Can Manufacturers Institute

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Aluminum Beverage Can: Driver of the U.S. Recycling System

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Executive Summary

Despite a decade of U.S. recycling system challenges, including stagnant recycling rates and unstable commodity values, aluminum used beverage containers (UBCs) have helped drive the economic viability of many recycling programs. The Can Manufacturers Institute (CMI), the national trade association of the metal can manufacturing industry and its suppliers, engaged Gershman, Brickner & Bratton, Inc. (GBB) to produce a report which quantifies the relative value of aluminum UBCs in domestic recycling programs and investigates how UBCs can further be a driver of the national recycling system.

Section 1 of this report provides an introduction to the need for the analysis herein, the intentions of the research, and the high-level findings resulting from the work.

Section 2 describes the variation in composition of materials entering a single stream recycling materials recovery facility, or MRF, related to statewide legislation, particularly container deposit laws, and the level of consumer participation in the areas a MRF serves. This section provides an overview of container deposit laws, describes MRF operations – specifically related to UBCs – and examines the inbound material stream composition in states with and without container deposit laws. Technologies and techniques for improved MRF capture of UBCs are also described.

Section 3 examines the economic impacts on MRFs of recycling UBCs, including total MRF revenues according to material stream composition and market values, percentage of revenues attributable to UBCs, and monetary losses associated with non-recovery of UBCs. GBB developed a proprietary model to examine these impacts by predicting typical MRF capture rates and revenues from the major recovered commodity materials.

Section 4 provides an overview of the U.S. market for aluminum scrap, barriers to aluminum UBC recycling at a national level, and supply chain opportunities for aluminum UBC recycling.

While aluminum is currently the most highly valued commodity in the municipal recycling market, UBCs do not typically represent a large percentage of a MRF's material stream by weight, and, as such, UBCs do not necessarily represent as large a share of a MRF's revenue stream as may be expected. Nonetheless, based on the composition of inbound material streams, **UBCs represent 12.5% of typical MRF revenues in states with container deposit laws and 33% of typical MRF revenues in states without container deposit laws, using calendar year 2019 recycled commodity values.**

Commodity values over time are dynamic and dependent on both domestic and international supply and demand factors. As a recent example of such market fluctuations, aluminum commodity values fell by more than 25% from the 2019 North American average over the course of spring 2020, mostly due to the adverse economic impacts of the various stay-at-home orders enacted as a result of the COVID-19 U.S. national health emergency and global pandemic, but it is anticipated that the commodity value of aluminum will rebound once travel and other economic activity return to non-pandemic levels. **Without this important revenue stream from UBCs, most MRFs in the United States would not be able to operate without making other changes to their business practices and models.**

Understanding how to capture additional UBCs from a MRF's incoming revenue stream—both by changing MRF practices and by adding equipment—can make a dramatic difference in a MRF's bottom line. According to the information available at the time of this study, **up to an estimated 25% of all UBCs entering MRFs may be lost at the MRF due to non-recovery. Non-recovery at a MRF indicates that some of the UBCs that entered the single stream recycling system were not recovered in the aluminum**

commodity bales but instead ended up in other bales or in the residue.

With an estimated 25% loss of all UBCs entering MRFs due to non-recovery, it is possible that **an average MRF processing 50,000 TPY in a state with a container deposit law may be missing approximately $1.08 in gross revenue per ton, or $54,000 in a calendar year, while an average MRF in a state without a container deposit law may be missing approximately $5.95 in gross revenue per ton, or $297,500 in a calendar year, due to UBC non-recovery.** In the container deposit law MRF, capturing these additional UBCs would serve to increase gross annual revenues by roughly 3.1%, while in the non-container deposit law MRF, this would serve to increase gross annual revenues by approximately 8.3%.

The losses of UBCs at typical MRFs in North America have not been sufficiently studied, so many MRF operators are likely unaware of the true amount of losses they are incurring from improperly sorted or lost UBCs. As each MRF is different, detailed mass-balance studies would need to occur at the level of the individual MRF to best understand where and how UBCs are lost. Only then can industry researchers and innovators study and develop the best technical solution to increase UBC recovery. Advanced solutions such as robots already exist and may be a solution to recover more of the valuable aluminum at the MRF.

However, the data examined in this study indicate that **the increase in gross revenues generated at a theoretical 50,000 TPY non-deposit law state MRF by installing both an additional eddy current separator (ECS) unit on the MRF's residue line and a robot on the MRF's fiber line to capture additional UBCs could pay for the additional capital cost of the equipment in just over two years' time.** By installing only the additional ECS unit on the residue line, the resulting increased gross revenues at the same MRF could pay for the additional capital cost of the ECS unit in roughly one year's time; by installing only the robot on the fiber line, the resulting increased gross revenues at the MRF could pay for the additional capital cost of the robot in just over four years' time.

Of the aluminum cans that U.S. can makers ship, by weight only half are melted down to be turned into new cans or other recyclable products, representing massive economic and environmental losses. Thus, **apart from addressing these losses inside MRFs, the biggest potential gains to increasing UBC recycling are outside the MRF in the form of larger market drivers, increased focus on domestic secondary aluminum processing capacity for melting UBCs into can sheet, and changes associated with consumer recycling behavior,** assuming consumers have sufficient access to recycling.

Of these opportunities, **changing consumer recycling behavior has perhaps the most immediate and direct potential to increase domestic UBC recycling into can sheet.** Further research will be required to understand why and where so many aluminum cans are discarded as waste, and how the point of discard could be transformed into the point of recovery. Other opportunities such as an industry-wide recycling campaign targeting canned beverage drinkers as well as legislation banning and appropriately enforcing the disposal of aluminum cans, as individual jurisdictions have done for materials such as yard waste and cardboard, could build additional support for the aluminum can as the driver of the U.S. recycling system.

The aluminum beverage can has historically been a significant source of revenue for MRFs. **MRF revenues attributable to UBCs could be further increased by MRFs' installing more equipment to target UBC recovery.** Such equipment installations have been shown to have relatively short payback periods and may prove to be both financially attractive and feasible for MRF operators considering implementing facility upgrades. With increased investment to accurately capture, sort, and recover UBCs at MRFs, more UBCs can be sold and recycled, thereby increasing overall MRF revenues and effecting significant, positive environmental impact. **With greater use and recycling of aluminum cans, the entire recycling system benefits.**

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1 Introduction

The aluminum beverage can is the most recycled drink package in the United States and the world.[1,2] In the United States, the consumer recycling rate for aluminum cans[2] increased from 45.1 percent in 2017 to 49.8 percent in 2018. However, despite this recent improvement, there has been an overall decline in aluminum can consumer recycling rates in the United States since the early-1990s.[2] The past decade has brought a host of challenges to the U.S. recycling system, including stagnant overall recycling rates and unstable commodity values. Throughout these challenges, aluminum used beverage containers (UBCs) have supported the economic viability of many recycling programs across the country. UBCs are estimated to comprise only about 0.5 percent of the total U.S. residential and non-residential waste stream by weight,[3] with one recent study estimating that UBCs make up approximately 2.7 percent of the material available from all single-family households.[4] Yet, they are one of the most recycled and the most valuable recyclable materials, especially when compared to the alternative beverage container materials of plastic and glass.

The improper disposal of aluminum UBCs in the United States has major costs. In 2018, 45.2 billion cans–more than $800 million worth of aluminum–ended up in a landfill, a major loss to the economy and the environment.[5] That is the equivalent of almost 12 12-packs for each person in the United States going to landfill in only one year. Landfilling more than half of all UBCs instead of recycling them is especially disturbing because robust demand exists among producers of aluminum cans, which can be infinitely re-manufactured into new cans with significant cost and energy savings. In fact, making a can from recycled aluminum means more than 90 percent less energy used and greenhouse gas emissions generated compared to making a can from virgin aluminum.[6]

The Can Manufacturers Institute (CMI) engaged Gershman, Brickner & Bratton, Inc. (GBB) to produce a report which quantifies the relative value of aluminum used beverage cans (UBCs) in domestic municipal recycling programs and investigates how UBCs can further be a driver of the national recycling system.

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[1] Can Manufacturers Institute. (2017, October 24). Cans Are the Most Recycled Drinks Package in the World: Resource Recycling Systems Study Confirms Beverage Cans are the Global Leader in Recycling. *PR Newswire*. Accessed on 02/26/2020. URL: https://www.prnewswire.com/news-releases/cans-are-the-most-recycled-drinks-package-in-the-world-300542344.html

[2] The consumer rate for aluminum cans is defined by the Aluminum Association as the Pound of Cans Recycled by U.S. Consumers (or, Pounds of UBC Melted Domestically + Pounds of UBC Exports – Pounds of UBC Imports) divided by the Pounds of Can Shipped Corrected for Imports & Exports (or, Pounds of Cans Shipped by U.S. Producers – Pounds of Exported Unfilled Cans + Pounds of Imported Unfilled Cans). Source: The Aluminum Association. (2019, September). *The Aluminum Can Advantage: Key Sustainability Performance Indicators 2019.* Accessed on 06/02/2020. URL: https://www.aluminum.org/sites/default/files/KPI%20Report%202019.pdf

[3] U.S. Environmental Protection Agency. (2019, November). *Advancing Sustainable Materials Management: 2016 and 2017 Tables and Figures.* Accessed on 06/04/2020. URL: https://www.epa.gov/sites/production/files/2019-11/documents/2016_and_2017_facts_and_figures_data_tables_0.pdf

[4] The Recycling Partnership (2020, February 13). *2020 State of Curbside Recycling Report.* Accessed 02/26/2020. URL: https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2020/02/2020-State-of-Curbside-Recycling.pdf

[5] The Aluminum Association. (2019, September). *The Aluminum Can Advantage: Key Sustainability Performance Indicators 2019*. Accessed on 06/02/2020. URL: https://www.aluminum.org/sites/default/files/KPI%20Report%202019.pdf

[6] The Aluminum Association. (2013).*The Environmental Footprint of Semi-Finished Aluminum Products in North America: A Life Cycle Assessment Report.* Accessed on 1/31/2019. URL: https://www.aluminum.org/sites/default/files/LCA_Report_Aluminum_Association_12_13.pdf

The intent of this research is to:

- Describe the sortation process and accuracy by which cans are sorted and recovered at materials recovery facilities (MRFs);
- Identify the role of the UBC in the U.S. national average recycling stream and its associated MRF revenues based on current commodity pricing;
- Analyze the impact of UBC recycling and recovery rates on MRF revenue streams;
- Find opportunities to improve UBC recycling and capture rates; and,
- Outline the high-level market drivers and impacts of UBCs within the recycling industry.

In order to accomplish these goals, GBB developed a proprietary model for the U.S. municipal recycling stream materials composition coming in to MRFs and the associated revenues from the major recovered commodity materials including UBCs, ferrous cans, PET and HDPE containers, mixed plastics, old corrugated cardboard (OCC), old newsprint (ONP), mixed papers, and glass. GBB's model distinguished states with container deposit laws from those without container deposit laws, as these regulations impact the share of UBCs that arrive at MRFs for sortation and capture, and thus the relative share of UBCs in the incoming MRF stream compared to other materials and the resulting MRF revenues. A high-level summary of the findings regarding the share of UBCs in the recycling stream and the corresponding share of MRF revenues is shown below in Table 1.

Table 1 – Average Share of UBCs in Inbound MRF Material & Revenue Streams, 2019 Commodity Market Values[7,8]

2019 Commodity Market Values	Average for States with Container Deposit Laws	Average for States Without Container Deposit Laws
Total MRF Revenues ($/Ton)	$34.74	$71.55
UBC MRF Revenues ($/Ton)	$4.33	$23.61
UBC % Share of MRF Revenues	12.6%	33.0%
UBC % Share of MRF Stream (by Weight)	0.4%	2.2%

GBB further used this model to generate scenario analyses predicting how typical MRF revenues might vary with changing UBC input and capture rate assumptions. In addition, GBB has provided a high-level overview of several emerging technologies and their application to MRFs—specifically, how these technologies would apply to the sortation and recovery of UBCs—and a review of market and supply chain conditions that can either help or hinder UBC recycling and capture.

[7] GBB calculated compositional values using single stream recycling characterization data from eight (8) studies that represented four (4) states with container deposit laws and four (4) states without container deposit laws. Industry standard compositional studies examine incoming materials at a given facility. Compositional details and further information on methods is presented in Section 2.4 below. Using the averages of these compositional studies, GBB calculated revenues using calendar year 2019 average recycling commodity market values. Per ton values account for negatively valued commodities but not for the cost of residue disposal, as the compositional studies are inbound only and the cost of residue disposal varies widely across the United States. Further details regarding recycling commodity market values and attributable commodity revenues are provided in Section 3 below.

