Analysis of Tennessee's Household Generated Waste

Determining the Quantity and Value of Uncaptured Recyclables from Single-Family Households

INTRODUCTION

In 2015 the Tennessee Department of Environment and Conservation (TDEC) contracted with the Southeast Recycling Development Council (SERDC) to provide technical assistance to local governments and policy makers on recycling, economics of recycling, and business demand of recycled feedstock. Providing this depth of assistance is intended to support TDEC with the objectives laid out in their 2015 - 2025 Solid Waste and Materials Management Plan.

Within this multi-year plan from TDEC, objective 1 "Update Goals and Measure Progress" outlines the need to "more accurately measure the disposition of MSW in Tennessee."[1] As such, this study aims to determine the amount of recyclable material available from the residential sector. A deeper understanding of what is currently generated will shed light on the potential recyclable material that is not being captured under the current residential recycling infrastructure. To drill down further into more tangible figures, this analysis focuses on single-family generation as it pertains to households with four units or less. This number of units was selected as the threshold because "multi-unit complexes with more than four units are considered commercial establishments, and their collection rates are not set by the city."[2] Furthermore, the U.S. Census data counts households by number of units in this manner and as a result the county data for this analysis utilized the census data to extract the number of households within our targeted range.

This analysis employs two separate methods to examine the amount of uncaptured (meaning yet to be recovered through current recycling system) recyclable material from Tennessee's single-family households. Utilizing two methods for this study offers the advantage of examining household generation of recyclables from different perspectives, strengthening our understanding of the opportunity to recycle more material. These methods are described in more detail in the following section.

METHODOLOGY

Waste Studies Method

To examine the composition of the waste generated in Tennessee, data on the breakdown of disposed material were found in reputable waste characterization reports that conducted physical waste sorts in other

[1] Tennessee Department of Environment and Conservation 2015 – 2025 Solid Waste and Materials Management Plan (2015). https://tn.gov/assets/entities/environment/attachments/swm_2025-plan_tdec_2025-final-plan.pdf

[2] An Analysis of Variable Rates for Residential Garbage Collection in Urban Areas. Duke University.https://archive.epa.gov/wastes/conserve/tools/payt/web/pdf/upaperf1.pdf

cities in the country. The most comprehensive report was that of the entire State of Illinois[3], while the other two studies looked at Montgomery County, Maryland[4] and Prince William County, Virginia[5]. Given that no physical waste sorts are a part of this study's scope, these reports were identified for use in this analysis of Tennessee's waste stream.

In choosing these studies, there were a number of parameters considered. Each of these selected studies carried out their analysis between 2013 and 2015 (Table 1), which ensures the data reflected the current waste stream composition. All of these identified reports are from states that do not have deposits on beverage containers (non-deposit states), which is consistent for Tennessee as a state without a deposit system in place. Additionally, these studies were found to be robust and thorough in their analysis by extracting hundreds of samples at different times in the year from the generating sectors of residential and commercial as well as urban and rural settings (Table 1).

The collected samples from the waste sorts were separated into various material categories. Every report had slightly different ways of listing the categories. As a result, categories and subcategories were compared and reconfigured where necessary to create consistency amongst the columns of compiled percentages for this analysis. From the greater list of all materials (recyclable and non-recyclable) found in the waste stream, SERDC identified a list of the target recyclables that are the more commonly accepted items in a municipal recycling program (Table 2).

After confirming the list of recyclables from the broader categories, the next step involved extracting the percentages of these recyclable materials found in the waste stream from the dozens of samples that were examined in each of these reports. Only residentially sourced samples were used in this compilation. Each individual report already contained a mean average for the different types of recyclable materials as well as non-recyclable materials from the numerous collected samples. For this analysis, the percentages of recyclables were recorded and averaged amongst all the residential data in the reports to provide a thorough estimation. See bottom highlighted row in Table 3 for the average percentages used after incorporating the data from the selected residential samples.

TDEC provided municipal solid waste (MSW) data from each of Tennessee's 95 counties. All Tennessee counties are required to submit a yearly report on this information to the state via the Re-TRAC system. Re-TRAC is a web-based database management tool that collects, organizes, and sorts waste management related data. TDEC has required its counties to enter in yearly solid waste reports through Re-TRAC since 2007.[6]

3 Illinois Commodity/Waste Generation and Characterization Study Update. (2015). Retrieved September 3, 2015, from http://www.illinois.gov/dceo/whyillinois/KeyIndustries/Energy/Recycling/Documents/2015 Waste Characterization Update FINAL.pdf

4 Montgomery County Waste Characterization Study Summary of Results. (2013). Retrieved September 3, 2015, from https://www.montgomerycountymd.gov/sws/resources/files/studies/waste-composition-study-130726.pdf

5 Prince William County Virginia Waste Characterization Study Summary of 2013-2014 Results. (2014). http://gbbinc.com/gbbwp2013/wp-content/uploads/2013/10/PWC-Waste-Characterization-Final-Report.pdf

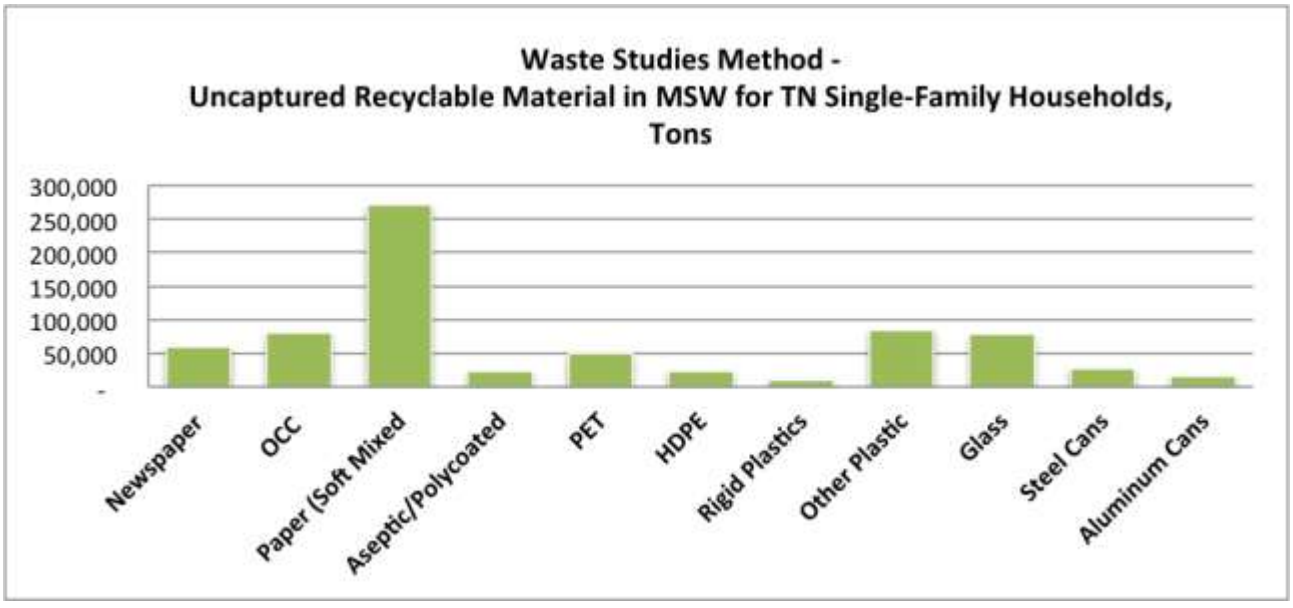
6 Re-TRAC Connect Case Studies. Retrieved on May 17, 2016. http://www.re-trac.com/case-studies/tennessee.html

