SOLID WASTE GENERATION AT MTU

Introduction

Environmental Engineers in a variety of job types will continue to deal with the problem of solid waste disposal for the next several decades. Decisions regarding solid waste disposal are made by environmental divisions of corporations (e.g., 3M reduced its chemical waste flows by 50% in less than 10 years; AT&T has set the goal to reduce solid waste by 25%, reduce paper use by 15%, and increase paper recycling to 35%), by environmental consulting firms (e.g., in design of landfills, design of waste incinerators), and by environmental divisions of municipal, state and federal governments (e.g., the huge landfill for New York City is closing because it has been filled to capacity). Given that we generate 4.3 pounds of waste (this is just municipal solid waste) per person per day in the U.S. ($> 4 \times 10^{11}$ lbs/yr), considerable work will remain for future engineers.

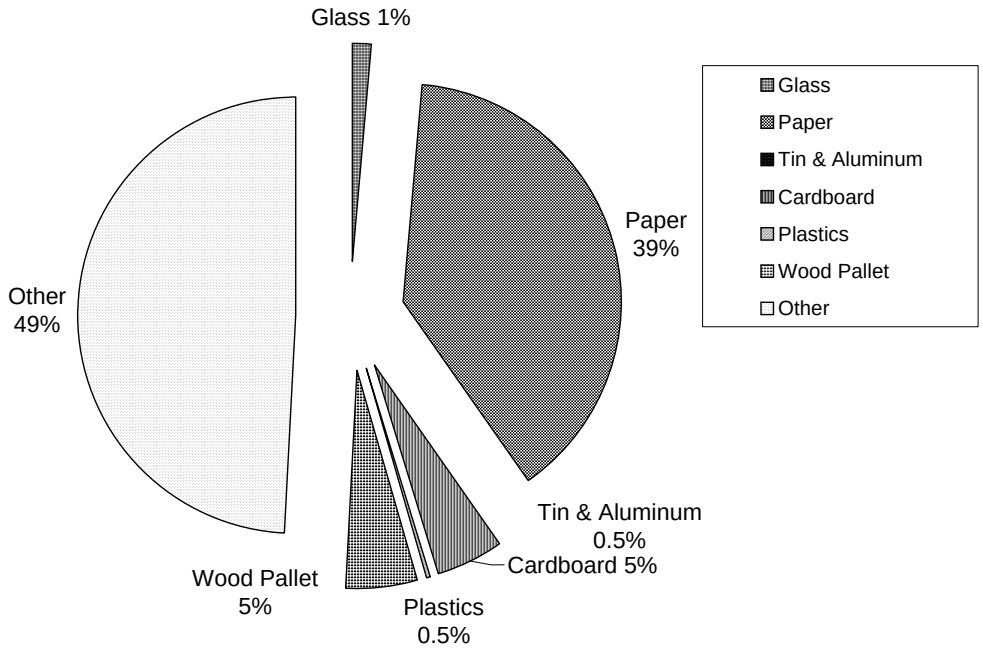
Some very important decisions regarding solid waste are made by every individual on a daily basis. First, it is a personal choice how much solid waste we generate. Individual households have shown that it is possible to generate only 0.5 pounds per person per day even in the U.S. In northern Europe where the standard of living is comparable to that in the U.S., rates of solid waste generation average less than one pound per person per day.

What choices do we as individuals have? The choice to return beverage containers (return rates range from 0-90% in the U.S. depending largely on the size of the deposit), the choice to recycle (recycling rates range from 0 to as high as 86%; Seattle boasts a recycling participation rate of 63%; the U.S. average is 15% of the solid waste stream is recycled), the choice to avoid unnecessary packaging when possible, the choice of food products that have reusable or recyclable containers, and the choice to minimize patronage of those fast food vendors who use only disposable food containers are some of the more obvious choices that we make on a daily or weekly basis. Other choices that will confront you less frequently include the community in which you live (does it have recycling programs), the politicians for whom you vote, the contractors whom you choose for building projects (some contractors now have policies to reduce use of wood), and the pressure you bring to bear on your local communities to develop responsible solid waste management plans. Information to help you make informed decisions about recycling may be found on the web at: www.epa.gov/recyclecity/ Included in this handout is information on the recycling opportunities that are available in and around Houghton.

What is the significance of solid waste generation? If the problem with solid waste was simply the expense incurred in disposing of it, market forces ultimately would solve the problem. Tipping fees, the price charged to municipalities by landfills, have risen from $5/ton to >$50/ton in the U.P. in roughly 15 years; costs are much higher for large cities. Ideally, this cost is passed directly back to residents through garbage service fees or garbage bag charges (as in Houghton and Hancock). Increased prices bring pressure on people to reduce the amount of trash (or to dump trash in the woods). However, the costs of waste disposal are only one part of the picture. Another part of the picture is the energy consumption associated with trash generation. About 25% less

energy is required to produce molten glass from crushed glass than from sand. Reuse of a glass beverage container 10 times will reduce the energy required to provide that container by nearly 80%; reusing it just once would reduce the energy requirement by about 30%. The pressure on renewable and nonrenewable resources represents another major impact of waste generation. There would be little need to cut the remaining old-growth timber if waste of wood in construction was minimized. At present, the impact of waste generation on CO_2 emissions (emissions generated by fuel consumption required to produce the waste) may be the most serious problem.

A key factor that influences if and how much solid waste streams can be reduced is the composition of the waste stream. The accompanying handout from the EPA documents the average composition of municipal solid waste produced in the U.S. (see http://www.epa.gov/osw/nonhaz/municipal/msw99.htm). Clearly, the impact of recycling programs will depend on the fraction of recyclable material in the waste stream.



