closing the loop

A GUIDE TO PACKAGING MATERIAL FLOWS AND TERMINOLOGY

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Pollution is nothing but the resources we are not harvesting. We allow them to disperse because we've been ignorant of their value.

R. Buckminster Fuller

A Guide to Packaging Material Flows and Terminology

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Closing the Loop: A Guide to Packaging Material Flows and Terminology

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Introduction

According to the Sustainable Packaging Coalition's Definition of Sustainable Packaging, one of the criteria to achieving sustainable packaging is that materials must be effectively recovered at the end of their useful life, and then re-used in industrial or biological cycles. To make this happen, it is critical to connect packaging design and manufacture with the available end-of-life recovery systems, creating a "closed loop" material system. Often, however, in the United States, the two ends of the packaging supply chain — the packaging designers and the recyclers — do not communicate effectively with each other, materials are sent to landfill, or otherwise wasted, and a closed-loop system is never realized.

One of the barriers to effective communication along the packaging supply chain is the lack of a common lexicon for packaging materials. The same material is often called by different terms during the design, manufacture, use, collection, and reprocessing phases of the package's life cycle.

This absence of commonly understood terminology hinders discussions along the supply chain. For example, it is confusing for municipal managers seeking to communicate to consumers which materials should be placed in their recycling bins, and recyclers are unable to communicate to packaging designers about why a package is not currently recyclable given the constraints of recycling infrastructure. A comprehensive list of packaging material types would help to close this communication gap and allow for more productive discussions along the supply chain.

To help solve this problem, the Guide to Packaging Material Flows and Terminology defines the major packaging materials and introduces the various terms and synonyms that are applied to the materials during the life cycle phases of production, use and collection, and reprocessing. The Guide also presents the current life cycle of each material in graphic form to demonstrate the flow of the packaging material from resource extraction to its eventual fate at end-of-life, highlighting the existing gaps standing in the way of an ideal closed-loop system.

Scope of Guide

The packaging materials profiled in the Guide are aluminum, glass, steel, high-density polyethylene, low-density and linear low-density polyethylene, polyethylene terephthalate, polypropylene, and paper.

The profiled materials were chosen based on both the U.S. production quantity (by weight) of the material used in packaging applications, as well as availability of recovery statistics provided by the U.S. Environmental Protection Agency's *Municipal Solid Waste in the United States: 2007 Facts and Figures* report. (U.S. EPA 2008b). The profiled materials were also selected because they are currently the most commonly recycled materials in that they can be recovered and processed in adequate quantities with reasonable costs, and there are existing end markets for the post-consumer recycled material. As improvements are made toward a comprehensive closed-loop recovery system for packaging in the United States, additional materials currently produced in smaller quantities and/or those not yet collected for recycling or composting may be added to the Guide.

The Guide to Packaging Material Flows and Terminology contains information only about packaging materials produced and recovered in the United States. In the material flow maps, waste generation figures are used as a proxy for production. Both waste generation and recovery figures for packaging materials in municipal solid waste are from 2007. (EPA 2008b)

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Thanks to all of our reviewers and contributors from within the Sustainable Packaging Coalition community and beyond!

How to Use This Document

General Information

The major materials used for packaging each have a dedicated section in the document. Each material is divided further by either color (e.g. clear or green) or application (e.g. bottle or film), depending on which is more appropriate to the material. These divisions are indicated in the key located along the left side of each page. Within each material's section, there are four main features: Material Description, Terminology, Material Flow Maps and Contextual Pie Charts.

Material Flow Maps

The flow maps reflect the current life cycle of materials in the U.S. as informed by 2007 U.S. Environmental Protection Agency statistics. (U.S. EPA 2008b) As per the U.S. EPA MSW Characterization Methodology (U.S. EPA 2008a), the portion of the maps encompassing Sort, Reprocessing, and Other Beneficial Use includes both recyclables sold within the U.S. as well as exported.

Terminology

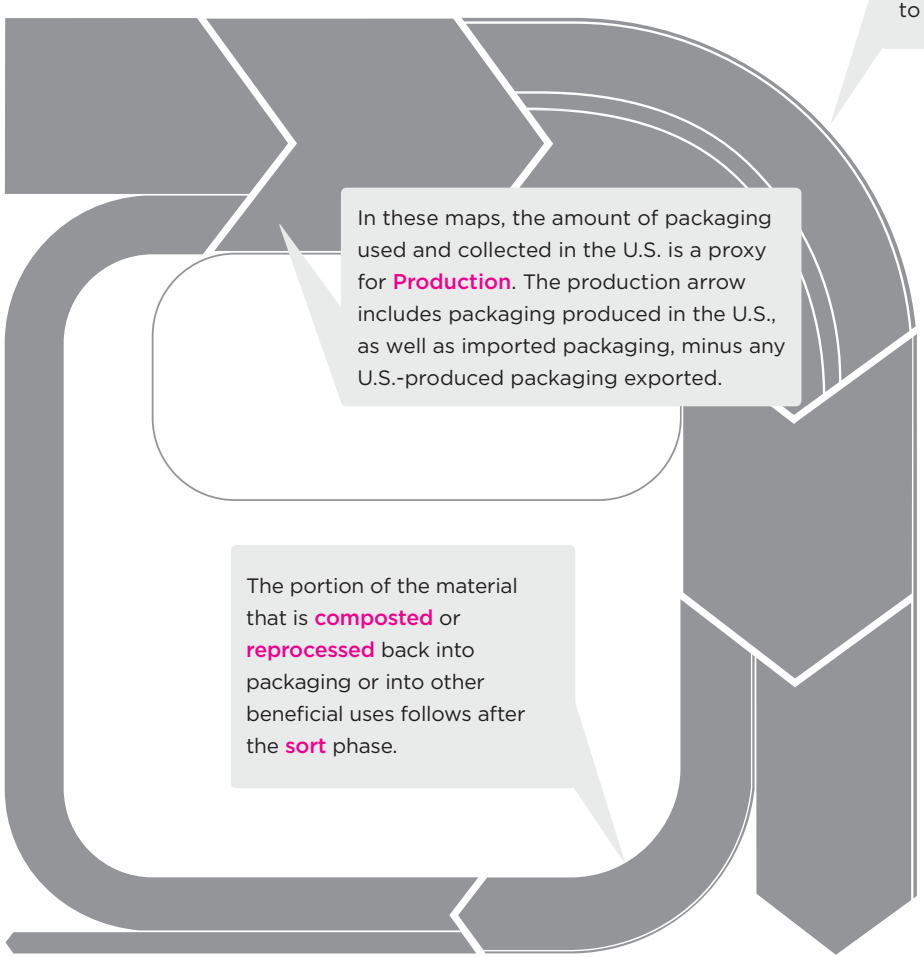
The terminology section is divided into three phases of the material's life cycle: Production, Use and Collection, and Reprocessing. The various terms are listed by phase of the life cycle and are cross-referenced by color or application using the colored boxes from the key.

The distribution of packaging by color or application is reflected in the **Use** phase on the diagram. Packaging designed for **reuse** skips directly from collection back to production

The major raw materials or inputs for virgin production are listed under **Resource Extraction**.

In these maps, the amount of packaging used and collected in the U.S. is a proxy for **Production**. The production arrow includes packaging produced in the U.S., as well as imported packaging, minus any U.S.-produced packaging exported.

The common contaminants introduced during **Collection**, which inhibit **sorting** and **reprocessing**, are listed under **Contaminants**.



The portion of the material that is **composted** or **reprocessed** back into packaging or into other beneficial uses follows after the **sort** phase.

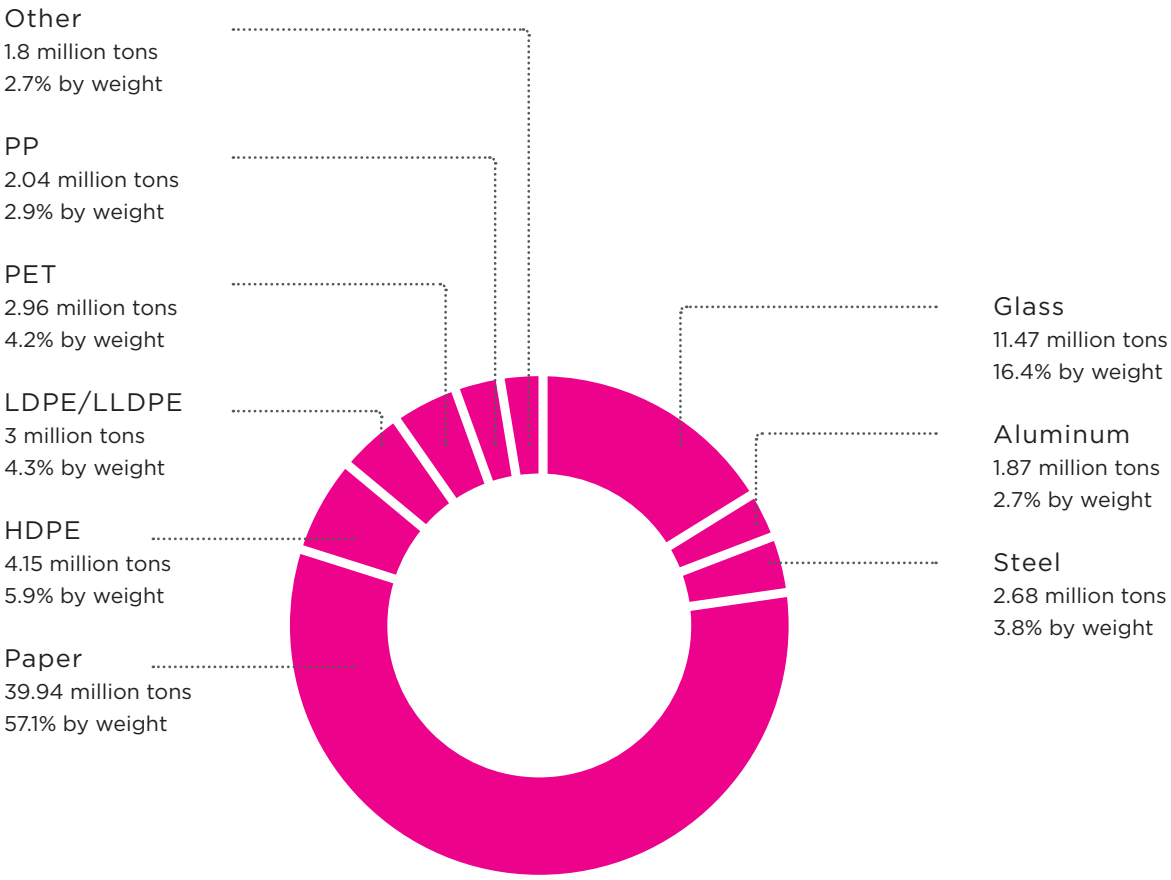
Where a material is not reprocessed back into packaging or reused, the most common **Other Beneficial Uses** for each material are listed on the diagram.

The material that is lost from the system is reflected as **Litter** or **Discard**. Discard includes both landfill and incineration (with or without energy recovery). Because litter is difficult to measure and there are few sources of comprehensive data, this document assigns a small amount of litter equally to each packaging material. The actual amount of litter of any particular material may be more or less than the amount shown in the graphic.

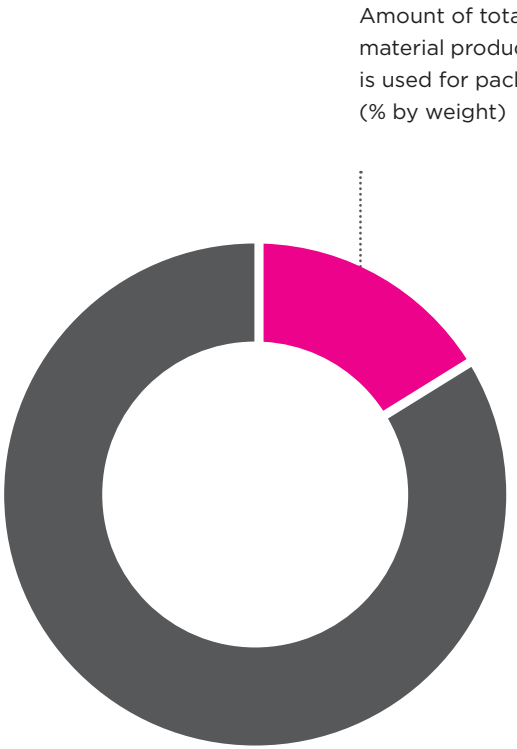
Contextual Pie Charts

Each Material Flow page includes two pie charts. The first pie chart reflects the amount of U.S. packaging made from the material as a percent by weight. The second pie chart reflects packaging as a total amount of the material produced.

The data for each material's pie chart varies by year and source; sources and dates are cited. The production data is also labeled as to its scope, U.S. or North America. This information was included to help the reader put each material into the larger context of both packaging materials and material production in general within the U.S.