A filter on this county-by-county MSW data was used to extract information from exclusively Class I landfills since they are the ones that accept household waste as well as material from commercial sources.[7] To examine only the residentially sourced material in this MSW data, a published estimate was identified from the U.S. Environmental Protection Agency (EPA) on the percentage of residential material found in the total MSW generation. This EPA residential estimate of 55% was used for this study's calculation.[8]

Next, 2014 U.S. Census data was utilized to determine the percentage of single-family households per county. This percentage was applied to the residential data to analyze only the material that was generated by single-family households. From examining this census data, it is important to note that 87% of the residential material is from single-family households in Tennessee while 13% is from multi-family structures (a household with more than 4 units).

After going through the necessary steps to extract the data for waste generated by single-family households, the aforementioned residential average percentages for recyclables (bottom row in Table 3) found in the waste stream were applied to this data. Applying these averages by commodity offered more insight into the levels of lost recyclables generated in these households.. See Chart 1 below for the breakdown of estimated recyclable material by commodity type from this method's estimations. The aggregate of all recyclable materials under this method is 1,448,188,286 pounds or 724,094 tons.

Chart 1. Waste Studies Method – Estimation of Uncaptured Recyclables

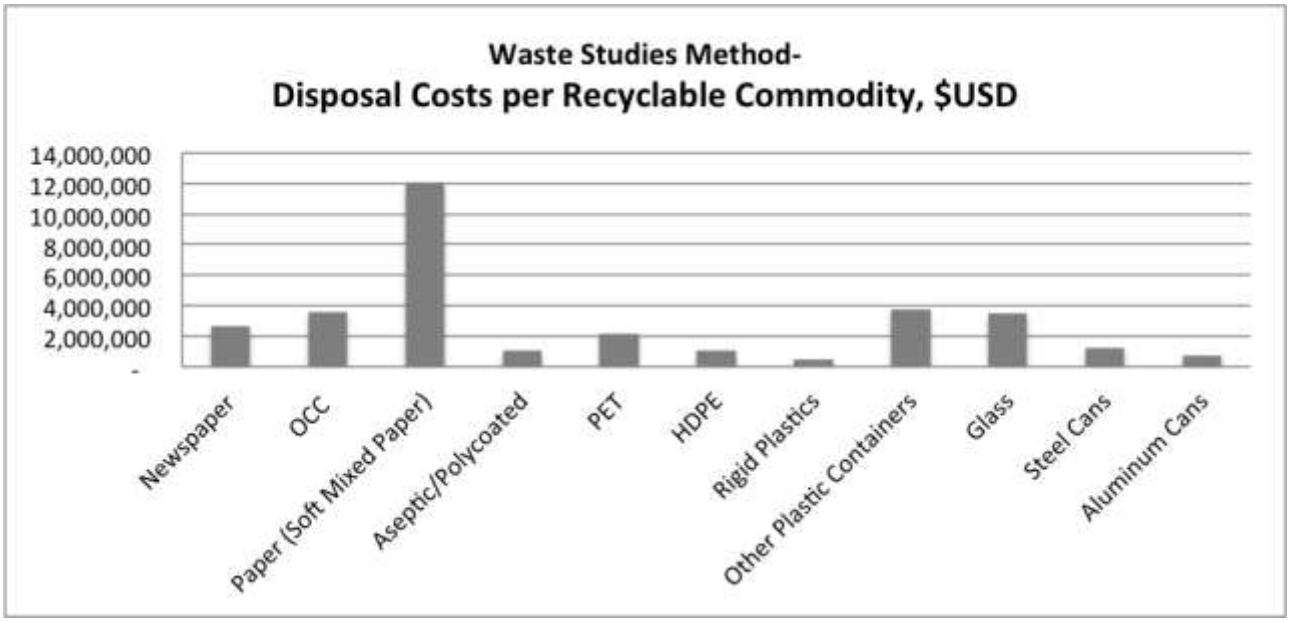


[7] "Landfill Permit." Retrieved on March 1, 2016 from https://www.tn.gov/environment/article/permit-waste-landfill-permit

[8] U.S. EPA, "Municipal Solid Waste Generation, Recycling and Disposal, Facts and Figures, 2010." (2010 was the last year that the EPA published this estimate on portion of commercial and residential in MSW.), http://www.epa.gov/osw/nonhaz/municipal/pubs/msw_2010_rev_factsheet.pdf

Chart 2. Disposal Costs of Recyclable Materials – Waste Studies Method

The chart below describes the disposal costs associated with the recyclable material estimated in the waste stream. A regional average tipping fee of $44.46/ton was identified for the southeast region from the Environmental Research Education Foundation (EREF) that released an analysis in March 2016.[9] This average was used to calculate the costs to dispose of the recyclable material.



[9] Environmental Research Education Foundation IEREF) Analysis on Average Tip Fees. Retrieved on May 19, 2016. http://www.wastedive.com/news/eref-study-west-coast-reports-highest-average-tipping-fees-other-regions/415294/

Graphic 1. Visual Description of Steps in Waste Studies Method

As a visual aide, this graphic serves to illustrate the steps involved from using the set of waste studies to determine the amount of recyclables in the MSW from single-family households in Tennessee.

