Waste Reduction Model (WARM)

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The goals for this presentation

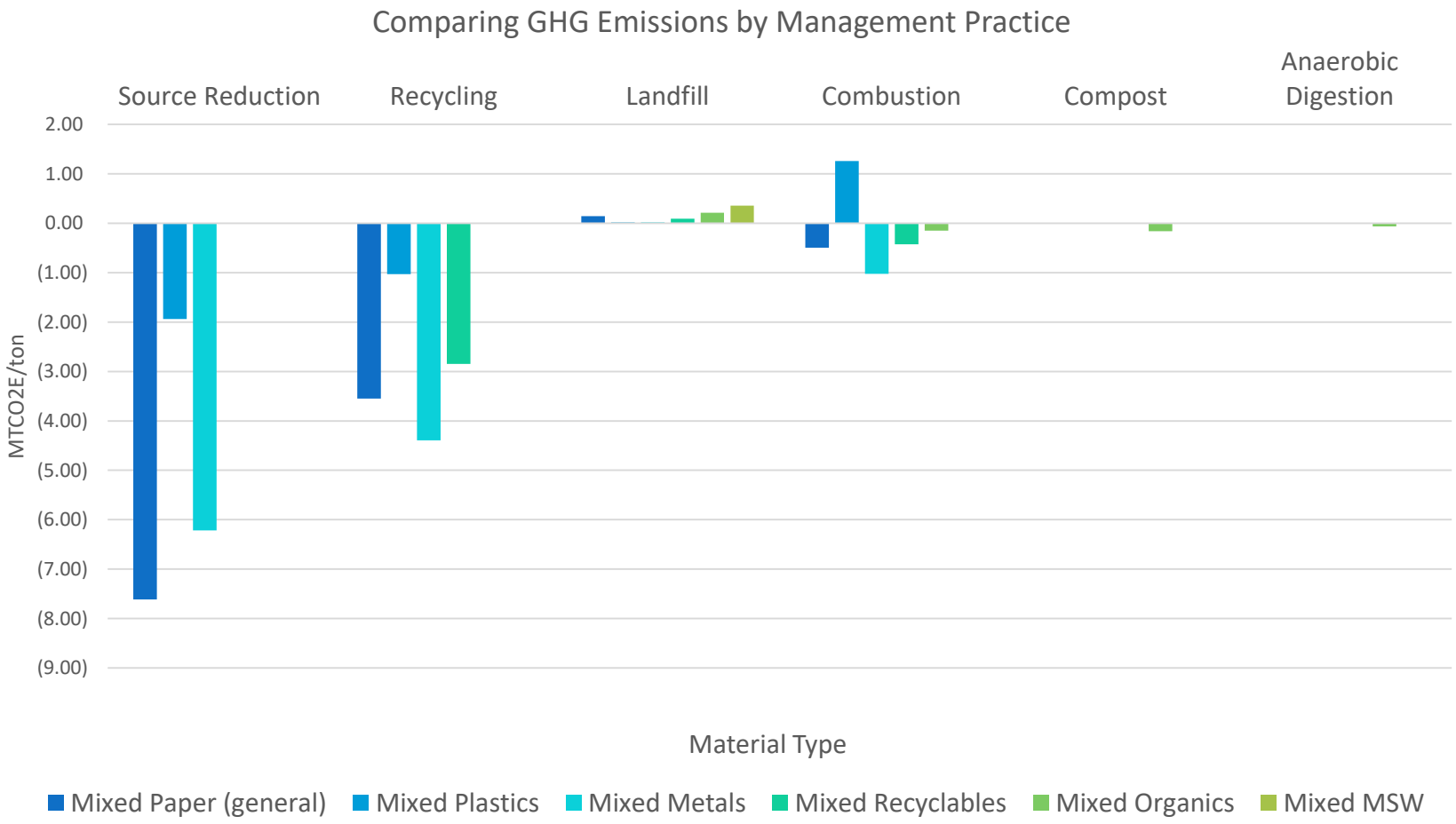
