FLORIDA POLYTECHNIC UNIVERSITY

State of Recycling in Florida: Understanding the Costs, Environmental Impacts, and Ways to Improve

July 25th, 2023

Florida Polytechnic University

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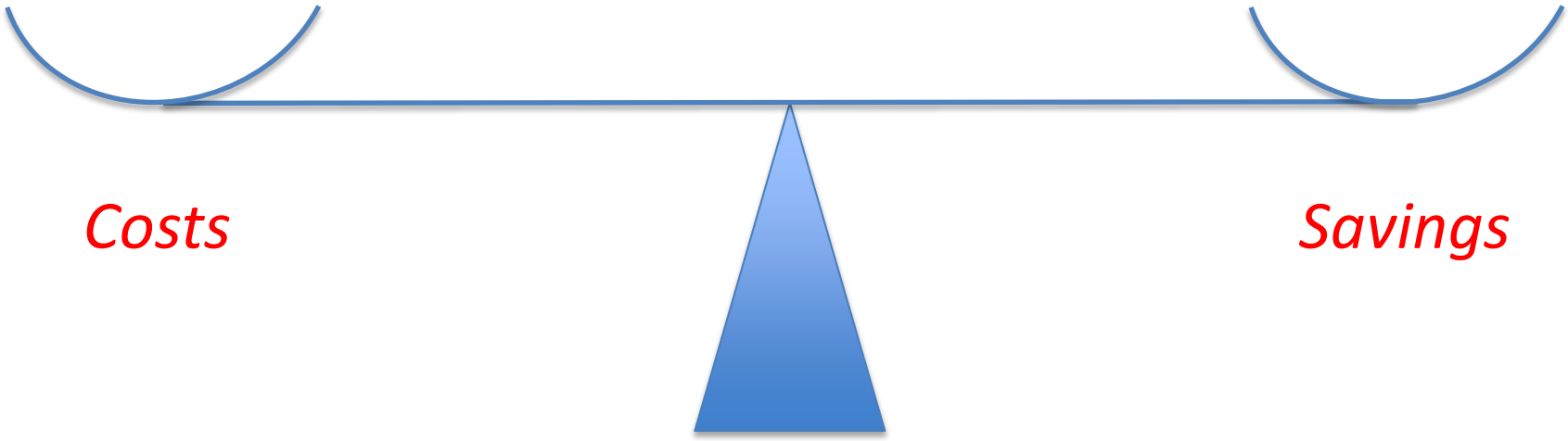
Cost of Recycling

- Collection
  xxx $/ton
- Processing
  xxx $/ton

- Commodity
  xxx $/ton
- No Landfill
  xxx $/ton



Costs

Savings

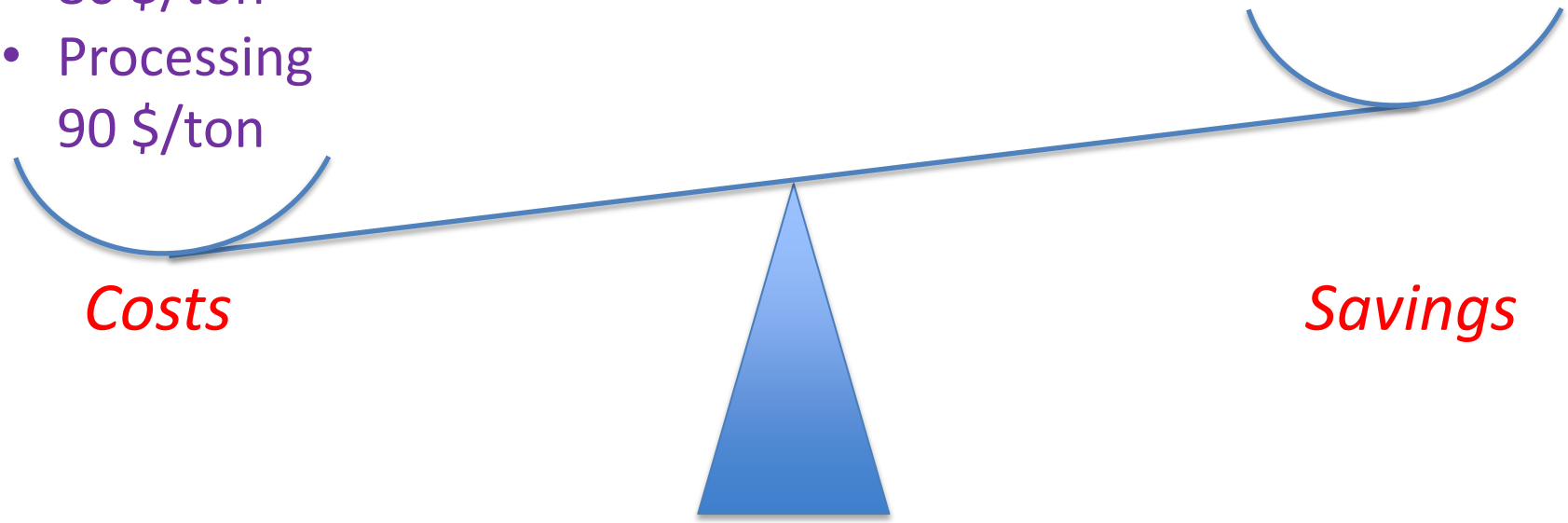
Cost of Recycling

- Collection
  80 $/ton
- Processing
  90 $/ton

Costs

- Commodity
  100 $/ton
- No Landfill
  35 $/ton

Savings



Where do we go from here?

- Improve markets
- Recycle more efficiently, less “trash”
- Alternative technologies and programs
- *Change recycling programs?*

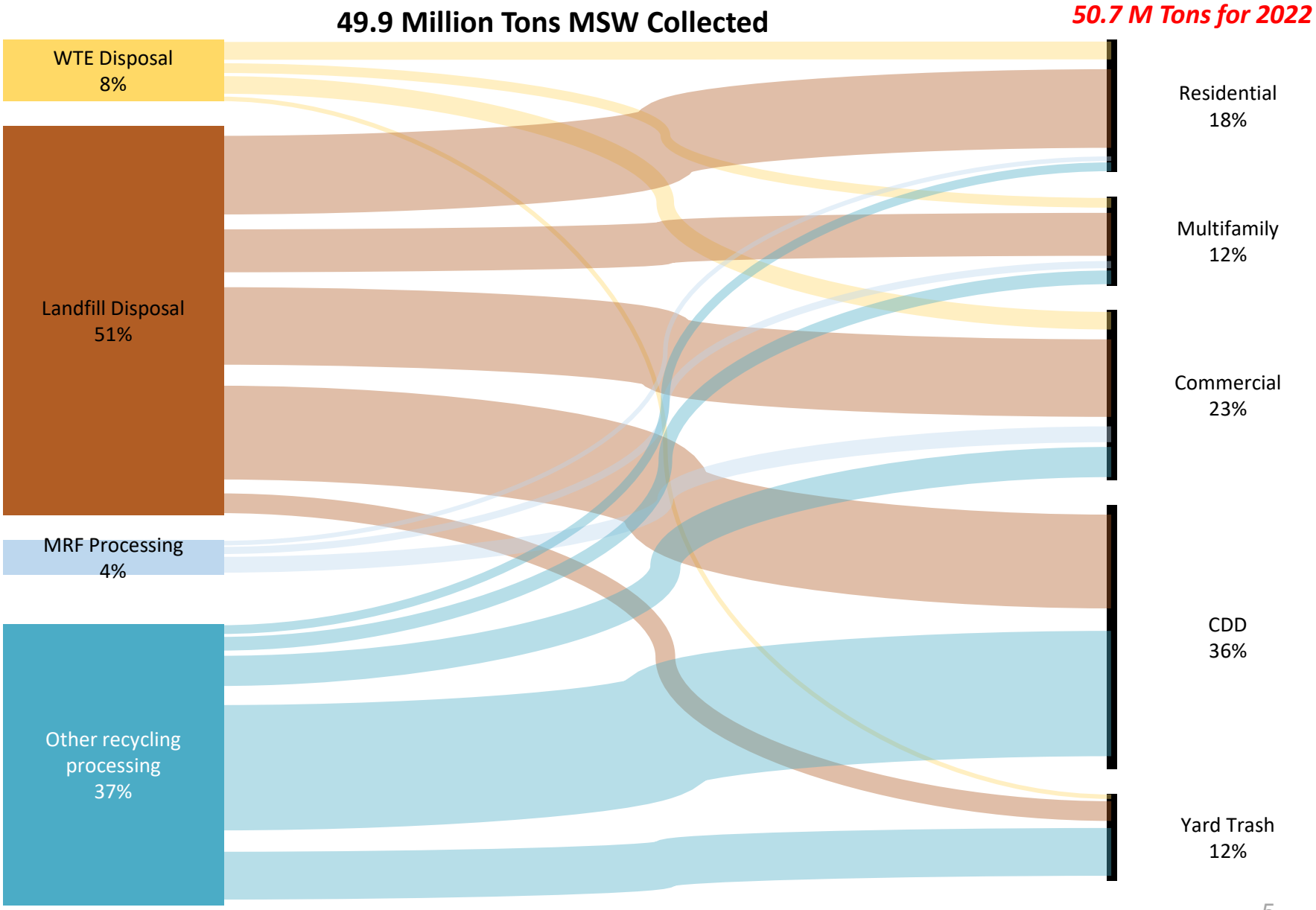
Project Objectives

- Compile county-specific waste management costs and recycling program data **to create a model that predicts a counties waste management cost portfolio.**

- Use existing waste LCA models to develop impact factors **(the GHG emissions per ton of a waste component managed a specific way) for the same categories of waste management types and waste components associated with the cost portfolio**.

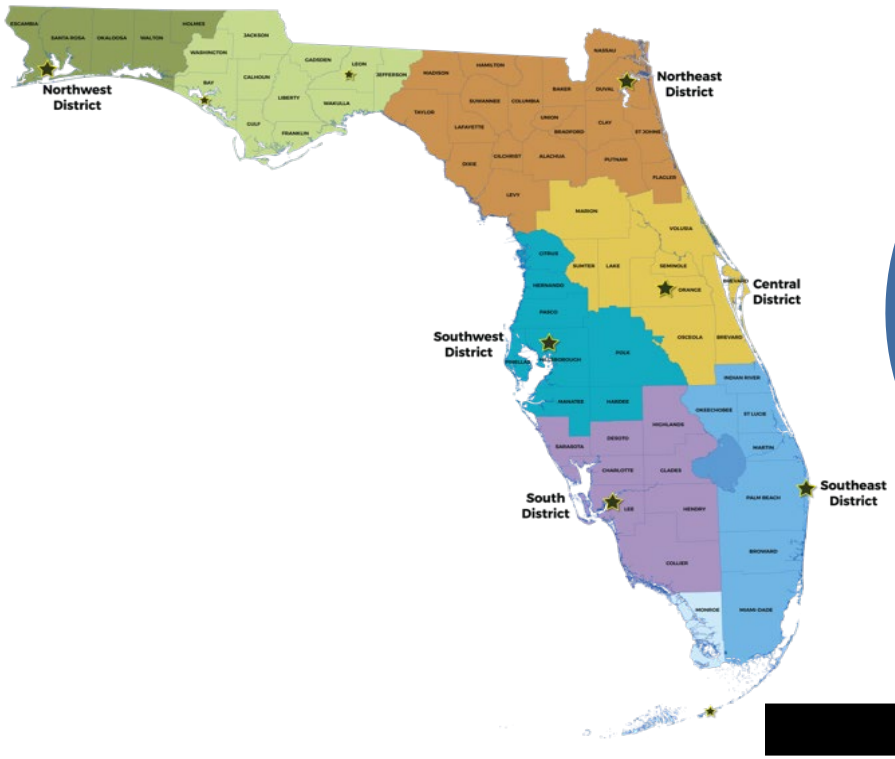
- Use the model and portfolios to **estimate the cost and GHG emissions impact of various alternative recycling program scenarios**.

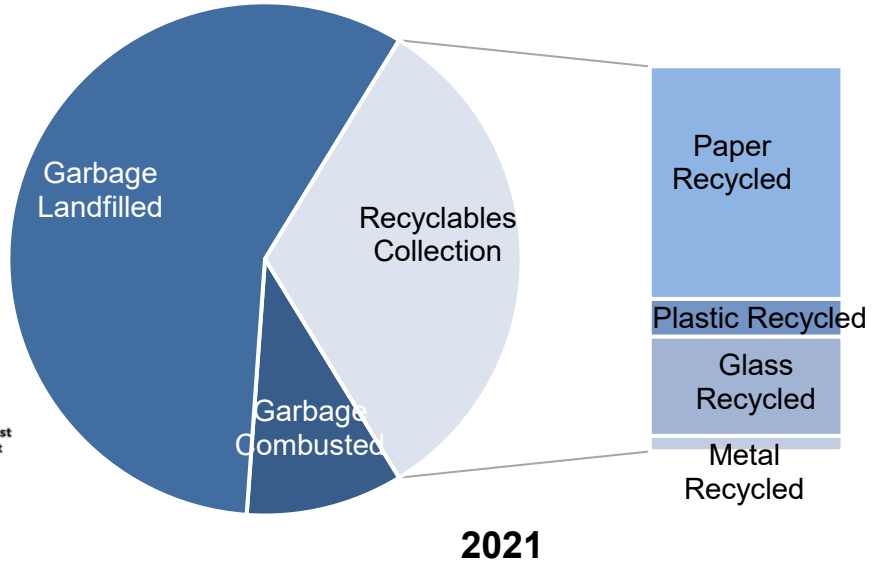
2021 Florida MSW Flows



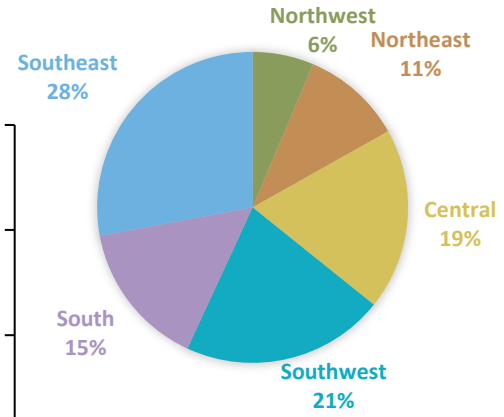
Original source data: FDEP 2021 Florida Solid Waste Management Report

Regionalize MSW Flows



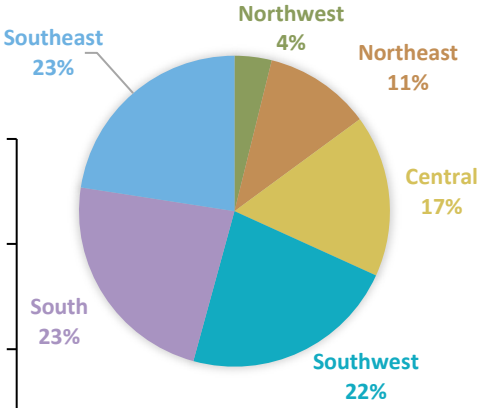


2021 Total MSW Collected per Region



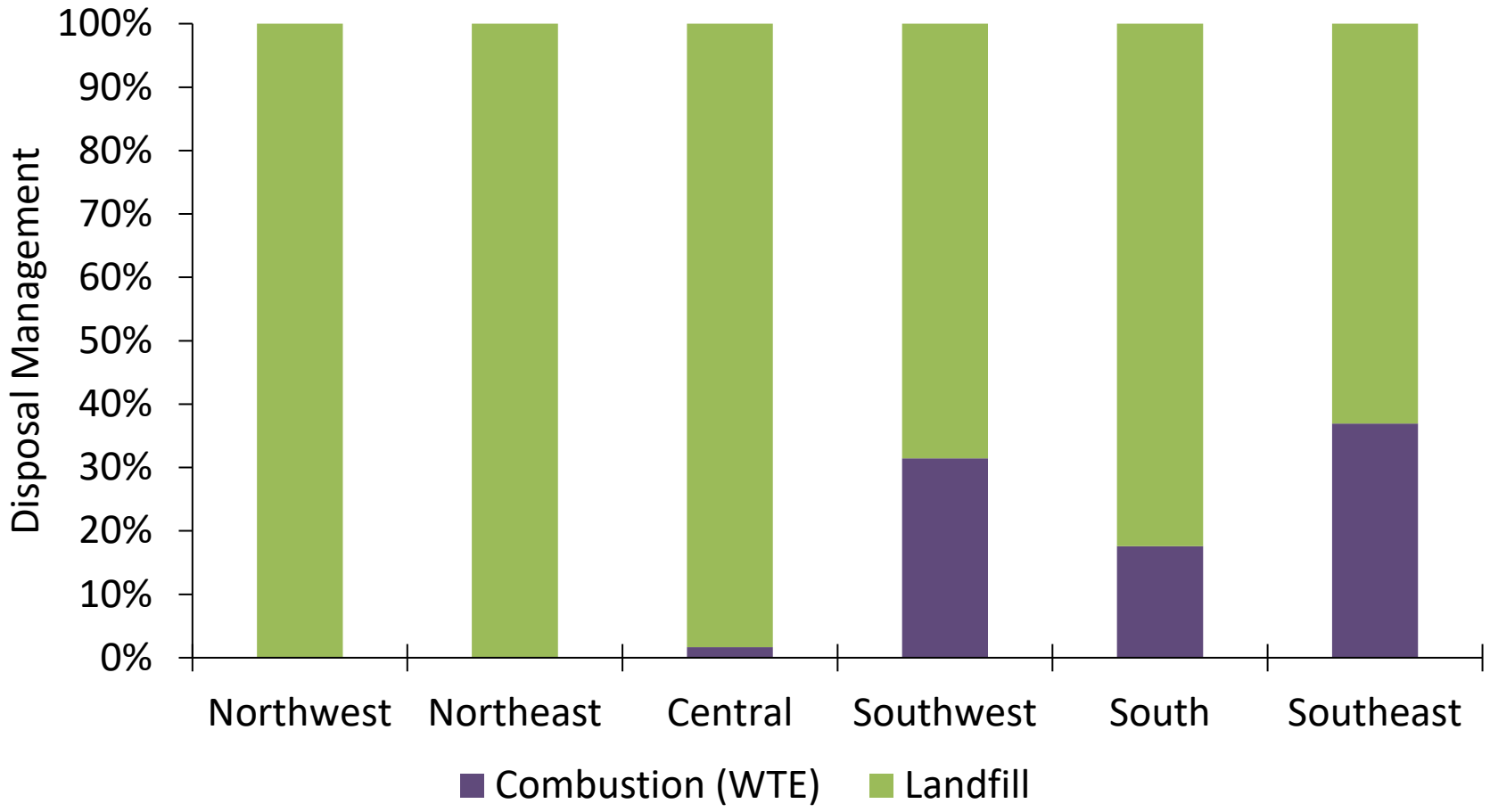
Original source data: FDEP 2021 Florida Solid Waste Management Report

