Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures

A Methodology Document

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U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery

Contents

INTRODUCTION

This methodology document provides detailed methodology descriptions for selected products to supplement the information found in EPA's Municipal Solid Waste in the United States Facts and Figures report series. The products included in this document are:

- Major Appliances
- Small Appliances
- Furniture and Furnishings
- Carpet and Rugs
- Batteries, Lead-Acid
- Consumer Electronics
- Paper and Paperboard
- Glass Containers and Packaging
- Steel Containers and Packaging
- Aluminum Containers and Packaging
- Plastic Products
- Wood Packaging
- Food Waste
- Yard Trimmings
- Scrap Tires

The methodology for estimating generation, recovery, and discards are described separately. For each product, a brief discussion, a flow diagram, and major data gaps are included.

The material flows methodology used for making generation estimates is based on production data for the materials and products in the municipal solid waste (MSW) stream. Adjustments are made for imports and exports and for diversions from MSW. Adjustments are also made for the lifetimes of products. Food wastes and yard trimming generation are accounted for by compiling data from a variety of waste sampling studies.

Industry data and state level data provide the basis for recovery through recycling and composting. Discards is the calculated difference between generation and recovery through recycling and composting.

MAJOR APPLIANCES

Summary

Major appliances consist of many different types, sizes, and styles. Major appliances include: clothes washers and dryers, dishwashers, freezers, microwave ovens, ranges (built-in, free-standing, and surface types), refrigerators, room air conditioners, water heaters, and trash compactors.

The primary source of data on annual shipments of major appliances is projected data from Canon Communications in *Annual Appliance Industry Forecasts.* Unit weight and material composition data for major appliances are based on government and industry studies. Recovery rates for ferrous (steel) from major appliances were based on data from the Steel Recycling Institute.

Major appliances are categorized as durables, with an estimated average useful life of eight to 25 years. The life span differs from appliance to appliance. In the material flows methodology, generation of major appliances is based on shipment figures, adjusted for the individual life span of each appliance. Therefore, current year generation is based on a rolling average of previous year's shipments. For example, assuming a 10 to 25 year life span for a refrigerator, a rolling average of shipments between 1986 and 2001 is the basis for 2011 generation of refrigerators into the waste stream.

Unit weights for each type of appliance are determined by using the averaged weights of most of the different sizes available. Steel is the predominant material comprising major appliances, accounting for approximately 70 percent of total generation. Other materials found in appliances in varying amounts include copper and brass, aluminum, glass, rubber, paperboard, and plastics.

Currently, steel is the primary material recovered for recycling, although refrigerants (e.g., chlorofluorocarbons) in refrigerators and PCBs are removed from appliances and recovered but not included in the material flow methodology. Due to the method of crushing appliances, sometimes occurring with the crushing of damaged car bodies, it is difficult to extract other materials for recycling.

Figure 1 is a flow chart illustrating estimates of generation, postconsumer recovery, and discards of major appliance. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Total shipments (including net imports) of major household appliances = room air conditioners + dishwashers + dryers + freezers + microwave ovens + ranges + refrigerators + washers + water heaters + trash compactors.

2. Unit weight conversion factors, by material component, for major appliances manufactured. Conversion factors based on retail and manufacturer websites and various research studies.

3. Total shipments of major household appliances = individual appliance shipments (1) x unit weight conversion factors, by material component, by appliance (2).

4. Temporary diversion based on estimated useful life for each major appliance. To account for time lag, a rolling average range used to estimate tons discarded. For example, assuming a 10 to 25 year life span for a refrigerator, a rolling average of shipments between 1986 and 2001 is the basis for 2011 generation of refrigerators into the waste stream. The appliances and useful life ranges are shown below.

Appliance	Temporary Diversion Time Lag (years)
Air Conditioners, Room	10-20
Dishwashers	8-16
Dryers	15-21
Freezers	10-30
Microwave Ovens	8-16
Ranges	15-21
Refrigerators	10-25
Refrigerators Compact	3-7
Washers, Clothes	9-17
Water Heaters	9-17
Trash Compactors	8-12

5. Generation of major appliances = individual appliance shipments (3) adjusted for temporary diversion based on useful life of appliance (4).

6. Recovery of steel from major appliances = generation of steel in all major appliances (5) X recovery rate for appliances. Percentage recovery is provided by the Steel Recycling Institute.

7. Discards of major appliances = generation - recovery of steel.

Data Gaps

- Recovery of material other than steel is assumed to be zero.

- Limited composition data.

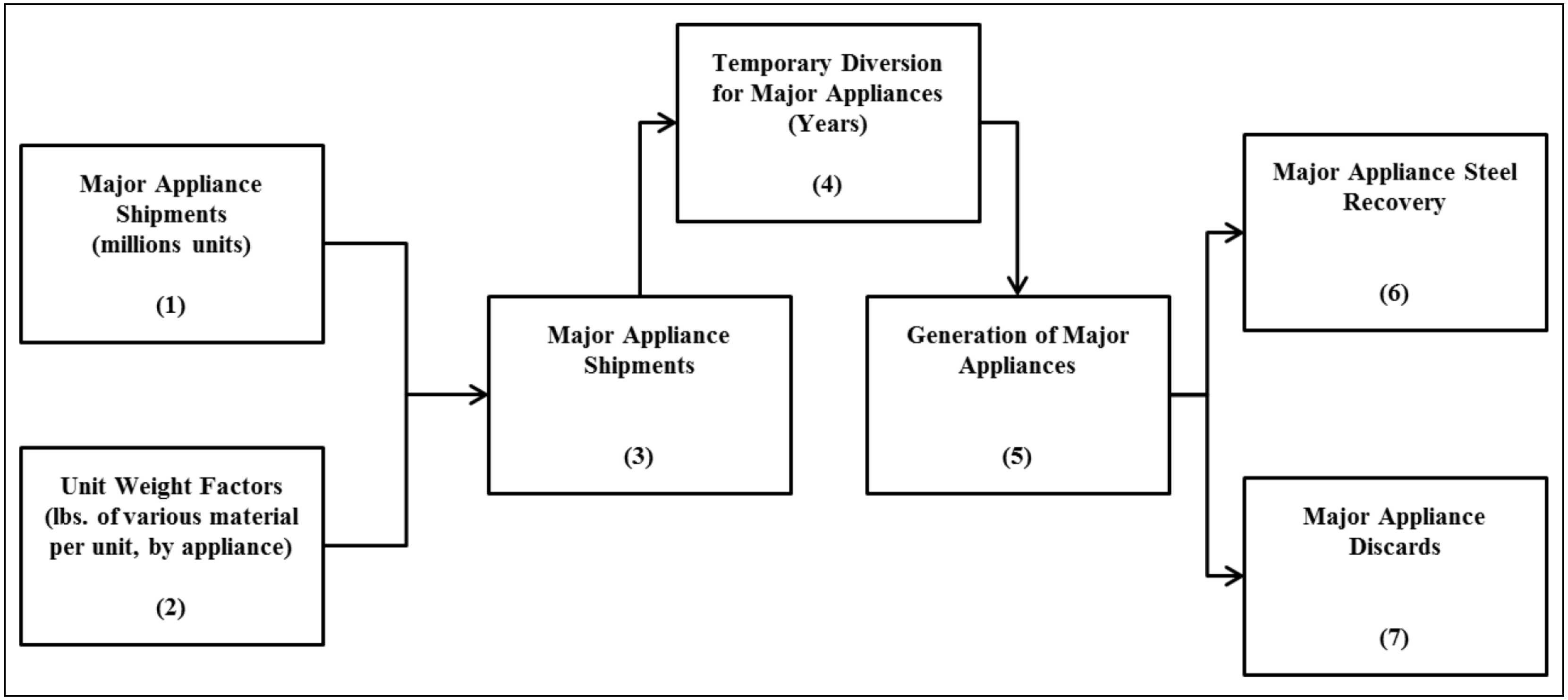

Figure 1. Material Flow Methodology: Major Appliances

SMALL APPLIANCES

Summary

Small appliances consist of many different types, sizes, and styles. Examples of small appliances include electric fans, coffee makers, electric irons, and food mixers. Shipment data for some small appliances are only reported as "other" and includes similar, but different, small appliances. For example, the U.S. Census Bureau combines drink makers, whippers, juicers, grinders, ice crushers, and coffee grinders into a single category. Aluminum and plastic are the predominant materials used in small appliances.

The primary source of data on annual shipments of small appliances is from the U. S. Department of Commerce, Census Bureau and annual appliance industry statistical reviews. Unit weight and material composition data for small appliances are based on published shipped weights from retail websites and personal communication with small appliance retailers and repair shops. Recovery of small appliances for recycling is assumed to be negligible, except for steel magnetically recovered at MSW combustion facilities and limited data on residential recovery.

Small appliances are categorized as durables, with an estimated average useful life of four to ten years. In the material flows methodology, generation of small appliances is based on shipment figures, adjusted for product life span. Therefore, 2011 generation is based on a rolling average of shipments between 2001 and 2007 (four to ten years prior).

Figure 2 is a flow chart illustrating estimates of generation, postconsumer recovery, and discards of small appliances. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Total shipments of small appliances = electric fans + broilers + coffee makers + deep fat fryers + toaster ovens + waffle irons/griddles + frying pans/skillets + airspace heaters + electric irons + electric bed coverings + electric heating pads + portable humidifiers + food mixers + blenders + food processors + vacuums, others.
2. Net Imports of small appliances = imports – export.
3. Total apparent consumption of small appliances = individual appliance shipments (1) + net imports of small appliances (2)

4. Unit weight conversion factors, by material component, for small appliances manufactured. Used to convert apparent unit consumption to tonnage.

5. Temporary diversion based on estimated useful life for each small appliance. To account for time lag of four to ten years, a rolling average range used to estimate tons generated.

6. Generation of small appliances = individual appliance shipments (3) adjusted for temporary diversion based on useful life of appliance (5).

7. Recovery assumption that steel in small appliances is recovered for recycling through magnetic separation at combustion facilities. Additional tonnage estimated collected through curbside and drop-off programs by the Steel Recycling Institute.

8. Discards of small appliances = generation - recovery of small appliances.

Data Gaps

- Limited composition data.
- Recovery of material other than steel is assumed to be zero.
- U.S. Department of Commerce, Census Bureau. Current Industrial Reports discontinued in 2011. This is a critical source of data.

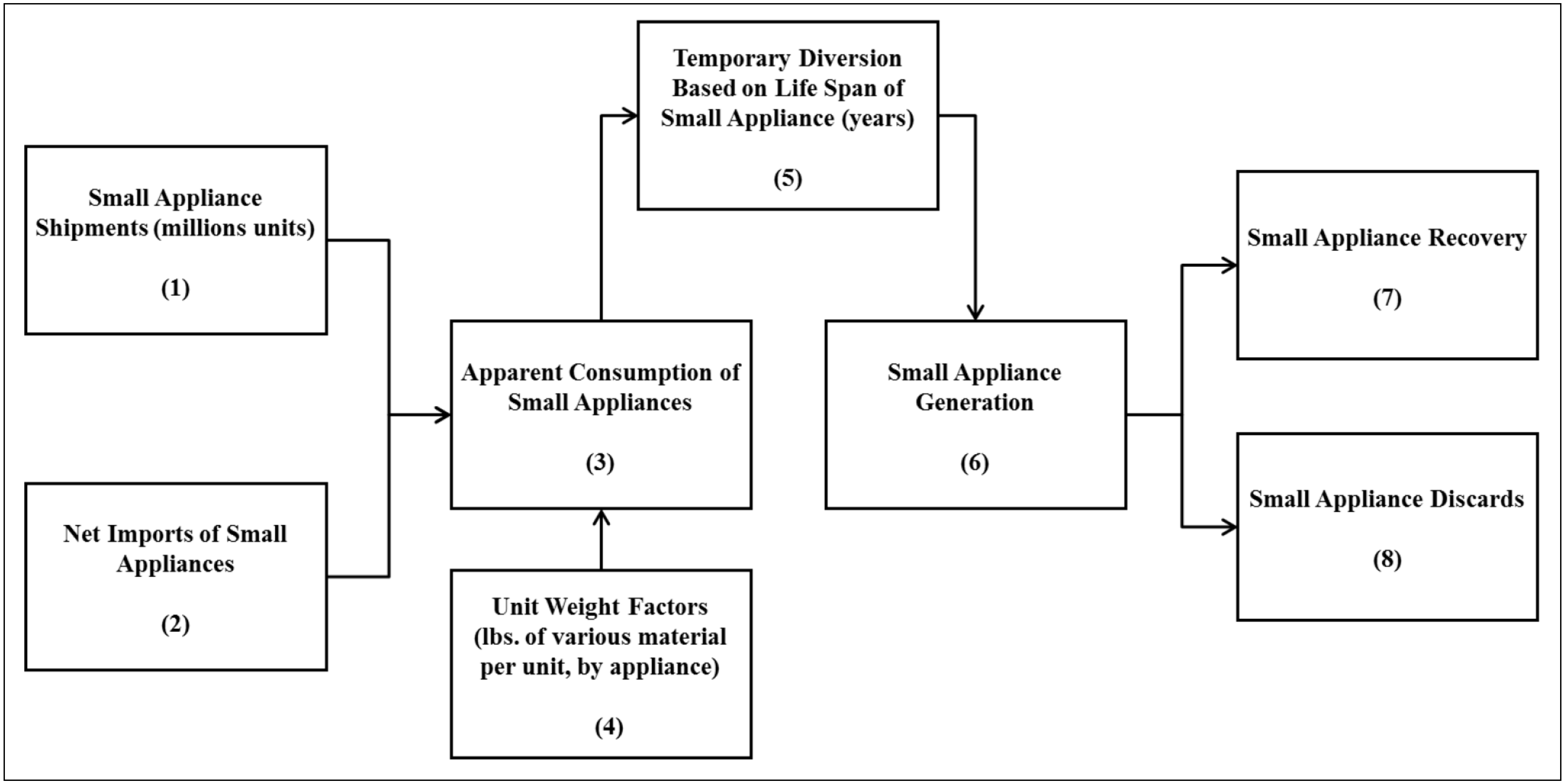

Figure 2. Material Flow Methodology: Small Appliances

FURNITURE AND FURNISHINGS

Summary

Furniture and furnishings are comprised primarily of household and office furniture. Materials consumed in manufacturing furniture and furnishings include wood, steel, textile, plastic, glass, aluminum, and rubber and leather. Wood and steel are the primary materials, accounting for 58 percent of total furniture and furnishings generation.

