Stakeholder Working Group Meeting: Looking beyond Florida's 75% Recycling Goal: Development of a Methodology and Tool for Assessing Sustainable Materials Management Recycling Rates in Florida

May 13th, 2019

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

University of Florida

Hinkley Center for Solid and Hazardous Waste Management

Projects History

2016
Hinkley Center Florida Solid Waste Management: State of the State **(HC16/17 Project)**

2018
FDEP WasteCalc Upate

2019
Hinkley Center Looking beyond Florida's 75% Recycling Goal: Development of a Methodology and Tool for Assessing Sustainable Materials Management Recycling Rates in Florida **(HC17/18 Project)**

2019
FDEP WasteCalc & Waste Compositions

2019
Hinkley Center An Integrated Tool for Local Government to Track Materials Management and Progress toward Sustainability Goals **(HC19/20 Project)**

Today's Goals

Introductions/Agenda

↓

Previous HC 16/17 Project Results

↓

HC 18/19 Project Overview & Progress

↓

Next Steps and HC 19/20 Project

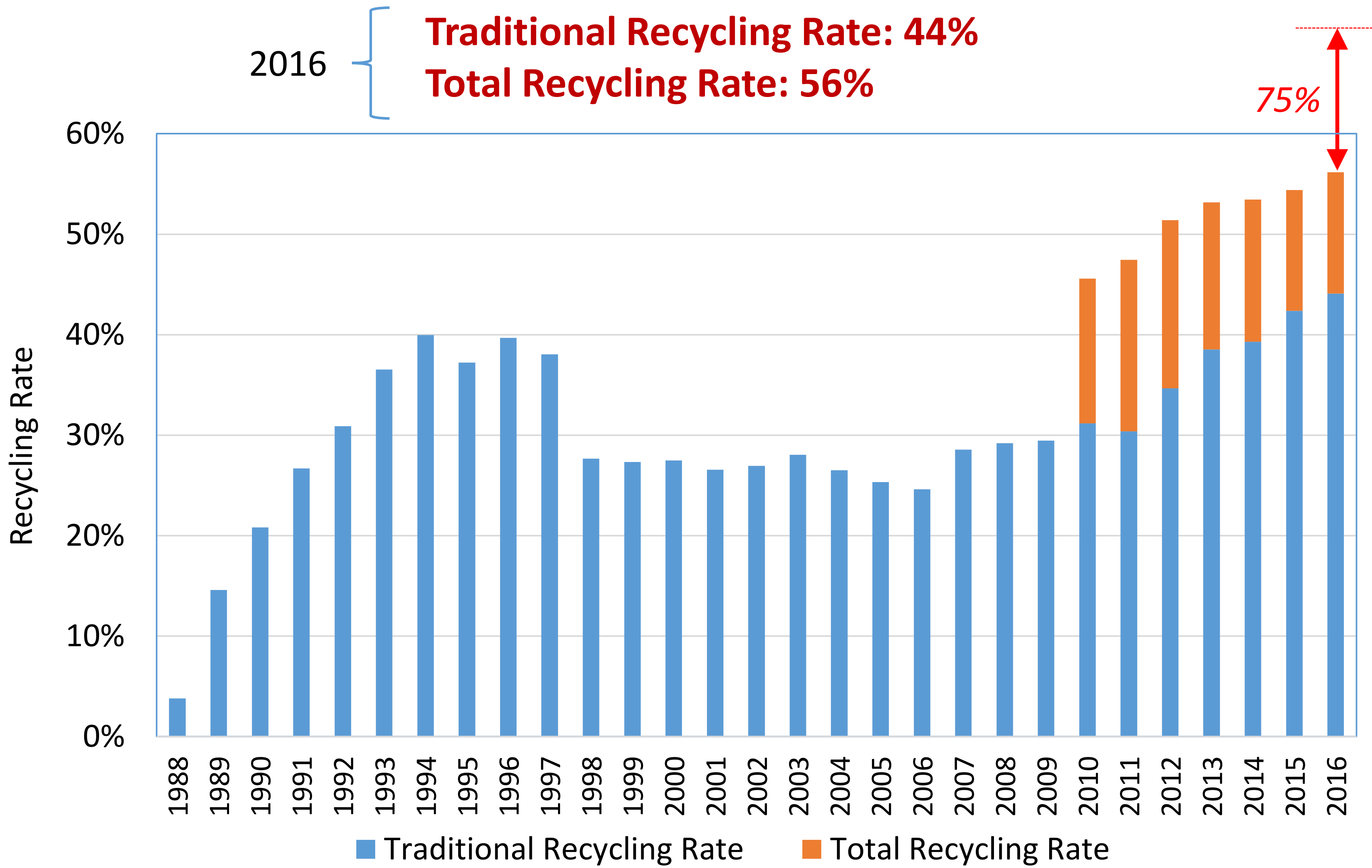
Agenda

Activity	Schedule
Introductions, Motivation, Objectives	12:30-12:40 am
Previous HC 16/17 Project Results	12:40-1:00 pm
HC 18/19 Project Overview & Progress	1:00-1:55 pm
Next Steps and HC 19/20 Project	1:55-2:15 pm
Discussion	2:15-2:30 pm
Adjourn	2:30 pm

Florida Solid Waste Management: State of the State (HC16/17) Project Overview

- Motivated by the 75% recycling rate goal
- Assessed the waste mass flow by generator, management, and material type
- Estimated the costs associated with waste collection and management
- Estimated the waste management GHG and energy footprints
- Evaluated potential management approaches to reach 75% recycling rate
- Developed a method to incorporate SMM into waste goals

Florida's Recycling Rate



Florida Solid Waste Management: State of the State

For 2016

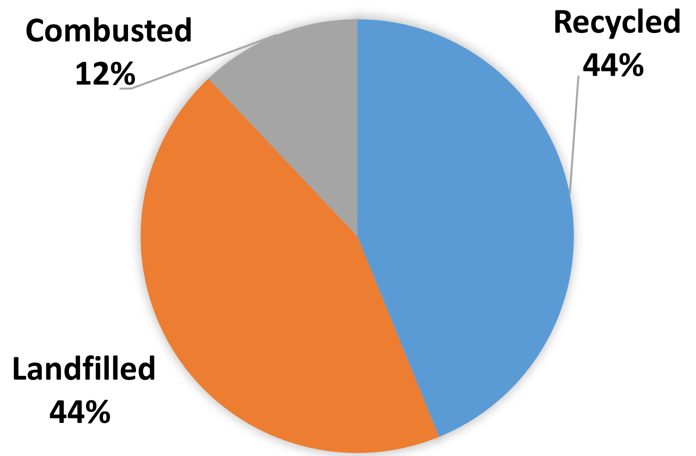
12.35 million tons residential

9.15 million tons non-residential

11.30 million tons C&D Debris

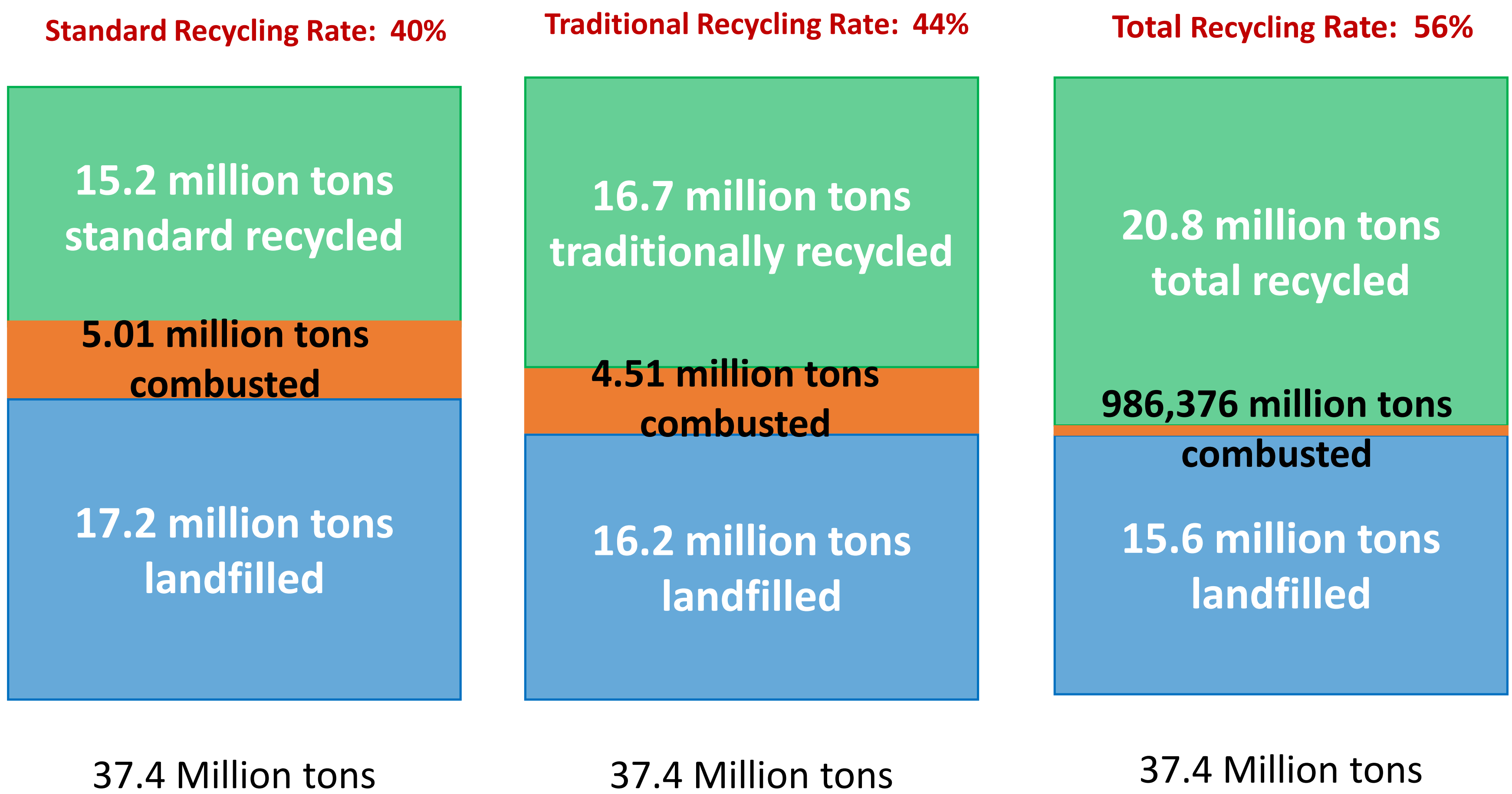
4.20 million tons yard trash

37.4 Million tons

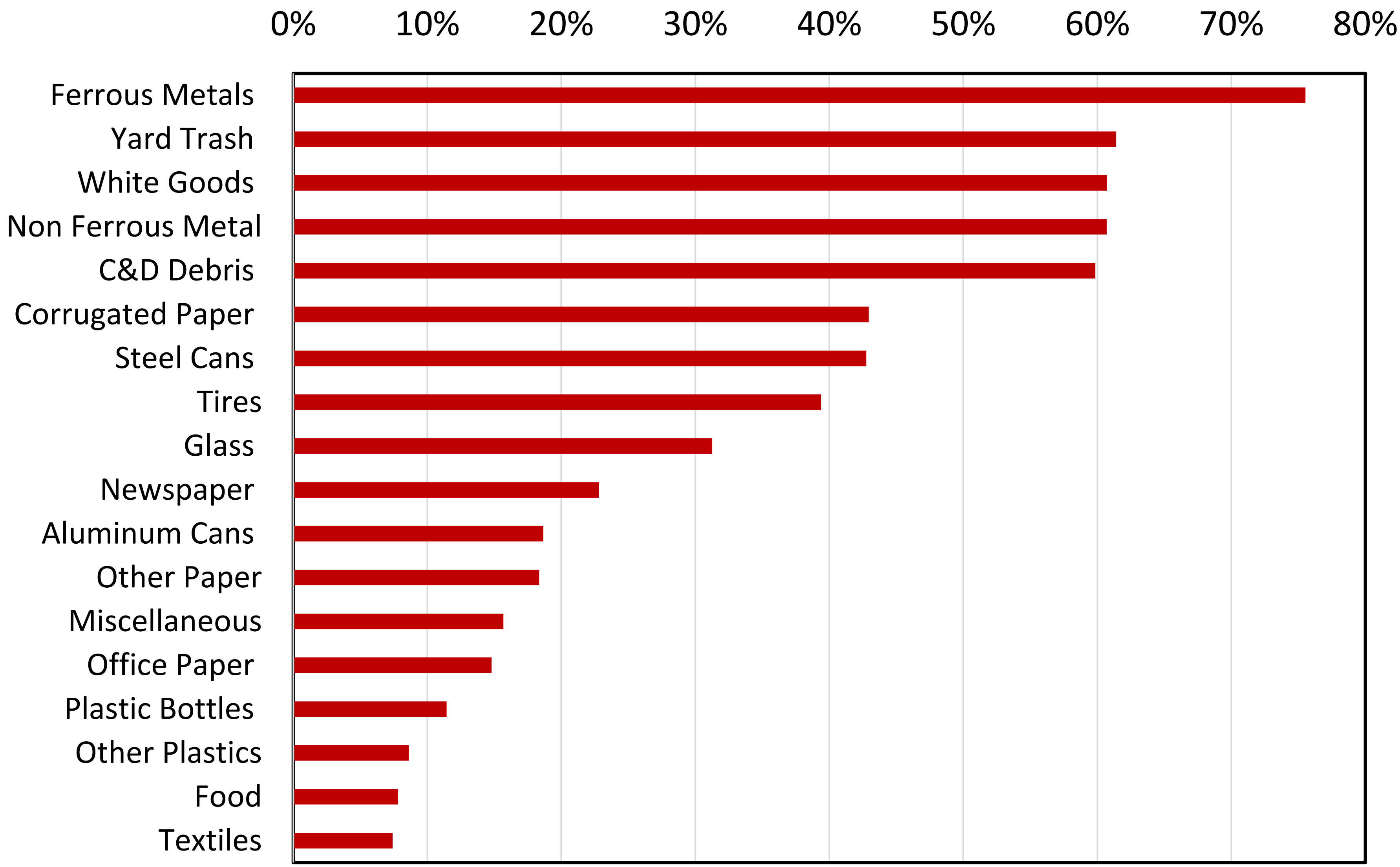


Standard Recycling Rate: 40%
Traditional Recycling Rate: 44%
Total Recycling Rate: 56%

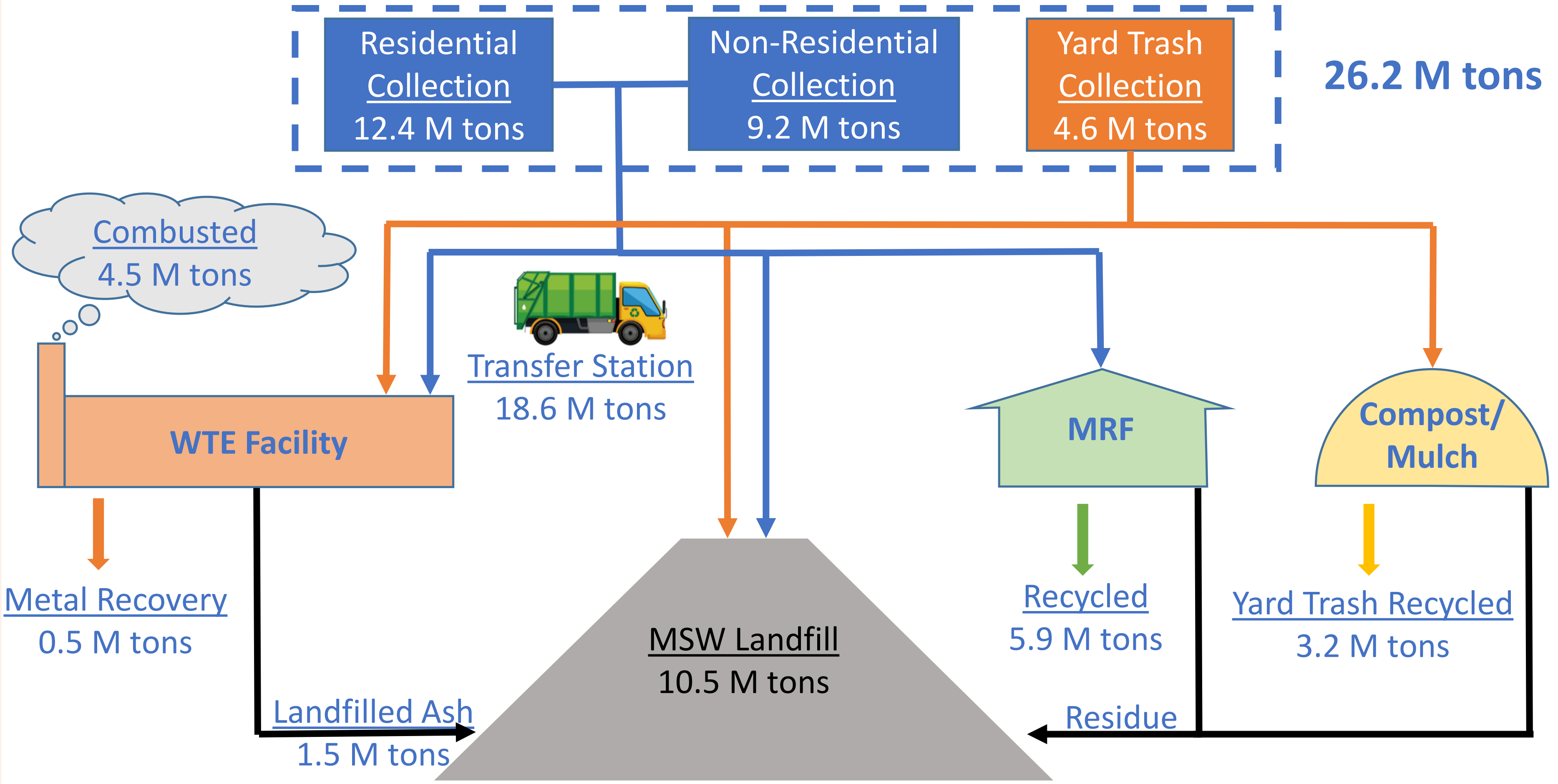
Calculation of Recycling Rates (2016)



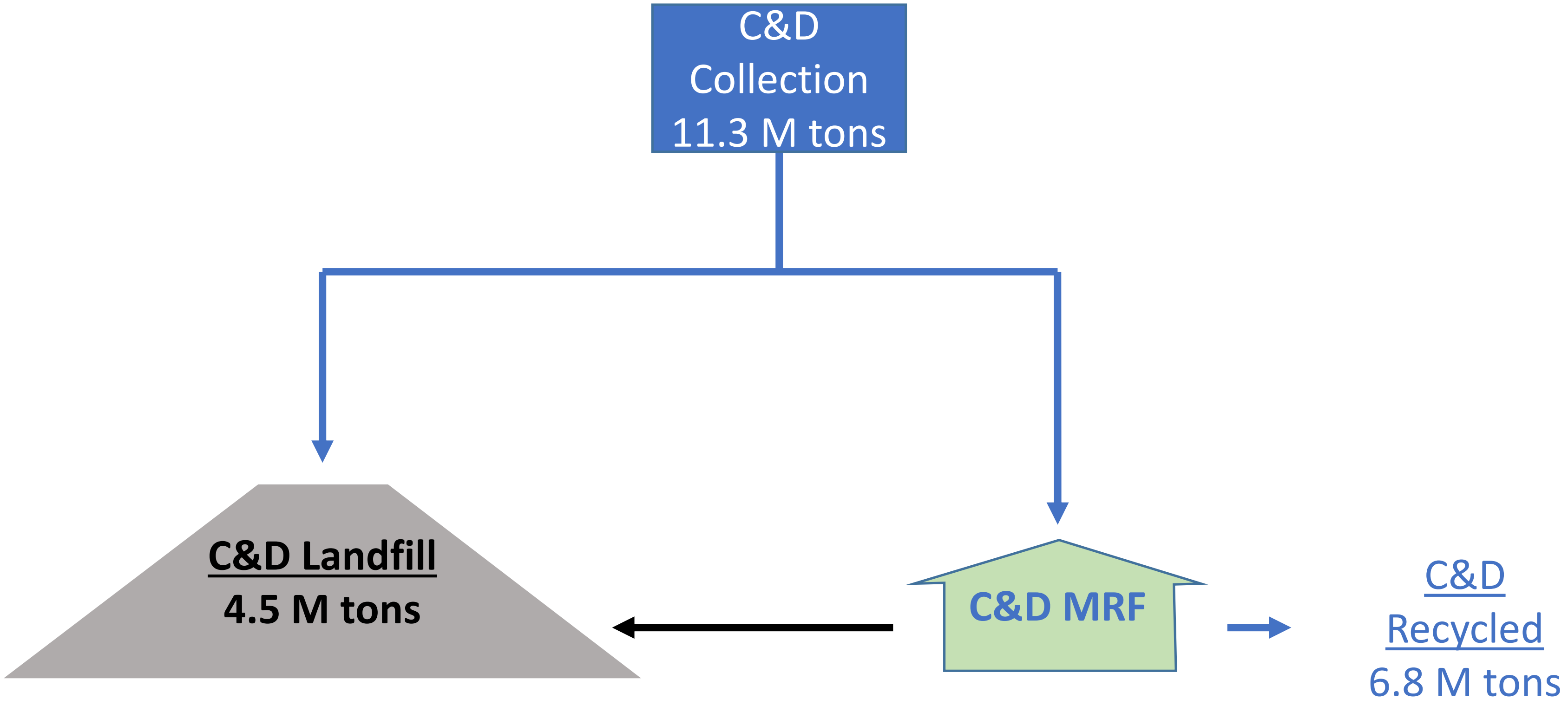
Material's Recycling Rate (2016)



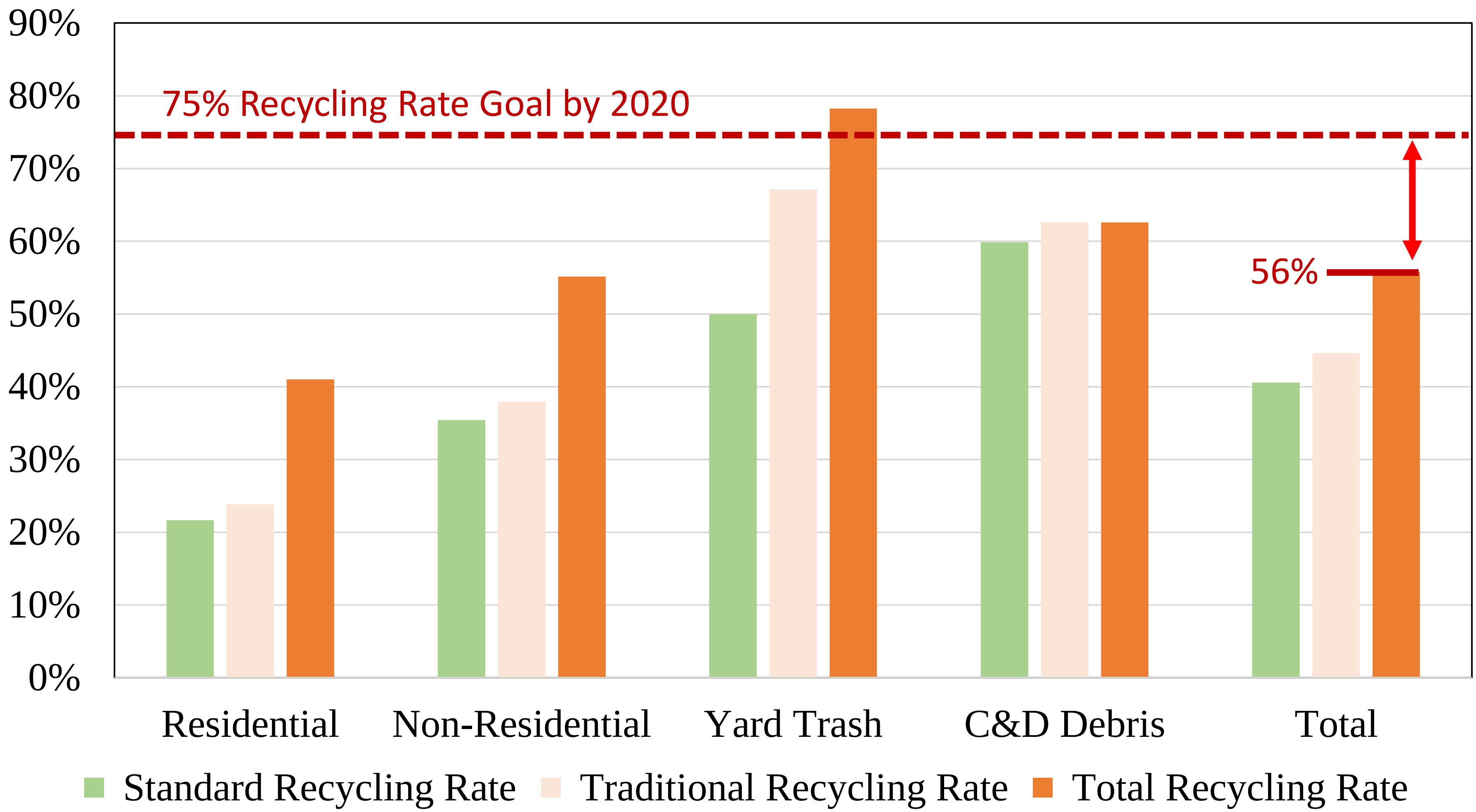
Florida Material Mass Flow (2016)



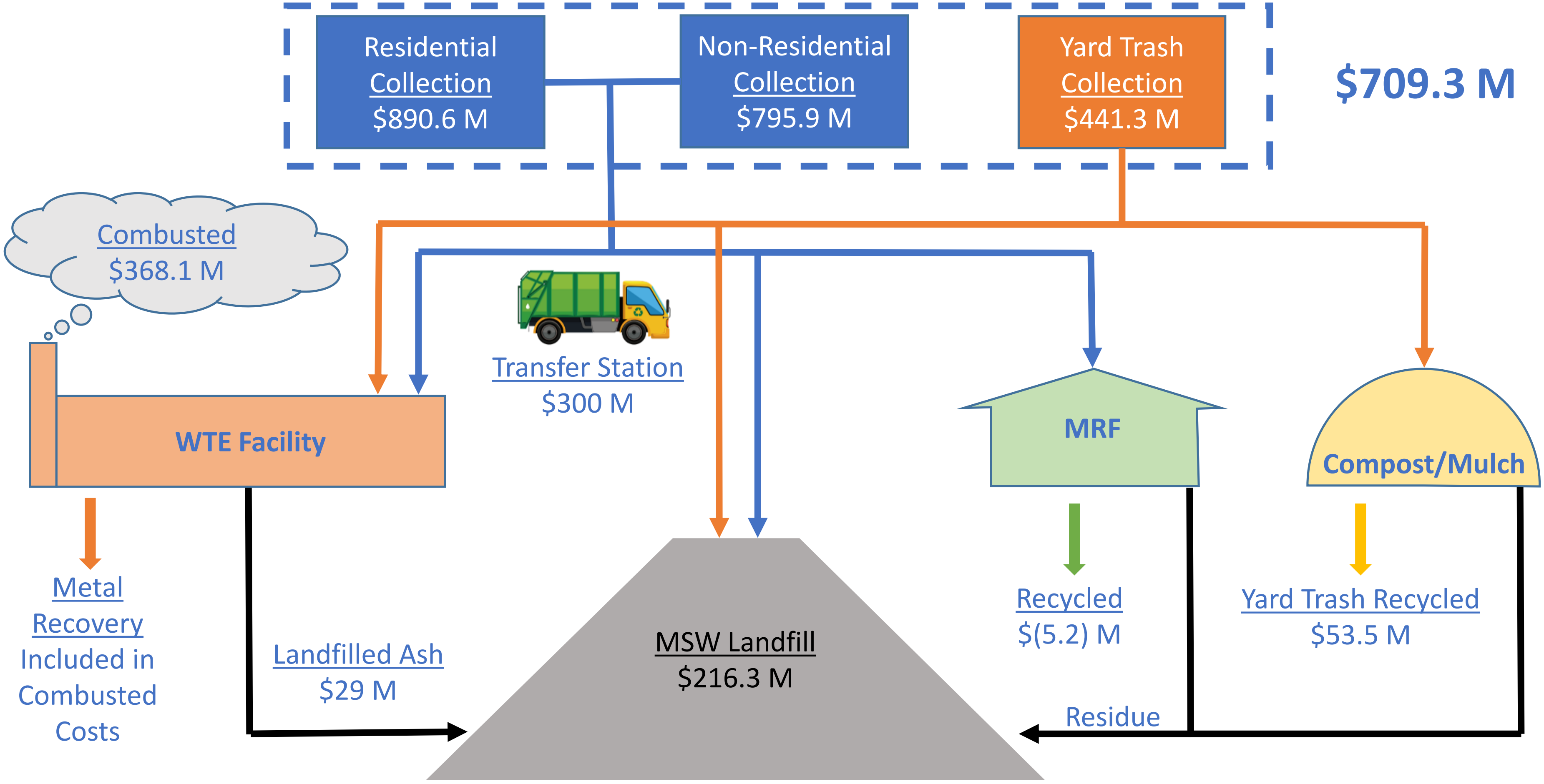
Florida Material Mass Flow (2016)



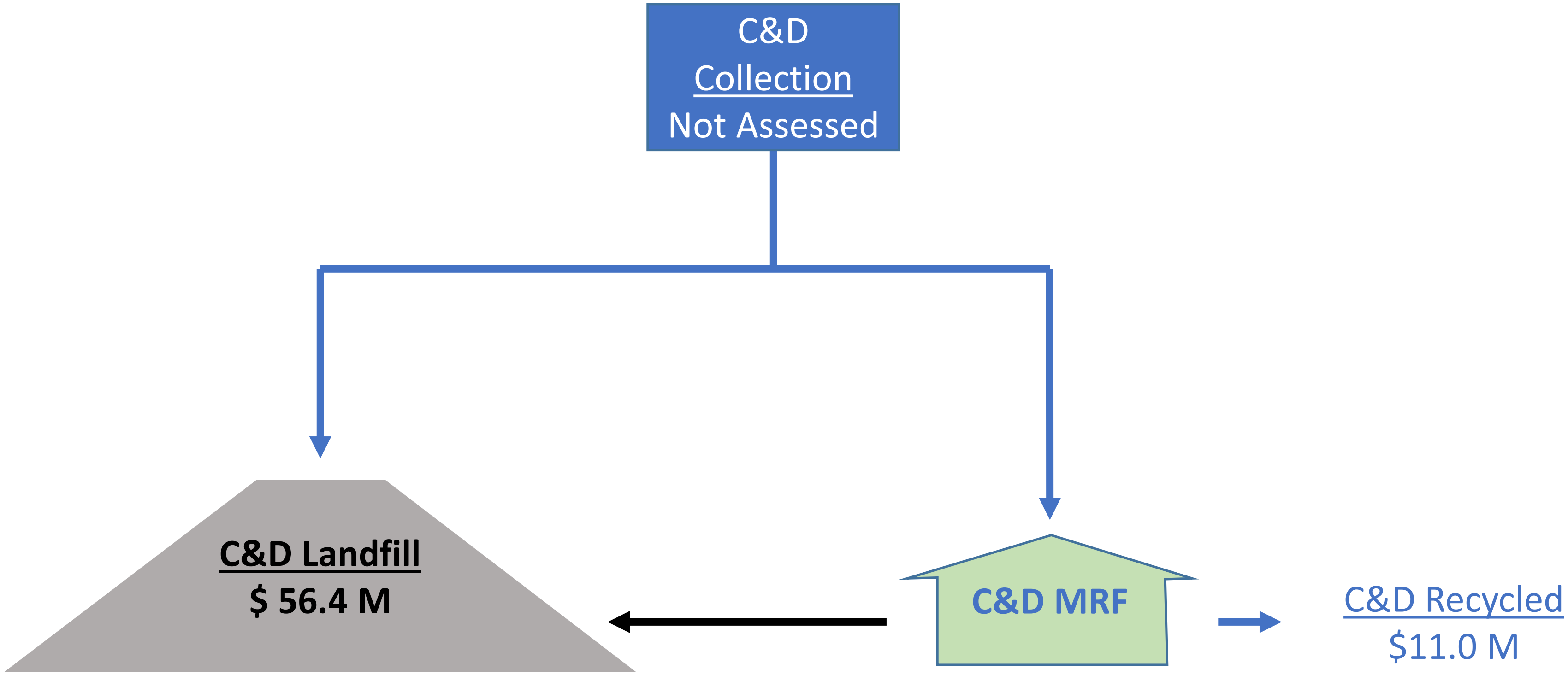
Generator Recycling Rates (2016)



Florida Material Cost Flow (2016)



Florida Material Cost Flow (2016)



Total Costs (not including Transfer Station): $2.9 Billion
Total Costs (including Transfer Station): $3.2 Billion

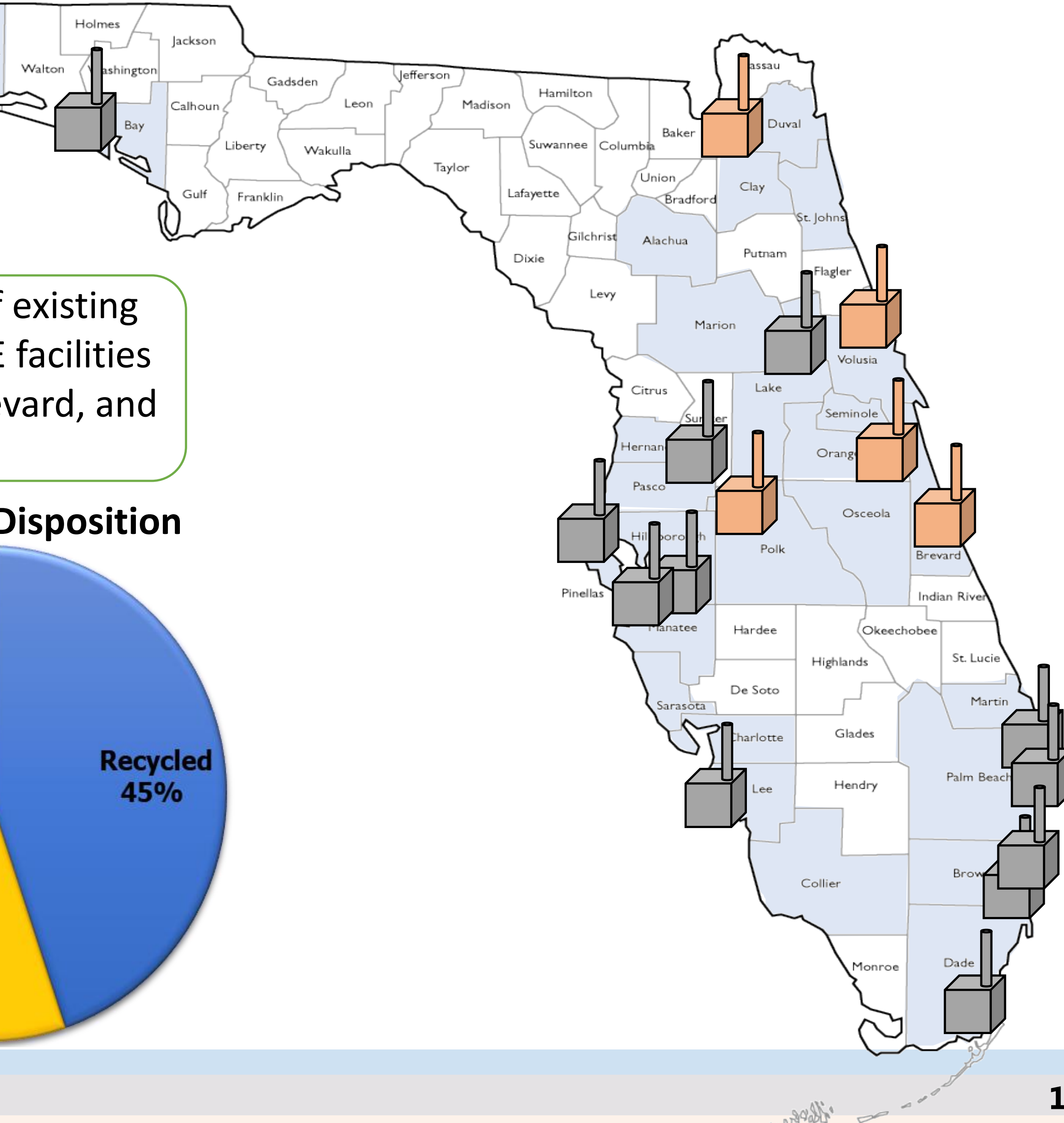
Evaluating Reaching 75% Using Different Approaches

