Scoping Study for Additional Economic Indicators
U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery
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Background

For Task 6, the following municipal solid waste (MSW) economic indicators were developed:

1) MSW generation versus real Gross Domestic Product (GDP),
2) MSW disposal versus tipping fees, and
3) MSW product recycling rates versus commodity values.

For Task 7.1, six additional economic indicators were scoped for potential future inclusion in the Characterization of Municipal Solid Waste in the United States report series.

The indicators shown in this memorandum were selected by EPA from a previously developed larger list of indicators. The results of the scoping study of indicators for possible future inclusion in the MSW characterization report series are shown in the next section.

Results

The results of the scoping study are presented below in a separate table for each indicator. The information presented in each table includes:

- Name and description of indicator;
- Why the indicator might be of interest;
- Data caveats and limitations, including data availability gaps;
- Data availability, including cost, location, frequency of publication, and available years; and
- Highlights from other studies performing similar work.

Additionally, an annotated bibliography of studies related to each indicator, grouped by indicator, is included at the end of this memo.

Indicator 1 Name	Recycling Versus Percent of Population Served by Curbside Recycling
Description	These could include 1) recycling rates of selected commodities (e.g., ONP, OCC, steel cans, aluminum cans, PET, HDPE) or 2) overall amount recovered for recycling per capita versus the percent of population served by curbside recycling.
Interest	In discussion about recycling rates versus commodity values, it appeared that commodity recycling rates were increasing rapidly in the 1990s as curbside recycling programs were being widely implemented. This indicator will help supplement this analysis and help provide a picture of the potential relationship between curbside recycling and recycling rates.
Caveats and Limitations	Percent of population served by curbside recycling has started to level off; however, it could still be interesting to track how the large increase in curbside recycling and more recent leveling off compares with recycling rates. Additionally, this may be more valuable as a historical review because current data for population served by curbside collection are incomplete. . Population served by curbside collection was not included in the 2012 MSW in the United States Facts and Figures data tables and figures.
Data Location	• **Recovery for Recycling:** MSW in the United States Facts and Figures Reports. Intermediate years not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm • **Population Data:** U.S. Census Bureau: Current estimates (http://www.census.gov/popest/data/index.html); Historical estimates: http://www.census.gov/popest/data/historical/index.html). • **Recycling Rates of Commodities:** MSW in the United States Facts and Figures Reports. Intermediate years and data for specific commodities not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm • **Percent w/Curbside Recycling:** MSW in the United States Facts and Figures Reports. (Table 25 of the 2011 report). Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm (1995-2011 data). *BioCycle* State of Garbage Reports (1990-1993 data only available through old paper editions and not online).
Available Years and Gaps	• **Recovery for Recycling:** 1960-2012 (ongoing publication) • **Population Data:** 1900-2012 (ongoing publication) • **Recycling Rates of Commodities:** 1990-2012 (ongoing publication) • **Percent w/Curbside Recycling:** 1990-1993, 1995-1997, 1999-2001, 2005-2011.
Frequency of Publication	• **Recovery for Recycling:** Primary report published every other year, but data available for every year. • **Population Data:** Annually • **Recycling Rates of Commodities:** Primary report published every other year, but data available for every year. • **Percent w/Curbside Recycling:** Primary report published every other year, but data available for every year. It appears that these data will no longer be published after 2011.
Data Cost	• **Recovery for Recycling:** Free • **Population Data:** Free • **Recycling Rates of Commodities:** Free • **Percent w/Curbside Recycling:** Free
Other Work Performed	**CRI, 2012.** Although curbside recycling has been rising for years, it has little effect on beverage container recycling rate. **Beatty, 2006.** Curbside recycling programs have only a marginal impact on total recycled quantities. **Jenkins, 2000.** This study concludes that curbside recycling programs increase households' intensity of recycling for the five materials examined (glass bottles, plastic bottles, aluminum, newspaper, and yard waste). **EPA, 1994.** The study concludes that the more households that receive curbside collection of recyclables, the more residential materials a community will recover.

Indicator 2 Name	**MSW Disposal per Capita Versus Percent of Population Served by Curbside Recycling**
Description	This could include an indicator graphing MSW disposal per capita versus percent of population served by curbside recycling. It also may be worthwhile to explore the change in MSW disposal per capita each year versus the change in population served by curbside recycling. This might be able to supplement the story that curbside recycling is a driving force to limit the amount of material that goes into MSW discards..
Interest	During the Task 6 report, it was found that MSW discarded per capita and real GDP per capita had a much stronger relationship before the wide implementation of curbside recycling programs. Starting in the 1990s, it seemed that other factors affecting MSW disposal per capita became a driver. This indicator investigates how the availability of curbside recycling, which allows people to more easily recycle materials that may otherwise go into MSW discards, may be related to MSW disposal per capita.
Caveats and Limitations	Percent of population served by curbside recycling has started to level off; however, it could still be interesting to track how the large increase in curbside recycling and more recent leveling off compares with MSW per capita disposal.
Data Location	• **MSW Disposal:** MSW in the United States Facts and Figures Reports. Intermediate years not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm • **Population Data:** U.S. Census Bureau: Current estimates: http://www.census.gov/popest/data/index.html; Historical estimates: http://www.census.gov/popest/data/historical/index.html. • **Percent w/Curbside Recycling:** MSW in the United States Facts and Figures Reports. (Table 25 of the 2011 report). Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm (1995-2011 data). *BioCycle* State of Garbage Reports (1990-1993 data only available through old paper editions and not online).
Available Years and Gaps	• **MSW Disposal:** 1960-2012 (ongoing publication) • **Population Data:** 1900-2012 (ongoing publication) • **Percent w/Curbside Recycling:** 1990-1993, 1995-1997, 1999-2001, 2005-2011 (does not appear to be ongoing)
Frequency of Publication	• **MSW Disposal:** Primary report published every other year, but data available for every year. • **Population Data:** Annually • **Percent w/Curbside Recycling:** Primary report published every other year, but data available for every year. It appears that these data will no longer be published after 2011.
Data Cost	• **MSW Disposal:** Free • **Population Data:** Free • **Percent w/Curbside Recycling:** Free
Other Work Performed	**Department of Ecology, State of Washington, 2013.** With curbside recycling opportunities available, residents and businesses are likely to recycle more and dispose of less waste. **Sidique, 2013.** A variety of policy instruments such as, recycling ordinances, drop-off recycling centers, and source reduction education appear to be effective in changing solid waste disposal and recycling rates. Increased recycling per-capita decreases the amount of municipal solid waste disposed per capita.