The feasibility of incineration will depend on the fraction of

Figure 1 Waste Composition at MTU. The figure represents the solid waste distribution (% mass) for a total truck load of 3.14 tons of which about 20-25% was sampled. Sample date was 9/25/97. The "other" category consists of food containers, hardware, and nonrecyclable paper and cardboard.

the waste that is combustible. Solid waste produced by businesses differs greatly from solid waste generated in the home. A senior design class determined the composition of the 100 tons/month of waste produced by MTU in 1997 (Fig. 1). This study showed that Michigan Tech generated 1,200 tons of solid waste annually for a disposal cost of $115,000 (in 1997). The generation rate is approximately 1 pound per student per day which is much lower than the average for the U.S. population (4.3 pounds per person per day) and at other universities. Paper makes up over one third of the waste stream. Glass, tin and aluminum, and plastics make up only a few percentage points a piece. The

objective of this lab is to determine the composition of the waste generated by one building within the university and to recommend ways to reduce this waste stream. For help in formulating recommendations, information on recycling in Houghton and the Keweenaw area is included at the end of this handout.

Procedure:

The custodians have delivered to us all of the waste collected in the Environmental Sciences and Engineering Building on Thursday and Friday. Because of waste generated on the weekend, Mondays represent the largest load of waste removed each week. We will sort the waste into the categories listed in the table below.

Be sure to wear your lab coat, plastic gloves and face mask while sorting. Each group will work together on sorting the contents of bags of garbage. Empty the contents of the bag onto the floor, and then transfer the contents to the other garbage bags labeled according to the waste categories above. If hazardous substances are encountered (needles, chemicals, containers marked radioactive), we will set these aside in a box. When the class has finished sorting the garbage, weigh each of the bags to determine the relative amounts in each category. Fill in the table below, and include it in your lab report.

Category	Volume (L)	% of Total	Pounds	% of Total
Newsprint				
Office paper				
Glossy paper (magazines, journals, advertizements)				
Glass				
Aluminum				
Other metal				
Cardboard				
Styrofoam peanuts				
Other plastics				
Other (including other paper)				
Organic matter (e.g., food)				

Report:

RESULTS: (To be incorporated into the text)

1. Make two pie charts of the ESE Bldg. garbage composition, one in units of % by volume, the other in % by weight.

2. Include the table above with any additional categories that you find are necessary.

POINTS TO DISCUSS:
1. Why is the composition of the waste that you sorted different from the composition of the average municipal solid waste in the U.S.?

2. Is the composition of the waste that you sorted different from the average composition of MTU's waste as shown in Figure 1 above? Provide enough information on the statistical test that you use to answer the question so that a reader could repeat the test and get the same results. Why might the Dow waste be different from that shown in Fig. 1?

3. Does your conclusion about the most important waste category change when units of volume are used rather than units of weight? Which is most appropriate to use?

4. Based on the composition of waste in the ESE building and on the list of materials that is recyclable in Houghton, what materials would you recommend be recycled in this building? Explain the factors that you considered in reaching this decision. Estimate how much you think that the total mass of waste could be reduced.

5. Based on the information provided below, has the generation of waste in the Dow Building changed in composition or quality in the past 8 years? Explain any statistical tests that you use to support your conclusions.

6. If MTU institutes a recycling program, it will be important to document the magnitude of the change in the waste stream and to determine the recovery rate of recycled materials. Propose a system for determining in a statistically valid fashion the extent to which the waste stream is reduced by recycling operations, and the fraction of recycled materials that are recycled (i.e., the recovery rate or recycling efficiency).

	1999	2000	2002	2007	2008	2009
Category	% Wt.	% Wt.	% Wt.	% Wt.	% Wt.	% Wt.
Newsprint	2.38%	0.42%	1.29%	0.37%	0.9%	0%
Office Paper	32.23%	28.77%	27.74%	5.81%	8.7%	13%
Glossy paper	8.80%	7.18%	11.61%	7.93%	7.0%	0%
Recyclable paper	43.40%	36.38%	40.65%	14.11%	16.65%	13.00%
Glass	0.11%	3.48%	3.23%	1.98%	4.5%	3%
Aluminum	0.15%	0.00%	1.29%	0.99%	3.3%	1.60%
Other metal	0.00%	2.25%	3.87%	0.35%	0.0%	
Cardboard	8.52%	4.78%	4.52%	12.59%	11.6%	14.90%
Styrofoam peanuts	0.62%	0.00%	0.65%	2.23%	0.5%	0%
Other plastics	2.45%	6.98%	8.39%	25.60%	23.9%	16.70%
Other (including other paper)	37.89%	35.87%	23.87%	27.10%	24.1%	37.70%
Organic matter (e.g. food)	6.85%	10.27%	13.55%	15.05%	15.4%	13.20%

Recycling in the Keweenaw

Keweenaw businesses support recycling of the items below

ANTIFREEZE

Dave's Marathon	Hancock	482-3410	

APPLIANCES, LARGE NON-REFRIGERATION: oven, washer, dryer, water heater, etc.

Keweenaw Scrap Metal	Calumet	337-3699	No charge
Julio Contracting	Ripley	482-2650	$10/unit + pick-up fee

APPLIANCES, LARGE REFRIGERATION: refrigerator, freezer, air conditioner, etc.

A *Tag* certifies that a unit has been processed by a Professional Freon Remover, indicated below with **

Julio Contracting	Ripley	482-2650	$30 w/tag, $55 w/o tag
Keweenaw Scrap Metal	Calumet	337-3699	No charge w/tag
** *Pillowman Appliance*	Chassell	523-4213	$60/unit—remove Freon, tag & recycle
** *Brian Bekkala Repair*	Calumet	337-5781	$50/unit—remove Freon, tag & recycle

BATTERIES, LEAD-ACID: car, boat, motorcycle, tractor, etc.

Dave's Marathon	Hancock	482-3410	
Fine Line Tire	Hancock	482-6268	No cracked or leaking cases
Wal-Mart	Houghton	482-0639	With purchase of new battery
Swift True Value Hardware	Houghton	482-0530	
Keweenaw Scrap Metal	Calumet	337-3699	
Julio Contracting	Ripley	482-0666	

BATTERIES, RECHARGEABLE: Ni-Cad, Ni-MH, Li-ion, small sealed lead. See www.rbrc.com for more info

Cellular One	Houghton	482-8484	
Wal-Mart	Houghton	482-0639	
Swift True Value Hardware	Houghton	482-0530	

CELL PHONES

Wal-Mart	Houghton	482-0639	
Cellular One	Houghton	482-8484	

ELECTRONICS: computers, televisions, phones, microwaves, VCRs, batteries, fluorescent tubes, etc.

