



Florida Atlantic University  
College of Engineering & Computer Science

# **“INVESTIGATION OF RECYCLING ALTERNATIVES FOR SWACCC”**

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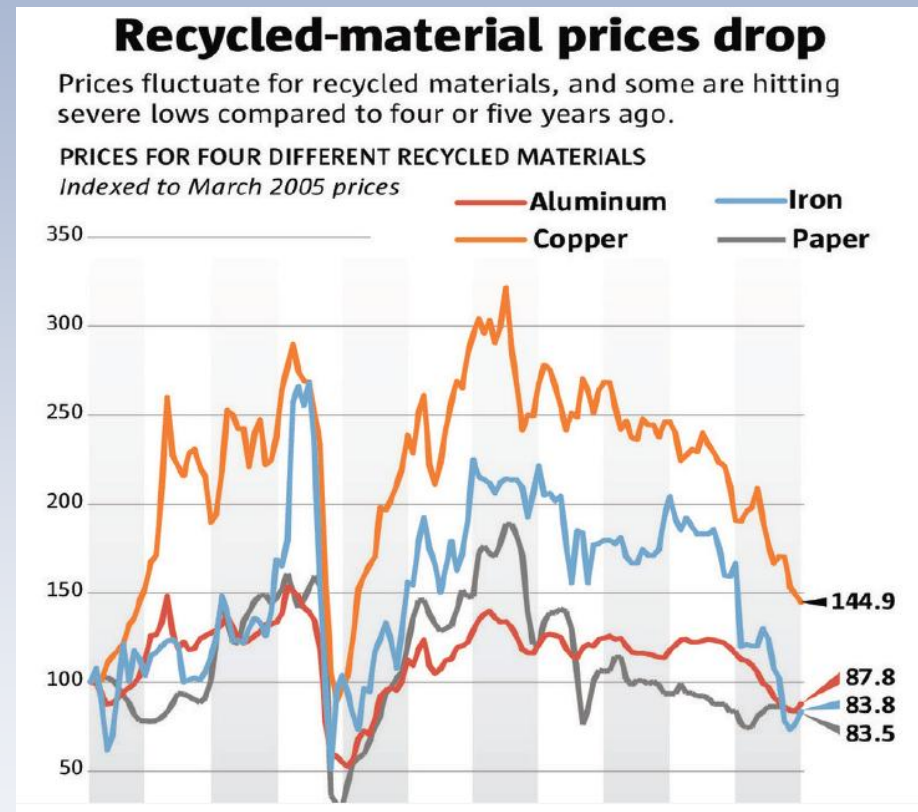
**SWANA Florida Winter Conference 28-30<sup>th</sup> Jan 2018**

## SWANA 2017



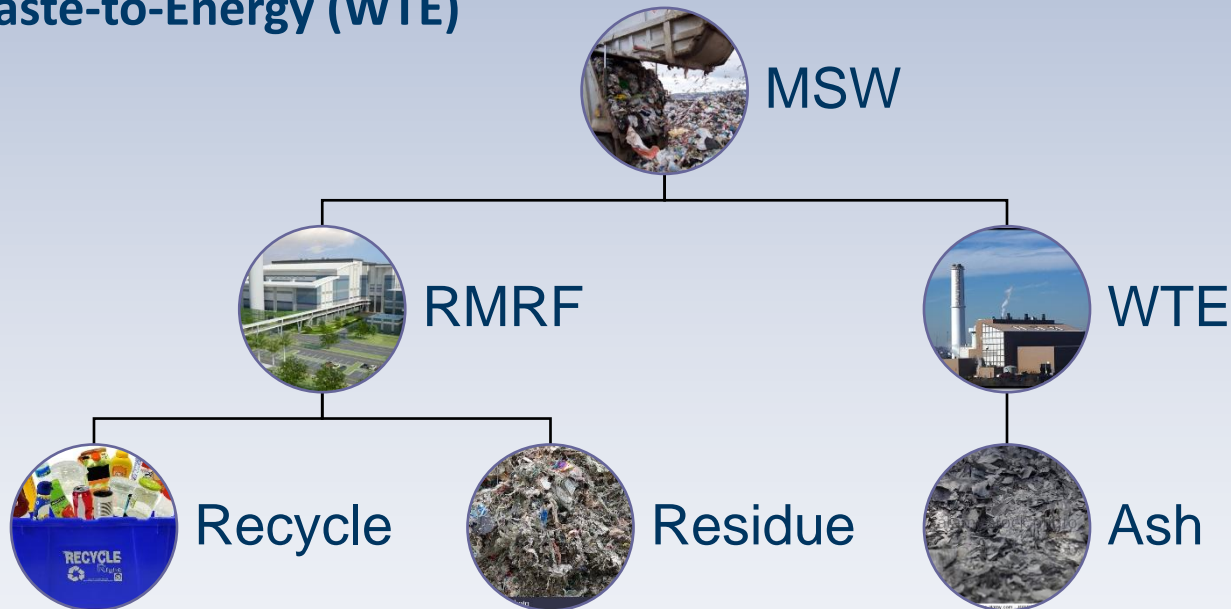
## Scope of the Project

- Secondary commodities market has experienced an economic downturn
- Recycling is not producing adequate financial returns
- “Green Fence” increased quality standards
- FAU conducted a cost-benefit analysis based on economic, social and environmental aspects