Packaging materials, as a percent by weight of all U.S. packaging (U.S. EPA 2008b)



Packaging material, as a percent by weight of all U.S. production of that material (U.S. EPA 2008b) (Sample graphic for illustration purposes)

Aluminum

Key

- Other
- Foil and Closures
- Beverage Containers

Material Description

Aluminum used in packaging is an alloy of aluminum metal and magnesium. The chief primary source of aluminum is bauxite ore, which is refined by the Bayer process to produce alumina. Caustic soda, calcined lime, and pitch are added to the alumina and carbon anodes made from coke convert it to aluminum metal via the Hall-Heroult smelting process. For recycled aluminum, scrap aluminum and hardening agents are also added.

The aluminum alloy serves as the feedstock for casting processes or wrought processing. Wrought processing begins with the casting of an ingot or billet that is then worked to shape via processes such as rolling, extrusion, and forging. The majority of aluminum used in packaging is used as beverage containers. Other applications include foils and components of multi-layer/composite packaging.

Aside from packaging, aluminum is also used in transportation (automobiles, airplanes, trucks, railcars, marine vessels, etc.), construction (windows, doors, siding, etc), consumer durables (appliances, cooking utensils, etc.), electrical transmission lines, machinery, and many other applications.

Aluminum foil is colloquially known as “tin foil” although it contains no tin. While the manufacture of tin foil was supplanted by aluminum foil in the early twentieth century, the name has remained as an artifact in popular usage.

Common Packaging Applications

Beverage cans

Containers

Pouches

Multi-laminate packages

Aseptic packages

Foils

Aluminum aerosol cans

Cosmetics packaging (caps, tubes, fitments)

Aluminum

Key

- Other
- Foil and Closures
- Beverage Containers

Terminology

Production

- Aluminum
- Aluminum can sheet
- Aluminum foil
- Beverage container aluminum
- Can body alloys 3004 and 3104
- Can lid alloy 5182
- Can end
- Aluminum barrier layer
- Barrier layer
- Alloy 9020

Use/Collection

- Aluminum
- Aluminum cans
- Cans
- Used beverage cans (UBC)
- Beverage cans
- Pop cans
- Soda cans
- Beer cans
- Aluminum Foil
- Tin foil
- Pie tins
- Disposable baking pans
- Aerosol cans
- Spray paint cans

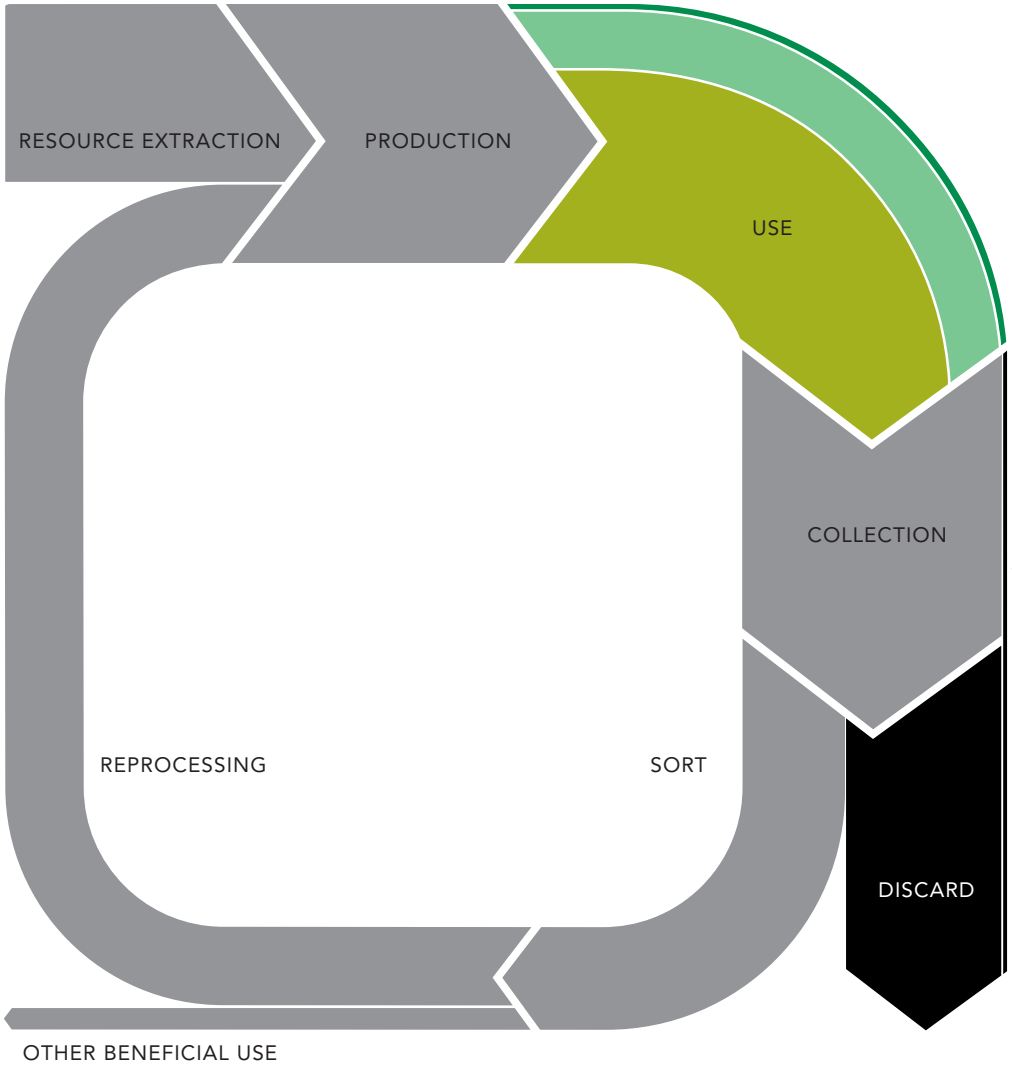
Reprocessing

- Aluminum can scrap
- Used beverage cans (UBC)
- Post-consumer aluminum can scrap
- Shredded aluminum used beverage can scrap
- Densified aluminum used beverage can scrap
- Baled aluminum used beverage can scrap
- Briquetted aluminum used beverage can scrap
- Post-consumer aluminum foil

Material Flow: Aluminum

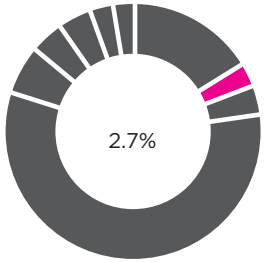
Key

- Other
- Foil and Closures
- Beverage Containers

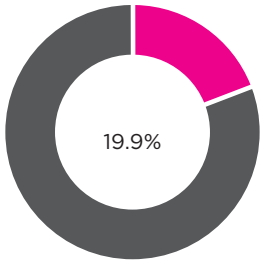


Bauxite ore
Caustic soda
Calcined lime
Cryolite
Carbon anodes

Steel deoxidation
Aluminum castings
Other



Amount of U.S. packaging that is aluminum (% by weight)



Amount of U.S. aluminum production that is packaging, 2007 (% by weight) (The Aluminum Association 2008)

Contaminants

Steel or ferrous metals
Lead and other metals
Mixed aluminum items (e.g. siding, screen doors, bimetal cans)
Excessive food, grease or dirt
Paint cans with dried paint
Household utensils
Wire hangers
Pots and pans
Batteries
Electronics
Plastics
Wood
Glass
Sand

Glass

Key

- Other Glass
- Brown Glass
- Green Glass
- Clear Glass

Material Description

Soda-lime Glass is an inorganic substance created at high temperatures and cooled quickly to solidify it into a non-crystalline condition. It consists of silica sand (silicon dioxide), limestone (calcium carbonate), and soda ash (sodium carbonate), along with a number of other minerals that help in processing, provide clarity and provide color.

Soda-lime glass is the most common glass type for packaging applications and is also called **container glass** or **packaging glass**. The three most popular colors are clear, brown, and green. Because soda-lime glass typically has a slight green color due to impurities in the sand, decolorizing agents such as cobalt oxide and selenium are added to produce a **clear** or **flint** glass. **Brown** or **amber glass** is created by combining sulfur with carbon and iron-containing compounds to create iron polysulfides that provide the amber color, which prevents the transmission of most ultraviolet (UV) light through containers used to house products susceptible to light degradation. **Green glass** is created with the addition of minerals, typically iron chromite, to produce a green color.

Cullet is broken pieces of recovered glass. It is added to the glass furnace as recycled content to create a new batch of glass, reducing the energy load on the process. It is commonly traded on the scrap market as flint, amber or green cullet, when separated by color. Mixed cullet consists of a mix of all the colors and is typically recycled through other beneficial uses like roadbed, concrete, filtration, sandblasting, fiberglass, tile and others.

Glass bottles are unique among beverage containers in the U.S. today in that they may be collected, washed and sterilized, and refilled for **reuse** a number of times before eventually being discarded or recycled.

Common Packaging Applications

Food jars (sauces, condiments, pickles, baby food)

Beverage bottles (milk, soft drinks, beer, wine, liquor, juice, water)

Pharmaceutical containers

Cosmetic containers

Key

- Other Glass
- Brown Glass
- Green Glass
- Clear Glass

Terminology

Production

- Soda-lime glass
- Container glass
- Packaging glass
- Beverage glass
- Clear glass
- Flint glass
- Amber glass
- Brown glass
- Green glass

Use / Collection

- Clear glass
- Clear bottles
- Brown glass
- Brown bottles
- Beer bottles
- Green glass
- Green bottles

Reprocessing

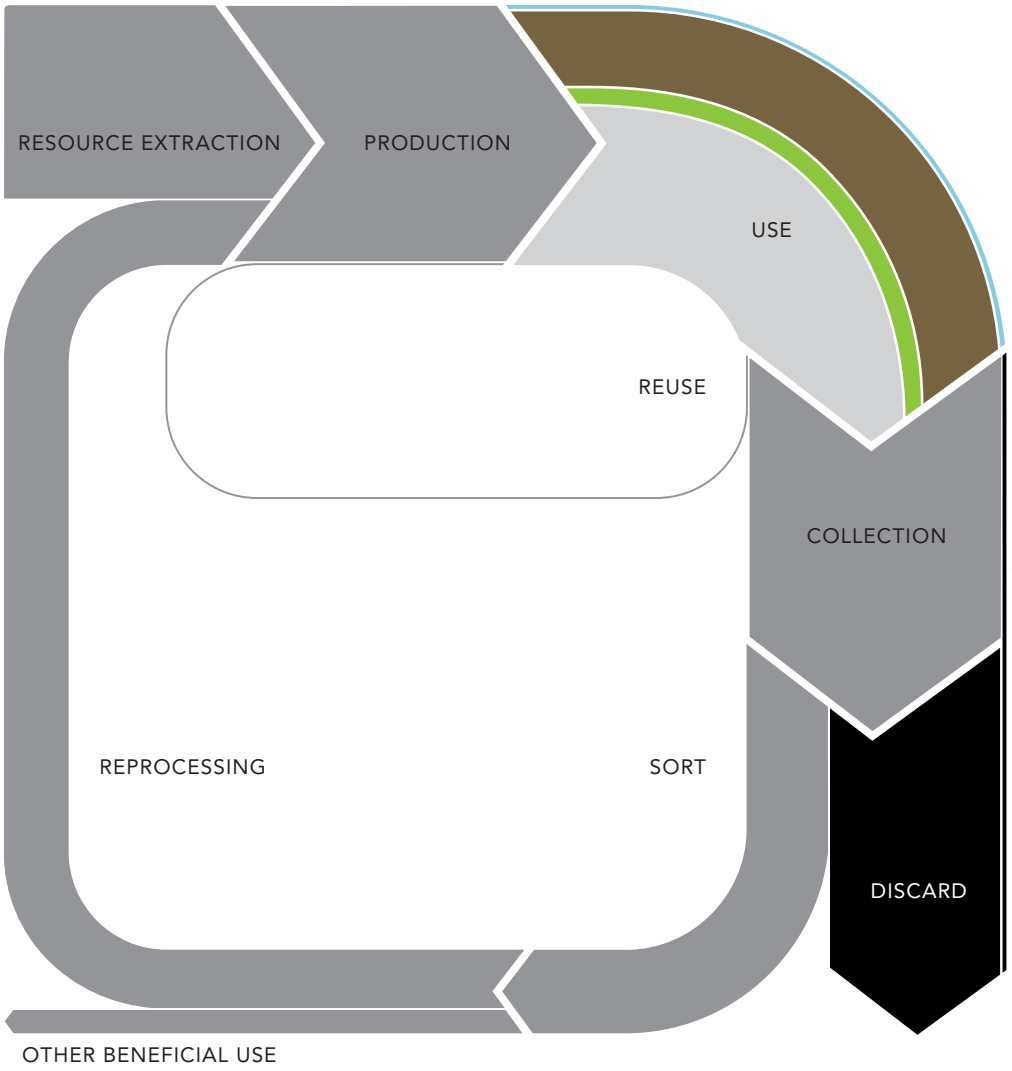
- Flint cullet
- Amber cullet
- Green cullet
- Mixed cullet
- 3-mix cullet
- 2-mix cullet

Material Flow: Glass

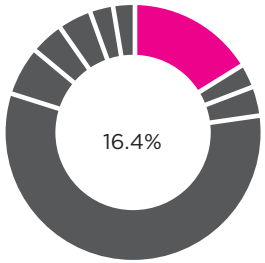
Key

- Other Glass
- Brown Glass
- Green Glass
- Clear Glass

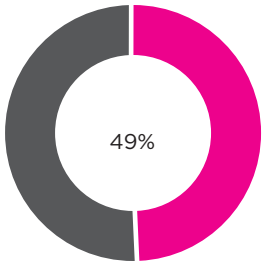
Silica
Limestone
Soda ash
Alumina
Colorants



Roadbed and concrete
Filtration
Sandblasting
Building products (fiberglass, tile, etc.)
Other



Amount of U.S. packaging that is glass (% by weight)



Amount of U.S. glass production that is packaging, 1999 (% by weight) (U.S. DOE 2004)

Contaminants

Lead crystal
Mirrors
Glassware/stemware
Pyrex®
Light bulbs
Window pane or auto glass
Borosilicate glass (laboratory glass)
Non-glass closures
Ceramics
Porcelain
Metal
Rocks
Bricks
Wood
Excessive organics

Steel

Key

Other
Cans

Material Description

Steel is an alloy of iron that contains carbon between 0.2% and 1.7% by weight. It is malleable under suitable conditions and is distinguished from cast iron by its malleability and lower carbon content. It is made from iron ore, coke (made from bituminous coal and limestone), and often recycled steel scrap.