1) Discuss how WARM can be used

2) Provide a brief history and overview of WARM

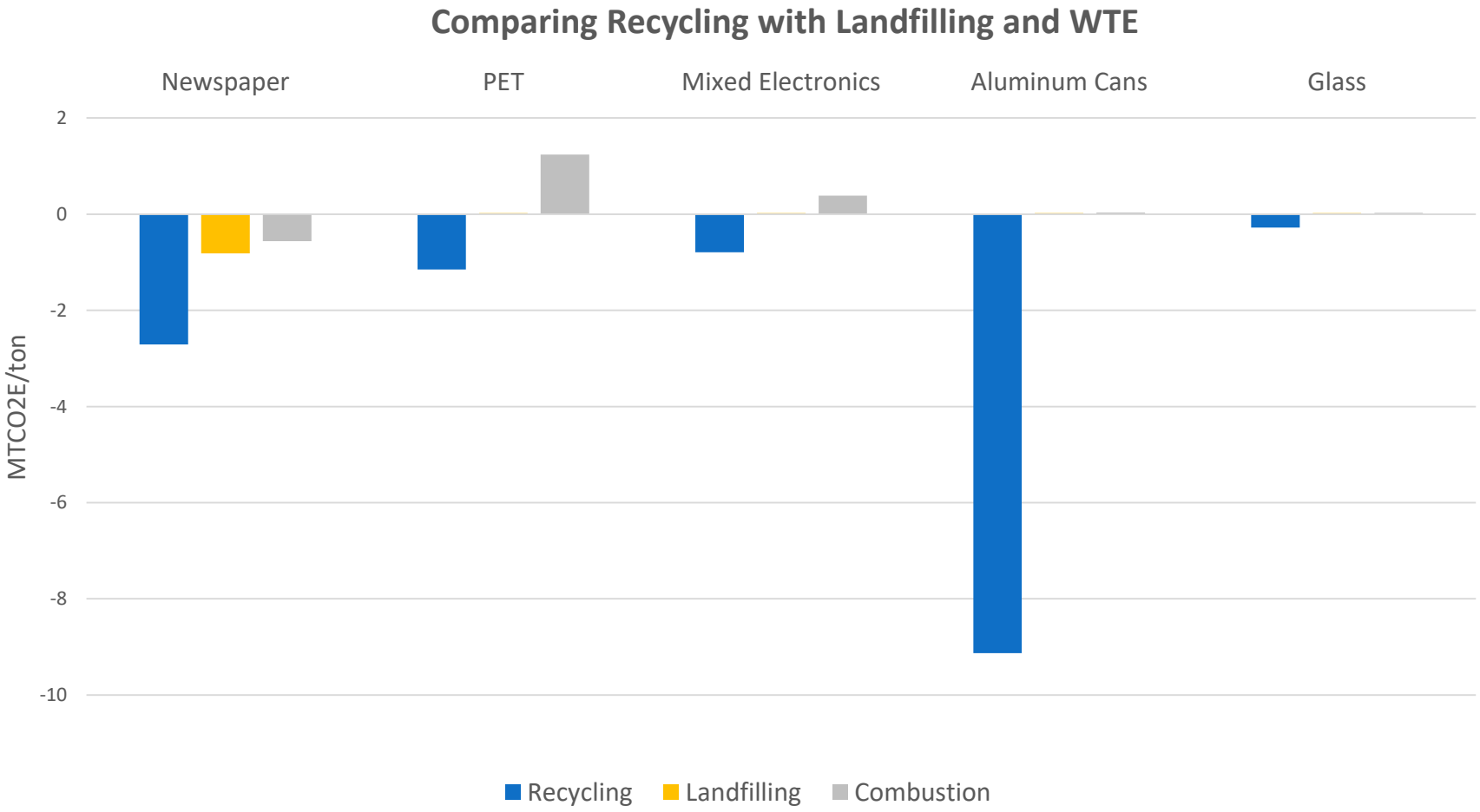
3) Walk through WARM version 15 updates to both platforms