Western UP District Health Dept RSVP Program		482-7382	www.wupdhd.org/rsvp/e-waste.html

MOTOR OIL, USED

Houghton Co. Transfer Station	Houghton	482-8872	
Dave's Marathon	Hancock	482-3410	

PACKING MATERIALS: peanuts, bubble wrap, flexible foam, used coolers (and outer cartons)

The Shipping Shop	Houghton	487-6167	Place clean, loose materials in a plastic bag
Superior Shipping	Houghton	482-2646	Peanuts / bubble wrap

PAINT, LATEX

Marquette Wallpaper & Paint	Marquette	228-8376	$1/can, *Benjamin Moore* and *Mautz* brands free
Houghton Co. Transfer Station	Houghton	482-8872	Must be dry in the can

PLASTIC SHOPPING BAGS

Wal-Mart	Houghton	482-0639	

PRINTER INK CARTRIDGES

Wal-Mart	Houghton	482-0639	

SCRAP METAL, FERROUS & NON-FERROUS: copper, aluminum, steel, junk cars, etc

Julio Contracting	Ripley	482-2650	$10/unit + pick-up fee
Keweenaw Scrap Metal	Calumet	337-3699	
Houghton Co. Transfer Station	Houghton	482-8872	No cars or refrigerators

TIRES: price per tire

Fine Line Tire	Hancock	482-6268	Car / Light Truck $3.25, Large Truck $7.40
The Tire Shop	Hancock	482-1850	Car $3, Light Truck $4, Large Truck varies
Dave's Auto	Laurium	337-5020	Car / Light Truck $3.50

WASTE MANAGEMENT RECYCLING GUIDELINES

Each recycling program has special guidelines that depend on available markets. Just because something is recyclable in other locations does not mean it is here, but we can recycle a lot! Please follow the guidelines below. If contamination becomes a problem, we may have to start charging customers to drop off recycling.

ACCEPTABLE ITEMS

Office paper (any color **except fluorescent** bond, photocopy, printer/laser, notebook, legal, fax, plotter); shredded is OK, if placed in plastic bags. **Remove staples & clips.**
Envelopes (labels and windows OK)
White, pastel, interoffice, brown envelopes w/string closure. **NO Tyvek** (reinforced-fiber) **or padded** envelopes
Magazines and catalogs
Newspapers and inserts
Telephone books
Post-it™ notes
Junk mail (unopened OK)
Paperback books
Soft cover computer manuals
Hard cover books
Manila file folders
White/pastel packing paper (**NO tissue)**
White boxboard or card stock
Soft drink or beer cartons
Cereal box-type cardboard (remove inner packaging)
Paper bags or other brown paper
Gray paperboard, boxboard, egg cartons
Dark-colored accordion files
CORRUGATED CARDBOARD (**flatten; remove staples**)
PLASTICS #1 PETE or #2 HDPE only (**rinse**)
PLASTIC BAGS (grocery store bags)
METAL cans, tin cans, jar lids and foil products (**rinse**)

Remove paper clips and staples.
Small amounts of tape are OK.

SUMMER HOURS: MAY 1-OCT 31

Mon., Tue., Wed., Fri.	**9 am – 3 pm**
Thursday	**9 am – 7 pm**

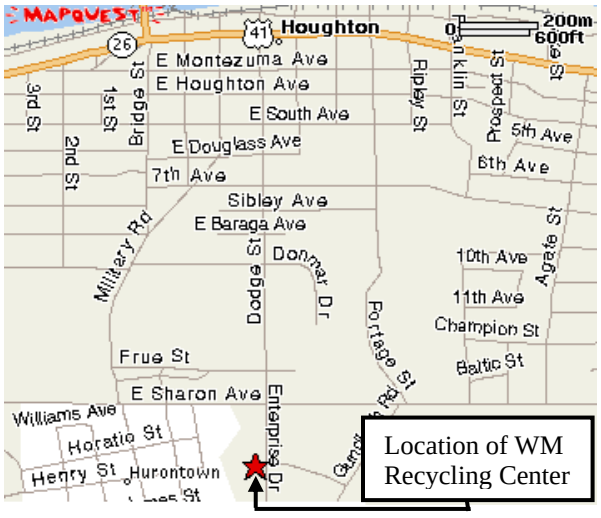
WINTER HOURS: NOV 1-APRIL 30

Mon. and Wed.	**8 am – 5 pm**
Thursday	**8 am – 7 pm**

UNACCEPTABLE ITEMS

NO Plastic transparencies or photographs
NO Metal spiral or plastic ring bindings
NO Candy wrappers or chip bags
NO Pizza boxes or other food containers
NO Brightly colored (fluorescent) paper
NO Tyvek (reinforced-fiber) or padded envelopes
NO Paper towels, napkins, or tissue paper
NO Dark-colored hanging files
NO Carbon paper (carbonless is OK)
NO Wax paper
NO Paper ream wrappers (most are plastic-coated or tan inside)
NO GLASS of any kind
NO PLASTIC other than #1 PETE or #2 HDPE

OUR RECYCLING PROGRAM IS NOW SINGLE STREAM. ALL ACCEPTABLE RECYCLING MAY BE MIXED.