[8] Tonnages noted throughout are measured in short tons (1 ton = 2,000 pounds).

2 Container Deposit Laws, MRF Operations, and Material Composition

2.1 Introduction

The composition of materials entering a single stream recycling materials recovery, or MRF, can vary widely. Some of this variation is due to the level of participation in the areas a MRF serves, but much of the variation can be attributed to whether or not a state has a container deposit law. This section provides an overview of container deposit laws, describes MRF operations – specifically related to UBCs – and examines the inbound material stream composition in states with and without container deposit laws.

2.2 Overview of Statewide Container Deposit Laws and Their Impacts

A beverage container deposit law, commonly known as a "bottle bill," requires a minimum refundable deposit on beer, soft drink, and other beverage containers in order to encourage a high rate of recycling or reuse of these containers. These statewide laws are designed to reduce litter and capture bottles, cans, and other containers for recycling. Deposit amounts vary from five cents to 15 cents, depending on the type of beverage and volume of the container. The following ten states have some form of container deposit law currently in effect: California, Connecticut, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Hawaii. The State of Delaware previously had a container deposit law but has since repealed it.

In states with container deposit laws, a retailer pays the distributor for each beverage container purchased. The cost is passed on to the consumer, who in turn pays the deposit to the retailer when buying the beverage. Consumers receive a refund on the deposit when they return empty containers to a supermarket or other designated redemption center. The deposit may also incentivize scavengers to recover beverage containers from curbside recycling bins or fugitive litter to be returned. The container distributors will then reimburse the supermarket or redemption center for each container. Depending on the state, unredeemed deposits are returned to the state, retained by distributors, or used for program administration.

Container deposit laws create two primary streams for beverage container collection: the reimbursement systems and curbside recycling programs. While beverage containers made from aluminum, certain plastics like HDPE and PET[9], and glass may be placed in a curbside recycling bin with other recyclable materials, these containers may also be returned at a bottle deposit redemption center. In states with container deposit laws, both recycling programs and redemption centers desire to capture used beverage containers that are made from high-value commodity materials. This differs from states without container deposit laws, in which recycling revenues from these valuable beverage containers are collected primarily by municipal recycling programs.

2.3 Overview of Materials Recovery Facility (MRF) Operations

In states with container deposit laws, containers that are collected from supermarkets or other redemption centers (as opposed to at the curb) bypass MRF processing and are baled for direct sale on the recycled commodities market. When discarded materials are collected for recycling from curbside programs and recycling convenience centers in either type of state, the materials are transported to a MRF for processing. A MRF separates, sorts, and processes waste materials to be sold as raw material

[9] Plastic used beverage containers are commonly composed of polyethylene terephthalate (PET) or high-density polyethylene (HDPE).

inputs for remanufacturing and reprocessing. MRFs seek to capture high-value commodities, like nonferrous and ferrous metal materials[10], in order to generate revenue from commodity sales and reduce the amount of residue material sent to the landfill. Common materials processed in municipal recycling stream MRFs are nonferrous metals (including UBCs), ferrous containers, PET and HDPE containers, mixed plastics, old corrugated cardboard (OCC), old newsprint (ONP), mixed papers, and glass.

A typical MRF utilizes a combination of both manual and mechanical separation techniques to sort and recover materials. There are trade-offs between capital and operations and maintenance (O&M) costs when considering whether to employ manual or mechanical separation processes. Each MRF has to individually calculate these trade-offs as such aspects as local labor rates and even availability of qualified sorters will factor into the choice of increasing automation or relying on manual sortation. In general, the larger the MRF and the more tons that are processed, the more automation is required simply to sort the amount of material flowing though the MRF.

2.3.1 *Typical MRF Process and Sequencing*

When incoming recyclable waste material haulers arrive at a MRF, they dump the unsorted, or commingled, recyclable material onto the tipping floor A front-end loader or other similar type of bulk material handling equipment will then move this material into a drum feeder, a large steel bin at the start of the processing line that deposits material on a conveyor belt. This material travels along the belt to a pre-sort station, where workers manually remove any trash, unrecyclable items, and any other materials that could damage the system or expose workers to risk of injury.

Next, a series of screens separate the larger, flat materials such as cardboard and newspaper from the smaller fiber and bottles and cans. The final screen is specialized to separate the two-dimensional materials (such as mixed paper) from the three-dimensional materials (most bottles and cans). The two-dimensional stream moves on to a fiber recovery process, and the three-dimensional stream is conveyed to a separate processing area, generally called the "container line." Here, powerful magnets are used to pull ferrous metal materials from the stream, while an eddy current separator (see Box 1), which typically follows the magnets, is used to draw non-ferrous metals from the remaining commingled material.

After an eddy current separator removes nonferrous

Box 1 - Eddy Current Separators

Eddy current separators (ECS) are a well proven, effective, and established technology for non-ferrous metal resource recovery. An eddy current separator removes non-ferrous metals based on the conductivity and weight of the material. As materials pass over a rotating pulley drum at the end of a conveyor belt, a high-speed spinning internal rotor with permanent magnets creates a magnetic field that generates electrical currents within the non-ferrous metals.

These induced electrical currents in the non-ferrous materials do not always follow a linear path and will change direction (eddy current), causing the material to repel when faced by the opposing magnetic field in the separator. A large piece of nonferrous metal will generate more currents and therefore more force for repulsion than a small piece. When the non-ferrous materials repel, they become airborne, allowing them to be separated from the material stream. Most eddy current equipment vendors guarantee a UBC capture rate of 95 percent or greater of the UBCs present on the MRF's container processing line.

[10] Ferrous metals are metal alloys (combinations of several different metals) containing iron. The presence of iron causes most ferrous metals to be magnetic, with some exceptions, such as stainless steel. Non-ferrous metals may or may not be metal alloys but do not contain any iron; thus, all non-ferrous metals are non-magnetic.

metals from the waste stream, the nonferrous stream is not a UBC-only stream. There still remain non-UBC nonferrous metals as well as collateral materials, such as fiber and plastics, mixed into the larger nonferrous stream. A quality control sorter may be utilized to further clean the recovered nonferrous stream to achieve a higher value aluminum stream that primarily consists of UBCs. In some MRFs, this station is manned to ensure that secondary commodities buyers receive clean UBC bales. In other MRFs, this station is not manned, as the recovered aluminum from the ECS unit may be a stream clean enough to sell (depending on incoming material composition and MRF equipment and processes) or the price differential of a cleaner UBC bale may not justify the additional cost of staffing such a station. MRFs make such decisions based on factors internal to their operations as well as on the changing needs of the scrap market.

Plastic containers may be sorted manually by workers on a conveyor line or mechanically using density air blowers, optical sorters, and/or robotic systems. Glass is often mechanically separated and processed into finely crushed pieces, or cullet. Due to high percentages of glass breakage during collection and handling, the quantity of glass that a MRF can recover using hand-sorting practices is limited.

Once the separating process is complete, recycling balers are used to compact the separated commodity materials into blocks, or bales, for easy stacking and transport. The compacted bales of recyclables vary in size and weight depending on the material as well as the size and type of baling equipment.

Any remaining materials that cannot or fail to be recovered are considered residue at most MRFs. This residue stream consists of non-program materials that are not accepted by the MRF, actual trash, and recyclable materials that are difficult to recover due to size or being misshapen or simply missed by the mechanical and manual sorting. In nearly all cases, this residue is landfilled or otherwise disposed at a fee for both the hauling and disposal. Reducing the amount of residue from the MRF and maximizing the recovery of the recyclable materials that might be missed is a consistent goal for MRF operators. Therefore, the MRF may pass this residue material through a final manual or automated inspection prior to disposal. The economics of adding a sorter or an additional piece of automated equipment to the residue line is frequently dependent on how much valuable material can be recovered before disposal as well as how much material can be diverted from the cost of landfilling. A MRF must weigh the potential labor and/or capital and O&M costs of this effort against the potential value of the recyclable materials that may remain in the residue to ensure that the potential revenue increases will pay for the additional costs expended.

2.3.2 *Recent Advancements in MRF Technology: Robotics*

Modern sorting equipment has advanced to mechanize the material identification and sorting processes traditionally completed using manual labor at a MRF. The recycling industry uses the term “automation” to refer to advanced separators, optical sorters, and/or full-fledged artificially intelligent sorting robots. Commonly, these technologies will incorporate sensors and cameras to gather data, monitor material flow through the system, and increase separation efficiencies and recovery. Automation has also helped MRFs overcome several labor challenges, including increasing wages, worker shortages, and high worker turnover.

According to the 2018 Recycling Today article, *Sorting it all out: Considerations for integrating optical sorters and robotics in a MRF, o*ptical sorters are best suited for fiber and container sorting in medium- to high-volume streams, while robots are more appropriate for lower volume streams, such as the recovery

of missed recyclables on the final residue line.[11] Optical sorters utilize wide, flat belts to help spread-out items that are then identified with near-infrared light (NIR) that shines on these objects. The type of material will determine whether the light from the NIR beams is reflective or transmissive as well as the wavelength range. The nature and wavelength of the light is then analyzed by a spectrometer to identify the items by material, particularly plastics and fibers. Robotic systems, on the other hand, use artificial intelligence (AI) to examine thousands of digital photos and quickly process data to recognize and capture specific materials in an expansive recycling stream. These systems' sophisticated AI programming further allows for improved sorting performance over time through machine learning. Robots most frequently use suction cups, movable tongs, or grippers to grab material off the conveyor and often are placed on a line after an optical sorter to achieve high-quality outputs. UBC containers are generally well recognized by the AI programming on these MRF robots.

Since these sorting robots are so new to the recycling MRFs, data on performance and maintenance costs is not readily available to the public. GBB's preliminary discussions with MRF operators indicate that most maintenance is simple and straightforward, with the frequent replacements of the grippers or suction cups representing the majority of costs. As the AI programs continue to evolve and improve, frequent programming updates are also necessary to improve the performance of the robots. Most robots at MRFs can pick between 60 and 80 items per minute off the conveyor belt and can do so accurately for up to 4 material types. Conversely, a top performing manual sorter will pick up to 50 items per minute of a singular material type, and it is extremely difficult for a manual sorter to achieve this level of performance for an entire shift.

Current robots are also somewhat limited on what size conveyor upon which they can be placed, and by how much throughput they can effectively sort, as the material must be relatively dispersed to be identified and grasped. Continual improvements result in robots increasing in size, speed, and ability to identify partially covered items on the belts.[12]

Optical sorters and AI robotics units are nearly three times as expensive as ECS units in most applications and configurations, making the efficient (and less expensive) ECS the most common choice for MRFs to automate the recovery of UBCs.[13] However, as discussed in the next section, UBCs do not always arrive at the container line where an ECS is typically located. Robots or an additional ECS unit strategically located in another area of the MRF could capture additional UBCs that would otherwise be lost as residue or contamination in other commodity bales.

2.3.3 *UBC Recovery Rates at MRFs: Potential Losses and Areas for Improvement*

[11] Redling, A. (2018, July 11). Sorting it all out: Considerations for integrating optical sorters and robotics in a MRF. *Recycling Today*. Accessed on 06/04/2020. URL: https://www.recyclingtoday.com/article/considerations-for-integrating-optical-sorters-and-robotics-in-a-mrf/

[12] One U.S. robotics company, AMP Robotics, has deployed 54 AI nodes into single-stream recycling facilities across the United States and Canada, 31 of which target extraction of UBC aluminum, including 12 that are installed on fiber lines to extract flattened cans to improve the overall quality of fiber bales. Other nodes are stationed at the residue point of MRFs, to capture remaining recyclable materials that may otherwise be landfilled. On average, of the tens of millions of objects that pass under each of these nodes in a month, the nodes perceive UBC aluminum as 0.05% of objects on fiber lines, and 3.5% of objects on residue lines.

[13] Current market prices for ECS units average approximately $100,000, while robotic units average approximately $300,000 in most MRF applications and configurations. Figures are simple high-level, pre-tax capital costs estimates and do not include financing costs, installation costs, depreciation, or operations and maintenance costs.

