Stakeholder Working Group Meeting
Florida Solid Waste Management: State of the State

June 5, 2018

Department of Environmental Engineering Sciences
Engineering School for Sustainable Infrastructure and Environment

University of Florida

UNIVERSITY of FLORIDA

Hinkley Center for Solid and Hazardous Waste Management

Today's Goals

- Summarize State of the State with respect to solid waste management.
  - Tons, disposition, cost
- Discuss what would be required to reach a 75% recycling rate.
- Present ideas for integrating sustainable materials management into solid waste management decision making.
- Brainstorm on possible next steps for Florida.

State of the State

↓

Getting to 75%

↓

Integrating SMM

↓

Where does Florida go from here?

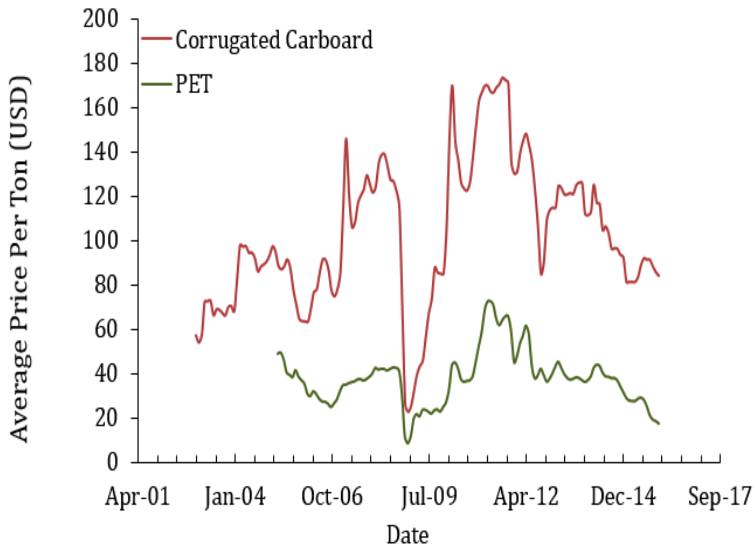
Agenda

Activity	Schedule
Introductions, Motivation, Objectives	10:00-10:15 am
State of Waste Management in Florida	10:15-11:00 am
Alternative Strategies and Approaches to Increase Recycling Rate	11:00-11:45 am
Lunch	11:45-12:30 pm
Looking Beyond the Ton	12:30-1:15 pm
Next Steps for Florida	1:15-2:00 pm
Adjourn	2:00 pm

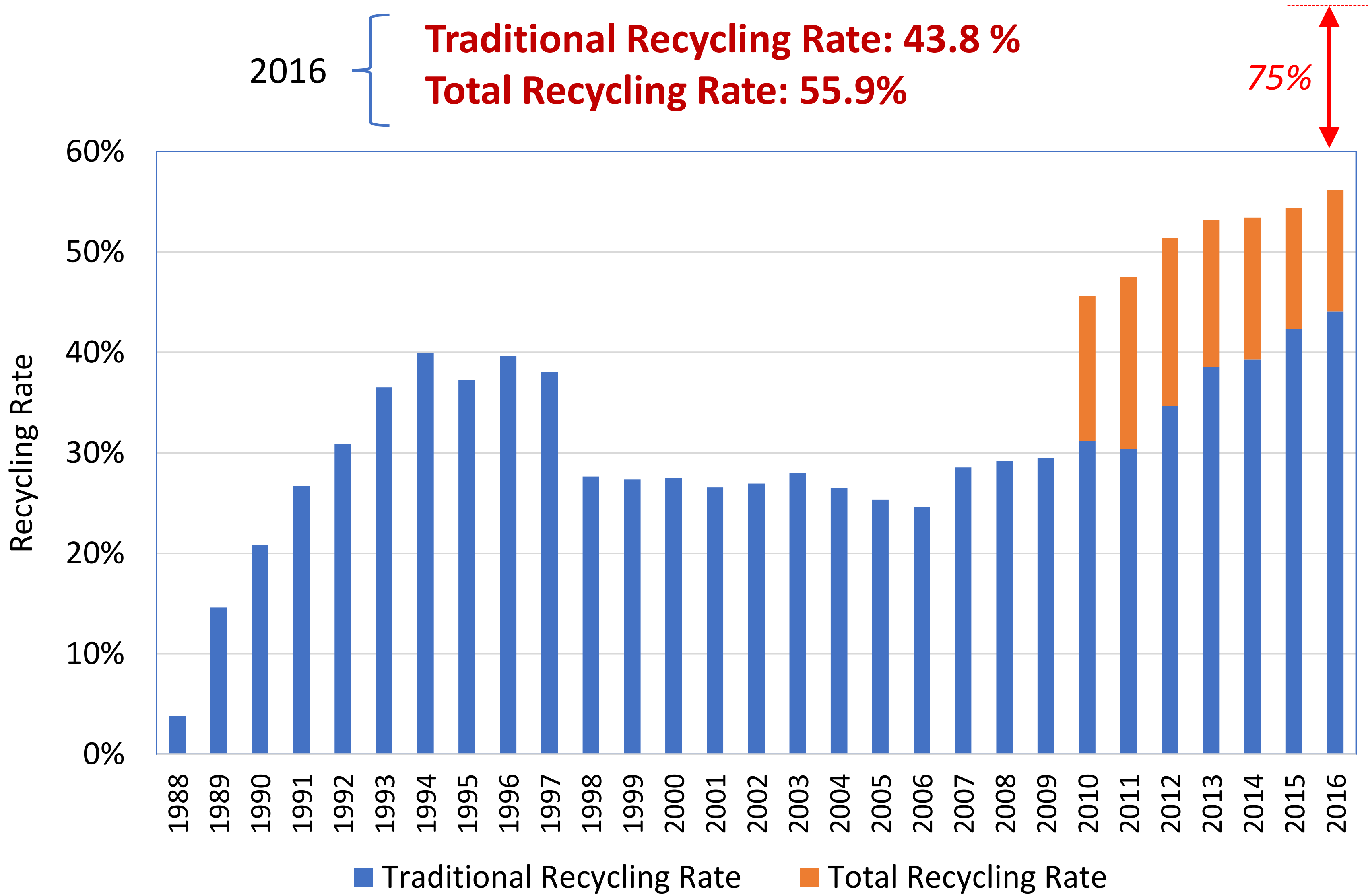
Motivation

- Hinkley Center Research Project → *Florida Solid Waste Management: State of the State*
- Market values for recyclable commodities are lower than they have been in years.
- The waste stream has evolved: less newspaper, more composite packaging
- Statutory, regulatory, and policy requirements drive additional recycling or landfill diversion
  - Florida 75% recycling goal; required C&D recycling where economically feasible

Recyclables Commodity Pricing – Monthly Averages



Florida Historic Recycling Rates



OPINION | ENVIRONMENT

China's War on Foreign Garbage

Imported recycling has been a boon for China. So why ban it?

By Adam Minter

28 July 20, 2017, 5:00 PM EDT

Sustainable Materials Management

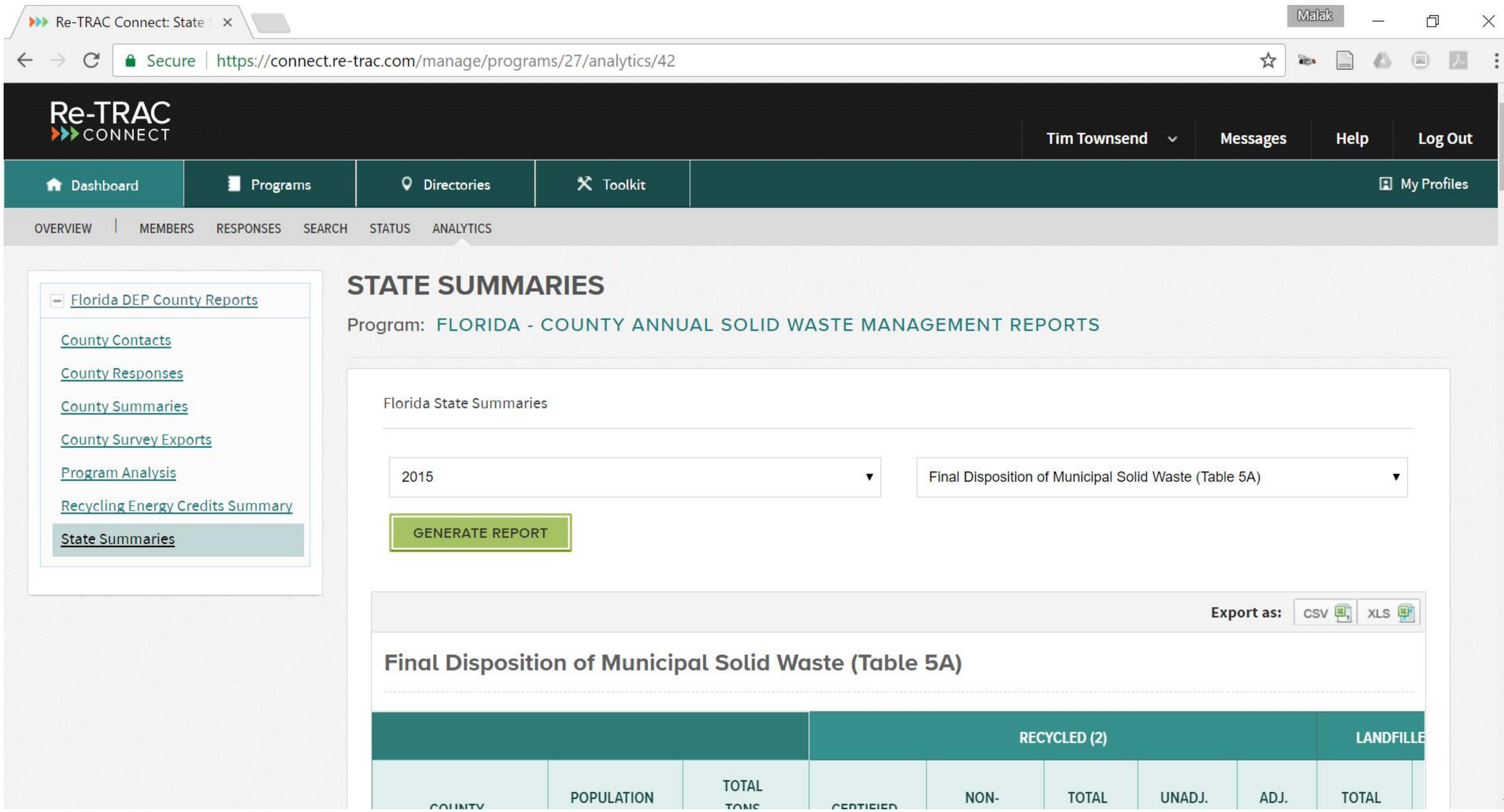
- Systemic approach to using and reusing materials productively
- Represents a change in how our society thinks about the use of natural resources
- Looks at a product's entire lifecycle to reduce environmental impacts, conserve resources, and reduce costs

https://www.epa.gov/smm

State of the State
Waste Flow

Current Data

Reporting System



Current Data

Types of Recycling Credits

Total Recycling Credits	• Traditional recycling credits • Renewable energy recycling credits
Traditional Recycling Credits	• As defined by FDEP
Standard Recycling Credits	• Only MSW material components recycled

Current Data

Recycling Credits

Traditional Recycling Credits

- Yard trash used as a landfill cover
- Other MSW used as landfill cover
- Treated contaminated soil used as a landfill cover
- Fuel or fuel substitute recycling credits
- Recycling of MSW material components

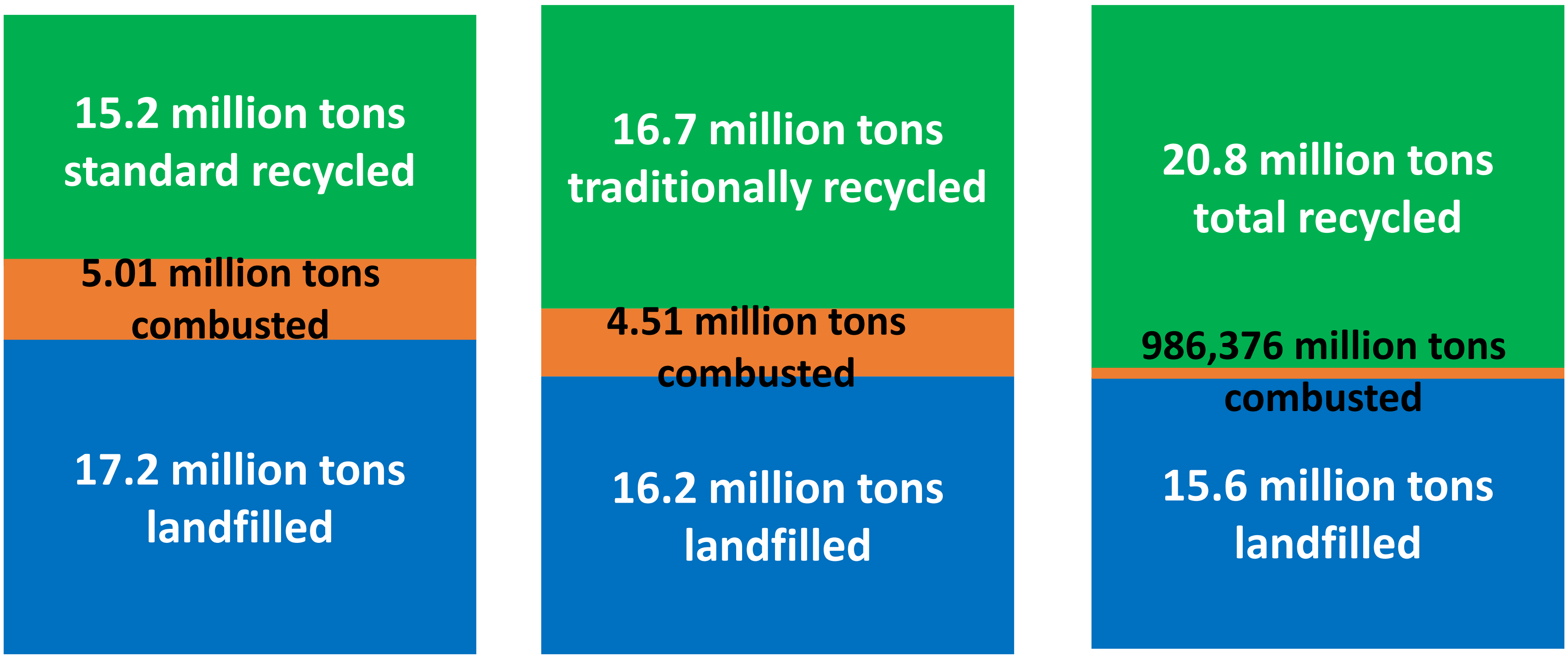
Recycling Credits

Renewable Recycling Credits

- Landfill gas generated from yard trash
- Landfill gas generated from MSW
- Waste To Energy
- Other renewable energy other than WTE
- Yard trash disposed beneficially in a landfill to generate energy other than landfill gas

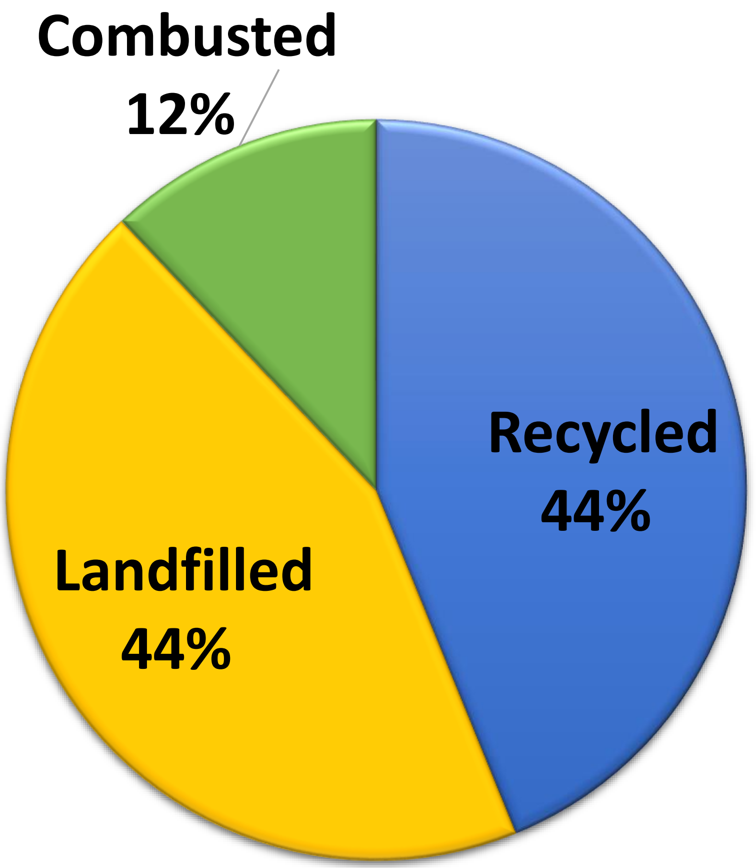
Florida Total Waste Generation

Standard Recycling Rate: 40.6% | **Traditional Recycling Rate: 44.7%** | **Total Recycling Rate: 55.5%**

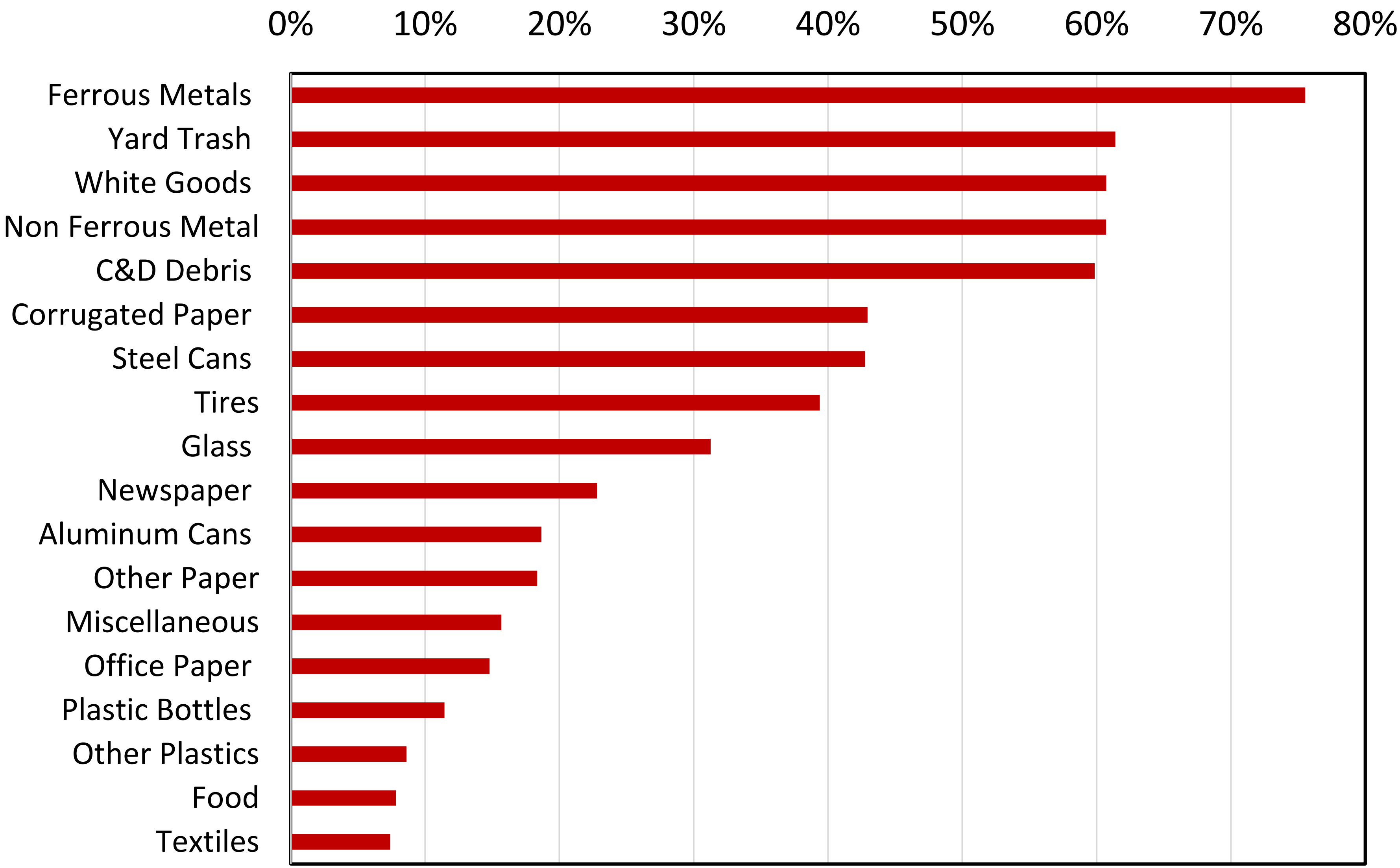


37.4 Million tons | 37.4 Million tons | 37.4 Million tons

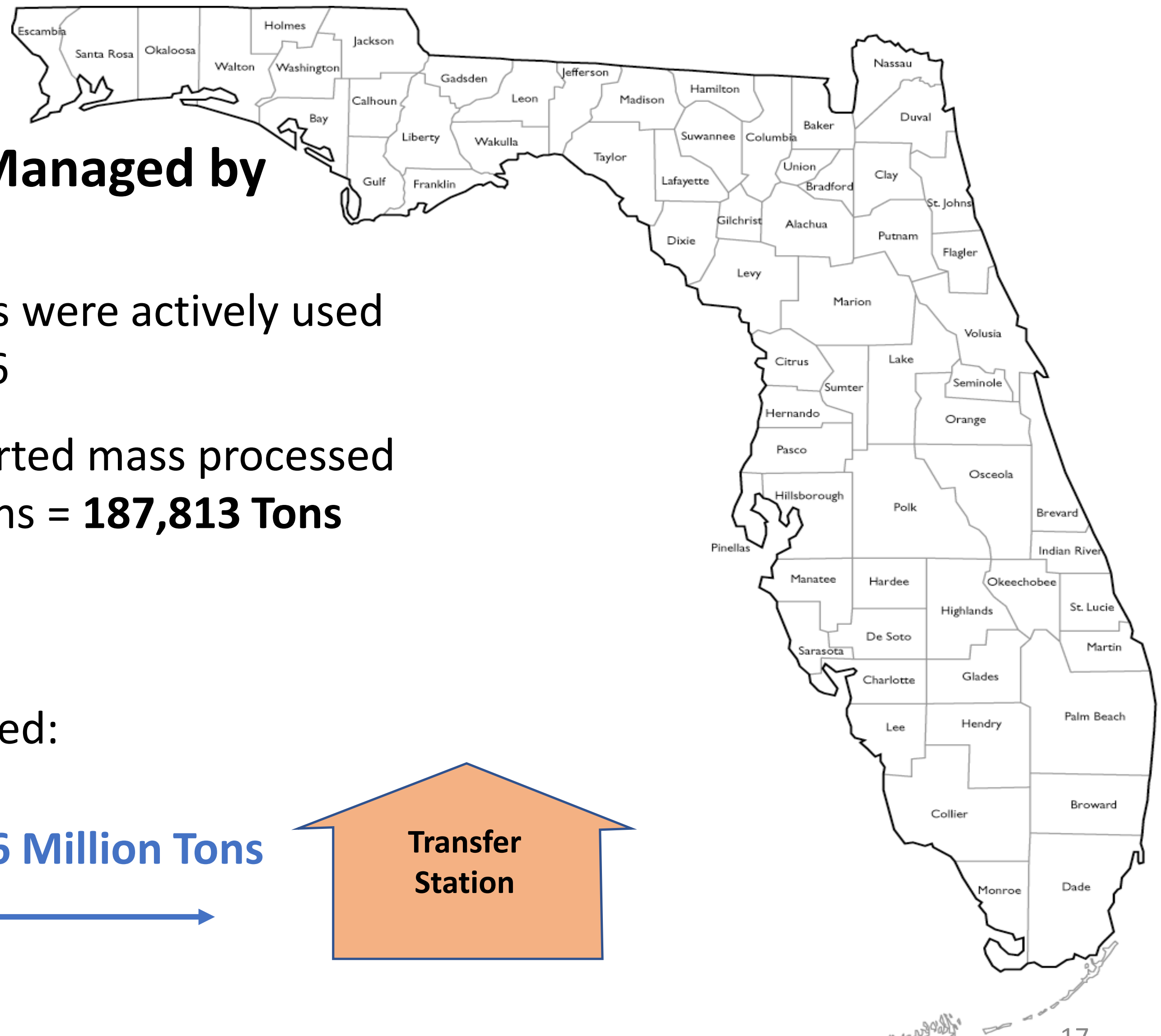
Florida Waste Disposition



Florida Recycling Rate by Component



Transfer Station Mass Managed



Estimated Mass Managed by Transfer Station:

- **99** transfer stations were actively used in the state in 2016
- Averaged the reported mass processed at **9** transfer stations = **187,813 Tons**

- Total Tons Managed:

18.6 Million Tons →

Transfer Station

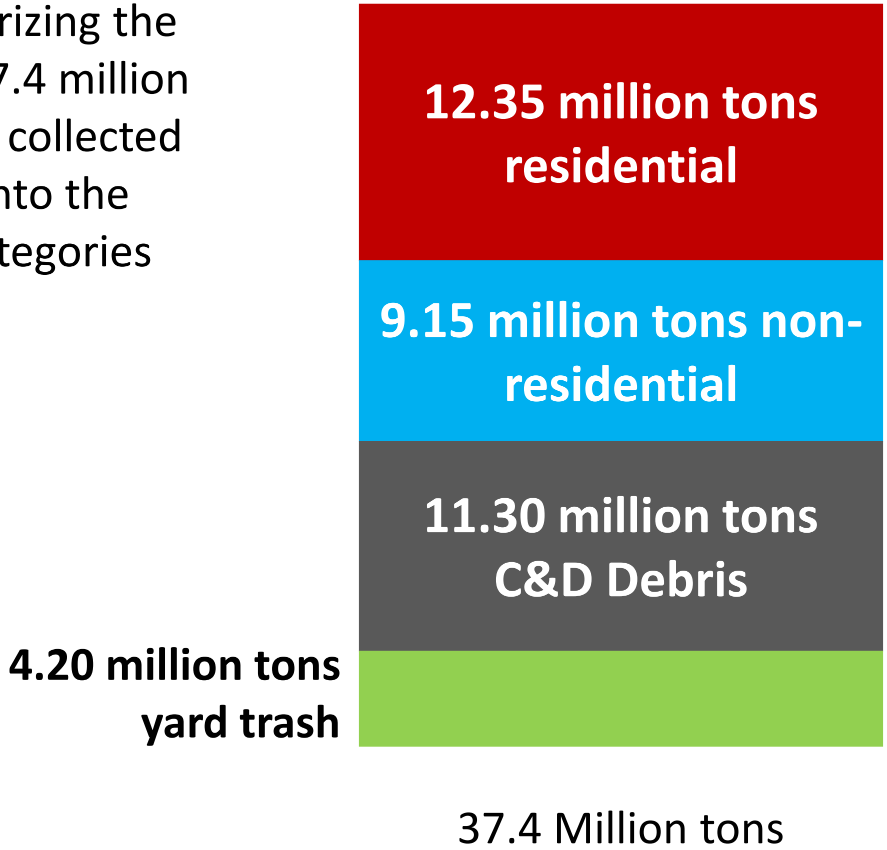
Next, Let's Break This Down By 4 Major Categories

1. Residential MSW*
2. Non-residential MSW*
3. C&D Debris
4. Yard Trash

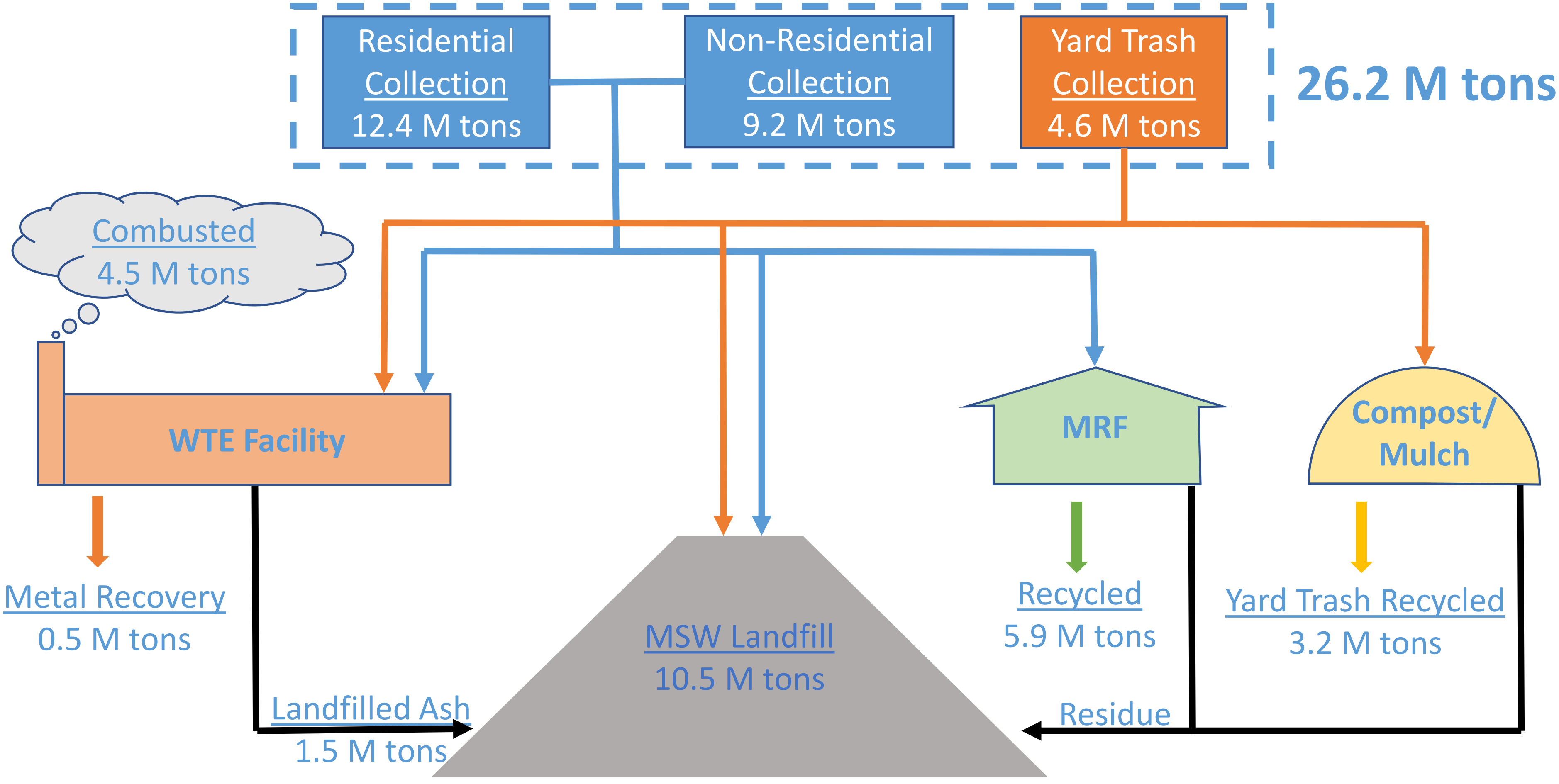
- *Not including yard trash or C&D debris.

State of Florida Total Waste Generation by Category

- Categorizing the total 37.4 million tons of collected MSW into the four categories



Florida Material Mass Flow (2016)



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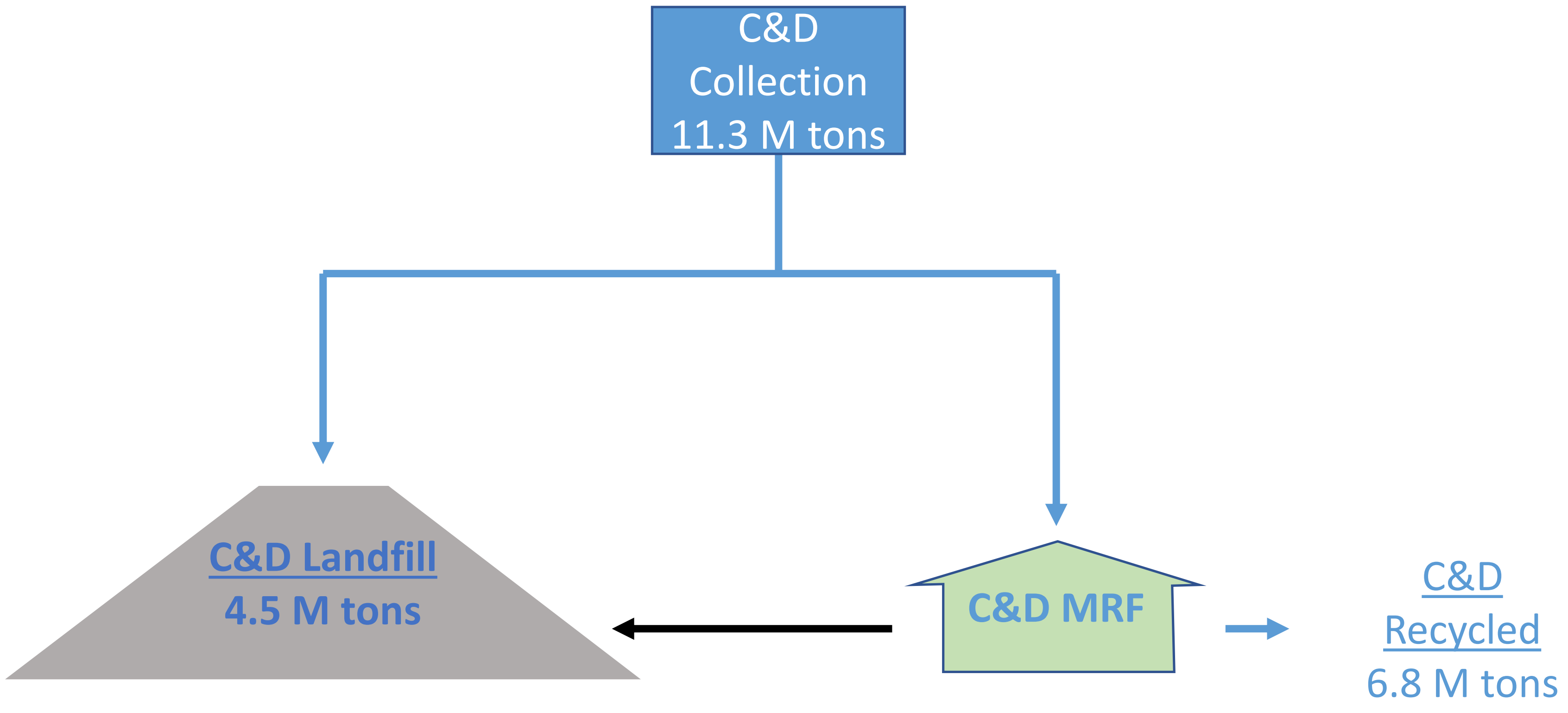
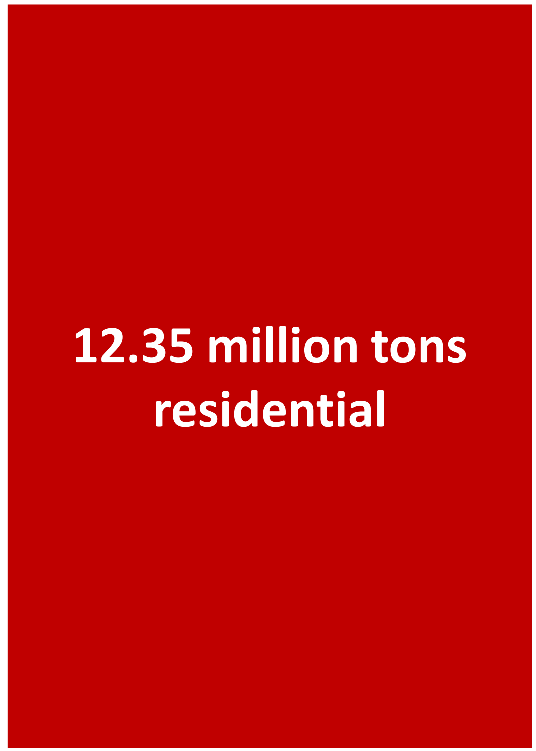


Residential Waste

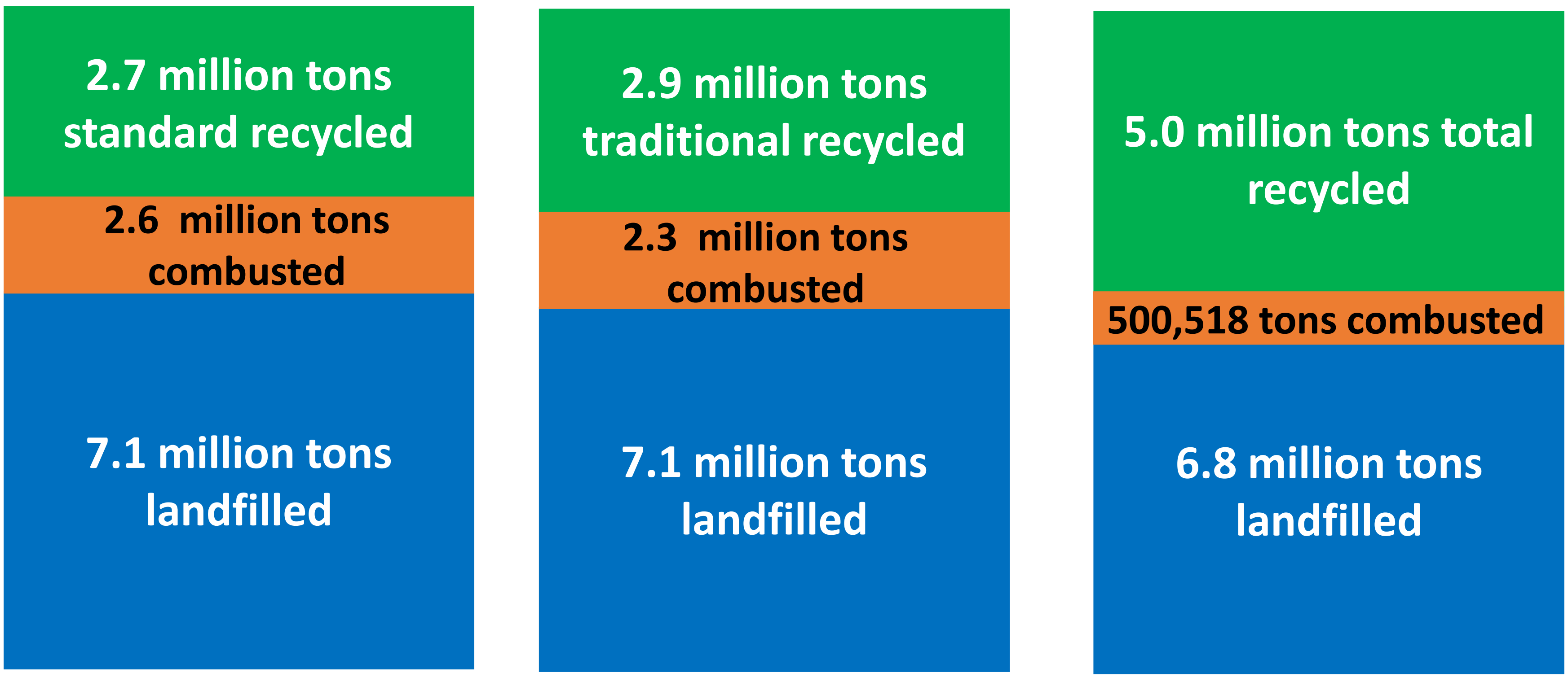
- Categorizing the total 37.4 million tons of collected MSW into the four categories



12.35 Million tons

Residential Waste

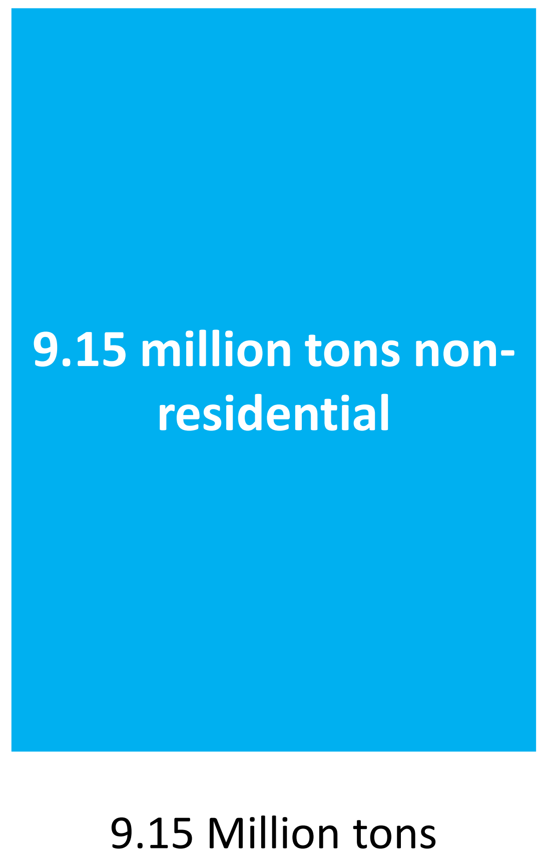
Standard Recycling Rate: 21.7% | **Traditional Recycling Rate: 23.8%** | **Total Recycling Rate: 41.0%**