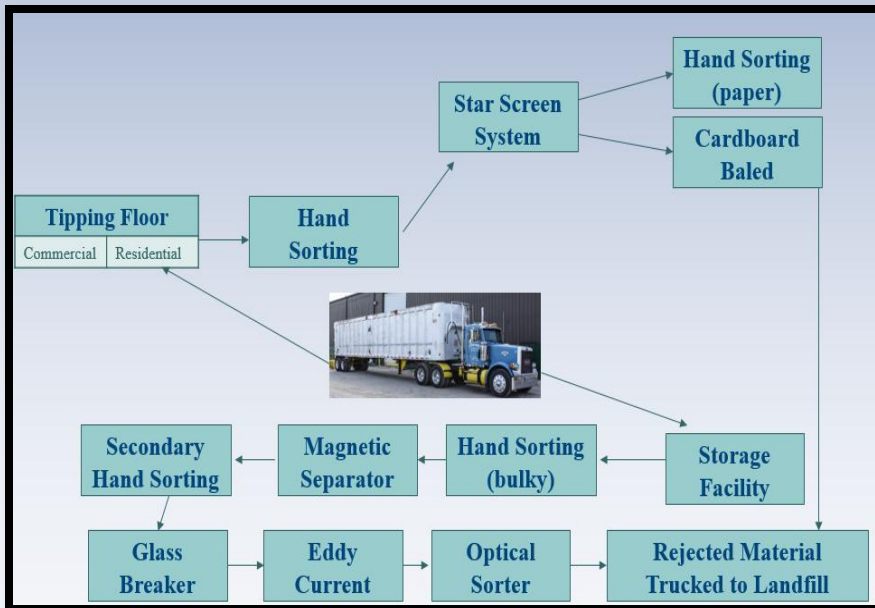
# Existing Conditions

- Solid Waste Authority of Crab Cake County (SWACCC) owns two facilities
  - Recovered Materials Processing Facility (RMRF)
  - Waste-to-Energy (WTE)



## RMRF

- 150,000 sq. ft. facility
- 750 tons per day of recyclable material
- Dual Stream Program



## Waste-To-Energy

- Two incinerators – Under Capacity
  - 0.8 million tons per year
  - 1 million tons per year



## **Approach**

- **Establish selection criteria**
- **Determine viable alternatives**
- **Evaluate carbon emissions and energy consumption using the WARM model to identify the most desirable alternatives**
- **Perform an engineering alternative analysis**
- **Perform a sensitivity analysis**
- **Identify the preferred option/make recommendations**

# Preliminary Selection Criteria

- **Viable options are selected based on:**
  - The objectives of the project
  - Industry experts opinion
  - Engineering judgment
- **Options were narrowed down based on preliminary USEPA WARM\* Model results**
  - Emissions estimates
  - Energy consumption estimates

\* Waste reduction model

## **Alternatives Considered**

**Incinerate all recyclables with energy recovery (WTE)**

**Recycle metals only**

**Recycle metals and glass only**

**Recycle metals, glass, and plastics only**

**Recycle containers only**

**Recycle containers and corrugated cardboard only**

**Recycle fibers only**



## Assumptions

- Total waste processed = 91,800 tons
  - Amount of recyclables processed through RMRF
- Emissions from landfilling = National Average
- Water/wastewater service and electricity costs are considered proportional to the volume of processed recyclables
- Recycling program costs and employee personnel costs are assumed to be constant
- Source reduction = Zero

## WARM Model (USEPA)

- Estimates GHG emissions (MTCO<sub>2</sub>E)
- Estimates energy consumption (MBTU)
- Compares the output to base scenarios

### WARM Model

U.S. ENVIRONMENTAL PROTECTION AGENCY

Climate Change - Waste

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#### Waste Reduction Model (WARM)

NEW VERSION: Updated November 2009  
(Version 10, 11/09)

EPA created WARM to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions and energy savings from several different waste management practices. WARM Online was last updated November 2009.

Use this worksheet to describe the baseline and alternative MSW management scenarios that you want to compare. Please follow the steps below to enter your material tonnage information in the input boxes in the tables, and select appropriate landfill and waste transport characteristics. For information on the definition of each of the WARM material types as well as data source and year of underlying life-cycle data, please see the [WARM materials definitions link](#).