1108 Enterprise Drive • Houghton • 482-0320
S. of Sharon Ave., across from Charter Communications

10-01-08

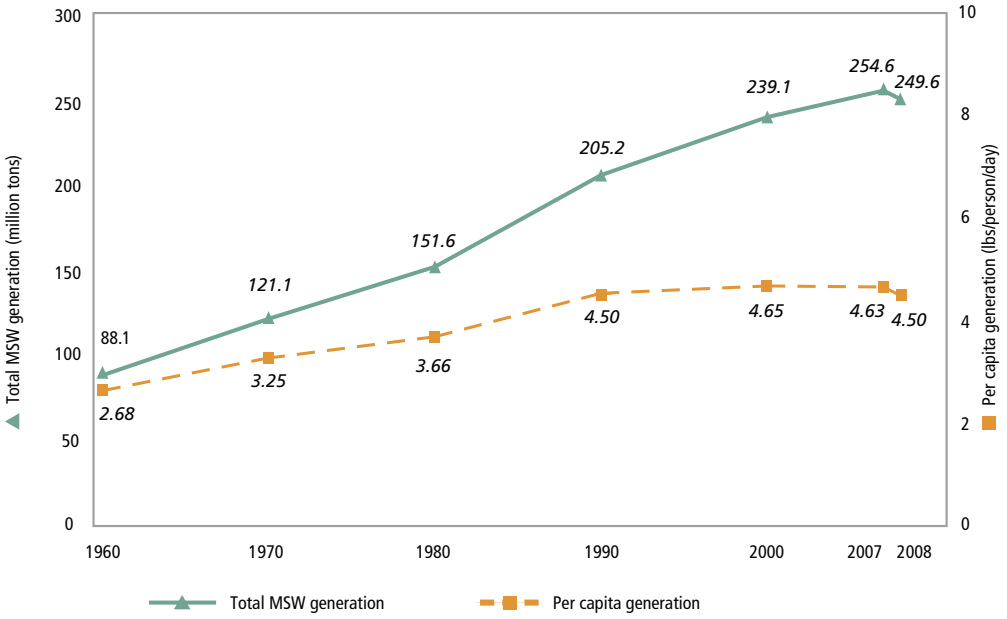
EPA
United States
Environmental Protection
Agency

Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008

The U.S. Environmental Protection Agency (EPA) has collected and reported data on the generation and disposal of waste in the United States for more than 30 years. We use this information to measure the success of waste reduction and recycling programs across the country. These facts and figures are current through calendar year 2008.

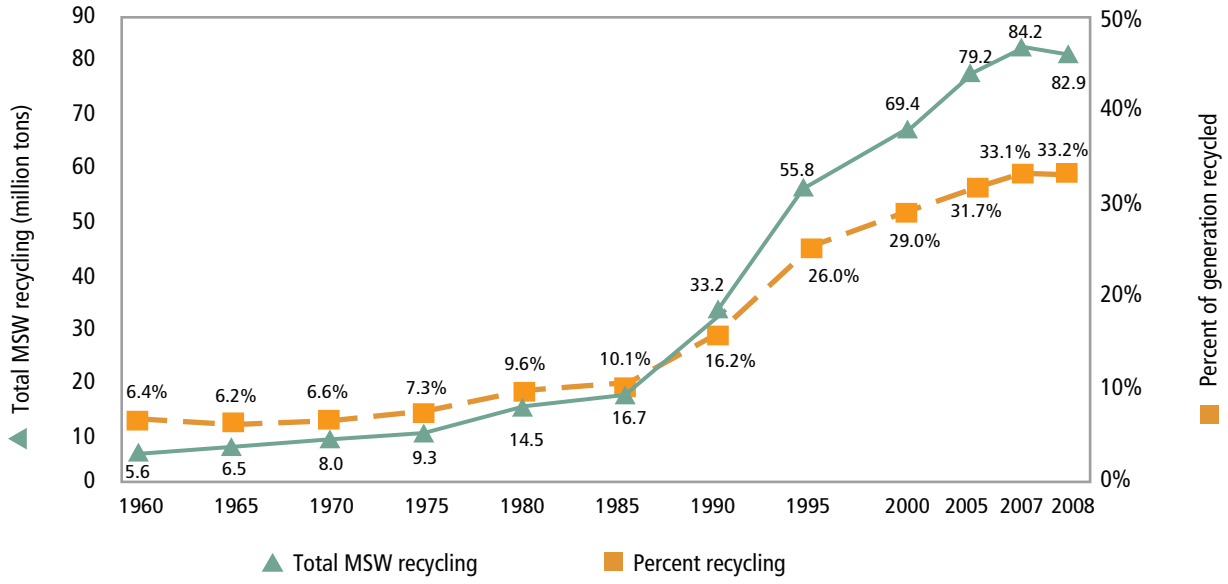
In 2008, Americans generated about 250 million tons of trash and recycled and composted 83 million tons of this material, equivalent to a 33.2 percent recycling rate* (see Figure 1 and Figure 2). On average, we recycled and composted 1.5 pounds of our individual waste generation of 4.5 pounds per person per day.

Figure 1. MSW Generation Rates, 1960 to 2008



* The previously published 2007 recycling rate, 33.4 percent, was revised to 33.1 percent in this year's report, based on updated data (see Figure 2).

Figure 2. MSW Recycling Rates, 1960 to 2008



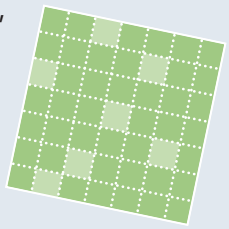
Trends in Municipal Solid Waste in 2008

Our trash, or municipal solid waste (MSW), is made up of the things we commonly use and then throw away. These materials range from packaging, food scraps, and grass clippings, to old sofas, computers, tires, and refrigerators. MSW does not include industrial, hazardous, or construction waste.

In 2008, Americans recovered about 61 million tons (excluding composting) through recycling. Composting recovered 22.1 million tons of waste. We combusted about 32 million tons for energy recovery (about 13 percent). Subtracting out what we recycled and composted, we combusted (with energy recovery) or discarded 3 pounds per person per day.