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

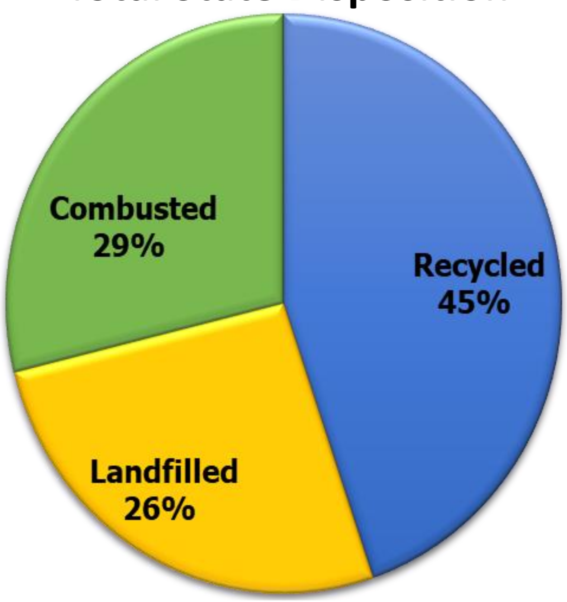
NOTE: Applied only to counties with populations of 150,000+

WTE Approach

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

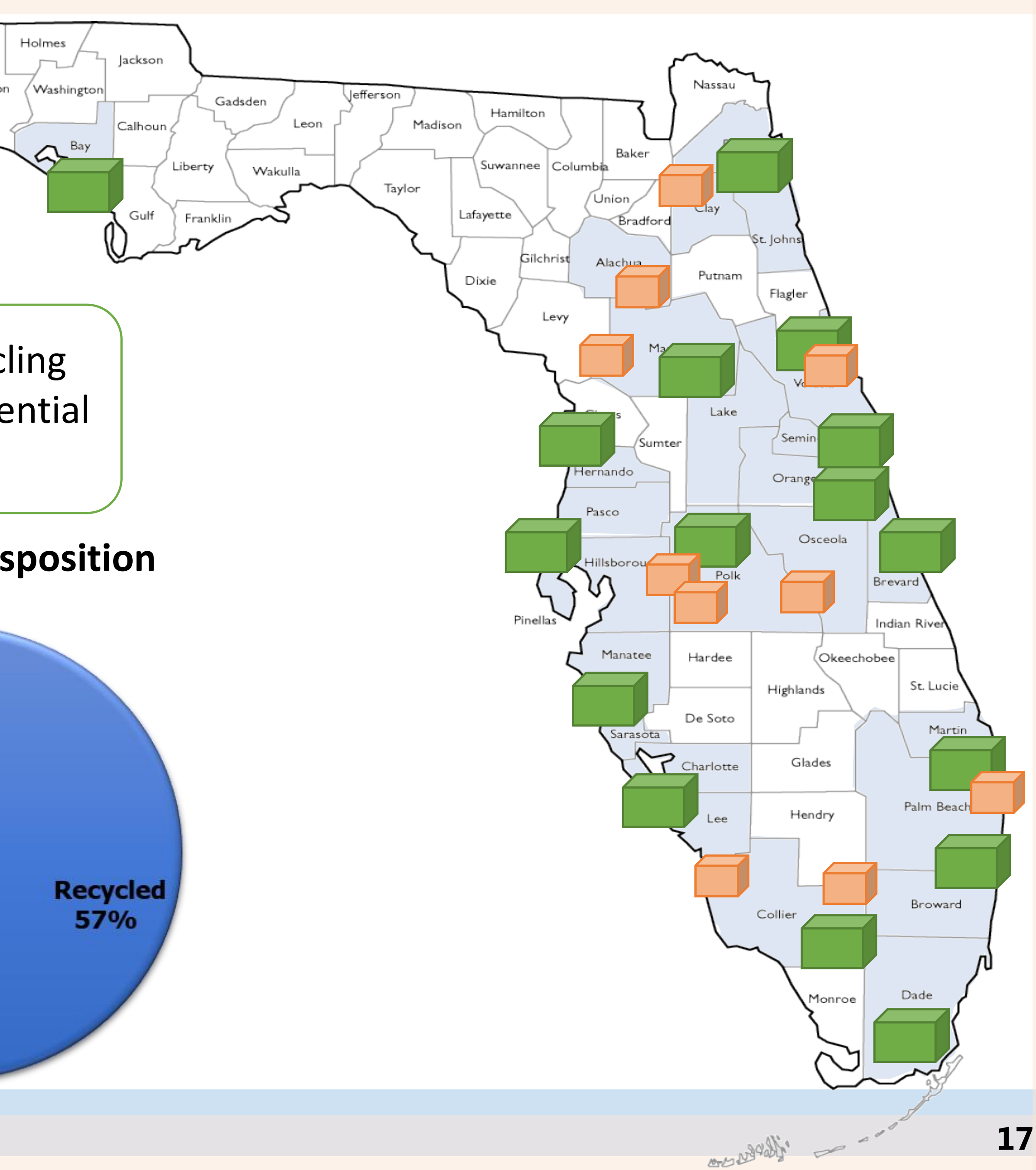


Total State Disposition

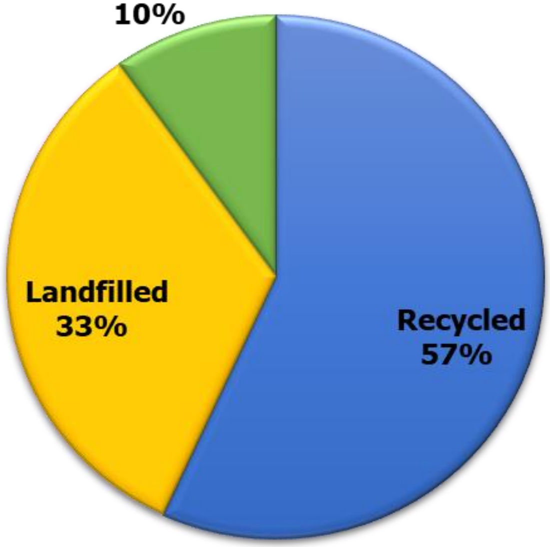


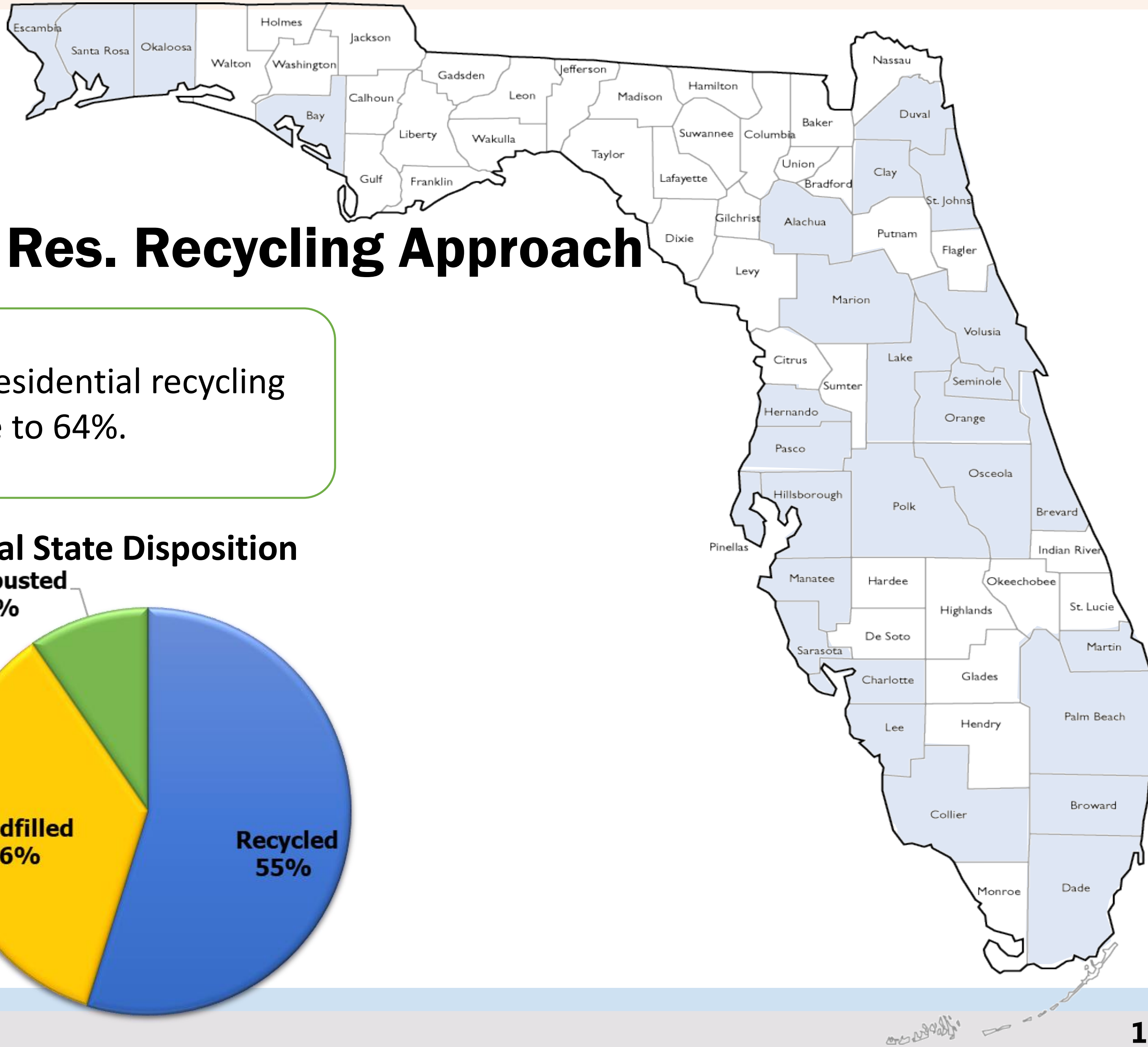
MWP Approach

Increase the residential recycling rate to 56% and the non-residential recycling rate to 48%.



Total State Disposition





Mandatory Res. Recycling Approach

Increase the residential recycling rate to 64%.

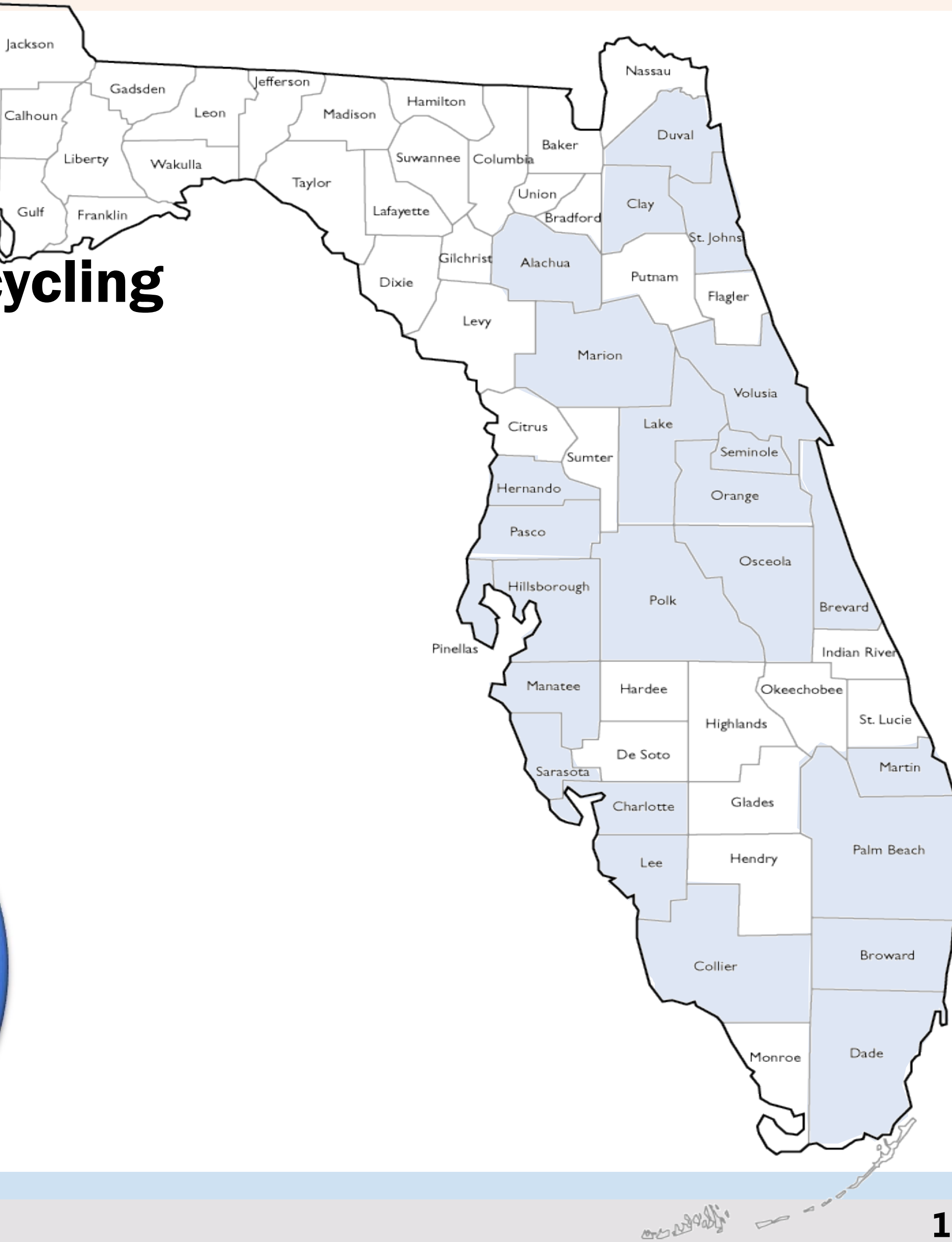
Total State Disposition

Combusted 9%

Landfilled 36%

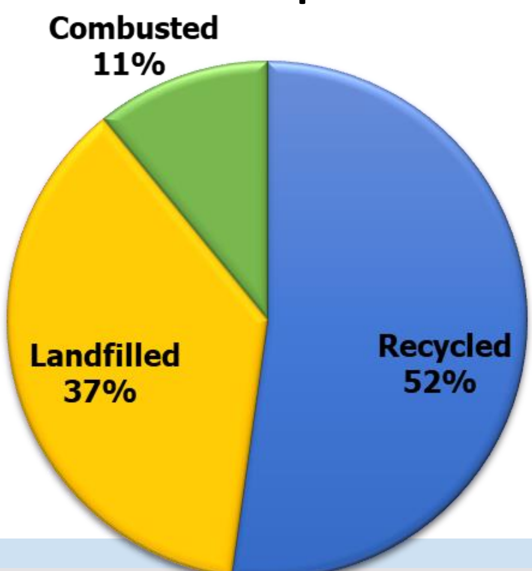
Recycled 55%

Mandatory C&D and YT Recycling Approach



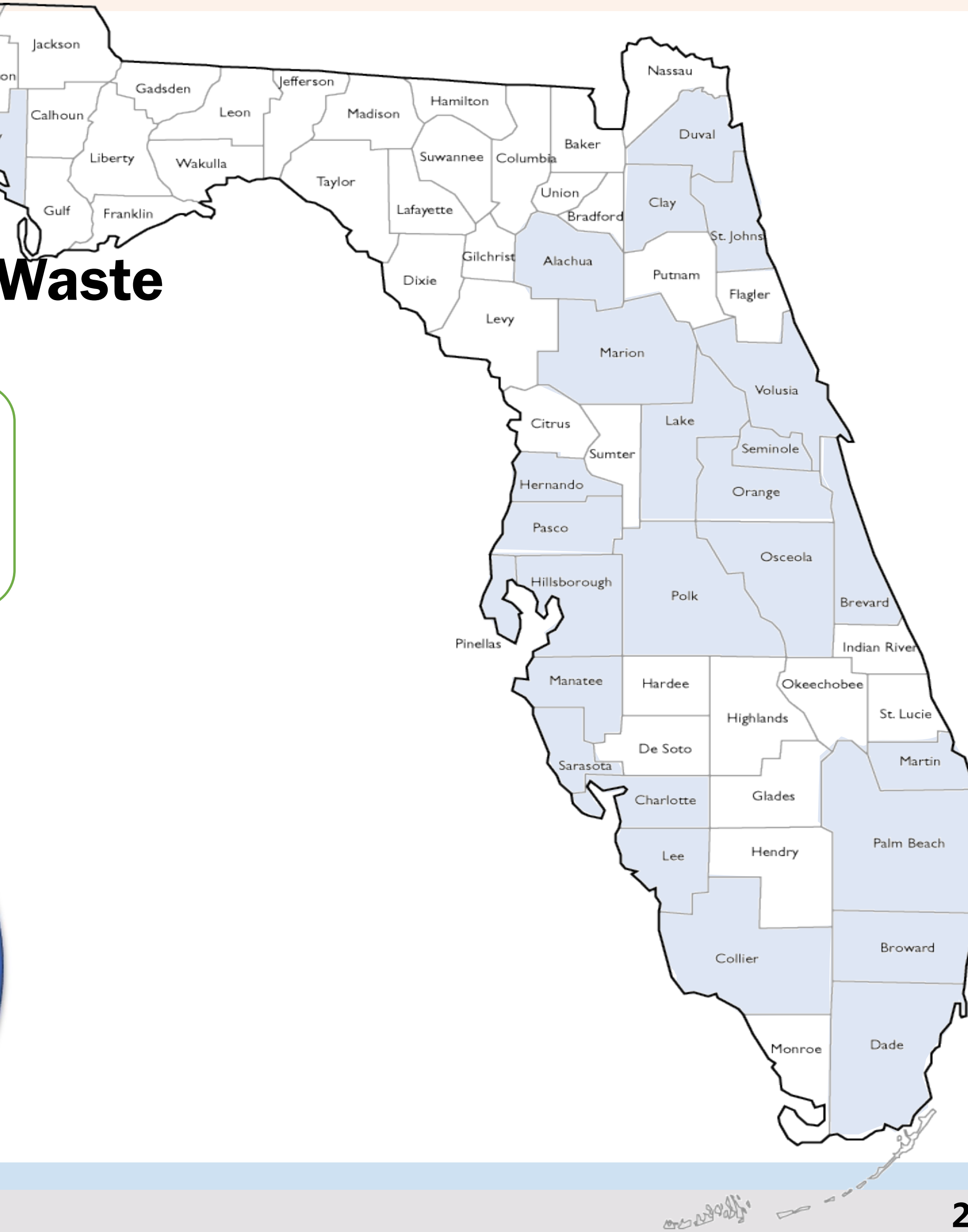
Increase C&D recycling to 77% and YT recycling to 97%.

Total State Disposition

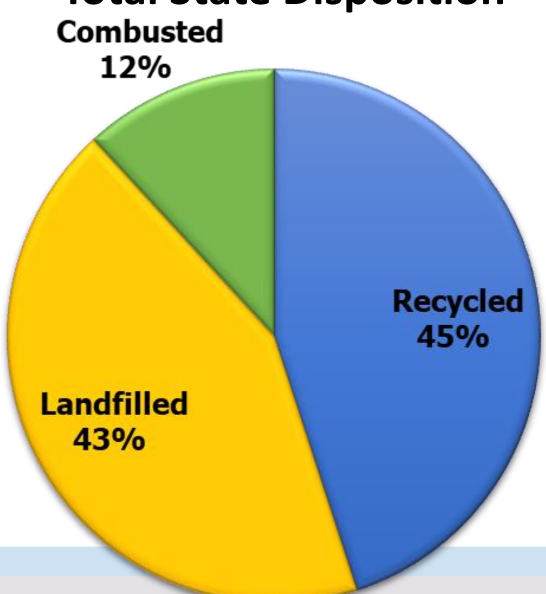


Mandatory Non-Res. Food Waste Composting Approach

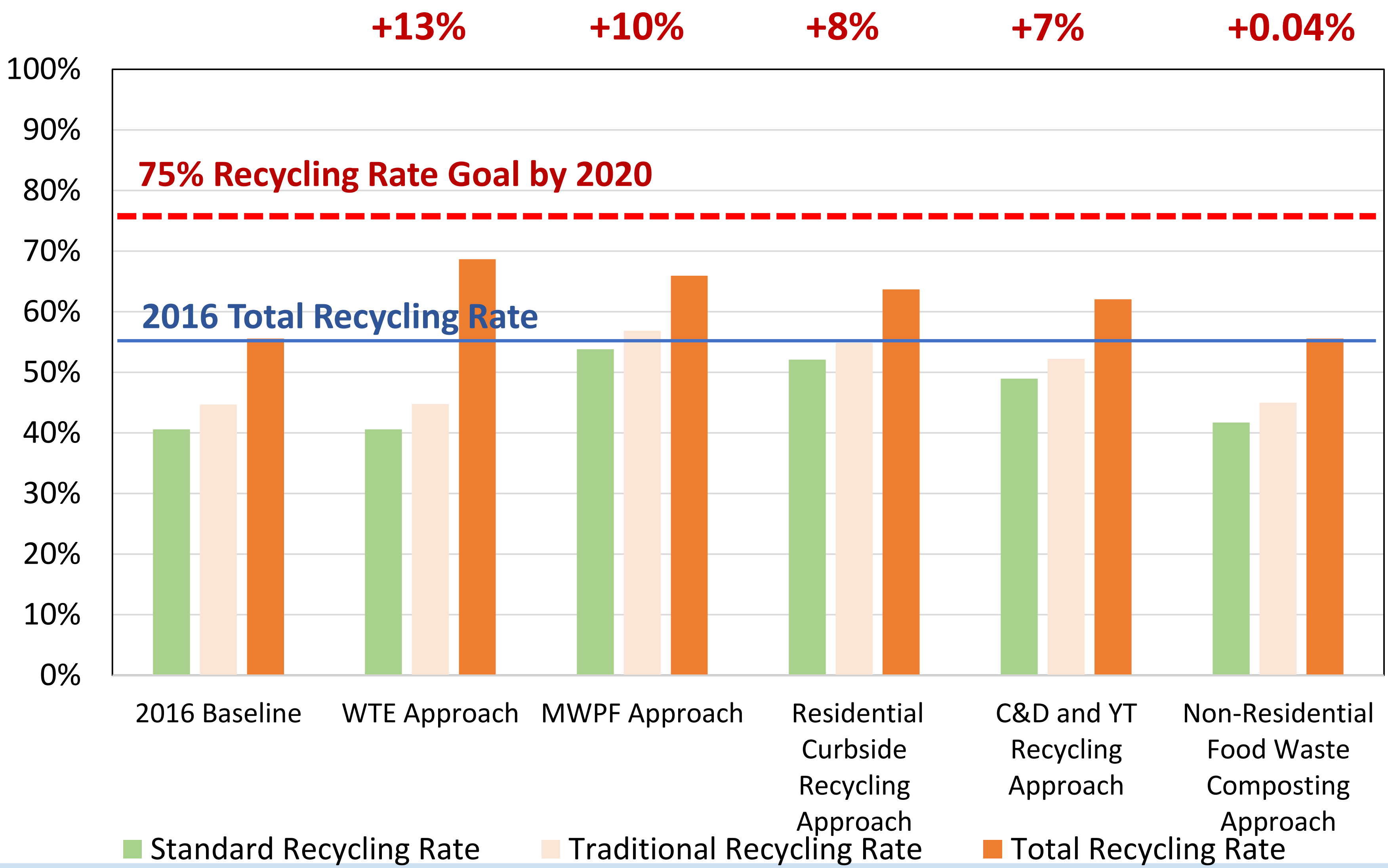
Increase the non-residential food waste recycling rate to 58%.

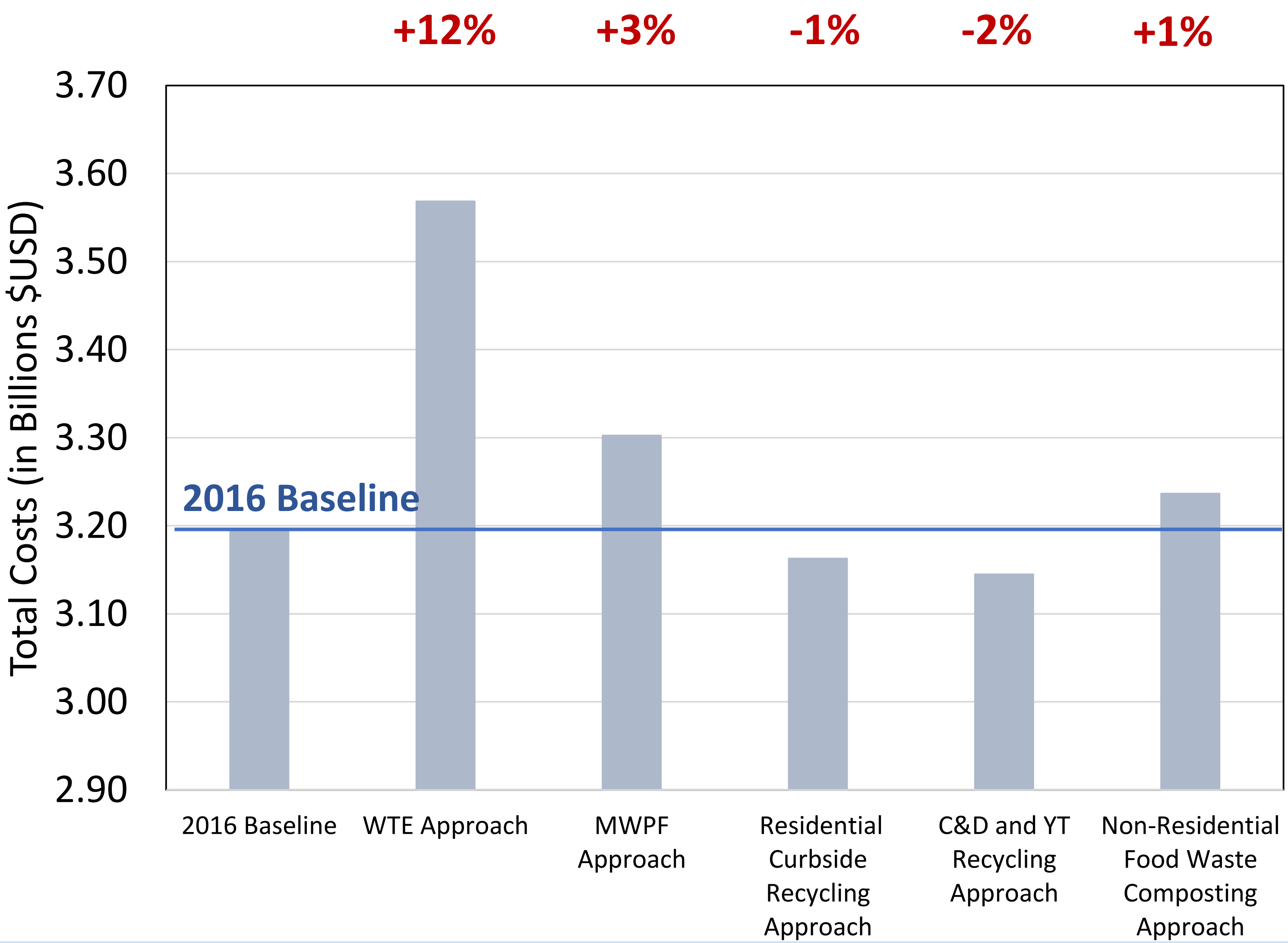
Total State Disposition



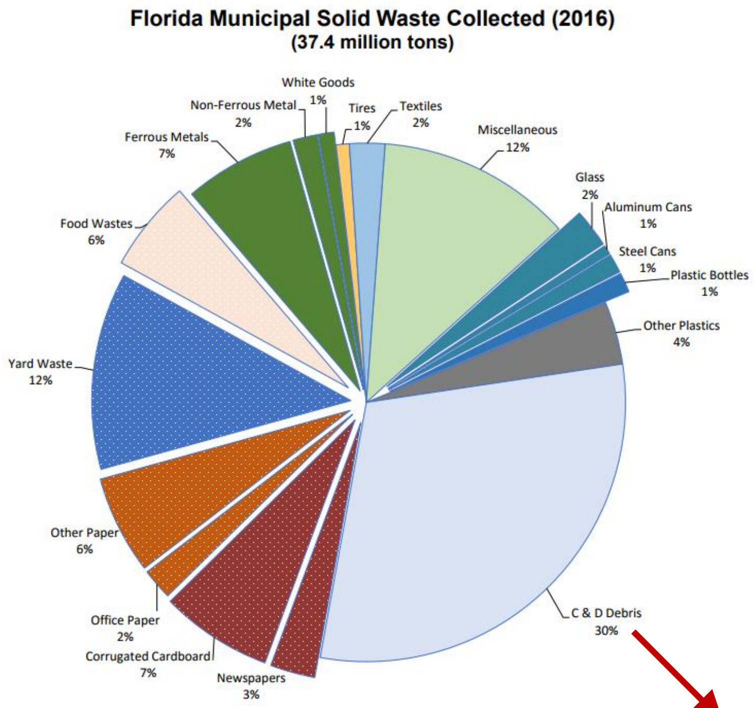
Impact on Recycling Rates (Percentage Points)

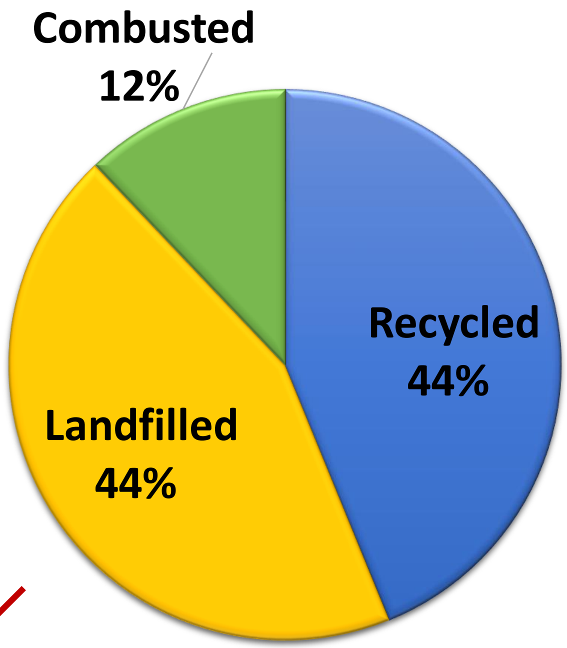


Impact on Costs (2016)



Quantifying Environmental Impacts (2016)





WARM

US EPA Waste Reduction Model (WARM)

LCA Tool created by EPA for simple environmental footprint calculations

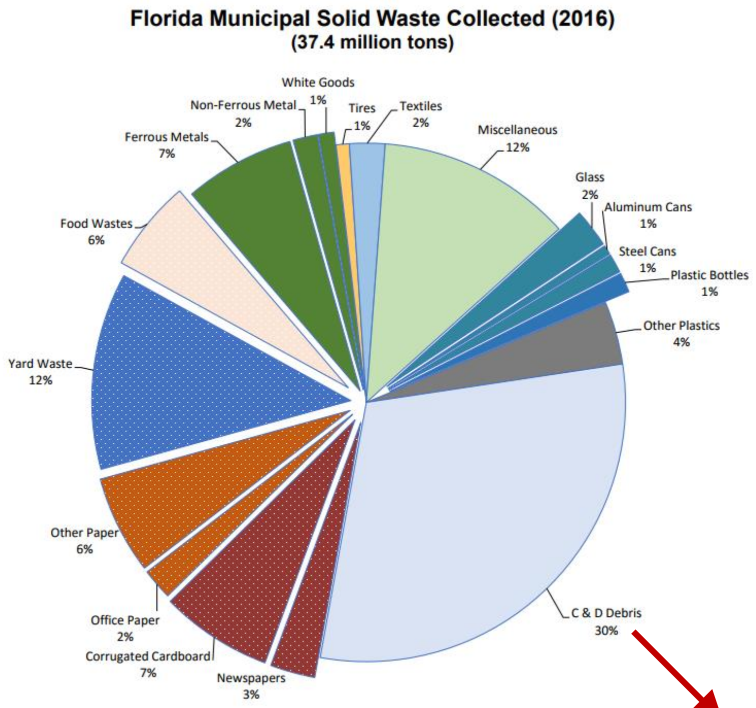
Provides for a material and its management its associated energy footprint

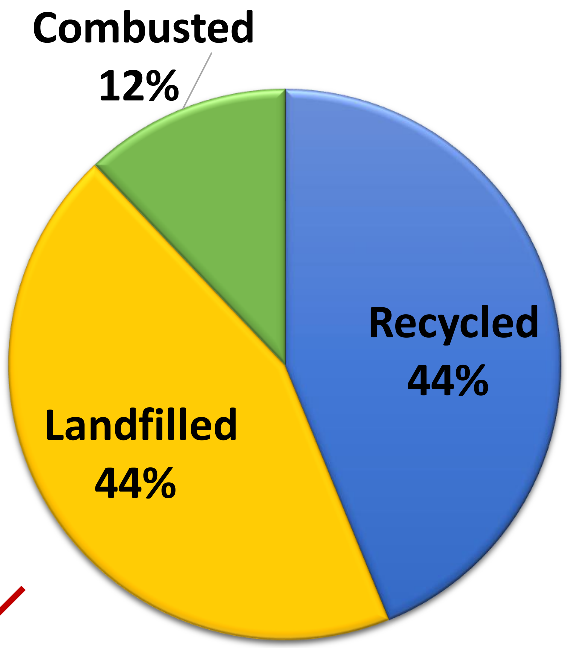
Material	Energy Savings per Ton of Material Source Reduced (million BTU)	Energy Savings per Ton of Material Recycled (million BTU)	Energy Savings per Ton of Material Landfilled (million BTU)	Energy Savings per Ton of Material Combusted (million BTU)	Energy Savings per Ton of Material Composted (million 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

Provides for a material and its management its associated carbon footprint

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

Quantifying Environmental Impacts (2016)





WARM

Energy Footprint = -12,900 MJ/person

GHG Footprint = -1.08 tCO2eq./person

Quantifying Environmental Impacts (2016)

Total 2016 GHG Emissions Footprint:

=

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

How does each scenario's recycling rate, costs, and footprint compare to 2016?