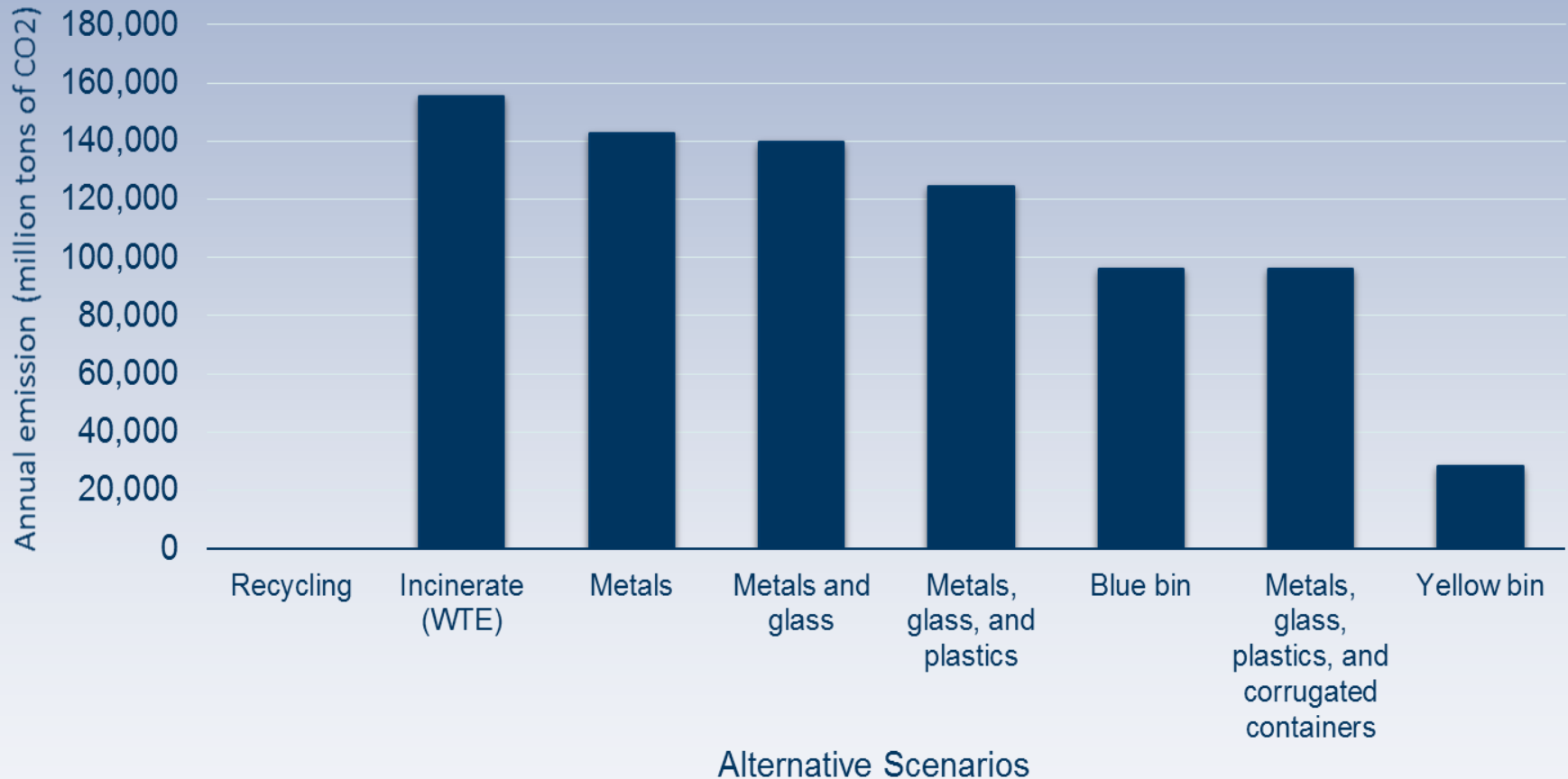
**Tips:**

- If the listed material is not generated in your community/organization or you do not want to analyze it, leave it blank or enter 0.
- Make sure that the total quantity generated equals the total quantity managed.
- If you have any questions, consult the [WARM User's Guide](#).