Data on shipment values of furniture and furnishings are provided by the Department of Commerce in dollars. First, the ratio of the current year shipment values to the previous year shipment value is determined (expressed as constant dollars). This ratio is then applied to the previous year shipment tonnage. Adjustments are made for imports and exports and adjustments are made for the lifetimes of the furniture.

Consumption of materials in manufacturing furniture and furnishings is calculated by multiplying the reported consumption of material by the appropriate weight conversion factor. For furniture and furnishings not reporting materials consumed in manufacturing, the value of shipments is used as the basis for estimating quantities of material consumed. Adjustments are then made to account for imports and exports, and conversion losses during manufacturing. The primary sources of data are the *Census of Manufacturers* and *Annual Survey of Manufacturers*.

Furniture and furnishings are categorized as durable products, with an estimated average useful life of 10 to 20 years for all furniture and furnishings. In the material flows methodology, generation of furniture and furnishings is based on shipment figures, adjusted for the average 10 to 20 year life span. Therefore, the rolling average of 1991 to 2001 shipments is the basis for 2011 generation of furniture and furnishings into the waste stream. Generation of furniture and furnishings represents products at the end-of-life (after primary use and reuse by secondary owners).

Recovery of furniture and furnishings for recycling is assumed to be insignificant. Actual recovery for remanufacture of either furniture or other products is generally not feasible due to the difficulty in removing wood finishes and stains on the wood. Metal furniture, and in particular, office furniture, may be recovered as steel scrap, however, this amount appears to be quite small at this time. The only recovery of materials from furniture identified was mattress recovery.

Figure 3 shows flow charts illustrating estimates of material discards from furniture and furnishings. Each block of the diagram contains a reference number corresponding to the following remarks.

1. Value of furniture shipments.
2. Conversion factors. This is the percent change of shipment value from previous year.
3. Materials consumed in furniture = previous year material tonnage X conversion factors (2). The percent change per year of annual value of shipments is applied to previous year shipments of individual materials used in furniture and furnishings.
4. Net import adjustment factor = (value of shipments (1) + imports – exports) divided by value of shipments (1).
5. Net imports of furniture = Net imports factor (4) x consumption (3).
6. Consumption of material in furniture = net imports of furniture (5) + domestic consumption of materials in furniture and furnishings (3).
7. Conversion loss factors of furniture for textiles, steel, aluminum, rubber, glass, and plastics.
8. Conversion losses for furniture = conversion loss factors (7) x consumption of material (6).
9. Adjusted consumption of furniture = domestic consumption of materials (6) – conversion losses (8).
10. Temporary diversion for furniture. Note: Average service life for furniture and furnishers assumed to be from 10 to 20 years.
11. Generation of furniture = adjusted consumption of furniture (9) – temporary diversion of furniture (10). Note: Generation for given year based on annual average apparent consumption for a 10 year period, starting 20 years previous (i.e., 10 year rolling average lagged 10 years).
12. Recovery of furniture
13. Discards of furniture = Generation of furniture (11) – recovery of furniture (12).

Data Gaps

- Material consumption data are no longer available; a new data source has not been identified. This is a critical data gap. Without material consumption data, value of shipments is used as a surrogate for increasing/decreasing furniture and furnishing generation.

- Current data on furniture life span unavailable.

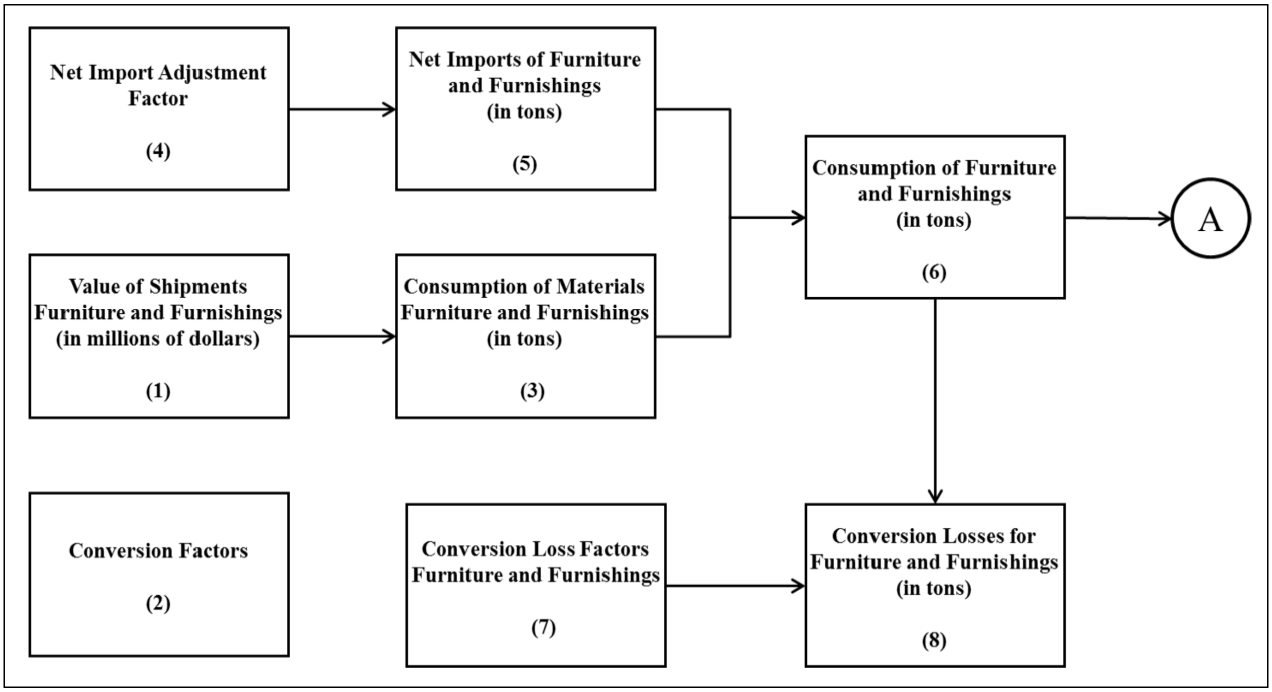

Figure 3. Material Flow Methodology: Furniture and Furnishings

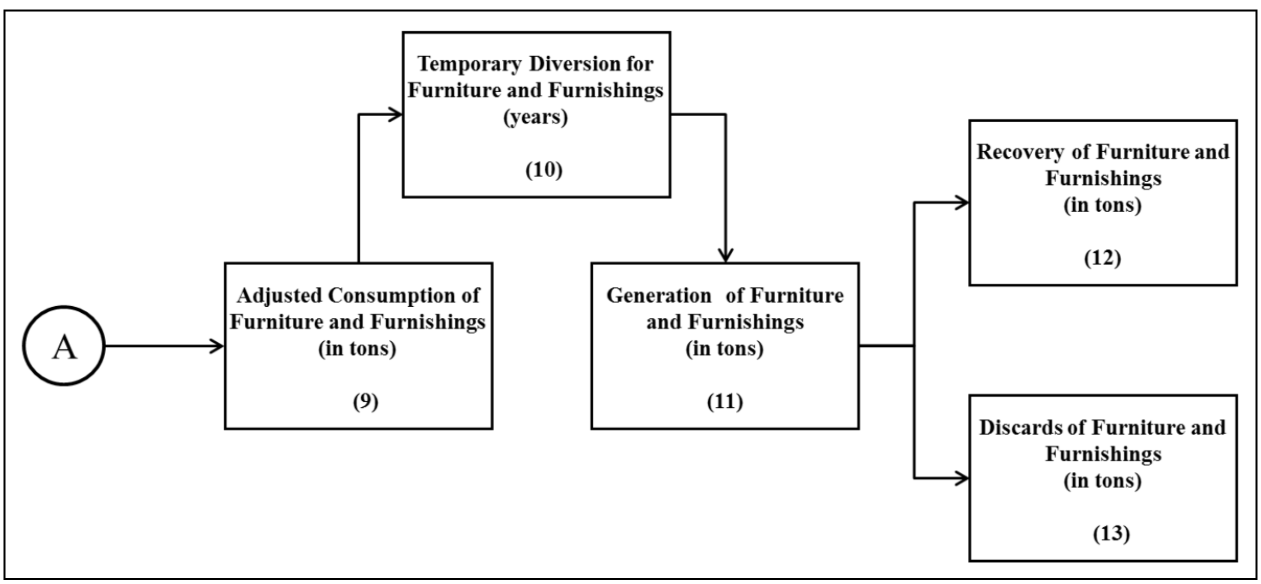

Figure 3. Material Flow Methodology: Furniture and Furnishings (Continued)

CARPET AND RUGS

Summary

There are many different types of carpets and rugs. Carpets and rugs are categorized as woven, tufted, and other rugs (e.g., knitted, needle punched, braided). Plastic padding/underlay used with carpets and rugs is also included. Tufted carpet is the largest category, accounting for over 90 percent of total carpet and rug generation. Not included as MSW carpets and rugs are those generated from transportation industries such as vehicle and aviation.

The primary source of data on carpets and rugs is the U.S. Department of Commerce *Current Industrial Report for Carpets and Rugs (MA314Q)* and the International Trade Commission online database of imports and exports. Shipment data are reported in million square yards and converted to weight based on published conversion factors for the various components comprising carpets and rugs. The primary components of carpets and rugs are fiber, adhesives, and the backing. Fibers are categorized as a textile, adhesives as rubber, and the backing primarily as plastic. Padding and underlay are also categorized as plastic.

Carpets and rugs are categorized as durables, with an estimated average useful life of five to 15 years. In the material flows methodology, generation of carpets and rugs is based on shipment figures, adjusted for temporary diversion of carpets and rugs. Therefore, current year generation is based on a rolling average of previous year’s shipments.

Figure 11 is a flow chart illustrating estimates of generation, postconsumer recovery, and discards of carpets and rugs. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Total shipments of carpets and rugs = woven carpet and rugs + tufted carpet and rugs + other carpet and rugs.
2. Total exports of carpets and rugs = woven carpet and rugs + tufted carpet and rugs + mother carpet and rugs.
3. Total imports of carpets and rugs = woven carpet and rugs + tufted carpet and rugs + other carpet and rugs.
4. Total apparent consumption of carpets and rugs = shipments + imports - exports. Note: carpets and rugs are temporarily diverted from the waste stream based on a

useful life of five to 15 years; therefore current year apparent consumption is not the actual amount of carpets and rugs discarded in current year.

5. Average weight per square yard of carpets and rugs, by material component, for carpets and rugs manufactured = fiber (1.97 lbs per square yard), adhesives (1.72 1bs per square yard), and backing (0.52 lbs per square yard).

6. Padding and underlay for carpets and rugs (tons shipped per year).

7. Total apparent consumption of carpets and rugs = apparent consumption of individual carpet and rug type (4) converted to weight measurement (5) + padding/underlay for carpets and rugs (6).

8. Temporary diversion based on estimated useful life for carpets and rugs; assumed 5 to15 years useful life.

9. Generation of carpets and rugs = apparent consumption of individual carpets and rugs adjusted for temporary diversion based useful life. Note: Average service life for carpets and rugs assumed to be from 5 to 15 years. Generation for given year based on average annual shipments for 10 year period, starting 5 years previous (i.e., 10 year rolling average lagged 5 years).

10. C&D (construction & demolition) Carpet and Rug Generation. Generation reduced by 10 percent (assuming disposed of as C&D waste).

11. Generation of carpets and rugs classified as municipal solid waste = total generation of carpets and rugs (9) - carpets and rugs classified as construction and demolition waste (10).

12. Carpet and rug fibers and padding/underlay recovered for recycling.

13. Discards of carpets and rugs classified as municipal solid waste = generation of carpets and rugs classified as municipal solid waste (11) - recovery of carpet and rug fibers and padding/underlay (12).