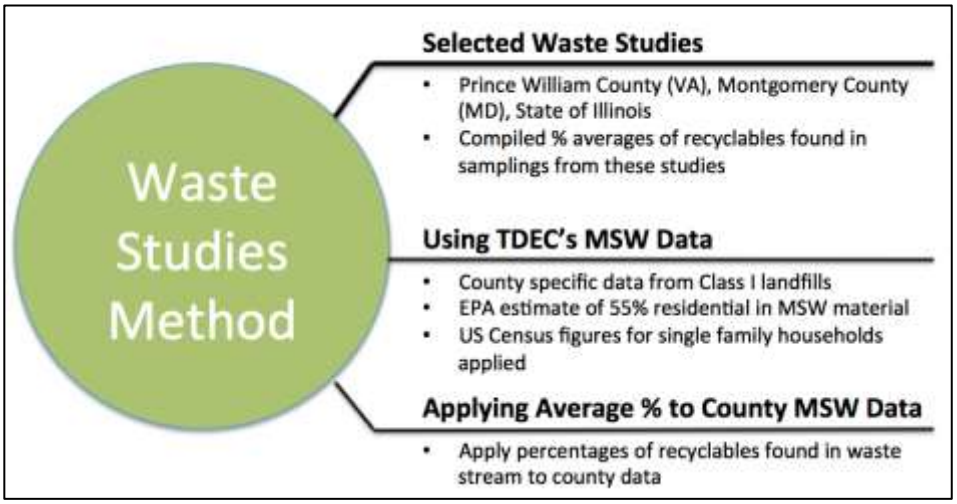


Table 1. Summary of Selected Waste Characterization Studies

The chart below describes the parameters from each of the waste studies used in this analysis.

List of Waste Reports	Publish Date of Study	Type of Waste Sampling	Total # of Samples Collected	Sates of Samples	Size of Samples	Study's Main Objective
Montgomery County, Maryland	2013	4 sampling events at county transfer station	300	October, January, April, June of 2013	200 Lbs. sample sizes from loads	Determine composition of MSW stream
Prince William County, Virginia	2014	2 week long sampling events at county landfill	100	November 2013 and May of 2014	200 Lbs. sample sizes from loads	Estimate types and quantities of recyclable and compostable waste in residential stream
State of Illinois	2015	28 sampling events at 27 solid waste facilities located throughout Illinois	263	31 days between September 2014 and December 2014	200 to 300 Lbs. sample sizes	Supporting efforts to increase the quantity of materials recycled or composted in Illinois

Table 2. Categories and Subcategory Groupings from Waste Characterization Report

This table describes the broader recyclable categories identified from the waste studies as well as the subcategory materials used for this analysis.

Paper	Plastic	Glass	Metal
Newspaper	#1 PET Bottles/Jars, Other PET Containers	Recyclable Glass Bottles & Jars	Aluminum Beverage Containers
Uncoated OCC/Kraft	#2 HDPE Bottles/Jars (Clear, Color), Other HDPE Containers		Ferrous Containers (Tin Cans)
Aseptic / Poly-coated cartons	#3-#7 Bottles		
Mixed Paper - High Grade Office Paper, Boxboard, Paperboard, Magazines, Phone Books, Other Recyclable Paper	Other Plastics – Recyclable containers and tubs, other rigid plastics		

Table 3. Percentages of Recyclables Found in Waste Studies – Residential Samples Only

The table below shows the categories and subcategories of recyclable materials and their respective composition percentages that were taken from the three waste studies. These categories were identified as focus materials in the residential waste stream as they are the more common items collected for recycling from households. The subcategories below are self-explanatory except for the 'Other Plastics Containers,' which includes other recyclable containers/tubs and other rigid plastics.

		Paper				Plastic				Glass	Metal	
List of Waste Characterization Studies	**Type of Location**	**News paper**	**Un-coated OCC/ Kraft**	**Mixed Paper**	**Aseptic /Poly-coated cartons**	**#1 PET Bottles/Jars, Other PET Con-tainers**	**#2 HDPE Bottles/Jar (Clear, Color), Other HDPE Containers**	**#3-#7 Bottles**	**Other Plastics Con-tainers**	**Recycl-able Glass Bottles & Jars**	**Aluminum Beverage Containers**	**Ferrous Contain ers (Tin Cans)**
Montgomery County, Maryland	Urban	2.1%	1.00%	10.40%	1.3%	1.50%	0.60%	0.10%	2.90%	1.40%	0.40%	0.90%
Montgomery County, Maryland	Urban	2.2%	1.20%	10.10%	1.9%	1.80%	0.70%	0.10%	3.20%	2.40%	0.40%	1.00%
Montgomery County, Maryland	Urban	2.6%	1.30%	10.10%	2.1%	1.80%	0.60%	0.10%	3.20%	1.60%	0.50%	0.80%
Montgomery County, Maryland	Urban	2.9%	2.30%	11.00%	1.0%	2.70%	1.00%	0.10%	3.50%	4.50%	0.70%	1.50%
Prince William County, Virginia	Urban	2.1%	2.70%	8.40%	0.8%	1.50%	0.90%	0.10%	3.70%	1.80%	0.50%	0.80%
Prince William County, Virginia	Urban	1.7%	6.80%	10.50%	0.6%	2.50%	1.30%	0.10%	4.10%	3.80%	0.80%	0.90%
State of Illinois	Urban & Rural	2.4%	4.30%	10.20%	0.20%	1.70%	0.90%	0.90%	2.80%	3.60%	0.70%	1.00%
State of Illinois	Urban	2.2%	4.30%	9.00%	0.20%	1.50%	0.90%	0.90%	2.60%	4.20%	0.60%	1.20%
State of Illinois	Rural	2.8%	4.20%	15.00%	0.20%	2.20%	1.30%	1.20%	3.60%	3.90%	1.00%	1.60%
Average for Residential		**2.33%**	**3.12%**	**10.52%**	**0.92%**	**1.91%**	**0.91%**	**0.40%**	**3.29%**	**3.02%**	**0.62%**	**1.08%**

Household Average Generation Method

In 2015 North Carolina's Department of Environment and Natural Resources (N.C. DENR) obtained research from about 18 solid waste programs from around the country to produce a total average for the pounds of recyclables a single-family household generates in one year. This estimate accounts for the projection of all potential recyclables generated out of a single-family home, both in the waste and recycling streams. N.C. It is important to note that this projection aims to highlight the highest potential amount of recyclables generated.

DENR captured this data from programs that had performed composition studies on their trash and recycling streams so that they would have an aggregate amount of all recyclables generated from a household regardless of where this material was taken.

