Waste Reduction Model (WARM)

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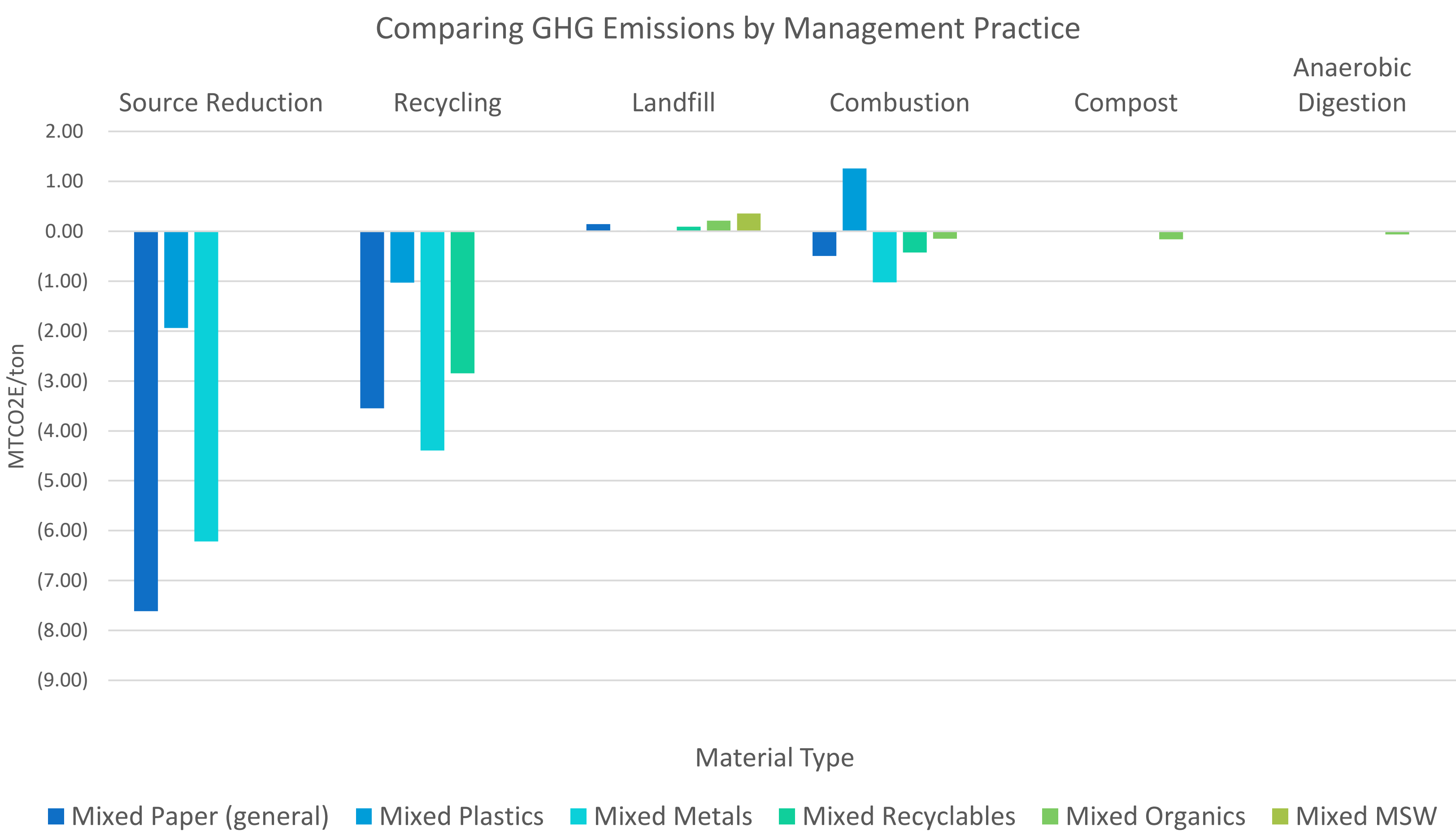
The goals for this presentation

1) Discuss how WARM can be used
2) Provide a brief history and overview of WARM
3) Walk through WARM version 15 updates to both platforms
4) Walk through two examples using WARM version 15