Approach Comparison Using SMM

Where 1 is equal to the 2016 total recycling rate, total footprint, and total cost

For Example:

2016 Recycling Rate = 59%

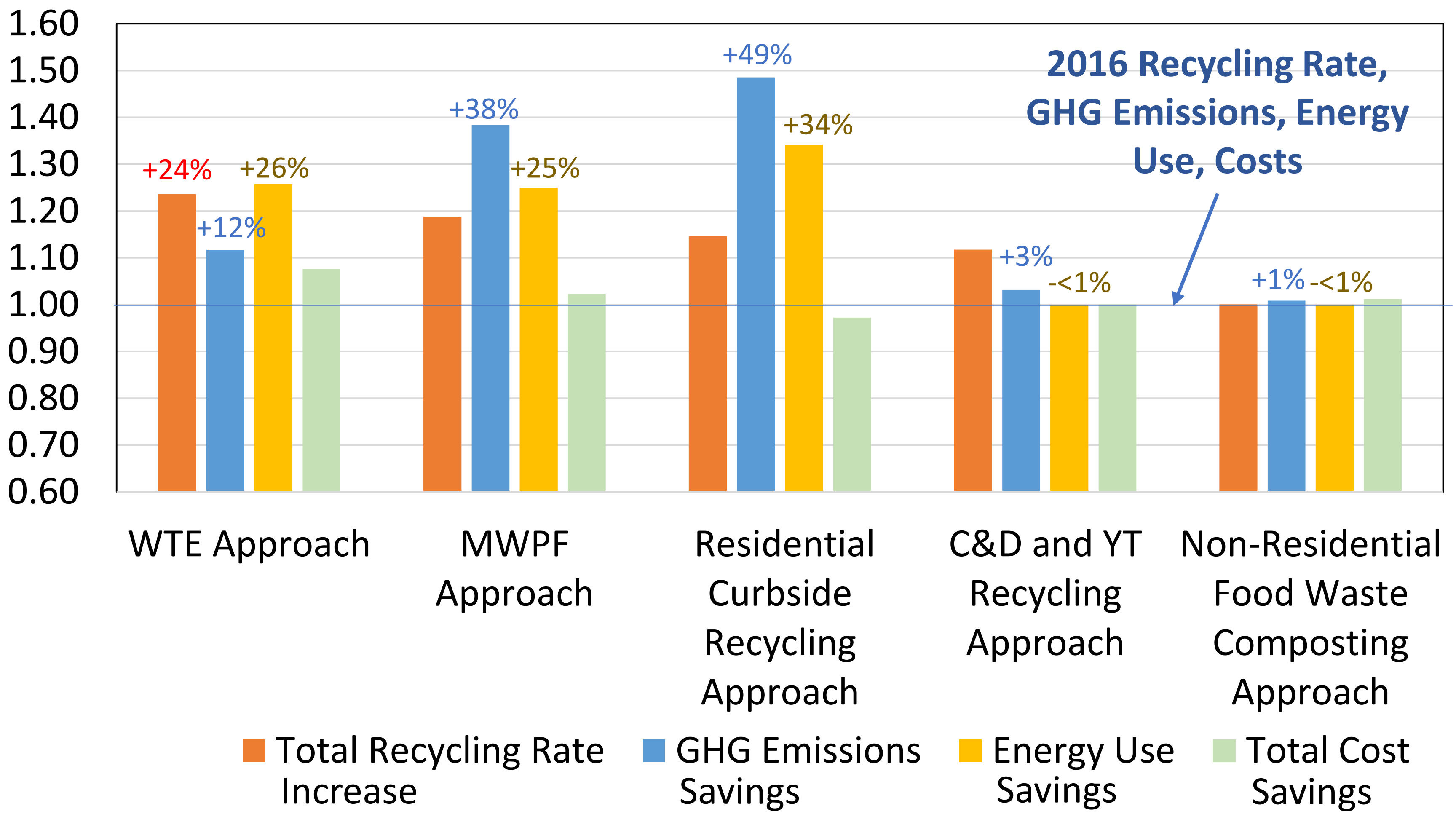
WTE Approach Recycling Rate = 69%

Then, $\frac{59\%}{69\%} = 1.24$

Where the WTE Approach's Recycling Rate is 24% greater than 2016

Approach Comparison Using SMM

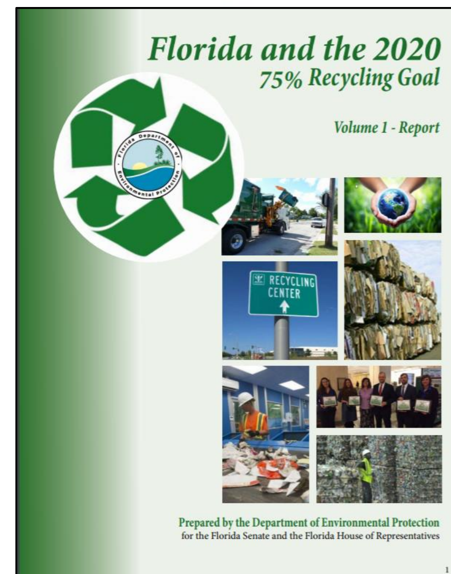
Where 1 is equal to the 2016 total recycling rate, total footprint, and total cost



Conclusions

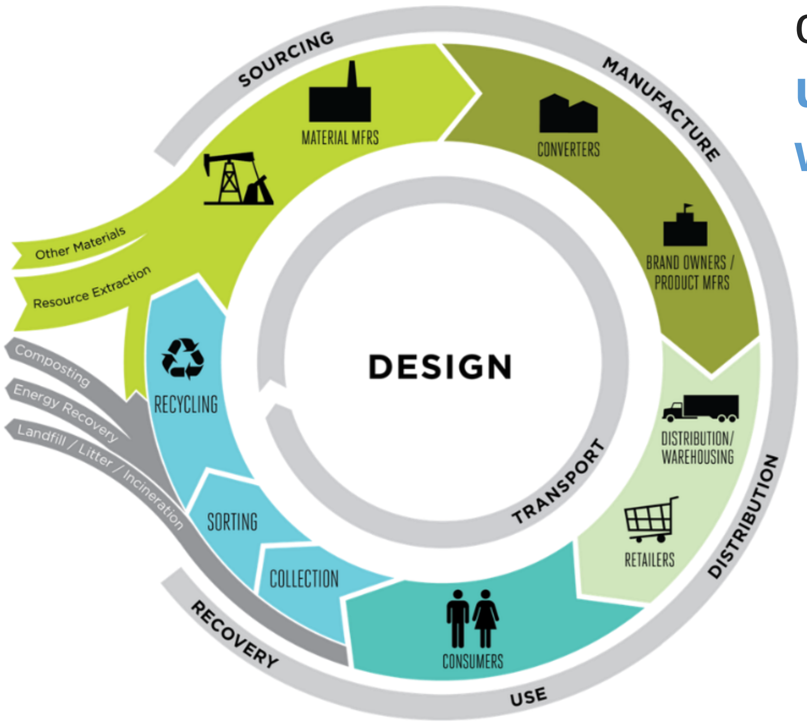
Executive Summary

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%.



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

Sustainable Materials Management



"**SMM** is a systemic approach to using and reusing materials more productively over their entire life cycles. It seeks to **use materials in the most productive way** with an emphasis on using less. "

Considers the impacts of a decision on the:

1. **Environment**
2. **Society**
3. **Economy**

https://www.epa.gov/smm/sustainable-materials-management-basics

Using environmental impacts in goal setting

Challenge with Recycling Rates:

Treats all materials environmental, social, and economic impacts equally

1 ton
paper
recycled

1 ton
aluminum
recycled

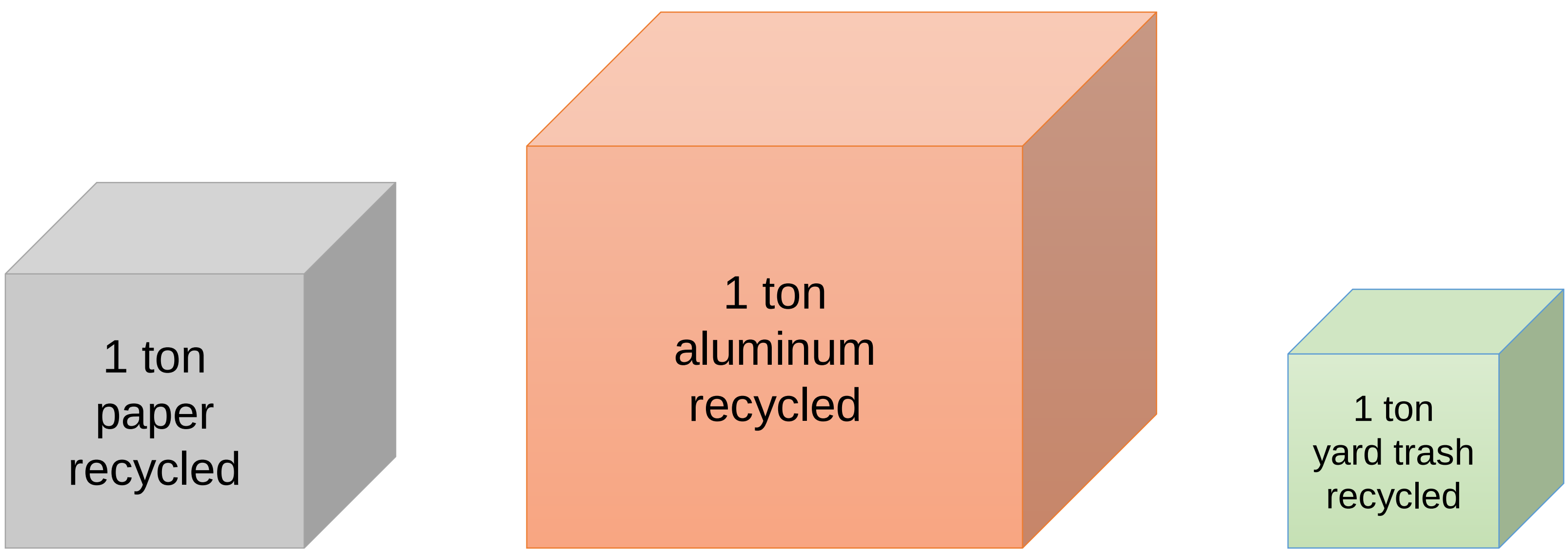
1 ton
yard trash
recycled

Using environmental impacts in goal setting

Challenge with Recycling Rates:

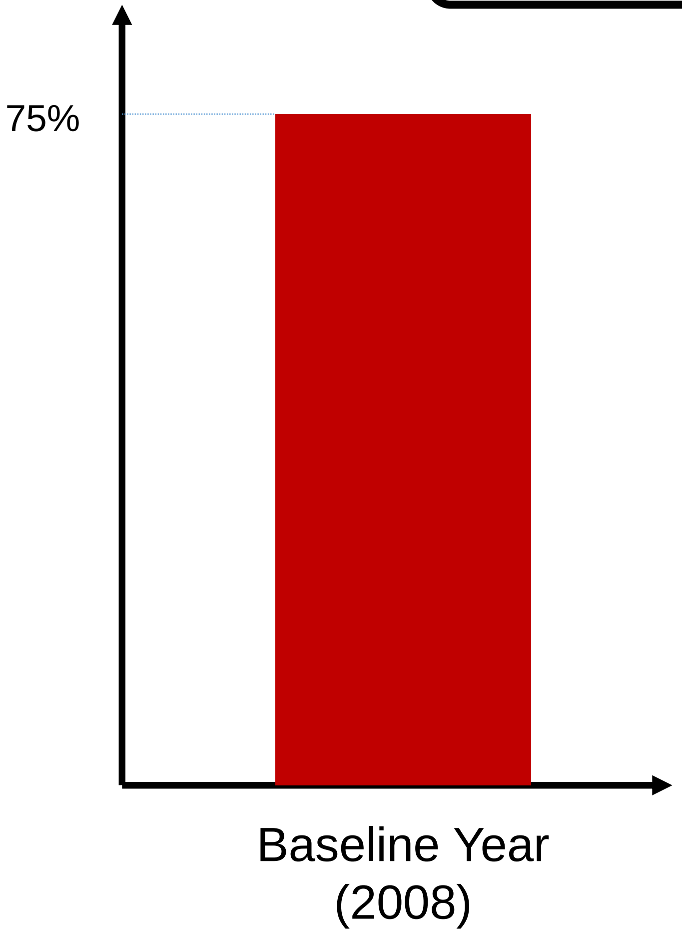
Different materials have different environmental impacts

For instance for energy savings:

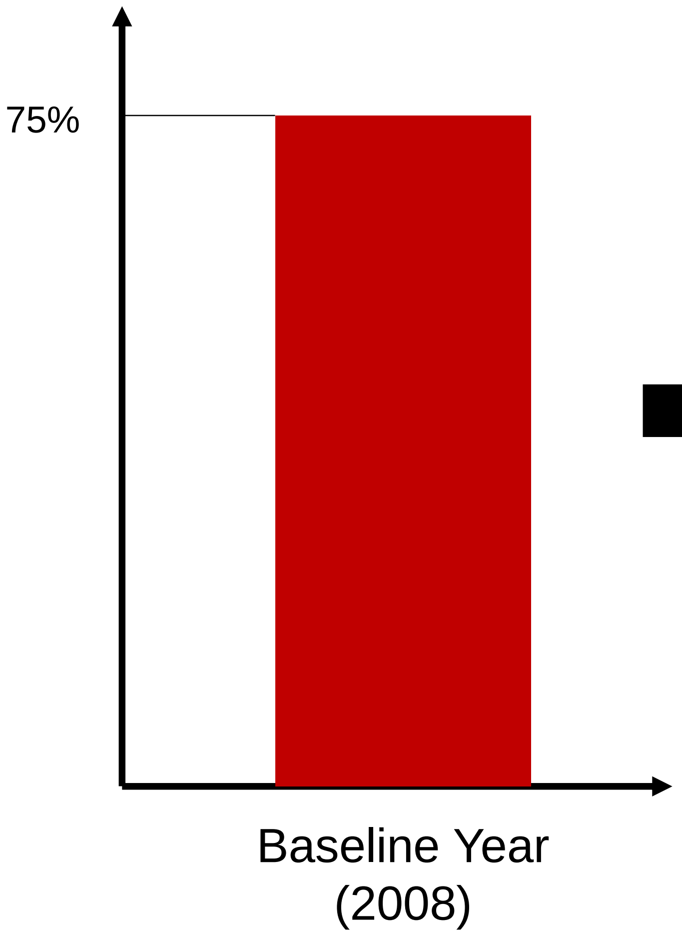


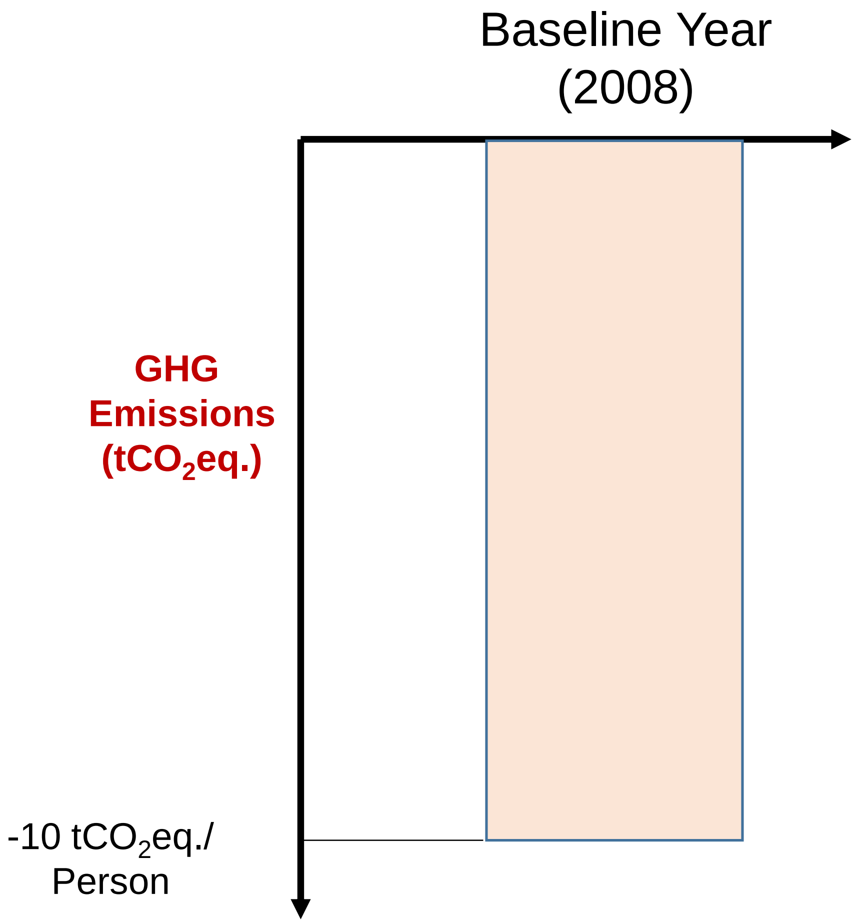
Using environmental impacts in goal setting

Identify which year you want to set as your "baseline



Using environmental impacts in goal setting

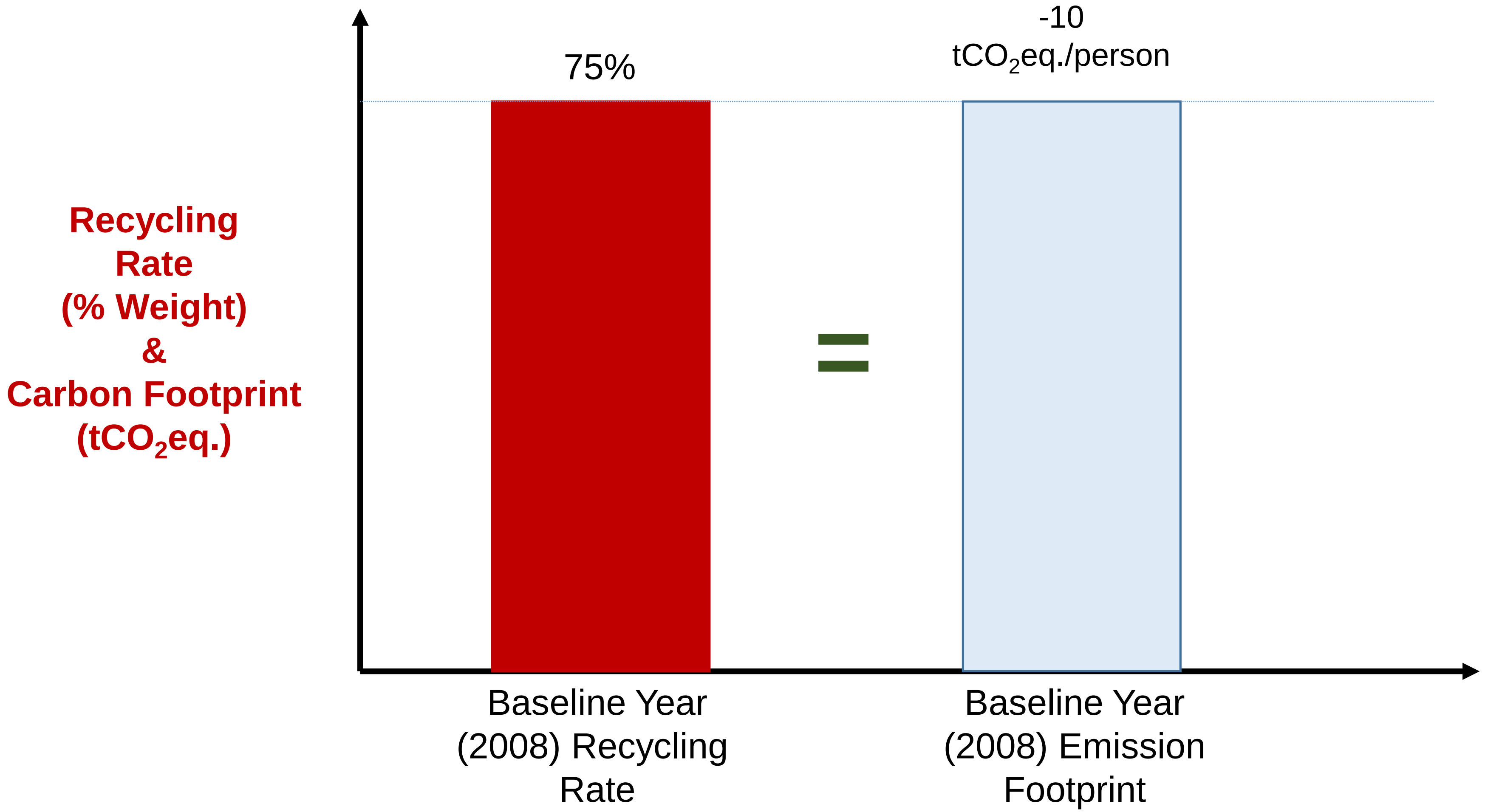




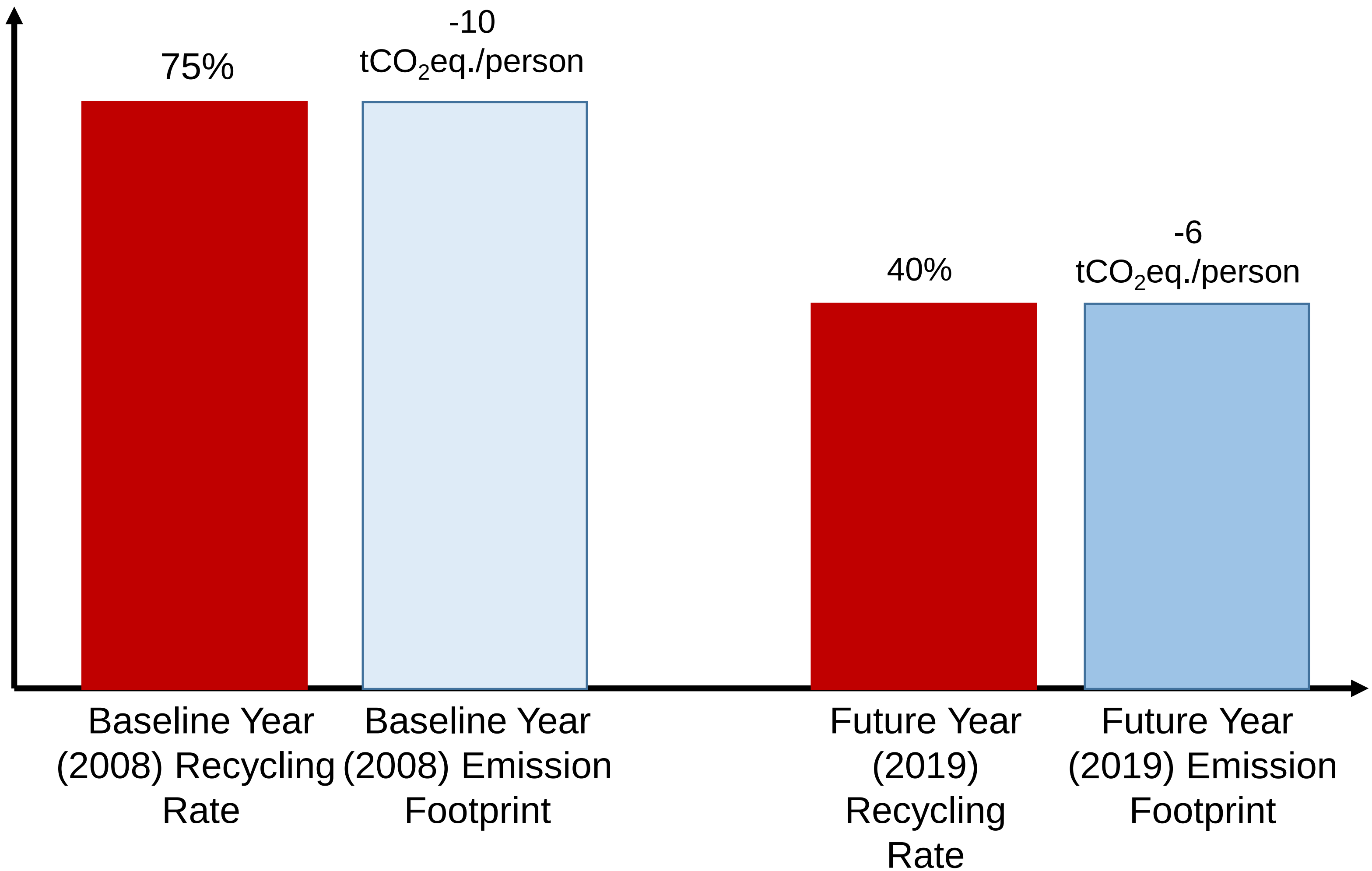
Then calculate for your "baseline" its emission footprint

Using environmental impacts in goal setting

For example, we assume that 75% recycling is equivalent to -10 tCO_2eq./person

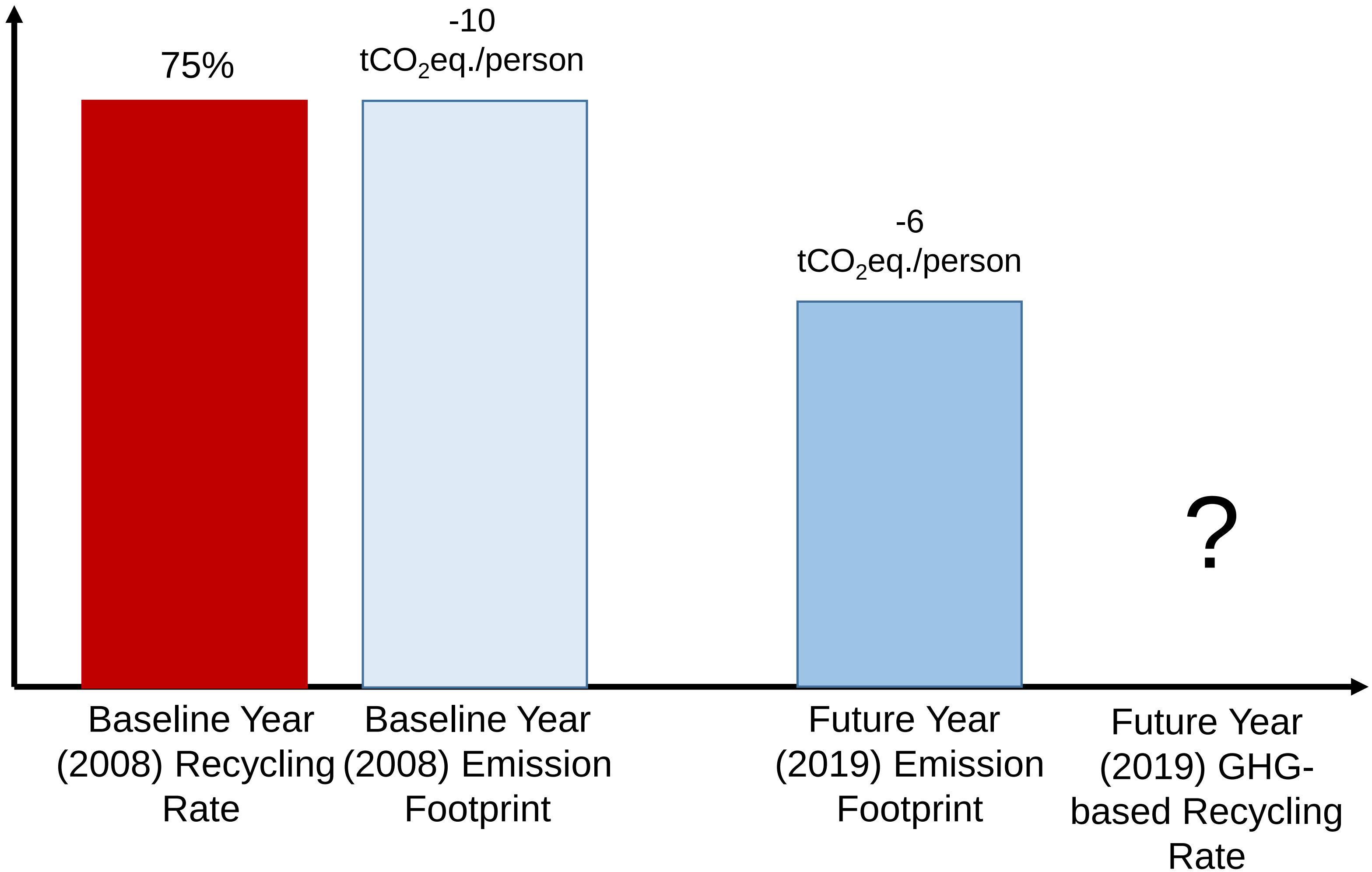


Using environmental impacts in goal setting



Using environmental impacts in goal setting

How to calculate a GHG-based Recycling Rate?



Using environmental impacts in goal setting

Target

Baseline Year (2008):

Mass-Based Recycling Rate = 75%

GHG Emissions = -10 tCO_2eq./person

Future Year (2019):

Mass-Based Recycling Rate = 40%

GHG Emissions = -6 tCO_2eq./person

Goal to use 75% as a comprehensive metric

Want to compare the future year's footprint to how close it is to reaching 75% target

GHG-Based Recycling Rate

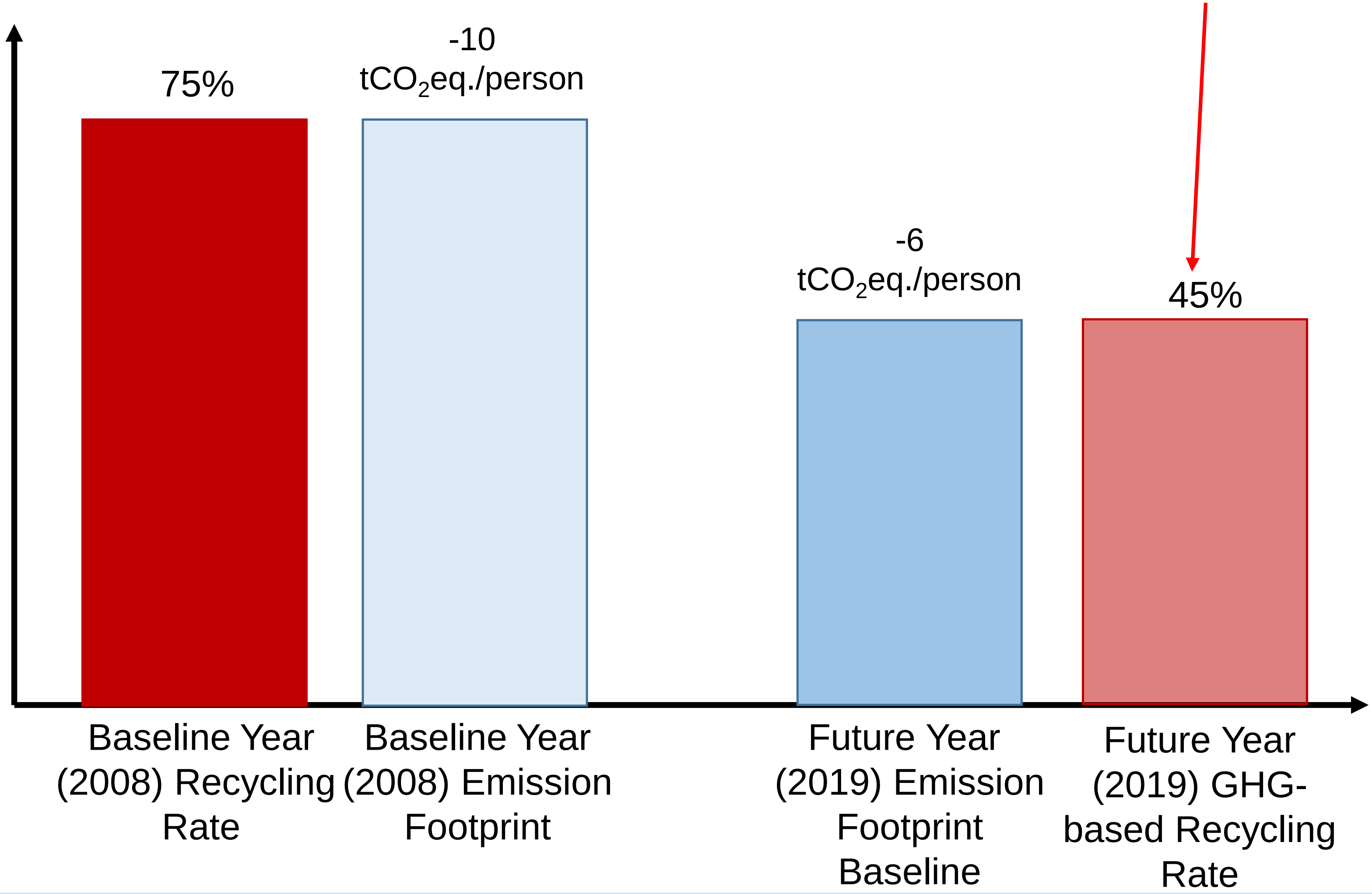
$$= \frac{\textit{Future Year GHG footprint}}{\textit{Baseline Year GHG footprint}} = 60\%(\textbf{Target Recycling Rate}) = 45\%$$

Shows how much the future year is in reaching the baseline year GHG emissions

Multiplying by 75% allows us to compare the progress of the future year to the baseline year

Using environmental impacts in goal setting

$$\text{GHG-Based Recycling Rate} = \frac{\textit{Future Year GHG footprint}}{\textit{Baseline Year GHG footprint}}\,(\textbf{Target Recycling Rate}) = X\%$$



Environmental Science & Technology

Article

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

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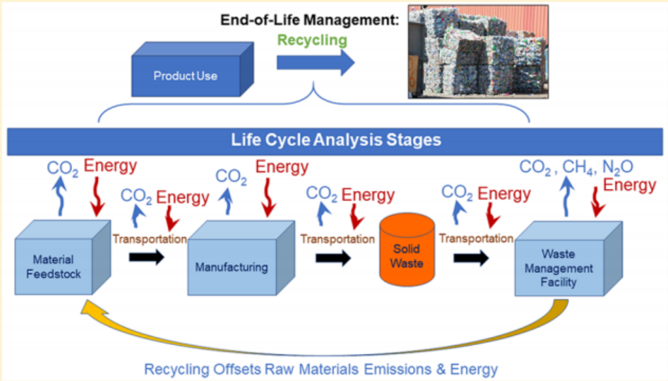
Supporting Information

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.



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Approaches to integrate sustainable materials management into waste management planning and policy

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ABSTRACT

Many solid waste policy makers are adopting sustainability practices following one of the three most commonly followed approaches: zero-waste, circular economy, and sustainable materials management (SMM). Although some communities have embraced these models, challenges remain to integrate these concepts into solid waste policy and planning. Several approaches for integrating SMM were demonstrated. The approaches centered on using SMM concepts to prioritize and strategically plan for more sustainable waste management and to create performance metrics to track solid waste management system progress. Waste information from five regions were compiled to assess current data adequacy; necessary data were in many cases limited. Findings showed that many of the regions will need to better track and report their individual materials generated and disposed of to more accurately apply SMM. Among the common outcomes of the SMM approaches illustrated was the need to better target specific materials in the waste stream for recovery, such as metal and paper products. Other findings included the need to more effectively promote and track waste reduction efforts given the dramatic beneficial outcomes when using an SMM-based performance metric, such as an energy use reduction goal.