MRFs utilize eddy current separators mainly because they are a proven and effective technology for non-ferrous metal resource recovery. Most equipment vendors will guarantee a UBC capture rate of at least 95 percent of the UBCs present on a MRF's container processing line, with some exceptions, such as deformed cans or aluminum that does not arrive on the container line. The reality is most whole aluminum cans that are on the container line will be recovered by a properly operating ECS unit. Recent ECS testing at a MRF in Florida showed UBC recovery rates in excess of 99 percent.[14] **UBCs can only be recovered by the ECS unit if the items make it to the unit - this is not always the case.**

UBCs entering MRFs may be lost at the MRF due to non-recovery. Non-recovery at a MRF indicates that some of the UBCs that entered the single stream recycling system were not recovered in the aluminum commodity bales but instead ended up in other bales or in the residue. **Lost or non-recovered UBCs at a MRF may or may not be landfilled, depending on possible subsequent processing methods.** A lost or non-recovered UBC at a MRF means that the MRF did not include the UBC in the appropriate bale and will therefore not benefit from the higher revenue associated with that material. If the UBC is mistakenly included in a PET bale, for example, and the PET recycler that purchases that bale employs technology such as an ECS to sort out aluminum materials and achieve a cleaner PET stream, that PET recycler may aggregate the recovered aluminum for subsequent sale to an aluminum recycler. In this case, the UBC will still be recycled, but not because it was recovered for UBC recycling at the MRF.

Box 2 - Reasons for UBC Non-Recovery at MRFs

- Cans crushed vertically into "pucks"
  - Pucks are smaller than most MRF screens, separated into fines or residue streams
- Cans crushed horizontally into flat objects
  - Flat objects are sorted like paper
- Recyclables are bagged
  - Bagged recyclables are not processable without mechanical bag openers
- Whole loads of recyclables too contaminated for processing
  - *Note: this occurs relatively infrequently*
- Material falls off conveyor belt at belt transition points
- Sleeve-wrapped UBCs may be causing some recovery issues at the MRF, but there is limited data on this issue; these sleeves can also cause issues at the aluminum recycler.

UBCs may be lost at MRFs through non-recovery due to a variety of reasons, as summarized in Box 2. As aluminum cans are collected and transported to the MRF, they may become crushed or compacted vertically into "pucks" or flattened horizontally into nearly two-dimensional objects. This crushing and flattening can occur as a result of consumer action, compaction within the load of recyclables, and vehicles or equipment running over stray cans. The pucks tend to be smaller than many of the MRF screens, causing them to be separated out into the fines or residue streams, while the flattened UBC items tend to act more like paper, causing them to be sorted into the fiber streams. Many MRFs have a container return sort station at the fiber quality control locations; however, it is difficult for the manual laborers to identify and then pick (recover) these flattened cans, especially if they are under other fiber.

Other UBCs can be lost due to MRF practices. Many MRFs will remove any bagged material as residue at the presort station, regardless of whether the bagged material contains recyclables or not. Many UBCs can be lost as a result of this practice, but it is also a necessary practice, as the bags will cause disruptions

[14] Ramsdel, C. (2017, January 3). Modern Separation Equipment Increases Ferrous and Nonferrous Recovery Rates for MSW/MRF Facilities. *Waste Advantage Magazine*. Accessed on 06/04/2020. URL: https://wasteadvantagemag.com/modern-separation-equipment-increases-ferrous-and-nonferrous-recovery-rates-for-mswmrf-facilities/

– and potentially damage to the equipment – if not removed. It is also dangerous to have manual sorters try to open the bags at the sort conveyor. Some MRFs have installed mechanical bag openers to address this issue; thus, bagged material is not necessarily prohibited at all MRFs, but bagging behavior by consumers has been a recent focus in an effort to minimize contamination for the maximum likelihood of recycling. In one recent study at several Ohio MRFs without mechanical bag openers, educating consumers to place recyclables loose in the bin, instead of bagged, resulted in a 55% increase in the revenue attributable to UBCs and an 81% increase in total per ton revenues—from an increase of less than 1% by weight of aluminum cans in the MRF's stream.[15]

Periodically, although it occurs relatively infrequently, if a load of recyclables entering a MRF exhibits too much contamination, it may be rejected outright and subsequently disposed, even when it does contain high value recyclables such as UBCs. As such, efforts to reduce contamination in recyclables can help to increase the likelihood of recycling.

UBCs can also be lost with material that can fall out of the stream and onto the MRF floor at conveyor transitions. Most MRF locations require daily cleaning of the floor areas beneath the equipment to clean up the materials that have fallen from the conveyors, which may include UBCs.

There is adequate public information on the composition of the incoming single stream materials, which is discussed in the next section. Unfortunately, details on the fate of some of the materials that are not properly recovered at the MRF are more difficult to ascertain. GBB analyzed the results of three such studies in an effort to understand what share of UBCs end up in various material streams at a typical MRF. The Oregon Department of Environmental Quality conducted a study in 2011 at 5 MRFs located in the Portland, Oregon region.[16] This study examined all material outputs and measured how much of each commodity resulted in each of the output streams. GBB also has access to a confidential MRF assessment report for a Midwest MRF in a container deposit law state in 2015.[17] These studies differed slightly in what was researched from the other report but give useful information, especially regarding UBCs in the residue stream. A third study was done as part of a University report that analyzed the mass balance of a MRF in Florida in 2018.[18] This report tracked where materials (including UBCs) ended up from each major piece of sorting equipment.

Although the Oregon study was conducted nearly ten years ago in 2011, it is important to note that at the time the study was done, these MRFs would have been considered modern – and many MRFs across the country today are still operating equipment that was considered modern at that time. The range of locations and dates of the studies constitutes a reasonable cross-section of U.S. MRFs that operate in different regional markets and with different types and ages of equipment.

These studies enable a more in-depth look at the UBCs in the MRF, although the emphasis of each study was somewhat different. A further issue with making assumptions from so few data points is that each

[15] Source: The Recycling Partnership. Revenues are measured as outgoing revenues and include the cost of residue disposal in the local market.

[16] State of Oregon Department of Environmental Quality. (2011, March). *Composition of Commingled Recyclables Before and After Processing*. Accessed on 06/04/2020. URL: https://www.oregon.gov/deq/FilterDocs/CommingledRecyclablesBAProcessing.pdf

[17] RRT Design and Construction. (2015, December). *MRF Assessment Report.*

[18] Damgacioglu, H., Peres, L., & Celik, N. (2018, March). *Assessment and Evaluation of Contamination in Single Stream Recycling Systems Due to Broken Glass and Other Non-Recyclables.* Accessed on 06/04/2020. URL: http://floridalandfillcapacity.com/files/Assessment_and_Evaluation_of_Contamination_in_Single_Stream_Recycling_Systems.pdf

MRF is inherently different, with differing levels of automation and equipment and even different processing procedures. However, the resulting numbers are very telling and indicate that there are more losses of UBCs in the MRF than most operators suspect. Table 2 below shows the combined results of these studies for the UBCs – **the average rate of correct sortation and recovery of aluminum in the MRF is only 73.4%.**

Table 2 – Distribution of UBCs by Output Location at a MRF

Reference Study/Output Location of UBCs at the MRF	Recovered Aluminum	Fiber Streams	Residue	Other	Total
Oregon DEQ Study	65.6%	28.1%	3.1%	3.1%	**100%**
Midwest MRF Assessment[1]	79.4%	11.2%	9.5%	N/A	**100%**
Florida MRF Study	75.2%	7.2%	9.0%	8.6%	**100%**
Average	**73.4%**	**15.5%**	**7.2%**	**5.9%**	**N/A**

(1) Recovered % of UBC were not reported, just estimated based on the percentage of aluminum in residue at 9.5%, for a recovery of 90.5%. Other losses were also not recorded.

There seems to be a wide variety of distribution of the aluminum cans, especially for the fiber streams. The results from the Oregon study seem to have a very high percentage of UBCs ending up in the fiber stream, although the reasons for this are unclear. The Florida study showed the MRF losing most of the "other" category at the pre-sort station, which may indicate losses due to the removal of whole bags.

There are many instances where the reported recovery of UBCs is approximately 90%, and the guaranteed recovery from installed ECS units is 95% or greater. There are several likely reasons for this apparently vast difference, although more study is warranted for confirmation. First, most MRFs only generalize the visible incoming UBC content and then compare this to the UBCs in the residue. The Midwest MRF study and the Florida study both show approximately 9% of the UBCs in the residue, which would indicate approximately a 90-91% capture rate, but this does not account for other losses. In addition, according to the data from these studies, approximately 25% of the other types of aluminum in the stream are also captured by the ECS, thereby adding to the total recovered aluminum tonnage. If a MRF only examines the incoming tonnage of UBCs and the outgoing tonnage of aluminum bales, the recovery rate will be skewed higher due to the presence of other non-UBC aluminum in the outgoing bales.

If MRF operators take merely a cursory look at the losses of UBCs within the processing system, they might easily come up with a loss of 1 in 10 cans. However, the above information indicates that there might be more losses throughout the system than initially assumed. **A more in-depth evaluation would help to reveal where aluminum cans might be lost from recovery at the MRF, impacting the recovery rates and the revenue from the sale of the aluminum bales.**

Once this information is known, the MRF operators can customize a plan to best target the recovery of additional UBCs. This could include making sure all existing equipment is operating as designed and possibly adding other equipment to recover more aluminum cans. For instance, using the Florida study as an example, 5% of the UBC losses occur at the pre-sort (part of the "other" category). Assuming that these UBCs were in bags, the installation of a bag breaker would liberate these cans (and other recyclables) for recovery. Another option would be to add a second ECS unit to the residue line to recover missed UBCs that may have fallen through screens or were missed by the main ECS unit. This is the most common

solution for MRFs, with some already having a second unit installed for further recovery of aluminum.[19] Many MRFs are looking to replace the older fiber screens with newer, anti-wrap screens that reduce the labor needed to clean them often and that will improve the recovery of fiber as well as potentially improving the separation of UBCs. A newer option is to install a specialized robot on a fiber recovery line to recover aluminum and other containers of value (such as PET, which is also common on fiber lines).

For a theoretical MRF based on the Florida data, the inclusion of a bag breaker, a robot on the fiber line, and a secondary ECS unit on the residue outfeed line will result in greater capture of UBCs. It is assumed that 5% of the UBCs in the "Other" category are liberated by the bag breaker and recovered at the current recovery percentage of 75.2%[20] for an additional recovery of 3.8%. If a Robotic sorter was added to the correct location on the recovered fiber stream, it is assumed it could recover an additional 80% of the 7.2% of UBCs found in the fiber streams for an additional recovery of 5.8%. Finally, if an ECS unit was placed in an appropriate location on the residue stream with a recovery efficiency of 95%, an additional 8.5% of the UBCs would be recovered. **If all of these options were implemented simultaneously, this would boost the overall UBC capture rate by 25% from 75.2% to 93.3%, or more than 18 percentage points.** The results of the potential recoveries for the Florida example are shown below in Table 3.

Table 3 – Increase in UBC Capture Rates at MRFs with the Addition of MRF Equipment[21]

	Fiber Line	Residue Stream	Other	Recovered % Total	% Recovery Increase
% of UBCs Recovered at Each Location	7.2%	9.0%	8.6%	75.2%	0.0%
Added Bag Breaker at Pre-Sort Station	-	-	3.8%	3.8%	5.1%
Added Robot at Fiber Lines	5.8%	-	-	5.8%	7.7%
Added ECS Unit on Residue Stream	-	8.5%		8.5%	11.3%
Total Potential UBC Recovery	13.0%	17.5%	12.4%	**93.3%**	**24.1%**

These types of additions are all very contingent on the MRF configuration itself, as there may not be room for additional equipment, or there is no location where the output streams are consolidated enough to place the equipment. Thus, individual assessments of each MRF are important in understanding the greatest needs and technical possibilities. However, **a potential increased recovery of 25% more UBCs is noteworthy to MRF operators, and the overall return on investments of this additional equipment should be further investigated.**

Such an increase in capture rates can dramatically increase revenues associated with UBCs given the high value of aluminum: **it is possible that an average MRF processing 50,000 TPY in a state with a container deposit law may be missing approximately $54,000 in gross revenue in a calendar year, while an average MRF in a state without a container deposit law may be missing approximately $297,500 in gross revenue in a calendar year, due to UBC non-recovery.** (The detailed dollar values of the impact on revenues, as well as the assumptions used for calculation, are explored in Section 3 below.)

[19] Daum, M. (2019, February 28). Capturing the Last Can. *Recycling Today*. Accessed on 06/05/2020. URL: https://www.recyclingtoday.com/article/increasing-ubcs-capture-in-mrfs/

[20] If the other equipment noted is also in use, this recovery percentage would increase.

[21] Theoretical scenario based on the Florida study previously referenced.

