Trashed Cans

The Global Environmental Impacts of Aluminum Can Wasting in America

Jennifer Gitlitz

June 2002

CRI

CONTAINER RECYCLING INSTITUTE

Container Recycling Institute
4361 Keystone Ave
Culver City, CA 90232

www.container-recycling.org
www.bottlebill.org

“Trashed Cans: The Global Environmental Impacts of Aluminum Can Wasting in America”
by Jennifer S. Gitlitz

ISBN # 1-931976-03-1

Container Recycling Institute
4361 Keystone Ave, Culver City, CA 90232
Tel. (310) 559-7451
www.container-recycling.org
www.bottlebill.org

Trashed Cans

The Global Environmental Impacts of Aluminum Can Wasting in America

by Jennifer Gitlitz

June 2002

CONTAINER RECYCLING INSTITUTE

Container Recycling Institute
www.container-recycling.org
www.bottlebill.org

Acknowledgments

The Container Recycling Institute would like to extend its gratitude to
The Merck Family Fund,
The Naomi and Nehemiah Cohen Foundation,
The Turner Foundation,
and our many hundreds of individual donors
for their generous support in making this report possible.

Jenny Gitlitz would like to express her special thanks to
Kyle Paulson and David Markert for their research assistance,
Lance King for his editorial assistance,
and to Pat Franklin for her overall project guidance.

Additional thanks to Steve Apotheker,
Linda Gaines, Doug Koplow, Clark McKinley, Jeff Morris,
Frank McManus, Lori Pottinger, Jerry Powell, and John Stutz for their peer review,
and to Steven Skoblow for his patience and support.

Front cover photo: trash can by Michael Gitlitz, aluminum can lid by Jeanette Madden, design by Jenny Gitlitz.
Back cover photo: Jeanette Madden, courtesy of International Rivers Network.

TABLE OF CONTENTS

LIST OF FIGURES, TABLES AND APPENDICES

Biography of the Author

Jenny Gitlitz has been a recycling practitioner, researcher, teacher, and activist since 1985. She has implemented curbside recycling programs in two California cities, has been the lead organizer for several recycling conferences, and has spoken and published widely. She has completed two masters degrees, where her research focused on the relationship between the primary aluminum and hydroelectric industries, and their environmental and social effects. She served as executive director of the Massachusetts Recycling Coalition, and has worked as a consultant to the Container Recycling Institute since February 2001. Jenny has recently joined CRI's staff through an Environmental Leadership grant from the Switzer Foundation.

She lives in Massachusetts with her husband, Steven Skoblow, and her daughters, Dvorah and Aviva.

Foreword

Throwing away aluminum cans is an environmental tragedy. To make replacement cans for those we landfill, litter or incinerate, we must extract and process vast quantities of raw materials and energy, thereby creating massive amounts of pollution and devastating fragile ecosystems around the world. Because recycling rates for aluminum cans have remained relatively high compared to those for glass and plastic bottles, the global impacts of wasting ever-greater numbers of aluminum cans have received little public attention.

Americans currently trash half of the 100 billion aluminum beverage cans they purchase each year. At 49.2%, the aluminum can recycling rate in 2001 was the lowest it had been in 15 years, and even lower than the rate achieved twenty years earlier. Americans are wasting more aluminum cans than ever: three-quarters of a million tons a year. CRI estimates that by 2003, Americans will have sent ***over one trillion cans*** to landfills or incinerators, or littered them along our nation's roads, beaches, farms, and scenic places.

Many Americans seem to be unaware of the aluminum can wasting problem, and the far-reaching energy and environmental implications of replacing these cans, believing instead that the most important reason to recycle is to save landfill space. This report sets the record straight, documenting the far more devastating impacts of not recycling aluminum cans: wasted energy, habitats destroyed, and pollution generated by mining and processing bauxite and other raw materials to make new cans.

The Container Recycling Institute commissioned Jenny Gitlitz to document the global impacts of aluminum beverage can wasting in America in order to inform the public about a growing environmental problem. This report is intended to communicate the real costs of this "throwaway" package, and to focus attention on a means to eliminate this needless waste of energy and material resources.

Fortunately, a proven solution to the aluminum can waste problem already exists in some parts of the United States and in many other countries: the mandatory deposit system. Modeled after the voluntary deposit return system created by the beverage industry more than a century ago to retrieve their own refillable beer and soda bottles, it relies on the financial incentive of the refundable deposit to encourage the recycling of aluminum cans and other beverage containers.

The beer and soft drink industries began replacing the voluntary return system with throwaway containers more than 50 years ago, and by 1990, it had been almost completely dismantled. Today, beer and soda manufacturers and distributors rely almost exclusively on one-way, throwaway cans and bottles to deliver their products, leaving nearly 100 billion wasted aluminum cans and glass and plastic bottles in their wake each year.

The modern, mandatory deposit system is an antidote to this tide of waste. On average, the ten U.S. states now requiring a refundable deposit on beverage containers already achieve a 71.6% overall recycling rate for *all* beverage containers—including those not covered by the deposit, compared to a rate of only 27.9% in the 40 non-deposit states.

If we can muster the political will to implement deposits, and to take other steps discussed in this report, the high recycling rates found in deposit states can be replicated nationwide.

We welcome your comments, and hope that all who read this report are moved to seek solutions to reverse the aluminum can wasting trend.

Pat Franklin, Executive Director
Container Recycling Institute

EXECUTIVE SUMMARY:

ALUMINUM CAN RECYCLING AND WASTING IN AMERICA

More aluminum beverage cans are being wasted—landfilled, littered or incinerated—than ever before. In the year 2001, 50.7 billion cans were *not recycled* in the United States: just over half of the 100 billion cans sold that year—and 50% more than were wasted in 1990. This report discusses the environmental impacts of making aluminum cans from virgin materials, analyzes the causes of the wasting trend, and offers solutions to increase the can recycling rate.

In the last decade, Americans wasted 7.1 million tons of cans: enough to manufacture 316,000 Boeing 737 airplanes.

The quantity of aluminum wasted in America is staggering. In the year 2001, 760,000 tons of aluminum cans were wasted—165,000 tons more than were wasted in 1990. This was more aluminum metal than was used nationally for trucks, buses, bridges, and roadway applications combined.[1] Between 1990 and 2000, Americans wasted a total of 7.1 million tons of cans: enough to manufacture 316,000 Boeing 737 airplanes—or enough to reproduce the world's entire commercial airfleet 25 times.[2]

At a time when large parts of the country are experiencing electricity price hikes, Americans continue to squander one of the most energy-intensive consumer products on the market: single-serving, single-use aluminum beverage cans. Despite the significant energy-saving potential of recycling used aluminum beverage cans (UBC's), the national UBC recycling rate dropped below 50% in 2001. Had the 50.7 billion cans wasted last year been recycled, they would have saved the energy equivalent of 16 million barrels of crude oil: enough energy to generate electricity for 2.7 million U.S. homes for a year, or enough to supply over a million cars with gasoline for a year (see Appendix C).

Aluminum can production contributes to a panoply of environmental damages, many of which could be avoided through increased recycling efforts. Mining and refining bauxite ore and other material inputs generates large quantities of toxic solid waste, liquid effluents and air emissions. Primary aluminum smelting and beverage can manufacturing also require vast amounts of electricity and generate additional pollutants. Mining, materials processing, and energy production—including the construction of scores of hydroelectric dams to power aluminum smelters—are also responsible for the widespread destruction of wildlife habitat and the displacement of hundreds of thousands of indigenous peoples around the world.

Recycling aluminum cans has numerous environmental benefits over producing them from virgin materials. Had the 50.7 billion cans wasted in 2001 been recycled, they would have:

- Avoided the emission of more than three million tons of greenhouse gases[3];
- Avoided the emission of 75,000 tons of sulfur dioxide and nitrogen oxide emissions—contributors to smog and acid rain;
- Reduced soil erosion and habitat loss from strip mining for bauxite and coal;
- Reduced toxic runoff from mining which contaminates soil and waterways;
- Reduced solid wastes and liquid effluents from smelting and other industrial processes;
- Reduced damage to salmon habitats in the Pacific Northwest and Canada; and
- Avoided landfilling, littering or incinerating 760,000 tons (12 million cubic yards) of aluminum.[4]

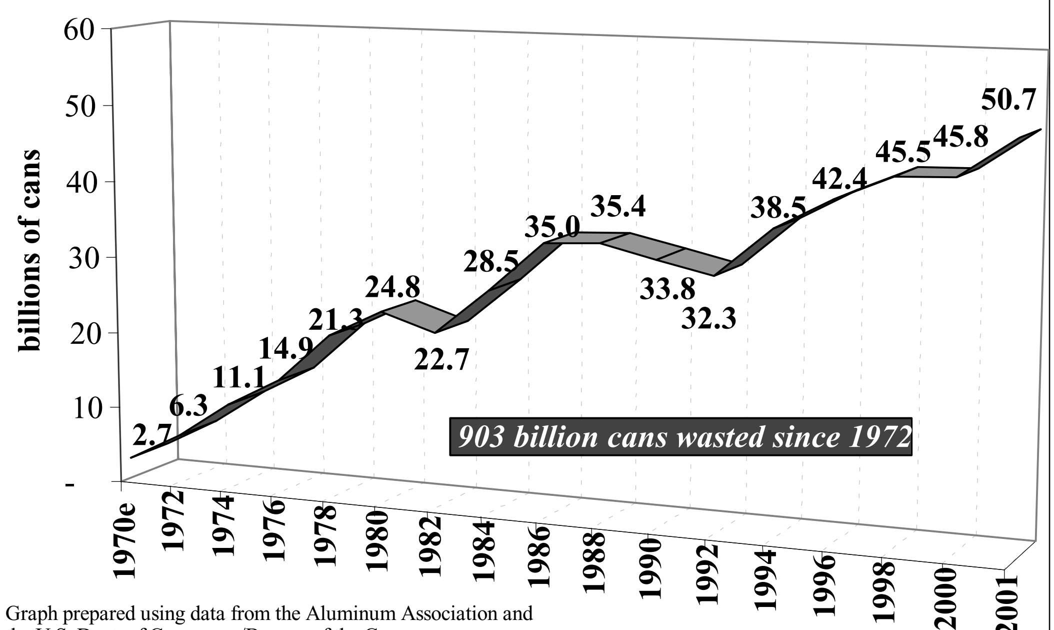
Had the 50.7 billion cans wasted in 2001 been recycled, they could have saved the energy equivalent of 16 million barrels of crude oil--enough energy to generate electricity for 2.7 million U.S. homes for a year.

Since mining, processing, and smelting operations often take place in other countries or locations far removed from most American consumers, few Americans are aware of these adverse "upstream" environmental impacts of wasting and continually replacing aluminum cans. Instead, greater attention has been given to the "downstream" environmental impacts of wasting: litter and landfill disposal.

Residential curbside recycling programs targeting cans and other containers mushroomed across the country during the late 80's and 90's, leading many people to believe that aluminum recycling was increasing. While these curbside programs have done an admirable job of recovering newspapers and steel food cans, they have been unable to meet the challenge of recycling the growing number of aluminum beverage cans consumed away from home—in offices, cars, schools, airports, convenience stores, etc.

As a result of increasing total can sales, shifting consumption patterns, and other economic factors, total aluminum can wasting has increased—not decreased—in the last decade, despite the growth in curbside recycling. In the last thirty years, aluminum can waste in the U.S. has grown from under 100,000 tons to 760,000 tons per year, despite the high economic value of aluminum cans relative to other scrap materials, and despite over three decades of private, municipal, and state efforts to develop a national recycling infrastructure. As Figure 1 shows, Americans wasted more than twice as many cans in the year 2001 as in 1981, and eight times more than in 1972, the first year aluminum beverage can recycling data were collected.

Figure 1. Aluminum Beverage Cans Wasted in the United States,



Graph prepared using data from the Aluminum Association and the U.S. Dept. of Commerce/Bureau of the Census.
1970 and 1971 are CRI estimates.

Container Recycling Institute, 2002.

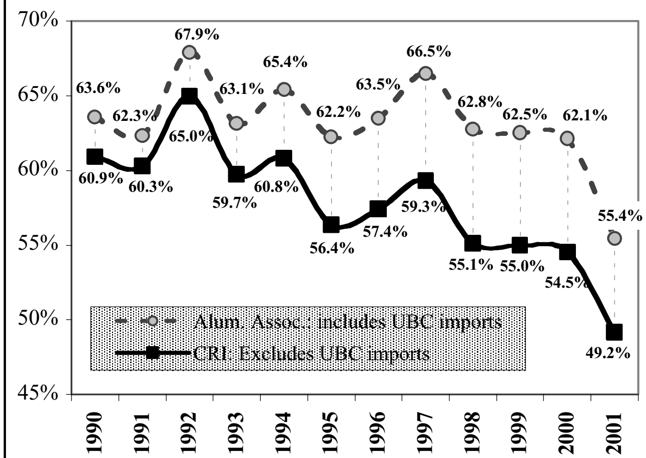
Americans wasted more than twice as many cans in the year 2001 as in 1981, and eight times more than in 1972.

Misleading reporting of aluminum can recycling rates by industry trade associations has masked the problem. Trade associations are inflating aluminum can recycling rates by including billions of *imported scrap cans* in their calculations (6.5 billion in 2001)—cans which were never sold in the United States. Although the U.S. Environmental Protection Agency has affirmed that the method CRI uses to calculate the aluminum can recycling rate is consistent with its own, the Aluminum Association continues to publish the higher recycling rate figures, which are widely viewed as "official" and have been broadly disseminated in the media. These competing methodologies are described in Appendix A.

The can recycling rate has not improved appreciably in twenty years.

Whether one relies upon CRI or trade association reporting, there is no disputing that wasting is up and recycling is down, as Figure 2 shows. The can recycling rate has not improved appreciably in twenty years. As early as 1982, almost 56% of the nation's aluminum cans were recycled. CRI analysis of industry and government data shows that aluminum can recycling peaked at 65% in 1992. After rising and falling over the next five years, the recycling rate began a steady decline to a 15-year low of 49.2% in 2001—lower than the rate achieved two decades ago.[5]

Figure. 2 The Aluminum Can Recycling Rate, 1990-2001: Two methods of measurement



Graph prepared using data from the Aluminum Association and tł U.S. Department of Commerce. Sharp peaks and valleys are the result of periodic holding of inventory to maximize scrap revenues.

Container Recycling Institute, 2002.

While our analysis focuses on the environmental impacts of wasting, there are also economic impacts. For example, at an average scrap value of 58¢/lb, the 45.8 billion cans wasted in 2000 represented almost $800 million in lost gross revenues. From 1986 to 2000, about 9.6 million tons of cans with a market value of over $10 billion were wasted (see Appendix B-1).

CRI has identified several factors contributing to the decline in aluminum can recycling and the increase in wasting over the last decade:

- American lifestyles are changing. Beverages are increasingly being consumed away from home and away from the convenience of residential curbside recycling.
- Inflation has eroded the effectiveness of the standard 5-cent container deposit required in eight states. A nickel in 1971—when the nation's first deposit law was enacted—had over four times the buying power that it does today. While the nation's 10 deposit states recycle approximately 80% of aluminum cans, even their rates have been declining. In Michigan, where the deposit is 10 cents, the annual aluminum can recycling rate is 95%, the highest in the nation.
- A robust economy and recent low unemployment have reduced many people's incentive to "scavenge" for cans, whose scrap value has rarely exceeded two cents per can, and has not kept pace with inflation.
- As concern about a "landfill crisis" waned and as curbside recycling grew in the 1990's, a sense that the garbage problem had been solved diminished public attention to recycling. Funding for recycling education and promotion was also reduced in many communities.[6]
- Total can sales have grown due to population growth and small increases in per capita consumption. In 1990, 249 million Americans purchased an average of 348 cans per person; in 2000, 281 million Americans purchased an average of 358 cans per person.

If the federal government were to enact a national deposit system, aluminum can recycling could be increased from the current 49% to 80% or more nationwide.

Private recycling efforts, non-residential recycling programs and municipal curbside programs are important elements of a successful national recycling strategy, but they alone cannot reverse the wasting trend. If the federal government were to enact a national deposit system similar to existing systems in ten states, or establish a mandatory recycling goal (as several countries have done), aluminum can recycling could be increased from the current rate of 49.2% to a rate of 80% or more nationwide. Either move could save the annual energy equivalent of 10 million additional barrels of oil, and could cut annual greenhouse gas production by 1.9 million tons.[7] Financial incentives have been, and remain, a key to reversing the wasting trend.

The beverage industry has a role to play as well. Beverage manufacturers could institute voluntary financial incentives to address the growing problem of aluminum can waste. The Swedish and Norwegian governments, for example, have adopted mandatory aluminum can recycling goals ranging from 75% to 90%, and have left the development and implementation of the system to private industry. The voluntary, industry-led deposit system in Sweden has resulted in a nationwide aluminum can recycling rate of 86% in 2000, and has ensured that the program is financed by beverage producers and consumers rather than taxpayers.

People need to be informed about the environmental and economic impacts of their consumption, and they need frequent reinforcement about how to recycle. More importantly, they need convenient recycling options for the cans they buy away from home.

Public education is also important, but must not take the form of short-lived advertising campaigns. People need to be informed about the environmental and economic impacts of their consumption, and they need frequent reinforcement about how to recycle. More importantly, they need convenient recycling options for the cans they buy away from home.

Aluminum can recycling is on a downward spiral, and the current recycling infrastructure is not capable of halting this decline. We hope this report will generate greater public awareness of the environmental damage resulting from the production of aluminum cans, and will encourage government, industry, and the American people to adopt aggressive strategies to reverse the 38-year aluminum can wasting trend and its associated environmental impacts.

I. THE GROWTH OF ALUMINUM CAN WASTING

Since the first Earth Day in 1970, Americans have thrown away 910 billion cans worth over $25 billion in current dollars.

For three decades, citizens, local and state governments, and private industry have made increasing efforts to encourage recycling, prompted first by environmental concerns, then by a "landfill crisis," and finally by favorable economics and the desire to pre-empt regulation. During this time, aluminum cans were looked upon as recycling's golden child because they were recycled at rates far higher than any other material. This was, and still is, due to their high market value, their recognizability by consumers, and the relative ease with which they can be separated from the rest of the household trash. Indeed, aluminum cans continue to be recycled at rates that are nearly twice that of glass and plastic bottles. But despite the high scrap value of cans, the proliferation of curbside recycling programs,[8] and the existence of container deposit laws, or "bottle bills," in ten U.S. states, aluminum can recycling in the United States has declined and wasting has grown.

Since the first Earth Day in 1970, Americans have thrown away 910 billion cans worth over $25 billion in current dollars. If the present trend continues, we will have squandered one trillion cans by 2003.[9]

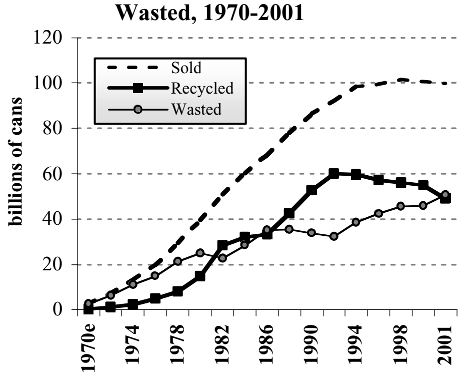
In the year 2001 alone, Americans wasted 760,000 tons of cans: more than the total amount of aluminum used nationally for trucks, buses, bridges, street and roadway applications combined.[10] From 1990 to 2000, we wasted 7.1 million tons of cans: enough aluminum to manufacture 316,000 Boeing 737 airplanes—or enough to reproduce the world's entire commercial airfleet 25 times.[11]

We have also wasted a tremendous amount of energy making new cans from raw ore to replace those that were not recycled. The energy required to replace three decades of wasted cans—16 million tons of aluminum—is equivalent to about 342 million barrels of crude oil.[12]

Two million of these 700-pound bales could have been made from the aluminum cans wasted in the U.S. last year.

While can sales rose rapidly in the 1970's, aggressive recycling measures were implemented as well, boosting the recycling rate from less than 15% in 1970 to 37% in 1980. In 1972, eight years after one-way aluminum cans were introduced in the American marketplace, about 6 billion cans were trashed, while only a billion were recycled, as Figure 3 shows. By 1982, the recycling rate had risen to 55.6%: over half of the 51 billion cans sold. Over the next ten years, the recycling rate climbed steadily, peaking at 65% in 1992. That year the aluminum companies boasted that their product was the most recyclable—and environmentally sound—beverage container on the market.

Figure. 3 U.S. Cans Sold, Recycled and Wasted, 1970-2001



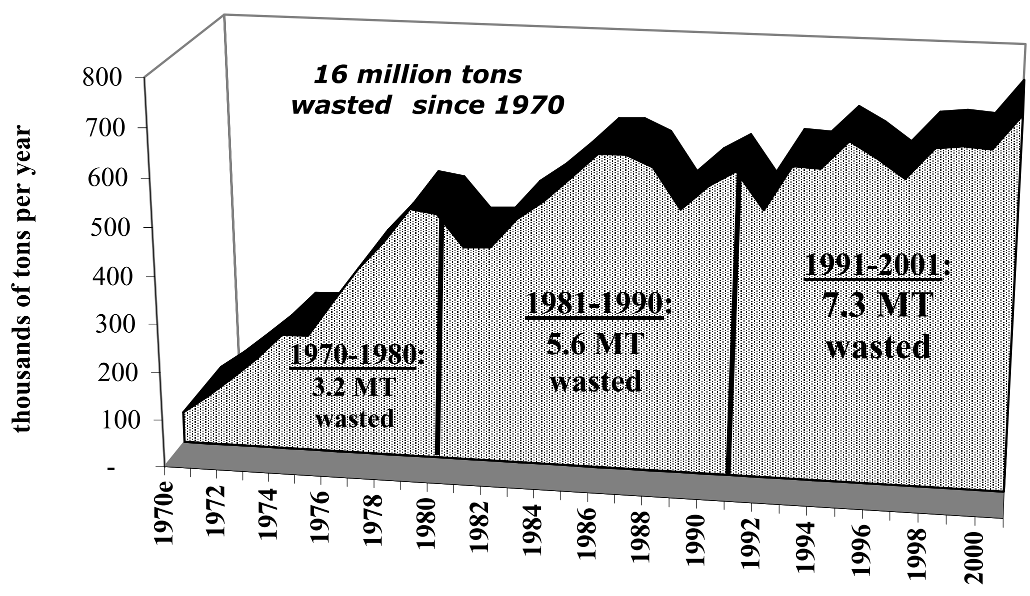
See Appendices A-4 and A-5 for sources and derivation.
Container Recycling Institute, 2002.

Although the number of cans recycled has climbed steadily, the number of cans wasted has grown faster, quadrupling in the last 25 years.

But this recycling success has not been sustained. *After peaking in 1992, the aluminum can recycling rate dropped to a 15-year low of 49.2% in the year 2001—a rate that had already been exceeded 20 years earlier.* Of the 100 billion cans sold in 2001, 49 billion were recycled and 51 billion were wasted.

Today, despite the implementation of thousands of curbside programs in the 1990's, we are wasting more than ever. While we purchased 8.8 billion more cans in 2001 than we did in 1991, we recycled 5.8 billion *fewer* and wasted 14.6 billion *more*. In the year 2001, we wasted 134,000 tons more than were wasted in 1991, as Figure 4 shows. Had beverage can manufacturers not taken steps to reduce the amount of aluminum used to produce the average beer or soda can, the number of tons being wasted would have been even higher.[13]

Figure 4. Aluminum Cans Wasted in the United States, 1970 - 2001



See Appendices A-4 and A-5 for sources and derivation. *Container Recycling Institute, 2002.*

In the year 2001, 760,000 tons of aluminum cans were sent to the landfill—134,000 tons more than were wasted in 1991.

The public—and even much of the recycling community—is largely unaware of this increase in wasting, in part because the aluminum industry's major trade groups, led by the Aluminum Association, publish an inaccurate recycling rate[14] that includes billions of imported scrap cans—cans that were never sold in the United States. In 2000, for example, the recycling rate published by industry was inflated by 8 percentage points.

When the Container Recycling Institute (CRI) first brought the issue to the attention of the U.S. Environmental Protection Agency (EPA) and the Aluminum Association in 1999, a senior EPA official agreed that CRI's approach was consistent with EPA's own methodology. The EPA even delayed publication of its annual *U.S. Characterization of Municipal Solid Waste* until the data was revised to exclude imported scrap cans. Despite EPA's affirmation, the Aluminum Association continues to publish the higher figures, which are widely viewed as "official" statistics and have been broadly disseminated in the media. Appendix A details these competing methodologies.

In 2000, we were actually closer to recycling only "half" of the aluminum cans we consumed (54.5%), than we were to recycling "nearly two thirds" of our consumption, as the Aluminum Association claimed.