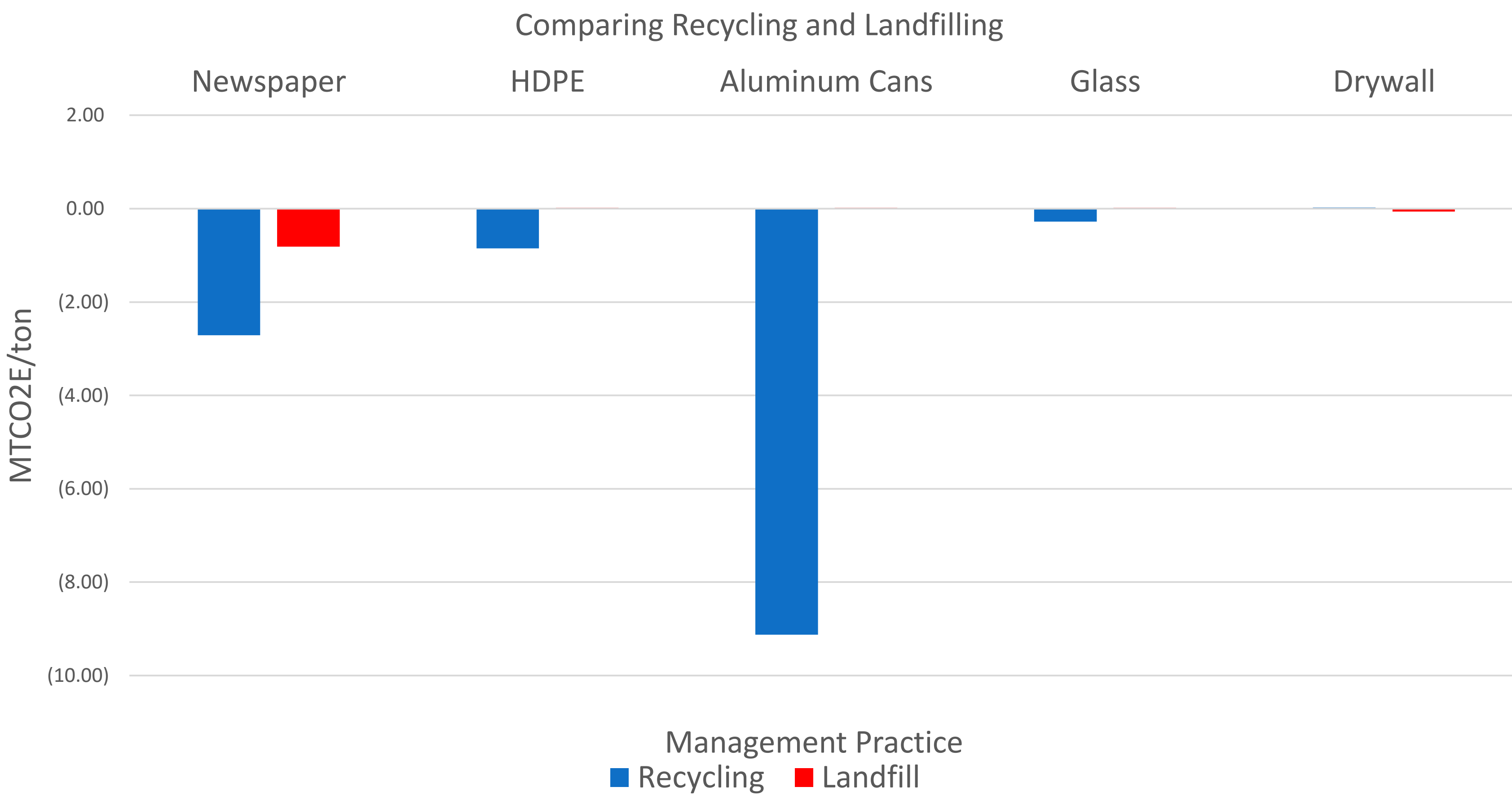
What type of questions can WARM answer?

1. Which management practices are environmentally preferable on average?
2. Which materials should I focus on collecting and recycling?
3. What are some of the environmental benefit of the actions of my organization?
4. What are the economy-wide impacts of my landfill diversion practices?
5. What areas do I need to do more research?

1. What management practices are environmentally preferable on average?



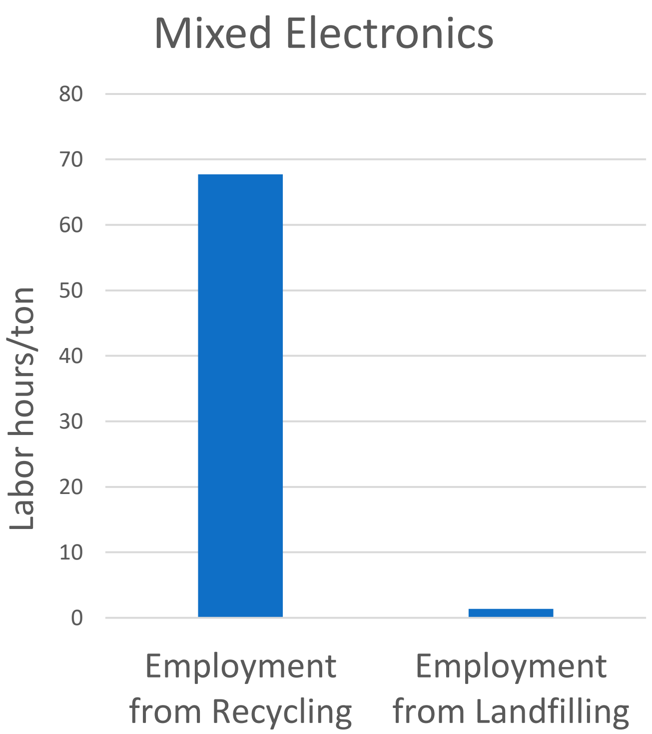
2. What materials should I focus on collecting and recycling?