2.4 Inbound MRF Material Composition

2.4.1 *Recycling Stream Composition in Container Deposit vs. Non-Container Deposit States*

In order to determine how bottle bill laws impact inbound MRF material compositions, GBB compared single stream recycling characterization data from eight (8) studies that represented four (4) states with container deposit laws[22] and four (4) states without container deposit laws.[23] Detailed characterization studies of single stream recyclables are not as plentiful as MSW waste characterization studies,[24] but GBB was able to find representative data from its own single stream characterization work as well as from similar publicly available studies. GBB found the data regarding UBC content to be very consistent, based on the status of the state as container or non-container deposit law state. Table 4 below presents GBB's calculation of the average percentages of the most common single stream materials or commodities from these eight studies. Commodity categories include fibers (OCC, ONP, and mixed fiber), glass, plastics (PET, HDPE, and mixed plastics), metals (nonferrous and ferrous), and residues (including non-recyclable or non-program materials and fibers, organics, and bags and film). Percentages represent the commodities' share of the recycling stream by weight.

[22] Single stream recycling characterization data for states with container deposit laws includes information from the following studies: *Boston Recovery Rate Study*, 2013 (2-week recovery waste sort for multiple areas in Boston, MA, publicly available study completed by DSM Environmental Services: https://static.squarespace.com/static/53763861e4b05ff1a0878696/t/5388977ce4b0490f4007824a/1401460604251/Siegler0314rr%20(2).pdf); *IDNR Audit Iowa Board Document*, 2017 (State of Iowa, comingled recyclables report, publicly available by the Iowa Department of Natural Resources (IDNR): http://www.iowadnr.gov/Portals/idnr/uploads/waste/wastecharacterization2017.pdf); *Kent County Solid Waste Characterization Study*, 2017 (4-day waste and recyclables characterization study by GBB); and *Composition of Commingled Recyclables*, 2011 (State of Oregon report for the five largest commingled recyclable facilities for the year 2011, publicly available by Oregon DEQ: https://www.oregon.gov/deq/FilterDocs/CommingledRecyclablesBAProcessing.pdf).

[23] Single stream recycling characterization data for states with container deposit laws includes information from the following studies: *Fayetteville Waste Characterization*, 2015, (2-week waste characterization study for Fayetteville, NC, by GBB); *Lancaster Single Stream Waste Sort*, 2019 (3-day single stream recycling waste sort for Lancaster, PA, by GBB); *Lee County Waste Sort*, 2016 (2-week waste sort for Lee County, FL, by GBB); *Nashville Single Stream Sort*, 2018 (single stream recycling sort for Nashville, TN, by GBB).

[24] The relatively smaller amount of available single stream residential recycling composition studies, compared to residential MSW composition studies, indicates an opportunity and a need for additional funding for such studies to build up a robust database of nationwide information, similar to the information available on MSW composition.

Table 4 – Average Recycling Commodity Share (%) of Total Recycling Stream by Weight for States With and Without Container Deposit Laws[25]

Recycling Commodity	Average % Share by Weight – States *With* Container Deposit Laws	Average % Share by Weight – States *Without* Container Deposit Laws
Fibers	**65.7%**	**46.7%**
Old Corrugated Cardboard (OCC)	18.6%	26.2%
Old Newsprint (ONP)	20.2%	3.9%
Mixed Fiber	26.9%	16.6%
Glass	**12.5%**	**13.8%**
Glass	12.5%	13.8%
Plastics	**7.6%**	**14.3%**
PET (#1)	3.0%	6.5%
HDPE (#2) - Natural	1.3%	2.0%
HDPE (#2) - Colored	1.3%	2.6%
Mixed Plastic (#3 - 7 and Other)	2.0%	3.2%
Metals	**3.0%**	**5.1%**
Aluminum Cans (UBCs)	0.4%	2.2%
Ferrous	2.6%	2.9%
Residues	**11.3%**	**20.1%**
Other Residue	10.2%	7.5%
Other Fibers	0.6%	9.2%
Organics	0.1%	2.1%
Bags and Film	0.4%	1.3%
Total[26]	**100.0%**	**100.0%**

As illustrated in Figure 1 and Figure 2 below, fiber and paper materials are the most common commodity category in single stream recycling for both container deposit and non-container deposit states, representing 67.7 percent and 46.7 percent of the total stream by weight, respectively. GBB found higher percentages of OCC, all plastics, and aluminum cans in states without container deposit laws. Aluminum cans, specifically, averaged 2.2 percent of the stream in states without container deposit laws and only 0.4 percent in states with container deposit laws. This difference can be directly attributed to the incentive of the deposit refund for removing these container types from the commingled recycling stream and altering the relative share of the materials as a percentage of the total stream by weight. For similar reasons, GBB observed that a higher percentage of the total stream by weight in states with container

[25] Note on methods: Industry standard compositional studies examine incoming materials at a given facility. Thus, percentages given indicate the share of specific commodities as a percentage of the total inbound material weight. Outbound percentages may be similar, although not identical, to inbound percentage shares. Further, data on outbound material stream compositions are generally not publicly available. As such, calculating an average or typical outbound material stream composition is not feasible, as it can vary greatly between MRFs depending on level of automation, staffing, and operational procedures. Percentages based on findings in the eight studies previously noted.

[26] Figures may not total due to rounding.

deposit laws was composed of ONP and mixed fiber. GBB observed the quantities of glass and ferrous metals as a share of the total weight to be similar in both types of streams.

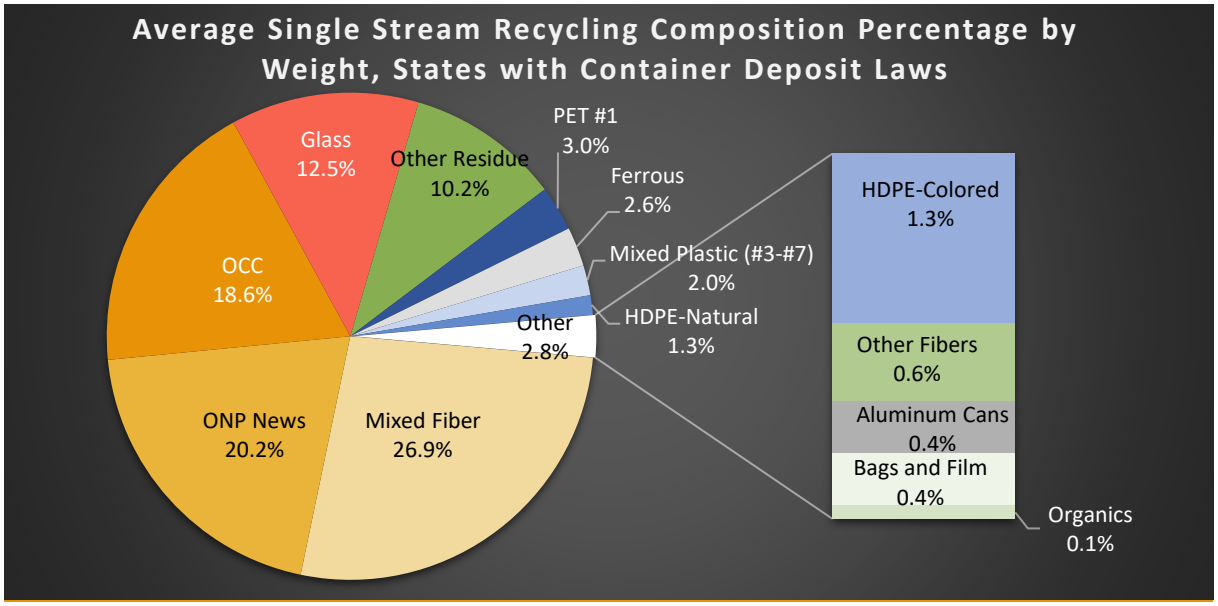

Figure 1 – Average Single Stream Recycling Composition Percentage by Weight, States with Container Deposit Laws

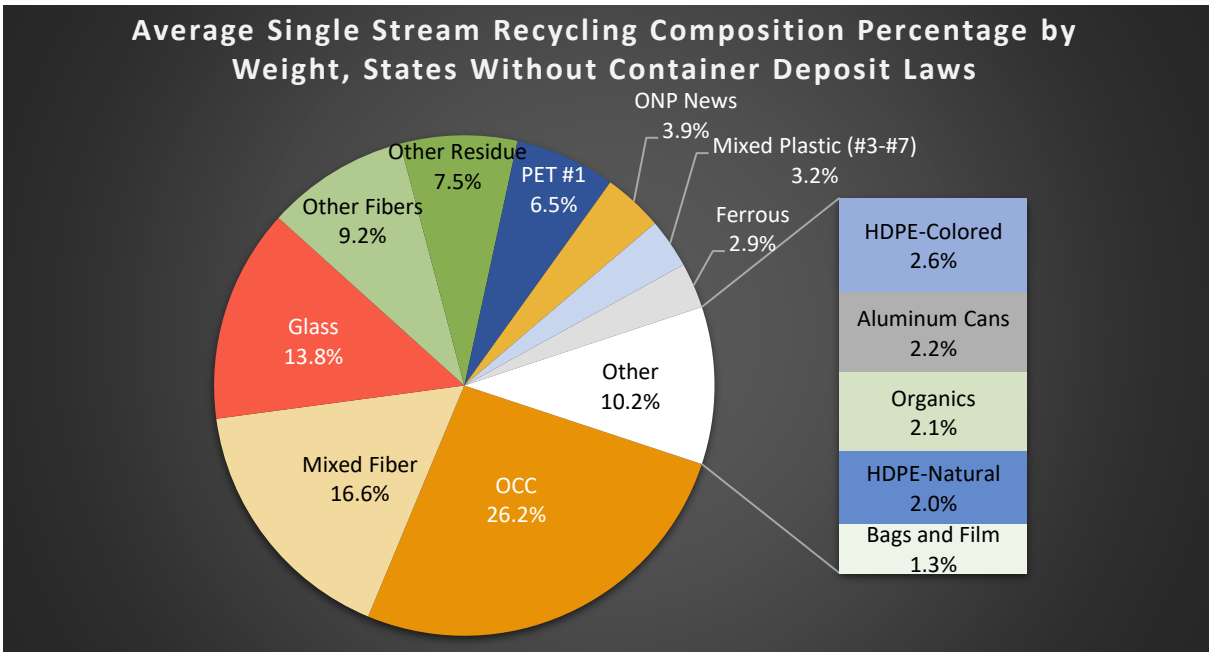

Figure 2 – Average Single Stream Recycling Composition Percentage by Weight, States Without Container Deposit Laws

Aluminum is not the only recyclable nonferrous metal in the waste stream. Recyclable nonferrous metals also include copper, lead, zinc, nickel, titanium, cobalt, chromium, and precious metals. However,

aluminum is typically the only nonferrous metal present in a MRF's material stream because it is generally the only nonferrous metal used in containers and packaging (which end up at MRFs), as opposed to durable goods such as appliances and furniture (which do not typically end up at MRFs).[27] Aluminum containers and packaging include cans (beverage, food, and non-food) as well as foil, closures, lids, and other packaging elements. Of all aluminum containers and packaging produced in North America, more than 60% are UBCs.[28] UBCs make up the majority of the aluminum that is processed at a MRF, but the ECS will also capture other recyclable aluminum materials, such as food cans and aluminum lids and foil, contributing to the overall recovered aluminum tonnages. Aluminum lids and foils are frequently not considered recycling program items as they may contribute to contamination or increased residue, depending on the grades of aluminum scrap a MRF markets to its buyers. Some recycling stream characterization studies look specifically at UBCs separately from the other aluminum, while others do not, depending on the goals of the study.

The average UBC today weighs just under 0.475 ounces, for a total of 33.69 cans per pound, and 67,380 cans per ton.[29] Using the potential capture rate of approximately 75% calculated in Section 2.3.3 above, as well as the average MRF stream compositions, it is possible that **a medium to larger size MRF processing 50,000 tons of recyclables per year in a non-deposit law state may be losing up to 275 tons of UBCs per year, or more than 18.5 million individual cans, due to non-recovery.** The weight and number of lost cans per year, depending on the MRF location, is shown in Table 5 below.

Table 5 – Potential Lost UBCs per Year at a Typical MRF

	States With Container Deposit Laws	States Without Container Deposit Laws
Percentage of UBCs	0.4%	2.2%
Total TPY UBCs[1]	200	1,100
Recovery Percentage	75%	75%
Assumed Recovery of UBC (TPY)	150	825
Remaining (Lost) TPY of UBCs	50	275
Remaining (Lost) pounds per year UBCs[2]	100,000	550,000
Number of lost UBCs per year	**3,369,000**	**18,529,500**

(1) Based on a total tonnage processed at the MRF of 50,000 tons per year (TPY)

(2) Assumes 33.69 UBCs per lb.