The aluminum industry published a recycling rate of 62.1% for the year 2000, presenting a much rosier picture of aluminum can recycling than was warranted. We were actually closer to recycling only "half" of the aluminum cans we consumed (54.5%), than we were to recycling "nearly two thirds" of our consumption, as the Aluminum Association claimed. In 2001, the recycling rate corrected for scrap can imports fell below 50%, but the aluminum industry continues to publish an inflated rate of 55.4%.

The declining rate of aluminum can recycling is also obscured in part because the recycling rate for the nation's garbage as a whole has almost doubled in the past eight years: from 16% in 1991 to 28% in 1998.[15] Although these national gains are largely attributable to increased recovery of plastics, mixed paper, and yard debris, many people may incorrectly assume that they are due to an equal increase in recycling of all materials.

Brief history of aluminum can sales and recycling

Reynolds Metals introduced the all-aluminum can to the American public in 1964, when steel beverage cans and refillable glass bottles still dominated the market. That year, only twenty-four million soft drinks were sold in aluminum cans.[16] Encouraged by ad campaigns which promised "no deposit/no return" hassles, consumers soon embraced the lightweight, unbreakable aluminum can with the easy-open pull tab.

Aluminum can sales peak[ed] at 102.2 billion in 1999, or 368 cans per capita per year—one a day for every man, woman and child in America.
Photo: Jeanette Madden.

By 1972, annual sales of beer and soda in aluminum cans had grown to 7.5 billion units, while steel beverage can sales were still four times as high—about 30 billion units.[17] By 1980, however, a complete market reversal had occurred: steel beverage can sales had dropped to under 14 billion units, while aluminum can sales matched glass bottle sales at 40 billion units, and the 64-ounce PET bottle was just beginning to appear on the market. During the 1980's, sales of PET bottles and aluminum cans both enjoyed rapid growth, while sales of steel cans and refillable glass bottles both declined steadily. By 1990, steel can and refillable glass sales had dropped to 4.5 and 3.5 billion units respectively, and by 1994, steel had completely disappeared from the marketplace, while refillable glass had dropped to less than 5% of the packaged beverage market, as Appendix H shows.

For three and a half decades after their introduction, aluminum can sales increased at a meteoric pace, peaking at 102.2 billion in 1999, or 368 cans per capita per year—one a day for every man, woman and child in America, as Appendix G shows. (By contrast, the

The data suggest that the characteristics of the aluminum can itself: lightweight, able to keep beverages cold, unbreakable—and especially non-returnable—led to a meteoric increase in beverage consumption.

average European buys 75 cans a year[18]). Aluminum beverage can production now consumes 22% of **all** the primary aluminum produced in the United States annually.

The data suggest that the characteristics of the aluminum can itself: lightweight, able to keep beverages cold, unbreakable—and especially non-returnable—led to a meteoric increase in beverage consumption. For example, between 1984 and 1994, the market share of aluminum cans grew from 58% of a 105 billion-unit beer and soft drink market to 72% of a 137 billion-unit market.

In the late 1970's and 1980's, aluminum can recycling also increased rapidly. In 1972, recycling opportunities were scarce, and only 15% of the cans sold were recycled. But as sales grew in the seventies, Reynolds and Coors led the industry in developing thousands of "buyback" recycling centers and programs to collect used beverage cans (UBC's), which were cheaper than virgin ingot for making new can stock. The intrinsic value of aluminum has encouraged steady recovery until the mid-1990's, even as UBC prices have fluctuated over the years.

During that same period, states began passing legislation which placed deposits ranging from 2.5 cents to 10 cents on carbonated beverages (beer and carbonated soft drinks). By 1987, 71 million people, or 30% of the American population, lived in states with deposit laws, or "bottle bills." Finally, curbside recycling programs began spreading in the late 1980's, also reaching a third of the American population by 1992, and providing another convenient recycling opportunity for those to whom scrap values and deposits were less important.

As a result of these three recycling options, two thirds (65%) of the aluminum cans sold in the United States were being recycled by 1992—the highest recovery rate for any product or material in the U.S. municipal solid waste stream. The aluminum industry heavily promoted the recyclability of cans, and public acceptance ran high.

Since then, however, the UBC recycling rate has shrunk considerably as collection options have failed to keep pace with increased total can sales—especially for beverages purchased away from home, and as financial incentives to recycle have not kept pace with the changing economy. Less than half the 100 billion cans sold in 2001 were recycled—a rate that is 4 percentage points lower than the recycling rate achieved in 1981.[19] Although half the American population now has access to curbside recycling, and although almost a third of the population has a modest financial incentive to recycle—in the form of deposits, the aluminum can recycling rate has not changed appreciably in over twenty years**.**

II. THE ENVIRONMENTAL IMPACTS OF WASTING AND REPLACEMENT PRODUCTION

The impacts of wasting occur both "downstream" and "upstream" of the consumer. The focus has traditionally been on the downstream, post-consumer impacts of wasting: increased garbage hauling costs and increased pressure on landfills and incinerators. For cans, these impacts are relatively minimal, since cans comprise less than 1% of the municipal solid waste stream.[20]

That does not mean can waste is insignificant: since 1970, Americans have land-filled an estimated 257 million cubic yards of aluminum, or 16 million tons, as Appendix D shows. Aluminum can litter, another downstream impact, does not shatter and cut skin as glass litter does, and may not harm marine life as plastic litter does,[21] but it can be danger-ous to livestock and can damage farm machinery. Can litter is unsightly along our nation's roads, beaches, and farmlands, and poses significant cleanup costs for local communities, highway departments, park managers, retailers, and private landowners.

Focusing on the volume or tonnage of can waste as it contributes to local landfill, incinerator, and litter burdens, however, deflects public attention from the less visible yet more significant "upstream" (or pre-consumer) environmental impacts of manufacturing aluminum cans. The quantity of aluminum cans wasted annually pales in comparison to the quantity of waste generated by the virgin materials extraction, refining, processing, smelting and manufacturing stages needed to produce these cans. Furthermore, cans buried in a landfill are basically inert and harmless, whereas great environmental and social harm is done by manufacturing aluminum for cans—from mining to the energy-intensive smelting and can making processes.

Each year, hundreds of thousands of tons of wasted cans must be "replaced" with new cans made entirely from virgin materials. The upstream environmental impacts of this "replacement production" dwarf the impacts at the county landfill.

Bauxite mining and alumina refining are global undertakings

Unlike glass production, for example, where most of the major raw materials can be found within a 250-mile radius, aluminum production is a complex global endeavor. Primary (virgin) aluminum is produced from bauxite ore which is strip mined in large quantities in Australia, Guinea, Jamaica, and Brazil. Strip mining and ore processing produces about two and a half tons of wet mining wastes per ton of aluminum produced. It has historically led to severe soil erosion, as millions of tons of exposed earth and crushed rock were left to wash into streams and oceans. Strip mining destroys whatever wildlife habitat had existed above the mine, and is difficult—if not impossible—to re-establish even with intentional revegetation.

A red mud lake in Jamaica. Dust from alumina refining and export operations has caused respiratory and aesthetic damage, and portside alumina spills have harmed coastal coral reefs. In 2000, the U.S. imported 3 million tons of bauxite and 400,000 tons of alumina from Jamaica, over 90% of which was used for primary aluminum..

Photo: Dr. Robert J. Lancashire, University of the West Indies.

In addition, the wet mining wastes often contaminate local waterways. For example, red mud wastes from bauxite mining (see photo above) and alumina refining have contaminated Jamaican water supplies with caustic soda, increasing the risk of hypertension among local people. Bauxite mining also reduces land available for agriculture, often necessitating the relocation of rural farmers.

Industry sources report that 3 square meters of land are required to mine the 4-5 tons of bauxite needed to produce one ton of primary aluminum ingot.[22] This means that about 600 acres of land were strip mined to produce the bauxite needed to reproduce the 760,000 tons of aluminum beverage cans Americans wasted in the year 2001 alone. While this may not seem like a huge amount or acreage, it is important to note three things: 1) the land lost to strip mining is not all contiguous; the mining occurs in smaller parcels in many distinct ecosystems around the world—each of which sustains individual damage; 2) the actually acreage impacted extends well beyond the site of the mine, by processes such as soil erosion and toxic runoff into streams and aquifers; and 3) the damage is cumulative, occurring year after year as long as wasting and replacement production continue.

The clean ore is then refined into alumina (Al_2O_3) using oil and gas, and some coal and electricity.[23] There are no active bauxite mines in the United States; we must import all the bauxite and alumina needed to make the 4.2 million tons of primary aluminum ingot we produce each year.

The Kirkvine alumina refinery in Jamaica. Alumina refining creates about two tons of caustic red mud wastes per ton of primary ingot, as well as a host of airborne emissions.
Photo: Dr. Robert Lancashire

Between bauxite mining and alumina refining, 4-5 tons of mining tailings and red mud wastes are created per ton of aluminum ingot produced. Therefore, at least 3 million tons of mud wastes were created—in countries outside the U.S.—in the process of replacing the 760,000 tons of aluminum cans wasted in the United States last year.[24]

Primary aluminum production is energy-intensive

The combined energy requirements for bauxite mining and alumina refining are approximately 26 million British Thermal Units (Btu's) per ton of primary aluminum produced (which may yield about 66,800 beverage cans).[25] This is about as much energy as is contained in 4.5 barrels of crude oil, or in 208 gallons of gasoline.

Aluminum has often been called "frozen electricity," because the electric demands of making aluminum are so high: electricity accounts for 65 to 70% of the total energy used in the entire aluminum can production process.[1] The primary aluminum smelting process entails reducing (separating) the aluminum metal from the oxide through electrolysis.[26] Primary smelting requires about 7 kilowatt-hours (kWh) of electricity per pound of aluminum ingot produced, which will later yield about 33 beverage cans.

Finally, ingots are manufactured into beverage cans, using about 36 million Btu's per ton. So, the total energy required for producing cans from 100% primary aluminum (aluminum made from virgin ore) is approximately 193 million Btu's per ton—or the energy equivalent of 3 ounces of gasoline per 12-oz beverage can. Making a ton of cans from 100% recycled (secondary) aluminum only requires about 70 the ingot stage; it does not include can making. But ingots are not final consumer products; electrical cable, patio

[1] About 35% the energy used in smelting and can production is fossil fuel-based, both as thermal energy (process heating), and as a direct input or feedstock (carbon anodes, for example).

furniture and beverage cans are. Can manufacturing alone is very energy-intensive, whether one starts with cans or with primary ingot. Nonetheless, a 64% energy savings is immense; it far exceeds the proportion of savings that accrue from recycling paper, glass, and most other materials in the waste stream.

When cans are landfilled, they are not available for recycling; they must be "replaced" by new cans made entirely from primary ingot. This "replacement production" requires about 123 million Btu's per ton,[27] or 1,840 Btu's per wasted can. This is equivalent to the energy contained in about 2 ounces of gasoline, or a sixth of a can. One way to understand this energy waste is to visualize one beverage can full of gasoline being poured out on the ground each time someone does not recycle a six-pack of beer or soda, Another way to visualize the wasted energy is in terms of the electricity used by familiar appliances. Replacing one wasted can requires just over half a kilowatt-hour of electricity: enough to keep a 100-watt bulb lit for more than 5 hours, or to power an average laptop computer for 11 hours.

Replacing one wasted can requires just over half a kilowatt-hour of electricity: enough to keep a 100-watt bulb lit for more than 5 hours, or to power an average laptop computer for 11 hours.

Table 1. Wasted Aluminum Cans, and the Energy Required Replace Them (a)

Year	Weight of Wasted Cans (thousand tons)	Total Energy Savings Lost (b) (trillion Btu)	Electricity equivalent (TWh)	Homes electrified for 1 year (million)	Could supply electricity to all homes in these cities (c)	Crude oil equivalent (million bbls)	Gasoline equivalent (million gals)
1972-1980	3,017	371	109	10.8	Electricity for all the homes in the 16 largest cities for one year.	64	2,965
1981-1990	5,616	690	202	20.0	The 13 largest U.S. cities for two years.	119	5,519
1991-2000	7,109	873	256	26.6	The 20 largest cities for two years.	151	6,986
Total, 1972-2000	**16,074**	**1,974**	**579**	**57.3**	Exactly half of all U.S. homes for one year.	**342**	**15,796**
Year 2001 alone	760	93	27	2.7	Chicago, Dallas, Detroit, San Francisco, Seattle.	16	746

(a) This table provides several different ways of looking at the same energy value. The total energy savings forgone by wasting cans can be expressed in Btus, or in other measures, some of which are listed here.

(b) Assumptions on energy values: the amount of energy required for replacement production is the difference bewteen the amount required to make a container from all virgin materials and the amount needed to make a container from 100% secondary (recycled) materials, minus process losses. Source for energy values: "Mandated Recycling Rates: Impacts on Energy Consumption and Municipal Solid Waste Volume." L.L. Gaines and F. Stodolsky, Argonne National Laboratory, ANL/ESD-25, December 1993. Source for materials losses: EPA GHG doc

(c) Based on Year 2000 population, using an average of 2.5 people per household. 20 largest cities (in order) are: New York, Los Angeles, Chicago, Houston, Philadelphia, Phoenix, San Diego, Dallas, San Antonio, Detroit, San Jose, Indianapolis, San Francisco, Jacksonville, Columbus (OH), Austin, Baltimore, Washington, Nashville, El Paso. Total U.S. population: 281 million.

See Appendix C for further notes and sources. *Container Recycling Institute, 2002.*

About 93 trillion Btu's of energy were required to replace the 50.7 billion cans wasted in the year 2001, as Table 1 shows. This is equivalent to 16 million barrels of crude oil (almost a quarter of the anticipated annual yield from the Arctic National Wildlife Refuge)[28] or 746 million gallons of gasoline (enough to drive 15 billion car-miles).[29] Expressed in terms of electricity, the wasted energy amounted to 27 billion kWh—enough to supply 2.7 million homes with electricity for a year—or the combined populations of Chicago, Dallas, Detroit, San Francisco, and Seattle.[30] Regardless of how it is measured, it is an enormous amount of squandered energy, especially at a time when much of the country faces electricity shortages and skyrocketing prices.

The single-serving aluminum can is the most energy-intensive beverage container in the marketplace today. For example, it takes about 1,840 Btu's to replace one wasted aluminum can with a new can made entirely from virgin materials, whereas it takes only 983, 568, and 299 Btu's to replace a wasted one-way PET plastic, HDPE plastic, and glass bottle, respectively.[31]

Greenhouse gases generated by primary aluminum manufacturing

Greenhouse gas emissions associated with aluminum ingot and can manufacturing are generated in three major ways: fossil fuel combustion for thermal and electric energy, process-related emissions from primary aluminum smelting, and damming rivers for hydroelectricity.

1) Fossil fuel combustion. Fossil fuels are used for electricity generation, thermal processes, and to make materials inputs at every step of the production process: from bauxite mining to can manufacturing. When fossil fuels are burned (for electricity generation or thermal processes), carbon dioxide (CO_2) is emitted. Perhaps the most important source of fossil fuel use along the aluminum production chain is coal. About half of the electricity required for U.S. primary smelting is coal-generated.[32] An estimated two million tons of coal were burned to generate the thermal and electric energy required to replace just half of the cans wasted in the United States in the year 2000.[33] As Appendix E shows, over 8 tons of combustion-related CO_2 are emitted for each ton of primary ingot produced.

2) Primary aluminum smelting. The electrolytic reduction (smelting) process itself produces three types of greenhouse gases. About two tons of CO_2 are emitted per ton of primary aluminum produced, as carbon in the anodes combines with oxygen in the alumina. About 260 pounds of carbon monoxide (CO), another greenhouse gas, are also emitted per ton of primary aluminum produced. More importantly, about 3 pounds of the "perfluorocarbons" C_2F_6 and CF_4, are also released per ton of primary aluminum smelted.[2] These very rare fluoride gases are not produced in any other known industrial or natural process. Although three pounds of fluorides may seem small compared to the amount of CO_2 produced per ton, they contribute greatly to global warming processes, because unlike CO or CO_2 emissions, they are not broken down by combustion, sunlight, or reaction with other atmospheric gases, and there are no known "sinks" for them (such as forests are for CO_2). As a result, CF_4 and C_2F_6 are thought to persist in the atmosphere for tens of thousands of years, and have so-called "global warming potentials" that are 6,500 and 9,200 times greater than that of carbon dioxide.[34]

3) Damming rivers. Hydroelectric power is used to generate 52.5% of the electricity used in primary aluminum production worldwide. In North America as a whole, more than two thirds of the electricity used for primary aluminum production comes from hydro, while the figure for the United States is 48%.[35] In many cases, dams have been constructed in large part—if not exclusively—to provide power to aluminum smelters, often with extensive government subsidies. Hydro has enjoyed a good public image, because unlike fossil fuels, it is renewable and produces no apparent emissions. But hydro, too, may contribute to processes driving global climate change. By drowning trees in vast temperate and tropical forests, hydroelectric reservoirs destroy the carbon "sinks" that help absorb excess CO_2 in the atmosphere. Reservoirs also create conditions for the anaerobic decay of submerged vegetation, a process which generates methane—a greenhouse gas twenty times more potent than CO_2.

The U.S. Environmental Protection Agency has estimated that when all sources of greenhouse gases are accounted for[3], 4.08 tons of greenhouse gas emissions (expressed as metric tonnes of carbon equivalent, or MCTE) are avoided for each ton of aluminum cans

---

[2] These gases are emitted during brief "anode effects," which occur when the amount of alumina dissolved in the molten cryolite cell bath drops too low. They can be reduced by careful monitoring of the smelting process, and by pollution control equipment.

[3] Excluding methane generation and the loss of carbon sinks from forests inundated by hydroelectric reservoirs.

recycled.[36] In the year 2001, about 3.1 million tons (MTCE) of greenhouse gases were generated to replace the 760,000 tons of cans Americans failed to recycle, as Table 2 shows. This is equivalent to the emissions generated by about 2.3 million average American cars on the road for a year.[37]

Table 2. Greenhouse Gases Produced by Replacing Wasted Cans

Year	Weight of Wasted Cans (thousand tons)	Greenhouse Gases Produced* (million MTCE)	CO_2 equivalent* (millions of tons)
1972-1980	3,017	12.3	45.1
1981-1990	5,616	22.9	83.9
1991-2000	7,109	29.0	106.2
Total, 1972-2000	**15,742**	**64.2**	**235.1**
Year 2001 alone	760	3.1	11.4

* Figure used is 4.08 MTCE per ton of replacement aluminum cans produced. One MTCE is equivalent to 3.66 tons of carbon dioxide gas. See Appendix C (notes e and f) for sources and explanatory notes.

Container Recycling Institute, 2002.

It is also equivalent to about one fifth of one percent of net greenhouse gas emissions generated in the United States in 1999.[38] Although this is but a tiny fraction of the total, it in fact represents a significant opportunity for emissions reduction. Through the Kyoto protocol, the international community[4] has established a goal to reduce greenhouse gas emissions in industrialized countries by 5% over 1990 levels by the year 2012 (or by 67.9 million MTCE in the United States). Were all the used beverage cans wasted in 2000 recycled instead, this would meet over 4% of the U.S. emissions reduction goal. This is a substantial amount, considering that the industrial infrastructure for recycling cans is already in place; the methods for capturing used cans merely need to be expanded and utilized to their fullest potential.

As with energy use, aluminum cans have a much greater impact on greenhouse gas production than PET, HDPE, and glass beverage bottles do. According to figures derived from a 1998 EPA report, 62 grams of greenhouse gasses are emitted to replace each wasted aluminum can with an aluminum can made from virgin ore, compared to 35 for a wasted one-way glass bottle, 27 for a wasted PET bottle, and 16 for a wasted HDPE bottle.[39]

In 2001, almost 6 million tons of air pollutants were emitted in the process of replacing the 760,000 tons of aluminum cans wasted in the United States—or 7.4 tons of pollutants for every one ton of cans wasted.

Other toxic air pollutants from primary aluminum smelting

In addition to greenhouse gasses such as carbon monoxide and carbon dioxide, other pollutants are released during alumina refining, anode manufacturing, and primary smelting. These include particulates, fluorides, sulfur and nitrogen oxides, volatile organic compounds, and polycyclic organic matter. Some of these are also generated in secondary aluminum production, but generally in much lower amounts. Appendices E-1 through E-4 list the major emissions released in primary and secondary aluminum manufacturing. In 2001, almost 6 million tons of air pollutants were emitted in the process of replacing the 760,000 tons of aluminum cans wasted in the United States—or 7.4 tons of pollutants for every one ton of cans wasted (Appendix E-3).

4 The United States has thus far refused to become a signatory to the Kyoto treaty.

In many parts of the world, serious damage to vegetation and livestock has been attributed to airborne fluoride emissions from nearby aluminum smelters.

- **Particulates** ("particulate matter") are airborne solid or liquid particles from 0.01 to 100 microns in size, and are respiratory irritants. About 103 thousand tons of particulates were emitted into the atmosphere in 1999 as a result of U.S. primary aluminum production. Almost 16 thousand tons of particulates were released into the atmosphere in the process of replacing the UBC's wasted in the year 2001.

- **Fluoride** is one of the worst pollutants emitted. For each ton of primary aluminum produced, about 3 pounds of particulate and gaseous fluoride compounds are vented to the atmosphere, primarily as a result of partial evaporation of the fluoride-rich cryolite in the molten cell bath.

In many parts of the world—including Japan and Norway, the Pacific Northwest and Ohio in the United States, and along the St. Lawrence River on the U.S./Canadian border—serious damage to vegetation and livestock has been attributed to airborne fluoride emissions from nearby aluminum smelters. Cattle ingesting fodder contaminated with fluorides have suffered from crippling mineralization of ligaments and joints, enlargement of leg bones, and the wearing away of "chalky" teeth, leading to reduced milk production, malnutrition, stunted growth, and sometimes death. A wide variety of trees and agricultural crops have also been damaged by fluoride emissions from smelters in Montana, Oregon, Washington, Idaho and New York.[40] Smelter workers face occupational health risks from indoor exposure to fluoride gases and particulates, including respiratory irritation, and if concentrations are high enough, mild to moderate skeletal fluorosis.

Pollution control mechanisms, including pot hoods and wet and dry scrubbers, exist to capture fluorides, so that modern fluoride emissions are about 50% lower than they were 30 years ago. They have not been eliminated though, especially not in older smelters or in less developed countries. According to the U.S. EPA's Toxic Release Inventory and the National Pollutant Release Inventory in Canada, primary smelters released 9.6 million pounds of hydrofluoric acid alone, "ranked as one of the most hazardous compounds to ecosystem and human health," into the U.S. and Canadian environments in 1999.[41]

- **Nitrogen and sulfur oxides**, both contributors to acid rain, are also produced during primary aluminum manufacturing. For each ton of primary aluminum manufactured, about 177 pounds of sulfur oxides (SO_X), are emitted as a result of electricity generation from coal, of sulfur released from petroleum coke during anode baking, and of the primary smelting process, when trace amounts of sulfur present in the anodes react with the alumina in the cell bath. In most U.S. plants, wet and dry scrubbers control SO_X emissions—as with fluorides—but industry-wide SO_X emissions are still estimated at 355 thousand tons.[42] An average of 60 pounds of nitrogen oxides (NO_X) are emitted per ton of primary aluminum manufactured, primarily as a result of high temperature combustion for electricity generation. In the lower atmosphere, nitrogen oxides are converted to ozone (O_3), a component of urban smog, which is not only unsightly but can aggravate respiratory distress in children, the elderly and asthmatics. In the upper atmosphere, nitrogen oxide combines with O_3, breaking down the stratospheric ozone which protects us from the sun's ultraviolet rays. About 111 million pounds of SO_X and 39 million pounds of NO_X were produced to replace the cans wasted in 2001.[43]

About 111 million pounds of SO_X and 39 million pounds of NO_X were emitted to replace the cans wasted in 2001.

- About 1.7 pounds of **volatile organic compounds (VOC's)** are emitted per ton of primary aluminum produced.[44] Emitted from various industrial processes, VOC's are gases containing carbon and elements such as bromine, chlorine, fluorine, hydrogen, nitrogen, oxygen, and sulfur. According to the EPA, "VOC's can cause eye, nose, and throat irritations, headaches, dizziness, visual disorders, memory impairment; some are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans."[45] Some VOC's are also precursors to ozone, or smog, formation. About 3,510 tons of VOC's were produced by the primary aluminum industry in 1999. In 2001, about 482 tons of VOC's were emitted for replacement production of wasted cans.[46]

An estimated 3 billion gallons of water were required to make new aluminum cans to replace those wasted in 2001 alone.