12.35 Million tons | 12.35 Million tons | 12.35 Million tons

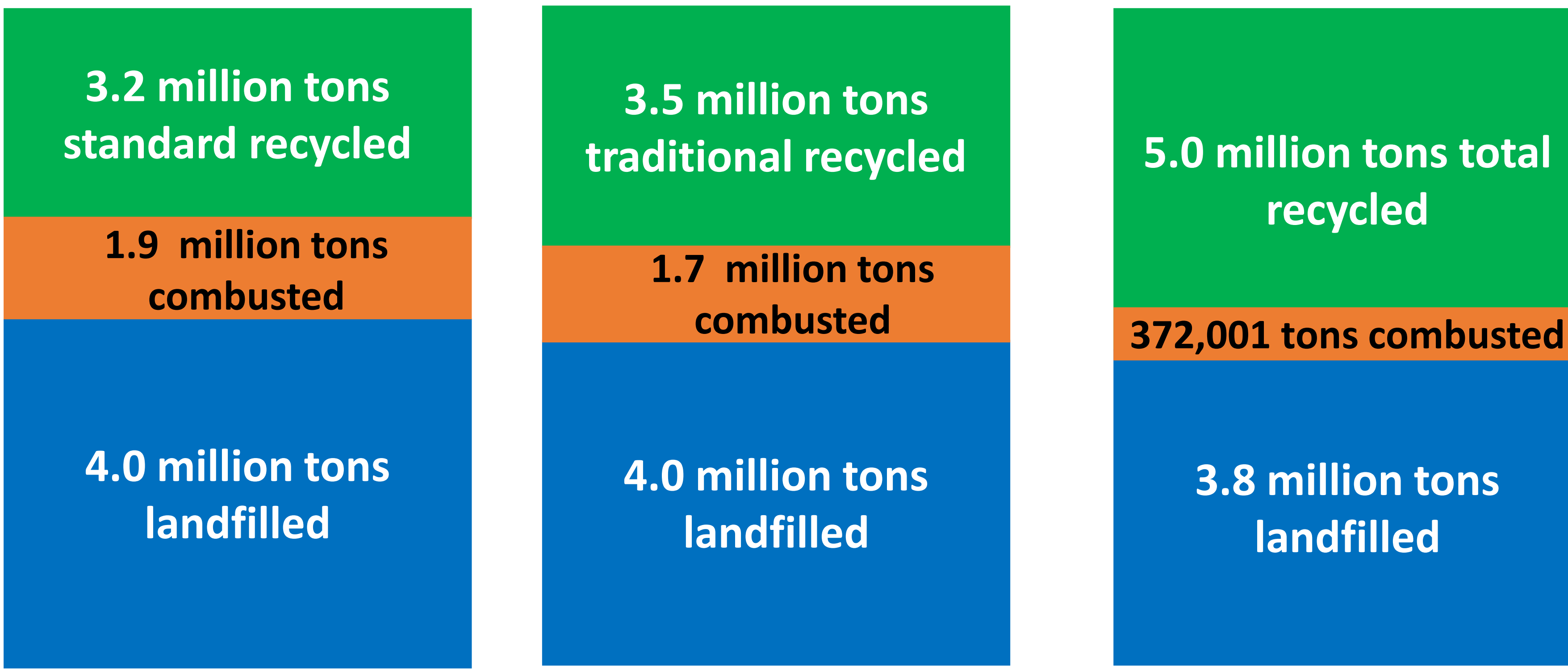
Non-Residential Waste

- Categorizing the total 37.4 million tons of collected MSW into the four categories



Non-Residential Waste

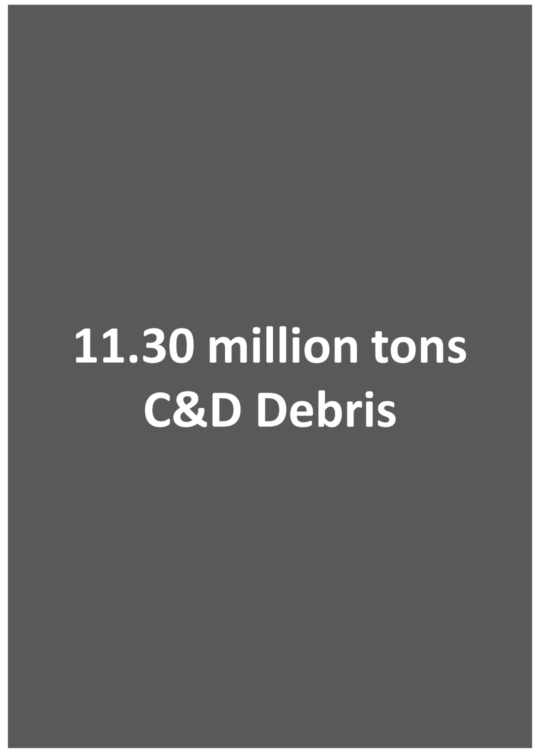
Standard Recycling Rate: 35.4% **Traditional Recycling Rate: 38.0%** **Total Recycling Rate: 54.8%**



9.15 Million tons | 9.15 Million tons | 9.15 Million tons

C&D Debris

- Categorizing the total 37.4 million tons of collected MSW into the four categories



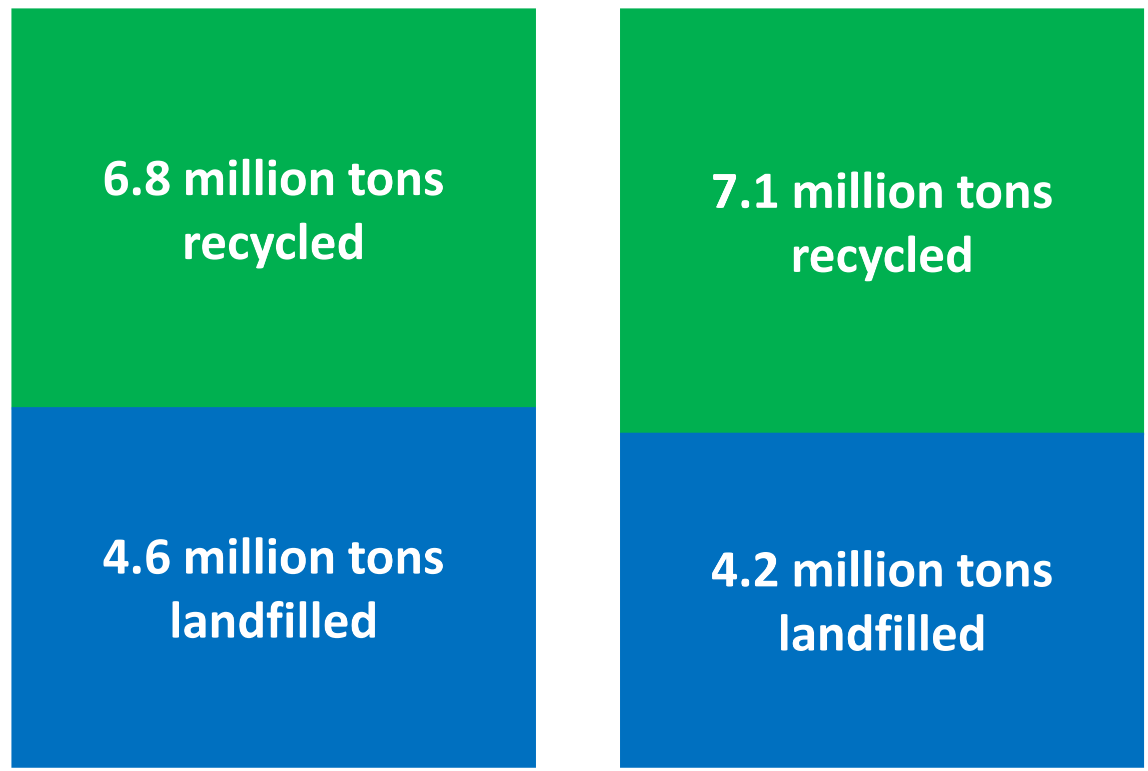
11.30 Million tons

C&D Debris

- C&D is assumed to not be combusted and it is assumed the treated contaminated soil recycling credits and other MSW used for LF cover recycling credits originate from the landfill C&D tons

Standard Recycling Rate: 59.9%

Traditional Recycling Rate: 62.6%
Total Recycling Rate: 62.6%



11.30 Million tons

11.30 Million tons

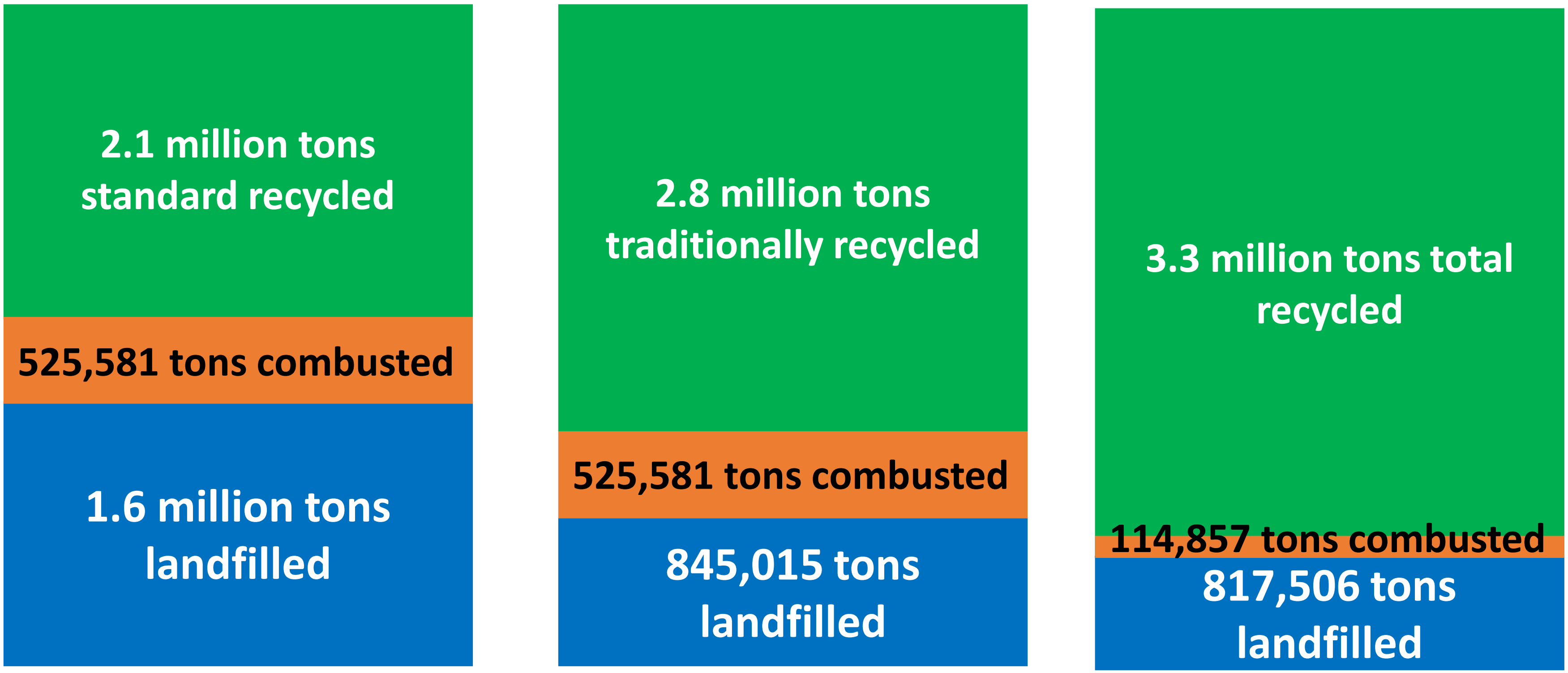
Yard Trash

- Categorizing the total 37.4 million tons of collected MSW into the four categories

4.20 Million tons

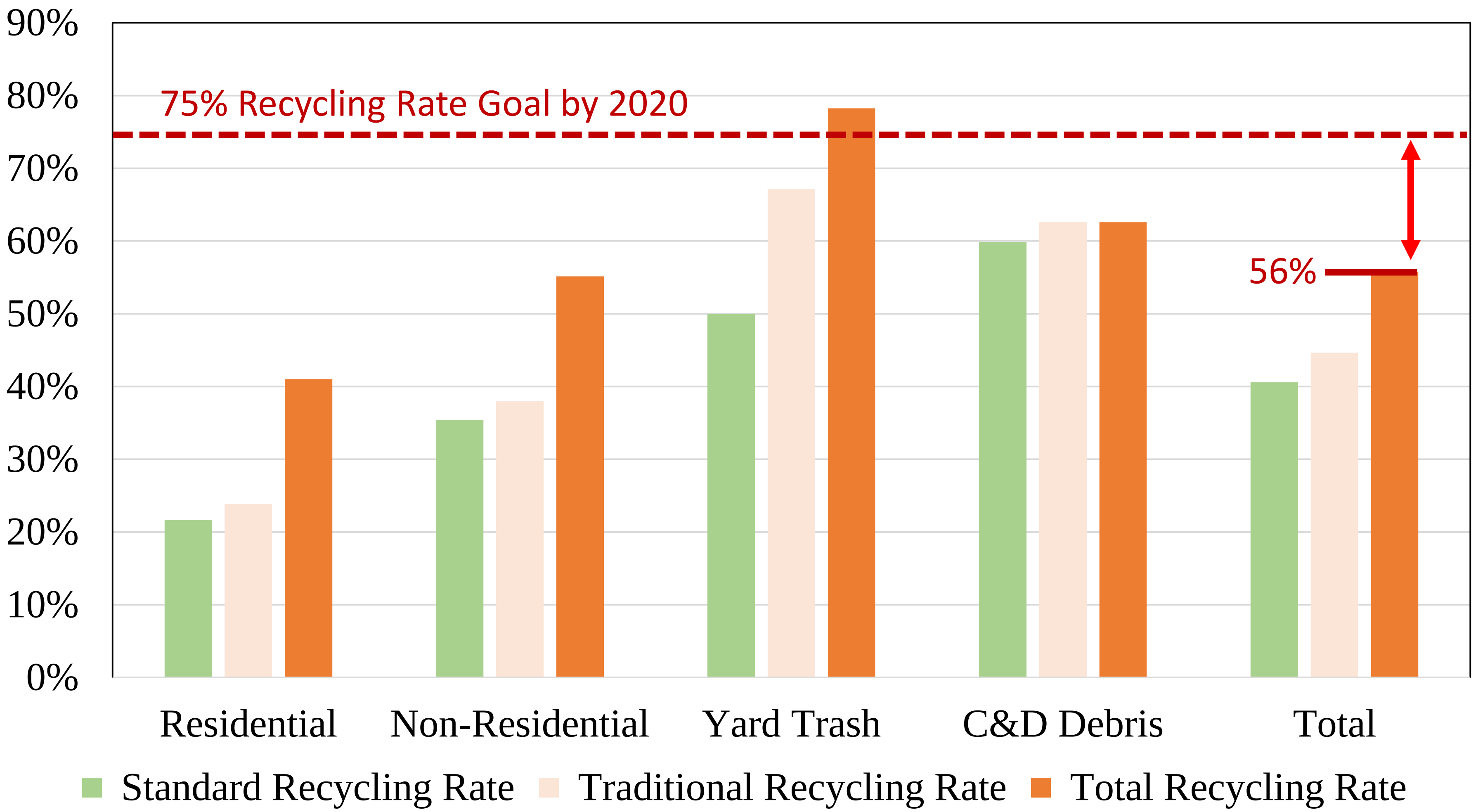
Yard Trash

Standard Recycling Rate: 50.0% | **Traditional Recycling Rate: 67.1%** | **Total Recycling Rate: 78.2%**



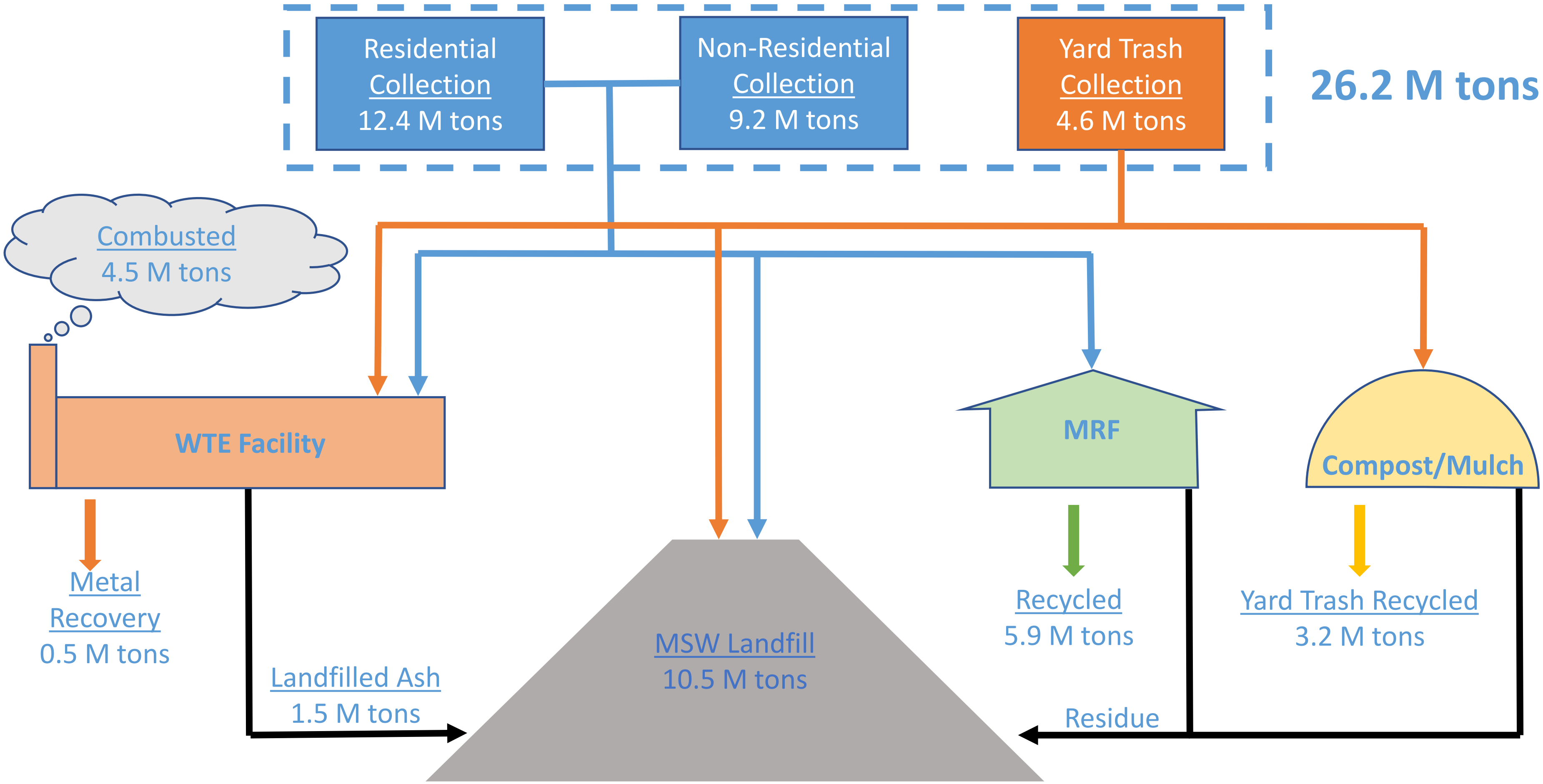
4.20 Million tons | 4.20 Million tons | 4.20 Million tons

Recycling Rates by Category

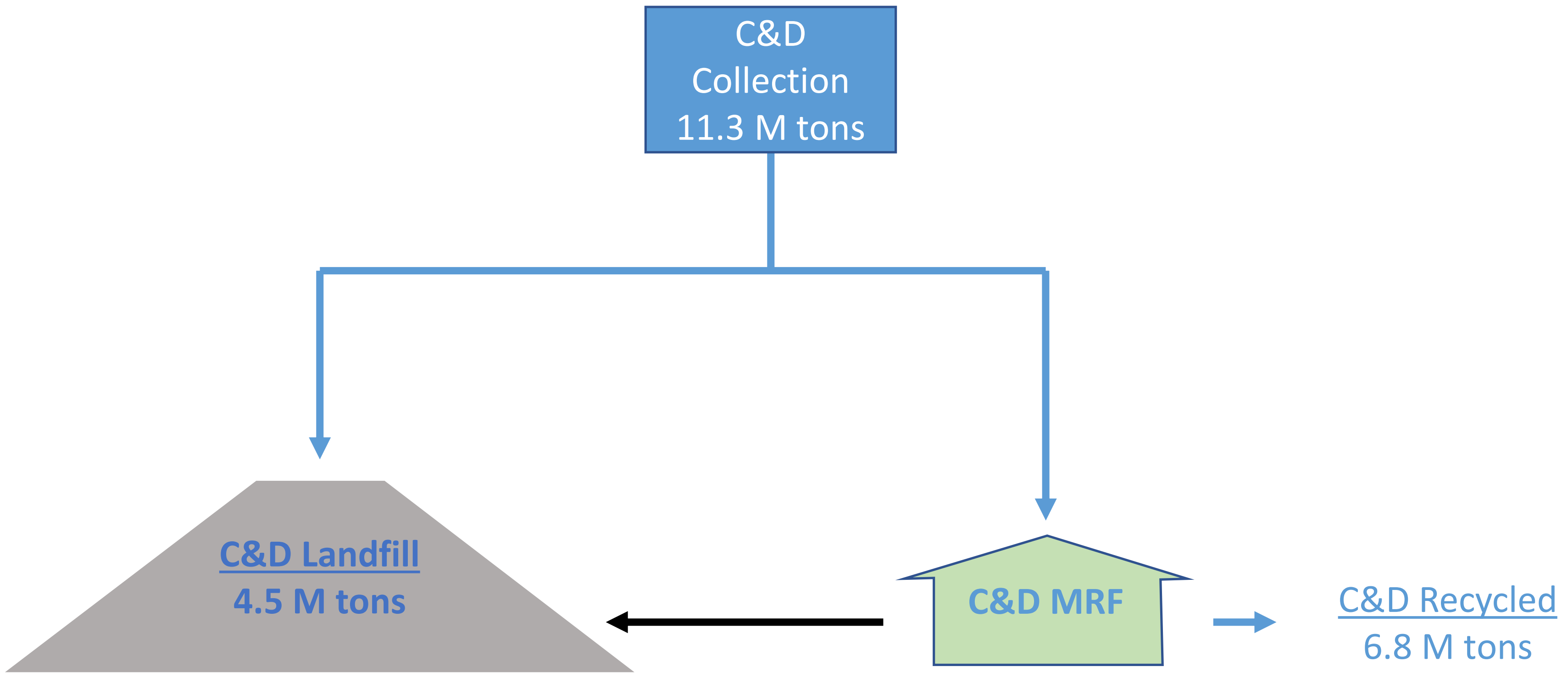


State of the State
Costs

Florida Material Mass Flow (2016)

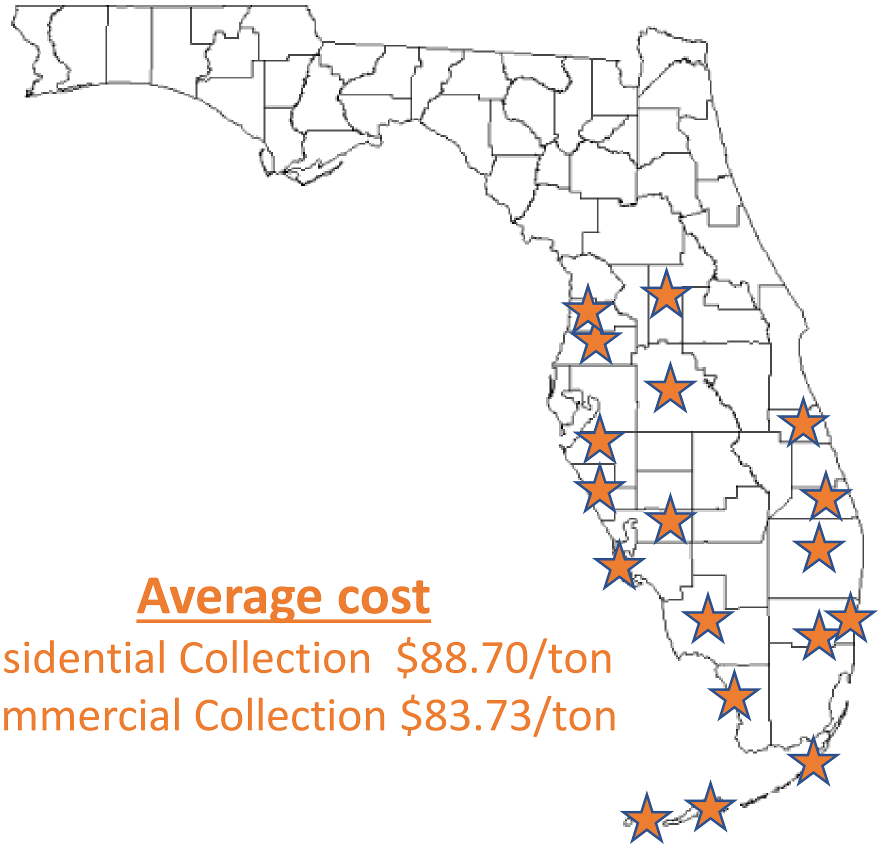


Florida Material Mass Flow (2016)



Residential & Commercial Collection Costs

	Residential	Commercial
City of Sanibel FY2016/2017	$ 121.45	$ 122.38
City of Eustis 2017	$ 82.76	$ -
Indian River County 2015	$ 89.49	$ -
City of Key West 2012	$ 189.80	$ 98.48
City of Coconut Creek 2012	$ -	$ 55.46
City of Lauderdale Lakes 2012	$ -	$ 98.94
Manatee County Area 1 2012	$ -	$ 74.94
Manatee County Area 2 2012	$ -	$ 68.99
Monroe County Area 1 2012	$ -	$ 75.55
Monroe County Area 2 2012	$ -	$ 88.24
Monroe County Area 3 2012	$ -	$ 86.52
Monroe County Area 4 2012	$ -	$ 92.74
Palm Beach County FY2016	$ 107.93	$ -
Charolette County FY2016	$ 68.27	$ -
Collier County FY2016	$ 62.57	$ -
Hernando County FY2016	$ 54.33	$ -
Pasco County FY2016	$ 91.02	$ -
Polk County FY2016	$ 66.95	$ -
Sarasota County FY2016	$ 60.29	$ -
Martin County FY2016/2017	$ 125.56	$ -
Palm Beach County FY2017/2018	$ 121.45	$ 58.81

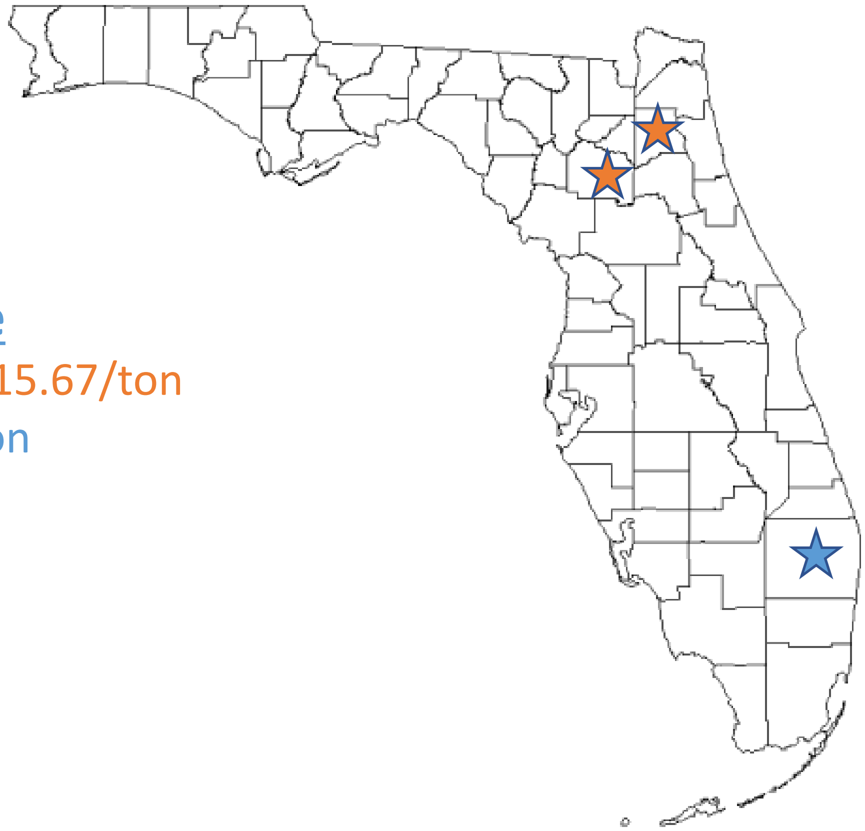


Average cost

Residential Collection $88.70/ton

Commercial Collection $83.73/ton

MSW Landfill Disposal Costs



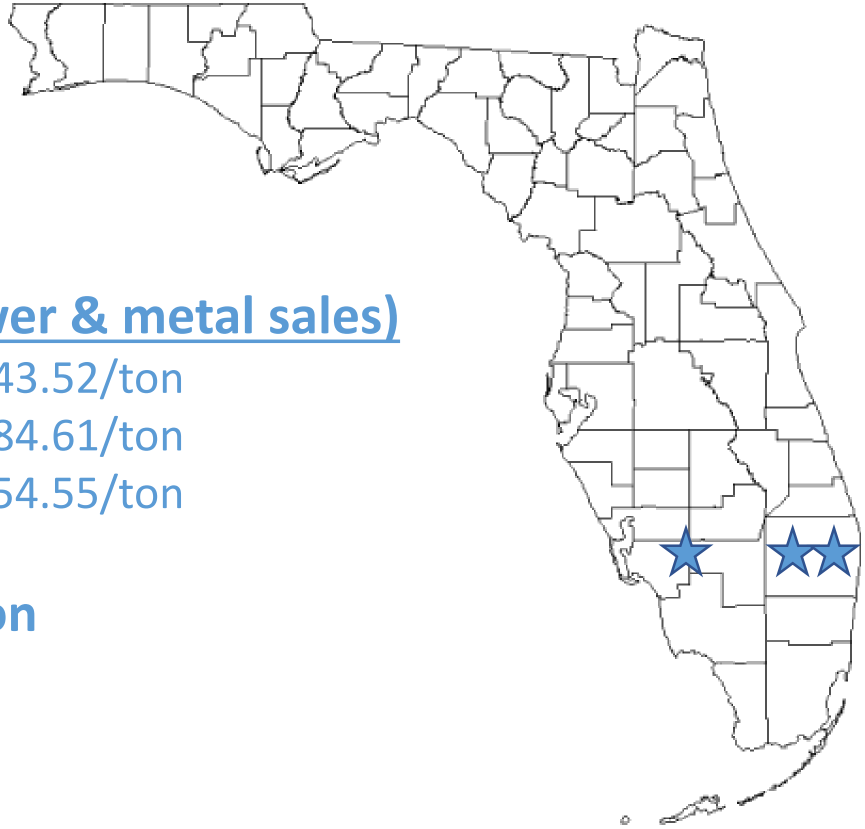
Landfill Disposal Charge

Average of recent bid/negotiations $15.67/ton

Public landfill audit $24.35/ton

Average = $20/ton

Waste-to-Energy Costs

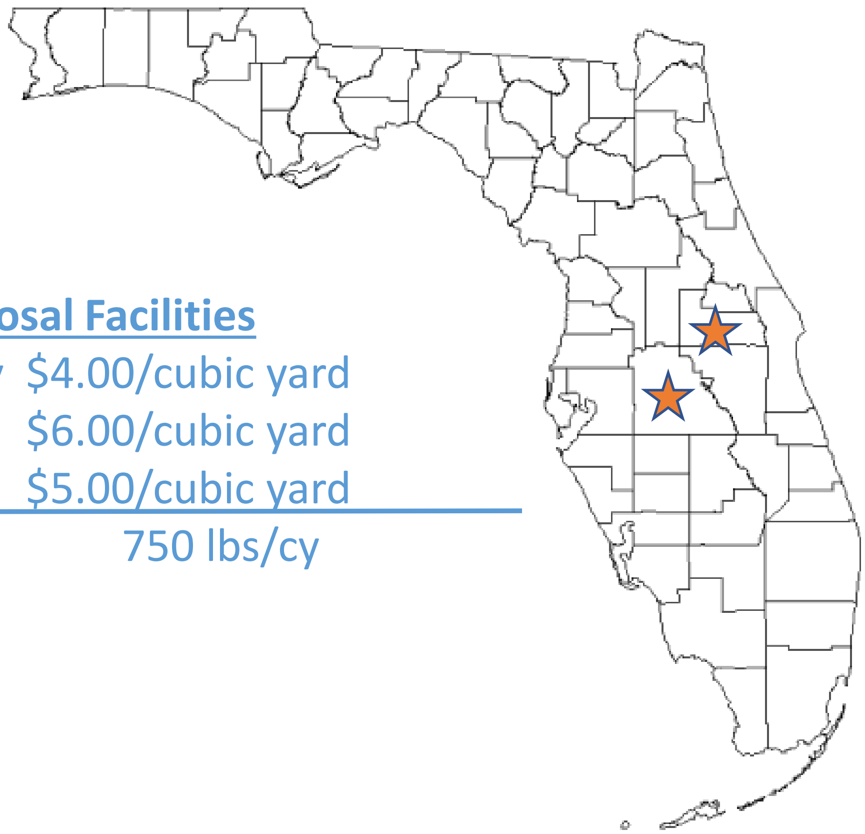


Cost per combusted ton (net of power & metal sales)

Lee County	$43.52/ton
Palm Beach County REF 1	$84.61/ton
Palm Beach County REF 2	$54.55/ton

Average = $60.89/ton

C&D Disposal Facility Costs



Survey of Private Central Florida C&D disposal Facilities

Typical Orange County C&D disposal facility	$4.00/cubic yard
Polk County C&D disposal facility	$6.00/cubic yard
Average	$5.00/cubic yard
C&D bulk density (rolloff container)	750 lbs/cy

C&D Disposal Cost = $13.33/ton

C&D Recycling Facility Costs

Reference	Capacity (tons/year)	Capital Cost ($/ton)	O&M Cost ($/ton)	Recycle Revenue ($/ton)	Net Cost ($/ton)
Texas, 2006 [1]	127,000	0.76	27.75	10 - 14	
Texas, 2006 [1]	127,000	1.00	38.38	10 - 14	
Brazil, 2007 [2]	42,000	0.57	5.80		
Brazil, 2007 [2]	208,000	0.28	4.48		
Arkansas, 2009 [3]	4,000	1.22	152.92	40.21	
Average		**$0.76**	**$45.87**	**$21.49**	**$25.14**

1) *North Central Texas Council of Governments Construction and Demolition Material Recovery Facility Feasibility Study (R.W. Beck, 2007)*
2) *Evaluation of investments in recycling centres for construction and demolition wastes in Brazilian municipalities (Nunes, 2007)*
3) *City of Fayetteville, AK Recycling Program Study (R.W. Beck, 2009)*

Yard Trash Recycling Facility Costs

Reference	Capacity (tons/year)	Capital Cost ($/ton)	O&M Cost ($/ton)	Recycle Revenue ($/ton)	Net Cost ($/ton)
Haaren, 2009 (1)	40,000	6.53	15.92	10 - 31	
Pisarek, 2012 (2)	55,000	3.40	47.54		
Levis, 2013 (3)		2.55	23.61	6.88	
Average		**$4.16**	**$29.02**	**$15.96**	**$17.22**

1) *Large scale aerobic composting of source-separated organic wastes: A comparative study of environmental impacts, costs, and contextual effects (Haaren, 2009)*
2) *Large-scale composting options for YVR : cost analysis" (Pisarek, 2012)*
3) *Composting Process Model Documentation" (Levis, 2013)*

Material Recycling Facility (MRF) Costs

Reference	Type	Capital Cost ($/ton)	O&M Cost ($/ton)	Recycle Revenue ($/ton) [5]	Net Cost ($/ton)
Combs, 2012 [1]	Single Stream		14.50		
GBB, 2008 [2]	Single Stream	42.57	61.27		
Pressley, 2015 [3]	Single Stream	16.28	7.78		
R.W. Beck, 2009 [4]	Single Stream	7.55	124.52		
Average		**$22.13**	**$52.02**	**$98.41**	**$(24.26)**
Combs, 2012 [1]	Dual Stream		9.30		
Pressley, 2015 [3]	Dual Stream	15.83	6.54		
R.W. Beck, 2009 [4]	Dual Stream	7.82	121.14		
SWA of Palm Beach	Dual Stream	$127			
Average		**$91.81**		**$98.41**	**$(6.60)**

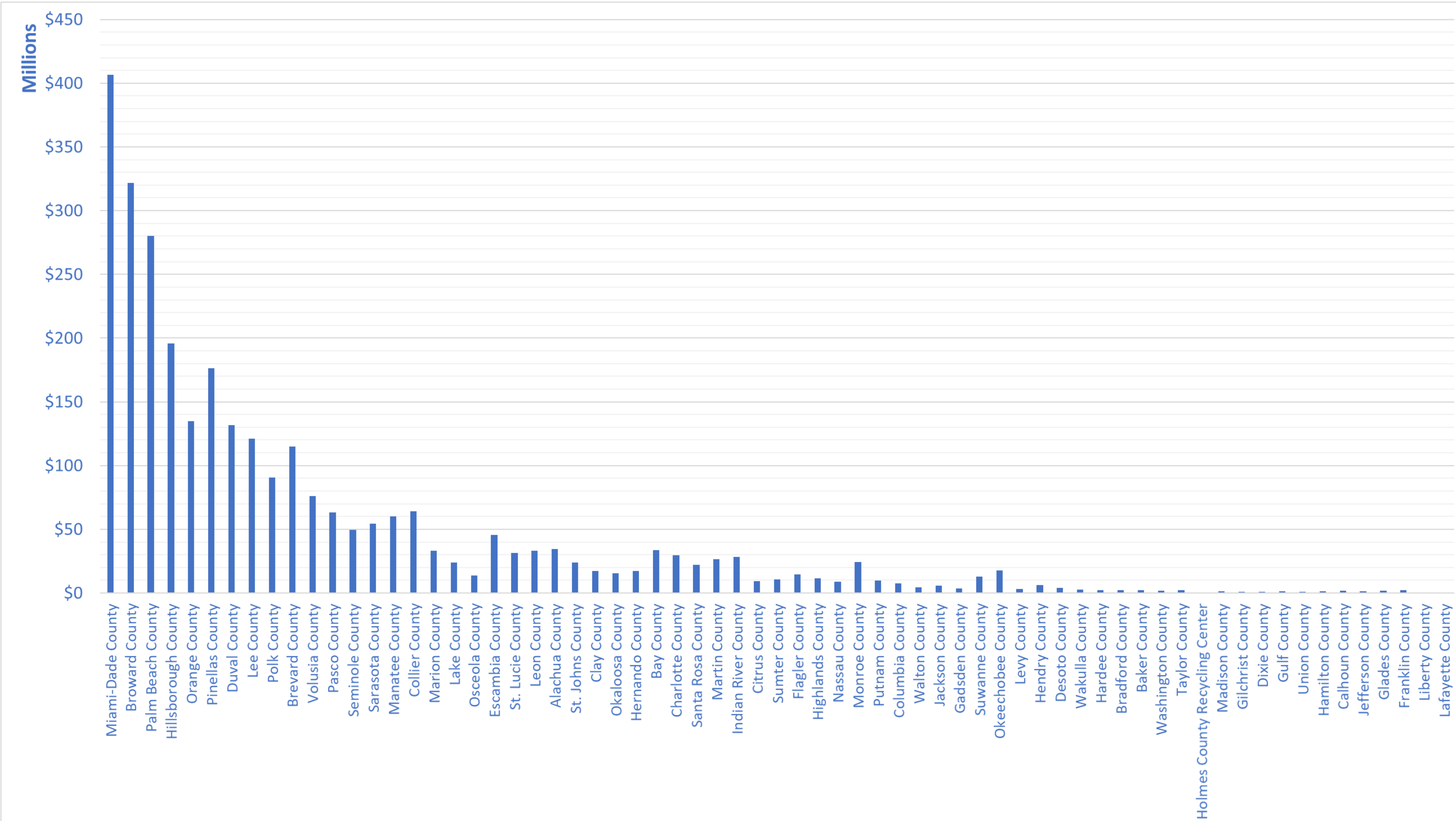
Average statewide cost = 0.7 x $(24.26) + 0.3 x $(6.60) = $ (18.96)

1) *Life Cycle Analysis of Recycling Facilities in a Carbon Constrained World (Combs, 2012))*
2) *Materials Recovery Facility Feasibility Report" (Gershman, Brickner & Bratton, Inc., 2008)*
3) *Analysis of material recovery facilities for use in life-cycle assessment (Pressley, 2015)*
4) *City of Fayetteville, AK Recycling Program Study (R.W. Beck, 2009)*
5) *Component Cost Summary (SWA of Palm Beach County, 2016)*

Florida Solid Waste Management Costs

	Tons	$/ton	Cost
Residential Collection	12,352,407	$ 88.70	$ 1,095,658,501
Non-Residential Collection	9,156,042	$ 83.73	$ 766,635,397
Yard Trash Collection	4,590,265	$ 88.70	$ 407,156,506
C&DD Collection	11,302,678		$ -
Subtotal Collection	**37,401,392**		**$ 2,269,450,403**
Recycled (MRF)	5,917,287	$ (18.96)	$ (112,191,753)
Yard Trash Recycled	3,210,669	$ 17.22	$ 55,287,728
C&DD Recycled	6,765,707	$ 25.14	$ 170,089,874
C&DD Disposed	4,536,971	$ 13.33	$ 60,477,823
MSW Combusted (WTE)	4,513,600	$ 60.89	$ 274,833,104
WTE Ash Landfilled	1,448,968	$ 20.00	$ 28,979,360
WTE Metals Recycled	502,733		$ -
MSW Landfilled	10,505,457	$ 20.00	$ 210,109,140
Subtotal	**37,401,392**		**$ 687,585,277**
Total			**$ 2,957,035,680**