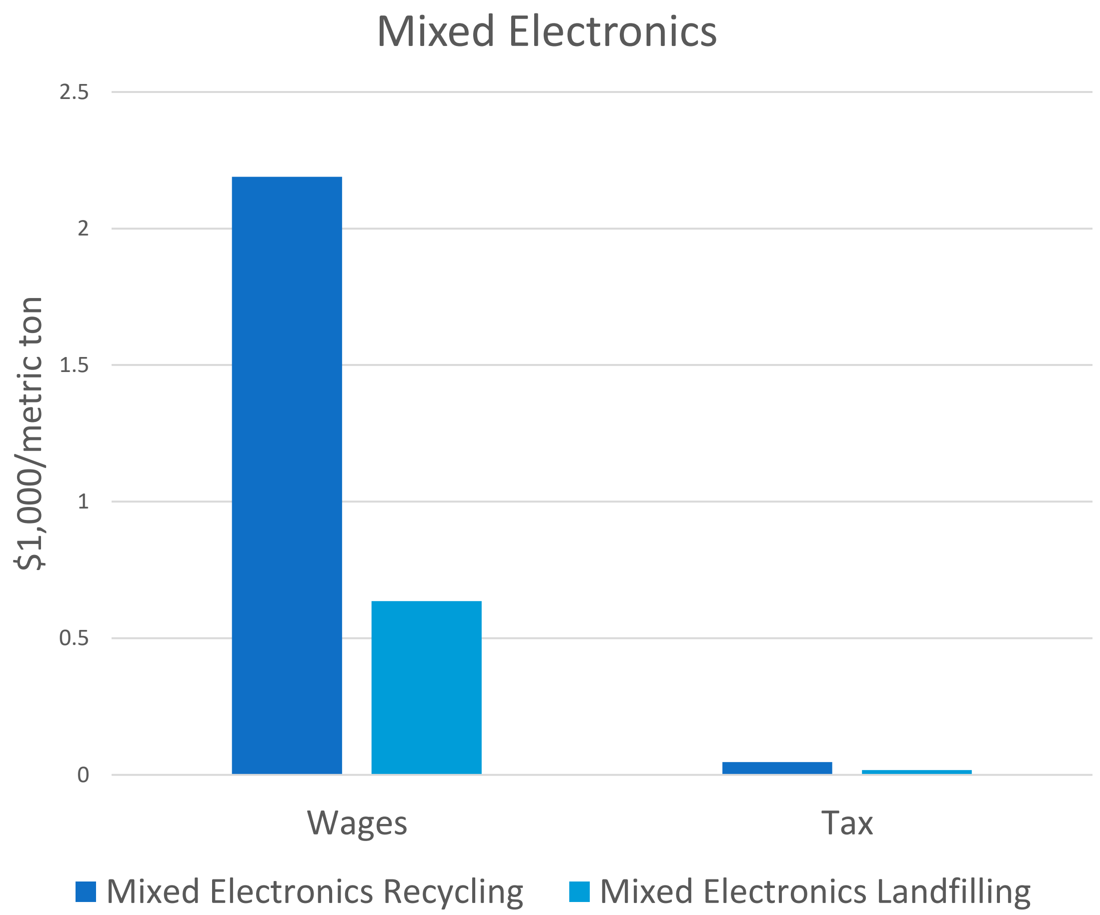


3. What are some of the environmental benefit of the actions of my organization?

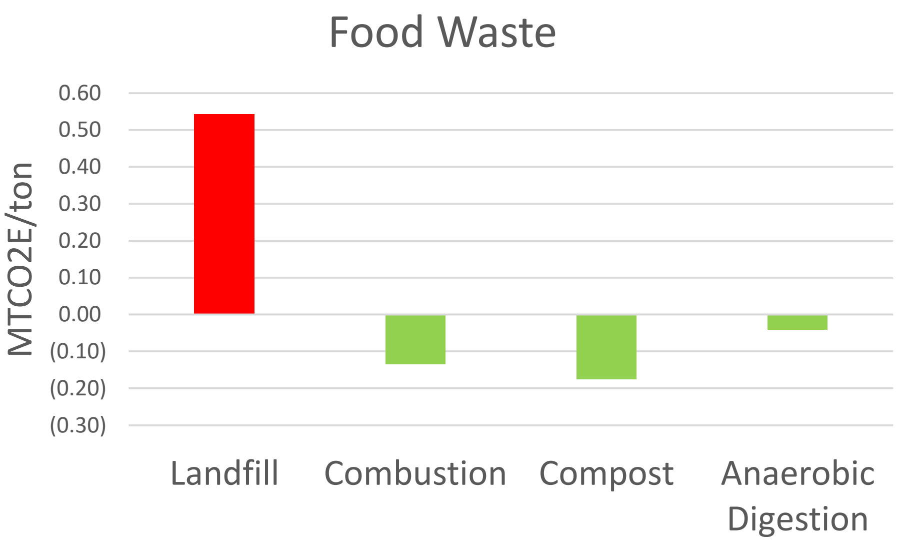
In 2018, the city of Omaha diverted X tons from the landfill for composting, anaerobic digestion and recycling. The environmental benefit of these efforts was reduction of approximately Y metrics tons of carbon dioxide equivalent in the environment, which is equivalent to the removal of Z cars on the road for 1 year.

