

Source Reduction-Scoping Analysis
U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery
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Background

EPA's contractor measured source reduction¹ for each year from 1997-2012 in municipal solid waste (MSW) generation based on a 1996 baseline using real personal consumption expenditures (PCE)² as the driving factor.

Source reduction activities may include:

- Redesigning products or packages to reduce the quantity of the materials used;
- Substituting lighter materials for heavier ones;
- Lengthening the life of products;
- Using packaging that reduces product damage or spoilage;
- Reducing the amount of products or packages used by businesses or consumers;
- Reusing products or packages; and
- Managing organic wastes such as food waste and yard trimmings on-site prior to generation.

PCE³ measures U.S. consumer spending on goods and services such as food, clothing, vehicles, and recreation services and accounts for approximately 70 percent of U.S. Gross Domestic Product, a key indicator of economic growth. Additionally, EPA's National Source Reduction Characterization Report For Municipal Solid Waste in the United States⁴ found real PCE to be the strongest driving force of MSW generation among several possible drivers. PCE also makes intuitive sense as a driver because consumer spending leads to obtaining products or packaging that ends up being discarded as MSW.

As personal consumption expenditures increase, the amount of waste generated also tends to increase; therefore, there is a direct positive relationship between PCE and MSW generation. The Bureau of Economic Analysis (BEA) annually computes PCE, and by tracking PCE over time, EPA can gain insight into expected MSW generation. As outlined in the methodology section, below, the contractor calculated the ratio of MSW generation to PCE in 1996 to calculate projected MSW generation from 1997 to 2012 using that ratio. The difference between this projected MSW generation and actual generation is source reduction.

¹ As outlined in National Source Reduction Characterization Report For Municipal Solid Waste in the United States, "Source reduction activities reduce the amount or toxicity of wastes before they enter the municipal solid waste management system." Source reduction, also known as waste prevention, occurs before waste generation is measured.

² For real PCE, the value of the dollar is consistent over time, for example, \$1,000 in 1960 is equal to \$1,000 in 2012. In this case, real PCE is chained to \$2005 meaning the dollar value for each year is equal to the value of the dollar in 2005.

³ See Chapter 5: Personal Consumption Expenditures of the Bureau of Economic Analysis (BEA) NIPA handbook for a more detailed description: <http://www.bea.gov/national/pdf/NIPAhandbookch5.pdf>

⁴ National Source Reduction Characterization Report For Municipal Solid Waste in the United States. November 1999. EPA530-R-99-034. <http://www.epa.gov/osw/conserves/pubs/r99034.pdf>