Data Gaps

- U.S. Department of Commerce has discontinued the Current Industrial Report series for all products including carpet and rugs.

- Assumption that 10 percent of generation is through the C&D waste streams needs further research.

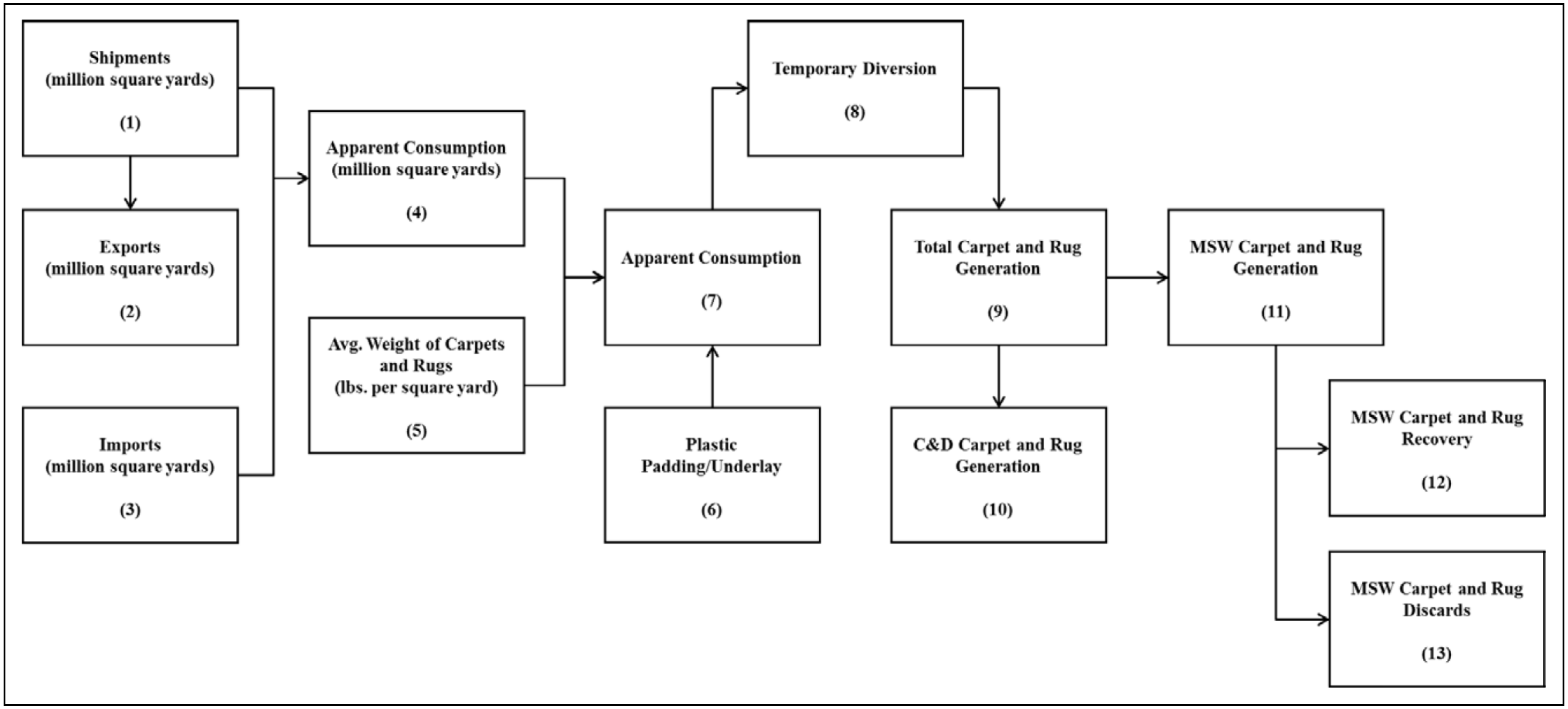

Figure 4. Material Flow Methodology: Carpets and Rugs

BATTERIES, LEAD-ACID

Summary

Lead-acid vehicle batteries for cars, trucks, and motorcycles are considered in the material flow methodology. Other batteries used in applications such as aircraft and military vehicles, boats, heavy-duty trucks and tractors, are not included in the material flows methodology.

Lead-acid batteries have three major components, which are lead, the plastic polypropylene case, and other materials including battery fluids. Lead accounts for approximately 48 percent of total vehicle battery generation, plastic cases 6 percent, and the remaining 46 percent is comprised of other materials in the battery, including fluids.

The primary source of data for lead-acid batteries is the Battery Council International and U.S. Census Bureau, and the National Automobile Dealers Association (NADA).

Generation of vehicle batteries is determined based on replacement battery purchases, including imported batteries, and the number of vehicles deregistered annually. Unit weight conversion factors for lead in batteries and plastic cases for each type of battery are used to calculate battery generation. Recovery of batteries has been consistently high due to a well established recovery system. For the material flows methodology it is assumed that the lead, plastic cases, and other materials in the battery are all recovered at the same rate.

Figure 5 is a flow chart illustrating estimates of lead, plastic, and other material discards from vehicle batteries. Each block of the diagram contains a reference number corresponding to the following remarks.

1. Number of domestic vehicle replacement batteries sold (includes both car and trucks). Assumption is that for every replacement battery sold, a used lead-acid battery was generated.
2. Number of imported vehicle replacement batteries (includes cars and trucks). Assuming 90 percent of total vehicle battery imports are used as replacement batteries.
3. Number of deregistered cars and trucks. To determine the number of deregistered cars separately from deregistered trucks, the number of total deregistered vehicles

was multiplied by the percent operational cars represented of total operational cars and trucks. Assuming batteries in deregistered vehicles are no longer in use.

4. Number of domestic motorcycle replacement batteries calculated by dividing motorcycle registrations by two. Assuming one battery is replaced for every two motorcycles.

5. Number of deregistered motorcycle batteries is assumed to equal 25 percent of motorcycle registrations.

6. Number of imported motorcycle replacement batteries. Assuming 90 percent of total motorcycle battery imports are used as replacement batteries.

7. Lead in batteries. 22.3 pounds of lead per car battery. 38.7 pounds of lead per truck battery; 4.8 pounds lead per motorcycle battery.

8. Total lead generation = lead/vehicle battery X number vehicles batteries + and lead/motorcycle battery x number of motorcycle batteries.

9. Apparent consumption of plastic battery cases equals the number of batteries generated (the sum of domestic and imported replacement batteries and deregistered vehicles).

10. Plastic battery case conversion factor at 6 percent of total battery weight based on manufacturer product specifications.

11. Plastic generation = number of batteries cases (9) x plastic per battery (10).

12. Other materials, including battery fluid, calculated by difference comprise 46 percent of battery weight.

13. Total generation of lead-acid batteries = generation of lead (8) + generation of plastic battery cases (11) + generation of other materials in batteries (12).

14. Recovery. Total battery lead recovery data are available from both Battery Council International and The Bureau of Mines. However, it is not possible to determine how much of total recovered lead is from vehicle, truck, and motorcycle lead-acid batteries. It is assumed that the recovery rate of these types of lead-acid batteries is equal to recovery rate of total battery lead. It is also assumed that the recovery rates for the plastic case and the other materials are the same as lead.

15. Total discards of lead, plastic, and other materials = total generation of lead, plastic, and other material - recovered lead, plastic, and other material.

Data Gaps

- Motorcycle replacement battery and deregistration assumptions need to be updated.

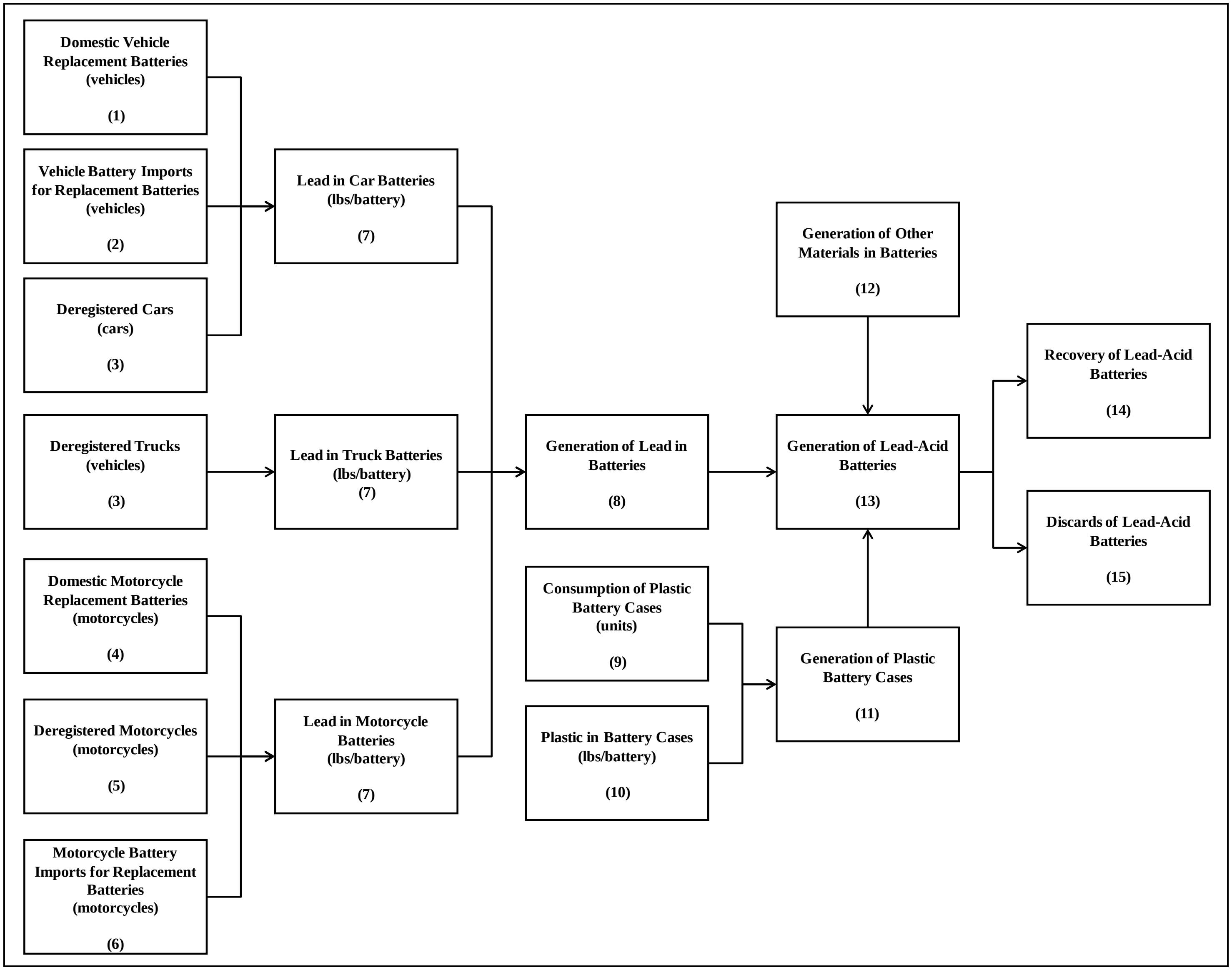

Figure 5. Material Flow Methodology: Batteries, Lead-Acid

CONSUMER ELECTRONICS

Summary

Consumer electronic products include electronic products used in residences and commercial establishments such as businesses and institutions. Consumer electronics include video and audio equipment and information products. Video products include standard televisions (TV), projection TV, high density TV, liquid crystal display TV, VCR decks, camcorders, laserdisc players, and digital versatile disc players (DVD). Audio products include rack audio systems, compact audio systems, portable compact discs (CD), portable headset audio, total CD players, and home radios. Information products include cordless/corded telephones, mobile telephones, telephone answering machines, facsimile (fax) machines, personal computers, computer printers, computer monitors, modems, and fax modems. Certain other electronic products such as separate audio components are excluded because of data limitations.

Consumer electronic generation is estimated by calculating the annual apparent consumption. Apparent consumption equals U.S. manufacturer shipments plus U.S. imports minus U.S. exports. Consumer electronics are categorized as durables, with an estimated average useful life of 3 to 23 years, depending on the product (see the table below). Therefore, current year generation is based on a rolling average of previous year's shipments. The year in which a particular electronic item enters the municipal solid waste stream is determined from the estimated life span of the item. Average weights for consumer electronics were estimated after collecting information from retail websites, consumer electronic magazines, and weighing available items.

The generation methodology combines data from two sources for domestic shipments: (1) The Consumer Electronics Association (CEA); and (2) the U.S. Department of Commerce trade data. CEA data reflect shipments of consumer electronics to retail outlets. The U.S. Census Bureau's *Current Industrial Reports* include trade data (shipments, imports, and exports) from the U.S. Department of Commerce.

The methodology for estimating electronics recovery follows the methodology used in the EPA report "Electronics Waste Management in the United States Through 2009" May 2011. State level data collected from 31 state agency websites represented about 68 percent of the US population in 2011. To fill in the two data gaps (1) states without data and (2) commercial recovery missed from the states' reporting mechanism similar assumptions used in the May 2011 report were applied.