Indicator 3 Name	Recycling and Composting Versus Percent of Population Served by Pay-As-You-Throw (PAYT) Waste Collection
Description	These could include 1) recycling rates of selected commodities (e.g., ONP, OCC, steel cans, aluminum cans, PET, HDPE) or 2) overall amount recovered for recycling and composted per capita versus the percent of population served by PAYT waste collection. It also may be worthwhile to explore the change in overall recycling rates each year versus the change in population served by PAYT waste collection. This might be able to supplement the story that PAYT waste collection is a driving force to drive recycling up.
Interest	PAYT forces households to feel the impact of the marginal cost of sending materials to the waste stream. It incentivizes households to think more critically about what "trash" can be recycled, and could increase the percentage of each commodity type that is recycled or composted.
Caveats and Limitations	There are some data gaps in PAYT data and data do not seem to be published regularly. Thus, this may just be a historical review.
Data Location	• **Recycling and Composting:** MSW in the United States Facts and Figures Reports. Intermediate years not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm • **Population Data:** U.S. Census Bureau: Current estimates (http://www.census.gov/popest/data/index.html); Historical estimates: http://www.census.gov/popest/data/historical/index.html). • **Recycling Rates of Commodities:** MSW in the United States Facts and Figures Reports. Intermediate years and data for specific commodities not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm. Some years and specific products only available in historical tables. • **PAYT:** http://www.epa.gov/wastes/conserve/tools/payt/states/06comm.htm (PAYT for 2006) http://www.epa.gov/wastes/conserve/tools/payt/states/comminfo.htm (PAYT population from 1986-1999) http://www.epa.gov/wastes/conserve/tools/payt/pdf/sera06.pdf (75,000,000 in 2006 in PAYT – no data 2000-2005)
Available Years and Gaps	• **Recycling and Composting:** 1960-2012 (ongoing publication) • **Population Data:** 1900-2012 (ongoing publication) • **Recycling Rates of Commodities:** 1990-2012 (ongoing publication) • **PAYT:** 1986-1999, 2006 (does not appear to be ongoing)
Frequency of Publication	• **Recycling and Composting:** Primary report published every other year, but data available for every year. • **Population Data:** Annually • **Recycling Rates of Commodities:** Primary report published every other year, but data available for every year. • **PAYT:** Does not appear to be published in an ongoing report.
Data Cost	• **Recycling and Composting:** Free • **Population Data:** Free • **Recycling Rates of Commodities:** Free • **PAYT:** Free
Other Work Performed	**EPA and Green Waste Solutions, 2010.** Of the total diversion in PAYT communities, about 25-30% is related to an increase in commodity recycling (e.g., paper, cardboard and commingled materials) and about 70-75% is related to source reduction and compost/yard waste collection. **Waste Zero, 2010-2013.** Case studies in Sandwich, and Shrewsbury, MA indicate an increase in recycling by 74% for plastic, metals,

Indicator 3 Name	Recycling and Composting Versus Percent of Population Served by Pay-As-You-Throw (PAYT) Waste Collection
	and glass and 20% for paper in Sandwich and increased their recycling by 17% after implementing PAYT programs. **Lauf, P., 2008.** Visual surveys indicate that recycling participation could be indirectly related to cost of participating. **Skumatz, 2002 and 2006.** PAYT programs decrease residential MSW by about 17 percent in weight, with 8-11 percent being diverted directly to recycling and yard programs.