Florida Solid Waste Management Costs



Florida Transfer Station Tonnage

Transfer Station Name	City	County	Year	Tonnage
GAINESVILLE SOLID WASTE MANAGEMENT FACILITY	GAINESVILLE	ALACHUA	2014	178,000
CENTRAL TRANSFER STATION	MIAMI	MIAMI-DADE	2016	152,958
NORTHEAST DADE TRANSFER STATION	N MIAMI BEACH	MIAMI-DADE	2016	192,365
WEST DADE TRANSFER STATION	MIAMI	MIAMI-DADE	2016	241,757
KEY WEST TRANSFER STATION AND HAULING SERVICE INC	KEY WEST	MONROE		48,793
SWA CENTRAL COUNTY TRANSFER STATION	LANTANA	PALM BEACH	2014	374,811
NORTH COUNTY TRANS STA (JUPITER)	JUPITER	PALM BEACH	2014	210,026
SWA WEST CENTRAL TRANSFER STATION	ROYAL PALM BEACH	PALM BEACH	2014	272,720
SWA WEST COUNTY TRANSFER STATION	BELLE GLADE	PALM BEACH	2014	31,166
SWA SOUTH COUNTY TRANS STA (DELRAY BCH)	DELRAY BEACH	PALM BEACH	2014	189,976
SWA SOUTHWEST COUNTY TRANSFER STATION (TS)	Delray Beach	PALM BEACH	2014	173,376
Average Tonnage (tons/yr)				**187,813**

# FDEP Permitted Transfer Stations	99
Average Annual Tonnage	187,813 tons
Estimated total transfer station tonnage	**18,593,532 tons**

Transfer Station Costs

Reference	Capacity (tons/year)	Capital Cost ($/ton)	O&M Cost ($/ton)	Total Cost ($/ton)
Jacksonville, 2011 (1)	260,000	1.48	3.59	
Jacksonville, 2011 (1)	390,130	1.42	3.59	
Jacksonville, 2011 (1)	552,630	1.38	3.59	
Clark County, 2016 (2)	51,508	3.66	9.27	
Clark County, 2016 (2)	136,512	1.85	5.79	
Albuquerque NM, 2014 (3)	520,000	1.35	5.85	
Average		**1.86**	**5.28**	**7.14**
Alachua Co FL, 2016 (4)	181,606			10.00
Clay Co. FL, 2016 (5)	131,000			16.77
Average				**11.30**

1) *City of Jacksonville Transfer Station Preliminary Feasibility Study Update" (Kessler Consulting, Inc. , 2011)*
2) *Clark county solid waste district transfer facility feasibility study final report" (GT environmental, inc. , 2016)*
3) *Addendum, Albuquerque Transfer Station Feasibility Analysis" (J.R. Miller & Associates , 2014)*
4) *Alachua County Solid Waste Management 2016 Fund Data*
5) *Clay County Solid Waste Management 2016 Fund Data*

Transfer Hauling Costs

Assume:
70-mile round-trip
22 tons per load

Transportation cost = 70 miles per load x $1.59 per mile / 22 miles per load = $5.06/ton

Alachua County 2016 transportation cost = $8.83

Average Hauling Cost: $6.95/ton
Transfer Station Cost: $11.30/ton
Total Transfer Cost: $18.25/ton

Table 10: Average Marginal Costs per Mile, 2008-2015

Motor Carrier Costs	2008	2009	2010	2011	2012	2013	2014	2015
Vehicle-based								
Fuel Costs	$0.633	$0.405	$0.486	$0.590	$0.641	$0.645	$0.583	$0.403
Truck/Trailer Lease or Purchase Payments	$0.213	$0.257	$0.184	$0.189	$0.174	$0.163	$0.215	$0.230
Repair & Maintenance	$0.103	$0.123	$0.124	$0.152	$0.138	$0.148	$0.158	$0.156
Truck Insurance Premiums	$0.055	$0.054	$0.059	$0.067	$0.063	$0.064	$0.071	$0.092
Permits and Licenses	$0.016	$0.029	$0.040	$0.038	$0.022	$0.026	$0.019	$0.019
Tires	$0.030	$0.029	$0.035	$0.042	$0.044	$0.041	$0.044	$0.043
Tolls	$0.024	$0.024	$0.012	$0.017	$0.019	$0.019	$0.023	$0.020
Driver-based								
Driver Wages	$0.435	$0.403	$0.446	$0.460	$0.417	$0.440	$0.462	$0.499
Driver Benefits	$0.144	$0.128	$0.162	$0.151	$0.116	$0.129	$0.129	$0.131
TOTAL	**$1.653**	**$1.451**	**$1.548**	**$1.706**	**$1.633**	**$1.676**	**$1.703**	**$1.593**

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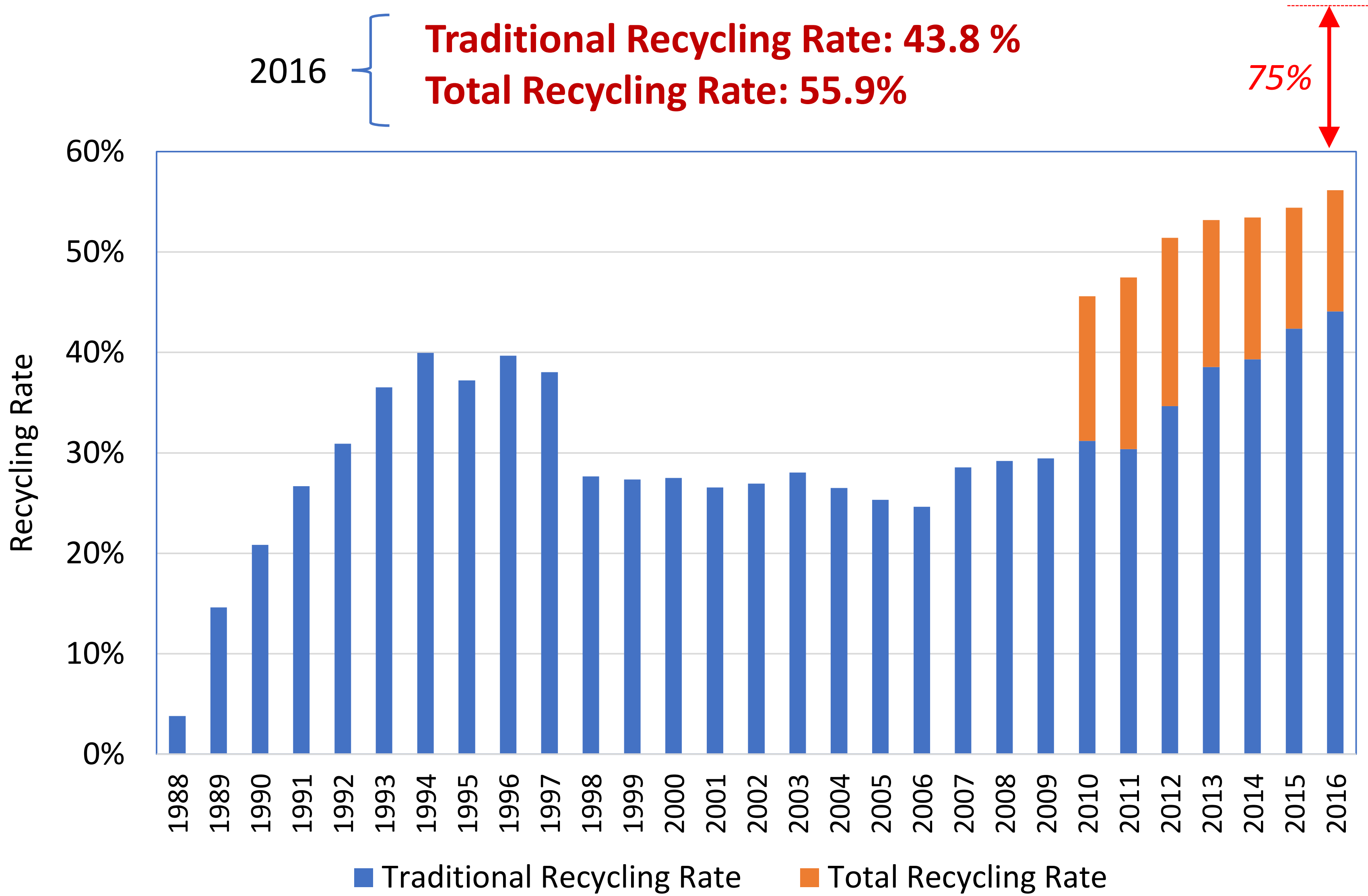
Subtotal	**37,401,392**		**$ 687,585,277**
Transfer Station	**18,593,532**	**$ 18.25**	**$ 339,331,959**
Total			**$ 3,296,367,639**

Discussion of Costs

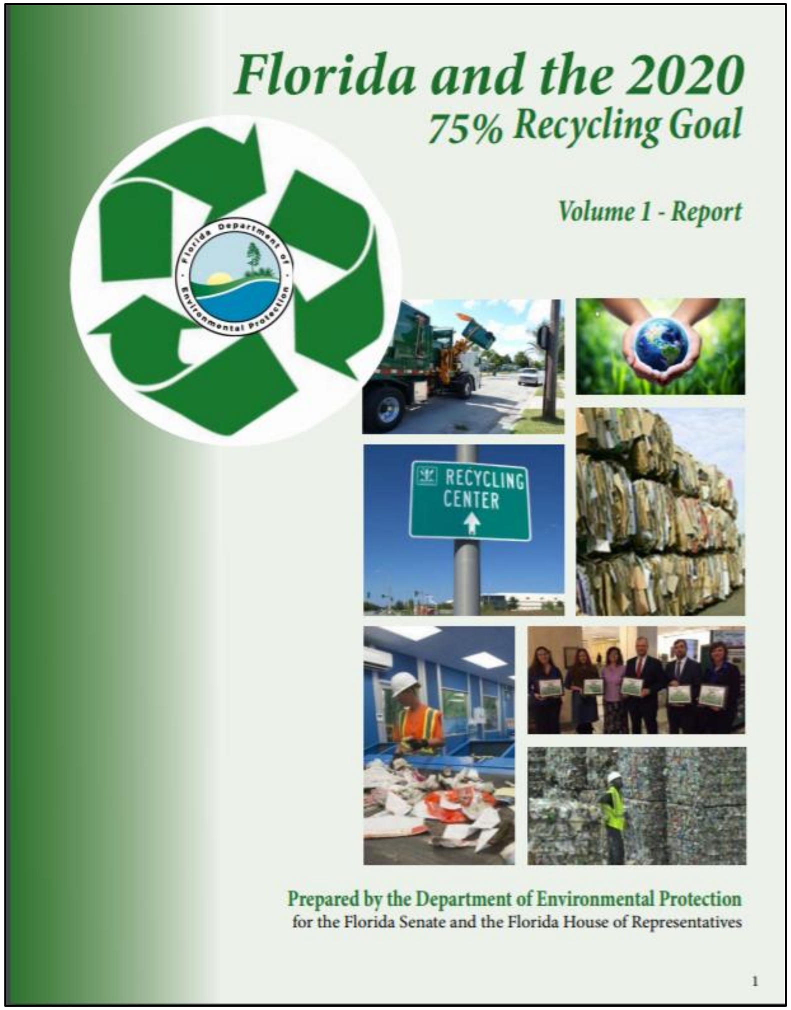
Getting to 75%

Florida Historic Recycling Rates



Where are we now?

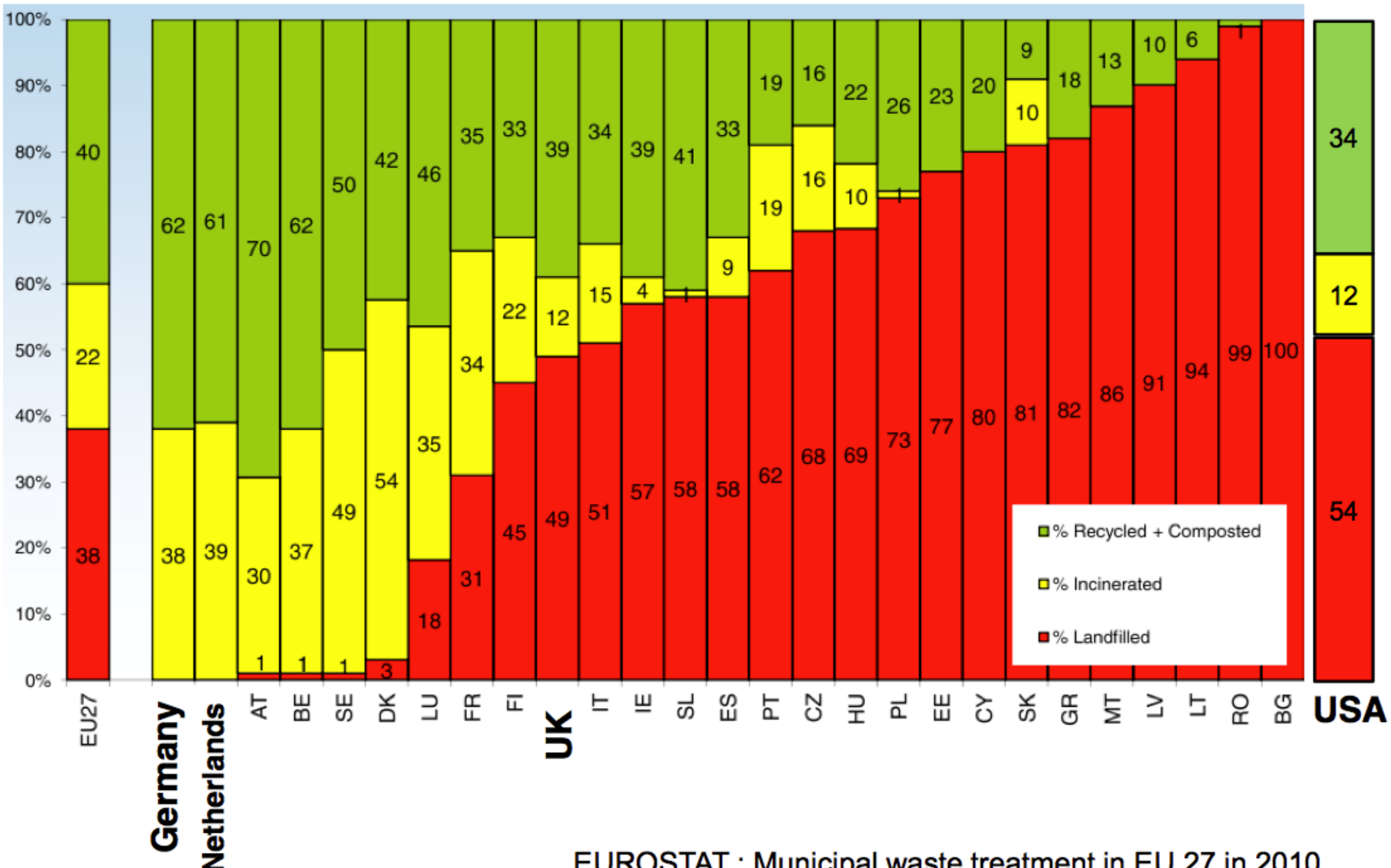
- FDEP submitted a report to the legislature
  - Discusses single stream recycling, markets, C&D, organics, and commercial recycling, education and outreach, and sustainable materials management, and options
  - Are we on track?



FDEP Report to the Legislature (Dec. 2017)
https://floridadep.gov/waste/waste-reduction/documents/florida-and-2020-75-recycling-goal

Can 75% be Reached?

Global MSW Management

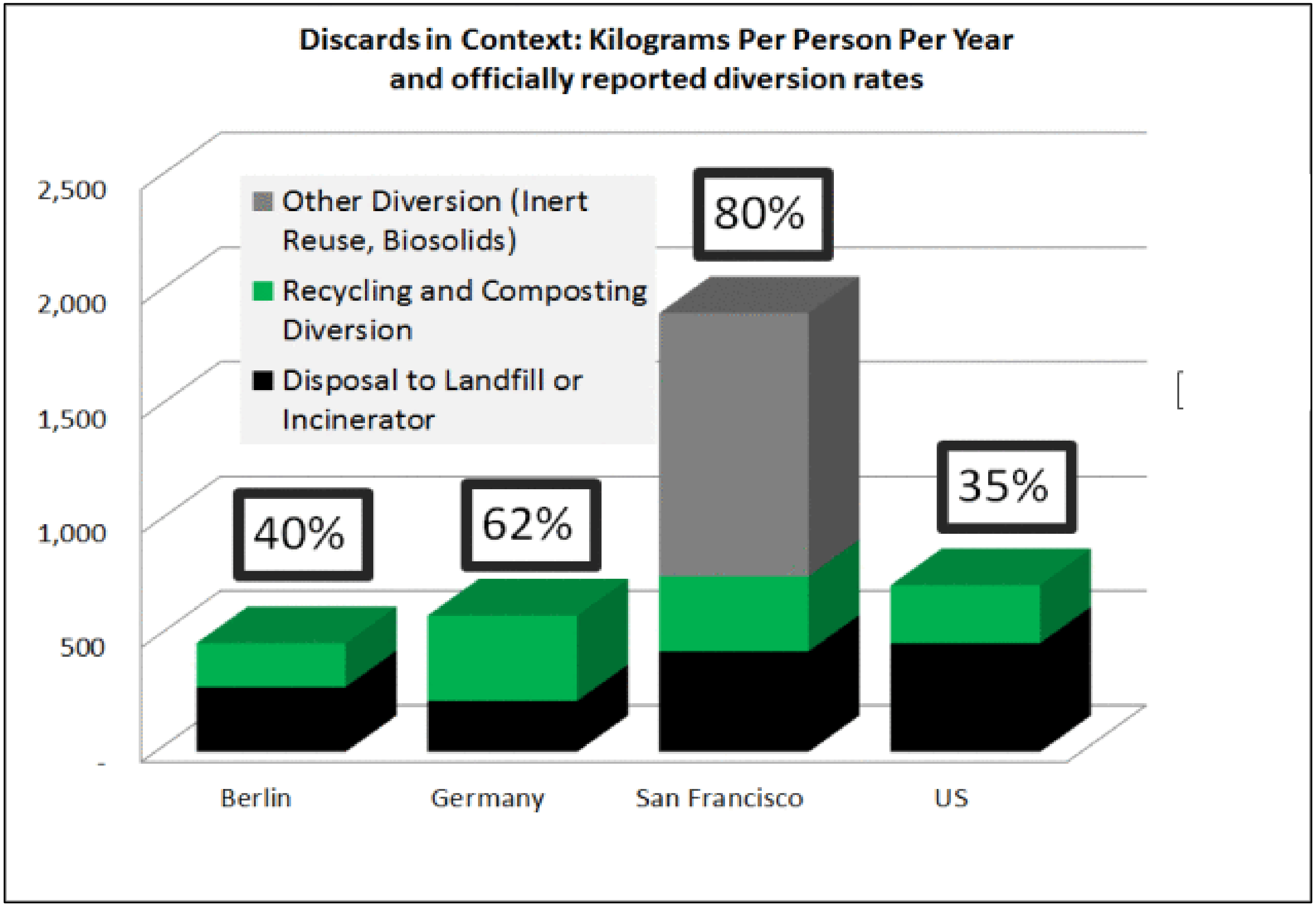


EUROSTAT : Municipal waste treatment in EU 27 in 2010

Reported Recycling Rates Across the US

Location	Recycling Rate	Comment
San Francisco, CA	80%	Zero Waste Policies, ban on disposable plastic bas, mandatory recycling and composting
Los Angeles, CA	76%	Planning and implementation of programs to achieve the 2025 zero waste to landfill goal
Portland, OR	70%	Aggressive recycling and waste diversion program that requires more labor which increases the cost per ton of collecting MSW
San Antonio, TX	29%	Pilot Program for organic waste that focuses on composting
NYC, NY	19%	Low rate due to inefficiencies related to the performance of private companies
Atlanta, GA	12.5%	New residential recycling programs, “Cartlanta Program”
Chicago, IL	9%	Lack of recycling interest and public participation

How do we compare?



San Francisco's Famous 80% Waste Diversion Rate: Anatomy of an Exemplar
https://discardstudies.com/2013/12/06/san-franciscos-famous-80-waste-diversion-rate-anatomy-of-an-exemplar/

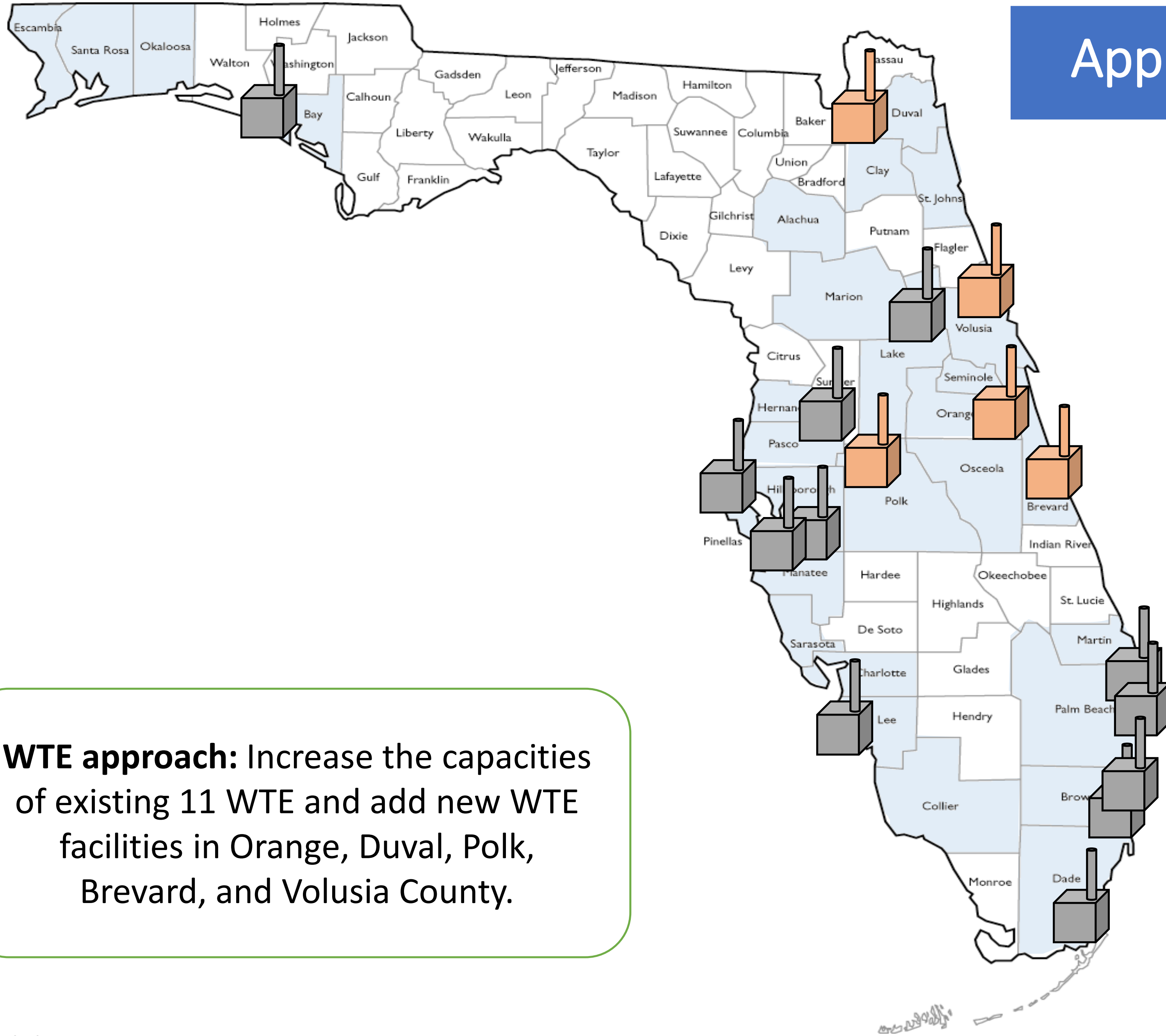
Let’s look at some potential technology shifts in the Florida solid waste industry and how they would move the needle with respect to Florida’s recycling rate.

Possible Changes to Florida's Solid Waste Management Approach

1. Waste-to-Energy (WTE) Approach
2. Mixed Waste Processing (MWP) Approach
3. Mandatory Residential Curbside Recycling Approach
4. Mandatory Construction & Demolition Debris (C&D) and Yard Trash (YT) Recycling Approach
5. Mandatory Non-Residential Food Waste Composting Approach

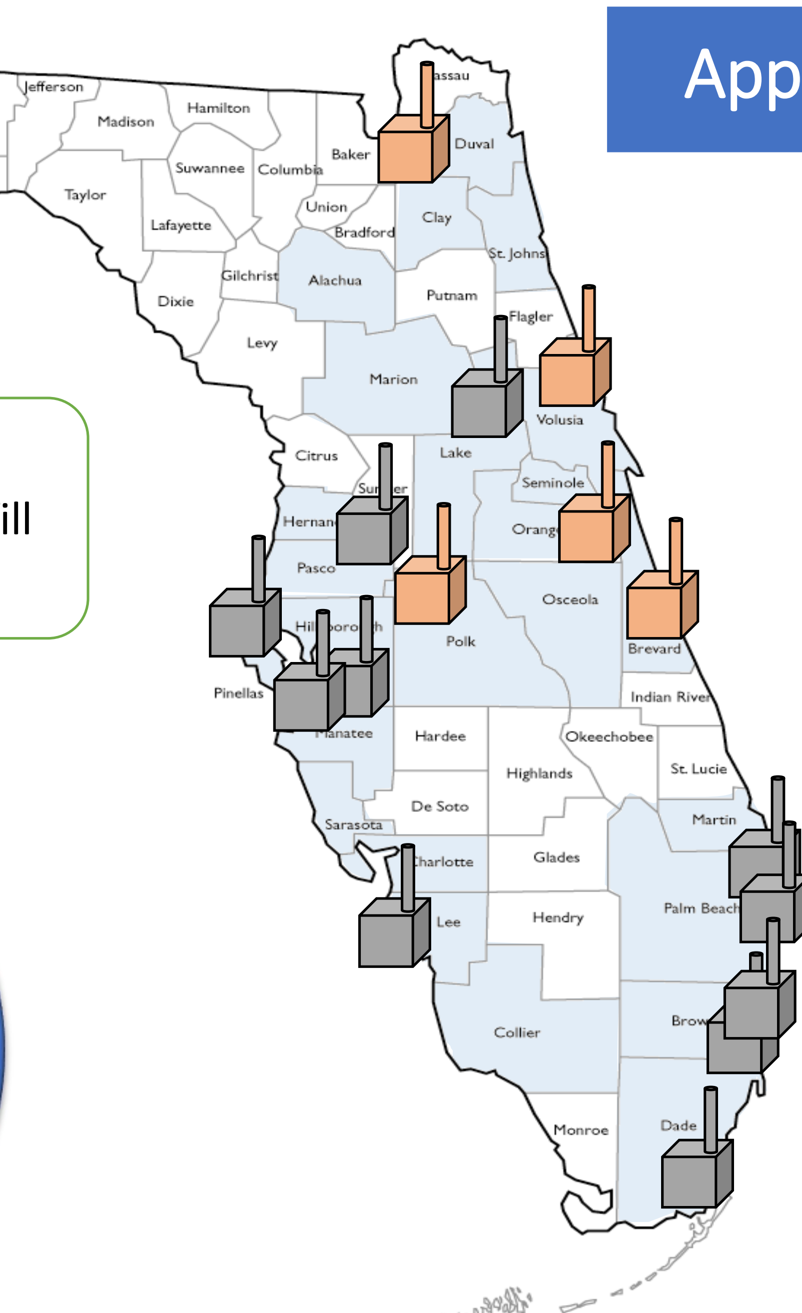
NOTE: Applied only to counties with populations of 150,000+

Approach 1



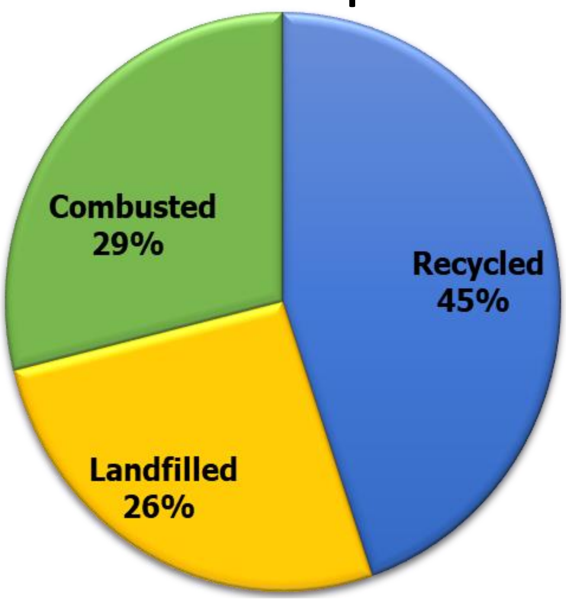
WTE approach: Increase the capacities of existing 11 WTE and add new WTE facilities in Orange, Duval, Polk, Brevard, and Volusia County.

Approach 1

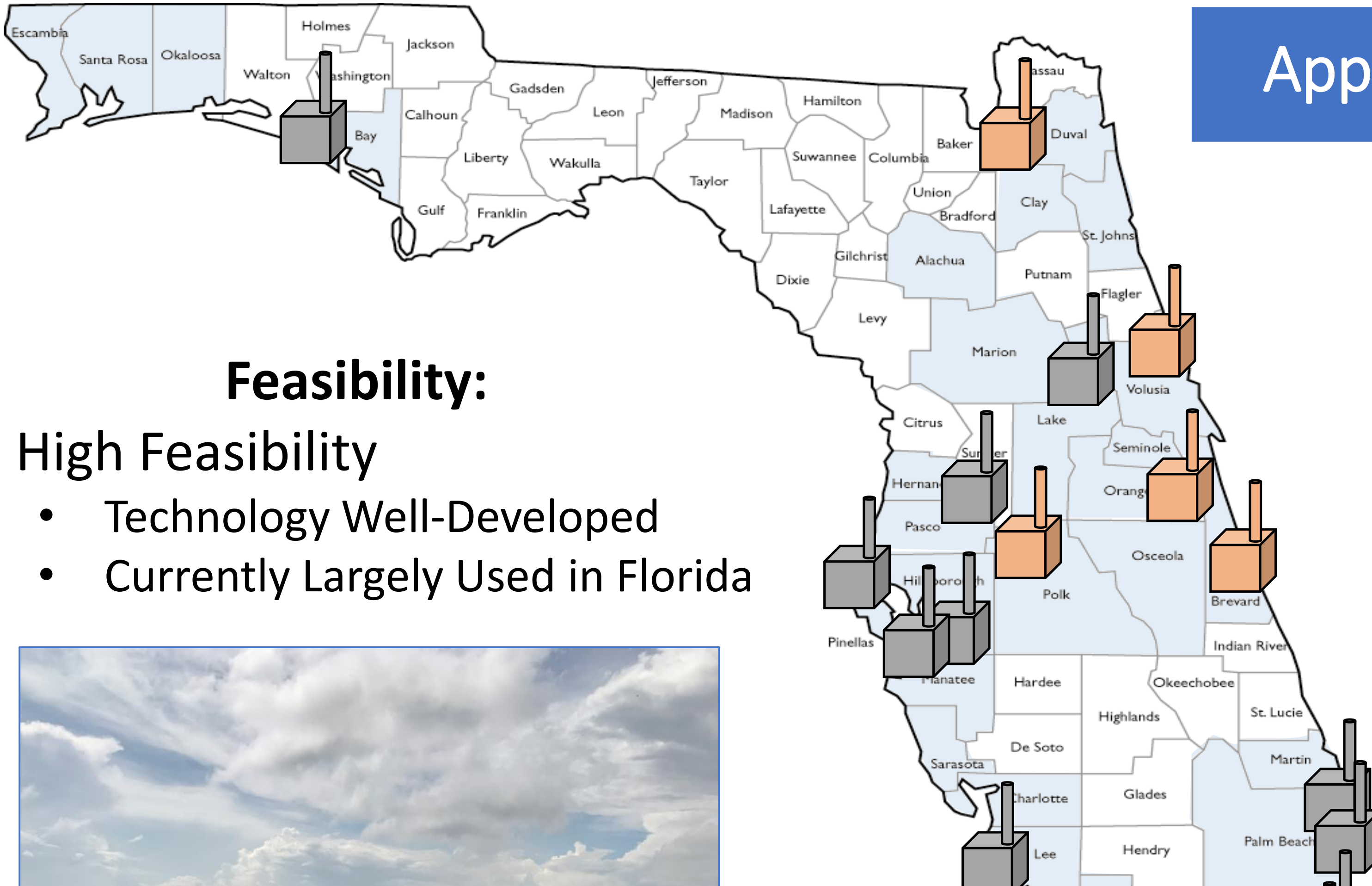


WTE approach: The increased capacity results in a target landfill rate of 2.6% in those counties.

Total State Disposition



Approach 1



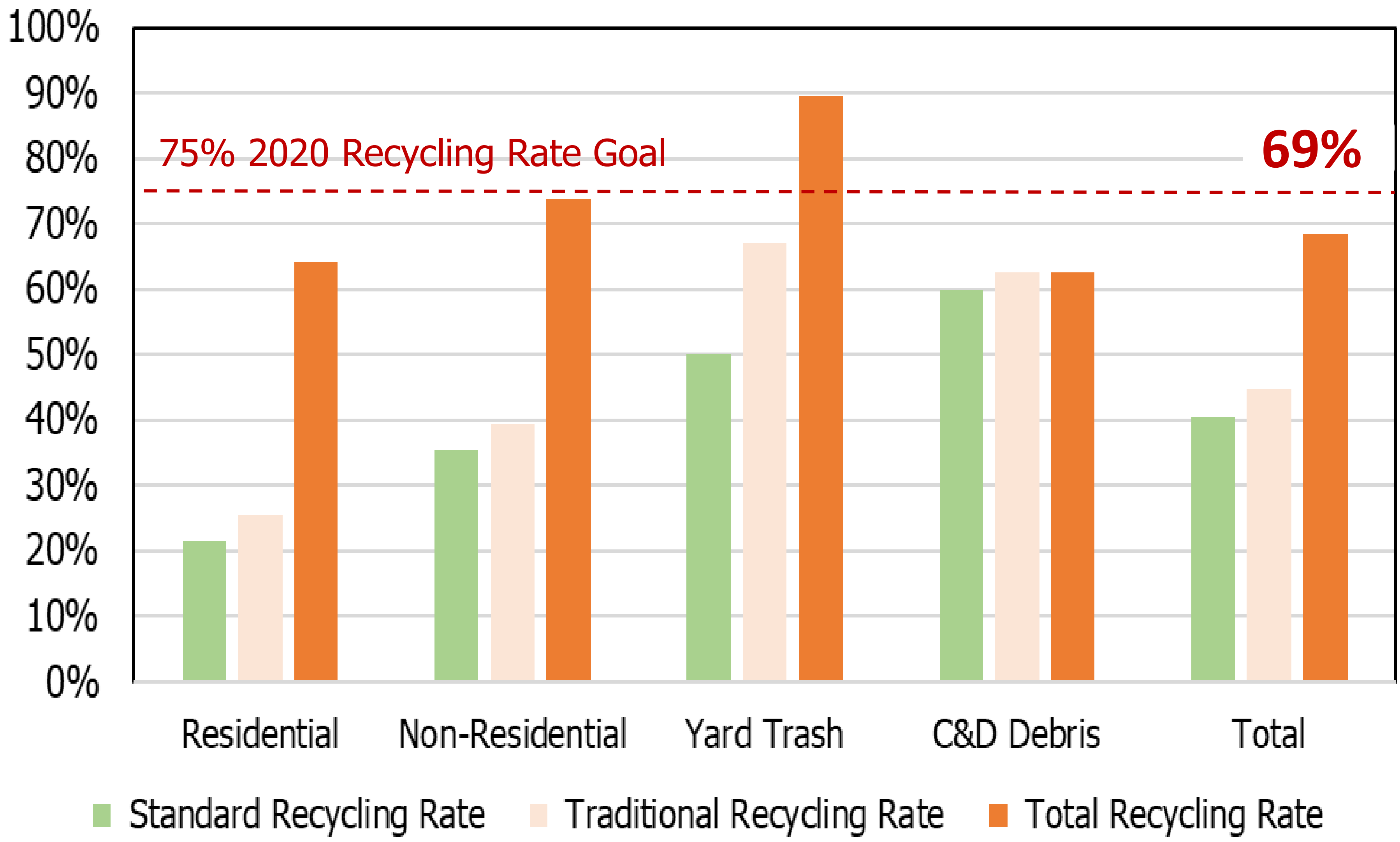
Feasibility:

- High Feasibility
  - Technology Well-Developed
  - Currently Largely Used in Florida

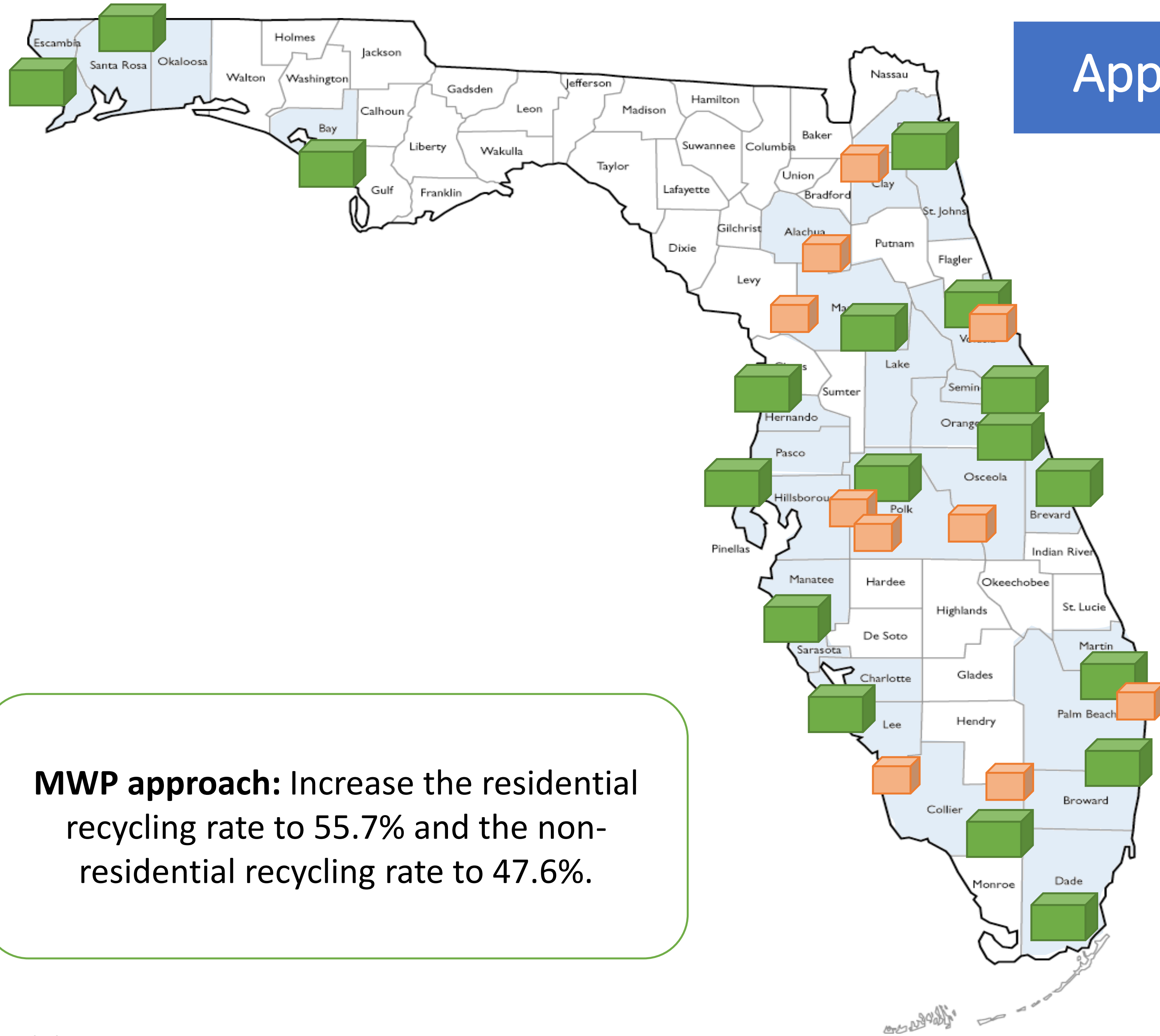
WTE Facility in Palm Beach County, FL

Total Recycling Rate= +13.1%

Approach 1

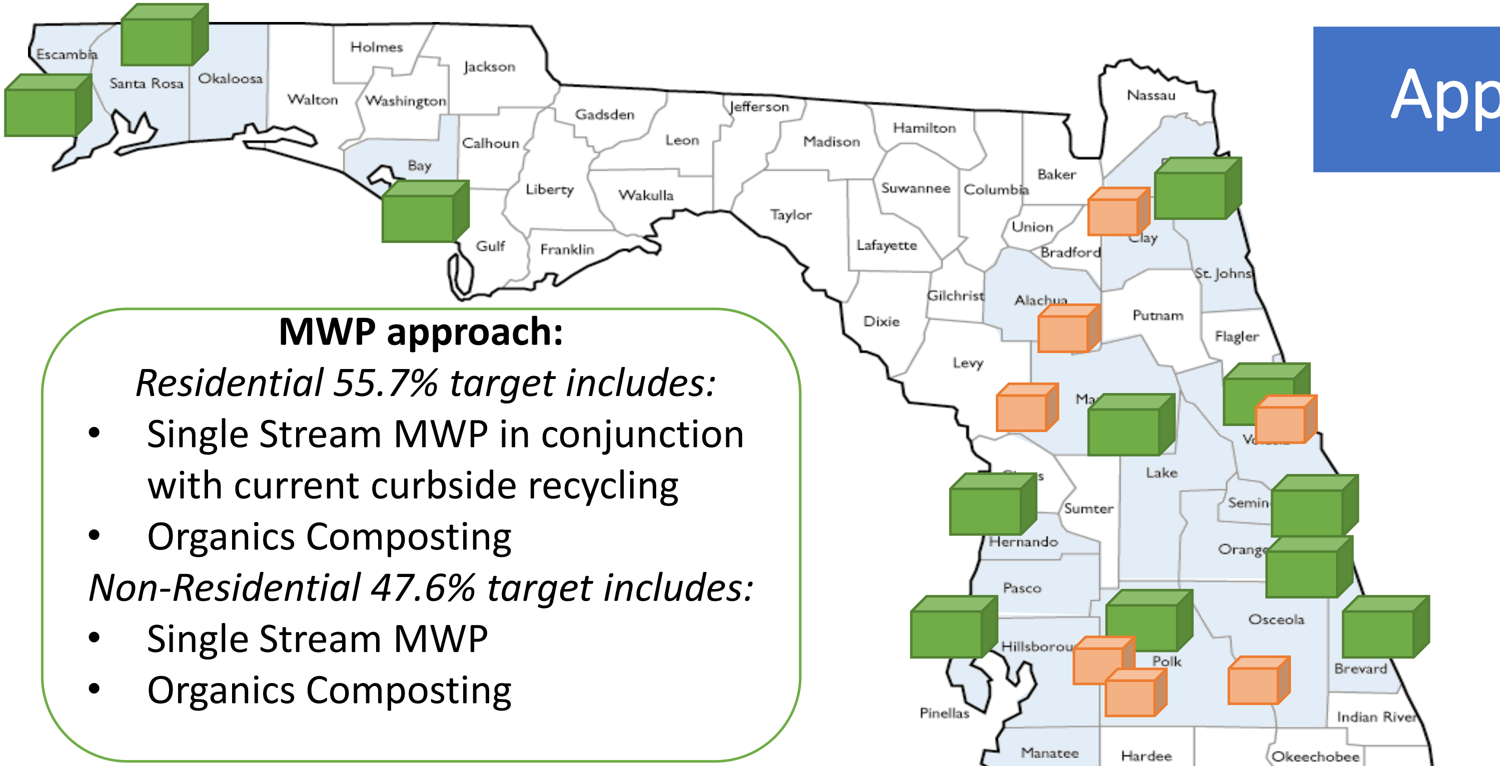
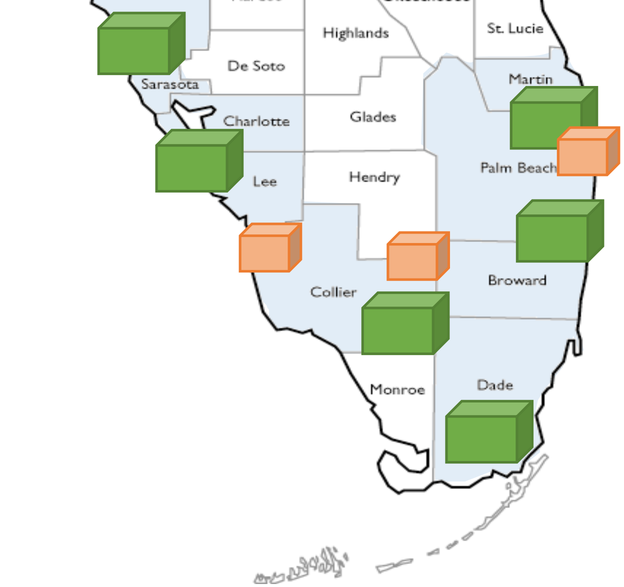


Approach 2



MWP approach: Increase the residential recycling rate to 55.7% and the non-residential recycling rate to 47.6%.