Tinplate steel is steel sheet coated on both sides with a thin layer of tin. In packaging, tinplate steel is used to hold and preserve food and beverages, especially acidic ones, and prevent the steel from coming into contact with the food and corroding. The tin is removable and also recyclable as scrap.

Steel cans may be colloquially known as “tin cans,” although this refers to the tinplate steel used in food and beverage containers. Aside from food cans and containers, steel is used in numerous non-packaging sectors to make cars, trains, appliances, bridges, buildings, surgical instruments, and more.

Because steel is magnetic, it is relatively easy to sort it with a magnet from other recyclables. At a metal scrap yard or drop-off facility, any steel item may be easily sorted and recycled. However, the typical curbside collection process and material recovery facility (MRF) is not equipped to handle non-packaging or hazardous items such as clothes hangers, paint cans, and knives, despite the fact that they may be recyclable. These items are considered contaminants, for example, because hangers snag and bind the conveyor belts and sorting screens, cans with partially dried paint can spill, and aerosol cans can explode if caught in the machinery. One major contaminant to the steel recycling process is radioactive scrap, and scrap dealers and mills have installed radiation detection devices to ensure these contaminants are eliminated before reprocessing.

Common Packaging Applications

Food and beverage cans and containers, sometimes plated with tin or polymers to prevent acidic food from reacting with steel.

Paint cans

Aerosol cans

Other containers (e.g. spices, automobile additives)

Material Flow: Steel

Key

- Other
- Cans

Terminology

Production

- Steel
- Tin plate
- Tinplate steel
- Ferrous metal
- Ferrous steel
- Bimetal cans
- Bimetal

Use / Collection

- Steel
- Steel cans
- Cans
- Tin
- Tin cans
- Metal cans
- Iron
- Metal
- Scrap metal
- Aerosol cans
- Bimetal cans

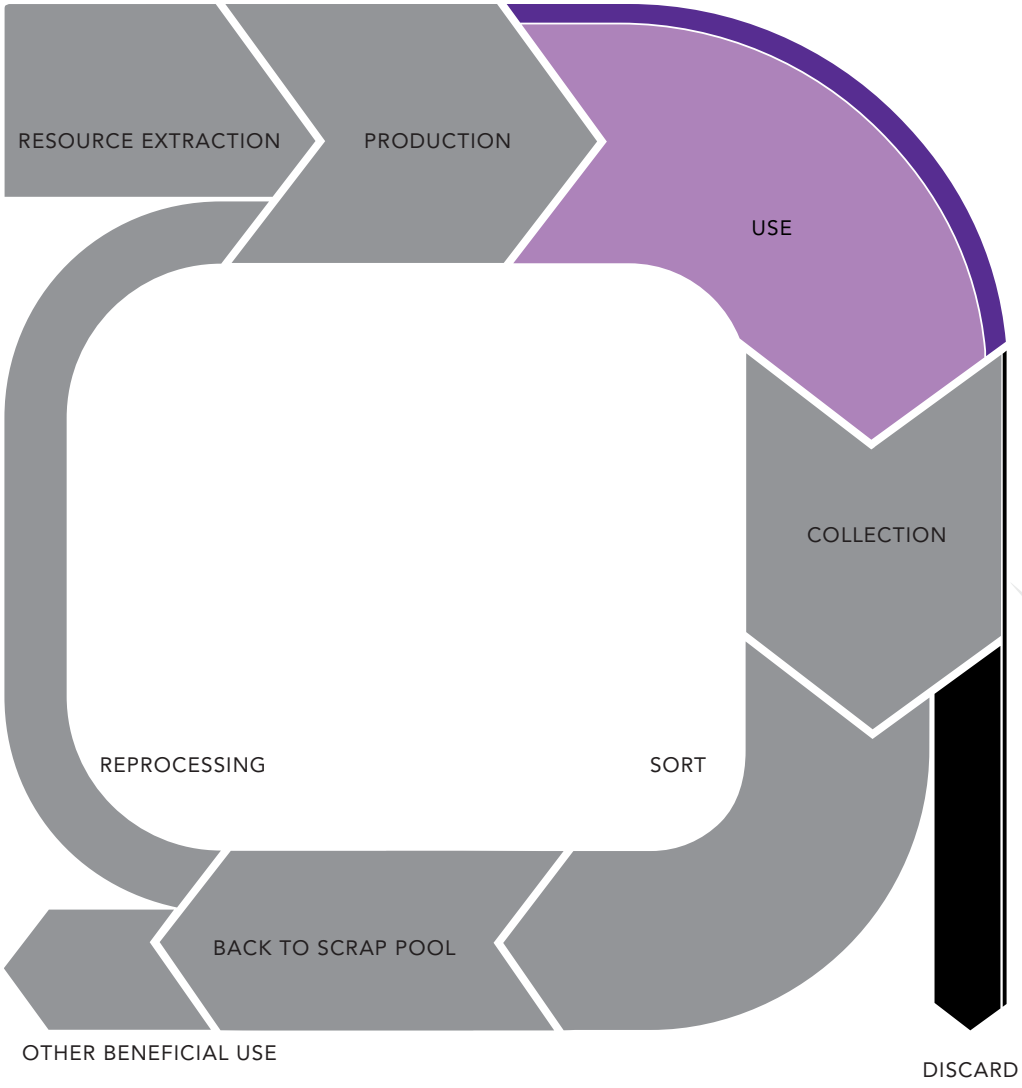
Reprocessing

- Ferrous scrap
- Steel can bundles
- Bimetal cans

Material Flow: Steel

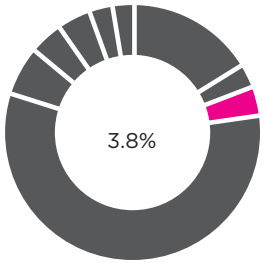
Key

- Other
- Cans

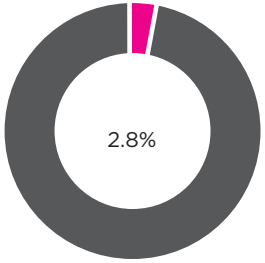


Iron ore
Coal
Limestone
Zinc
Chromium
Tin

Construction
Automotive
Transportation
Appliances
Surgical instruments
Other



Amount of U.S. packaging that is steel (% by weight)



Amount of U.S. steel production that is packaging, 2006 (% by weight) (American Iron and Steel Institute 2006)

Contaminants

Non-ferrous metals
Excessive rust and corrosion
Paint cans
Household knives
Wire hangers
Pots and pans
Batteries
Electronics
All plastics
Wood
Glass
Radioactive material

Polyethylene Terephthalate (PET)

Key

- Bottles
- Other Rigid Containers
- Other Packaging*

Material Description

Polyethylene terephthalate is a polymer in the polyester family made from petroleum and natural gas derivatives (terephthalic acid and ethylene glycol), along with a catalyst, frequently antimony trioxide.

Polyethylene terephthalate is frequently referred to as **PET**, but because PET is a registered trademark of a milk product, it is identified as **PETE** on some packaging. It is also frequently identified and referred to by its SPI resin code **#1**. **rPET** is PET that has been recycled, typically through a mechanical process. **cPET** is crystalline PET, which has been partially crystallized to hold its shape at high temperatures. Because of the crystalline structure, cPET is opaque. Additional types of PET include amorphous PET (aPET), PETG (glycol-modified PET), and GPETG (PETG/aPET/PETG coextrusion).

Some communities collect only plastic bottles, regardless of polymer. Others specify both the polymers and formats to be collected, while some collect all rigid plastic containers. The benefits of an all-bottle collection program include a reduction in consumer confusion about the SPI resin codes #1-7 and a high-quality stream of bottles (most bottles are PET and HDPE) with fewer contaminants. The benefits of an all-rigid-plastic collection system is a reduction in consumer confusion along with the ability to capture other polymer shapes, such as jars, clamshells, tubs, and lids, many of which are recyclable. While these shapes are frequently made with polymers that are compatible with today's recycling technology, some of them are made from different forms or undesirable colors of the same polymer or a look-alike polymer that renders them into contaminants that must be sorted out of the recycling stream. For example, while a frozen food tray and water bottle are both made of PET and bear SPI code #1, the tray is not recyclable with the bottle. PVC is a contaminant for PET reprocessing, and a clamshell made of PVC is extremely hard for sorting and reprocessing personnel to distinguish from one made of PET.

If the material recovery facility (MRF) uses hand-sorters, an all-bottle system makes sorting easier, while automatic optical sorting technology could easily identify all the polymers in an all-rigid-plastic collection. As more MRFs are outfitted with optical sorters to easily identify polymers, additional packaging shapes of PET could be included in collection.

Common Packaging Applications

Bottles (e.g. soft drink, water, liquor, edible oil, condiments)

Food jars (peanut butter, mayonnaise, etc.)

Strapping

Cosmetic jars

Food trays

Clamshells (e.g. take-out food, pre-washed salad, etc.)

Blister packages

Cups

Coatings

Films

*includes coatings, closures, caps, trays, shapes, etc.

Polyethylene Terephthalate (PET)

Key

- Bottles
- Other Rigid Containers
- Other Packaging*

Terminology

Production

- Polyethylene terephthalate
- PET
- cPET (crystalline PET)
- rPET (recycled PET)
- aPET (amorphous PET)
- PETG (glycol-modified PET)
- GPETG (PETG/APET/PETG coextrusion)

Use / Collection

- #1 plastics
- #1
- PET
- PETE
- Plastic #1
- Plastic bottles
- Water bottles
- Soda bottles
- Pop bottles
- Beverage bottles
- Clamshell