Looking beyond Florida's 75% Recycling Goal: Development of a Methodology & Tool for Assessing SMM Recycling Rates in Florida (HC 18/19) Project Motivation

- Hinkley Center Research Project
  →*Florida Solid Waste Management: State of the State*
- 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?

HC 18/19 Project Objectives

- **Develop a publicly available LCA tool** used to measure and compare social, economic, and environmental impacts for various Florida solid waste management approaches.
- **Develop additional lifecycle impact (LCI) factors** (e.g., energy use, emissions, etc.) that will allow users to consider a wider variety of impacts associated with various materials management approaches.

HC 18/19 Project Tasks

- **Task 1:** Compile available data on lifecycle impact factors
- **Task 2:** Develop lifecycle impact factors (LCI)
- **Task 3:** Create a LCA tool
- **Task 4**: Use the tool to evaluate best materials management approaches in Florida

	A	AZ	BA	BB	BC	BD
1	ALL UNITS TONS			HC 16/17 Workbook		
2						
3	Four Categories	Total				
4	County	Collected	Recycled Direct	Recycled Post WTE	Landfill Direct C&D	Landfill Direct non-C&D
5	Miami-Dade County	5,062,400	824,996	-	602,380	2,450,251
6	Broward County	3,889,118	1,276,653	14,892	817,593	928,616

+

WasteCalc Public Reports

+

EPA United States Environmental Protection Agency **Waste Reduction Model (WARM)**

+

Other LCA Models

+

Industry Data

= Workbook-Based LCA Tool

County	Corrugated Paper Total	Corrugated Paper Recycled	%	Office Paper Total	Office Paper Recycled	%	Yard Trash Total	Yard Trash Recycled	%	Newspaper Total	Newspaper Recycled	%
Miami-Dade	491,053	109,196	22%	222,746	14,566	7%	658,112	107,370	16%	253,120	6,424	3%
Broward	233,347	99,968	43%	38,891	17,292	44%	388,912	43,175	11%	38,891	22,759	59%
Palm Beach	170,412	68,814	40%	34,778	12,752	37%	224,053	215,091	96%	93,900	17,007	18%
Hillsborough	218,290	84,924	39%	49,518	12,056	24%	277,376	177,260	64%	63,042	21,084	33%
Orange	214,136	103,407	48%	90,197	17,740	20%	264,136	138,719	53%	68,546	18,899	28%
Pinellas	173,916	58,487	34%	21,471	18,275	85%	285,000	274,678	96%	49,384	17,534	36%
Duval	155,054	63,909	41%	23,854	9,764	41%	384,653	8,063	2%	14,909	1118	7%
Lee	86,000	52,982	62%	16,450	7,238	44%	283,708	223,272	79%	25,300	15,545	61%
Polk	72,848	43,993	60%	15,690	5,719	36%	97,504	0	0%	35,864	5,517	15%
Brevard	114,111	34,689	30%	32,603	2,079	6%	385,532	272,455	71%	40,754	6,859	17%

FDEP Total Tons of MSW Collected and Recycled

What is WasteCalc?

- WasteCalc is an online waste composition calculator model funded for development through a 1999-2000 DEP Innovative Recycling Grants program.

- Available through FDEP at: https://fldeploc.dep.state.fl.us/wastecalc/

What is WasteCalc used for?

- WasteCalc is used by county solid waste and recycling coordinators to estimate their county's total MSW composition.

- The calculator provides coordinators with data for recycling program planning and annual reporting purposes.

WasteCalc Functionality

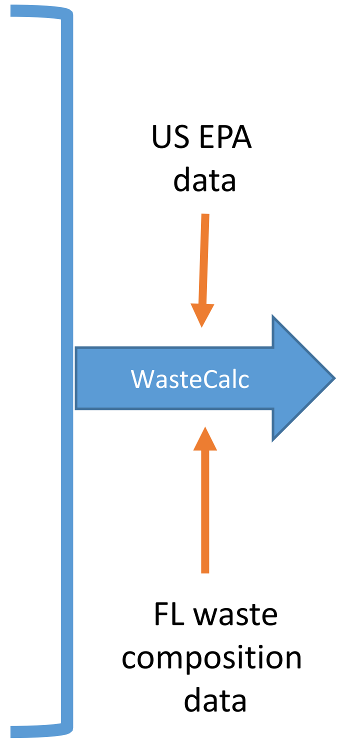
Input

Recycled Tons	
Newspaper	Ferrous Metals
Glass	White Goods
Aluminum Cans	Non Ferrous Metals
Plastic Bottles	Other Paper
Steel Cans	Textiles
Corrugated Boxes	C&D Debris
Office Paper	Food Waste
Yard Trash	Miscellaneous
Other Plastics	Tires

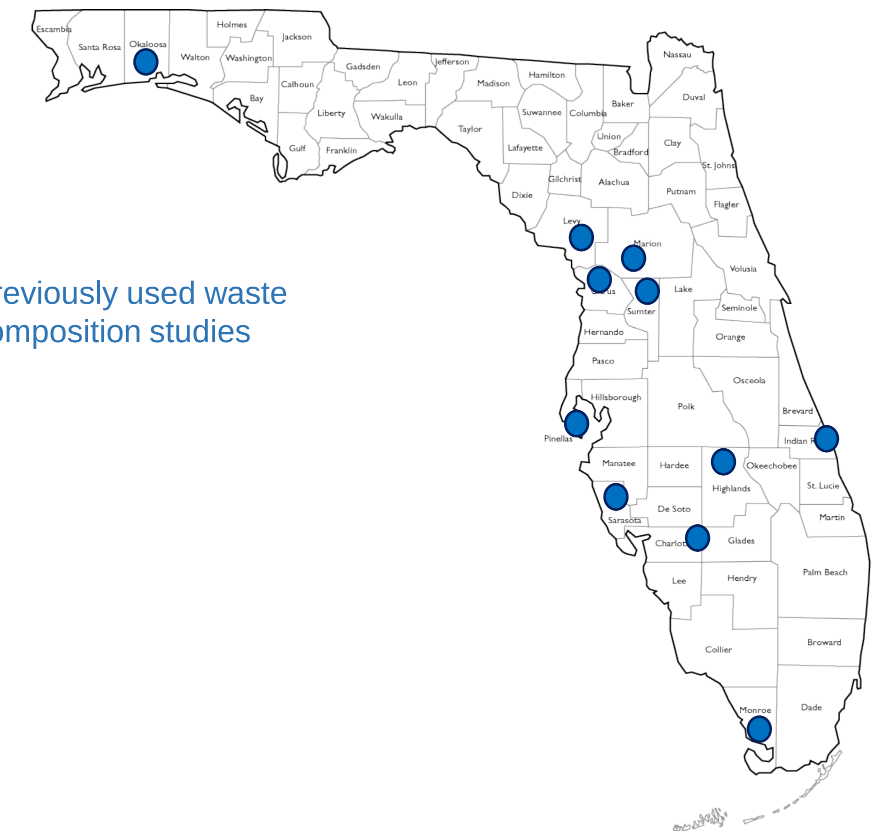
Landfilled Tons

Combusted Tons

Behind the Scenes



Behind the Scenes: Waste Composition Data



Previously used waste composition studies

WasteCalc Functionality

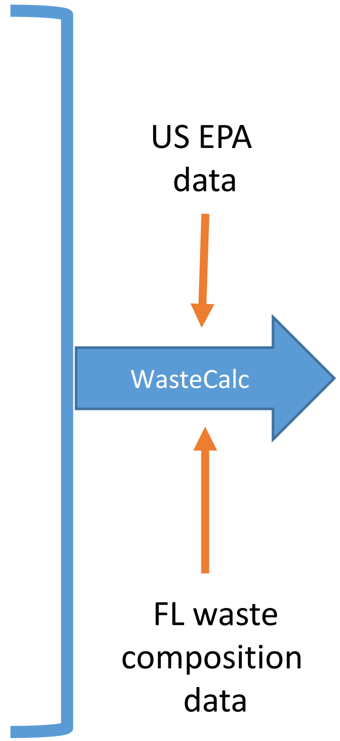
Input

Recycled Tons	
Newspaper	Ferrous Metals
Glass	White Goods
Aluminum Cans	Non Ferrous Metals
Plastic Bottles	Other Paper
Steel Cans	Textiles
Corrugated Boxes	C&D Debris
Office Paper	Food Waste
Yard Trash	Miscellaneous
Other Plastics	Tires

Landfilled Tons

Combusted Tons

Behind the Scenes



Output

% MSW Composition

Newspaper
Glass
Aluminum Cans
Plastic Bottles
Steel Cans
Corrugated Boxes
Office Paper
Yard Trash
Other Plastics
Ferrous Metals
White Goods
Non Ferrous Metals
Other Paper
Textiles
C&D Debris
Food Waste
Miscellaneous
Tires

WasteCalc Functionality

Input

Recycled Tons	
Newspaper	Ferrous Metals
Glass	White Goods
Aluminum Cans	Non Ferrous Metals
Plastic Bottles	Other Paper
Steel Cans	Textiles
Corrugated Boxes	C&D Debris
Office Paper	Food Waste
Yard Trash	Miscellaneous
Other Plastics	Tires

Landfilled Tons

Combusted Tons

Collected C&D Tons

WasteCalc Functionality

Input

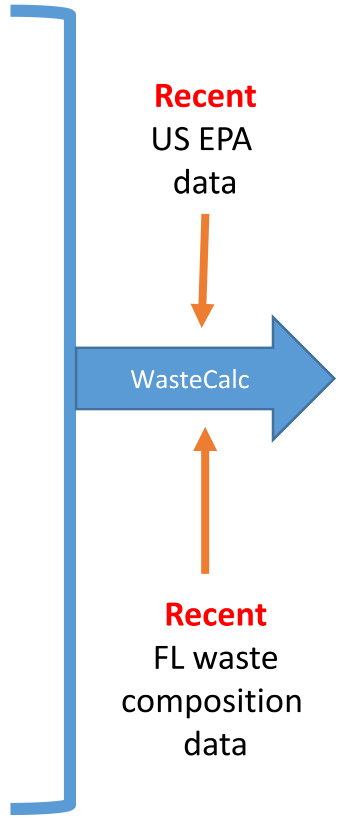
Behind the Scenes

Recycled Tons	
Newspaper	Ferrous Metals
Glass	White Goods
Aluminum Cans	Non Ferrous Metals
Plastic Bottles	Other Paper
Steel Cans	Textiles
Corrugated Boxes	C&D Debris
Office Paper	Food Waste
Yard Trash	Miscellaneous
Other Plastics	Tires

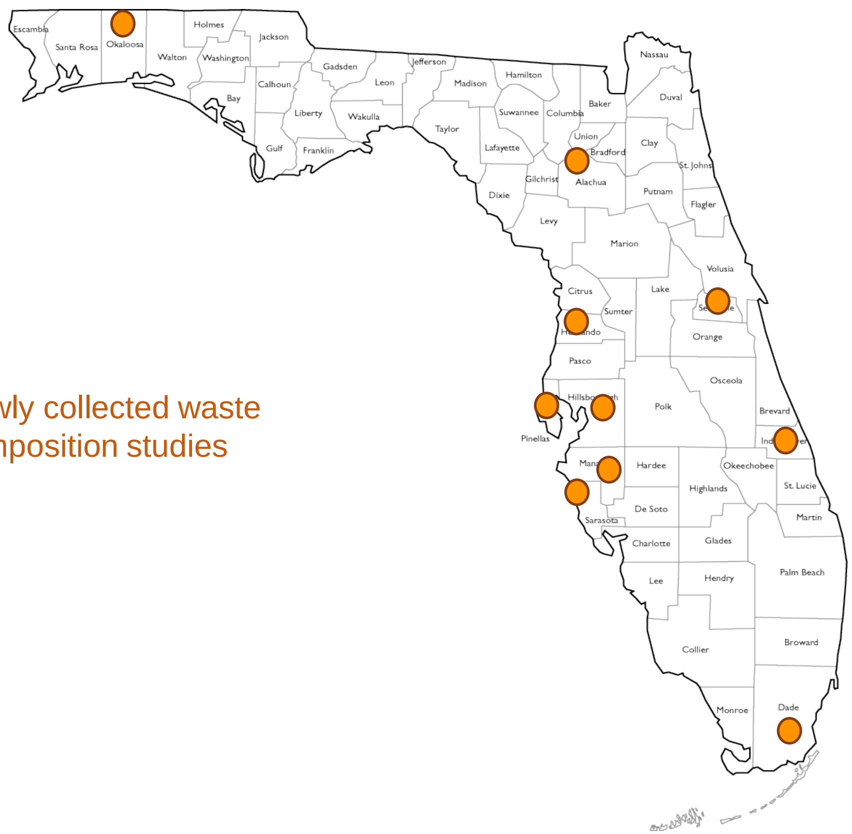
Landfilled Tons

Combusted Tons

Collected C&D Tons



Behind the Scenes: Waste Composition Data



Newly collected waste composition studies

WasteCalc Functionality

Input

Recycled Tons	
Newspaper	Ferrous Metals
Glass	White Goods
Aluminum Cans	Non Ferrous Metals
Plastic Bottles	Other Paper
Steel Cans	Textiles
Corrugated Boxes	C&D Debris
Office Paper	Food Waste
Yard Trash	Miscellaneous
Other Plastics	Tires

Landfilled Tons

Combusted Tons

Collected C&D Tons

Behind the Scenes

Recent US EPA data

WasteCalc

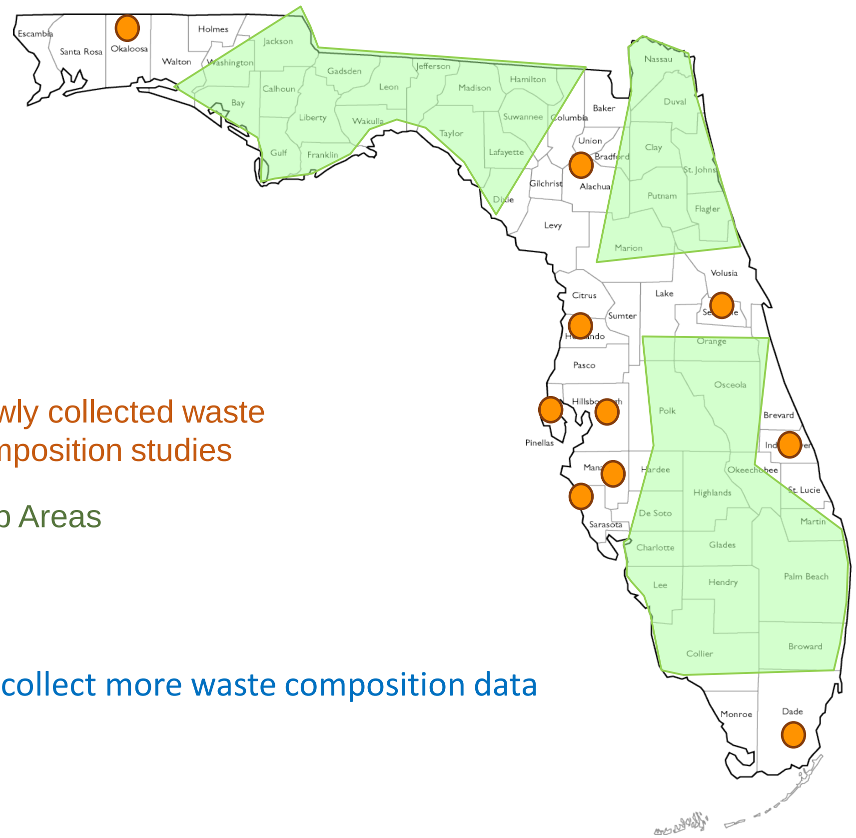
Recent FL waste composition data

Output

% MSW Composition
Newspaper
Glass
Aluminum Cans
Plastic Bottles
Steel Cans
Corrugated Boxes
Office Paper
Yard Trash
Other Plastics
Ferrous Metals
White Goods
Non Ferrous Metals
Other Paper
Textiles
C&D Debris
Food Waste
Miscellaneous
Tires

Tons MSW Composition
Newspaper
Glass
Aluminum Cans
Plastic Bottles
Steel Cans
Corrugated Boxes
Office Paper
Yard Trash
Other Plastics
Ferrous Metals
White Goods
Non Ferrous Metals
Other Paper
Textiles
C&D Debris
Food Waste
Miscellaneous
Tires

What's next? Waste Composition Data

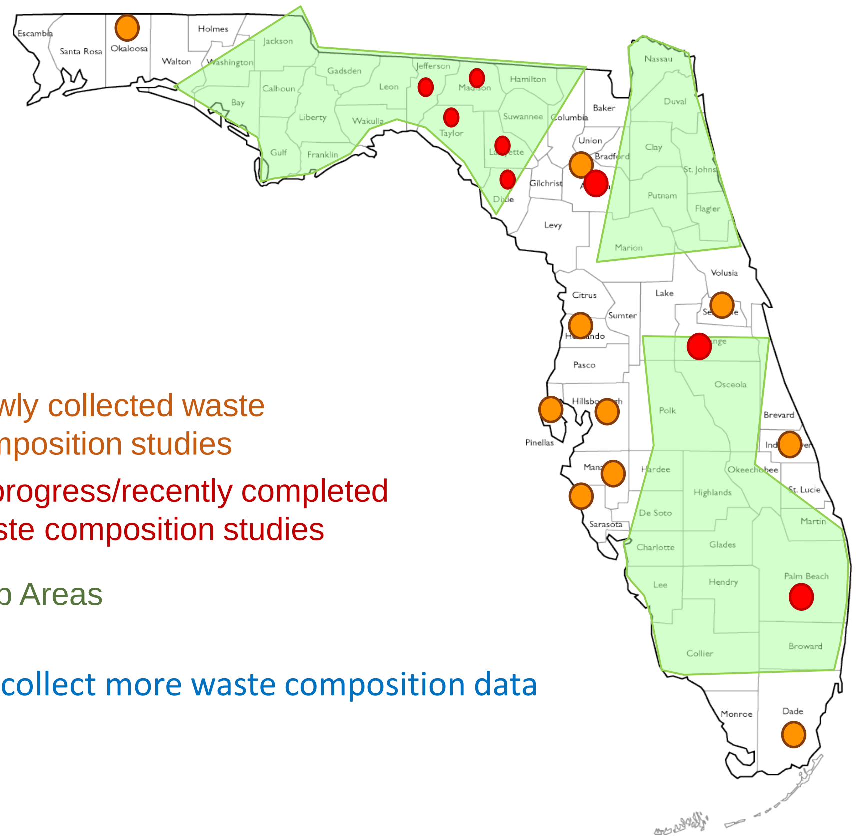


Newly collected waste composition studies

Gap Areas

Goal: To collect more waste composition data

What's next? Waste Composition Data



Newly collected waste composition studies

In progress/recently completed waste composition studies

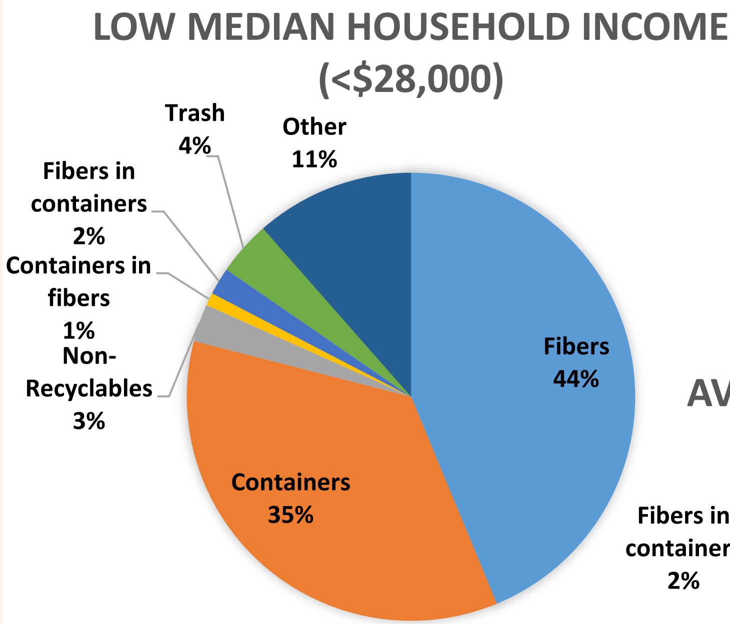
Gap Areas

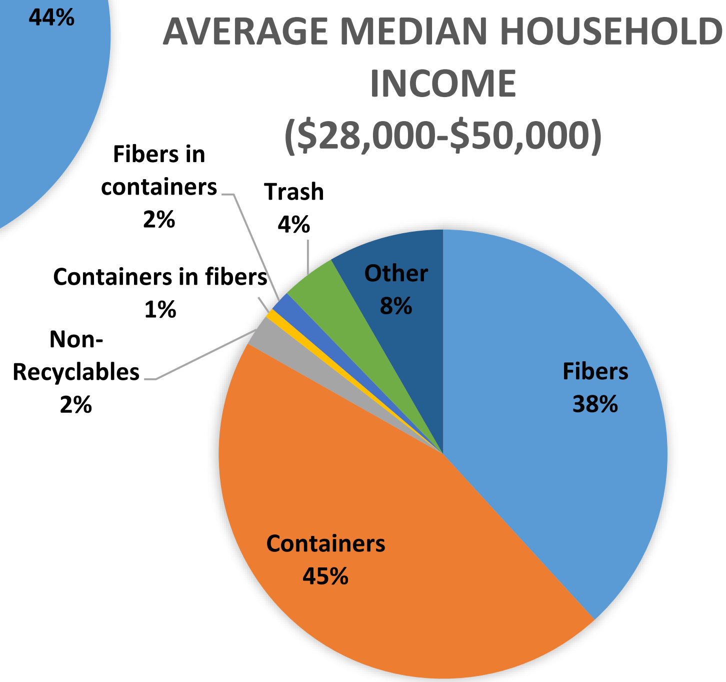
Goal: To collect more waste composition data

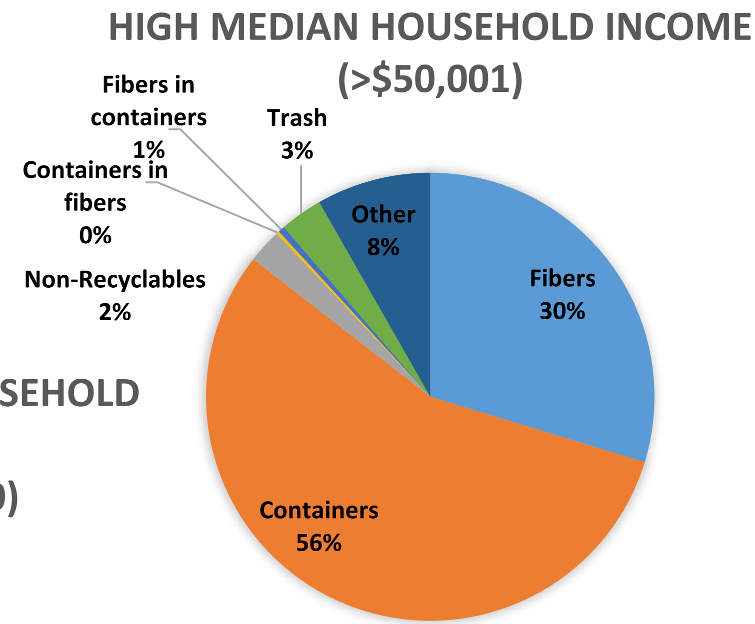
Question...

Is there a correlation between socio-demographic factors and waste disposal?

Recyclables

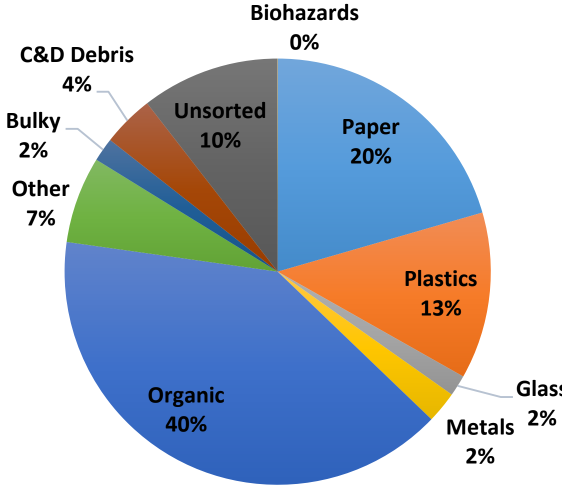




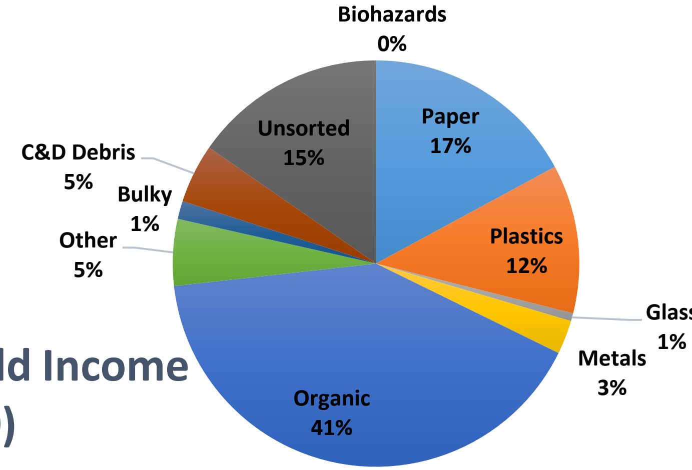


Solid Waste

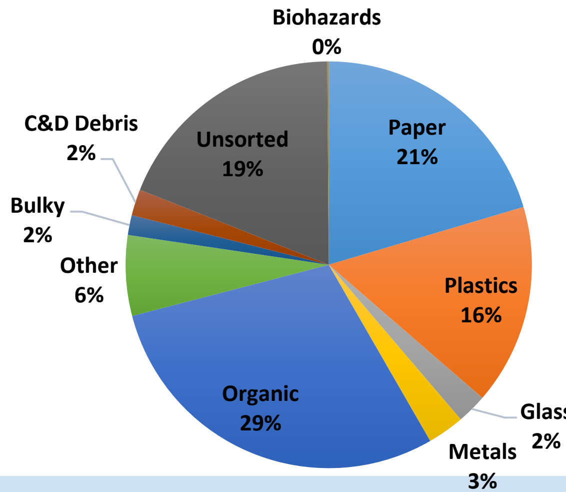
Low Median Household Income (<$28,000)



High Median Household Income (>$50,001)

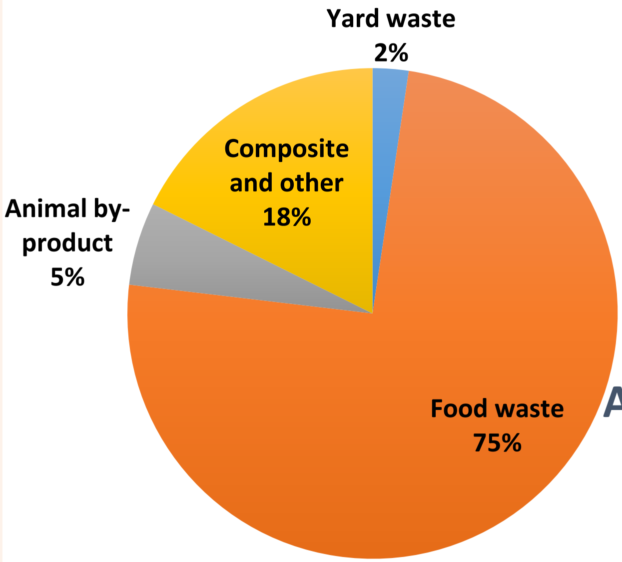


Average Median Household Income ($28,001-$50,000)

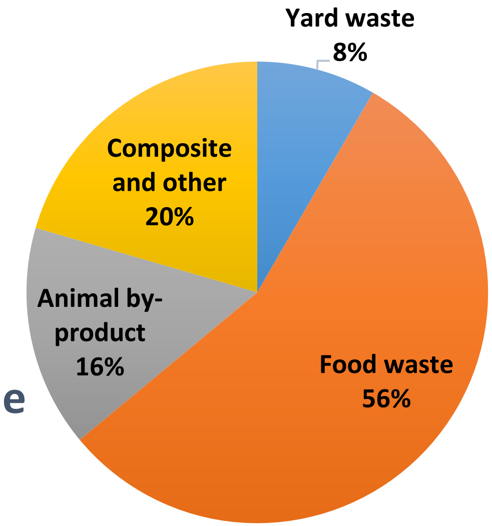


Solid Waste-Organics

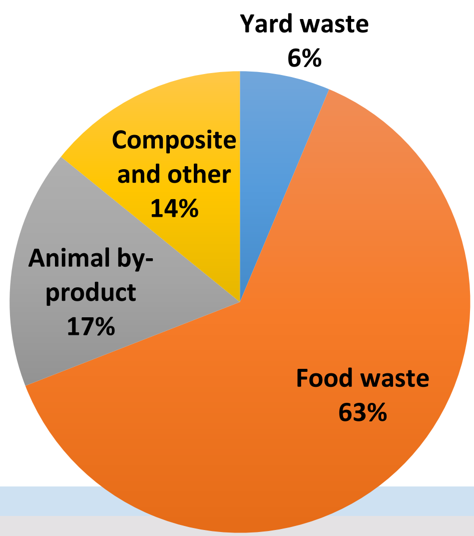
Low Median Household Income (<$28,000)



High Median Household Income (>$50,001)

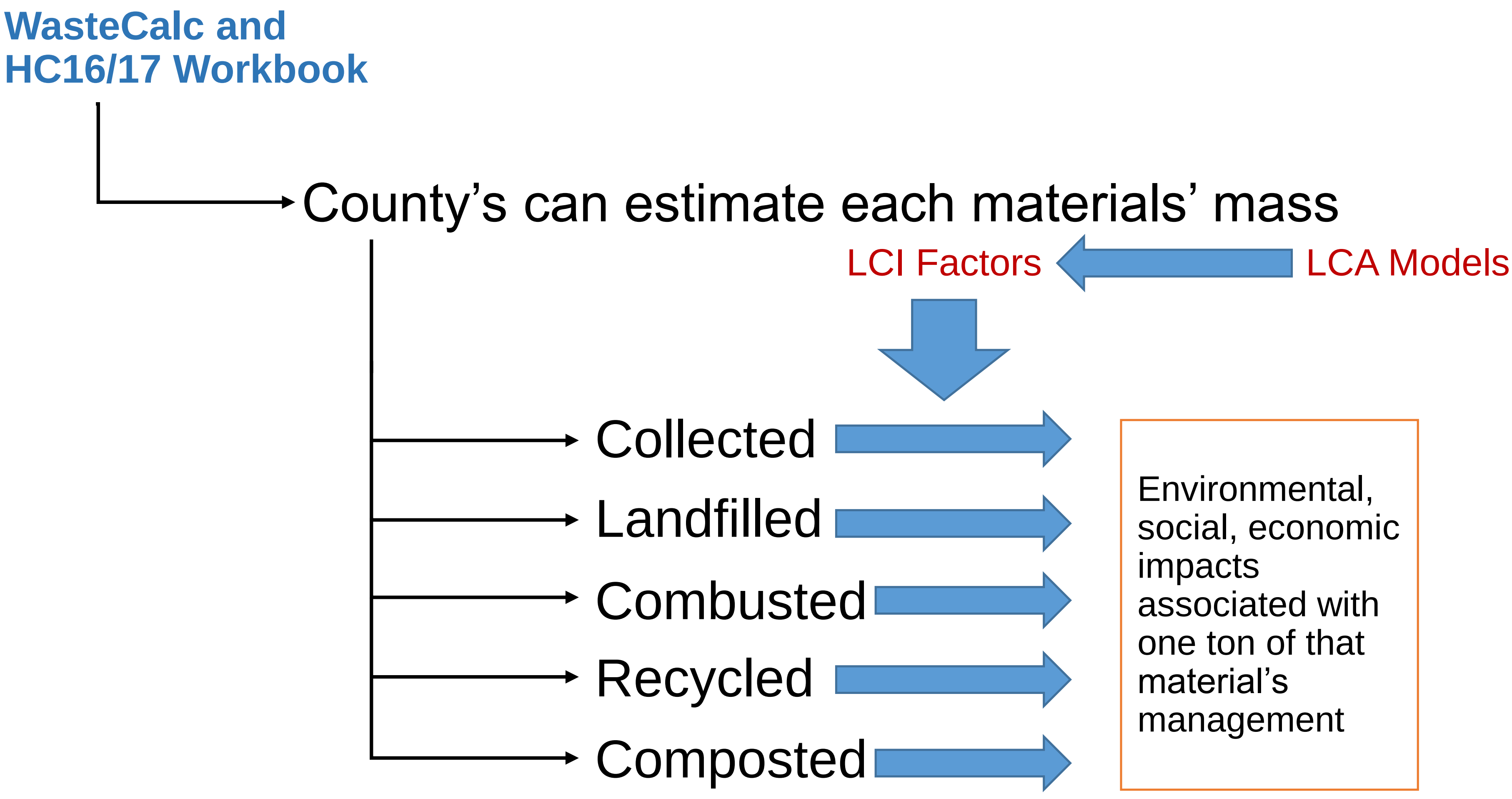


Average Median Household Income ($28,001-$50,000)




Glass
G
40

Workbook-Based LCA Tool



US EPA Waste Reduction Model (WARM)

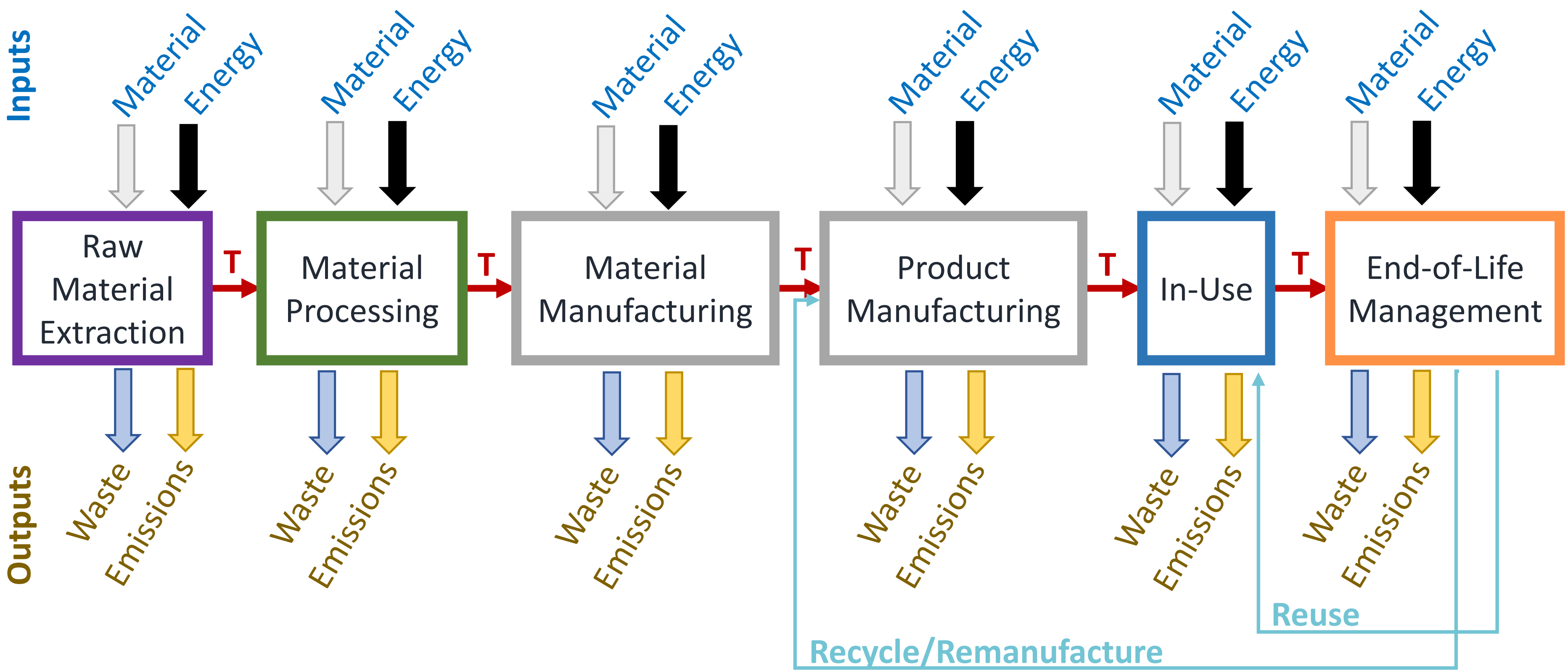
Provides for a material and its management its associated energy footprint