Approach 2

MWP approach:

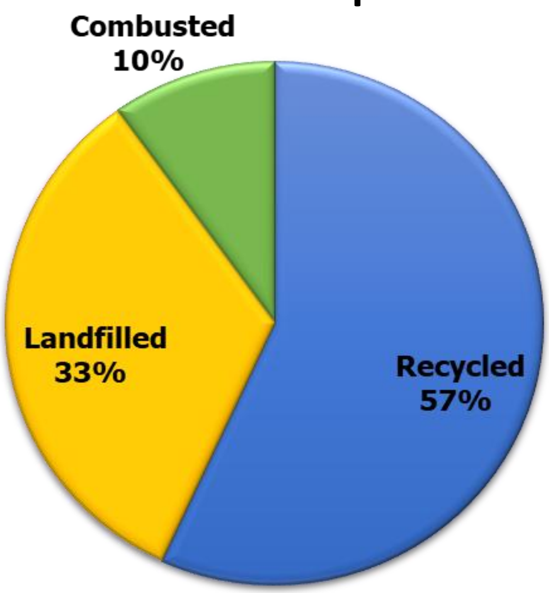
Residential 55.7% target includes:

- Single Stream MWP in conjunction with current curbside recycling
- Organics Composting

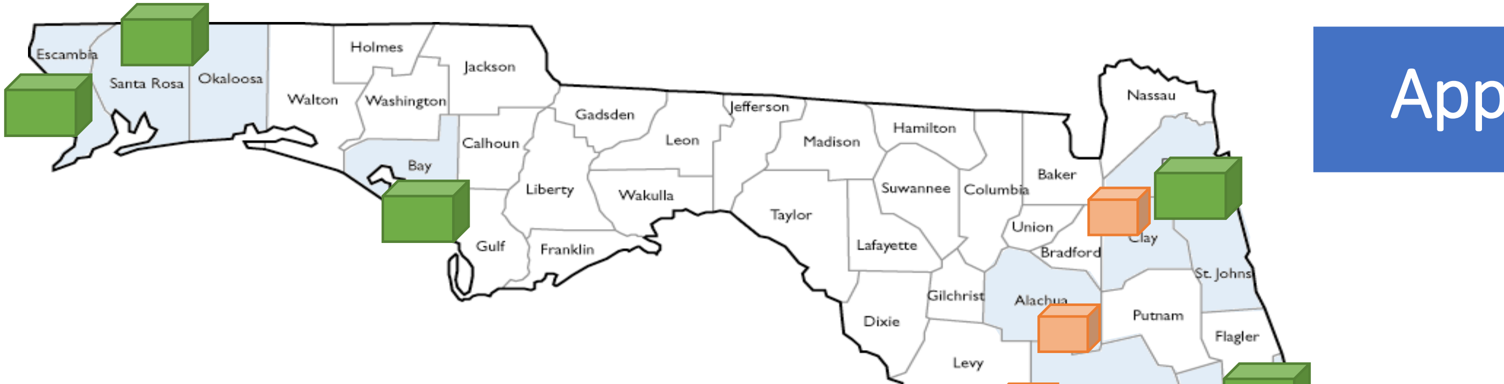
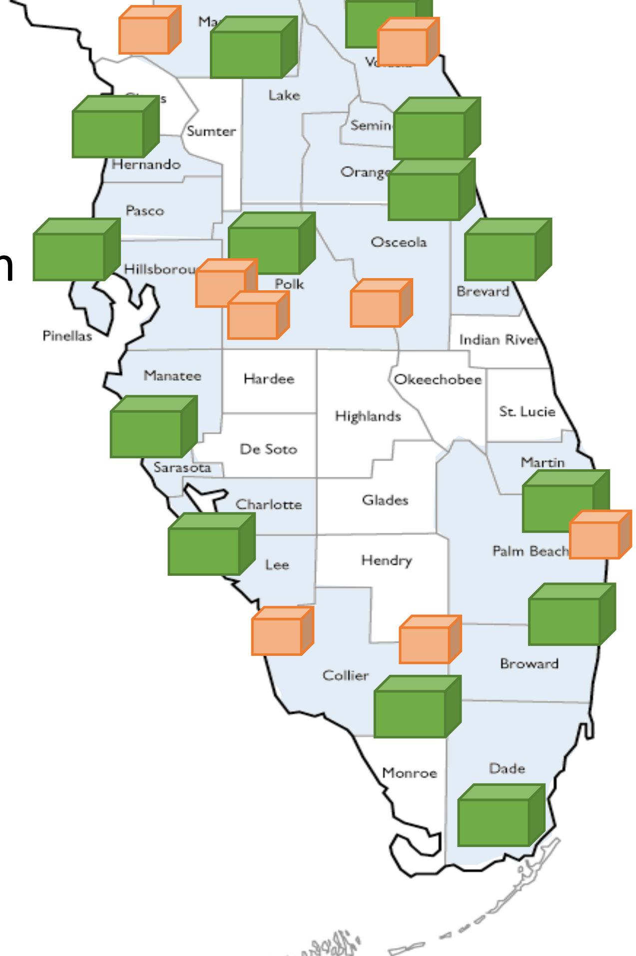
Non-Residential 47.6% target includes:

- Single Stream MWP
- Organics Composting

Total State Disposition



Approach 2

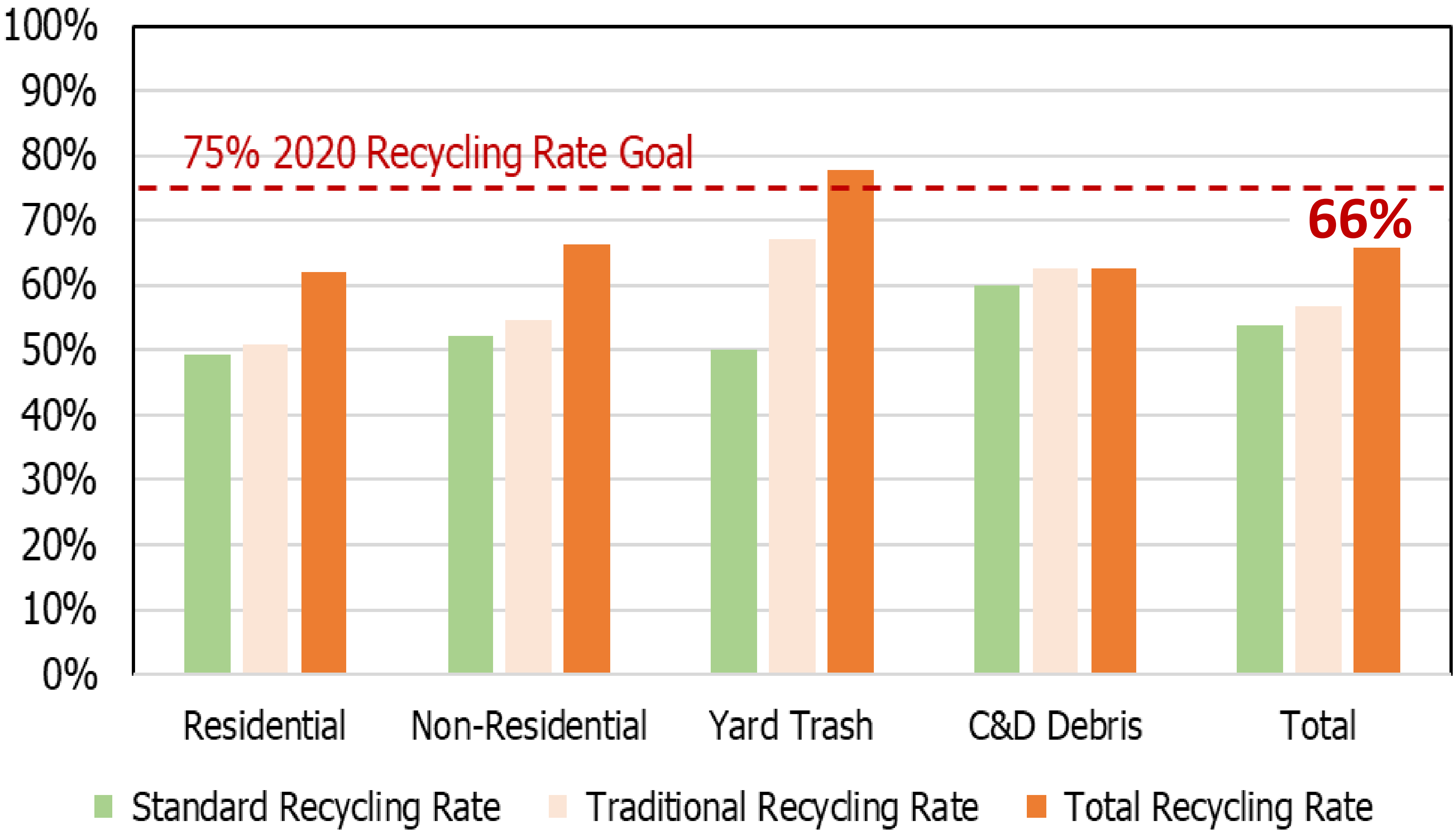
Feasibility:

- Questionable Feasibility
  - Not currently used Florida
  - Large investment across the nation

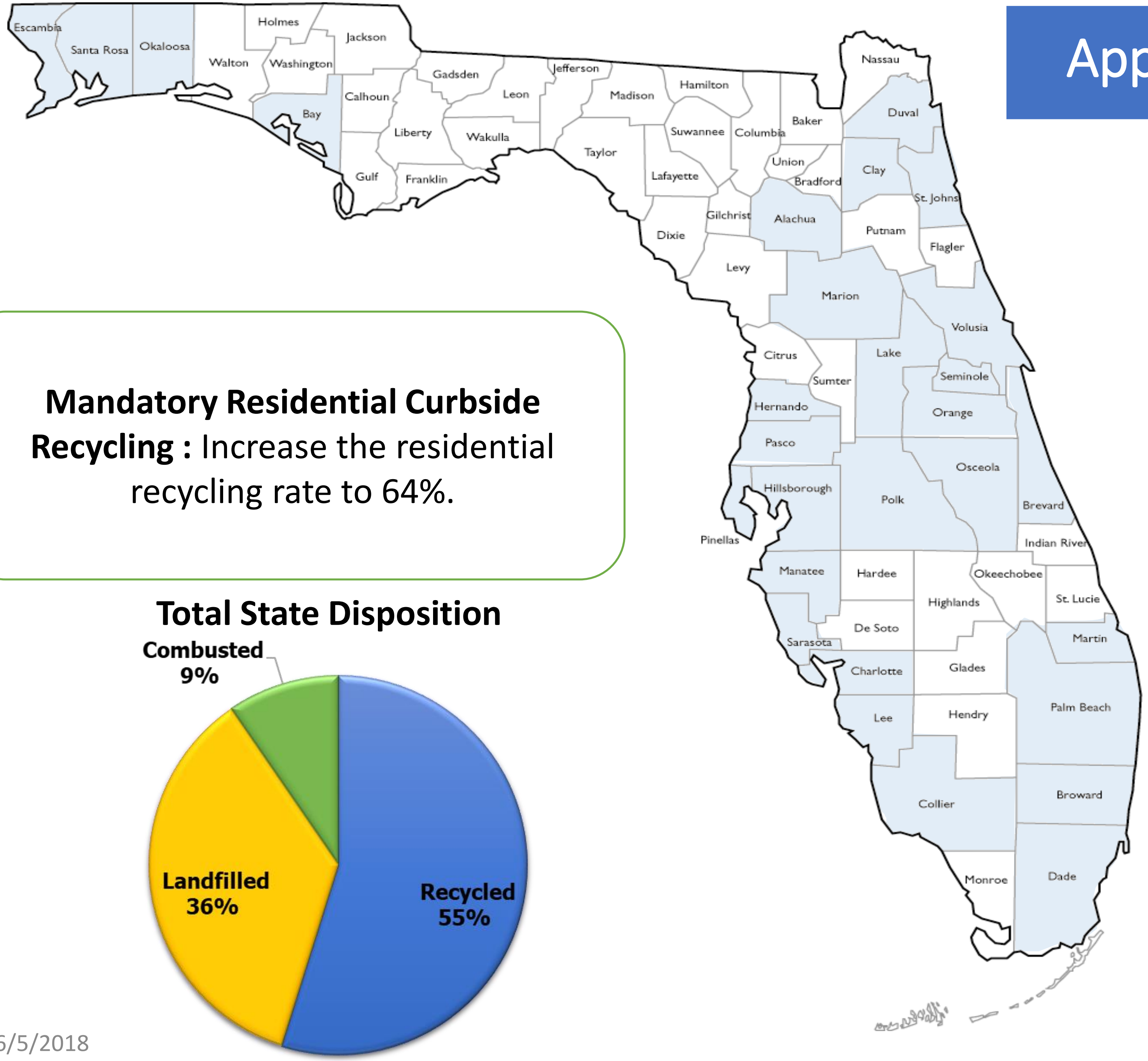
Mixed Waste Processing Facility in Santa Clara, CA

Approach 2

Total Recycling Rate= +10.4%



Approach 3



Mandatory Residential Curbside Recycling : Increase the residential recycling rate to 64%.

Total State Disposition

Approach 3

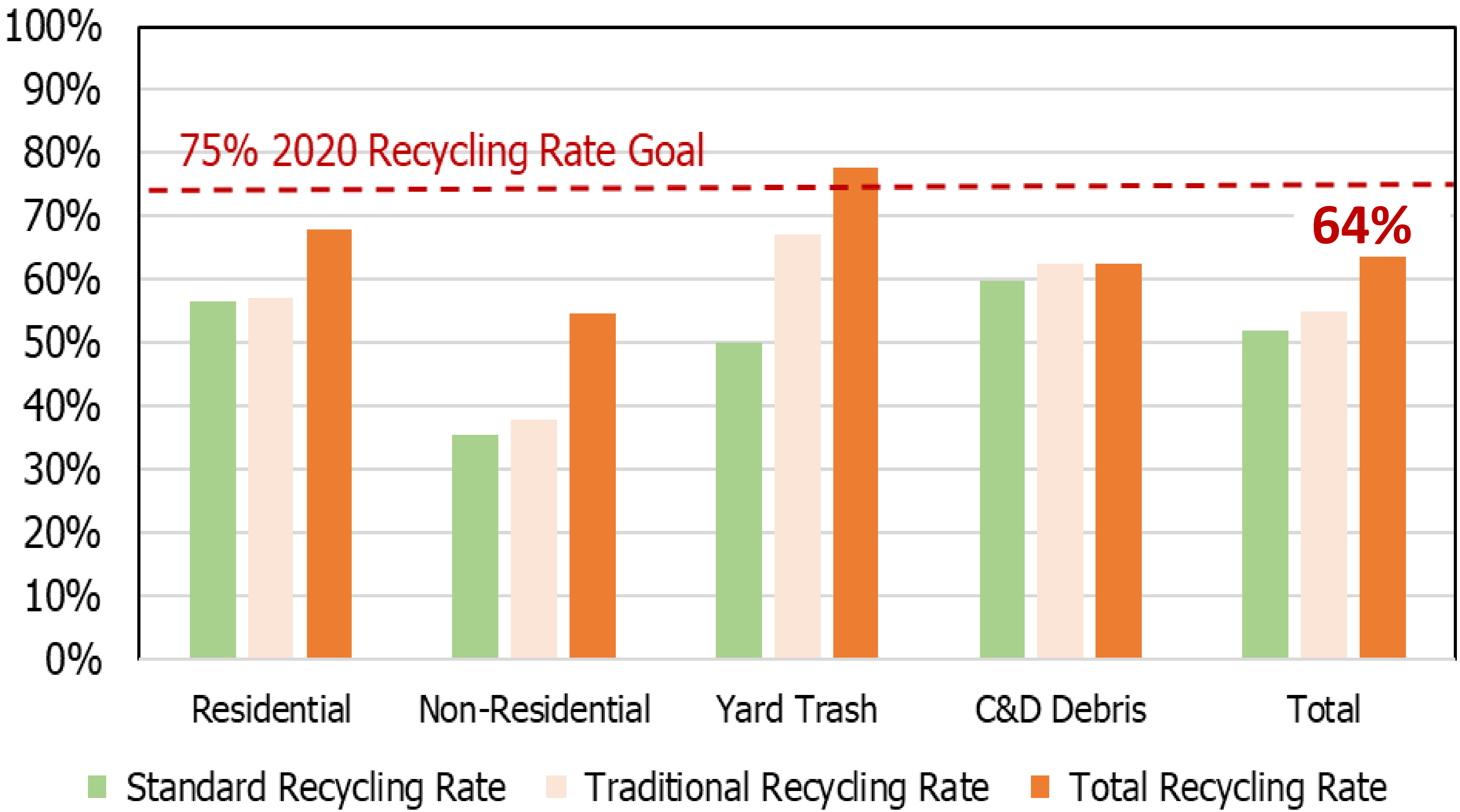

Feasibility:

- Feasible since no technological challenges but challenges faced from citizens

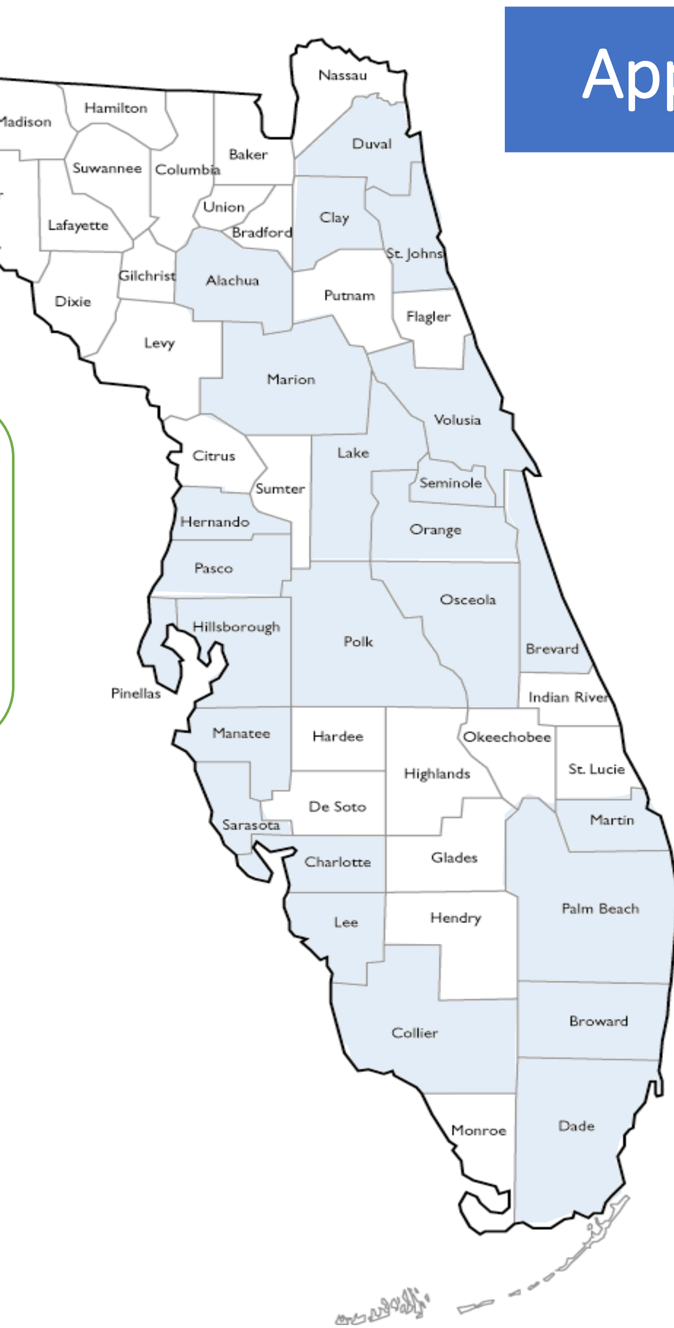
Single Stream MRF in Tallahassee

Total Recycling Rate= +8.12%

Approach 3

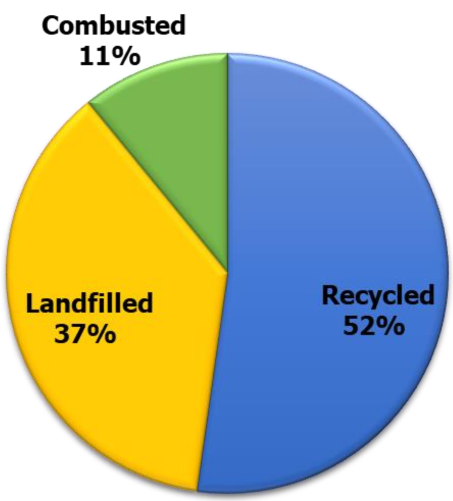


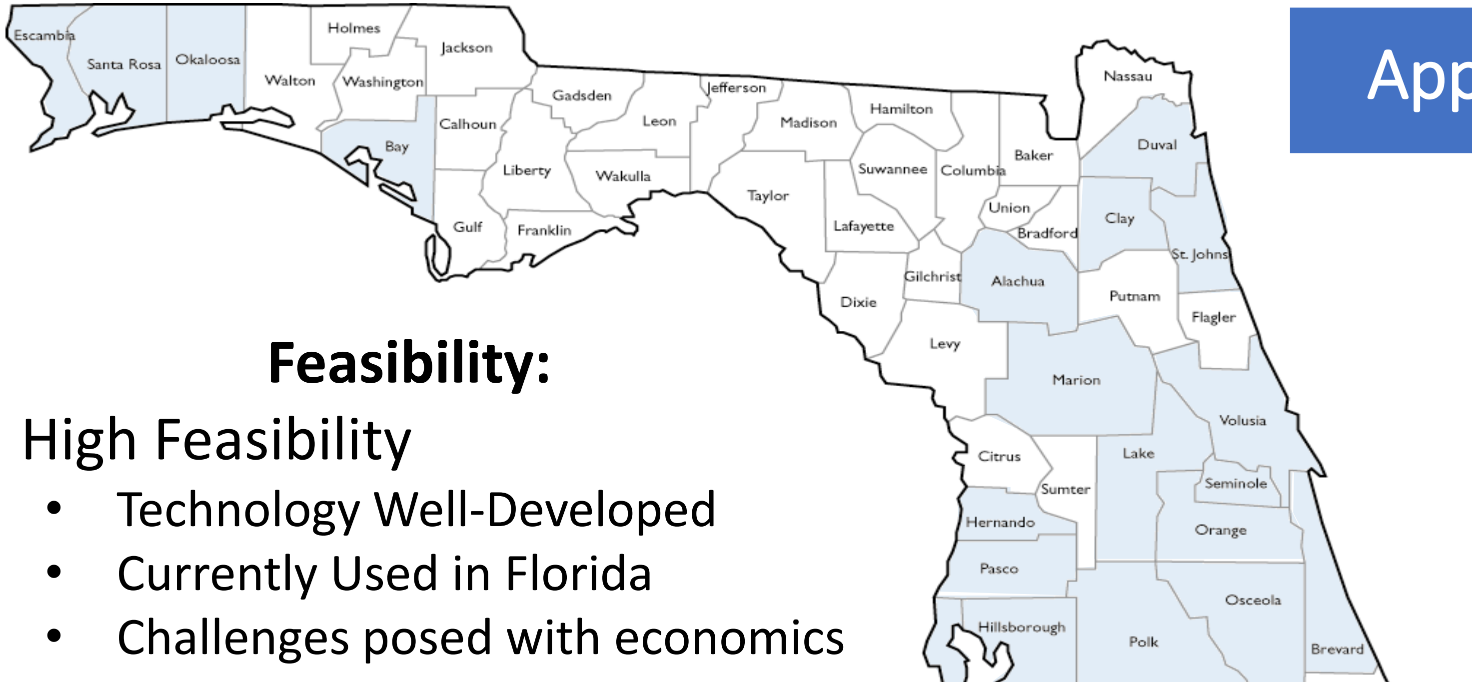
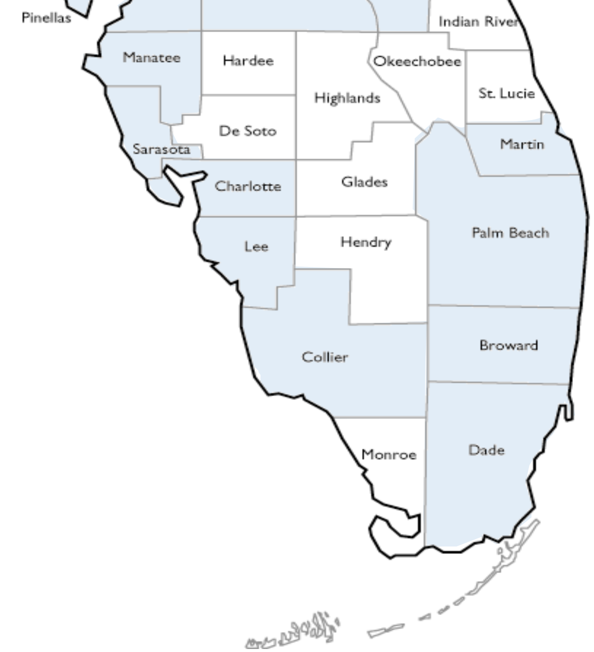
Approach 4

Mandatory C&D and YT Recycling Approach: Increase C&D recycling to 76.5% and YT recycling to 97%.

Total State Disposition



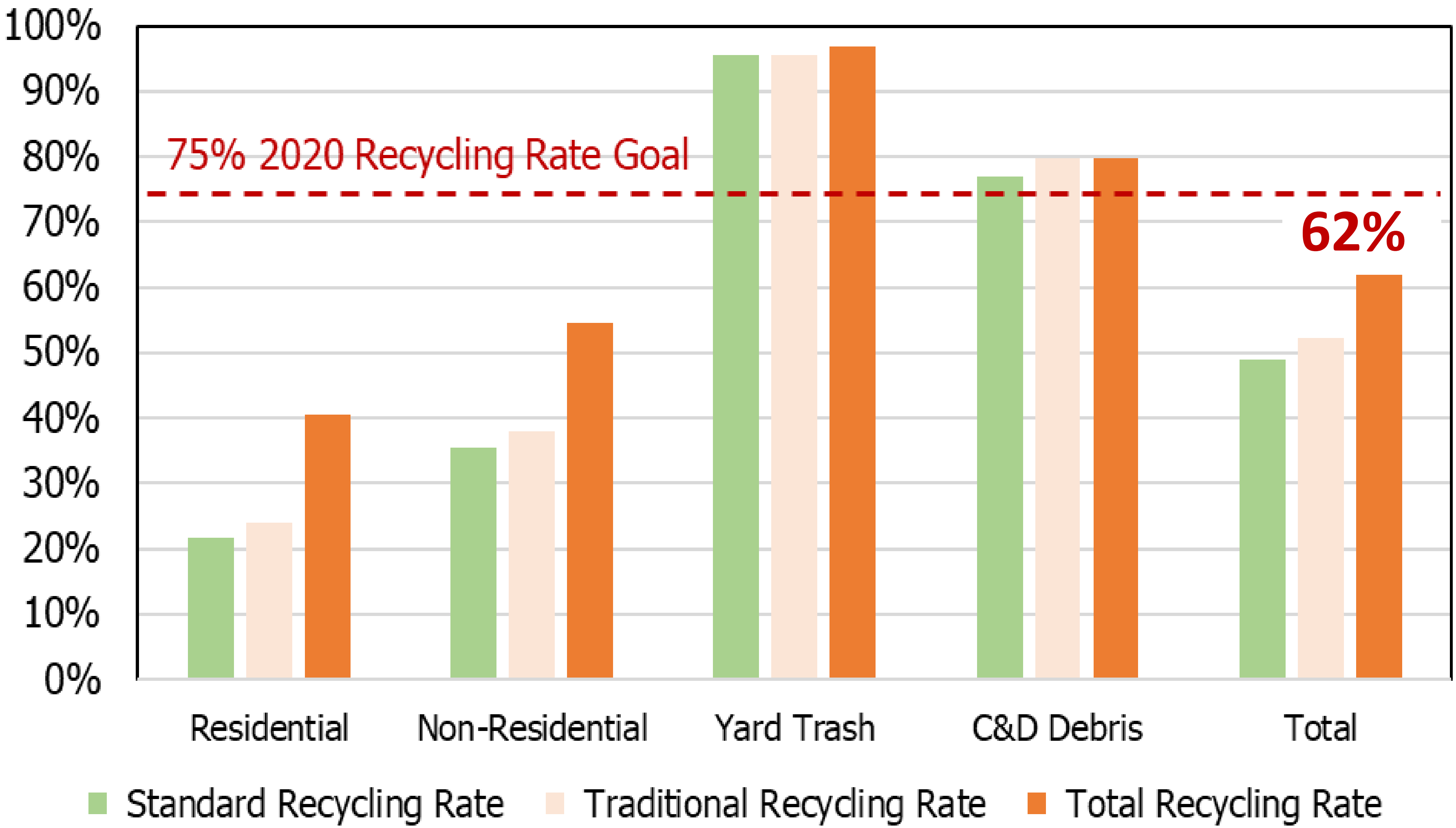
Approach 4

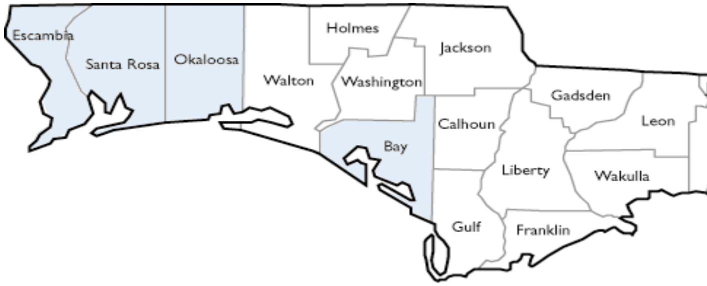
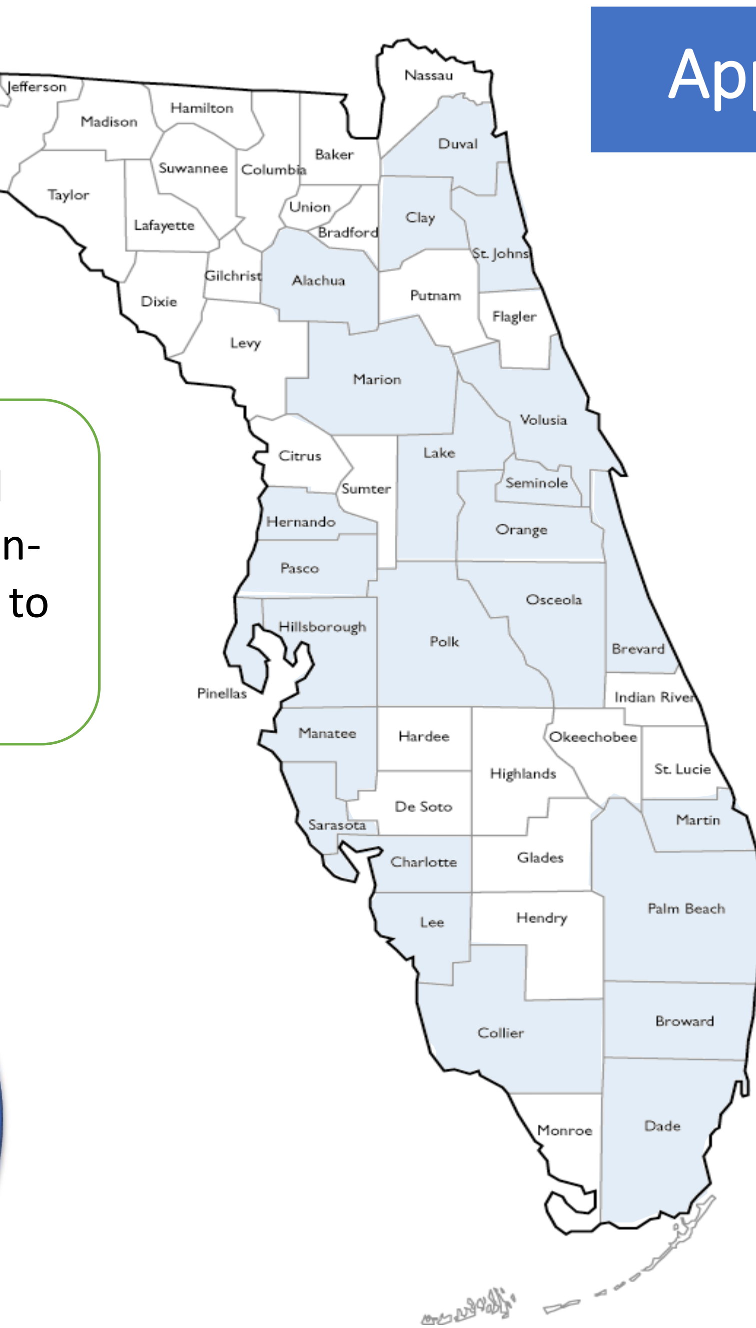
Feasibility:

- High Feasibility
  - Technology Well-Developed
  - Currently Used in Florida
  - Challenges posed with economics

C&D Recycling Facility in Tallahassee

Total Recycling Rate= +6.51%

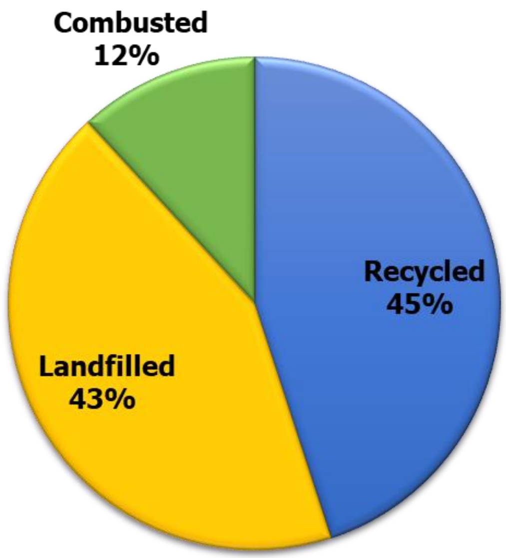


Approach 5

Mandatory Non-Residential Food Waste Composting: Increase the non-residential food waste recycling rate to 58%.

Total State Disposition



Approach 5

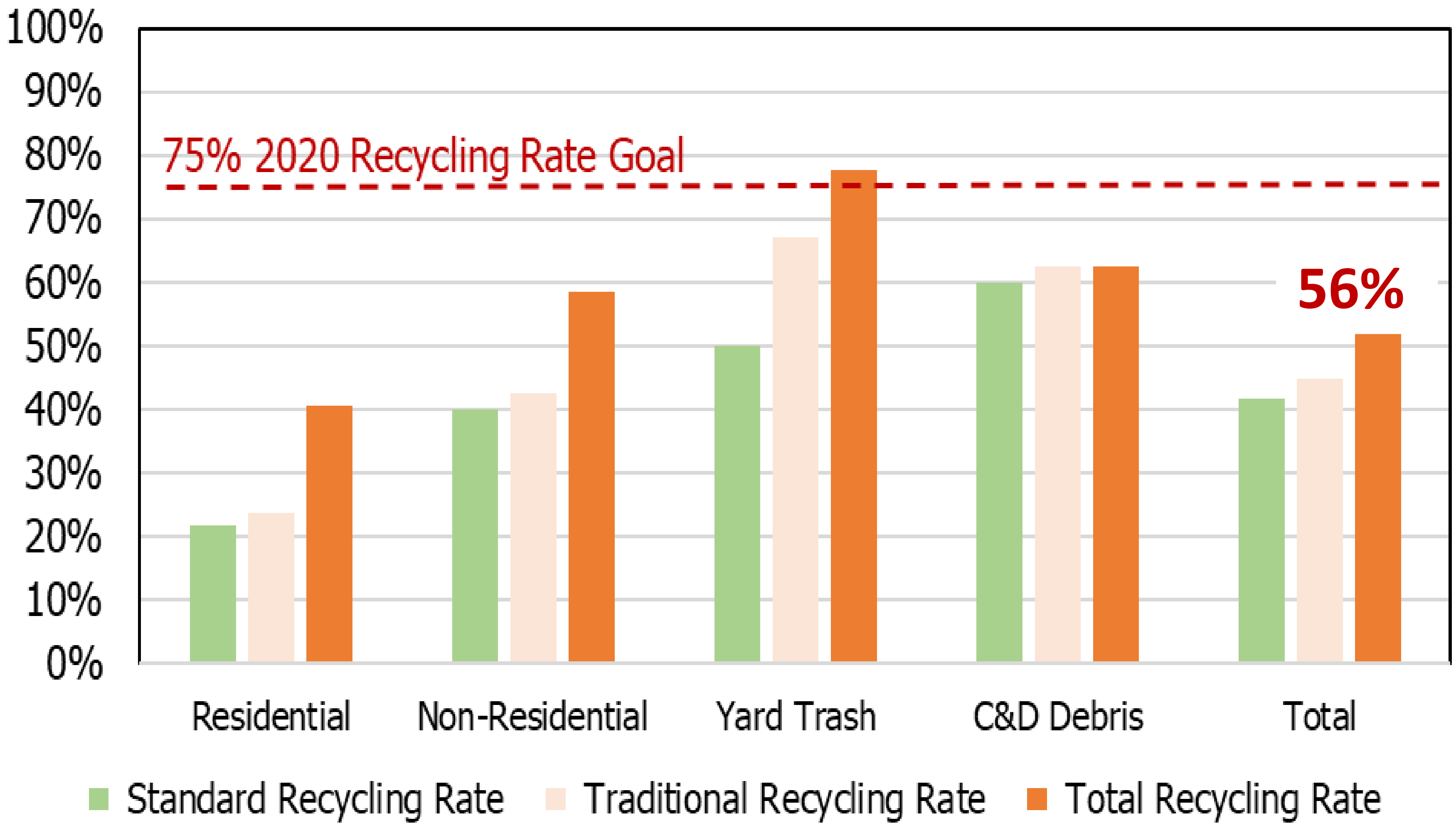
Feasibility:

- Feasible
  - Technology Well-Developed
  - Challenges posed with economics

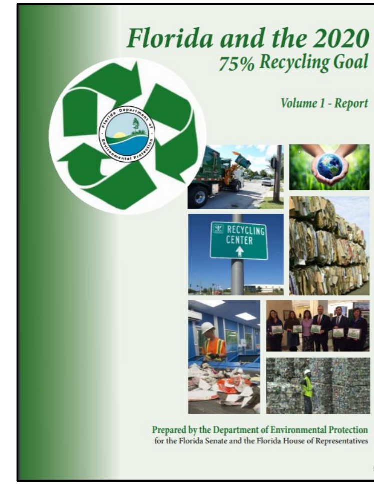
Aerobic Composting for Organics from Mixed Waste System in Gilroy, CA

Approach 5

Total Recycling Rate= +0.04%



Where are we now?



Executive Summary

Given these challenges and others detailed in the report, the current practices in Florida are not expected to significantly increase the recycling rate beyond the state's current rate of 56%; causing it to level off. Without significant changes to our current approach, Florida's recycling rate will likely fall short of the 2020 goal of 75%.