2021 Total Recyclables Collected per Region



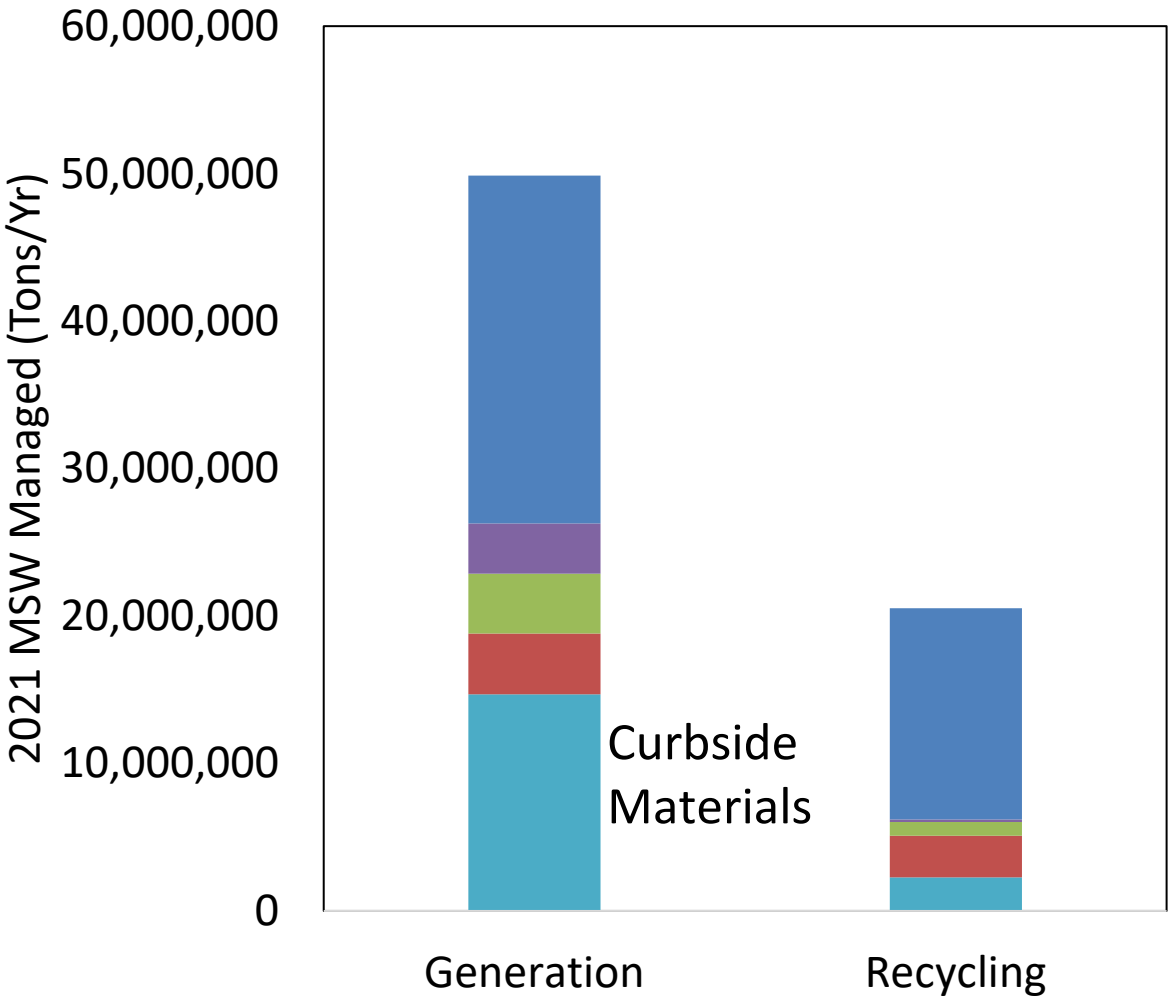
Original source data: FDEP 2021 Florida Solid Waste Management Report

Disposal Management per Region



Original source data: FDEP 2021 Florida Solid Waste Management Report

Define Materials Scope of Project



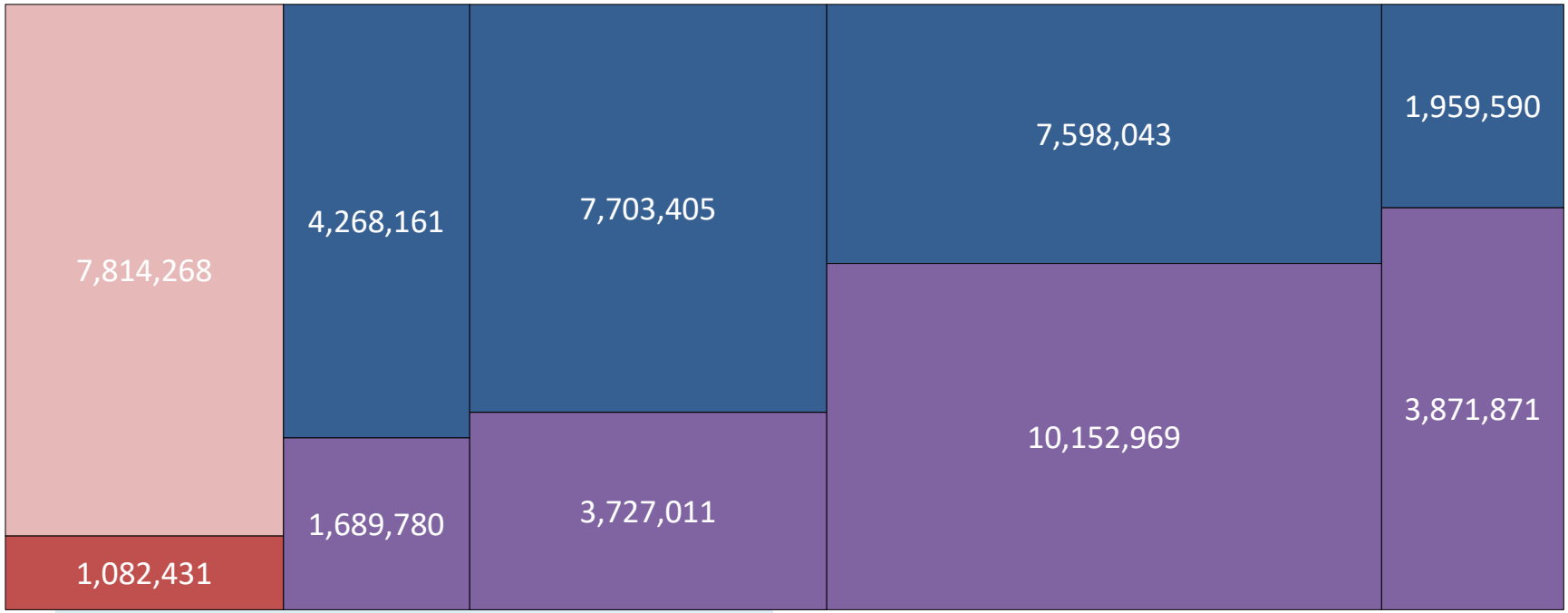
Source: FDEP

2021 Florida Recycling

Garbage Collection : 29,343,467 Tons (59%)

Recycling Collection : 20,524,062 Tons (41%)

Total = 49,867,529 Tons Collected

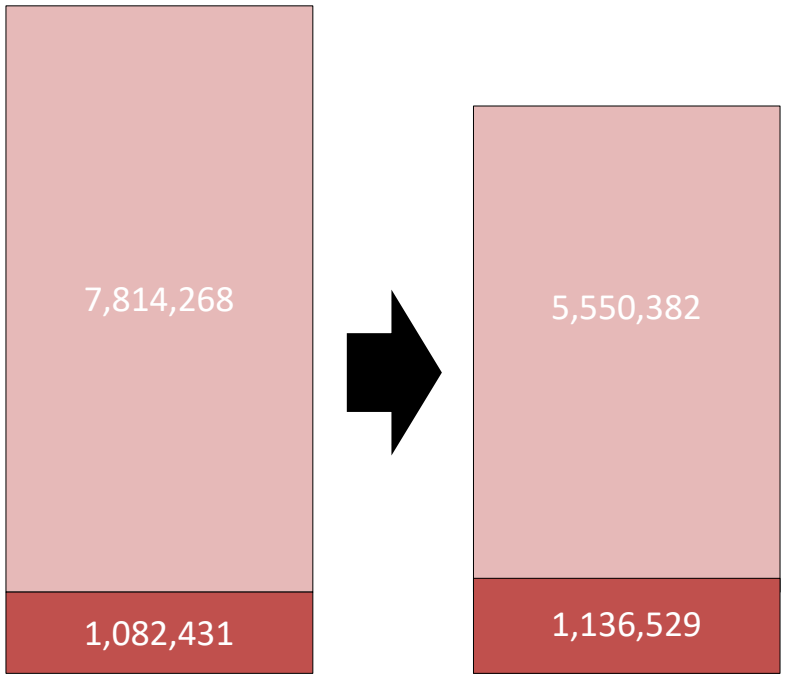


	Residential	Multifamily	Commercial	C&D Debris	Yard Trash
	8,896,699	5,957,941	11,430,416	17,751,012	5,831,461
Recycling Rate	**13.9%**	**28.4%**	**32.6%**	**57.2%**	**66.4%**

C&D Debris and YT are not included as part of these numbers

Source: FDEP

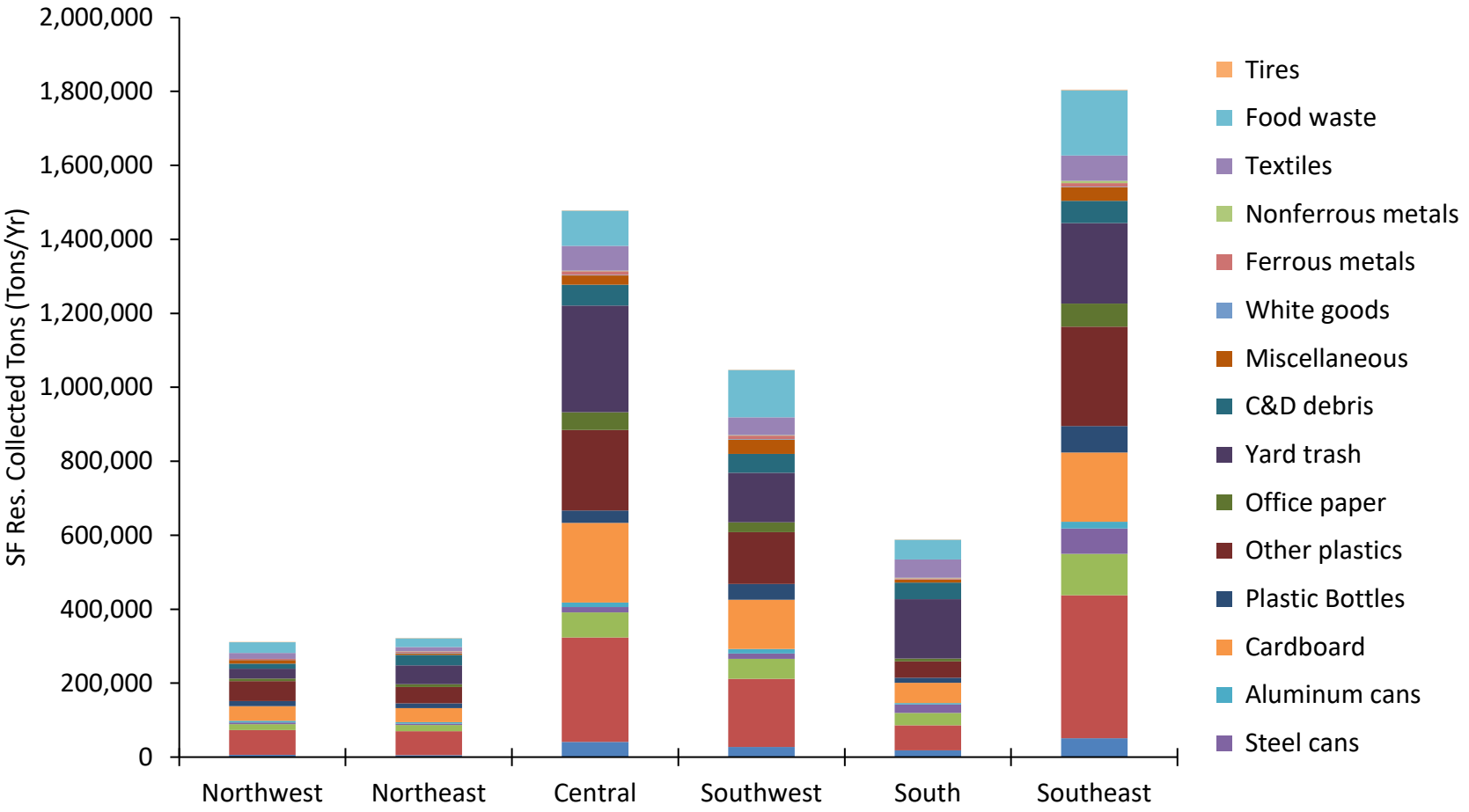
Refining SF Residential Mass Estimates Using FDEP Data



	Residential	Residential
	8,896,699	6,686,910
Recycling Rate	13.9%	20.5%

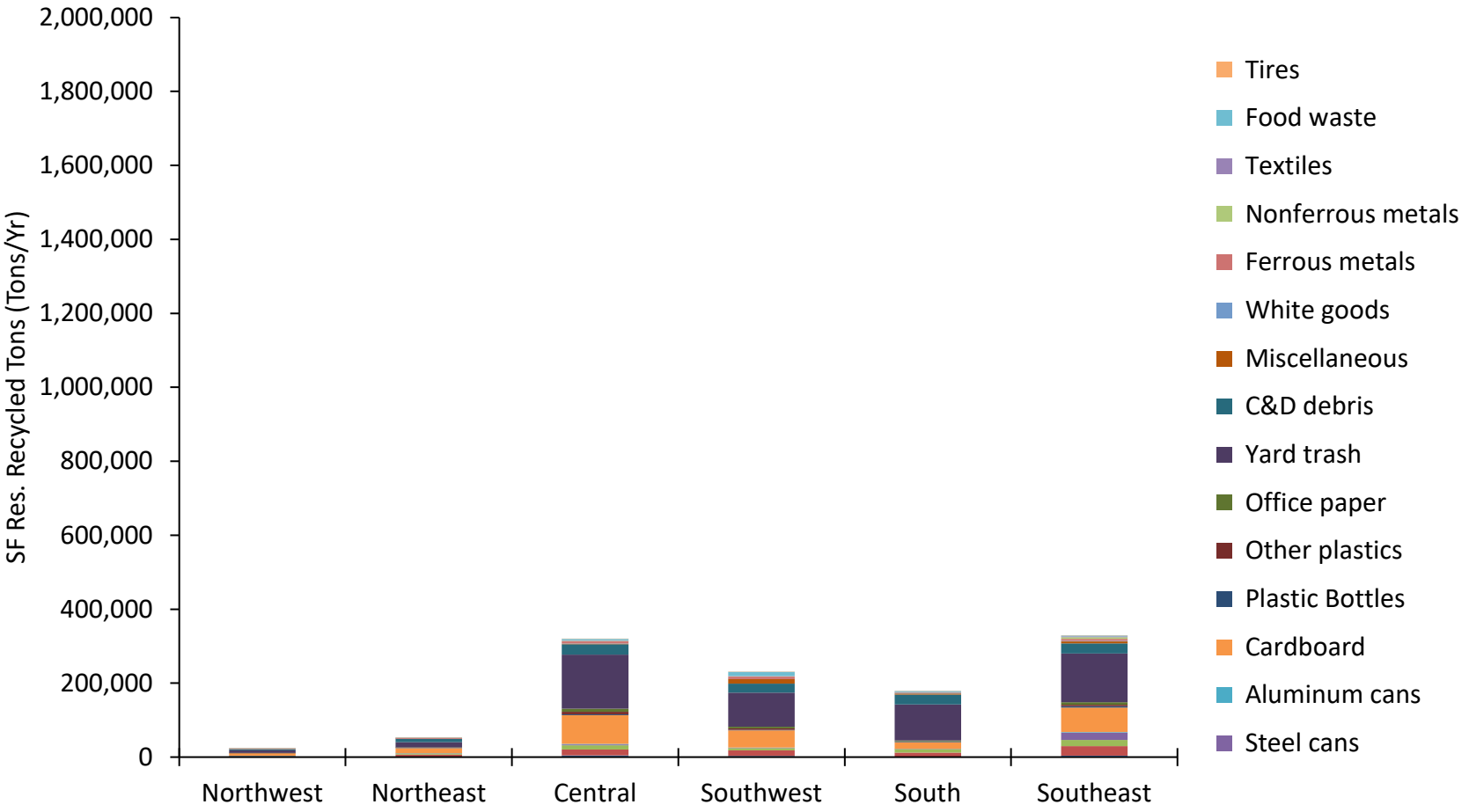
Material parameter	% Coming from Res.
Newspaper	90%
Other paper	90%
Glass	90%
Steel cans	90%
Aluminum cans	90%
Cardboard	70%
Plastic Bottles	90%
Other plastics	90%
Office paper	90%
Yard trash	50%
C&D debris	5%
Miscellaneous	5%
White goods	5%
Ferrous metals	5%
Nonferrous metals	5%
Textiles	70%
Food waste	50%
Tires	5%