4) Walk through an example using WARM version 15

1. What management practices are environmentally preferable on average?



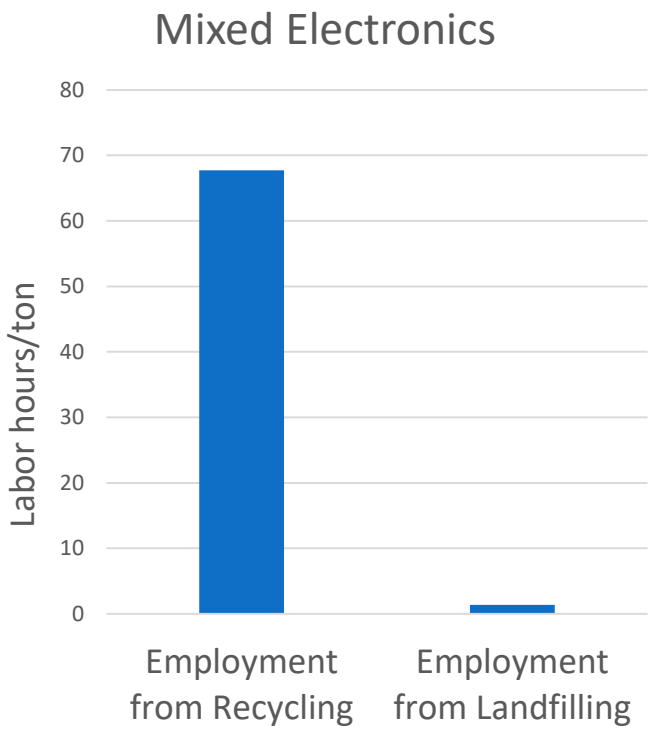
2. Which materials should I focus on collecting and recycling?