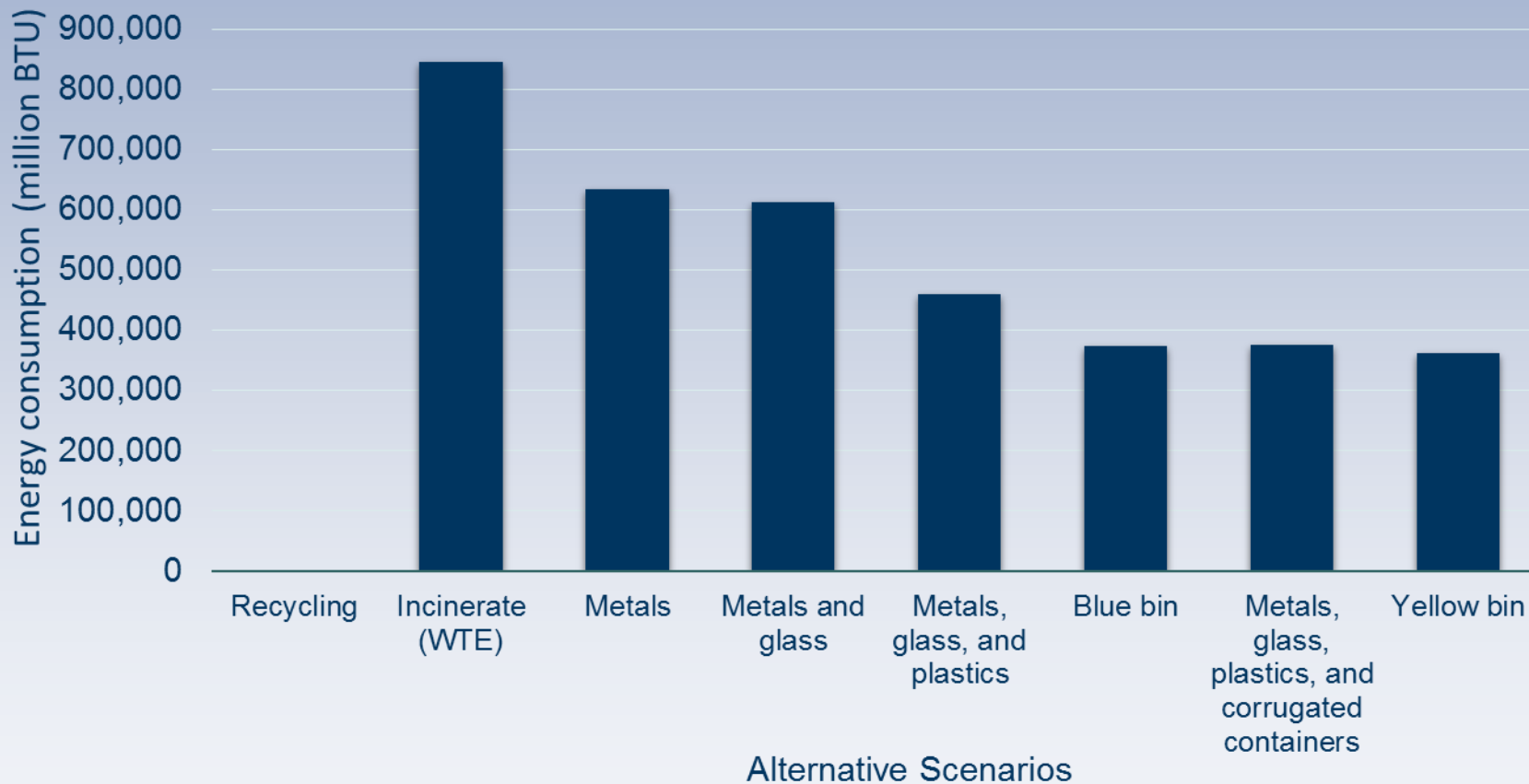
**Steps 1 and 2. Baseline and Alternative Scenarios**

Material	Baseline Scenario					Tons Generated	Alternative Scenario				
	Tons Recycled	Tons Landfilled	Tons Composted	Tons Incinerated	Tons Composted		Tons Recycled	Tons Landfilled	Tons Composted	Tons Incinerated	Tons Composted
Aluminum Cans	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Steel Cans	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Copper Wire	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Glass	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
HDPE	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
LDPE	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
PET	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Corrugated Cardboard	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Megatons / Bird-class mail	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Newspaper	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Office Paper	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Phonebooks	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	0	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