SF Res. Collected Tons per Region



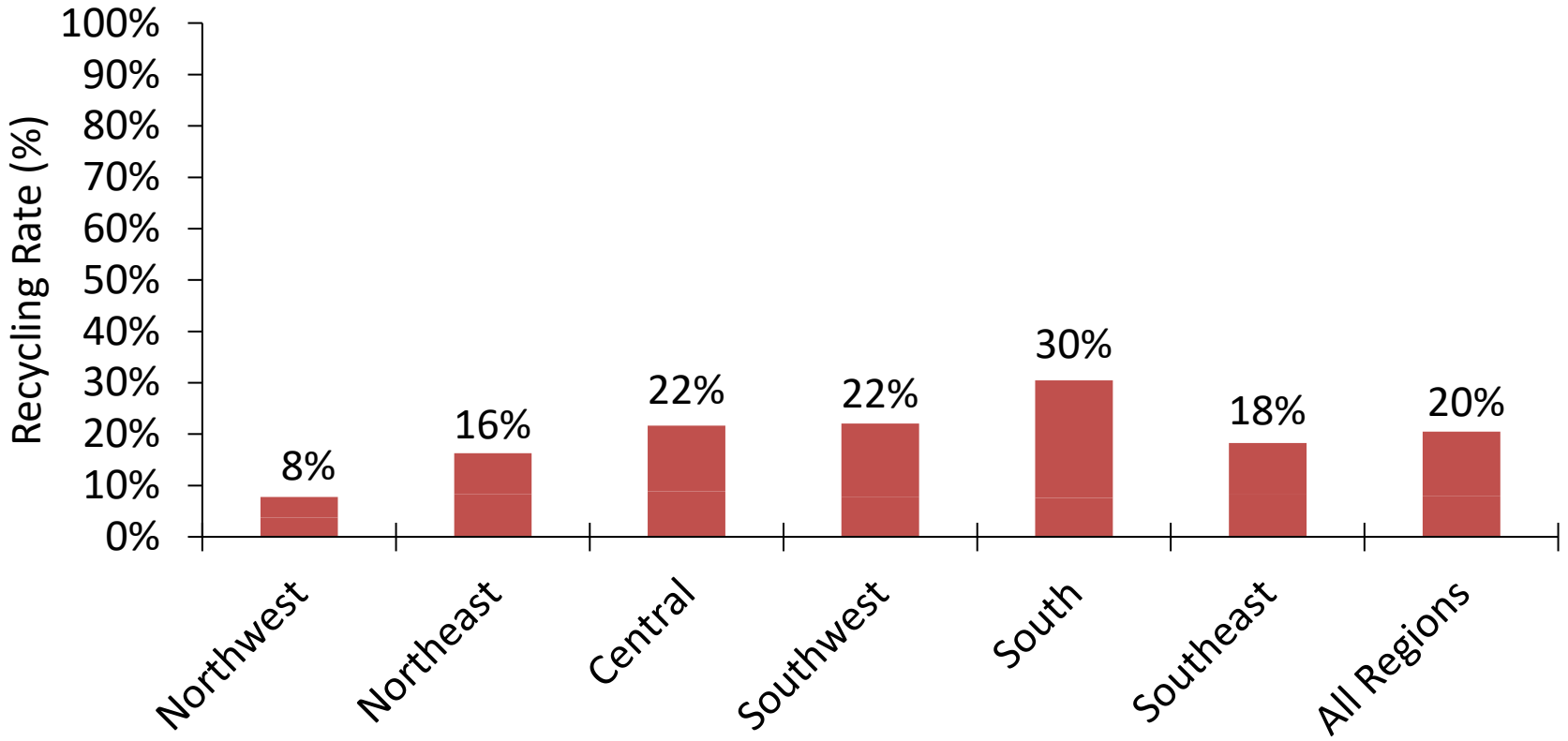
Original source data: FDEP 2021 Florida Solid Waste Management Report

SF Res. Recycled Tons per Region



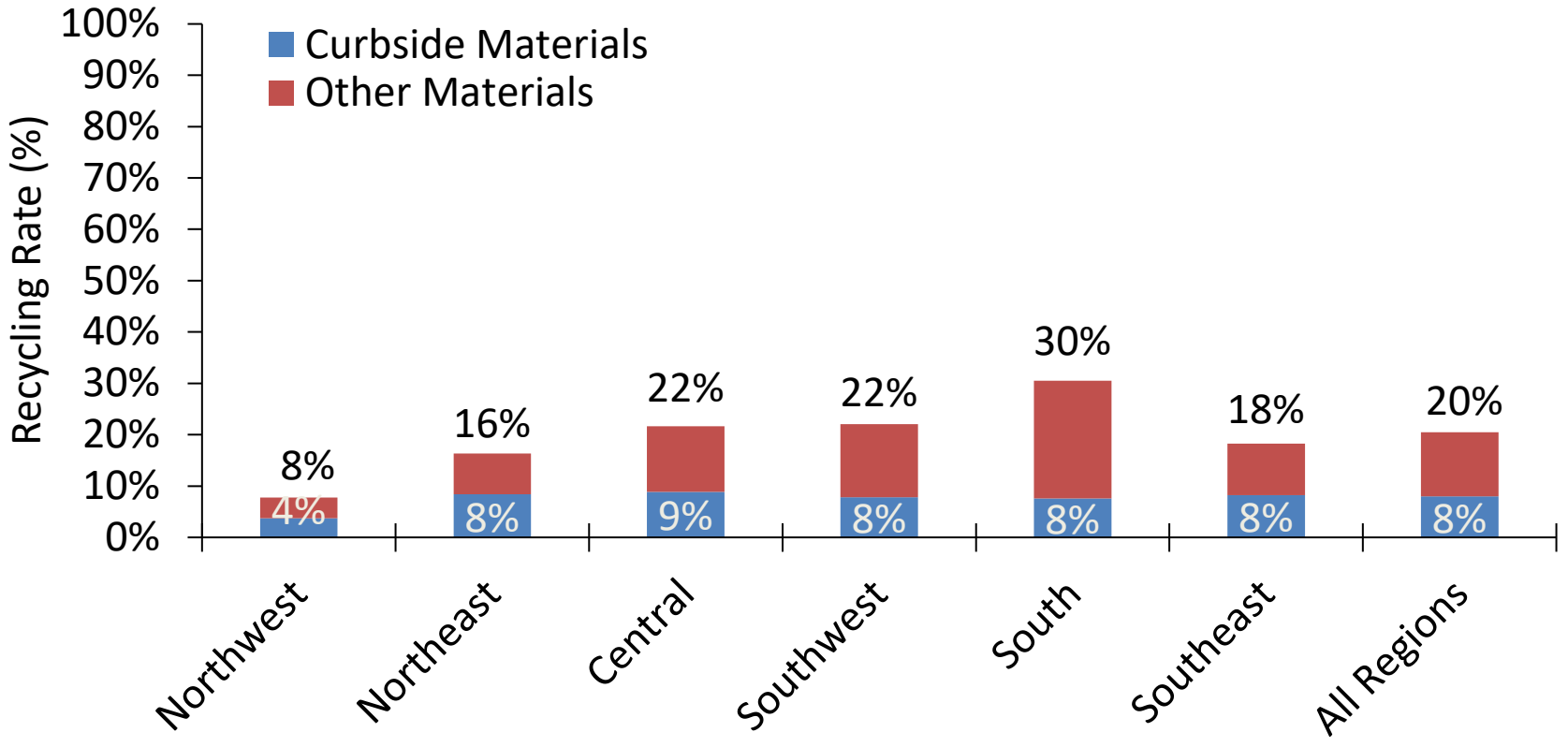
Original source data: FDEP 2021 Florida Solid Waste Management Report

2021 Recycling Rates per Region



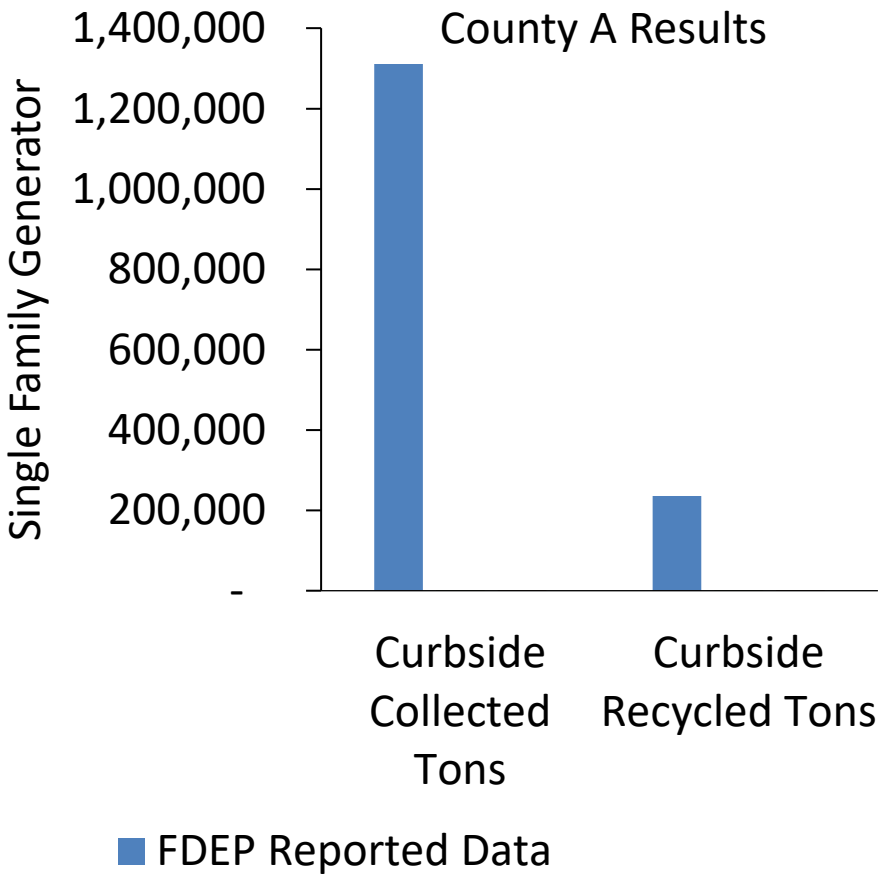
Original source data: FDEP 2021 Florida Solid Waste Management Report

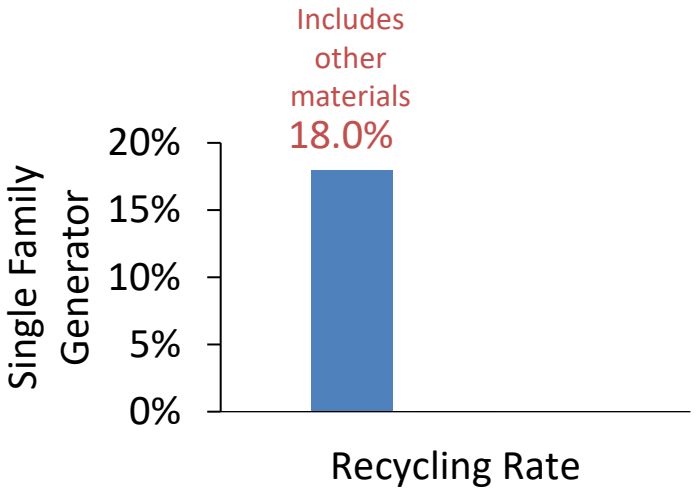
2021 Recycling Rates per Region



Original source data: FDEP 2021 Florida Solid Waste Management Report

Data Quality Assessment



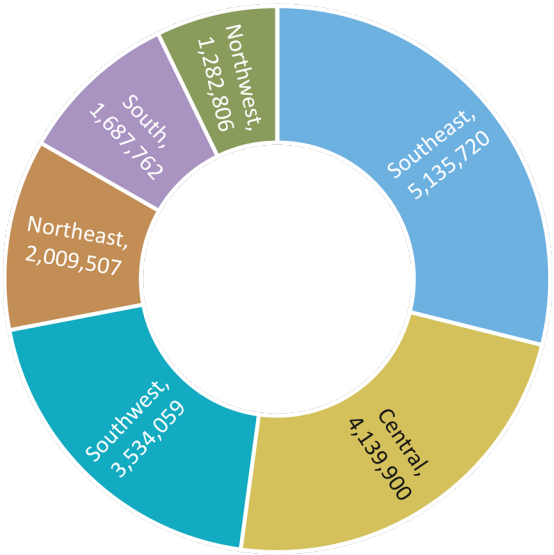


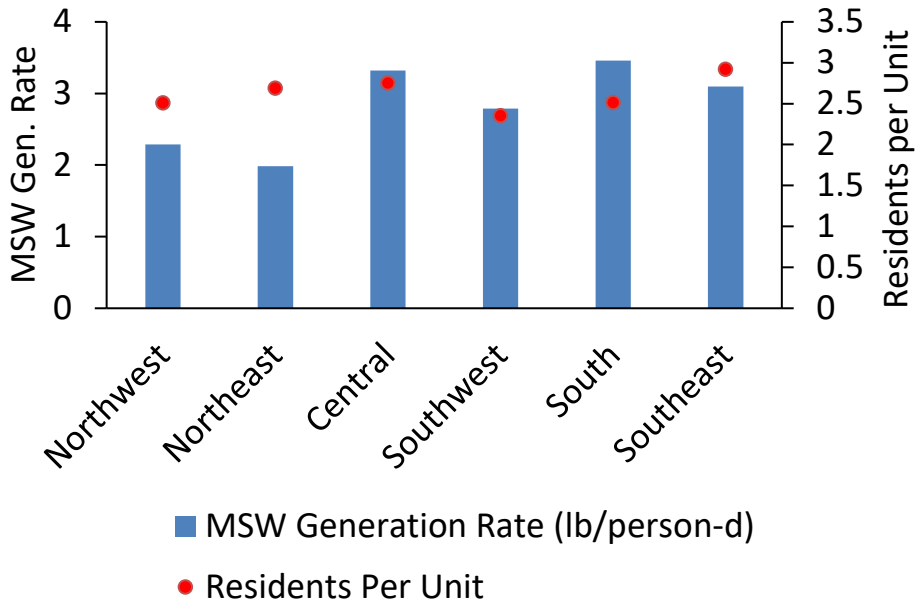
The FDEP reported data for SF includes all 18 material categories which clouds the true curbside recycling rate

Note:

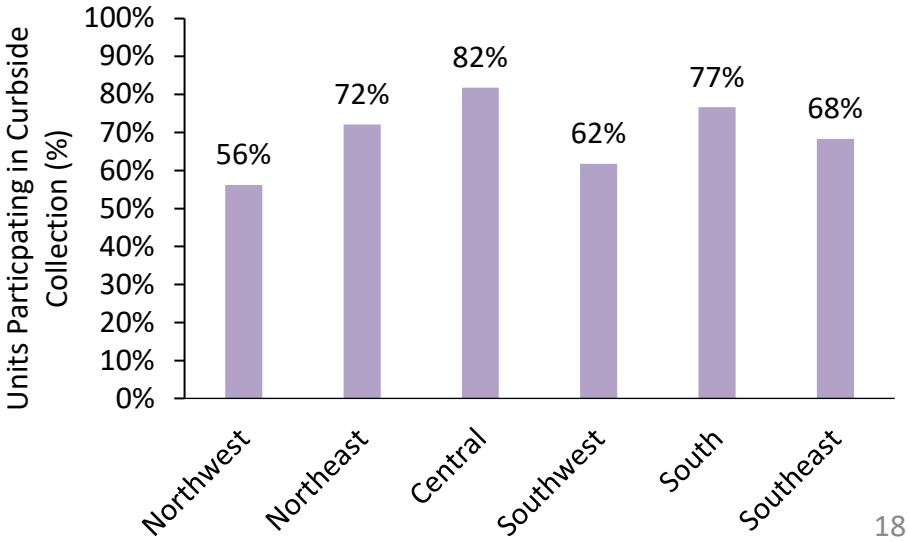
- County provided data on total collected recyclables and average contamination rate
- FDEP recycled data is actual amounts sent for remanufacture

Total Single-Family population





Total Residential Single-Family Units

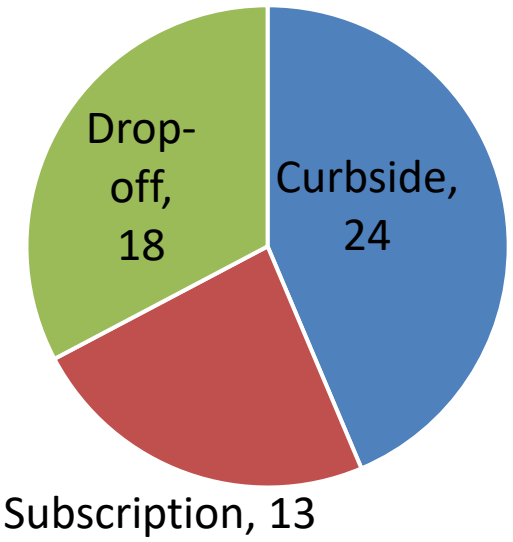


Original source data: FDEP 2021 Florida Solid Waste Management Report

County Recycling Program Statistics

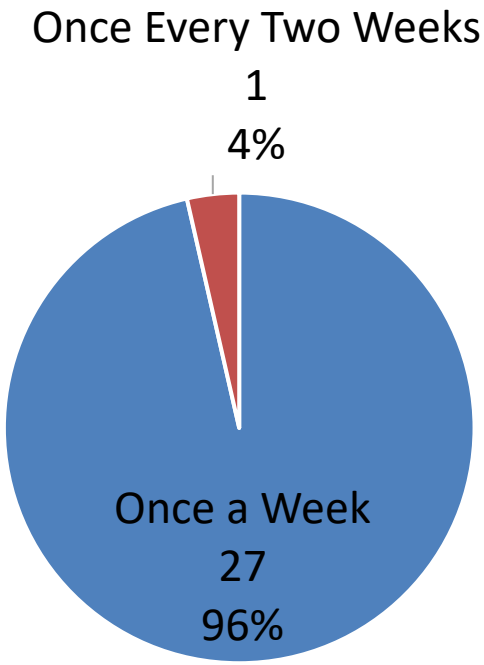
Collected details on the 67 Florida recycling programs

Recycling Program Types



Curbside Availability

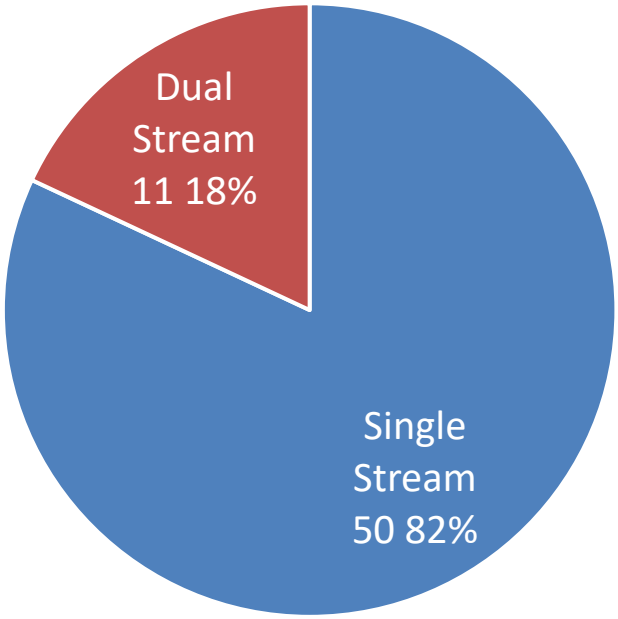
Sample Size of 55



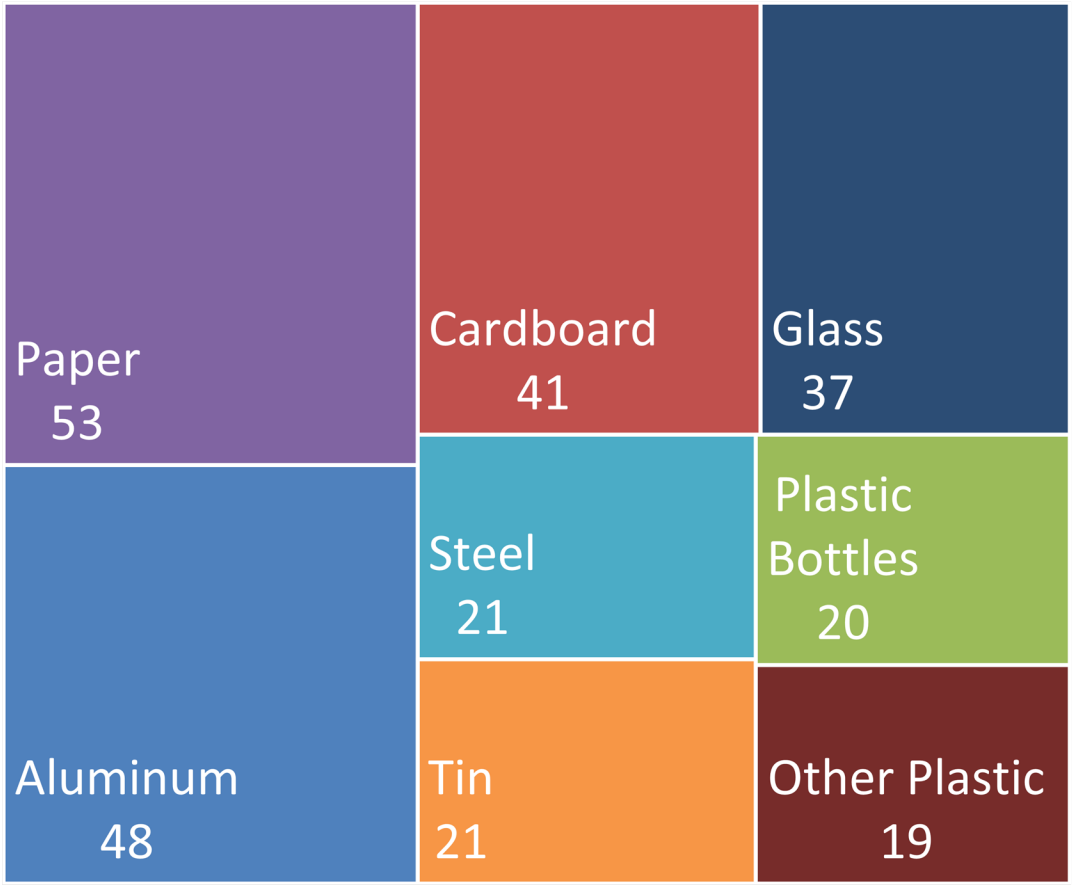
Frequency of Collection

Sample Size of 28

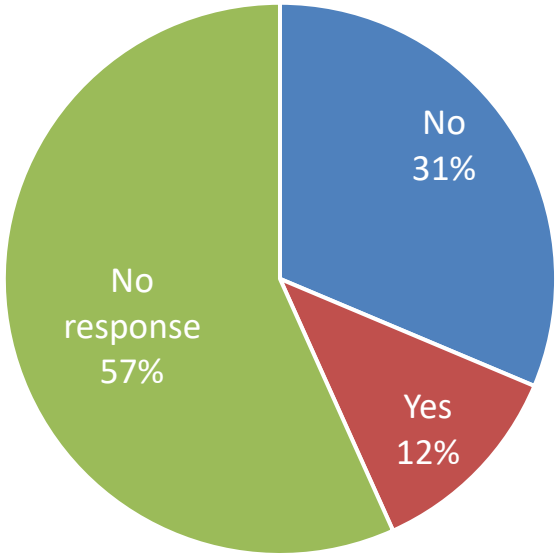
Material Accepted



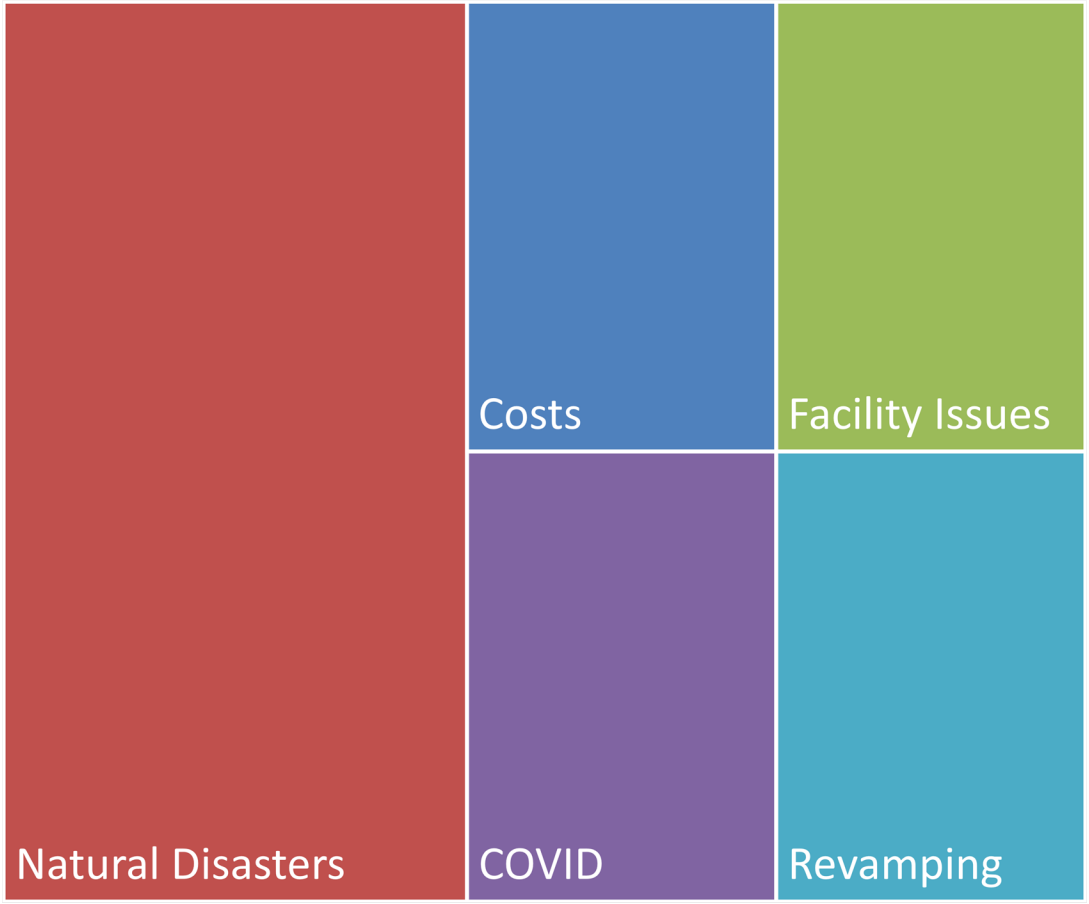
Sample Size of 61



Recycling Pauses in the Past 5 Years and Their Causes



Sample Size of 67



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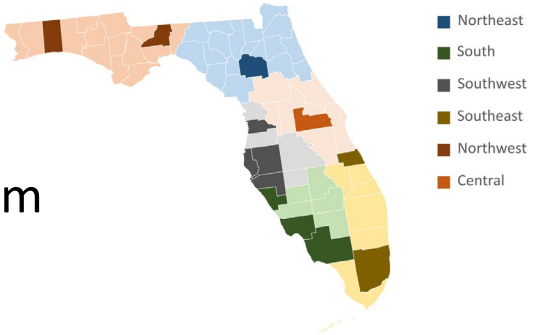
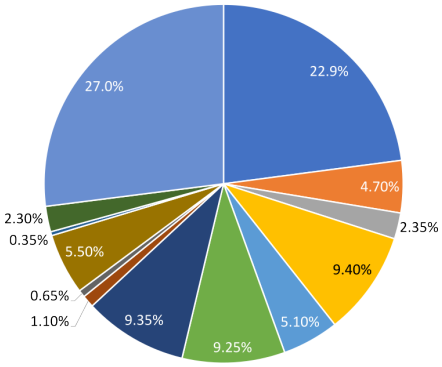
Garbage Composition

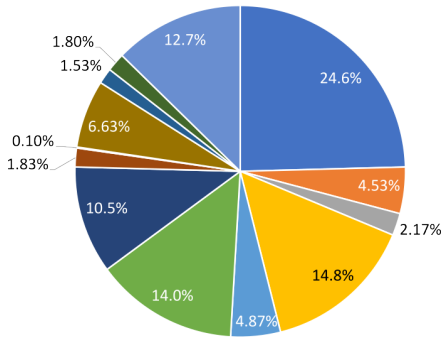
Studies from 2010-2022



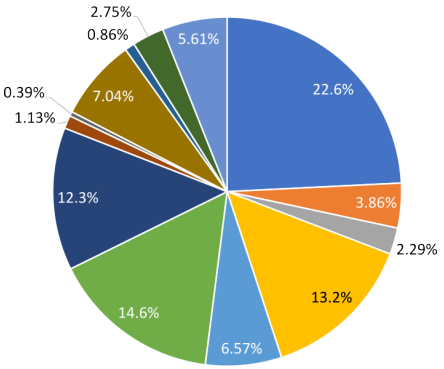
Northwest



Southeast

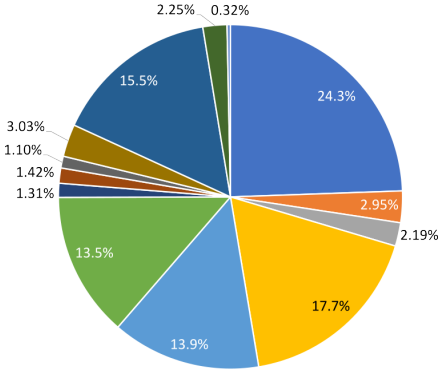


Southwest

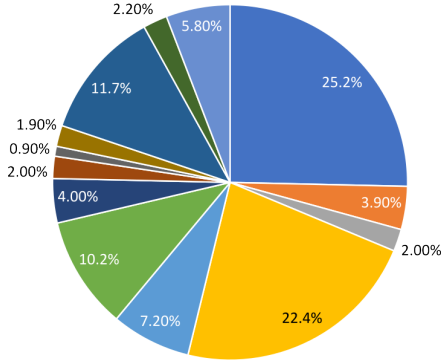


Paper
Glass Packaging
Steel and Aluminum Cans
Plastics
Other Nondurable Goods
Food Waste
Yard Trash
Electronics
Household Waste
C&D Debris
Liquids and grit
Durable metals
All other garbage

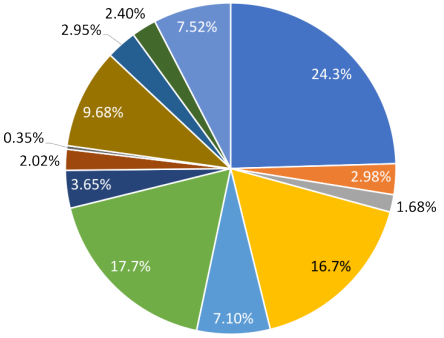
Northeast



Central



South



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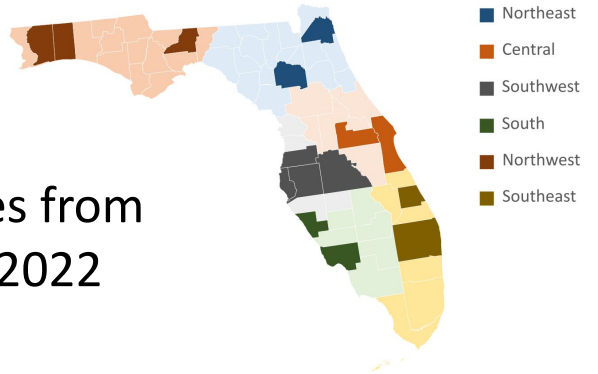
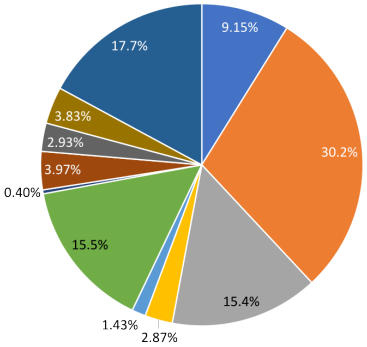
Recycling Composition