3 UBC Revenues

3.1 Overview

In order to understand the economic impacts of UBC capture and loss at MRFs, GBB examined historical averages of North American single stream recycling commodity values, the total revenues MRFs generate

[27] U.S. Environmental Protection Agency. (2019). *Advancing Sustainable Materials Management: 2016 and 2017 Tables and Figures.* Accessed on 06/04/2020. URL: https://www.epa.gov/sites/production/files/2019-11/documents/2016_and_2017_facts_and_figures_data_tables_0.pdf

[28] Source: The Aluminum Association, 2017.

[29] Source: Can Manufacturers Institute, 2018.

based on commodity values weighted by stream composition, the average percentage of revenues UBCs generate at MRFs, and the monetary losses associated with non-recovery of UBCs.

3.2 Single Stream Recycling Commodity Values & MRF Gross Revenue Model

3.2.1 *Single Stream Recycling Commodity Values*

GBB compiled recycling commodity values for the most recent five years from 2015 to 2019 utilizing data aggregated from RecyclingMarkets.net, an online resource that offers a comprehensive online commodity pricing index for post-consumer recovered materials. Figure 3 below illustrates the North American average value of each commodity type from 2015 to 2019. Commodity values change over time and are market- and trade-dependent, but the value of aluminum by unit weight has remained consistently high relative to other commodities, and it has proved to be the most valuable consumer recycling commodity since 2017. The value of aluminum averaged $1,082.22 per ton in 2019.

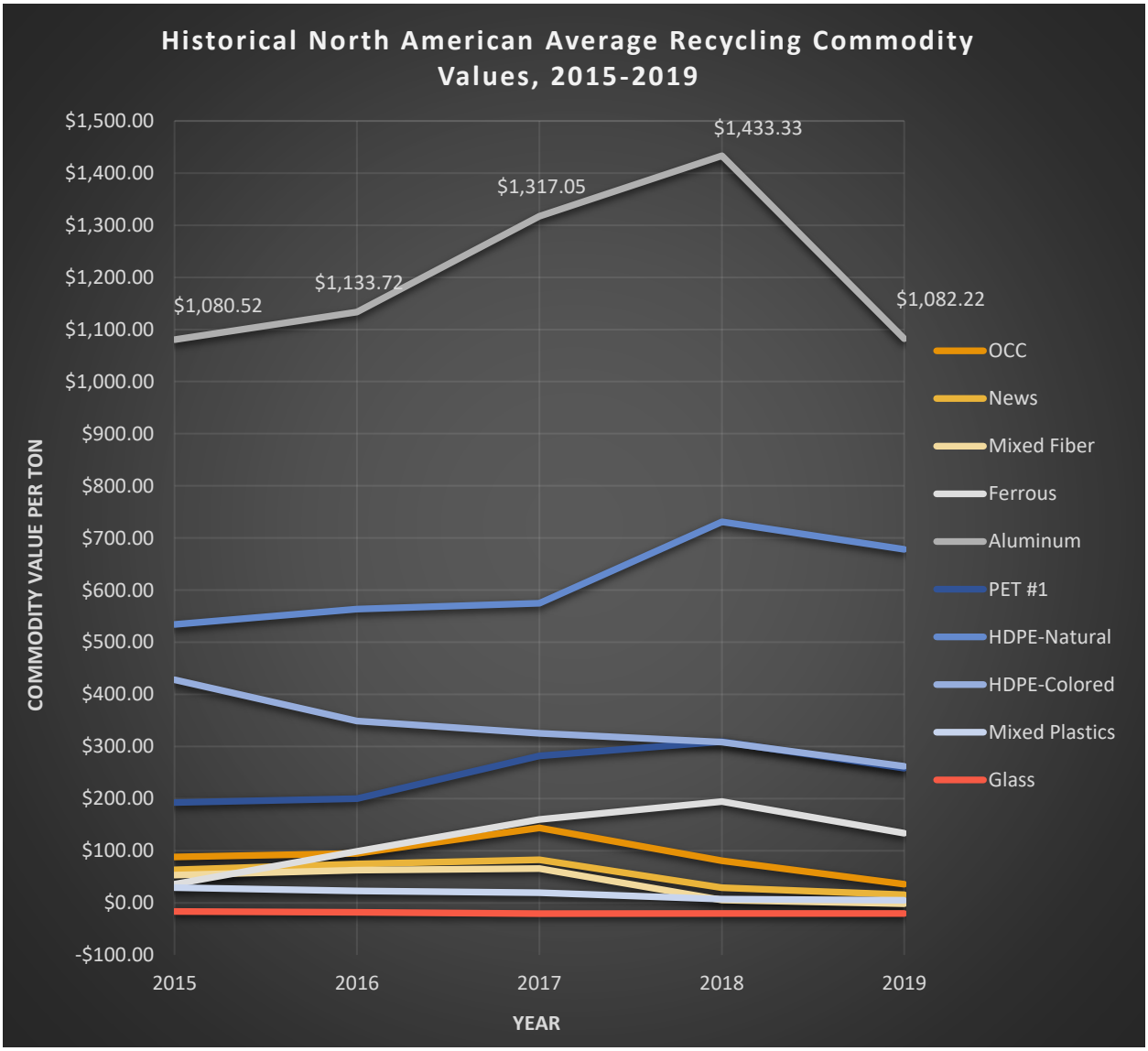

Figure 3 – Historical North American Average Recycling Commodity Values, 2015-2019

Over the course of spring 2020, aluminum commodity values fell by more than 25% from the 2019 North American average, mostly due to the adverse economic impacts of the various stay-at-home orders enacted as a result of the COVID-19 U.S. national health emergency and global pandemic. These conditions have disrupted supply of UBCs to container deposit systems due to temporary suspensions of recycling programs across the United States, including those for curbside pickup, drop-off, and container deposit, as well as decreased participation in drop-off and container deposit programs as individuals remain at home for longer periods of time. At the same time, an abundant global supply of aluminum and temporary pauses to various manufacturing operations has lowered demand for recycled aluminum and lowered global commodity values.

Aluminum recyclers producing aluminum sheet from UBCs for beverage cans, which have seen increased sales amid the pandemic, have tried to make up for the decline in post-consumer UBCs with increased use of other forms of scrap so that the average recycled content of U.S. beverage cans stays at or near its current 73 percent.[30] However, it is likely that with the disruption of UBC flows there will be some increase in imports from overseas to supplement the restricted domestic supply (see Section 4.3 below for further information on aluminum market dynamics).[31] Similarly, low oil prices and resulting low virgin plastic prices have also depressed the commodity values for competing recycled plastic resins.[32]

Conversely, for most MRFs, the values for fiber commodities have increased due to the decreased supply of OCC and sorted office paper coming from the commercial sector and the increased demand for manufacturing of shipping boxes and non-commercial grade toilet paper (a result of shifting consumer demands and activity as well as stockpiling during extended periods of time at home).[33] This market shift has helped offset the loss of revenue from aluminum's lower commodity value. It is anticipated that the commodity value of UBCs and other recycled commodities will rebound to previous levels similar to those used in the analysis of this report once travel and other economic activity return to non-pandemic levels.

3.2.2 *MRF Gross Revenue Model*

After compiling the average recycling commodity value, GBB calculated average gross[34] value per incoming recyclables ton by multiplying the average commodity values by the average recycling stream

[30] The Aluminum Association. (2019, September). *The Aluminum Can Advantage: Key Sustainability Performance Indicators 2019*. Accessed on 06/02/2020. URL: https://www.aluminum.org/sites/default/files/KPI%20Report%202019.pdf

[31] Pyzyk, K. (2020, May 20). Pandemic exacerbates UBC recycling issues, following aluminum market decline. *Waste Dive*. Accessed on 06/04/2020. URL: https://www.wastedive.com/news/ubc-aluminum-can-recycling-pandemic-coronavirus/577668/

[32] Paben, J., & Leif, D. (2020, May 28). Plastics processors grapple with drops in pricing and demand. *Resource Recycling.* Accessed on 06/04/2020. URL: https://resource-recycling.com/plastics/2020/05/28/plastics-processors-grapple-with-drops-in-pricing-and-demand/

[33] Staub, C. (2020, May 19). OCC supply shortfalls drive up prices. *Resource Recycling*. Accessed on 06/04/2020. URL: https://resource-recycling.com/recycling/2020/05/19/occ-supply-shortfalls-drive-up-prices/

[34] Gross MRF tonnage values are the standard for which the value of recyclables and the potential gross revenue for a MRF are compared. Net MRF revenues would account for revenues due to processing fees as well as costs associated with the disposal of residues as well as costs attributed to operations and maintenance of the facility. Such revenues and costs vary widely depending on the location of the MRF and the equipment utilized, and these details are generally not publicly available. As such, calculating an average or typical net value per ton as opposed to gross value per ton is not feasible. Note that residues do not have any inherent commodity value but rather are assumed as a cost liability equal to the cost of disposal. The cost of disposal is not included in the gross calculations as disposal rates vary significantly across North America, sometimes by $100 per ton, or more, depending on the location and market.

composition for both states with and without container deposit laws. Figure 4 and Figure 5 below present the weighted values per ton of single stream recyclables at MRFs in each type of state. On the whole, per ton recycling commodity values peaked most recently in 2017 but have fallen significantly following recycling market fluctuations as a result of China's National Sword waste import policy changes. Further, states without container deposit laws experience significantly higher gross per ton single stream recycling revenues due to the larger share of UBCs in the stream and aluminum's high commodity value: in calendar year 2019, gross per ton total revenues averaged only $34.74 in states with container deposit laws, with $4.33 per ton attributable to UBCs, while the gross per ton total revenues in states without container deposit laws averaged $71.55 per ton, with $23.61 per ton attributable to UBCs.[34]

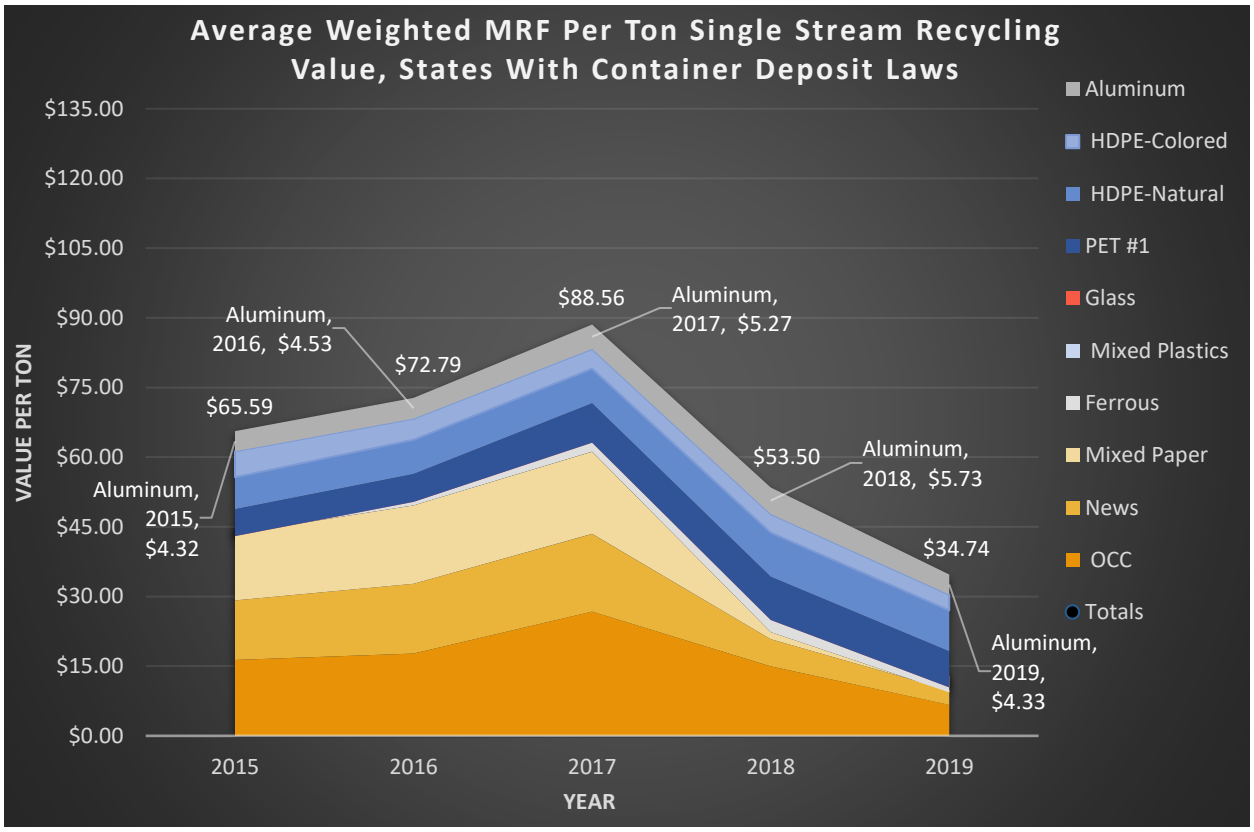

Figure 4 – Average Weighted MRF Per Ton Single Stream Recycling Value, States With Container Deposit Laws[34]