Per capita factors developed from available data applied to population in states without data were used to estimate recovery in states where data were not identified.

The assumption to estimate the commercial recovery missed by the states' data collection efforts is that commercial recovery accounts for 67 percent of total recovery. This assumption is applied to the states' residential data to estimate commercial recovery (i.e., residential recovery/.33 – residential recovery = commercial recovery).

Figure 6 is a flow chart illustrating estimates of consumer electronics discards. Each block of the diagram contains a reference number corresponding to the following remarks.

1. Domestic shipments of consumer electronics.
2. Net imports of consumer electronics.
3. Apparent consumption of consumer electronics = domestic shipments of consumer electronics (1) + net imports of consumer electronics (2).
4. Temporary diversion based on estimated useful life for consumer electronics.

Estimated Life of Selected Consumer Electronics (in year)	
	Temporary Diversion Primary and Secondary Use
Video Products	
Direct View Color TV	7 - 23
Projection TV	7 - 15
HDTV	7 - 23
LCD Color TV	9 - 15
Plasma	7 - 15
TV/VCR Combination	10 - 12
Videocassette Players	7 - 10
VCR Decks, DVD Players, Camcorders	7 - 10
Audio Products	
Home and Portable Audio Products	3 - 15
Home Information Products	
Mobile Telephones	3 - 7
Cordless/Corded Telephones	3 - 8
Telephone Answering Machines	3 - 8
Fax Machines	3 - 8
Personal Computers	3 - 18
Personal Computers Laptop	2 - 8
Computer Printers	4 - 14
Aftermarket Computer Monitors	5 - 13
Personal Computers Monitors - Flat panel	3 - 14
Keyboards	3 - 6
Mouse Devices	3 - 6

5. Generation of consumer electronics = apparent consumption of consumer electronics adjusted for temporary diversion based useful life.

6. Recovery of consumer electronics.

7. Discards of consumer electronics = generation of consumer electronics (5) – recovery of consumer electronics (6).

Data Gaps

- Certain other electronic products such as separate audio components are excluded because of data limitations.
- Some newer electronic products such as GPS units and tablets have not been added to the product list. Data availability is unknown.
- Recovery data are not available for all states.
- Most state agency accounting of recovery does not include recovery through the commercial sector.

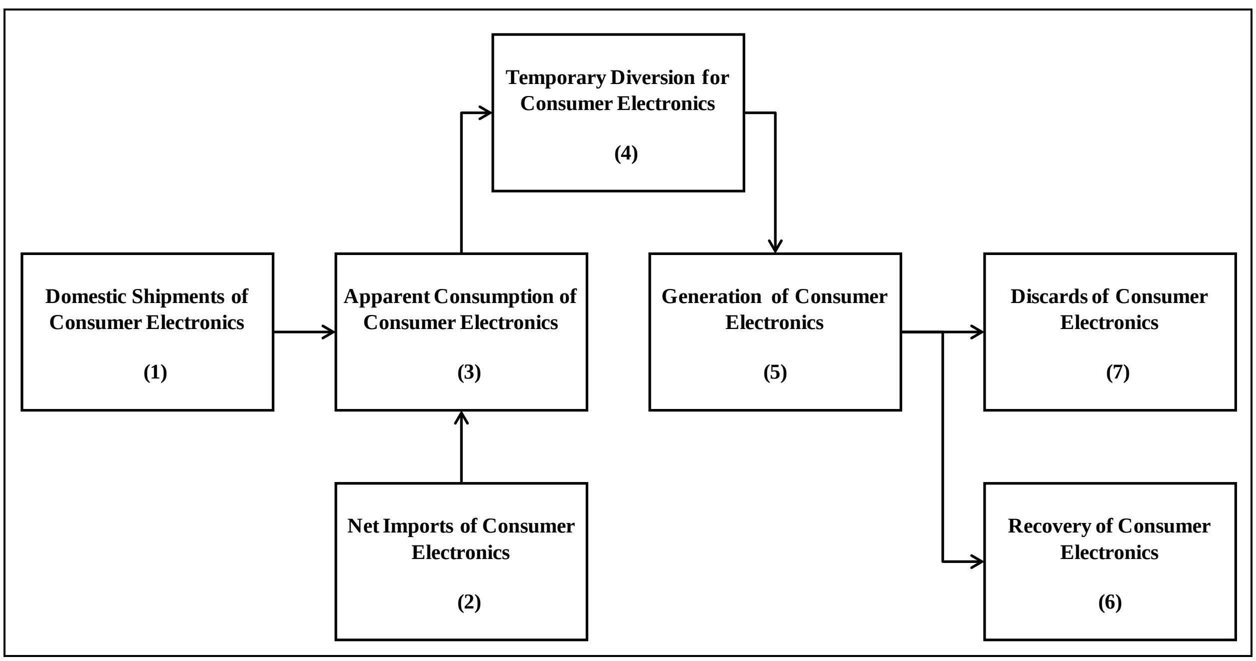

Figure 6. Material Flow Methodology: Consumer Electronics

PAPER AND PAPERBOARD

Summary

Collectively, the many products made of paper and paperboard[1] materials comprise the largest component of MSW. The paper and paperboard materials category includes products such as office papers, newspapers, corrugated boxes, milk cartons, tissue paper, and paper plates & cups.

Estimates of paper and paperboard generation are based on statistics published by the American Forest & Paper Association (AF&PA). These statistics include data on new supply (production plus net imports) of the various paper and paperboard grades that go into the products found in MSW. The AF&PA new supply statistics are adjusted to deduct converting scrap, which is generated when sheets or rolls of paper or paperboard are cut to make products such as envelopes or boxes. Converting scrap rates vary from product to product; the rates used in this report were developed as part of a 1992 report for the Recycling Advisory Council, with a few more revisions as new data became available. Various deductions also are made to account for products diverted out of municipal solid waste, such as gypsum wallboard facings (classified as construction and demolition debris) or toilet tissue (which goes to wastewater treatment plants).

Estimates of recovery of paper and paperboard products for recycling are based on annual reports of recovery published by AF&PA. The AF&PA reports include both post- and preconsumer recovery of paper and paperboard purchased by U.S. paper mills, plus exports of recovered paper, plus a relatively small amount estimated to have been used in other products such as insulation and animal bedding. Adjustments are made to the recovery as reported by AF&PA to remove preconsumer recovery from the postconsumer recovery estimate.

Figure 7 is a flow chart illustrating estimates of paper and paperboard discards. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. New supply of paper and board. Includes production for domestic use plus imports minus exports. Includes office paper file diversion reentering the paper supply.

2. Diversion of products. Includes office paper in files, magazines, books, and of products not counted as MSW, e.g., construction paper and board, toilet tissue.

3. Converting scrap (non-MSW industrial scrap).

4. Unrecovered converting scrap.

5. Recovered converting scrap.

6. Generation of paper and board = new supply of paper and board (1) – converting scrap – diversion of paper and board (2).

7. Adjustment for packaging of imported goods.

8. Adjusted generation = generation of paper and board (6) + adjustment for packaging of imported goods (7).

9. Postconsumer recovery.

10. Total recovery of paper and board = postconsumer recovery (9) + recovered preconsumer converting scrap (5).

11. Discards of paper and board = adjusted generation (8) – total Recovery of paper and board (9).

Data Gaps

- Current data for adjustments for packaging of imported goods are not available.

- Current data on adjustment for converting scrap are not available.

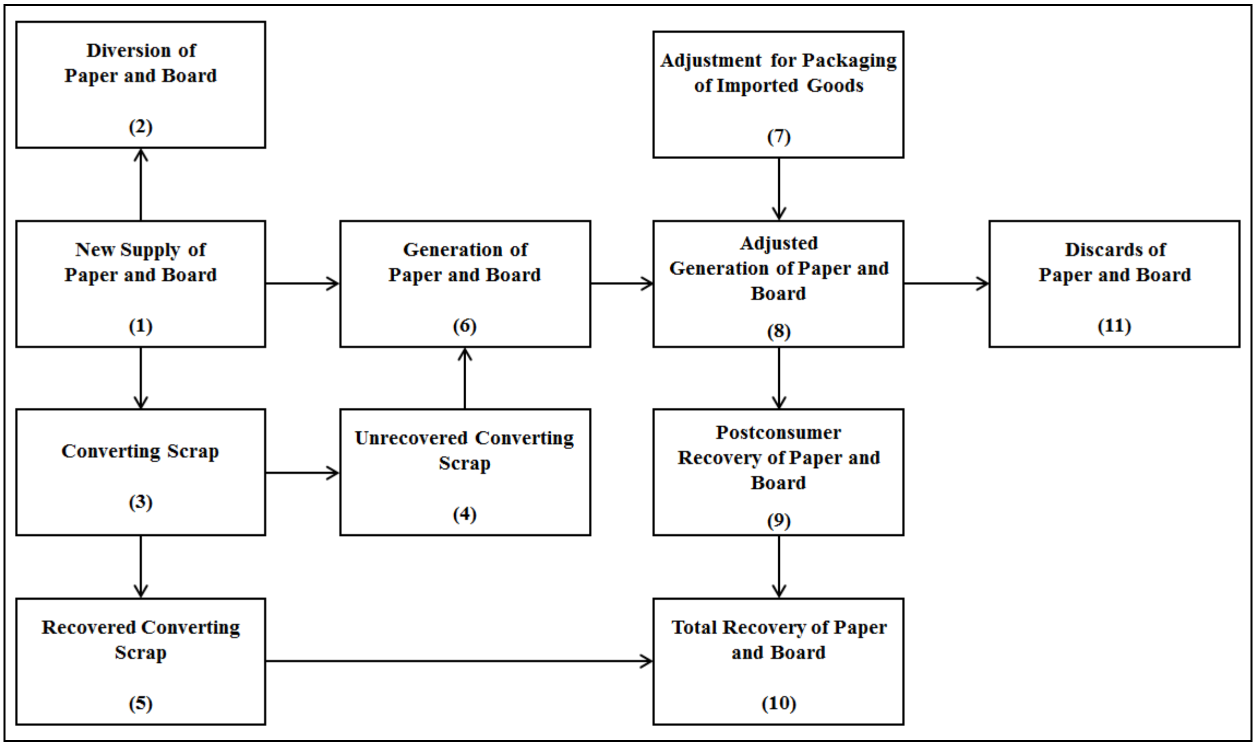

Figure 7. Material Flow Methodology: Paper and Paperboard

GLASS CONTAINERS AND PACKAGING

Summary

Glass containers are comprised of beer and soft drink, wine and liquor, and food and other containers. Beer and soft drink bottles account for 59 percent of total glass container generation, wine and liquor containers 19 percent, and the remainder as other glass containers. Glass container volumes of one gallon and less are included.

Generation of glass containers is calculated based on unit container weights and container shipments. The primary source of domestic glass container production data is the Glass Packaging Institute. Until 2009, domestic production data was obtained from the U.S. Census Bureau Current Industrial Report series for glass containers. The source of import and export data is the U.S. International Trade Commission’s online trade database. Glass container recovery is estimated from the combination of two data sources. First the Glass Packaging Institute provides the quantity of glass recovered for glass container recovery and then state environmental agency websites are researched for state level recycling data (including data from bottle bill states). The difference between the two data sources is assumed to equal the quantity of recovered glass going to low-end markets such as construction aggregate.

Figure 8 show flow charts illustrating estimates of material discards from glass containers and packaging. Each block of the diagram contains a reference number corresponding to the following remarks.

1. Shipments of empty glass containers by container type. Data do not represent total industry. To adjust upward, factors were developed by comparing 2008 Census data to 2008 GPI data and applied to beer and three categories of other containers.
2. Glass container unit weights (thousand gross) = weight of domestic production of glass container (pounds) divided by domestic production of glass containers (gross).
3. Domestic shipment weight = containers shipped (1) x conversion factor (2).
4. Net imports (imports - exports) of glass containers filled with product. Includes glass containers for wine, liquor, and beer.
5. Import glass container unit weight conversion factors. Liquid measurements converted to gross of bottles represented by volume x weight per gross of bottles.

6. Net import of filled glass containers = net imports (4) x unit weight conversion factors (5).

7. Net imports (imports - exports) of empty glass containers.

8. Glass container unit weights (thousand gross) = weight of domestic production of glass container (pounds) divided by domestic production of glass containers (gross). Assumed same conversion factors for imported empty containers.

9. Net imported empty glass containers = containers (7) x conversion factors (8).

10. Generation of glass containers = domestic shipments glass containers (3)+ imports of glass containers (6) + imports of empty glass containers (9).

11. Recovery of glass containers.

12. Discards of glass containers = generation of glass containers (10) - recovery of glass containers (11).

Data Gaps

- Domestic shipment data do not represent total industry.

- Missing imports of food and other products in glass containers. Imports of alcohol beverages are included.

- State level recovery data could include recovered bottles imported into one state from another state resulting in double counting.