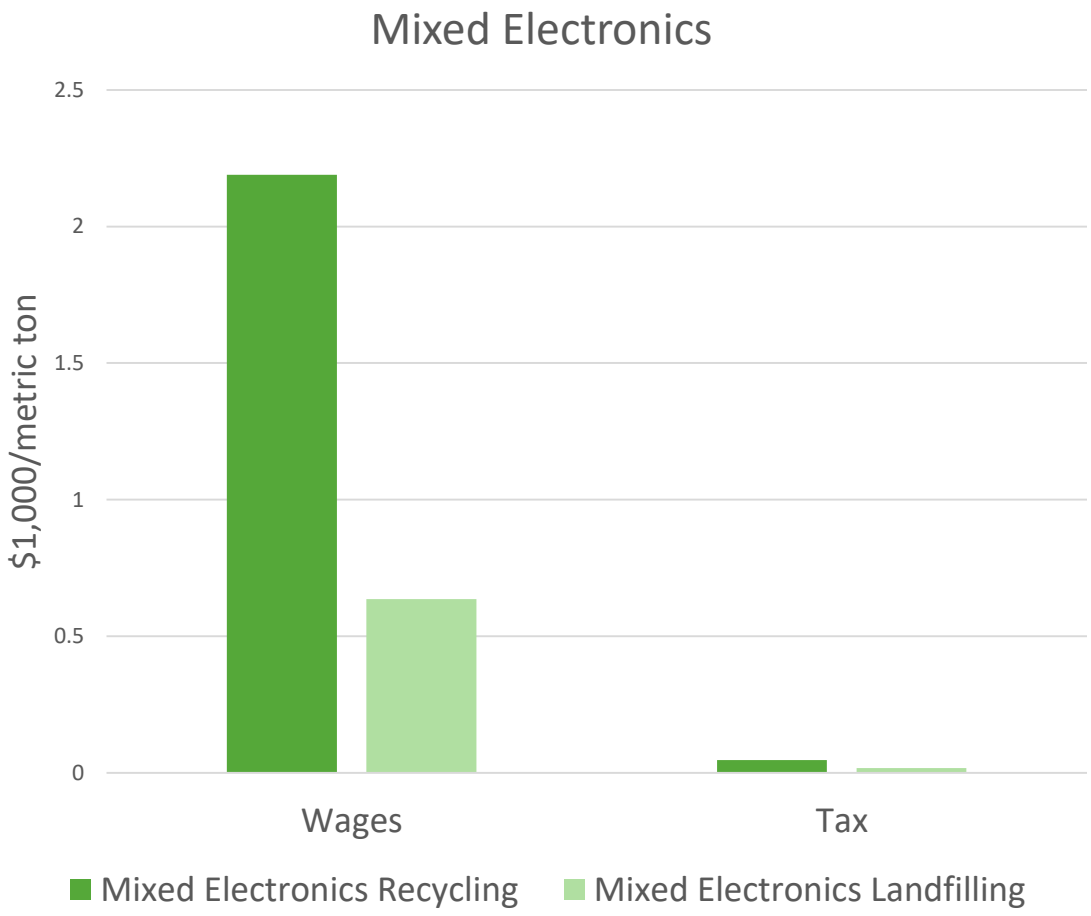


3. What are some of the environmental benefit of the actions of my organization?

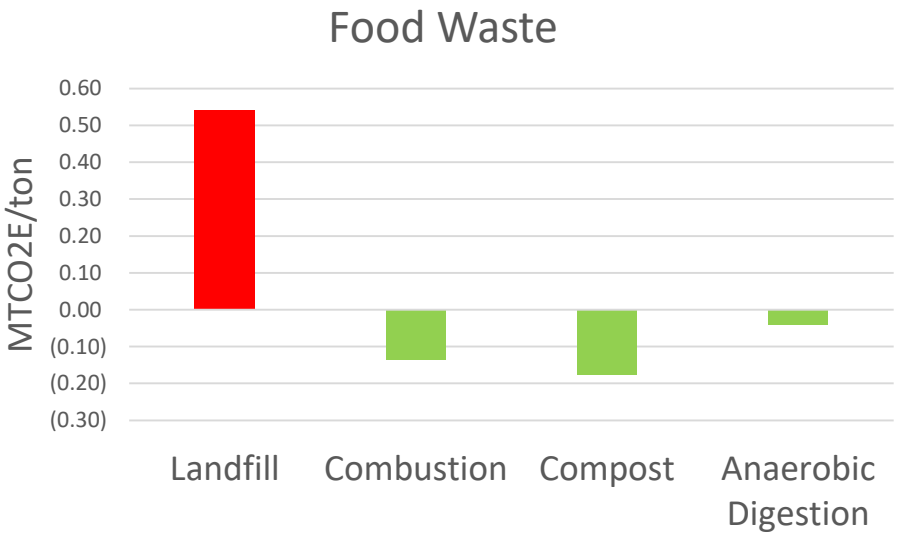
In 2018, the city of Omaha diverted X tons from the landfill for composting, anaerobic digestion and recycling. The environmental benefit of these efforts was reduction of approximately Y metrics tons of carbon dioxide equivalent in the environment, which is equivalent to the removal of Z cars on the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

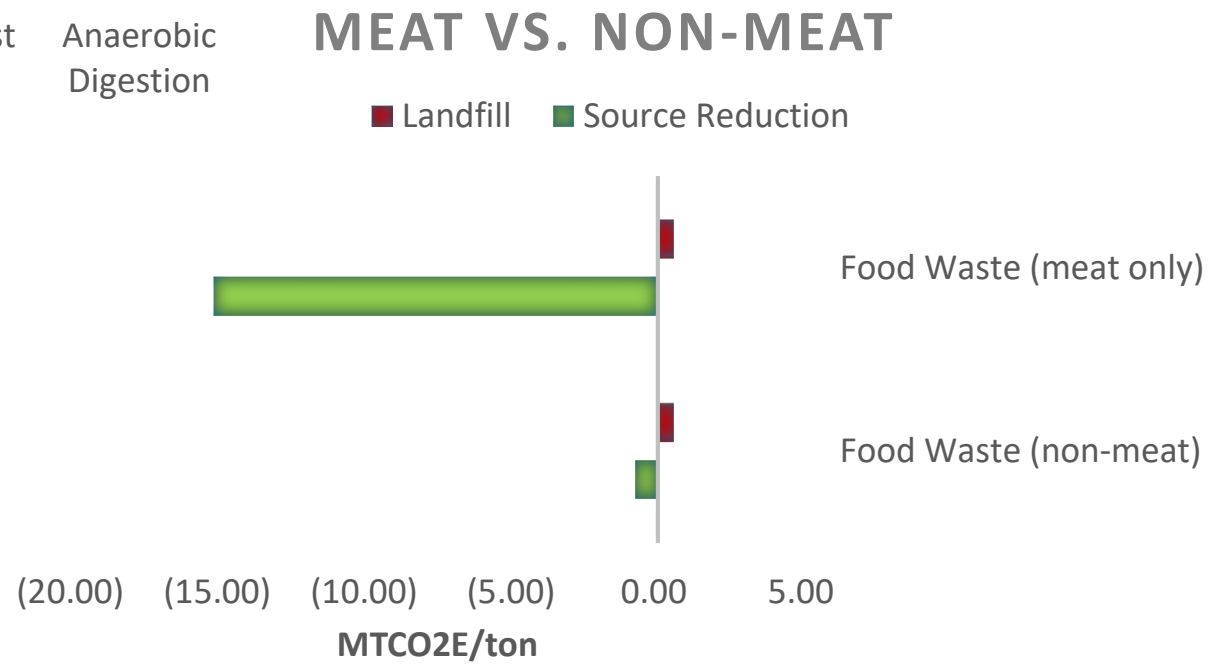
4. What are the economy-wide impacts of my landfill diversion practices?