Table 4 shows the list of these selected cities and their respective data that leads to the average of 866 pounds per household for the amount of all recyclables that a single-family household generates in one year.[10] To validate the information from these cities, SERDC conducted an internal evaluation process that ensured these reported estimations were in line with the data collected from the locations in the waste studies mentioned in the prior section.

Using the average of 866 pounds, SERDC calculated the total potential amount of recyclables generated per year for single-family households (US Census data) for all 95 counties in Tennessee. Next, we subtracted the amount of recyclables already captured from single-family households in 2014. This data was found in each county's annual progress report that is provided to the state. This procedure yielded the remaining pounds of recyclables not currently captured in the recycling infrastructure.

As shown in Table 5, there were 20 counties that did not have consistent residential recycling data from their annual progress report: Bradley, Cumberland, Fayette, Fentress, Grundy, Hamblen, Hickman, Houston, Humphreys, Jackson, Lauderdale, Lawrence, Lewis, Madison, Marion, Montgomery, Pickett, Smith, Stewart, Wayne. The inconsistent data from these counties had to do with some counties only reporting commercial or industrial data while others had all sources of material lumped into one figure. With the calculations used for this specific method, some counties had abnormally high capture rates compared to the other counties. For all of these specific "outlier" counties, SERDC applied an average of the proportion of the amount of recyclables captured over the total potential amount of recyclables. This average was found to be 21%, which means that on average 21% of the total potential recyclables were captured. This 21% average was applied to those 20 counties with inconsistent recycling data.

Averages of recyclables found in single stream material were applied to this calculation of remaining pounds. The total estimate of all recyclable materials under this method is 1,479,934,686 or 739,967 tons.

[10] "Measuring the Generation of Residential Recyclables in NC and Beyond (2016)." http://www.cra-recycle.org/wp-content/uploads/2016/03/CRA-B10-Rob-Taylor.pdf

Table 4. Single-Family Averages of Total Recyclables Generated (Waste & Recycling Streams)

Community	Pounds of Recyclables / Year (waste & recycling streams) for SF households
Apex, NC	964
Asheville, NC	849
Austin, TX	854
Cary, NC	923
Cincinnati, OH	963
Fayetteville, NC	757
Fort Worth, TX	804
Fuquay-Varina, NC	889
Garner, NC	750
Holly Springs, NC	856
MA subscription (rural)	856
MA subscription (suburban)	839
Minneapolis, MN	896
Raleigh, NC	810
Saint Louis Park, MN	827
Tuscon, AZ	880
Worcester, MA (high income)	1005
Worcester, MA (med. Income)	857
Average	**866**

Chart 3. Estimation of Uncaptured Recyclables - Household Average Generation Method

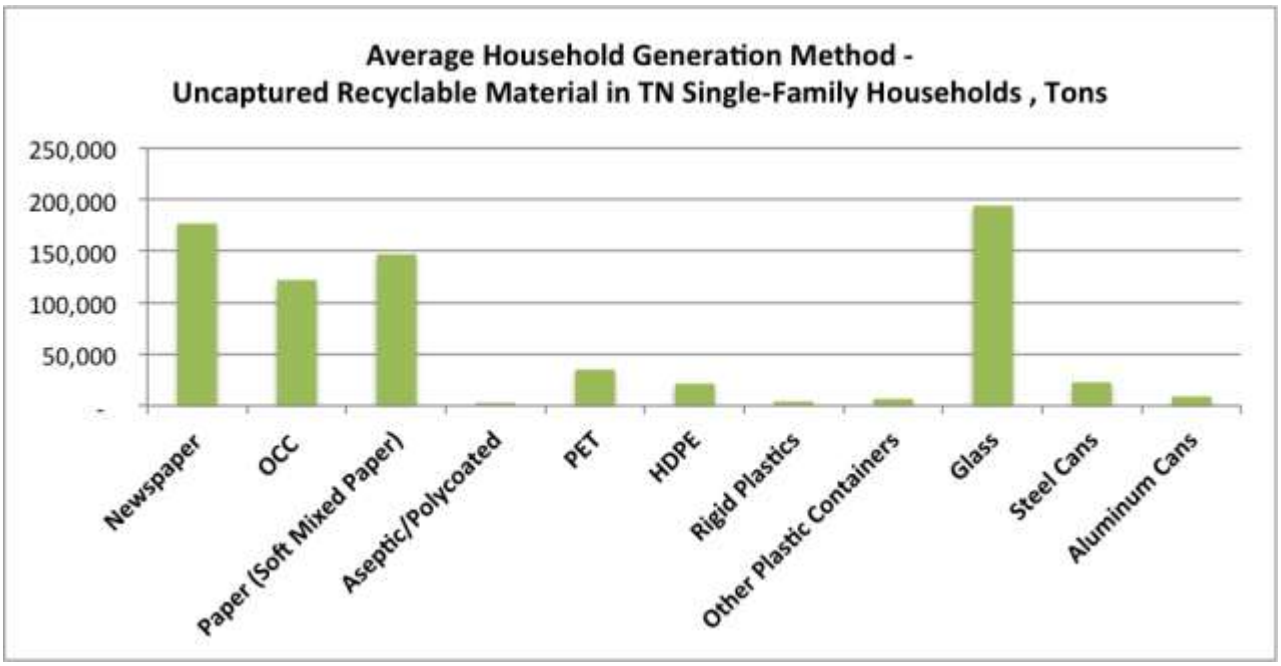
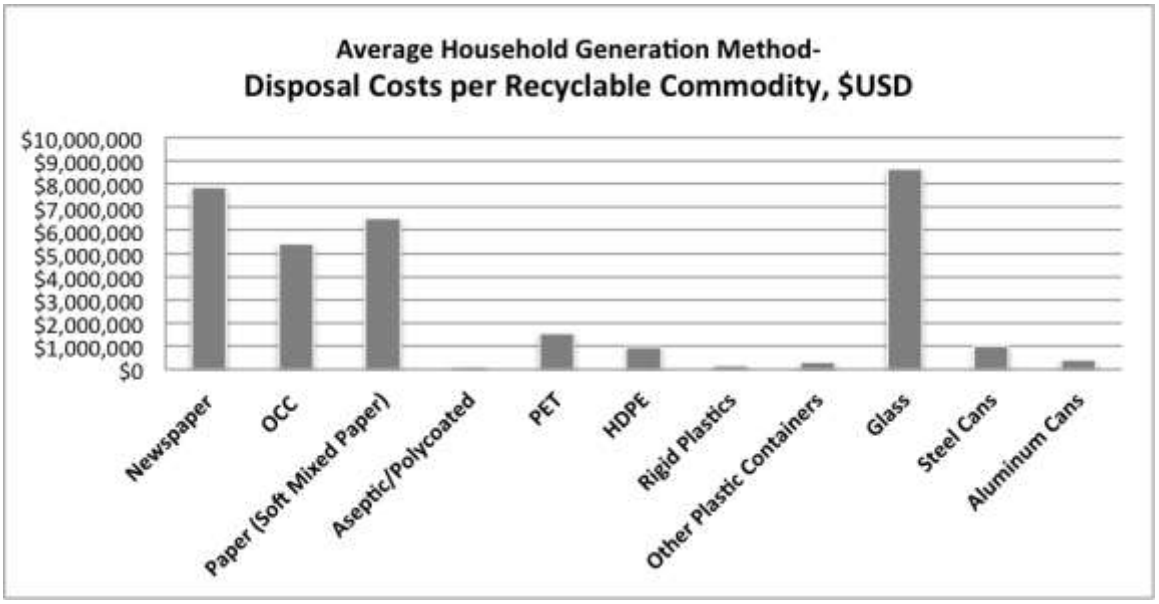