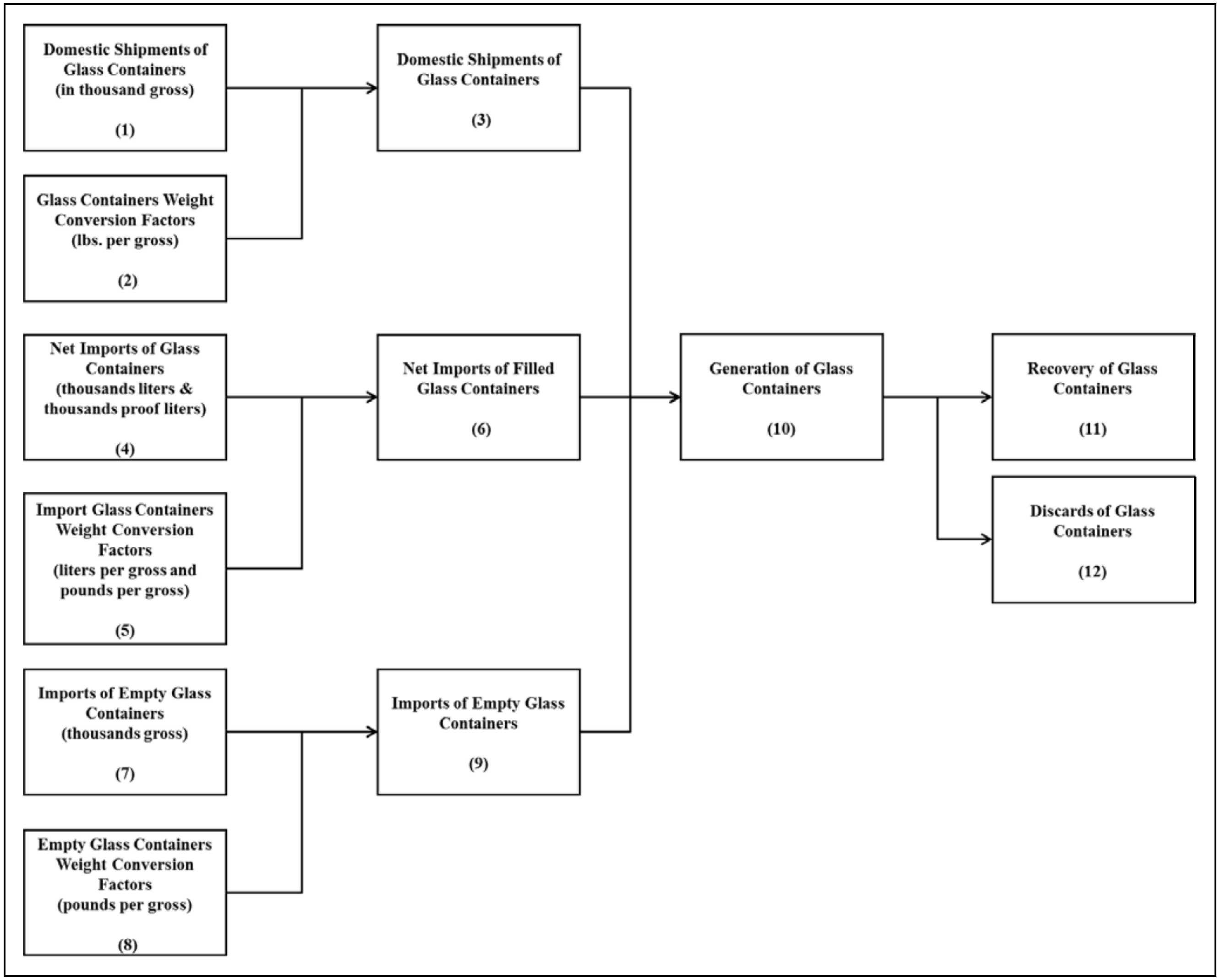

Figure 8. Material Flow Methodology: Glass Containers and Packaging

STEEL CONTAINERS AND PACKAGING

Summary

Steel containers and packaging is comprised of cans and other containers and packaging. Cans are categorized as food and nonfood cans. Other steel containers and packaging includes items such as barrels, drums, shipping pails, crowns, and strapping. Food and nonfood cans is the largest category comprising steel containers and packaging, accounting for over 80 percent of total generation.

Generation of steel cans for food and other types of cans is calculated based on consumption of tin plate and tin free steel by domestic can makers less conversion losses during the production of cans. The primary source of this information is the American Iron and Steel Institute (AlSI) annual report. Quantities of steel cans recovered are based on recovery rates determined by the Steel Recycling Institute.

Generation of other (barrels, drums, pails and all other packaging) steel containers and packaging is based on domestic shipment data compiled by the American Iron and Steel Institute. Similar to can production, AISI statistics on various steel grades into container, packaging, and shipping markets (adjusted for non-MSW markets such as the automobile industry) are used to estimate other steel containers and packaging. Recovery rates for other steel containers and packaging are based on estimates provided by the Steel Recycling Institute.

Figure 9 is a flow chart illustrating estimates of generation, postconsumer recovery, and discards of steel containers and packaging. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Domestic shipments of tin plate and tin free steel to can makers.
2. Imports of tin plate and tin-free steel to can makers = percent of total domestic shipments of tin plate and tin free steel that is shipped to can makers x total imports of tin plate and tin free steel. Assumes that the percent of total imported tin plate and tin free steel that is shipped to can makers is equal to the percent of total domestic shipments of tin plate and tin free steel that is shipped to can makers.

3. Domestic consumption of tin plate and tin free steel by can makers = domestic shipments of tin plate and tin free steel to can makers (1) + imports of tin plate and tin free steel to can makers (2).

4. Conversion loss (prompt scrap). Conversion = domestic consumption of tin plate and tin free steel by can makers x conversion loss factor of 12.5 percent.

5. Total steel in cans produced by can makers = domestic consumption of tin plate and tin free steel (3) - conversion loss (4).

6. Loss of cans by product filler = total steel in cans produced by can makers (5) x loss of cans by product filler (1 percent).

7. Generation of steel in steel food and other cans = total steel in steel cans produced (5) – loss of cans by product filler (6).

8. Recovery of steel food and other cans = industry recovery rate of steel cans x generation of steel in steel food and other cans (7).

9. Discards of steel cans = steel beverage can generation (7) - steel beverage can recovery (8).

10. Domestic shipments of steel barrels, drums, shipping pails, and other steel packaging estimated from black plate and tin-coated sheet sold into container, packaging, and shipping markets.

11. Conversion loss = domestic shipments of steel barrels, drum, shipping pails, and other steel packaging (10) x conversion loss factor (12.5 percent).

12. Generation of steel barrels, drums, shipping pails, and other steel packaging = domestic shipments (10) - converting losses (11).

13. Recovery of steel barrels, drums, shipping pails, and other steel packaging = industry recovery rate of steel barrels, drums, and shipping pails and other steel packaging x generation of steel barrels, drums, shipping pails, and other steel packaging (12).

14. Discards of steel barrels, drums, shipping pails, and other steel packaging = generation of steel barrels, drums, shipping pails, and other steel packaging (12) - recovery of steel barrels, drums, shipping pails, and other steel packaging (13).

Data Gaps

- Scrap loss for barrels, drums, and shipping pails assumed to be the same as steel cans.

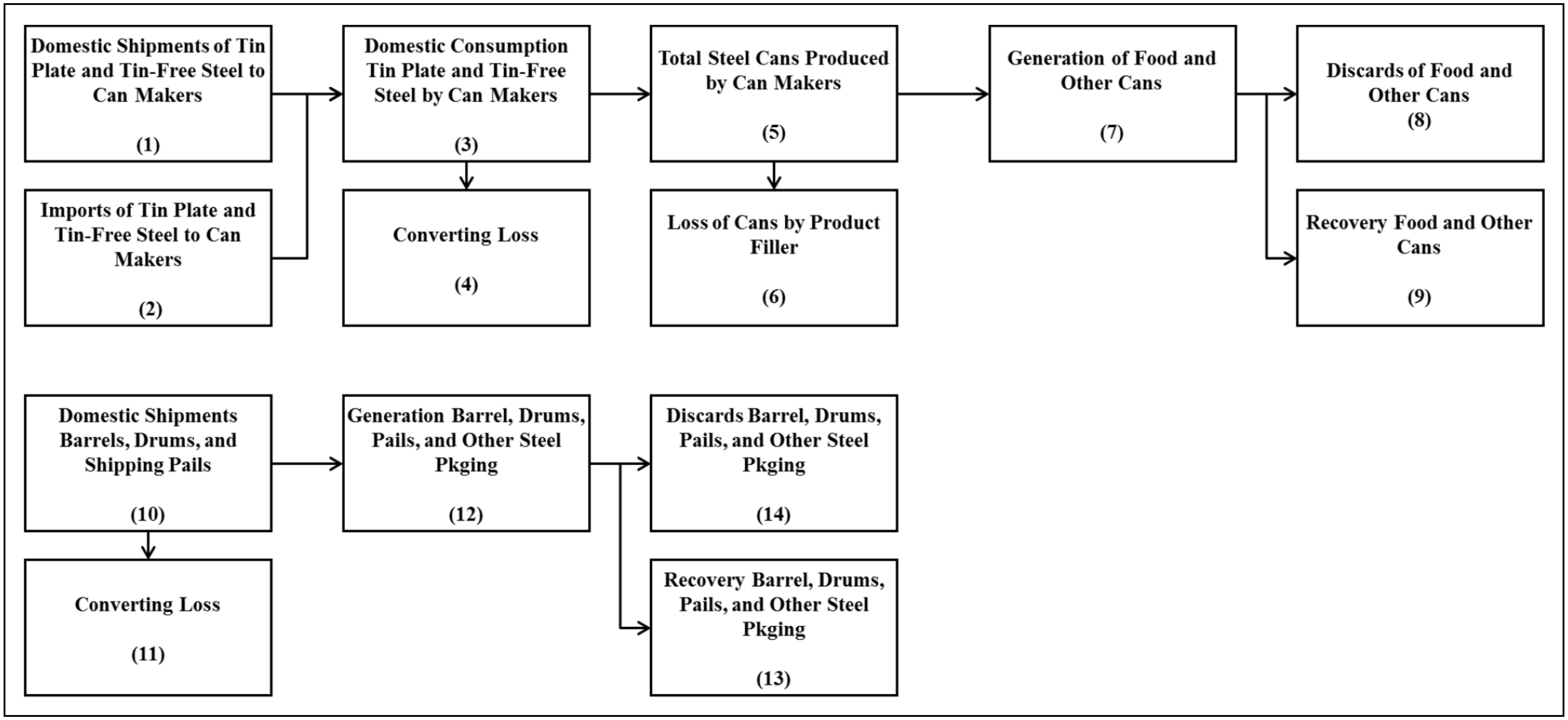

Figure 9. Material Flow Methodology: Steel Containers and Packaging

ALUMINUM CONTAINERS AND PACKAGING

Summary

Aluminum containers and packaging is comprised of cans and other containers and packaging. Cans are categorized as beverage cans (soft drink and beer), or food and other nonfood cans. Other aluminum containers and packaging includes items such as foil, closures, and aluminum lids. Beverage cans is the largest category of aluminum containers and packaging, accounting for over 70 percent of total generation.

Generation of aluminum cans is calculated based on unit can weights and can shipments. The primary source of aluminum container and packaging generation and recovery data is The Aluminum Association. Generation of aluminum foil for containers and packaging is also based on data from the Aluminum Association. Generation of closures is estimated at less than 1 percent of foil based on a discontinued data series from a Current Industrial Report of the U.S. Census Bureau.

Figure 10 is a flow chart illustrating estimates of generation, postconsumer recovery, and discards of aluminum containers and packaging. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Total domestic aluminum consumption. This includes net imports (imports – exports) based on data from Aluminum Association.
2. Conversion factor: 28.93 lbs/1,000 cans (2011). Conversion factor has decreased over time as cans are lightweighted.
3. Food and other cans = aluminum sheet and plate used for containers and packaging minus sheet and plated used domestically for beverage cans adjusted for 25 percent production scrap.
4. Shipments into household and institutional foil markets and foil used in semi-rigid food containers. Assumes a 1 percent fabrication loss. Closures assumed at 2,000 tons.
5. Generation of Aluminum containers and packaging = beverage containers (1) + food and other cans (3) + foil and closures (4).
6. Cans melted by domestic end users + exported used beverage containers (UBC) - imported UBC. UBCs recovered from foreign sources and imported to the U.S. to

be melted to produce new cans by U.S. producers are not included in the U.S. recovery estimates.

7. Discards = generation – recovery

Data Gaps

- Only aluminum can recovery estimates are available; other aluminum packaging recovery estimates are not available. Food and other cans and foil recovery estimated at 0 percent based on Aluminum Association input.