Indicator 4 Name	MSW Disposal per Capita Versus Percent of Population Served by Pay-As-You-Throw (PAYT) Waste Collection
Description	These could include indicators graphing MSW disposal per capita versus percent of the population served by PAYT waste collection. It could also look at change in MSW disposal per capita versus the change in population served by PAYT waste collection.
Interest	PAYT forces households to feel the impact of the marginal cost of sending materials to the waste stream. It incentivizes households to think more critically about what "trash" can be recycled, and could decrease the amount of MSW disposed per person if there are alternative recycling options.
Caveats and Limitations	There are some data gaps in PAYT data and data do not seem to be published regularly. Thus, this may just be a historical review.
Data Location	• **MSW Disposal:** MSW in the United States Facts and Figures Reports. Intermediate years not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm • **Population Data:** U.S. Census Bureau: Current estimates (http://www.census.gov/popest/data/index.html); Historical estimates: http://www.census.gov/popest/data/historical/index.html). • **PAYT:** http://www.epa.gov/wastes/conserve/tools/payt/states/06comm.htm (PAYT for 2006) http://www.epa.gov/wastes/conserve/tools/payt/states/comminfo.htm (PAYT population from 1986-1999) http://www.epa.gov/wastes/conserve/tools/payt/pdf/sera06.pdf (75,000,000 in 2006 in PAYT – no data 2000-2005)
Available Years and Gaps	• **MSW Disposal:** 1960-2012 (ongoing publication) • **Population Data:** 1900-2012 (ongoing publication) • **PAYT:** 1986-1999, 2006 (does not appear to be ongoing)
Frequency of Publication	• **MSW Disposal:** Primary report published every other year, but data available for every year. • **Population Data:** Annually • **PAYT:** Does not appear to be published in an ongoing report
Data Cost	• **MSW Disposal:** Free • **Population Data:** Free • **PAYT:** Free
Other Work Performed	**Bucciol, 2011.** PAYT programs increase per capita sorted waste by 9.6%, but have no bearings on the amount of per capita total waste. **Waste Zero, 2010-2013.** Case studies in Gloucester, Sandwich, and Shrewsbury, MA indicate a decrease in solid waste by 26%, 42%, and 39% respectively after implementing PAYT programs. **EPA and Green Waste Solutions, 2010.** In PAYT municipalities an average of 467 pounds per capita was disposed of compared to 918 pounds per capita in the non-PAYT municipalities. **Skumatz, 2002 and 2006.** PAYT systems have a huge impact on diversion – reducing residential disposal by about 17% – often with low administrative costs.

Indicator 5 Name	**Recycling Rate of Selected Commodities Versus Landfill Tipping Fees**
Description	These could include recycling rates of selected commodities (e.g., ONP, OCC, steel cans, aluminum cans, PET, HDPE) versus landfill tipping fees.
Interest	Higher landfill tipping fees may increase recycling rates. Those that pay the tipping fee may not always directly pay the marginal cost of sending materials to the landfill; however, the higher tipping fees could potentially lead to other efforts that ultimately incentivize the diversion of recyclable materials from landfills, and this indicator would explore that relationship.
Caveats and Limitations	There are some years with no data for landfill tip fees. 2012-2013 data is from a different survey: Waste & Recycling News. They have now closed their doors. It appears that the National Waste & Recycling Association (formerly NSWMA) will continue to perform their survey, which is the source of the 1985-2010 data.
Data Location	• **Recycling Rates of Commodities:** MSW in the United States Facts and Figures Reports. Intermediate years and data for specific commodities not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm • **Landfill Tipping Fees:** National Solid Wastes Management Association (NSWMA). 2012. Municipal Solid Waste Landfill Facts. October 2012 (Data for 1985-2010). Association is now called: National Waste & Recycling Association. Link: https://wasterecycling.org/home-sitewide. Waste & Recycling News, 2013 Landfill Tipping Fee Survey. Spring 2013 (Data for 2012 and 2013).
Available Years and Gaps	• **Recycling Rates of Commodities:** 1990-2012 (ongoing publication) • **Landfill Tipping Fees:** 1985-1988, 1990, 1992, 1995**,** 1998, 2000, 2002, 2004, 2006-2008, 2010, 2012-2013
Frequency of Publication	• **Recycling Rates of Commodities:** Primary report published every other year, but data available for every year. • **Landfill Tipping Fees:** Discussions with the National Waste & Recycling Association (formerly NSWMA) indicate they will continue publishing landfill tip fee data.
Data Cost	• **Recycling Rates of Commodities:** Free • **Landfill Tipping Fees:** Free
Other Work Performed	**NRDC, 1997.** At the same time that tipping fees at landfills have been increasing dramatically, the rate of recycling has almost tripled.

Indicator 6 Name	**Recycling and Composting per Capita Versus Landfill Tipping Fees**
Description	These could include amount of material diverted from landfills through recycling and composting per capita versus the landfill tipping fee. It also may be worthwhile to explore the change in overall weight of material diverted from landfills through recycling and composting versus the change in landfill tip fees over that same period. This might be able to supplement the story that increased tip fees encourage diversion from landfills.
Interest	Higher landfill tipping fees may increase the incentive to recycle. Those that pay the tipping fee may not always directly pay the marginal cost of sending materials to the landfill; however, the higher tipping fees could potentially lead to other efforts that ultimately incentivize the diversion of recyclable and compostable materials from landfills, and this indicator would explore that relationship.
Caveats and Limitations	There are some data gaps in landfill tip fee data. Any change analysis would sometimes be a change over 1 year and sometimes in multiple years, but this would be done for identical years to the analysis for change in recycling and composting. 2012-2013 landfill tip fee data is from a different survey: Waste & Recycling News. They have now closed their doors. It appears that the National Waste & Recycling Association (formerly NSWMA) will continue to perform their survey, which is the source of the 1985-2010 data.
Data Location	• **Recycling and Composting:** MSW in the United States Facts and Figures Reports. Intermediate years not published in the Facts and Figures Reports obtained from historical tables. Link: http://www.epa.gov/osw/nonhaz/municipal/msw99.htm • **Population Data:** U.S. Census Bureau: Current estimates (http://www.census.gov/popest/data/index.html); Historical estimates: http://www.census.gov/popest/data/historical/index.html). • **Landfill Tipping Fees:** National Solid Wastes Management Association (NSWMA). 2012. Municipal Solid Waste Landfill Facts. October 2012. Association is now called: National Waste & Recycling Association. Link: https://wasterecycling.org/home-sitewide. Waste & Recycling News, 2013 Landfill Tipping Fee Survey. Spring 2013 (Data for 2012 and 2013).
Available Years and Gaps	• **Recycling and Composting:** 1960-2012 (ongoing publication) • **Population Data:** 1900-2012 (ongoing publication) • **Landfill Tipping Fees:** 1985-1988, 1990, 1992, 1995**,** 1998, 2000, 2002, 2004, 2006-2008, 2010, 2012-2013
Frequency of Publication	• **Recycling and Composting:** Primary report published every other year, but data available for every year. • **Population Data:** Annually • **Landfill Tipping Fees:** Discussions with the National Waste & Recycling Association (formerly NSWMA) indicate they will continue publishing landfill tip fee data.
Data Cost	• **Recycling and Composting:** Free • **Population Data:** Free • **Landfill Tipping Fees:** Free
Other Work Performed	**Williams, T, Soil and Mulch Producer News, 2013.** This article states the less landfills charge for waste, the less incentive for food waste recovery. Higher tipping fees increase the volume of food waste recovery. **Risse, 2012.** High landfill tipping fees make composting an attractive financial alternative. **EPA, 1994.** This study concludes that high disposal costs lead to higher recovery levels.