Methodology

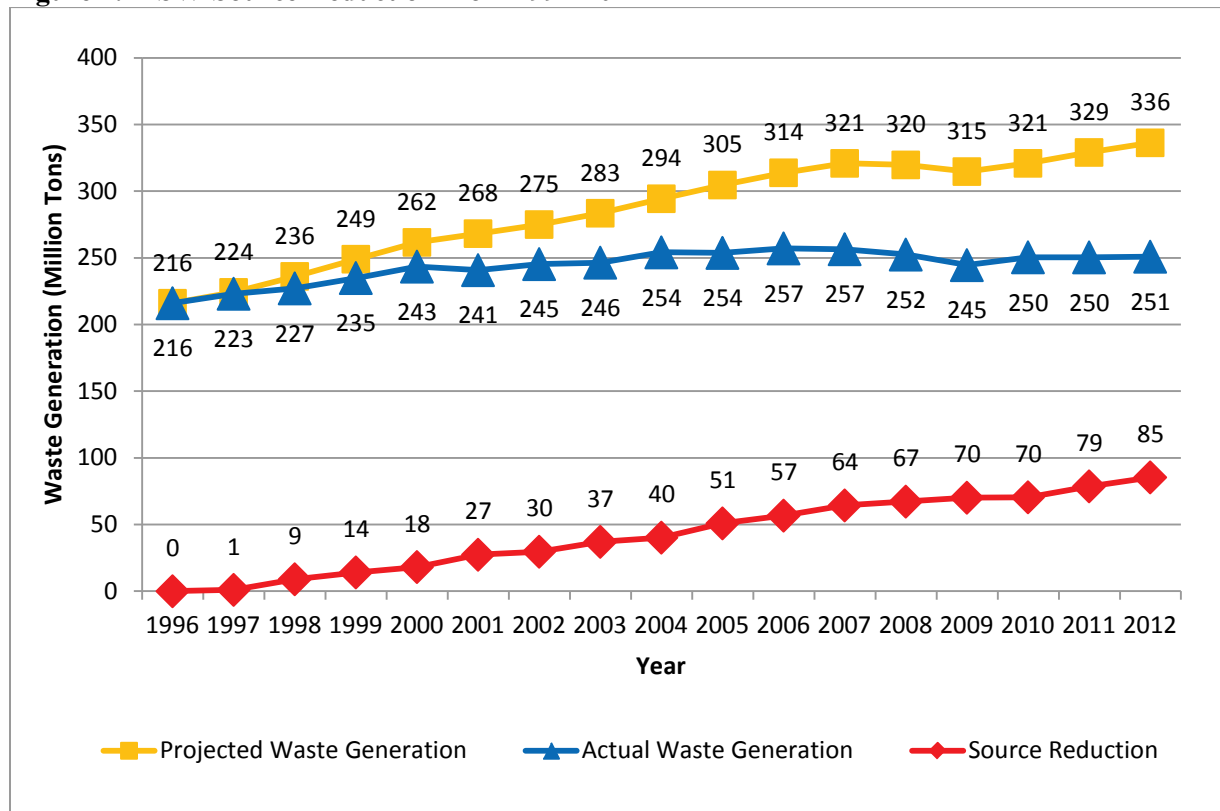
The contractor used the following methodology, as outlined in Chapter 2 of EPA’s national source reduction characterization report to perform this analysis:

- 1) Calculated the ratio of MSW generated to real PCE in 1996, the baseline year;
- 2) Multiplied the ratio in Step 1, by the real PCE for each year to calculate projected MSW generation in the absence of source reduction (yellow line in Figure 1);
- 3) Plotted actual MSW generated (blue line in Figure 1) against projected MSW generation (Step 2);
- 4) Calculated source reduction as the difference between projected MSW and actual MSW generated (red line in Figure 1).

Results

Figure 1 shows MSW source reduction relative to a real PCE driver from 1997 to 2012 using the methodology described above. The yellow line shows the projected MSW generation based on the 1996 baseline MSW to real PCE ratio. This projection is tied to real PCE, and as real PCE increased from 1996-2007 and 2009-2012, the projected MSW generation increased. Similarly, as real PCE decreased between 2007 and 2009, the projected MSW generation decreased. The blue line shows actual MSW generation for each year, and the red line shows the calculated source reduction, the difference between projected and actual MSW generation, from 1997-2012 using real PCE as the driving factor. As shown by the red line in Figure 1, source reduction has grown every year from 1997-2012 with the exception of 2009-2010 when it remained approximately the same. In 2012, source reduction is estimated at 85 million tons of MSW. This is equivalent to 25 percent of the 336 million tons projected MSW generated that year.

Figure 1. MSW Source Reduction from 1997-2012



Discussion and Limitations

This methodology to calculate source reduction assumes that real PCE, in the absence of source reduction, is a perfect predictor of MSW generation. Therefore, there are limitations to this methodology with respect to the fact that there may be other driving factors outside of real PCE and source reduction.

Additionally, PCE is comprised of consumers purchasing both goods and services (see Table 1), and each particular group of goods or services may be associated with generating different levels of product or packaging per dollar spent. As shown in Table 1, consumer spending on each of these goods and services groupings increased at different rates from 1996 to 2012. Therefore, if consumers start spending relatively more on groups of goods or services that produce more MSW, in the absence of source reduction, the “projected” MSW generation should be slightly higher than it is in Figure 1. This would mean that source reduction is greater than is shown in Figure 1 (i.e., Figure 1 would underestimate source reduction). Similarly, if consumers start spending relatively more on groups of goods or services that produce less MSW, in the absence of source reduction, the projected MSW generation should be slightly lower than it is in Figure 1. This would mean that source reduction is less than is shown in Figure 1 (i.e., Figure 1 would overestimate source reduction).