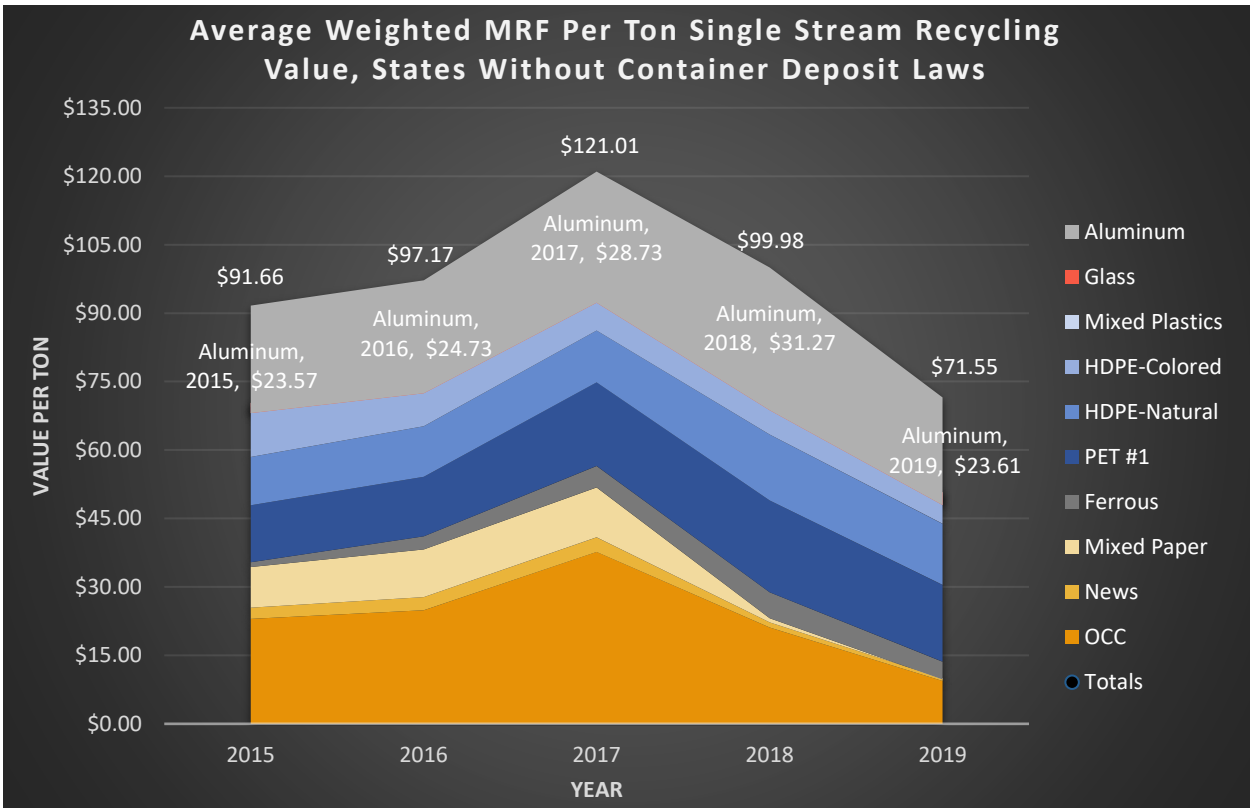

Figure 5 – Average Weighted MRF Per Ton Single Stream Recycling Value, States Without Container Deposit Laws[34]

Because of the high commodity value of aluminum, states without container deposit laws—with more UBCs entering MRFs—not only have higher overall gross per ton single stream recycling revenues but also have a greater percentage of those revenues attributable to UBCs. Figure 6 and Figure 7 below illustrate the percentage share, weighted by material stream composition, of gross revenues attributed to each of the top five commodities in both states with and without container deposit laws. In calendar year 2019, these top five commodities combined represented 89.16% of gross MRF revenues in states with container deposit laws and 97.7% of gross MRF revenues in states without container deposit laws. In the same year, UBCs alone accounted for approximately 12.46% of gross revenues in states with container deposit laws and 33.0% of gross revenues in states without container deposit laws—a larger share than any other single material commodity in states without container deposit laws.

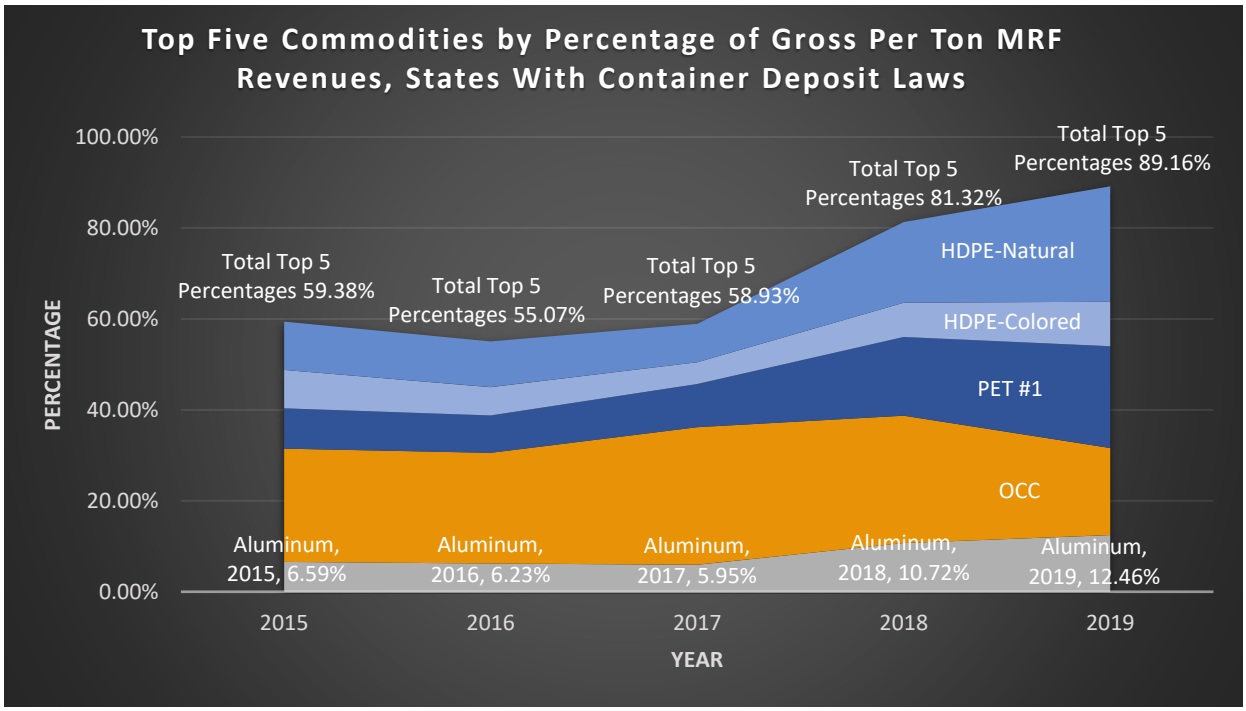

Figure 6 – Top Five Commodities by Percentage of Gross Per Ton MRF Revenues, States With Container Deposit Laws

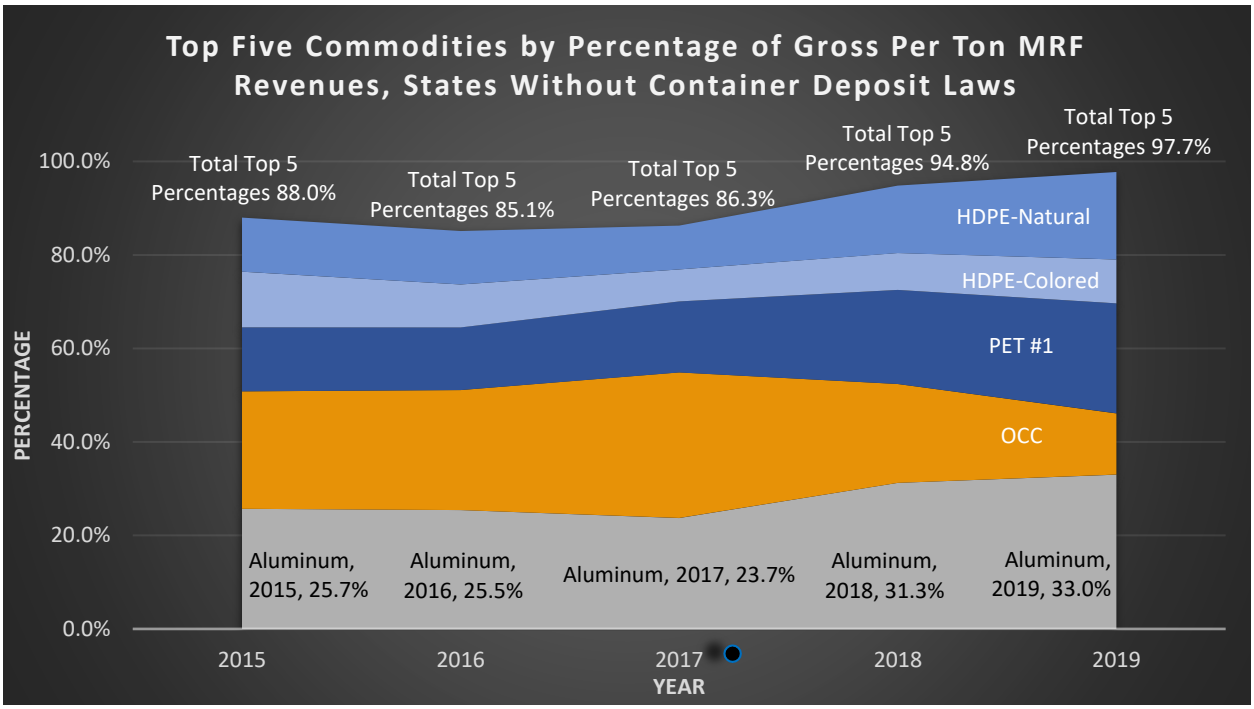

Figure 7 – Top Five Commodities by Percentage of Gross Per Ton MRF Revenues, States Without Container Deposit Laws

MRFs typically have very tight operating margins, and with the recent dip in commodity values, many MRFs are currently operating at a loss, with the hope that the markets will recover in the near future. Some MRFs have closed as a result of the current market challenges, while others have changed what they are accepting or have started charging additional fees. The costs of operating a MRF (and paying for the capital equipment) vary greatly depending on the level of automation and the tonnages processed. Typically, the costs per ton to process recyclables can range from $60 per ton to $90 per ton[35] or greater depending on the capital debt and throughput. Certainly, if the incoming material has a maximum value of approximately $72, and the cost to process that ton is $90, then the revenue alone is not enough to sustain the recycling program. As such, many locations charge a tip fee, or a fee the MRF charges haulers to accept their materials, to process the recycling to offset this cost difference. To keep these tip fees low and publicly acceptable, gleaning the maximum value from the incoming materials is key. **With such a high percentage of gross revenues attributable to UBCs, it is reasonable to conclude that, without any changes to their business practices and models, most MRFs around the country could not operate without the revenues that UBCs provide.**

3.3 MRF Gross Revenue Losses Associated with UBC Non-Recovery and Potential Revenue Impact of Increased UBC Capture Rates

Using the potential UBC loss rates calculated in Section 2.3.3 above as well as the average MRF stream compositions and commodity values, it is possible that **an average MRF processing 50,000 TPY in a state with a container deposit law may be missing approximately $1.08 in gross revenue per ton, or $54,000 in a calendar year, while an average MRF in a state without a container deposit law may be missing approximately $5.95 in gross revenue per ton, or $297,500 in a calendar year, due to UBC non-recovery.** In the container deposit law MRF, capturing these additional UBCs would serve to increase gross annual revenues by roughly 3.1%, while in the non-container deposit law MRF, this would serve to increase gross annual revenues by approximately 8.3%.[36]

GBB further calculated the potential revenue gains associated with increasing the average UBC capture rate at MRFs, for example if a second ECS unit was installed or if additional equipment such as a robot was to capture UBCs lost to the fiber streams. The potential gross per ton revenues for these scenarios for both states with and without container deposit laws are presented below in Table 6. The results are based on the increased MRF equipment capture rates depicted from the earlier section by adding additional equipment to the processing system.