Studies from 2014-2022



Northwest



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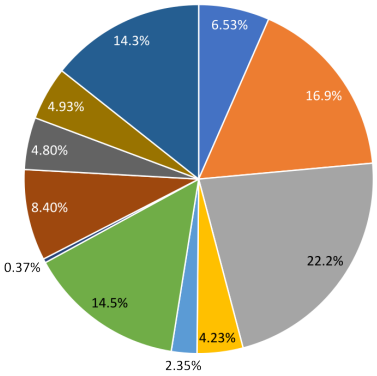
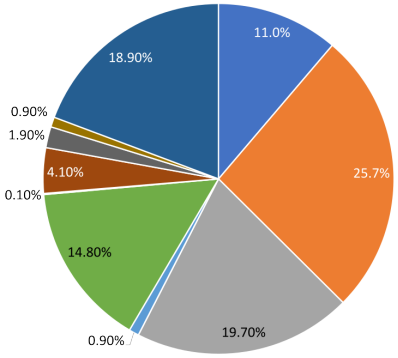
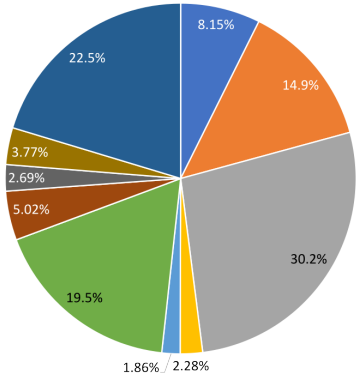


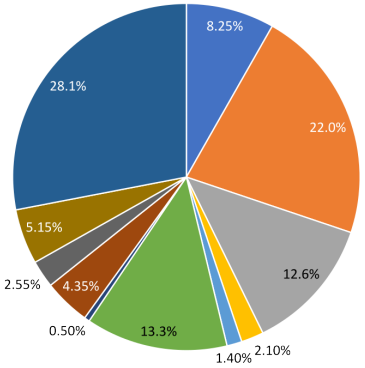
Southeast



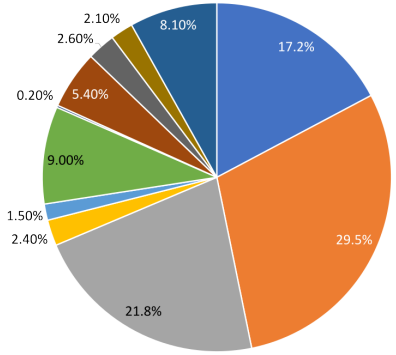
Northeast



Central



South



- Newspaper
- Mixed Paper
- Glass Packaging
- Steel Cans
- Aluminum Cans
- Corrugated Boxes
- Aseptic Cartons
- PET Bottles and Jars
- HDPE Bottles
- Mixed Plastics
- All other garbage

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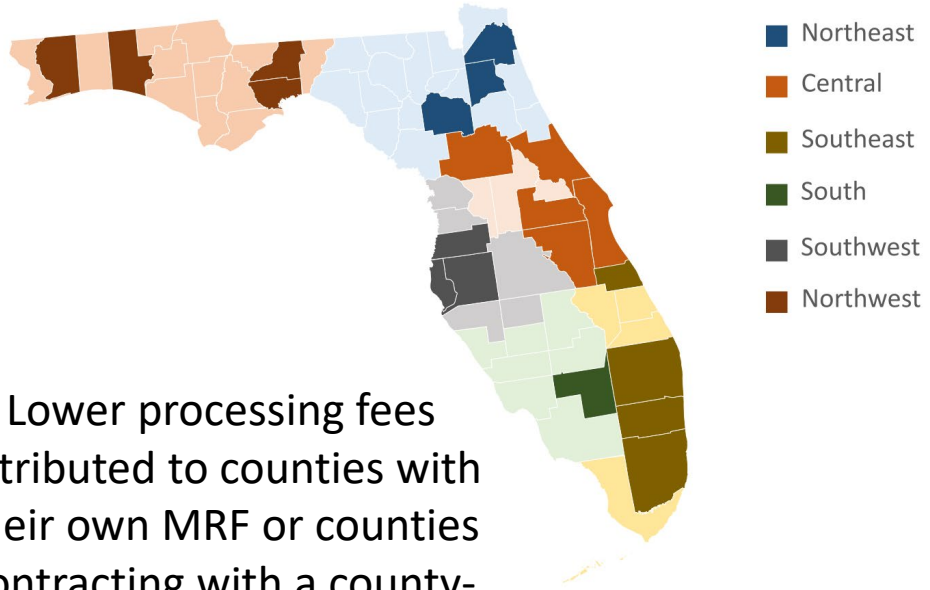
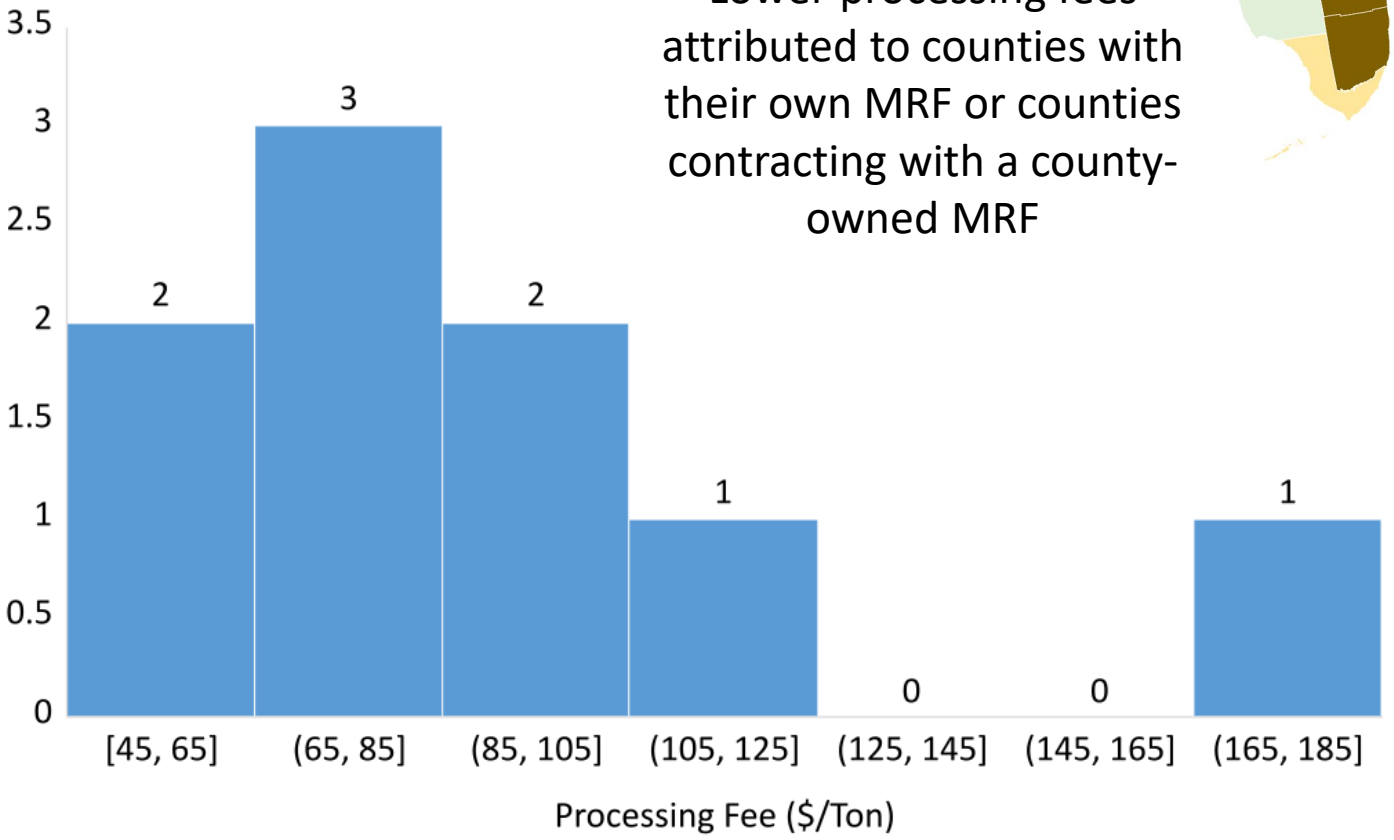
Average MRF Processing Fee

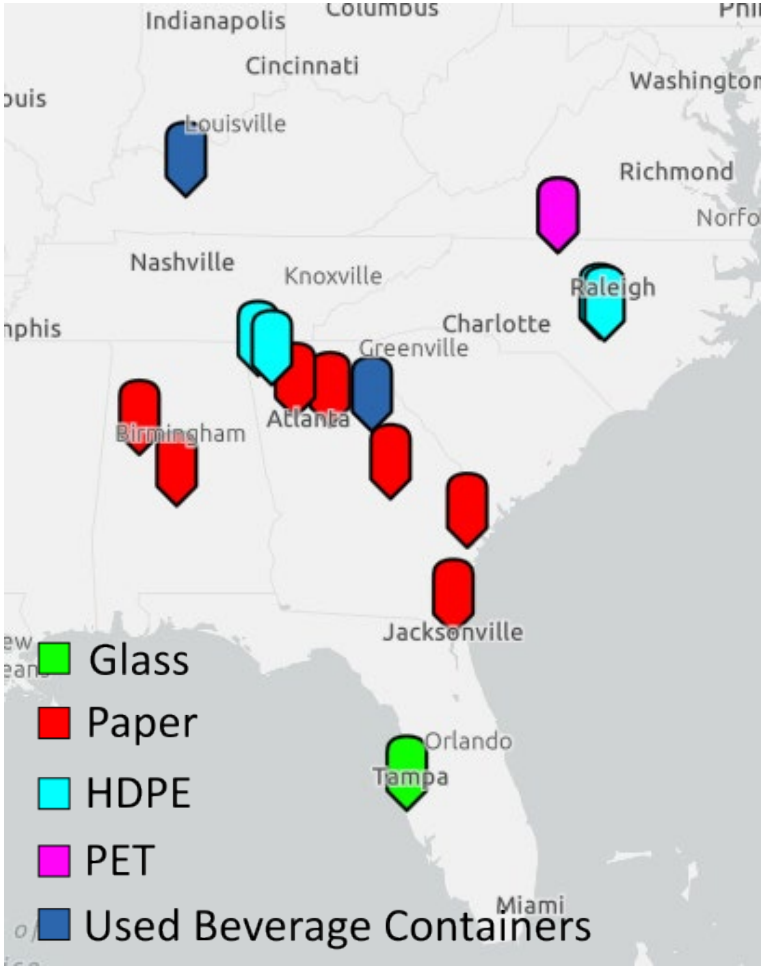


Lower processing fees attributed to counties with their own MRF or counties contracting with a county-owned MRF



Mapping where MRFs send their Materials

- Most materials are remanufactured domestically
- About ~25% of sorted mixed paper is exported



Modeling Costs and Evaluating Cost Impacts of Recycling Program Changes

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Collection Cost Parameters

Collection Model Inputs:				
		Residential Garbage Waste:	Single Stream Recycling:	Dual Stream Recycling:
Collection schedule				
Number of households at one stop	(households/stop)	1	1	1
Participation rate	(number of houses participating/ total number of houses)	1	0.6	0.6
Collection frequency	(1 / week)	2	1	1
Number of working days a week	(days/week)	4	5	5
Working hours a day per wage and per vehicle	(hours/day-vehicle)	9	9	9
Collection operation times				
Loading time at one service stop	(min/stop)	0.2	0.2	0.45
Travel time between service stops (100% participation)	(min/stop)	0.2	0.2	0.17
Travel time between service stops, adjusted	(min/stop)	0.2	0.4	0.3
Travel time between route and disposal facility	(min/trip)	30	20	20
Time to unload at disposal facility	(min/trip)	16	9	9
Labor				
Number of workers per vehicle	(person/vehicle)	2	2	2
Economic data				
Fringe benefit rate	(fringe benefit $/wage$)	0.4	0.4	0.4
Salary expenses rate	($/worker-year)	$ 40,000	$ 40,000	$ 40,000
Vehicle operational parameters				
Utilization factor	(max occupied yd3 / usable yd3)	1	1	1
Usable vehicle capacity	(yd3/ trip)	29	29	29
Economic life of a vehicle	(year)	10	10	10
Unit price of a vehicle	($/vehicle)	$ 240,000	$ 240,000	$ 240,000
Vehicle operation and maintence cost	($/vehicle)	$ 40,000	$ 40,000	$ 40,000
Waste stream compaction density	(lb/yd3)	507	122	122
Travel speeds				
Between collection stops	(miles/hour)	6	6	7
From route to disposal facility	(miles/hour)	40	45	45
Distances				
Distance between collection route and disposal facility	(miles/trip)	20	15	15
Distance between service stops (100% participation)	(miles/stop)	0.02	0.02	0.02
Distance between service stops, adjusted	(miles/stop)	0.02	0.04	0.04
Fuel usage rates				
Diesel during driving to disposal facility	(miles/gal)	5	5	5
Diesel during collection	(miles/gal)	2.35	2.35	2.35
Diesel while idling /dropping off waste	(gal/hour)	1	1	1
MSW/recyclables storage system				
Unit price of a bin	($/bin)	$ 8	$ 8	$ 8
Number of bins for each house	(bins/house)	1	1	2

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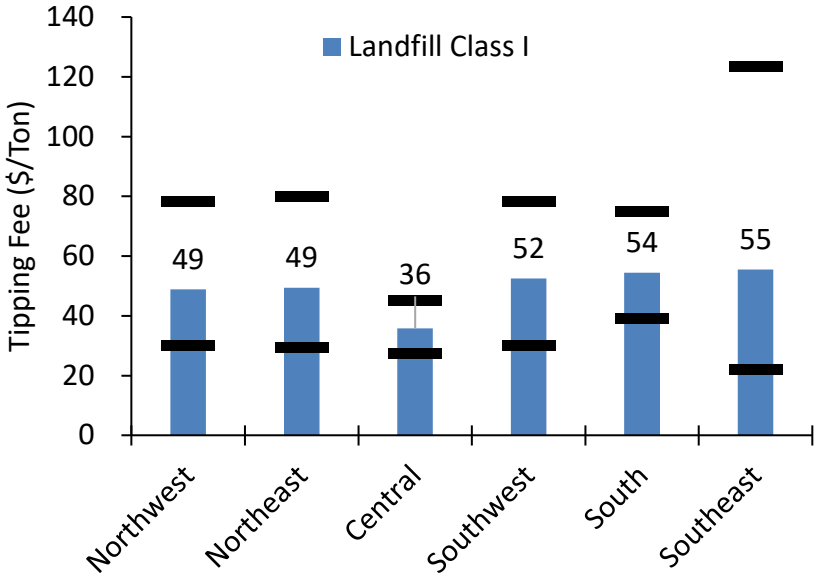
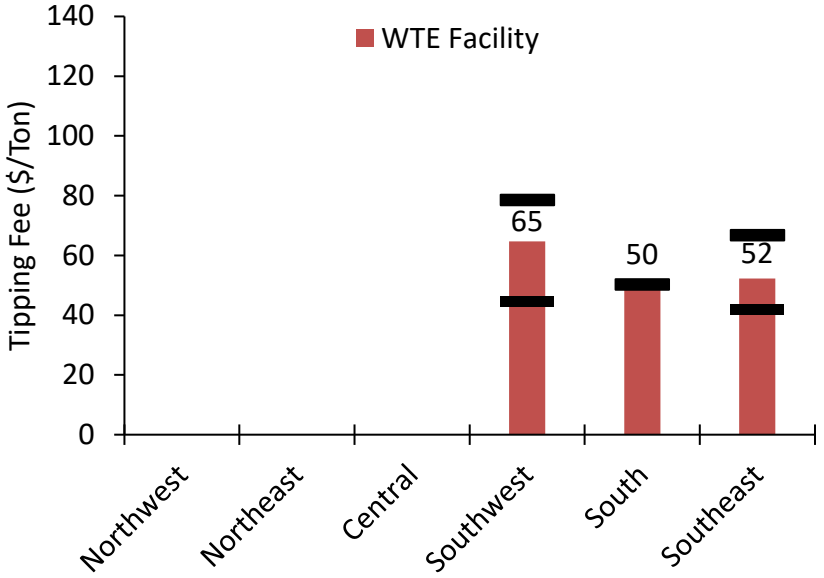
Disposal Cost Parameters





Original source data: FDEP 2021 Florida Solid Waste Management Report

Economic Parameters

Economic Properties:

Discount rate			
Year	**2021**	**0.010**	%

Inflation Conversion	
Slope For Projections	**1.6955**

Current-dollar and "real" GDP
https://www.bea.gov/data/gdp/gross-domestic-product
11:22:17 GMT-0400 (Eastern Daylight Time)
Data Source: U.S. Bureau of Economic Analysis