- According to one industry source, about 10 pounds of **organics (hydrocarbons)** are also emitted per ton of primary aluminum produced, due to electricity generation, anode production, and smelting. This includes some polycyclic organic matter (POM), a suspected carcinogen, and a developmental, reproductive, and respiratory toxicant.[47] Although controlled by dry scrubbers, an estimated 21,000 tons of organics were emitted by the primary aluminum industry in 1999. In 2001, about 2,776 tons of organics emissions were attributable to replacement production for wasted cans.[48]

Comparative rates of water use in primary and secondary manufacturing

Industrial water consumption in manufacturing primary rolled aluminum sheet—a precursor to beverage can sheet—far exceeds the demands of making rolled sheet from recovered aluminum. This is due to the fact that primary sheet manufacturing includes bauxite washing and alumina refining, two water-intensive processes that are eliminated in recycling aluminum.

According to industry sources, 4,502 gallons of water are required to make one ton of primary rolled aluminum, while only 760 gallons are required to make one ton of secondary rolled aluminum (see Appendix E-4). An estimated 3 billion gallons of water were required to make new aluminum cans to replace those wasted in 2001 alone. If poured out at once, this would flood more than 18 thousand acres of land to a depth of six inches.

Other material inputs

In addition to the 4-5 tons (8,000-10,000 pounds) of bauxite ore needed, an estimated 1,586 pounds of other material inputs are required to make one ton (2,000 pounds) of primary rolled aluminum. These include caustic soda, calcined coke, pitch, lube oil and lime. They do not include materials needed to generate electricity for refining and primary smelting processes. For example, an average of 1.2 tons of coal are burned to generate enough electricity to make each ton of primary rolled aluminum produced in the United States.[5]

Making a ton of primary rolled aluminum sheet requires about 10,000 lbs of bauxite and 1,586 lbs of other material inputs. Secondary rolled sheet requires about 3,300 pounds of scrap aluminum, and only 124 pounds of other material inputs.

By contrast, only 124 pounds of other material inputs are required to make a ton of secondary rolled aluminum—less than a tenth of the inputs needed to make rolled sheet from virgin materials. These include alloying elements, salts used in fluxing, water treatment chemicals and lubricating oils. The major input required is about 3,300 pounds of reclaimed aluminum scrap, used instead of bauxite.

Waste products from primary aluminum manufacturing

About 9,620 pounds of residues are generated from manufacturing one ton of primary rolled aluminum sheet. These waste products include about 100 pounds of spent carbon cathodes and refractory (non-burnable) materials per ton of primary aluminum ingot produced, or about 208,000 tons generated industry-wide in 1999.[49] These come from the bottoms and sides of the cells ("pots") where aluminum is smelted. Because they contain cyanide and fluoride compounds, outdoor piles of spent potlinings can contaminate groundwater if not properly controlled by linings and leachate recovery systems, and are

[5] About 50% of the electricity used by the U.S. primary aluminum industry is coal-generated.

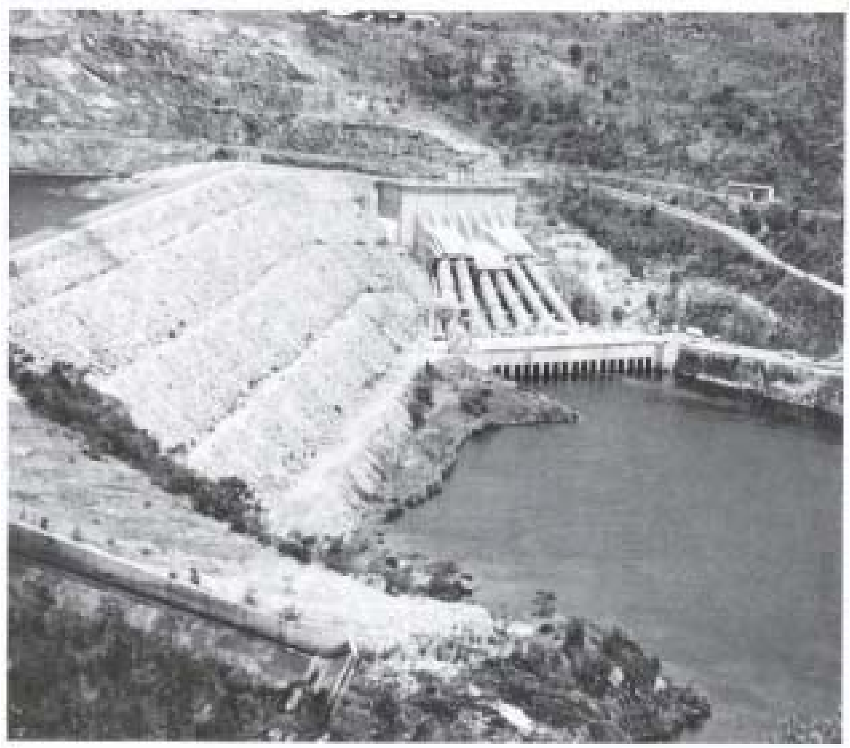
thus regulated as a hazardous waste. About 38,000 tons of spent potlinings were produced to replace UBC's wasted in 2001.

In contrast, 1,458 to 2,519 pounds of residues are produced while manufacturing secondary rolled sheet: only 15-25% as much as from primary manufacturing, as Appendix E-4 shows. Secondary waste products include dross and salt cake, residues, which despite containing some corrosive and toxic elements, are currently unregulated by the EPA. According to the U.S. Office of Industrial Technologies, about 1 million tons of aluminum dross and saltcake are landfilled in the U.S. each year.[50]

Other impacts of hydroelectric development associated with aluminum production

Despite its image as a clean, "renewable" source of energy,[51] hydroelectric development has had devastating regional environmental and social consequences. Dams that have been built primarily to supply the aluminum industry have flooded over 30,000 square kilometers of forested land worldwide. They have caused the relocation of over 200,000 indigenous people—from the Nile to the Caroni River in Venezuela, impinged on reindeer herds in Norway's fragile sub-Alpine plateaus, destroyed habitat and threatened biodiversity in Brazilian and Asian rainforests, enabled the spread of debilitating tropical diseases in African valleys, and submerged archeological treasures.[52]

Built in 1965 to supply cheap power for a 174,000 ton aluminum smelter in Tema, the Akosombo Dam on Ghana's Volta River created a reservoir which covered 4% of the country, inundating the homes of 80,000 people in 740 villages. The reservoir exacerbated waterborne diseases, including schistosomiasis, onchocerciasis (river-blindness), and malaria, and has done little in the way of rural electrification or local economic development.



Closer to home, in the Pacific Northwest, ten smelters in Washington, Oregon, and Montana have an annual production capacity of about 1.8 million tons of primary aluminum, using hydroelectricity from a chain of dams along the Columbia and Snake Rivers. Over the last 50 years, strains of wild salmon on the Columbia have been pushed to near extinction due to the demands of the hydroelectric system and other agricultural, municipal and industrial uses. Rising electricity demand on the west coast, coupled with the 2000-2001 drought, have exacerbated existing pressures on the salmon.

The reduced water flow also means that the Bonneville Power Administration (BPA), the federal utility that operates these dams, cannot meet its own customers' demands, and with prices on the open market skyrocketing in response to deregulation in California, intense competition among electric consumers has been ignited. In the fall of 2000, BPA asked the region's primary aluminum industry to shut all of its plants down until October 2003, and has even paid them not to produce aluminum. In the spring of 2001, aluminum industry representatives met with high level Washington officials, calling on the U.S. government to protect their long-term access to low cost bulk power.

What the aluminum industry has not publicized in its vocal campaign to protect over 7,000 regional smelter jobs, is that each year, Americans trash more aluminum—of all types—than is produced by all ten primary smelters in the Pacific Northwest: 2.2 million tons, according to the Environmental Protection Agency's Office of Solid Waste.[53] The amount of *aluminum beverage cans* wasted—760,000 tons in 2001—was equivalent to 42% of the total production capacity of these 10 smelters—or the entire annual output of four major smelters operating at full throttle, as shown in Appendix F.

Were we to increase our national aluminum can recycling rate from 49% to 80%, 461,000 *additional* tons of aluminum could be saved annually, theoretically enabling the permanent closure of two large primary smelters in the Pacific Northwest. Were we to achieve a national aluminum can recycling rate of 90%—a rate which has already been surpassed in Michigan—we could save an additional 610,000 tons of aluminum: an amount equivalent to the annual production of at least three major Pacific Northwest smelters. While such permanent plant closures would cause regional labor hardships in towns that have grown dependent on local smelters, they would be offset by the creation of recycling jobs across the country. They would also free up large blocks of electricity, relieving some of the price pressures on ratepayers throughout the western power grid, and perhaps forestalling the need to construct more natural gas-fired power plants.

To the north in Canada, similar struggles are being waged between those who want to dam rivers to produce electricity for aluminum smelting, and those who would leave the rivers wild. In 1999, Canadian smelters produced 2.63 million tons of aluminum, using hydroelectricity from large dams and vast reservoirs in Quebec and British Columbia—and still profiting from longstanding subsidies from the Canadian government. These reservoirs have created multiple environmental and social impacts: mercury contamination of fish in Quebec's La Grande River; the loss of indigenous ways of life among over 10,000 native Cree and Inuit people in Quebec, and hundreds of Cheslatta and Haisla people in British Columbia; the extinction and near extinction of wild salmon strains in the Frasier and Columbia rivers and their tributaries; seasonal disruptions of the freshwater-saline balance in James Bay estuaries; and impacts on the migration of caribou and other species dependent on vast, contiguous temperate forests.

Were we to achieve a national aluminum can recycling rate of 90%—a rate which has already been surpassed in Michigan—we could save an additional 610,000 tons of aluminum: an amount equivalent to the annual production of at least three major Pacific Northwest smelters.

And the Canadian aluminum industry wants still more from Canada's rivers. Like the United States, Canada is a prodigious producer of aluminum for domestic use.[54] It is also the largest exporter of aluminum to the United States. Alcan will sell us aluminum as fast as we can use it and throw it away: the U.S. now buys some 2.6 million tons a year from Alcan, almost as much as Canada's entire annual primary production.[55] For years, the Canadian aluminum industry has teamed up with provincial water and electric authorities in British Columbia and Quebec to try to increase water diversion from the Frasier and build new dams on the Great Whale River, one of the few remaining great wild rivers in North America. Should either of these projects go forward, ecosystems that support

The world's burgeoning primary aluminum industry has plans to build many more dams in places as disparate as Brazil, China, Chile, Mozambique, and even Iceland.

diverse species including salmon, caribou, and migratory waterfowl, will be damaged, and native Cree and Inuit people will lose still more of their ancestral hunting grounds.

The development pressure is not limited to North America. The world's burgeoning primary aluminum industry has plans to build many more dams—in places as disparate as Brazil, China, Chile, Mozambique, and even Iceland.

The proposed Mepanda Uncua Dam on Mozambique's Zambezi River would provide 450 MW for an expansion of the Mozal aluminum smelter near Maputo. The dam would flood 100 square kilometers of important pastoral land on the river's floodplain, displace an estimated 2,000 people, and further reduce valuable silt infusions into the environmentally-sensitive Zambezi delta.[56]

The proposed Alumysa Project in southern Chilé would entail the construction of six large dams, together producing 1,154 MW for a 440,000 ton aluminum smelter. Additional infrastructure includes miles of new roads and transmission lines in undeveloped areas, and a new deepwater port. Should the project be completed, farmers would be relocated due to 96 square kilometers of projected flooding. Salmon fisheries and a host of vulnerable land, riverine) and marine species would also face threats from fluoride deposition from the smelter, mercury, and other heavy metals released into the water, and spillage of imported alumina.[57]

The largest remaining wilderness area in Europe is also threatened by hydroelectric development for the production of aluminum. The Norwegian company Norsk Hydro has teamed up with Iceland's national power company to propose a series of dams along several major rivers north of the Vatnajoekull Glacier in the Icelandic highlands. Norsk Hydro would buy all of the electricity generated—an estimated 750 MW—to power its proposed 420,000 ton Reydaral smelter. Environmentalists in Iceland and Norway, as well as the national Icelandic Planning Agency, have been fighting the project. They object to the proposed inundation of over 50 square kilometers of land containing more than 100 scenic waterfalls, the loss of habitat for reindeer and pink-footed geese, and other impacts on regional wildlife and agriculture.[58]

The proposed Mepanda Uncua Dam on Mozambique's Zambezi River would displace an estimated 2,000 people and would reduce important silt infusions into the environmentally sensitive Zambezi delta.

Finally, major tributaries of the Amazon River are threatened by Brazil's powerful aluminum industry. In response to the recent drought, aluminum companies have faced mandatory cutbacks in energy purchases, and are now hoping to build more of their own dams to hedge against future supply restrictions. Alcoa, Billiton, and other Brazilian and multinational consortia have proposed building fourteen dams with more than 4,000 MW of combined capacity on the Tocantins and Araguaia river systems. If completed, the Santa Isabel and Serra Quebrada dams would flood vast areas of rainforest, displacing tens of thousands of people, including members of the indigenous Surui , Karaja, Apinajé and Krikati tribes.[59]

As long as world—and especially American—aluminum demand is high, these development pressures will continue unabated. If aluminum recycling increases dramatically and consumption levels off, however, these river systems might still have a chance.

III. DRIVING FORCES OF ALUMINUM CAN WASTING AND RECYCLING

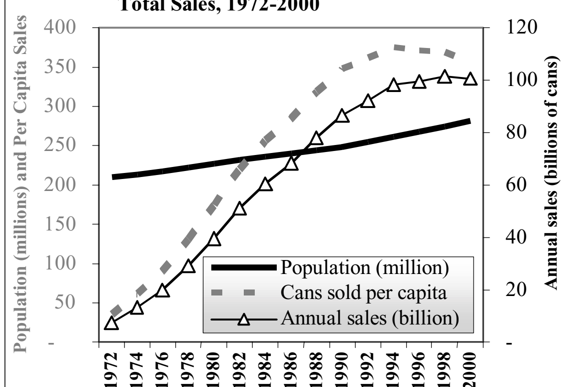
A variety of interrelated factors have affected aluminum can wasting and recycling over the past three decades, including growth in can sales, new recycling opportunities, financial incentives and disincentives, changing beverage container consumption patterns, and a variety of economic factors. Other factors include consumer apathy, public attention diverted to other environmental issues, and a de-emphasis on recycling education and promotion.

Since the aluminum can was introduced in 1964, U.S. population growth and increased per capita consumption have resulted in steadily increasing can sales. Sales experienced meteoric growth in the 1970's, averaging 23% annually. Growth continued in the next two decades, but at a far slower pace: 8% in the 1980's, and 2% in the 1990's. CRI analysis suggests that during the late 1970's and the 1980's, the tremendous sales growth was partially mitigated by certain economic, social, and convenience factors favorable to can recycling. During the 1990's, however, some of these factors were removed or reversed, resulting in a dramatic increase in wasting despite only modest increases in annual can sales.

Can sales skyrocket in the 1970's and 1980's, but recycling meets the challenge

In 1972, 210 million Americans purchased an average of 36 aluminum cans per year, or three cans a month. By 1990, the population had grown to 248 million, and per capita consumption had increased to 348—almost one a day for every person in America old and young. As a result, 86 billion cans were sold in 1990: *79 billion more than in 1972,* as Figure 5a shows.

Figure 5a. Population Growth , Per Capita Sales , and Total Sales, 1972-2000

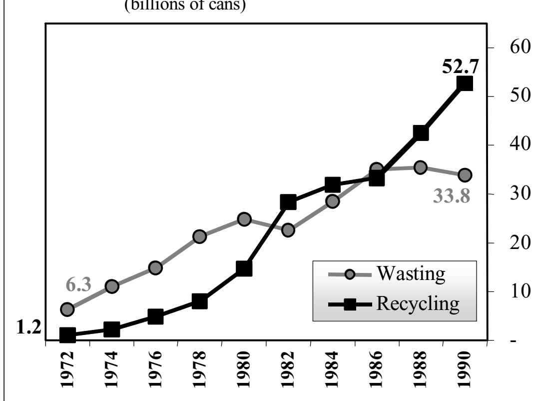


See Appendices A-4, A-5, and G for sources and derivation.

Container Recycling Institute, 2002

These sales increases were matched by increasingly aggressive recycling efforts. In the 1970's, thousands of industry-operated "buyback" centers opened across the country. Throughout the 1970's and 1980's, deposit systems were enacted in ten states and one city, eventually[60] reaching 29% of the U.S. population. Finally, almost 3,000 curbside recycling programs were implemented in the late 1980's, reaching 15% of the population by 1990. Public awareness also ran high, as the "landfill crisis" of the mid- to late- 1980's received much media attention, and spurred many to recycle for environmental or civic reasons.

Figure 5b. Annual Recycling and Wasting, 1972-1990
(billions of cans)



See Appendices A-4, A-5, and G for sources and derivation.

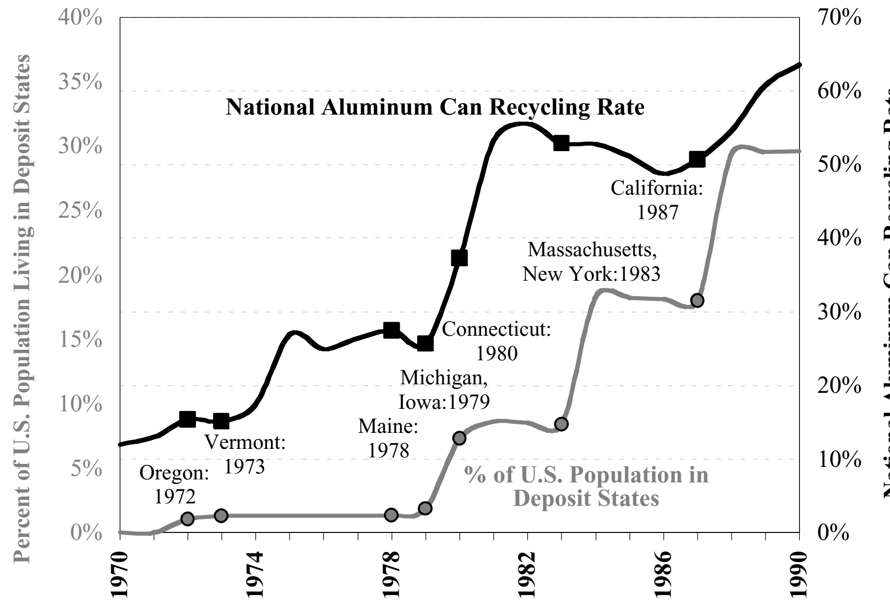
Container Recycling Institute, 2002

Skyrocketing can sales resulted in a 4-fold increase in annual can ***wasting:*** 6.3 billion cans were wasted in 1972, while 33.8 billion were wasted in 1990. Can ***recycling*** grew even more dramatically during this period: from 1.2 billion in 1972 to 52.7 billion in 1990: a 45-fold increase, as Figure 5b shows.

The economic incentives provided by the 10 state (and one local) bottle bills implemented between 1972 and 1987 may have been the most important factor in allowing recycling growth to outpace wasting growth in the 70's and 80's, and enabling the national aluminum can recycling rate to rise from

15% to 50%. As Figure 6 shows, there is a strong correlation between the implementation dates of state bottle bills and the rise of the national aluminum can recycling rate, beginning with the nation's first deposit law, implemented in Oregon in 1972, and culminating with California's in 1987.

Figure 6. The Effect of Deposit Laws on the UBC Recycling Rate, 1970-1990

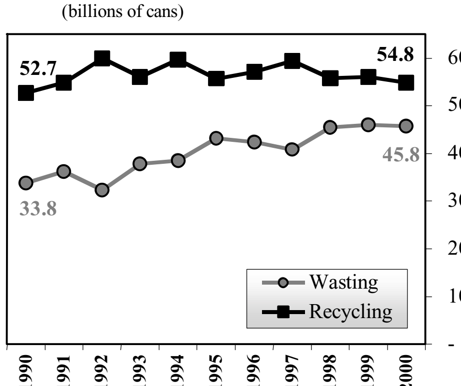


Note: Dates reflect year of implementation. Sources: Graph prepared using information from the Aluminum Association and the Dept. of Commerce/U.S. Bureau of the Census. *Container Recycling Institute, 2002.*

Wasting grows, recycling slips in the 1990's

In contrast to the 1970's and the 1980's, however, recycling in the 1990's was unable to keep pace with comparatively moderate increases in can sales. While per capita can sales grew by only 10 cans during the decade, per capita *wasting grew by* 27 cans, and per capita recycling declined by 17 cans, as Appendix G shows. As a nation, we *bought 14.1 billion more* cans in 2000 than we did in 1990, yet we *wasted 12 billion more and recycled only 2.2 billion more,* as Figure 5c shows. The two major reasons for this increase in wasting appear to be changing consumption patterns and decreasing financial incentives to recycle.

Figure 5c. Annual Recycling and Wasting, 1990-2000
(billions of cans)



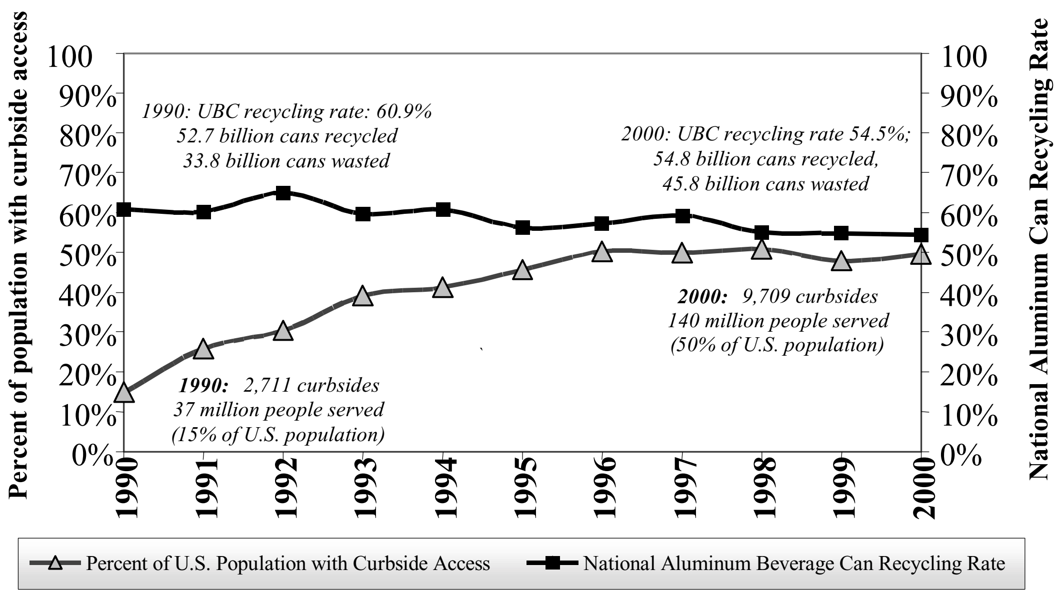
See Appendices A-4, A-5, and G for sources and derivation.
Container Recycling Institute, 2002

Changing beverage consumption patterns

Not only are Americans buying more beverages than ever before, but our lifestyles have changed as well. We work longer hours, commute longer distances to work, and catch many meals and snacks on the go. The beverage and retail industries have taken advantage of this "immediate consumption" trend, installing more beverage vending machines in gas stations, office building lobbies, shopping malls, stadiums, airports, college dorms, high schools, etc. The beverage industry plans to continue this sales trend through aggressive marketing techniques in "underutilized" niches.[61]

Residential curbside recycling programs cannot capture containers that are sold away from home for "immediate consumption." As Figure 7 shows, the number of curbside programs more than tripled nationally from 1990-2000. In 1990, there were 2,711 curbside programs serving 15% of the U.S. population; by the year 2000, that number had grown to 9,709, serving half of the U.S. population. Despite the increase in recycling access during this decade, aluminum can recycling dropped from 63.6% to 54.5%, and the number of cans wasted annually increased by 12 billion.

Figure 7. Aluminum Can Recycling vs. Access to Curbside Programs, 1990-2000



Sources: Aluminum Association, U.S. Bureau of the Census, *BioCycle*. *Container Recycling Institute, 2002.*

Without convenient recycling options away from home, many people simply throw their cans in the trash.

The diminishing role of financial incentives in the 1990's

Financial incentives have a direct bearing on recycling, as is evidenced by the vast difference between the year 2000 recycling rate for aluminum cans (54.5%), and the recycling rates for glass bottles (27.5%) and PET plastic bottles (22.8%) in the United States.[62] When the economic impetus diminishes, recycling activity shrinks as well.

There are two types of economic factors influencing the UBC recycling rate:

1) the intrinsic or "natural" market value of scrap cans

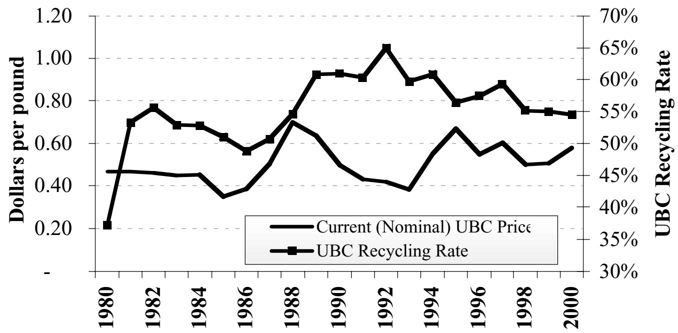
2) the refund or "artificial" value of aluminum cans created by deposit systems

1. Factors Affecting Intrinsic Market Value

The intrinsic value of used aluminum cans has made them profitable to recycle. Despite often dramatic fluctuations in the market price for used cans during the last two decades, the UBC recycling rate has only once dipped below 50%.