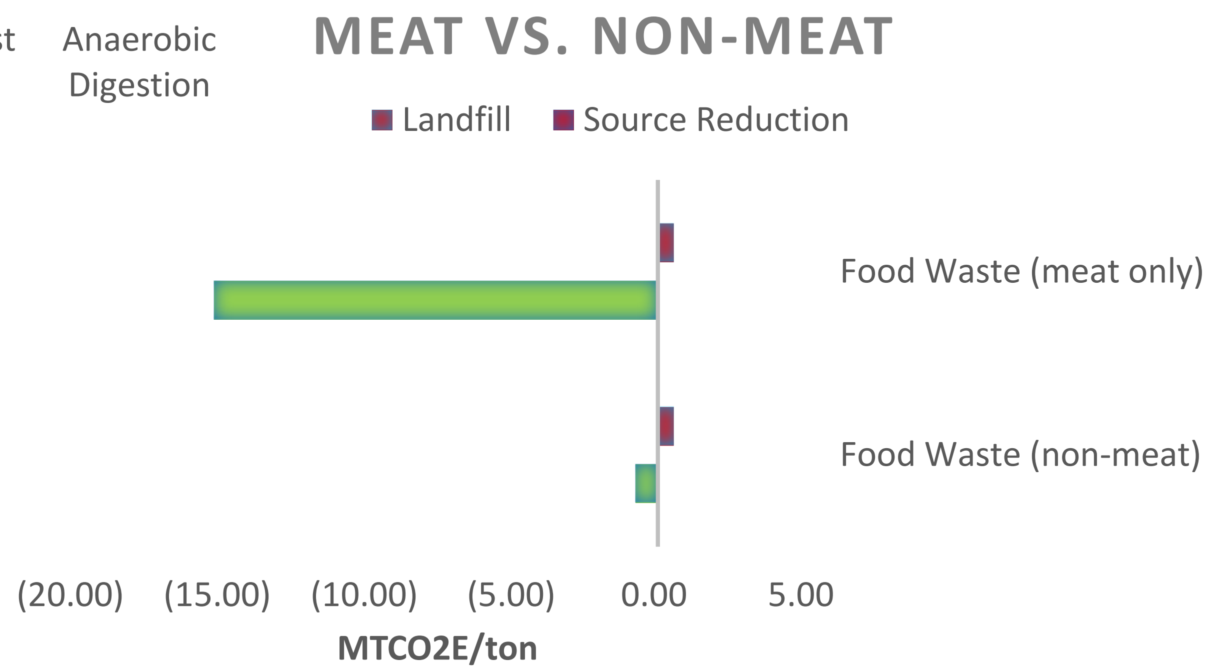
4. What are the economy-wide impacts of my landfill diversion practices?





5. What areas require more research?





WARM Overview

- WARM was created in 1998. WARM version 15 will be published very soon.

- WARM calculates **GHG emissions** and **energy use (BTU)**of baseline and alternative waste management practices, including **source reduction**, **recycling**, **combustion**, **composting**, **anaerobic digestion** and **landfilling**

- WARM has **60 materials** modeled - from paper to plastic to organics and building materials
  - Focus in municipal solid waste and the built environment
  - Now modeling multiple types of electronic equipment

WARM version 15 - screenshot

Waste Reduction Model (WARM)

1 Scenarios | 2 Further Characteristics | 3 General Information | 4 Calculation

	Baseline Scenario						Alternative Scenario					
Material	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Anaerobically Digested**	**Tons Generated**	**Tons Source Reduced**	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Anaerobically Digested**
Corrugated Containers	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
Magazines/Third-class Mail	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
Newspaper	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
Office Paper	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
Phonebooks	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
Textbooks	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
Mixed Paper (general)	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
Mixed Paper (primarily residential)	0	100	0	N/A	N/A	100	0	100	0	0	N/A	N/A

Next

WARM version 15 - screenshot

Waste Reduction Model (WARM)

1 Scenarios | 2 **Further Characteristics** | 3 General Information | 4 Calculation

Locations

In order to account for the avoided electricity-related emissions in the landfilling and combustion pathways, EPA assigns the appropriate regional "marginal" electricity grid mix emission factor based on your location

Please select state or national average: National Average

Region location: **National Average**

Waste Transport Characteristics

Emissions that occur during transport of materials to the management facility are included in this model. You may use default transport distances, 20 miles, or provide information on the transport distances for the various MSW management options.

- (●) Use default distance
- ( ) Define distance

Management option	Default Distance (miles)	Defined Distance (miles)
Landfill	20	
Combustion	20	
Recycling	20	
Composting	20	
Anaerobic Digestion	20	