The first scenario shows the current capture rate of a typical MRF system with the existing ECS unit of approximately 75%. The second scenario assumes adding an additional ECS unit to the residue line, thereby increasing the capture rate by 8.5 percentage points for a total capture rate of 83.5%. This result is similar to instead adding a robot to the fiber line which would increase the capture rate by 5.8 percentage points for a total capture rate of 80.8%, as shown in scenario three in Table 6. However, if both units are added to the MRF, as shown in the fourth scenario, the capture rate would increase by 14.3 percentage points to a total capture rate of 89.3% and significantly increase the associated revenue, especially in states without container deposit laws.

[35] CB&I Environmental and Infrastructure, Inc., & Moore & Associates. (2016, October). *Material Recycling Facility Contract Development Phase 1 Report* [Data from publicly owned MRFs]. Accessed on 06/04/2020. URL: https://www.a2gov.org/departments/trash-recycling/Documents/Ann%20Arbor%20MRF%20-%20Phase%201%20Report%20-%20for%20electronic%20distribution.pdf

[36] Calculated using 2019 average per ton recycling commodity market values.

If a MRF processing 50,000 tons per year (TPY) of recyclables in a state without container deposit laws realized a UBC capture rate of 89.3% by installing both types of equipment, its annual gross revenues attributable to UBCs would increase by roughly $170,000.[36] **In just over two years' time, the increased gross revenues could pay for the additional capital cost of both an additional ECS unit and a robot.** By installing only the additional ECS on the residue line, the resulting increased gross revenues at the same MRF could pay for the additional capital cost of the ECS in roughly one year's time; by installing only the robot on the fiber line, the resulting increased gross revenues at the MRF could pay for the additional capital cost of the robot in just over four years' time.[37] While other factors must also be considered depending on the individual needs of the MRF, with these potential gains, public policy officials and investors may want to consider targeting investment in such equipment.

Table 6 – Potential Additional Per Ton Gross Revenues Associated with Increased UBC Capture Rates of MRF Equipment[36]

UBC Capture Scenario	Gross Revenues per Year (per ton[1]) from UBCs, States with Container Deposit Laws		Gross Revenues per Year (per ton[1]) from UBCs, States without Container Deposit Laws	
	Additional Gross Revenue Compared to Scenario 1	Total Gross Revenue from UBCs	Additional Gross Revenue Compared to Scenario 1	Total Gross Revenue from UBCs
Scenario #1: Current Average MRF UBC Capture Rate: 75%	N/A	$162,333 ($3.25)	N/A	$892,832 ($17.86)
Scenario #2: Adding a second ECS unit on the residue line, increasing MRF UBC capture rate to 83.5%	$18,398 ($0.37)	$180,731 ($3.62)	$101,187 ($2.02)	$994,019 ($19.88)
Scenario #3: Adding a Robotic Sorter to the post-sort fiber line[38], increasing MRF UBC capture rate to 80.8%	$12,554 ($0.25)	$174,887 ($3.50)	$69,045 ($1.38)	$961,877 ($19.24)
Scenario #4: Adding both an ECS unit to the residue line and a Robotic Sorter to the post-sort fiber line, increasing MRF UBC capture rate to 89.3%	$30,951 ($0.62)	$193,284 ($3.87)	$170,233 ($3.40)	$1,063,065 ($21.26)

(1) Based on a total tonnage processed at the MRF of 50,000 TPY
Note: Per ton dollar figures may not total due to rounding.

[37] Assuming simple pre-tax capital equipment costs, not including debt service, installation, depreciation, or operations and maintenance costs.
[38] Not all MRFs have a combined fiber line after the fiber post-sort stations. Each MRF will need to identify the fiber line with the greatest propensity to having aluminum cans if they are placing only a single robot. The above scenario assumes that nearly all UBCs are on a line that the robot can access.

4 Recycling Rate Improvements & Market Barriers and Opportunities

4.1 Overview

A September 2019 report by The Aluminum Association found that the 2018 consumer recycling rate for UBCs in the United States was 49.8 percent, an increase from 45.1 percent in 2017.[39] While aluminum cans remain by far the most recycled beverage package in the United States, returning aluminum to the system must be increased on a national scale.[40] Indeed, if more individual consumers ensured that their aluminum cans end up in recycling bins, MRFs would be able to recover more UBCs for sale to aluminum recyclers, thereby significantly increasing gross MRF revenues attributable to UBCs.

4.2 Overview of The U.S. Market for Aluminum Scrap

Aluminum cans are considered to be a scrap material, as opposed to a waste product. Thus, it is highly marketable and has historically retained a relatively high value compared to other recycled commodities. This high material value has incentivized MRFs to invest in equipment that recovers relatively high percentages of the aluminum stream compared to other streams. Additionally, the size and shape of aluminum cans has remained relatively uniform over time, ensuring that recovery of these cans is relatively easy compared to other streams that now see a wide variety of types, shapes, and sizes, such as plastics.

Aluminum as a recycled commodity has historically moved relatively quickly in the U.S. market due to high demand in domestic manufacturing activities and the difficulty of and relative cost and energy usage associated with aluminum ore mining, processing, and smelting compared to recycling. Mining, processing, and smelting virgin aluminum for use in manufacturing is significantly more labor and machinery intensive, expensive, and environmentally polluting than recycling aluminum.[41]

In contrast to virgin aluminum's energy intensive, multi-step process, recycling aluminum is much easier and more cost-effective, as well as involves more than 90% less energy use. Once UBCs are sorted and baled at a MRF, the bales are transported to an aluminum reclamation plant, where the UBCs are shredded into small pieces, run through a thermal process to remove any remaining non-recyclable materials such as paints, lacquers, plastic sleeves, and coatings, and then fed into a melting furnace.[42] The product from the melting furnace is relatively pure molten aluminum, which is then allowed to cool and

[39] The consumer rate for aluminum cans is defined by the Aluminum Association as the Pound of Cans Recycled by U.S. Consumers (or, Pounds of UBC Melted Domestically + Pounds of UBC Exports – Pounds of UBC Imports) divided by the Pounds of Can Shipped Corrected for Imports & Exports (or, Pounds of Cans Shipped by U.S. Producers – Pounds of Exported Unfilled Cans + Pounds of Imported Unfilled Cans). Source: The Aluminum Association, *The Aluminum Can Advantage: Key Sustainability Performance Indicators 2019,* September 2019.

[40] Smith, T. (2019, September 3). The value of aluminum recycling. *Recycling Today*. Accessed on 02/26/2020. URL: https://www.recyclingtoday.com/article/workshop-addresses-aluminum-packaging-and-dross-recycling/

[41] Byrne, B. (2016, May 27). The Rise of the Beer Can. *The Atlantic*. Accessed on 02/26/2020. URL: https://www.theatlantic.com/technology/archive/2016/05/rise-of-the-beer-can/484406/

[42] A high level of contamination can cause operational, compliance, and safety issues for aluminum recyclers, as well as dilute the monetary value of UBC recycling. At the time of this report, The Aluminum Association was in the processing of developing an Aluminum Can Design Guide to mitigate the presence of non-aluminum contaminants from the UBC stream – such as plastic labels, tops, and shrink sleeves as well as adhesives – and address the associated challenges these contaminants present.

harden into rectangular blocks called ingots. These ingots are then sold to manufacturers to make new products.

4.3 Market Barriers to Aluminum UBC Recycling in the United States

Despite the historic success of moving recovered aluminum, today there are three main market barriers for manufacturers to purchase and use domestic recycled aluminum from UBCs in the United States:

- Abundant global supply of aluminum;
- Secondary aluminum recycling capacity in the United States; and,
- Consumer action at the point of discard—i.e., individuals disposing their UBCs instead of recycling them—and little to no incentive for diversion.

Over the course of a year, from 2018 to 2019, prices for used aluminum cans in the U.S. fell approximately 25 percent, as previously illustrated in Figure 3 above. The global market has a strong influence on domestic recycling commodity values, and **the recent trend has been an abundance of global aluminum supply in comparison to global demand, causing global and domestic prices to fall.**[43]

The domestic recycling market for aluminum has also been shifting. Over the past decade, both U.S. capacity for aluminum recycling and aluminum imports have largely been increasing.[44] While there have been some instances of aluminum recyclers switching to making aluminum sheet for automotive and industrial components rather than for beverage cans,[45] **it is possible for U.S. recyclers to produce more beverage can aluminum sheet with existing infrastructure given the overall increase in U.S. secondary aluminum recycling capacity.** Demand for aluminum can sheet is anticipated to rise, since beverage can sales are up significantly at present compared to the past few years and expected to increase further over the next five years, both in North America and globally.[46] Further, the U.S. aluminum can industry desires to maintain its high recycled content of beverage cans above 70 percent. However, to maintain a high recycled content rate and avoid more imported aluminum sheet, domestic recyclers must continue to fulfill the vast majority of beverage can sheet demand in the United States, and U.S. consumers must place more UBCs in the recycling bin instead of the trash to ensure there is an adequate material supply for domestic recyclers.

A considerable barrier to more aluminum cans entering the recycling stream is consumers not participating fully, consistently, or at all in recycling. As noted above**, the U.S. consumer recycling rate for UBCs is just under 50 percent and is unlikely to significantly increase without consumers placing more UBCs in recycling bins.** This near 50 percent rate, which has been confirmed by highly detailed waste composition analyses that GBB has both reviewed and conducted for clients, represents a large amount of material and value leakage from the recycling system: **ensuring that individual consumers place their**

[43] Pyzyk, K. (2020, May 20). Pandemic exacerbates UBC recycling issues, following aluminum market decline. *Waste Dive*. Accessed 06/04/2020. URL: https://www.wastedive.com/news/ubc-aluminum-can-recycling-pandemic-coronavirus/577668/

[44] Source: The Aluminum Association.

[45] Tita, B. (2019, March 19). Aluminum Makers Ditch Can Business. *Wall Street Journal.* Accessed 01/29/2020. URL: https://www.wsj.com/articles/aluminum-makers-ditch-can-business-11552834801

[46] Globe Newswire. (2020, April 8). *Global Food & Beverage Metal Cans Industry (2020 to 2025) – Emerging Economies Offer High-Growth Potential Present Opportunities*. Accessed on 06/05/2020. URL: https://www.globenewswire.com/news-release/2020/04/08/2013501/0/en/Global-Food-Beverage-Metal-Cans-Industry-2020-to-2025-Emerging-Economies-Offer-High-Growth-Potential-Present-Opportunities.html

UBCs in recycling bins instead of the garbage would serve to significantly increase MRF revenues. Additionally, recapturing these UBCs within the recycling system would boost the domestic supply of UBCs that can be processed into aluminum can sheet, potentially easing the pressure on manufacturers to import supplemental material from overseas.[47]

The United States' relatively low UBC consumer recycling rate is not a worldwide trend. **The United States, by and large, lacks regulatory incentives to recycle or otherwise divert waste from disposal, except in select local jurisdictions.** In contrast, a number of other developed countries have very high costs of waste disposal that serve to incentivize waste diversion from disposal: local and national regulations tax or otherwise financially penalize waste disposal, while providing financial breaks and promotions for recycling and waste conversion technologies – thereby serving to increase the overall recycling rate. In other countries with less robust or established recycling systems, some have, over time, developed a culture of waste picking. This is where individuals salvage high value recyclable materials from waste streams as a form of income. Waste picking can also serve to increase a country's overall recycling rate.

In addition to legal and cultural inducements serving to increase the consumer recycling rate in various locations across the globe, many developed nations have a strong history and emphasis on source separation and consumer responsibility, as opposed to placing responsibility for sortation upon facilities like MRFs in the United States. Single stream recycling was introduced in most areas of the United States in the 1990s and 2000s and still today remains the most popular and largely most cost-effective method for consumer recycling. Single stream recycling has served to encourage recycling participation and increase the overall amount of materials put in a recycling program but on average increases the risk of commodity contamination and incorrect consumer recycling habits. Single stream recycling is likely to remain the most prevalent recycling system in the United States for the foreseeable future, due to its increased efficiency and cost-effectiveness, but more outreach and education will be required to ensure consumers are recycling properly in this commingled system.

Thus, for the reasons discussed here, apart from addressing UBC losses inside MRFs, the biggest potential gains to increasing UBC recycling are outside the MRF in the form of larger market drivers, increased focus on domestic secondary aluminum processing capacity for melting UBCs into can sheet, and changes associated with consumer recycling behavior, assuming consumers have sufficient access to recycling. Of these opportunities, **changing consumer recycling behavior has perhaps the most immediate and direct potential to increase domestic UBC recycling into can sheet.** These changes can be driven in large part by supply chain stakeholders. More detail on this topic is provided below.