People continue to recycle cans at rates exceeding those for glass and plastic bottles.[63] The correlation between UBC prices and recycling rates at first glance appears

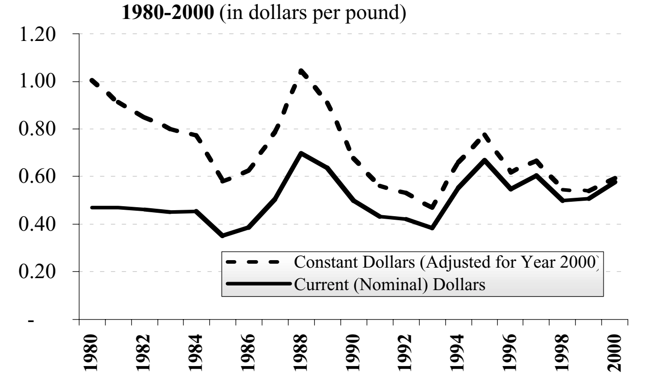
Figure 8a. UBC Price vs. Recycling Rate, 1980-2000



Source for UBC prices: Industry surveys conducted by *Container Recycling Report* and *Bottle and Can Recycling Update,* publications of *Resource Recycling* magazine.

Container Recycling Institute, 2002.

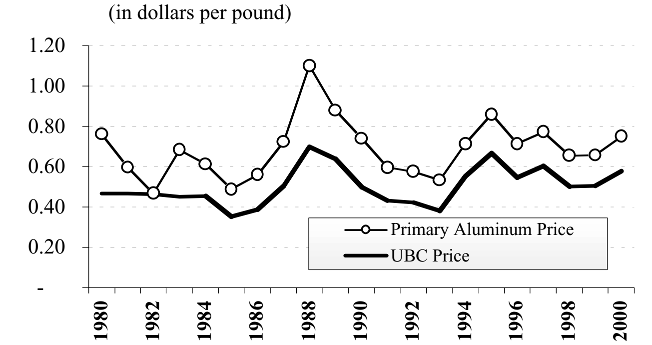
Figure 8b. Average UBC Value in Current and Constant Dollars, 1980-2000 (in dollars per pound)



Sources: Price in current dollars: see Fig. 8a. Price in constant (2001) dollars derived fron the Consumer Price Index.

Container Recycling Institute, 2002.

Figure 8c. UBC Scrap Prices Track Primary Ingot Prices (in dollars per pound)



Primary ingot prices are annual averages for the U.S. spot market. Source for 1980-19 prices: "Minerals Yearbook 2000." U.S. Geological Survey, 2000. Source for 1999-2000 prices: "Aluminum." Patricia Plunkert, U.S. Geological Survey, 2001.

Container Recycling Institute, 2002

very weak, as Figure 8a shows. Nonetheless, over time there has been a steady erosion in the real value of UBC's, which some industry analysts believe is having a detrimental long-term effect on the recycling rate.

As Figure 8b shows, the current (nominal) price for a pound of UBC scrap has stayed largely within the 45-55 cent range since 1980. The **real** value of UBC scrap, as measured in constant (year 2001) dollars, however, has been gradually slipping over the past 20 years. So, although one could collect a pound of cans and get 50 cents for it in 1998, just as one could in 1987, the purchasing power of 50 cents has declined, making it less worthwhile to collect cans.

The widening gap between the current and constant value of UBC scrap reflects how UBC prices have failed to rise over time, in contrast to the way other consumer goods and services have risen with inflation. In fact, the scrap price for UBC's closely follows world prices for primary (virgin) aluminum ingot, which have also failed to rise significantly in the last 20 years, as Figure 8c shows.

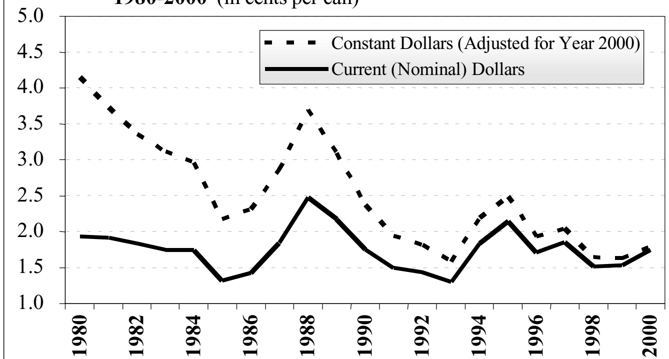
This price stagnation has many causes, including falling energy prices, and excess global primary aluminum production capacity due in part to the entry of eastern bloc countries into the global market, beginning in 1990 with the breakup of the Soviet Union.

Another factor holding prices down is the widespread subsidization of the primary aluminum industry in the United States, Canada, and in many other parts of the world. Because of long-term, cut-rate energy contracts, below-market water rates, the easy acquisition of government lands for mining, and a myriad of tax breaks and infrastructural assistance, aluminum companies have perhaps been less vulnerable to global economic forces than some other primary industries. Subsidies and easy development terms have enabled the world aluminum primary industry to expand capacity ahead of demand. As long as excess primary aluminum production capacity exists on the global market, and as long as the cost of making virgin ingot remains low, UBC prices will remain suppressed.

Ironically, depressed UBC scrap prices have also been exacerbated by the trend of can "lightweighting." Since 1972, the average weight of the aluminum can has been reduced by 35%, through various design changes in the walls and lid of the can (see Appendix J for a more detailed discussion). This is a positive technological trend; without it, aluminum can waste in 2001 would have been 1,167,000 tons instead of 760,000 tons. Paradoxically, however, the lightweighting trend has also had a negative impact on can recycling. The reduced weight of individual cans has made it increasingly difficult for low-income individuals to collect cans for supplemental income. Whereas in 1987 it took about 27 cans to make a pound (worth 50¢), it took 33 cans to make a pound (also worth 50¢)—in 1998, a decade later. In other words, *the time cost of making 50 cents has increased at the same time that the real value of 50 cents has declined.*

Figure 8d makes it clear that while the current (nominal) value of one aluminum can has largely fluctuated between 1.5¢ and 2¢ during the 1980's and 1990's, the *constant* value of one can was actually cut in half: from 4¢ to 1.7¢.[6]

Figure 8d. Average UBC Value in Current and Constant Dollars, 1980-2000 (in cents per can)



Sources: UBC prices: see Fig. 8a and 8b. Average can weight: Aluminum Association.
Container Recycling Institute, 2002.

While it is not known exactly what percentage of scrap cans are collected by "scavengers," anecdotal evidence suggests that their role is important, especially in urban areas. As the American economy grew more prosperous during the 1990's, alternative means of making money became more attractive than collecting scrap cans. After reaching a ten-year high of 7.5% in 1992, unemployment began a steady drop—as did the aluminum can recycling rate, as Appendix I shows. At the same time, the federal minimum wage rose from $3.35 in 1987 to $5.15 in 1997. When all of these factors are combined: the shrinking constant value of cans, the increased number of cans needed to make a pound, and the growing access to paying unskilled jobs, the effect is that the relative reward-to-effort ratio for collecting cans has declined. As Appendix B-2 shows, in 1988 a person needed to collect 146 cans to make as much money as he or she could by working one hour at a minimum wage job. In 2001, it took more than twice as many—345 cans—to make enough to equal one hour of minimum-wage labor. The figures have fluctuated slightly from year to year, but the trend is clear: it pays less and less to recycle for the intrinsic market value of cans.

Reynolds Metals—the corporate pioneer of aluminum can recycling—saw the writing on the wall. In 1998, Reynolds, which processed 50%-60% of all the scrap cans collected in the U.S., got completely out of the can reclamation business, selling all 400 of its buyback and processing center assets to Wise Metals, a can manufacturer, and Tomra North America, a maker of reverse-vending machines.

According to industry sources, as throughput declined, the operational costs of running these buyback centers began to exceed revenues, and more than half of them have closed in the last four years.[64] Buybacks run by other companies have been subject to the same economic forces, and have been diminishing in number as well. This massive closure of buybacks is an unfortunate development, because it has removed an important recycling opportunity for millions of individuals who saved or collected cans exclusively for the monetary reward.

[6] See note b) in Appendix B-1.

2. Factors Affecting the Refund Value

Because the "natural" market forces that impede greater aluminum can recycling are difficult—if not impossible—to control, the introduction of an "artificial" market value, in the form of refundable deposits, has become all the more important. Begun in the early 1970's primarily as a method of controlling beverage container litter resulting from the demise of the industry-led, voluntary bottle return system, state-legislated "bottle bills" have had a dramatic effect on the nationwide UBC recycling rate, as Figure 6 showed. Because the refund value of an aluminum can in deposit states is typically 5 cents: three to five times as much as it is worth as UBC scrap in non-deposit states, deposit states enjoy aluminum can recycling rates ranging from 65% to 95%—in contrast to the national average of 54.5% in 2000.

According to a recent report by Businesses and Environmentalists Allied for Recycling (BEAR), beverage containers on the whole[7] are recovered at a per capita rate of 491 per year in deposit states, compared to only 191 per capita in non-deposit states. The BEAR report found that in 1999, 29% of the U.S. population living in the 10 deposit states recovered over 50% of **all** the beverage containers recycled nationally.[65]

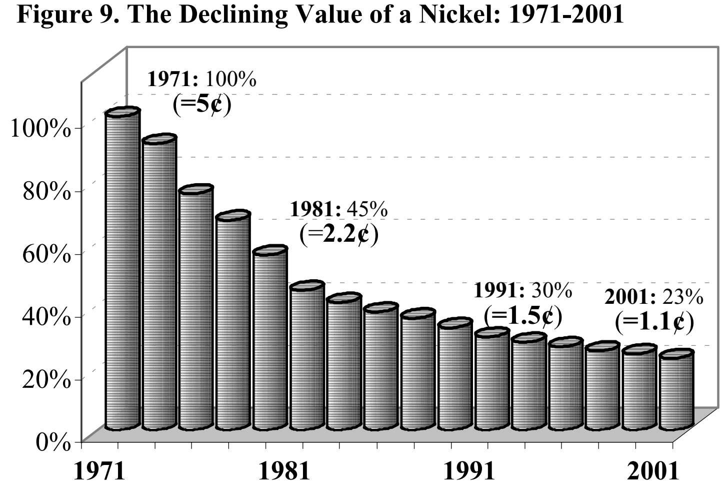
The effectiveness of deposit laws at *maintaining* recycling at high levels, however, has been limited by the declining value of the dollar, and by the failure of deposits to keep pace with inflation.

In 1971, Oregon adopted the nation's first deposit law, setting the refund value at a nickel per container. Because the enabling legislation did not tie this deposit value to any measure of inflation or purchasing power—such as the Consumer Price Index or the minimum wage—it has remained unchanged to this day. Oregon's nickel refund has also served as the standard for most of the nation's other deposit states.[8] And like Oregon, none of the deposit states have tied their refund values to an inflationary index.

Seven years after Oregon's bottle bill was enacted, the nickel was worth only 3.1 cents in 1971 terms—62% of its original value, as Figure 9 shows. Despite this loss in real value, the nickel still served as the model deposit amount, and was adopted by Maine in 1978, Iowa in 1979, and Connecticut in 1980. As late as 1983, both New York and Massachusetts also adopted the nickel deposit, although by then it was only worth 41% as much as it had been when adopted by Oregon legislators. Even California, which passed the country's last bottle bill in 1986, chose the nickel as the refund value for 2-liter containers, and provided a refund value of only 2.5 cents on smaller single-serving bottles and cans.

By 1981, ten years after the first bottle bill was enacted in Oregon, the nickel had lost 55% of its value in 1971 terms. Over the next 20 years, inflation continued—if less sharply—so that by 2001, a 1971 nickel was worth 1.1 cents.

Figure 9. The Declining Value of a Nickel: 1971-2001



Source: CRI, chart derived from the Consumer Price Index

Since then,

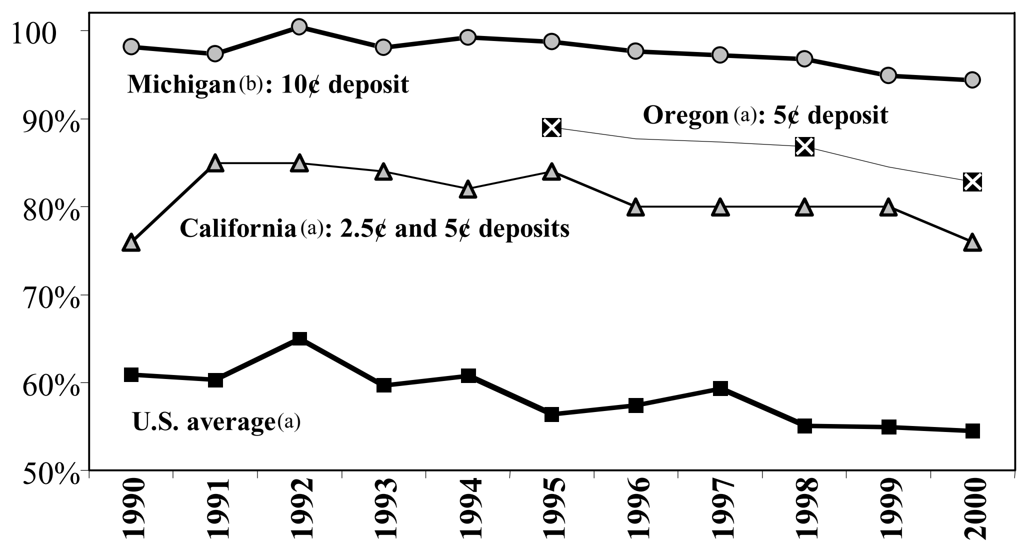
[77] Including aluminum cans and glass and plastic beverage bottles.

[8] The only exceptions to this rule have been Michigan and California.

inflationary pressures have continued—if less sharply—so that by 2001, a 1971 nickel was only worth 1.1 cents—23% of its value in 1971. For many people, it is no longer worthwhile to save a can or bottle for the 5-cent refund value.

The effect of the declining value of a nickel can be seen in sliding redemption rates in several bottle bill states, as Figure 10 shows.[66] While the high recycling rates in deposit states—compared to the much lower national average—show that deposits provide a financial incentive over and above the intrinsic scrap value of UBC's, it is also clear that in most deposit states, recycling rates for UBC's and other containers have been slipping in recent years. In Michigan—the only state with a 10¢ refund—the redemption rate has also declined, but still remains above 95%.

Figure 10. Aluminum Can Recycling Rates in Deposit States and Nationally



(a) Recycling rate for aluminum only (container types reported separately.)
(b) Redemption of plastic, glass and aluminum containers not reported separately. Actual state recycling rates for aluminum are probably higher than those indicated here, because in some states, cans are considered unredeemed (or "abandoned") even when they are recycled through curbside programs or by commercial haulers, and because some non-carbonated beverages in aluminum cans are also being recycled for their scrap value. See endnote 66 for sources.

Container Recycling Institute, 2002.

The high recycling rates in deposit states—compared to the much lower national average—make it clear that deposits still provide a financial incentive over and above the intrinsic scrap value of UBC's. But the declining real value of the nickel deposit has led to slipping redemption rates in recent years.

Over the years, recycling advocates in numerous states have tried to raise the deposit to keep up with inflation, but all of these proposals have been defeated by vigorous lobbying pressure from the beverage industry. State officials often resist raising the refund value for fear of exacerbating existing problems with fraudulent inter-state redemption, and some retailers in border towns fear that a 10-cent deposit would harm their sales if customers flock to neighboring non-deposit states to purchase drinks.

Unlike the 1970's, and 1980's, which heralded slow but steady growth in container deposit legislation across the country, no new bottle bills were enacted in the 1990's. From 1986, when California passed its unique deposit law, until 2001, the politically powerful beverage industry lobby successfully kept bottle bills stalled in state legislative committees all over the country. Only in Kentucky (2000) and Hawaii (2001) were bottle bills voted on by one or both houses of the legislature. On April 30th, 2002, the Hawaii state legislature broke the logjam, passing the nation's first new bottle bill in sixteen years. As this report goes to press, the governor has not yet signed the bill into law, but has previously stated his support of the bill.

Every state has attempted to expand existing deposit laws to include other beverages, but only two have succeeded. California expanded its law to include other single serving beverages such as bottled water, tea and other non-carbonated beverages. In 1989, Maine expanded its law to include all beverages except milk and cider.

Other factors contributing to decreased recycling and increased wasting

Lesser factors driving can wasting may include consumer apathy, public attention redirected to other environmental issues, and the perception that recycling has "arrived" or is old news.[67] In the wake of the Mobro garbage barge in the 1980's; the public was acutely aware of the landfill crisis, and felt recycling was a civic duty. Yet as new mega-landfills have opened and eased the disposal crunch, and as global warming has commanded so much media attention, interest in recycling may have waned.

Finally, decreased awareness of recycling opportunities may suppress recycling. Significant behavioral changes take time, and must be reinforced by on-going public education. Recycling education has declined as state and local budget cuts have "diverted [funds] to other programs perceived to be of higher importance."[68]

IV. REVERSING THE WASTING TREND

Existing recycling infrastructures and scrap prices alone have been unable to halt the increase in aluminum can wasting over the past decade. If we are to reverse the wasting trend, a combination of new recycling opportunities must be employed, and existing opportunities must be expanded. Aluminum beverage can wasting can be significantly reduced by a variety of measures, including:

1) increasing financial incentives by establishing voluntary or mandatory deposits, and raising existing deposit values;
2) legislating recycling goals with specific dates;
3) expanding existing collection infrastructures and creating new ones; and
4) increasing public education to promote existing recycling opportunities.

1. Increase financial incentives through voluntary or mandatory deposits

As the preceding sections have shown, the combination of UBC scrap value, voluntary curbside programs, a shrinking number of buybacks, and a limited number of bottle bills, has not been able to sustain a national aluminum can recycling rate above 61%.

The only mechanism proven to achieve beverage container recycling rates of 80% or higher is the deposit system. At present, ten U.S. states have deposit laws, serving 29% of the American public (81 million people).

The only proven mechanism for achieving beverage container recycling rates of 80% or higher is the deposit system.

In 2000 and 2001, new container deposit bills were introduced in 16 U.S. states and Puerto Rico. At the federal level, bills to enact national container deposit legislation have been filed every year for more than 25 years. Although public support for bottle bills runs high, no new deposit laws have been enacted in over fifteen years, in large part due to heavily-financed campaigns waged against them by the beverage industry. They claim that bottle bills increase their costs, and generally oppose all mandatory recycling programs, preferring voluntary collection systems funded by taxpayers.

Despite the declining value of the 5-cent deposit, on average, the ten deposit states still consistently attain redemption rates of 78%. The details of container deposit legislation vary by state,[69] but the results are consistent: recycling rates that are two to three times higher than those of non-deposit states, and twenty to forty percentage points above the national average, as Figure 10 demonstrates.[9]

Deposit systems complement curbside recycling, targeting those who recycle for economic reasons, and providing a financial incentive for recovery away from home.

The beverage industry also claims that deposit systems and curbside programs are in competition. In fact, deposit systems complement curbside recycling, targeting those who recycle for economic reasons, and providing a financial incentive for recovery away from home, where so many beverages are now consumed.

The effectiveness of existing bottle bills would be strengthened if the average container deposit were raised from 5 cents to 10 cents or more. Although a nickel today is worth about a third of what it was in the mid-1970's, when four out of ten bottle bills were adopted, the 5-cent deposit is still the norm. If container deposit amounts had kept pace with inflation, redemption rates would undoubtedly be higher. In Michigan, the only state to have adopted a 10-cent deposit, 95% of aluminum beverage cans and containers covered by the deposit are being recycled. Despite these facts, the beverage industry has opposed efforts to raise deposits in every state which has proposed an increase, claiming that higher deposits would result in lower sales and lower profits. They also argue that lower sales would result in lower revenues from state excise taxes on beer and soft drinks.

The U.S. beverage industry also has the choice to voluntarily place deposits on their throwaway containers. For decades prior to the 1970's, the beer and soft drink industries required deposits on refillable bottles, and today they continue this practice in Ontario, Mexico, and most western European and South American countries. As recently as 1960, 53% of all beer and 95% of all soft drink containers sold in the United States were refillable glass bottles which required a deposit. The Coca-Cola Company required their bottlers to use refillables and prohibited them from using cans until 1960.

2. Legislate recycling goals with specific dates: the Swedish Experience

One alternative to a mandatory national bottle bill is to set enforceable national recycling goals and deadlines for achieving them. The beverage industry would then decide how to attain the rates—through a voluntary deposit system or through other industry-funded collection systems, or both. Mandated goals would guarantee sustainability of the recycling infrastructure and make producers responsible for recovery of aluminum cans or other container packaging.

Sweden is one country that has successfully adopted such an approach. In 1982, the Riksdagen (the Swedish Parliament) passed legislation requiring that aluminum cans be recycled at a rate of 75% by 1985, or face a ban. This action was the culmination of years of pressure by environmental groups who had been unhappy with the single-serving aluminum can since it was first imported into Sweden in the early 1970's. The environmentalists noted the growing problem of beverage can litter, and were outraged at the pollution impacts of mining and manufacturing aluminum.

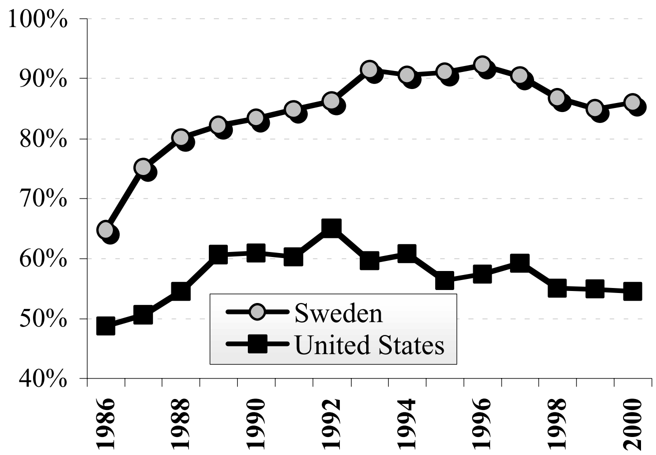
When PLM, a large European beverage can manufacturer (now ANC-REXAM), announced plans to build a can-making plant in Sweden in 1979, the concerns of environmentalists were echoed by the National Board of Technical Development, which

[9] Most deposit states do not maintain separate statistics for redemption of aluminum, plastic and glass. We assume that aluminum can recovery is at least as high as overall (aggregate) recovery.

claimed that using aluminum cans for single-serve beer and soft drinks would be "wastefulness of the first order unless there was a system for reclaiming the cans."[70]

After considering other recycling systems, including curbside collection, the beverage industry instituted a voluntary deposit program in 1984. The deposit value on cans was initially 25 öre (about 5 cents per can), but was doubled to 50 öre in 1987. Although the 75% goal was soon attained, the Swedish government continued to raise the recycling goal incrementally. The current goal of 90% was exceeded in 1997 but it has subsequently dropped to 86%, reportedly due to increased away-from-home consumption and the declining value of the current deposit. Returpak, the company administering the return system, hopes to meet the 90% goal by increasing public education and advertising over the next two years. If this strategy is unsuccessful, they will consider increasing the deposit value again.[71]

Figure 11. Recycling Rate for Aluminum Cans in Sweden and the United States, 1986-2000



Sources: The Aluminum Association; U.S. Bureau of the Census, Department of Commerce; AB Svenska Returpack.

In Sweden, the national deposit system has consistently achieved aluminum can recycling rates 15-35 percentage points higher than those achieved in the United States.

While Sweden's national aluminum can recycling rate has dropped slightly below the current goal of 90%, it has consistently been 15-35 percentage points higher than rates achieved in the United States, as Figure 11 shows.