In 2008, office-type paper recovery rose to about 71 percent (4.3 million tons), and about 65 percent of yard trimmings were recovered (see Figure 3). Metals were recycled at a rate of almost 35 percent (see Table 1). By recycling more than 7 million tons of metals (which includes aluminum, steel, and mixed metals), we eliminated greenhouse gas (GHG) emissions totaling close to 25 million metric tons of carbon dioxide equivalent ($MMTCO_2E$). This is equivalent to removing more than 4.5 million cars from the road for one year.*

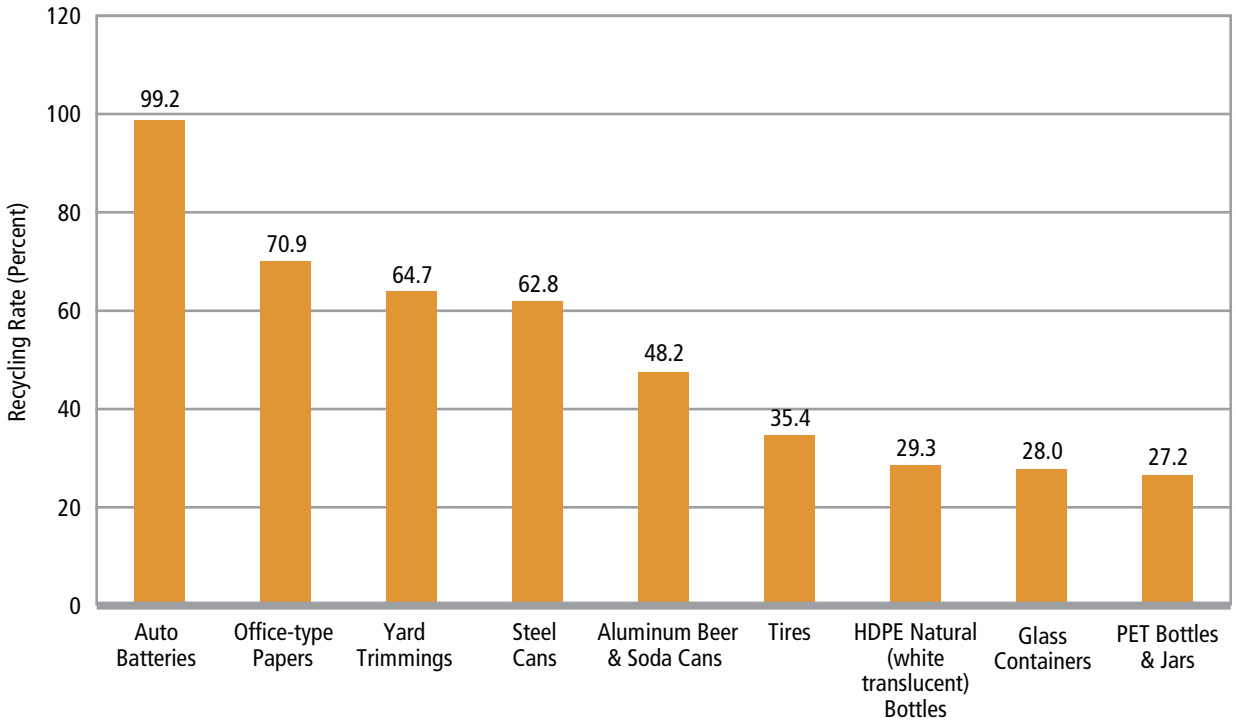
Over the last few decades, the generation, recycling, composting, and disposal of MSW have changed substantially. While solid waste generation has increased, from 3.66 to 4.50 pounds per person per day between 1980 and 2008, the recycling rate has also increased—from less than 10 percent of MSW generated in 1980 to over 33 percent in 2008. Disposal of waste to a landfill has decreased from 89 percent of the amount generated in 1980 to 54 percent of MSW in 2008.



About 135 million tons of MSW (54 percent) was discarded in landfills in 2008 (see Figure 4).

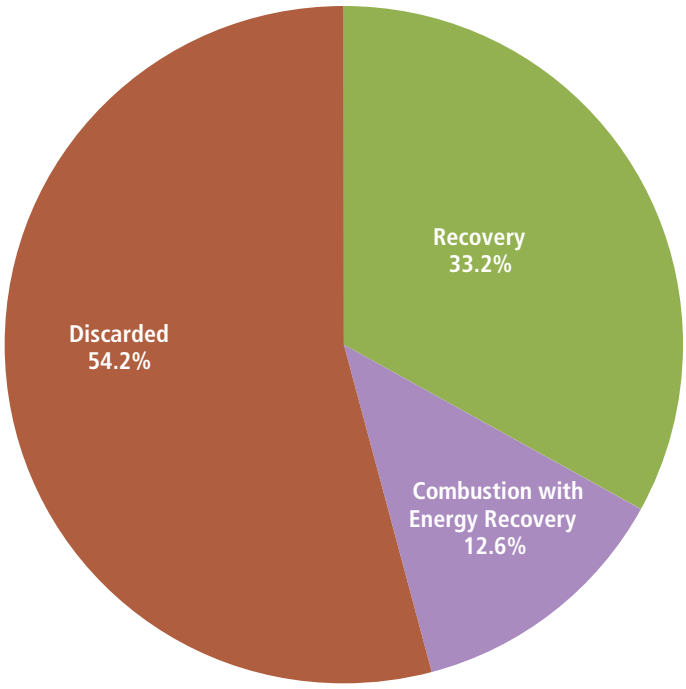
* All benefit calculations in this fact sheet are derived from EPA's WAste Reduction Model (WARM). Please see www.epa.gov/warm

Figure 3. Recycling Rates of Selected Products, 2008*



*Does not include combustion (with energy recovery).

Figure 4. Management of MSW in the United States, 2008



Sources of MSW

We estimated residential waste (including waste from apartment houses) to be 55 to 65 percent of total MSW generation. Waste from commercial and institutional locations, such as schools, hospitals, and businesses, amounted to 35 to 45 percent.

Nationally, we recycled and composted 83 million tons of municipal solid waste. This provides an annual benefit of 182 million metric tons of carbon dioxide equivalent emissions reduced, comparable to the annual GHG emissions from more than 33 million passenger vehicles.

