AEROSOL RECYCLING INITIATIVE

Aerosol Recycling Initiative: Propelling Increased Access and Improved Labeling

A resource for the latest information on aerosol recycling and industry efforts to increase aerosol recycling access and labeling.

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I. EXECUTIVE SUMMARY

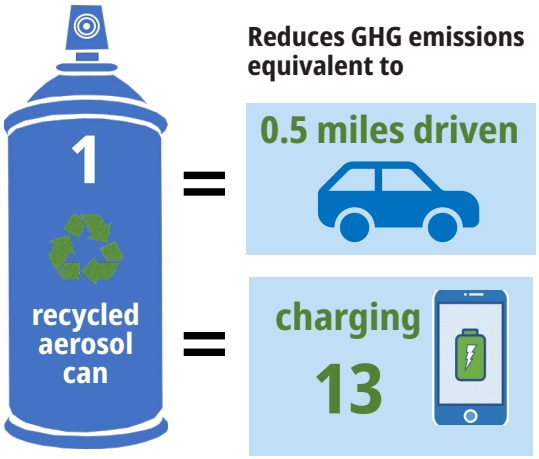
Nearly 4 billion aerosol containers—made from almost 300,000 tons of steel or aluminum[1]—are sold in the United States (U.S.) each year. These products are then used and disposed of by consumers and workers, resulting in a significant amount of packaging material that can end up as waste in a landfill if it is not recycled.

Recently, there have been questions regarding the accessibility and safety of recycling aerosol products. However, recycling, in general, and specifically aerosol products, when incorporated as part of a broader waste management system, can provide enormous benefits to communities, the economy, and the environment. Increasing recycling reduces the need for raw material extraction by keeping valuable material in circulation, retain economic value, create jobs, and reduce greenhouse gas (GHG) emissions.

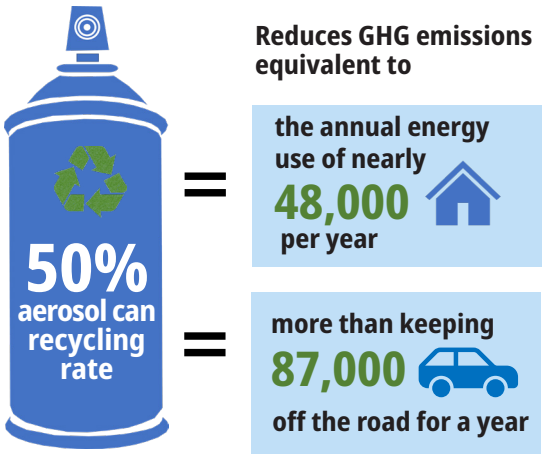
From an environmental standpoint, recycling just one aerosol reduces GHG emissions by the equivalent of driving 0.5 miles in the average gasoline-powered passenger vehicle or charging 13 smartphones.[2]

Looking at a larger scale, a 50-percent recycling rate of aerosols annually delivers savings equivalent to the energy use of nearly 48,000 U.S. homes per year or the annual GHG emissions from more than 87,000 gasoline-powered passenger vehicles.[2]

GREENHOUSE GAS SAVINGS EQUIVALENCY



GREENHOUSE GAS SAVINGS EQUIVALENCY

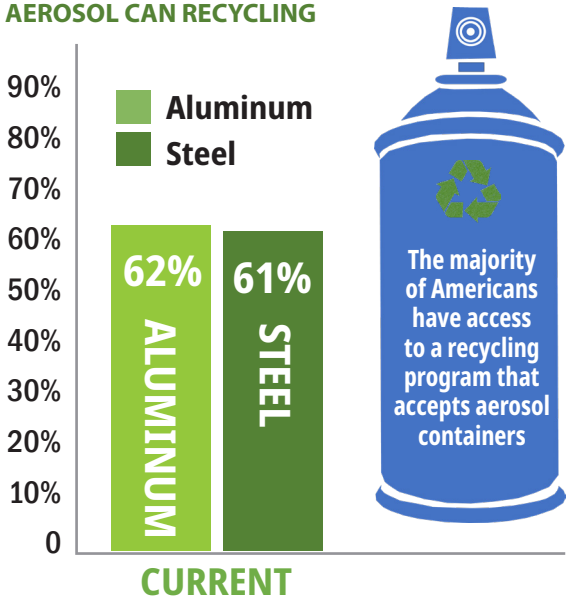


SOURCE: EUNOMIA, EPA WARM MODEL

Economically, a 50-percent recycling rate of aerosols generates more than $39 million each year.[2] Since metal recycles forever, the benefits compound as the aluminum and steel from these products continues to be recycled.

While there are many benefits to recycling aerosol cans, there is also uncertainty about their appropriate end-of-life management. More and more stakeholders are questioning whether a product's packaging is truly recyclable, leading to questions about recycling rates and what happens to a product after it is put in the recycling bin. This growing concern coincides with decreased opportunities for end users to recycle aerosol cans. For example, the national access rate for aerosol products (the percent of Americans with access to recycling programs that accept aerosols) dropped from 70 percent in 2016 to just above 60 percent in 2021.[3]

CURRENT U.S. ACCESS RATE FOR AEROSOL CAN RECYCLING



SOURCE: SUSTAINABLE PACKAGING COALITION

In order to reverse this negative trend and improve the aerosol can's recycling story, the Can Manufacturers Institute (CMI) and the Household & Commercial Products Association (HCPA) launched the Aerosol Recycling Initiative in May 2022 with the support of 17 companies across the aerosol value chain. The Initiative aims to make recycling aerosol cans easier for the end user by achieving two quantitative goals by 2030:

- At least an 85 percent recycling access rate for aerosol cans in the U.S. market.
- At least 90 percent of aerosols labeled as recyclable with messaging about how to properly recycle them.

AEROSOL RECYCLING INITIATIVE

AEROSOL RECYCLING BY 2030

85% Achieve at least an 85 percent recycling access rate for all aerosol cans.

90% Label at least 90 percent of all aerosols as recyclable with messaging on how to properly recycle them.

WWW.THEHCPA.ORG/AEROSOL-RECYCLING-INITIATIVE

The Initiative established four focus areas and accompanying activities[4] for the initial phase:

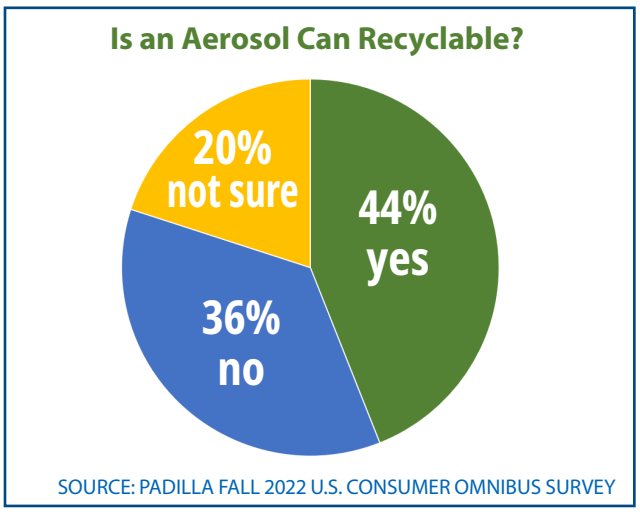
INITIAL AEROSOL RECYCLING INITIATIVE FOCUS AREAS

	Focus Area	Activity
	**Addressing data gaps**	Labeling analysis to establish a baseline for current recycling-related messaging on aerosols. Environmental and economic impact analysis to evaluate the potential benefits of recycling more aerosols. Aerosol can testing to assess the extent to which residual contents remain in aerosols that reach MRFs.
	**Increasing the acceptance of aerosol cans at material recovery facilities (MRFs)***	Interviews with MRF operators to understand their concerns about accepting and processing aerosols.
	**Understanding consumer awareness**	Omnibus survey to obtain insights on consumer sentiment and awareness of recycling aerosols.
	**Publishing information on the aerosol can's recycling story**	A white paper explaining the aerosol can's recycling story.

*MRFs are where combined recyclables are sorted.

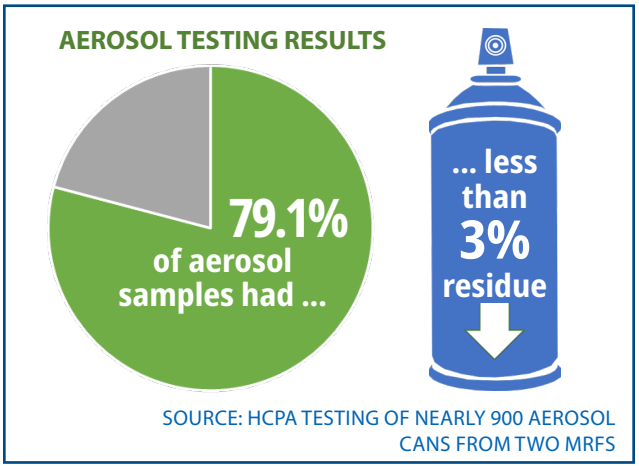
While it would be ideal for all consumers to empty aerosol cans before putting them in the recycling and for all recycling programs to accept these products at curbside, that isn't the current reality.

Data from the omnibus survey found that more than half of consumers are either unsure if aerosols can be recycled or think they are not recyclable at all.



Regarding acceptance, the Sustainable Packaging Coalition's 2020-2021 availability of recycling study found that more than 60 percent of U.S. households have access to a recycling program that accepts aerosol cans. The recycling programs that do not accept aerosol cans are reluctant to accept them mainly due to safety concerns that come from consumers not emptying the leftover product from the can.

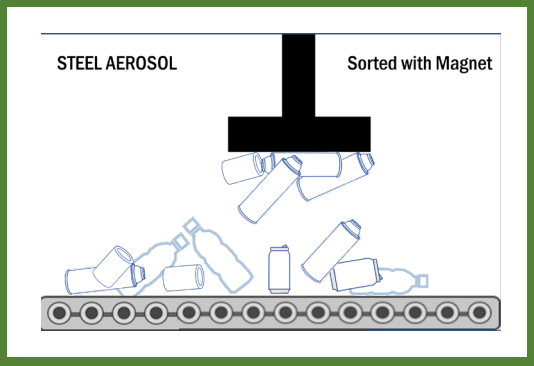
Interestingly, even with a lack of clear communication about how to dispose of an aerosol, most of these cans have no or minimal leftover product. The Initiative determined this by pressure testing nearly 900 aerosols from two MRFs and found that nearly 80 percent of the tested cans had less than three percent residue.

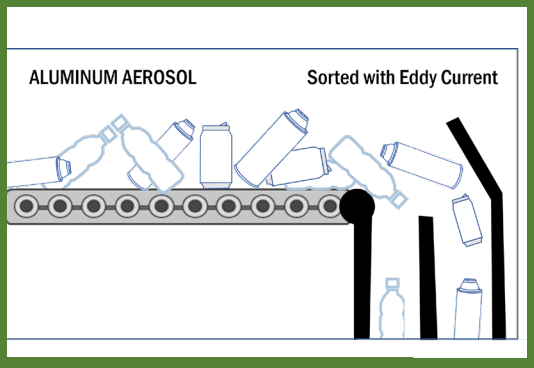


The aerosol industry believes that recycling programs and the MRFs that sort recyclables should accept aerosol cans for several reasons.

1. MRFs can sort both aluminum and steel aerosol cans with existing equipment.
2. Since aerosols are made from metal, they have ready end-markets (i.e., buyers) and can be a beneficial source of revenue for MRFs.
3. According to research from Factory Mutual Corporation, the risks associated with including empty aerosols in the recycling stream are manageable.
4. While some MRF operators perceive aerosols as a fire risk, it is actually very rare for these products to be identified as the cause of a MRF fire.
5. When a recycling program is silent regarding its acceptance of aerosols, as too many often are, consumers do not know where to empty the leftover product or how to dispose of the can.

ALUMINUM AND STEEL AEROSOLS ARE SORTED AT MATERIAL RECOVERY FACILITIES WITH EXISTING EQUIPMENT





AEROSOL RECYCLING INITIATIVE

Looking to the next phase, the Initiative has already identified areas that can help achieve the 2030 goals.

INITIAL PHASE Establishing Foundation

Publishing documents on the aerosol recycling story

Addressing data gaps

Comprehending barriers to increased acceptance at MRFs

Understanding consumer awareness

NEXT PHASE Progressing Toward Targets

Formed Aerosol Recycling Initiative Labeling Task Force to develop a guide with message options to meet the labeling goal

Engaging MRFs, municipalities, and retailers to offer aerosol recycling access; advocating for inclusion of aerosol cans on statewide "recyclable" lists

There is work to be done on the labeling goal with the labeling baseline study finding that only 29 percent of aerosol cans include messaging about how to appropriately recycle the can, specifically that the can must be empty before disposing of it. That being said, the Initiative believes this can be addressed fairly quickly since brands that sell products in aerosol cans have control over what is on the label. In fact, HCPA formed an Aerosol Recycling Initiative Labeling Task Force to help companies make certain label changes to help meet the 2030 goal while still being compliant with state and federal requirements.

Regarding access, this will involve a multi-pronged approach:

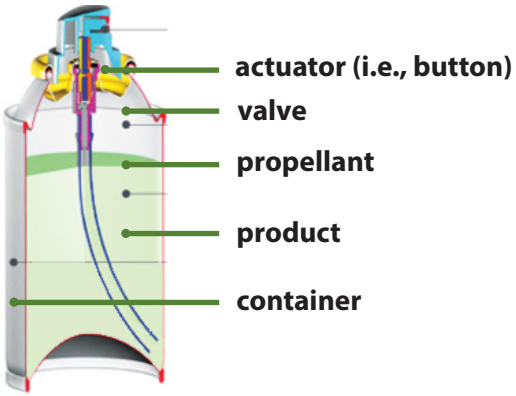
- Incentivize MRFs that do not currently accept aerosols to shift to acceptance by offering industry-funded communications to the community with directions about how to properly recycle these products.
- Educate municipalities—the MRFs' customers—about the benefits of recycling aerosols to build a network of stakeholders who can advocate for the acceptance of these products in recycling programs.
- In areas where there is no curbside recycling program for aerosols, partner with retailers that have regular pick-ups of surplus or dented aerosols to provide consumers with a convenient recycling access point.
- Advocate for aerosols to be included on statewide "recyclable" lists, especially in states that have passed Extended Producer Responsibility (EPR) programs for packaging. EPR laws are designed to shift the costs of managing product packaging at end-of-life from municipalities and consumers to the product manufacturers. At the time of publication, five states (California, Colorado, Maine, Minnesota and Oregon) have passed such laws.

The full white paper details the data and insights that the Initiative has gathered to date regarding the accessibility, understanding, and safety of recycling aerosols in an effort to achieve the 2030 goals for the benefit of the environment and the economy.

II. AEROSOL PRIMER

A. AEROSOL BASICS

AEROSOL PRODUCT DELIVERY SYSTEM



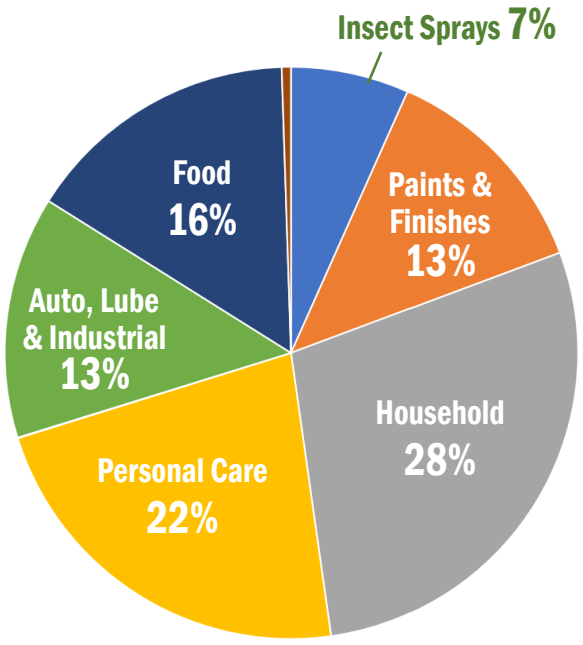
Why Choose Aerosol Products?	
SAFE	Hermetically sealed and individually tested during the manufacturing process to ensure that the contents do not leak or spill. The containers are tamper-resistant and tamper-evident.
SUSTAINABLE	Designed to deliver the right amount of product exactly where it's needed, minimizing waste and spillage. Empty aerosol containers are also recyclable, enabling the metal to be used again in new products.
COST-EFFECTIVE	Control the particle size, spray pattern, volume dispensed per second, and concentration of the spray for maximum effectiveness. The tightly sealed package protects the product and extends its useful life. For example, aerosol spray paint can be stored without risk of evaporation.
CLEAN AND SANITARY	Can be applied without contact, protecting users from exposure to mess and bacteria. In addition, the sealed container prevents any product contamination.
CONVENIENT	Spill-proof, which is helpful for medical and personal care products. They eliminate the need for mixing containers and applications, which is especially helpful for medical personnel, travelers, children, and the elderly. Aerosol products provide the same performance throughout the lifespan of the product.
UNIQUE	Allow consumers and workers to use products that would otherwise be unavailable, such as shaving cream and spray deodorant, long-distance spray insecticides, asthma inhalers, and other medical products.