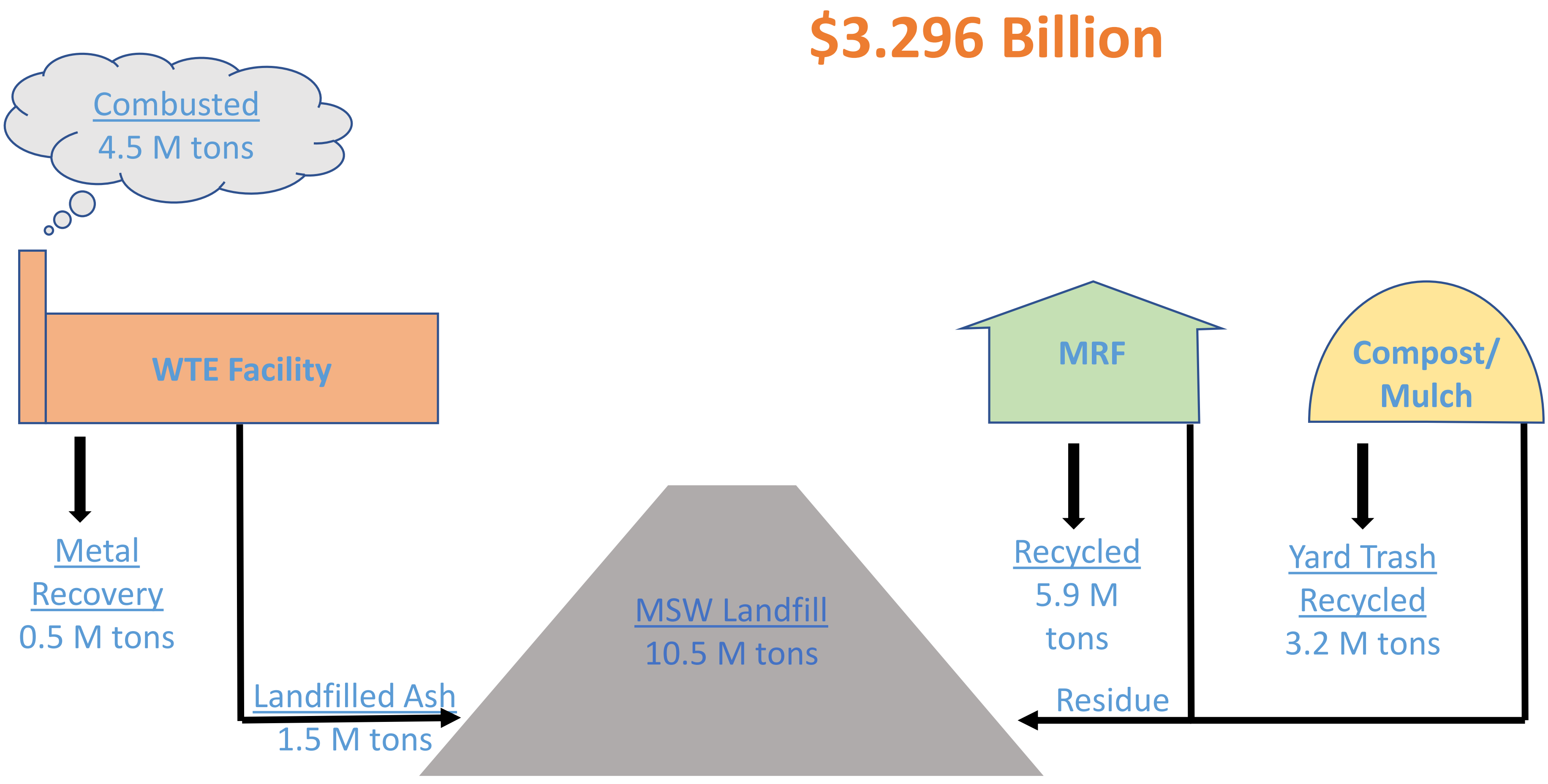
Conclusion

It is important to note that the weight-based goals, as described in the legislation, are aspirational. Dr. Townsend's research suggests that, even if many of the options presented in Table 1 were implemented, the 75% goal may not be achieved. Further, there is a developing consensus in other states and at the federal level that suggest using a weight-based goal may not result in efficient or effective recycling; rather, incorporation of source reduction and sustainable materials management concepts into a comprehensive statewide recycling program may be needed.

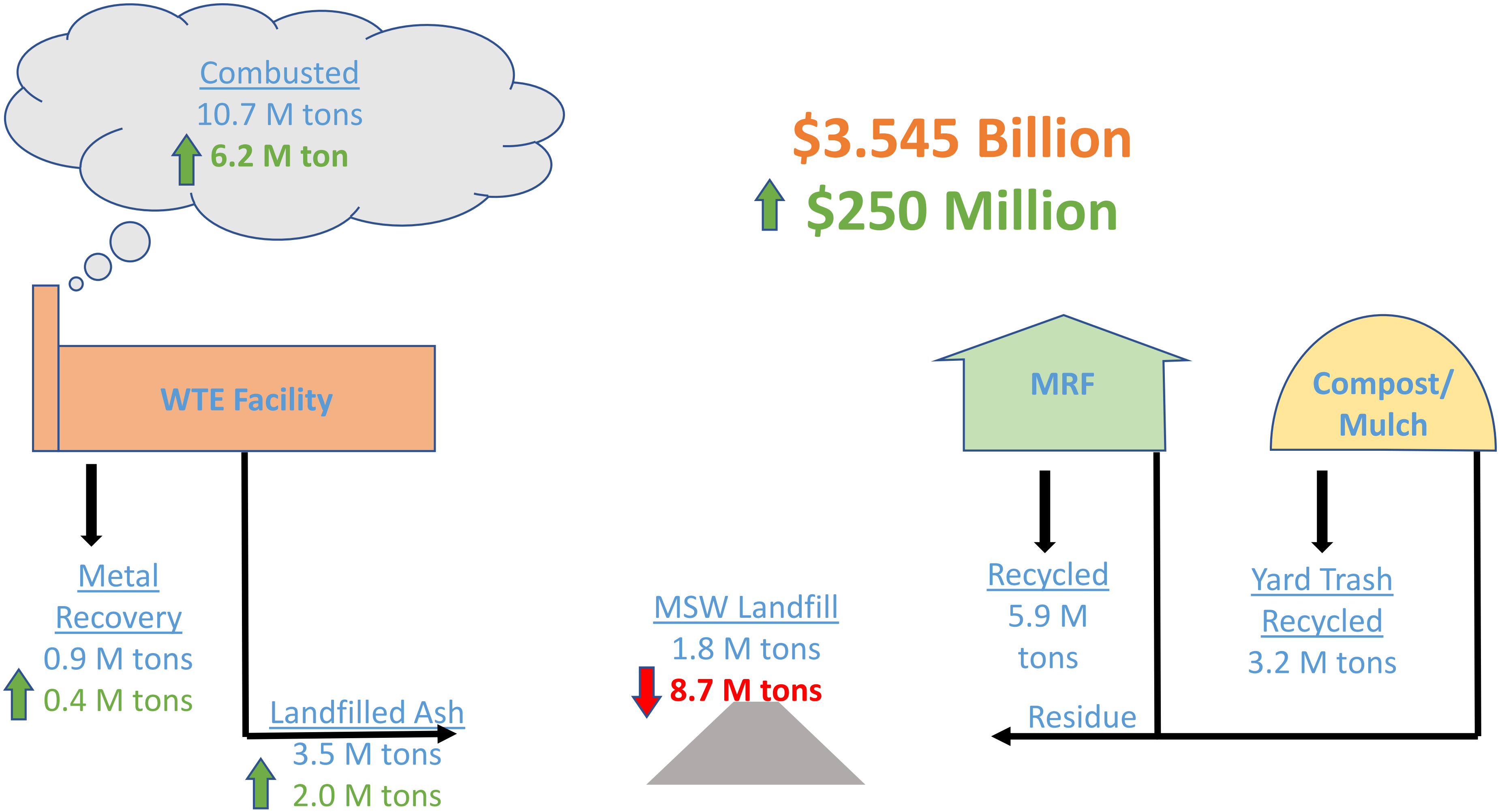
FDEP Report to the Legislature (Dec. 2017)
https://floridadep.gov/waste/waste-reduction/documents/florida-and-2020-75-recycling-goal

Getting to 75%
Costs

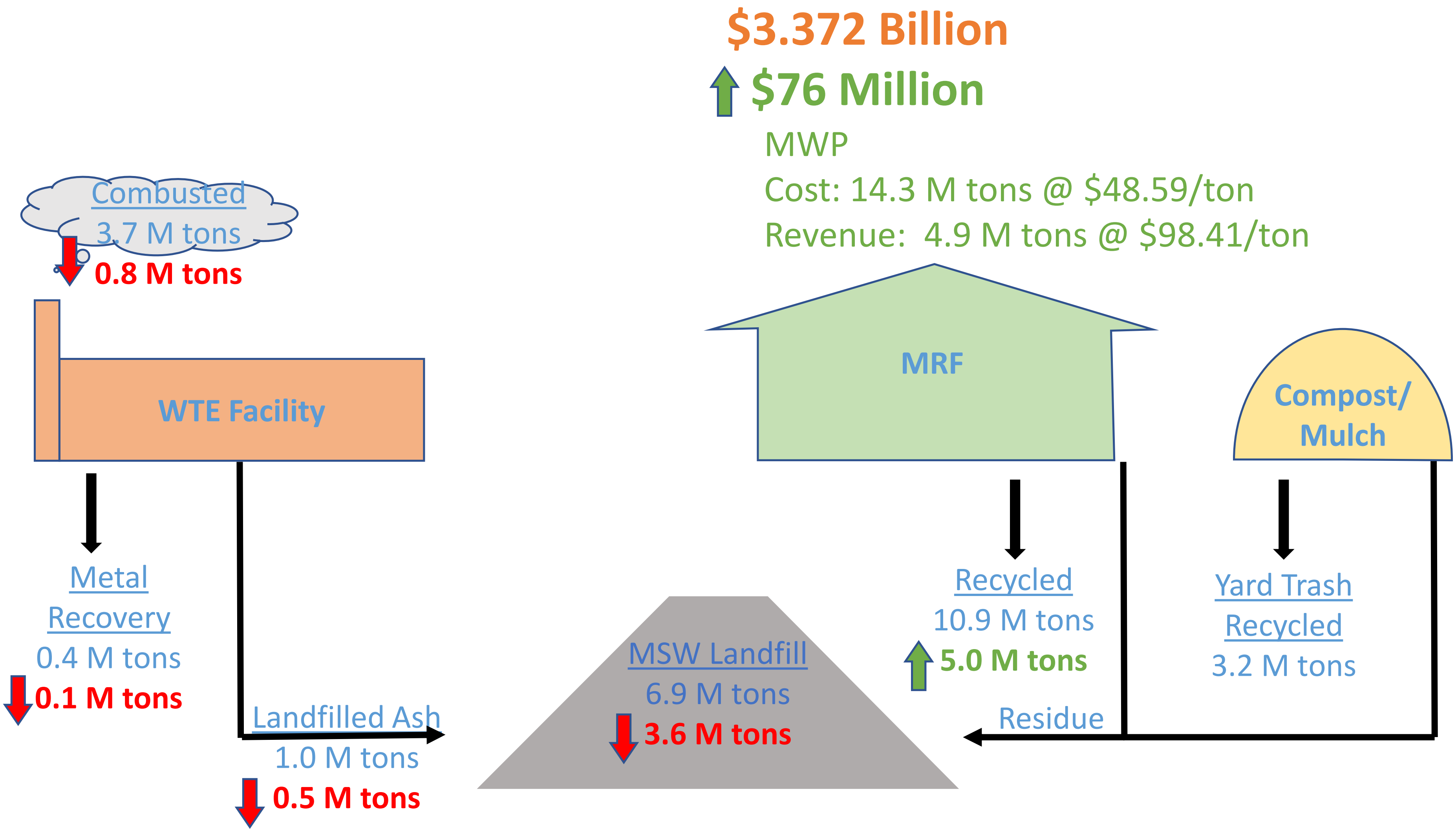
Florida Material Mass Flow (2016)



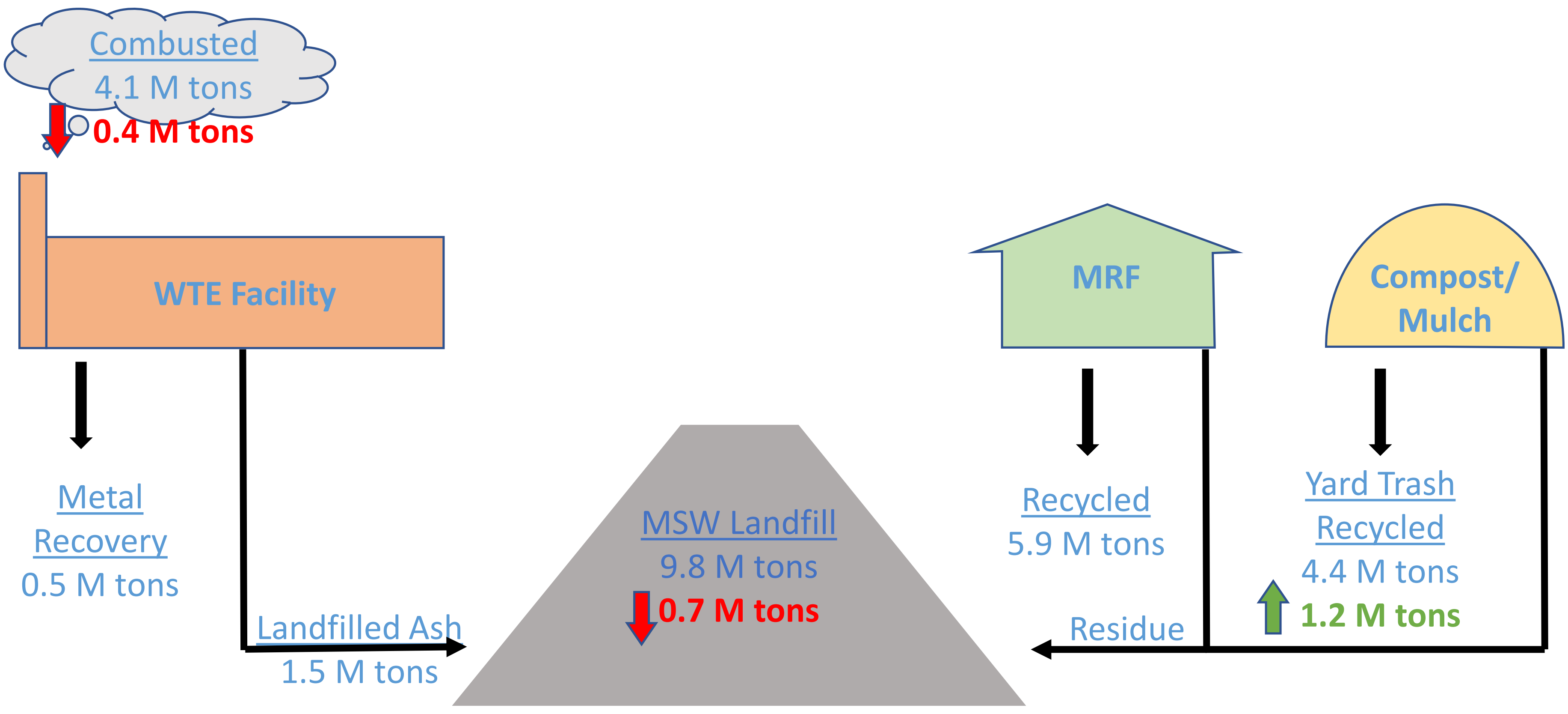
Material Mass Flow (WTE Approach)

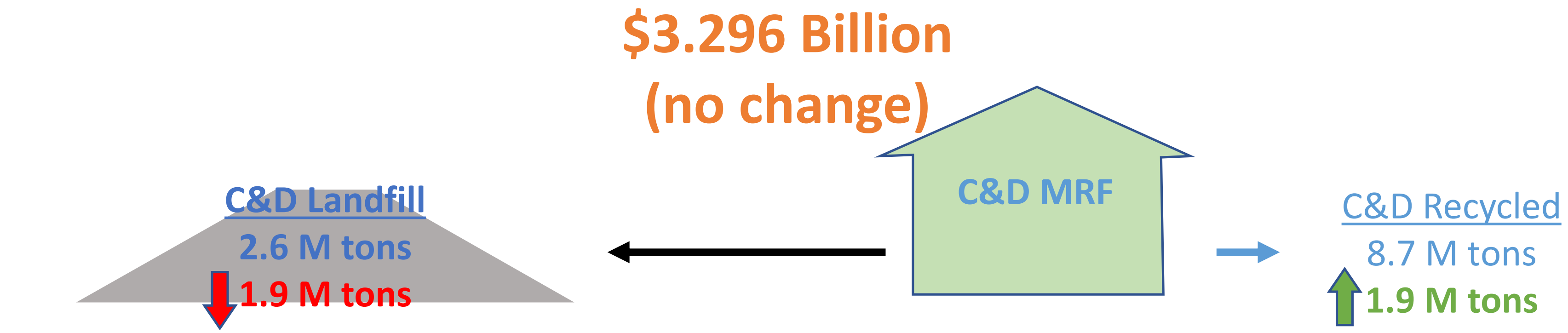


Material Mass Flow (MWP Approach)



Material Mass Flow (Mandatory C&D and YT Approach)

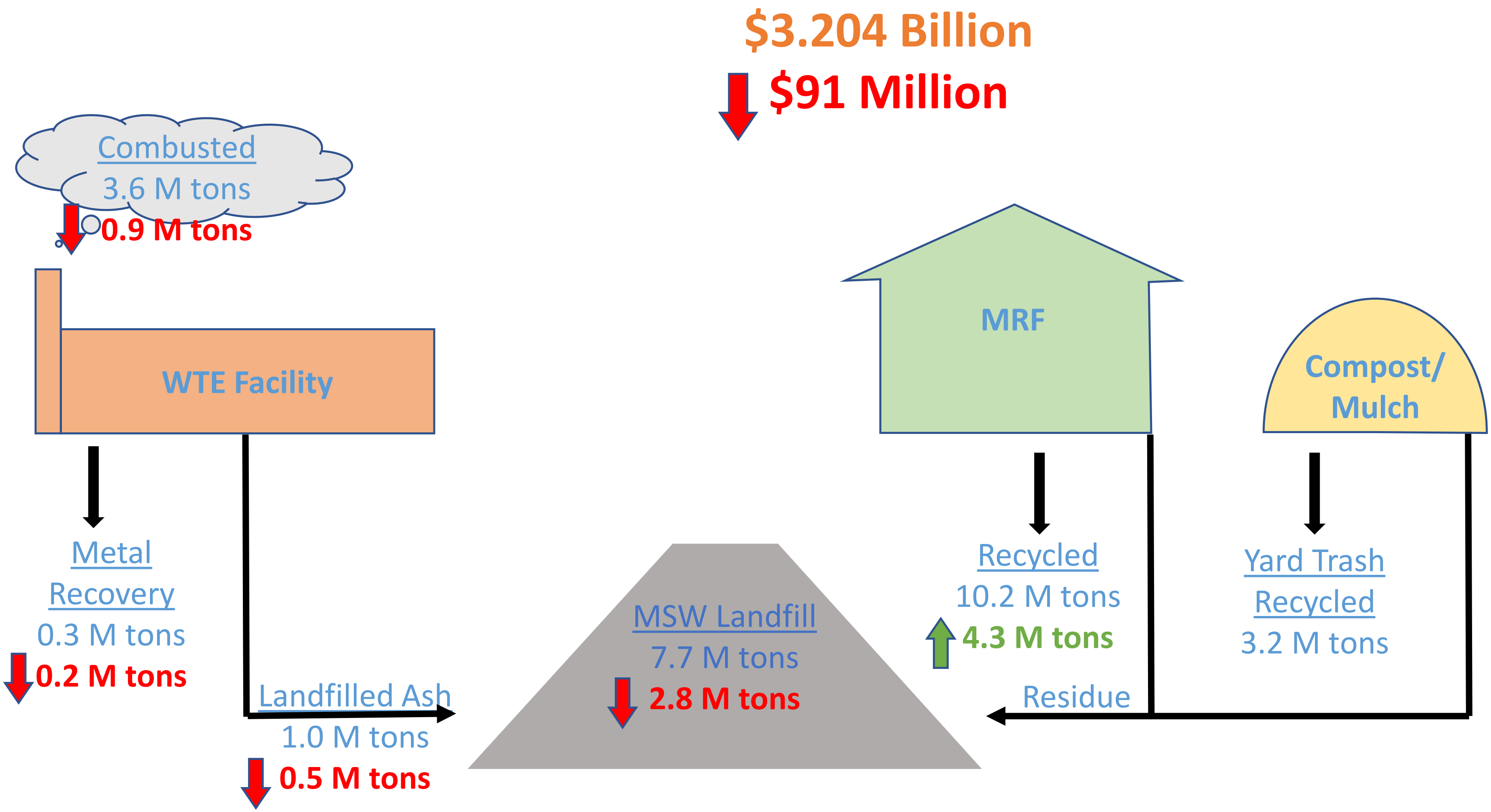




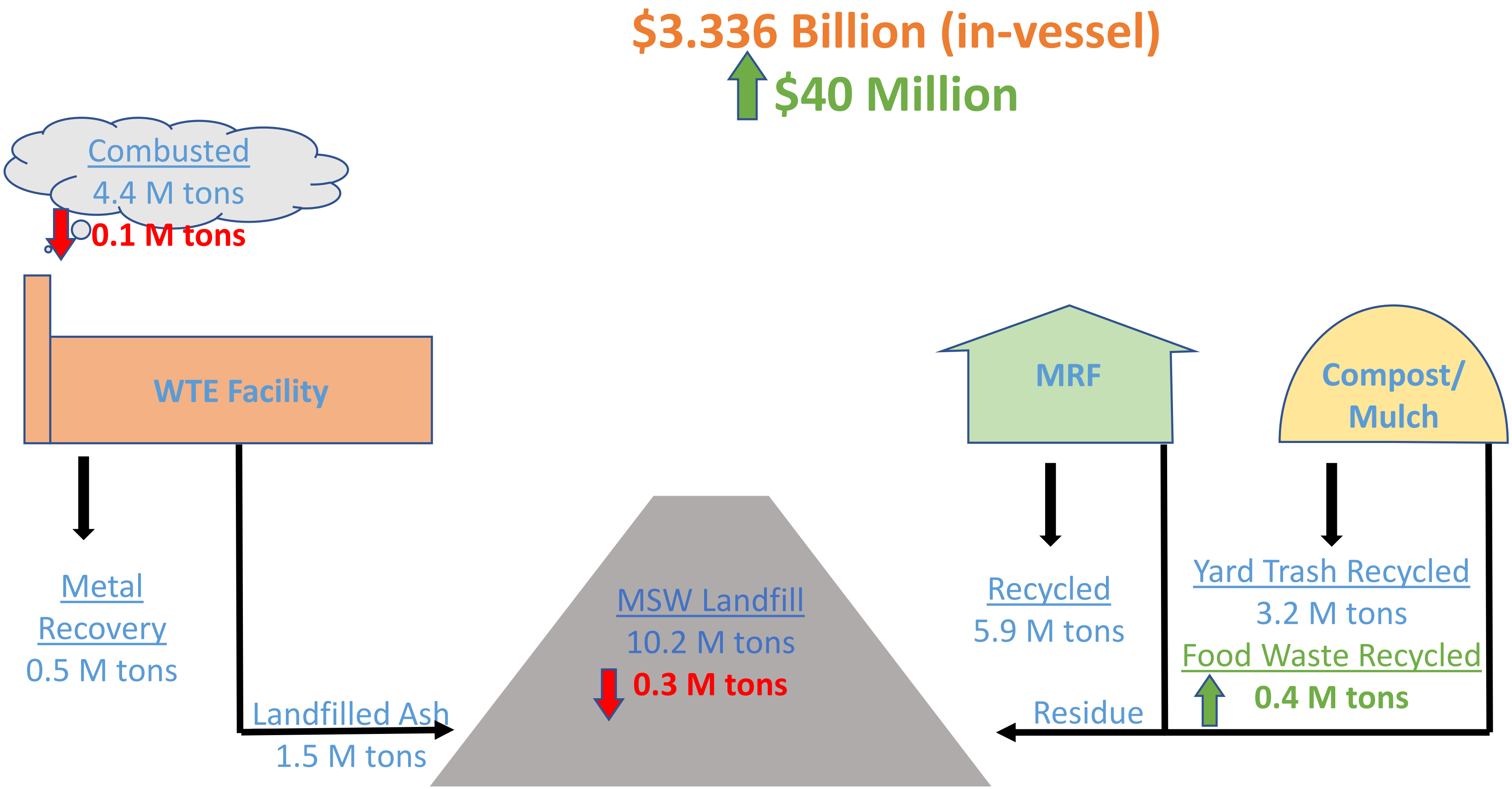
Material Mass Flow (Mandatory C&D and YT Approach)

Florida Material Mass Flow (2016)

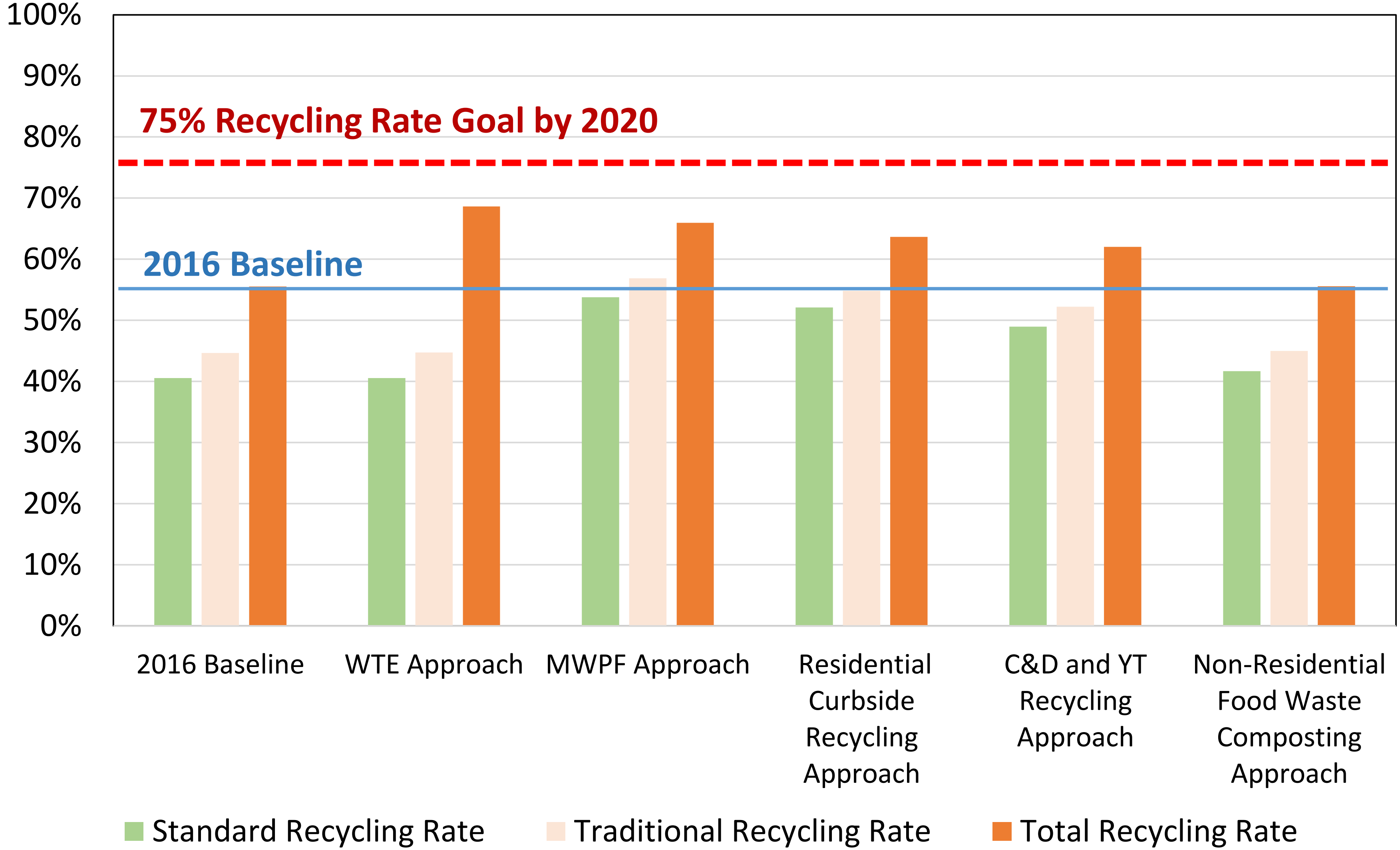
Material Mass Flow (Mandatory Curbside Recycling Approach)



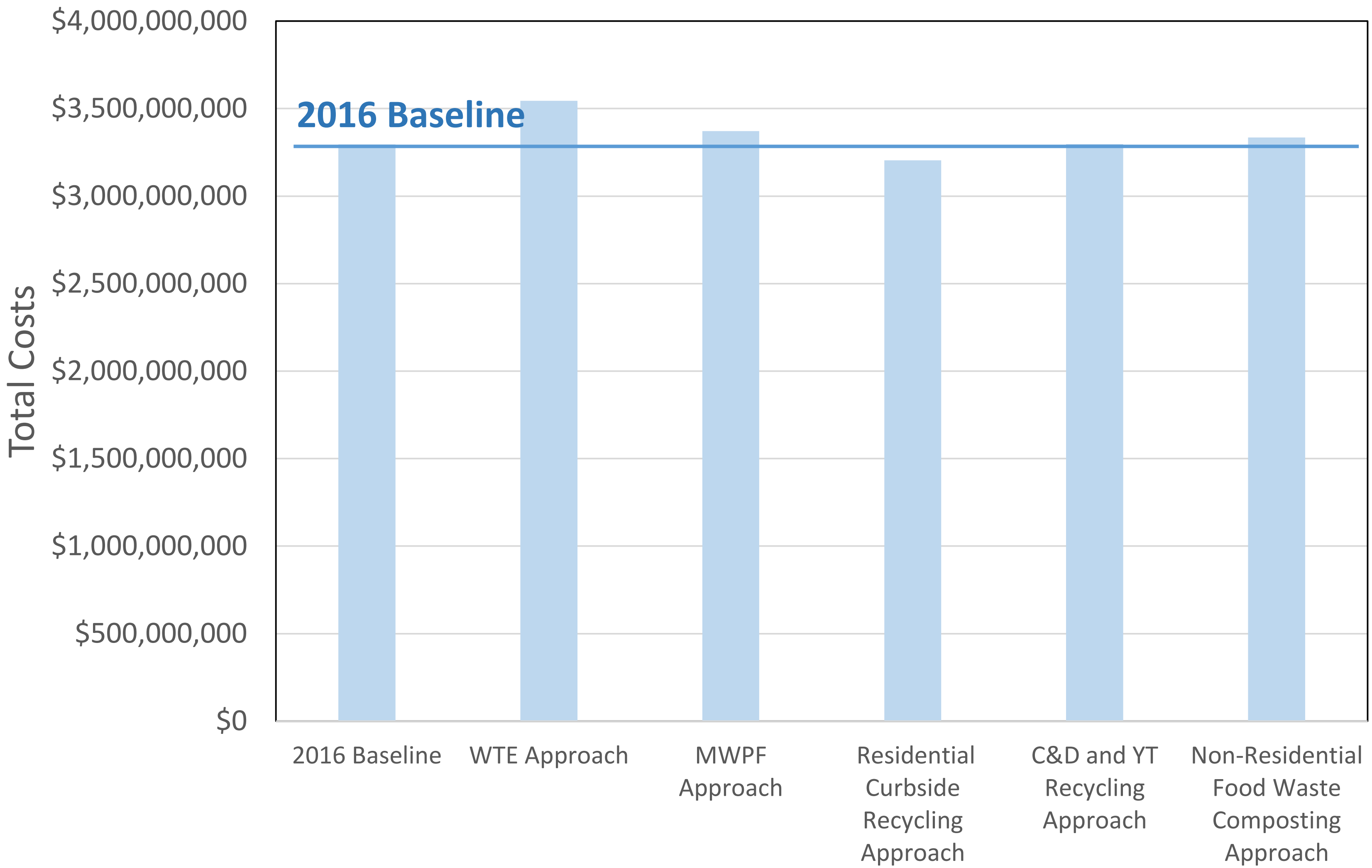
Material Mass Flow (Non-Residential Food Waste Composting)



Approaches Summary



Approaches Summary



Looking Beyond the Ton

Problems with Recycling Rates as Targets for Waste Management System Progress

Current approach focuses on chasing tons, problems with this approach…

Accounting

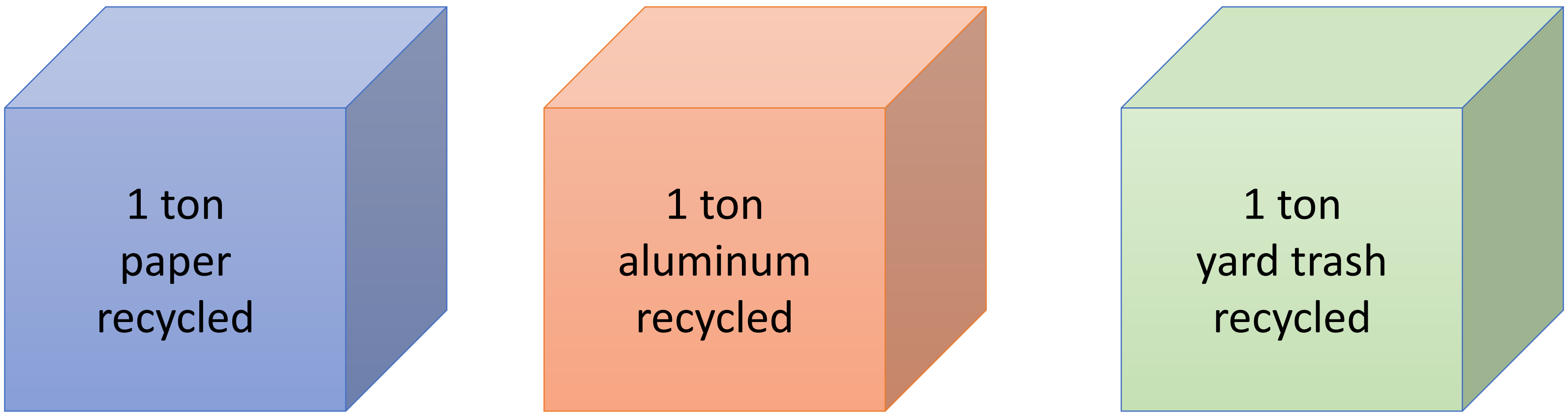
- What counts?
  - Alternative daily cover (ADC) at landfills
  - WTE
  - Landfill gas to energy
  - Concrete and asphalt recycling
  - Utility and industrial waste recycling
- Creative Accounting
  - How good are the numbers?
  - How do you avoid cherry picking or double-counting?
- Total or per capita?

Substance

- Does not reflect source reduction (if you reduce the numerator, you also reduce the denominator).
- Treats all materials the same. We know materials have differing impacts with regard to environmental burdens, economics and landfill capacity consumption.

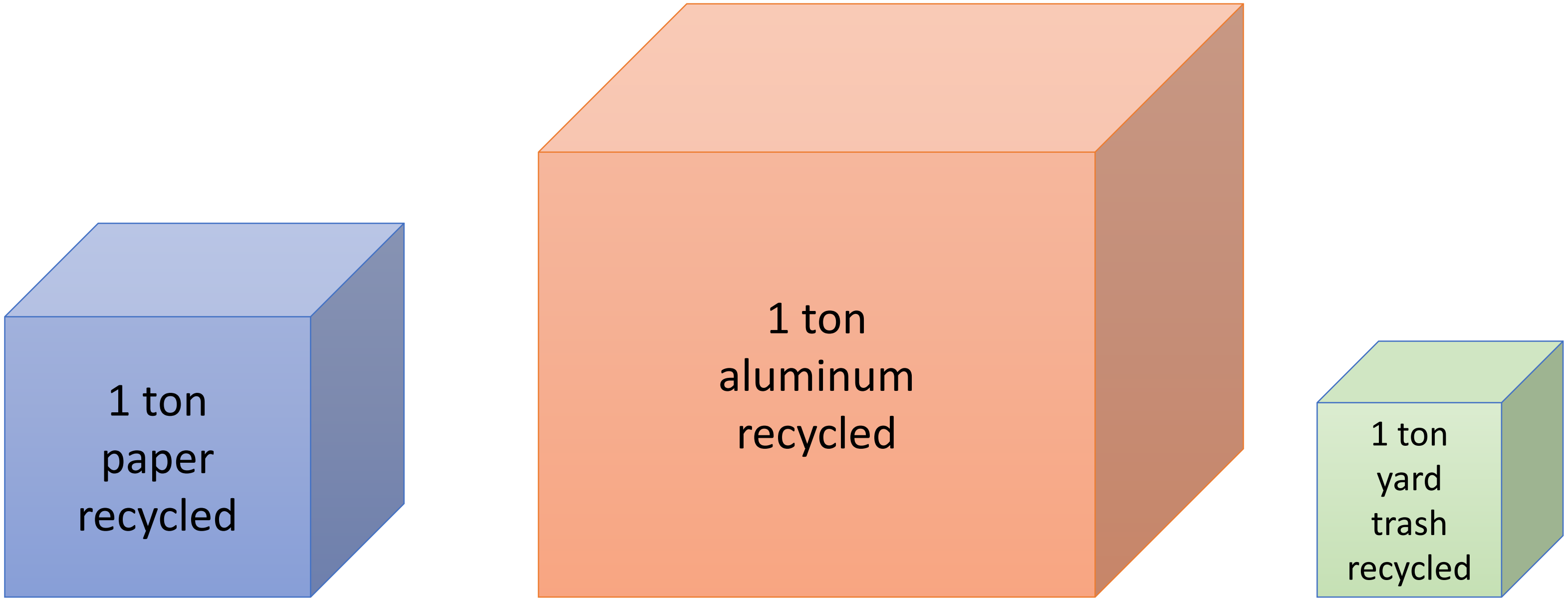
The Fallacy of Solely Chasing after Tons

All materials are treated the same



The Fallacy of Solely Chasing after Tons

Different materials result in different outcomes



Shifting Focus to Sustainable Materials Management

- Systemic approach to using and reusing materials productively
- Represents a change in how our society thinks about the use of natural resources
- Looks at a product's entire lifecycle to reduce environmental impacts, conserve resources, and reduce costs

https://www.epa.gov/smm

Metrics to Track Progress Besides Tons

- Greenhouse gas emissions
- Energy production/consumption
- Impact on air
- Impact on water
- Resource consumption
- Human toxicity
- Landfill capacity
- Jobs
- Costs

United States Environmental Protection Agency

Environmental Topics | Laws & Regulations | About EPA | Sea

CONTACT US

Waste Reduction Model (WARM)

EPA created the Waste Reduction Model (WARM) to help solid waste planners and organizations track and voluntarily report greenhouse gas (GHG) emissions reductions from several different waste management practices. WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, anaerobic digestion, combustion, composting and landfilling.