3. Expand existing collection infrastructures and create new ones

New recycling systems must be developed to reach consumers who are not served by traditional curbside programs, and to target containers consumed away from home. This can be done in a variety of ways:

a) **Maintain existing residential recycling opportunities:** After a decade of rapid service expansions, the population served by traditional curbside recycling programs (those serving primarily single-family homes) has not increased appreciably since 1996. Budgetary pressures have also forced officials in several major cities and states (including Philadelphia, New York, and Florida) to propose or approve deep funding cuts for existing recycling programs. These service losses threaten to diminish recycling activity for all materials in the waste stream, not just aluminum cans, and should be resisted.

b) **Increase multi-family apartment recycling**. While traditional curbside programs expanded nationwide during the 1990's, multi-family apartment recycling remained fairly limited, due to a variety of obstacles. These include a lack of storage space, garbage haulers who do not provide recycling services, institutional inertia, and an absence of local laws requiring owners to provide recycling services. At present, one third of all Americans live in multi-family housing.[72] Expanding recycling programs to multi-family dwellings could significantly increase recovery of aluminum cans in this segment of the population.

c) **Increase away-from-home recycling opportunities:**

i. **Increase recycling in restaurants and commercial buildings**: Commercial recycling is seldom mandated by state and local laws. While our busy lifestyles increasingly find us consuming packaged beverages away from home, voluntary recycling is rarely provided by commercial buildings, including hotels and offices. Even many government buildings do not provide recycling opportunities for workers and visitors.

ii. **Increase recycling in public places.** Recycling bins—as well as appropriate signage and custodial upkeep—remain limited in many other public places, including airports, stadiums, parks, malls, and beaches. While increasing numbers of containers are purchased for immediate consumption in public places, programs to collect these containers remain largely voluntary, and thus difficult to sustain over the long term.

4. Increase public education to promote existing recycling opportunities

While a combination of new and expanded recycling opportunities is needed to reverse aluminum can wasting and increase recycling, it must be accompanied by on-going public education. The public needs constant information on how, where—and most importantly—why to recycle.

People who have moved need to learn how recycling works in their new neighborhoods. College students, office workers, tourists and others need information on existing and new recycling programs. Frequent information is also important because recycling programs evolve: the list of accepted materials changes, ways to prepare material change, collection days change, etc. Educational cutbacks on the local, state and corporate levels threaten to diminish recycling in the public consciousness, and to reverse progress achieved over the last several decades.

Educating the public about why recycling matters is as important as providing information on how and where to recycle. Because society places such a high premium on convenience, and because even a 10-cent or 15-cent deposit may not motivate some middle-class and wealthy people to recycle, the argument must also be made on environmental or altruistic grounds. The public needs to know about the consequences of wasting. They need specific information about the extra energy that is consumed by **not** recycling, and about pollution and other environmental impacts that come from using virgin materials to create "replacement" beverage containers and other consumer goods.

Financial incentives are by far the most effective means of recovering aluminum cans and other beverage containers, but they must be supplemented by other recycling opportunities and continued public education programs.

A multi-pronged approach is needed

Reversing the wasting trend for aluminum cans and other materials in the waste stream requires an integrated strategy. Financial incentives are by far the most effective means of recovering aluminum cans and other beverage containers, but they must be supplemented by other recycling opportunities and continued public education programs. We live in a diverse society where beverages are purchased and consumed in a variety of places, and we need *a multiplicity of recycling options* to meet these needs.

V. CONCLUSION

The single-serving aluminum can is the most energy-intensive and environmentally destructive beverage container on the market.

Since its introduction nearly four decades ago, the aluminum beverage can has been a phenomenal market success, with annual sales growing from only 7.2 billion cans in 1972 to 100 billion in 2001. Unfortunately, despite the evolution of an aluminum recycling industry committed to capturing billions of used cans each year, 50.7 billion cans were landfilled, littered or incinerated in 2001—half of all those sold.

The American public is largely unaware of the serious environmental damages resulting from this level of can wasting. The single-serving aluminum can is the most energy-intensive and environmentally destructive beverage container on the market. For example, replacing one wasted aluminum can with a new can made entirely from virgin materials takes 2,368 British thermal units (Btu's), nearly two and a half times the energy needed to make a PET plastic bottle from virgin materials and eight times the energy needed to make a glass bottle from virgin materials. The 62 grams of greenhouse gasses emitted to replace a wasted aluminum can is approximately twice that needed to replace a wasted one-way glass bottle or PET bottle.[73] When cans are recycled, less energy is required, fewer greenhouse gas emissions are produced, toxic runoff and soil erosion from bauxite mining is eliminated, and a host of other environmental impacts are avoided.

In the 1970's and 1980's, aluminum can recycling was experiencing tremendous growth, despite rapidly escalating can sales. The combination of buybacks, curbside recycling programs, and state and municipal deposit systems boosted the can recycling rate from 15% in 1972 to an all-time high of 65% in 1992.

This initial, impressive rise in aluminum can recycling, however, has not been sustained in the last decade. The can recycling rate fell to a 15-year low of 49.2% in 2001, the first time in 20 years that more cans were wasted than recycled. Paralleling the decline in can recycling has been a tremendous upsurge in aluminum can wasting and energy consumption. Annual wasting rose from 34 billion cans (594,000 tons) in 1990 to 50 billion cans (760,000 tons) in 2001: a 28% increase by weight. The electricity needed to replace the aluminum cans wasted last year with new cans made from virgin materials could supply over two and a half million American homes with electricity for a year.

Without adequate systems to recover the growing flood of cans and bottles, we will see increased energy consumption and environmental damage result from a relentless cycle of production, wasting, and replacement production.

There are many factors contributing to the recent increase in aluminum can wasting in the United States, but three stand out above the rest. First, neither the scrap value of cans nor the refund value of containers in deposit states have kept pace with inflation, thus reducing the economic incentive to return them. Second, we are increasingly a society on the go, consuming more and more beverages away from home and away from the convenience of the curbside recycling bin. Finally, the network of buybacks established in the 1970's and 1980's has been gradually disappearing since the late 1990's, and no new statewide deposit systems have been implemented since 1986.

Unless some of these problems are addressed, the current wasting trend can be expected to continue. Moreover, packaging trends over the past fifteen years demonstrate that cans have enduring consumer appeal, and that despite market share losses to PET bottles—particularly in the soft drink market, cans are likely to be with us for the foreseeable future. In fact, industry analysts predict less than a 1% loss in aluminum can sales by 2004.[74]

Although many of the socio-economic and demographic forces driving wasting are beyond our control, the financial incentive to recover aluminum cans and other beverage containers is not. The refundable deposit system is the only mechanism proven to recover beverage containers at rates that exceed 70%, and deposits of 10 cents result in recovery rates that exceed 90%.

The refundable deposit system is the only mechanism proven to recover beverage containers at rates that exceed 70%.

Currently, mandatory deposit systems in ten states recover the beverage containers they target at rates of 70-95%, compared to the national container recycling rate of 44%, and the far lower rate of 27.9% in the 40 non-deposit states. A recent report by Businesses and Environmentalists Allied for Recycling (BEAR) found that half of all the beverage containers recovered in 1999 were recycled by only 29% of the U.S. population: residents of the 10 deposit states.

If aluminum can wasting is to be reversed, deposit systems need to be extended to the rest of the U.S. population—not just to recover cans—but to recover all throwaway beverage containers. Industry analysts predict that annual container sales will rise from 207 billion in 2000 to over 212 billion by 2004. Without adequate systems to recover the growing flood of cans and bottles, we will see increased energy consumption and environmental damage result from a relentless cycle of production, wasting, and replacement production.

Additional gains in the fight against waste could be made by adopting the other measures outlined in this report: increasing the deposit value to 10 cents, making recycling mandatory in commercial establishments, extending collection programs to multi-family homes, and educating the public about the continuing importance of recycling. By adopting these policies and programs, we can stem the tide of aluminum can wasting, and reduce the global environmental impacts caused by cans trashed in the United States.

ENDNOTES

---

[1] Source for other aluminum products: "Aluminum Statistical Review for 1999," The Aluminum Association, 2000, p. 27-29, Trends in Selected Markets: 178 x 10^6 lbs (bridge, street & highway) + 936 x 10^6 lbs (trucks & buses) = 1,114 x 10^6 lbs.
[2] Based on aluminum can wasting from 1990-2000 (7.1 million tons), 16,000 jets in the worldwide commercial fleet, and an average of 35,000 lbs of aluminum per plane.
[3] Expressed in metric tonnes of carbon equivalent (MTCE) per ton of material wasted: GHG's produced by replacement production (4.60 MTCE/ton of cans) is the difference between the amount produced when 100% virgin materials are used (5.39 MTCE/ton) and when 100% recycled materials are used (0.79 MTCE/ton) (see note a above). Source: Exhibit 2-2, p. 24, "Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste," U.S. EPA 530-R-98-013, September 1998.
[4] About 28% of the nation's garbage is incinerated; 72% is landfilled. Because they are non-combustible, cans are an undesirable contaminant in waste-to-energy plants (garbage incinerators): they drain energy from the system and create slag which can clog the works. Once burned, cans are often removed from the incinerator ash with aluminum magnets and sold for their scrap value, but it is uneconomical for incinerator operators to remove them first.
[5] See Appendices A-1 and A-2 for full calculation of methodology and sources used.
[6] About 55% of the wasting increase is attributable to declining can recycling. 28% is due to population growth: there are 32 million more people living in America than there were in 1990. About 7% of the increase is due to increasing per capita consumption: the average American bought 357 cans in 2000, eleven more than in 1990. These two factors are independent of the declining recycling rate.
[7] Derived by applying a theoretical 80% national recycling rate to the number of cans domestically available for recycling in 2000.
[8] According to surveys by *BioCycle* magazine, the number of Americans served by curbside recycling programs went from 37 million in 1990 to 140 million in 2000.
[9] It is improbable that current trends will change in the next two years, because no major efforts to recover more cans are planned: passage of additional bottle bills (beyond Hawaii) is unlikely due to intense industry pressure, and the implementation of new curbside programs has plateaued due to increasing collection costs for municipalities. Finally, the major beverage manufacturers (Coke, Pepsi, Anheuser-Busch) have not taken real steps to promote or facilitate increased recycling on a large (non-symbolic) scale.
[10] See note 1.
[11] See note 2.
[12] See Appendices B and C for full derivation.
[13] By thinning can walls and sloping lids inward, can manufacturers were able to reduce average can weight by 15% between 1990 and 2001, and to increase production from 22 cans per pound in 1972 to 33.4 cans in 2001.
[14] The aluminum trade groups use an old method of computing recycling statistics that dates from a period when very few scrap cans were imported to the United States, and were not factored in when calculating the recycling rate. In the last decade, however, this method of calculating has become obsolete, because the number of scrap cans imported almost tripled—going from 2.9 billion in 1992 to 7.8 billion in 2000. In 1992, imported scrap cans accounted for only 5% of the 62.7 billion scrap cans used by American secondary aluminum smelters; by 2000, imported cans accounted for 12% of 62.6 billion scrap cans used. Nevertheless, the Aluminum Association does not deduct these imported scrap cans before computing the aluminum can recycling rate. In other words, Americans are recycling fewer of their own cans, yet "getting credit" for recycling those sold, consumed, and collected abroad.
[15] U.S. Environmental Protection Agency, "Environmental Fact Sheet: Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 1998." EPA-530-F-00-024, April 2000. Source for aluminum can recycling numbers: Container Recycling Institute (see Appendices A-1 to A-5).
[16] Truini, Joe. "Aluminum can toasts 35 years." *Waste News*, July 12, 1999.
[17] "Beverage Can Shipments (1970-1998)." Can Manufacturers' Institute (www.cancentral.com).
[18] "Danish move on cans seen boosting aluminium use." Reuters News Service, UK, January 18, 2002.
[19] Source for the 1982 recycling rate: The Aluminum Association. Source for the 1999 recycling rate: Container Recycling Institute: see Appendices A-1 through A-5 for derivation.
[20] All aluminum discards, including beverage cans, comprise 1.4% of the U.S. municipal solid waste stream (220 million tons) by weight, or 3.2 million tons of wasted aluminum metal. As a whole, aluminum is recovered at a rate of only 27.9%. In other words, 2.2 million tons of aluminum metal are wasted annually in the United States, including 690,000 tons of aluminum beverage cans. Source for waste stream numbers: U.S. Environmental

Protection Agency, "Environmental Fact Sheet: Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 1998." EPA-530-F-00-024, April 2000. Source for cans: CRI (Appendix A-5).

[21] Although littered plastic six-pack can holders do continue to main and kill marine life.

[22] "Life Cycle Inventory Report for the North American Aluminum Industry." By Roy Weston Inc. for the Aluminum Association, November 1998, p. 5-2.

[23] Low end of range: "Energy and Environmental Profile of the U.S. Aluminum Industry." U.S. Department of Energy, Office of Industrial Technologies (OIT), July 1997, p. 29. High end of range: S.Y. Shen, "Energy and Materials Flows in the Production of Primary Aluminum," Prepared by Argonne National Laboratory for the Department of Energy, (ANL-CNSV-21), October, 1981, p. 2-5; I.J. Polmear, Ed., "Light Alloys: Metallurgy of the Light Metals," 2nd edition. Edward Arnold, London, 1989, p. 8; L.L. Gaines and F. Stodolsky. "Mandated Recycling Rates: Impacts on Energy Consumption and Municipal Solid Waste Volume." Argonne National Laboratory, ANL/ESD-25, December 1993, p. 72.

[24] Source for environmental damage from bauxite mining (for photo caption): "Jamaica Bauxite Case (BAUXITE)." Trade and Environment Database, http://www.american.edu/ted/bauxite.htm. Source for U.S. imports from Jamaica: "Bauxite and Alumina." U.S. Geological Survey, Mineral Commodity Summary, January 2001.

[25] Derived from Gaines, Figure 5.2, page 72.

[26] This is done by submerging the alumina in a bath of molten cryolite, and sending high voltage electricity through the bath, using carbon anodes and cathodes. These are made from coke and pitch, petroleum and coal derivatives. As the anodes and cathodes are consumed, they leave behind about 200 pounds of spent cathode and anode waste per ton of aluminum produced.

[27] "Replacement energy" is the difference between the 100% virgin requirement (193 MBtu/ton) and what would have been used had the cans been recycled (70 MBtu/ton).

[28] The U.S. Geological Survey estimates that there are 3.2 billion barrels of economically recoverable oil in the Arctic National Wildlife Refuge, which could be extracted over 50 years. Figures quoted are expected economically recoverable yields at a commercial oil price of $20 a barrel. "Arctic National Wildlife Refuge, 1002 Area, Petroleum Assessment, 1998, Including Economic Analysis." USGS 1998.

[29] Although gasoline or Alaskan crude may not be used to make aluminum, this comparison is useful because different energy forms are increasingly interchangeable, and as a society, we ought to be focusing on total demand reduction rather than just on developing new energy resources. Aluminum recycling is one of many important conservation measures.

[30] The residential populations of these cities are from the April 1, 2000 census, U.S. Bureau of the Census (http://aol1.infoplease.com/ipa/A0763098.html),as follows: Boston 589,141, Chicago 2,896,016, Dallas 1,188,580, Detroit 951,270, San Francisco 776,733, Seattle 563,374, Washington, D.C. 572,059. They have all been divided by an average of 2.5 people per household. For derivation of the energy required to replace wasted aluminum, see note (h) in Appendix C.

[31] Figures derived from the energy, greenhouse gas, and average container weights used in Table ES-2 of the report "Understanding Beverage Container Recycling: A Value Chain Assessment Prepared for the Multi-Stakeholder Recovery Project (MSRP)," Businesses and Environmentalists Allied for Recycling (BEAR). Jan. 16, 2002. This report derives much of its data from the EPA Greenhouse Gas report (see note 3).

[32] The actual breakdown is 50.5% coal, 48% hydro, and 1.5% nuclear energy.

[33] Calculation: Forgone energy savings from not recycling UBC's in 2000 = 102.9×10^{12} Btus (see Appendix 2). Multiply by 50.1% (proportion of coal-generated electricity used by the U.S. aluminum industry) = 51.5×10^{12} Btus of coal energy wasted, divided by the energy value of coal (25.2×10^{6} Btu/ton) = 2.05 million tons of coal.

[34] U.S. EPA 530-R-98-013, 1998, p. 4.

[35] U.S. figure from Table 1-5, OIT, July 1997. World and North America figures are from "International Aluminium Institute Statistical Report: Electrical Power Used In Primary Aluminium Production (Form ES.002)," Table 1, "Energy Sources of Electrical Power in 2000," International Aluminium Institute, September 20, 2001.

[36] U.S. EPA 530-R-98-013, September 1998, Exhibits 4-3 and 4-4. Avoided emissions for recycling (3.88 MTCE/ton of UBC's collected at curbside) are scaled up for 5% losses between the curb and the mill door.

[37] 1 million MTCE is equivalent to the emissions produced annually by 750,000 cars, each driving 11,000 miles at an average fuel efficiency of 20 miles per gallon. Source: "Getting WARM: An Easy Away to Calculate Climate Impacts." *Reusable News,* U.S. Environmental Protection Agency (EPA 530-N-00-006), Fall 2000, p. 9.

[38] Net emissions in 1999 were 1.57 billion MTCE. Net emissions in 1990 were 1.36 billion MTCE. Derived from Table ES-1, "Executive Summary: Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-1999." U.S. Environmental Protection Agency, April 2001.

[39] Figures derived from the BEAR report and the EPA Greenhouse Gas report.

[40] Sources: Prival, Michael J. and Farley Fisher. “Fluorides in the Air.” *Environment,* Vol. 15, No. 3. April 1973, p. 25-32; R. Pardy, and co-workers, “Purari Overpowering Papua New Guinea?” The International Development Action for Purari Group, IDA, Fitzroy, Victoria 3065, Australia, 1978, p. 181; “Asahan Dam: Energy for Whom? “ *Environesia,* Vol. 3 No. 2, June 1989. Published by WALHI, The Indonesian Environmental Forum, Jakarta, 1989.
[41] Derived from data in the EPA’s Toxic Release Inventory, reported on the “Environmental Defense Scorecard,” http://www.scorecard.org.
[42] Derived from U.S. EPA 530-R-98-013, Tables 1-13-1-15.
[43] For derivation, see Appendix E.
[44] For derivation, see Appendix E.
[45] U.S. Environmental Protection Agency: http://www.epa.gov/iedweb00/largebldgs/i-beam_html/glossary-b.htm.
[46] For derivation, see Appendix E.
[47] “Environmental Defense Scorecard,” http://www.scorecard.org.
[48] For derivation, see Appendix E.
[49] “Energy and Environmental Profile of the U.S. Aluminum Industry.” U.S. Department of Energy, Office of Industrial Technologies, July 1997, pp. 61-62.
[50] “Recycling of Aluminum Dross/Saltcake, Project Fact Sheet.” Office of Industrial Technologies, Energy Efficiency and Renewable Energy, U.S. Department of Energy, September 1999.
[51] The longevity of hydroelectric dams is debatable. As silt builds up behind the dams, reservoir capacity declines, and the structural integrity of the dams can also be compromised. At best, these conditions can lead to diminishing output over time and the eventual need to retire a hydroelectric power plant; at worst they can lead to a dam breach with catastrophic loss of life downstream. For further information, see “The Social and Environmental Effects of Large Dams,” by Edward Goldsmith and Nicholas Hildyard, Sierra Club Books, 1984.
[52] Source for 30,000 sq. km of flooding and 200,000 people relocated: Gitlitz, Jennifer. “The Relationship Between Primary Aluminum Production and the Damming of World Rivers.” International Rivers Network Working Paper #2, Berkeley, CA, 1993. This report profiles nine countries and provinces where certain dams have been built primarily to meet aluminum industry demands: Brazil, British Columbia, Chile, Egypt, Ghana, Indonesia, Norway, Quebec, and Venezuela. It is not a comprehensive list of either flooding or human relocation from dam projects related to aluminum; the actual numbers are probably much higher.
[53] “Characterization of Municipal Solid Waste in the United States, 1999 Update.” U.S. EPA 2000.
[54] In 1999, Canadian per capita consumption was 71 pounds; U.S. per capita consumption was 80 pounds. Source: “Aluminum Statistical Review for 1999,” p. 45.
[55] They also import 920,000 tons and recycle 123,000 tons per year. Derived from “Aluminum Statistical Review for 1999,” p. 48.
[56] Hoover, Ryan. “Damming the Zambezi for Aluminum: Proposed Dam a ‘Power Play’ to Gain Control of Upstream Dam?” *World Rivers Review,* Vol. 16 No. 5, October 2001. International Rivers Network, Berkeley, CA.
[57] Aguirre, Monti. “Six Dams in Chile’s Alumysa Project.” *World Rivers Review,* Vol. 16 No. 5, October 2001. International Rivers Network, Berkeley, CA; Gitlitz 1993, pp. 128-130.
[58] Finnsson, Arni. “Icelandic Dams and Aluminum Smelters Meet Resistance: Norsk Hydro Dams Would Drown 100 Waterfalls.” *World Rivers Review,* Vol. 16 No. 5, October 2001. International Rivers Network, Berkeley, CA.
[59] Switkes, Glenn. “Aluminum Companies Press for Dams on Amazon.” *World Rivers Review,* Vol. 16 No. 5, October 2001. International Rivers Network, Berkeley, CA.
[60] In chronological order of deposit law enactment, the ten states and one city are: Oregon (1971); Vermont (1972); Maine and Michigan (1976); Iowa, Connecticut, and Columbia, MO (1978); Massachusetts (1981); Delaware (which exempts aluminum cans) and New York (1982); and California (1986).
[61] Source: "Beverage Packaging in the U.S. 2000," Beverage Marketing Corporation, October 2000. p. 200.
[62] Glass recycling rate derived from Table 5, "Municipal Solid Waste in the United States: 1999 Facts and Figures." p. 35. U.S. Environmental Protection Agency, Office of Solid Waste., 2000. Source for PET recycling rate: "2000 National Post-Consumer Plastics Recycling Report," by R.W. Beck for the American Plastics Council, 2000.
[63] The U.S. recycling rates for PET plastic and glass bottles are about 26% and 30% respectively.
[64] Personal communication with Chuck Riegle and Tony Dellavolpe of Tomra North America, February 8, 2002.
[65] Table ES-1, BEAR report, 2002.
[66] Source for redemption rates shown in Figure 10: U.S.: CRI, derived from the Aluminum Association and the U.S. Department of Commerce (see Appendix A-5); California: California Department of Conservation (http://www.consrv.ca.gov/dor/Dor%20Notices/calendar501.htm); Oregon: personal communication with Peter Spendelow, Oregon Department of Environmental Quality, August 2, 2001; Michigan: personal communication

with Matt Flechter, Waste Management Division, Michigan Department of Environmental Quality, August 15th, 2001.

[67] Rankin, Karen. "Who's filling the recycling bins?" *Resource Recycling*, February 2001.

[68] "1999 National Post-Consumer Plastics Recycling Report." American Plastics Council, September 2000, p. 3.

[69] Bottle bills require the retailer to collect a refundable deposit on each beverage can or bottle sold. Deposits range from 2.5 cents in California to 10 cents in Michigan, but the norm is a nickel. The retailer in turn passes this deposit on to the consumer when the beverage container is purchased. The consumer can recover the deposit at certified redemption centers, reverse vending machines at supermarket locations, and various recycling centers. The bottler usually pays handling fees of 1-3 cents per container to the retailer or the redemption center. Bottlers and distributors generally keep unredeemed deposits as a way to offset handling costs.

[70] "Successful Deposit System for Aluminum Cans" ENVIRO, No. 12, November 1991.

[71] Personal communication with Hans Funke, AB Svenska Returpack, Stockholm, Sweden, August 28, 2001.

[72] "Statistical Abstract of the United States." Table No. 1209: "Housing Units—Characteristics by Tenure and Region." U.S. Census Bureau, 2000.

[73] Figures derived from the energy, greenhouse gas, and average container weights used in Table ES-2 of the BEAR report (see note 31) and the EPA Greenhouse Gas report (see note 3).

[74] "Beverage Packaging in the U.S. 2000," pp. 215-216.

Appendix A-1: Competing Methods for Calculating the Used Beverage Can Recycling Rate

The Container Recycling Institute (CRI)'s methodology for calculating the aluminum can recycling rate differs from that employed by the three aluminum industry trade organizations: the Aluminum Association (AA), the Can Manufacturers' Institute (CMI), and the Institute of Scrap Recycling Industries (ISRI). In computing the used beverage can (UBC) recycling rate, the Aluminum Association divides the number of cans "collected" for recycling in the United States by the number of cans sold domestically. The "collected" cans include domestic, exported and imported scrap cans in the numerator of the equation, but only domestically-produced (and sold) new cans in the denominator, as Appendices A-2 through A-4 show. This methodology produces an artificially high recycling rate because it includes imported scrap cans which were not originally sold in the United States.

Since 1998, CRI has calculated and published a recycling rate which reflects cans bought and recycled by American consumers. When imported scrap cans are deducted from the numerator of the equation, the resulting *domestic* recycling rate is lower than the rate published by the aluminum industry.

Prior to 1990, so few scrap cans were imported from abroad that their inclusion in the numerator did not significantly affect the recycling rate derived. In 1991, just 2 billion scrap cans were imported—only 2.2% of the number of cans sold domestically. By 1998, the number of imported scrap cans had peaked at 8.2 billion, or 8% of the number of cans sold domestically. In the year 2001, imported UBC's were down to 6.54 billion, which, when deducted from the 100.3 billion cans sold domestically, and adjusted for net exports of new unfilled cans,[*] produced a recycling rate of 49.2%, not 55.4%, as reported by the Aluminum Association. Despite this small decline in imported UBC's, the effective gap between the recycling rate derived by the Aluminum Association and that derived by CRI is still three times wider now than it was in 1991.