5. Which areas require more research?





WARM Overview

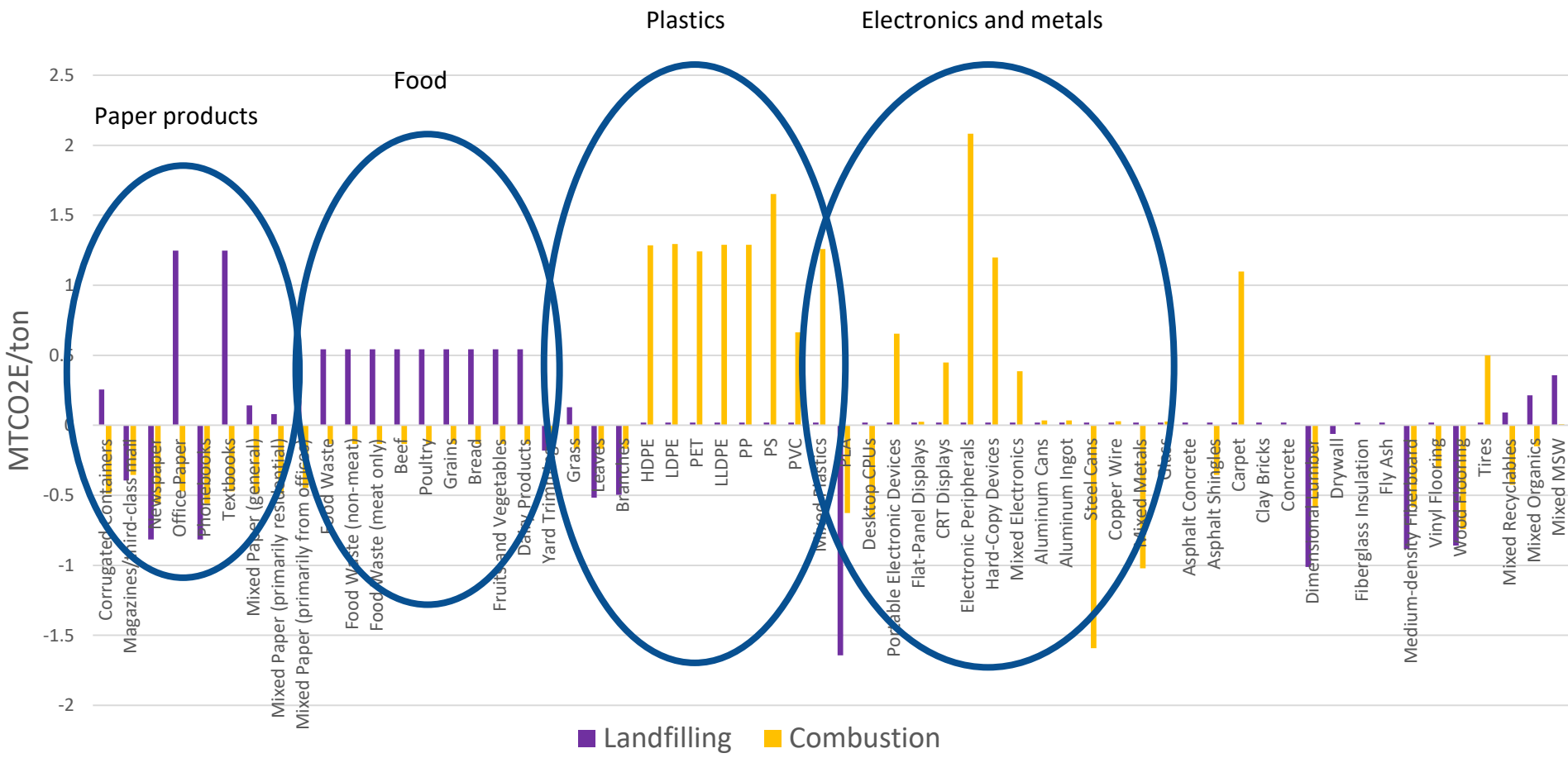
- WARM was created in 1998. WARM version 15 will be published in June 2019.
- WARM calculates **GHG emissions** and **energy use (BTU)** of baseline and alternative waste management practices, including **source reduction**, **recycling**, **combustion**, **composting**, **anaerobic digestion** and **landfilling**
- WARM now calculates the economic impact of management practices.
- 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 Overview