Basic Information about WARM

- What is WARM?
- WARM Tool

Documentation

- Documentation for Greenhouse Gas Emission and Energy Factors Used in WARM

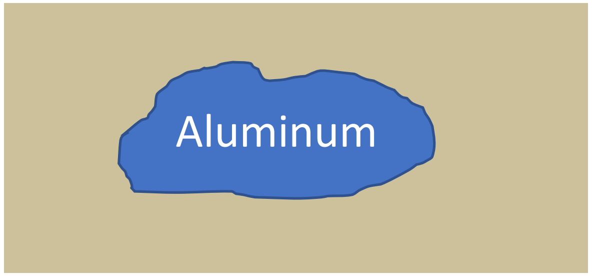
Metrics to Track Progress Besides Tons

- Greenhouse gas emissions
- Energy production/consumption
- Impact on air
- Impact on water
- Resource consumption
- Human toxicity
- Landfill capacity
- Jobs
- Costs

US EPA's WARM (bracketing: Greenhouse gas emissions; Energy production/consumption)

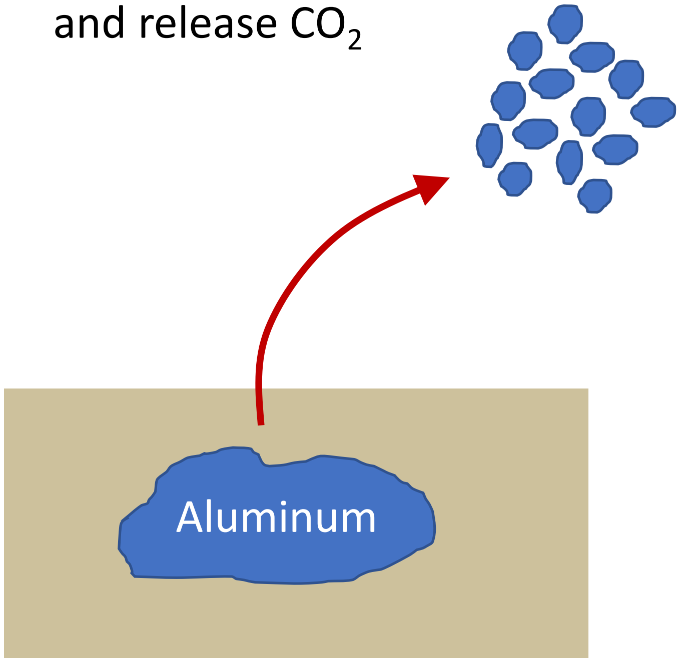
Let's consider the life-cycle of an aluminum can

Source of Aluminum in Earth



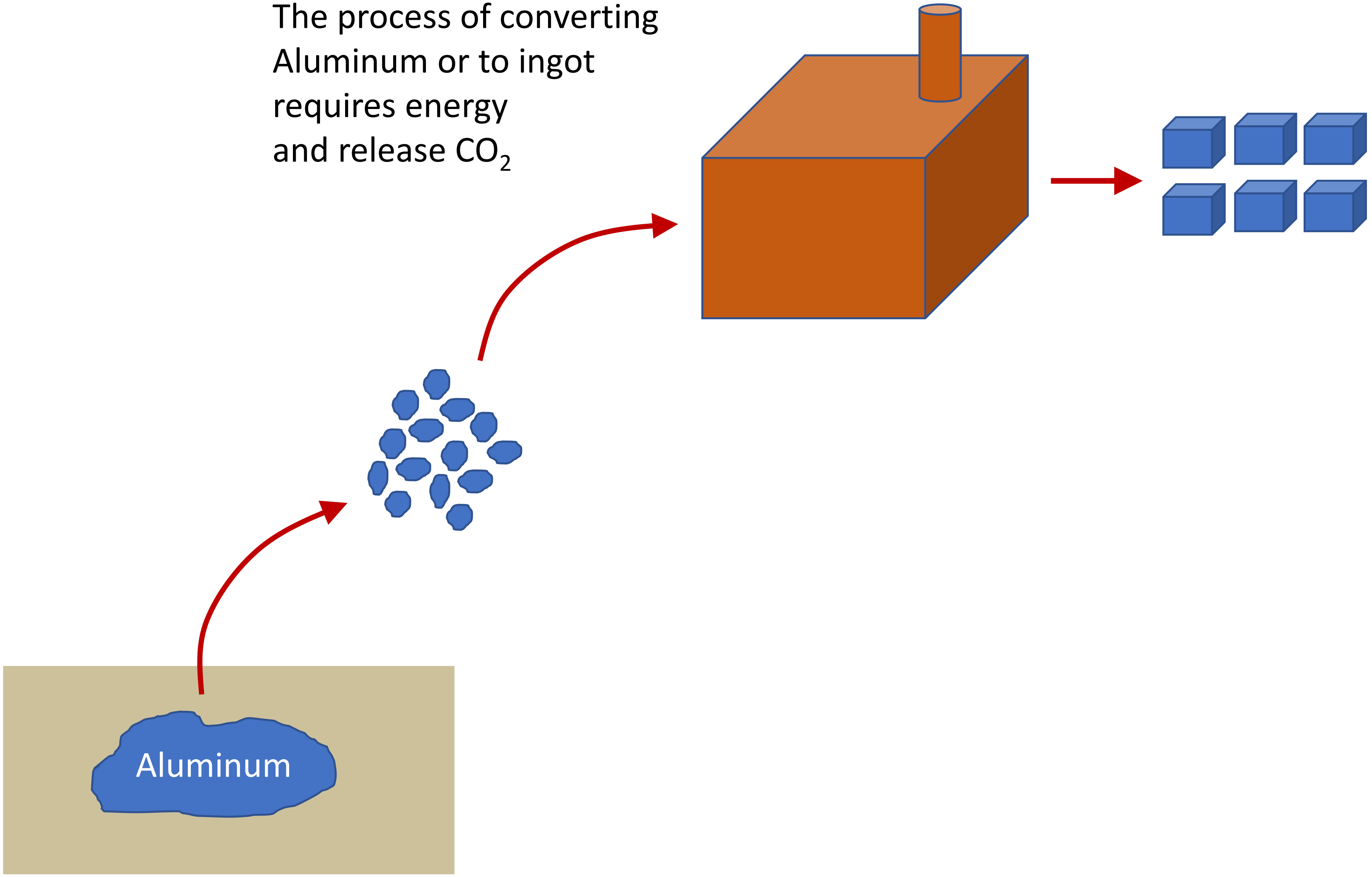
Let's consider the life-cycle of an aluminum can

The process of mining the Aluminum from the earth requires energy and release CO_2



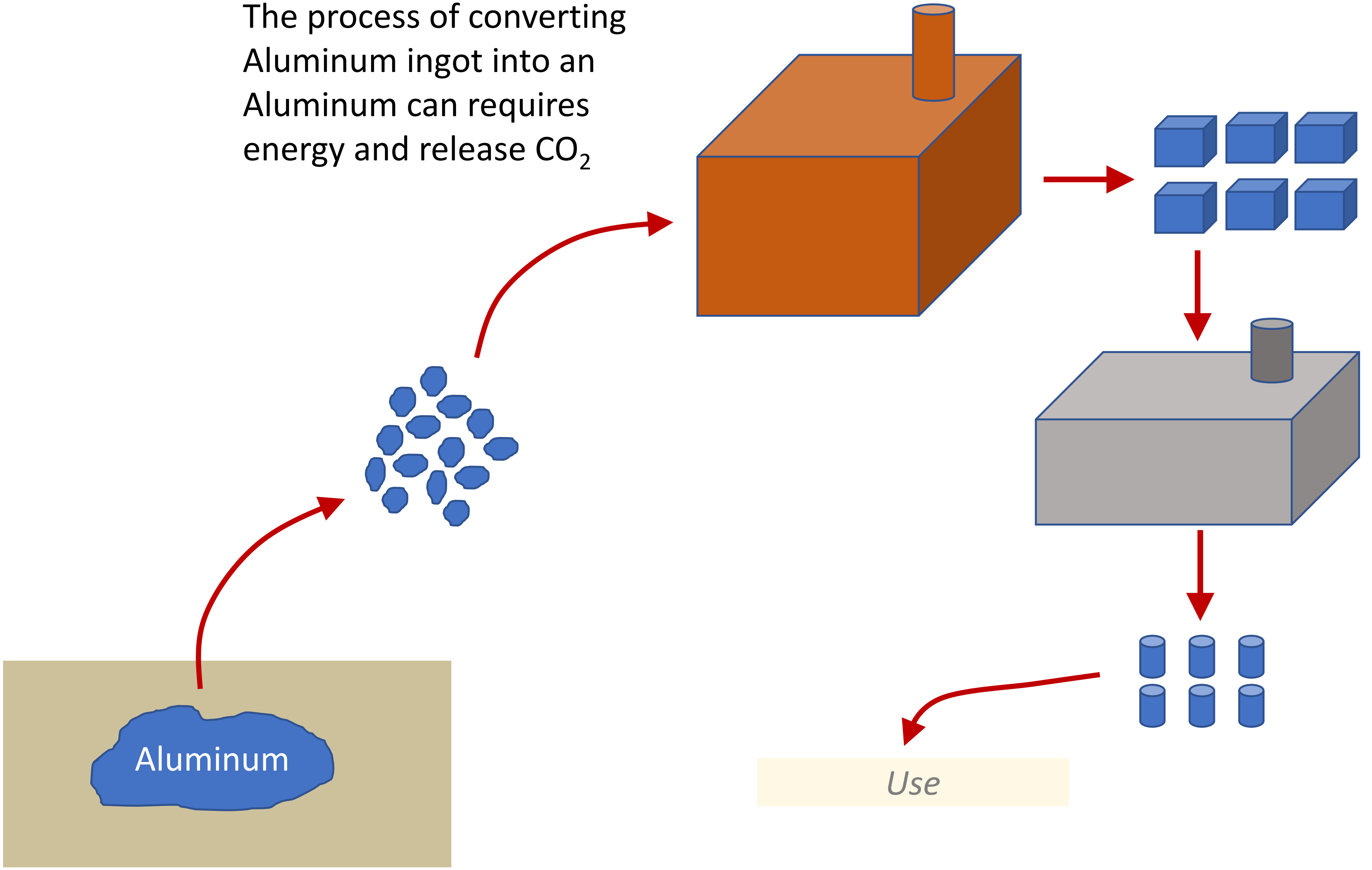
Let's consider the life-cycle of an aluminum can

The process of converting Aluminum or to ingot requires energy and release CO_2



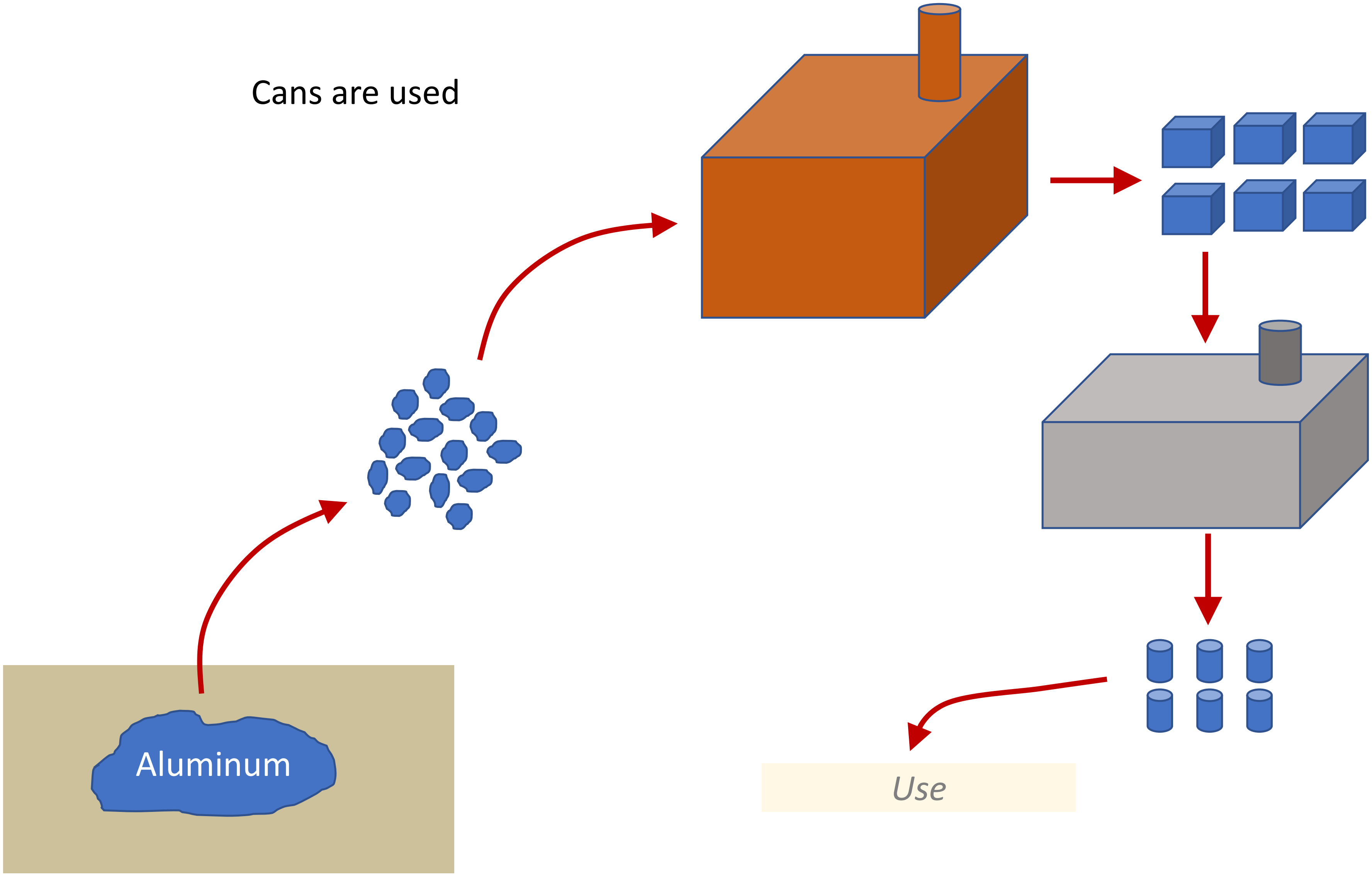
Let's consider the life-cycle of an aluminum can

The process of converting Aluminum ingot into an Aluminum can requires energy and release CO_2

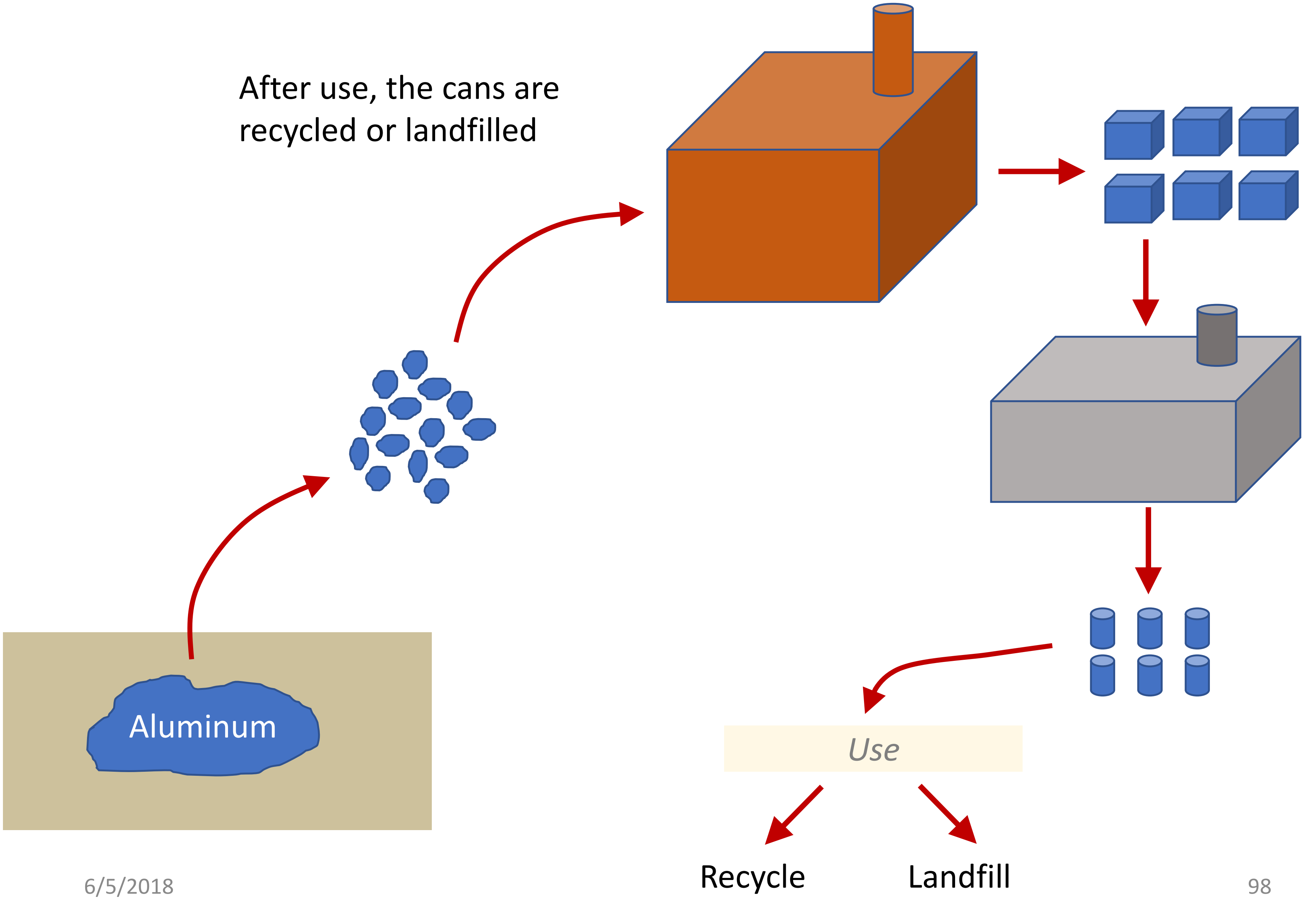


Let's consider the life-cycle of an aluminum can

Cans are used

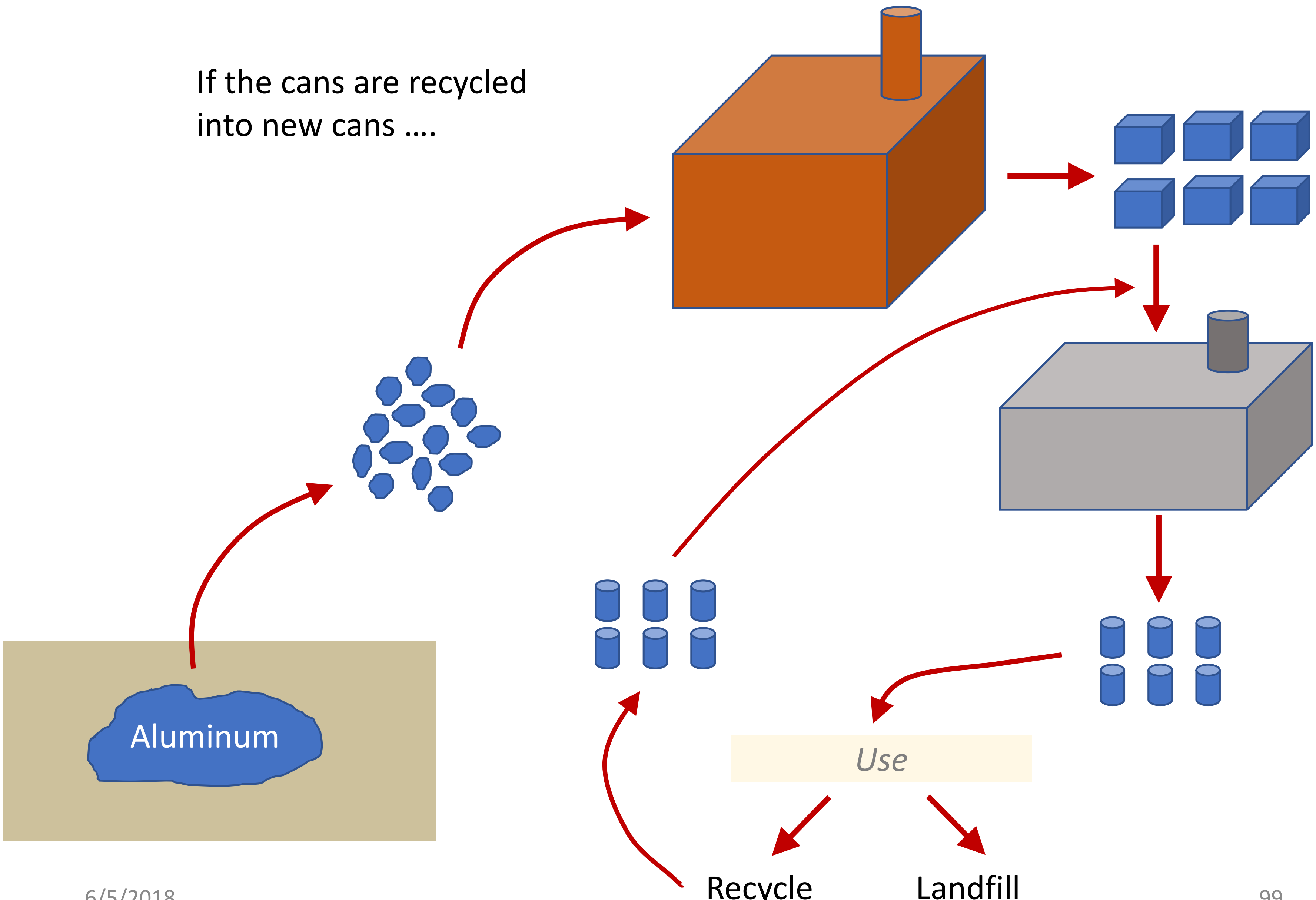


Let's consider the life-cycle of an aluminum can



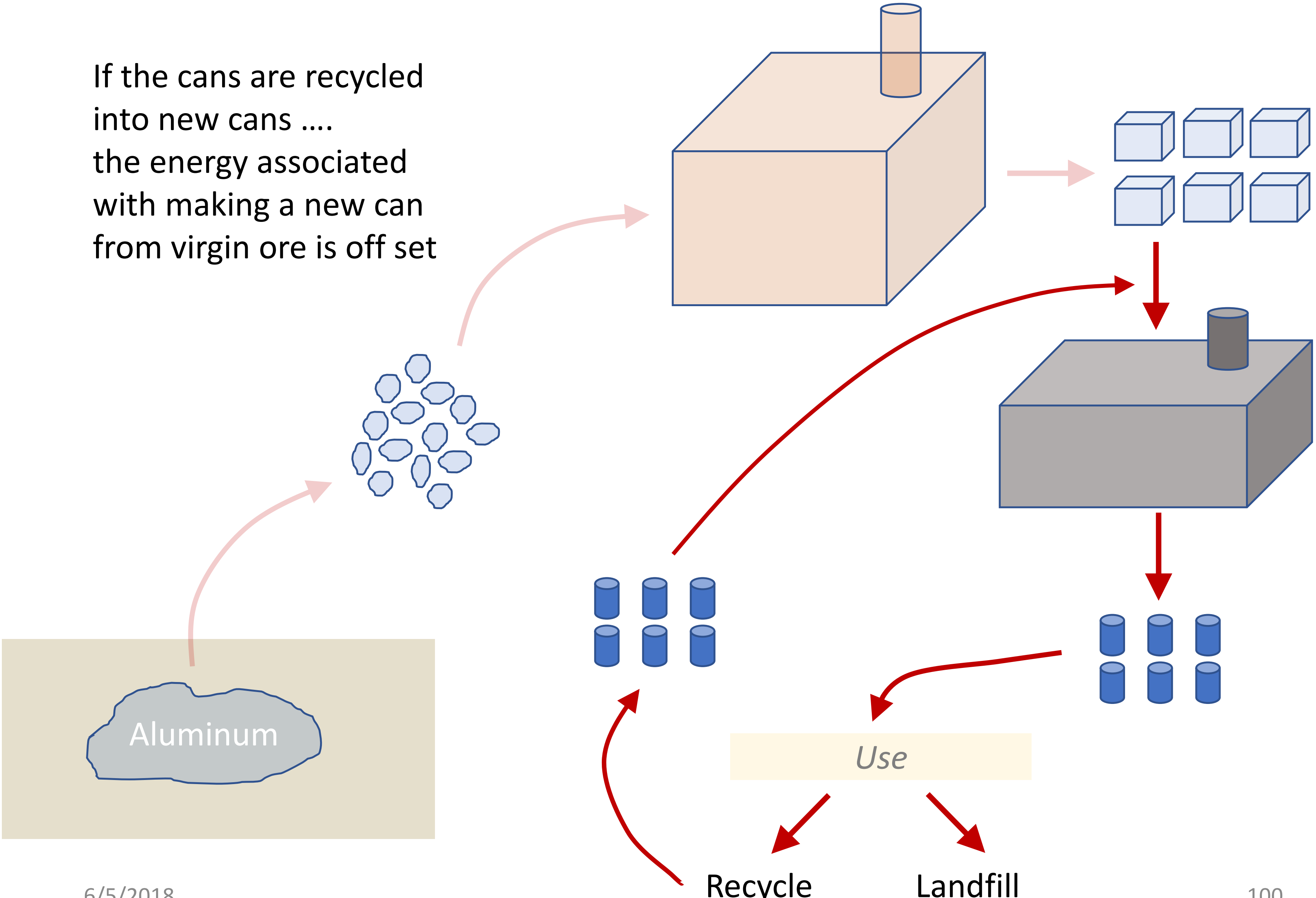
Let's consider the life-cycle of an aluminum can

If the cans are recycled into new cans ....



Let’s consider the life-cycle of an aluminum can

If the cans are recycled into new cans ….
the energy associated with making a new can from virgin ore is off set



Example of how materials have different consequences: Energy

Aluminum

- Recycling → the amount of energy it takes to make a new aluminum product from a recycled aluminum product is much less
- WTE → no energy is produced from combusting aluminum
- Landfilling → no energy is produced from landfilling aluminum

Yard Trash

- Recycling → when yard trash is mulched, there is a net consumption of energy
- WTE → energy will be captured from combusting yard trash in energy facility
- Landfilling → energy may be captured from landfilling yard trash

WARM GHG Emission Factors

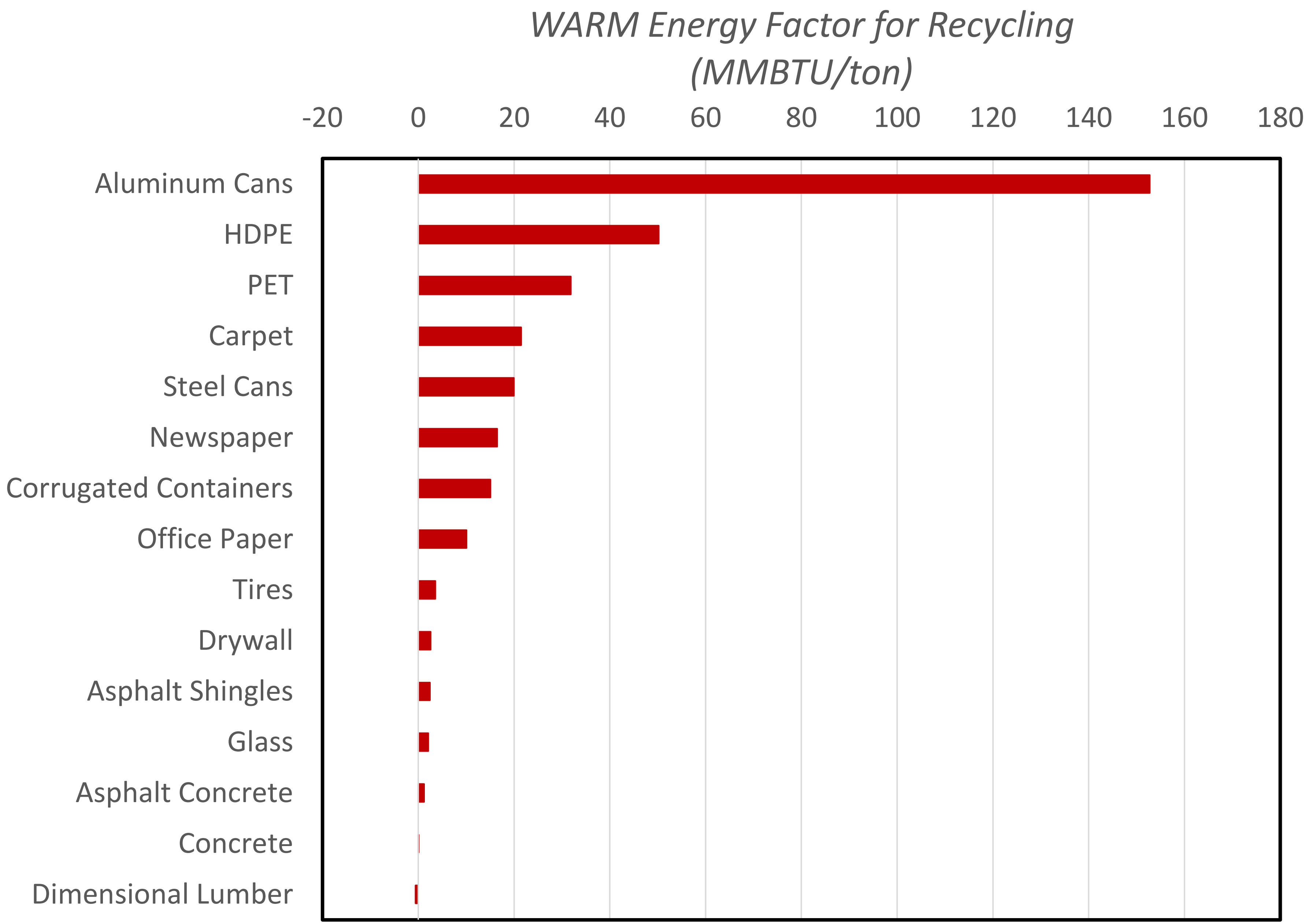
Per Ton Estimates of GHG Emissions for Baseline and Alternative Management Scenarios

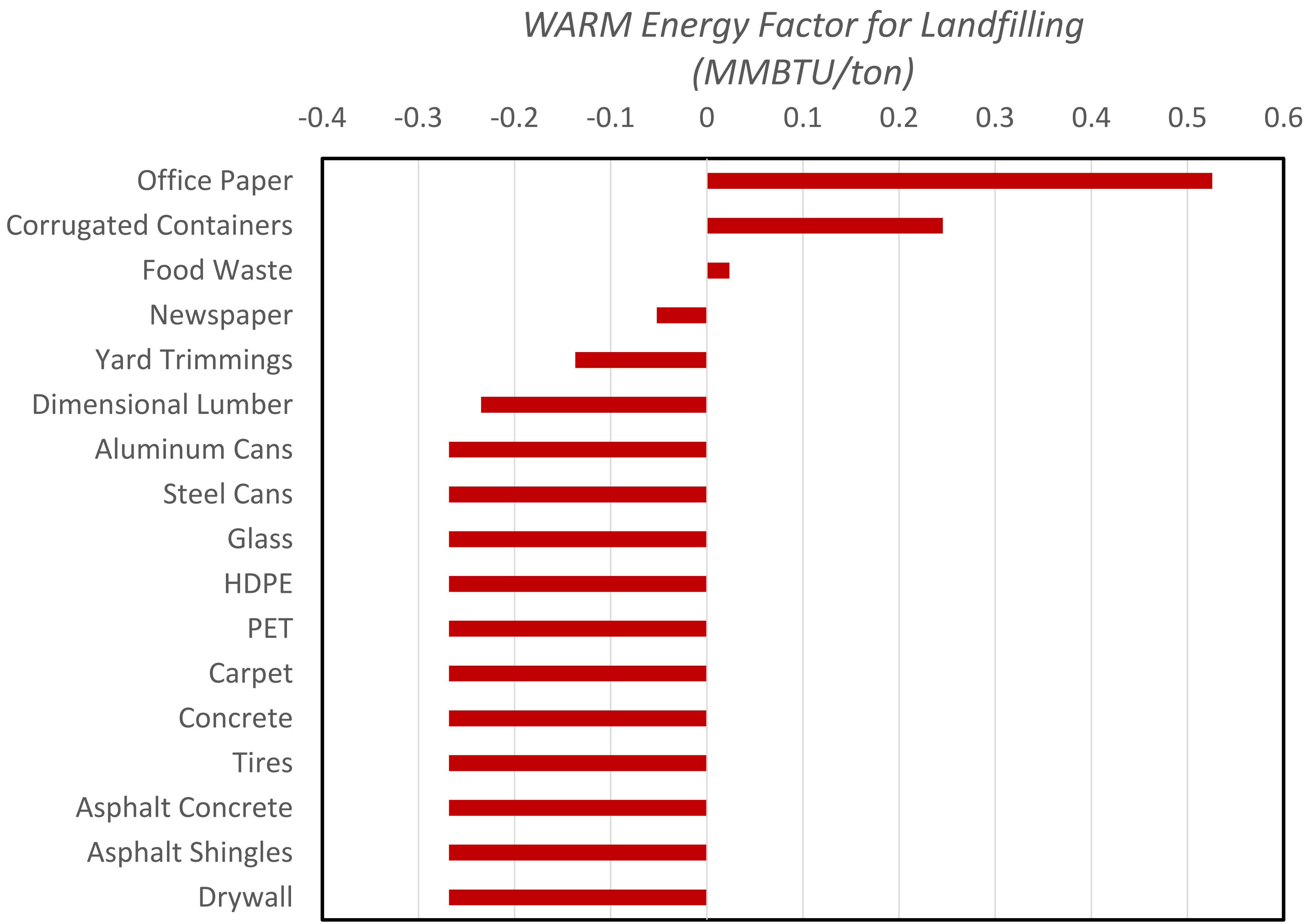
Material	GHG Emissions per Ton of Material Source Reduced ($MTCO_2E$)	GHG Emissions per Ton of Material Recycled ($MTCO_2E$)	GHG Emissions per Ton of Material Landfilled ($MTCO_2E$)	GHG Emissions per Ton of Material Combusted ($MTCO_2E$)	GHG Emissions per Ton of Material Composted ($MTCO_2E$)	GHG Emission per Ton of Material Anaerobically Digested
Aluminum Cans	(4.91)	(9.11)	0.02	0.04	NA	NA
Aluminum Ingot	(7.47)	(7.19)	0.02	0.04	NA	NA
Steel Cans	(3.06)	(1.81)	0.02	(1.57)	NA	NA
Copper Wire	(7.01)	(4.71)	0.02	0.03	NA	NA
Glass	(0.53)	(0.28)	0.02	0.03	NA	NA
HDPE	(1.47)	(0.87)	0.02	1.23	NA	NA
LDPE	(1.80)	NA	0.02	1.24	NA	NA
PET	(2.20)	(1.12)	0.02	1.21	NA	NA
LLDPE	(1.58)	NA	0.02	1.23	NA	NA
PP	(1.55)	NA	0.02	1.23	NA	NA
PS	(2.50)	NA	0.02	1.60	NA	NA
PVC	(1.95)	NA	0.02	0.64	NA	NA
PLA	(2.09)	NA	(1.64)	(0.97)	(0.15)	NA
Corrugated Containers	(5.60)	(3.12)	0.23	(0.51)	NA	NA
Magazines/third-class mail	(8.60)	(3.07)	(0.39)	(0.37)	NA	NA
Newspaper	(4.77)	(2.75)	(0.82)	(0.58)	NA	NA
Office Paper	(7.97)	(2.86)	1.22	(0.49)	NA	NA

WARM Energy Factors

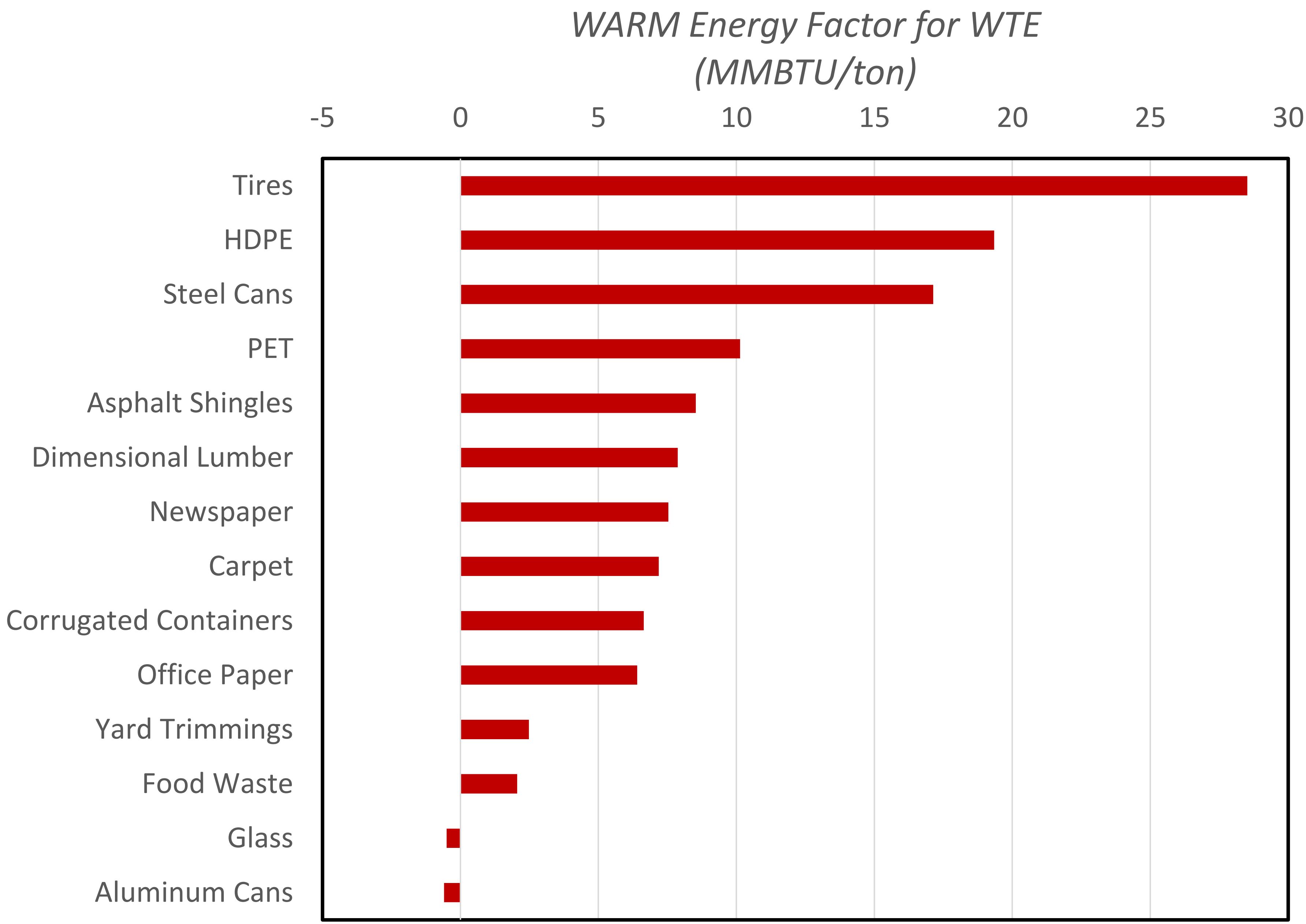
Per Ton Estimates of Energy Use for Alternative Management Scenarios

Material	Energy Savings per Ton of Material Source Reduced (million BTU)	Energy Savings per Ton of Material Recycled (million BTU)	Energy Savings per Ton of Material Landfilled (million BTU)	Energy Savings per Ton of Material Combusted (million BTU)	Energy Savings per Ton of Material Composted (million BTU)	Energy Savings per Ton of Material Anaerobically Digested (million BTU)
Aluminum Cans	(89.69)	(152.76)	0.27	0.60	NA	NA
Aluminum Ingot	(126.95)	(113.85)	0.27	0.60	NA	NA
Steel Cans	(29.88)	(19.97)	0.27	(17.14)	NA	NA
Copper Wire	(122.36)	(82.59)	0.27	0.54	NA	NA
Glass	(6.90)	(2.13)	0.27	0.50	NA	NA
HDPE	(61.21)	(50.20)	0.27	(19.34)	NA	NA
LDPE	(71.02)	NA	0.27	(19.24)	NA	NA
PET	(50.26)	(31.87)	0.27	(10.13)	NA	NA
LLDPE	(66.37)	NA	0.27	(19.30)	NA	NA
PP	(66.59)	NA	0.27	(19.31)	NA	NA
PS	(74.99)	NA	0.27	(17.40)	NA	NA
PVC	(48.34)	NA	0.27	(7.46)	NA	NA
PLA	(30.69)	NA	0.27	(7.94)	0.58	NA
Corrugated Containers	(22.32)	(15.07)	(0.25)	(6.64)	NA	NA
Magazines/third-class mail	(33.23)	(0.69)	0.04	(4.89)	NA	NA
Newspaper	(36.46)	(16.49)	0.05	(7.53)	NA	NA
Office Paper	(36.60)	(10.08)	(0.53)	(6.40)	NA	NA


WARM Energy Factor for Recycling (MMBTU/ton)
-20
0
20
40
60
80
100
120
140
160
180
Aluminum Cans
HDPE
PET
Carpet
Steel Cans
Newspaper
Corrugated Containers
Office Paper
Tires
Drywall
Asphalt Shingles
Glass
Asphalt Concrete
Concrete
Dimensional Lumber

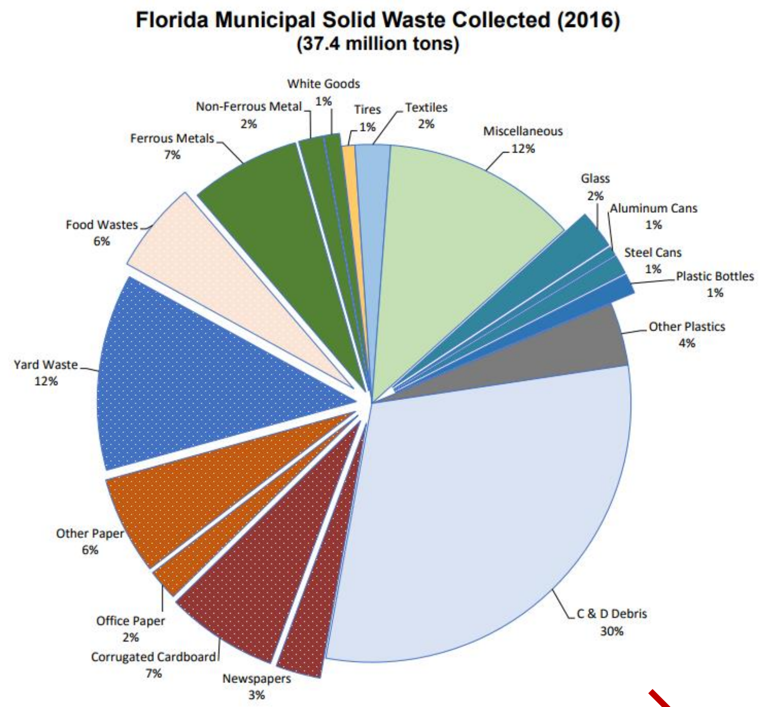


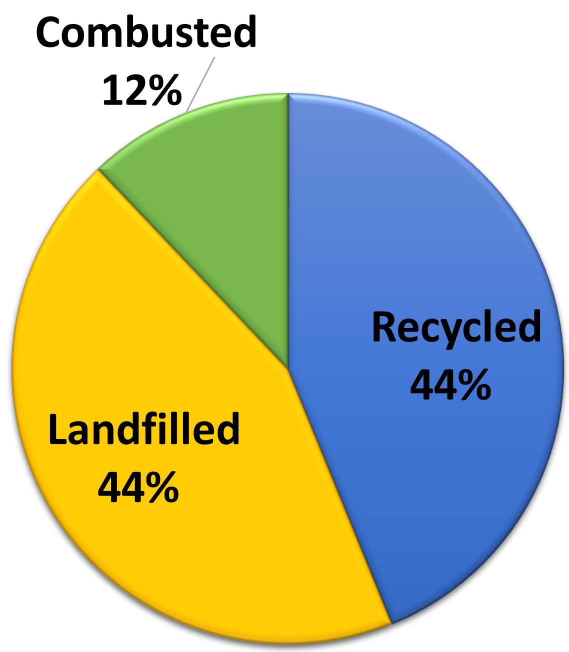
WARM Energy Factor for Landfilling
(MMBTU/ton)
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
Office Paper
Corrugated Containers
Food Waste
Newspaper
Yard Trimmings
Dimensional Lumber
Aluminum Cans
Steel Cans
Glass
HDPE
PET
Carpet
Concrete
Tires
Asphalt Concrete
Asphalt Shingles
Drywall



WARM Energy Factor for WTE
(MMBTU/ton)
-5
0
5
10
15
20
25
30
Tires
HDPE
Steel Cans
PET
Asphalt Shingles
Dimensional Lumber
Newspaper
Carpet
Corrugated Containers
Office Paper
Yard Trimmings
Food Waste
Glass
Aluminum Cans

Florida's Energy and Greenhouse Gas Footprints Associated with 2016 Waste Management