Annotated Bibliography

Indicator - 1 Recycling Versus Percent of Population Served by Curbside Recycling

Container Recycling Institute (CRI), "Curbside Recycling Access Rates and Beverage Container Recycling Fact Sheet." 2012.
http://www.bottlebill.org/assets/pdfs/Curbside%20vs%20Beverage%20Fact%20Sheet.pdf
This report compares curbside recycling access to recycling rates of container bottles. Even though access to curbside recycling has been rising for years, it has little effect on the beverage container recycling rate. This is due to several factors: 1) Many beverages are consumed and discarded away from home, where recycling services are not available and 2) curbside recycling is often NOT provided to multi-family residences, and these comprise around one-third of the U.S. housing stock, per the U.S. census.

Sidique, S., Joshi, S., Lupib, F., "Factors influencing the rate of recycling: An analysis of Minnesota counties." Resources, Conservation and Recycling, 54, 2010, 242–249. (Also relevant to indicators 3 and 5).
https://www.msu.edu/~lupi/Minn_recycle_rates_Sidique-Joshi-Lupi_2010_RCR.pdf
This study examines the effect of policy, income and demographic variables on the rate of recycling in Minnesota counties. After accounting for random effects and endogenous policy variables, study results demonstrate that variable pricing of waste disposal significantly increases the rate of recycling. This confirms the previous findings from cross-sectional studies that variable pricing is an effective policy tool for increasing the amount of recycling and reducing waste generation. Study findings also indicate that regulations can be an effective means of increasing recycling. We found that the enactment of recycling ordinances making residential recycling mandatory increases the rate of recycling.

Biocycle, "The State of Garbage in America." 2010.
http://www.biocycle.net/images/art/1010/bc101016_s.pdf
The State of Garbage survey requested information about the number of curbside recycling programs and percentage of population served by these programs. Although the report discusses the number of curbside recycling programs throughout the nation, and the population served by these programs, a correlation is not made between population served by curbside recycling programs and recycling per capita.

Kinnaman, T., "The Optimal Recycling Rate." January 2010.
http://digitalcommons.bucknell.edu/fac_pubs/6
Data from this study suggest that the net social costs of recycling fall with increases in the recycling rate above 8% in the United States. Policies in the United States that serve to increase the recycling rate over existing levels would therefore be socially beneficial. But recycling rates in both counties have remained relatively constant or grown only slightly over the past decade. One possible reason could be the rising costs faced my municipal governments. But results here also suggest that the net private costs of recycling – those costs internalized by municipal governments– also fall with increases in the recycling rate for all recycling rates over 25%.

Beatty, T., Berck, P. and Shimshack, J., "Curbside Recycling in the Presence of Alternatives." December 2006 (draft report).
http://econ.tulane.edu/shimshack/post_recycling.pdf
This study finds that the marginal impact of expanding curbside programs on total recycled quantities is small, in part because curbside programs significantly cannibalize returns from drop-off recycling centers. Failure to account for cannibalization from other modes may substantially over-estimate the benefits of curbside programs. Results suggest that incremental expansion of curbside access may not be cost-effective.

Aadland, D, Caplan, A., "Curbside Recycling: Waste Resource or Waste of Resources?" December 5, 2005.
http://www.uwyo.edu/aadland/research/recycle/nsfrecycling.pdf
This study addresses the often contentious debate over state and local recycling policy by carefully estimating the social net benefit of curbside recycling. Across the sample of cities, it was found that the estimated mean social net benefit of curbside recycling is almost exactly zero. On a city-by-city basis, however, the social net-benefit analysis often makes clear predictions about whether a curbside recycling program is an efficient use of resources. Surprisingly, several existing curbside recycling programs in the study sample are inefficient.

Jenkins, R., Martinez, S., Palmer, K., and Podolsky, M., "The Determinants of Household Recycling: A Material Specific Analysis of Recycling Program Features and Unit Pricing." 2000.
http://www.rff.org/Documents/RFF-DP-98-41-REV.pdf
This paper examines the impact of two popular solid waste programs on the percent recycled of several different materials found in the residential solid waste stream. The study examines a unique, national, household-level data set containing information on the percent recycled of five different materials: glass bottles, plastic bottles, aluminum, newspaper, and yard waste. The analysis indicates that drop-off and curbside recycling programs increase households' intensity of recycling for the five materials, curbside recycling programs have a bigger effect on behavior than drop-off programs, and that the added convenience created by a recycling program creates a stronger incentive to recycle than having to pay at the margin for trash disposal. This interpretation suggests that collecting more materials at curbside will produce greater waste diversion.