Chart 4. Disposal Costs of Recyclable Materials – Household Average Generation Method

The chart below describes the disposal costs associated with the estimated recyclable material generated from single-family households that is not currently being recovered. The aforementioned southeast regional tipping fee average of $44.46 per ton is used here again to calculate the cost to dispose of these materials.[11]



[11] Environmental Research Education Foundation IEREF) Analysis on Average Tip Fees. Retrieved on May 19, 2016. http://www.wastedive.com/news/eref-study-west-coast-reports-highest-average-tipping-fees-other-regions/415294/

Graphic 2. Visual Description of Steps in Average Pounds per Household Method

The below graphic illustrates the steps taken for the household average method.

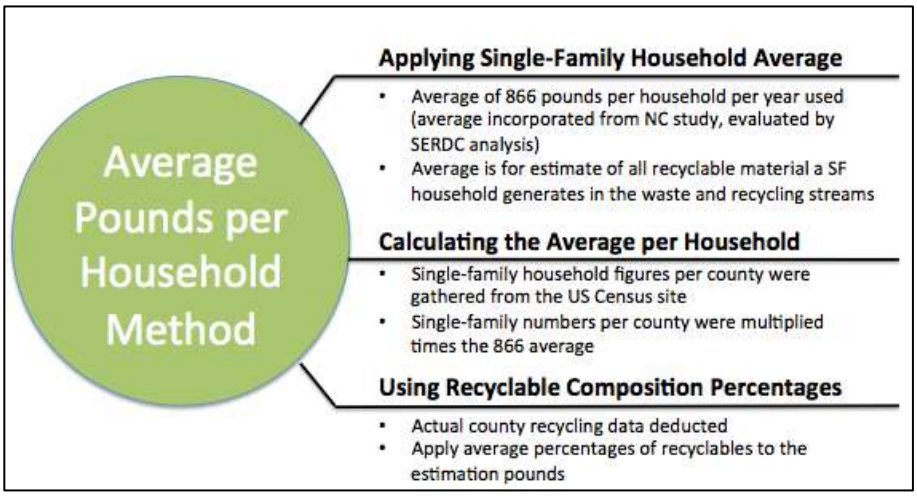


Table 5. Counties with Inconsistent Residential Recycling Data

These counties had inconsistent recycling data for various reasons. The average proportion of captured recycled material was used for all these counties. The description for each county's inconsistency is listed below. Many of these counties reported their recycling data for all their sectors, including commercial, industrial and residential. For these counties, the average proportion of captured material was used. This average was also applied to the other counties listed below that had an abnormally high capture rate of over 90%. TDEC's Ashby Barnes was instrumental in providing his extensive knowledge base on these outlier counties.

County	Recycling Data Inconsistency Description
Bradley	Capture rate was 96%
Cumberland	Capture rate was 93%
Fayette	All sectors in one figure
Fentress	Capture rate was 175%. TDEC indicated that it is possible that they are counting some of their commercial recycling pick up as part of their residential program since the county provides hauling for residential and commercial locations.
Grundy	Only reported industrial and commercial figures

Hamblen	Capture rate was 132%. Hamblen County has a MRF that is run by Goodwill, which is a hub for a Hub and Spoke program. This scenario might account for a higher capture rate.
Hickman	Contains commercial figures. They collect recyclable material from some of their area industrial businesses, which they may be reporting in with their public collection.
Houston	Only commercial figures
Humphreys	Only commercial figures
Jackson	All sectors in one figure
Lauderdale	All sectors in one figure
Lawrence	Contains commercial figures. They pick up OCC at over 200 county businesses which were probably recorded from the residential sector.
Lewis	Contains commercial figures. Had significant tonnages indicated as residential sector that should have been recorded as commercial or industrial in the APR.
Madison	All sectors in one figure
Marion	Only report industrial and commercial figures
Montgomery	All sectors in one figure
Pickett	All sectors in one figure
Smith	All sectors in one figure
Stewart	Only industrial figures
Wayne	Contains commercial figures. Some commercial/industrial figures were included in the residential data.

MARKET VALUE OF RECYCLABLE COMMODITIES

One of the many goals of this research is to estimate the economic value of commodities not presently captured in Tennessee. This specific goal is also tied to Objective 1, "Update Goals and Measure Progress," and Objective 3, "Enhance Processing and End Markets" from TDEC's Solid Waste Management Plan. This knowledge of the economic value of lost recyclables will allow the state of Tennessee to assess current recycling programs and better understand the amounts of material that provide the greatest opportunity for diversion; resulting in the greater economic and environmental gain.

Through research and communication with industry experts[12], the commodity index chosen for this analysis was from Recycling Markets Limited (RML). The RML pricing index provided expansive historical data that shows the pricing fluctuations from previous years. SERDC extracted the necessary data from the past three years to produce a pricing average that accounts for these fluctuations, providing a better sense on what the recyclable commodities have been worth over a longer span of time. The southeast regional average was selected for Tennessee and the first published prices from each month were the ones recorded for this analysis.

Despite its high recyclability, glass remains a commodity that has a weaker economic gain with respect to its value in the recycling market. Glass was assigned a price of $0/pound due to its current pricing position. Also, aseptic and poly-coated cartons are becoming more accepted in recycling programs although it depends on the local MRF's ability to process this type of layered material. The pricing index did not include a current regional price or historical pricing data for this material, which resulted in assigning aseptic and poly-coated cartons a $0/pound value. The Institute of Scrap Recycling Industries (ISRI) has listed a bale spec for "aseptic packaging and gable-top cartons"[13] but this commodity continues to grow as a material that is acceptable in recycling programs.