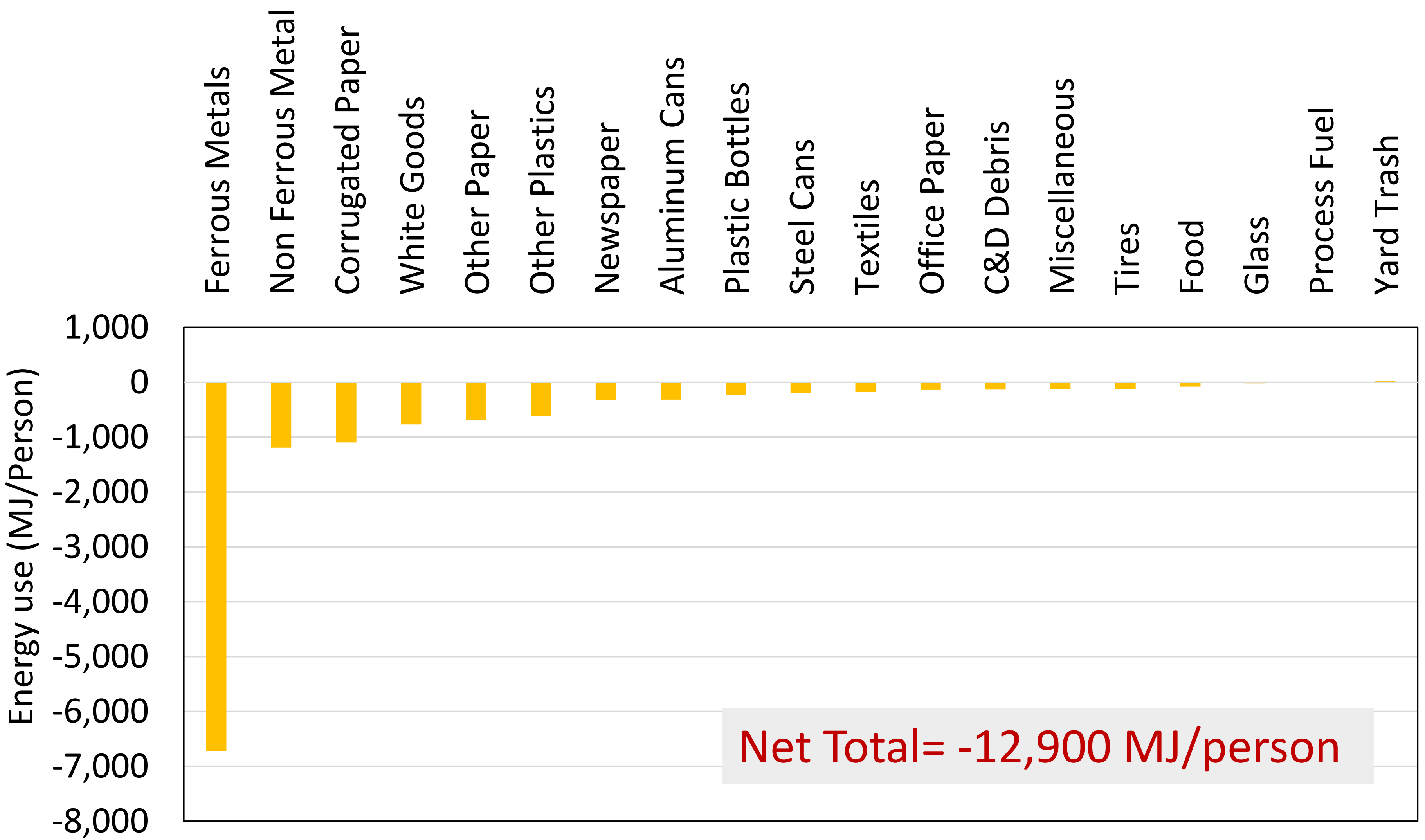


WARM

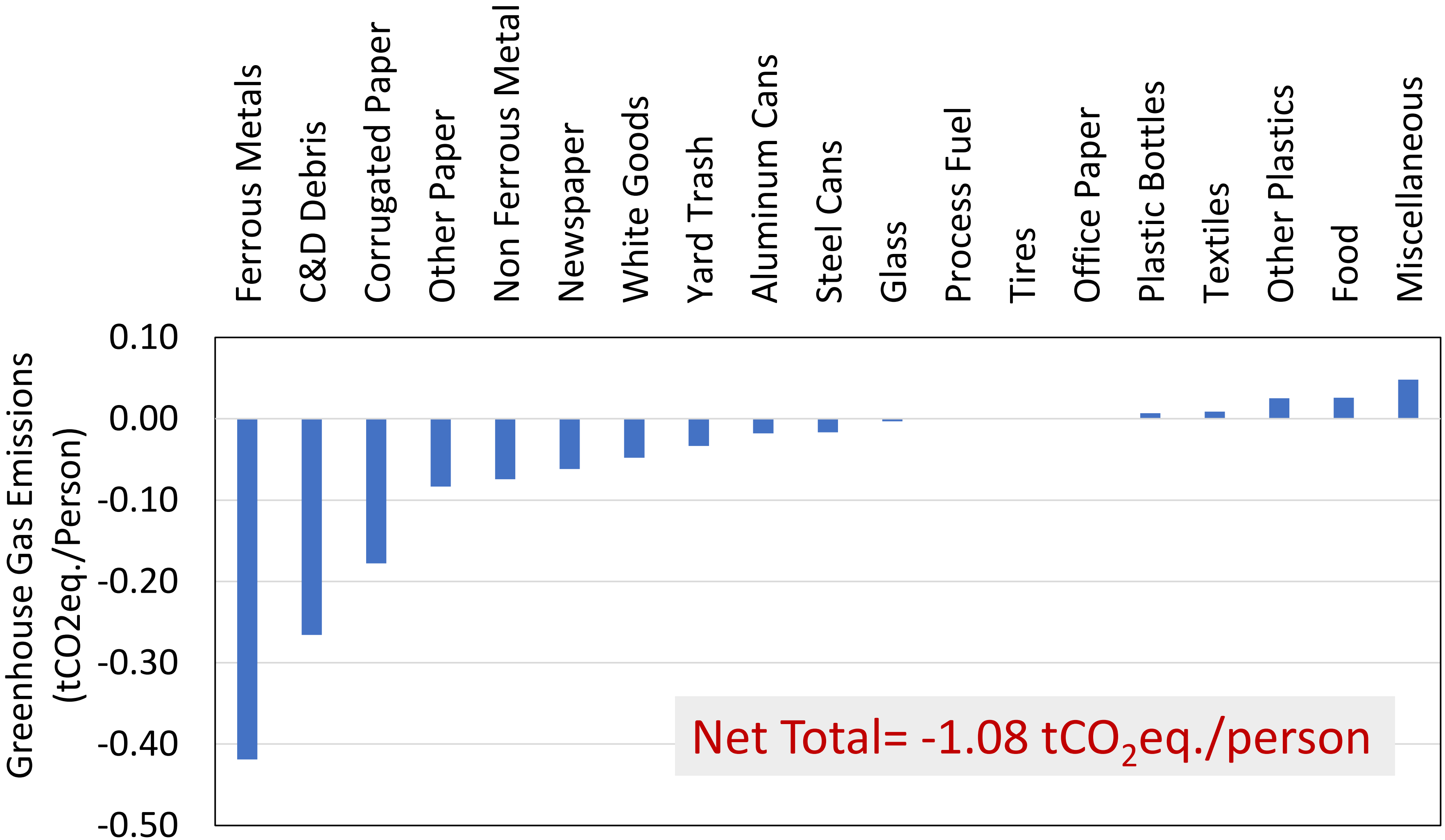
Energy Footprint = -12,900 MJ/person

GHG Footprint = -1.08 tCO2eq./person

2016 Energy Use Footprint



2016 GHG Emissions Footprint



Equivalent Current Environmental Impact

2016 GHG Emissions Footprint: -1.08 $tCO_2eq.$/ Person

=

4.7 million

Vehicles Taken off Road for One Year

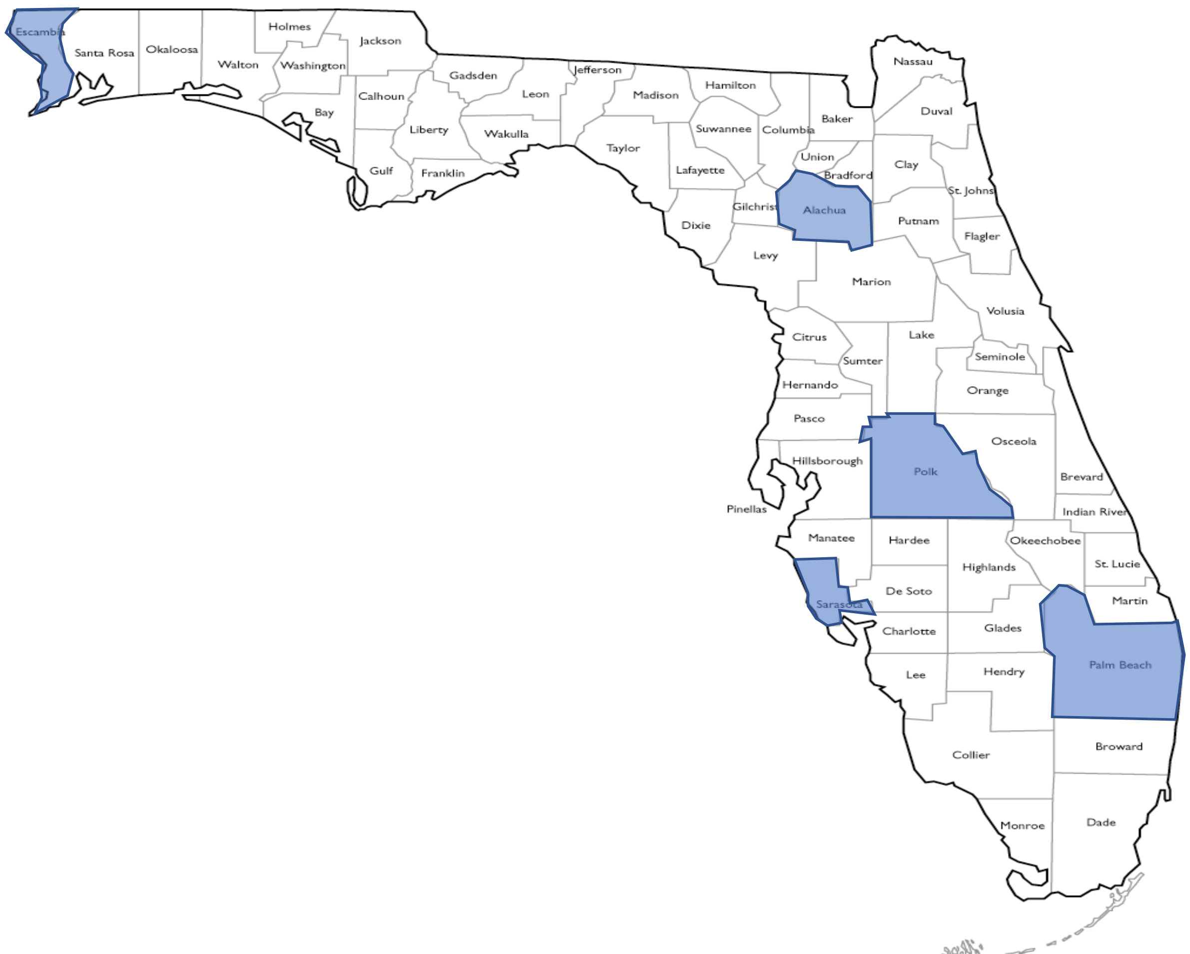
1.1 million

Garbage Trucks of Waste Recycled Instead of Landfilled

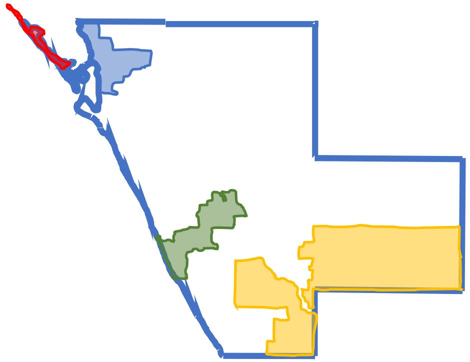
3.3 million

Homes Powered for One Year

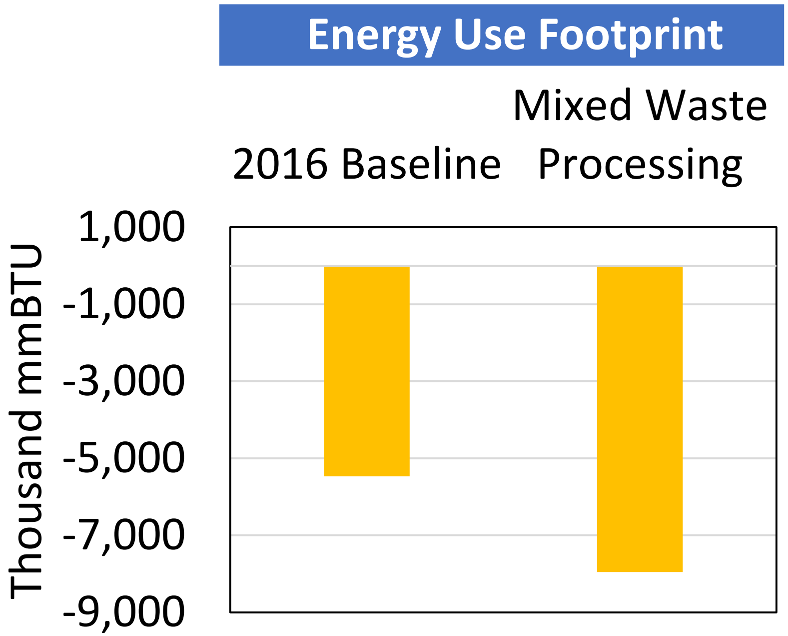
With local government partners, we illustrated the utility of these types calculations for different waste management options

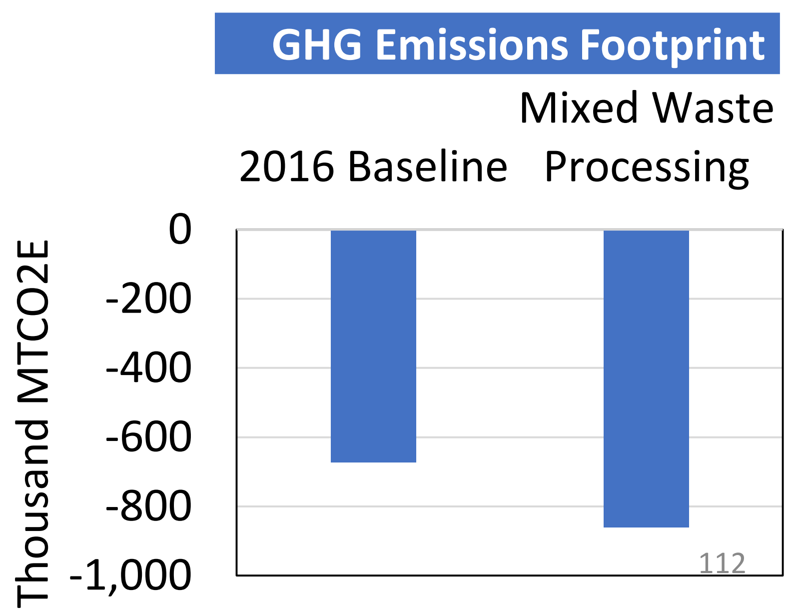


Sarasota County Case Study

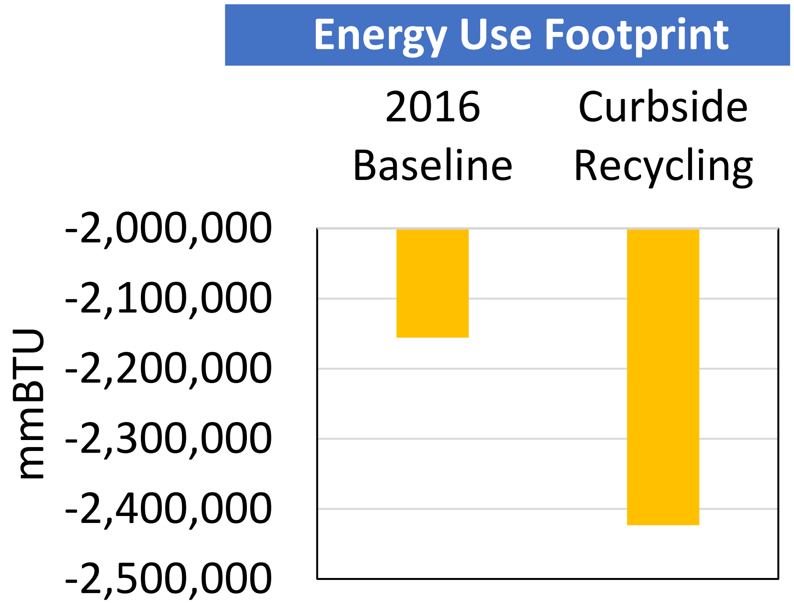


- The County looked at using WARM to evaluate different alternative scenarios, like a MWP alternative scenario
- Results showed that you can use MWP has more avoidance than the baseline
- This is because recycling offsets virgin material extraction, manufacturing, and transportation

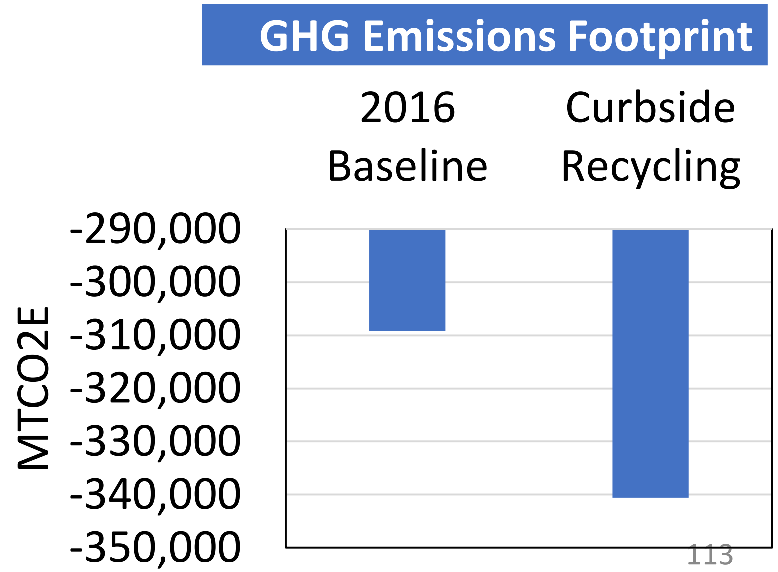




Alachua County Case Study



- The County looked at using WARM to evaluate different alternative scenarios, like increased curbside recycling alternative scenario
- Results showed that you can use increasing recycling has more avoidance than the baseline
- This is because recycling offsets virgin material extraction, manufacturing, and transportation

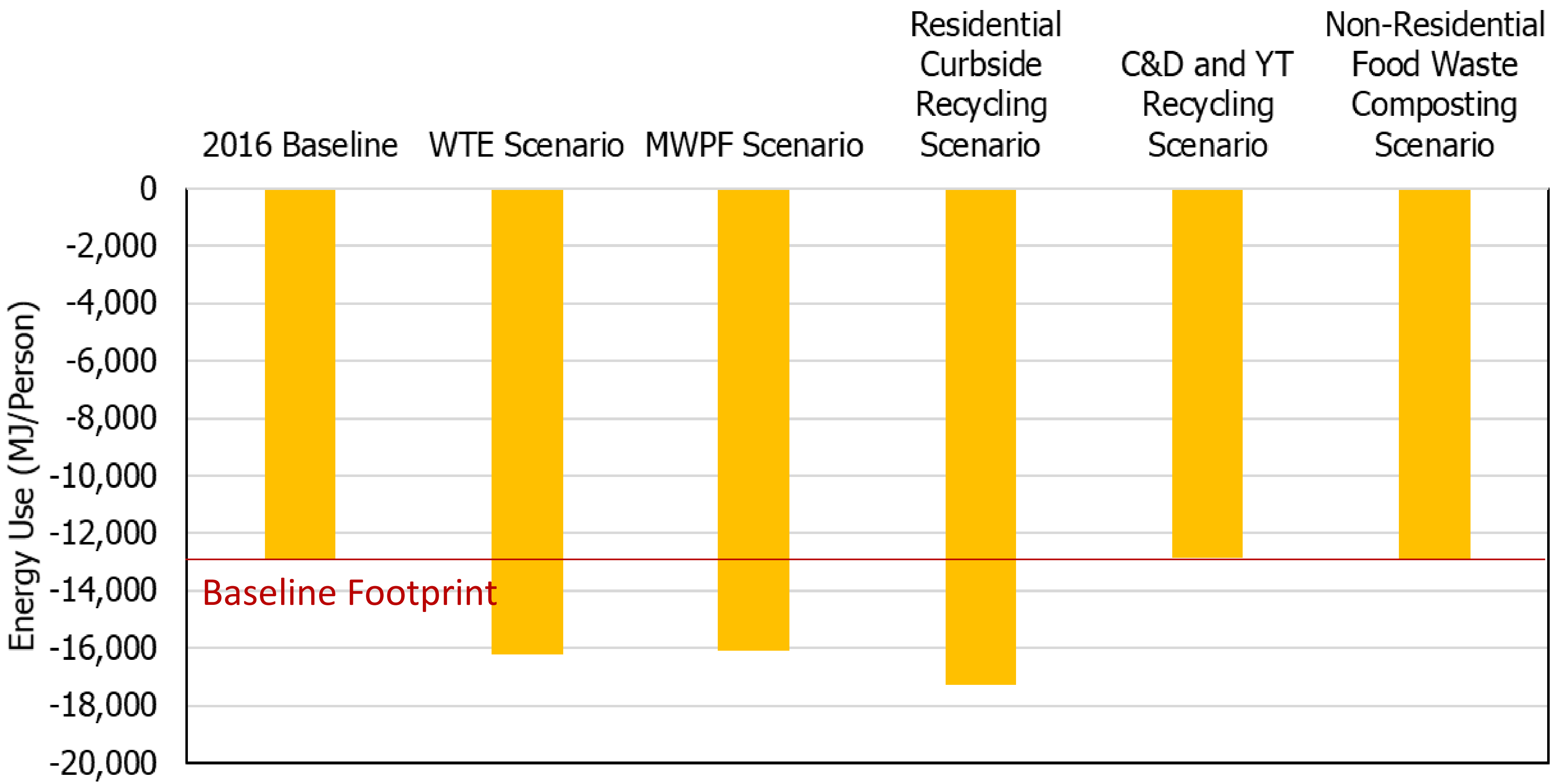


Possible Changes to Florida's Solid Waste Management Approach

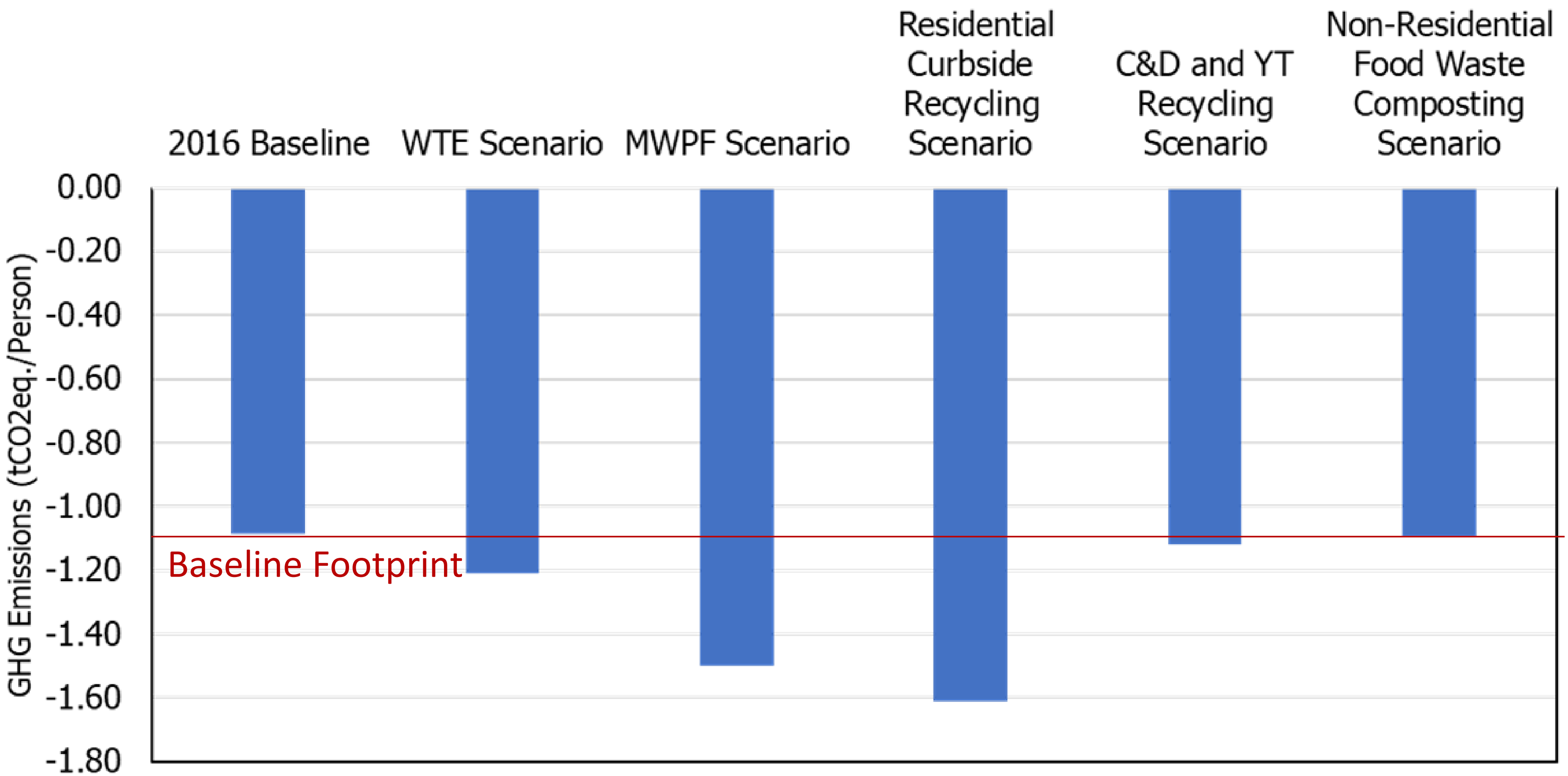
1. Waste-to-Energy (WTE) Approach
2. Mixed Waste Processing (MWP) Approach
3. Mandatory Residential Curbside Recycling Approach
4. Mandatory Construction & Demolition Debris (C&D) and Yard Trash (YT) Recycling Approach
5. Mandatory Non-Residential Food Waste Composting Approach

NOTE: Applied only to counties with populations of 150,000+

Statewide Alternatives Energy Use Footprint

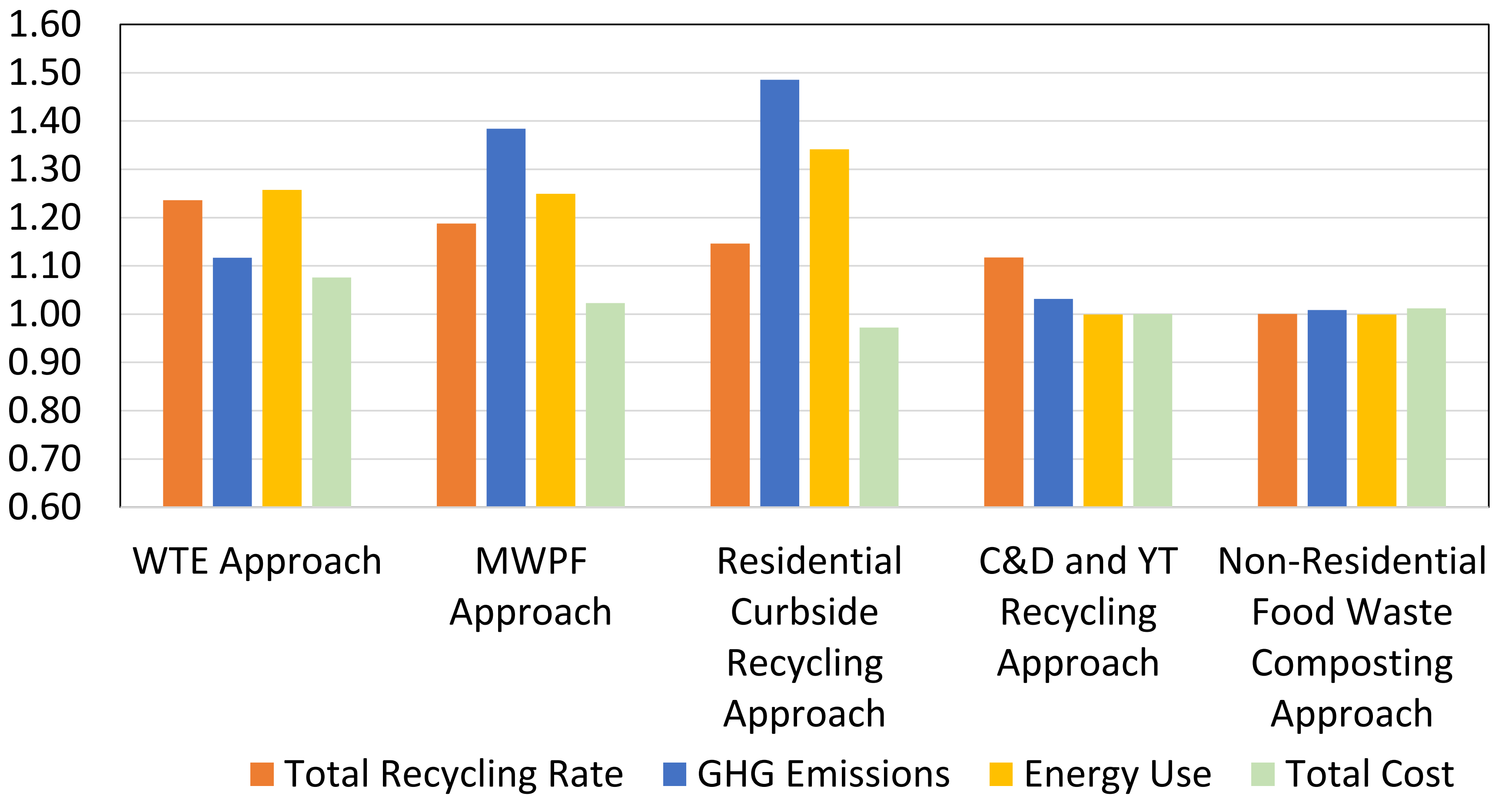


Statewide Alternatives GHG Emission Footprint



Approach Comparison Using SMM

Where 1 is equal to the baseline total recycling rate, total footprint, and total cost



Integrating SMM

- We are not on track to reach 75%
- Strategies do exist to increase our recycling rate, but no single strategy is going to get us there. Multiple approaches would need to be employed. These come with a cost.
- Tools exist to relate waste management to outcomes such as energy savings and GHG avoidance.
- How can this be integrated into statewide policy making?

Environmental Science & Technology

Article

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pubs.acs.org/est

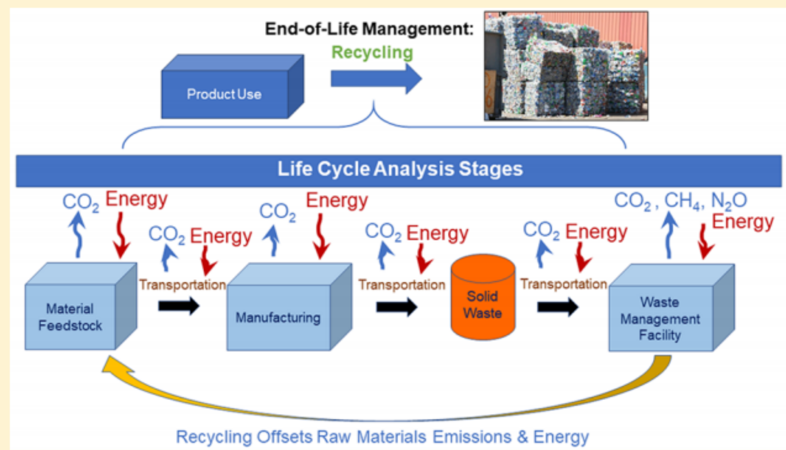
Replacing Recycling Rates with Life-Cycle Metrics as Government Materials Management Targets

Malak Anshassi, Steven Laux, and Timothy G. Townsend*

Department of Environmental Engineering Sciences, Engineering School of Sustainable Infrastructure and Environment, University of Florida, 333 New Engineering Building, P.O. Box 116450, Gainesville, Florida 32611-6450, United States

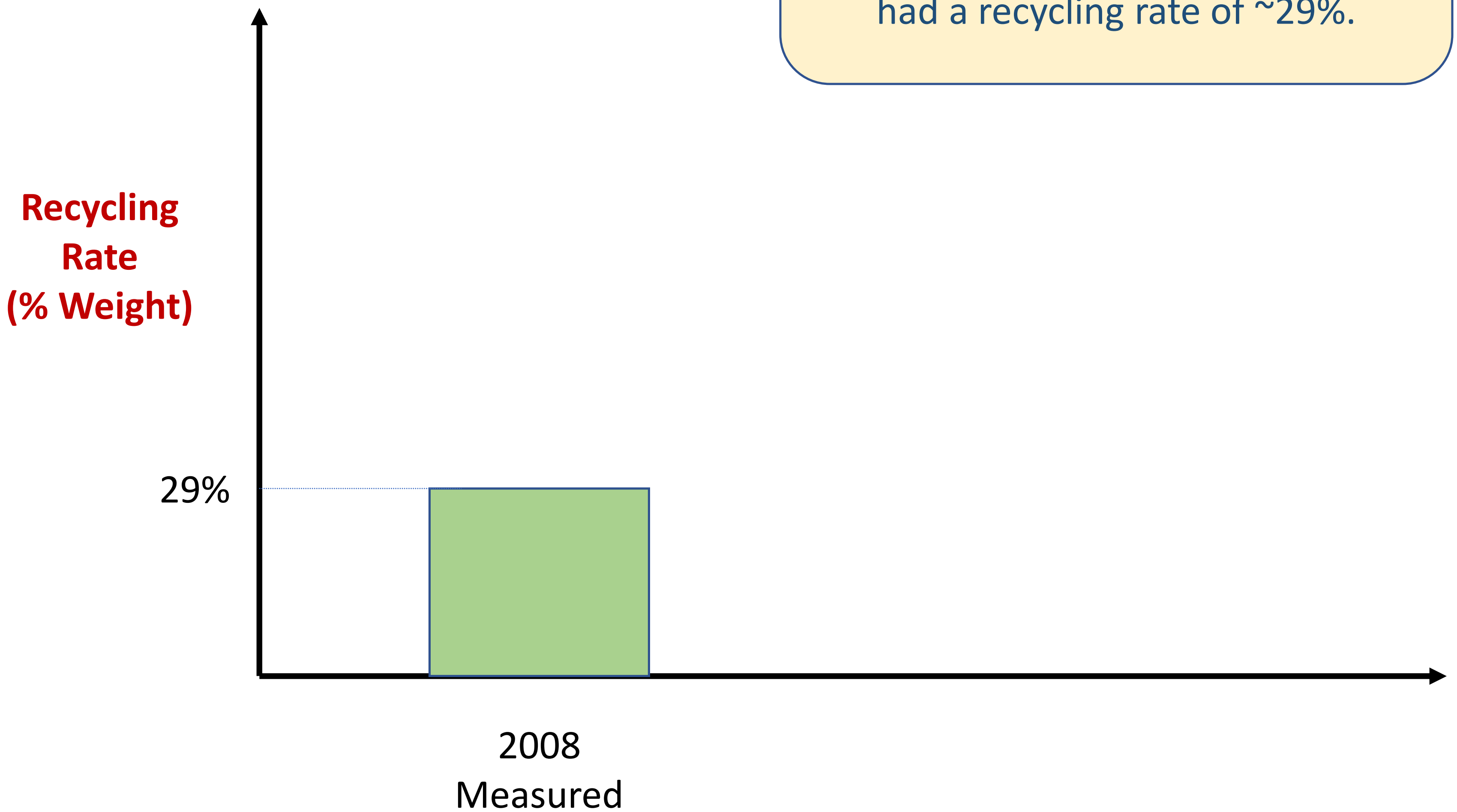
Supporting Information

ABSTRACT: In Florida, the passing of the Energy, Climate Change, and Economic Security Act of 2008 established a statewide mass-based municipal solid waste recycling rate goal of 75% by 2020. In this study, we describe an alternative approach to tracking performance of materials management systems that incorporates life-cycle thinking. Using both greenhouse gas (GHG) emissions and energy use as life-cycle indicators, we create two different materials management baselines based on a hypothetical 75% recycling rate in Florida in 2008. GHG emission and energy use footprints resulting from various 2020 materials management strategies are compared to these baselines, with the results normalized to the same mass-based 75% recycling rate. For most scenarios, LCI-normalized recycling rates are greater than mass-based recycling rates. Materials management strategies that include recycling of curbside-collected materials such as metal, paper, and plastic result in the largest GHG- and energy-normalized recycling rates. Waste prevention or increase, determined as the net difference in per-person mass discard rate for individual materials, is a major contributor to the life-cycle-normalized recycling rates. The methodology outlined here provides policy makers with one means of transitioning to life-cycle thinking in state and local waste management goal setting and planning.



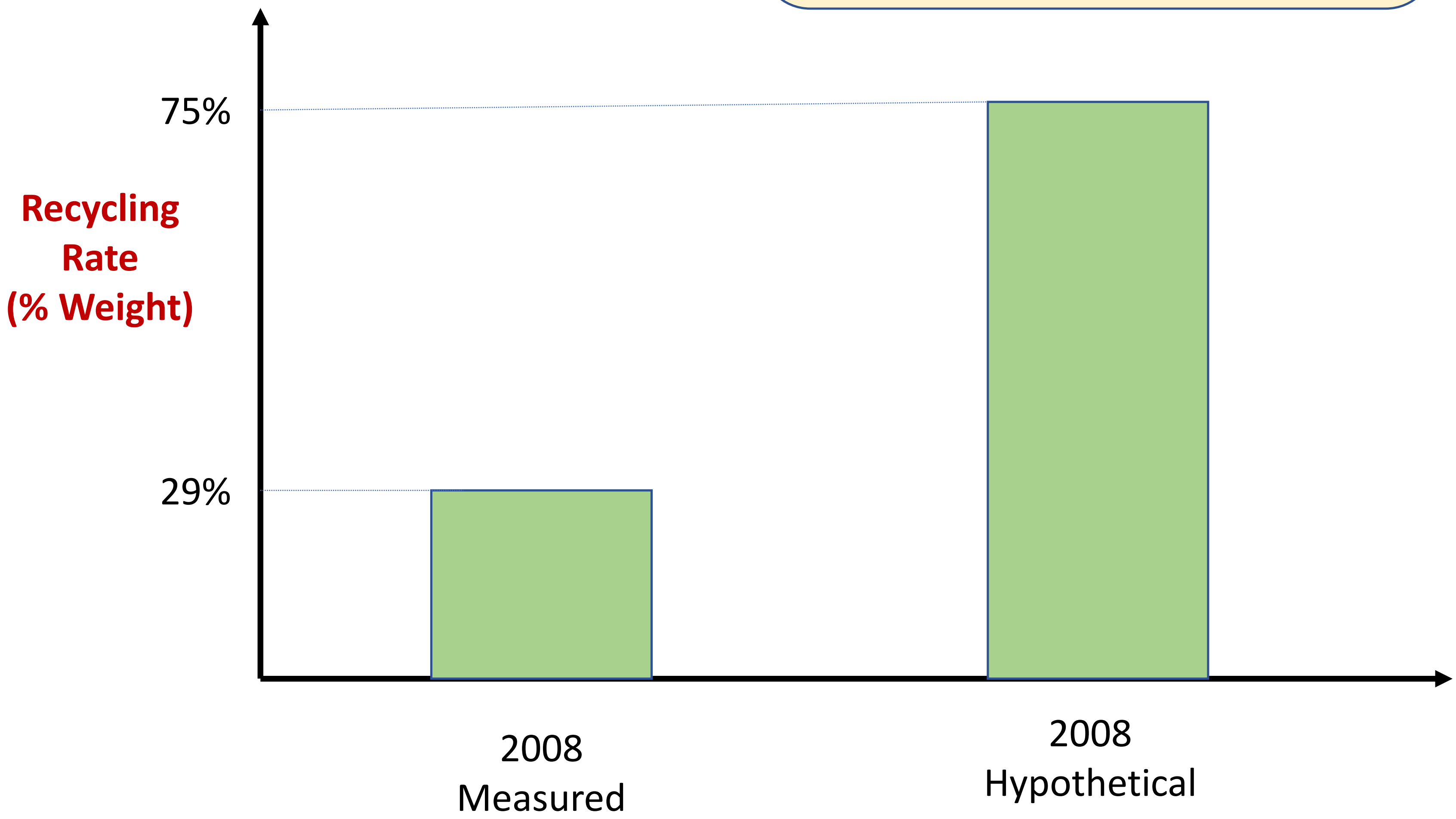
Approach

Since the statute was passed in 2008, let's set this as our baseline year. Originally in that year Florida had a recycling rate of ~29%.