The aerosol delivery system started with a patent in 1931, and now provides products, such as air fresheners, deodorants, disinfectants, foods, lubricants, and shaving creams that people depend on around the world. While aerosol containers make up a relatively small portion of the total metal cans manufactured in the U.S., there are still nearly four billion total cans produced in the country per year[5] of which approximately three-quarters are steel and one-quarter are aluminum.

Aluminum and steel aerosol cans are made with metal that recycles forever and are important to recycle so that metal stays circulating to become new cans or other recyclable products rather than in the landfill. Using recycled aluminum and steel in new products significantly reduces greenhouse gas emissions. Consider how using recycled aluminum production entails 94 percent less carbon emissions than virgin aluminum production,[7] and recycled steel saves more than 70 percent of the carbon generated from virgin steel production.[8] Further, recycling metal delivers more resilient supply chains for domestic manufacturers, which provides the opportunity to hire more Americans to make additional products with this recycled material.

For more on the history of the aerosol can, the different types of aerosol cans, and the propellants used in aerosol cans, please see Appendix A.

PRODUCT CATEOGORY BREAKDOWN FOR AERSOLS IN THE U.S.



SOURCE: HCPA AEROSOL PRESSURIZED PRODUCTS SURVEY[6]

B. PREVIOUS INDUSTRY EFFORTS AND RESEARCH ON AEROSOL RECYCLING

While aerosol cans have consistently been included in many local recycling programs, the aerosol industry has conducted research and pursued activities to enhance knowledge of and increase the amount of aerosol recycling.

RESEARCH

As the flammability of aerosol products became more of a concern, the industry worked to ensure that they can be recycled safely. In the 1990s, the Chemical Specialty Manufacturers Association (CSMA), now HCPA, hired Factory Mutual Research Corporation (FMRC) to conduct a risk assessment of recycling aerosol cans.[9] The scope of this study covered the operations of a typical MRF, which sorts single-stream recyclables. The research considered risks like fires and explosions in the MRF due to the presence of non-empty aerosol cans in the recycling stream.

The assessment found the likelihood of an accident with no significant consequences to be low or remote. Further, FMRC determined the likelihood of an accident with significant consequences to be very low. Therefore, the conclusion of this analysis was that when systematically addressed, the risks associated with the inclusion of empty aerosol containers in the recycling stream are manageable. As part of the analysis, FMRC provided a series of risk reduction opportunities to minimize the additional risk attributed to the inclusion of aerosol cans.[10]

More recently, CMI, HCPA, and the Pet Food Institute collaborated to sponsor research by Resource Recycling Systems (RRS) to learn more about the current state of affairs for recycling aerosol and pet food cans.[11]

The goals of the research were to:

- Develop a better understanding of capabilities at MRFs to sort, process, and sell aerosol and pet food containers.
- Document specific technical hurdles at MRFs or within the commodity bale that impede recycling.
- Develop actionable recommendations.

RRS interviewed 14 independent and two national MRF operators. This included small, regional, and national waste service providers, accounting for approximately 25 percent of the total number of residential MRFs in the U.S. that process about half of the total tonnage of recyclables. RRS also interviewed aluminum and steel end-market stakeholders, including traders, intermediary scrap processors, metal recyclers, and mills. The learnings from this research will be discussed in Section IV(E) of the white paper on how aerosols are recycled by various processors.[12]

COMMUNICATIONS

In August 2018, the Consumer Aerosol Products Council (CAPCO) launched Mist Understood, a campaign that aimed to change consumer perceptions about certain aspects of aerosol products, including recycling, through creative activities and environmental education. The campaign involved a dedicated website to provide updated information on the impacts of aerosols, share community building moments through social media and in-person engagements, and showcase a series of creative video content about new ways to view aerosol products. The website also included a page focused solely on recycling. The active consumer messaging phase of Mist Understood ran through October 2019, as evidenced by its X (formerly Twitter) page.

In 2021, Mist Understood reemerged as a platform by CAPCO to provide online classes about the aerosol industry. As of June 2023, the courses page includes 10 classes, two of which are specifically related to aerosol recycling: Aerosol 101 with Nicholas Georges of HCPA and Aerosol 201 with Gary Okey of Recycle Aerosol.

C. CURRENT U.S. REGULATORY LANDSCAPE FOR THE DISPOSAL OF AEROSOL PRODUCTS

FEDERAL REQUIREMENTS

In the U.S., the principal law that creates the framework for the proper management of hazardous and non-hazardous waste is the Resource Conservation and Recovery Act (RCRA).[13] The corresponding regulations[14] carry out the congressional intent by providing explicit, legally enforceable requirements for waste management. To understand how aerosol containers are disposed of in relation to these regulations, it's critical to consider where the aerosol waste is generated, and whether the container is empty or has leftover contents.

Aerosols From Industrial, Institutional, and Commercial Sources

Waste generated in commercial, institutional, and industrial settings, including waste generated by an aerosol manufacturer or retailer, is subject to RCRA. When the aerosol container is empty, which is defined[15] as having 3-percent or less by weight residue left in the container, the container is a non-hazardous waste and can be offered to a recycling program. An aerosol container likely has 3-percent or less by weight residue left in it when the button is pushed and no more product is released. When the aerosol container has leftover contents—more than 3-percent residue—the aerosol container is considered hazardous waste under RCRA and must be managed as such. In this case, the aerosol can only be recycled if it is sent to an appropriate destination facility that is equipped with technology to puncture and drain the product. The focus of this white paper is on increasing aerosol recycling from residential sources. See Appendix B for more information on aerosols from industrial, institutional, and commercial sources.

Aerosols From Households

Household waste, which includes waste generated by consumers in homes, hotels, motels, campgrounds, and other residential sources, is excluded from RCRA regulations under the household hazardous waste (HHW) exemption.[16] As such, households are not subject to any federal requirements related to the disposal of aerosol cans, whether empty or not. Consumers need to be educated and encouraged to dispose of their aerosol products appropriately—when empty, offer the container to the appropriate local recycling program, and when containing leftover product, offer it to a local HHW program.

STATE ACTIVITY

A growing number of states in recent years have passed or are considering passing EPR laws for packaging, which are designed to shift the costs of managing product packaging at end-of-life from municipalities and consumers to the product manufacturers. Five states—California,[17] Colorado,[18] Maine,[19] Minnesota,[20] and Oregon[21]—have passed EPR laws for packaging thus far and, absent activity at the federal level, several more are likely to move forward with their own versions in the near future. Additionally, Vermont has passed an EPR law for HHW.[22]

None of these states have, as of yet, finished their full rulemaking process, so it is not possible to say with certainty how aerosol cans will be addressed. All five of the packaging EPR states have indicated their intention to make a determination on the recyclability of empty aerosol cans within their state and promulgate regulatory requirements accordingly. Empty aerosol cans could potentially be considered:

A. Widely recyclable within a state, meaning they are required to be included in curbside collection statewide.
B. Recyclable but not appropriate for curbside collection, meaning they are required to be collected for recycling statewide but must be collected through drop-off locations.
C. Not recyclable in the state, meaning municipalities can include aerosols on their lists of recyclable materials to be collected if they would like but are not obligated.

As implementation progresses for these laws, they will have significant implications for the recycling rate of aerosol cans and have the potential to increase or decrease aerosol recycling. As described in the next section, the Aerosol Recycling Initiative was established in part to develop the information and take the steps necessary for aerosols to be considered widely recyclable in states with EPR programs.

III. AEROSOL RECYCLING INITIATIVE AND 2030 GOALS

Under the leadership of CMI and HCPA, and with the support of industry sponsors from across the value chain, the Aerosol Recycling Initiative was launched in May 2022. CMI represents U.S. metal can manufacturers and their suppliers, and HCPA represents companies that make and sell formulated products used for cleaning, protecting, maintaining, and disinfecting homes and commercial environments.

The Aerosol Recycling Initiative's vision is for end-users to be able to easily recycle aerosol products and feel confident in the appropriate way to do so. The Initiative has two quantitative goals to achieve by 2030:

85% Achieve at least an 85 percent recycling access rate for all aerosol cans.

90% Label at least 90 percent of all aerosols as recyclable with messaging on how to properly recycle them.

AEROSOL RECYCLING INITIATIVE

INITIAL AEROSOL RECYCLING INITIATIVE SPONSORS

GOLD TIER

Ball

TRIVIUM PACKAGING

SILVER TIER

AEROFIL

PLZ CORP

P&G

scJohnson

BRONZE TIER

CRC

SONOCO

SUPPORTER

ARM & HAMMER

CCL

CROWN Brand-Building Packaging™

DiversifiedCPC INTERNATIONAL

DSC DS CONTAINERS

Honeywell

reckitt

SHERWIN WILLIAMS

SUMMIT packaging systems

To make progress toward the two 2030 goals, CMI and HCPA have established a foundation that the industry can continue to build upon.[23] To start, the initiative has made the following efforts:

- Analyze the environmental and economic benefits of recycling aerosol products.
- Survey consumers on their understanding of the recyclability of aerosols.
- Determine the amount of content remaining in aerosol containers that reach MRFs.
- Develop a baseline on the number of aerosol products that have appropriate recycling messaging.
- Identify MRFs that do not accept aerosol cans and engage in discussions with them.

Some of these initial activities were conducted to gain a better understanding of the current state of aerosol recycling and the importance of recycling more aerosol cans. Others were directly related to making progress toward the 2030 goals, such as directly engaging MRFs on what they need to change to go from not accepting aerosols to accepting aerosols, so the access rate increases. More information about the results of these activities is outlined below as part of the sections on the current state of aerosol can recycling and the importance of increasing aerosol can recycling. Please see Appendix F for more details on how these activities were conducted.

This initiative is an ongoing effort. See Section VI for a description of the future activities under consideration to make even more progress toward the 2030 targets.

IV. CURRENT STATE OF AEROSOL RECYCLING

A. AVAILABLE INFORMATION ON AEROSOL RECYCLING LEVELS AND ACCEPTANCE

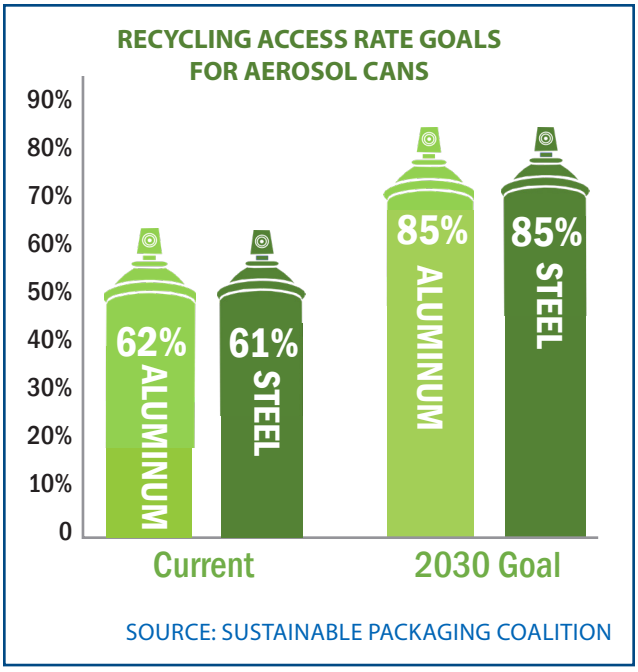
It is difficult to develop data granular enough to determine an aerosol-specific recycling rate. However, The Recycling Partnership conducts studies across major metropolitan areas to identify capture rates (i.e., the percent of recyclable packaging that was correctly put into the recycling), and it found an average 25-percent capture rate for aerosol cans across 16 participant capture rate studies. See Table 1 for results from some of those participant capture rate studies. This data shows that consumers need to be better educated about the recyclability of empty aerosol containers.

There is better aerosol-specific access rate data available. The Sustainable Packaging Coalition (SPC) confirmed in its latest recycling access report that a majority of Americans have access to a recycling program that accepts empty aerosol containers (i.e., access rate). In SPC's 2016 report, approximately 70 percent of Americans had access; however, this number decreased in 2021 to just over 60 percent for both aluminum and steel aerosol containers. This decrease is one of the reasons CMI and HCPA decided to launch the Aerosol Recycling Initiative. Without taking action to reverse this trend, aerosol cans are at risk of not being able to be labeled as recyclable. Ultimately, more aerosol cans are expected to be recycled if they are labeled as recyclable and consumers have easy access to aerosol recycling.

TABLE 1: PERCENT OF USED AEROSOL CANS PLACED INTO RECYCLING BY HOUSEHOLD RECYCLING PROGRAM PARTICIPANTS

Community	Rate
Atlanta	28%
Chicago	21%
Denver	33%
Gahannal/Reynoldsburg, OH	18%
Sarasota County, FL	29%

SOURCE: THE RECYCLING PARTNERSHIP PARTICIPANT CAPTURE RATE STUDIES IN VARIOUS COMMUNITIES

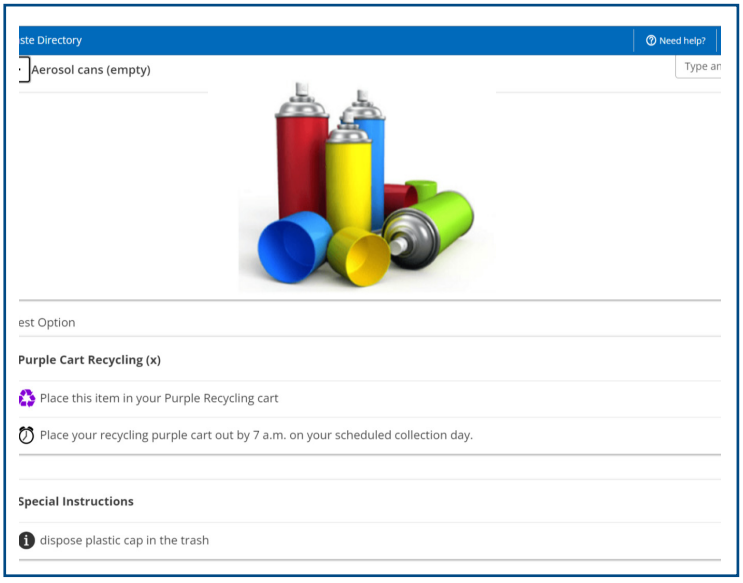


SOURCE: SUSTAINABLE PACKAGING COALITION

AEROSOL RECYCLING INITIATIVE

EXAMPLES WHERE CONSUMERS HAVE ACCESS TO AEROSOL RECYCLING:

SOURCE: PRINCE GEORGE'S COUNTY DEPARTMENT OF THE ENVIRONMENT



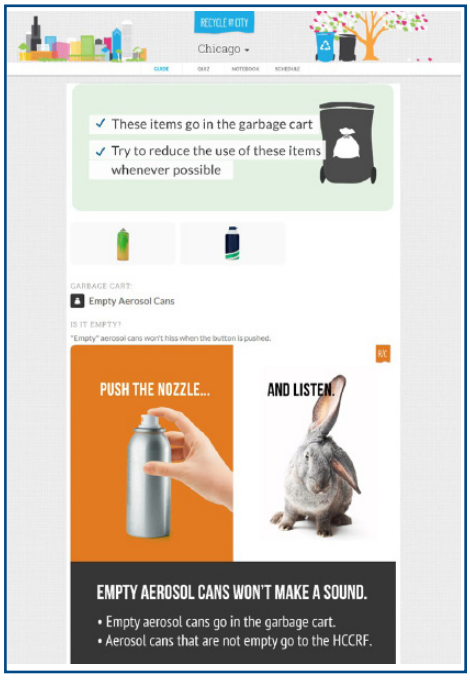
SOURCE: CITY OF DENVER

TABLE 2: LARGEST U.S. COMMUNITIES THAT DO NOT ACCEPT AEROSOL CONTAINERS

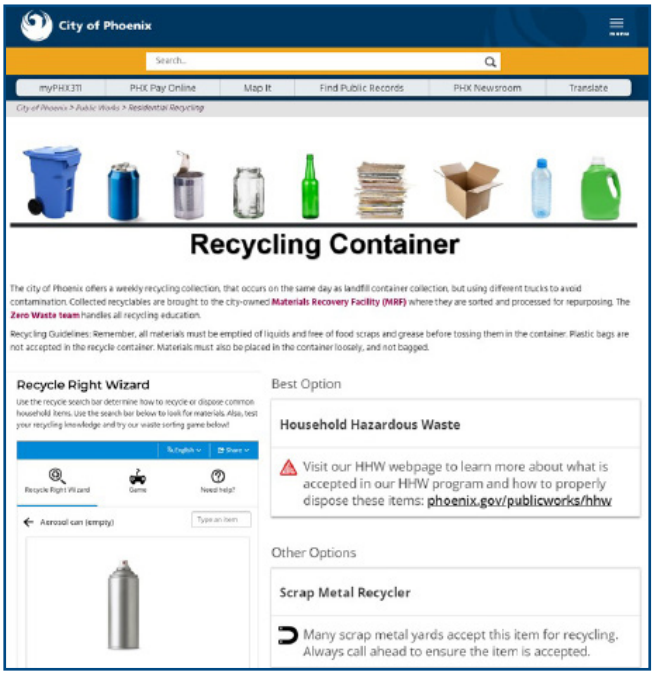
City	Single-Family Households Served
Chicago	706,412
Phoenix	436,115
Detroit	299,388
Indianapolis	289,104
Dallas	282,072

THE RECYCLING PARTNERSHIP'S NATIONAL RECYCLING DATABASE[24]

EXAMPLES WHERE CONSUMERS DO NOT HAVE ACCESS TO AEROSOL RECYCLING



SOURCE: CITY OF CHICAGO



SOURCE: CITY OF PHOENIX

There are several potential reasons for the decline in the aerosol container access rate, but the main one seems to be MRF concerns about safety. The aerosol industry has heard this directly from MRF operators, as well as interviews that GBB and RRS conducted. For instance, several MRFs reported hearing small pops during baling of metal cans, although balers are designed to withstand these sorts of bangs.