Parameter	Year	GDP in billions of current dollars	GDP in billions of chained 2012 dollars	2012 Deflator	Convert to 2020 US$
1980 Price Adjustment	1980	2,857	6,759	42.3	2.68789
1981 Price Adjustment	1981	3,207	6,931	46.3	2.45556
1982 Price Adjustment	1982	3,344	6,806	49.1	2.31266
1983 Price Adjustment	1983	3,634	7,118	51.1	2.22550
1984 Price Adjustment				.9	2.14800

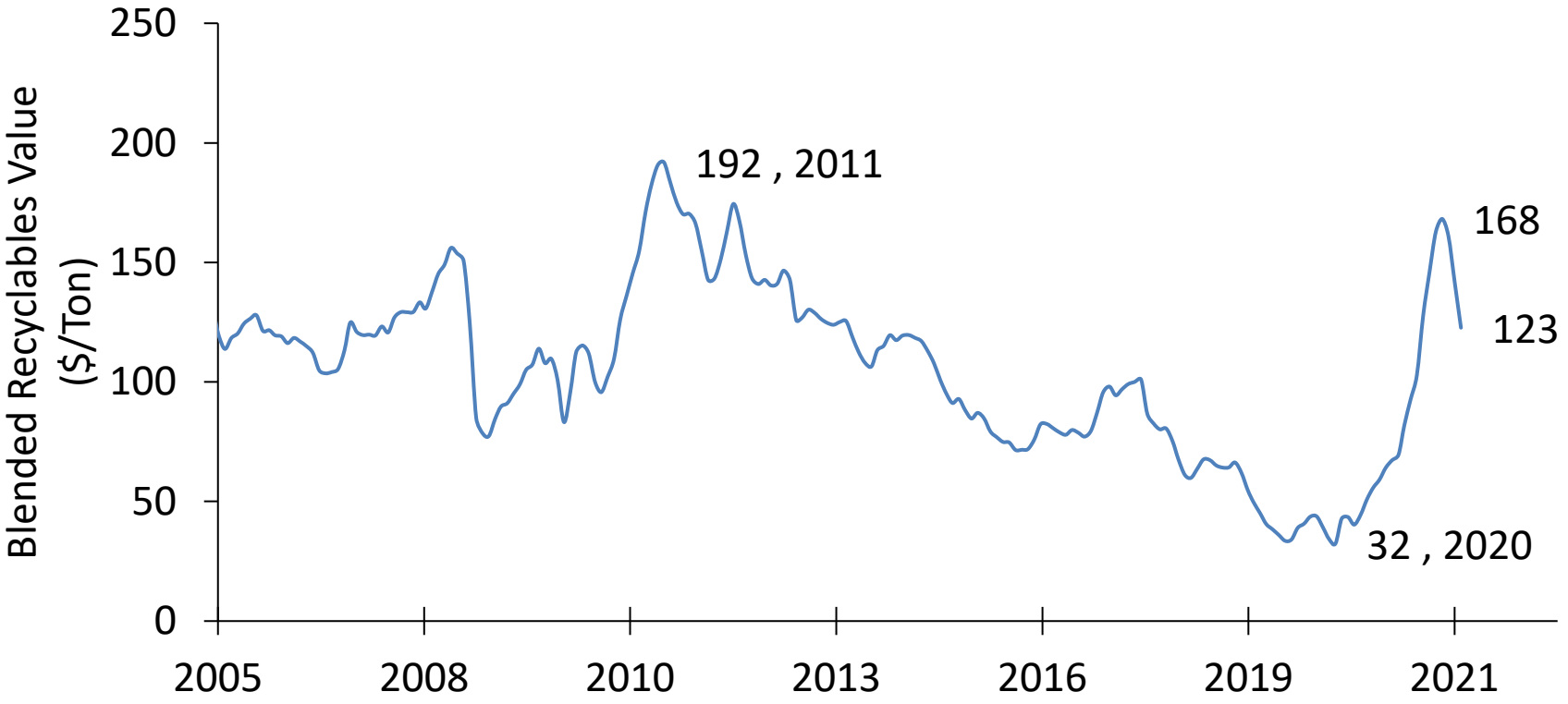
Historic Diesel Prices

Year	**2021**	**3.052**	US$/Gal

U.S. No 2 Diesel Retail Prices
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emd_epd2d_pte_nus_dpg&
11:22:17 GMT-0400 (Eastern Daylight Time)
Data Source: U.S. Energy Information Administration

Year	U.S. No 2 Diesel Retail Prices Dollars per Gallon
2021	3.052
2020	3.052
2019	3.056
2018	3.178
2017	2.650
2016	2.304

MRF Parameters



Other Important Parameters:

1. Processing Fee
2. Revenue Sharing Structure

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MRF Parameters

MRF A

(low fee, high revenue share)

Processing Fee (PF): $85/ton
Revenue Share to County: 98%
AMV Floor? Yes, $50/ton
MRF Pays Residual Disposal Fee? No
Conditions:

1. When AMV > PF = County receives 98% of Net Diff. between PF and AMV
2. When AMV < PF = New PF assessed calculated as Net Diff. between PF and AMV **BUT** if greater than the floor value then the max PF will be $35/ton

MRF B

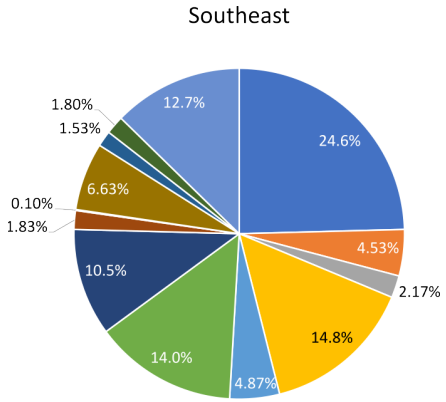
(high fee, low revenue share)

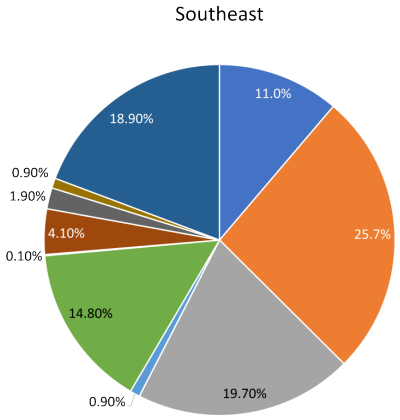
Processing Fee (PF): $170/ton
Revenue Share to County: 60%
AMV Floor? No
MRF Pays Residual Disposal Fee? Yes
Conditions:

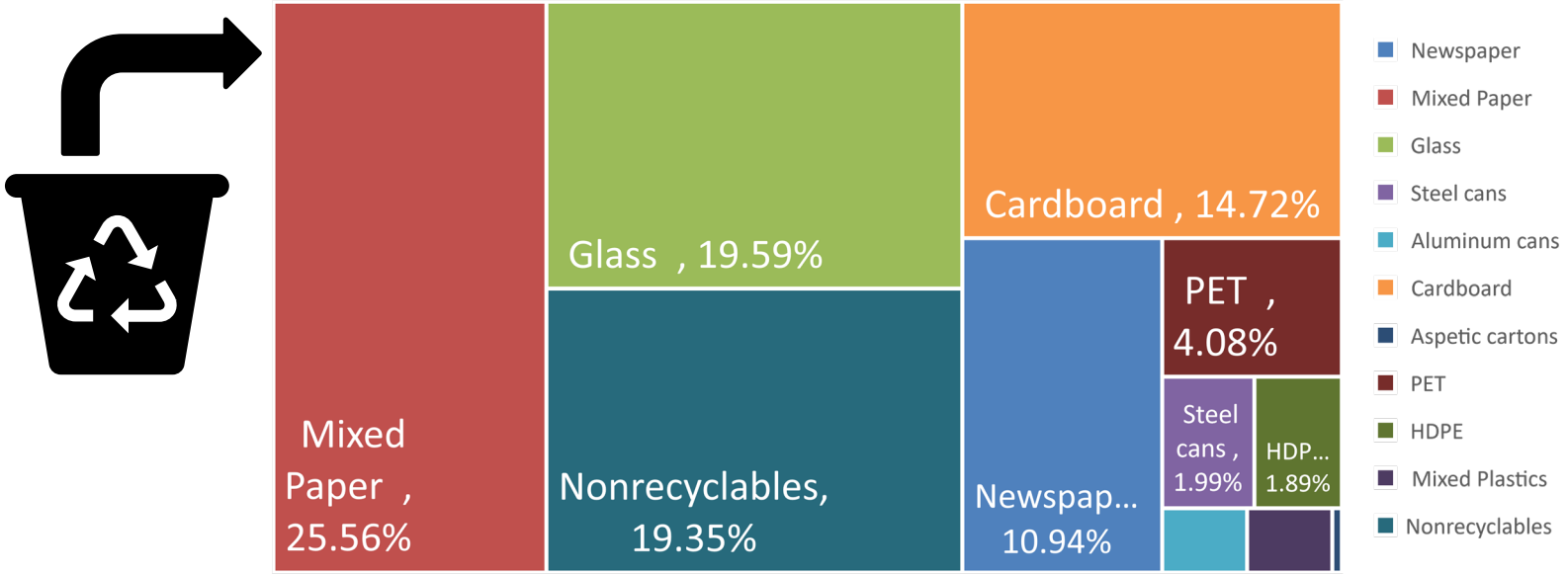
1. When AMV > PF = County receives 60% of Net Diff. between PF and AMV
2. When AMV < PF = New PF assessed calculated as Net Diff. between PF and AMV

Modeling Costs

- Cost Impacts for the Southeast:
  - Diversion rate= 22%
  - Recycling rate= 18%
  - Contamination rate= 20%
  - Participation rate= 68%
  - Generation rate=3.10 lbs/person-day
  - Assume using composition data