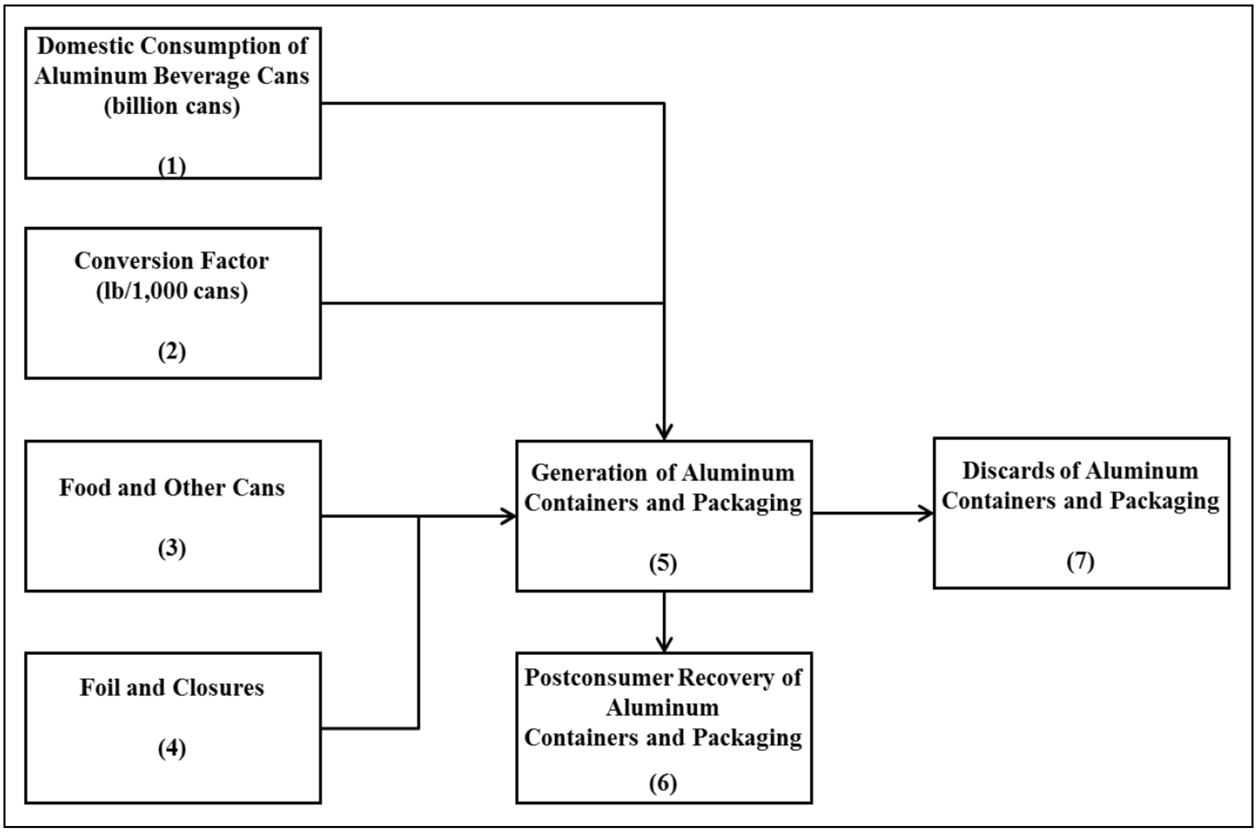

Figure 10. Material Flow Methodology: Aluminum Containers and Packaging

PLASTICS PRODUCTS

Summary

Plastics have been one of the fastest growing components of municipal solid waste (MSW) in recent years. Plastics are found in all three major MSW categories: durables, nondurables, and containers and packaging.

The primary data source for plastics production data is published annually by the American Chemistry Council in the *Resin Review.* The product line items in this annual report provide the basis for allocating resin use to specific products. Plastics in the durable goods such as appliances and lead-acid batteries and nondurable goods such as diapers and footwear are estimated using other material flow methodologies. Those categories that have lifetimes of more than one year are lagged; in other words have a temporary diversion before generation. There is an adjustment for imports and exports, as well as fabrication losses, to estimate generation.

The primary sources of data on plastics recovery are annual industry sourced recovery surveys. Two primary sources are the American Chemistry Council and the National Association for PET Container Resources (NAPCOR).

Figure 11 is a flow chart illustrating estimates of generation, postconsumer recovery, and discards of plastics in MSW products. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Domestic production of plastics from recovered and virgin resin = durable plastic products + nondurable plastics products + plastic containers and packaging. For resin sales data that include sales to Canada, total sales reduced by ratio of Canada/US population.

2. Net import adjustment factors for select products made with plastics = total net imports value (imports - exports) divided by total domestic shipment values.

3. Net imports of plastics in select products = plastic used in select MSW products (1) x net import adjustment factor (2).

4. Plastic resin used in MSW products = net imports of plastics in MSW products (3) + recovered and virgin resin (1).

5. Fabrication scrap loss = plastic resin used in MSW products x 1 percent fabrication scrap loss.

6. Apparent consumption of plastics in MSW products = plastic resin used in MSW products (4) - fabrication scrap loss (5)

7. Temporary diversion for durable and non-durable plastic products. Based on estimated useful life for durable and nondurable MSW products made with plastics

8. Generation of plastics in MSW products = apparent consumption (6) adjusted for temporary diversion for durable and nondurables (7) + generation of plastics in other MSW products (9) such as appliances and lead-acid batteries.

9. Generation of plastics in other MSW products. Source: Material flow methodologies for other MSW products (e.g., plastic from lead-acid batteries).

10. Recovery of plastics in MSW products. Includes separate recovery estimates for durables, nondurables, and containers and packaging.

11. Discards of plastics in MSW products = generation of plastics in MSW products (9) - recovery of plastics in MSW products (10)

Data Gaps

- Net import adjustment generation factors for products made with plastics do not cover all products; shipment values for some HTS/NAICS product codes are missing. Therefore imports of some plastic products are not accounted for.
- Recovery data for durable goods are limited.
- Fabrication loss may be underestimated for some products.

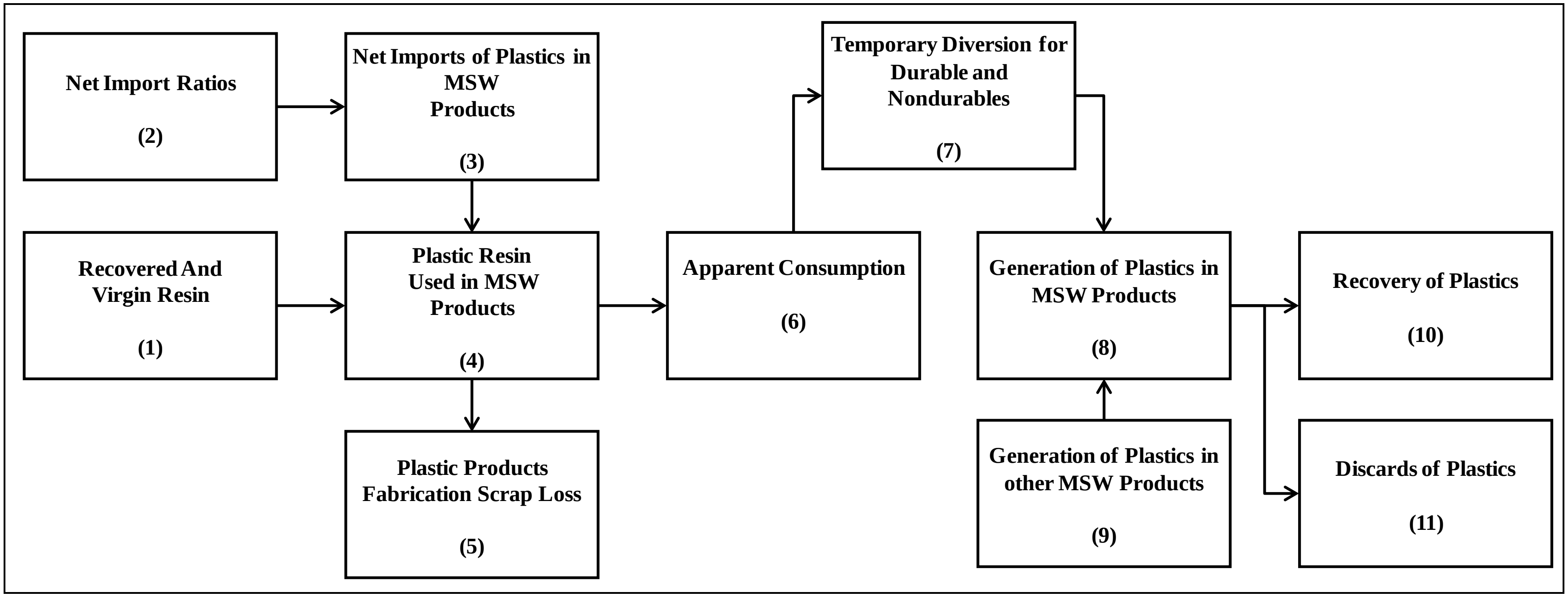

Figure 11. Material Flow Methodology: Plastics Products

WOOD PACKAGING

Summary

Wood packaging includes reusable and expendable wood pallets and other wood packaging. Other wood packaging includes crates, wooden containers, and dunnage. Pallets are estimated to account over 90 percent of total wood packaging.

Generation of wood packaging is determined from the production of new pallets each year. The primary source of new pallet production is the National Wooden Pallet and Container Association and annual market research information from the Fredonia Group. The number of pallets are converted to board foot and then to thousand tons.

Pallet Enterprise estimates the percentage of reusable versus expendable pallets produced. The number of reuses each pallet can endure is also considered. Reusable pallets are assumed to be reused four times per year. Reusable pallets weigh more and last longer than expendable pallets. Reusable pallet loss due to normal use is assumed to be 15 percent per use. Expendable pallets are assumed to be· discarded the year they are produced. Other wood packaging is estimated to be 10 percent of the total generation of pallets.

Reuse of pallets is accounted for in generation and therefore, is not included in recovery for recycling. Recovery of wood packaging includes recycling wood into compost, mulch, or similar uses. Recovery of wood packaging for fuel is not, however, included with recovery for recycling of wood packaging.

Figure 12 is a flow chart illustrating estimates of wood packaging production, generation, recovery, and discards. Each block of the diagram contains a reference number corresponding to the following remarks.

1. Total pallet production based on increase in demand from base year 2006.
2. Reusable pallet production (in units) = total pallet production (1) X percent of total pallets that are reusable (2006 data).
3. Wood use in reusable pallet production = reusable pallet production (in units) (2) X 17 board foot per pallet.

4. Reusable pallet new supply = reusable pallet new supply (in board feet) (3) X 55 pounds per board foot.

5. Reusable pallets remaining in use from previous year to current year. Reusable pallets remaining in service equals previous year's total pallet in use less pallets removed from service.

6. Refurbished reusable pallets returned to service from previous year to current year. Assumes pallets refurbished in current year are returned to service the following year.

7. Total reusable pallets in use = reusable pallets new supply (4) + reusable pallets remaining from previous year (5) + reusable pallets refurbished and returned to use from previous year (6).

8. Reusable pallets removed from service = 47.8 percent [the number of pallets removed after a 15 percent loss during each of the four reuses in a year; (100 - 15%) x (100 - 15%) x (100 - 15%) x (100 - 15%)].

9. Total reusable pallet generation = reusable pallets in use (7) – reusable pallets removed from service (8).

10. Expendable pallet production = total pallet production (1) – reusable pallet production (2).

11. Expendable pallet generation = expendable pallet production (in units) (10) X 30 pounds per pallet.

12. Other wood packaging expressed as a percent of expendable pallet production. Other wood packaging = Expendable pallet production (board feet) (10) X 20 percent.

13. Scrap loss = other wood packaging (12) X scrap loss factor (15 percent).

14. Other wood packaging generation = other wood packaging (12) - scrap loss (13).

15. Other wood packaging generation (in tons) = other wood packaging generation (14) X (.0625 cubic feet per board foot X 22 pounds per cubic foot). This calculation assumes that other wood packaging is constructed of soft wood.

16. Total wood packaging generation = reusable pallet generation (9) + expendable pallet generation (11) + other wood packaging generation (15).

17. Wood packaging recovery. Total recovery numbers also include pallets processed at landfills.

18. Wood packaging Discards = total wood packaging generation (20) – wood packaging recovery (17).

Data Gaps

- Pallet production data is based on projected market growth instead of actual units produced.
- Current data on other wood packaging production are not available.
- Current recovery and end-of-life management data are not available. Recovery and end-of-life management trended from a 2009 article using 1999 though 2006 data.[1]

[1] Robert J. Bush, Philip A. Araman. "Pallet Recovery, Repair and Remanufacturing in a Changing Industry: 1992 to 2006". August 2009. *Pallet Enterprise*.