More generally, MRF fires are a growing issue, largely due to the increasing prevalence of batteries in the recycling stream. Fire Rover, a company that sells fire safety and suppression technology to MRFs, said there were more publicly reported fires at MRFs in 2022 than in all the years since they began tracking this data in 2017. There were 390 fire incidents at MRFs in 2022. About 50 percent of these fires[25] were due to lithium-ion batteries and the other half were the result of traditional fire hazards, such as propane tanks, accelerants, chemicals, flares, hot charcoal, and cigarette butts. More specifically, the U.S. Environmental Protection Agency (EPA) issued a report in July 2021 that found 64 waste facilities across 28 states experienced 245 fires that were caused by, or likely caused by, lithium metal or lithium-ion batteries between 2013 and 2020.[26]

As these fire incidents have increased, so has the cost of fire insurance for MRFs. The aerosol industry heard from one MRF operator that is not willing to accept aerosol cans because they do not want to incur any potential increase in fire insurance premiums.

While some perceive aerosols as posing a fire risk, ultimately it is very rare for an aerosol container to be identified as the cause of a MRF fire. If it is, it is likely the result of a flammable aerosol product with significant leftover material that has improperly been recycled in combination with another material acting as the ignition source. A lack of data on the root causes of MRF fires makes it difficult to conclusively assert the actual risk from aerosols in MRFs.

Based on the SPC access rate data, the majority of Americans have access to a recycling program that accepts aerosol containers; however, there is a lack of information about whether or not individual MRFs accept these products. A community can structure a contract with a MRF to include certain recyclables, but it is typically individual MRF operators who decide whether or not to process aerosol containers.

HCPA staff reached out to 67 large U.S. MRFs to confirm whether aerosols are accepted, and if not, to understand why that is the case. Resources that were helpful in this effort were *Waste Today's* list of North America's 75 largest MRFs[27] and The Recycling Partnership's Residential MRF Map.[28] The results of HPCA's outreach are presented in Table 3.

TABLE 3: RESULTS OF MRF OUTREACH ON ACCEPTANCE OF AEROSOL CONTAINERS

Republic Services	Waste Management	Other MRFs
• Of the 11 Republic Services MRFs on the contact list, two were reached by phone and confirmed they do not accept aerosol containers. • At a corporate level, Republic Services generally does not accept aerosol containers, but some of its MRFs may accept aerosol containers due to their contract with a municipality or for other reasons. • The metal and aluminum page on Republic Services' Recycling Guide website has no information on aerosols.[29]	• None of the 21 Waste Management (WM) MRFs were reached by phone. • At a corporate level, WM generally does not accept aerosol containers; however, some of its MRFs accept aerosol containers. • The WM website[30] on what is recyclable notes that acceptance of aerosols "varies by jurisdiction" and "Waste Management facilities and commodity vendors accept steel, mixed metal, and aluminum aerosol packages."	• 10 MRFs communicated (by phone or on their website) that they explicitly accept aerosols. • 21 MRFs had no information on their website about whether they accept aerosol containers, and they were not reached or did not communicate that information by phone. • Three MRFs confirmed via phone or on their website they do not accept aerosol containers.

SOURCE: HCPA

The aerosol industry also had several in-depth conversations with MRF operators including representatives from Atlantic Coast Recycling, Balcones Resources, Lakeshore Recycling Systems, Republic Services, Rumpke, and Waste Management. GBB and Jensen Hughes also had in-person visits with three Portland, OR, area MRFs: EFI Recycling, Far West Recycling, and Mid-Valley Garbage Recycling.

From these conversations with MRF operators, the following criteria proved most important for a MRF to move to accepting aerosol cans, with safety being paramount.

- Safety: Ensure safety in all aspects of the process including receiving, sorting, and processing at the facility, as well as storage, transportation, and shipping. The greatest area of concern was usually at the baler, with the tip floor (i.e., where material is unloaded from collection trucks) being the next area of concern.
- Technology: Advancements to take the risk out of the aerosol can at the beginning of the sorting process upon initial arrival at the facility. Examples of such technology include:
  - Human or robotic recovery of aerosols specifically to handle aerosols differently than other recovered commodities.
  - Depressurizers for the cans without having to use the baler.
  - Perforators to remove air volume and liquids prior to baling.
  - Artificial Intelligence that could identify the non-desirables, like paint cans, propane cylinders, and other materials, that could potentially cause fires or injuries to employees at the beginning of MRF processing.
- Operations: A forward-thinking operator who values and desires increased material recovery.
- Financials: Show ultimately lower costs to MRFs or increased revenue from the recovery of aerosol cans.
- Marketability: Proof of end markets for the material. Aerosols do well on this front.

"We're stuck in the middle. The manufacturers want it, the markets want it, but how can we safely get it to them?"

- Mark Molitor, LRS

"We want to recycle well, recycle correctly, and collect a lot of material."

-Large Independent MRF Operator

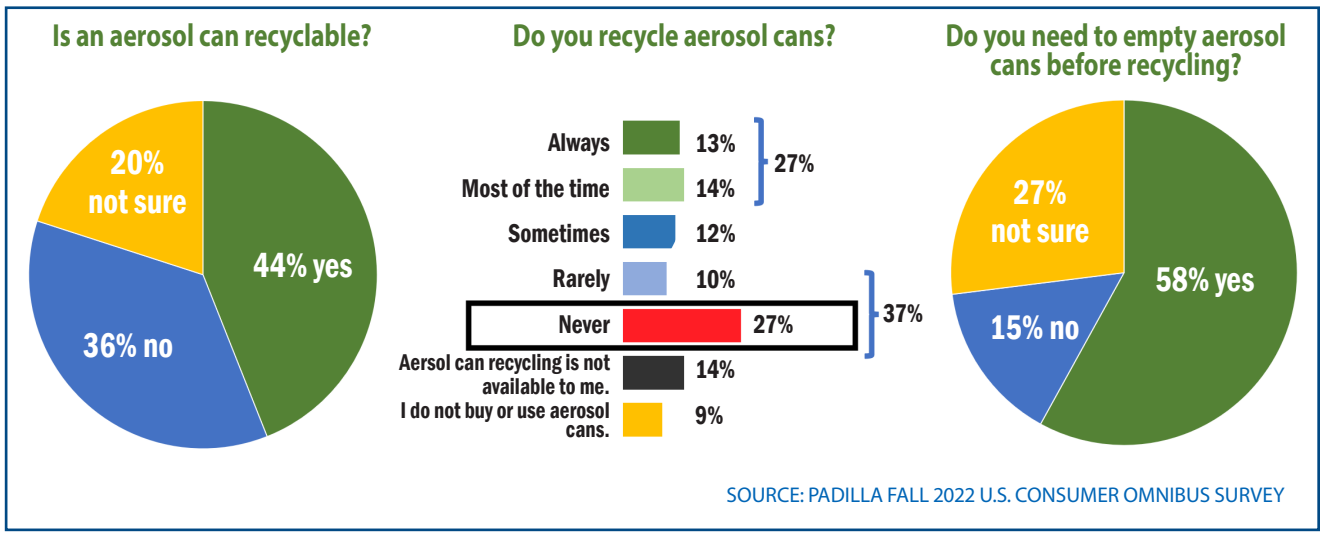
"We have multiple homes for aerosols, and we can sell it all day long."

-Jeff Snyder, Rumpke Waste & Recycling

B. CONSUMER UNDERSTANDING OF AEROSOL RECYCLING

The first step in the chain of events needed to successfully recycle any consumer product packaging, including aerosols, is the appropriate disposal of the recyclable packaging by the consumer so that the container can be collected, sorted, and sent to a processor for recycling. The level of consumer awareness of the recyclability of aerosols, and how to recycle them is critical to consumers correctly putting aerosol containers in the recycling.

To learn the current level of consumer understanding of aerosol can recyclability, CMI and HCPA included 10 questions in an online omnibus survey conducted by Padilla, a market research and consulting firm, in fall 2022.[31] Respondents were general population adults (18+) across the U.S. A summary of key takeaways is below and more information on the methodology for these activities is in Appendix F.



Key Takeaways - General:

- Less than half (44%) of respondents think that an aerosol can is recyclable, with more than a third (36%) saying it is not recyclable and a significant proportion (20%) unsure of whether or not aerosols can be recycled.[32]
- Only 28% of respondents purchase aerosol products "rarely," "very rarely," or "never," indicating that the majority of consumers use aerosols with some degree of frequency.

Key Takeaways - How to Recycle Aerosols:

- Over two-in-five (42%) of respondents do not know if aerosol cans are accepted for recycling where they live.
- Over one-quarter (27%) of respondents "never" recycle aerosol cans and over one-third (37%) state that they "rarely" or "never" recycle aerosol cans, and these respondents exclude those who said aerosol can recycling is not available to them (14%) or they do not buy or use aerosol cans (9%); only a little over one-quarter (27%) said they recycle aerosol cans "always" or "most of the time."
- More than half of respondents (58%) understand that an aerosol can needs to be emptied before it can be recycled, but a substantial portion (27%) do not know and even fewer (15%) do not believe that aerosols need to be emptied before recycling.
- One-quarter (25%) of respondents "never" check the label of aerosol cans for recycling information and an additional 16% say that they "rarely" check the label.

Key Takeaways - Generational Differences:

- Millennials purchase aerosol products more frequently (35%) and are the generational group most likely to think that aerosol cans are recyclable (60%) and sustainable (24%).
- Millennials are also more likely than any other generational group to say that aerosol cans are accepted for recycling where they live (38%), that they recycle them always or most of the time (38%), and that the can needs to be empty before recycling (66%).

Overall, consumer understanding of whether an aerosol can is recyclable and how to appropriately recycle it is mixed. Encouragingly, the generational group most likely to purchase aerosol cans—Millennials—is also the group most likely to recycle aerosols and with the highest level of awareness of the need to empty the can before recycling. Of substantial concern, however, is the high proportion of respondents who do not think aerosols are recyclable, do not know if aerosols are accepted for recycling where they live, rarely or never recycle aerosol cans, and do not know or do not believe that the can needs to be emptied before offering it for recycling. Additionally, two-in-five respondents say they rarely or never check the label of aerosol cans for recycling information.

The results reveal that consumers are not used to considering the can label as a source of information because the aerosol cans they purchase do not typically include instructions on how to properly recycle the can (see discussion in Section III(E)). This represents a significant opportunity to educate consumers on aerosol recyclability, especially how container labels can provide information on how to appropriately recycle empty cans.

C. EXTENT TO WHICH CONTENTS REMAIN IN AEROSOLS THAT REACH MRFS

One of the concerns shared by MRFs about the recycling of aerosol containers is not knowing whether the container is empty. The risk of a fire is a significant concern for MRFs, as is the risk posed by residual contents that can harm employees (e.g., bear spray).

To better understand the volume and makeup of residual content, nearly 900 aerosol can samples were collected from two MRFs: the Metrolina MRF in Charlotte, NC, and the West Tennessee Recycling Hub in Henderson, TN. All samples were collected at the MRFs before the baling step in the sortation process and then shipped using a Department of Transportation special permit to Recycle Aerosol located in Bells, TN, for measurements while adequately handling any potential risk. The purpose of collecting and analyzing these samples was to provide MRF operators with information that will give them more certainty on typical residual content levels in aerosols collected via curbside.

Volunteers from HCPA and various initiative sponsor companies were split into three teams:

Team 1: Collected and recorded a variety of information for each sample, including the Product Name, Product Marketer, Container Type (Aluminum, Steel, Plastic), whether it was a “standard” aerosol product or a “compartmented” aerosol product (bag-on-valve (BOV), piston, etc.), the net contents (as labeled), whether the label had flammability warnings, whether the label markets the product as recyclable (and if so, how), and the propellant(s) in the product.

Team 2: Recorded an “initial weight” for each sample (in grams) and any remaining pressure in the container (in pounds per square inch (psi)).

Team 3: Puncturing and depressurizing each sample using a device specifically designed for aerosol containers. This team drained, collected, and weighed the “concentrate” (product that is dispensed) and after weighing the empty container determined the difference between the initial weight and the empty container and concentrate, assuming any remaining weight difference to be the propellant(s).

TESTING PRESSURE OF AEROSOLS COLLECTED FROM TWO MRFs

RESULTS

About the Containers

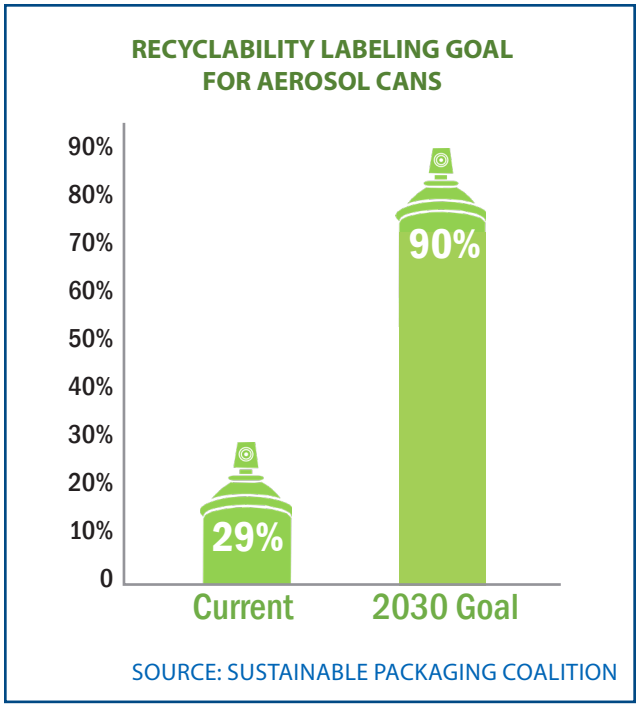
Of the aerosol container samples collected, approximately 75 percent were steel, 22.5 percent were aluminum, and 2.5 percent were plastic. This container type breakdown is consistent with the overall mix of aerosol containers manufactured for the U.S. aerosol market.

Further, 92 percent of the aerosol delivery systems were traditional aerosols while 6 percent were BOV systems and 3 percent were piston systems. Based on market information from the HCPA Aerosol Pressurized Products Survey, this is also close to reflecting the overall market.

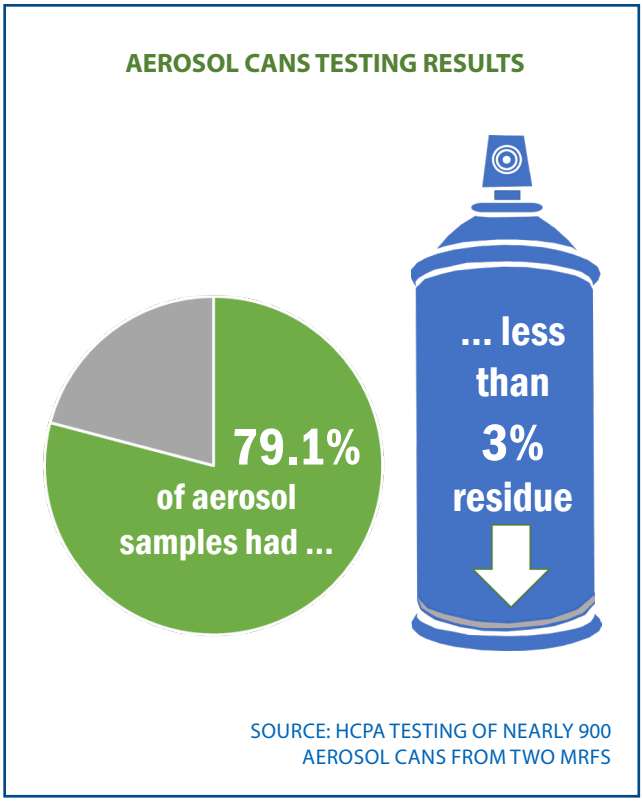
The product breakdown was also similar to what would be expected. A majority of the containers were intact; however, some were partially flattened or punctured (31.7%).

Labeling

More than half of the containers had some kind of marketing on the label that the product was recyclable (56.3%). This number is slightly lower than, but still close to, the national baseline Eunomia determined (63%), as described in Section IV(F). However, overall, 30.1 percent of the labels used messaging beyond the general chasing arrows recycling symbol, such as How2Recycle, TerraCycle, or a Disposal Statement Section. This is also consistent with Eunomia's baseline for cans with recyclable messaging that includes how to appropriately recycle the can (29%, as measured by cans with the How2Recycle symbol, described further in Section IV(F)).



AEROSOL RECYCLING INITIATIVE



Testing Results of Residual Contents - Weight

A large majority of the products had no or minimal leftover contents. Nearly all (87.7%) of the samples had less than 5-percent residue in the container and 79.1 percent of samples had less than 3-percent residue. Three percent residue is a critical figure, as discussed earlier, since the EPA under RCRA defines empty as having no more than this figure by weight of total capacity for containers with less than 119 gallons. Three percent residue was also the cutoff value used to define an empty aerosol can in FMRC's risk assessment of recycling aerosol cans.