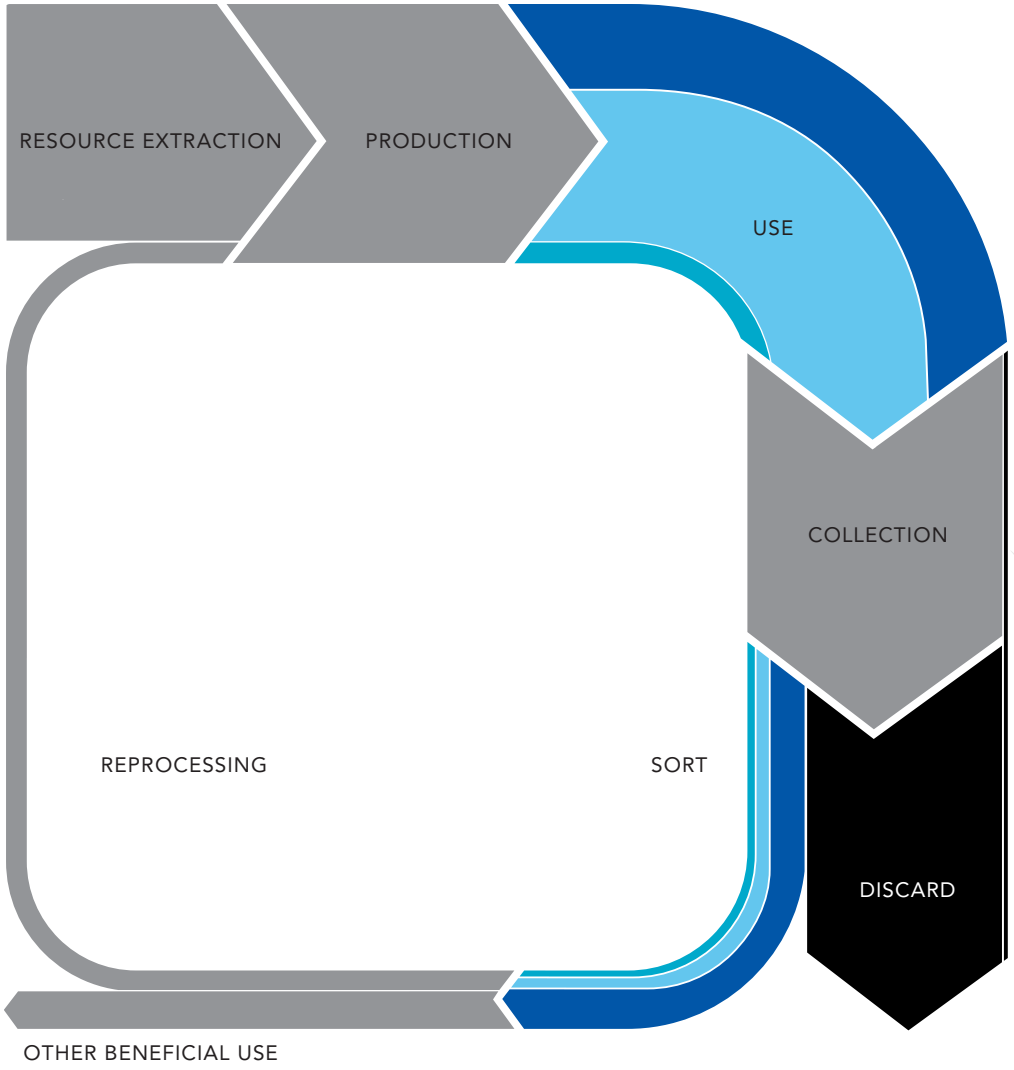
Reprocessing

- PET mixed color bottles
- PET clear beverage containers
- PET green beverage containers
- PET mixed clear and green beverage containers
- PET mixed color bottles and jars
- PET mixed color rigid containers
- Mixed resin mixed color bottles
- Mixed resin pigmented bottles
- rPET

Material Flow: PET

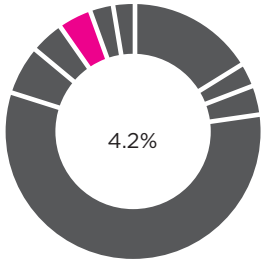
Key

- Bottles
- Other Rigid Containers
- Other Packaging*

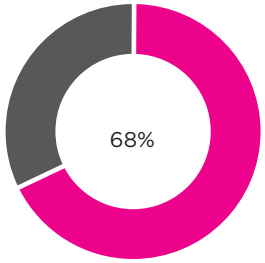


Crude oil
Natural gas
Catalysts
Additives

Carpet and fiber
Sheet and film
Strapping
Clothing and textiles
Other



Amount of U.S. packaging that is PET (% by weight)



Amount of U.S. PET production that is packaging, 2005 (% by weight) (American Chemistry Council 2006, NAPCOR 2005)

Contaminants

Non-PET shrink labels
PVC (e.g., clamshells, blister packs)
PS (e.g., packing peanuts, clamshells)
PLA (e.g., bottles, clamshells)
PET with opaque, translucent, or unusual colors
Copolymers of PET, such as PET-G
Barrier materials, especially ones containing nylon
Oxo-biodegradable polymer formulations
Garden hoses
Video or audio tapes
Metals, including closures or seals
Glass
Wood
Paper and paper labels
Excessive organics

*includes coatings, closures, caps, trays, shapes, etc.

High-density Polyethylene (HDPE)

Key

- Bottles
- Other Packaging*
- Film
- Other Rigid Containers

Material Description

High-density polyethylene is a polymer in the polyolefin family. It is made from a petroleum and natural gas derivative (ethylene) and catalysts. Aluminum trialkyltitanium tetrachloride and chromium oxide are the most common catalysts.

High-density polyethylene is frequently referred to as **HDPE** or "**HD**" and is also denoted by its SPI resin code **#2**. The different types of polyethylenes are distinguished from each other by the degree of molecular linearity or branching and crystallinity within the polymer, which affects their density. HDPE is typically produced in low pressure reactors and has a linear molecular structure with little branching.

In packaging, HDPE colors range from "natural" (a milky white often seen in milk jugs) to special, brand-specific colors (e.g., detergent bottles). Plastics reprocessing companies have begun investing in optical color-sorting technology for recycling, since mixing multiple colors when reprocessing produces black HDPE, which is less desirable for packaging applications.

Some communities collect only plastic bottles, regardless of polymer. Others specify both the polymers and formats to be collected, while some collect all rigid plastic containers. The benefits of an all-bottle collection program include a reduction in consumer confusion about the SPI resin codes #1-7 and a high-quality stream of bottles (most bottles are PET and HDPE) with fewer contaminants. The benefits of an all-rigid-plastic collection system is a reduction in consumer confusion along with the ability to capture other polymer shapes, such as jars, clamshells, tubs, and lids, many of which are recyclable. While these shapes are frequently made with polymers that are compatible with today's recycling technology, some of them are made from different forms or undesirable colors of the same polymer or a look-alike polymer that renders them into contaminants that must be sorted out of the recycling stream. If the material recovery facility (MRF) uses hand-sorters, an all-bottle system makes sorting easier, while automatic optical sorting technology could easily identify all the polymers in an all-rigid-plastic collection.

Common Packaging Applications

Milk, water, and juice jugs

Non-carbonated beverage bottles

Laundry products and other household product bottles

Shampoo bottles

Dairy and deli tubs

Snack food packaging and cereal box liners (in film form)

Grocery sacks and t-shirt bags

Institutional liners

Crates

*includes coatings, closures, caps, trays, shapes, etc.

High-density Polyethylene (HDPE)

Key

- Bottles
- Other Packaging*
- Film
- Other Rigid Containers

Terminology

Production

- High-density Polyethylene
- HDPE
- HD
- PE-HD

Use / Collection

- HDPE
- #2 plastics
- #2
- Plastics #2
- Milk bottles
- Milk jugs
- Detergent bottles
- Detergent containers
- Detergent jugs
- Motor oil containers
- #2 juice bottles
- Laundry product bottles
- Water bottle caps
- Water jugs
- Opaque grocery bags
- Non-stretchy merchandise bags

Reprocessing

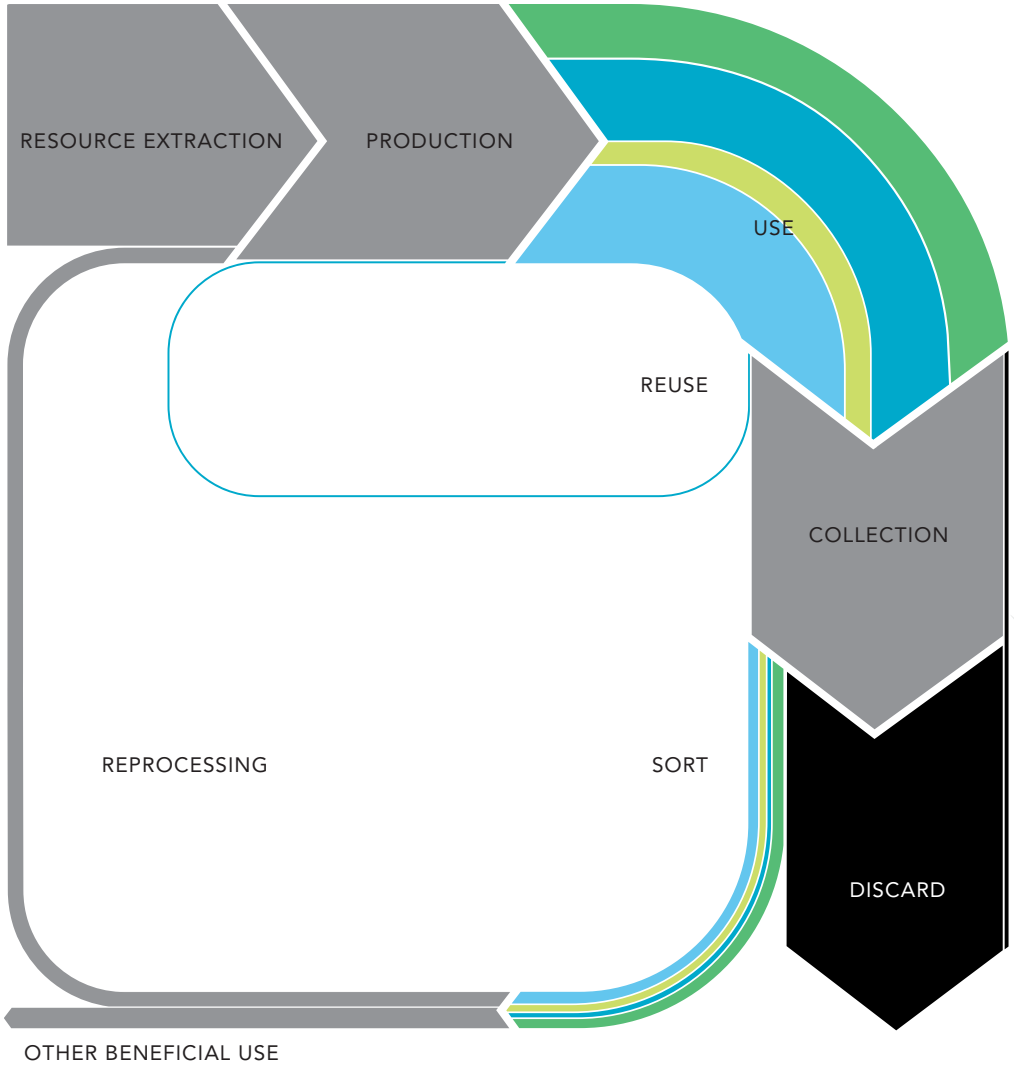
- HDPE mixed color bottles
- HDPE natural bottles
- HDPE pigmented bottles
- Mixed resin mixed color bottles
- Mixed resin natural bottles
- Mixed resin pigmented bottles
- HDPE film, non-stretchy

Material Flow: HDPE

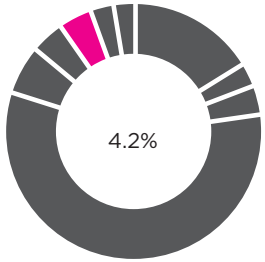
Key

- Bottles
- Other Packaging*
- Film
- Other Rigid Containers

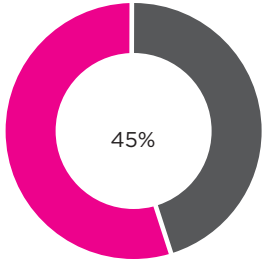
Crude oil
Natural gas
Catalysts
Additives



Pipe
Lawn and garden
Wood plastic composite lumber
Film, bags, and sheet
Automotive
Buckets, crates and pallets
Other



Amount of U.S. packaging that is HDPE (% by weight)



Amount of U.S. and Canada HDPE production that is packaging, 2008 (% by weight)
(ACC Plastics Industry Producers Statistics Group, as compiled by Veris Consulting, LLC 2009)

Contaminants

Non-HDPE plastics
PVC labels
PS (e.g., packing peanuts)
HDPE with calcium carbonate or talc fillers (e.g. pharmaceutical bottles)
Oxo-biodegradable polymer formulations
Garden hoses
Video or audio tapes
Metals, including closures or seals
Glass
Wood
Paper and paper labels
Excessive organics

*includes coatings, closures, caps, trays, shapes, etc.

Low-density Polyethylene (LDPE) / Linear Low-density Polyethylene (LLDPE)

Key

- Film
- Other Containers and Packaging*

Material Description

Low-density polyethylene and linear low-density polyethylene are members of the polyolefin family of plastics. They are made from a petroleum and natural gas derivative (ethylene), along with catalysts (for LLDPE) or peroxide or other initiators (for LDPE).

Low-density polyethylene is frequently referred to as **LDPE**. Linear low-density polyethylene is referred to as **LLDPE** and they are both included in the SPI resin code **#4**. LDPE and LLDPE are distinguished from each other by their type of branching and degree of molecular linearity, which are determined by the polymerization process. LLDPE contains short chain branches of uniform length which result from the incorporation of a comonomer (e.g. butene, hexene, or octene) into the polymer chain. LDPE contains long chain branches of varying length.