Analyzing MSW

We analyze waste by material, such as paper and paperboard, yard trimmings, food scraps, and plastics, and by major product categories, which include durable goods (such as furniture), nondurable goods (such as paper or clothing), containers and packaging (such as milk cartons and plastic wrap), and other materials (such as food scraps).

Materials in MSW

Total MSW generation in 2008 was 250 million tons. Organic materials continue to be the largest component of MSW. Paper and paperboard account for 31 percent, with yard trimmings and food scraps accounting for 26 percent. Plastics comprise 12 percent; metals make up 8 percent; and rubber, leather, and textiles account for almost 8 percent. Wood follows at around 7 percent and glass at 5 percent. Other miscellaneous wastes make up approximately 3 percent of the MSW generated in 2008 (see Figure 5).

Figure 5. Total MSW Generation (by material), 2008
250 Million Tons (before recycling)

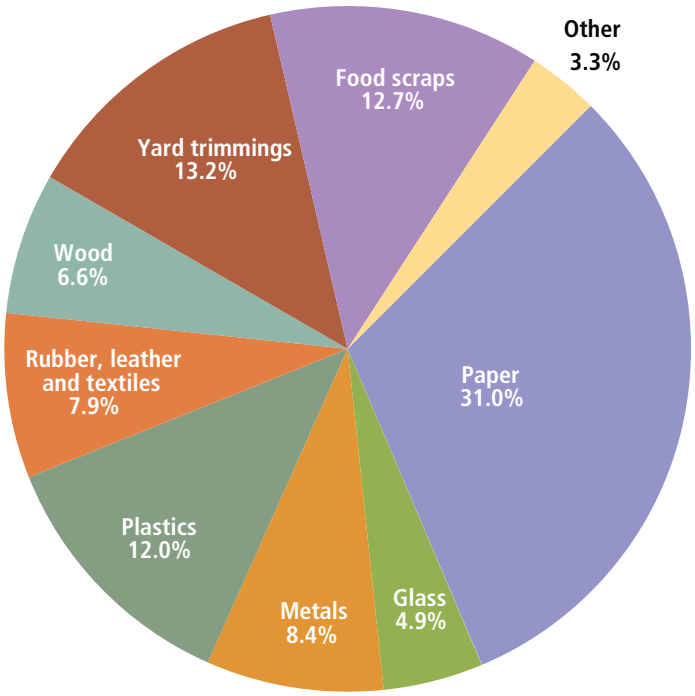


Table 1. Generation and Recovery of Materials in MSW, 2008*
(in millons of tons and percent of generation of each material)

Material	Weight Generated	Weight Recovered	Recovery as Percent of Generation
Paper and paperboard	77.42	42.94	55.5%
Glass	12.15	2.81	23.1%
Metals			
Steel	15.68	5.29	33.7%
Aluminum	3.41	0.72	21.1%
Other nonferrous metals†	1.76	1.21	68.8%
Total metals	**20.85**	**7.22**	**34.6%**
Plastics	30.05	2.12	7.1%
Rubber and leather	7.41	1.06	14.3%
Textiles	12.37	1.89	15.3%
Wood	16.39	1.58	9.6%
Other materials	4.50	1.15	25.6%
Total materials in products	**181.14**	**60.77**	**33.5%**
Other wastes			
Food, other‡	31.79	0.80	2.5%
Yard trimmings	32.90	21.30	64.7%
Miscellaneous inorganic wastes	3.78	Negligible	Negligible
Total other wastes	**68.47**	**22.10**	**32.3%**
Total municipal solid waste	**249.61**	**82.87**	**33.2%**

* Includes waste from residential, commercial, and institutional sources.

† Includes lead from lead-acid batteries.

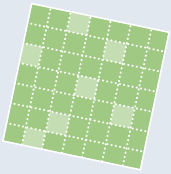
‡ Includes recovery of other MSW organics for composting.

Details might not add to totals due to rounding.

Negligible = Less than 5,000 tons or 0.05 percent.

Significant amounts of material from each category were recycled or composted in 2008. The highest recovery rates were achieved in yard trimmings, paper and paperboard, and metals. About 21 million tons of yard trimmings were composted, representing a five-fold increase since 1990. We recycled more than half the paper and paperboard we generated. Recycling these organic materials alone kept 26 percent of MSW out of landfills and combustion facilities. Recycling amounts and rates (recovery as a percent of generation) for all materials in 2008 are listed in Table 1.

Recycling and composting 83 million tons of MSW saved 1.3 quadrillion Btu of energy, the equivalent of more than 10.2 billion gallons of gasoline.



Products in MSW

The breakdown, by weight, of waste generated in 2008 by product category is shown in Figure 6. Containers and packaging made up the largest portion of MSW generated: 31 percent, or about 77 million tons. The second largest portion came from nondurable goods, which amounted to about 24 percent, or about 59 million tons. Yard trimmings make up the third largest segment, accounting for 13 percent, or almost 33 million tons.

The generation and recovery of materials in the product categories, by weight and recovery as a percent of generation, are shown in Table 2. This table shows that the recovery of containers and packaging was the highest of the four product categories, with about 44 percent of the generated materials recycled. Steel, paper products, and aluminum were the most recycled materials by percentage in this category. More than 63 percent of steel packaging (mostly cans) was recycled. Sixty-six percent of paper and paperboard containers and packaging was recycled, including nearly 77 percent of all corrugated boxes. The recycling rate for aluminum packaging was 38 percent, including just over 48 percent of aluminum beverage cans.