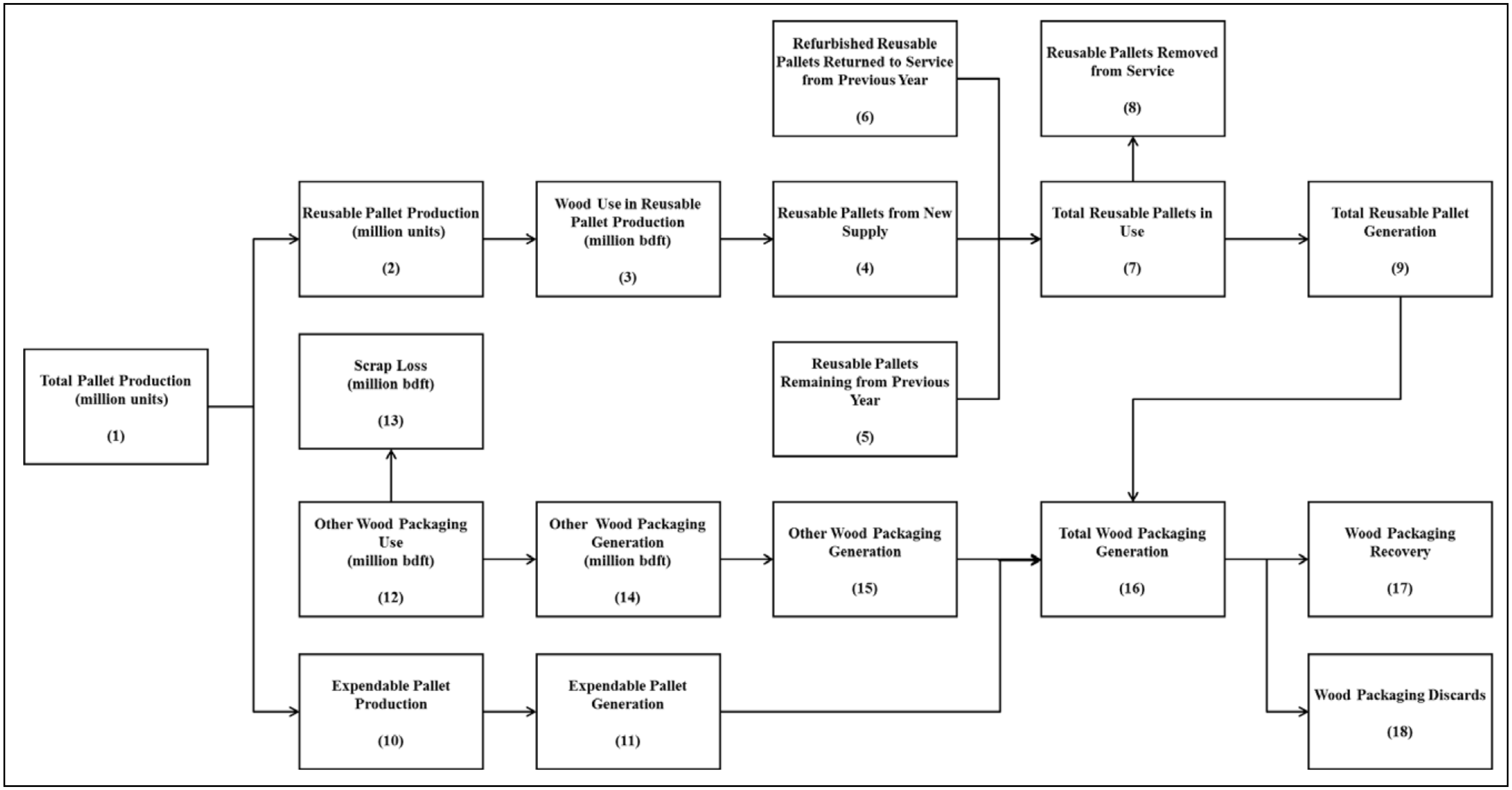

Figure 12. Material Flow Methodology: Wood Packaging

FOOD WASTE

Summary

Food waste consists of uneaten food and food preparation wastes from residences, commercial establishments such as grocery stores and sit-down and fast food restaurants, institutional sources such as school cafeterias, and industrial sources such as factory lunchrooms. Preconsumer food waste generated during the manufacturing and packaging of food products is considered industrial waste and therefore not included in MSW food waste estimates.

Food waste from residential and commercial sources is estimated using factors based on data from sampling studies in various parts of the country in combination with demographic data on population, grocery store sales, restaurant sales, numbers of employees, and numbers of students, patients, and prisoners in institutions. The residential and commercial sourced factors are reviewed and revised as more sampling studies become available.

Figure 13 is a flow chart illustrating estimates of generation, recovery, and discards of food wastes. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Average residential food waste generation factor (lb per person per day). Data range is from 0.16 to 0.67 pounds per person per day. This data range is from curbside sampling in Arizona, California, Canada, Illinois, Minnesota, Missouri, Vermont, Washington, Wisconsin. Lower end data from Minnesota and Wisconsin; higher end data from Arizona and California.
2. Generation of residential food waste = average residential food waste factor (1) X U.S. population.
3. Average commercial food waste generation factors. Generation factors developed from sampling studies conducted in the following sectors: grocery stores, restaurants, prisons, educational institutions, nursing homes and residential hospitals, hotels, and employee cafeterias.
4. Generation of commercial food waste = average commercial food waste factors (3) X appropriate demographic and economic statistics.
5. Total generation = residential food waste (2) + commercial food waste (4)
6. Recovery through food waste composting. Recovery estimated from state agency data on food waste composted. See data gaps for further discussion.

7. Recovery through mixed MSW composting as tabulated by *BioCycle*.[2]

8. Total recovery through composting = food waste composting (6) + mixed MSW composting (7).

9. Discards = generation (5) – recovery (8).

Data Gaps

- Recovery through MSW composting includes non-food products and materials.

- Some food waste may be collected with yard trimmings and not accounted for as food waste recovery.

- There may be some additional commercial and institutional sources of food waste that are not accounted for due to the lack of available onsite sampling studies.

- State agency reported food waste composted may include non-MSW food waste from industrial sources including high volume food waste composting from processors. Recovery data for food waste other than composting is not available (e.g., food donations).

- Latest available state agency reported food waste recovery through composing data are used, therefore data year will vary. Methodology assumes food waste composting is fairly constant (i.e., an established composting program continues to operate, at a minimum, at the last reported level). For 2011, data were found for 33 states with the following data years

Number of States	Data Year
1	2008
7	2009
17	2010
8	2011
33	Total

[2] Latest data: Dan Sullivan. Mixed Waste Composting Facilities Review. Nationwide Survey. *BioCycle*. November 2011. Available online at: http://www.westwendovercity.com/.

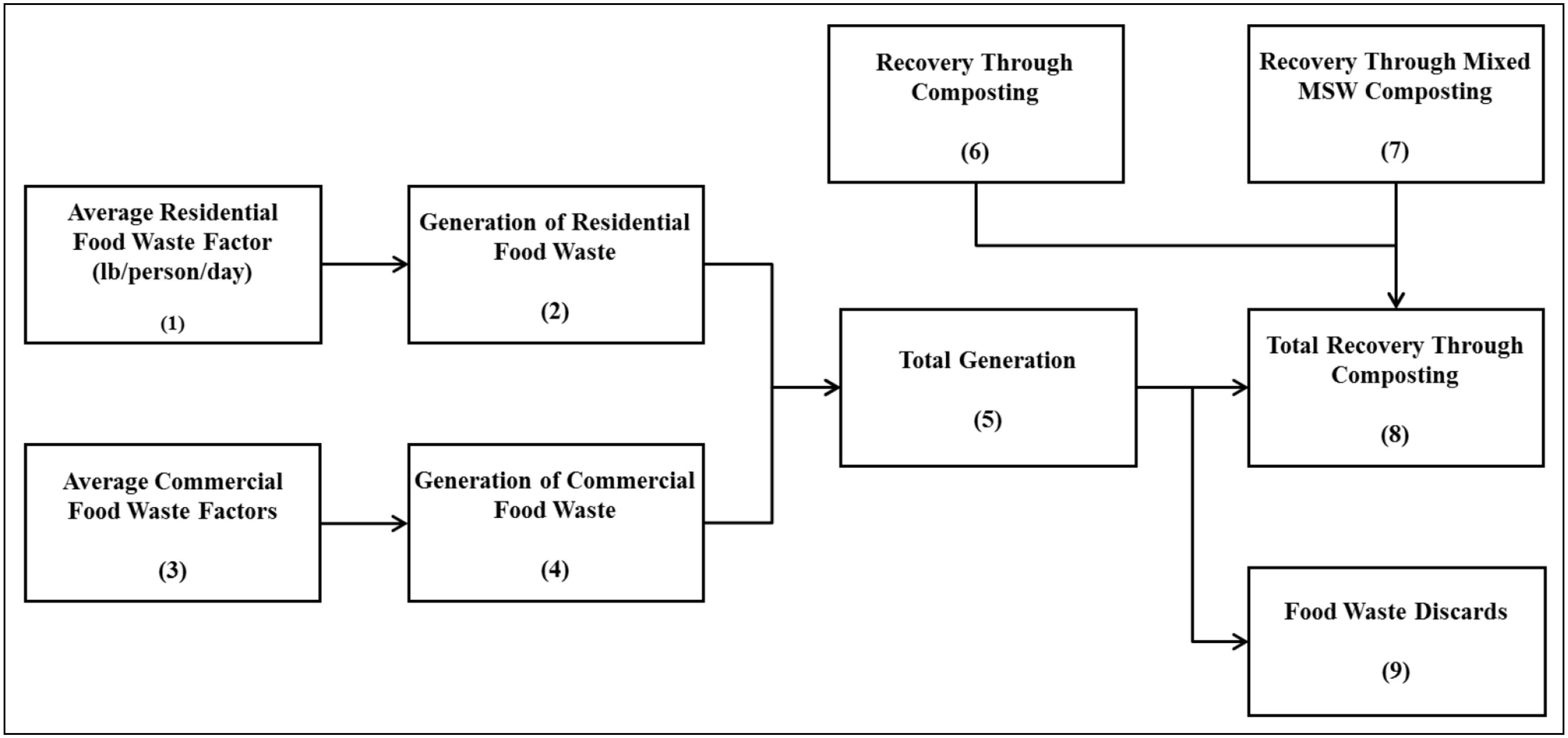

Figure 13. Material Flow Methodology: Food Waste

YARD TRIMMINGS

Summary

Yard trimmings include grass, leaves, and tree and brush trimmings from residential, institutional, and commercial sources. Yard trimmings do not include trees from these sources, vegetative clearing by utility companies, or land clearing for development.

The definition of yard trimmings includes the amount that enters the solid waste management system and does not include yard trimmings managed on-site through backyard composting or mulching. Yard trimmings generation is based on a factor developed in 2006 from data on yard trimming generation (in pounds per person per year) from all regions of the U.S. applied to U.S. population from Census Bureau *Current Population Reports*.

While in past years generation of yard trimmings had been increasing steadily as population and residential housing grew (i.e., constant generation on a per capita basis), in the 1990s local and state governments started enacting legislation that discouraged yard trimmings disposal in landfills and encouraged source reduction. Legislation affecting yard trimmings disposal in landfills was tabulated, using published sources. In 1992, 11 states and the District of Columbia–accounting for more than 28 percent of the nation's population–had legislation in effect that bans or discourages yard trimmings disposal in landfills. The tabulation of current (2011) legislation shows 22 states representing about 40 percent of the nation's population have legislation affecting disposal of yard trimmings. In addition, some local and regional jurisdictions regulate disposal of yard trimmings. This has led to an increase in source reduction such as backyard composting and the use of mulching mowers to allow grass trimmings to remain in place since the early 1990's.

Recovery for composting of yard trimmings is estimated using information from state composting programs. State reported composting tonnages may vary on a yearly basis with the amount of storm debris composted. It should be noted that the estimated recovered yard trimmings for composting does not include yard trimmings recovered for direct land spreading disposal. It also should be noted that these recovery estimates do not account for source reduction activities taking place onsite; the yard trimmings recovery estimates are based on material sent off-site for management.

Figure 14 is a flow chart illustrating estimates of generation, recovery, and discards of yard trimmings. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Generation of yard trimmings before source reduction = current U.S. population x 281 pounds per person per year (based on EPA funded data gathering in 2006).
2. Generation after source reduction. Assumed based on 50 percent reduction in states affected by legislation and 40 percent of the US population affected by legislation. 100% x 50% x 40% = 20%.
3. Recovery estimates compiled from states with yard trimmings legislation. Recovery data gathered from state environmental agencies; 22 state environmental websites researched for yard trimmings composting data.
4. Recovery in all states with yard trimmings legislation including states that do not report data. States not reporting data were estimated from per capita rates in states with data (3) that have legislation.
5. Recovery estimates compiled from states without yard trimmings legislation. Recovery data gathered from state environmental agencies; 28 state and District of Columbia environmental websites researched for yard trimmings composting data.
6. Recovery in all states without yard trimmings legislation including states that do not report data. States not reporting data were estimated from per capita rates in states with data (4) that do not have legislation.
7. Recovery reported as mulch. Data gathered from various state environmental agencies.
8. Total Recovery = recovery in all states with yard trimmings legislation (4) + recovery in all states without yard trimmings legislation (6) + recovery reported as mulch.
9. Discards = generation (2) – total recovery (8).

Data Gaps

- Source reduction is based on the assumption that legislation is the major driver. This assumption is out dated. Many states and local governments aggressively promote source reduction without legislation. Additionally, as states repeal yard trimmings legislation, the impact on source reduction has not been researched.
- Some states do not report data on composting programs. Developed per capita recovery factors from states with data applied to population in states with no reported data.

- State agency recovery data may include storm debris data that are not accounted for in the generation estimate.
- State agency recovery data may include other non-yard trimming materials not included in the generation estimate such as food waste.