One percent of samples had 50 percent or more content left, and 3.4 percent of samples had 20 percent or more leftover content remaining.

It must be noted that for products with dried contents remaining, such as paint on the side of the container, this residual content was included and not scraped off. However, while this may slightly depress a few of the values for the remaining residual contents, these dried materials would not pose a risk within a MRF.

Testing Results of Residual Contents - Pressure

In addition to the weight, the remaining pressure of each sample was measured. However, there were several samples (111 total) where the pressure could not be recorded due to broken valve stems, the product contained a metered valve, the actuator could not be removed, or an adapter that the team did not have on hand was needed (as was needed for whipped cream or cheese spray products).

Testing the pressure helped identify which products contained remaining propellant. It is also important to understand the differences between propellant types. When a liquefied propellant is used in the product, the pressure will be zero when the product is empty; however, when a product uses a compressed gas, there will always be a remaining pressure while the container is intact.

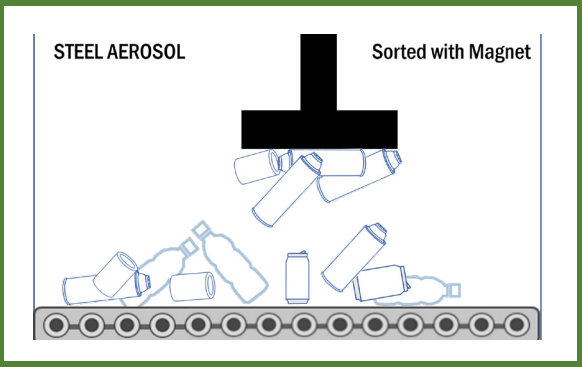
Nearly all (86%) of the samples did not have a pressure that qualifies as hazardous by most federal and international jurisdictions (29 psi or higher). Of the samples (14%) that did have higher pressures equal to or greater than 29 psi, half had residual contents of less than 3 percent. Further analysis of the 14 percent of samples showed that about one-third (5.1 percent overall) did not have flammable warnings.

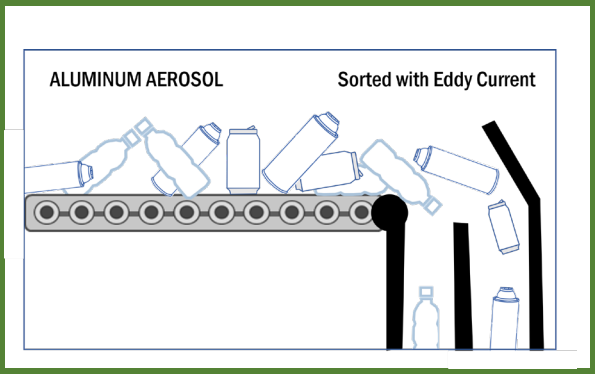
These results demonstrate that the industry's hypothesis is correct that a majority of aerosol containers that consumers put in their recycling bins are empty. While CMI and HCPA cannot state that there is no risk from recycling aerosol containers, it is unlikely that the potential contents from aerosol containers would be sufficient to cause a fire on their own without other sources to contribute as fuel. More on the aerosol fire hazard risk to MRFs can be found in Appendix D.

D. HOW AEROSOLS ARE SORTED AT MRFS

A major benefit for MRFs is that there is no need for additional equipment to sort out aerosols. Further, while aerosol cans are a relatively low volume recyclable for MRFs, they can be sold along with other commodities (e.g., steel cans, mixed aluminum excluding used beverage cans (UBC)).

ALUMINUM AND STEEL AEROSOLS ARE SORTED AT MATERIAL RECOVERY FACILITIES WITH EXISTING EQUIPMENT





Sorting Steel Aerosol Cans

Steel packaging is a ferrous metal, which means that it is magnetic. As a result, steel aerosol cans, along with all other steel packaging, can be separated from other single-stream recyclables at the MRF with a magnet. Magnets are a common piece of equipment in MRFs, and they can capture nearly 100 percent of all ferrous material.

After the magnet effectively pulls away the steel packaging, no further sortation is needed since all steel packaging can be baled together for sale. This is because any kind of steel is able to be recycled into any steel product.

Sorting Aluminum Aerosol Cans

Aluminum aerosol containers are non-ferrous metal, but they can still be effectively sorted. An eddy current separator is used at most MRFs to separate out all non-ferrous metal (e.g., aluminum beverage cans, aluminum food cans, aluminum aerosol cans). Eddy-current separators have rapidly rotating magnets at the end of the conveyor belt that generate electric currents within non-ferrous metal objects. This repulses the non-ferrous metal from the conveyor belt such that it shoots over a screen and into a separate collection point than the rest of the material. As with the magnets for steel, eddy current separators are very effective. Most eddy-current separator vendors guarantee a UBC capture rate of at least 94 percent[34] and some studies have put the effectiveness at close to 100 percent.[35]

Aluminum aerosol cans typically require further sorting after the eddy current. This is due to the aluminum mills that melt down UBCs to make new aluminum can sheet not wanting to see any aluminum aerosol cans in the UBC bale out of fear that a pressurized aerosol container may make its way into the hot melted aluminum at their facilities. Given this and that other non-UBC aluminum items such as food containers and foil can affect the UBC bale price, there is typically a person that manually sorts out the UBCs from the non-UBC aluminum at many MRFs since they want to command the best price for the UBC bale, which is frequently one of the most valuable commodities in a MRF. The non-UBC aluminum can be sold to other metal scrap recovery buyers.

Notably, this extra sortation would happen regardless of the presence of aluminum aerosol containers since these aluminum mills want only UBCs for ease of production. Aluminum is mixed with different elements (e.g., copper, magnesium, zinc) to create alloys that have certain properties needed for a finished product. Mixing too many different alloys makes producing a new aluminum product more difficult. For example, the body of an aluminum beverage can is typically a 3004 series alloy, while an aluminum food can is typically 5352 or 5050 series alloy (see Table 3). An aerosol can is another series alloy, a 1000 series, that contains more primary (i.e., new) aluminum than most aluminum packaging.

Aluminum mills that melt down UBCs to make sheet for new cans have told the aerosol industry that they would welcome aluminum aerosols into what they melt down to make can sheet since the 1000 series alloy does not spoil the careful chemistry they are managing to make new can sheet for beverage cans. However, in those same conversations with mill operators, the safety concern of non-punctured aerosol cans finding their way into the melted aluminum and then combusting has resulted in some aluminum mills rejecting UBC bales that contain aerosol containers.

TABLE 4: COMMON ALUMINUM PACKAGING ALLOYS

Alloy	Typical Aluminum Container Made with Alloy
1000 Series	Aerosol Containers
3000 Series	Beverage Can Body
5000 Series	Food Containers; Beverage Can Top

Typically, the non-UBC aluminum is either kept in a large receptacle or another separate area of the MRF if there is space. Then some MRFs sell the non-UBC aluminum unbaled to a buyer, while others bale it prior to sale. While MRF operators may collect and sell non-UBC aluminum slightly differently, there are ready buyers when MRFs offer non-UBC aluminum for sale.

E. HOW AEROSOLS ARE RECYCLED BY VARIOUS PROCESSORS

Having sufficient end markets (i.e., processors that buy material to recycle it into new products) is key to a package being accepted for recycling and the package being recycled. Both aluminum and steel aerosol cans that consumers put in their recycling have buyers eager to buy them either alone or as part of larger commodities (e.g., non-UBC aluminum). Further, there are also several recyclers in the U.S. that specialize in aerosol can recycling, typically sourced from commercial sources.

Steel Aerosol Can Recycling

As previously mentioned, an advantage of steel is that this metal in any kind of steel product can be melted down and relatively easily made into any other kind of steel product. This is one of the reasons why RRS after interviewing 13 MRFs, including representatives from two of the largest MRF operators in the U.S., in the 2021 research referenced earlier found that there are no penalties, price upgrades, or rejections for steel bales that contain aerosols.

MRFs typically sell a mixed bale of all kinds of steel packaging to brokers and scrap managers that further process the material before being sold to end markets.[36] These end markets include the basic oxygen and electric arc steel production facilities that can be found in almost every state. In other words, while some may not want steel aerosols, the end markets for steel bales containing steel aerosols are widespread. These end markets will take the steel in the steel can bales and other kinds of steel to form a variety of products, such as buildings, cars, and bridges.

Aluminum Aerosol Can Recycling

Aluminum aerosol cans have ready end markets and are typically bought as part of a non-UBC aluminum bundle.

As previously described, many MRFs collect the non-UBC aluminum together, which includes aluminum aerosol cans. One large buyer of non-UBC aluminum is the deox industry, specifically Gottlieb Inc. in Pennsylvania. Gottlieb sources non-UBC aluminum from across the country and turns it into deox, a critical component in the steel-production process to remove oxygen content. Another buyer is the remelt scrap ingot (RSI) industry. According to The Aluminum Association's North American Aluminum Industry Plant Directory[37] published in 2019, there are more than 100 secondary aluminum ingot facilities in North America, many of which make RSI. RSI producers recycle various kinds of aluminum scrap into an intermediary product without a specific chemical composition. Then when there is a buyer with a specific need, the RSI producer remelts the intermediary product (hence the name RSI) and adds certain elements to meet the unique chemical specifications for the intended end product. RRS found that the RSI and deox producers are the main buyers of non-UBC aluminum that contains aluminum aerosol cans.

Specialty Aerosol Can Recycling from Commercial Sources

There are several companies in the U.S. that specialize in aerosol can recycling. They include Clean Earth, Recycle Aerosol, and U.S. Econology. These companies charge for processing aerosol cans. Typically, it is commercial businesses with dented or surplus filled aerosol cans that pay these companies to safely recycle them. Each company recycles aerosol cans through a distinctive process.

Clean Earth says it recycles nearly all components of full to empty aerosol cans. From an aerosol can, Clean Earth recycles hard plastic caps, actuators (spray, foam, solid stream, and spray actuators), dip tubes, all valve components, and exterior body containers. Clean Earth has a "custom built, cutting-edge" aerosol recycling plant in Morgantown, WV, capable of recycling more than 7 million cans per year. It claims to be the only company in the nation capable of capturing and separating the propellant from aerosols for recycling and re-blending into fuels at this volume and speed. The captured fuels can be used as a cleaner burning alternative to coal for producing electricity and powering cement kilns.

Recycle Aerosol says it has unique technology and processes to recycle each part of the aerosol can. It accepts full, used, and empty aerosol cans in bulk as well as non-typical aerosol products like camping cylinders and inhalers. The Recycle Aerosol team reviews each aerosol prior to acceptance and develops a processing strategy that includes identifying end uses for each by-product. Then, similar aerosol products are batch-processed to produce valuable recycled materials, returning component chemicals and packaging to markets where their values can be realized.

U.S. Ecology says it is the first and only company in the U.S. offering patent-pending Aerosol Recycling Technology (ART) that produces recyclable metal as well as reusable alternative and liquid fuels. Further, U.S. Ecology asserts that it sends zero waste to landfills with zero emissions. The ART process includes the following steps:

1. Cans transferred into hopper featuring an airtight inert chamber.
2. Under vacuum, cans are compacted to produce dry metal bricks for multi-purpose recycling.
3. Liquid product and gas propellant 100 percent captured and separated by vacuum and compression technology to produce reusable alternative fuel.
4. Patented technologies further compress gas propellant into purified recyclable liquid fuel, similar to Liquid Petroleum gas.

CASE STUDY: BALL CORPORATION

Effective partnerships are imperative to increasing aerosol recycling rates

Ball Corporation is on a mission to increase can recycling rates, with the aim of achieving 90% global recycling rates for aluminum beverage cans, bottles, and cups by 2030.[38]

Ball believes that moving towards a more sustainable waste management system is to focus on the benefits of recycling and real circularity.

Ball's dedication to recycling extends beyond beverage cans. We have set our sights on the recycling of aluminum aerosol cans, fully aware that the challenges in this arena are even more formidable than those in beverage can recycling. These aerosol cans, being multi-material and pressurized, pose unique challenges and require special attention in recycling centers. Moreover, consumer awareness regarding aerosol can collection and recycling remains limited.

One of the steps in the mission has been the successful partnership with Recycle Aerosol in the U.S. to collect aerosol cans that are deemed unsaleable and are never used by consumers. Recycle Aerosol has developed its engineered process to collect the fluids and gases from the unused aerosols and provide these valuable separated ingredients to new end users. Once the used aerosol cans have been emptied, they are re-melted and the re-melted secondary ingots (RSI) are then shipped to Ball to be used to make new aerosol cans with infinitely recyclable aluminum.[39] The partnership with Recycle Aerosol started in 2021 and we have managed to collect and recycle 2,410,026 lb (around 1,000 tonnes) of aluminum from the aerosol cans so far. An average weight of one aluminum aerosol can is around 0.066 lb. This means that this aluminum could be used to produce around 40 million cans with the aluminum inside capable of being recycled over and over. The average primary aluminum carbon-footprint is 8 metric tons of carbon dioxide-equivalent ($MTCO_2e$)/ MT of aluminum in the U.S.[40] Recycling aluminum

significantly reduces energy consumption by 95% and GHG emissions are reduced up to 98%[41] compared to primary aluminum production, which involves collection, sorting, pre-treatment, melting and casting. With this in mind, Ball's joint project with Recycle Aerosol managed over three years to avoid emitting around 8000 $MTCO_2e$ into the atmosphere. That corresponds to the energy used to power 1,000 houses in one year.[42]

Creating a closed loop cycle of waste management is an important element of the transition to a circular economy where the reuse of products and materials is a key component. A real circular economy requires a systemic solution that maintains a flow of resources, regenerates them, retains their value, or even adds value to them over time.[43] Through facilitating effective partnerships, as seen here, Ball can effectively transition to active circularity.

F. RECYCLING MESSAGING ON AEROSOLS

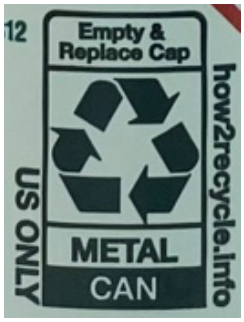
Ultimately, more aerosol cans will be recycled if they are labeled as recyclable with instructions on how to appropriately recycle them and consumers have easy access to aerosol recycling.

At the national level, companies are not obligated to provide information to the end user for most aerosol products on how to recycle or otherwise dispose of the aerosol can. The only national guidance on recyclability labeling comes from the Federal Trade Commission (FTC) in the *Guides for the Use of Environmental Marketing Claims* ("Green Guides"), which provides guidance for marketers on what may constitute a deceptive "recyclable" claim.[44] The Green Guides provides useful clarity on when an aerosol container may be labeled as "recyclable" without causing consumer deception, but it does not place any requirements on companies to include a label statement about recyclability or standardize how "recyclable" claims are conveyed. Some product types, such as pesticide products regulated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), are required to include storage, disposal, and recycling information on the label.[45] However, most consumer products have no such requirements.

To fill this gap, several companies have voluntarily included information on the aerosol container regarding how to safely recycle aerosol cans. Additionally, states across the country have recently been looking at ways to better communicate recyclability information for their populations through EPR and environmental marketing claims legislation,[46] though what this means for aerosol cans sold in different states is not yet clear.

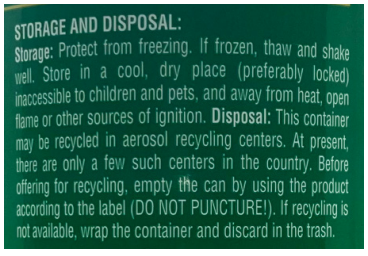
Given that "recyclable" labeling is both optional and not standardized, a number of different types of labeling related to end-of-life are currently included on aerosol cans. To understand how predominant recyclability labeling is within the aerosol industry and how labeling may differ between product types, CMI and HCPA hired Eunomia as part of a team of consultants led by Gershman, Brickner & Bratton (GBB) to assess the types of labels on aerosol products at various types of stores across the U.S.

This assessment included in-store characterization of aerosol products and labeling practices compiled by unique stock-keeping unit (SKU) codes.[47] The study included 17 different stores of varying types (grocery, big box, home improvement, industrial supply, and automotive) across four U.S. states in different geographic areas (Colorado, Illinois, North Carolina, and Oregon). Broadly, in addition to mention of recycling on the label, three types of recycling-related labels were observed:



How2Recycle,[48] a label developed by a third-party organization (a project of the nonprofit GreenBlue) that includes both information on whether a product or its packaging is recyclable and how to appropriately recycle it.