The method used by CRI is consistent with that used by the U.S. Environmental Protection Agency in computing recycling rates for a wide variety of materials in the waste stream. In a letter dated April 7, 1999, Elizabeth Cotsworth, Acting Director of the U.S. EPA's Office of Solid Waste wrote, "…the methodology suggested by the Container Recycling Institute in determining aluminum can recycling rates is consistent with the recycling measurement methodology used by the EPA."

Last year, the Aluminum Association and its sister trade groups widely advertised a 62.1% UBC recycling rate for the year 2000, and on their website and in their media kits even went so far as to say "almost 2 out of 3 cans are recycled." In its April 2002 media release, the Aluminum Association not only continued to include UBC imports in their reported 2001 recycling rate (55.4%), but did not even acknowledge the 7-percentage point drop from the previous year's recycling rate. These upbeat corporate messages downplay ground that has been lost in the last several years, and understate the true cost of wasting in energy and environmental terms.

---

[*] CRI has attemped to account for the net effects of imported and exported new filled cans as well, but the data are too limited to be reliable. Estimates are presented in Appexdix A-2, but are not used in the CRI/EPA recycling rate derived in Appendix A-5. Note, however, that because our estimated net number of imported new filled cans is only 368 *million* (as compared to 6.5 *billion* imported scrap cans), it has almost no effect on the domestic UBC recycling rate.

Appendix A-2: Calculating the Used Aluminum Can Recycling Rate*

The Aluminum Association method:

Weight of scrap cans collected (includes exported and imported UBCs):	1,665	million pounds	
Multiplied by the average number of cans per pound:	33.4	cans per pound	
Equals the number of cans recycled (includes cans exported for recycling):	55.6	billion cans	(numerator)
Divided by the number of new cans [made and] shipped [in U.S.]:	100.3	billion cans	(denominator)

Cans collected [recycled]	**55.6**	=	**The UBC Recycling Rate:**
Cans shipped	**100.3**		**55.4%**

The Container Recycling Institute/Environmental Protection Agency method:

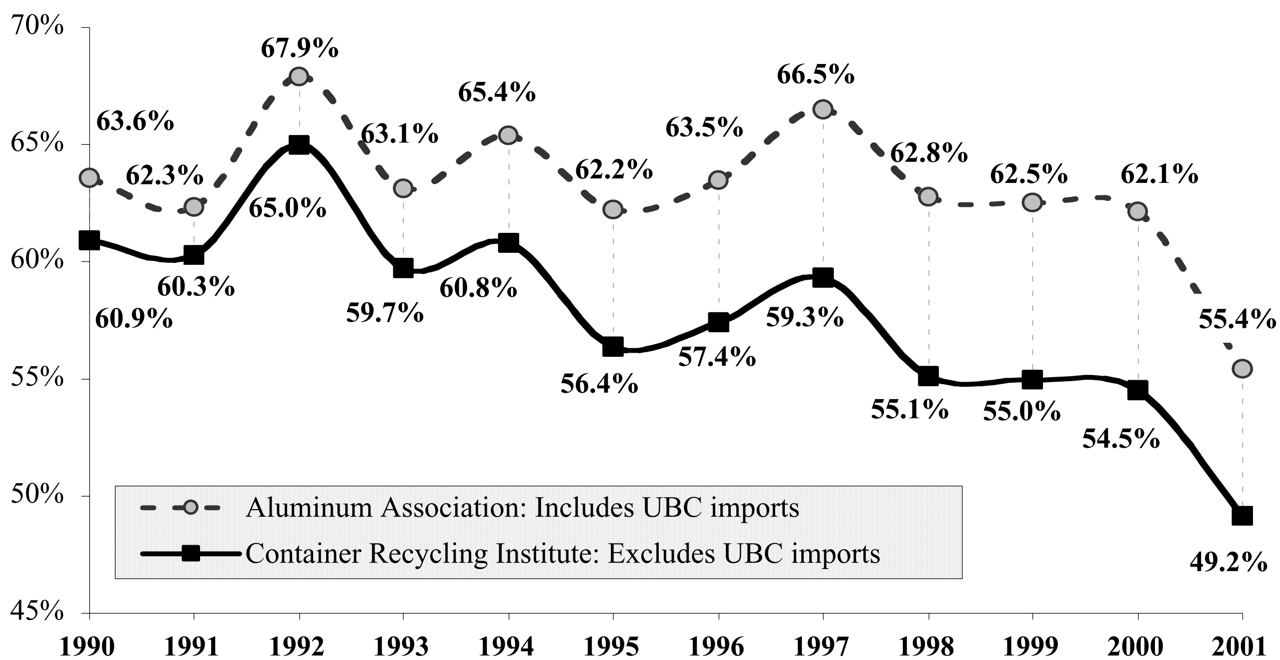
The number of collected cans recycled domestically and exporte	55.6	billion cans	
Minus the number of imported scrap cans	6.5	billion cans	
Equals the # of cans recycled that were sold in the U.S.	49.1	billion cans	(numerator)
New cans made and shipped in the U.S.:	100.3	billion cans	
Plus new imported unfilled* cans:	0.5	billion cans	
Minus new exported unfilled* cans	1.0	billion cans	
Equals the # of cans available for recycling in the U.S.:	99.8	billion cans	(denominator)

Cans recycled that were originally sold in the U.S.	**49.1**	=	**The UBC Recycling Rate:**
Domestic cans available for recycling:	**99.8**		**49.2%**

Example uses figures from the year 2001.

* Accurate data on imported and exported filled cans are unavailable. The U.S. Department of Commerce collec information on new imported and exported beverages by beverage type, but not by container material. Based on their aggregated data, CRI has made estimates on imported and exported filled cans, making assumptions on the proportion of imported and exported beverages in aluminum cans as follows: 72% of the carbonated soft drinks; 3% of the mineral water, 100% of the beer, and 100% of aluminum cans between 355 ml and 3.8 liters (raw import/export data is in liters; converted based on 12 ounces per unit). Our estimates are: 1.7 billion imported filled cans and 1.3 billion exported filled cans, for a net import of 0.4 billion cans. But because this is only an estimate, we have not used it in computing the recycling rate as shown above and in Appendix A-5. In any event, the difference in recycling rates produced is almost negligible: 49.0% vs. 49.2%.

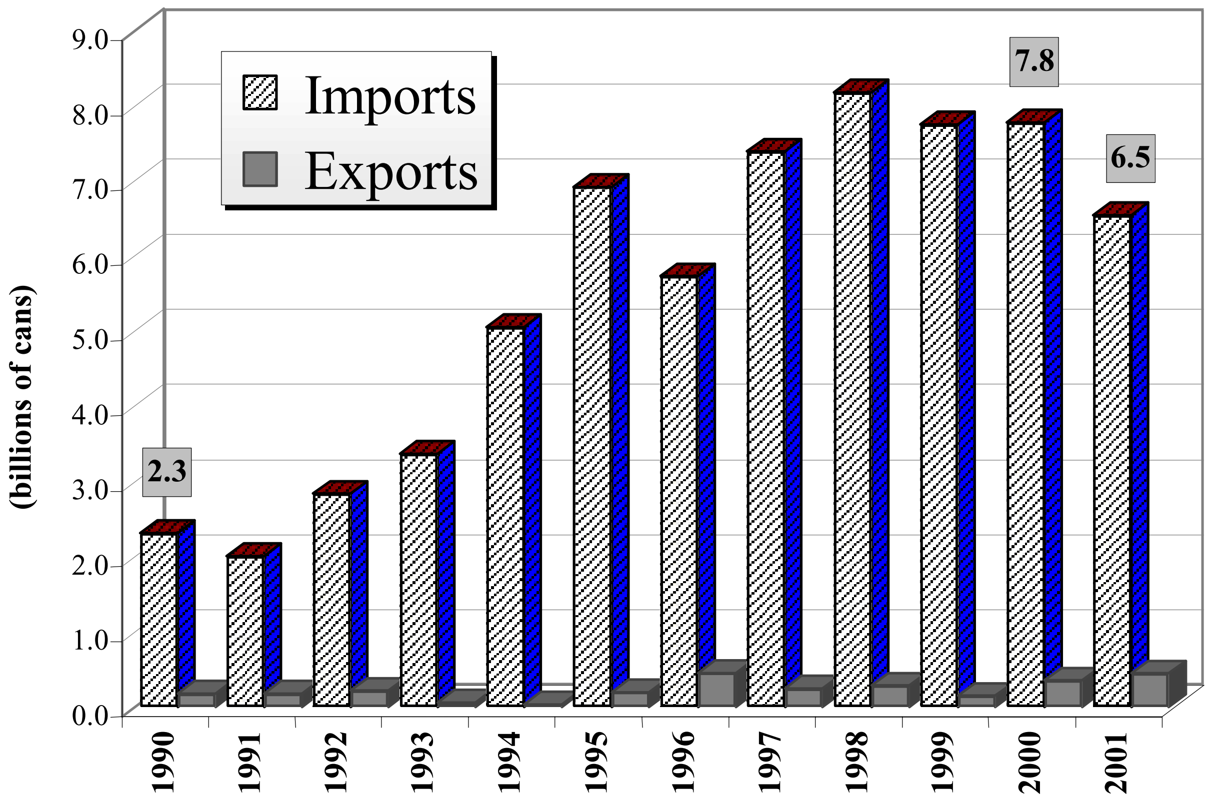
The Aluminum Can Recycling Rate, 1990-2001: Two methods of measureme



Graph prepared using data from the Aluminum Association and the U.S. Department of Commerce.

Container Recycling Institute, 2002.

Appendix A-3: Imported vs. Exported Scrap Aluminum Cans, 1990-2001



Source: Graph prepared using data from the U.S. Dept. of Commerce/Bureau of the Census.

Container Recycling Institute, 2002.

Appendix A-4: Used Beverage Can (UBC) Recycling 1972-2003, According to the Aluminum Association

Year	New Cans Shipped			Used Beverage Cans (UBCs) Collected*				Used Beverage Cans (UBCs) Wasted			
	(billions) Denominator	# of cans per pound	(million lbs)	(million lbs)	(billion cans) Numerator	(thousand tons)	*Recycling rate*	(billion cans)	(million lbs)	(thousand tons)	*Wasting rate*
A	B	C	D (=B*C)	E	F (=C*E)	G	H (=F÷B)	I (=B*L)	J (=D*L)	K	L (=1-col. H)
1972	7.5	21.75	345	53	1.2	27	15.4%	6.3	292	146	84.6%
1973	10.0	22.25	449	68	1.5	34	15.1%	8.5	381	191	84.9%
1974	13.4	22.70	590	103	2.3	52	17.4%	11.1	487	244	82.6%
1975	15.4	23.00	670	180	4.1	90	26.9%	11.3	490	245	73.1%
1976	19.8	23.30	850	212	4.9	106	24.9%	14.9	638	319	75.1%
1977	24.9	23.47	1,061	280	6.6	140	26.4%	18.3	781	390	73.6%
1978	29.3	23.65	1,239	340	8.0	170	27.4%	21.3	899	449	72.6%
1979	33.2	23.69	1,401	360	8.5	180	25.7%	24.7	1,041	521	74.3%
1980	**39.6**	**24.23**	**1,634**	**609**	**14.8**	**305**	**37.3%**	**24.8**	**1,025**	**513**	**62.7%**
1981	46.7	24.45	1,910	1,017	24.9	509	53.2%	21.8	893	447	46.8%
1982	51.0	25.21	2,023	1,124	28.3	562	55.6%	22.7	899	450	44.4%
1983	55.6	25.70	2,163	1,144	29.4	572	52.9%	26.2	1,019	510	47.1%
1984	60.4	26.00	2,323	1,226	31.9	613	52.8%	28.5	1,097	549	47.2%
1985	64.9	26.60	2,440	1,245	33.1	623	51.0%	31.8	1,195	597	49.0%
1986	68.3	27.00	2,530	1,233	33.3	617	48.7%	35.0	1,297	648	51.3%
1987	72.2	27.40	2,635	1,335	36.6	668	50.7%	35.6	1,300	650	49.3%
1988	77.9	28.25	2,758	1,505	42.5	753	54.6%	35.4	1,253	626	45.4%
1989	81.4	29.30	2,778	1,688	49.5	844	60.8%	31.9	1,090	545	39.2%
1990	**86.5**	**28.43**	**3,043**	**1,934**	**55.0**	**967**	**63.6%**	**31.5**	**1,109**	**554**	**36.4%**
1991	91.2	28.87	3,159	1,969	56.8	985	62.3%	34.4	1,190	595	37.7%
1992	92.4	29.29	3,155	2,142	62.7	1,071	67.9%	29.7	1,013	506	32.1%
1993	94.2	29.51	3,192	2,015	59.5	1,008	63.1%	34.7	1,177	589	36.9%
1994	99.0	30.13	3,286	2,149	64.7	1,075	65.4%	34.3	1,137	568	34.6%
1995	100.7	31.07	3,241	2,017	62.7	1,009	62.2%	38.0	1,224	612	37.8%
1996	99.0	31.92	3,102	1,969	62.9	985	63.5%	36.1	1,133	566	36.5%
1997	100.5	32.57	3,086	2,052	66.8	1,026	66.5%	33.7	1,034	517	33.5%
1998	102.0	33.04	3,087	1,938	64.0	969	62.8%	38.0	1,149	575	37.2%
1999	102.2	33.10	3,088	1,930	63.9	965	62.5%	38.3	1,158	579	37.5%
2000	**100.8**	**33.12**	**3,043**	**1,891**	**62.6**	**946**	**62.1%**	**38.2**	**1,152**	**576**	**37.9%**
2001	100.3	33.40	3,003	1,665	55.6	833	55.4%	44.7	1,338	669	44.6%
2002	100.8	33.79	2,983	1,591	53.8	796	53.3%	47.0	1,392	696	46.7%
2003	99.7	33.72	2,957	1,479	49.9	740	50.0%	49.8	1,478	739	50.0%
Total, 1972-2003	2,141	n/a	73,223	40,463	1,202	20,232	56.2%	938	32,760	16,380	2724.7%
Change (#)	92.2	12.0	2,612	1,426	48.7	713	34.7%	43.5	1,186	593	-34.7%
Change (%)	1229%	55%	757%	2691%	4226%	2691%	225.5%	685%	406%	406%	-40.9%

Source for data: "Aluminum Can Reclamation," Aluminum Association, 2001 and 2003.

Appendix A-5: Used Beverage Can (UBC) Recycling 1972-2003, According to the Container Recycling Institute and the U.S. EPA.

Year	New Cans (a)				Used Beverage Cans			Used Beverage Cans (UBCs) Recycled (c)				Used Beverage Cans (UBCs) Wasted (c)			
	Shipped	Imported	Exported	Available	Collected (b)	Imported	Domestic (c)								
	(billions)	(billions)	(billions)	(billions)	(billions)	(billions)	(billions) Numerator	(billions)	(million lbs)	(thousand tons)	*Recycling rate*	(billions)	(million lbs)	(thousand tons)	*Wasting rate*
M	N (=B)	O	P	Q (=N+O-P)	R (=F)	S	T (=R-S)	U (=R-S)	V (=U÷C)	W	X (=T÷Q)	Y (=AB*Q)	Z (=Y÷C)	AA	AB (=1-X)
1972	7.5	n/a	n/a	7.5	1.2	n/a	n/a	1.2	53	27	15.4%	6.3	292	146	84.6%
1973	10.0	n/a	n/a	10.0	1.5	n/a	n/a	1.5	68	34	15.1%	8.5	381	191	84.9%
1974	13.4	n/a	n/a	13.4	2.3	n/a	n/a	2.3	103	52	17.4%	11.1	487	244	82.6%
1975	15.4	n/a	n/a	15.4	4.1	n/a	n/a	4.1	180	90	26.9%	11.3	490	245	73.1%
1976	19.8	n/a	n/a	19.8	4.9	n/a	n/a	4.9	212	106	24.9%	14.9	638	319	75.1%
1977	24.9	n/a	n/a	24.9	6.6	n/a	n/a	6.6	280	140	26.4%	18.3	781	390	73.6%
1978	29.3	n/a	n/a	29.3	8.0	n/a	n/a	8.0	340	170	27.4%	21.3	899	449	72.6%
1979	33.2	n/a	n/a	33.2	8.5	n/a	n/a	8.5	360	180	25.7%	24.7	1,041	521	74.3%
1980	**39.6**	**n/a**	**n/a**	**39.6**	**14.8**	**n/a**	**n/a**	**14.8**	**609**	**305**	**37.3%**	**24.8**	**1,025**	**513**	**62.7%**
1981	46.7	n/a	n/a	46.7	24.9	n/a	n/a	24.9	1,017	509	53.2%	21.8	893	447	46.8%
1982	51.0	n/a	n/a	51.0	28.3	n/a	n/a	28.3	1,124	562	55.6%	22.7	899	450	44.4%
1983	55.6	n/a	n/a	55.6	29.4	n/a	n/a	29.4	1,144	572	52.9%	26.2	1,019	510	47.1%
1984	60.4	n/a	n/a	60.4	31.9	n/a	n/a	31.9	1,226	613	52.8%	28.5	1,097	549	47.2%
1985	64.9	n/a	n/a	64.9	33.1	n/a	n/a	33.1	1,245	623	51.0%	31.8	1,195	597	49.0%
1986	68.3	n/a	n/a	68.3	33.3	n/a	n/a	33.3	1,233	617	48.7%	35.0	1,297	648	51.3%
1987	72.2	n/a	n/a	72.2	36.6	n/a	n/a	36.6	1,335	668	50.7%	35.6	1,300	650	49.3%
1988	77.9	n/a	n/a	77.9	42.5	n/a	n/a	42.5	1,505	753	54.6%	35.4	1,253	626	45.4%
1989	81.4	n/a	n/a	81.4	49.5	n/a	n/a	49.5	1,688	844	60.8%	31.9	1,090	545	39.2%
1990	**86.5**	**0**	**0**	**86.5**	**55.0**	**2.32**	**52.7**	**52.7**	**1,852**	**926**	**60.9%**	**33.8**	**1,189**	**594**	**39.1%**
1991	91.2	0.1	0.3	91.0	56.8	2.01	54.8	54.8	1,899	950	60.3%	36.1	1,252	626	39.7%
1992	92.4	0.2	0.4	92.2	62.7	2.85	59.9	59.9	2,045	1,022	65.0%	32.3	1,102	551	35.0%
1993	94.2	0.3	0.6	93.9	59.5	3.37	56.1	56.1	1,901	950	59.7%	37.8	1,282	641	40.3%
1994	99.0	0.6	1.4	98.2	64.7	5.05	59.7	59.7	1,981	991	60.8%	38.5	1,277	638	39.2%
1995	100.7	0.4	2.2	98.9	62.7	6.92	55.7	55.7	1,794	897	56.4%	43.2	1,389	695	43.6%
1996	99.0	1.4	0.9	99.5	62.9	5.73	57.1	57.1	1,789	895	57.4%	42.4	1,327	664	42.6%
1997	100.5	0.6	0.9	100.2	66.8	7.40	59.4	59.4	1,825	912	59.3%	40.8	1,252	626	40.7%
1998	102.0	0.3	1.0	101.3	64.0	8.19	55.8	55.8	1,690	845	55.1%	45.5	1,377	688	44.9%
1999	102.2	0.5	0.6	102.1	63.9	7.76	56.1	56.1	1,696	848	55.0%	46.0	1,389	694	45.0%
2000	**100.8**	**0.5**	**0.7**	**100.6**	**62.6**	**7.78**	**54.8**	**54.8**	**1,656**	**828**	**54.5%**	**45.8**	**1,381**	**691**	**45.5%**
2001	100.3	0.5	1.0	99.8	55.6	6.54	49.1	49.1	1,469	735	49.2%	50.7	1,519	759	50.8%
2002	100.8	0.6	1.3	100.1	53.8	5.30	48.5	48.5	1,434	717	48.4%	51.7	1,529	765	51.6%
2003	**99.7**	0.7	1.1	99.3	49.9	5.83	44.0	44.0	1,306	653	44.3%	55.3	1,640	820	55.7%
Total, 1972-2003	2,141	6.8	12.4	2,135	1,202	77.0	763.9	1125	38,061	19,030	52.7%	1,010	34,983	17,491	17
Change (#)	92.2	n/a	n/a	n/a	48.7	n/a	n/a	42.9	1,253	627	29.0%	49.0	1,348	674	-29.0%
Change (%)	1229%	n/a	n/a	n/a	4226%	n/a	n/a	3721%	2364%	2364%	188.4%	771.3%	462.0%	462.0%	-34.2%

(a) Includes only new unfilled cans. Data on imported and exported new filled cans is unavailable. It is estimated in Appendix A-2, but is not used in CRI's reported recycling rate. See Appendix A-2 for clarification.
(b) Includes UBC exports.
(c) From 1972-1989, data is from the Aluminum Association (Appendix A-3 columns F and H). From 1990-2003, data is derived as indicated.
Source for columns N and R: "Aluminum Can Reclamation," Aluminum Association, 2001 and 2003.
Source for columns O, P and S: Bureau of the Census, U.S. Department of Commerce.

Appendix B-1: Forgone Revenues from Not Recycling Cans, 1972-2001

Year	Average # of cans per pound (a)	Used beverage cans wasted (a)		Average UBC Price (b)				Forgone Revenues (b)	
				Current		Constant		Current	Constant
		(thousand tons)	(million lbs)	($/lb)	(cents/ can)	($/lb)	(cents/ can)	(million $)	(millions Year 2001$)
1972	21.8	146	292	*0.45*	*2.1*	*1.91*	*8.8*	131	556
1973	22.3	191	381	*0.45*	*2.0*	*1.79*	*8.1*	172	685
1974	22.7	244	487	*0.45*	*2.0*	*1.62*	*7.1*	219	788
1975	23.0	245	490	*0.45*	*2.0*	*1.48*	*6.4*	220	725
1976	23.3	319	638	*0.45*	*1.9*	*1.40*	*6.0*	287	893
1977	23.5	390	781	*0.45*	*1.9*	*1.32*	*5.6*	351	1,027
1978	23.7	449	899	*0.45*	*1.9*	*1.22*	*5.2*	405	1,099
1979	23.7	521	1,041	*0.41*	*1.7*	*1.00*	*4.2*	427	1,042
1980	**24.2**	**513**	**1,025**	**0.47**	**1.9**	**1.01**	**4.2**	**480**	**1,031**
1981	24.5	447	893	0.47	1.9	0.91	3.7	418	814
1982	25.2	450	899	0.46	1.8	0.85	3.4	415	762
1983	25.7	510	1,019	0.45	1.8	0.80	3.1	459	816
1984	26.0	549	1,097	0.45	1.7	0.77	3.0	497	847
1985	26.6	597	1,195	0.35	1.3	0.58	2.2	421	692
1986	27.0	648	1,297	0.39	1.4	0.62	2.3	500	809
1987	27.4	650	1,300	0.50	1.8	0.79	2.9	655	1,021
1988	28.3	626	1,253	0.70	2.5	1.04	3.7	874	1,309
1989	29.3	545	1,090	0.64	2.2	0.91	3.1	693	990
1990	**28.4**	**594**	**1,189**	**0.50**	**1.8**	**0.68**	**2.4**	**593**	**804**
1991	28.9	626	1,252	0.43	1.5	0.56	1.9	540	702
1992	29.3	551	1,102	0.42	1.4	0.53	1.8	464	586
1993	29.5	641	1,282	0.38	1.3	0.47	1.6	490	600
1994	30.1	638	1,277	0.55	1.8	0.66	2.2	705	843
1995	31.1	695	1,389	0.67	2.1	0.77	2.5	926	1,076
1996	31.9	664	1,327	0.55	1.7	0.62	1.9	726	819
1997	32.6	626	1,252	0.60	1.9	0.67	2.0	755	834
1998	33.0	688	1,377	0.50	1.5	0.54	1.6	688	747
1999	33.1	694	1,389	0.51	1.5	0.54	1.6	703	748
2000	**33.1**	**691**	**1,381**	**0.58**	**1.7**	**0.59**	**1.8**	**797**	**820**
2001	33.4	760	1,519	0.50	1.5	0.50	1.5	758	758
	Subtotal, 1986-2000	9,578	19,157					$ 10,111	$ 12,708
	Average price			0.527	1.7	0.666	2.2		
	Subtotal, 1990-2000	7,109	14,217					$ 7,388	$ 8,578
	Average price			0.517	1.7	0.603	1.9		
	Total, 1972-2001	15,907	31,814					*$ 15,771*	*$ 25,243*
	Average price			*0.49*	*1.79*	*0.90*	*3.5*		

(a) See Appendices A-4, A-5.