In Table 5 below there is a column that shows the percent of disposed waste that indicates how much of the recycled material is part of the waste stream. These are the average percentages that were taken from the waste studies. Table 6 includes a similar column but incorporates percentages from a single-stream composition, which is important to note because the composition used in these two methods varies, which affects the amount and market value of the various listed recyclables.

Due to the wide range of recyclable plastics, the Association of Plastic Recyclers provided technical support on the composition of plastic pricing for this analysis. The suggested breakdown of this commodity pricing was as follows:
PET – used PET (baled, picked up)
HDPE – used 52% of the colored HDPE pricing and 48% of the natural HDPE pricing (percentages are according to the 2014 National Postconsumer Plastics Bottle Recycling Report[14])
Rigid Plastics – used 30% colored HDPE, 26% PP Postconsumer, 44% PET
Other Plastic Containers – used Comingled #1-#7

[12] Cornell, Dave (Association of Plastic Recyclers). "Re: question on commodity prices for plastics." Message in response to Meredith Leahy from Dave Cornell. 28 March 2016. E-mail.
[13] "Scrap Specifications Circular" (2016). http://www.isri.org/docs/default-source/commodities/specsupdate.pdf
[14] "2014 United States National Postconsumer Plastics Bottle Recycling Report" (2014). https://plastics.americanchemistry.com/Education-Resources/Publications/2014-National-Post-Consumer-Plastics-Bottle-Recycling-Report.pdf

Table 5. Commodity Values of Lost Recyclables – Waste Studies Method

Focused Material	3 Year Southeast Regional Average $/lb.	Amount Available to Recycle in SF Households, Lbs.	% of Disposed Waste	Market Value
Newspaper	$0.03	119,995,687	2.3%	$3,149,887
OCC	$0.05	160,680,919	3.1%	$8,164,328
Paper (Soft Mixed Paper)	$0.03	541,783,100	10.5%	$14,551,269
Aseptic/Poly-coated Cartons	$0	47,380,271	0.9%	$0
PET	$0.15	98,365,563	1.9%	$14,741,808
HDPE	$0.30	46,865,268	0.9%	$13,958,503
Rigid Plastics	$0.17	20,600,118	0.4%	$3,591,655
Other Plastic Containers	$0.04	169,435,969	3.3%	$6,548,471
Glass	$0	155,530,890	3.0%	$0
Steel Cans	$0.03	55,620,318	1.1%	$1,783,233
Aluminum Cans	$0.51	31,930,183	0.6%	$16,180,836
Total:		**1,448,188,286**	**28.1%**	**$82,669,989**

Table 6. Commodity Values of Lost Recyclables – Household Average Method

Focused Material	3 Year Southeast Regional Average $/lb.	Amount Available to Recycle in SF Households, Lbs.	% of Recycling Stream	Market Value
Newspaper	$0.03	352,668,436	23.8%	$9,257,546
OCC	$0.05	243,153,269	16.4%	$12,354,815
Paper (Soft Mixed Paper)	$0.03	293,619,042	20.2%	$7,886,052
Aseptic/Poly-coated Cartons	$0	5,919,739	0.4%	$0
PET	$0.15	70,592,885	4.8%	$10,579,584
HDPE	$0.30	43,510,080	2.9%	$12,959,183
Rigid Plastics	$0.17	6,807,700	0.5%	$1,186,931

Other Plastic Containers	$0.04	13,467,406	0.9%	$520,497
Glass	$0	388,926,835	26.3%	$0
Steel Cans	$0.03	44,102,054	3.0%	$1,413,948
Aluminum Cans	$0.51	17,167,242	1.2%	$8,699,616
Total:		**1,479,934,686**	**100%**	**$64,858,171**

Table 7. Varying Capture Rates

As with any projection, it's beneficial to consider the incremental steps toward reaching a long range goal. The information below shows the amount of material that could be captured based on the incremental percentages.

	Potential Capture Rates			
Estimated Recyclables Not Captured	**25%**	**50%**	**75%**	**100%**
Waste Studies Method (tons)	181,024	362,047	543,071	724,094
Estimated Recyclables Not Captured, Household Average Method (tons)	184,992	369,984	554,976	739,967

COUNTY-BY-COUNTY & RURAL VS URBAN GENERATION

Table 8 below shows the full listing of all 95 counties in Tennessee along with each one's respective metro or non-metro continuum code from the United States Department of Agriculture (USDA). The USDA assigns each county with a rural-urban continuum code (RUC), numbers 1 through 3 are representative of urban/metro counties and 4 through 9 are rurally or non-metro classified counties. Similarly, the Illinois study used the same classification for their study. According to the USDA's 2013 Rural-Urban Continuum Codes[15], Tennessee is comprised of 42 urban counties and 53 rural counties. Also listed is the side-by-side comparison of the total lost recyclables estimated from each of the described methods in this study for each county.

Charts 3 and 4 depict the percentage of the estimated lost recyclables for each method in order to better understand that more density of the material resides in more heavily populated counties.

[15] "Rural-Urban Continuum Codes." *Overview*. United States Department of Agriculture (USDA), 10 May 2013. Web. 3 Sept. 2015. <http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx>.

Table 8. County-by-County Listing

All TN Counties	Metro or Non-Metro	Rural - Urban Continuum Codes	Lost Recyclables via Waste Studies Method (Lbs.)	Lost Recyclables via Household Average Method (Lbs.)
Anderson	Metro	2	18,471,064	17,340,541
Bedford	Nonmetro	4	7,380,300	6,247,013
Benton	Nonmetro	7	6,690,902	5,427,646
Bledsoe	Nonmetro	8	1,195,862	3,500,066
Blount	Metro	2	16,006,144	29,834,880
Bradley	Metro	3	18,838,347	23,860,121
Campbell	Metro	2	7,336,099	15,086,696
Cannon	Metro	1	2,007,489	3,842,834
Carroll	Nonmetro	6	5,436,254	7,934,611
Carter	Metro	3	7,963,445	18,028,801
Cheatham	Metro	1	6,772,311	11,025,340
Chester	Metro	3	1,591,039	2,342,332
Claiborne	Nonmetro	6	4,692,725	9,120,475
Clay	Nonmetro	9	970,725	1,121,666
Cocke	Nonmetro	6	11,553,272	10,476,021
Coffee	Nonmetro	4	12,379,574	14,273,438
Crockett	Metro	3	1,762,170	4,566,342
Cumberland	Nonmetro	4	4,704,809	15,549,610
Davidson	Metro	1	125,606,348	119,461,972
Decatur	Nonmetro	9	2,420,001	3,924,843
DeKalb	Nonmetro	6	3,473,514	5,211,322
Dickson	Metro	1	10,993,759	12,736,851
Dyer	Nonmetro	5	9,465,357	11,316,730
Fayette	Metro	1	1,001,701	9,716,590
Fentress	Nonmetro	9	2,727,553	4,863,259
Franklin	Nonmetro	6	8,464,540	4,415,699
Gibson	Nonmetro	4	11,391,419	11,943,544
Giles	Nonmetro	6	14,629,144	7,259,912
Grainer	Metro	2	3,242,725	6,892,141
Greene	Nonmetro	4	12,813,272	19,469,647
Grundy	Nonmetro	8	1,807,209	3,506,464