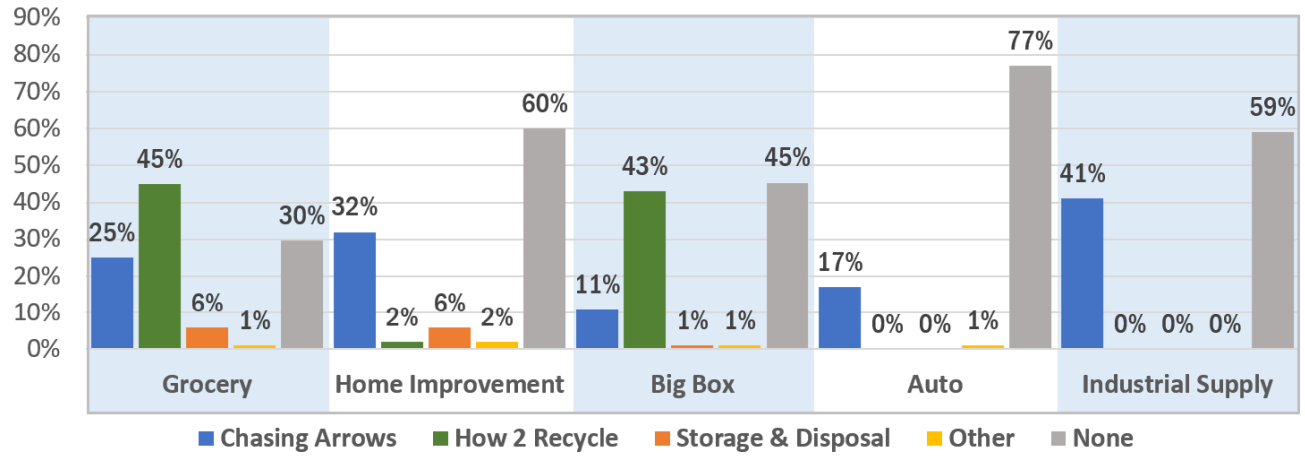
Chasing Arrows (a symbol of three looping arrows forming a triangle), which is generally seen in the U.S. as a universal symbol that an item is recyclable.


STORAGE AND DISPOSAL:
Storage: Protect from freezing. If frozen, thaw and shake well. Store in a cool, dry place (preferably locked) inaccessible to children and pets, and away from heat, open flame or other sources of ignition. **Disposal:** This container may be recycled in aerosol recycling centers. At present, there are only a few such centers in the country. Before offering for recycling, empty the can by using the product according to the label (DO NOT PUNCTURE!). If recycling is not available, wrap the container and discard in the trash.

Storage and disposal instructions, which often include information on the recyclability of the product/packaging and are a required part of the label for FIFRA-regulated pesticide products.[49]

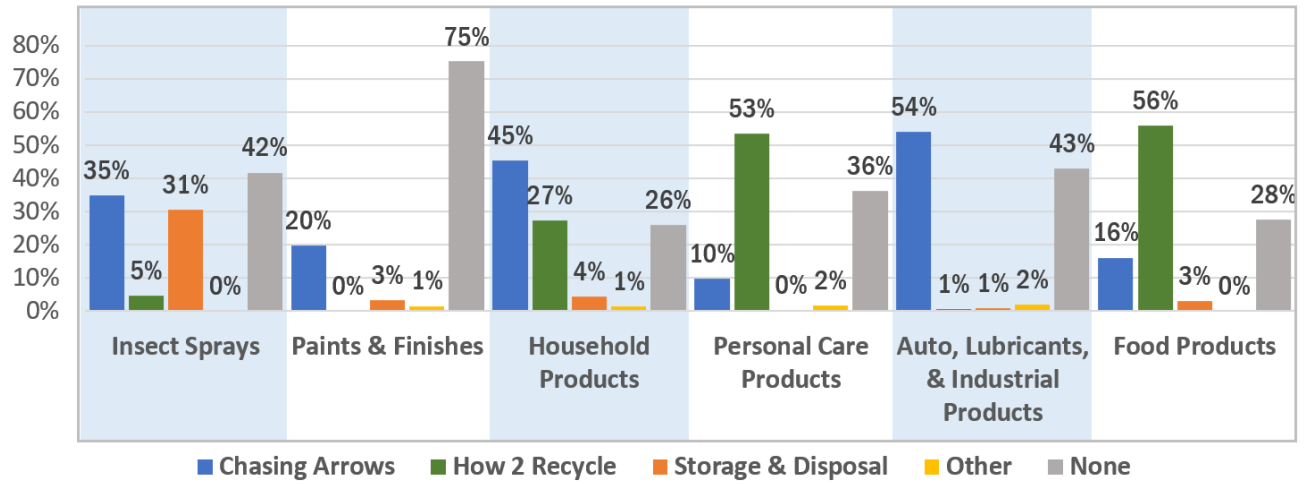
Overall, 63 percent of aerosol cans had some form of recycling instruction, but the types of labels observed varied significantly by store type and product category, as demonstrated in the graphs below.[50] Key takeaways are presented below. A full description of the study methodology can be found in Appendix F.

FIGURE 1: PERCENTAGE OF AEROSOL CAN LABEL TYPES BY STORE CATEGORY



SOURCE: EUNOMIA 2022 STORE SURVEY

FIGURE 2: PERCENTAGE OF AEROSOL CAN LABEL TYPES BY PRODUCT CATEGORY



SOURCE: EUNOMIA 2022 STORE SURVEY

Key Takeaways:

- How2Recycle was the only widely observed recycling label that included both information on the can's "recyclable" status and how to appropriately recycle it.
- The How2Recycle label was present on 29 percent of aerosol products overall and was most predominant on food (56%), personal care (53%), and household (27%) products.
- Significant fractions of product categories (25%-75% of each product category) had no instructions related to recycling, and in fact a lack of recycling messaging altogether was the most prevalent type of label observed.
- The Chasing Arrows was the second-most common type of recycling labeling, after no messaging at all.

Overall, the results show that despite the increasing use of consumer-facing labels with end-of-life information, additional efforts are needed to increase labeling with full instructions. Over two-thirds of aerosol cans in the U.S. market today do not have a label that includes both information on recyclability and how to appropriately recycle the aerosol can. This represents a significant opportunity for companies to update labels to help consumers better understand what to do with aerosol cans once they are finished with the product.

CASE STUDY: TRIVIUM PACKAGING

Aerosol Recycling Matters

It is often quoted that "It is the journey, not the destination, that matters." However, in the case of aerosol recycling, it is both. In the end, the destination matters most, keeping valuable resources out of landfills. However, the journey is also important as it offers opportunities for education and solutions to aid in the collecting and recycling of aerosols.

Leading the Way Through Collaboration

At Trivium Packaging (Trivium) we like to pioneer environmentally conscious solutions with an impact both now and for generations to come. For example, we partnered with Creando Conciencia, an urban recycling organization in Argentina that works with municipalities and communities to create a better world by collecting waste and subsequently separating, classifying, and recycling it. This groundbreaking initiative substantially increased the recollection and upcycle of aluminum aerosol cans. The initiative created jobs and allowed Creando Conciencia to collect aerosol cans from consumers and process them efficiently, using machinery, provided by Trivium, that depressurizes and compacts the aerosol at the same time. The compacted aerosols are then melted and formed into aluminum ingots, which are the building blocks of the can-making process. This is done via a one-of-a-kind process Trivium has with Aluar, a company that produces liquid aluminum with 60-percent green energy. The process flows liquid aluminum directly from Aluar into Trivium to produce the ingots, reducing energy and CO2 from transport. Trivium Argentina was the first manufacturer in Latin America to use recycled content from the region in the making of its own slugs to produce new cans.

This recycling initiative enables Trivium to make a difference in the three areas of Trivium's sustainability strategy: taking care of PEOPLE through social organizations, protecting our PLANET by reducing waste to landfill, and sharing our journey with our CUSTOMERS by walking the talk. In addition, it provides encouragement and education to the community regarding the recycling of aerosol cans.

Leading the Way Through Education

Trivium's newest white paper Aerosol Cans in Europe: A Story of Infinite Recyclability[51] takes an in-depth look at the growing segment of aerosol cans, their recyclability, issues that may negatively affect recycling rates, and how to overcome them. The 2023 Buying Green[52] report shows consumers' appetite for sustainable packaging continues to increase. Data showed that 79 percent of consumers are looking for products in sustainable packaging, with 71 percent choosing a product in the last six months based on its sustainability credentials. Additionally, 63 percent claim they are less likely to buy products with packaging that is harmful to the environment, and 71 percent claim they engage in sustainable activities such as recycling, buying local, and refilling bottles and containers. However, the report also found that consumer perceptions of recyclability do not always reflect reality. For example, aerosols are perceived to be less recyclable than a standard metal food can, though they are equally recyclable. Thus, significant potential exists to increase the recycling rates of aerosol cans through enhanced education to consumers on the recyclability of aerosol cans, and how to correctly dispose of them, enhancing the possibility for the cans to reach their correct recycling destination along the journey. One of the simplest ways to educate consumers is by using the Metal Recycles Forever™ logo in the artwork on the can. A simple visual that lets consumers know metal recycling matters.

TRIVIUM PACKAGING

AEROSOL RECYCLING INITIATIVE

V. IMPORTANCE OF INCREASING AEROSOL RECYCLING

A. ENVIRONMENTAL AND ECONOMIC IMPACT OF GREATER AEROSOL RECYCLING

Increasing the number of aerosols that are recycled rather than sent to landfills and incinerators, could provide substantial environmental and economic benefits in the U.S., including:

- Reducing GHG emissions, which are major drivers of climate change.
- Putting valuable material from recycled aerosols back into the economic stream (increased revenue for MRFs).
- Increasing job creation in material collection, sorting, and reprocessing.
- Increasing wages paid across the recycling industry associated with increased tonnage in material recycled.
- Shifting aerosols from waste disposal to recycling reduces disposal tipping fees and limits landfilling and incineration.
- Helping companies meet recycled content goals and targets.

To better understand these benefits, Eunomia estimated the economic and environmental impact of two future recycling rate scenarios for aerosols in the U.S., a 25-percent and a 50-percent recycling rate scenario. The methodology is described in Appendix F and the key takeaways are presented below.

Results of Scenarios

While data limitations may impact results, it is clear that recycling more aerosols would result in substantial overall GHG emissions reductions and economic benefits. It is more difficult to confidently estimate the costs associated with increasing aerosol recycling since marginal increases in the recycling rate of aerosols may be able to be supported with existing labor and infrastructure or through improvements made as part of a broader recycling system expansion. A summary of the estimated benefits for a 25-percent and a 50-percent recycling rate scenario are shown in Table 5 below, and the full results can be found in Appendix F.

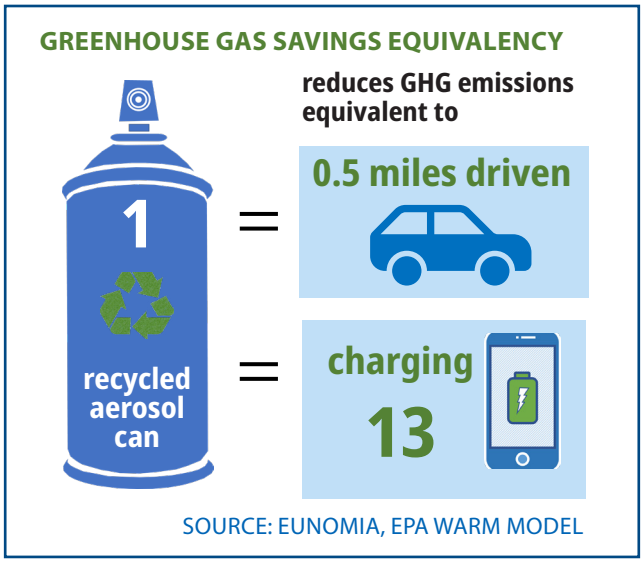
TABLE 5: ENVIRONMENTAL AND ECONOMIC BENEFITS OF GREATER AEROSOL RECYCLING UNDER A 25-PERCENT RECYCLING RATE AND A 50-PERCENT RECYCLING RATE[53]

Category	Benefits with 25% Recycling Rate	Benefits with 50% Recycling Rate
GHG emissions reduced	174,804 $MTCO_2e$	366,622 $MTCO_2e$
Economic value retained (material revenues/year)	$18,900,000	$39,062,000
Number of direct FTEs needed	280	590
Direct wages paid	$21,398,000	$43,375,000
Landfill tipping fee savings/year	$4,220,000	$8,554,000
Recycled content generated	6,000 tons aluminum 68,000 tons steel	13,000 tons aluminum 137,000 tons steel

SOURCE: EUNOMIA

Under the 25-percent recycling rate scenario, GHG emissions would be reduced in total by 174,804 metric tons of carbon dioxide equivalent ($MTCO_2e$), which is equivalent to the annual energy use of nearly 23,000 U.S. homes or the annual GHG emissions from nearly 42,000 gasoline powered passenger vehicles. Under the 50-percent recycling rate scenario, GHG emissions would be reduced in total by 366,622 $MTCO_2e$, which is equivalent to the annual energy use of nearly 48,000 U.S. homes or the annual GHG emissions from more than 87,000 gasoline-powered passenger vehicles.[54]

Each aerosol container recycled reduces GHG emissions on average by approximately the equivalent of 0.5 miles driven by an average gasoline-powered passenger vehicle or charging 13 smart phones.

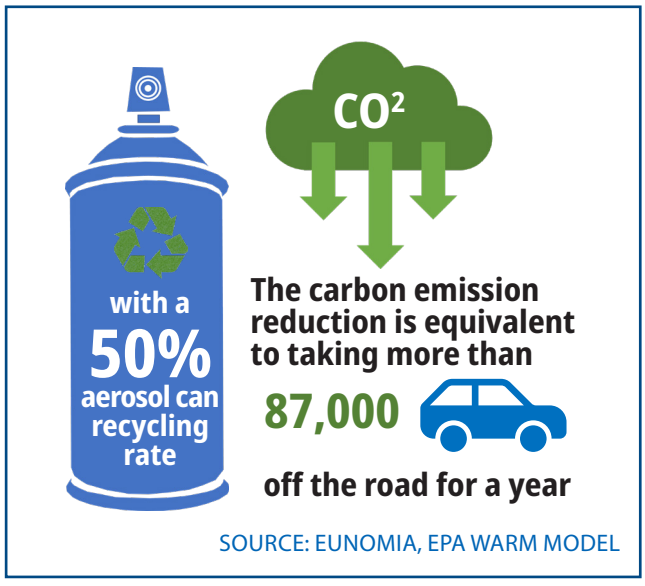


Nearly $19 million in economic value would be generated under the 25-percent recycling rate scenario, and more than $39 million would be generated under the 50-percent recycling rate scenario. The expected economic value generated, or total material revenue, represents $37,000 in revenue per MRF on average for the 25-percent recycling rate scenario and $77,000 in revenue per MRF on average for the 50-percent recycling rate scenario. It is important to note that actual revenues for a specific MRF could vary widely from these estimates depending on the size of the MRF and tonnage of aerosols received.

Based on the assumption that an increased volume of recycled material would necessitate an increase in labor, the 25-percent scenario and 50-percent scenario would require 280 full-time equivalent (FTE) employees and 590 FTEs, respectively, across the entire U.S. recycling system. The reprocessing step, which refers to the melting of sorted and commoditized secondary metal to produce new metal ingots or other raw materials, is the point in the value chain at which the largest proportion of jobs would be created under both scenarios. The total number of direct FTEs needed represents 0.5 FTE per MRF on average and 1.1 FTE per MRF on average for the 25-percent and 50-percent recycling rate scenarios, respectively. As with material revenue, it is important to note that job needs for a particular MRF could vary widely from these estimates depending on the size of the MRF and tonnage of aerosols received.

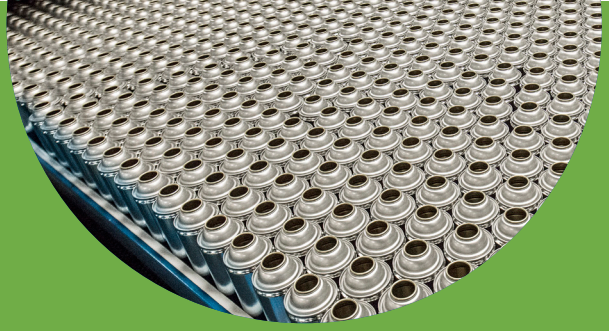
The 25-percent and 50-percent recycling rates relate to more than $21 million and more than $43 million, respectively, in total wages paid annually associated with aerosol can recycling. Reprocessing again accounts for the largest share of the increase in wages paid, followed by collections operations.

Diverting more aerosols from landfill or incineration would also result in avoided disposal costs (i.e., cost savings from avoiding paying disposal/landfill tipping fees). More than $4.2 million and more than $8.5 million in disposal costs would be avoided under the 25-percent recycling rate and 50-percent recycling rate scenarios, respectively.



Additionally, recycling more aerosols would result in more recycled content available for companies to incorporate into their products and packaging to meet ambitious recycled content targets. Under the 25-percent recycling rate scenario, 6,000 tons of aluminum and 68,000 tons of steel would be recovered. Under the 50-percent recycling rate scenario, 13,000 tons of aluminum and 37,000 tons of steel would be recovered.

There are other significant potential benefits to recycling more aerosols not mentioned here, such as the quality-of-life benefits to residents who live near landfill or incineration facilities from having fewer materials flowing to those locations. Due to difficulties in being able to accurately quantify such benefits, this analysis focused on GHG emissions reductions and direct economic benefits, which are both quantifiable and substantial.



VI. AEROSOL RECYCLING INITIATIVE NEXT STEPS

A. ACCESS

While the industry is acting via this initiative to support aerosols being more widely accepted, whether they are accepted is ultimately up to MRFs, municipalities, and state governments.