4.4 Supply Chain Opportunities for Aluminum UBC Recycling in the United States

Pabst produced the first canned beer in 1935, made from steel, and the image is still iconic. Beer can production was temporarily halted during WWII as metal was needed for the war effort. Subsequently, Alcoa and other companies reinvigorated beverage can production.[48] Bill Coors and his team at Adolph Coors Company, then the parent company of Coors Brewing Company, were instrumental in researching and developing the first aluminum can for mass production (and subsequent recycling) in the United

[47] Pressure to import supplemental material from overseas has been further exacerbated by the COVID-19 national health emergency and global pandemic, as noted in Section 3.2.1.

[48] Byrne, B. (2016, May 27). The Rise of the Beer Can. *The Atlantic*. Accessed on 02/26/2020. URL: https://www.theatlantic.com/technology/archive/2016/05/rise-of-the-beer-can/484406/

States: the company debuted its two-piece aluminum can to the public in 1959.[49] The first easy-open can was introduced in 1962, and the finger-loop was introduced in 1965. For the first time in 1969, sales of canned beer surpassed those of bottled beer.[48] Development of the stay-on tab can solidified the design of the beer can, which persists to the present day.

Over the succeeding decades, canned beer developed a reputation for being "cheap" beer, or poor quality. This was primarily because most canned beer was mass-produced lagers. The cost of utilizing another type of packaging equipment (in addition to glass bottles and metal kegs) along with relatively high costs for metal as a material meant that only the largest breweries produced canned beers.[50] Another reason many people scoffed at canned beer is the perception that the cans give the beer a metallic taste. In reality, all draft beer sold in bars comes from a metal keg and does not taste "metallic"—it is rather the proximity of the can to the drinker's nose that gives a metallic smell, and therefore a perception of flavor.[51] However, the stereotype remained.

In 2002, craft breweries began to reclaim cans for their purposes, and as of 2017 aluminum cans comprised 62% of the total beer volume produced and sold in the United States.[52] The environmental benefits of aluminum cans versus glass are most frequently cited, but there are also economic and business reasons to use cans. Implementing a canning line can be much easier than bottling, the cans protect the product much better than glass, and the can itself offers more space for branding the product—and branding is critical for new products coming to market today.[53]

In more recent years, most new ready-to-drink (RTD) alcoholic beverages that have come to market are packaged in aluminum cans. The rising popularity of canned cocktails and hard seltzers should not be underestimated. According to IWSR, a leading industry research firm, wine sales volumes fell 0.9% in 2019 - the first time since 1994 that sales volumes were lower year over year. Although this decline was not observed across the board (sparkling wine sales grew 4% in the same time period), this trend highlights the growth in popularity of seltzer and other beverages.[54] Much reason for this change is attributed to younger drinkers choosing RTD beverages over wine and their increasing proportion of the population.[55]

Beverage companies can play a leadership role by including recycling of the packaging as a value associated with their products. This branding can be both subtle and direct, with opportunities in advertising, at point of sale, and on the packaging. Messaging that is transformational in nature (i.e.,

[49] Anton, K. (2019, January 22). Happy 60th birthday to the recyclable aluminum can. *Molson Coors Beverage Company.* Accessed on 02/26/2020. URL: https://www.molsoncoorsblog.com/features/happy-60th-birthday-recyclable-aluminum-can?sf206530004=1

[50] Perozzi, C. (2015, July 15). From Church Key to Pop Top, a Look Back at Canned Beer. *Eater*. Accessed on 02/26/2020. URL: https://www.eater.com/drinks/2015/7/15/8942369/dirt-cheap-week-canned-beer

[51] Eddings, B. (2020, January 9). Here's the Difference Between Beer Bottles and Cans. *The Spruce Eats*., Accessed on 02/26/2020. URL: https://www.thespruceeats.com/bottles-vs-cans-353100

[52] Uhrich, M. (2019). Trends in Beer Packaging. *The Beer Institute.* Accessed on 02/26/2020. URL: https://www.beerinstitute.org/trends-beer-packaging/

[53] Byrne, B. (2016, May 27). The Rise of the Beer Can. *The Atlantic*. Accessed on 02/26/2020. URL: https://www.theatlantic.com/technology/archive/2016/05/rise-of-the-beer-can/484406/

[54] IWSR. (January 2020). *Wine Consumption in US Declines for First Time in 25 Years* [Press release]. Accessed on 02/26/2020. URL: https://www.theiwsr.com/wp-content/uploads/Press-Release-IWSR-2019-US-Beverage-Alcohol-Consumption.pdf

[55] Duprey, R. (2020, January 22). Did Hard Seltzer Just Cause the First Drop in Wine Consumption in 25 Years? *The Motley Fool*. Accessed on 02/26/2020. URL: https://www.fool.com/investing/2020/01/22/did-hard-seltzer-just-cause-the-1st-drop-in-wine-c.aspx

conveying what products specific materials can be recycled into) as opposed to generic (i.e., those that emphasize general resource conservation and environmental benefits) has been shown to have better outcomes as far as increasing recycling behaviors.[56] As a testament to this finding, Metal Packaging Europe has been using the trademark, "Metal Recycles Forever," since 2014 to engage and inform consumers about the impact of their recycling behaviors.[57]

Producers of all types of products—soda, wine, RTD cocktails, and beers both "cheap" and "premium"—can lead the industry toward sustained high levels of product recyclability. Small or craft producers sometimes use shrink sleeves or adhesive stickers to brand their cans and control for issues of production scale and cost, but these items can cause sortation challenges at the MRF as well as contamination problems at the recycler.[58] Product design innovation can help solve for these problems and maintain a high level of UBC recyclability.

Producers can also promote recycling as a value of their brands. While they are researching how to induce their customers to further enjoy their products, they can also research and fund ways to encourage their customers to recycle. RTD beverages in aluminum cans are popular with more than one traditional hard-to-reach audience, including but not limited to customers choosing lower price point beer and those consuming beverages on the go or away from home.

Importantly, beverage companies, both alcoholic and non-alcoholic, are frequently festival and event sponsors. This provides an excellent opportunity for beverage container producers to promote and sponsor the recycling of their packaging to a captive audience. Another captive audience for beverage can recycling is at bars and restaurants, although in this case, the audience is the staff and business owners. Beverage container producers can advocate to require businesses with on-site alcohol consumption permits to recycle beverage containers as a licensing condition, as done, for example, in North Carolina.[59]

Although working in individual states is daunting, these types of regulations traditionally originate at the state level. Those connected directly with liquor licenses must be pursued in the statehouses. States can also ban certain items from disposal—which is also the case in North Carolina: aluminum cans and plastic bottles are banned from disposal in a landfill or a waste-to-energy facility.

The beverage industry continues to play a lead role in advancing recycling; however, other industry stakeholders, government policymakers and opinion leaders, along with individuals, must also share responsibility for ensuring that UBC recycling reaches its full potential, a need that has been particularly highlighted during the current COVID-19 national health emergency and global pandemic and the resulting economic and recycling market challenges. **There is a need to chart a new course for UBC recycling–one that more aggressively fosters recycling and increases demand for UBCs. To do this, stakeholders need to promote the economic, energy, and environmental benefits of aluminum**

[56] Winterich, K., Gonzales, G. E., & Nenkov, G. (2019, September 29). This simple tweak could drastically raise our pathetic recycling rates. *Fast Company.* Accessed on 06/04/2020. URL: https://www.fastcompany.com/90410129/this-simple-tweak-could-drastically-raise-our-pathetic-recycling-rates

[57] Source: https://www.metalrecyclesforever.eu/

[58] Davis, D., de Thomas, D., & Matta, T. (2019). ASTRX Review of Material Flow at MRFs and Reprocessors. *Applying Systems Thinking to Recycling (ASTRX).* Accessed on 06/04/2020. URL: https://astrx.org/wp-content/uploads/2019/12/ASTRX-Review-of-Material-Flow-at-MRFs-and-Reprocessors-1.pdf

[59] North Carolina Department of Environmental Quality. (No date). *ABC Containers*. Accessed on 02/26/2020. URL: https://deq.nc.gov/conservation/recycling/abc-container-recycling

recycling and explore equitable, sustainable policy options for UBC recycling at the national, state and local levels.

5 Conclusion

Container deposit laws affect the amount of UBCs that arrive at MRFs for sortation and recovery by incentivizing their removal from the municipal stream in favor of recycling through the deposit system. In states with container deposit laws, UBCs averaged only 0.4% of the incoming material stream by weight, while in states without container deposit laws, they averaged 2.2% of the incoming material stream by weight. Aluminum is currently the most highly valued commodity in the municipal recycling market. However, because UBCs do not typically represent a large percentage of a MRF's material stream by weight, UBCs do not necessarily represent as large a share of a MRF's revenue stream as may be expected.

Nonetheless, based on the composition of inbound material streams, UBCs represent 12.5% of typical MRF revenues in states with container deposit laws and 33% of typical MRF revenues in states without container deposit laws, using calendar year 2019 recycled commodity values (understanding that values over time are dynamic and dependent on both domestic and international supply and demand factors, as evidenced by the recent market fluctuations due to the adverse economic impacts of the COVID-19 U.S. national health emergency and global pandemic). Without this important revenue stream from UBCs, most MRFs in the United States would not be able to operate without making other changes to their business practices and models as they would likely be unable to cover the costs involved in processing recyclables with today's depressed recycling commodity market values. Understanding how to capture additional UBCs from a MRF's incoming revenue stream—both by changing MRF practices and by adding equipment—can make a dramatic difference in a MRF's bottom line. According to the information available at the time of this study, an estimated 25% of UBCs coming in to MRFs may be lost due to non-recovery.

The losses of UBCs at typical MRFs in North America have not been properly studied, and many MRF operators are likely unaware of the amount of losses they are incurring from improperly sorted or lost UBCs. Most of the losses that are currently documented at MRFs are measured at the residue line only, but evidence suggests that as much as or more UBCs are lost in the MRF at other locations. MRF operators cannot rely on the advertised capture rates of ECS units alone and disregard other potential losses that quickly add up to lost revenue as well as lost economic value and unrealized positive environmental impact.

As each MRF is different, detailed mass-balance studies would need to occur at the level of the individual MRF to best understand where and how UBCs are lost. Only then can industry researchers and innovators study and develop the best technical solution to increase UBC recovery tailored to individual MRF configurations, operational processes, and incoming material streams. In particular, with the advent of robotics, there are advanced solutions that already exist in the marketplace that may be a solution to recover more of the valuable aluminum at the MRF. Rough estimates indicate that the increase in gross revenues generated at a theoretical 50,000 TPY non-deposit law state MRF by installing both an additional ECS unit on the MRF's residue line and a robot on the MRF's fiber line to capture additional UBCs could pay for the additional capital cost of the equipment in just over two years' time. By installing only the additional ECS unit on the residue line, the resulting increased gross revenues at the same MRF could pay for the additional capital cost of the ECS unit in roughly one year's time; by installing only the robot on the fiber line, the resulting increased gross revenues at the MRF could pay for the additional capital cost of the robot in just over four years' time.

Additionally, it cannot be understated that, apart from addressing UBC losses inside MRFs, the biggest potential gains to increasing UBC recycling are outside the MRF in the form of larger market drivers, increased focus on domestic secondary aluminum processing capacity for melting UBCs into can sheet, and changes associated with consumer recycling behavior, assuming consumers have sufficient access to recycling. Of these opportunities, changing consumer recycling behavior has perhaps the most immediate and direct potential to increase domestic UBC recycling into can sheet.

With a UBC recycling rate of just under 50%, more than half of all aluminum cans end up in a landfill, representing massive economic and environmental losses. Further research will be required to understand why and where so many aluminum cans are discarded as waste, and how the point of discard could be transformed into the point of recovery. Other opportunities such as an industry-wide recycling campaign targeting canned beverage drinkers as well as legislation banning and appropriately enforcing the disposal of aluminum cans, as individual jurisdictions have done for materials such as yard waste and cardboard, could build additional support for the aluminum can as the driver of the U.S. recycling system.

The aluminum beverage can has historically been a significant source of revenue for MRFs. MRF revenues attributable to UBCs could be further increased by MRFs' installing more equipment to target UBC recovery. Such equipment installations have been shown to have relatively short payback periods and may prove to be both financially attractive and feasible for MRF operators considering implementing facility upgrades. With increased investment to accurately capture, sort, and recover UBCs at MRFs, more UBCs can be sold and recycled, thereby increasing overall MRF revenues and effecting significant, positive environmental impact. With greater use and recycling of aluminum cans, the entire recycling system benefits.

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