Figure 6. Total MSW Generation (by category), 2008
250 million tons (before recycling)

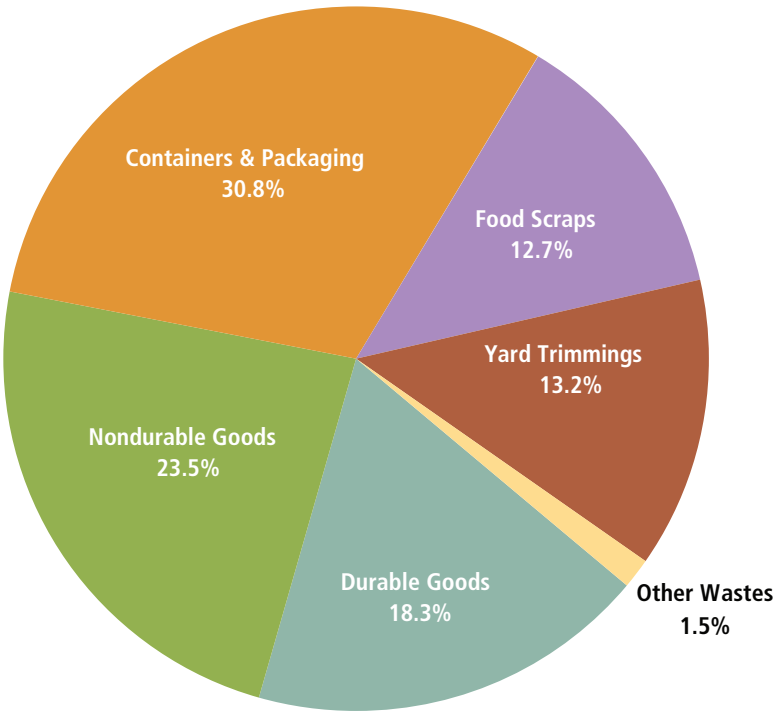


Table 2. Generation and Recovery of Products in MSW, 2008* (in millons of tons and percent of generation of each product)

Products	Weight Generated	Weight Recovered	Recovery as Percent of Generation
Durable goods			
Steel	13.13	3.68	28.0%
Aluminum	1.31	Negligible	Negligible
Other non-ferrous metals†	1.76	1.21	68.8%
Glass	2.10	Negligible	Negligible
Plastics	10.52	0.39	3.7%
Rubber and leather	6.34	1.06	16.7%
Wood	5.68	Negligible	Negligible
Textiles	3.35	0.44	13.1%
Other materials	1.48	1.15	76.2%
Total durable goods	**45.67**	**7.93**	**17.4%**
Nondurable goods			
Paper and paperboard	39.12	17.86	45.7%
Plastics	6.52	Negligible	Negligible
Rubber and leather	1.04	Negligible	Negligible
Textiles	8.78	1.45	16.5%
Other materials	3.25	Neg.	Neg.
Total nondurable goods	**58.71**	**19.31**	**32.9%**
Containers and packaging			
Steel	2.55	1.61	63.1%
Aluminum	1.88	0.72	38.3%
Glass	10.05	2.81	28.0%
Paper and paperboard	38.29	25.08	65.5%
Plastics	13.01	1.73	13.2%
Wood	10.71	1.58	14.8%
Other materials	0.27	Negligible	Negligible
Total containers and packaging	**76.76**	**33.53**	**43.7%**
Other wastes			
Food, other‡	31.79	0.80	2.5%
Yard trimmings	32.90	21.30	64.7%
Miscellaneous inorganic wastes	3.78	Negligible	Negligible
Total other wastes	68.47	22.10	32.3%
Total municipal solid waste	**249.61**	**82.87**	**33.2%**

* Includes waste from residential, commercial, and institutional sources.
† Includes lead from lead-acid batteries.
‡ Includes recovery of other MSW organics for composting.
Details might not add to totals due to rounding.
Negligible = less than 5,000 tons or 0.05 percent.

Table 3. Generation, Materials Recovery, Composting, Combustion With Energy Recovery, and Discards of MSW, 1960 to 2008 (in million of tons)

Activity	1960	1970	1980	1990	2000	2003	2005	2007	2008
Generation	88.1	121.1	151.6	205.2	239.1	242.2	249.7	254.6	249.6
Recovery for recycling	5.6	8.0	14.5	29.0	52.9	55.6	58.6	62.5	60.8
Recovery for composting*	Negligible	Negligible	Negligible	4.2	16.5	19.1	20.6	21.7	22.1
Total materials recovery	5.6	8.0	14.5	33.2	69.4	74.7	79.2	84.2	82.9
Combustion with energy recovery†	0.0	0.4	2.7	29.7	33.7	33.1	31.6	32.0	31.6
Discards to landfill, other disposal‡	82.5	112.7	134.4	142.3	136.0	134.4	138.9	138.4	135.1

* Composting of yard trimmings, food scraps, and other MSW organic material. Does not include backyard composting.

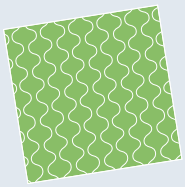
† Includes combustion of MSW in mass burn or refuse-derived fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets, tire-derived fuel).

‡ Discards after recovery minus combustion with energy recovery. Discards include combustion without energy recovery.

Details might not add to totals due to rounding.

Around 28 percent of glass containers were recycled, while about 15 percent of wood packaging—mostly wood pallets—was recovered. More than 13 percent of plastic containers and packaging was recycled, mostly from soft drink, milk, and water bottles. Plastic bottles were the most recycled plastic products. Recovery of HDPE natural (white translucent) bottles was estimated at about 29 percent. PET bottles and jars were recovered at 27 percent (see supporting 2008 MSW data tables).

Every ton of mixed paper recycled can save the energy equivalent of 185 gallons of gasoline.



Overall recovery of nondurable goods was 33 percent in 2008. Nondurable goods generally last less than three years. Paper products, such as newspapers and high-grade office papers were the most recycled nondurable goods. Newspapers alone were recycled at a rate of nearly 88 percent. Approximately 71 percent of high-grade office papers and 40 percent of magazines were recovered. Forty-one percent of unwanted mail, 30 percent of books, and 21 percent of telephone directories were recovered for recycling in 2008 (see the supporting data tables). Clothing and other textile products are included in the nondurable goods category. These products were recovered for recycling at a rate of almost 17 percent.