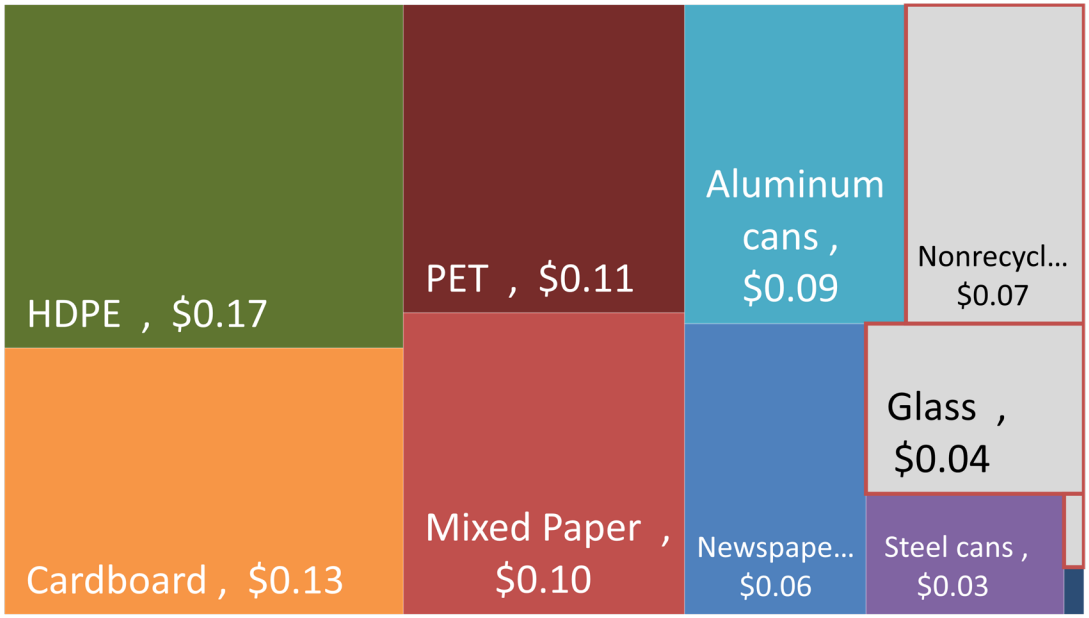






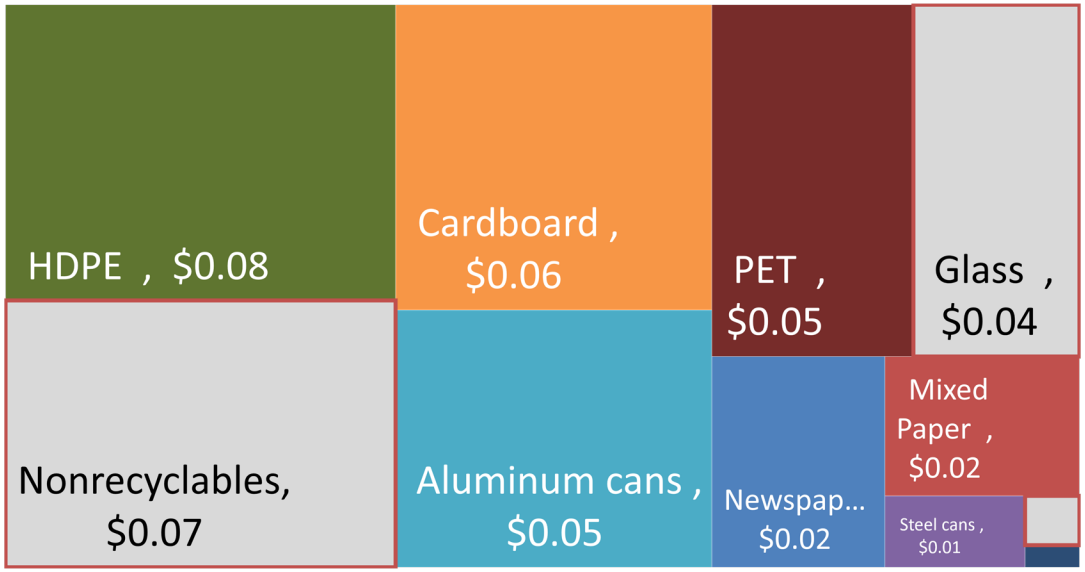
Value of the Bin

2021
$0.57 per bin

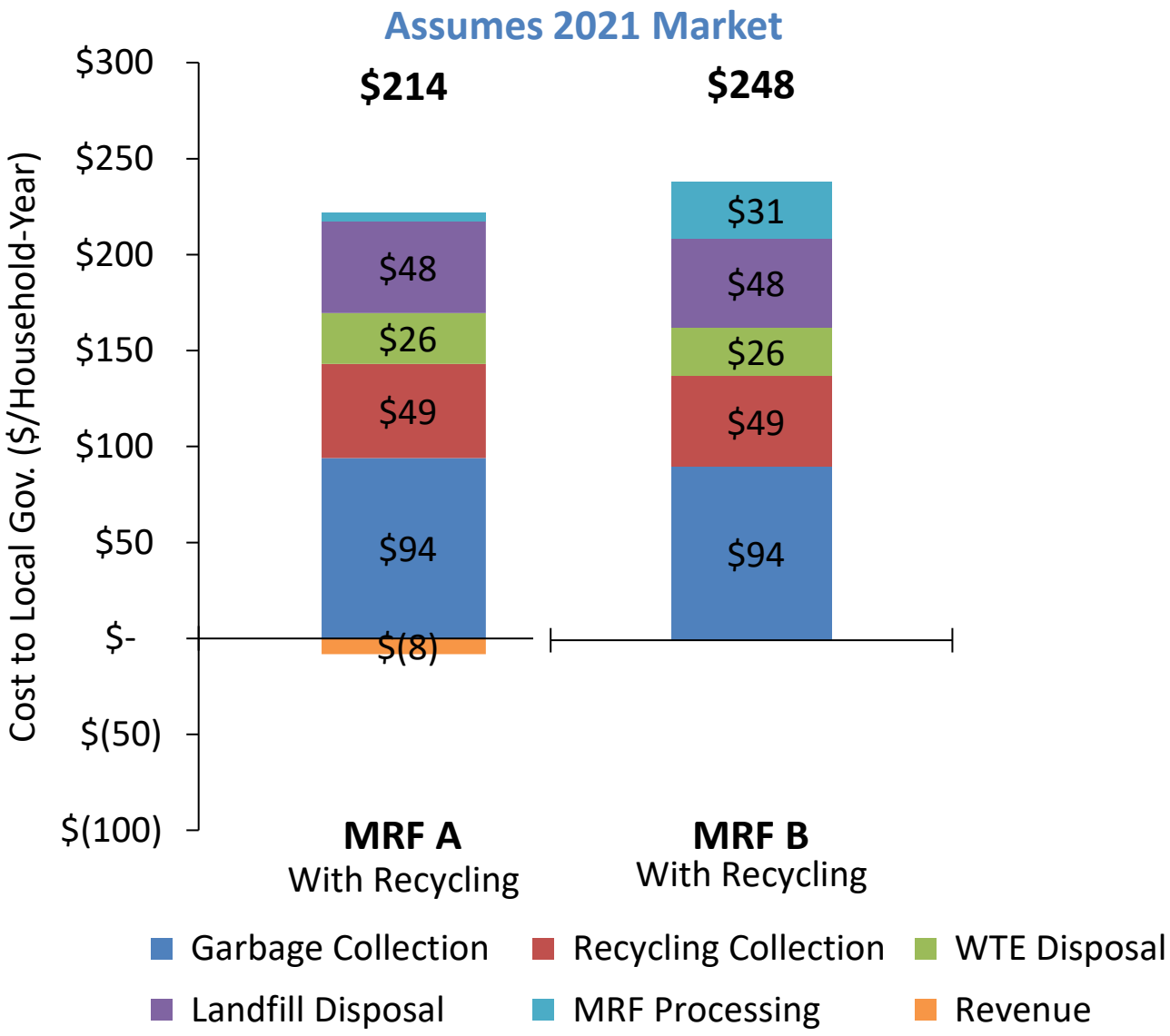


Note:
Negative value

2020
$0.18 per bin

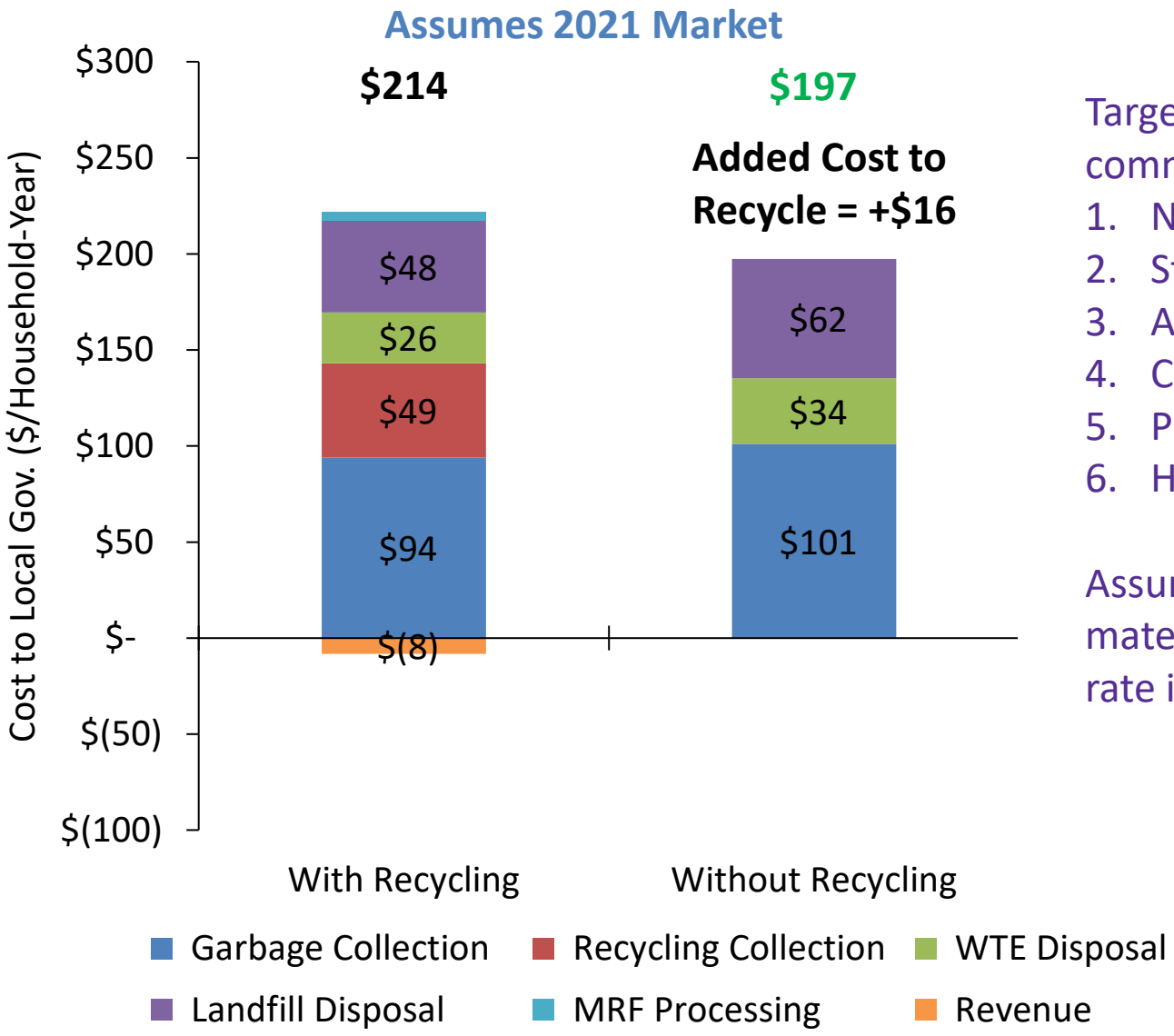


Local Gov. Costs



Local Gov. Costs

Assumes MRF A Contract



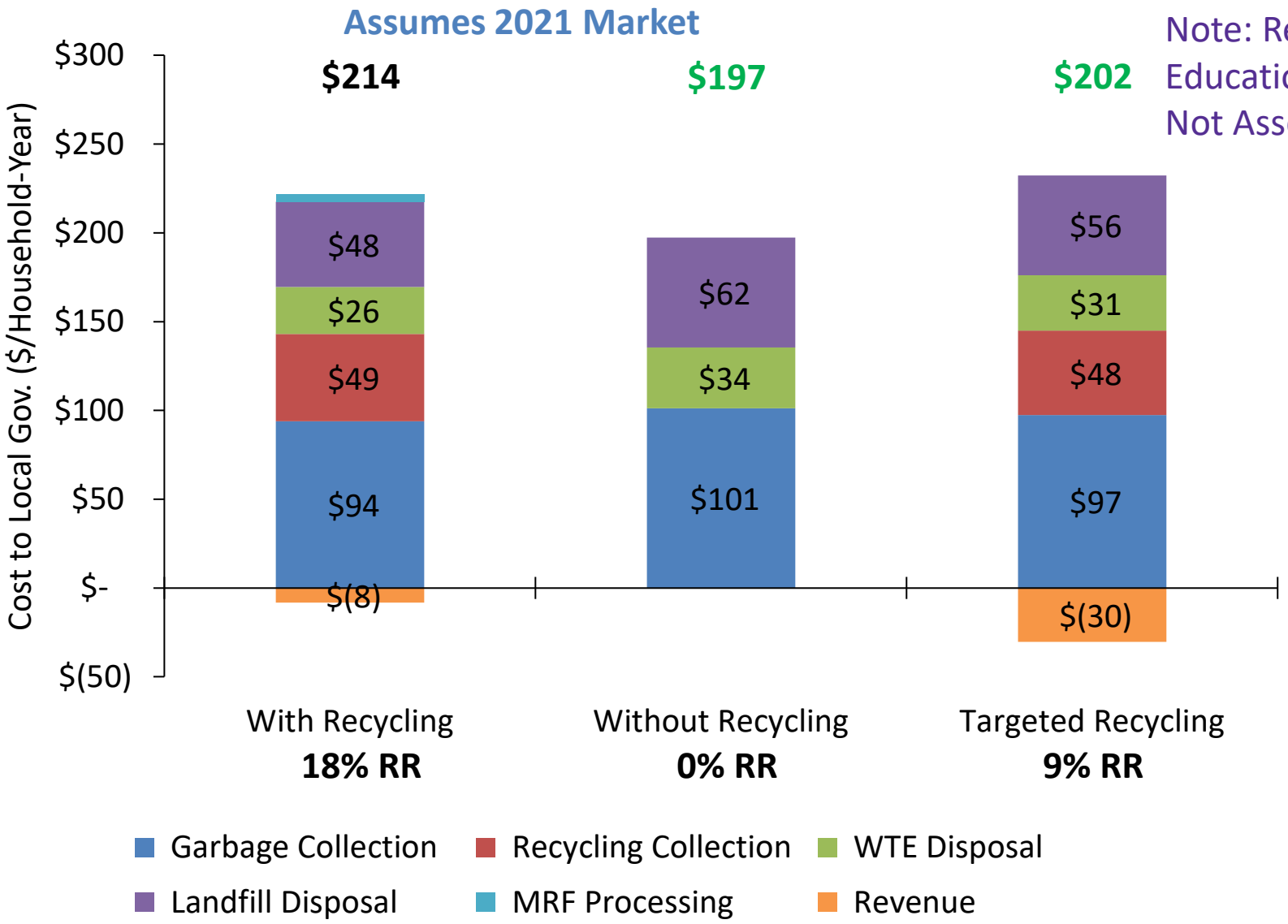
Target only high commodity materials:

1. Newspaper
2. Steel Cans
3. Al. Cans
4. Cardboard
5. PET
6. HDPE

Assume each of these materials recycling rate increases to 50%

Local Gov. Costs

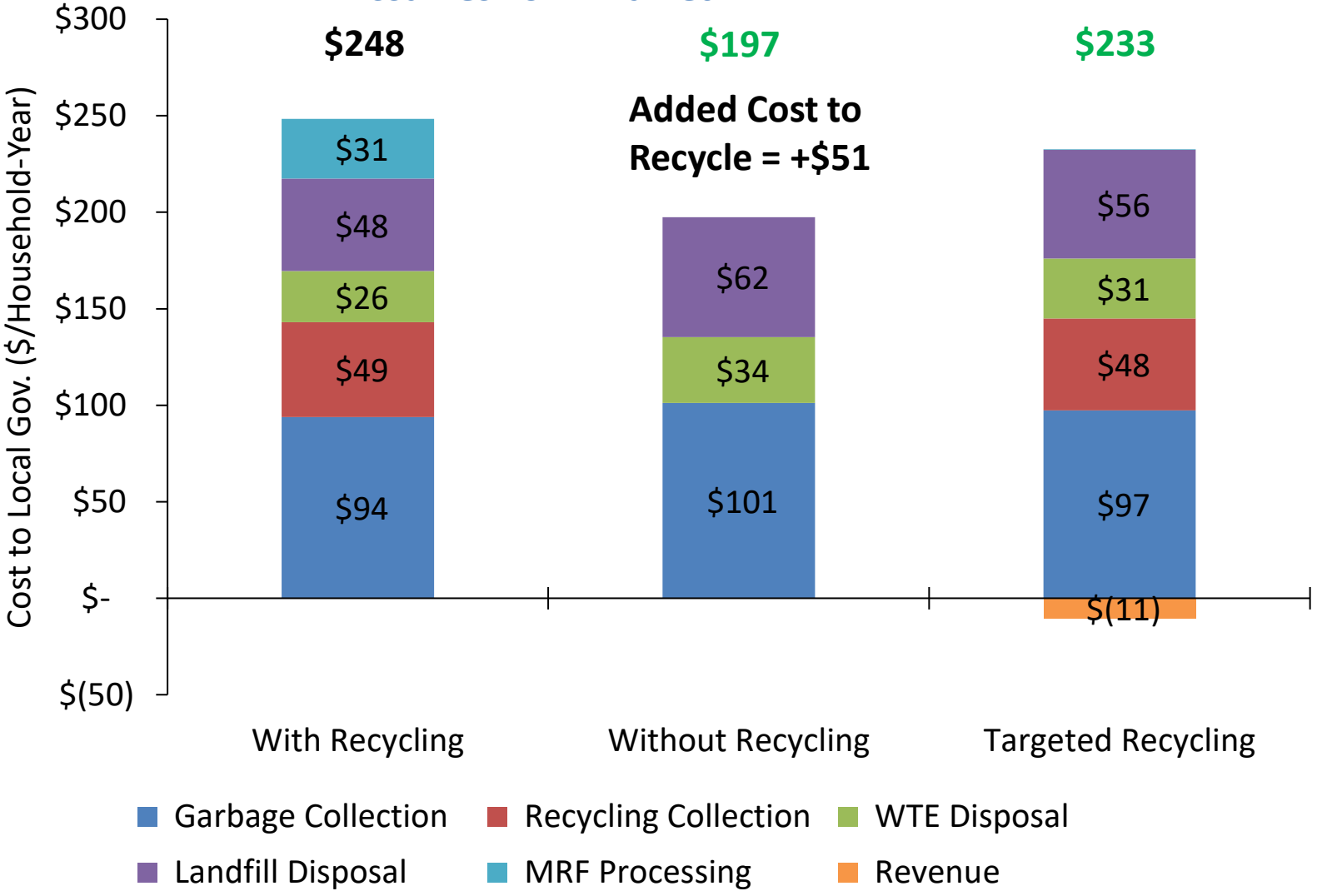
Assumes MRF A Contract



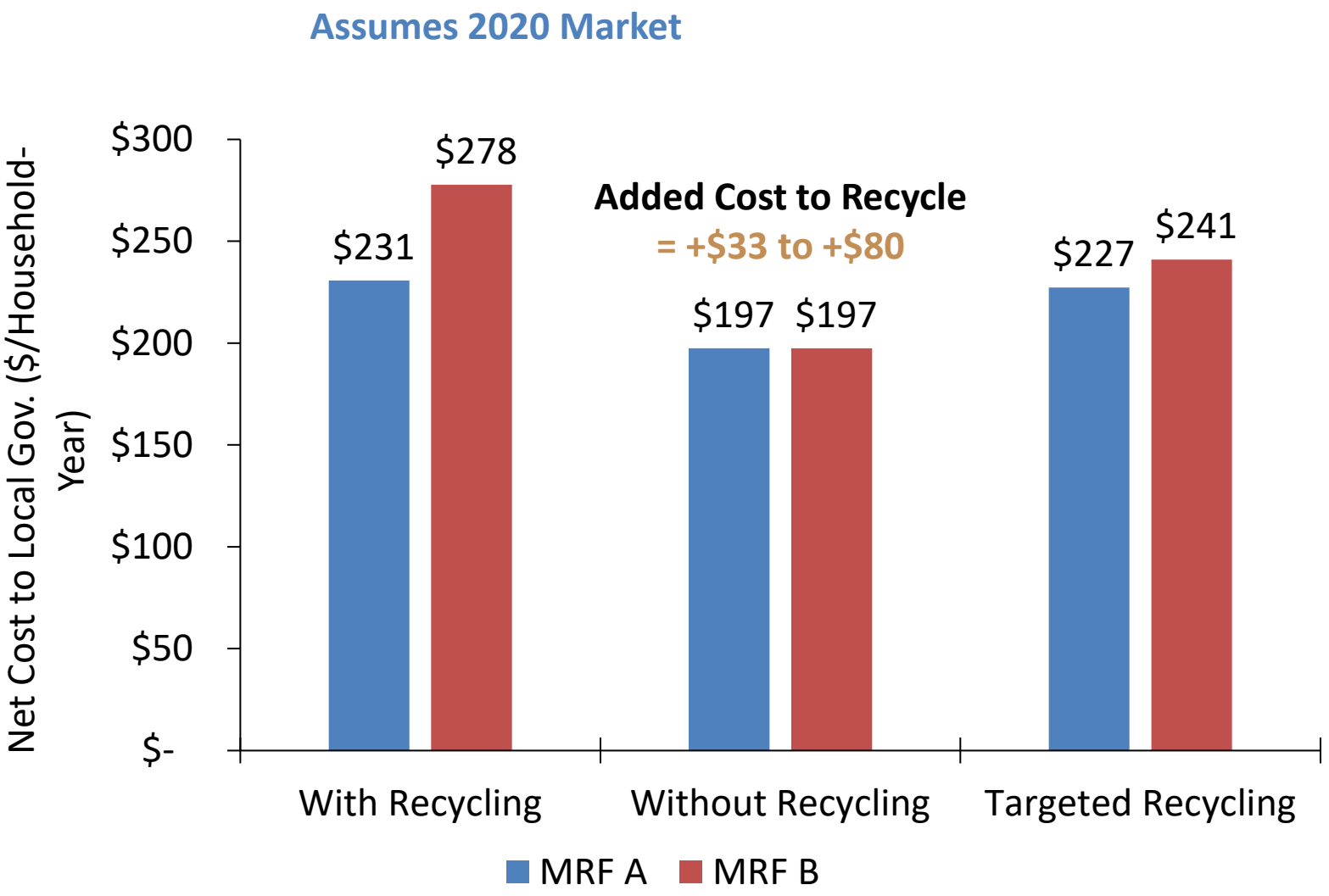
Local Gov. Costs

Assumes MRF B Contract

Assumes 2021 Market



Local Gov. Costs

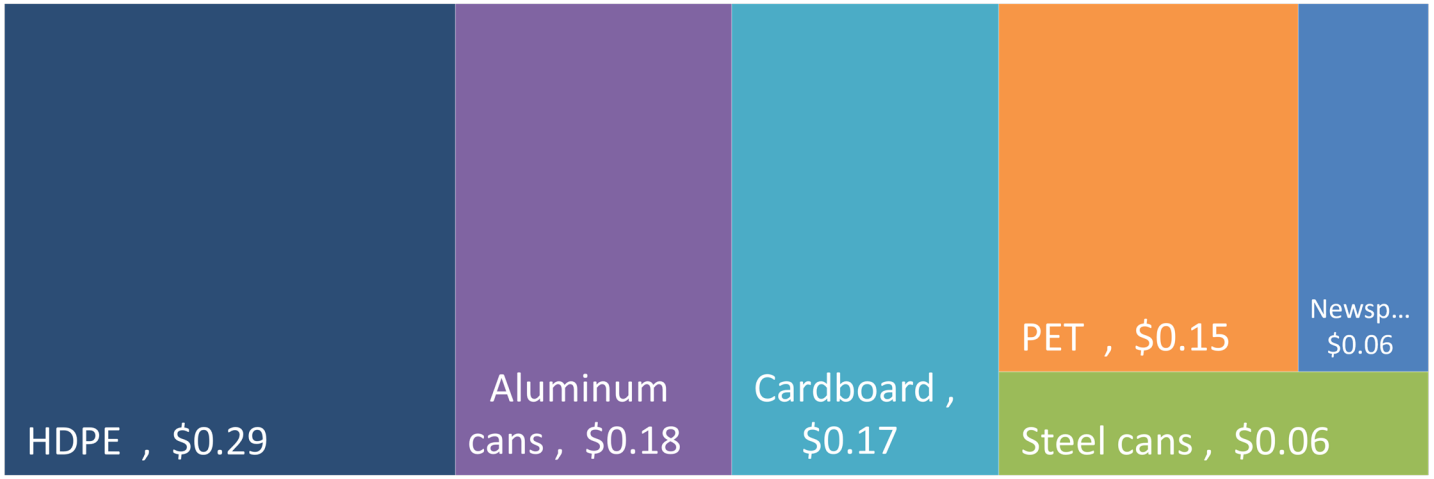


Value of the Bin

2021

$0.91 per bin

$0.57 per bin

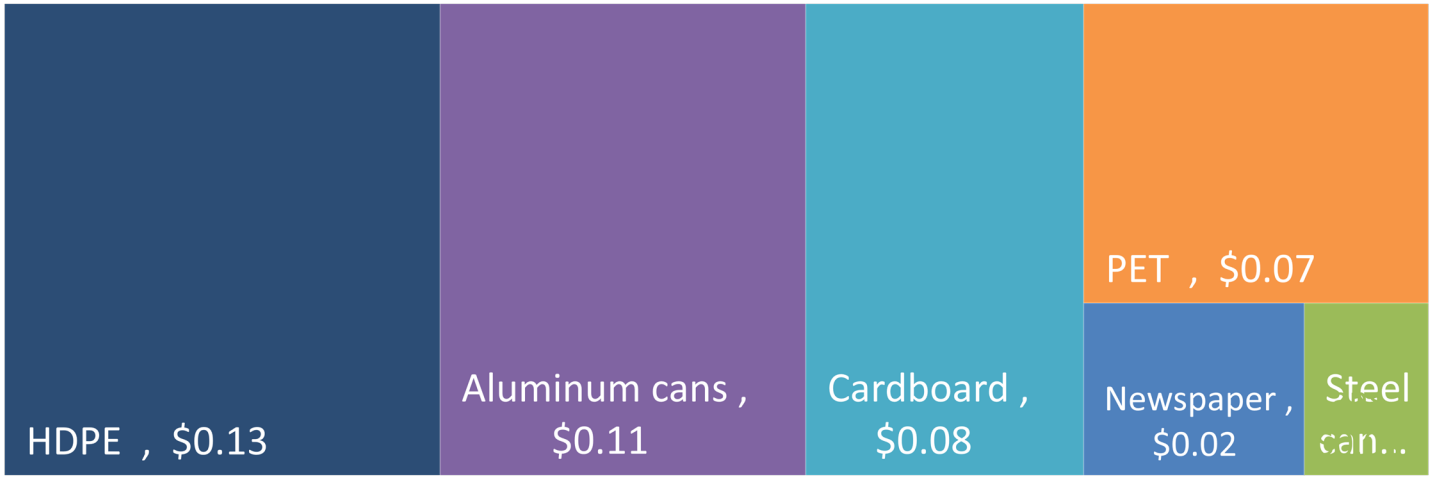


Targeted Recycling Approach

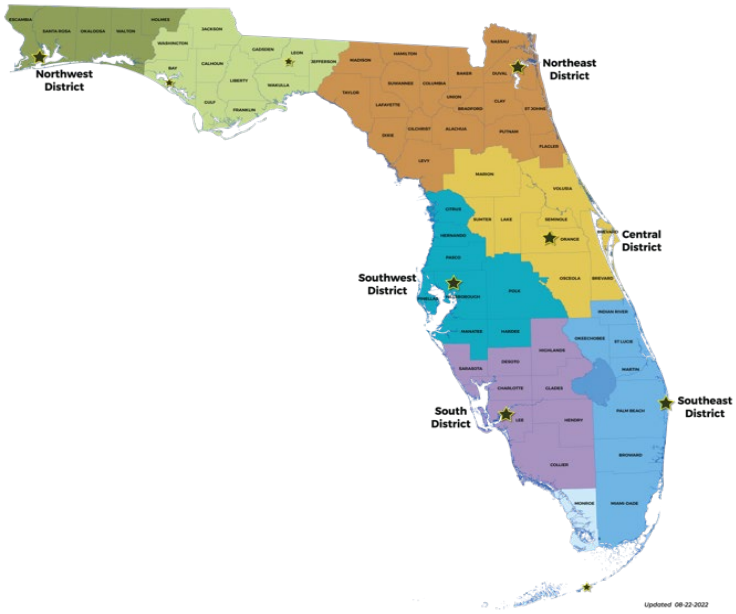
2020

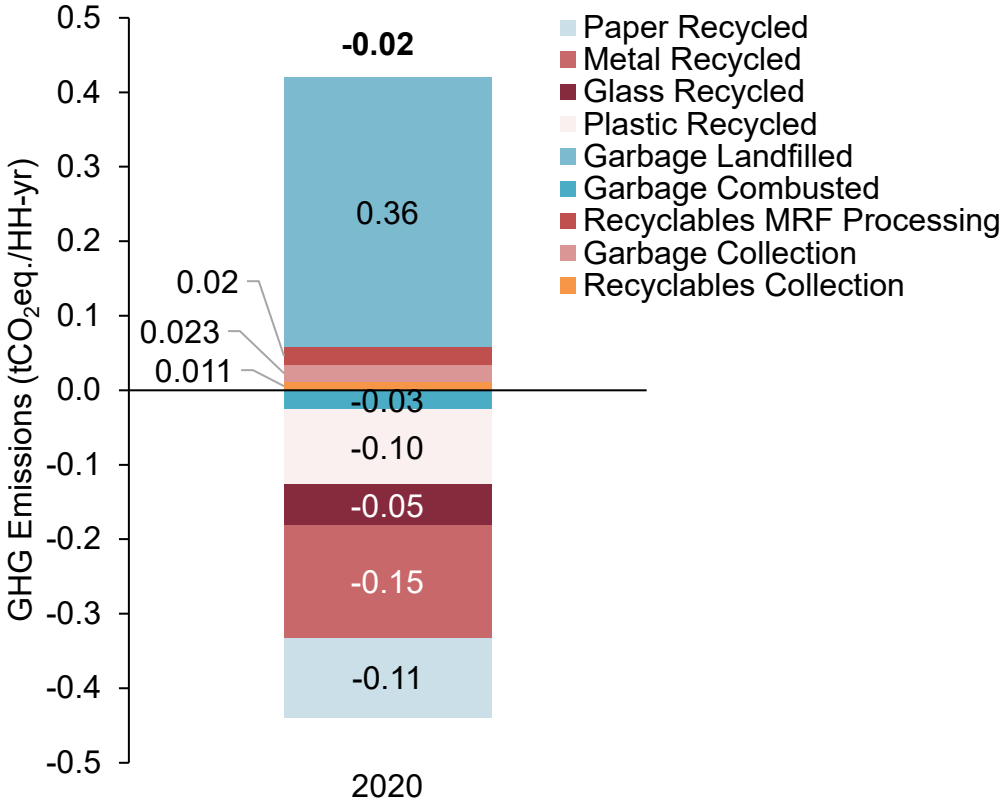
$0.43 per bin

$0.18 per bin



Next Steps: GHG Emissions Footprint





Regionalized based on waste composition, disposition, and WTE and landfill management data

An Integrated Tool for Local Government to Track Materials Management and Progress toward Sustainability Goals

Welcome to the Hinkley Center for Solid and Hazardous Waste Management Funded SMM and Was

This tool is an outcome of the Hinkley Center funded project titled, "An Integrated Tool for Local Government to Track Materials Management and Progress toward Sustainability Goals". In a previous Hinkley Center project titled, "Florida Solid Waste Management: State of the State", researc Florida (UF) estimated the material mass flow for the Florida solid waste stream and conducted a comprehensive analysis on the economic costs an associated with the 2016 waste stream. The researchers also conducted an evaluation of alternative waste management strategies upon the recyclin environmental footprint. The alternative waste management strategies were based on the concept of sustainable materials management (SMM). SM publication entitled "Beyond RCRA: Waste and Materials Management in the Year 2020." In 2009, EPA further developed the idea in "Sustainable Ma Road Ahead," which presented a roadmap for moving toward SMM. In these and other documents, SMM is characterized as a varying set of resource across the entire lifecycle of a material or product — from extraction through refinement, manufacturing, assembly, distribution, use, and end-of-life m focuses on identifying best material management practices based on environmental, economic, and social impacts. Lifecycle assessment (LCA) mo those impacts, and policymakers use LCA results to make SMM-informed decisions. In effort to continue this research, University of Florida researc developed LCA models and literature to create lifecycle impact (LCI) factors that can be used to measure the impacts of a community's waste manag the Hinkley Center project titled "Looking beyond Florida's 75% Recycling Goal: Development of a Methodology and Tool for Assessing Sustainable Recycling Rates in Florida". In another project the UF researchers worked with the Florida Department of Environmental Protection (FDEP) to update Composition Calculation Model (WasteCalc) , which is an online tool used to estimate the composition of municipal solid waste (MSW) generated in useful tool for recycling coordinators when preparing annual reports when actual waste composition data for a particular county is not available. In this have both functionalities of WasteCalc and LCI factors project.

What's New?

This tools includes the 2019 WasteCalc Model but it also now includes:

- **A breakdown of the landfill and combusted composition**
- **The ability to measure source reduction**
- **The ability to measure nine different life cycle impact indicators**

To read more on the scope of this project and documentation of this tool please visit:
https://faculty.eng.ufl.edu/timothy-townsend/research/florida-solid-waste-issues/tool-to-track-progress-toward-smm-goals/

To read more about the previous projects please visit:
https://faculty.eng.ufl.edu/timothy-townsend/research/florida-solid-waste-issues/florida-solid-waste-management/
https://faculty.eng.ufl.edu/timothy-townsend/research/florida-solid-waste-issues/looking-beyond-floridas-75-recycling-goal/

To read more about SMM please visit:
https://www.epa.gov/smm

To read more about what other states are doing please visit:
https://www.oregon.gov/deq/mm/Documents/mmFramework2020.pdf

This workbook tool provides local government and other users the opportunity to measure the impacts of their solid waste management pr description of the components of this workbook tool.

Tab No.	Tab Title	Tab Description
1	Introduction	Background of tool and SMM concept.
2	2019 WasteCalc Input	Users input data needed for the 2019 WasteCalc model.
3	2019 WasteCalc Results	Results produced using the 2019 WasteCalc model.
4	SMM Input	Users can select from seven models, which are used to estimate LCI factors.
5	SMM Results	The environmental and social footprints associated with waste management.
6	LCI Factors	The summary LCI factors used to measure the footprints.

For any questions regarding this tool please contact Dr. Tim Townsend at ttown@ufl.edu and Dr. Malak Anshassi at manshassi@ufl.edu or manshassi@floridapoly.edu

1 Introduction | 2 2019 WasteCalc Input | 3 2019 WasteCalc Results | 4 SMM Input | 5 SMM Results

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An Integrated Tool for Local Government to Track Materials Management and Progress toward Sustainability Goals

June 2021

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nature sustainability

Article

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The hidden economic and environmental costs of eliminating kerb-side recycling

Received: 20 October 2022

Accepted: 18 April 2023

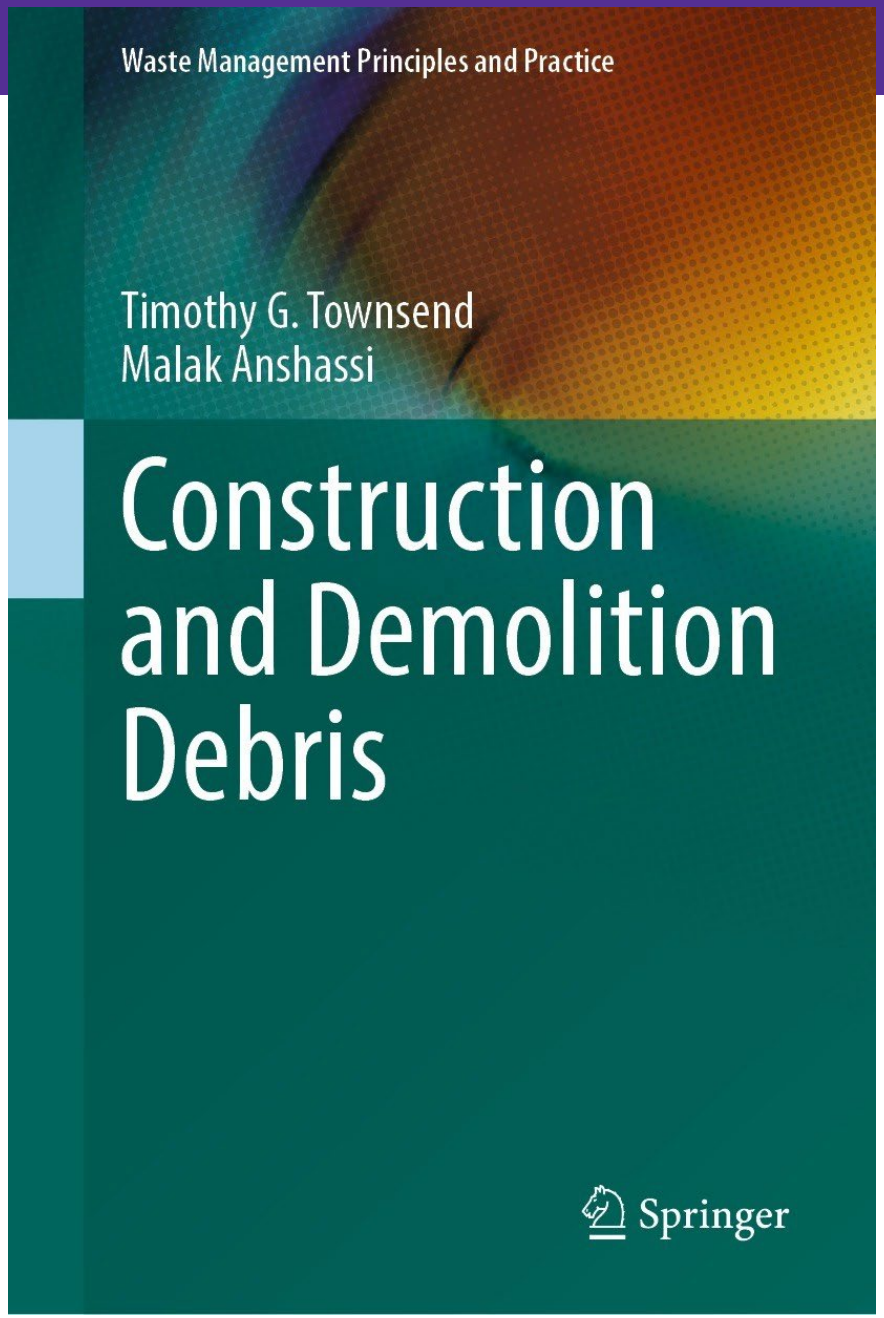
Published online: 22 May 2023

Check for updates

Malak Anshassi [1] & Timothy G. Townsend [2]

Local governments provide household collection of garbage and recyclables on a routine schedule, and these recycling programmes represent the most visible opportunity for everyday citizens to engage in sustainable practices. In the face of unprecedented challenges, and citing costs as the major driver, many US communities are shrinking or eliminating kerb-side recycling. Here we show that when recycling commodity markets were most lucrative in 2011, net US recycling costs were as little as US$3 per household annually, and when markets reached a minimum (in 2018–2020), the annual recycling-programme costs ranged from US$34 to US$42 per household. This investment offsets the greenhouse gas emissions from non-recycled household waste buried in landfills. If local governments restructure recycling programmes to target higher value and embodied carbon-intensive materials, recycling can pay for itself and reduce greenhouse gas emissions. Our analysis highlights that kerb-side recycling provides communities a return on investment similar to or better than climate change mitigation strategies such as voluntary green power purchases and transitioning to electric vehicles. Eliminating recycling squanders one of the easiest opportunities for communities and citizens to mitigate climate change and reduce natural resources demands.

https://www.nature.com/articles/s41893-023-01122-8



https://link.springer.com/book/10.1007/978-3-031-25013-2

Project Website: https://sites.google.com/view/anshassipolyhc/home?authuser=1

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FLORIDA POLYTECHNIC UNIVERSITY

Project Website

Thank You for Your Time!