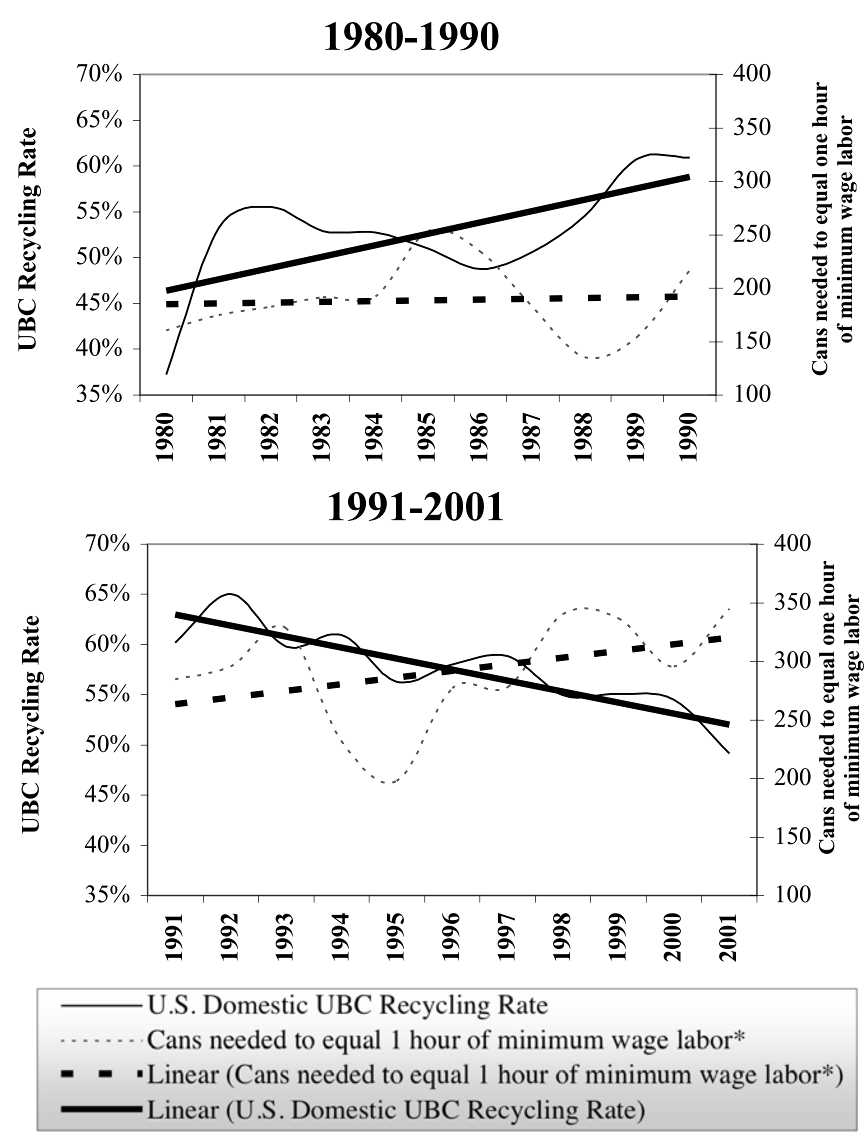
(b) Figures in italics are estimates. "Current" is the average nominal price for each calendar year, and actual forgone revenues for that year. "Constant" price and revenue is in Year 2001 dollars, based on the Consumer Price Index.

Source for UBC scrap prices: Industry surveys conducted by *Container Recycling Report* and *Bottle and Can Recycling Update* , publications of *Resource Recycling* magazine.

Container Recycling Institute, 2002.

Appendix B-2: The Effect of Monetary Reward on the UBC Recycling Rate, 1980-2001

Year	Average UBC Price ($/lb)	Average number of cans per pound	Monetary reward for collecting cans (cents/can)	U.S. Minimum Wage (current dollars)	Cans needed to equal 1 hour of minimum wage labor*	U.S. Domestic UBC Recycling Rate
	A	B	C (=A÷B)	D	E (=D÷C)	F
1980	**0.47**	**24.2**	**1.9**	**3.10**	**160**	**37.3%**
1981	0.47	24.5	1.9	3.35	175	53.2%
1982	0.46	25.2	1.8	3.35	183	55.6%
1983	0.45	25.7	1.8	3.35	191	52.9%
1984	0.45	26.0	1.7	3.35	192	52.8%
1985	0.35	26.6	1.3	3.35	253	51.0%
1986	0.39	27.0	1.4	3.35	234	48.7%
1987	0.50	27.4	1.8	3.35	182	50.7%
1988	0.70	28.3	2.5	3.35	136	54.6%
1989	0.64	29.3	2.2	3.35	154	60.8%
1990	**0.50**	**28.4**	**1.8**	**3.80**	**217**	**60.9%**
1991	0.43	28.9	1.5	4.25	285	60.2%
1992	0.42	29.3	1.4	4.25	296	65.0%
1993	0.38	29.5	1.3	4.25	328	59.8%
1994	0.55	30.1	1.8	4.25	232	61.0%
1995	0.67	31.1	2.1	4.25	198	56.3%
1996	0.55	31.9	1.7	4.75	277	58.0%
1997	0.60	32.6	1.9	5.15	278	58.8%
1998	0.50	33.0	1.5	5.15	341	55.0%
1999	0.51	33.1	1.5	5.15	337	55.1%
2000	**0.58**	**33.1**	**1.7**	**5.15**	**296**	**54.5%**
2001	0.50	33.4	1.5	5.15	345	49.2%



* This series takes into account UBC price in current (nominal) dollars, average can weight (the number of cans per pound), and the current (nominal) minimum wage.

Source for UBC scrap prices: Industry surveys conducted by *Container Recycling Report* and *Bottle and Can Recycling Update,* publications of *Resource Recycling* magazine.

Source for average can weight: The Aluminum Association.

Source for minimum wage: U.S. Dept. of Labor (www.dol.gov/dol/esa/public/minwage/chart2.htm).

Container Recycling Institute, 2002.

Appendix C: Energy and Environmental Ramifications of Wasting Used Beverage Cans

Year	UBCs Wasted Annually			Total Replacement Energy Required				Greenhouse Gases		Potential Alternative Energy & Material Uses			
	Number of cans (a) (billion)	Can weight (mill. lbs)	Can weight (thousand tons)	Total Energy (b) (trillion Btu)	Electricity equiv. (c) (TWh)	Crude oil equiv. (d) (million bbls)	Gasoline equiv. (d) (million gals)	Total GHGs (e) (million MTCE)	CO_2 equiv. (f) (million tons)	Modern Boeing 737s produced (g)	Homes electrified (h) (million)	Households' total energy needs met (h)	Cars supplied with gas (i)
1970 (est)	***2.7***	***129***	***64***	***7.9***	***2.3***	***1.4***	***63***	0.3	1.0	2,860	0.2	77,864	114,956
1971 (est)	*4.4*	*205*	*102*	*12.6*	*3.7*	*2.2*	*101*	0.4	1.5	4,549	0.4	123,872	182,881
1972	6.3	292	146	17.9	5.3	3.1	143	0.6	2.2	6,486	0.5	176,592	260,713
1973	8.5	381	191	23.4	6.9	4.1	187	0.8	2.8	8,477	0.7	230,817	340,770
1974	11.1	487	244	29.9	8.8	5.2	239	1.0	3.6	10,830	0.9	294,882	435,352
1975	11.3	490	245	30.1	8.8	5.2	241	1.0	3.7	10,880	0.9	296,247	437,369
1976	14.9	638	319	39.2	11.5	6.8	313	1.3	4.8	14,174	1.1	385,939	569,786
1977	18.3	781	390	48.0	14.1	8.3	384	1.6	5.8	17,355	1.4	472,558	697,668
1978	21.3	899	449	55.2	16.2	9.6	442	1.8	6.7	19,977	1.6	543,946	803,061
1979	24.7	1,041	521	64.0	18.7	11.1	512	2.1	7.8	23,145	1.9	630,197	930,399
1980	**24.8**	**1,025**	**513**	**63.0**	**18.5**	**10.9**	**504**	**2.1**	**7.7**	**22,787**	**1.8**	**620,456**	**916,018**
1981	21.8	893	447	54.8	16.1	9.5	439	1.8	6.7	19,846	1.6	540,387	797,808
1982	22.7	899	450	55.2	16.2	9.6	442	1.8	6.7	19,980	1.6	544,010	803,156
1983	26.2	1,019	510	62.6	18.4	10.8	501	2.1	7.6	22,656	1.8	616,877	910,735
1984	28.5	1,097	549	67.4	19.7	11.7	539	2.2	8.2	24,381	2.0	663,867	980,109
1985	31.8	1,195	597	73.4	21.5	12.7	587	2.4	8.9	26,554	2.1	723,031	1,067,457
1986	35.0	1,297	648	79.6	23.3	13.8	637	2.6	9.7	28,816	2.3	784,621	1,158,385
1987	35.6	1,300	650	79.8	23.4	13.8	639	2.7	9.7	28,892	2.3	786,682	1,161,429
1988	35.4	1,253	626	76.9	22.5	13.3	615	2.6	9.4	27,836	2.2	757,930	1,118,980
1989	31.9	1,090	545	67.0	19.6	11.6	536	2.2	8.1	24,228	1.9	659,679	973,926
1990	**33.8**	**1,189**	**594**	**73.0**	**21.4**	**12.6**	**584**	**2.4**	**8.9**	**26,421**	**2.1**	**719,395**	**1,062,088**
1991	36.1	1,252	626	76.9	22.5	13.3	615	2.6	9.3	27,822	2.2	757,540	1,118,405
1992	32.3	1,102	551	67.7	19.8	11.7	541	2.2	8.2	24,486	2.0	666,709	984,305
1993	37.8	1,282	641	78.8	23.1	13.6	630	2.6	9.6	28,501	2.3	776,025	1,145,696
1994	38.5	1,277	638	78.4	23.0	13.6	627	2.6	9.5	28,379	2.3	772,722	1,140,819
1995	43.2	1,389	695	85.3	25.0	14.8	683	2.8	10.4	30,870	2.5	840,547	1,240,953
1996	42.4	1,327	664	81.5	23.9	14.1	652	2.7	9.9	29,496	2.4	803,114	1,185,688
1997	40.8	1,252	626	76.9	22.5	13.3	615	2.6	9.3	27,823	2.2	757,571	1,118,450
1998	45.5	1,377	688	84.6	24.8	14.6	677	2.8	10.3	30,599	2.5	833,154	1,230,038
1999	46.0	1,389	694	85.3	25.0	14.8	682	2.8	10.4	30,866	2.5	840,439	1,240,793
2000	**45.8**	**1,381**	**691**	**84.9**	**24.9**	**14.7**	**679**	**2.8**	**10.3**	**30,702**	**2.5**	**835,975**	**1,234,203**
2001	50.7	1,519	760	93.3	27.3	16.1	746	3.1	11.3	33,764	2.7	919,334	1,357,271
1990-2000	442.0	14,217	7,109	873	256	151	6,986	29	106	315,964	25	8,603,191	12,701,438
1970-2001	909.9	32,147	16,074	1,974	579	342	15,796	66	240	714,438	57	19,452,977	28,719,668

(a) The figures used from 1972 to 1989 are from the Aluminum Association; from 1990-2001 they are derived by the Container Recycling Institute. 1970 and 1971 are CRI estimates.

(b) Total energy required for replacement production (123.7 MBtu/ton) is the difference between the amount required to make cans from all virgin materials (194 MBtu/t) and the amount needed to make a cans from 100% UBCs with 17% process losses (70.3 MBtu/t). This includes all sources of thermal energy and electricity. Electricity values were converted to BTUs using the current mix of sources in the U.S. aluminum industry (43% hydroelectric generation converted at 3412 Btu/kWh; 57% fossil fuel converted at10,500 Btu/kWh). Source for energy values: "Mandated Recycling Rates: Impacts on Energy Consumption and Municipal Solid Waste Volume." L.L. Gaines and F. Stodolsky, Argonne National Laboratory, ANL/ESD-25, December 1993. Source for process losses: see note e.

(c) The electric *equivalent* of total energy converted at 3,412 Btu/kWh. Average electricity requirements for primary aluminum ingot are 14 MWh/ton, 95% of which is avoided by producing ingot from UBCs.

(d) One barrel of crude oil has an energy value of 5.8 MBtu. One gallon of gasoline has an energy value of 0.125 MBtu.

(e) GHGs produced by replacement production, or avoided by recycling, is 4.08 MTCE/ton. Derived from "Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste." U.S. EPA 530-R-98-013 September 1998.

(f) As described on page 4 of the 1998 EPA study: "Because CO_2 is 12/44 carbon by weight, one metric ton of CO_2 is equal to 12/44 or 0.27 metric tons of carbon equivalent (MTCE)." The inverse would be: one MTCE is equivalent to 3.66 (1/0.27) tonnes of CO_2. EPA reference: The Intergovernmental Panel on Climate Change (IPCC), Climate Change 1995: The Science of Climate Change, 1996, p. 121.

(g) Based on the Boeing 737 800 series, the most commonly produced commerical passenger jet. It contains 37,347 pounds (18.7 tons) of aluminum. The number of planes listed here is for illustrative purposes only; there are not that many 737s in operation worldwide , let alone in the U.S. Sources: http://www.boeing.com/commercial/747family/index.html; personal communication with Bill Francoeur, Boeing, Oct. 2001 (via Brett Wilson). 17% process losses factored in.

(h) Average annual U.S. residential total energy consumption (excluding transportation) in 1997 was 101.5 MBtu. Average annual electric consumption for a U.S. household in 1997 was 10.1 MWh. Sources: Tables 949 and 969, Statistical Abstract of the United States: The National Data Book 2000 Edition, U.S. Census Bureau, 2001.

(i) Assumes the average car drives 11,000 miles per year averaging 20 mpg. Source: "Getting WARM: An Easy Away to Calculate Climate Impacts." Reusable News, U.S. Environmental Protection Agency (EPA530-N-00-006), Fall 2000, p. 9.

Container Recycling Institute, 2002.

Appendix D: Estimated Volume of Wasted Aluminum Cans, 1970-2001 (a)

Year	Weight (b)	Density	Volume
	(million lbs per year)	125 lbs/cu. yd. (c)	(million cu. yds)
	A	B	C=A*B
1970e	**129**	**125**	**1.0**
1971e	205	125	1.6
1972	292	125	2.3
1973	381	125	3.1
1974	487	125	3.9
1975	490	125	3.9
1976	638	125	5.1
1977	781	125	6.2
1978	899	125	7.2
1979	1,041	125	8.3
1980	**1,025**	**125**	**8.2**
1981	893	125	7.1
1982	899	125	7.2
1983	1,019	125	8.2
1984	1,097	125	8.8
1985	1,195	125	9.6
1986	1,297	125	10.4
1987	1,300	125	10.4
1988	1,253	125	10.0
1989	1,090	125	8.7
1990	**1,189**	**125**	**9.5**
1991	1,252	125	10.0
1992	1,102	125	8.8
1993	1,282	125	10.3
1994	1,277	125	10.2
1995	1,389	125	11.1
1996	1,327	125	10.6
1997	1,252	125	10.0
1998	1,377	125	11.0
1999	1,389	125	11.1
2000	**1,381**	**125**	**11.1**
2001	1,519	125	12.2
Total, 1990-2000	14,217		114
Total, 1970-2001	32,147		257

(a) Approximately 75% of the nation's unrecycled garbage goes to landills; a quarter goes to incinerators. U.S. Environmental Protection Agency. "Environmental Fact Sheet: Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 1998." EPA-530-F-00-024, April 2000.

(b) See Appendices A-4 and A-5 for derivation of wasted aluminum can weight, 1970-2001.

(c) Modified from: "Measuring Recycling: A Guide for State and Local Governments," pp. 59- 61, U.S. EPA, September 1997. Aluminum cans, whole: 50-75 lbs/yd3; compacted manually: 250-430 lbs/yd3. We assumed that manual compaction was unlikely in normal garbage collection and handling, and used the average of whole cans (62.5) multiplied by 2 (assumed 50% volume reduction through natural compaction and cushioning effect of MSW).

Container Recycling Institute, 2002.

Appendix E-1. Air Emissions from Production of Primary Aluminum Ingot (a)

		Sulfur Oxides (SOx)	Nitrogen Oxides (NOx)	Carbon Dioxide (CO_2)	Carbon Monoxide (CO)	Particulate Matter (PM)	Volatile Organic Compounds (VOCs)	Organics	Chlorides	Total Fluorides (TF)	Total Emissions
	Combustion-related emissions:										
	Alumina Refining	2.18	3.60	2,502.20	2.00	0.68	0.126	7.20			2,517.99
	Anode Production	1.12	0.60	275.44	ND	0.30	0.010	ND			277.47
	Primary Aluminum Smelting	124.82	48.22	11,028.00	2.60	35.96	0.254	1.40			11,241.25
	Primary Ingot Casting	3.44	1.60	745.00	0.40	0.72	0.056	1.50			752.72
	subtotal, combustion-related	**131.56**	**54.02**	**14,550.64**	**5.00**	**37.66**	**0.45**	**10.10**			**14,789.43**
	Process-related emissions:										
	Alumina Refining	--	--	--	--	1.00	--	--	--	--	1.00
	Coke Production	1.62	0.36	--	0.74	0.80	0.58	--	--	0.0008	4.10
	Anode Production	1.40	0.32	--	0.50	1.26	0.40	--	--	0.5	4.38
	Primary Aluminum Smelting	36.00	5.80	2,800.00	250.00	8.40	0.26	--	--	2.6	3,103.06
	Primary Ingot Casting	--	--	--	--	0.20	--	--	0.02	--	0.22
	subtotal, process-related	**39.02**	**6.48**	**2,800.00**	**251.24**	**11.66**	**1.24**		**0.02**	**3.10**	**3,112.76**
	TOTAL AIR EMISSIONS:	**170.58**	**60.50**	**17,350.64**	**256.24**	**49.32**	**1.69**	**10.10**	**0.02**	**3.10**	**17,902.18**
	Percentage of each pollutant	0.95%	0.34%	96.92%	1.43%	0.28%	0.01%	0.06%	0.00%	0.02%	100.00%
(tons)	**INDUSTRY-WIDE EMISSIONS, 1999** (b):	**355,149**	**125,962**	**36,124,201**	**533,494**	**102,685**	**3,510**	**21,028**	**32**	**6,456**	**37,272,517**

(a) Does not include fabrication steps to make end-products. ND = not determined.
(b) Derived by multiplying each pollutant by 4,164,019 short tons of primary aluminum produced in 1999.
Sources: Emissions: Tables 1-13 and 1-15, "Energy and Environmental Profile of the U.S. Aluminum Industry." U.S. Department of Energy, Office of Industrial Technologies, July 1997; Primary aluminum produced in 1999: "Aluminum Statistical Review for 1999," Aluminum Association, 2000.

Container Recycling Institute, 2002.

Appendix E-2. Air Emissions from Production of Secondary Aluminum Ingot

Pounds per ton (a)

	Sulfur Oxides (SOx)	Nitrogen Oxides (NOx)	Carbon Dioxide (CO_2)	Carbon Monoxide (CO)	Particulate Matter (PM)	Volatile Organic Compounds (VOCs)	Organics	Chlorides	Total Fluorides (TF)	Total Emissions
Combustion-related emissions:										
Scrap Pretreatment	0.36	0.30	162.12	ND	0.10		ND			162.88
Secondary Melting/Casting	1.92	1.26	609.02	0.42	0.54	0.026	1.70			614.89
subtotal, combustion-related	**2.28**	**1.56**	**771.14**	**0.42**	**0.64**	**0.03**	**1.70**	-	-	**777.77**
Process-related emissions:										
Scrap Pretreatment	--	--	--	--	0.40	0.10	--	0.40	--	0.90
Secondary Melting/Casting	--	--	--	--	0.38	0.10	--	0.34	--	0.82
subtotal, process-related	-	-	-	-	**0.78**	**0.20**	-	**0.74**	-	**1.72**
TOTAL AIR EMISSIONS, SECONDARY PRODUCTION:										
(lbs/ton of ingot produced)	**2.28**	**1.56**	**771.14**	**0.42**	**1.42**	**0.23**	**1.70**	**0.74**	**-**	**779.49**
Percentage of each pollutant	0.29%	0.20%	98.93%	0.05%	0.18%	0.03%	0.22%	0.09%	0.00%	100.00%

(a) Does not include fabrication steps to make end-products, including cans. ND = not determined.

Sources: Emissions: Tables 1-13 and 1-15, "Energy and Environmental Profile of the U.S. Aluminum Industry." U.S. Department of Energy, Office of Industrial Technologies, July 1997; Primary aluminum produced in 1999: "Aluminum Statistical Review for 1999," Aluminum Association, 2000.

Container Recycling Institute, 2002.

Appendix E-3. Air Emissions from "Replacement Production" of Wasted Used Aluminum Beverage Cans (UBCs)

	Sulfur Oxides (SOx)	Nitrogen Oxides (NOx)	Carbon Dioxide (CO_2)	Carbon Monoxide (CO)	Particulate Matter (PM)	Volatile Organic Compounds (VOCs)	Organics	Chlorides	Total Fluorides (TF)	Total Emissions
Total air emissions to make one ton of primary ingot using 100% virgin materials *(from Appendix E-1)* (lbs per ton)	170.58	60.50	17,350.64	256.24	49.32	1.69	10.10	0.02	3.10	17,902.18
Total air emissions to make one ton of ingot using 100% secondary materials *(from Appendix E-2)* (lbs per ton)	2.28	1.56	771.14	0.42	1.42	0.23	1.70	0.74	-	779.49
Total air emissions from making one ton of recycled cans (accounts for 13% process losses) (a) (lbs per ton)	24.16	9.22	2,926.48	33.68	7.65	0.42	2.79	0.65	0.40	3,005.44
Emissions from "replacement production" of wasted (landfilled) UBCs (b) (lbs/ton of wasted UBCs)	**146.42**	**51.28**	**14,424.17**	**222.56**	**41.67**	**1.27**	**7.31**	**(0.63)**	**2.70**	**14,896.75**
U.S. beverage cans wasted in 2001 (c) (tons)	**759,625**									
Total emissions for replacement production (d): (million lbs)	111.2	39.0	10,957.0	169.1	31.7	1.0	5.6	(0.5)	2.0	11,315.9
(tons)	**55,613**	**19,476**	**5,478,480**	**84,532**	**15,828**	**482**	**2,776**	**(239)**	**1,025**	**5,657,972**

(a) Emissions = (.83 tons UBCs + .17 tons of virgin ingot to compensate for 13% losses in the UBC recycling process.) Note: does not include emissions from rolling can sheet and drawing cans, which are assumed to be roughly equal whether using primary or secondary ingot.

(b) Derived by subtracting emissions from using one ton of UBCs to make new cans from emissions from making one ton of cans using 100% virgin materials.
(c) From Appendix A-5.
(d) Derived by multiplying per ton replacement emissions by UBCs wasted in 2001.

Notes: This is not a comprehensive list of all potential air emissions; some pollutants generated during secondary production are described anecdotally in OIT publication, but no quantities are listed. The secondary emissions listed here pertain not to UBCs specifically, but to scrap aluminum in general, much of which is much dirtier (containing industrial oils and greases) than UBCs. Therefore, certain emissions listed in the "difference" row may overstate the pollutants generated by secondary smelting using UBCs.

Container Recycling Institute, 2002.

Appendix E-4. Material and Energy Inputs and Environmental Outputs Per Ton of Product

	INPUTS								OUTPUTS						
	Bauxite ore	Scrap metal	Land	Water	Other material inputs*	Energy				Air Emissions					
	(lbs)	(lbs)	(sq. ft)	(gallons)	(lbs)	Fossil fuel	Non-fossil fuel	Total	Rolled aluminum (lbs)	CO_2	CO	SOx	NOx	PM	Other residues (lbs)
Primary rolled aluminum	10,180	-	29.4	4,502	1,586	112	60.3	172.7	2,000	24,952	156	180	88	92	9,620
Secondary rolled aluminum	-	3,310	-	760	124	24	1	25	2,000	3,370	8	22	52	8	1,458
Secondary using 13% primary ingot (see note a in Appx. E-3)	1,323	2,880	4	1,246	314	35	8	44	2,000	6,176	27	43	57	19	2,519
Inputs and outputs for "replacement production" (see note b in Appx. E-3)	**8,857**	**(2,880)**	**26**	**3,255**	**1,272**	**77**	**52**	**129**	**2,000**	**18,776**	**129**	**137**	**31**	**73**	**7,101**
U.S. beverage cans wasted in 2001 (tons) (see note c in Appx. E-3)	**759,625**														
Inputs/outputs for replacement production	(tons)	(tons)	(acres)	(billion gallons)	(tons)	Bbl crude oil equivalent (millions)	Electricity equivalent (TWh)	Total energy (million Mbtu)	(tons)	(tons)	(tons)	(tons)	(tons)	(tons)	(tons)
(see note d in Appx. E-3)	3,363,849	(1,093,746)	598	2.47	483,099	10.13	11.5	97.9	759,625	7,131,491	48,905	52,209	11,896	27,757	2,697,027

* For primary rolled aluminum, other material inputs include caustic soda, calcined coke, pitch, lube oil and lime. For secondary rolled aluminum, other material inputs include alloying elements, salts, water treatment chemicals and oil.