Overall, about 17 percent of durable goods were recovered in 2008. Nonferrous metals other than aluminum had one of the highest recovery rates—around 69 percent—due to the high rate of lead

recovery from lead-acid batteries. With a 99 percent recycling rate, lead-acid batteries continue to be one of the most recovered products. Recovery of steel in all durable goods was 28 percent, with high rates of recovery from appliances and other miscellaneous items.

Measured by percentage of generation, products with the highest recovery rates in 2008 were lead-acid batteries (99 percent), newspapers (88 percent), corrugated boxes (77 percent), office-type papers (71 percent), major appliances (67 percent), steel packaging (63 percent), yard trimmings (65 percent), aluminum cans (48 percent), commercial printing papers (43 percent), standard mail (41 percent), magazines (40 percent), and paper bags and sacks (38 percent) (see supporting 2008 data tables).

Recycling and Composting Collection Programs**

- Approximately 8,660 curbside recycling programs exist nationwide, down from 8,875 in 2002.
- About 3,510 community composting programs are operational, an increase from 3,227 in 2002.

Table 4. Generation, Materials Recovery, Composting, Combustion With Energy Recovery, and Discards of MSW, 1960 to 2008 (in pounds per person per day)

Activity	1960	1970	1980	1990	2000	2005	2007	2008
Generation	2.68	3.25	3.66	4.50	4.65	4.62	4.63	4.50
Recovery for recycling	0.17	0.22	0.35	0.64	1.03	1.08	1.14	1.10
Recovery for composting*	Negligible	Negligible	Negligible	0.09	0.32	0.38	0.39	0.40
Total Materials Recovery	0.17	0.22	0.35	0.73	1.35	1.46	1.53	1.50
Combustion with energy recovery†	0.00	0.01	0.07	0.65	0.66	0.58	0.58	0.57
Discards to landfill, other disposal‡	2.51	3.02	3.24	3.12	2.64	2.58	2.52	2.43
Population (millions)	179.979	203.984	227.255	249.907	281.422	296.410	301.621	304.060

* Composting of yard trimmings, food scraps, and other MSW organic material. Does not include backyard composting.

† Includes combustion of MSW in mass burn or refuse-derived fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets, tire-derived fuel).

‡ Discards after recovery minus combustion with energy recovery. Discards include combustion without energy recovery.

Details might not add to totals due to rounding.

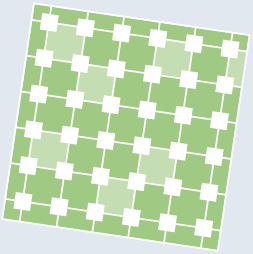
** Source: For 2002 data: *BioCycle* 2006.
For 2008 data: EPA, *Supporting 2008 data tables and figures.*

Disposing of MSW

While the number of U.S. landfills has steadily declined over the years, the average landfill size has increased. At the national level, landfill capacity appears to be sufficient, although it is limited in some areas.

- Since 1990, the total amount of MSW going to landfills dropped by about 7 million tons, from 142.3 million to 135.1 million tons in 2008 (see Table 3).
- The net per capita discard rate (after recycling, composting, and combustion for energy recovery) was 2.43 pounds per person per day, lower than the 2.51 per capita rate in 1960, when virtually no recycling occurred in the United States (see Table 4).

Recycling just 1 ton of aluminum cans conserves more than 207 million Btu, the equivalent of 36 barrels of oil, or 1,665 gallons of gasoline.



The Benefits of Recycling

Recycling has environmental benefits at every stage in the life cycle of a consumer product—from the raw material with which it's made to its final method of disposal. Aside from reducing GHG emissions, which contribute to global warming, recycling also reduces air and water pollution associated with making new products from raw materials. By utilizing used, unwanted, or obsolete materials as industrial feedstocks or for new materials or products, we can each do our part to make recycling work.

Nationally, we recycled 83 million tons of MSW. This provides an annual benefit of 182 million metric tons of carbon dioxide equivalent emissions reduced, comparable to removing the emissions from 33 million passenger cars. But the ultimate benefits from recycling are cleaner land, air, and water, overall better health, and a more sustainable economy.

Resources

The data summarized in this fact sheet characterizes the MSW stream as a whole by using a materials flow methodology that relies on a mass balance approach. For example, to determine the amounts of paper recycled, information is gathered on the amounts processed by paper mills and made into new paper on a national basis, instead of counting paper collected at curbside on a state-by-state basis. Using data gathered from industry associations, businesses, and government sources, such as the U.S. Department of Commerce and the U.S. Census Bureau, we estimate tons of materials and products generated, recycled, and discarded. Other sources of data, such as waste characterizations and research reports performed by governments, industry, or the press, supplement these data.

Energy Recovered from Waste Combustion

- In 2008, about 32 million tons of materials, or 12.7 percent, were combusted for energy recovery.
- MSW combustion for energy recovery has remained fairly constant since 1990.

The benefits of recycling and composting, such as elimination of GHG emissions, are calculated using EPA's WARM methodology. Please see:

www.epa.gov/warm

WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, composting, combustion, and landfilling. The model calculates emissions in metric tons of carbon equivalent (MTCE), metric tons of carbon dioxide equivalent ($MTCO_2E$), and energy units (million Btu) across a wide range of material types commonly found in MSW. EPA developed GHG emissions reduction factors through a life-cycle assessment methodology. EPA's report, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (EPA-530-R-02-006), describes this methodology in detail (www.epa.gov/climatechange/wycd/waste/downloads/fullreport.pdf).

Full data tables on MSW characterization that support this Report and Summaries of the MSW characterization methodology and WARM are available on the EPA Web site along with information about waste reduction and recycling. Please see:

www.epa.gov/epawaste/nonhaz/municipal/msw99.htm

www.epa.gov/epawaste/conserve/rrr/index.htm

In percentage of total MSW generation, recovery for recycling (including composting) did not exceed 15 percent until 1990. Growth in the recovery rate to current levels (33.2 percent) reflects an increase in infrastructure and market demand for recovery over the last decade.

United States
Environmental Protection
Agency

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Solid Waste and Emergency Response (5306P)
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