Hamblen	Metro	3	26,450,173	15,445,133
Hamilton	Metro	2	66,620,110	64,856,414
Hancock	Nonmetro	8	936,889	2,244,813
Hardeman	Nonmetro	6	4,104,527	1,798,045
Hardin	Nonmetro	6	4,164,064	5,767,021
Hawkins	Metro	2	10,994,084	17,028,169
Haywood	Nonmetro	6	No data	3,510,538
Henderson	Nonmetro	6	1,131,049	8,545,476
Henry	Nonmetro	7	2,515,682	7,687,825
Hickman	Metro	1	4,904,799	5,854,707
Houston	Nonmetro	8	1,204,917	2,211,732
Humphreys	Nonmetro	6	5,316,357	4,926,498
Jackson	Nonmetro	8	1,118,034	3,056,259
Jefferson	Metro	3	6,923,298	12,761,788
Johnson	Nonmetro	6	3,542,116	5,595,198
Knox	Metro	2	122,814,357	106,358,944
Lake	Nonmetro	9	2,012,192	1,654,717
Lauderdale	Nonmetro	6	2,888,956	6,440,789
Lawrence	Nonmetro	6	587,640	10,389,891
Lewis	Nonmetro	6	4,772,950	3,228,131
Lincoln	Nonmetro	6	837,600	9,914,459
Loudon	Metro	2	63,881,683	10,628,983
Macon	Nonmetro	4	3,792,753	5,642,149
Madison	Nonmetro	6	31,001,414	22,458,755
Marion	Metro	1	5,417,438	7,459,263
Marshall	Metro	3	5,620,794	8,488,376
Maury	Metro	2	39,447,703	15,524,237
McMinn	Nonmetro	6	21,990,858	13,755,105
McNairy	Metro	1	1,492,933	5,783,740
Meigs	Nonmetro	8	1,118,862	3,805,048
Monroe	Nonmetro	6	7,899,889	12,452,484
Montgomery	Metro	2	44,736,710	39,092,259
Moore	Nonmetro	9	923,766	1,590,790
Morgan	Metro	2	2,721,129	5,458,337
Obion	Nonmetro	7	7,638,577	5,889,750
Overton	Nonmetro	7	13,814,474	2,438,819
Perry	Nonmetro	8	1,309,840	2,614,583
Pickett	Nonmetro	9	722,784	1,495,096

Polk	Metro	3	1,491,576	5,561,985
Putnam	Nonmetro	4	14,750,022	9,935,024
Rhea	Nonmetro	6	8,828,641	9,894,998
Roane	Metro	2	8,168,052	13,929,975
Robertson	Metro	1	12,045,960	20,030,377
Rutherford	Metro	1	20,685,779	61,535,990
Scott	Nonmetro	6	4,987,057	6,492,679
Sequatchie	Metro	2	1,250,086	3,449,425
Sevier	Nonmetro	4	1,272,982	20,865,658
Shelby	Metro	1	220,806,633	208,553,567
Smith	Metro	1	4,203,717	4,833,570
Stewart	Nonmetro	8	2,582,587	3,525,129
Sullivan	Metro	2	68,037,025	39,704,560
Sumner	Metro	1	37,144,660	44,563,239
Tipton	Metro	1	13,640,737	16,849,369
Trousdale	Metro	1	1,525,532	1,434,807
Unicoi	Metro	3	4,083,975	6,129,615
Union	Metro	2	2,493,594	4,458,212
Van Buren	Nonmetro	9	155,031	1,552,846
Warren	Nonmetro	6	10,586,940	8,061,495
Washington	Metro	3	48,992,728	23,647,567
Wayne	Nonmetro	8	2,806,382	4,032,639
Weakley	Nonmetro	7	5,297,371	10,367,262
White	Nonmetro	7	4,244,478	6,639,608
Williamson	Metro	1	48,486,737	30,605,942
Wilson	Metro	1	28,459,531	29,127,414
Total:			1,448,188,286	1,479,934,686

Estimated Material Generation by Municipal Solid Waste Planning Region

The grouping below reflects the 66 Solid Waste Planning Regions in Tennessee as outlined in TDEC's Solid Waste and Material Management Plan.[16] The estimates of lost recyclables from both methods have been compiled for the counties that comprise each region. There are 57 single-county planning regions.

Chart 5. Material Generation for Planning Regions Without 57 Single-County Regions

Planning Region	Sum of Lost Recyclables via Waste Studies Method (Lbs.)	Sum of Lost Recyclables via Household Average Method (Lbs.)
Central	33,738,129	32,515,266
Crockett/Dyer/Gibson	42,180,589	68,781,697
Interlocal	23,770,539	43,173,918
Marshall/Maury	5,663,451	10,242,141
North Central	25,695,016	29,315,800
Northeast	136,204,671	144,147,747
Shiloh	24,188,371	38,633,430
Southeast	126,726,950	121,097,051
Stewart/Montgomery/ Robertson	81,190,746	66,372,964
Grand Total	**499,358,462**	**554,280,016**