The aerosol industry is committed to increasing acceptance of aerosol cans. This acceptance could be through a variety of means (e.g., curbside, drop-off) depending on the locality. The industry will prioritize efforts to increase acceptance of aerosol containers in curbside programs because it's the most convenient option for consumers. The aerosol industry also believes, according to the data described above, that accepting and recycling more aerosols can have a positive environmental impact and generate revenue for recycling programs. Nevertheless, the aerosol industry will also pursue other forms of access such as drop-offs at certain locations.

The actions the aerosol industry is pursuing to increase acceptance rate of aerosols include:

Advocate for inclusion of aerosols on statewide recyclability lists. As more states make statewide recyclability lists to reduce confusion on what is recyclable or not as part of EPR systems, the aerosol industry will advocate for inclusion of aerosol cans on those lists. Excluding aerosols is a missed opportunity to capture valuable metal and collect material that can readily be recycled and has valuable end markets. In Oregon, aerosol cans will be included in the depot program, a network of drop-offs to collect recyclables that are not included in the curbside collection program. While the aerosol industry supports aerosols being included in a curbside program to make it convenient for consumers to recycle aerosol cans, drop-off collection still allows for consumers to have access to recycling services.

Explore shredding at aluminum mills. MRFs have indicated that they would be more inclined to accept aerosols if they could put them in the UBC bale since then they could sell them at the UBC price and not have to worry about any downgrades in price paid or rejections of the bale due to the inclusion of aerosols in a UBC bale. UBCs are consistently one of the most valuable commodities in recycling programs. The aluminum mills that buy UBC bales and melt them down to make new beverage cans typically do not want aerosol cans in the UBC bales out of a concern that a pressurized aerosol can could find its way into melted metal and cause an incident. In talking with aluminum mills, the aerosol industry has learned that if there were no safety concerns, the aluminum mills would welcome aerosol cans in the mix since the 1000 series alloy that is typically used in aerosol cans is easy to work with in making new aluminum products.

Having a shredder at the relatively small number of aluminum mills that melt down UBC bales to ensure no pressurized aerosol cans are getting through to the melted metal could be easier than trying to change any processes at the several hundred residential MRFs across the U.S. However, the kind of shredder necessary is expensive, takes up space, and may slow down the manufacturing process since it's an additional step. The aerosol industry is having ongoing conversations with the leading U.S. aluminum mills about what is possible. Shredding or perforation of aluminum aerosols at the MRF may also be a potential solution to this concern, but the feasibility of this has not yet been deeply explored.

Continued direct engagement with MRFs that do not accept aerosols. The aerosol industry has and will continue to directly engage MRFs that do not accept aerosol cans on their reasons for not accepting them and what it would take to get aerosols on their accepted list. The reality is that with an access rate of 62 percent for aluminum aerosol cans and 61 percent for steel aerosol cans, there are many MRFs that accept and process aerosol cans. Most all that accept aerosol cans do it with existing equipment–a magnet for steel and an eddy current for aluminum. More MRFs can and should do the same. The aerosol industry hopes with various initiatives – research, case studies, direct engagement, technology, innovation, etc., as well as incentives from the industry such as a community communications campaign the MRF serves on the importance of emptying aerosol cans before putting them in the recycling– more MRF operators will decide to accept aerosols. There may be some MRFs that prefer to separate out aerosols alone using a robot or a human and then send the aerosols for processing to facilities that specialize in aerosol recycling.

While this is possible, the aerosol industry believes using existing equipment and putting aerosols in with other aluminum or steel containers for sale is the best and simplest approach overall. Further, if there is separate collection of aerosol containers, it could increase risk with the potential accumulation of propellants. In contrast, Eunomia found that in MRFs that accept aerosols, aerosols only represent 0.9 percent of UBC bales, 2.7 percent of steel can bales, and 2 percent of mixed metal bales, and in MRFs that do not accept aerosols, aerosols only make up 0.6 percent of UBC bales, 1.7 percent of steel can bales, and 1.3 percent of mixed metal bales.

Continued engagement with MRFs that do accept aerosols. The aerosol industry has and will continue to directly engage MRFs that do accept aerosols to make sure that they continue to accept aerosols. For MRFs that accept aerosols, but do not explicitly communicate that they accept aerosols, the aerosol industry will encourage them to be more explicit so consumers know they can recycle aerosols and recycle them correctly. There are also insights to be learned from MRFs that accept aerosols that can be used to better explain why MRFs not accepting aerosols should accept them.

Encourage municipalities to include aerosols in their recycling programs. Municipalities can insist aerosols be included in their recycling program and in turn have aerosols included in their contracts with MRFs as a recyclable item. The aerosol industry is considering offering incentives for municipalities that make this choice to include aerosols in their local recycling program. One potential incentive is offering to do a local marketing campaign on the importance of putting only empty aerosols in the recycling bin. Up to this point, the aerosol industry's direct engagement has been more with MRFs rather than municipalities, but that may change in the future.

Investigate retailer drop-off programs. Many retailers currently have a regular pick-up service at their stores to collect and recycle aerosol cans that are dented or surplus that cannot be sold. It is possible that these existing collection programs could be expanded to include providing consumers the ability to drop off their empty metal aerosols at the store for recycling. The aerosol industry is considering supporting such expansions. Most of this interest is offering this retailer drop-off in places with no or low (e.g., subscription curbside, drop-off) recycling access. The aerosol industry has had initial conversations with companies that provide the aerosol can collection and recycling service to large retailers and will be reaching out to retailers with existing aerosol collection setups to engage further.

B. LABELING

This goal's progress is primarily under the aerosol industry's control. Specifically, brands that sell products in aerosol cans have control over what is on the aerosol can label and can choose to put appropriate recycling messaging. Note that label changes cost money. So, some brands may choose to wait to make the change as part of making other label changes, meaning that label changes may occur over time rather than be immediate. Also, some brands may be quicker to adopt the change than others and some may adopt it across all their aerosol products or start with a subset.

Created Labeling Task Force. One way the industry is mobilizing on label changes is through HCPA's Aerosol Recycling Initiative Labeling Task Force. The Task Force is developing a guide that includes a variety of messaging options to meet the 2030 goal, stating not only that aerosol cans are recyclable, but also how to properly do so (i.e., empty before putting in the recycling). One option that is currently used on many aerosols as detailed above is the How2Recycle label. Another option is the new RecycleCheck from The Recycling Partnership. This label has the benefit of providing localized, up-to-date information to users who scan a QR code of whether aerosol cans are accepted where that person is located. There may be other third-party options, or a company could use its own messaging, that sufficiently communicates the recyclability of the aerosol container and how to recycle it.

The guide will also provide information on which options are in compliance with federal and state rules, such as the recycling labeling guidance in the FTC Green Guides and in California's Truth in Labeling for Recyclable Materials law (SB 343).

C. RESEARCH

The aerosol industry commissioned the research included in this white paper since it needed updated information on the understanding and importance of aerosol recycling. There is additional research that could be done to make progress toward the Initiative's 2030 goals.

Updated MRF fire safety assessment. The aerosol industry has conducted recycling facility fire safety research in the past, but it recognizes an updated version may be helpful. The aerosol industry is currently considering a project that would determine the maximum and/or average heat release rate fire from a typical mix of post-consumer aerosol materials, evaluate the conditions under which ignition of aerosols occurs during the baling process, and understand if existing fire mitigation strategies at MRFs are sufficient to manage the risk of increased aerosol can volume. The audience for this updated MRF fire safety assessment would be MRFs that do not currently accept aerosol cans, as well as regulators considering whether to include aerosols in lists of recyclables.

Consumer views of certain recyclability messaging. While the initiative's 2030 labeling goal is clear that recyclability messaging must say it is recyclable and how to recycle the aerosol (i.e., empty it before putting it in the recycling), there are different words and visuals that could be used to meet this threshold. The aerosol industry may undertake research to understand which visuals and words result in the greatest resonance and clarity with consumers.

Awareness campaign on emptying aerosols before putting them in the recycling. As noted above, the aerosol industry is looking into offering local communications campaigns on aerosol recycling as incentives to get MRFs to start accepting aerosols and municipalities to insist on including aerosols in their local recycling programs. The aerosol industry is considering working with a municipality and MRF that already accepts aerosol cans to test if this kind of communications campaign delivers more aerosol cans that are recycled properly (i.e., emptied). If the aerosol industry can show it has a proven communications campaign, that should help make the incentive offer more enticing.

Over time, the aerosol industry intends to provide updates on progress toward its two 2030 goals.

VII. APPENDIX

A. GLOSSARY

Bag-On-Valve (BOV) aerosol system. A type of compartmentalized aerosol dispenser, featuring a composite metal/plastic bag, attached to the valve body.

Capture rate. The weight of recyclable material collected for recycling (not including contaminants) divided by the weight of all recyclables in the waste stream.[55]

Compressed Gas. A substance or mixture of substances that is a gas at normal room temperature and pressure, and is stored under pressure in a container. Compressed gases include both permanent gases and liquefied compressed gases.

Flammability. The ability of a substance to burn or ignite.

Liquefied Gas. A gaseous substance at ambient temperature and pressure that is liquefied by pressurization or refrigeration. Also known as a liquefied compressed gas.

Non-flammable. A substance that is not able to combust.

Permanent Gas. A gas or mixture of gases that cannot be liquefied except at extremely low temperatures (i.e., cryogenic temperatures). Permanent gases include air and nitrogen. In aerosol applications, a permanent gas will exist in the aerosol container in a gaseous state only.

B. AEROSOL BASICS CONTINUED

History of the Aerosol Can

The first U.S. patent for an aerosol delivery system, Method and Means for the Atomizing or Distribution of Liquid or Semiliquid Material, was granted to Erik Rotheim in 1931. The patent provided a method for the distribution of a "concentrate" (i.e., the product, means for carrying the method, and the preparation of the product).

The patent describes the inner working of an aerosol product, with the metal container being fitted with a valve to allow for the product to dispense. Dimethyl ether was used as the initial propellant in the patent and is still one of the various propellants used today in aerosol products.

While the patent was granted in 1931, the first aerosol product was not commercialized until the 1940s and World War II, which was an insecticide referred to as a "bug bomb" that protected soldiers from mosquitoes carrying diseases. Both the container and valve were made of steel.

Since the 1940s, the aerosol delivery form has evolved, and aerosol products have become a significant part of modern life, especially in protecting our health. Aerosol product containers are made primarily from steel or aluminum, though plastic aerosol containers have become more common in recent years.

How Aerosol Cans Work

In these products, the propellant and concentrate are spatially together within the container.

The valve is a self-closing device attached to the container to allow dispensing of the contents. The actuator controls the angle, particle distribution and shape, and amount of the spray. Pressure on the actuator depresses the stem, interrupting

the sealing action of the gasket and exposes the stem orifice to the pressurized flow of the product in the container, thereby opening the valve. When the button is released, the spring returns the stem orifice to the sealed position, closing the valve. The desired material for capture in aerosol recycling is typically the metal rather than these inner workings.

Beyond the typical aerosol delivery form that comprises a majority of the market, there are also compartmented aerosol products in which the propellant is separated from the product being expelled.

One such example is the BOV aerosol system. The bag acts as a barrier system where the product that is expelled is filled within and the propellant is outside (but within the container). When actuated, the propellant activates, the bag collapses, and the product is sprayed.

Another type of compartmented aerosol container is the piston aerosol container. In this system, the product is again separated from the propellant in which the product is filled above the piston while the propellant is sprayed through the bottom of the container and remains below the piston (and is plugged after filling). As the product is actuated, the piston pushes up against the product, spraying it from the container.

Propellants

The aerosol delivery form is a pressurized dosage that can deliver the right amount of product through a variety of different kinds of sprays. An assortment of design choices by aerosol formulators and manufacturers impact how the product sprays and performs, with the propellant playing a critical role. The choice of propellant affects the type of spray (examples include stream, foam, and fine mist), distance and particle size of the spray, stability of the product, and solvency.

There are two main types of aerosol propellants: compressed gases and liquefied gases.

Liquefied gas propellants are gaseous at ambient temperatures and pressures but will condense to liquids under moderate pressures. They also condense into liquids under low temperatures. Common liquefied gas propellants include propane, n-butane, isobutane, dimethyl ether, difluoroethane, tetrafluoroethane, and tetrafluoropropene.

Liquefied gas propellants, when confined, maintain a constant pressure. This pressure remains constant at a given temperature as long as one drop of liquid propellant remains to be converted to gas. The vapor pressure of liquefied gas propellants is a significant specification, as this characteristic makes hydrocarbon, hydrofluorocarbon, hydrofluoroolefin, and dimethyl ether propellants appropriate for dispensing and atomizing product ingredients. Aerosol product manufacturers sometimes blend different propellants together to achieve a desired characteristic.

Compressed gases are those that cannot exist as a liquid at the temperatures and pressures associated with aerosol containers. This property precipitates performance characteristics that are dramatically different from propellants that can be in the liquefied state in an aerosol product. Common compressed gases used as aerosol propellants include nitrogen, compressed air, carbon dioxide, and nitrous oxide.

One of the benefits of using a compressed gas propellant is that temperature changes have little effects on the pressure. Another is that these propellants, unlike most liquefied gas propellants, are nonflammable. However, products using compressed gas propellants do not maintain their pressure over the lifetime of the product. As the product is dispensed, more volume becomes available within the container and the pressure drops as a result.

It is important to note that none of these aerosol propellants deplete the ozone layer. In fact, no aerosol products contain chlorofluorocarbons (CFCs), which are harmful to the ozone, because CFCs were banned in 1989 pursuant to the Montreal Protocol. Further, most aerosol propellants have little to no global warming potential,[56] and with their minimal use, do not contribute significantly to climate change. Aerosol propellants also have negligible photochemical reactivity, so these substances have minimal potential for turning into smog. Still, the aerosol industry consistently invests resources to develop new technology to lessen the impact that aerosol products have on the environment.

C. REQUIREMENTS APPLICABLE TO AEROSOLS CONSIDERED TO BE HAZARDOUS WASTE

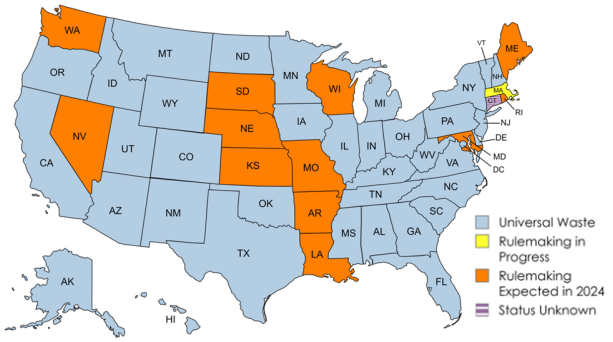
As part of regulations under RCRA, the EPA promulgated the Universal Waste Rule to establish a streamlined hazardous waste management system for widely generated hazardous wastes to encourage environmentally sound collection and proper management of the wastes within the system. The universal waste regulations are a set of alternative hazardous waste management standards for specified hazardous wastes, including hazardous waste batteries, certain hazardous waste pesticides, mercury-containing equipment, and hazardous waste lamps.

More recently, EPA has recognized that inclusion of aerosol products in the universal waste program could benefit the wide variety of establishments generating and managing aerosol cans, including the retail sector, by providing a clear protective system for managing discarded aerosol cans. Including aerosol cans in the streamlined universal waste regulations would ease regulatory burdens on retail stores and others that discard hazardous waste aerosol cans, promote the collection and recycling of these cans, and encourage the development of municipal and commercial programs to reduce the quantity of these wastes going to municipal solid waste landfills or combustors. On February 7, 2020, the EPA's rule[57] to add waste aerosol containers to the universal waste program under RCRA regulations became effective.

By adding waste aerosol containers to the federal universal waste program, the EPA made it easier for states to add waste aerosol containers into their state universal waste programs. As state regulations where aerosol containers are regulated as a non-universal hazardous waste are more stringent than the EPA's universal waste regulations for aerosols, states are not obligated to amend their regulations to add aerosol containers to their state universal waste programs, though the EPA encourages them to follow the federal guidelines. Since the EPA's final rule became effective, HCPA has been encouraging state regulators to amend their regulations.

As of February 21, 2024, 36 states and the District of Columbia have added aerosol containers to their universal waste programs and nearly all the remaining states have confirmed that they will be making similar amendments to their regulations. Here is a snapshot of the current status of state universal waste programs.

STATE ACTION ON ADDING AEROSOL CANS INTO UNIVERSAL WASTE PROGRAMS



SOURCE: HCPA

D. AEROSOL FIRE HAZARD RISK TO MRFS

All MRFs have to handle any aerosol cans sent to their facility, whether they intentionally accept them or not. MRFs that explicitly accept aerosols may see increased fire safety risks due to the larger volume of material, however, all MRF operators must be aware of the hazard presented by improperly disposed aerosol containers and be prepared to handle these safely.

Since risk is a product of consequence frequency and severity, minimizing the potential severity of an aerosol can depressurization is a reasonable method for keeping overall aerosol fire risk within accepted industry criteria. Best practices for reducing the potential consequences can be relatively simple and cost-effective, such as managing ignition sources, providing adequate separation between other combustible materials and the areas where depressurization of an aerosol container typically occurs, and providing adequate ventilation to prevent flammable gas accumulation.[58] These are common safety measures that are typically already in place at most MRFs.