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

Provides for a material and its management its associated carbon footprint

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

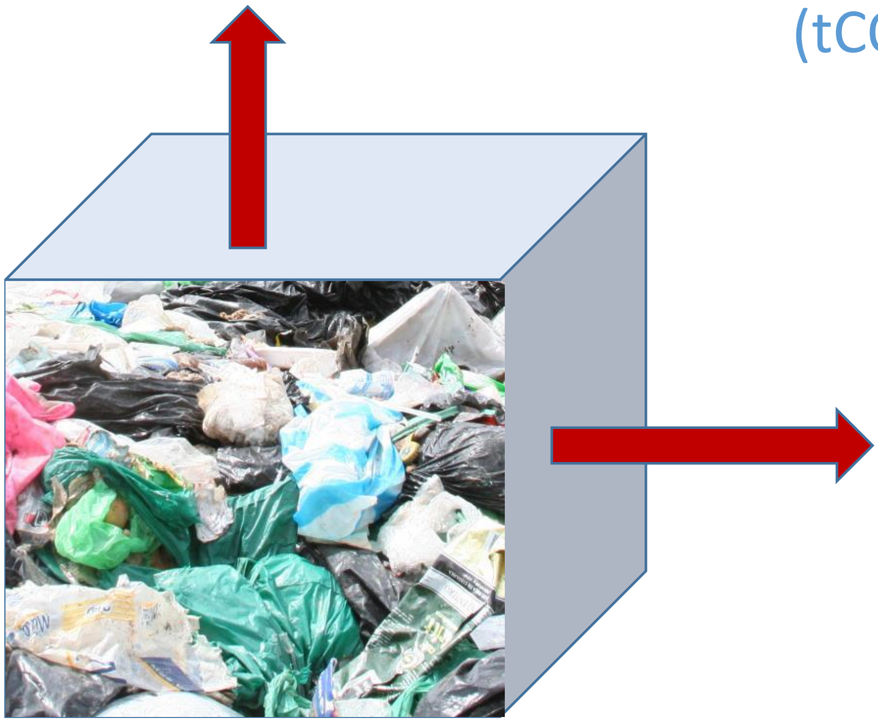
LCA Model Scope



Use LCA to translate the inputs and outputs to environmental impacts (e.g., global warming potential)

LCI Factors – Global Warming Potential Factors

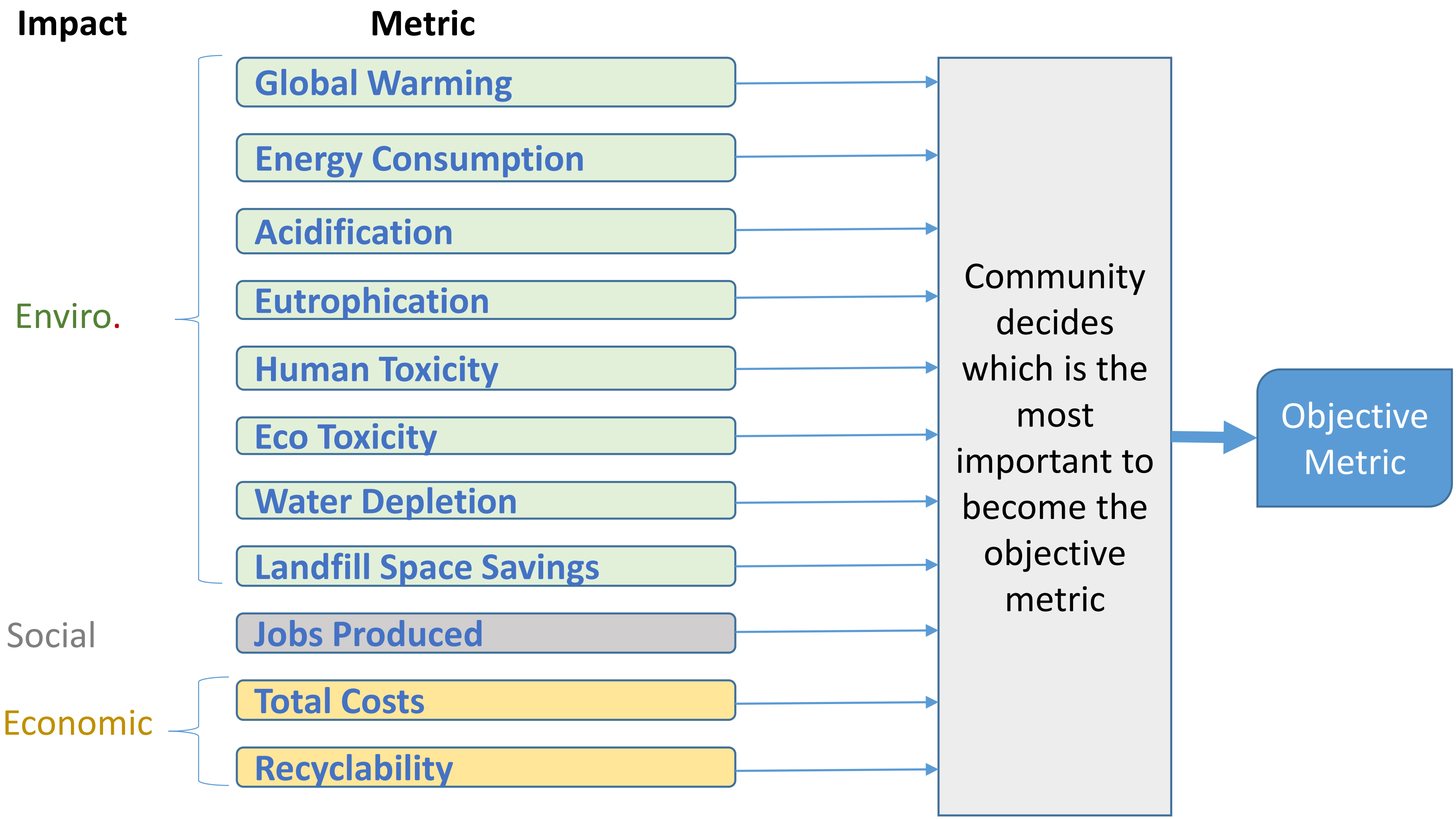
Net CO_2, CH_4, N_2O, … → Metric Tons of CO_2 Equivalents (tCO2eq.)



Mass of Waste

$$\frac{tCO_2eq.}{Ton\ Waste}$$

LCI Factors



Impact
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Enviro.
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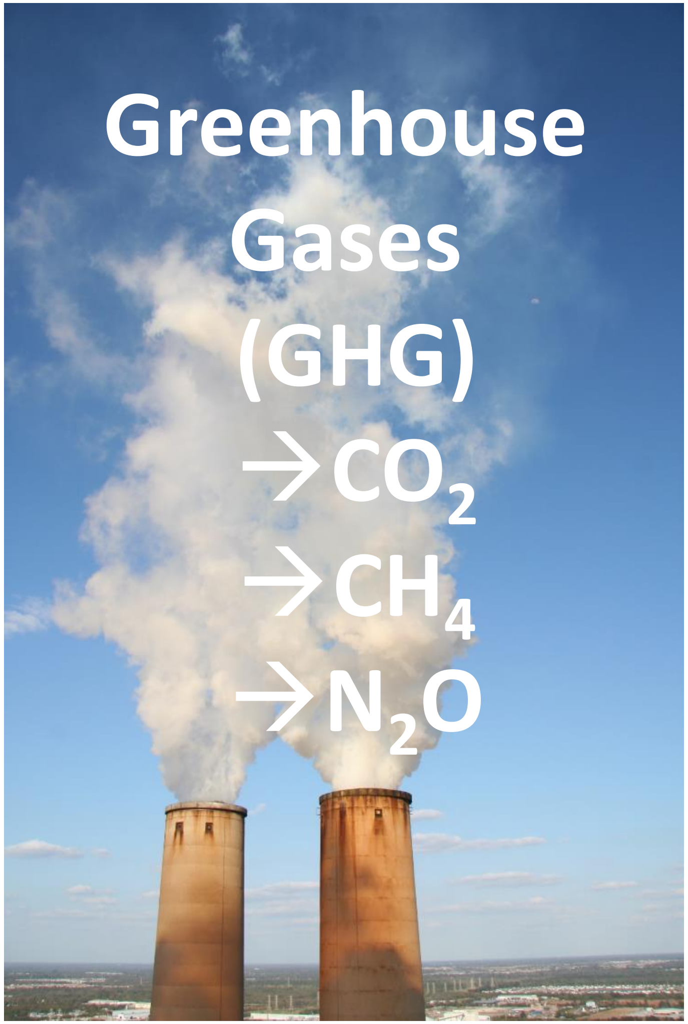
Human Toxicity
Eco Toxicity
Water Depletion
Landfill Space Savings
Social
Jobs Produced
Economic
Total Costs
Recyclability
Community decides which is the most important to become the objective metric
Objective Metric

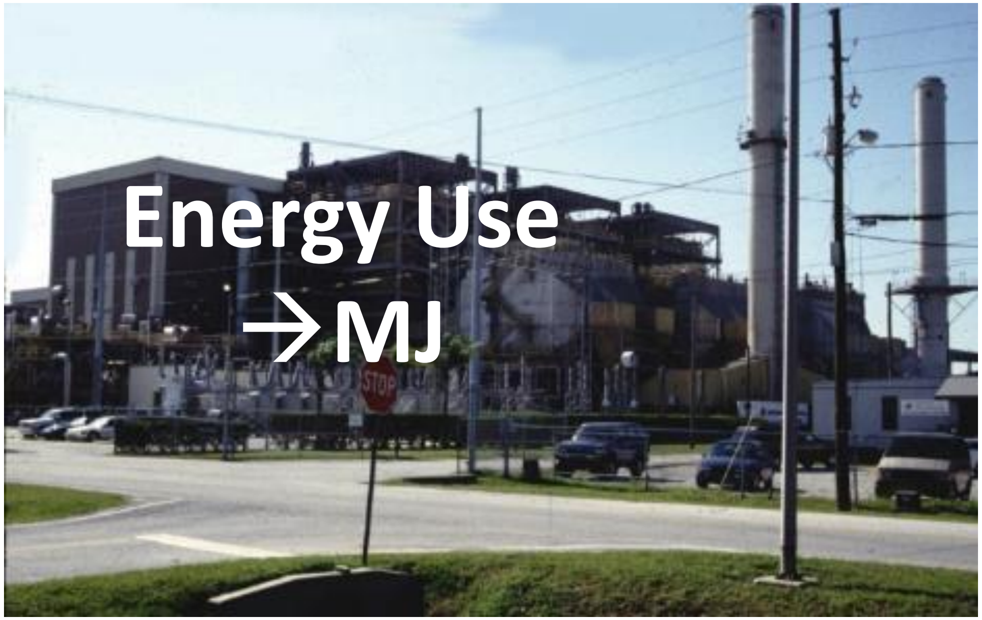
Global Warming Potential (GWP)

- GHG absorb energy and slow energy from escaping into space which causes the Earth to get warmer
- GHG are expressed as units of $tCO_2eq.$of material to allow for comparison of global warming impacts of different gases relative to CO_2
- Measure of how much energy the emission of 1 ton of gas will absorb over a given period of time, relative to the emissions of 1 ton of CO_2



Energy Use

- Energy consumed by different processes
- Expressed as units of MJ
- Measure of the direct and indirect energy use throughout the life cycle and can include both renewable and non-renewable energy source



Acidification Potential

- Increasing concentration of hydrogen ions within the environment due to addition of acids
- Adverse impacts on soils and plant growth, damage to buildings, rivers, lakes, etc.
- Expressed as units of kgSO_2eq. to allow for comparison of acids in the air relative to SO_2
- Measure of acidifying substances often as air emissions

Acidification Potential

→ SO_2

→ NO_x

→ HCl

→ NH_3

→ HF

Eutrophication Potential

- Enrichment of aquatic ecosystems with nutrients (nitrates and phosphates) that causes undesirable algal growth
- Adverse impacts lakes and coastal environments causing damage to plant and animal populations
- Expressed as units of kgNeq. to allow for comparison of nutrients in the water relative to N
- Measure of nutrients emissions to the water and air

Eutrophication Potential

→ NO_x

→ N_2

→ P

→ NH_4

→ PO_4

→ COD

Human Toxicity Potential

- Release of toxic materials to humans due to inhalation or ingestion by humans
- Adverse impacts include causing cancer and other non-cancer diseases
- Expressed as units of comparative toxic units (CTUh) interpreted as disease cases per kg of substance emitted
- Measure of releases of chemicals toxic (cancer and non-cancer) to humans in the air, water, and soil

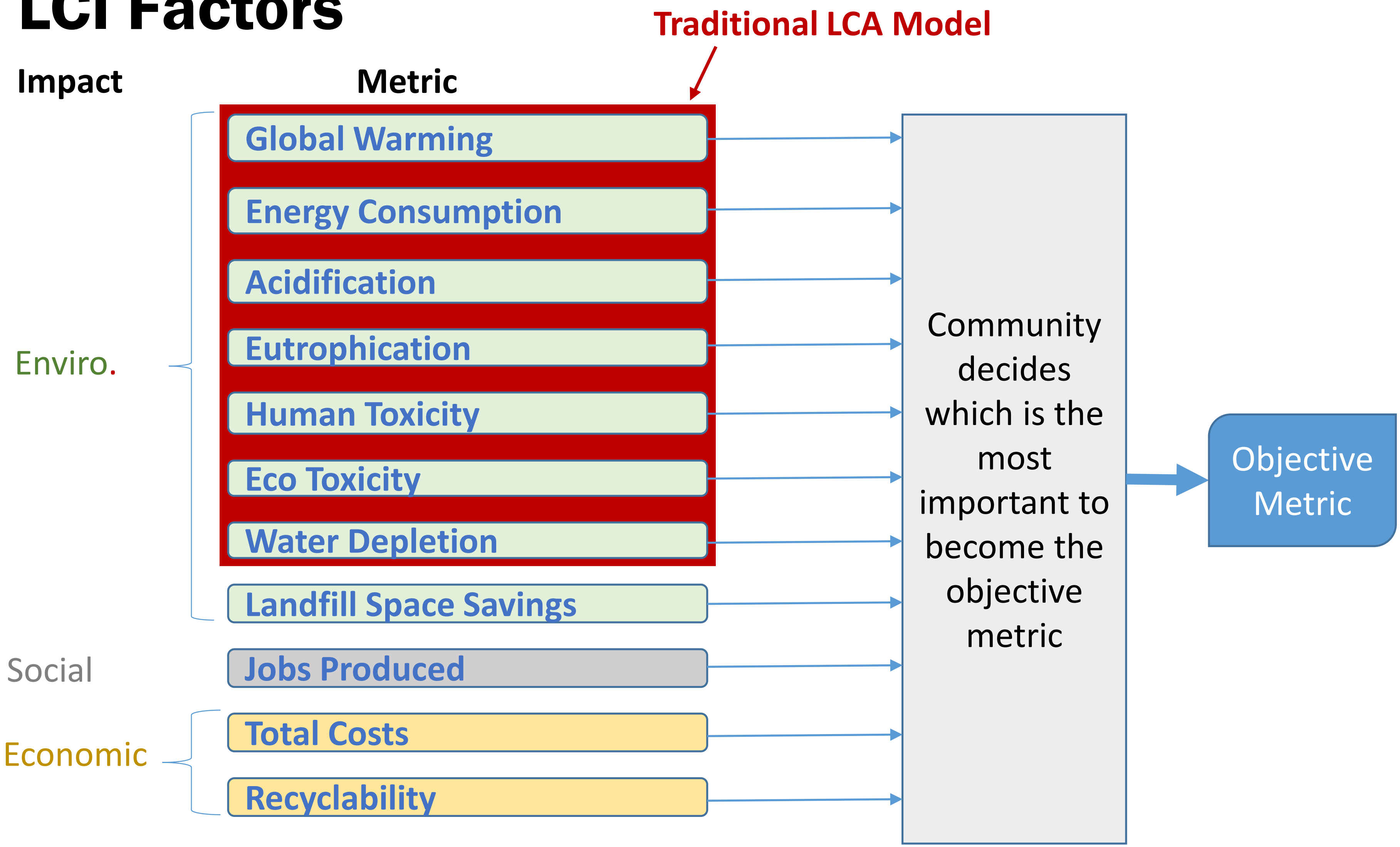
Aquatic Ecotoxicity Potential

- Release of toxic materials to aquatic ecosystem
- Expressed as units of comparative toxic units (CTUe) interpreted as the potentially affected fraction of species over time and volume per kg of substance emitted
- Measure of releases of chemicals toxic to aquatic ecosystem in the air, water, and soil

Water Depletion Potential

- Freshwater from lakes, rivers, and wells consumed by different processes
- Expressed as units of m^3
- Measure of the water used in such way that the water is evaporated, incorporated into products, transferred to other watersheds, or disposed into the sea

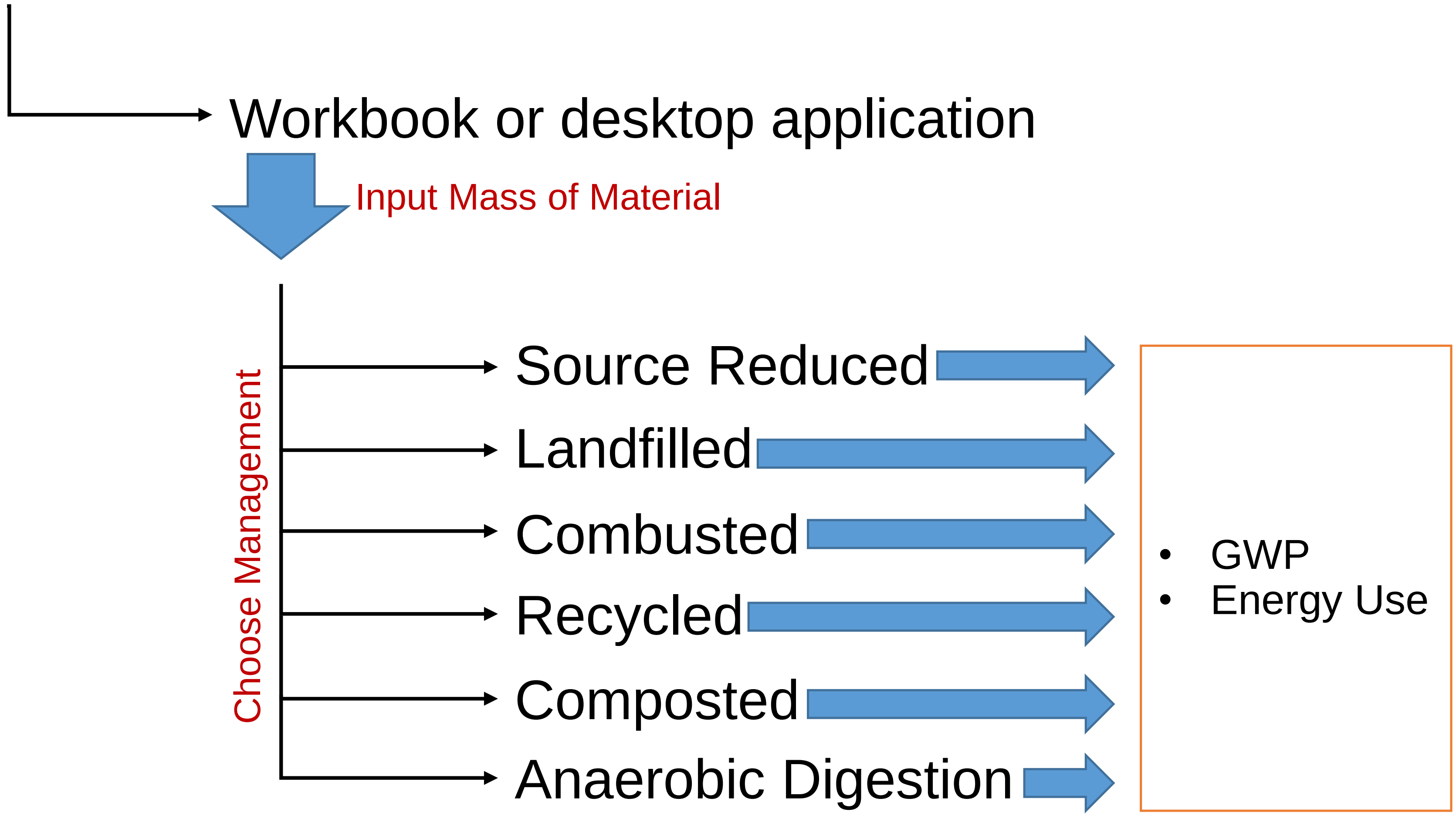
Methods of Obtaining Environmental-Based LCI Factors



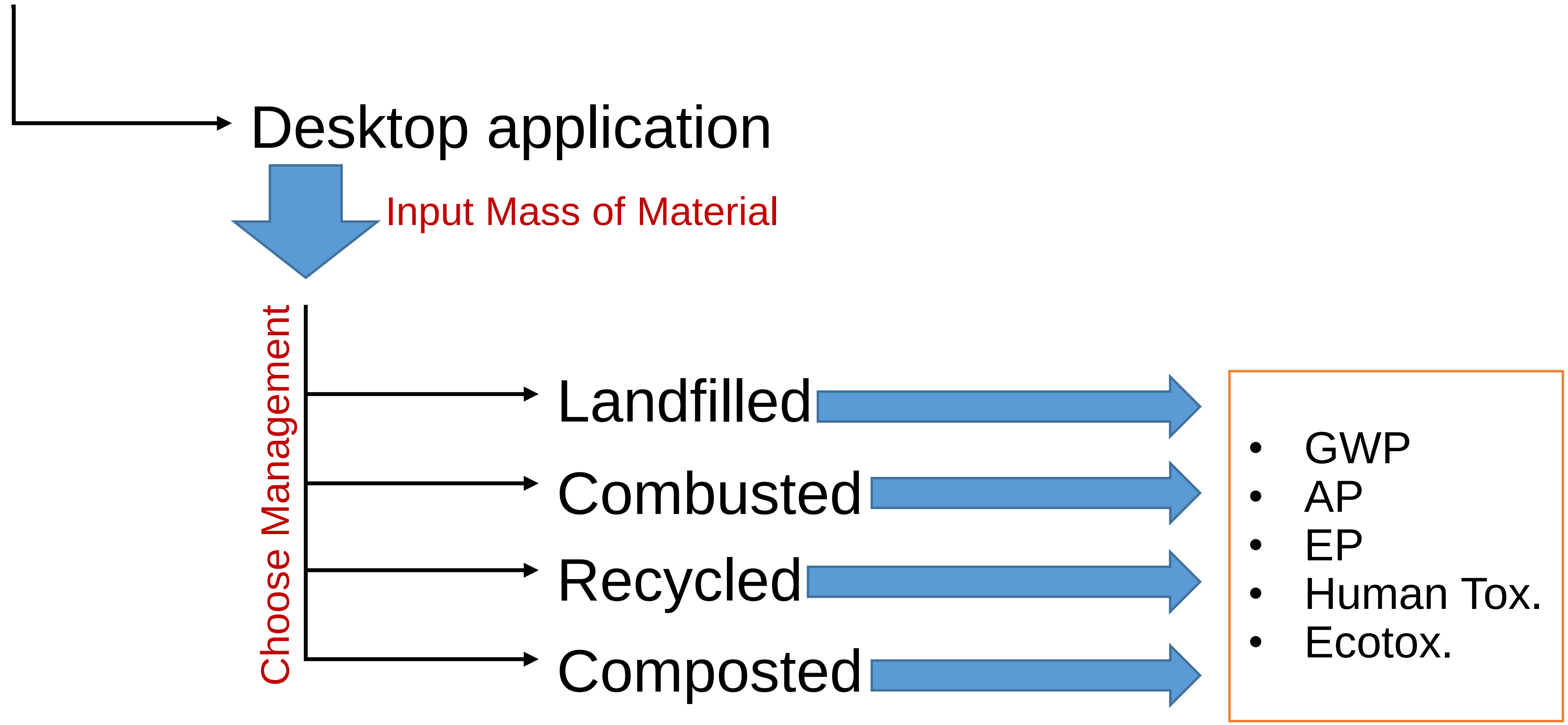
Differences in Waste LCA Models

- Waste Reduction Model **(WARM)**
- Municipal Solid Waste – Decision Support Tool **(MSW-DST)**
- Solid Waste Optimization Life-cycle Framework **(SWOLF)**
- Environmental Assessment System for Environmental Technologies **(EASETECH)**

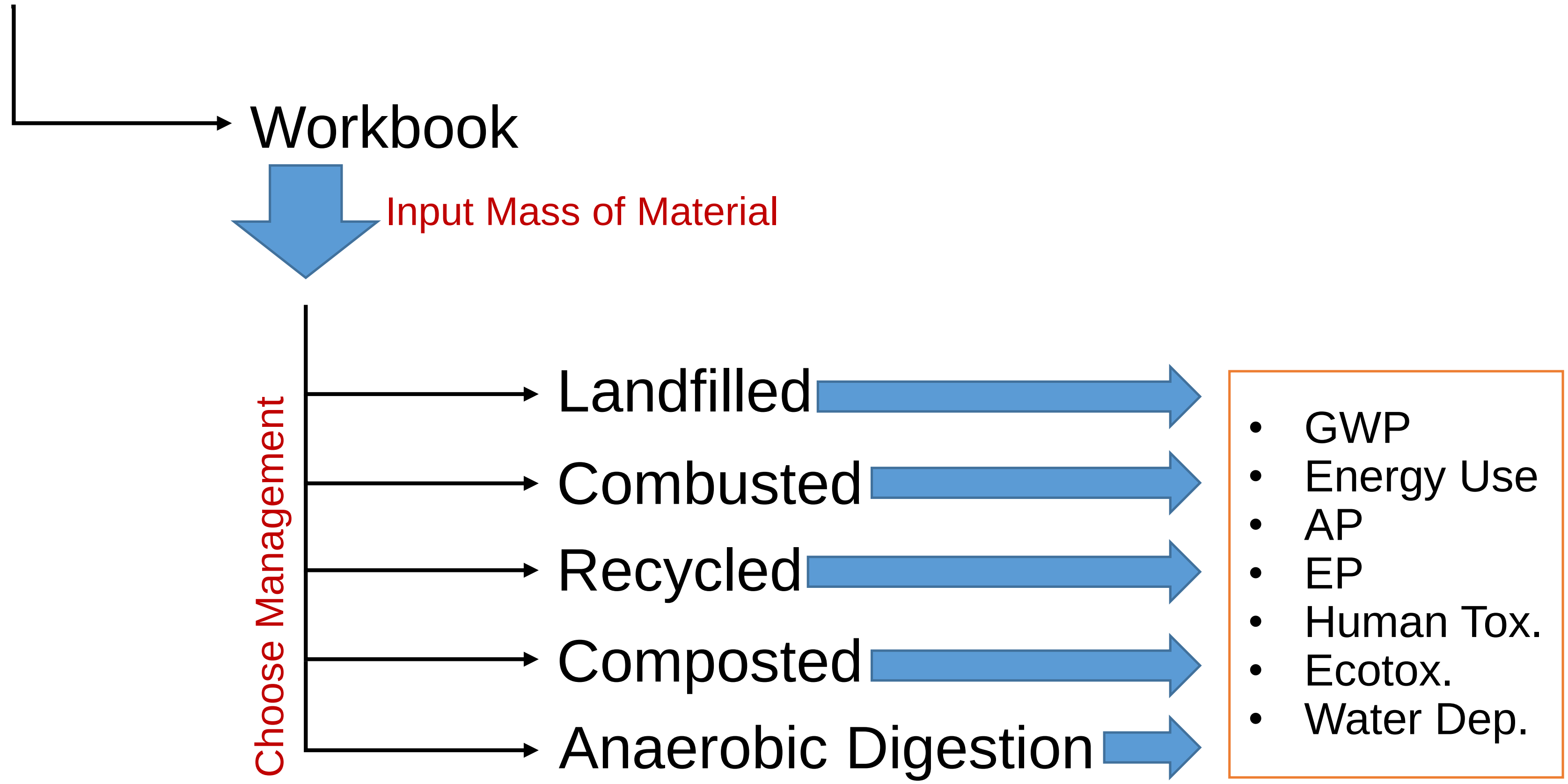
WARM (US, US EPA)



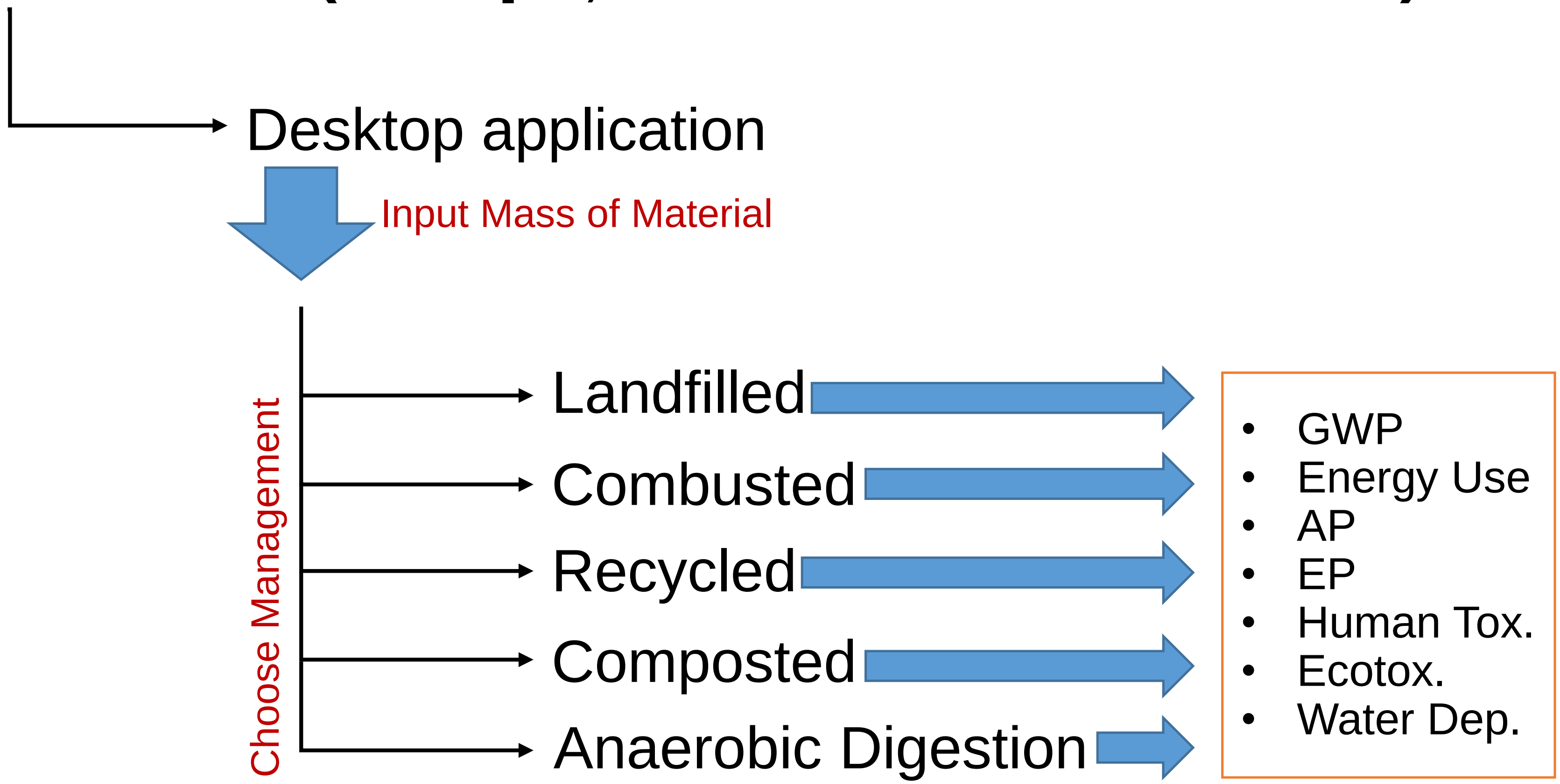
MSW-DST (US, US EPA)