Some communities collect only plastic bottles, regardless of polymer. Others specify both the polymers and formats to be collected, while some collect all rigid plastic containers. The benefits of an all-bottle collection program include a reduction in consumer confusion about the SPI resin codes #1-7 and a high-quality stream of bottles (most bottles are PET and HDPE) with fewer contaminants. The benefits of an all-rigid-plastic collection system is a reduction in consumer confusion along with the ability to capture other polymer shapes, such as jars, clamshells, tubs, and lids, many of which are recyclable. While these shapes are frequently made with polymers that are compatible with today's recycling technology, some of them are made from different forms or undesirable colors of the same polymer or a look-alike polymer that renders them into contaminants that must be sorted out of the recycling stream. If the material recovery facility (MRF) uses hand-sorters, an all-bottle system makes sorting easier, while automatic optical sorting technology could easily identify all the polymers in an all-rigid-plastic collection.

LDPE and LLDPE are commonly used as a film for bags or wraps and are typically collected through commercial recycling pick–ups rather than at curbside. LDPE grocery bags are collected from the public in storefront collection boxes, while LLDPE stretch film is used for product distribution and is collected by store employees at the back of the store. Store take-back programs are currently the best collection option for these films, as they present serious operational problems for most material recovery facilities. The bags wrap around and bind the sorting equipment, necessitating frequent work stoppages during which employees must cut and remove the bags from the equipment.

Common Packaging Applications

Bags (grocery, bread, fresh produce, garbage, dry cleaning, newspapers, etc).

Shrink wraps and stretch films

Heat-sealable coatings and films

Squeezable bottles

Food storage containers

Container lids

*includes coatings, closures, caps, trays, shapes, etc.

Low-density Polyethylene (LDPE) / Linear Low-density Polyethylene (LLDPE)

Key

- Film
- Other Containers and Packaging*

Terminology

Production

- Low-density polyethylene
- LDPE
- Linear low-density polyethylene
- LLDPE

Use / Collection

- #4 plastics
- #4
- Plastics #4
- LDPE
- Plastic bags
- Grocery bags
- Shrink wrap
- Film plastics
- Carrier bags
- Plastic sacks
- LLDPE
- Dry-cleaning bags

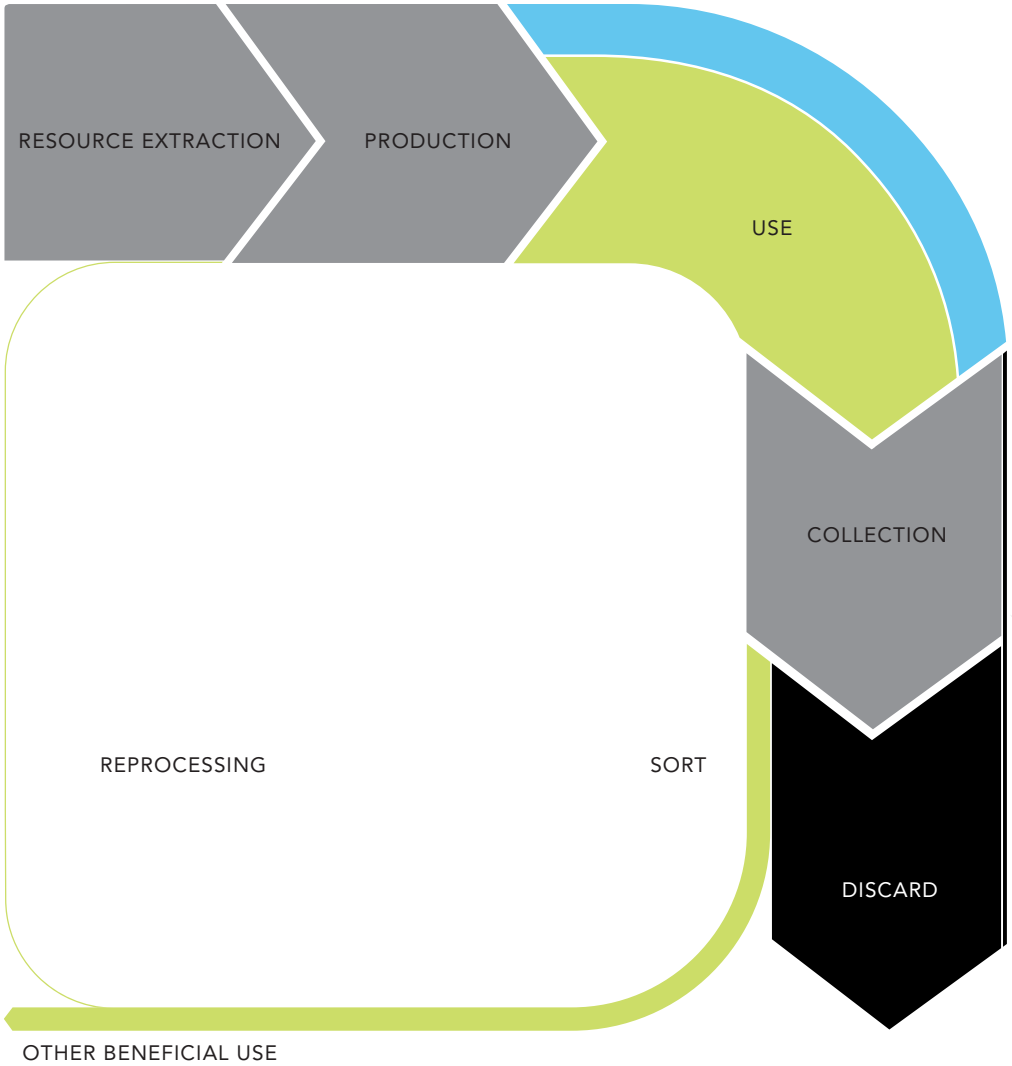
Reprocessing

- LDPE mixed color bottles
- LDPE natural bottles
- LDPE pigmented bottles
- Mixed resin mixed color bottles
- Mixed resin natural bottles
- Mixed resin pigmented bottles
- LLDPE stretch film

Material Flow: LDPE/LLDPE

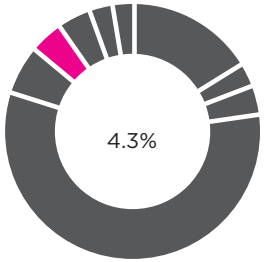
Key

- Film
- Other Containers and Packaging*

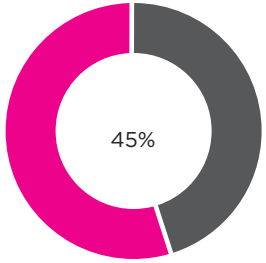


- Natural gas
- Crude oil
- Peroxides
- Additives
- Catalysts

- Shipping envelopes
- Landscape timber
- Wood plastic composite lumber
- Trash and compost bins
- Floor tile, paneling
- Film and sheet
- Grocery sacks
- Bags and liners
- Other



Amount of U.S. packaging that is LDPE/LLDPE (% by weight)



Amount of U.S. and Canada combined LDPE/LLDPE production that is packaging, 2008 (% by weight) (ACC Plastics Industry Producers' Statistics Group, as compiled by Veris Consulting, LLC 2009)

Contaminants

- Non-LDPE plastics
- PVC films
- PS (e.g., packing peanuts)
- Oxo-biodegradable polymer formulations
- Non-PE films
- Video or audio tapes
- Metals, including closures or seals
- Glass
- Wood
- Excessive dirt, moisture, or food
- Paper

*includes coatings, closures, caps, trays, shapes, etc.

Polyproplylene (PP)

Key

- Rigid Containers
- Film
- Other Packaging*

Material Description

Polypropylene is a member of the polyolefin family of plastics. It is made from a petroleum and natural gas derivative (propylene), along with a catalyst (Ziegler-Natta catalyst). Polypropylene is frequently referred to as **PP** and is also denoted by its SPI resin code **#5**. PP is used for both rigid and film applications of packaging.

Some communities collect only plastic bottles, regardless of polymer. Others specify both the polymers and formats to be collected, while some collect all rigid plastic containers. The benefits of an all-bottle collection program include a reduction in consumer confusion about the SPI resin codes #1-7 and a high-quality stream of bottles (most bottles are PET and HDPE) with fewer contaminants. The benefits of an all-rigid-plastic collection system is a reduction in consumer confusion along with the ability to capture other polymer shapes, such as jars, clamshells, tubs, and lids, many of which are recyclable. While these shapes are frequently made with polymers that are compatible with today's recycling technology, some of them are made from different forms or undesirable colors of the same polymer or a look-alike polymer that renders them into contaminants that must be sorted out of the recycling stream. If the material recovery facility (MRF) uses hand-sorters, an all-bottle system makes sorting easier, while automatic optical sorting technology could easily identify all the polymers in an all-rigid-plastic collection.

Common Packaging Applications

- Bottle caps
- Juice bottles
- Yogurt cups
- Drink cups
- Potato chip bags
- Cosmetic jars
- Margarine and other dairy tubs
- Takeout containers
- Medicine bottles
- Drinking straws
- Wrapping films and layers in snack food wrappers
- Labels
- Auto battery housings
- Pallets

*includes coatings, closures, caps, trays, shapes, etc.

Polyproplylene (PP)

Key

- Rigid Containers
- Film
- Other Packaging*

Terminology

Production

- Polypropylene
- PP

Use / Collection

- #5 plastic
- PP
- Polypropylene
- Bottle caps
- Plastic caps
- Yogurt cups
- Margarine tubs
- Bottles
- Pouring spouts on bottles

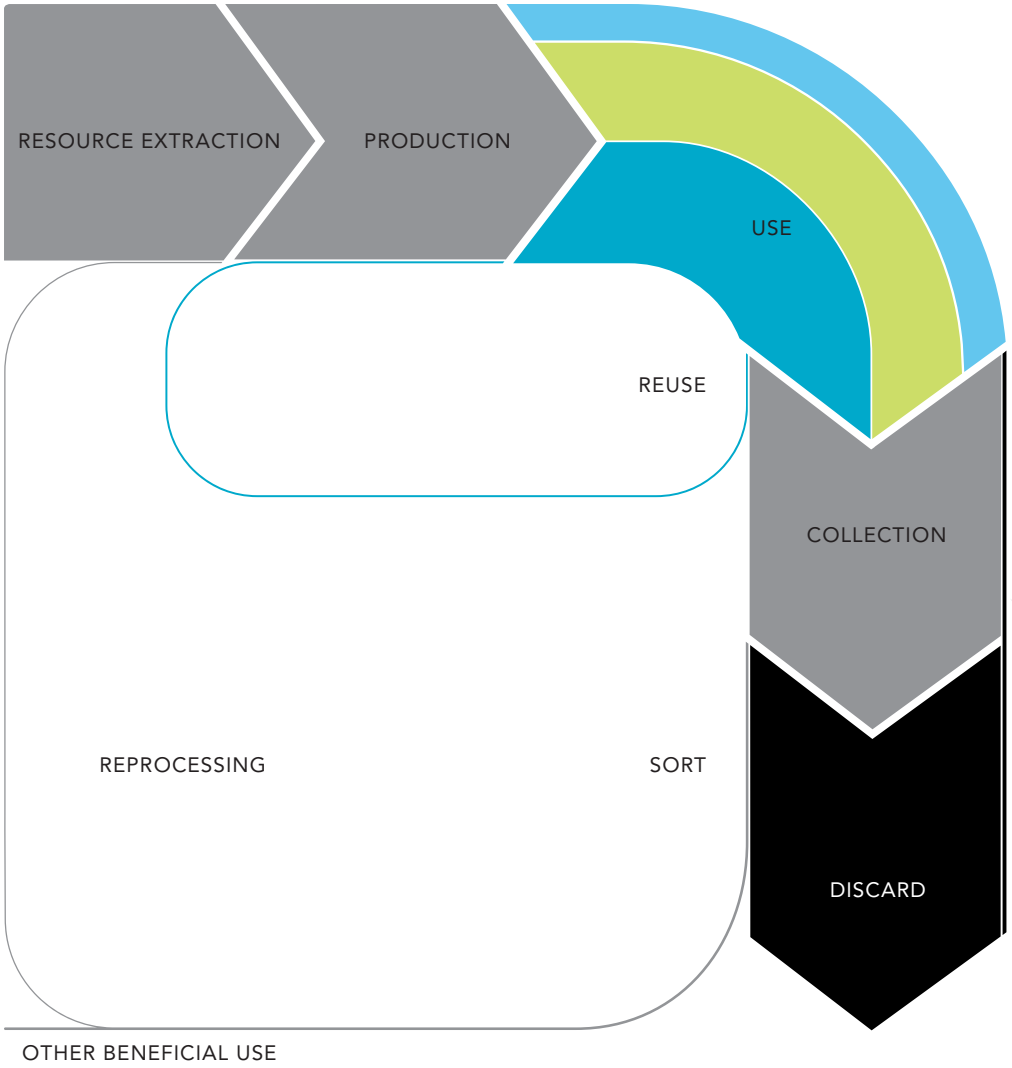
Reprocessing

- PP mixed color bottles
- PP natural bottles
- PP pigmented bottles
- Mixed resin mixed color bottles
- Mixed resin natural bottles
- Mixed resin pigmented bottles

Material Flow: PP

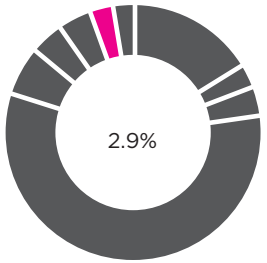
Key

- Rigid Containers
- Film
- Other Packaging*

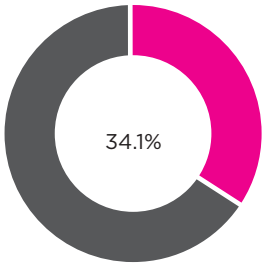


Natural gas
Crude oil
Catalysts
Additives

Automotive (battery cases, signal lights, cables, ice scrapers, etc)
Garden tools, storage bins
Pallets, sheets, trays
Other



Amount of U.S. packaging that is polypropylene (% by weight)



Amount of NAFTA PP production that is packaging, 2008 (% by weight) (ACC Plastics Industry Producers' Statistics Group, as compiled by Veris Consulting, LLC 2009)

Contaminants

Non-PP plastics
PVC labels
PS (e.g., packing peanuts)
HDPE / LDPE water bottle caps
Metals, including closures or seals
Oxo-biodegradable polymer formulations
Garden hoses
Video or audio tapes
Glass
Wood
Paper and paper labels

*includes coatings, closures, caps, trays, shapes, etc.