Source for rows 1 and 2: derived from Figures 5-2 and 5-6, "Life Cycle Inventory Report for the North American Aluminum Industry." by Roy Weston Inc. for the Aluminum Association, November 1998.

Container Recycling Institute, 2002.

Appendix F. Aluminum Can Wasting vs. Smelter Capacity in the Pacific Northwest

Company	Location	Production Capacity (1999) (thousand short tons)
1. Reynolds Metals	Troutdale, Oregon	133
2. Columbia Falls Aluminum	Columbia Falls, Montana	184
3. Reynolds Metals	Longview, Washington	225
4. Kaiser Aluminum and Chemical	Mead, Washington	220
	Subtotal	**762**
5. Vanalco	Vancouver, Washington	128
6. Aluminum Company of America	Wenatchee, Washington	242
7. Kaiser Aluminum and Chemical	Tacoma, Washington	112
8. Goldendale Aluminum	Goldendale, Washington	185
9. Northwest Aluminum	The Dalles, Oregon	90
10. Intalco Aluminum	Bellingham/Ferndale, Washington	300
Total Pacific Northwest (PNW) primary aluminum production capacity, 1999		**1,819**
Total U.S. primary aluminum production capacity, 1999:		4,724
PNW capacity as a proportion of U.S. primary production capacity, 1999:		**38.5%**
Total Pacific Northwest (PNW) primary aluminum production capacity, 1999		1,819
Production capacity of selected primary smelters in PNW (#1-4 above).		*762*
Wasted used aluminum beverage cans (UBC's), 2001 (thousand short tons):		*760*
Wasted UBCs as a proportion of PNW primary production capacity (760÷1,819)**:**		**41.8%**
Total U.S. primary aluminum production, 1999:		4,164
Wasted UBCs as a proportion of U.S. primary production (1999)		**18%**
Total aluminum wasted in 1998, including non-can sources (thousand tons):		2,200
Total aluminum wasted (1998) as a proportion of U.S. primary production (1999)		**47%**

Sources:

1. Total amount of aluminum wasted: U.S. EPA Municipal Solid Waste Characterization Study, 1999 Update
2. UBC's recycled and wasted: see Appendix A
3. Production capacities of PNW smelters: "Primary Aluminum Plants Worldwide-1998, Part I-Detail." U.S. Geological Survey Washington, D.C., July 1999; and "Aluminum Statistical Review for 1999." The Aluminum Association, Washington, D.C., 2000

Container Recycling Institute, 2002.

Appendix G: Per Capita Sales, Recycling and Wasting of Aluminum Beverage Cans

Year	U.S. Population* (million)	Cans per pound	New Cans Sold in U.S. (a) cans (b) (billions)	New Cans Sold: cans/capita per year	New Cans Sold: lbs (millions)	New Cans Sold: lbs/capita per year	UBCs Recycled cans (b) (billions)	UBCs Recycled: cans/capita per year	UBCs Recycled: lbs (millions)	UBCs Recycled: lbs/capita per year	UBCs Wasted cans (b) (billions)	UBCs Wasted: cans/capita per year	UBCs Wasted: lbs (millions)	UBCs Wasted: lbs/capita per year
1970	205	*20.8*	*3.0*	*15*	*145*	*0.7*	*0.3*	*2*	*129*	*0.6*	*2.7*	*13*	*129*	*0.6*
1971	208	*21.3*	*5.0*	*24*	*235*	*1.1*	*0.7*	*3*	*205*	*1.0*	*4.4*	*21*	*205*	*1.0*
1972	210	21.8	7.5	36	345	1.6	1.2	5	292	1.4	6.3	30	292	1.4
1973	212	22.3	10.0	47	449	2.1	1.5	7	381	1.8	8.5	40	381	1.8
1974	214	22.7	13.4	63	590	2.8	2.3	11	487	2.3	11.1	52	487	2.3
1975	216	23.0	15.4	71	670	3.1	4.1	19	490	2.3	11.3	52	490	2.3
1976	218	23.3	19.8	91	850	3.9	4.9	23	638	2.9	14.9	68	638	2.9
1977	220	23.5	24.9	113	1,061	4.8	6.6	30	781	3.5	18.3	83	781	3.5
1978	223	23.7	29.3	132	1,239	5.6	8.0	36	899	4.0	21.3	96	899	4.0
1979	225	23.7	33.2	148	1,401	6.2	8.5	38	1,041	4.6	24.7	110	1,041	4.6
1980	**227**	**24.2**	**39.6**	**174**	**1,634**	**7.2**	**14.8**	**65**	**609**	**2.7**	**24.8**	**109**	**1,025**	**4.5**
1981	229	24.5	46.7	204	1,910	8.3	24.9	108	1,017	4.4	21.8	95	893	3.9
1982	232	25.2	51.0	220	2,023	8.7	28.3	122	1,124	4.9	22.7	98	899	3.9
1983	234	25.7	55.6	238	2,163	9.3	29.4	126	1,144	4.9	26.2	112	1,019	4.4
1984	236	26.0	60.4	256	2,323	9.9	31.9	135	1,226	5.2	28.5	121	1,097	4.7
1985	238	26.6	64.9	273	2,440	10.3	33.1	139	1,245	5.2	31.8	134	1,195	5.0
1986	240	27.0	68.3	284	2,530	10.5	33.3	139	1,233	5.1	35.0	146	1,297	5.4
1987	242	27.4	72.2	298	2,635	10.9	36.6	151	1,335	5.5	35.6	147	1,300	5.4
1988	244	28.3	77.9	319	2,758	11.3	42.5	174	1,505	6.2	35.4	145	1,253	5.1
1989	247	29.3	81.4	330	2,778	11.3	49.5	200	1,688	6.8	31.9	129	1,090	4.4
1990	**249**	**28.4**	**86.5**	**348**	**3,041**	**12.2**	**52.7**	**212**	**1,852**	**7.4**	**33.8**	**136**	**1,189**	**4.8**
1991	252	28.9	91.0	361	3,151	12.5	54.8	218	1,899	7.5	36.1	144	1,252	5.0
1992	255	29.3	92.2	362	3,147	12.3	59.9	235	2,045	8.0	32.3	127	1,102	4.3
1993	258	29.5	93.9	364	3,183	12.3	56.1	217	1,901	7.4	37.8	147	1,282	5.0
1994	261	30.1	98.2	376	3,258	12.5	59.7	229	1,981	7.6	38.5	147	1,277	4.9
1995	264	31.1	98.9	374	3,183	12.0	55.7	211	1,794	6.8	43.2	163	1,389	5.3
1996	268	31.9	99.5	372	3,117	11.6	57.1	213	1,789	6.7	42.4	158	1,327	5.0
1997	271	32.6	100.2	370	3,077	11.4	59.4	219	1,825	6.7	40.8	150	1,252	4.6
1998	274	33.0	101.3	369	3,067	11.2	55.8	204	1,690	6.2	45.5	166	1,377	5.0
1999	278	33.1	102.1	368	3,084	11.1	56.1	202	1,696	6.1	46.0	165	1,389	5.0
2000	**281**	**33.1**	**100.6**	**358**	**3,038**	**10.8**	**54.8**	**195**	**1,656**	**5.9**	**45.8**	**163**	**1,381**	**4.9**
2001	*284*	33.4	99.8	*351*	2,988	*10.5*	49.1	*173*	1,469	*5.2*	50.7	*179*	1,519	*5.3*
Change, 1990-2000 (#):	32.5	4.7	14.1	10.1	-3.7	-1.4	2.2	-16.7	-196.3	-1.6	12.0	26.8	193	0.1
Change, 1990-2000 (%):	13%	16%	16%	3%	0%	-12%	4%	-8%	-11%	-21%	35%	20%	16%	3%
Change, 1972-2001 (#):	78.9	12.7	96.8	336.8	2843.5	9.8	48.7	171.1	1340.2	4.5	48.1	165.7	1390.6	4.7
Change, 1972-2001 (%):	39%	61%	3227%	2302%	1967%	1392%	14766%	10634%	1042%	724%	1800%	1272%	1081%	752%

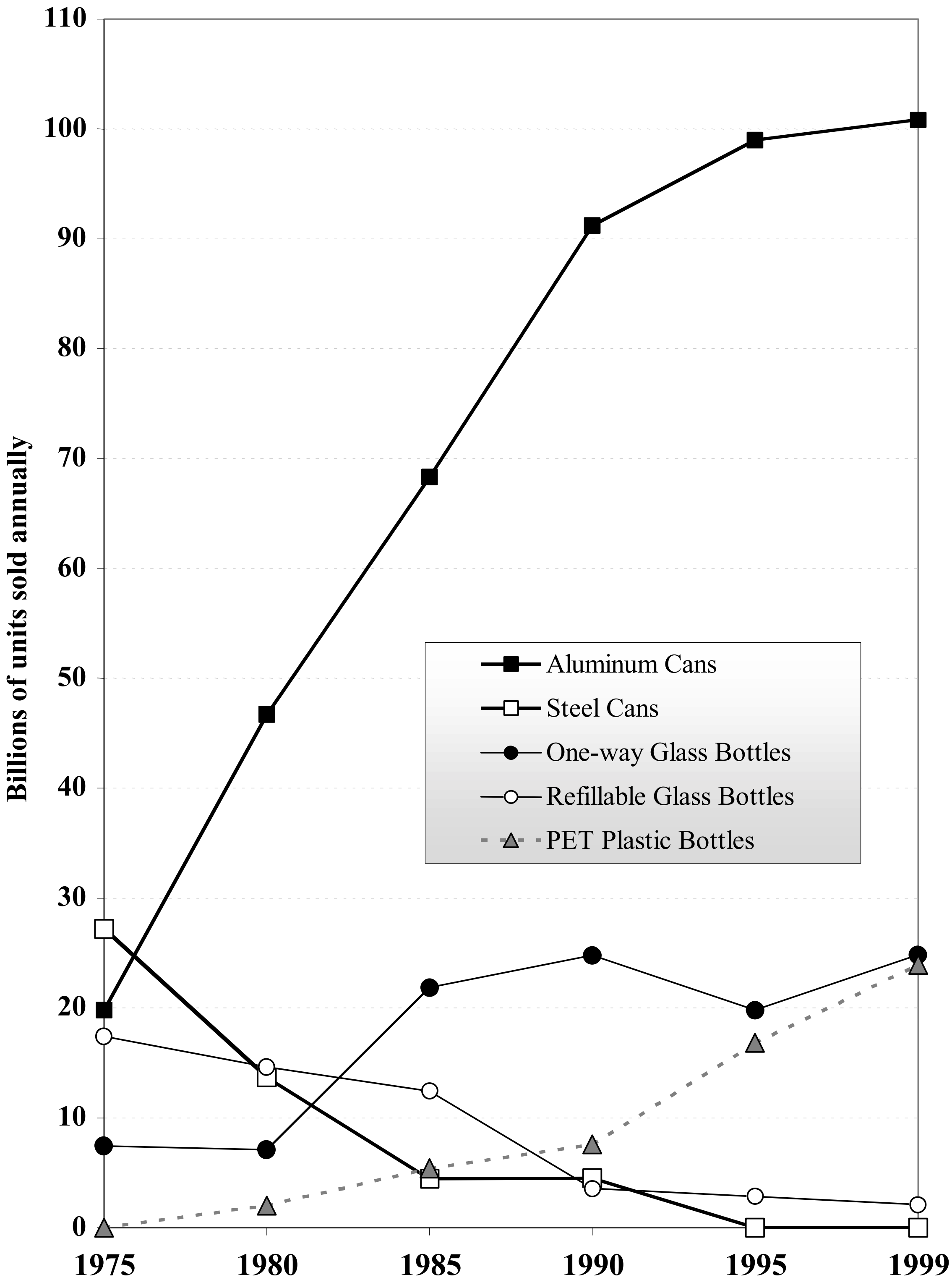
(a) Pertains to new unfilled cans produced and sold in the U.S., minus exported new unfilled cans, plus imported new unfilled cans. Data on imported and exported new filled cans is unavailable.

(b) Numbers in this column are taken from Appendix A-4 column B (for 1972-1989), and Appendix A-5 column Q (for 1990-2001).

* Note: the population figures for 1990 and 2000 are from actual U.S. decennial census data. The population figures for 1991 to 1999 are estimates based on a steady growth rate of 1.2% during the intercensal years. The U.S. Bureau of the Census has not issued revised estimates of intercensal years. The population for 2001 is a CRI estimate. Other figures in italics, including those for aluminum sales, recycling and wasting for 1970 and 1971, are CRI estimates.

Container Recycling Institute, 2002.

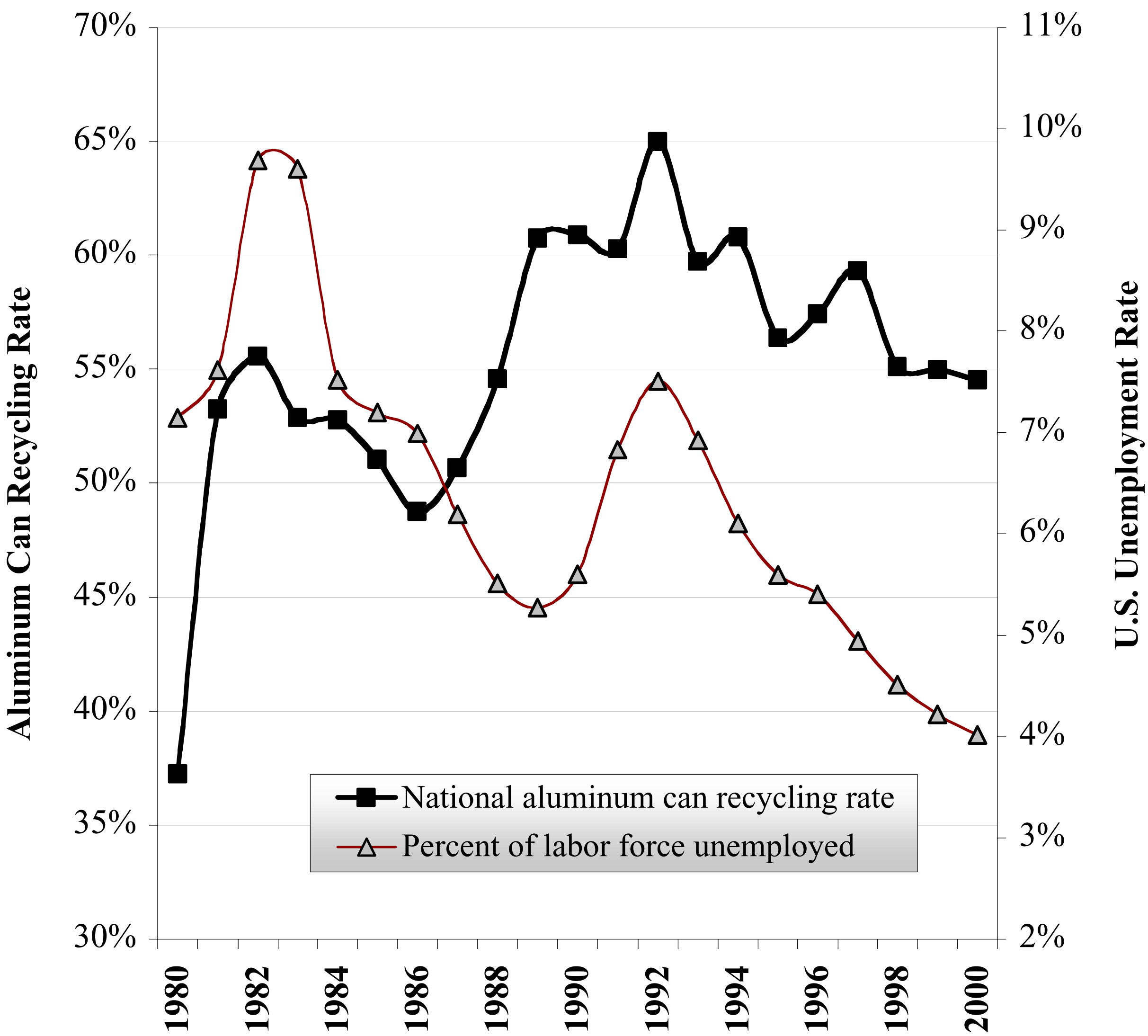
Appendix H. U.S. Soft Drink and Beer Packaging, 1975-1999



Sources: Beverage Marketing Corp. 2000, Aluminum Association 2001, Can Manufacturers' Institute 2002.

Container Recycling Institute, 2002.

Appendix I. Unemployment vs. Aluminum Can Recycling, 1980-2000



Source for employment: Office of Employment and Unemployment Statistics, U.S. Bureau of Labor Statistics, 2001 (URL: http://stats.bls.gov/cpsaatab.htm).

Note: We think that the lack of correlation in the two rates between 1987 and 1989 is due to the implementation of the California bottle bill in September 1987, and the beginning of curbside recycling in some parts of the country.

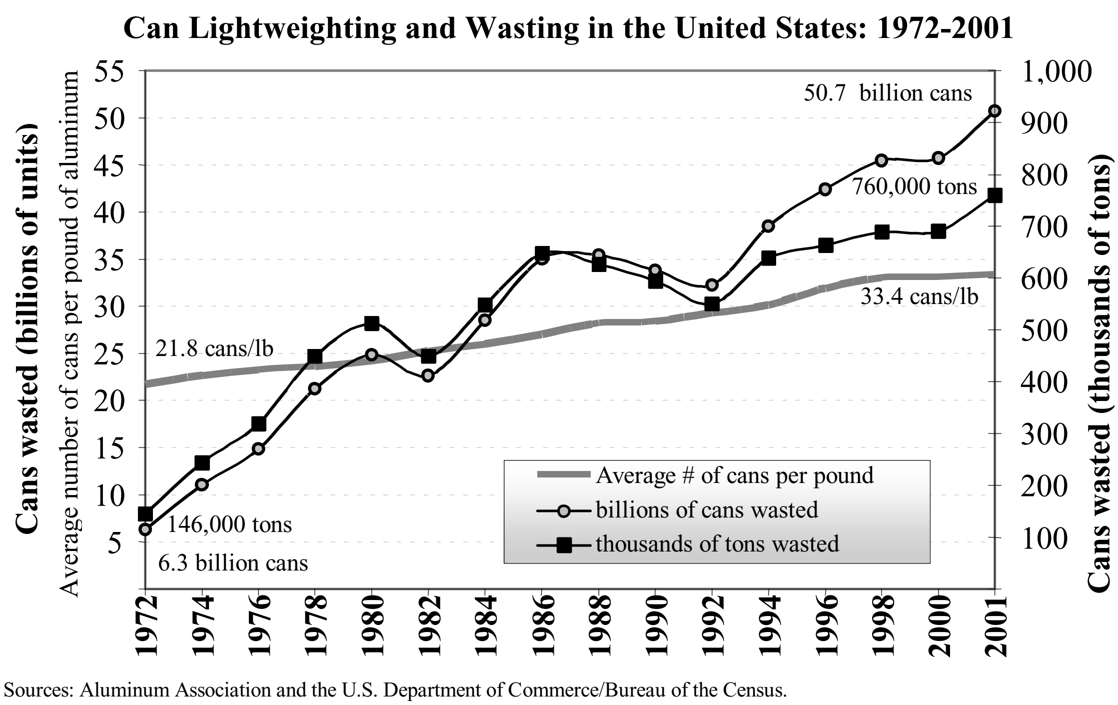
Container Recycling Institute 2002.

Appendix J: The Effects of Lightweighting

In this report, we have alternately used units wasted, expressed in *billions of cans*, and amount wasted by weight, expressed in *thousands of tons*. The aluminum can and beverage industries measure sales and compute the used can recycling rate using the unit measure. The tonnage measure helps assess wasted UBCs' contribution to our nation's landfills, but more importantly, it helps measure the energy and environmental impacts associated with can wasting and replacement production using virgin materials.

By both measures, wasting has increased dramatically in the last three decades. The number of U.S. cans wasted annually grew from 6.3 billion in 1972 to 50.7 billion in 2001: a eightfold increase. During the same period, aluminum can waste went from 146,000 to 760,000 tons per year: more than a fivefold increase. Since 1990, the number of cans wasted annually has grown from 31.5 to 50.7 billion: a 50% increase. By weight since 1990, wasting has grown from 554,000 tons to 760,000 tons: a 28% increase. The discrepancy between these two rates is due to the industry's efforts to "lightweight" cans, that is, to squeeze more cans out of a pound of ingot. By thinning can walls and shrinking lid size, they have reduced average can weight by 15% since 1990, and by a total of 35% since 1972. Had they not done so, the amount wasted today would be hundreds of thousands of tons higher.

The aluminum industry often points to lightweighting to demonstrate their commitment to efficiency and energy responsibility—and they do deserve credit for their efforts. Surely environmental damages would be greater had lightweighting not been pursued. The industry's emphasis on lightweighting and other technical improvements, however, is at odds with the lack of attention they pay to declining UBC recycling rates. Although the savings incurred by lightweighting is important, it does not come close to offsetting the additional wasting resulting from tremendous increases in beverage consumption and decreases in the national recycling rate. The graph below shows that while the number of cans produced per pound of ingot has risen steadily since 1972, the *total quantity* of cans wasted--measured in units *and* by weight--has risen more rapidly.



Sources: Aluminum Association and the U.S. Department of Commerce/Bureau of the Census.

Container Recycling Institute, 2002.

What environmental leaders are saying about

Trashed Cans: The Global Environmental Impacts of Aluminum Can Wasting in America

"This timely and well-written report documents nothing less than a national disgrace with global implications: the squandering of hundreds of thousands of tons of valuable, energy intensive aluminum each year. In this age, when energy security, economic risks, climate change and biodiversity loss are front and center on the international stage, the wasting of over 15 million barrels of oil each year, the avoidable emission of millions of tons of greenhouse gases, and the perpetuation of habitat-destroying bauxite mining—often in some of the world's most ecologically and economically fragile areas—must stop. With eight out of ten Americans supporting recycling as a viable remedy to these abuses, it is outrageous that beverage can vendors and their aluminum suppliers continue to selfishly ignore the devastating ecological burdens and national economic risks their processes and products engender. Decision-makers at every level of government—international, national, state and local—should review this report and take action promptly to compel manufacturers to take responsibility for their impositions and reverse this unacceptable environmental and economic disgrace."

Allen Hershkowitz, PhD, Senior Scientist, Natural Resources Defense Council

"Jenny Gitlitz has been the aluminum industry's most consistent and responsible environmental watchdog for years. Now she and the Container Recycling Institute have documented the unfathomable quantities of this most resource-intensive of minerals going into America's landfills. It's critically important work, and they've done us all a great service."

Alan Thein Durning, Executive Director, Northwest Environment Watch

"This report is an excellent review of the key issues pertaining to aluminum can recycling, reuse, and waste. If applied widely, the proposed solutions would help set this sector on a more sustainable path and bring other parts of our consumer-driven economy along with it."

Anne Platt McGinn, Senior Researcher, The Worldwatch Institute
(Organizaton listed for identification purposes only)

"Who ever said recycling can't save the planet? This report sheds vital light on the global legacy of American consumer culture. From the massive energy waste and global warming pollution to the rampant environmental destruction of mining and hydropower, the innocent looking aluminum can truly leaves a global imprint. The lesson: convenience comes with a price and a responsibility. Now more than ever, recycling mandates for aluminum and other waste should clearly be a part of the national energy policy. What simpler way for every American to contribute to energy savings and energy security."

John Passacantando, Executive Director, Greenpeace USA

"Aluminum cans are easily recycled and the benefits of doing so are numerous and sizeable. In her report, Jennifer Gitlitz documents how poorly Americans are doing: last year we threw away 51 billion cans with the energy equivalent of 16 million barrels of crude oil. The numbers are not only staggering, but leave ample room for Gitlitz's solutions. This is compelling reading."

Thomas Feiler, Managing Director, Rocky Mountain Institute

"This well-researched report provides comprehensive economic and environmental information for decisionmakers and citizens. It lays the foundation for planners to determine more rational use of aluminum resources."

Neil Seldman, President, Institute for Local Self-Reliance

"A revealing and shocking look at how our throw-away culture is harming the planet by wasting aluminum cans. A must-read for anyone interested in protecting rivers and other ecosystems around the world."

Juliette Majot, Executive Director, International Rivers Network

"In just the last ten years, Americans have thrown away--instead of recycling--enough aluminum cans to replace the world's entire commercial aircraft fleet 23 times! We could easily recycle close to 100 percent of our beverage cans; instead, we recycle barely half. And that percentage has been shrinking every year! 'Trashed Cans' makes a powerful case that it is time to re-mobilize Americans on this issue."

Denis Hayes, President and CEO, The Bullitt Foundation, and Chair, Earth Day Network