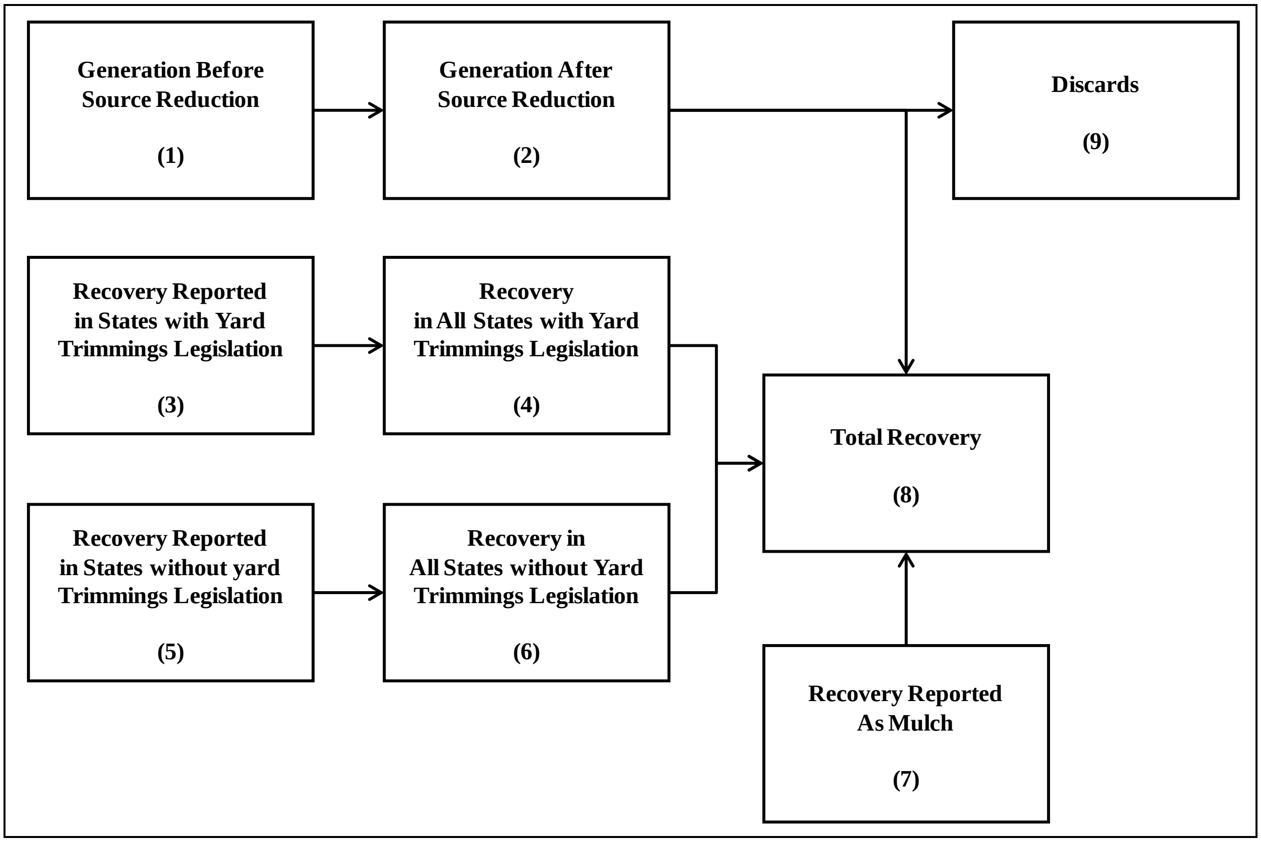

Figure 14. Material Flow Methodology: Yard Trimmings

SCRAP TIRES

Summary

Used tires (scrap tires) from cars and trucks are considered in the material flows methodology. Used tires from buses, heavy-duty tractor trucks, and farm and construction equipment are not included.

The basic components of tires include natural and synthetic rubber, plasticizers, and carbon black, steel wire, and fabric—in the form of nylon, polyester, and metallic cords. For the material flows methodology, material components of a tire are classified as rubber, steel, and textiles.

Scrap tires are generated when tires are replaced on registered vehicles and when tires are removed from vehicles that are taken out of service and deregistered. Scrap tires may also be imported into the United States for end-of-life management. The materials flow methodology assumes one tire is removed from service for every replacement tire sold and four tires are removed from service for every deregistered vehicle. An average weight is assumed for calculation of quantities for used tires material generated from the number of tires. Recovery of used tires for recycling is estimated from the Rubber Manufacturers Association (RMA) data and does not include recovery of used tires for fuel uses.

The primary sources of data for calculations associated with scrap tires are the RMA, the U.S. Department of Commerce International Trade Commission (ITC) online database, the National Automobile Dealers Association, and Modern Tire Dealer Magazine statistics.

Figure 15 illustrates generation, postconsumer recovery, and discards of used tires. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. Number of domestic vehicle replacement tires sold = car replacement tires + truck replacement tires. Assumes a used tire is generated for every replacement tire sold.
2. Number of deregistered vehicle tires = (car deregistrations x 4 tires/vehicle) + (truck deregistrations x 4 tires/vehicle). Assumes four tires are removed from service for every deregistered vehicle. To determine the number of deregistered

cars separately from deregistered trucks, the number of total deregistered vehicles was multiplied by the percent operational cars represented of total operational cars and trucks.

3. Imported used tires.

4. Total used car and truck tires = replacement car tires + replacement truck tires + deregistered car tires + deregistered truck tires + imported used tires.

5. Used tire weight conversion factors for cars and trucks. Car conversion factor (22.5 pounds per used tire, average); truck conversion factor (66 pounds per used tire, average).

6. Total used tires = (car used tires (units) x unit weight of car tire (lbs per tire) + truck used tires (units) x unit weight of truck tire (lbs per tire)) ÷ 2,000 lbs per ton.

7. Material composition of used tires (percent of used tire weight) = Rubber (64.0 percent) + textiles (19.2 percent) + steel (16.8 percent). Material composition of used tires equals the composition of new tires adjusted for rubber loss during use. Rubber loss during use is assumed to be 20 percent.

8. Material composition of used tires (tons). Rubber = total used tires x percent of used tire that is rubber (64.0 percent); Textiles = total used tires x percent of used tire that is textiles (19.2 percent); Steel = total used tires x percent of used tire that is steel (16.8 percent).

9. Net car tire retreads diverted in current year = current year car tire retreads – car tire retreads two years previously. (Note: assumes average car tire retreads have a useful life of two years and then the retread tires are ready for end-of-life management.)

10. Net truck tire retreads diverted in current year = current year truck tire retreads – truck tire retreads one year previously. (Note: assumes average truck tire retreads have a useful life of one year and then the retread tires are ready for end-of-life management.)

11. Net tire retreads = net car and truck retread tires (units) x unit weight of tire (lbs per tire) ÷ 2,000 lbs per ton. Net tire retreads reenter MSW generation.

12. Generation of used tires = used tires – tires diverted to retreading (tons) + used tire retreads from previous years ready for end-of-life management (tons).

13. Recovery of used tires for recycling = generation of used tires x recovery rate of used tires. (Note: tires recovered for fuel use not included in this recycling rate.)

14. Discards of used tires = generation of used tires – recovery of used tires for recycling.

Data Gaps

- Deregistered vehicle data are only available as total vehicles and do not distinguish between cars and trucks. To determine the number of used tires generated from deregistered cars separately from deregistered trucks, the number of total deregistered vehicles was multiplied by the percent operational cars represented of total operational cars and trucks.

- The number of scrap tires generated from deregistered vehicles (four per vehicle) does not include spare tires. No available data have been identified to estimate the occurrence or size (full size or space-saver) of spare tires removed when vehicles are deregistered.

- Imported used tires are assumed to be car tires. This assumption needs to be reviewed.

- Average weight of used truck tires is the average of light duty and commercial truck tires (including medium and heavy duty trucks). No available data have been identified to determine the ratio of used tires from light, medium, and heavy duty trucks.

- Composition of used tires is adjusted by applying a percent rubber loss due to wear to new tire composition. This assumption needs to be reviewed.

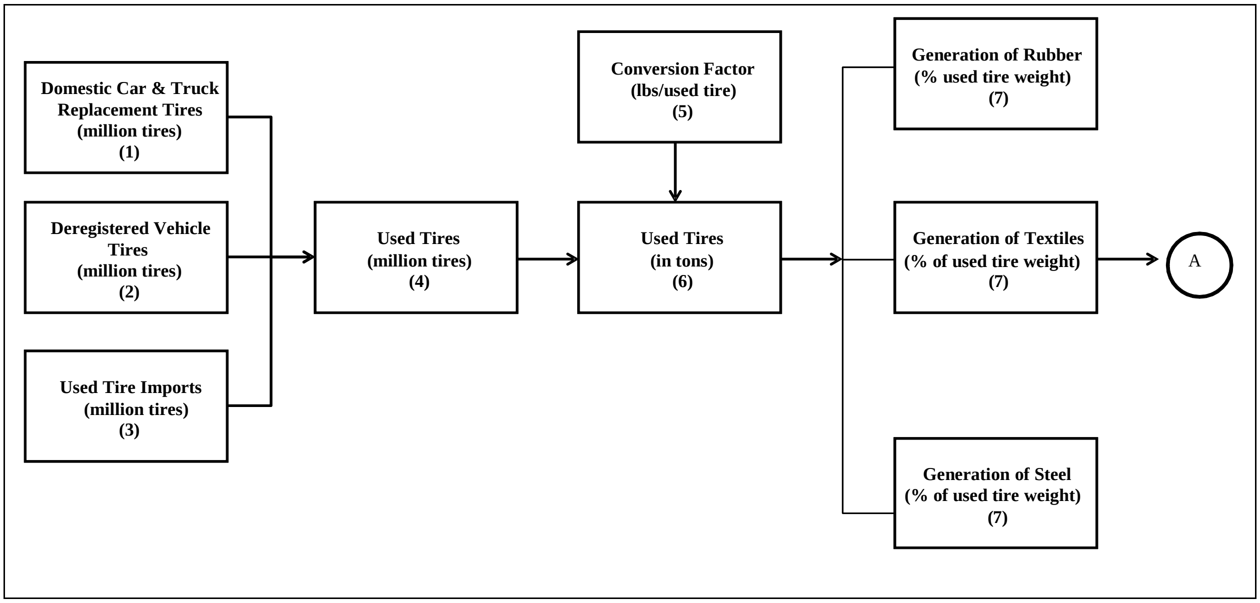

Figure 15. Material Flow Methodology: Used Tires

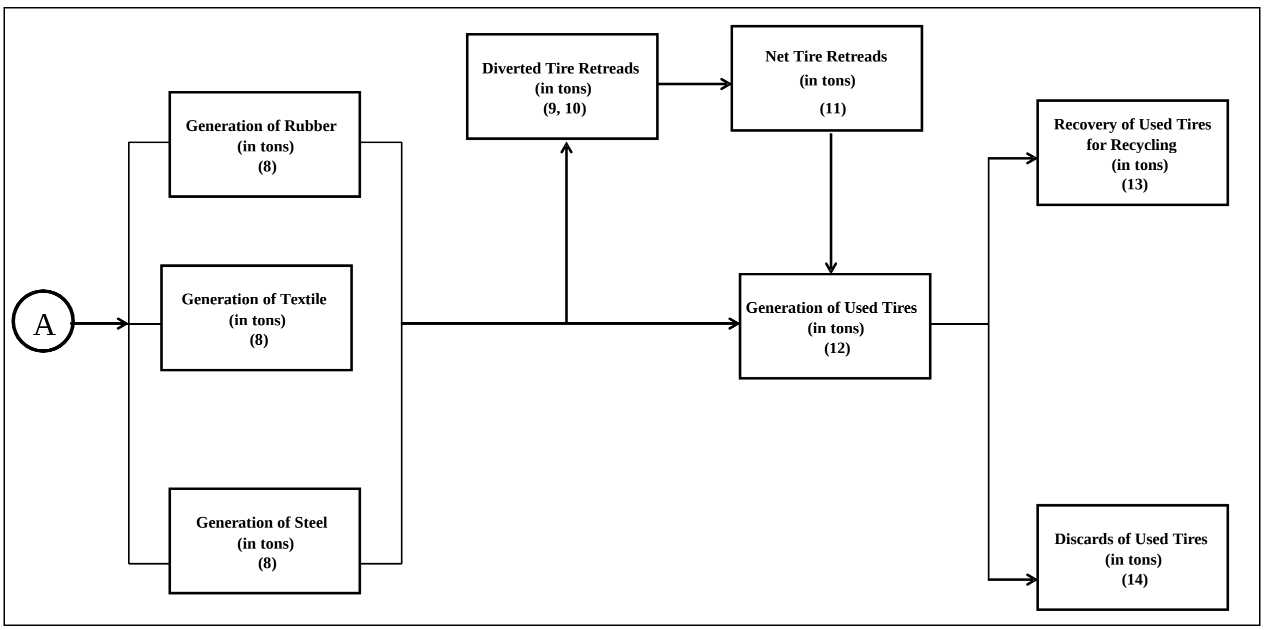

Figure 15. Material Flow Methodology: Used Tires (Continued)