Source reduction

WARM version 15 - screenshot

1 Scenarios > 2 Further Characteristics > 3 General Information > **4 Calculation**

Calculation Properties

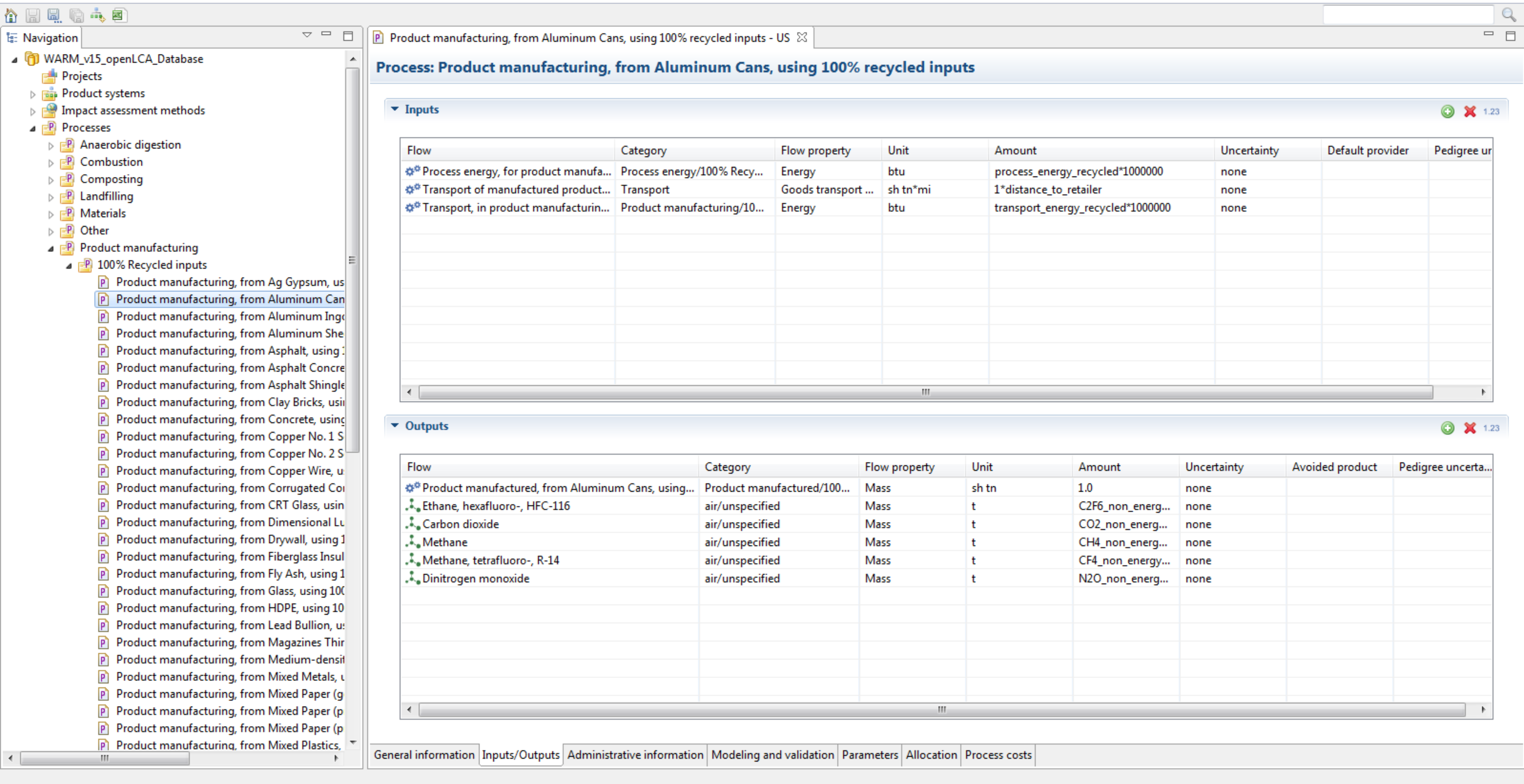
Please select the result output unit:

- (•) Metric Tons of Carbon Dioxide Equivalent (MTCO2E)
- ( ) Metric Tons of Carbon Equivalent (MTCE)
- ( ) Units of Energy (million BTU)
- ( ) Labor Hours - employment supported by materials management
- ( ) Wages ($) - all forms of employment income from materials management
- ( ) Taxes ($) - taxes collected by the federal, state and local government from materials management

You can return to this screen to generate results with another output unit once the initial report has been generated.

Calculate

Using WARM Data and Emissions Factors



New for WARM version 15

- Economic estimates of 5 management practices
- Updated electronics categories
- Update key emissions factors, similar to previous version updates
- Updated documentation
  - New information on material choice
  - Updated memo of food donation
  - Clarity on transportation emissions factors