Table 1. Increase in Real Consumer Spending (PCE) by Product Type from 1996-2012.⁵

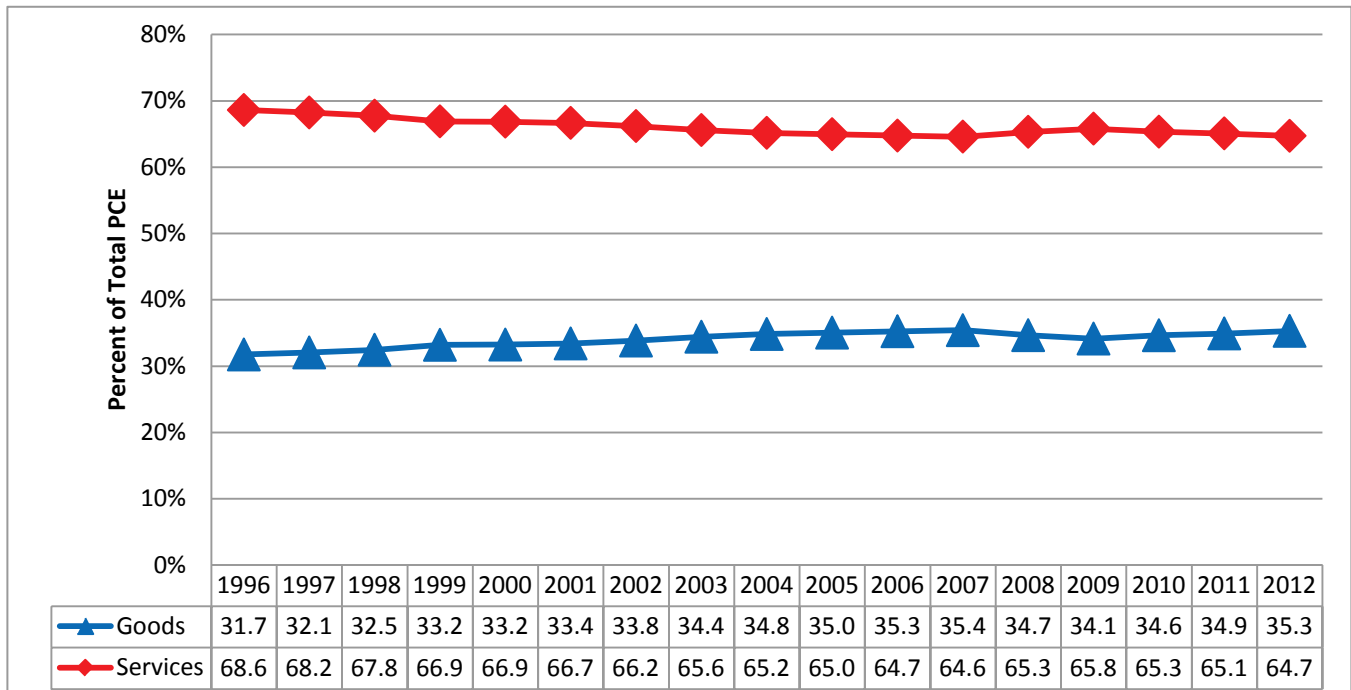
Major Product Type	Increase from 1996-2012 ^a
Goods	73%
Durable goods	144%
Motor vehicles and parts	40%
Furnishings and durable household equipment	116%
Recreational goods and vehicles	507%
Other durable goods	124%
Nondurable goods	43%
Food and beverages purchased for off-premises consumption	29%
Clothing and footwear	63%
Gasoline and other energy goods	-4%
Other nondurable goods	72%
Services	47%
Household consumption expenditures (for services)	45%
Housing and utilities	36%
Health care	60%
Transportation services	11%
Recreation services	39%
Food services and accommodations	38%
Financial services and insurance	57%
Other services	48%
Real PCE	56%

^a Increases are relative to real (adjusted for inflation) dollars.