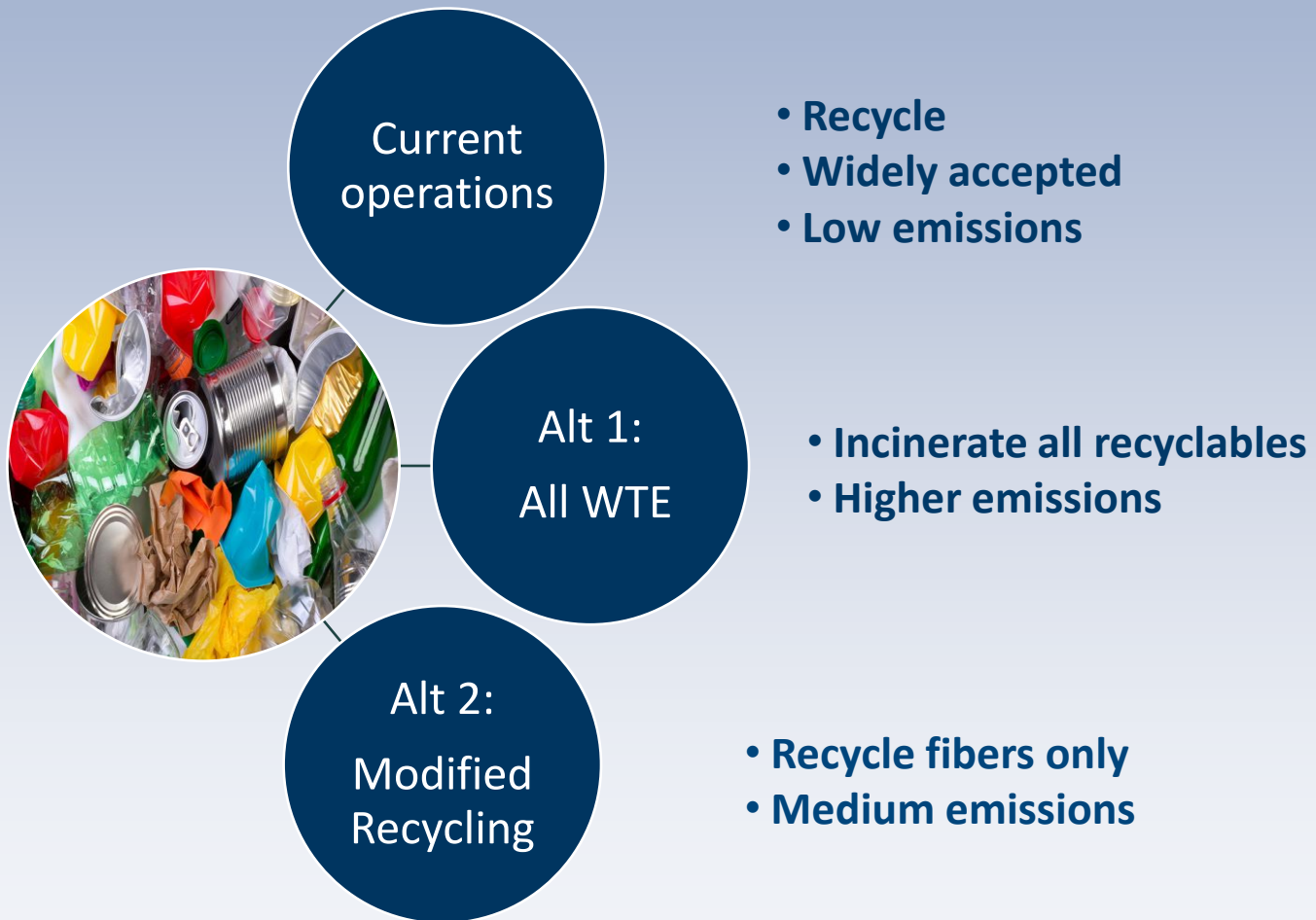
# WARM Model – Carbon Emissions



# Warm Model – Energy Consumption



# Alternatives Selected



# Cost-Benefit Analysis

Selection criteria are:

## Economic (present worth)

- Salvage value
- Operational cost

## Non economic (social and environmental)

- Public perception
- Energy savings
- Landfill life
- Emission reduction
- Total employment generated

# Scoring

Score	Description
3	Most preferred alternative
2	Second most preferred alternative
1	Least preferred alternative

# Ranking and Weight of Criteria

Obtained through ranking in order of importance

Criteria	Weight
Economic (present worth)	6
Public perception	5
Energy savings	4
Landfill life	3
Emission reduction	2
Total employment generated	1
<b>Total (Max = 18 unweighted and 63 weighted)</b>	



## Economic (Net Present Worth)

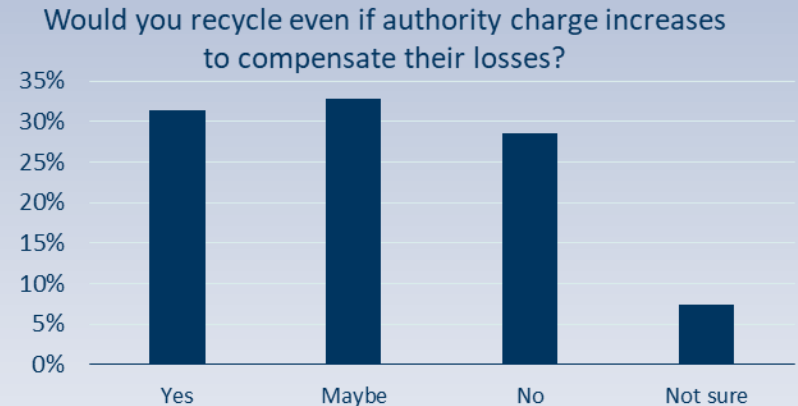
The Net Present Worth (NPW) was calculated based on the following:

- 30 year design period
- Salvage value estimated based on the average market price
- Operating cost was calculated for fiscal year 2015

Comparison	Current operations	Alt 1	Alt 2
Net Present worth ,Millions \$	1,641	1,028	1,231
Score assigned	1	3	2

# Public Perception

A survey was conducted to a group of 140 individuals



Comparison	Current operations	Alt 1	Alt 2
Score assigned	3	1	2

## Landfill Life

- Medium sized landfill (about 65 acres) was assumed
  - 65 feet maximum height (3:1 slope)
  - with a 10% daily soil cover allowance

Comparison	Current operations	Alt 1	Alt 2
Landfill useful life, years	14.34	14.10	14.27
Score assigned	3	1	2

# Cost-Benefit Analysis

Unweighted and (Weighted)

Criteria	Weight	Status Quo	Alt 1	Alt 2
<b>Economic (present worth)</b>	<b>6</b>	<b>1 (6)</b>	<b>3 (18)</b>	<b>2 (12)</b>
Public perception	5	3 (15)	1 (5)	2 (10)
Energy savings	4	3 (12)	1 (4)	2 (8)
Landfill life	3	3 (9)	1 (3)	2 (6)
Emission reduction	2	3 (6)	1 (2)	2 (4)
Total employment generated	1	3 (3)	1 (1)	2 (2)
<b>TOTAL</b> <small>Max 18(63)</small>		<b>16 (51)</b>	<b>8 (33)</b>	<b>12 (42)</b>

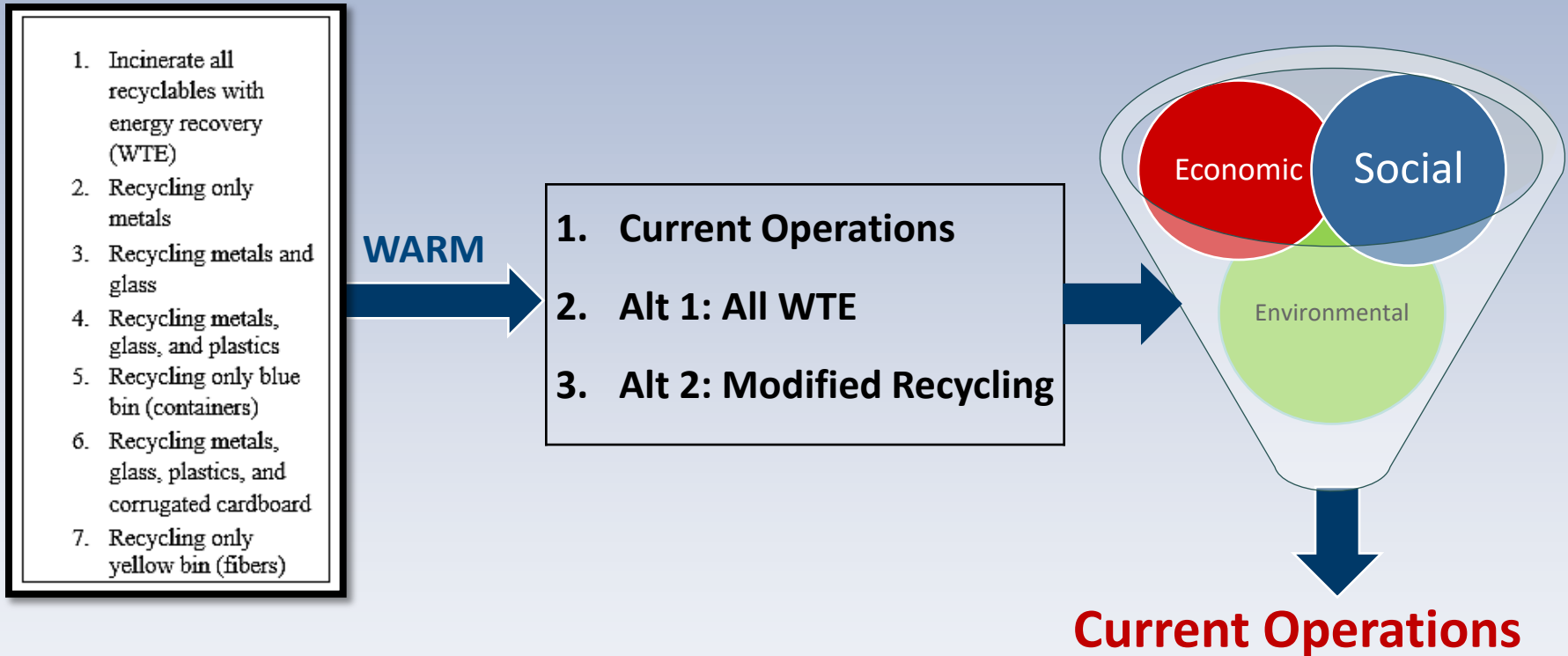
# Sensitivity Analysis

Unweighted and (Weighted)