New for WARM version 15 - Economics

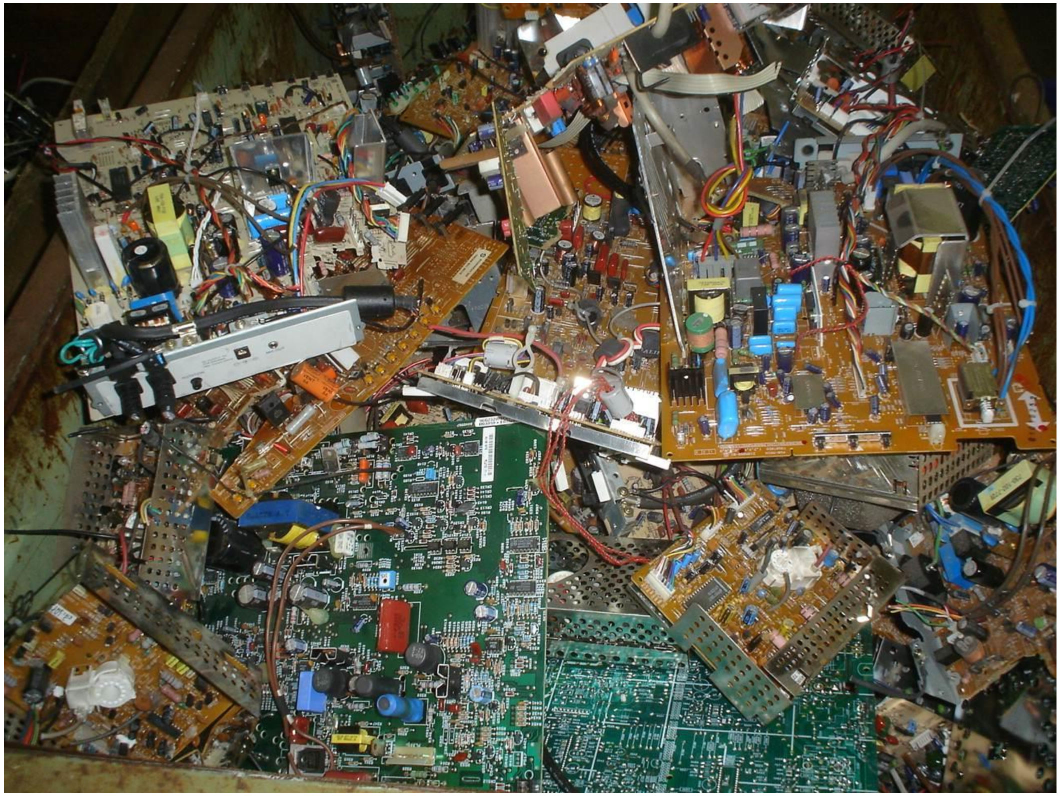
Economic estimates of 5 management practices

- Economic impacts of recycling, composting, anaerobic digestion, combustion and landfilling are modeled
- Results are presented in labor hours, wages and tax revenue
- Largely based on EPA's Recycling Economic Information (REI) Report published in 2016.
- Also used Tellus Institute report, "More Jobs, Less Pollution"

New for WARM version 15 - Electronics

Updated electronics categories:

- Desktop CPUs
- Portable Electronic Devices
- Flat-Panel Displays
- CRT Displays
- Electronic Peripherals
- Hard Copy Devices
- Mixed Electronics