Container Recycling Institute (CRI), "Bottle Bills Complement Curbside Recycling Programs." Bottle Bill Resource Guide, 2007-2013.
http://www.bottlebill.org/about/benefits/curbside.htm
Specific impacts of a deposit program on an existing curbside program will vary depending on the particular local economies of the curbside program. However, certain trends can be expected. One trend is that overall beverage container recovery rates will increase significantly.

EPA, EPA530-R-92-015 "Waste Prevention, Recycling, and Composting Options: Lessons from 30 Communities." Chapter 2, Demographics and Materials Generation and Recovery Levels. February, 1994.
http://www.epa.gov/osw/conserve/downloads/recy-com/chap02.pdf
This study compares population and MSW recovered where Percent Total Waste Recovered is the sum of MSW and C&D materials recycled and composted divided by the total waste generated (based on tonnages). The study also evaluates per capita and per household residential waste generation in rural, suburban, and urban communities. Chart 5.2 compares net recycling participation rates (the percent of total households serviced by curbside recycling collection multiplied by the participation of serviced households) with residential recycling rates. The study concludes that the more households that receive curbside collection of recyclables, the more residential materials a community will recover. Communities wishing to raise recycling levels not only target all households with recycling collection, but also secure the participation of serviced households.

Indicator 2- MSW Disposal per Capita Versus Percent of Population Served by Curbside Recycling

Department of Ecology, State of Washington, "Population with Access to Curbside Recycling." 2013.
http://www.ecy.wa.gov/beyondwaste/bwprog_swCurbsideRecycling.html
This article on the Department of Ecology website for The State of Washington concludes that with curbside recycling opportunities available, residents and businesses are likely to recycle more and dispose of less waste, resulting in natural resource and energy savings and reduced greenhouse gas emissions. Residents

and businesses in rural or underserved areas would recycle more if they had curbside services available. Some of the information in this article is based on opinion and observation. Therefore, not all claims are based on quantitative data.

Center for Sustainable Systems, University of Michigan. "Municipal Solid Waste Factsheet." Pub. No. CSS04-15, 2013.
http://css.snre.umich.edu/css_doc/CSS04-15.pdf
Curbside recycling programs currently serve close to 73% of people in the U.S.; almost two-thirds of these are single-stream, meaning materials such as glass and paper are separated at the recycling plant. The number of curbside programs in the U.S. has increased more than threefold since 1990. Source reduction activities help prevent materials from entering the MSW management system and are the most effective way to reduce waste generation.

Sidique, S., Joshi, S., Lupi, F., "Analyzing the Effectiveness of Solid Waste Reduction and Recycling Promotion Policies." 2013.
https://www.msu.edu/~lupi/Minnesota-Municipal-Recycle_Effectiveness.pdf (study summary)
This study examines the factors that affect MSW disposal and recycling. It also assesses the impact of policy variable, including curbside recycling and drop off facilities. Study results: Increased recycling per-capita decreases the amount of municipal solid waste disposed per capita. Study Conclusions: A variety of policy instruments such as, recycling ordinances, drop-off recycling centers, and source reduction education appear to be effective in changing solid waste disposal and recycling rates.

Biocycle, "The State of Garbage in America". 2010.
http://www.biocycle.net/images/art/1010/bc101016_s.pdf
The State of Garbage survey requested information about the number of curbside recycling programs and percentage of population served by these programs. Although the report discusses the number of curbside recycling programs throughout the nation, and the population served by these programs, a correlation is not made between population served by curbside recycling programs and MSW disposal.

EPA, EPA530-R-92-015 "Waste Prevention, Recycling, and Composting Options: Lessons from 30 Communities." Chapter 2, Demographics and Materials Generation and Recovery Levels. February, 1994.
http://www.epa.gov/osw/conserve/downloads/recy-com/chap02.pdf
This study compares population and MSW recovered where Percent Total Waste Recovered is the sum of MSW and C&D materials recycled and composted divided by the total waste generated (based on tonnages). The study also evaluates per capita and per household residential waste generation in rural, suburban, and urban communities. Percent of population served by curbside recycling is not discussed as a factor that affects MSW.

Indicator 3- Recycling and Composting Versus Percent of Population Served by Pay-As-You-Throw (PAYT) Waste Collection

WasteZero, Case Study, Gloucester, MA, 2010.
http://wastezero.com/media/17559/Gloucester_WZ%20Case%20Study.pdf
WasteZero is a provider of waste reduction programs. This company partners with municipalities throughout the US to develop innovative programs and services that reduce the amount of waste deposited into landfills and burned in incinerators, increase recycling, and generate savings and revenue. In 2009, the city of Gloucester, MA switched from first sticker (or tag) PAYT program to the PAYT plastic bag trash reduction program, where residents would only pay for the amount of trash they generated based on the number bags that they presented for collection. The study results show in only one month after implementing the program, the City documented a 37% reduction in trash volume. After the first full year, solid waste tonnage decreased 26% or 2,373 tons, which resulted in

more than $163,000 savings in tipping fees. Through 2011, residents reduced its solid waste tonnage by more than 2,000 tons annually, saving the City nearly $140,000 each year.

WasteZero, Case Study, Sandwich, MA, 2012.
http://wastezero.com/media/33938/Sandwich_WZ%20Case%20Study.pdf
Sandwich residents reduced their solid waste by 42%. Additionally, recycling efforts rose 74% for plastic, metals, and glass and 20% for paper. During this period, the Town's solid waste disposal costs dropped more than $10,000 per month for a first-year savings in excess of $120,000.