Criteria	Weight	Status Quo	Alt 1	Alt 2
Public perception	5	3 (15)	1 (5)	2 (10)
Energy savings	4	3 (12)	1 (4)	2 (8)
Landfill life	3	3 (9)	1 (3)	2 (6)
Emission reduction	2	3 (6)	1 (2)	2 (4)
Total employment generated	1	3 (3)	1 (1)	2 (2)
<b>TOTAL</b> <small>Max 15(45)</small>		<b>15 (45)</b>	<b>5 (15)</b>	<b>10 (30)</b>

Current operations again receives the highest score (UW:15; W:45) among the 3 options

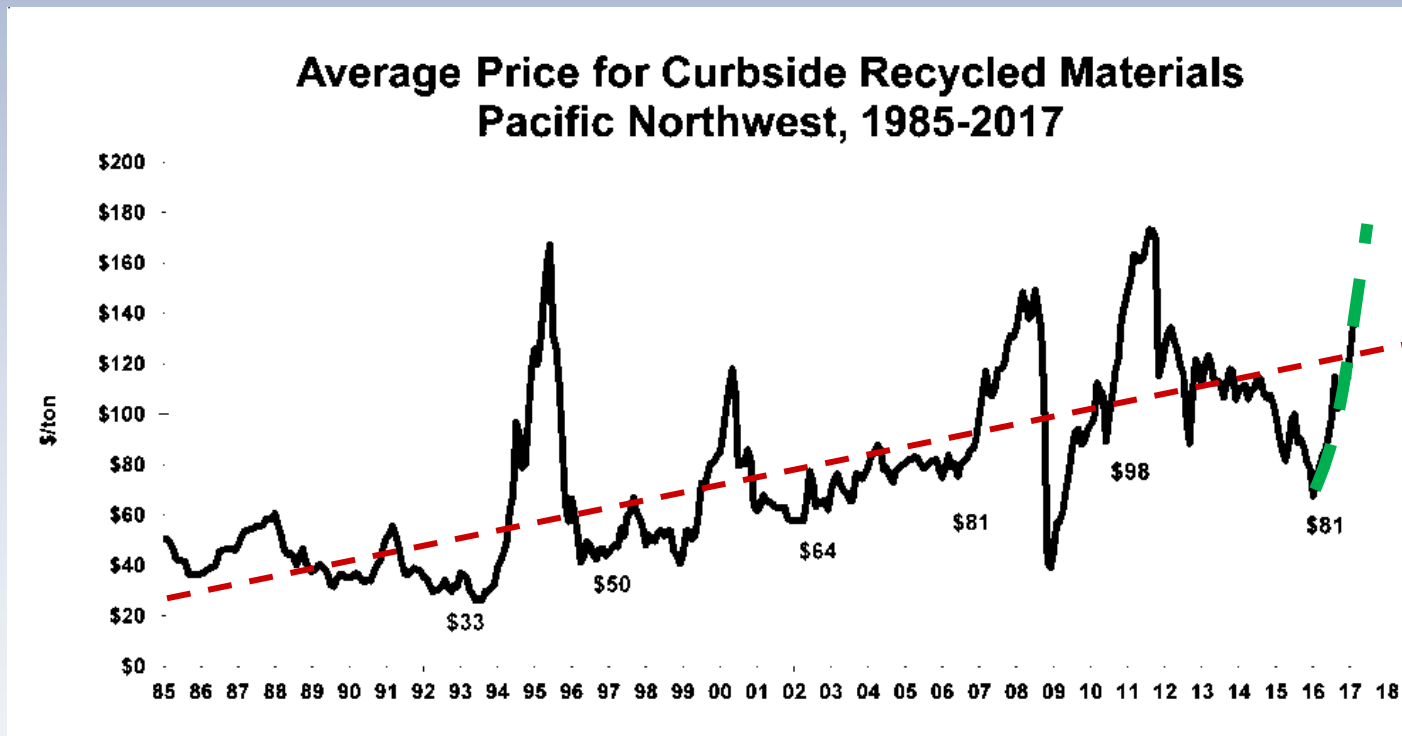
# Conclusion



**Recommendation:** continue current recycling practice

# Further Recommendations

- Commodity prices projected to rebound



Source: Sound Resource Management Group, 2017

# Current Challenges

ENVIRONMENT

## Recycling Chaos In U.S. As China Bans 'Foreign Waste'

December 9, 2017 · 8:00 AM ET  
Heard on Morning Edition

*Plastics Pile Up as China Refuses to Take the West's Recycling*

[查看简体中文版](#) | [查看繁體中文版](#) | [Leer en español](#)