⁵ These data were generated from Table 2.3.5U. Personal Consumption Expenditures by Major Type of Product and by Major Function and converting to real dollars using Table 2.3.4U. Price Indexes for Personal Consumption Expenditures by Major Type of Product and by Major Function (<http://www.bea.gov/iTable/iTable.cfm?ReqID=12&step=1%20-%20reqid=12&step=1&isuri=1#reqid=12&step=3&isuri=1&1210=x&1211=0&1203=18&1204=1999&1205=1000&1206=a>).

The amount of MSW generated per dollar spent for each of the goods and services groupings in Table 1 is beyond the scope of this analysis; however, it is worth noting that the growth in consumer spending from 1996 to 2012 on services (47 percent) increased at a slower rate than goods (73 percent). If services, for example, generate less MSW per dollar spent than goods, source reduction would be even higher than what is shown in Figure 1 (i.e., Figure 1 would underestimate source reduction). Figure 2 displays how, relative to total PCE, goods have generally increased relative to services since 1996. As discussed above, if data were compiled for the amount of MSW generated in both the goods and service sector, the data in Figure 2 could be used to provide a better estimate of source reduction, accounting for the differences in MSW generation intensity in the goods and services sectors.

Figure 2. Goods and Services Component of Total PCE



*Percent may not add up to 100 due to rounding and small corrections to BEA dataset.

Appendix A: Supplemental Uncertainty Analysis

The contractor explored the possibility of adding error bars to the projected MSW generation data. The projected MSW generation data are derived from MSW generation and PCE. Uncertainty (e.g., +/- X percent) could not be assigned to projected MSW generation because there was no associated uncertainty with the underlying data, which would have been needed to propagate the error through to projected MSW generation.

In a related effort, the contractor added 95 percent confidence intervals to both projected MSW generation (Figure 3) and the ratio of MSW to PCE (Figure 4). Confidence intervals are generated from the variability of the data themselves and not the uncertainty in generating the data. For example, data that deviate from a trend would have a much wider confidence interval and data more correlated with a trend line would have a smaller confidence interval (i.e., the gap between the two orange dotted lines in the figures).