New for WARM version 15 – Memos

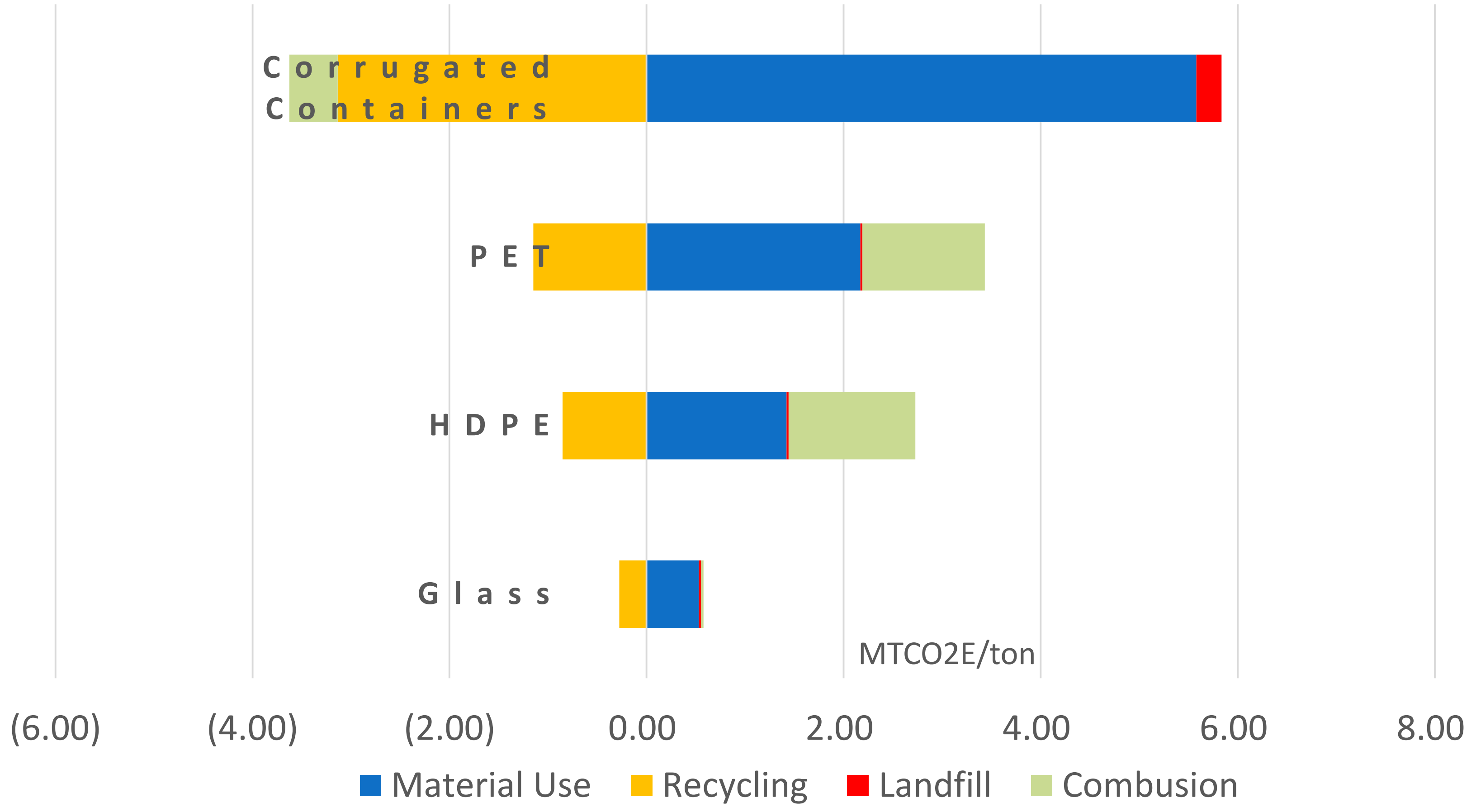
Updated Food Donation Memo

- Updated loss estimates based on Feeding America data
- Allows users to calculate a range of environmental benefits due to food donation
- Limited use for donation for animal feed

Construction Materials Memo

- Beginning stages, likely to be complete by Fall 2019
- Likely focus on Wood products and materials
- Interest in additional proxy information

Considering Material Choice



WARM version 15 – Example #1

Scenario:

We are going to compare the environmental benefit of our current organics waste management and a hypothetical scenario where New York state has met their 2030 commitment to reduce food waste to landfills by 50%.

- Hypothetical example where numbers are simply 10% of national figures

WARM version 15 – Example #1

Baseline	2015 data in million tons
Generated	3.9
Composted	0.2
Combusted	0.7
Landfilled	3.0

Alternative	2030 Goal in million tons
Generated	3.4
Source Reduced	0.5
Composted	1.0
Anaerobically Digested	0.25
Combusted	0.75
Landfilled	1.4

WARM version 15 – Example #1

1) Enter tonnage value in baseline and alternative:

1 Scenarios | 2 Further Characteristics | 3 General Information | 4 Calculation

Food Waste	N/A	30000(	700000	200000	0	3900000	5000(	N/A	ı00000	750000	1000000	250000

2) Enter case-specific information, if relevant:

1 Scenarios | **2 Further Characteristics** | 3 General Information | 4 Calculation

Locations

In order to account for the avoided electricity-related emissions in the landfilling and combustion pathways, EPA assigns the appropriate regional "marginal" electricity grid mix emission factor based on your location

Please select state or national average: Nebraska

Region location: **West North Central**

Waste Transport Characteristics

Emissions that occur during transport of materials to the management facility are included in this model. You may use default transport distances, 20 miles, or provide information on the transport distances for the various MSW management options.

- ○ Use default distance
- ◉ Define distance

Management option	Default Distance (miles)	Defined Distance (miles)
Landfill	20	125

WARM version 15 – Example #1

3) Enter organization information (optional)

4) Choose unit for results:

1 Scenarios | 2 Further Characteristics | 3 General Information | 4 Calculation

Calculation Properties

Please select the result output unit:

- (●) Metric Tons of Carbon Dioxide Equivalent (MTCO2E)
- ( ) Metric Tons of Carbon Equivalent (MTCE)
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Calculate

WARM version 15 – Example #1

Results:

Total Change in GHG Emissions (MTCO2E): **-2,869,033**

- Negative result indicates net reduction in GHG emissions

	Baseline Scenario						Alternative Scenario						
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E
Food Waste	N/A	3000000.00	700000.00	200000.00	0.00	1475921.75	500000.00	N/A	1400000.00	750000.00	1000000.00	250000.00	-1393111.60
						1475921.75							-1393111.60

Equivalent to:

609,137
Passenger vehicles driven for one year

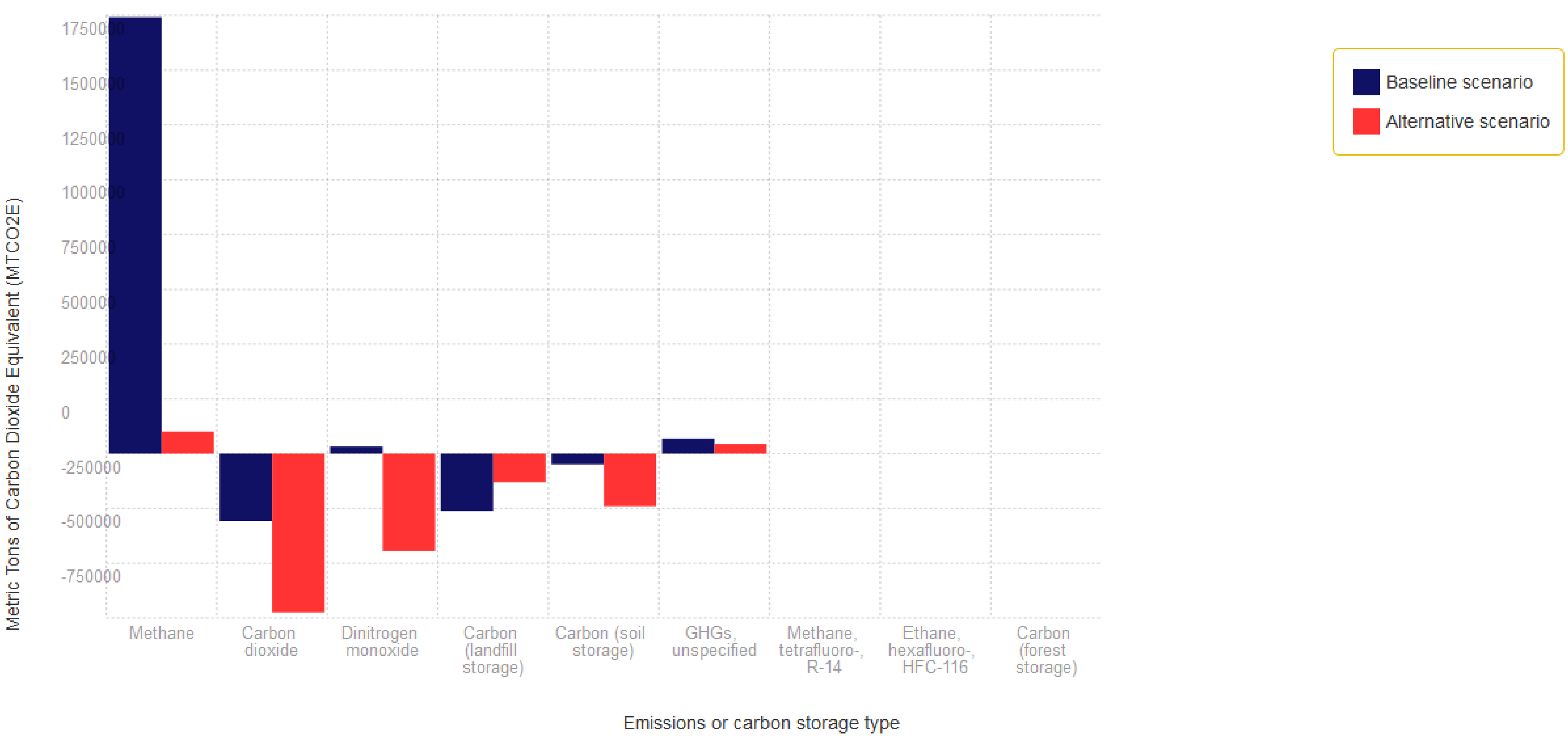
343,556
homes' energy use for one year

47,440,068
tree seedlings grown for 10 years

WARM version 15 – Example #1

Charts:

Flow contributions | Waste treatment contributions | Material contributions | Impact by source/offset



WARM version 15 – Example #2

Scenario: A bottling company has been making 100 tons of multi-layered plastic bottles (LDPE and PET combination) that have not been recyclable in the past.

The company has found a way to make two improvements to their product:

1) They have found a way to contain the same quantity with only 80 tons of plastic, and
2) They have managed to create the bottle out of a single, recyclable resin (PET). They estimate 50% of their production will be recycled.

WARM version 15 – Example #2

Data Entry:

	Baseline		Alternative		
	Landfill	Recycling	Source Reduction	Recycle	Landfill
HDPE	20		20		
PET	80			40	40

WARM version 15 – Example #2

Baseline (MTCO2E) = 2.03
Alternative (MTCO2E) = -73.50
Total benefit (MTCO2E)= -75.53

	Baseline Scenario						Alternative Scenario							
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E	Change (Alt-Base) MTCO2E
HDPE	0.00	20.00	0.00	N/A	N/A	0.41	20.00	0.00	0.00	0.00	N/A	N/A	-28.38	-28.79
PET	0.00	80.00	0.00	N/A	N/A	1.62	0.00	40.00	40.00	0.00	N/A	N/A	-45.12	-46.74
						2.03							-73.50	

a) For explanation of methodology, see the EPA WARM Documentation

b) Emissions estimates provided by this model are intended to support voluntary GHG measurement and reporting initiatives.

Total Change in GHG Emissions (MTCO2E): **-75.53**

WARM version 15 – Example #2

Approximate Net Benefits of:

Labor Hours =	2,145 hours
Wages =	$45,000
Tax Revenue =	$5,700

Calculation Properties

Please select the result output unit:

- ○ Metric Tons of Carbon Dioxide Equivalent (MTCO2E)
- ○ Metric Tons of Carbon Equivalent (MTCE)
- ○ Units of Energy (million BTU)
- ◉ Labor Hours - employment supported by materials management
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Calculate

Related Tools

- **Individual Waste Reduction Model (iWARM)**
- **Recycled Content (ReCon) Tool – Last updated 2010**
- **Policy and Program Impact Estimator: A Materials Recovery Greenhouse Gas (GHG) Calculator for Communities**
- **Greenhouse Gas Equivalencies Calculator**
- **Center for Corporate Climate Leadership Greenhouse Gas Inventory Guidance (Scope 3)**

Questions?

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WARM Documentation and Website

Documentation Chapters

Any material or waste management option that is modeled in WARM can be found in our chapters.

In each chapter, you will find emission factors, assumptions, limitations, offsets and life-cycle emissions.

Materials Chapters (March 2015)

Management Practices Chapters (February 2016)

WARM Model History

https://www.epa.gov/warm

Each Version includes a paragraph on any major updates.

The current version is WARM Version 14.