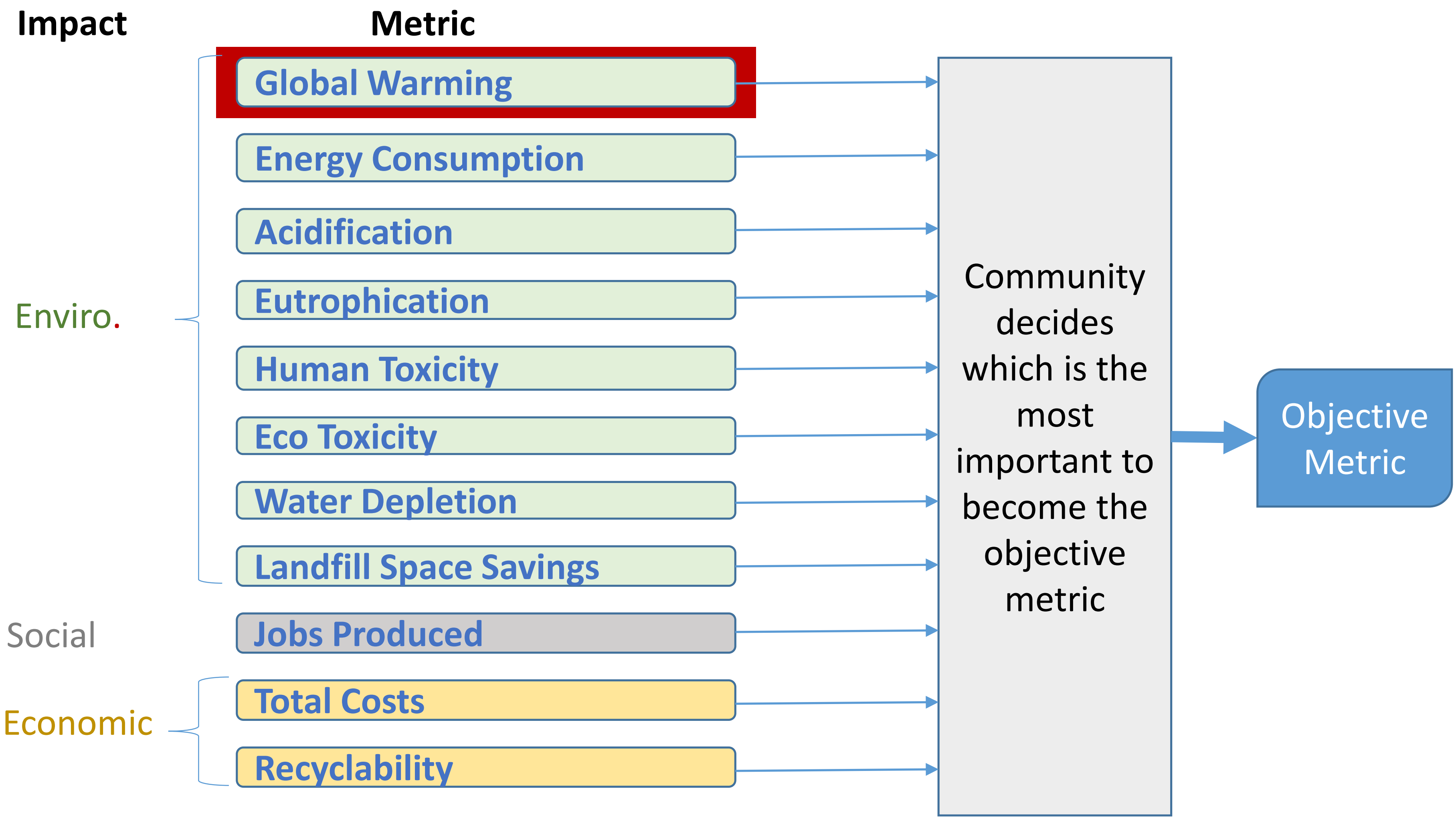
SWOLF (US, NC State)



EASETECH (Europe, Tech. Uni. Of Denmark)



LCI Factors



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Eco Toxicity
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Landfill Space Savings
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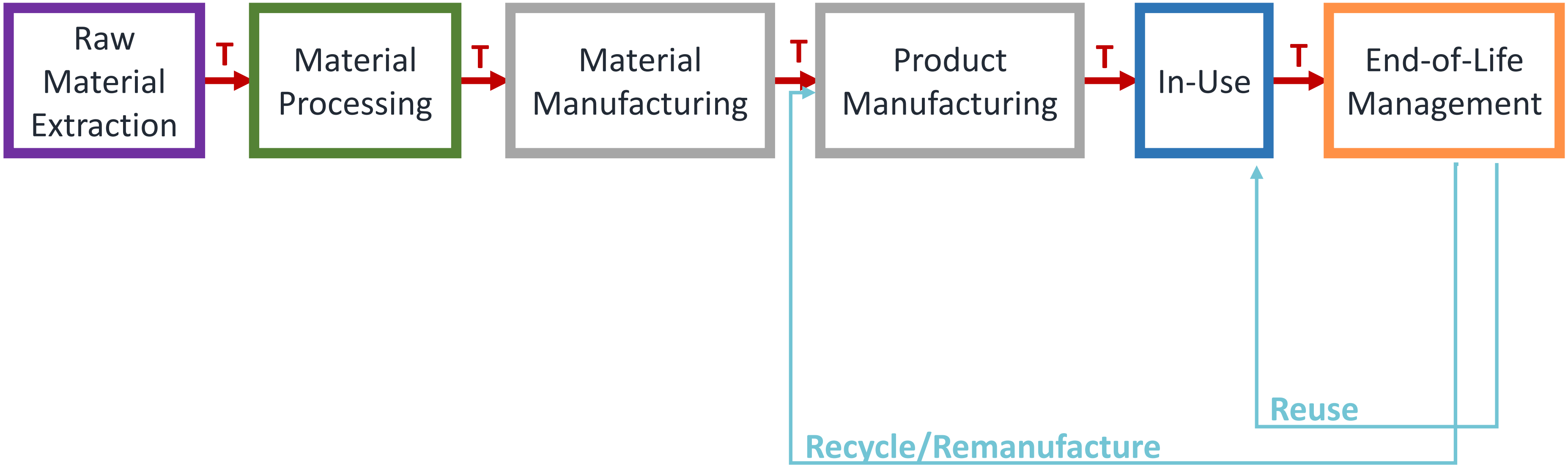
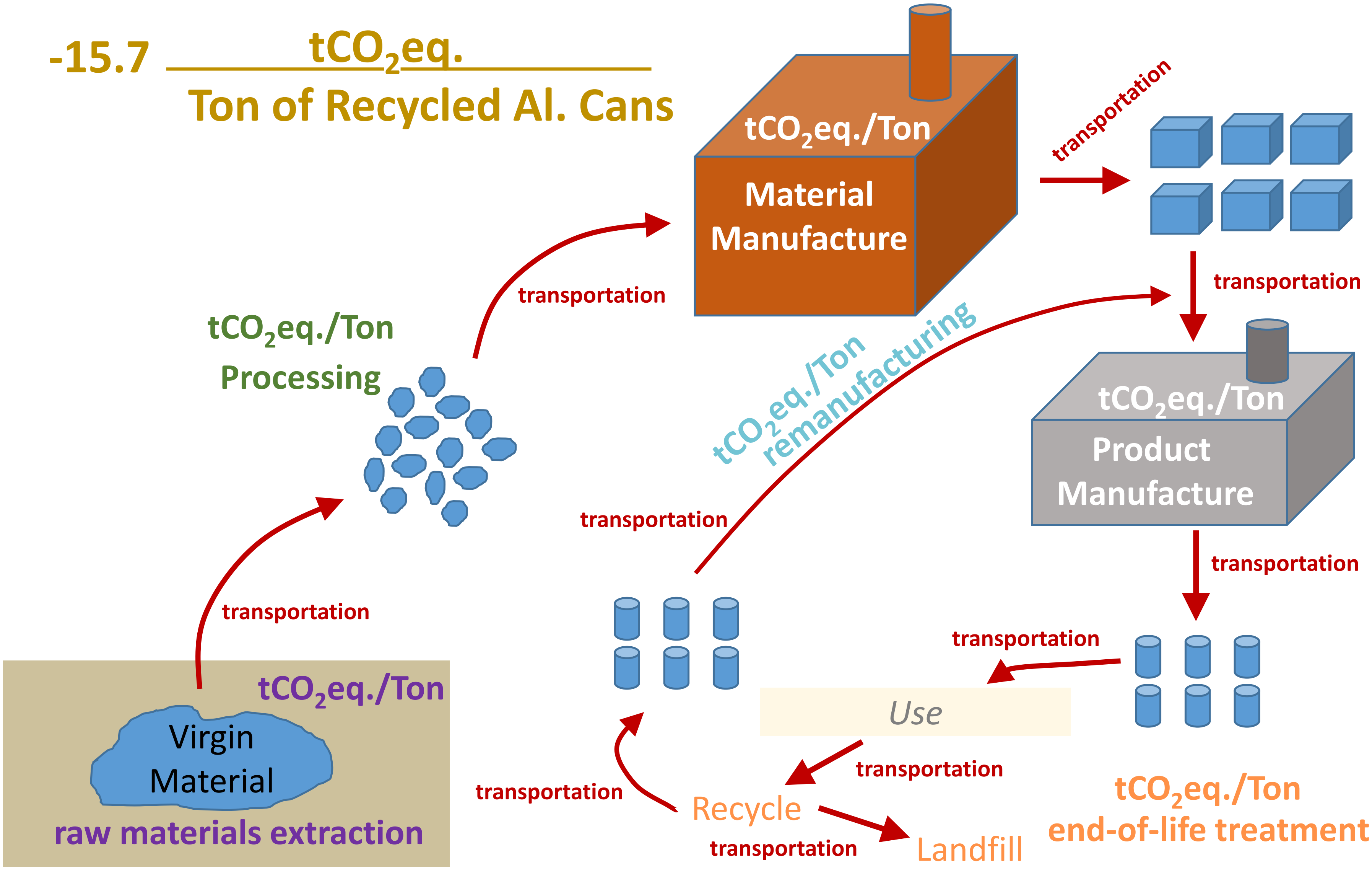
Total Costs
Recyclability
Community decides which is the most important to become the objective metric
Objective Metric

LCA Model Scope

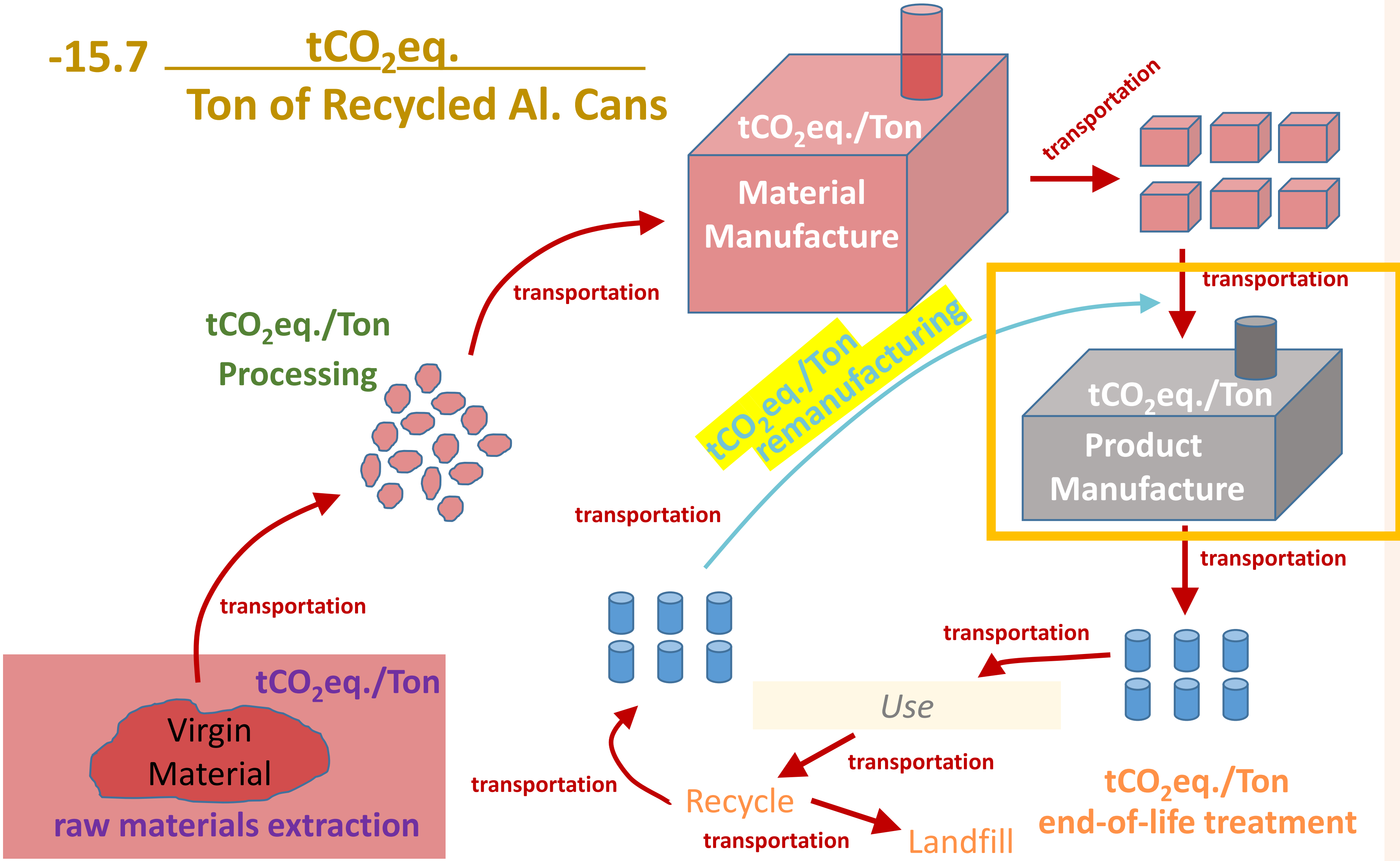


Example: Recycling Aluminum Cans in SWOLF

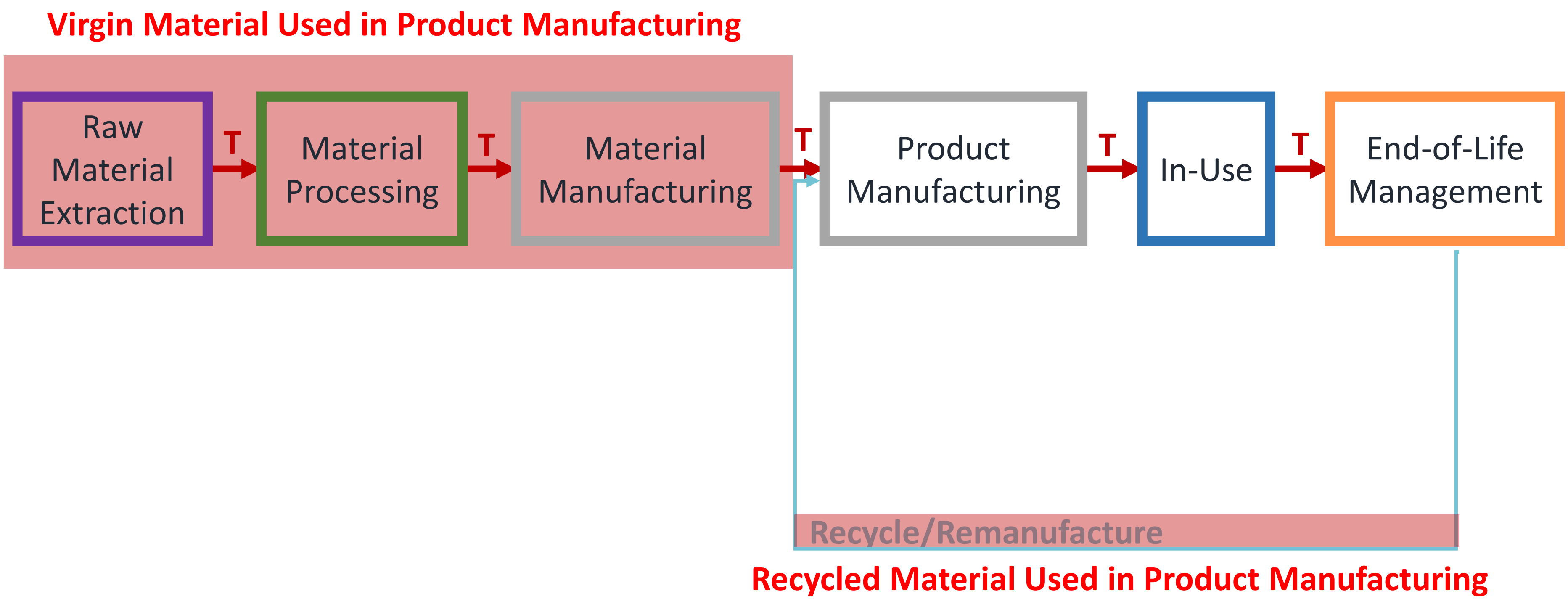
$-15.7 \frac{tCO_2eq.}{\text{Ton of Recycled Al. Cans}}$



Example: Recycling Aluminum Cans in SWOLF



SWOLF Model Scope For Recycling



SWOLF Model Scope For Recycling

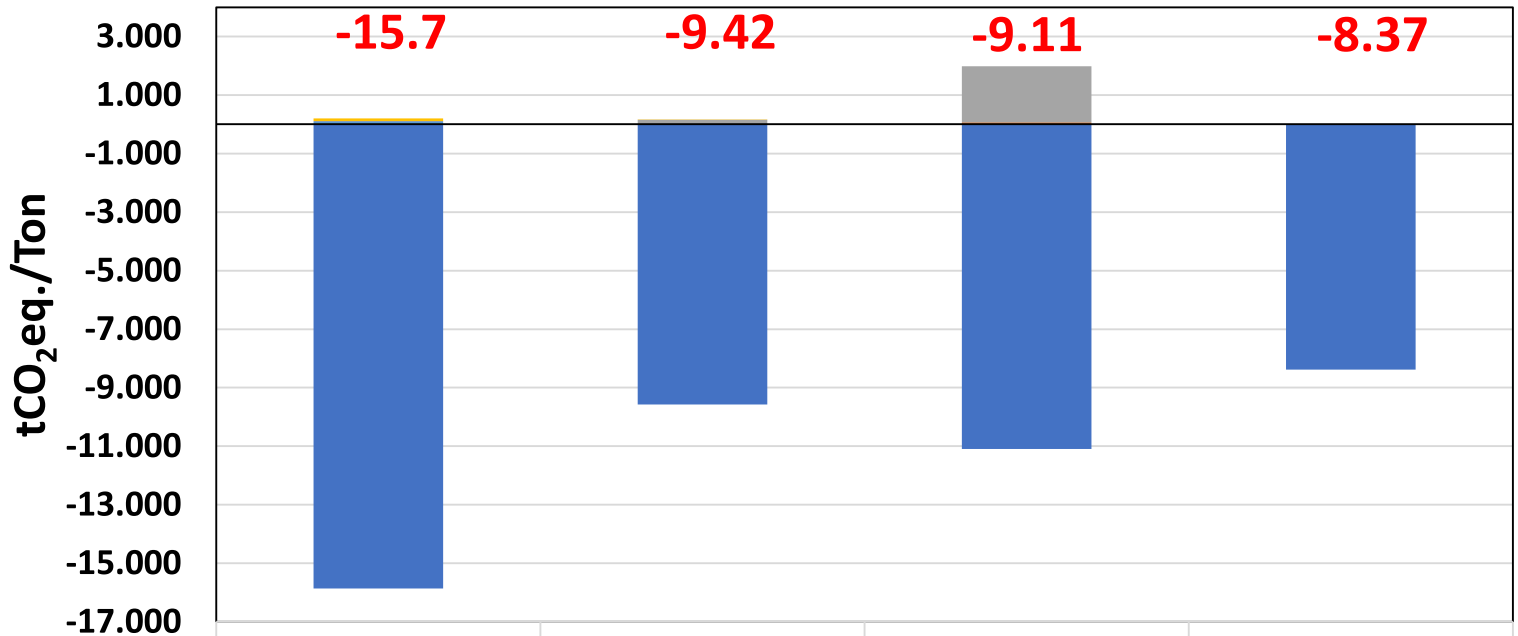
Virgin Material Used in Product Manufacturing − Recycled Material Used in Product Manufacturing + Sorting and Processing at a MRF + Disposal at Landfill

$$= -15.7 \frac{tCO_2eq.}{\text{Ton of Recycled Al. Cans}}$$

Differences in Waste LCA Models

- Some LCA models account for a greater offset
- Differences in underlying assumptions
- Methods used to calculate the GHG emissions for each stage

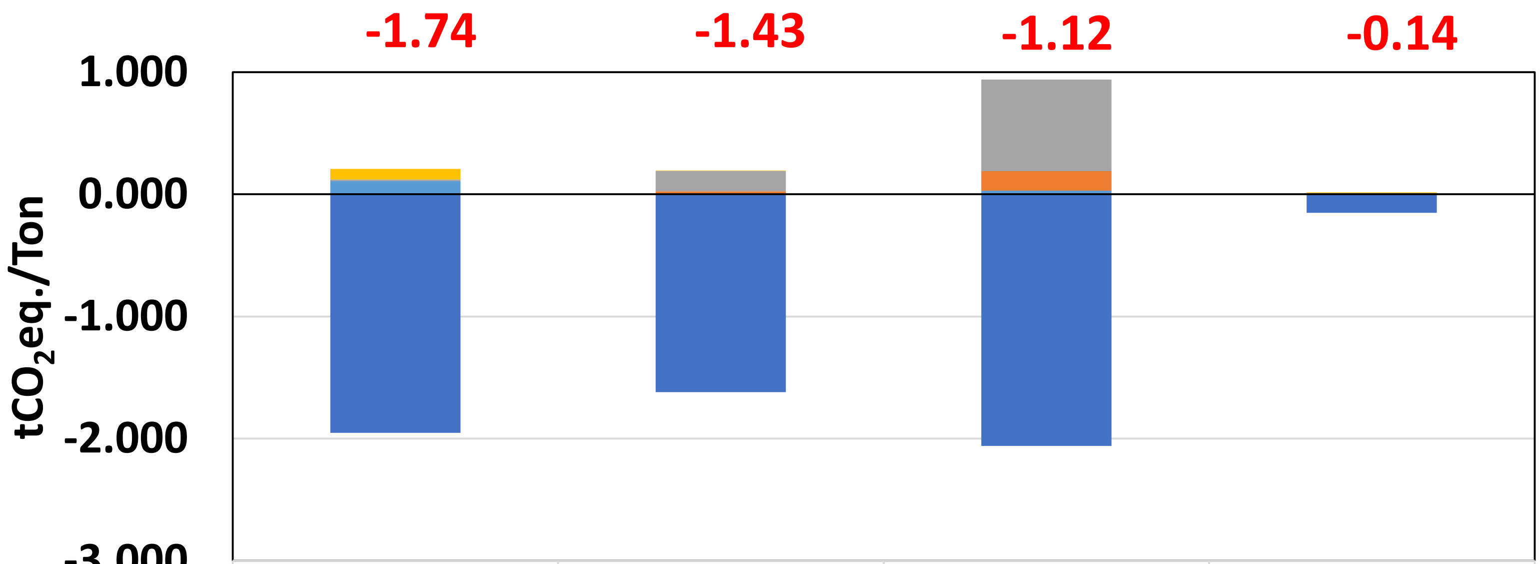
Recycling Aluminum Cans GHG Emission Factor ($tCO_2eq./ton$)



	SWOLF	MSW-DST	WARM	EASETECH
Remanufacturing	-15.9	-9.58	-11.1	-8.38
Landfill Residuals	0.087	0.004	0	0.005
Separation at MRF	0.012	0.133	1.92	0.009
Transportation	0.0001	0.016	0.03	0.001
Collection	0.104	0.005	0.03	0.001

Collection · Transportation · Separation at MRF · Landfill Residuals · Remanufacturing

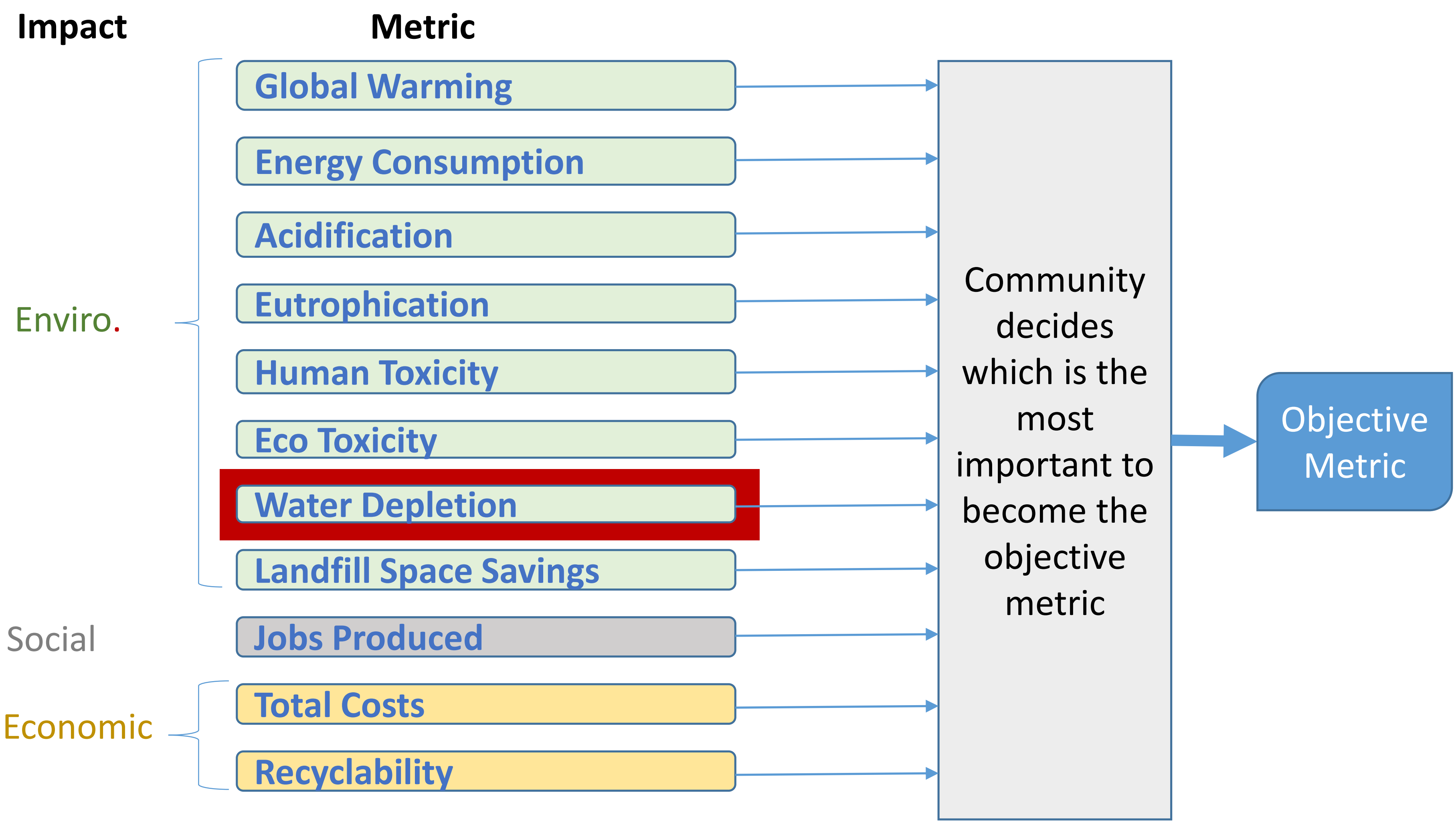
Recycling PET Bottles GHG Emission Factor ($tCO_2eq./ton$)



	SWOLF	MSW-DST	WARM	EASETECH
Remanufacturing	-1.95	-1.62	-2.06	-0.152
Landfill Residuals	0.087	0.004	0	0.005
Separation at MRF	0.012	0.166	0.75	0.009
Transportation	0.0001	0.020	0.16	0.001
Collection	0.109	0.006	0.03	0.001

Collection Transportation Separation at MRF
Landfill Residuals Remanufacturing

LCI Factors



Impact
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Landfill Space Savings
Jobs Produced
Total Costs
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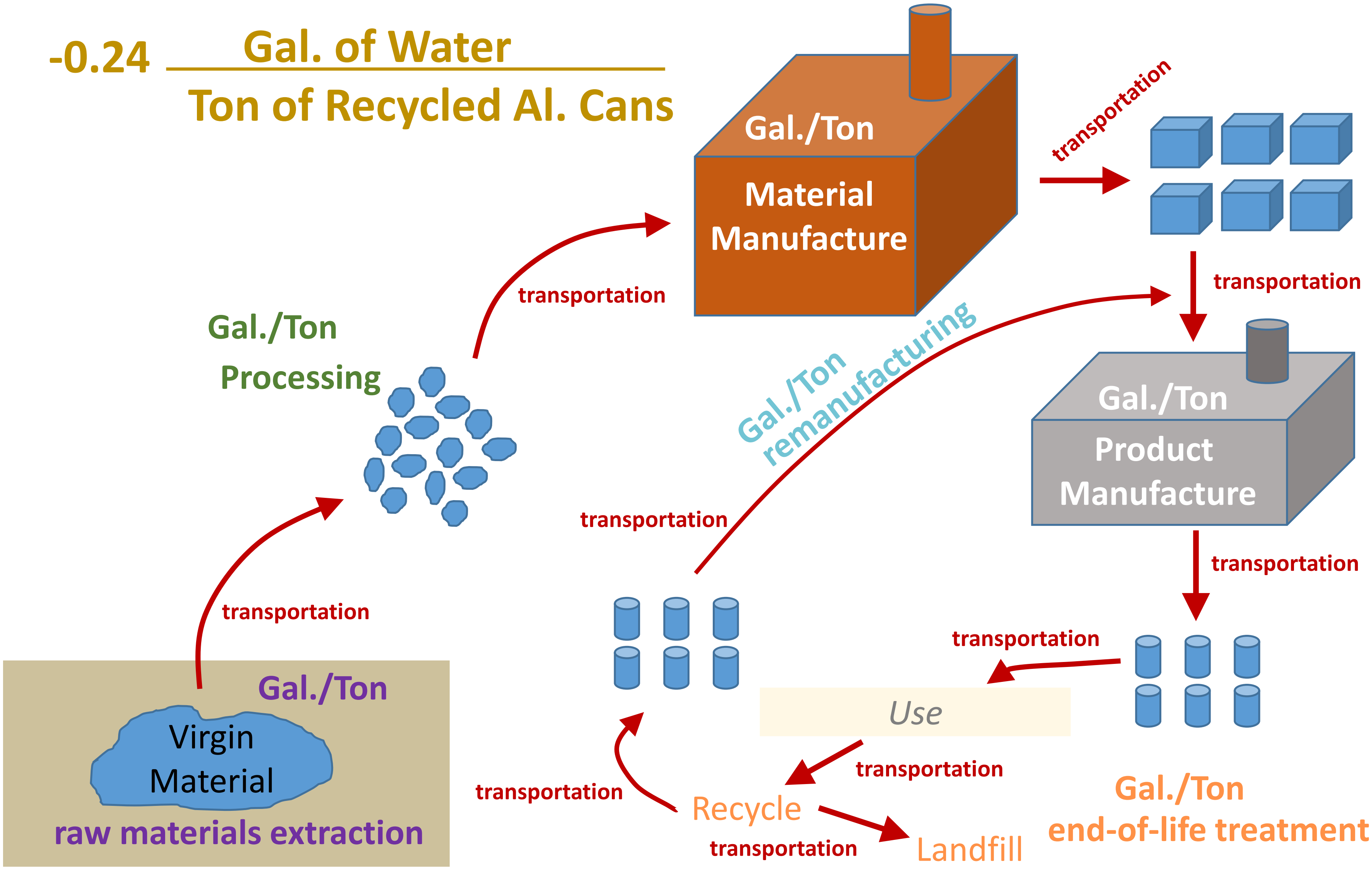
Objective Metric

Example: Recycling Aluminum Cans in SWOLF



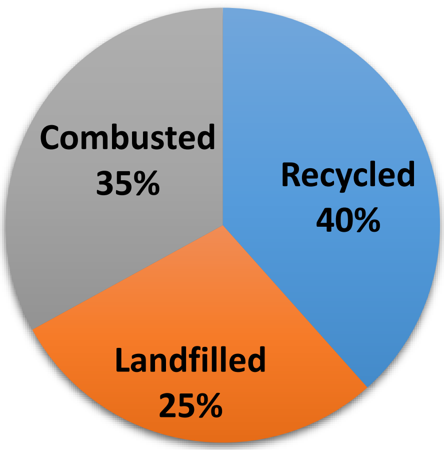
LCI Factors for Recycling Al. Cans & PET Bottles

SWOLF

Impact	Metric	Al. Cans	PET Bottles
Enviro.	Global Warming ($tCO_2eq./t$)	-15.7	-1.74
	Energy Consumption (MJ/t)	-158,260	-20,583
	Acidification ($kgSO_2eq./t$)	-4,615	-599
	Eutrophication ($kgN_2eq./t$)	-1.40	-2.40
	Human Toxicity (CTUh/t)	$-2.91x10^{-3}$	$-3.46x10^{-4}$
	Eco Toxicity (CTUe/t)	-51,388	-14,034
	Water Depletion (Gal./t)	-0.24	-0.03

Using environmental impacts in goal setting

For Hypothetical 2008

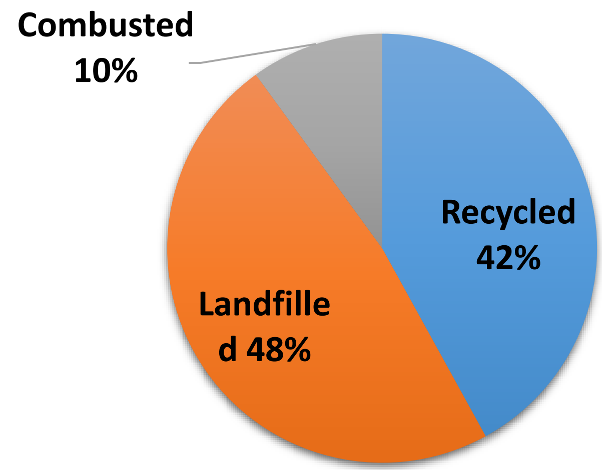


30.1 Million tons

Total Recycling Rate: 75%

Water Depletion Footprint: -0.03 Gal/person

For 2017



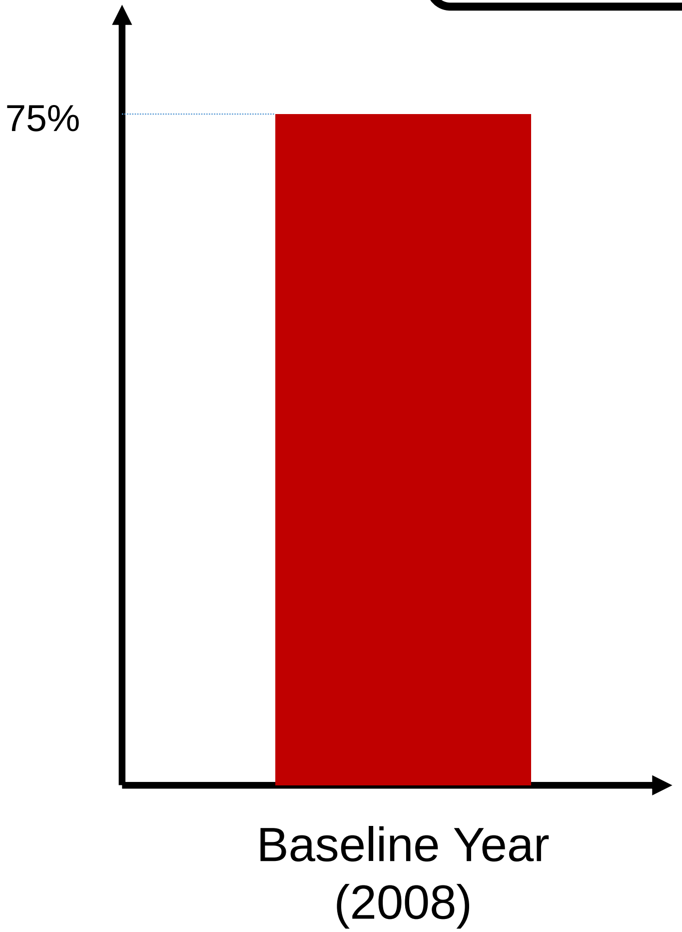
45.2 Million tons

Total Recycling Rate: 52%

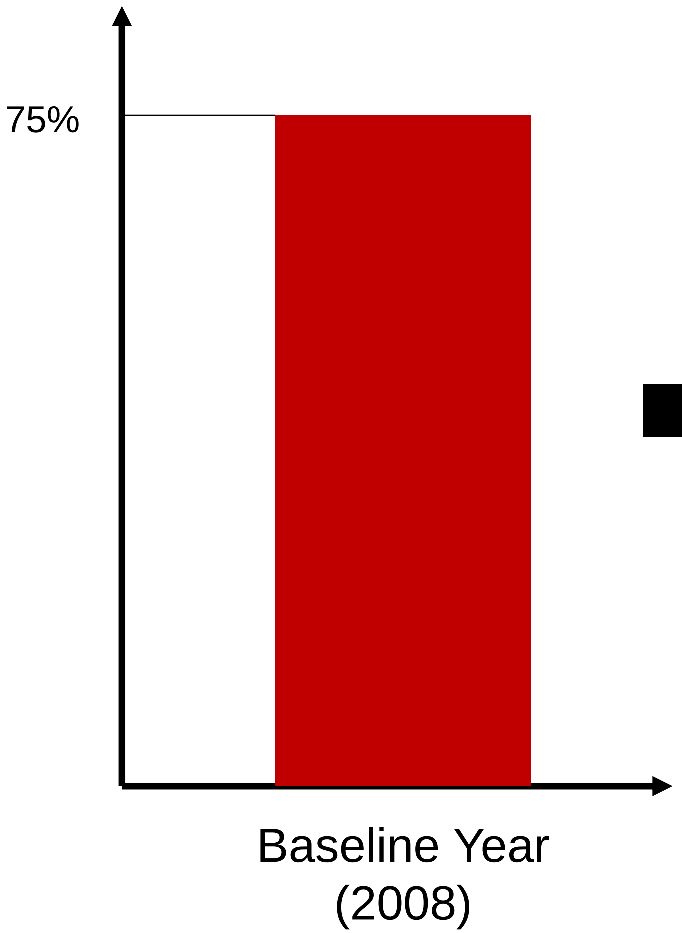
Water Depletion Footprint: -0.02 Gal/person