Figure 3. MSW Generation 95 Percent Confidence Interval

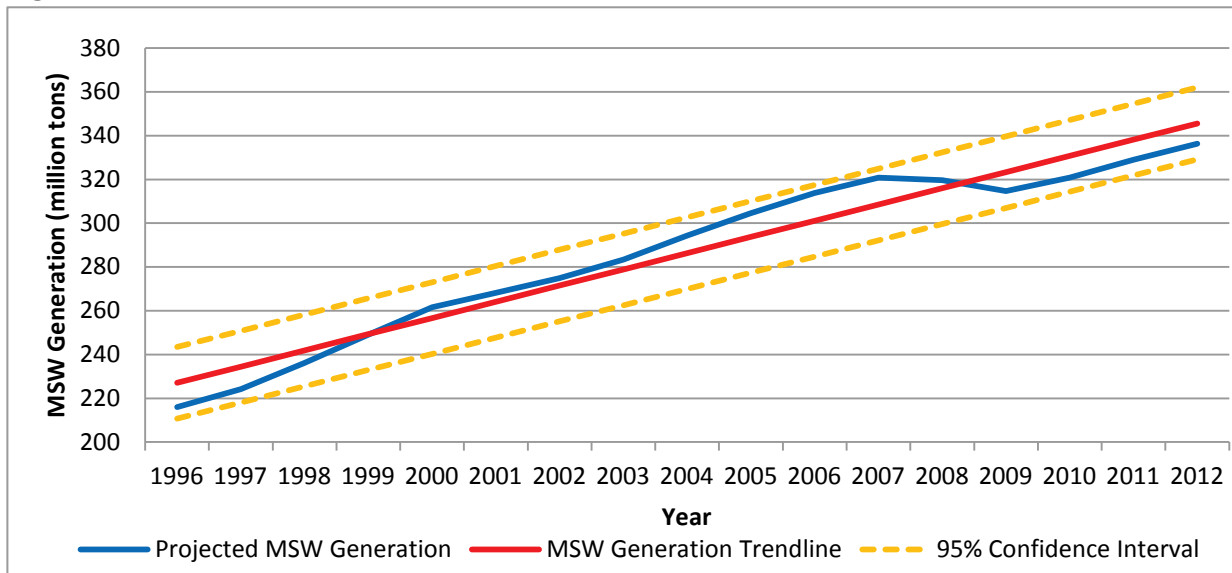
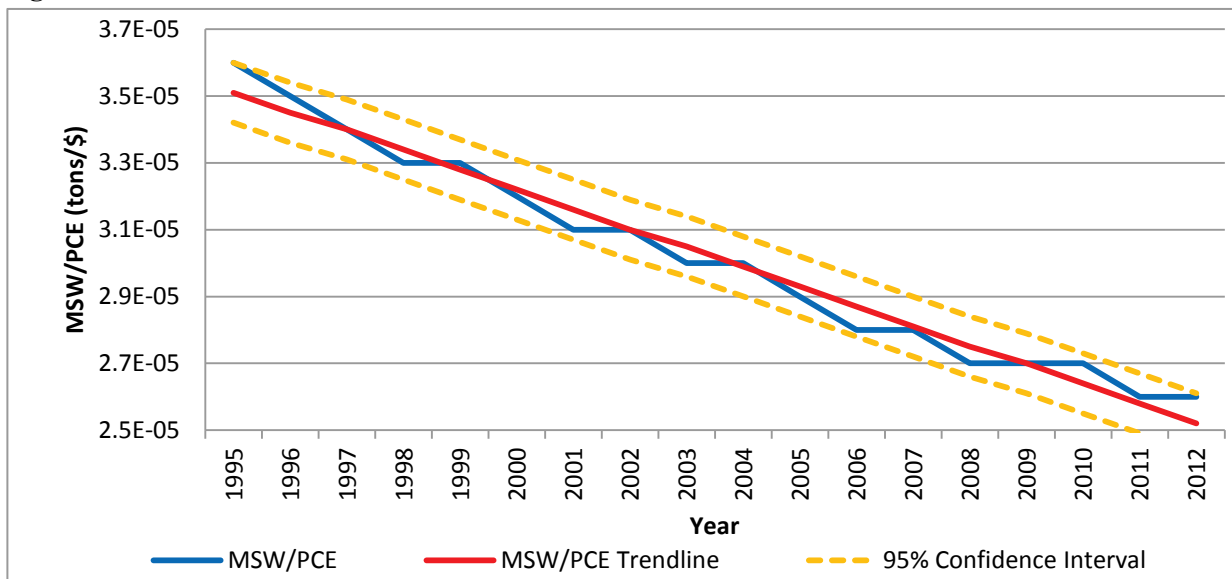


Figure 4. MSW to PCE Ratio 95 Percent Confidence Interval



Conclusions from the Appendix Figures

- Projected MSW generation (red trend line in Figure 3) increases by 7.4 million tons/year. This increase is driven by the increase in PCE. (The MSW to PCE ratio from 1996 is a constant number used to make this calculation for each year).
- The MSW to PCE ratio (red trend line in Figure 4) decreases by 0.60 tons of MSW per \$million PCE each year. This shows that less waste is being generated per \$million of PCE.
- From the confidence intervals, it can be reasonably assumed that in the absence of a change in the driving force behind these trends in Figures 3 and 4, it is 95 percent likely future projected MSW generation and MSW to PCE ratio will fall between the upper and lower bounds of the confidence intervals in the figures. This is a slight oversimplification because the confidence interval could change slightly depending on future years of data. This does not tell us anything about measurement error just the volatility (deviation or difference) of the data observations relative to the trend line.