Key

- Corrugated
- Boxboard & Cartons
- Other Paper Packaging

Material Description

Paper is a cellulose-based material most often made from hardwood and softwood wood chips, recycled paper, water, starches and sizing. Paper packaging can also be made from other fiber resources such as hemp, kenaf, palm, and bagasse (sugar cane), but currently these alternative sources represent a small niche market. Once processed into paper, however, these fibers can be included in the recycling system with wood fiber paper.

The wood chips can be pulped chemically or mechanically. In **mechanical pulping**, the wood fibers are broken down using mechanical separation to produce a pulp called **groundwood**, used to make newsprint and other lower quality papers. This process does not eliminate lignin, the "glue" that keeps the cellulose fibers together and what causes newsprint to yellow after exposure to the sun. **Chemical pulping** uses heat and chemicals to separate the lignin from the fibers. The most common chemical processes are alkali sulfite and alkali sulfate; **sulfate** (known as the "**kraft**" process) produces the strongest fibers. Natural pulps range from a light to medium brown color, but the pulp may be bleached with chlorine or hydrogen peroxide to whiten it.

Paper can be coated with natural or synthetic materials, such as waxes, foils, UV-activated varnishes, or polymers. It is typically printed with various inks using one of three different methods: flexography, used for printing on corrugated and kraft linerboard; lithography, used for printing folding carton stock and labels; and rotogravure, used for labels, wraps, and cartons.

There are two main types of paper used for packaging: **paperboard** and **sheet**.
Paperboard is a heavy, thick paper grade used as the base material for many packaging applications. Paperboard is generally classified into two categories:

1) **Containerboard** grade, primarily used for making **corrugated** boxes used as shippers or transport containers. **Corrugated containerboard** (synonym: **fiberboard**) is an assembly of various layers of **kraft paper** in which **linerboard** surrounds a **fluted medium**. Corrugated is often incorrectly called **cardboard** by the general public, such as "cardboard box." Common packaging applications for containerboard include shipping boxes and cartons, pizza boxes, pallets, and edge protectors.
2) **Boxboard** grade, which is used primarily for making folding cartons. In the folding carton industry the term **paperboard** is used interchangeably with the terms **board** or **folding boxboard**. Folding boxboard is paperboard suitable for conversion by folding into cartons. Other synonyms: **folding carton**, **cartonboard**, **boxboard**. Common packaging applications for boxboard include folding cartons (such as cereal boxes), set up boxes, beverage carriers, milk and juice cartons, and food service ware.

Sheet paper is also used for packaging. Sheet includes bleached and unbleached kraft paper. Common packaging applications include grocery and lunch bags, multi-walled bags for pet food or cement, labels, food wraps, or the billboard print material inside of a plastic clamshell.

All types of paper may be repulped together to produce recycled-content paper, although each grade of paper is frequently recycled back into that same grade (e.g. corrugated to corrugated) to more easily get the desired qualities of that grade. Because recycled paper fibers break down eventually, virgin fiber must always be added to the system. Paper recyclers maximize the fiber they can recover during the repulping process, but many treatments (e.g. wet strength additives), coatings (e.g. wax, polymers), laminate layers (e.g. foils, polymers) or components (e.g. plastic windows, staples) are all considered contaminants and reduce the amount of fiber that is easily recovered.

Aside from recycling, an additional beneficial use for paper is composting. Industrial composting is a promising future option for the beneficial recovery of food service paper packaging, in particular, because food scraps, liquid, or grease present no problems for composting. Unlike paper recycling systems, composting operations will accept wax-coated paper, although they refuse any paper with plastic or foil coatings.

Common Packaging Applications

- Aseptic packages (e.g. shelf-stable milk)
- Bags and sacks
- Beverage carriers
- Boxes, cartons, cores, tubes, and rolls
- Composite packages (e.g. paper can with metal ends)
- Food service packaging
- Juice boxes
- Labels
- Milk and juice cartons
- Pallets and edge protectors
- Pizza boxes, take-out food containers
- Trays
- Set-up boxes

Key

- Corrugated
- Boxboard & Cartons
- Other Paper Packaging

Terminology

Production

- Bending chipboard (BC)
- Boxboard
- Cardboard
- Carrier board
- Chipboard
- Clay-coated board
- Clay-coated kraftback (CCKB)
- Clay-coated newsback (CCNB)
- Clay-coated newsboard (CCNB)
- Coated one/two sides (C1S/C2S)
- Clay natural kraft (CNK)
- Coated freesheet
- Coated recycled board (CRB)
- Coated recycled paper board (CRP)
- Coated unbleached kraft (CUK)
- Containerboard
- Corrugated
- Corrugated cardboard
- Double kraft lined bending chipboard
- Folding carton
- Food board
- Freesheet
- Frozen-food board
- Greaseproof board
- Kraft
- Kraft board
- Kraft paper
- Light-weight coated sheet (LWC)
- Lined board
- Linerboard
- Liquid packaging board
- Medium
- Ovenable board
- Paperboard
- Recycled fiber paperboard (RFP)
- Recycled paperboard
- Solid bleached sulfate (SBS)
- Solid unbleached sulfate (SUS)
- Supercalendered paper (SC)

Production

- Test liner
- Unbleached board
- Uncoated board
- Uncoated freesheet
- Uncoated recycled paperboard (URP)
- White top liner

Use / Collection

- Aseptic containers
- Beverage carriers
- Boxes
- Brown board
- Brown paper
- Brown paper bags
- Cardboard
- Cardboard boxes
- Cereal boxes
- Cereal cartons
- Chip board
- Corrugated
- Corrugated boxes
- Grocery bags and sacks
- Juice boxes and cartons
- Lunch bags
- Milk cartons
- Mixed paper
- Moving boxes
- Multi-wall bags
- Paper
- Paper bags and sacks
- Paper board

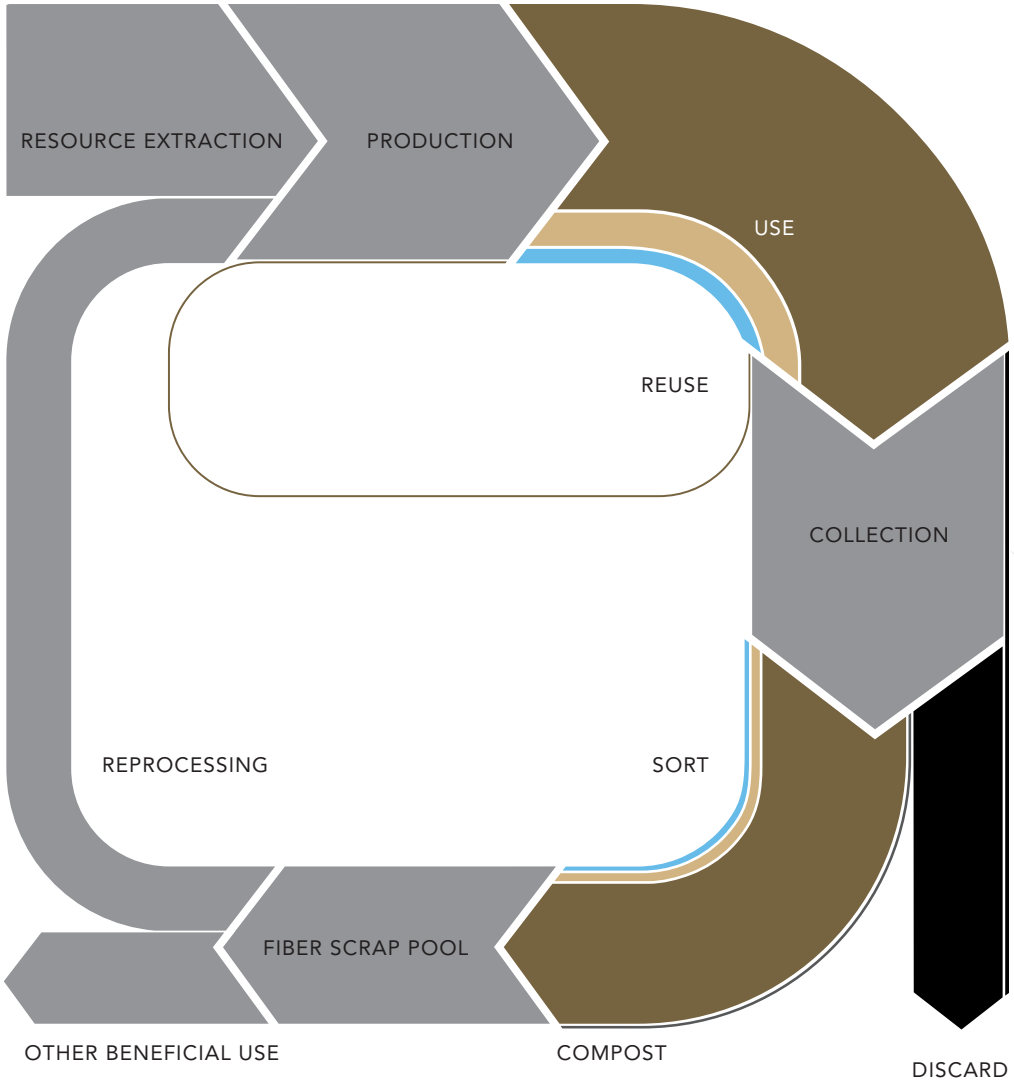
Reprocessing

- Beer carton stock
- Hard mixed paper
- OCC - old corrugated containers
- Plastic coated cups
- Polycoated bleached kraft
- Polycoated milk carton stock
- Residential mixed paper
- Soft mixed paper
- SOP - sorted office paper
- UOP - unsorted office paper
- Used brown kraft

Material Flow: Paper

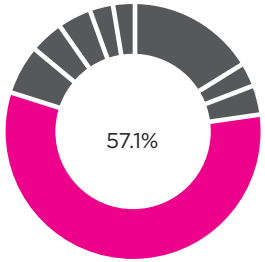
Key

- Corrugated
- Boxboard & Cartons
- Other Paper Packaging

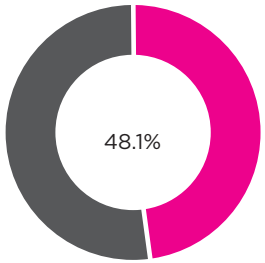


Wood chips
Sawmill residues
Water
Chemicals: Caustic soda, bleaching agents, sizing, starch, pigments.

Newspaper
Magazines
Writing paper
Books
Towel and tissue
Food service ware
Molded pulp



Amount of U.S. packaging that is paper (% by weight)



Amount of U.S. paper generated as municipal solid waste (as a proxy for production) that is packaging, 2007 (% by weight) (U.S. EPA 2008b)

Contaminants

Wax coatings
Hot-melt adhesives
Wet strength resins
Ultraviolet-cured inks and coatings
Brightly colored, fluorescent, or dye-saturated paper
Sanitary products or tissues
Thermal fax paper
Carbon paper
Books, stickers, tape
Double-walled bags with wet strength or plastic (e.g. cement, pet food)
Excessive food contamination
Plastics (e.g. bottles, strapping, films, expanded polystyrene)
Metals and foils, glass, dirt and sand
Radio frequency identification tags
Cloth, rags, and rope

Common Terms

Collection is defined, for the purpose of this Guide, as the collection of packaging materials in recycling drop-off or curbside collection systems.