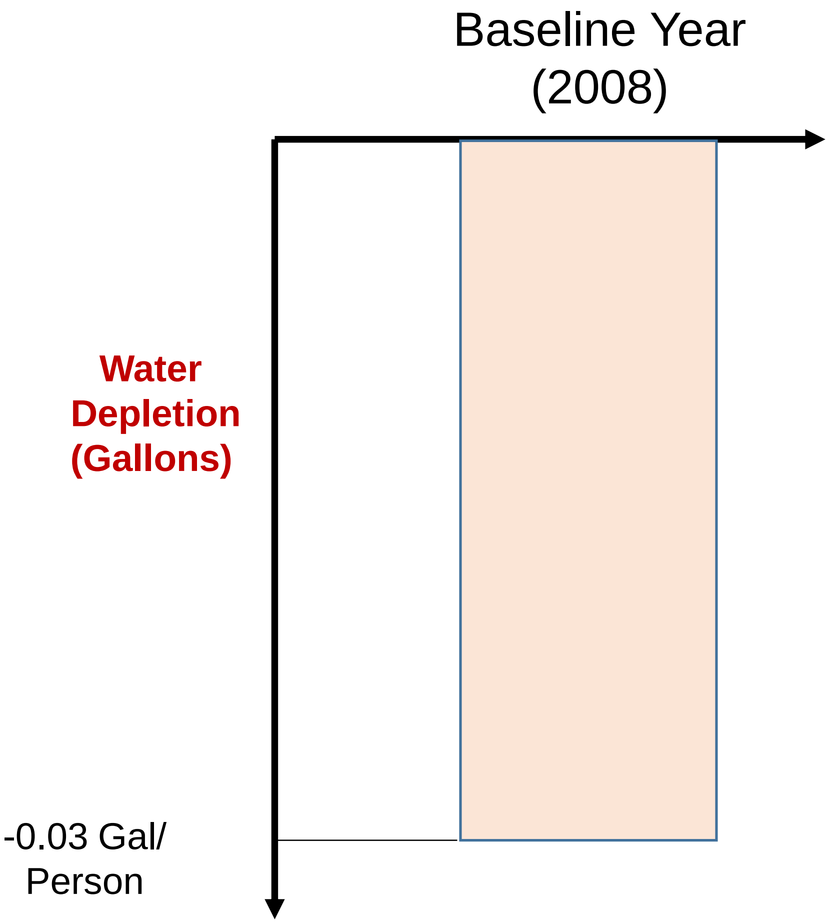
Using environmental impacts in goal setting

Identify which year you want to set as your “baseline



Using environmental impacts in goal setting

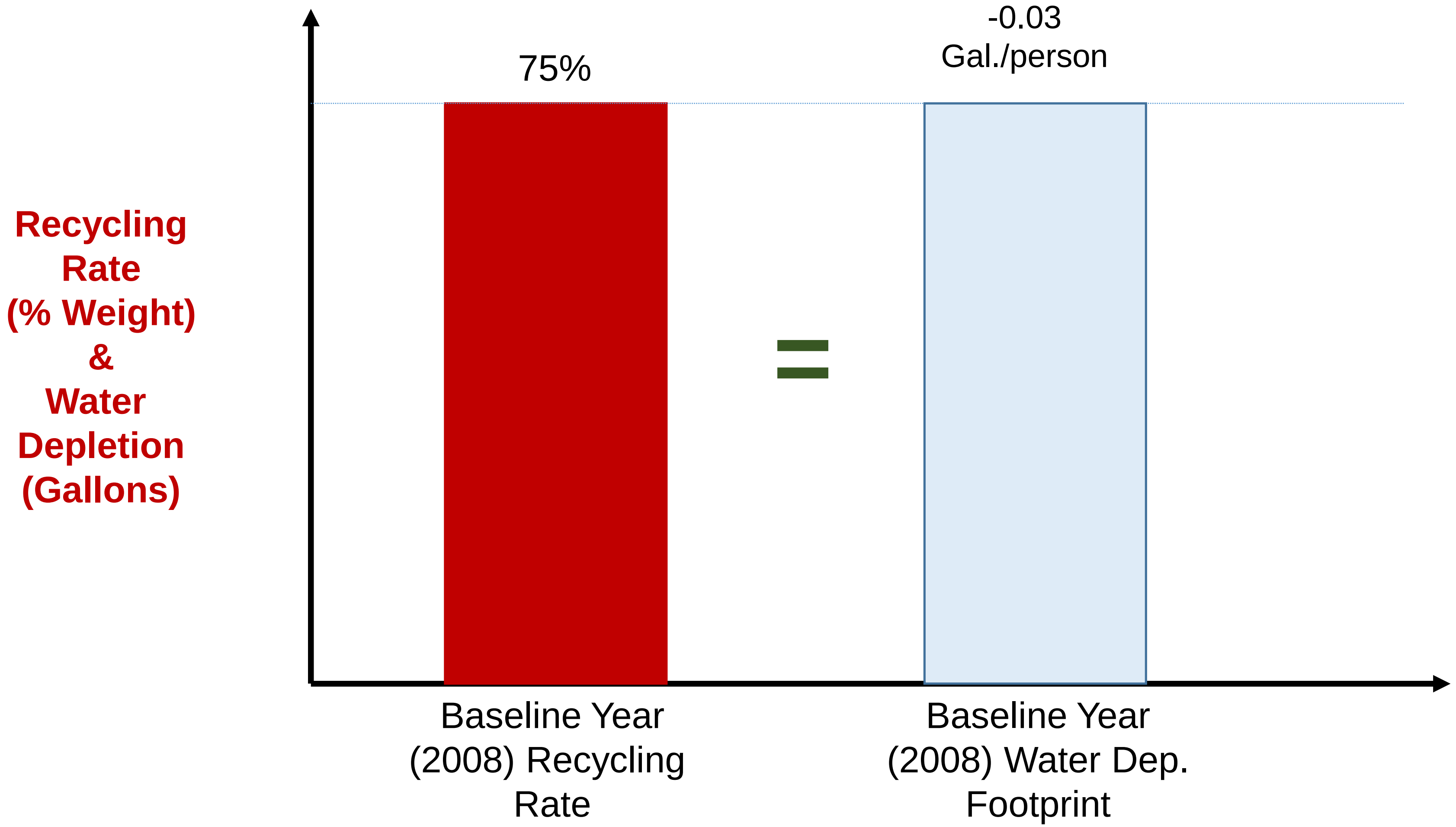




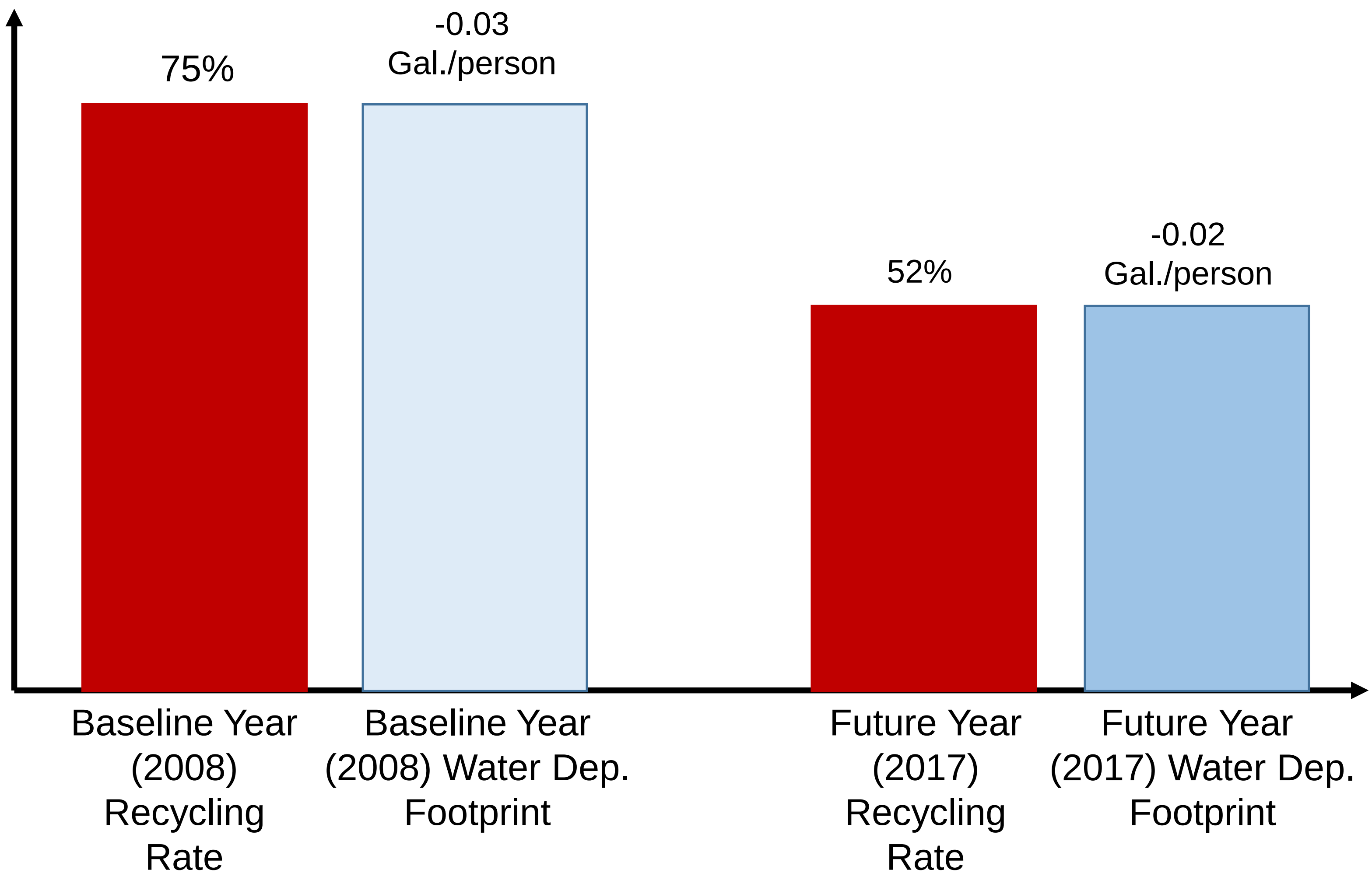
Then calculate for your "baseline" its water dep. footprint

Using environmental impacts in goal setting

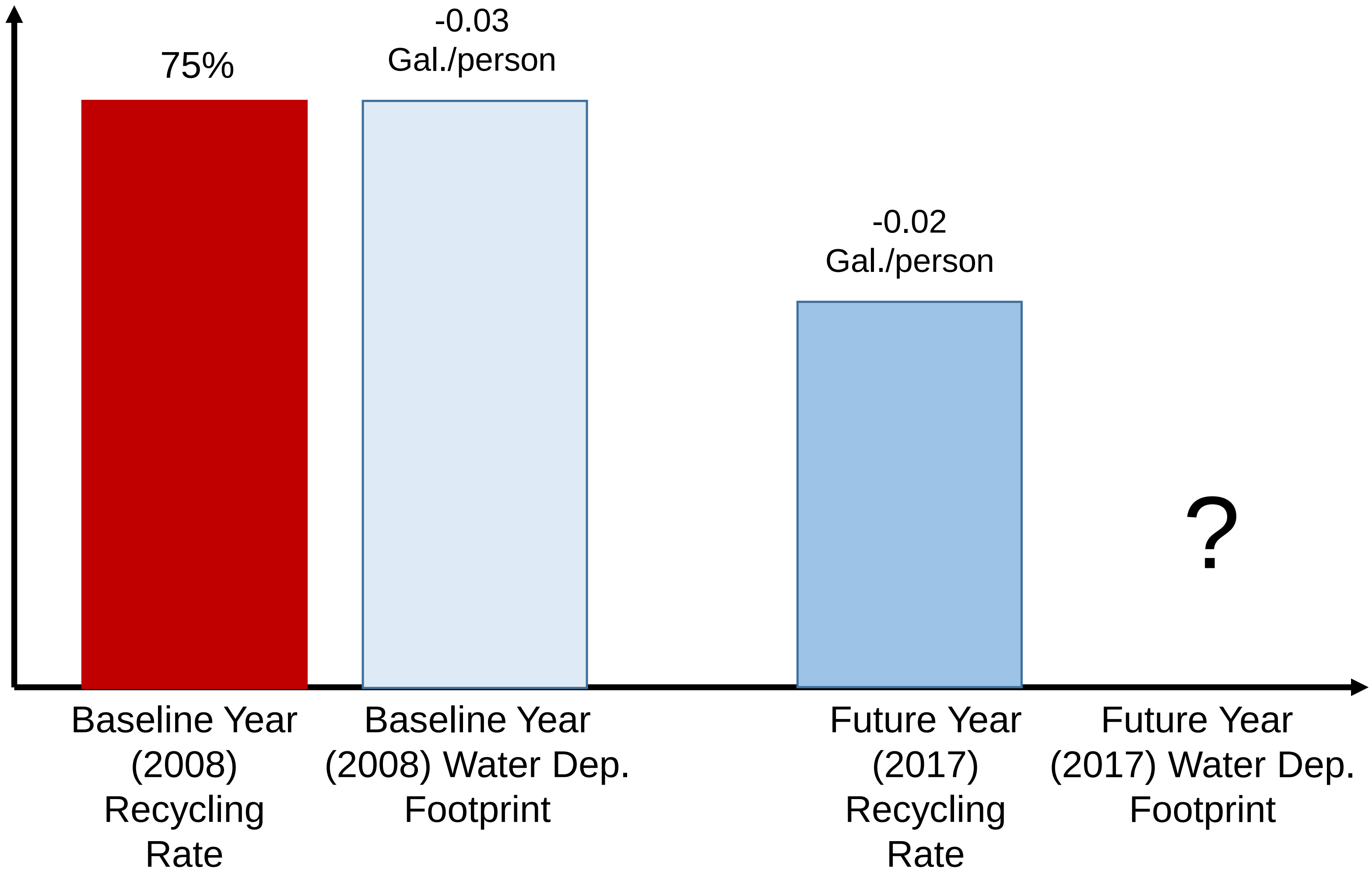
Now we can assume that 75% recycling is equivalent to Gal./person



Using environmental impacts in goal setting

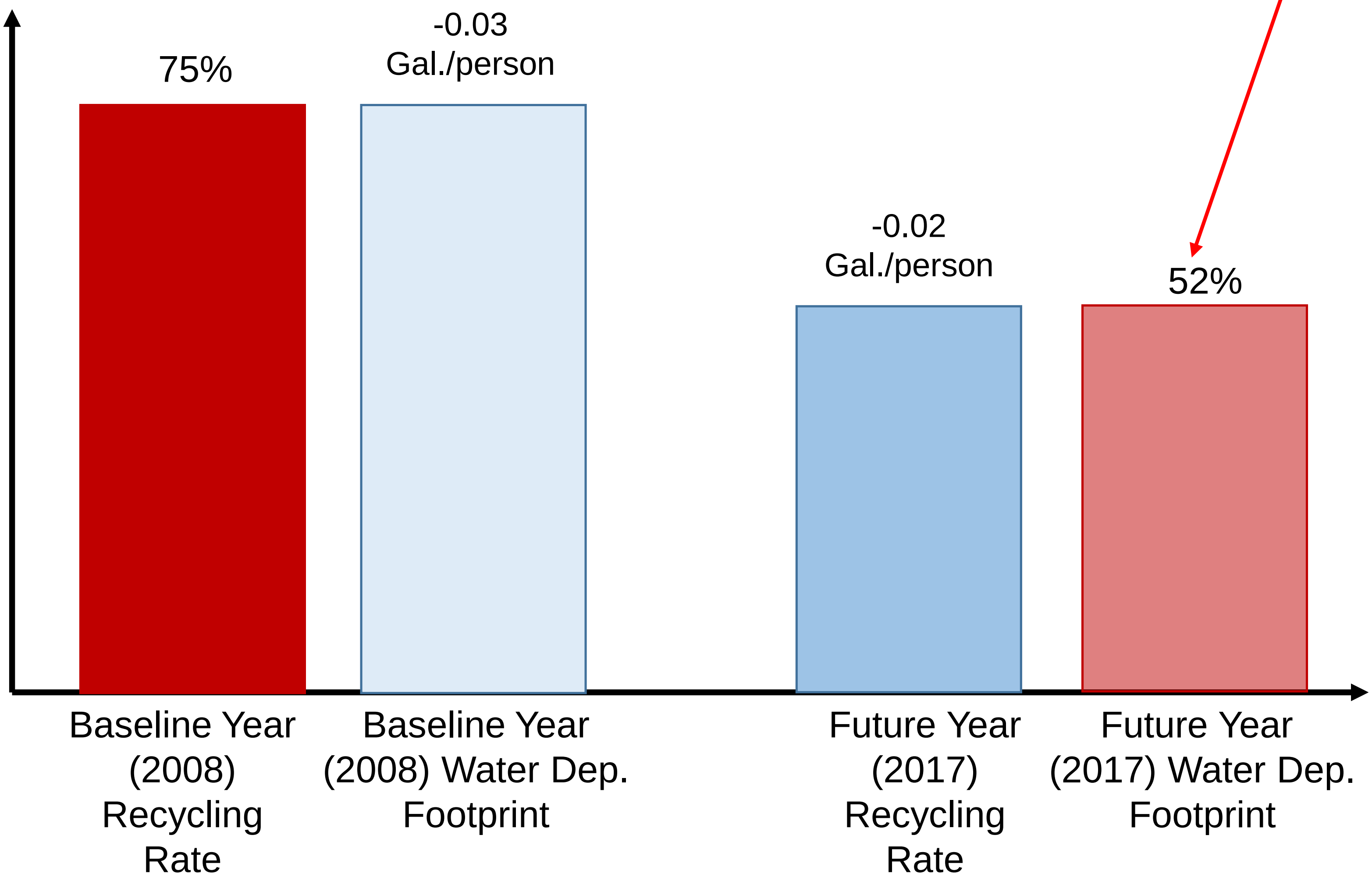


Using environmental impacts in goal setting

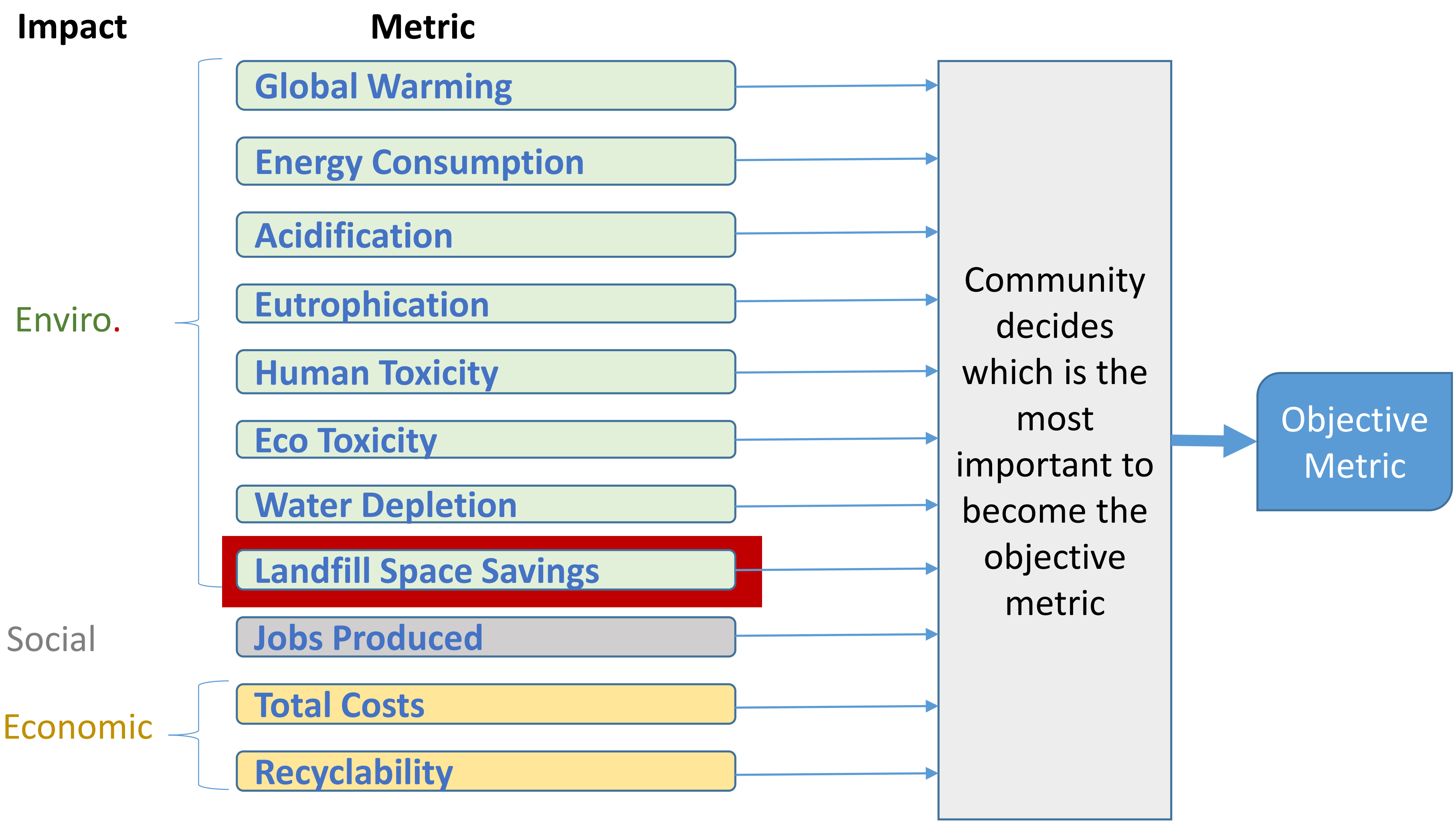


Using environmental impacts in goal setting

$$\textbf{Water Dep.-Based Recycling Rate} = \frac{\textit{Future Year Water Dep. footprint}}{\textit{Baseline Year Water Dep. footprint}} (\textbf{Target Recycling Rate}) = X\%$$



Metrics to Track Progress Besides Tons



Question…

Do different materials contribute to landfill volume?

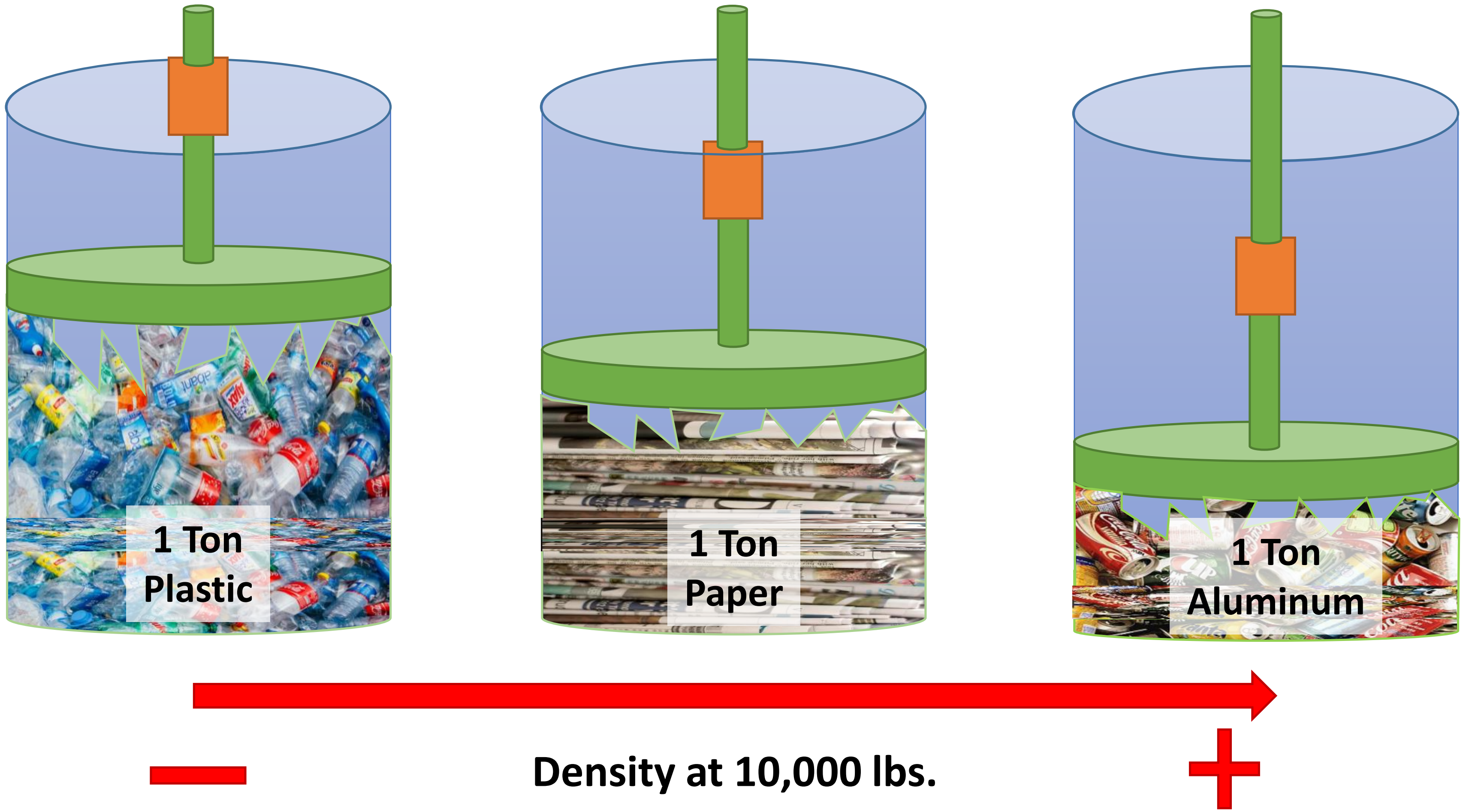
New River Landfill

Landfill Space Savings

Landfill Space Savings

Density!

Landfill Space Savings

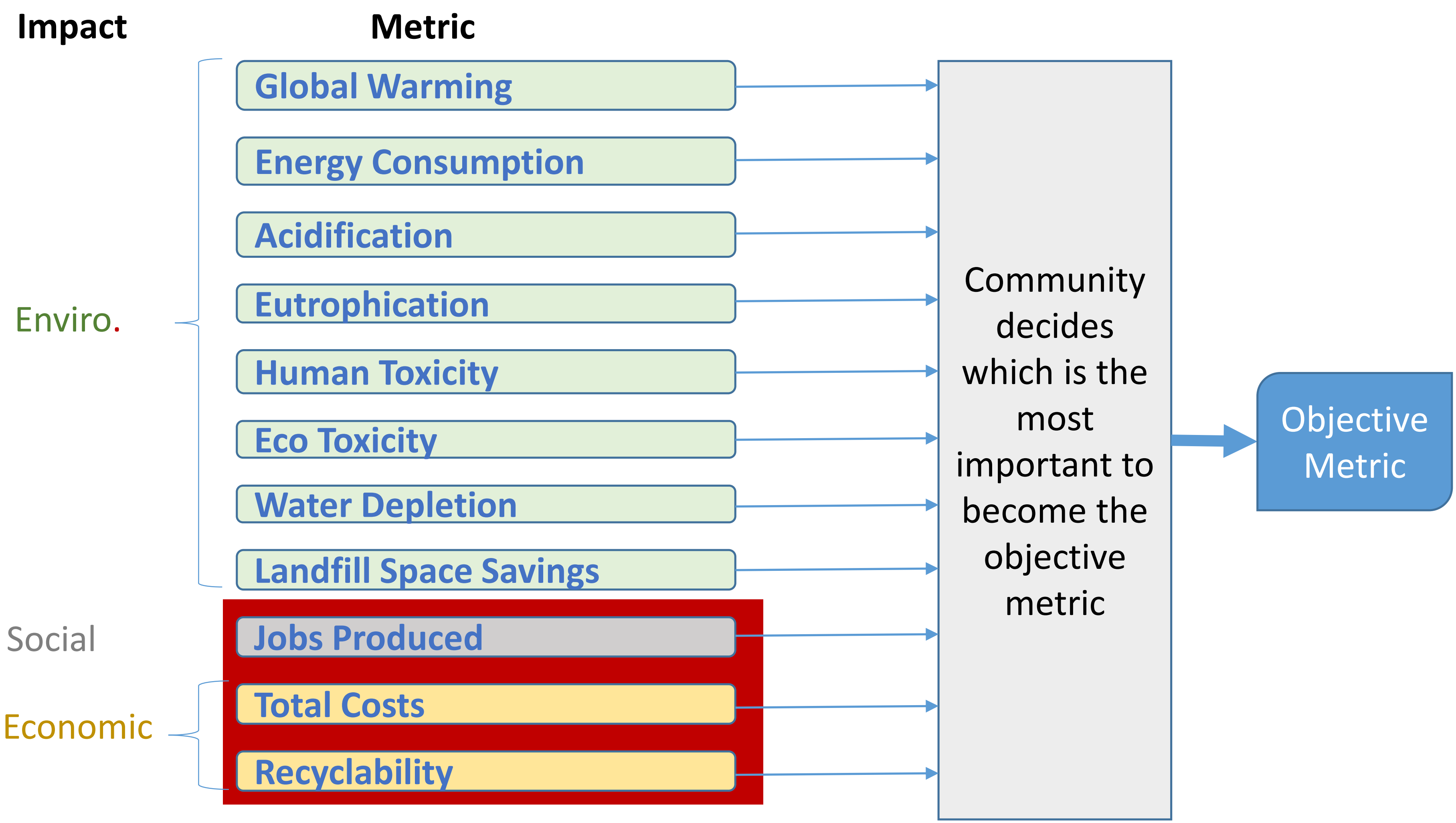


Landfill Space Savings

Collection and Transportation

Waste Compacted In Landfill

Metrics to Track Progress Besides Tons



Jobs Produced, Total Costs, and Recyclability

- Next step to gather data from industry to develop a method to measure the jobs produced, total costs, and recyclability of a material when it is managed by:
  1. Source Reduction
  2. Recycling
  3. Landfilling
  4. Composting
  5. Combustion
  6. Anaerobic Digestion

An Integrated Tool for Local Government to Track Materials Management & Progress toward Sustainability Goals (HC 19/20) Project Motivation

- Hinkley Center Research Project
  →*Florida Solid Waste Management: State of the State*
  →*Looking beyond Florida's 75% Recycling Goal: Development of a Methodology and Tool for Assessing Sustainable Materials Management Recycling Rates in Florida*
- Integration of improvements to the WasteCalc model
- Desire to incorporate SMM into Florida's waste management policy
- Lack of existing data regarding mass and types of materials reused and source reduction activities
- Need for a comprehensive waste management tool

HC 19/20 Objectives

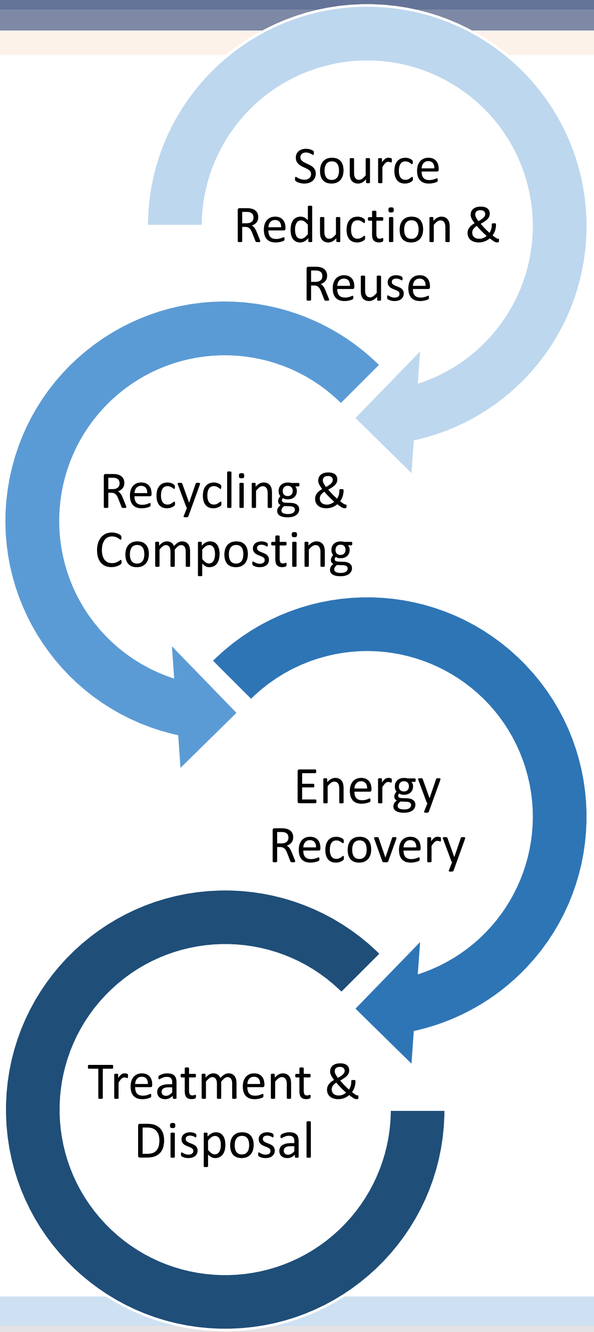
- **Refinements to the WasteCalc model** in a manner that retains its existing functionality
- **Incorporate SMM using metrics to measure** environmental, social, and economic **impacts** developed from the FY18/19 project, include new waste categories, and provide a **means to better integrate source reduction activities**
- **Develop necessary support materials** for future users and developers