WasteZero, Case Study, Shrewsbury, MA, 2013.
http://wastezero.com/media/33941/Shrewsbury_WZ%20Case%20Study.pdf
PAYT program implemented resulted in a 29% increase (243 tons) in recycling and a 39% decrease in trash after the first three months of implementing the WasteZero program. After the program's first 11 months, residents reduced their solid waste by 33% (3,550 tons) and increased their recycling by 17% (513 tons). Through fiscal year 2012, residents have reduced their solid waste tonnage by more than 4,000 tons or 40% annually and maintained a recycling rate of 34%.

U.S. EPA and Green Waste Solutions, "Unit Based Garbage Charges Create Positive Economic and Environmental Impact in New England States." 2010.
http://www.epa.gov/epawaste/conserve/tools/payt/tools/bulletin/summer10.pdf (this is a 2010 Summer Bulletin from the EPA that summarizes the Green Waste Solutions study)
According to the EPA, this study concludes PAYT communities generate about 49 percent less waste than those leaving the cost of trash in the tax base or in a fixed fee. In PAYT municipalities an average of 467 pounds per capita was disposed of compared to 918 pounds per capita in the non-PAYT municipalities. Of the total diversion in PAYT communities, about 25-30 percent is related to an increase in commodity recycling (e.g., paper, cardboard and commingled materials) and about 70-75 percent is related to source reduction and compost/yard waste collection. Source reduction and compost/yard waste were combined in this study because not all communities could isolate these items in reliable detail.

Lauf, P., "Comparison Of Recycling Rates Of Three Adjacent Communities In St. Clair County, Illinois." The Geographical Bulletin 50: 111-121, 2008.
http://www.gammathetaupsilon.org/the-geographical-bulletin/2000s/volume50-2/article4.pdf
This research project consists of two types of surveys to assess recycling in the city limits of Belleville, Swansea, and O'Fallon, Illinois, each of which uses a different type of recycling program. One method of data collection consisted of conducting visual surveys to observe participation rates. The second was a questionnaire mailed to homes in these communities requesting information on the household's recycling habits, attitudes toward curbside recycling, income, and highest education level achieved by head of household. This project determined that the most influential factor in determining whether people take part in a curbside recycling program is cost. Visual surveys of the three communities in this study revealed that: 9% of the study group in O'Fallon (flat fee) recycled during this study, 30% of the study group in Belleville (free recycling) recycled during this study, and 66% of the study group in Swansea (PAYT) recycled during this study. This is evidence that recycling participation could be indirectly related to cost of participating.

Skumatz, Lisa A., Ph.D. and David J. Freeman, "Pay as you Throw (PAYT) in the US: 2006 Update and Analyses", prepared for US EPA and SERA, by Skumatz Economic Research Associates, Superior CO, December 2006.
http://www.epa.gov/osw/conserve/tools/payt/pdf/sera06.pdf
PAYT has been embraced by almost 7,100 in the United States, and has led to the diversion of perhaps 6.5 million tons of municipal solid waste (MSW) per year that would otherwise have been landfilled. The research in this paper shows these programs are available to about 25% of the US population and about 26% of communities in the US – including 30% of the largest cities in the US. This study concludes that PAYT programs have an advantage over only simply

implementing recycling programs because PAYT encourages not only recycling, but also composting, source reduction, reuse, and the host of responsible methods of dealing with waste. Also PAYT systems have a huge impact on diversion – reducing residential disposal by about 17% -- often with low administrative costs. A series of other SERA studies found that PAYT programs decrease residential MSW by about 17 percent in weight, with 8–11 percent being diverted directly to recycling and yard programs, and another 6 percent decreased by source-reduction efforts (Lisa A. Skumatz, 2000. "Measuring Source Reduction: Variable Rates as an Example," Skumatz Economic Research Associates, Inc., Seattle WA / Superior, CO. and Skumatz, Lisa A., Ph.D., "Nationwide Diversion Rate Study—Quantitative Effects of Program Choices on Recycling and Green Waste Diversion: Beyond Case Studies", 1996. Skumatz Economic Research Associates, Inc., Seattle WA / Superior, CO.) Other PAYT effects: PAYT increases recycling: Recycling rates in non-PAYT communities were 4.3 percentage points higher in PAYT communities than non-PAYT communities. Yard waste diversion is higher: Yard waste diversion rates were 3.5 percentage points lower in non-PAYT communities compared to PAYT towns.

Canterbury , J. and Eisenfeld, S., "The Rise and Rise of Pay-As-You-Throw." 2006.
http://www.mswmanagement.com/MSW/Articles/The_Rise_and_Rise_of_PayAsYouThrow_1520.aspx
This article concludes that PAYT is saving communities millions of dollars and helping solve myriad municipal solid waste management challenges. Interviews from 7 states regarding the PAYT programs implemented in that state lend to the conclusions that PAYT programs are a good approach for meeting a variety of MSW management goals.

Skumatz, L., "Variable-rate or 'Pay-as-you-throw' Waste Management: Answers to Frequently Asked Questions." Policy Study 295, July, 2002.
http://reason.org/files/a4e176b96ff713f3dec9a3336cafd71c.pdf
Under a variable-rate system (PAYT), customers are provided an economic signal to reduce the waste they throw away because garbage bills increase with the volume or weight of waste they dispose. According to SERA's research, the key impacts communities have found from implementing variable-rate programs include reduction in disposal tonnage and an increase in recycling and yard-waste diversion as well as source reduction. SERA's research indicates that variable-rate programs increase recycling by 5–6 percent (with similar increases for both curbside and drop-off programs) and a survey in Iowa found that recycling increased by 30 percent to 100 percent, and averaged about 50 percent. Residential disposal has been reduced by 1.7 percent and residential waste-generation by 1.2 percent nationwide from just the source-reduction impacts of these existing programs.