Aerosol cans that contain residual fluids and propellants present risks to MRFs and buyers of recycled materials. Within a MRF, depressurization of post-consumer aerosol containers primarily occurs on the tip floor (negligible ignition risk), or within the baler (moderate ignition risk for steel,[59] negligible ignition risk for aluminum). In addition to safety-conscious MRF operators, buyers of metal bales have also expressed concern that pressurized aerosol cans may survive intact through the baler, presenting a potential fire explosion risk to the buyer's facility.[60]

Intake Processing

On the tip floor, aerosol can damage is most often resulting from crushing by vehicle tires or impact damage from the loader bucket scraping against the floor, which are examples of depressurization events. This will often result in immediate, near-complete depressurization of the container propellant and contents. Certain liquid solvents, such as those found within spray paint, were observed to remain in trivial quantities after the initial depressurization event, although this is based on anecdotal evidence and would require further testing and more evidence to corroborate.[61]

Where aerosol cans are interacting with industrial equipment on the tip floor, this typically corresponds to low burden depth and high local airflow rates, resulting in rapid dispersion of vapors. Control of sources of ignition within this small radius is generally adequate to prevent ignition of potentially flammable aerosol vapors released on the tip floor.

When an aerosol can depressurizes but does not ignite, there is the potential for residual spraying of contents that may be hazardous to personnel (e.g., paints, pesticides). In addition to industry-standard personal protective equipment, staff workstations should be provided with adequate ventilation to remove hazardous vapors from the workspace.

Baling

A steel baling machine is capable of depressurizing empty aerosol cans under certain conditions, and thus for facilities that accept aerosols, the steel baler is the most high-risk location for aerosol can-induced fires. This is because the baler provides conditions for both depressurization of aerosols (crushing), and ignition (steel sparking).[62] Note that this method does not provide for safe depressurization of filled aerosol containers so facilities that depressurize aerosol containers in the steel baler must presort charged containers from the waste stream. In accordance with the expected worst-case conditions, and industry standard practices for point source releases of this magnitude, an area classification scheme for metal baling machines handling flammable aerosol containers may be proposed.[63]

Liquified Petroleum Gas (LPG) Cylinders

A similar, but distinct hazardous waste received at MRFs is LPG cylinders (e.g., butane torch gas, camping stove gas, etc.). LPG cylinders are regulated differently than aerosols, however, this distinction is not always clear to consumers. LPG cylinders can hold significantly higher quantities than aerosol cans, and the contained product is always flammable. As LPG cylinders are not covered by the EPA Universal Waste Rule, these products, even if empty, generally should not be placed in household recycling collections, and where found must be sorted from the waste stream and held for appropriate disposal. Some states have requirements for separate takeback programs for LPG containers, and some retailers have trade-in programs for customers to exchange their empty used containers when replacing them with new ones. But these programs vary by municipality and the proper disposal responsibility falls on the consumer.

MRF Best Practices for the Prevention of Fires

For the prevention of facility fires, including any that may have been caused by an aerosol container, it is critical to control sources of ignition within the MRF. Best practices for controlling sources of ignition[64] at MRF sites include:

1. Prohibit smoking and open flames at the facility with ample “no smoking” signage.
2. Direct combustion engine exhaust away from combustible materials.
3. Maintain stable piles with dedicated aisle space to accommodate the movement of equipment.
4. Provide adequate ventilation in areas where release of container contents may occur to prevent accumulation of vapors over time.
5. Implement a hot work permit program for maintenance and construction activities that involve powered equipment and/or potential sources of ignition.

These practices are generally required at all MRF sites to prevent the combustion of any of the flammable materials present. A fire event resulting from aerosol propellant ignition may be momentary, however, this may ignite surrounding combustible materials, which can result in a prolonged fire within the facility. Requirements for active and passive fire protection systems, such as automatic fire sprinklers, fire-resistance-rated construction, fire detection, and alarm systems are generally regulated by the local building and fire codes (e.g. International Fire Code, NFPA 1[65]). Many of these requirements are enforced at the time of facility construction or initial occupancy, however, it is also recommended that facility operators perform periodic reviews of their fire protection systems for adequacy in protecting against current hazards within the facility.

Further research to test fire hazards associated with aerosols could draw more specific conclusions about their safe handling at MRFs.

E. UNITED KINGDOM AEROSOL RECYCLING INITIATIVE

Similar to the Aerosol Recycling Initiative in the U.S., the Aluminium Packaging Recycling Organization (ALUPRO) is spearheading a United Kingdom (UK) Aerosol Recycling Initiative. An estimated 650 million metal aerosols are used in the UK each year, with more than 80 percent of these likely to be consumed in households. The purpose of the initiative is to catalyze greater collection of aerosols in curbside systems to reduce their environmental impact and reduce the fees put on aerosol cans under the UK's EPR system.

The initiative started with research to understand the state of aerosol can recycling and how best to increase it.[66] The national public survey found that local government websites are the most common source of information used by respondents for aerosols recycling (45%), while 39 percent of respondents checked the packaging. Also, 52 percent of people reported feeling very or somewhat confident about the process of disposing of aerosols in their local area. Another component of the research was waste composition analyses. It observed that 56 percent of aluminum aerosols and 63 percent of steel aerosols were found in the recycling stream (as a percent of the total aerosols found in the recycling and residual waste). Further, 89 percent of all aerosols in the recycling stream were deemed as empty.

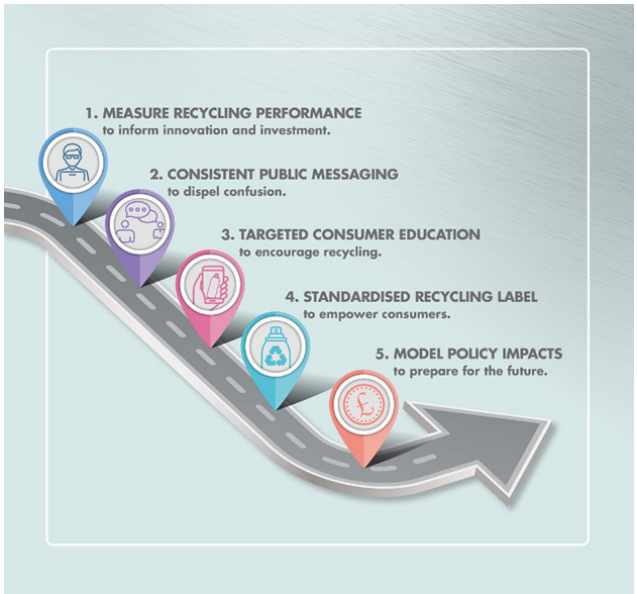
Coming out of the research, ALUPRO created a list of five priority actions:

1. Measure recycling performance to inform innovation and investment.
2. Consistent public messaging to dispel confusion.
3. Targeted consumer education to encourage recycling.
4. Standardized recycling label to empower consumers.
5. Model policy impacts to prepare for the future.

Ultimately, the UK Aerosol Recycling Initiative seeks to bring about a world where consumers recycle all their empty aerosols responsibly in their curbside system, knowing with confidence that this will result in their packaging being collected, sorted, recycled, and transformed into something new. Its goals are to increase the capture rate of aerosols in curbside collections to greater than 75 percent by 2030 and to drive high recycling rates of aerosols with initiatives that have good return on investment and good pilot performance.

ALUPRO, CMI, and HCPA are in regular communication to discuss their respective programs, learn from each other, and collaborate as appropriate.

UK AEROSOL RECYCLING INTITIATIVE ROADMAP



SOURCE: ALUPRO

F. METHODOLOGY

Consumer Omnibus Survey

The U.S. consumer survey results are from an online omnibus survey conducted by Padillia in fall 2022. An omnibus survey involved multiple sponsors and includes questions on a variety of subjects. CMI and HCPA were the sponsors of the questions pertaining to aerosol recycling within this omnibus survey. CMI and HCPA wrote the first draft of the questions and then worked with the Padilla team to refine the questions, so they delivered more useful results. The entire research was overseen by the experienced Padilla team.

TABLE 6: OMNIBUS SURVEY METHODOLOGY

Parameter	Description
Type	Online survey, approximately 4-5 minutes
Respondent	General population adults (18+ years old)
Geography	U.S. Nationwide
Branding	None (blind study)
Database	Padilla used a third-party vendor specializing in consumer research sampling
Incentives	Respondents were provided compensation as a "thank you" for their participation (e.g., points awarded)
Completed Surveys	N = 1,021

TABLE 7: DEFINITION OF GENERATIONAL GROUPS

Generation	Age
Generation Z	18-22
Millennials	26-41
Generation X	42-57
Baby Boomers	58+

Aerosol Container Testing for Residuals

In 2022, aerosol samples were collected from two locations—Metrolina MRF in Mecklenburg, NC, and West Tennessee Recycling Hub in Henderson, TN—in which the aerosol containers recycled by end-users were picked off conveyor lines before the bailing process in a MRF. This provided representative, whole samples from before the point in MRF processing when containers are crushed and the contents evacuated.

The samples were shipped to Recycle Aerosol, located in Bells, TN, using their special permit as the samples were treated as though they were hazardous waste, and stored at the facility before testing occurred.

Volunteers from the aerosol industry spent two days at Recycle Aerosol. The first day was for sample preparation. Every sample was identified numerically, and the information about each sample was recorded.

The information recorded was the:

- Product Name
- Product Marketer
- Container Type (Aluminum, Steel, Plastic, or Glass)
- Whether it was a Compartmented Aerosol
- Net Contents (as labeled)
- Flammability Warnings on the Label
- Whether the Label Markets the Product as Recyclable (and if so, how)
- Propellant(s) (if identified on label)
- MRF where Sample was Collected.

On the second day, volunteers were split up into three teams. The first team weighed and recorded the "initial weight" of each sample (in grams). The second team measured the pressure of each sample (if any). The third team punctured and depressurized each sample individually and drained the concentrate of the product into a beaker. The empty container and beaker were both weighed (in grams). Any difference between the initial weight, the concentrate in the beaker, and the empty container was assumed to be the propellant.

Recyclability Labeling Survey

A number of different types of labeling related to end-of-life are currently included on aerosol cans. In order to understand how predominant recyclability labeling is within the aerosol industry and how labeling may differ between product types, CMI and HCPA hired Eunomia to assess the types of labels on aerosol products at various types of stores across the U.S.

Eunomia undertook this analysis with in-store characterizations of aerosol products and labeling practices, compiled by unique SKU codes. In each store, aerosol products and labeling were documented via photographs of the shelving units containing aerosol containers and photos documenting the label type. To assess the frequency, the number of SKU codes was counted and grouped into product categories, as follows:

- Insect Sprays (personal insect repellants, and roach sprays, etc.)
- Paints and Finishes (paints, primers, varnishes, etc.)
- Household Products (air fresheners, disinfectants, cleaners, laundry products, waxes and polishes, dusters, etc.)
- Personal Care Products (shaving foams, hair products, deodorants, pharmaceuticals, sun care, hand sanitizer, etc.)
- Auto, Lubricants, and Industrial Products (refrigerants, cleaners, engine degreasers, lubricants, spray undercoating, tire inflator, carb and choke cleaner, brake cleaner, engine starting fluid, adhesives, etc.)
- Food Products (pan or cooking sprays, whipped cream, etc.)
- Miscellaneous (any products not covered under the above categories)

It is important to note that an individual SKU code is indicative of a unique product. However, that product can be the same brand and type of aerosol but have a different attribute, such as size, smell, or another functional attribute. While an SKU may offer a similar product relative to another SKU, SKUs can also represent the degree of exposure the consumer received from products since a higher number of SKUs associated with a similar product type correlates to more shelf space occupied.

To assess variability in aerosol products offered for sale to the public, a variety of store types and brands across different geographic regions were selected for inclusion in this study. To capture geographic variability, stores were visited in four different states (Colorado, Illinois, Oregon, and North Carolina). There were 17 stores evaluated, as shown in Table 8. Grocery stores were a primary focus since they tend to be used most frequently by a broad cross-section of society.

TABLE 8: SUMMARY OF STORES, STORE BRANDS, AND LOCATIONS SAMPLED

Store Type	Store Name	Location
Grocery Stores (8)	Safeway	Colorado
	Natural Grocers	Colorado
	Jewel Osco	Illinois
	Sunset Foods	Illinois
	Food Lion	North Carolina
	Harris Teeter	North Carolina
	Safeway	Oregon
	Albertson's	Oregon
Big Box Stores (4)	Target	Colorado
	Target	Illinois
	Target	North Carolina
	Target	Oregon
Home Improvement Stores (3)	Lowe's	Colorado
	Ace Hardware	Illinois
	Home Depot	North Carolina
Industrial Supply Store	Grainger	North Carolina
Automotive Store	Advance Auto	North Carolina

FIGURE 3: AVERAGE NUMBER OF SKUS IN EACH STORE TYPE

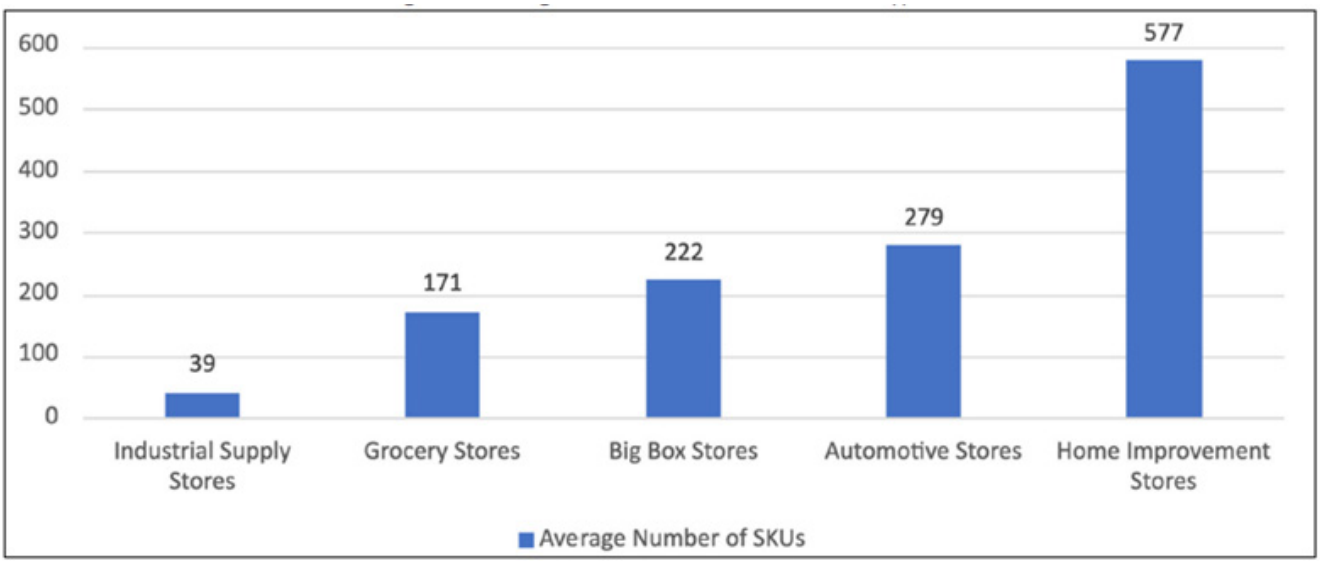


TABLE 9: NUMBER OF SKUS BY PRODUCT CATEGORY AND ASSOCIATED LABEL TYPES

Product Category	# of SKUs	Chasing Arrows	How2Recycle	Storage & Disposal	Other	None
Insect Sprays	350	35%	5%	31%	0%	42%
Paints & Finishes	1419	20%	0%	3%	1%	75%
Household Products	654	45%	27%	4%	1%	26%
Personal Care Products	1440	10%	53%	0%	2%	36%
Auto, Lubricants & Industrial	391	54%	1%	1%	2%	43%
Food Products	224	16%	56%	3%	0%	28%

Economic Impact Analysis of Recycling Aerosols

To understand the potential future environmental and economic impacts of increasing the recycling rate of aerosol cans, two recycling rate scenarios were modeled, a 25 percent recycling rate and a 50 percent recycling rate scenario.

The number of aluminum and steel containers sold in 2019 (most recent data available), according to the HCPA Annual Pressurized Product Survey,[67] was used as a baseline. The number of units from this source was multiplied by standard weights of aluminum and steel aerosol containers to determine the associated tonnages placed on the market in 2019 (see Table 10). The total tonnages of each container type placed on the market was used to determine the respective recycled tonnages of each container type in the recycling rate scenarios (see Table 11). In the 25 percent and 50 percent recycling rate scenarios, aluminum aerosols and steel aerosols are assumed to each have a 25 percent and a 50 percent recycling rate, respectively. Estimates from existing MRF studies were used to determine the percentage of aerosols for each type of bale or other collection of sorted metal (see Table 12). Average benefit-per-MRF breakdowns were calculated assuming there are 504 MRFs in the U.S. per Eunomia's MRF database.