Chart 6. Material Generation for Only 57 Single-County Regions

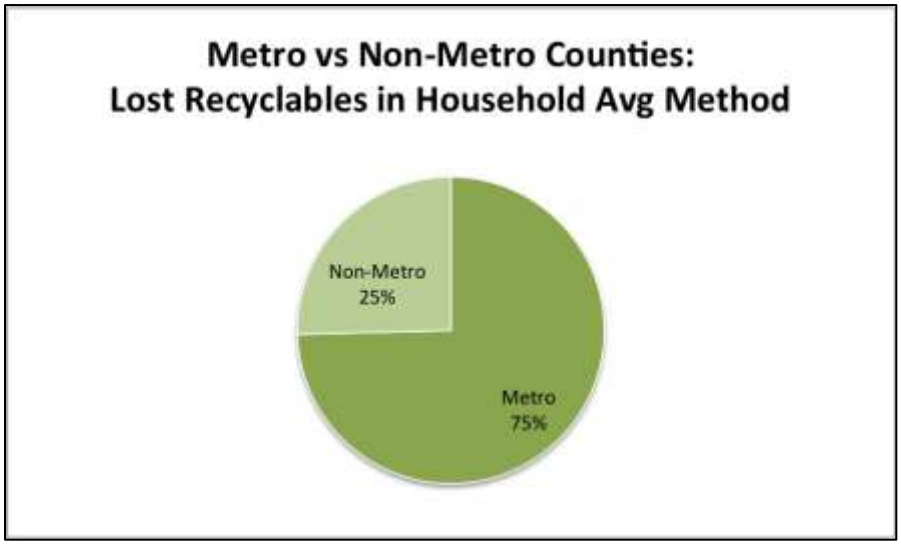
Planning Region	Sum of Lost Recyclables via Waste Studies Method (Lbs.)	Sum of Lost Recyclables via Household Average Method (Lbs.)
Single County Region	**948,829,824**	**925,654,670**

[16] Tennessee Department of Environment and Conservation 2015 – 2025 Solid Waste and Materials Management Plan (2015). https://tn.gov/assets/entities/environment/attachments/swm_2025-plan_tdec_2025-final-plan.pdf

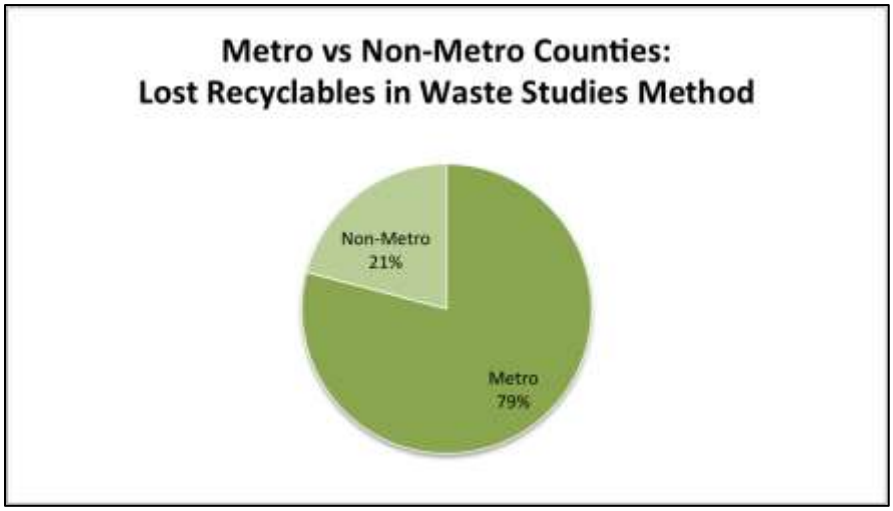
Chary 7. Material Generation for All Planning Regions

Planning Region	Sum of Lost Recyclables via Waste Studies Method (Lbs.)	Sum of Lost Recyclables via Household Average Method (Lbs.)
Central	**33,738,129**	**32,515,266**
Crockett/Dyer/Gibson	**42,180,589**	**68,781,697**
Interlocal	**23,770,539**	**43,173,918**
Marshall/Maury	**5,663,451**	**10,242,141**
North Central	**25,695,016**	**29,315,800**
Northeast	**136,204,671**	**144,147,747**
Shiloh	**24,188,371**	**38,633,430**
Single County Regions	**948,829,824**	**925,654,670**
Southeast	**126,726,950**	**121,097,051**
Stewart/Montgomery/ Robertson	**81,190,746**	**66,372,964**
Grand Total	**1,448,188,286**	**1,479,934,686**

Chart 3 and 4. Comparison of Metro vs. Non-Metro Counties



	Metro	Non-Metro
Pounds	1,145,134,173	303,054,112



	Metro	Non-Metro
Pounds	1,145,134,173	303,054,112

COMPARISON OF METHODS

As described throughout this report, SERDC identified two methods to learn more about recyclable material generated from single-family households and how much of this material is not being recovered through the current recycling systems. Both of these methods are based out on thorough data that was used to calculate these estimates of lost recyclables. The waste studies method utilized the numerous waste sorts to better understand total composition in the waste stream while the household average method employed data taken from numerous municipalities that had studied and gathered data about their households' waste and recycling streams. Another similarity is that both methods utilized the U.S. Census data for single-family households since this was a focus for this study.

A key difference between the two methods is the composition of recyclables used to examine specific lost recyclables. The waste studies method was looking at material destined for the landfill, which resulted in the percentages of recyclables being smaller for this method. Since the household average method projected the total amount of recyclables generated in a single-family household, the composition from the recycling stream was used which resulted in higher percentages of recyclables for most of the targeted recyclables. Additionally, this difference in material composition affects the total material values estimated for each method.

Despite the different approaches taken with these two methods, it is interesting to note that the estimate of the aggregate amount of lost recyclables were close. The waste studies method estimated that there were 1,448,188,2186 pounds of uncaptured recyclables from single-family households while the household average generation method showed a figure of 1,479,934,686 pounds. Both methods used the same regional pricing structure but once again the composition breakdowns for each one were different.

CONCLUSIONS / CLOSING

The purpose of this study is to more accurately measure the recoverable material lost to disposal in Tennessee.

This study pulled data from multiple sources to develop projects of the amount and type of recycling material lost to landfill disposal annually in Tennessee. Two separate methods independently point to a loss of nearly ¾ of a million tons of material that could be feeding Tennessee manufacturing facilities. In 2013 SERDC released a report titled, *A Characterization of Tennessee's Recycling Economy.* That report identified demand in the state that greatly exceeds the amount material than is captured, as reported by the Solid Waste Planning Districts. Capturing just half the lost material will generate $30 to $40 million annually, even in the down markets of recent times.

With just over one fifth of the residentially generated recyclables in Tennessee being collected, the opportunity to increase the material capture dramatically is a realistic goal. By implementing action steps toward the objectives in the 2015 – 2025 Solid Waste and Materials Management Plan, Tennessee can realize an increase in industrial feedstock for Tennessee manufacturers in the order of well over a half a million tons per year, generating tens of millions of dollars in revenue while reducing disposal costs a similar amount.