Folz, D., Giles, J., "Municipal Experience with "Pay As You Throw" Policies: Findings From a National Survey." 2001 (draft report).
http://web.utk.edu/~dfolz/payt.pdf
The aim of this study is to specify the impact of a PAYT policy and to identify any circumstances that condition the impact of this pricing policy on waste disposal and recycling behaviors in communities. This article concludes that in PAYT cities, households dispose of less solid waste and set out larger quantities of recyclables regardless of other policies or demographic features. Cities with PAYT also realize a higher overall level MSW diversion through recycling. Based on results from these analyses, PAYT appears to have its strongest incentive effect among cities with voluntary curbside recycling. If mandating recycling participation is not a politically feasible policy alternative to help control waste disposal costs, then local officials may find PAYT to be the next best policy choice to increase recycling and to reduce the proportion of the waste stream that winds up in the local landfill.

Indicator 4 - MSW Disposal per Capita Versus Percent of Population Served by Pay-As-You-Throw (PAYT) Waste Collection

WasteZero, Case Study, Sandwich, MA, 2012.
http://wastezero.com/media/33938/Sandwich_WZ%20Case%20Study.pdf

Sandwich residents reduced their solid waste by 42%. Additionally, recycling efforts rose 74% for plastic, metals, and glass and 20% for paper. During this period, the Town's solid waste disposal costs dropped more than $10,000 per month for a first-year savings in excess of $120,000.

WasteZero, Case Study, Shrewsbury, MA, 2013.
PAYT program implemented resulted in a 29% increase (243 tons) in recycling and a 39% decrease in trash after the first three months of implementing the WasteZero program. After the program's first 11 months, residents reduced their solid waste by 33% (3,550 tons) and increased their recycling by 17% (513 tons). Through fiscal year 2012, residents have reduced their solid waste tonnage by more than 4,000 tons or 40% annually and maintained a recycling rate of 34%.

Bucciol, A. Montinari, N., Piovesan, M., "Do Not Trash the Incentive! Monetary Incentives and Waste Sorting." Working Paper 11-093, March 9, 2011 (draft report).
http://www.hbs.edu/faculty/Publication%20Files/11-093.pdf
We find evidence that the PAYT incentive has the net effect of increasing the sorted waste ratio by around 12.2% and that it is complementary to the net effect of the DtD incentive (18.1%). In addition, municipalities with a PAYT program increase the amount of per capita sorted waste by 9.6%, but have no bearings on the amount of per capita total waste.

U.S. EPA and Green Waste Solutions, "Unit Based Garbage Charges Create Positive Economic and Environmental Impact in New England States." 2010.
http://www.epa.gov/epawaste/conserve/tools/payt/tools/bulletin/summer10.pdf (this is a 2010 Summer Bulletin from the EPA that summarizes the Green Waste Solutions study)
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Hall, C., Krumenauer, G., Luecke, K., Nowak, S., "City of Milwaukee: Impacts of Pay-As-You-Throw Municipal Solid Waste Collection." Spring, 2009.
http://www.lafollette.wisc.edu/publications/workshops/2009/waste.pdf
This report analyzes the possible implementation of a pay-as-you-throw (PAYT) user fee system for municipal solid waste (MSW) collection in the City of Milwaukee. The author of this study claims that PAYT programs replace flat fees with charges based on the quantity of MSW generated per household. PAYT systems may cause residents to recognize the cost of their individual disposal habits and reduce their waste. Pay-As-You-Throw can also promote behavioral change in the form of greater recycling. Municipalities and residents find these systems to be equitable, since those who generate more waste pay more for collection services. PAYT revenue may also provide financial benefits to the city by fully compensating program costs.

Skumatz, Lisa A., Ph.D. and David J. Freeman, "Pay as you Throw (PAYT) in the US: 2006 Update and Analyses", prepared for US EPA and SERA, by Skumatz Economic Research Associates, Superior CO, December 2006.
http://www.epa.gov/osw/conserve/tools/payt/pdf/sera06.pdf
PAYT has been embraced by almost 7,100 in the United States, and has led to the diversion of perhaps 6.5 million tons of municipal solid waste (MSW) per year that would otherwise have been landfilled. The research in this paper shows these programs are available to about 25% of the US population and about 26% of communities in the US – including 30% of the largest cities in the US. This study concludes that PAYT programs have an advantage over only simply

implementing recycling programs because PAYT encourages not only recycling, but also composting, source reduction, reuse, and the host of responsible methods of dealing with waste. Also PAYT systems have a huge impact on diversion – reducing residential disposal by about 17% -- often with low administrative costs.

Skumatz, L., "Variable-rate or 'Pay-as-you-throw' Waste Management: Answers to Frequently Asked Questions." Policy Study 295, July, 2002.
http://reason.org/files/a4e176b96ff713f3dec9a3336cafd71c.pdf
Under a variable-rate system (PAYT), customers are provided an economic signal to reduce the waste they throw away because garbage bills increase with the volume or weight of waste they dispose. According to SERA's research, the key impacts communities have found from implementing variable-rate programs include reduction in disposal tonnage and an increase in recycling and yard-waste diversion as well as source reduction. Residential disposal has been reduced by 1.7 percent and residential waste-generation by 1.2 percent nationwide from just the source-reduction impacts of these existing (variable rate) programs.