Compost is defined, for the purpose of this Guide, as the managed process that controls the biological decomposition and transformation of biodegradable materials into a humus-like substance called compost, carbon dioxide, water, and minerals.

Contaminants are defined, for the purposes of this Guide, as the major contaminants to a packaging material that are introduced during collection and which inhibit that material's sorting and reprocessing. While some contaminants are discarded, many are recyclable and simply present a problem when co-mingled with another material.

Discard is defined, for the purpose of this Guide, as packaging materials that are thrown away by consumers as municipal solid waste, disposed of in a landfill, and assumed to be a loss of embodied energy and resources from the packaging material system.

Litter is defined, for the purposes of this Guide, as the portion of solid waste carelessly discarded outside the regular garbage and trash collection and disposal system.

Material recovery facilities (MRFs) are processing facilities that sort recyclables by material type and remove contamination. A MRF may use a range of technologies, including manual sorting, as well as magnets, eddy currents, screens and trommels, air knives, belts, balers, and optical and infrared sensors.

Other Beneficial Use is defined, for the purpose of this Guide, as open loop recycling: the reprocessing of collected post-consumer packaging materials into non-packaging applications.

Packaging refers to all products used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer.

Post-consumer material Post-consumer material is material or finished products that have served their intended use and have been diverted or recovered from waste destined for disposal, having completed their lives as consumer items. Post-consumer materials are part of the broader category of recovered materials.

Production is defined, for the purpose of this Guide, as the manufacture of packaging materials from extracted resources and their conversion into packaging.

Recovered Materials Recovered materials are defined as waste materials and byproducts that have been diverted from landfilling, but do not include materials and byproducts generated from and commonly reused within an original manufacturing process.

Recycling is defined, for the purposes of this Guide, as the minimization of waste through the recovery and reprocessing of usable products that might otherwise become waste and be discarded.

Reprocessing is defined, for the purpose of this Guide, as closed loop recycling: the portion of a packaging material's life cycle after post-consumer recovery when it is recycled back into the packaging material's production process.

Resource extraction is defined, for the purpose of this Guide, as the extraction of both renewable and non-renewable natural resources (such as timber, minerals, natural gas, crude oil, water, etc.) for use in the production of packaging materials.

Reuse is defined, for the purposes of this Guide, as the ability of a package to be collected after use and continue to deliver the same packaging function repeatedly without the need to be reprocessed, as with refillable glass bottles or reusable crates and pallets.

Sort is defined, for the purpose of this Guide, as the separation of packaging materials, for the purpose of recycling, from non-recyclable waste, other recyclable packaging materials, and often by color, shape, or application.

Use is defined, for the purpose of this Guide, as the portion of a packaging material's life cycle between the application of the packaging and the purchase and use of the product.

Aluminum

Aluminum used in packaging is an alloy of aluminum metal and magnesium. The chief source of aluminum is bauxite ore, which is refined by the Bayer process to produce alumina. Caustic soda, calcined lime and pitch are added to the alumina and carbon anodes made from coke convert it to aluminum metal via the Hall-Heroult smelting process. For recycled aluminum, scrap aluminum and hardening agents are also added.

Baled aluminum used beverage can scrap refers to the ISRI specification (Taldon) for bales of a specified density, shape, and size of used beverage cans.

Bimetal cans are cans made with two different types of metal. This term historically has referred to a steel can with a tin coating but more recently encompasses steel cans with aluminum pull-tops. Bimetal cans are sorted with steel due to the magnetic quality of their steel component.

Briqueted aluminum used beverage can scrap refers to the ISRI specification (Taldork) for briquettes of a specified density, shape, and size of used beverage cans.

Densified aluminum used beverage can scrap refers to the ISRI specification (Taldack) for densified bundles of a specified density, shape, and size of used beverage cans.

Post-consumer aluminum foil is the ISRI specification (Tesla) for baled old household aluminum foil and formed foil containers of uncoated 1000, 3000 and 8000 series aluminum alloy.

Post-consumer aluminum can scrap is the ISRI specification (Talc) for old aluminum food and/or beverage cans.

Shredded aluminum used beverage can scrap is the ISRI specification (Talcred) for shredded used beverage cans.

UBC is the abbreviation for used beverage can.

Steel

Incinerator bundles (ISRI scrap code 215) refers to tin can scrap, compressed to charging box size and weighing not less than 75 pounds per cubic foot.

Steel is an alloy of iron that contains carbon between 0.2% and 1.7% by weight. It is malleable under suitable conditions and is distinguished from cast iron by its malleability and lower carbon content. It is made from iron ore, coke (made from bituminous coal and limestone), and often recycled steel scrap.

Steel can bundles (ISRI scrap code 213) refers to steel can scrap compressed to charging box size and weighing not less than 75 pounds per cubic foot.

Tin cans is a colloquial term for steel cans, although this refers to the tinplate steel used in food and beverage containers.

Tinplate steel is steel sheet coated on both sides with a thin layer of tin.

Glass

2-mix cullet is a term used to refer to shipments of mixed color cullet, typically a mix of green and brown cullet.

3-mix cullet is a term used to refer to shipments of mixed color cullet, denoting a mix of flint, green, and brown cullet.

Beneficiation, as used in the glass industry, is a part of reprocessing where the glass cullet is made furnace-ready by crushing, sizing and further removal of contaminants.

Brown or **amber glass** is soda-lime glass created by combining sulfur with carbon and iron-containing compounds to create iron polysulfides that provide the amber color, which prevents the transmission of most ultraviolet (UV) light through containers used to house products susceptible to light degradation.

Clear or **flint glass** is colorless, transparent soda-lime glass.

Cullet is crushed or whole pieces of recovered soda-lime container glass that are crushed and sized to manufacturer specifications.

Fines is a term used by glass processors for small glass pieces (usually less than 1/4 inch) that may or may not get recovered due to their size.

Green glass is soda-lime glass created with the addition of minerals, typically iron chromite, to produce a green color.

Processed (Furnace Ready) container glass cullet is crushed and whole contaminate-free scrap container glass that complies with the proper ISRI glass specifications, as follow: Various sizes from whole glass containers to -100 Mesh. However, the ideal material size is 3/8" to 3/4" with a 10% minimum of fine particles. Material size is based upon buyer and seller's agreement. *Outthrow Materials:* Organic Matter, allowable percentage based upon buyer and seller's agreement. *Prohibitive Materials:* ferrous metals, nonferrous metals, ceramics (such as cups, saucers, dinnerware, pottery, etc.), other glass (for example, plate window glass, heat-resistant glass—such as Pyrex—and lead-based glass—such as crystal ware, television tubes, vision ware, etc.), and other materials (such as bricks, rocks, etc.). ISRI publishes individual specifications for flint, amber, and green processed (furnace ready) container glass cullet.

Soda-lime glass is an inorganic substance created at high temperatures and cooled quickly to solidify it into a non-crystalline condition. It consists of silica sand (silicon dioxide), limestone (calcium carbonate), and soda ash (sodium carbonate), along with a number of other minerals that help in processing, provide clarity and provide color.

Unprocessed container glass cullet is broken or whole scrap glass containers that comply with the proper ISRI glass specifications, as follow: Cullet may be broken but not pulverized. Cullet should be free of excess moisture. *Outthrow Materials:* Normal container labels; ring and metal closures where processing capabilities permit. *Prohibitive Materials:* Non-acceptable items include non-container glass (vision ware, light bulbs, crystal, windows, mirrors, drinking glasses, ceramic, milk glass, etc.), metals, ores, minerals, bricks, clay, grinding and refractory materials, rocks, clay and ceramic closures. The quality of the unprocessed container glass cullet must be such that after beneficiation with a conventional container glass cullet processor it will be suitable for the production of glass containers. ISRI publishes individual specifications for flint, amber, and green unprocessed container glass cullet.

Polymers

aPET is amorphous PET, which has been cooled rapidly to prevent crystallization. It is clear in color, and is used for applications such as salad bar or take-out trays and clamshells.

Clamshell is a type of package made in the shape of two hinged shells or blister bubbles, hence the name clamshell. Clamshells are typically made out of a clear plastic for product visibility and may be reclosable.

Code #7 is a "catch-all" resin identification code created by the Society of Plastics Industry (SPI) to include any package made from a polymer that does not fall under SPI resin codes #1-6 (PET, HDPE, PVC, LDPE/LLDPE, PP, PS) or a package made of multiple polymers in a multi-layer construction. It currently includes all bio-based polymers, such as PLA. Code #7 is also referred to as "other" plastics.

Code #7 / other mixed color bottles refers to the baled recycled plastic standard (ISRI P-700) that specifies natural and pigmented bottles of any resin included under SPI resin code #7.

Code #7 / other natural bottles refers to the baled recycled plastic standard (ISRI P-701) that specifies only natural bottles of any resin included under SPI resin code #7.

Code #7 / other pigmented bottles refers to the baled recycled plastic standard (ISRI P-702) that specifies only pigmented bottles of any resin included under SPI resin code #7.

cPET is crystalline polyethylene terephthalate, frequently used in microwavable and ovenable food trays.

GPETG is a PETG/APET/PETG co-extruded film. It is used for rigid film items such as packaging for medical instruments and medical trays. It is also called GAG-PET in reference to its three layers.

HDPE is the abbreviation for high-density polyethylene.

HDPE mixed color bottles refers to the baled recycled plastic standard (ISRI P-200) that specifies only mixed household HDPE bottles (detergent, shampoo, household products, milk, etc.).

HDPE natural bottles refers to the baled recycled plastic standard (ISRI P-201) that specifies only milk, water, and juice (quart, 1/2 gallon, and 1 gallon bottles) bottles.

HDPE pigmented bottles refers to the baled recycled plastic standard (ISRI P-202) that specifies only mixed pigmented household HDPE bottles (detergent, shampoo, household products, etc.).

HDPE/LDPE film, or **grocery sack bale**, refers to a bale specification for mixed HDPE and LDPE stretch film, primarily made up of post-consumer HDPE grocery bags with a lesser amount of LDPE stretch film and bags.

High-density polyethylene is a polymer in the polyolefin family. It is made from a petroleum and natural gas derivative (ethylene) and catalysts. All forms of HDPE are referred to by SPI resin code #2.

LDPE is the abbreviation for low-density polyethylene.

LDPE mixed color bottles refers to the baled recycled plastic standard (ISRI P-400) that specifies natural and pigmented LDPE bottles.

LDPE natural bottles refers to the baled recycled plastic standard (ISRI P-401) that specifies only natural-colored LDPE bottles.

LDPE pigmented bottles refers to the baled recycled plastic standard (ISRI P-402) that specifies only pigmented LDPE bottles.

LLDPE is the abbreviation for linear low-density polyethylene.

LLDPE stretch film refers to a bale specification for clear LLDPE stretch film and bags. Bales may be specified for natural color only, colored film only, or a combination of the two. Colored or printed film or bags are often considered a contaminant.

Low-density polyethylene and **linear low-density polyethylene** are members of the polyolefin family of plastics. They are made from a petroleum and natural gas derivative (ethylene), along with catalysts or initiators such as peroxide. All forms of LDPE and LLDPE are referred to by SPI resin code #4.

Mixed resin mixed color bottles refers to the baled recycled plastic standard (ISRI P-000) that specifies any color bottles made of any resin included in the SPI resin codes #1-7.

Mixed resin natural bottles refers to the baled recycled plastic standard (ISRI P-001) that specifies natural-color bottles made of any resin included in the SPI resin codes #1-7.

Mixed resin pigmented bottles refers to the baled recycled plastic standard (ISRI P-002) that specifies pigmented bottles made of any resin included in the SPI resin codes #1-7.

Natural is a term referring to a colorless polymer such as HDPE or PP, typically milky-white in appearance.

Other Packaging is plastic packaging defined by the U.S. EPA's 2007 report "Municipal Solid Waste in the United States: Facts and Figures" to include coatings, closures, caps, trays, shapes, etc.

Other Rigid Container is defined as any non-bottle container that can maintain its shape when holding a product, is made of plastic, is capable of multiple reclosures, and is sold with an attached or unattached lid or cap.

PCR is the abbreviation for post-consumer resin.

PCR PET is post-consumer recycled polyethylene terephthalate.

PET clear beverage containers refers to the baled recycled plastic standard (ISRI P-101) that specifies only clear PET beverage containers (1, 2, 3 liter, 16 oz. soft drink bottles).

PET green beverage containers refers to the baled recycled plastic standard (ISRI P-102) that specifies only green PET beverage containers (1, 2, 3 liter, 16 oz. soft drink bottles).

PET mixed clear and green beverage containers refers to the baled recycled plastic standard (ISRI P-103) that specifies only clear or green PET beverage containers (1, 2, 3 liter, 16 oz. soft drink bottles).

PET mixed color bottles and jars refers to the baled recycled plastic standard (ISRI P-104) that specifies mixed color PET bottles and jars, such as liquor, edible oil, peanut butter, etc.