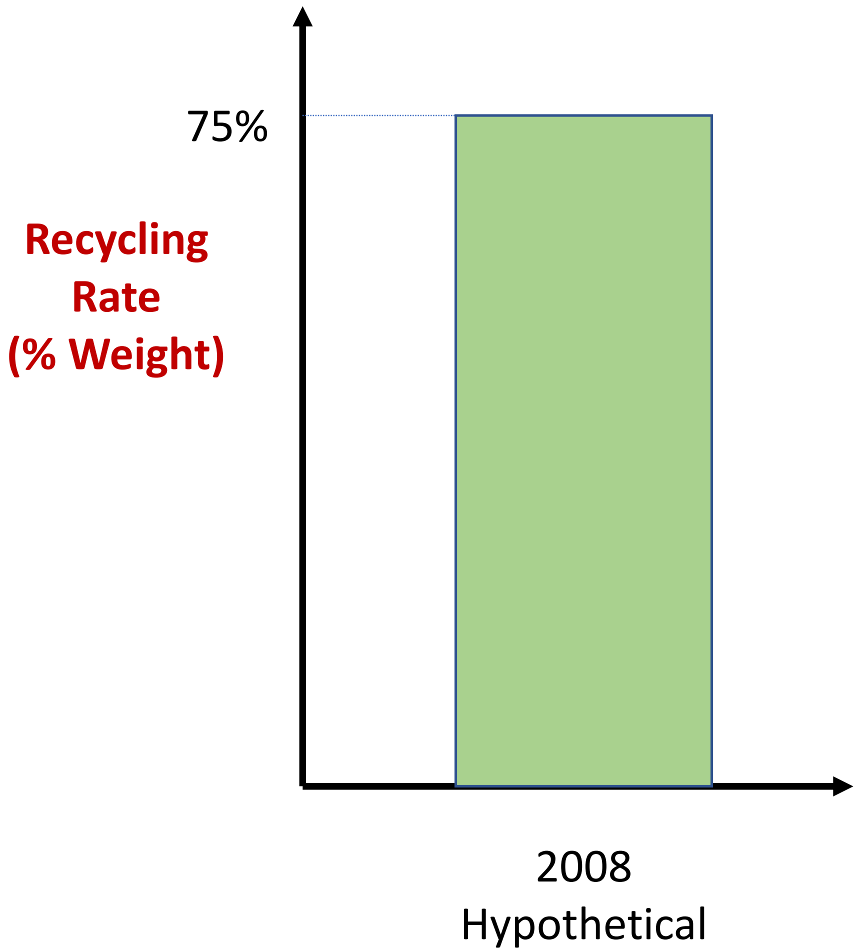
Approach

Then we come up with a hypothetical waste management scenario that reached 75% in 2008. We will use this to set the threshold the state will aspire to.



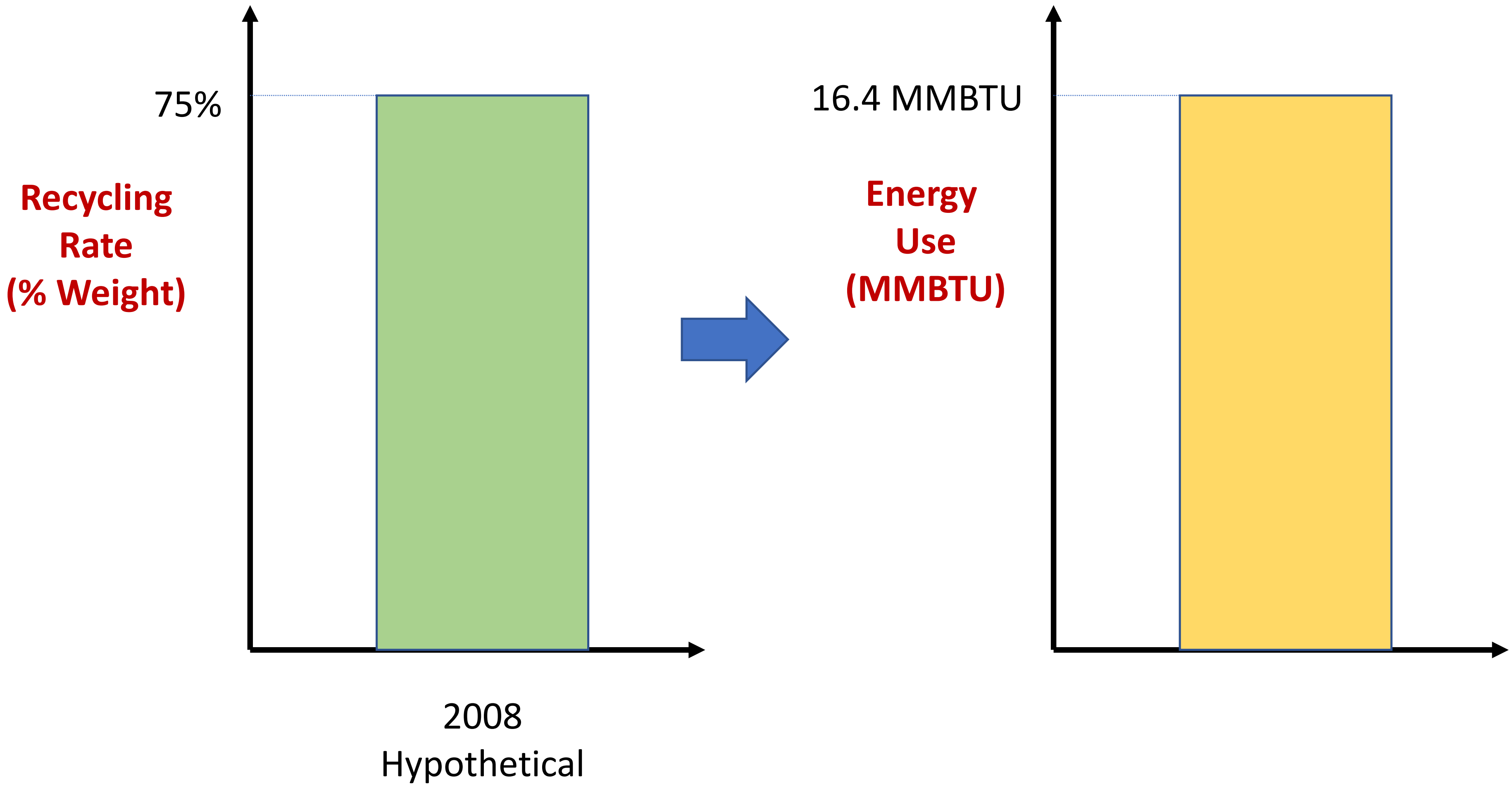
Approach

Use this hypothetical 75% recycling scenario, calculate a corresponding energy footprints (with WARM factors)

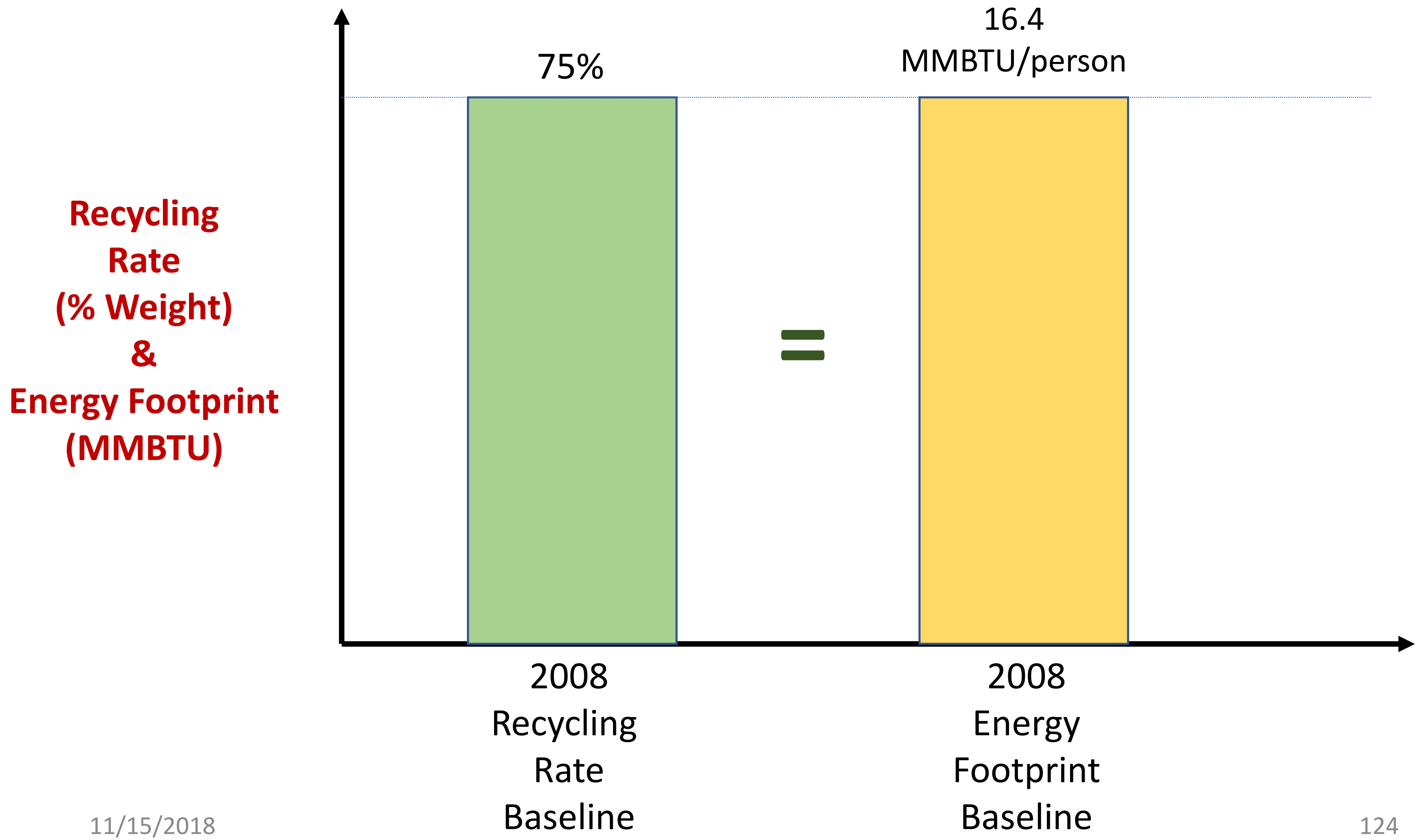


Calculate a “baseline” energy footprint

Approach

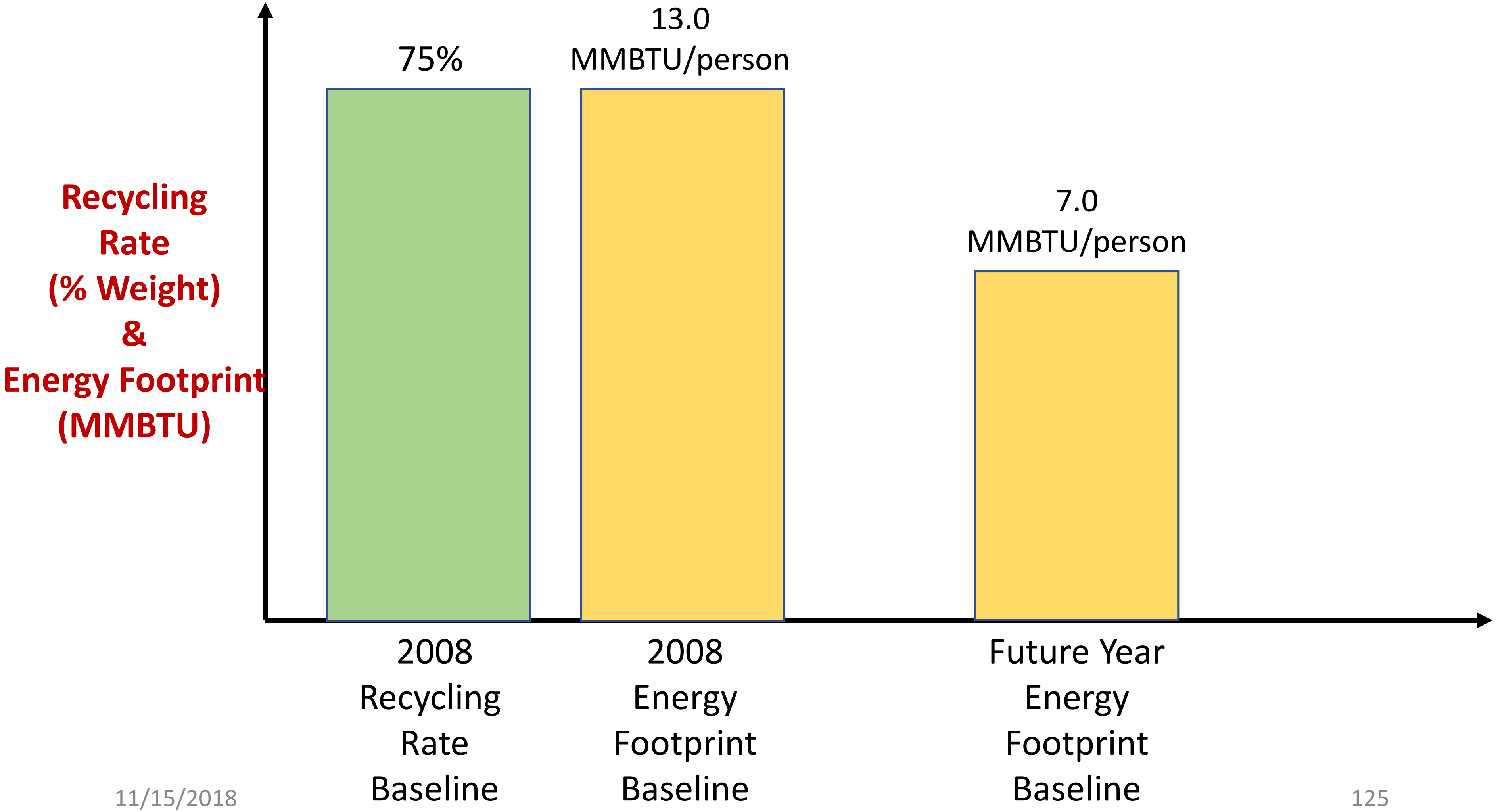


Approach



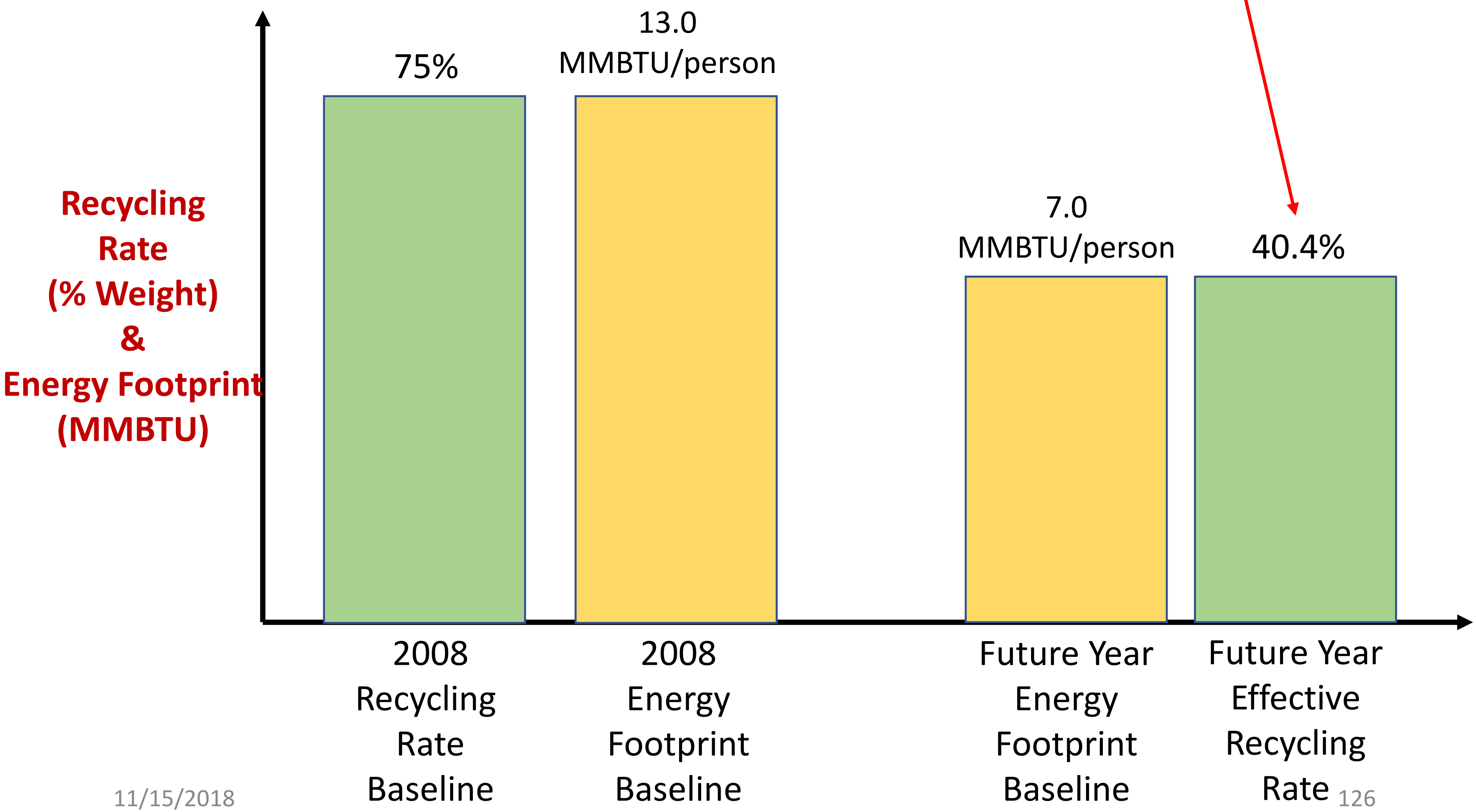
Recycling Rate (% Weight) & Energy Footprint (MMBTU)
75%
16.4 MMBTU/person
=
2008 Recycling Rate Baseline
2008 Energy Footprint Baseline

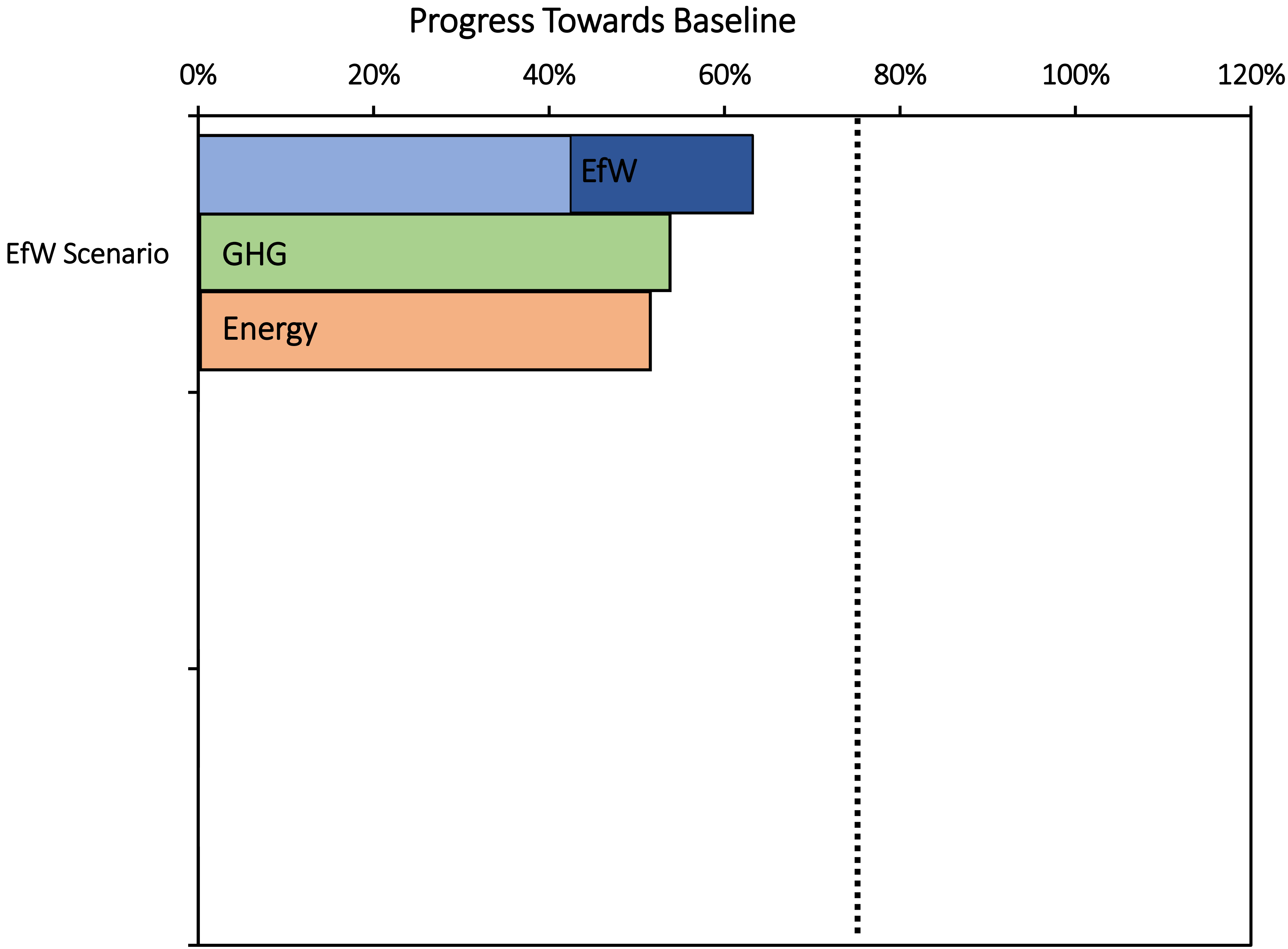
Approach


Recycling
Rate
(% Weight)
&
Energy Footprint
(MMBTU)
75%
13.0
MMBTU/person
7.0
MMBTU/person
2008
Recycling
Rate
Baseline
2008
Energy
Footprint
Baseline
Future Year
Energy
Footprint
Baseline

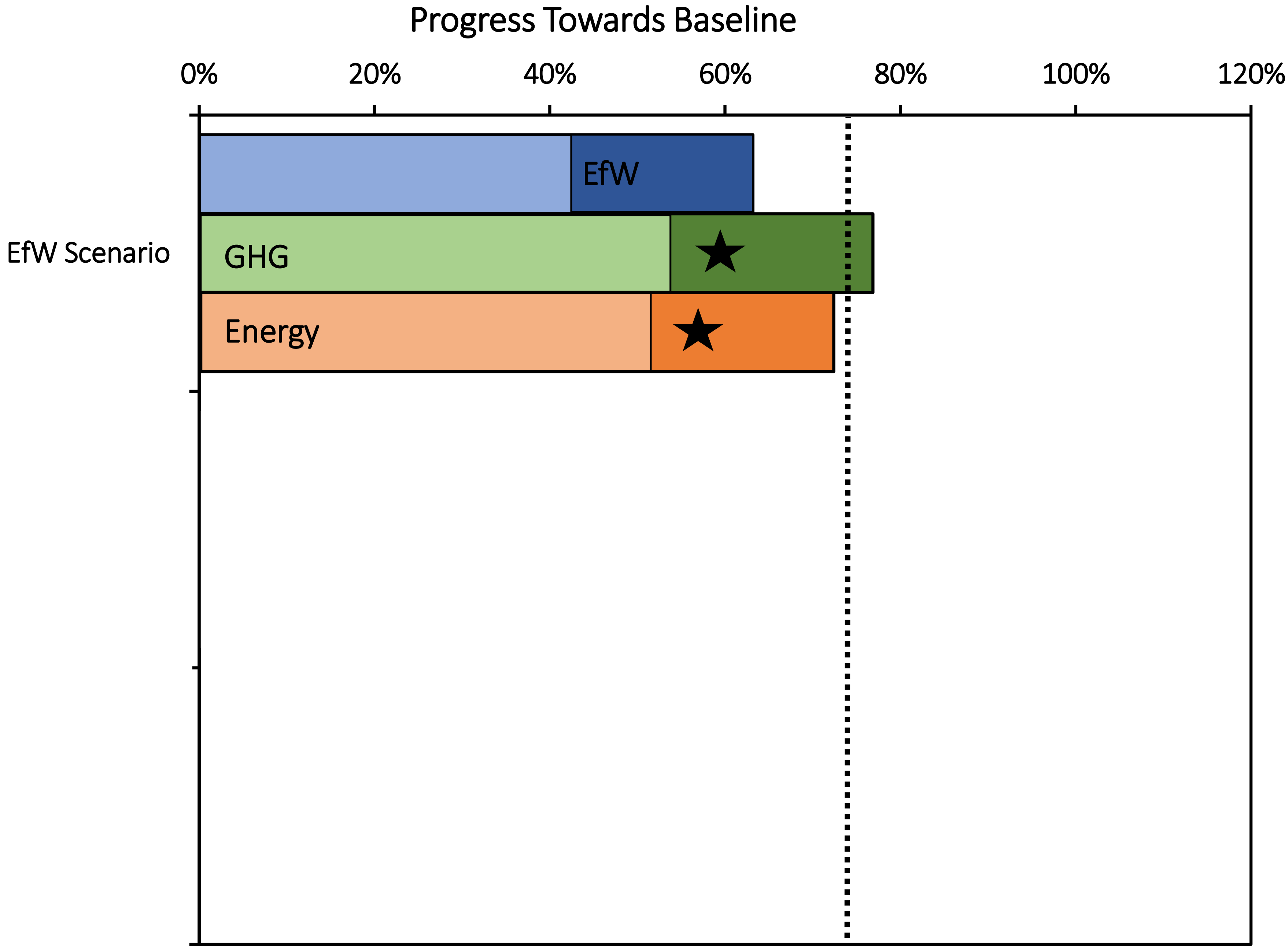
Approach

$$\frac{7.0}{13.0} \times 75\% = 40.4\%$$

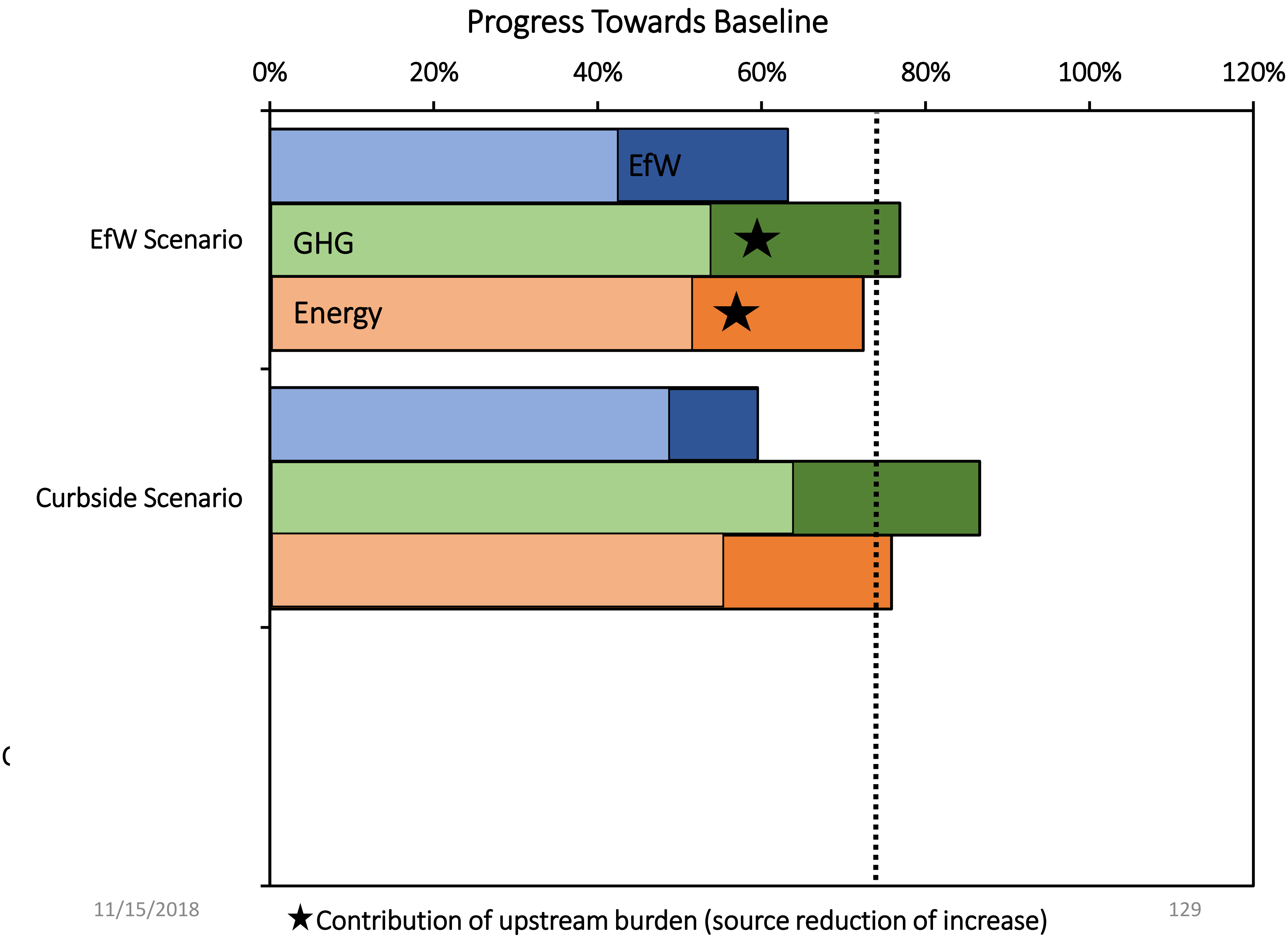




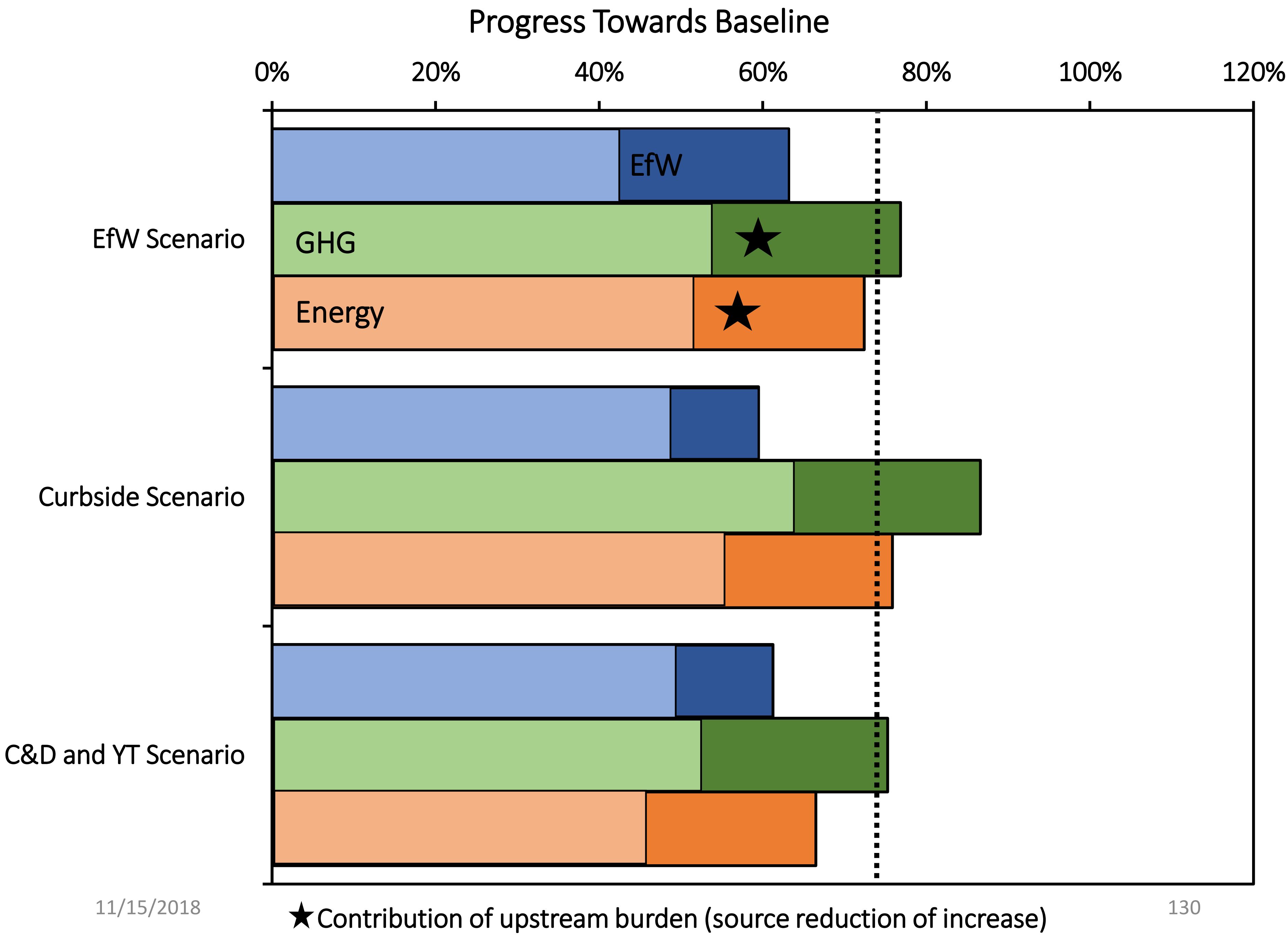
★Contribution of upstream burden (source reduction of increase)

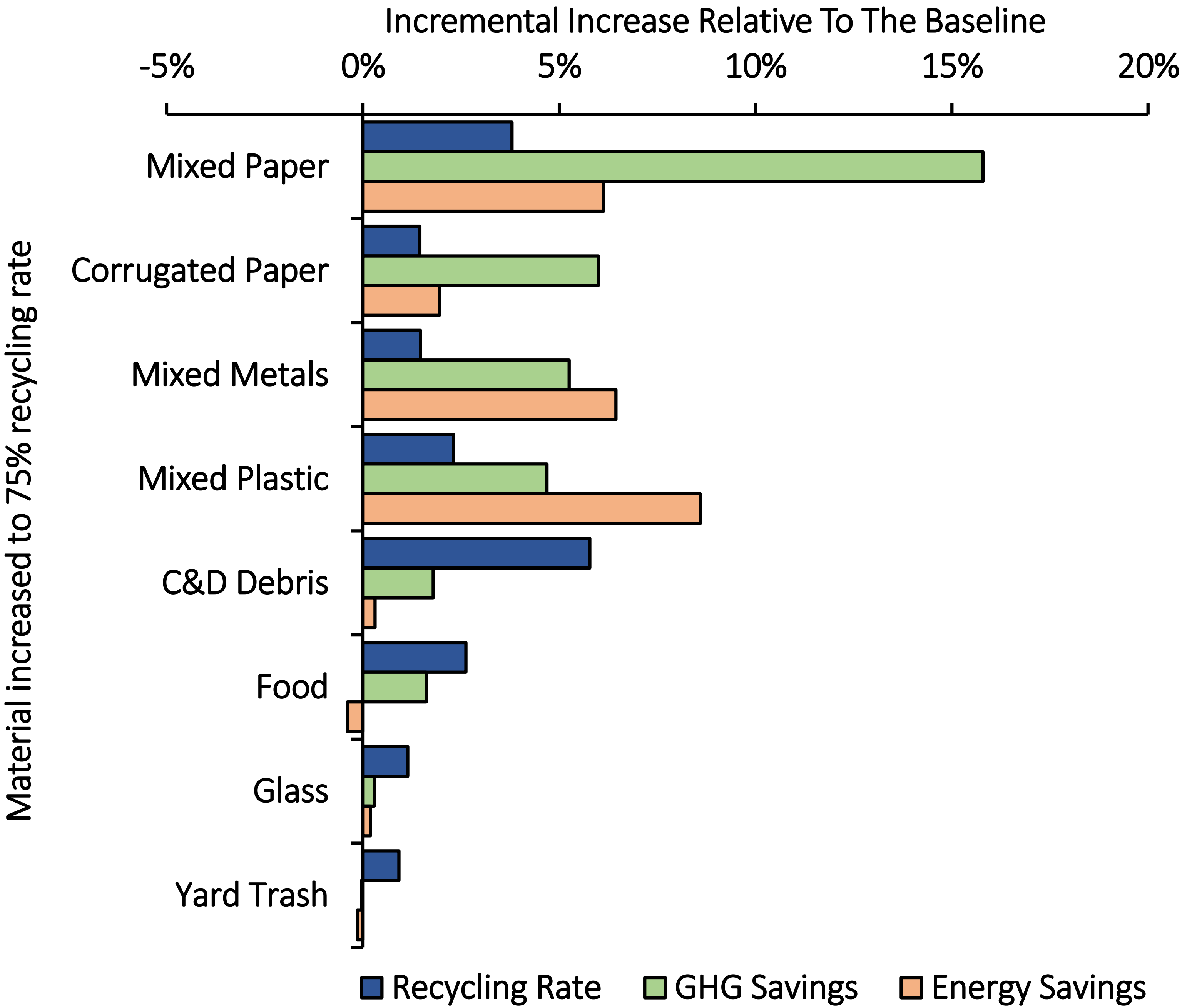


★Contribution of upstream burden (source reduction of increase)



Progress Towards Baseline
0%
20%
40%
60%
80%
100%
120%
EfW
GHG
Energy
EfW Scenario
Curbside Scenario
★Contribution of upstream burden (source reduction of increase)


Progress Towards Baseline
0%
20%
40%
60%
80%
100%
120%
EfW Scenario
Curbside Scenario
C&D and YT Scenario
EfW
GHG
Energy
★Contribution of upstream burden (source reduction of increase)



Incremental Increase Relative To The Baseline
-5%
0%
5%
10%
15%
20%
Material increased to 75% recycling rate
Mixed Paper
Corrugated Paper
Mixed Metals
Mixed Plastic
C&D Debris
Food
Glass
Yard Trash
Recycling Rate
GHG Savings
Energy Savings

Lessons

- Source reduction is very important
- Depending on which outcome you evaluated, results among materials differ
- But we have to be careful about how we interpret results. Remember the goal of SMM is look at the whole materials life cycle.

Example: Bottled vs Canned Beer

- Aluminum Can
  - Weight of can: 15g
  - Recycling rate: 33%
  - WARM GHG Emission Factor:
    -9.11 MTCO2E.ton
- Glass Bottle
  - Weight of can: 170g
  - Recycling rate: 10%
  - WARM GHG Emission Factor:
    -0.28 MTCO2E.ton

Example: Bottled vs Canned Beer

- Aluminum Can
  - Weight of can: 15g
  - Recycling rate: 33%
  - WARM GHG Emission Factor:
    -9.11 MTCO2E.ton
- End-of-life footprint for 1,000,000 beers
  - -49.3 MTCO2E

- Glass Bottle
  - Weight of can: 170g
  - Recycling rate: 10%
  - WARM GHG Emission Factor:
    -0.28 MTCO2E.ton
- End-of-life footprint for 1,000,000 beers
  - -1.53 MTCO2E

Example: Bottled vs Canned Beer

- Aluminum Can
  - Weight of can: 15g
  - Recycling rate: 33%
  - WARM GHG Emission Factor: -9.11 MTCO2E.ton
- End-of-life footprint for 1,000,000 beers
  - -49.3 MTCO2E
- Including manufacture:
  - 101.0 MTCO2E

- Glass Bottle
  - Weight of can: 170g
  - Recycling rate: 10%
  - WARM GHG Emission Factor: -0.28 MTCO2E.ton
- End-of-life footprint for 1,000,000 beers
  - -1.53 MTCO2E
- Including manufacture:
  - 97.6 MTCO2E

Next Steps for Research Team

- Continue exploring methods for integrating SMM into decision making options
- Go beyond GHG and energy as outcomes to evaluate
- Develop a tool that can be used by Counties to track their SMM footprint or recycling rate

Next Steps for Florida

Options

Options

- Do nothing

Options

- Do nothing
- Keep the current 75% goal, but extend the deadline

Options

- Do nothing
- Keep the current 75% goal, but extend the deadline
- Make a new weight-based goal

Options

- Do nothing
- Keep the current 75% goal, but extend the deadline
- Make a new weight-based goal
- Integrate SMM into new goals

Options

- Do nothing
- Keep the current 75% goal, but extend the deadline
- Make a new weight-based goal
- Integrate SMM into new goals

Let's take a closer look at two other states:
Oregon
Maryland

Oregon & SMM

(1) The Environmental Quality Commission shall adopt a statewide integrated solid waste management plan. The plan shall include, but need not be limited to, the following components of solid waste management:

(a) Waste prevention;

(b) Recycling;

(c) Solid waste collection and processing;

(d) Composting and energy recovery;

(e) Incineration;

(f) Disposal;

(g) Disposal capacity and facility siting; **and**

(h) Transportation.

https://www.oregonlaws.org/ors/459A.020

Maryland & SMM

B. Sustainable Materials Management Policy. It is the policy of the State that solid waste and recycling planning should, to the extent practicable, seek to:

(1) Minimize the environmental impacts of materials management over their entire life cycles, including from product design to production, consumption, and end-of-life management;

(2) Conserve and extend existing in-State disposal capacity through source reduction, reuse, and recycling;

(3) Capture and make optimal use of recovered resources, including raw materials, water, energy, and nutrients; and

(4) Work toward a system of materials management that is both environmentally and economically sustainable in the long term.

http://mde.maryland.gov/programs/LAND/RecyclingandOperationsprogram/Documents/EO-01.01.2017.13.pdf

Options for Integrating SMM

- Require FDEP or Counties to develop a SMM plan
- Use SMM outcomes to prioritize other specific regulatory or policy changes
- Require SMM metrics to be tracked at County level
- Replace 75% with an SMM-based target

Open Discussion

http://www.essie.ufl.edu/home/townsend/research/florida-solid-waste-issues/hc16/

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Engineering School of Sustainable Infrastructure & Environment

Dr. Timothy G. Townsend

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Home > Research > Florida Solid Waste Issues > Florida Solid Waste Management

Florida Solid Waste Management: State of the State

As new methods for the management of solid wastes are developed and refined, questions are often posed about the economic and environmental merits of these strategies. Finding the most suitable processes to answer these questions are still at large. In order to find solutions, a comprehensive analysis on the economic assessment of the available strategies and technologies for solid waste management in Florida, along with an evaluation of the environmental footprints of these approaches must be conducted. This reseach aims to uncover this information to achieve an estimate for the current material flow for the Florida solid waste stream, and develop a database of current and historic waste commodity prices.This project is funded by the Hinkley Center for Solid and Hazardous Waste Management. Project Scope: HC16Scope

Progress Reports

Progress Report 1: HC16PR01

Progress Report 2: HC16PR02

Progress Report 3: HC16PR03

Progress Report 4: HC16PR04

TAG Meeting Presentations

January 2017 TAG Meeting: HC16STAKEHOLDERFEB10

October 2017 TAG Meeting: HC16STAKEHOLDEROCT05