TABLE 10: BASELINE AMOUNT AND WEIGHT OF AEROSOL CONTAINERS SOLD IN 2019

	Number of Aerosols Containers Sold	Weight per Aerosol Container (lb)	Weight of Containers (tons)
Aluminum Aerosols	739,597,000	0.068	25,146
Steel Aerosols	2,882,428,824	0.190	273,830

TABLE 11: TONNAGE OF CONTAINERS RECYCLED UNDER RECYCLING RATE SCENARIOS

Recycling Rate Scenario	Weight			Number of Containers	
	Aluminum Aerosols (tons)	Steel Aerosols (tons)	Total Weight of Recycled Containers (tons, aluminum, and steel combined)	Total Number of Recycled Containers (Aluminum)	Total Number of Recycled Containers (Steel)
25%	6,000	68,000	74,000	176,471,000	715,789,000
50%	13,000	137,000	150,000	382,353,000	1,442,105,000

TABLE 12: ASSUMED AEROSOL PERCENTAGES OF COMMODITY OUTPUTS (% BY WEIGHT)

% of Bale Type that is Aerosols at MRFs that:	Aluminum Can UBC Bales	Steel Can Bales	Mixed Metal/Other Metal Commodities
Explicitly accept aerosols	0.9%	2.7%	2.0%
Do not explicitly accept aerosols	0.6%	1.7%	1.3%

SOURCES: MECKLENBERG MRF DATA AND KING COUNTY MATERIAL RECOVERY FACILITY ASSESSMENT (2020)

Environmental Impact Analysis of Recycling Aerosols

Using the EPA's Waste Reduction Model (WARM),[68] the baseline GHG emissions of aluminum and steel aerosol cans were determined by calculating the emissions that would be produced if all aerosol containers sold in 2019 (the most recent national tonnage data available) ended up in a landfill in $MTCO_2e$. Then, the respective emissions generated for each container type were calculated for each of the recycling rate scenarios, with the remaining proportion of containers assumed to be landfilled. GHG emissions savings generated in $MTCO_2e$ were determined by calculating the difference between the baseline emissions and the emissions of each recycling rate scenario.

Table 13 shows the GHG emissions savings generated by calculating the difference between the baseline emissions and emissions of each recycling rate.

TABLE 13: GREENHOUSE GAS EMISSIONS SAVINGS

Recycling Rate	Aluminum Aerosols Emissions Reduction ($MTCO_2e$)	Steel Aerosols Emissions Reduction ($MTCO_2e$)	Total Emissions Reduction of Steel and Aluminum Aerosols ($MTCO_2e$)
25% Recycled	-54,382	-120,421	-174,804
50% Recycled	-118,401	-248,221	-366,622

SOURCE: EUNOMIA CALCULATIONS, EPA WARM MODEL

The equivalent amount of GHG reductions from recycling aerosols in terms of emissions from cars, households, and electricity consumed was calculated using EPA's Greenhouse Gas Equivalencies Calculator.[69] To calculate equivalencies for the 25-percent and 50-percent recycling rate scenarios, the total emissions reduction from steel and aluminum aerosols combined for each scenario was used as the input for the Greenhouse Gas Equivalencies Calculator. To calculate the average equivalency per aerosol, the total emissions reduction from steel and aluminum aerosols for the 50-percent recycling rate scenario (366,622 $MTCO_2e$) was divided by the total number of recycled containers for the 50-percent recycling rate scenario (1,824,458,000 containers). The resulting approximation of average emissions reduction per aerosol recycled (0.0002 $MTCO_2e$) was used as the input for the Greenhouse Gas Equivalencies Calculator.

Economic Impact Analysis

Based on the assumption that an increased volume of recycled material would necessitate an increase in labor, to recycle aerosol containers at the 25-percent and 50-percent rates, additional employees will be needed to handle the increase in the flow of aerosol containers in curbside collections, sorting facilities, and reprocessing plants. Increasing the quantity of aerosol containers in curbside collections will result in additional trucks, drivers, and support staff to manage the aerosols in the recycling stream. Sorting facilities may also need to increase the number of FTE employees on the lines in their facilities. Jobs are scaled on a per-tonnage basis. A breakdown of the total direct jobs that would be created in the 25-percent and 50-percent recycling rate scenarios for aerosol containers is illustrated in the Table 14.

TABLE 14: DIRECT FTES NEEDED UNDER DIFFERENT RECYCLING SCENARIOS

	Number of Direct FTEs Needed	
Job Category	**25% Recycling Rate**	**50% Recycling Rate**
Collections Operations Total	100	210
Collections Support Total	10	20
Sorting Total	50	110
Reprocessing	120	250
Total	280	590

SOURCE: EUNOMIA CALCULATIONS/DATA, NRDC: FROM WASTE TO JOBS – WHAT ACHIEVING 75% RECYCLING MEANS FOR CALIFORNIA, RETURNING TO WORK: UNDERSTANDING THE DOMESTIC JOBS IMPACTS FROM DIFFERENT METHODS OF RECYCLING BEVERAGE CONTAINERS

Increased employment also means an increase in wages paid across the recycling industry associated with the increased tonnage in material recycled. Table 15 shows the total estimated direct wages paid under the 25-percent and 50-percent recycling rate of aerosols scenario.

TABLE 15: DIRECT WAGES UNDER A 25-PERCENT AND 50-PERCENT RECYCLING SCENARIO

Wage Category	**25% Recycling Rate**	**50% Recycling Rate**
Collections Operations Total	$7,003,000	$14,195,000
Collections Support Total	$717,000	$1,454,000
Sorting Total	$2,773,000	$5,621,000
Reprocessing	$10,905,000	$22,105,000
Total	$21,398.000	$43,375.000

SOURCE : EUNOMIA CALCULATIONS; EUNOMIA DATA

Aerosol cans are commodities that have a material value whether they are whole cans, loose, or baled, and can be sold on the market for manufacturing into new metal products. Processors will pay per ton for aluminum and steel containers as inputs for their furnaces. The average U.S. commodity value for aluminum and steel cans for 2019-2021 can be seen in Table 16. There is limited data on the value of non-UBC aluminum cans and thus a value on the lower end of aluminum UBC values has been used.

TABLE 16: MATERIAL REVENUES PER TON

Material	**Commodity Revenue per ton over a 3-year average**
Aluminum UBC Cans	$1,277
Steel Cans	$164

SOURCE: RECYCLINGMARKETS.NET

The expected material revenues in Table 17 were calculated using the commodity revenues in Table 16 to determine the material value of aerosol cans under the 25-percent and 50-percent recycling rate scenarios.

TABLE 17: POTENTIAL MATERIAL REVENUES UNDER RECYCLING SCENARIOS

Recycling Rate Scenario	Aluminum Aerosol Revenue	Steel Aerosol Revenue	Total Aerosol Revenue
25%	$7,659,634	$11,150,776	$18,900,000
50%	$16,595,873	$22,465,534	$39,062,000

SOURCE: EUNOMIA CALCULATIONS, RECYCLINGMARKETS.NET

Potential material revenues per MRF are shown below:

TABLE 18: REVENUES PER MRF UNDER EACH SCENARIO

Recycling Rate Scenario	Aluminum Aerosols Revenue/year ($)	Steel Aerosols Revenue/year ($)	Total Revenue/year ($)	Additional Revenue/year ($)
25%	15,000	22,000	37,000	23,000
50%	33,000	44,000	77,000	63,000

SOURCE: EUNOMIA CALCULATIONS

Aerosols that are recycled are no longer disposed of in landfill or elsewhere. As a result, there are cost savings from avoiding paying disposal tipping fees (e.g., landfill tipping fees). Tipping fees vary by state; however, the average tipping fee across the U.S. is approximately $54/ton.[70] Table 19 shows the disposal tipping fee savings that would be expected to be realized under the 25-percent and 50-percent recycling rate scenario:

TABLE 19: LANDFILL TIPPING FEE SAVINGS FROM 25 PERCENT AND 50 PERCENT RECYCLING RATE

	25%	50%
Landfill Tipping Fee Savings Per Year ($)	4,220,000	8,554,000

SOURCE: EUNOMIA CALCULATIONS, ENVIRONMENTAL RESEARCH & EDUCATION FOUNDATION 2021 MSW TIPPING FEE ANALYSIS

ENDNOTES

[1] The number of aluminum and steel containers sold in the U.S. in 2019 according to the Household & Commercial Products Association Aerosol Pressurized Products Survey (most recent data available) was used as a baseline. The baseline was multiplied by standard weights of aluminum and steel aerosol containers, estimated based on information provided by manufactures of aerosol containers for the U.S. market, to determine the associated tonnages placed on the market in 2019. This was calculated as 25,146 tons of aluminum aerosol cans and 273,830 tons of steel aerosol cans placed on the market in 2019.
[2] Impact analysis performed by Eunomia as part of the Aerosol Recycling Initiative; U.S. Environmental Protection Agency Waste Reduction Model (WARM).
[3] Sustainable Packaging Coalition, *2020-21 SPC Centralized Study on Availability of Recycling*.
[4] Our thanks to the team led by Gershwin, Brickner & Bratton (GBB) and consisting of GBB, Eunomia, and Jensen Hughes; Padilla; Resource Recycling Systems; and Factory Mutual Research Corporation for contributing to the data and insights in this report.
[5] Can Manufacturers Institute (CMI), *General Line Can Shipments 1970-2020*.
[6] HCPA, *Aerosol Pressurized Products Survey*.
[7] The Aluminum Association, *The Environmental Footprint of Semi-Fabricated Aluminum Products in North America*, 2022.
[8] World Steel Association, *Life Cycle Inventory (LCI) Study*, 2020; Broadbent, C. *Steel's Recyclability: Demonstrating the Benefits of Recycling Steel to Achieve a Circular Economy*. Int J Life Cycle Assess 21, 1658–1665, 2016.
[9] Factory Mutual Research, *Guidelines for Aerosol Can Recycling in Material Recovery Facilities*, 1998.
[10] Minimization of the entry of flammable material; Minimization of the pre-bale releases, which includes the separation and handling of full or partially full aerosol containers; Minimization of flammables in the hazard zones of MRFs, such as a the magnetic separation area, baling area, and bale storage area; Minimizing the sources of ignition; Minimize the area of where flammable and combustible materials are stored; Have adequate fire protection; and Train personnel on proper procedures and housekeeping.
[11] Resource Recycling Systems. *Surveying State of MRFs and End Market Barriers to Recycling Steel and Aluminum Aerosols and Pet Food Cans and Identification of Solution*, 2021.
[12] Other aerosol trade associations outside the U.S., such as the British Aerosol Manufacturers Association, Comité Français des Aerosols, and European Aerosol Federation (FEA), have also worked on the acceptance of empty aerosol containers in recycling programs. For example, FEA published 2021 research that came to a similar conclusion as the FMRC analysis with its finding that, with some basic precautions, emptied post-consumer aerosols can be included in the normal household waste packaging system effectively and safely. While understanding how aerosol recycling works in other countries is helpful for improving processes in the U.S., it's important to note that aerosol production in the U.S. is different than the rest of the world, specifically in terms of the volume of recyclables and the different mix of products and containers, which makes this a unique opportunity that has to be studied on its own.
[13] 42 U.S.C. § 6901 et. seq.
[14] 40 C.F.R. § 239 – 282.
[15] 40 C.F.R. § 261.7(b)(1)(A).
[16] 49 CFR § 261.4.
[17] California Plastic Pollution Prevention and Packaging Producer Responsibility Act of 2022, SB 54, 2022 Cal. Stat. ch. 75.
[18] Colorado Producer Responsibility Program for Recycling, HB 22-1355, 2022 Colo. Legis. Serv. ch. 306.
[19] Maine Stewardship Program for Packaging, LD 1541, 130th Leg., 2021 Sess. (Me. 2021).
[20] Minnesota, House File 3911, 93rd Legislature (2023-2024), Minnesota.
[21] Oregon Plastic Pollution and Recycling Modernization Act of 2021, SB 582, 2021 Or. Laws ch. 681.
[22] Vermont H. 67, 2023-2024 Leg., Reg. Sess. (Vt. 2023).
[23] CMI and HCPA engaged a team of consultants to help with some of these projects. This team of consultants was led by Gershman, Brickner & Bratton, Inc., (GBB) an international solid waste management consulting firm that helps public- and private-sector organizations craft practical, customized, and technically sound solutions for complex solid waste management challenges. The team also included Eunomia, an independent consultancy dedicated to helping its clients achieve better environmental and commercial outcomes, and Jensen Huges, a leader in fire safety, security, and risk-based engineering and consulting.
[24] This information was provided by Aaron Burman, Vice President of Data and Analytics at The Recycling Partnership, via email in August 2022.
[25] *Recycling Today*, "Fire Incidents Increased at Waste, Recycling Facilities in 2022," March 2023.
[26] Environmental Protection Agency (EPA), Office of Resource Conservation and Recovery, *An Analysis of Lithium-ion Battery Fires in Waste Management and Recycling*, July 2021.
[27] *Waste Today,* "List: North America's Largest MRFs," November 2021.
[28] The Recycling Partnership, Contributory data courtesy of *Resource Recycling*, Map of Commingled Residential MRFs in the U.S.
[29] Republic Services, Metal and Aluminum Recycling, 2024.
[30] Waste Management, Recycling 101 web page, 2024.
[31] Padilla, HCPA and CMI October Spotlight Report, November 2022.
[32] This confusion about what can and can't be recycled, as well as perception being different from the truth, is also covered in the Trivium's 2023 Buying Green Report, 2023.
[33] *Waste Advantage*, "Advanced Separation Equipment Increases Ferrous and Nonferrous Recovery Rates for MSW/MRF Facilities," June 2022.
[34] CMI, *Aluminum Beverage Can: Driver of the U.S. Recycling System*, June 2020.
[35] *Waste Advantage*, "Modern Separation Equipment Increases Ferrous and Nonferrous Recovery Rates for MSW/MRF Facilities," January 2017.

[36] Resource Recycling Systems, *Surveying State of MRFs and End Market Barriers to Recycling Steel and Aluminum Aerosols and Pet Food Cans and Identification of Solution*, 2021.
[37] Aluminum Association, *North America Aluminum Industry Plant Directory*, 2019.
[38] Ball Corporation (2023) *Climate Transition Plan.*
[39] World Aerosol (2022) "Ball partners with Recycle Aerosol to boost recycling rates."
[40] Hasanbeigi, A., Springer, C., Shi, D. 2021. *Aluminium Climate Impact - An International Benchmarking of Energy and CO2*, February 2022.
[41] Georgitzikis K., Mancini L., d'Elia E., Vidal-Legaz B., *Sustainability Aspects of Bauxite and Aluminium — Climate Change, Environmental, Socio-Economic and Circular Economy Considerations*, EUR 30760 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-40039-4, doi:10.2760/702356, JRC125390.
[42] EPA, Greenhouse Gas Equivalencies Calculator, 2024.
[43] Ball Corporation, *Real Circularity*, 2023.
[44] Federal Register, Federal Trade Commission, 16 CFR Part 260, *Guides for the Use of Environmental Marketing Claims*; Final Rule, Vol. 77 No. 197, October 11, 2012.
[45] 40 CFR § 156.10(i)(2)(x).
[46] California, Colorado, Maine, Minnesota and Oregon have all passed EPR legislation and California has additionally passed environmental marketing claims legislation, including what can be termed "recyclable."
[47] Online product sales were not included in this study.
[48] How 2 Recycle web page, 2024.
[49] 40 CFR § 156.10(i)(2)(x).
[50] "Percent of aerosol SKUs" refers to the percent of total aerosol "stock keeping units" (i.e., distinct type of item for sale) examined that have a certain kind of recyclability messaging.
[51] Trivium Packaging, *Aerosol Cans in Europe: A Story of Infinite Recyclability,* 2023.
[52] Trivium Packaging, *Buying Green Report*, 2023.
[53] All numbers in table 5 represent total value add (*e.g.,* GHG emissions reduction if 25% of aerosols are recycled as compared to 0%).
[54] EPA, Greenhouse Gas Equivalencies Calculator.
[55] The Recycling Partnership, "Start at the Cart," May 2018.
[56] Sixth Assessment Report of the United Nations Intergovernmental Panel on Climate Change.
[57] Federal Register, EPA, *Increasing Recycling: Adding Aerosol Cans to the Universal Waste Regulations*, Docket ID No. EPA–HQ–RCRA–2017–0463, February 7, 2020.
[58] Janes, A., *Evaluation and Mitigation of Fire and Explosion Risks Due to the Presence of Aerosol Cans in Metal Waste Recycling*. IChemE Hazards 26, 2016.
[59] Interview with MRF operator, December 6, 2022.
[60] Interview with MRF operator, February 9, 2023.
[61] Janes, 2016.
[62] Smith, D., "Health and Safety issues in post-consumer aerosol recycling", Conservation and Recycling 31, 25 August 2000.
[63] For this scenario, based on a fully charged flammable aerosol can as discussed above, the interior of the baling chamber and 3-foot radius surrounding may be rated Class I, Division 1, Group D, and an additional 2-foot radius of Class I, Division 2, Group D would extend from the Division 1 location. Class I locations are locations in which flammable gases or vapors may be present in the air in quantities sufficient to produce an ignitable mixture, with requirements for electrical equipment in Class I locations given by the National Electric Code (NEC) Article 500.
[64] Smith, D., 2000.
[65] NFPA 1, Fire Code, 2023
[66] Alupro, *Roadmap to Increasing UK Aerosol Recycling*, April 2023.
[67] HCPA, *Aerosol Pressurized Products Survey.*
[68] U.S. Environmental Protection Agency Waste Reduction Model: WARM uses a standard set of emissions rates for commonly used materials and the respective emissions per ton of material produced, source reduced, recycled, landfilled, combusted, composted, and anaerobically digested.
[69] EPA, Greenhouse Gas Equivalencies Calculator.
[70] Environmental Research and Education Foundation, *2021 Analysis of MSW Landfill Tipping Fees*.