcreek is expecting a smooth transition of service over the course of the acquisition. The township's contract is not due for renewal until March 31, 2022, according to Jessica James Stutzman, the Millcreek Township Recycling Coordinator.

Lake View Landfill

Lake View Landfill, just south of the Route 97 exit on Interstate 90, is in Summit Township, with an entrance at 851 Robinson Road Extension. It is owned by Waste Management and services both Erie County residents and other portions of the region, including New York. Erika Deyarmin-Young, Waste Management's Public Affairs Coordinator for Western Pennsylvania and West Virginia, said the landfill accepts about 700 tons of waste per day and has an anticipated remaining lifespan of 80 years, as was also reported by Pat Bywater of the Erie Times-News. At a height of more than 1,530 feet above sea level, the landfill is the second-highest point in Erie County.

Lake View Landfill, off Route 97 just south of Interstate 90, is the second-highest point in Erie County.

In 2017, Research and Markets projected that glass container consumption will rise by about 3.76 percent per year over the next five years in the United States. Given these figures, it can be projected that approximately 360,000 tons of glass will be added to Lake View Landfill over the next 50 years, causing the height of the landfill to rise by an additional 63 feet as a result of this glass alone. A link to the calculations can be found in this report's References.

Glass recycling remains an issue for Erie County residents and there are ongoing, private efforts to study the issue and reintroduce the practice to the region:

During the Spring 2019 semester, local university students from Gannon University, Edinboro University, and Penn State Behrend teamed up to analyze glass recycling from a variety of angles. In a series of presentations that were attended by representatives from Waste Management, Erie County government, and other local organizations, these students presented various topics, including:

- A survey of about 1,000 Erie County residents regarding interest in the development of a glass recycling drop-off program, conducted by Ashley Smith, Lili Burdick, Elizabeth Higgins, Da Ler, and Kellyn Prittie and overseen by Edinboro University's Jingze Jiang, Ph.D.;

- The various engineering applications and products for waste glass, as studied by Anne Helms and Ahmed S. Harb and advised by Varun Kasaraneni, Ph.D. of Gannon University;

- A feasibility study for adopting a dual-stream or multi-stream recycling system, conducted by Noah Lesik, James Hanchett, and Jacob Mertz and overseen by Gannon University's Bruce Kibler, Ph.D.;

- Daniel Gray and Camden Pauli, also advised by Jingze Jiang, Ph.D., conducted a survey of Erie County residents' general interest in glass recycling and the demographics of those most interested (found to be primarily college-educated females).

A glass-collection firm, Bayfront Glass LLC, was founded in June 2019 and hosts glass drop-off events across Erie County, similar to those conducted by Pittsburgh's branch of the Pennsylvania Resource Council. The Erie Times-News reported in the article, "Erie County Men Set to Open Glass Collection Company," that Erie residents can drop off their glass recyclables at one of these events and Bayfront Glass will crush the glass and sell it to CAP Glass.

Conclusions

Glass is less harmful to dump in a landfill than some materials, but there is an interesting paradox at play: Communities are throwing away an in-demand resource and further contributing to single-use container waste and CO_2 emissions. These actions come at a time when society needs to aggressively adopt cleaner and more circular economic policies to confront climate change, yet because of the cost of collecting and processing glass, recycling has become even rarer.

Glass recycling is a far more complex issue than commonly perceived, with both micro-economic factors and the gyrations of the global market at play. If Erie County and the nation are going to revive glass recycling, they must move quickly because it stands to reason that once a population finally becomes accustomed to new recycling rules, it is even more difficult and expensive to start again.

It is yet undetermined if drop-off programs will be the new national norm or if more stringent government policies like bottle bills are the solution, but one thing is certain: Reinstituting large-scale glass recycling across the United States and in Erie County will require a cooperative and cross-sector effort, as well as creative thinking and determination from all involved.

Recycling Data Tables (2016)

The following data, in tons, was taken from the most recently available

reports published by the EPA and Pa. DEP.

References

	United States	Pennsylvania	Erie
Total Materials [tonnage]	68,630,000.00	7,835,889.26	86,559.15

Glass			
Residential Single Stream	-	597,557.23	9,231.22
Residential Co-Mingled	-	60,030.84	4,301.36
Residential Mixed Glass	-	28,584.17	151.20
Residential Glass Totals	-	36,329.12	151.20
Commercial Single Stream	-	359,650.89	2,144.26
Commercial Co-Mingled	-	129,017.34	8,594.20
Commercial Clear Glass	-	5,706.16	33.06
Commercial Mixed Glass	-	18,956.72	4.97
Commercial Glass Totals	-	48,404.47	38.03
Combined Glass Totals	3,160,000.00	84,733.59	189.23

Plastic			
#2 [HDPE]	-	1,163.83	34.91
Film Plastic	-	189.38	34.89
Plastic Totals	3,240,000.00	7,071.22	69.80

Paper			
Cardboard	-	44,661.58	262.28
Magazines	-	5,092.49	73.52
Newspaper	4,490,000.00	23,408.45	87.63
Office Paper	-	3,714.80	6.00
Paper Totals	45,520,000.00	137,485.13	429.43

Metal			
Aluminum Cans	620,000.00	2,953.84	77.97
Tin Cans	-	3,222.83	35.37
Aluminum Scrap	-	4,655.03	136.94
Ferrous Metal	6,170,000.00	54,742.11	4,662.46
Non-ferrous Metal	1,390,000.00	1,591.26	55.96
Copper	-	3,116.42	40.36
Brass	-	396.09	18.49
Lead	1,390,000.00	4,914.87	1.00
Stainless Steel	-	979.36	59.60
Nickel	-	133.17	0.51
Wire/Cable	-	307.75	0.23
Mixed Metals	-	19,428.63	29.63
White Goods	-	39,507.32	1.42
Metal Totals	8,180,000.00	136,879.82	5,119.94

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