By KIMIKO de FREYAS-TAMURA JAN. 11, 2018

## China's Blow to Recycling Boosts U.S.'s \$185 Billion Plastic Bet

By **Jack Kaskey** and **Ann Koh**

December 5, 2017, 8:00 PM EST Updated on December 6, 2017, 3:53 PM EST

From **Climate Changed**

## Waste Management: Headwinds From China Ban On Foreign Waste

Jan. 10.18 | About: Waste Management, (WM)

## Mountains of U.S. recycling pile up as China restricts imports

Jason Margolis, PRI's The World Published 6:47 a.m. ET Jan. 2, 2018



## Further Recommendations

- Continue the highly visible and popular residential and commercial recycling program
- Optimize collection system
  - More competitively priced hauling contracts
  - Route optimization to save on fuel/hauling costs
- Willingness to pay higher rates to compensate for losses
- Reduce and Innovate



## INVESTIGATION OF RECYCLING ALTERNATIVES FOR SWACC

Andrea Garcia, Bishow Shaha, Lisandre Meyer, Matthew Swaney, Rohan Sethi



### PROBLEM STATEMENT

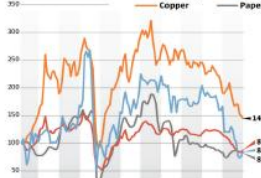
The Florida Atlantic University (FAU) student design team is acting as a consultant to the county commissioners who oversee the Solid Waste Authority of Crab Cake County (SWACC)

- The scope of the project is to conduct a cost-benefit analysis to determine the most preferred waste processing options from a series of scenarios
- SWACC is currently experiencing a downturn in the recycling market
- Revenues from resale have decreased

#### Recycled-material prices drop

Prices fluctuate for recycled materials, and some are hitting severe lows compared to four or five years ago.

PRICES FOR FOUR DIFFERENT RECYCLED MATERIALS

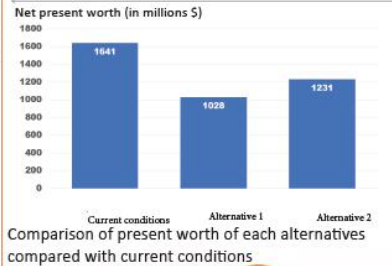


### ALTERNATIVES

Based on the results obtained, two management alternatives are identified for an alternative analysis based on economic, social, and environmental impacts criteria compared to the current operations

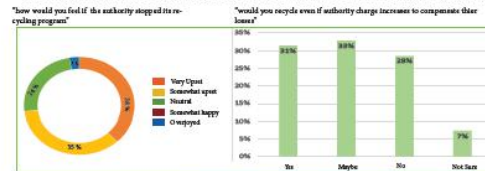


### ECONOMIC FACTORS



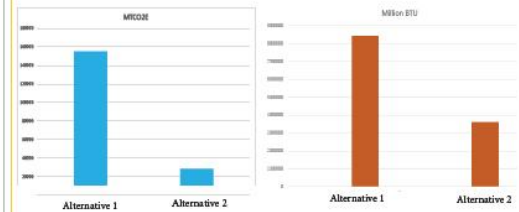
### SOCIAL IMPACTS

FAU Design team conducted its own survey to a group of 140 individuals to understand the public perception



### ENVIRONMENTAL IMPACTS

Estimated Annual Emissions (CO<sub>2</sub> and Energy consumption (Million BTU))



### MOST PREFERRED ALTERNATIVE

Criteria	Weight	Existing process		Alternative 1		Alternative 2		
		UW	W	UW	W	UW	W	
Economic comparison	Present worth	6	1	6	3	18	2	12
Non-economic comparison	Public perception	5	3	15	1	5	2	10
	Energy savings	4	3	12	1	4	2	8
	Emission reduction	3	3	9	1	3	2	6
Social and Environmental	Landfill life	2	3	6	1	2	2	4
	Total employment generated	1	3	3	1	1	2	2
Total (Max. possible: 18 unweighted and 63 weighted)		16	51	8	33	12	42	

- An unweighted and weighted analysis was conducted to select the most preferred alternative. In both cases, the existing process came out as the most preferred alternative (unweighted 16 out of 21, weighted 51 out of 63) among the three alternatives

### CONCLUSIONS AND RECOMMENDATIONS

- Owl Consultants recommends that SWACC continue their existing operational strategy, while trying to maximize collection of recyclables with a highly visible and popular residential and commercial recycling program
- Renegotiate recycling hauling contracts for more efficient dual stream collection
- Investigate stakeholders' willingness to pay and adjust fees accordingly
- Secondary commodities in the market has begun to rebound to historical peaks



Thank You