Indicator 5 - Recycling Rate of Selected Commodities Versus Landfill Tipping Fees

New Mexico Recycling Coalition, "Analysis of New Mexico Landfilling and Recycling Rates." June, 2011.
http://www.recyclenewmexico.com/Landfill_Rate_Presentation.pdf
Four NM landfills decreased their per ton fee for organics to increase diversion rates by approximately $10/ton.

NRDC, "Too Good to Throw Away." Chapter 3, February, 1997.
http://www.nrdc.org/cities/recycling/recyc/chap3.asp
At the same time that tipping fees at landfills have been increasing dramatically, the rate of recycling has almost tripled. Without waste disposal pressure being relieved by an almost 24 percent recycling rate, which diverts about 42 million tons of municipal waste from landfills and incinerators annually, the inflationary climb of landfill tipping fees would be even steeper.

Indicator 6 - Recycling and Composting per Capita Versus Landfill Tipping Fees

Williams, T., "Food Waste Recycling Continues to Grow Throughout the US." Soil and Mulch Producer News, March-April, 2013, Vol VII No 2, p. 4.
http://www.soilandmulchproducernews.com/index.php/online-publications/archives/2013/march-april-2013
http://www.soilandmulchproducernews.com/PDF/SMPNMar-Apr13.pdf
This article interviews Carrie Miller, Food Waste Manager of Waste Management Inc. in Orlando, FL, a company that services grocery stores in the state of FL. Miller concludes a main stumbling block to food waste recovery is the landfill tipping fee. The less landfills charge per ton for disposing of waste, the less incentive there is to recycle food waste. Conversely, when the tipping fees increase, so does the volume of food waste recycling.

Risse, M., Britt Faucette, B., "FOOD WASTE COMPOSTING: Institutional and Industrial Applications." Bulletin 1189, June 2012.
http://www.caes.uga.edu/applications/publications/files/pdf/B%201189_3.PDF
One of the benefits of food waste composting is the financial savings from landfill tipping fees and its potential financial gain from the sale of the finished product. As tipping fees increase and it becomes prohibitively more expensive to landfill, composting may be an attractive financial alternative as well as a value added opportunity.

Waste Business Journal, "Waste Market Overview and Outlook," 2012. $595 to order http://www.wastebusinessjournal.com/overview.htm
The Waste Market Overview examines the industry top to bottom covering waste generation, collection, processing, recovery and disposal by revenue and volume. The report details the relationship of past and future pricing to capacity and demand for disposal, and shows the increasing role of the private sector. Waste equipment and the emerging importance of e-waste, C&D recovery, food wastes, tires and medical wastes are examined.

St. Brown, M., Yoder, J., Chouinard, H., "Revenue sources to fund recycling, reuse, and waste reduction programs." June 30, 2011.
http://www.ecy.wa.gov/beyondwaste/pdf/WSUStudy.pdf
As landfill use declines (with help from the tipping fee incentive), revenues from tipping fees decline, which means the budget for recycling subsidization declines. Thus, per-unit tipping fees do not provide a sustainable revenue source to the extent that solid waste streams shift increasingly and substantially away from landfills toward recycling.
Recycling and waste reduction programs in Lane County received funding from tipping fees charged per ton of waste brought to landfills operated by Lane County. Therefore these programs had less funding when waste was brought to competing landfills. Lane County's solution was to charge a separate system benefit fee whose revenue is used for recycling and waste reduction programs. The new system benefit fee is charged per ton of waste no matter which landfill waste is brought to by the hauler. The fee is charged on waste but the revenues are used to fund recycling programs (Lane County, Oregon 2011). Specifically the waste hauler pays the fee but the charge is likely passed onto the disposer.
When organic waste is charged lower tipping fees than waste sent to the landfill disposers will have an incentive to separate out their organic waste and dispose of it at an organic waste or composting drop-off facility.
Tipping and similar fees for disposal are not sustainable means of funding increased recycling rates, but they can become an important driver of illegal dumping and other less environmentally friendly disposal methods if variable fees are increase substantially to cover higher recycling volume. As such fixed and variable fees can be used in a coordinated fashion to both provide disincentives for disposal, cover the costs of disposal, and fund litter and illegal dumping programs and enforcement. Revenue sustainability is still a difficult issue if recycling rates increase relative to disposal, but increases in recycling rates via advance disposal/recycling fees in conjunction with refunds for recycling will tend to mitigate litter and illegal dumping as well, so the long-term revenue sustainability concern is in turn mitigated somewhat.

Gallant, L., and Wellwood, M., "Financial Scenarios Project: Financing the Zero Waste Vision. Footprint Environmental Strategies." Prepared for: Regional District of Kootenay Boundary. Sept. 2005.
Declines in total fee-based revenue due to declines in landfill tipping fee revenue could be lessened through increases in revenue from fees for recycling or composting.

EPA, EPA530-R-92-015 "Waste Prevention, Recycling, and Composting Options: Lessons from 30 Communities." Chapter 2, Demographics and Materials Generation and Recovery Levels. February, 1994.
http://www.epa.gov/osw/conserve/downloads/recy-com/chap02.pdf
This study compares landfill tipping fees and MSW recovered where Percent Total Waste Recovered is the sum of MSW and C&D materials recycled and composted divided by the total waste generated (based on tonnages). The study concludes that those with the highest recovery rates also tend to have the highest tipping fees, while those with low tipping fees tend to have low recovery levels.