PETG is glycol-modified PET. It is clear but can be colored. Its modified properties, including lower melting temperature, are due to copolymerization. This makes it particularly well-suited for thermoforming applications, such as a bottle with a built-in handle.

PET mixed color bottles refers to the baled recycled plastic standard (ISRI P-100) that specifies any color of PET bottles, such as mixed soft drink, liquor, edible oil, etc. bottles.

PET mixed color rigid containers refers to the baled recycled plastic standard (ISRI P-110) that specifies mixed color PET rigid containers, such as mixed bottles, jars, tubs, trays, etc.

PET or **PETE** are abbreviations for polyethylene terephthalate.

PLA is the abbreviation for polylactic acid.

Polyethylene terephthalate is a polymer in the polyester family made from petroleum and natural gas derivatives (terephthalic acid and ethylene glycol), along with a catalyst, typically antimony trioxide. All forms of PET are referred to by SPI resin code #1.

Polylactic acid is a bio-based polymer derived from sugar or starch feedstocks such as corn, rice, sugar beets, sugarcane, wheat, or sweet potatoes. The most common packaging applications of PLA include films, coatings, thermoformed food and beverage containers, food service ware, and wrappers. PLA biopolymer can be clear, opaque, flexible or rigid. PLA currently falls under SPI resin code #7 (other).

Polypropylene is a member of the polyolefin family of plastics. It is made from a petroleum and natural gas derivative (propylene), along with a catalyst. All forms of PP are referred to by SPI resin code #5.

Polystyrene is a polymer made from a petroleum and natural gas derivative (styrene) and a catalyst. Typically, the term "polystyrene" refers to **general purpose polystyrene (GPPS)**, the basic form made without large amounts of additives. **Expanded polystyrene (EPS)** contains blowing or expanding agents to produce foamed applications such as packing peanuts, egg cartons, and meat trays. **High impact polystyrene (HIPS)** is opaque due to the incorporation of rubber compound additives which help reduce brittleness. All forms of PS are referred to by SPI resin code #6.

Polyvinyl chloride is a polymer made from petroleum or natural gas and rock salt derivatives (ethylene and vinyl chloride) along with a catalyst and peroxide initiator. It is also referred to by SPI resin code #3.

PP is the abbreviation for polypropylene.

PP mixed color bottles refers to the baled recycled plastic standard (ISRI P-500) that specifies natural and pigmented PP bottles.

PP natural bottles refers to the baled recycled plastic standard (ISRI P-501) that specifies only natural-colored PP bottles.

PP pigmented bottles refers to the baled recycled plastic standard (ISRI P-502) that specifies only pigmented PP bottles.

PS is the abbreviation for polystyrene.

PVC is the abbreviation for polyvinyl chloride.

rPET is recycled polyethylene terephthalate.

Paper

Aseptic packaging refers to a package in which sterile contents are filled into a sterile multi-laminate package often made of liquid packaging board, enabling the product to be shelf-stable.

Bending chipboard (BC) is a slightly better grade of chipboard that allows for folding while still being made of recycled fiber. It is a grade of folding carton board.

Boxboard is a grade of paper which is used primarily for making folding cartons. Other synonyms: folding carton, cartonboard.

Brown paper is a synonym for kraft paper.

Cardboard is a thin, stiff pasteboard, sometimes used for playing cards or signs. The general public misuses the term and often incorrectly refers to corrugated containerboard or even boxboard as cardboard.

Carrier board is clay-coated unbleached kraft paperboard with a wet strength additive to add moisture resistance. It is commonly used for beverage carriers.

Cartonboard is a synonym for boxboard.

Chemical pulp uses a combination of chemicals and heat to separate the lignin from the cellulosic fibers in wood. The result is a strong fiber with less color.

Chipboard is a type of panel board made from lower-grade secondary fiber or large, discrete chips, where stiffness is a priority, but appearance is less important (e.g. the back of writing tablets). Can be a synonym for cardboard.

Clay-coated board is paperboard that has been surface-coated with clay to even and smooth the surface to enhance printing and appearance.

Clay-coated kraftback (CCKB) is a white-lined coated recycled paperboard in which the filler and back are made from recycled kraft paper, including corrugated containerboard.

Clay-coated newsback or newsboard (CCNB) is a white-lined coated recycled paperboard in which the filler and back are made from recycled newsprint.

Clay natural kraft (CNK) is a synonym of solid unbleached sulfate and is coated with a thin layer of clay for an improved printing surface.

Coated one/two sides (C1S/C2S) is paperboard coated on either one or both sides for an improved printing surface. It is commonly used for leaflets, inserts, calendars, business cards, and other uses where high-quality printing is important.

Coated recycled board (CRB) and **coated recycled paperboard (CRP)** are synonyms and overarching boxboard terms that include clay-coated kraftback and clay-coated newsback, among others.

Coated unbleached kraft (CUK) is a synonym of solid unbleached kraft and is coated with a thin layer of clay for an improved printing surface.

Composite packaging is an overarching term for any package made with a combination of different materials that are not easily disassembled or separated from each other. A composite package may be multi-laminate, liquid packaging board, or used for aseptic applications. Also included as composite packages are bi-metal cans made of steel with aluminum tops and the paperboard cans with metal and/or plastic ends used for snack foods or frozen fruit juice.

According to ISRI, **Corrugated Containers (OCC)** consists of corrugated containers having liners of either test liner, jute or kraft. Prohibitive Materials may not exceed 1%. Total Outthrows may not exceed 5%.

Corrugated containerboard is a grade of paper primarily used for making corrugated boxes used as shippers or transport containers. It is an assembly of various layers of kraft paper in which linerboard surrounds a fluted medium. Corrugated is often incorrectly called cardboard by the general public, although in the paper industry, cardboard is a synonym for chipboard.

Double kraft lined bending chipboard is an uncoated recycled paperboard with a layer of recycled kraft fibers on both front and back to add strength and resist cracking. It is used for folding cartons.

According to ISRI, **Double-Sorted Corrugated (DS OCC)** consists of double-sorted corrugated containers, generated from supermarkets and/or industrial or commercial facilities, having liners of test liner, jute, or kraft. Material has been specially sorted to be free of boxboard, off-shore corrugated, plastic, and wax. Prohibitive Materials may not exceed 1/2 of 1%. Total Outthrows may not exceed 2%.

Fiberboard is a synonym for corrugated containerboard.

Fluted (or corrugating) **medium** is stiff, lightweight board used for the fluted layers of corrugated box board.

Folding boxboard or **folding board** is paperboard suitable for conversion by folding into cartons. The terms are synonyms for boxboard.

Folding carton is a three-dimensional carton made out of boxboard grade paper.

Food board is paperboard, typically coated or waxed in order to hold moist, oily, or liquid foods. It is typically referred to by grade, such as cupstock or platestock.

Freesheet is a paper made entirely of chemical pulp. Freesheet may be coated or uncoated.

Frozen-food board is paperboard made from waxed or poly-coated pulp and treated with sizing for water resistance and used for storing frozen foods.

Greaseproof board is paperboard treated to resist penetration of oil or grease by laminating with greaseproof paper (glassine) or by coating or laminating with other greaseproof materials.

Groundwood is the term used to refer to wood pulp generated using the mechanical separation of cellulosic fibers. This process does not eliminate lignin, the “glue” that keeps the cellulose fibers together and what causes newsprint to yellow after exposure to the sun.

According to ISRI, **Hard Mixed Paper (HMP)** consists of a clean, sorted mixture of various qualities of paper containing less than 10% groundwood content. Prohibitive Materials may not exceed 1/2 of 1%. Total Outthrows may not exceed 3%.

Kraft board is paperboard made almost wholly from kraft pulp.

Kraft paper is paper or paperboard made almost wholly from kraft pulp.

Kraft pulp is wood fiber paper manufactured by the Kraft or sulfate process. The Kraft process uses alkaline chemicals (sodium hydroxide and sodium sulfide) to chemically transform wood chips into a strong pulp.

Light weight coated sheet is paper with a coating applied on one or both sides of the sheet.

Lined board has multiple layers, typically consisting of a recycled layer sandwiched between one or two layers of higher-quality bleached fiber.

Linerboard (synonym: **facing**) is the lightweight, flat facing made of kraft or recycled paper that adheres to the fluted corrugating medium in corrugated board.

Liquid packaging board is a type of composite package consisting of multi-ply paperboard with one or more additional layers used for gable-top and brick cartons containing liquids. Along with paperboard, the layers typically include barrier coatings of polymers and/or aluminum foil laminate.

Mixed paper is recovered paper not sorted into categories such as old magazines, old newspapers, old corrugated boxes, etc. It is an inclusive "catch all" category for a wide variety of recovered paper.

Multi-laminate packaging is a subset of composite packaging that features a complex layered structure. Multi-laminate layers can include paperboard, polymers, and aluminum foil. Examples include drink pouches, potato chip bags, and bricks and cartons containing milk, soymilk, soup, and broth.

Outthrows is defined by ISRI as "all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the [scrap] grade specified."

Ovenable board is paperboard, typically coated with a heat-tolerant polymer, to allow the paperboard to be placed in the oven or microwave for heating food.

Paperboard is one of the two major product categories of the paper industry. It is a heavy, thick paper grade used as the base material for many packaging applications. The two major types are containerboard (corrugated) and boxboard.

Prohibitive Materials is defined by ISRI as: a) Any materials which by their presence in a packing of paper stock, in excess of the amount allowed, will make the packaging unusable as the grade specified; b) Any materials that may be damaging to equipment; c) All sorted recovered paper stock must be free of food debris, medical or hazardous wastes and poisonous or other harmful substances or liquids; and d) Wax is a Prohibitive unless accepted and pre-approved by the Buyer.

Recycled fiber paperboard (RFP) is recycled paperboard. It may be coated or uncoated.

Recycled paperboard is paperboard made with 100% recycled fibers and is typically gray in color.

According to ISRI, **Residential Mixed Paper** consists of a mixture of various qualities of paper not limited as to type of fiber content, normally generated from residential, multi-material collection programs. Prohibitive Materials may not exceed 2%. Total Outthrows may not exceed 5%.

Set-up boxes are three dimensional paperboard boxes that have been squared with one set of end flaps sealed and are ready to be filled with product.

According to ISRI, **Soft Mixed Paper** consists of a clean, sorted mixture of various qualities of paper not limited as to type of fiber content. Prohibitive Materials may not exceed 1%. Total Outthrows may not exceed 5%.

Solid bleached sulfate (SBS) is paperboard made of sulfate (kraft) pulp and bleached to give a white appearance.

Solid unbleached sulfate (SUS) (synonym: kraft board) is paperboard made of unbleached sulfate (kraft) pulp.

According to ISRI, **Sorted Office Paper (SOP)** consists of paper, as typically generated by offices, containing primarily white and colored groundwood-free paper, free of unbleached fiber. May include a small percentage of groundwood computer printout and facsimile paper. Prohibitive Materials may not exceed 1%. Total Outthrows may not exceed 5%.

Supercalendered paper is a paper that has been given a smooth finish by passing it through a series of rollers at high speed and pressure.

Unbleached board is made from unbleached pulp and is brown in color.

Uncoated recycled paperboard (URP) or **uncoated boxboard (URB)** are synonyms. It is produced from 100% post-industrial and post-consumer recovered paper. Some uncoated paperboard is produced with a top ply of white recovered fiber or vat dyed for color.

According to ISRI, **Unsorted Office Paper (UOP)** consists of printed or unprinted paper typically generated in an office environment that may include a document destruction process. This grade may contain white, colored, coated and uncoated papers, manila and pastel colored file folders. Prohibitive Materials may not exceed 2%. Total Outthrows may not exceed 10%.

According to ISRI, **Used Brown Kraft** consists of brown kraft bags free of objectionable liners and original contents. Prohibitive Materials None permitted. Total Outthrows may not exceed 1/2 of 1%.

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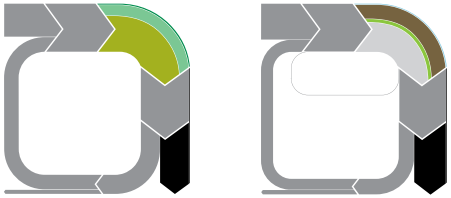

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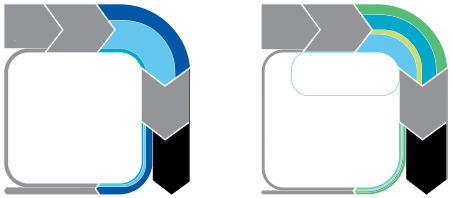

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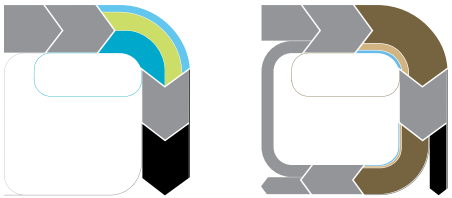

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