HC 19/20 Tasks

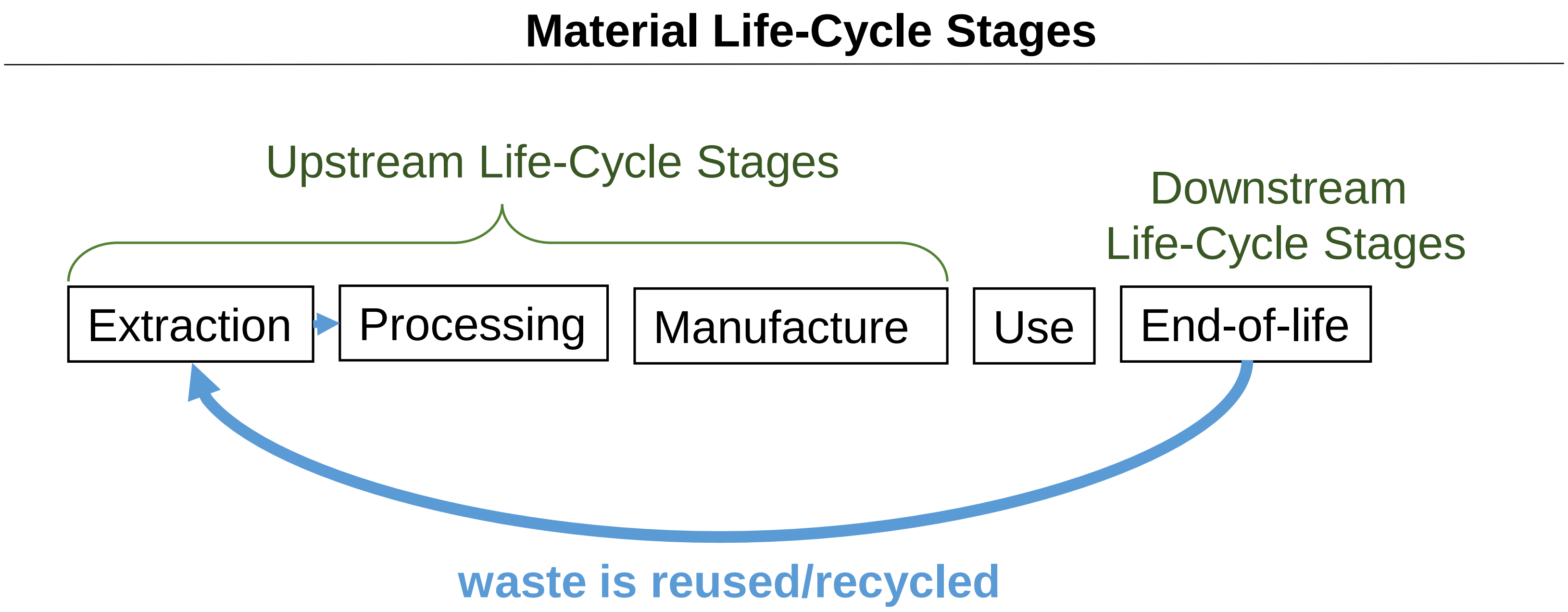
- **Task 1:** Research on source reduction and material reuse
- **Task 2:** Identify missing material categories
- **Task 3:** Develop missing impact factors
- **Task 4**: Refine the WasteCalc Model
- **Task 5**: Provide training and training materials

Source Reduction

- To truly measure SMM progress we need to track and measure source reduction
- Currently not tracked in Florida (e.g., materials managed by Goodwell)
- Need to account for materials like electronic devices (e.g., Best Buy take back programs)

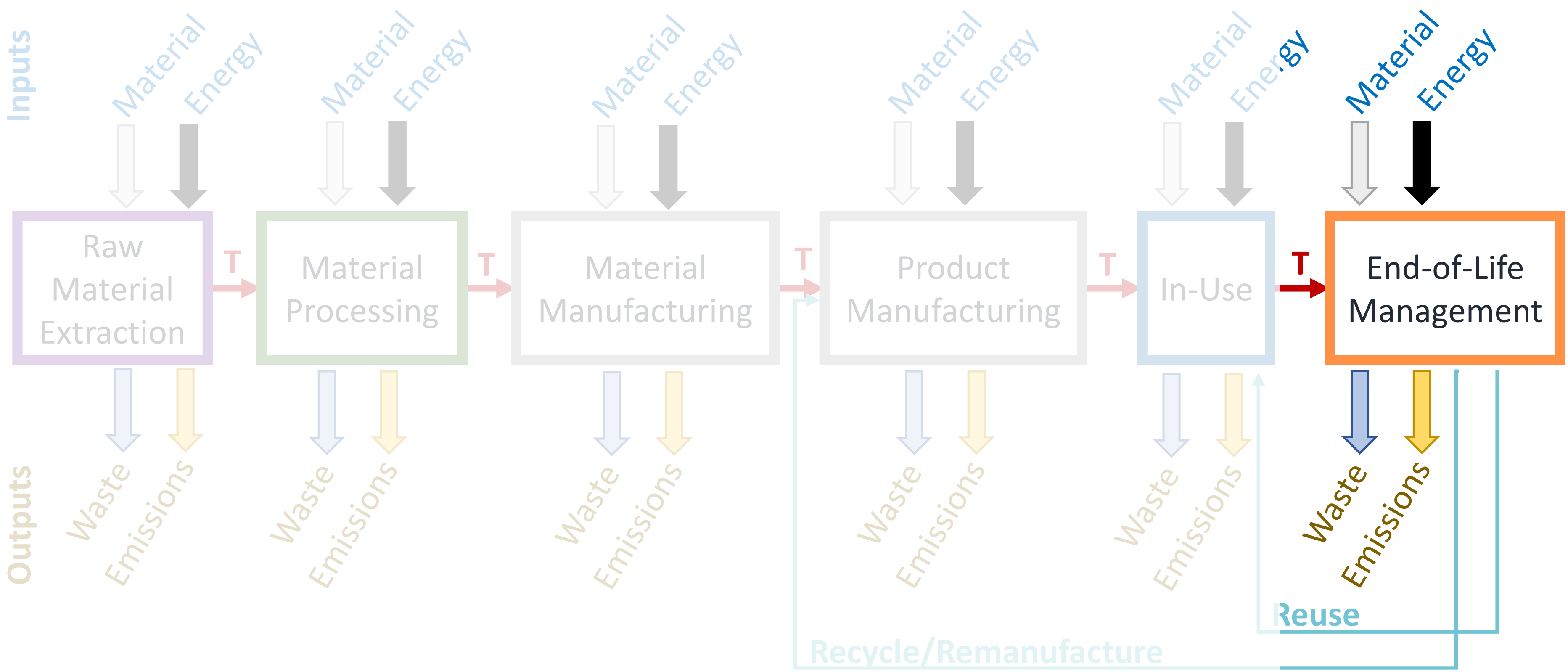


Importance of Upstream Impacts

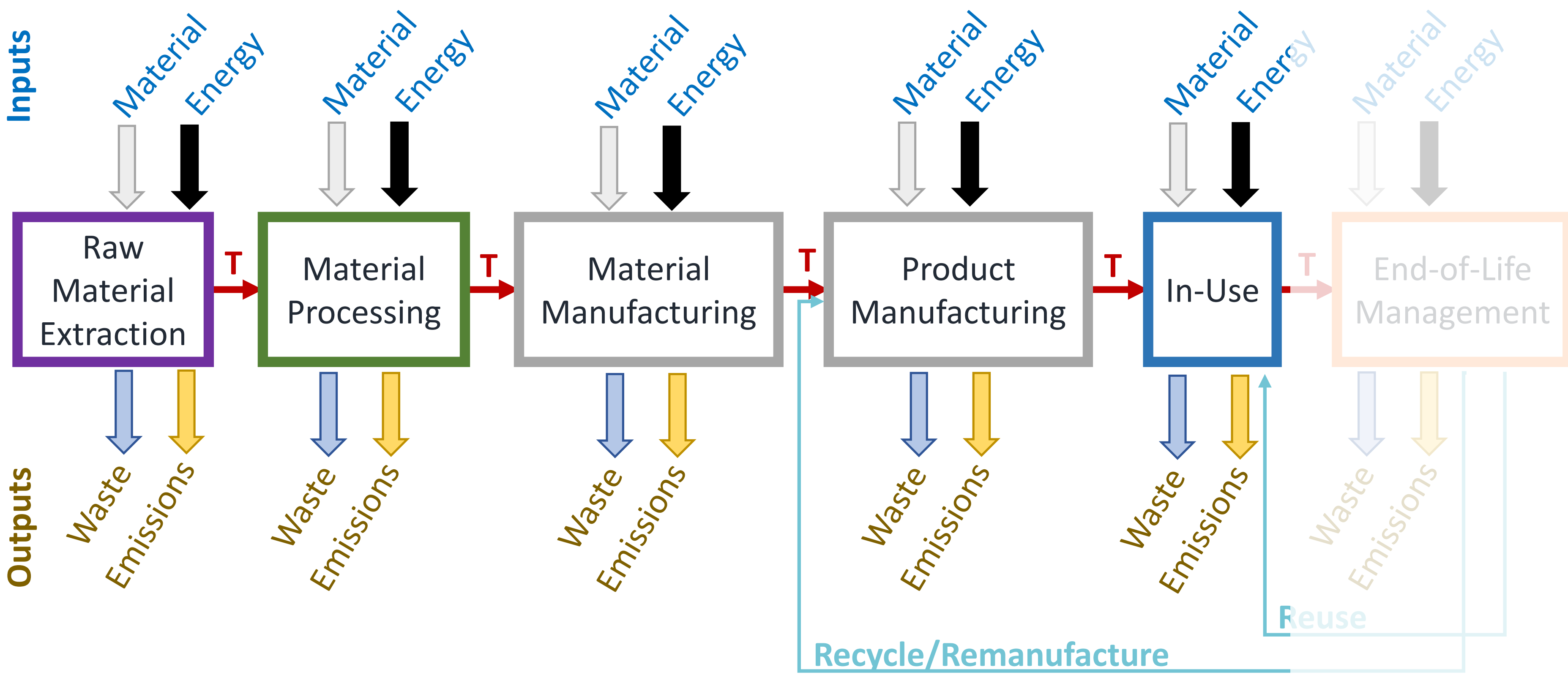


How do we include upstream impacts in decision-making?

Downstream

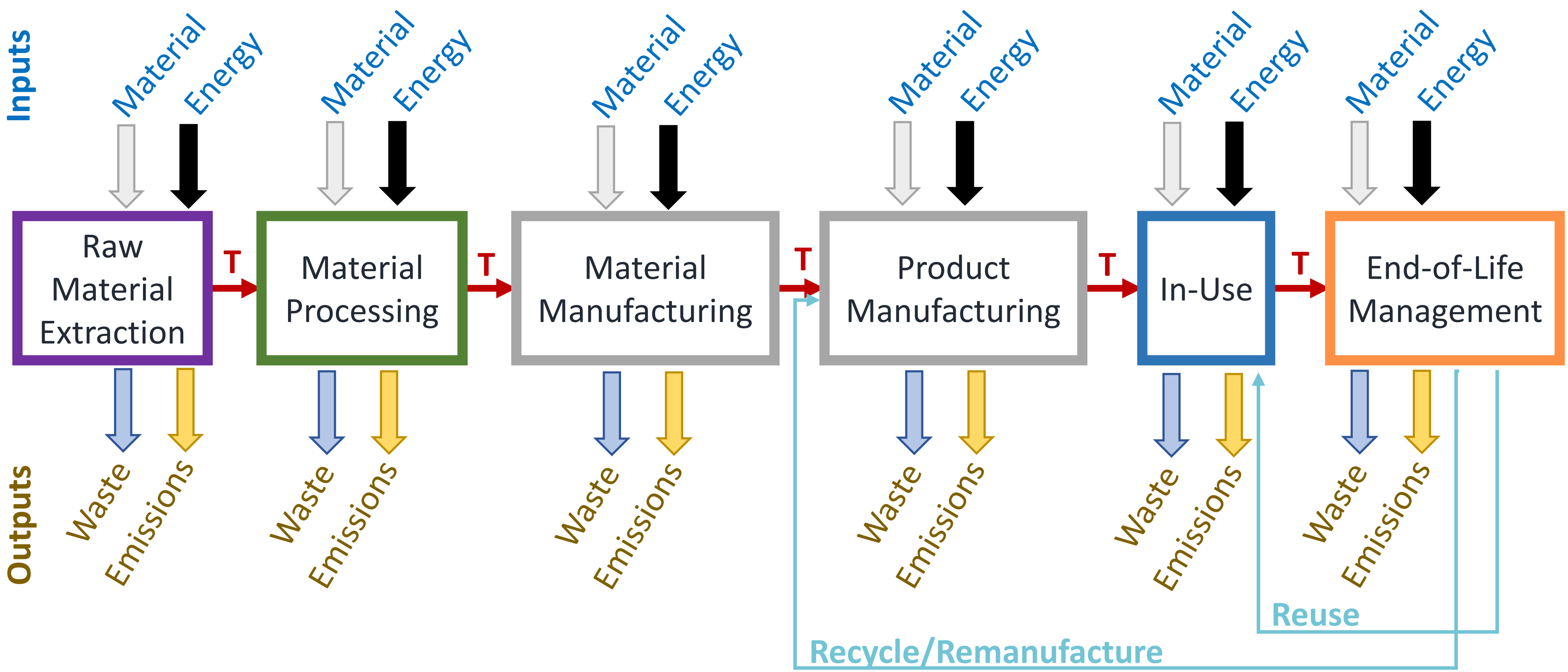

Inputs
Material
Energy
Raw Material Extraction
T
Material Processing
Material Manufacturing
Product Manufacturing
In-Use
End-of-Life Management
Outputs
Waste
Emissions
Reuse
Recycle/Remanufacture

Upstream



Inputs
Material
Energy
Raw Material Extraction
Material Processing
Material Manufacturing
Product Manufacturing
In-Use
End-of-Life Management
T
Outputs
Waste
Emissions
Reuse
Recycle/Remanufacture

Life cycle



Inputs
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Material Processing
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Material Manufacturing
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Product Manufacturing
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Waste
Emissions
Waste
Emissions
Waste
Emissions
Waste
Emissions
Waste
Emissions
Waste
Emissions
Reuse
Recycle/Remanufacture

Methodology

- Measurement of upstream and downstream environmental impacts.
- Applied to Alachua County’s waste stream.

How did we measure?

WARM Factors

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 ($MTCO_2E$)
Aluminum Cans	(4.91)	(9.11)	0.02	0.04

Masses

	2016 Data (short tons)				
Material	Consumed	Collected	Recycled	Disposed	Combusted
Aluminum Cans	1,022	1,022	305	717	0

Upstream
(Consumption or Production)

WARM Factors

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 ($MTCO_2E$)
Aluminum Cans	(4.91)	(9.11)	0.02	0.04

x

Masses

	2016 Data (short tons)				
Material	Consumed	Collected	Recycled	Disposed	Combusted
Aluminum Cans	1,022	1,022	305	717	0

We don't track consumption of products

Upstream
(Consumption or Production)

Non-durable goods

Material	Consumed	Collected
Aluminum Cans	1,022	1,022

Durable goods

Material	Consumed	Collected
Major appliances	3,664	2,272

C&D

Material	Consumed	Collected
Concrete	568,447	191,868

Upstream
(Consumption or Production)

WARM Factors

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 ($MTCO_2E$)
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X

Masses

	2016 Data (short tons)				
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Downstream
(Waste Management)

WARM Factors

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Downstream
(Waste Management)

WARM Factors

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 ($MTCO_2E$)
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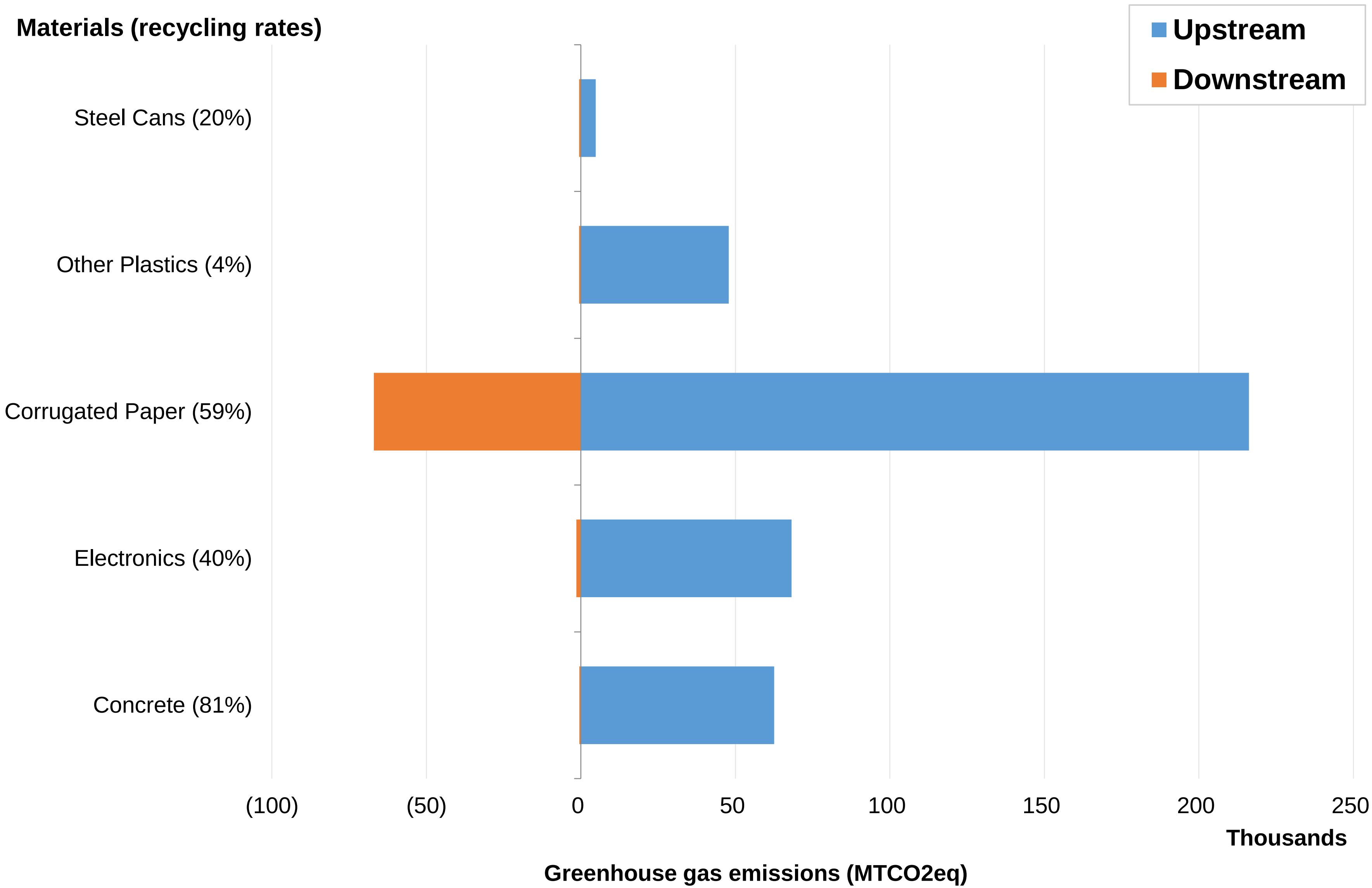


Alachua County waste management (2016)

What does it mean?

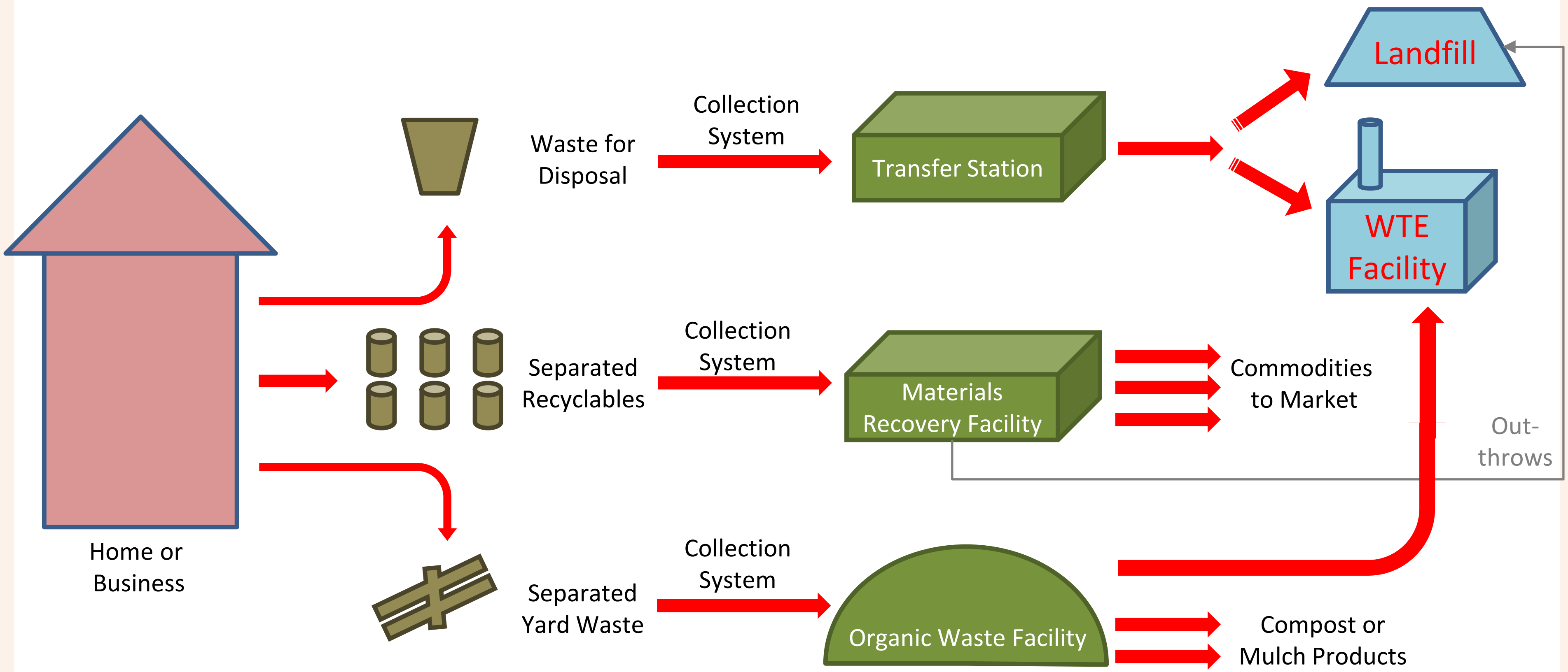
Recycling as much as we can → Consuming less

How much environmental benefits can be achieved with the source reduction of durable goods?

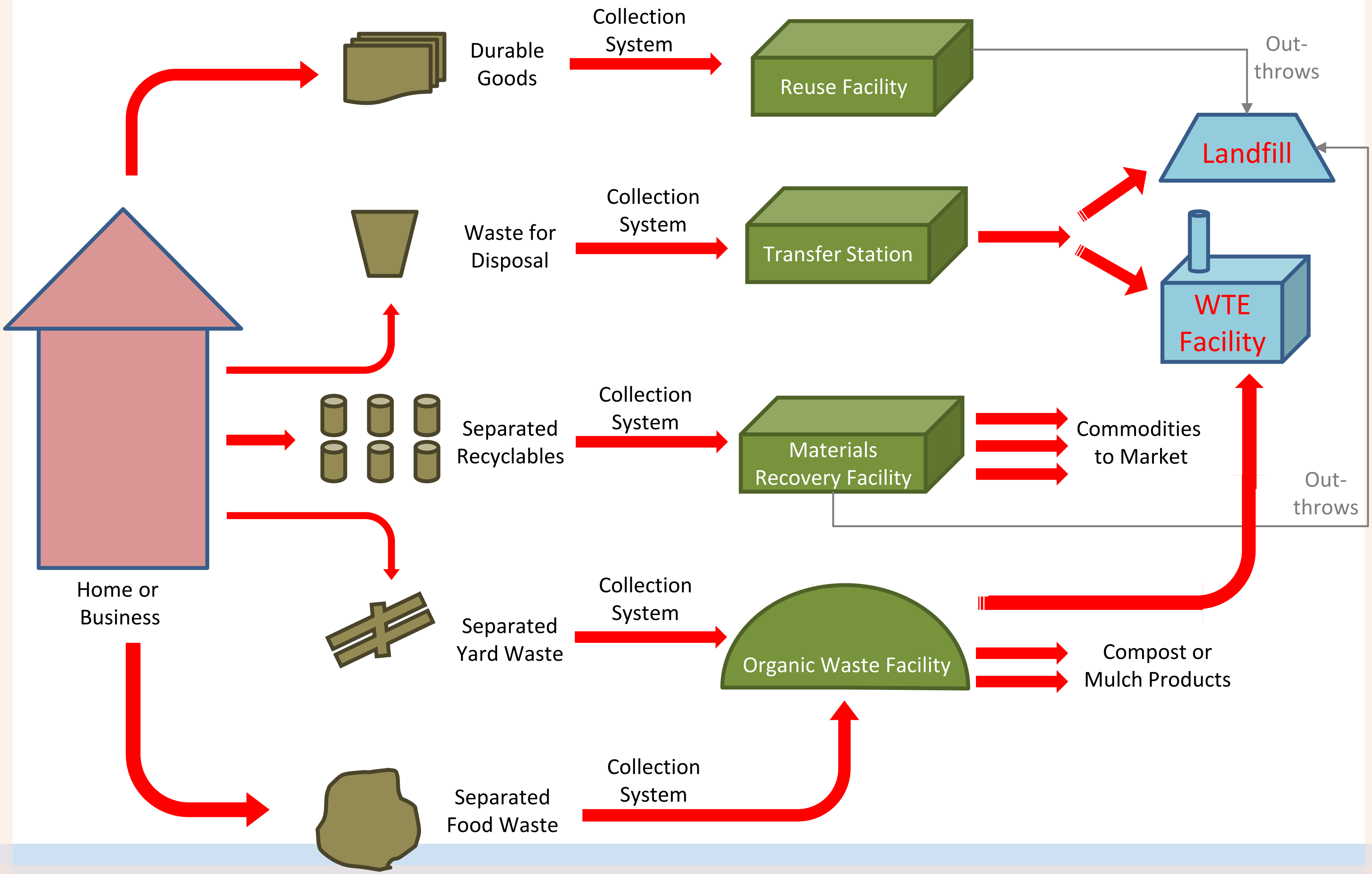
Motivation

Motivation

Conventional Waste Management



Bulky Waste Recovery Scenario



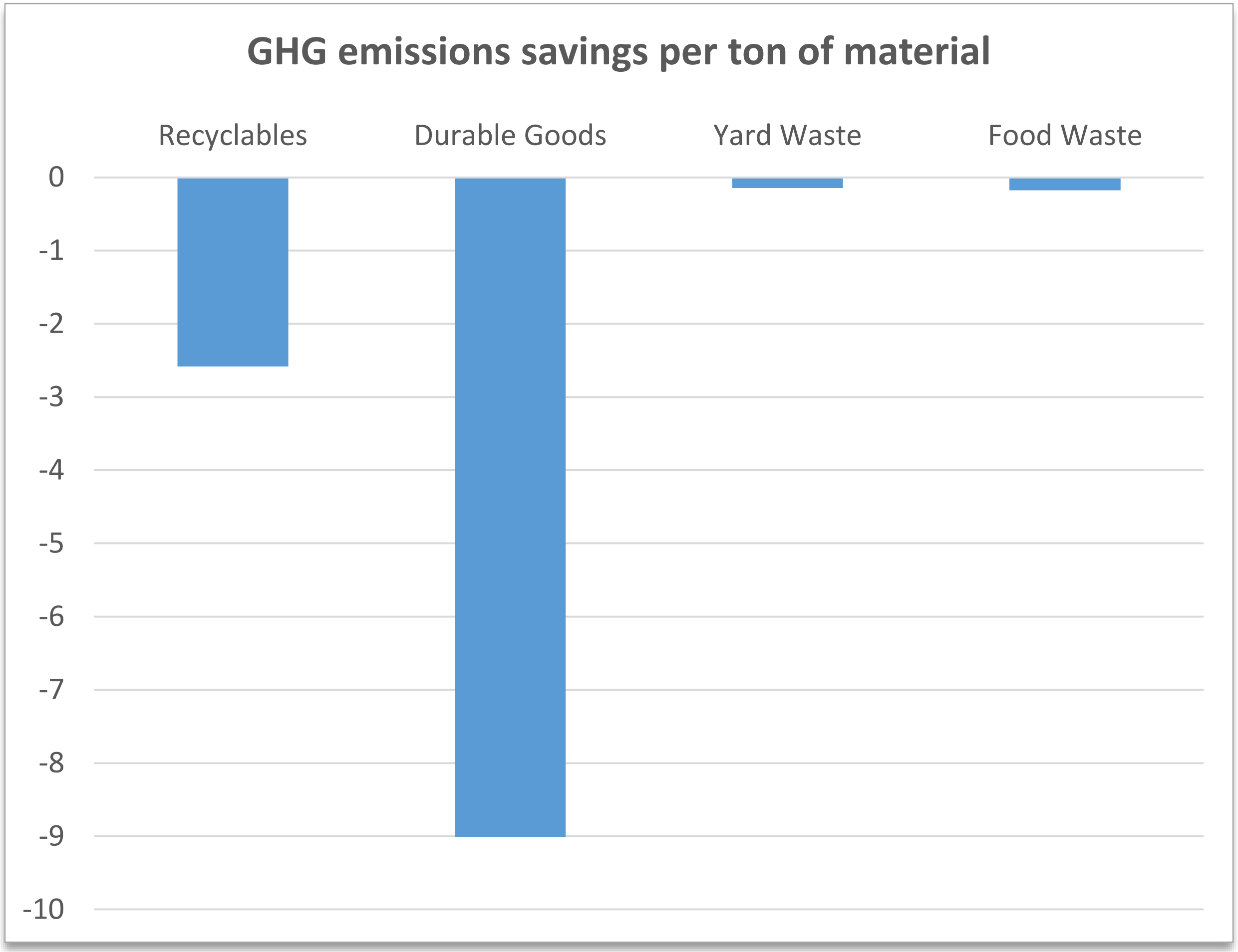
Model Development

- Mass data: Alachua County

- Recovery rates
  - Recyclables: Alachua County recycling rates
  - **Durable goods: 10% reuse** (with 5% out-throw rate)
  - Yard waste: Alachua County recovery rates
  - Food Waste: 50%

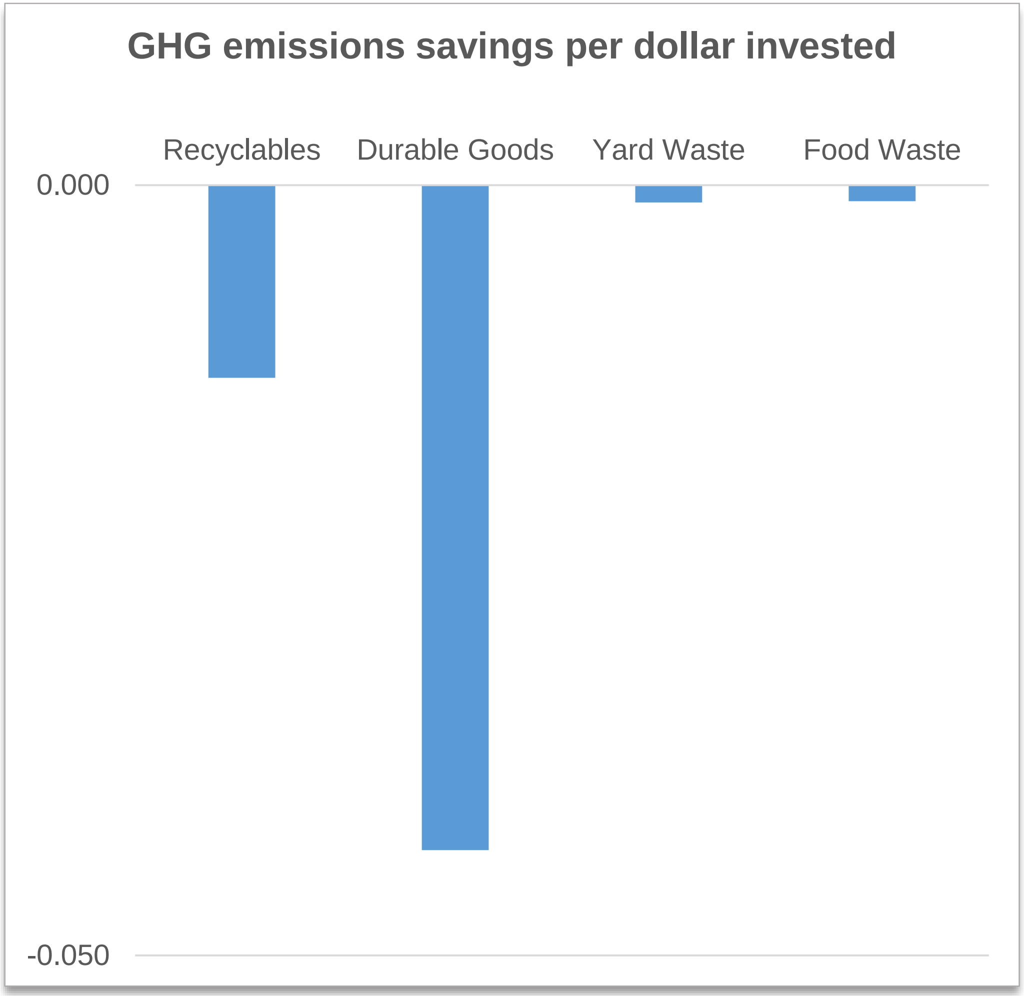
- Costs
  - Collection
  - Facilities

Results



GHG emissions savings per ton of material
Recyclables
Durable Goods
Yard Waste
Food Waste
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10

Results


GHG emissions savings per dollar invested
Recyclables
Durable Goods
Yard Waste
Food Waste
0.000
-0.050

Conclusion

- Durable goods reuse provide a greater benefit in terms of GHG emissions.

Open Discussion

https://www.essie.ufl.edu/home/townsend/research/florida-solid-waste-issues/hc18/

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Home > Research > Florida Solid Waste Issues > Looking Beyond Florida's 75% Recycling Goal

Looking Beyond Florida's 75% Recycling Goal: Development of a Methodology and Tool for Assessing Sustainable Materials Management Recycling Rates in Florida

The way in which many think about solid waste in the US is shifting. The US Environmental Protection Agency (EPA), for example, has adopted the approach of sustainable materials management (SMM) instead of solid waste management (both in spirit and literally in terms of a name change). In Florida, thanks to funding from the Hinkley Center and several municipalities, the University of Florida has begun to evaluate SMM as an approach as well. One tangible outcome of this research will be the development of a tool that can be used by local governments and the Florida Department of Environmental Protection (FDEP) to estimate and compare alternative recycling rates based on specific waste streams, composition, disposition, and life cycle assessment impact factors (e.g., GHG emissions and energy use). Project Scope: HC18Scope

Progress Reports

Progress Report 1: HC18PR01

Thank You!