- In its most basic form, WARM calculates the difference between a baseline (often landfilling) management practice and an alternative management practice.
- Example: 1 ton of “fly ash”
  - Baseline impact of landfilling 1 ton = 0.02 MTCO2E
  - Alternative impact of recycling 1 ton = -0.87 MTC02E
  - WARM result: The net impact of recycling, rather than landfilling, 1 ton of cardboard is -0.89 MTC02E
- GHG reduction benefits are mainly attributed to the energy savings associated with the use of recycled materials compared to virgin resources during production.

Using WARM Data and Emissions Factors

Comparing Landfill and WTE



WARM version 15 – openLCA and Excel

Waste Reduction Model (WARM)

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

Material	Baseline Scenario: Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Tons Generated	Alternative Scenario: 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

Version 15

Waste Reduction Model (WARM) -- Inputs

Use this worksheet to describe the baseline and alternative waste management scenarios that you want to compare. The blue shaded areas indicate where you need to enter information.
Please enter data in short tons (1 short ton = 2,000 lbs.)

1. Describe the baseline generation and management for the waste materials listed below.
If the material is not generated in your community 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.

2. Describe the alternative management scenario for the waste materials ge
Any decrease in generation should be entered in the Source Reduction co
Any increase in generation should be entered in the Source Reduction co
Make sure that the total quantity generated equals the total quantity mana

Material Type	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
Paper	Corrugated Containers				NA	NA	0.00					NA
	Magazines/Third-class Mail				NA	NA	0.00					NA
	Newspaper				NA	NA	0.00					NA
	Office Paper				NA	NA	0.00					NA
	Phonebooks				NA	NA	0.00					NA
	Textbooks				NA	NA	0.00					NA
	Mixed Paper (general)				NA	NA	0.00					NA
	Mixed Paper (primarily residential)				NA	NA	0.00					NA
	Mixed Paper (primarily from offices)				NA	NA	0.00					NA
Food Waste	Food Waste	NA					0.00		NA			
	Food Waste (non-meat)	NA					0.00		NA			
	Food Waste (meat only)	NA					0.00		NA			
	Beef	NA					0.00		NA			
	Poultry	NA					0.00		NA			

WARM version 15 Excel – Materials and Pathways

Material Type	Material	Tons Recycled	Tons Landfilled	Tons Combusted
Metals	Aluminum Cans			
	Aluminum Ingot			
	Steel Cans			
	Copper Wire			
	Mixed Metals			
Glass	Glass			
Construction Materials	Asphalt Concrete			NA
	Asphalt Shingles			
	Carpet			
	Clay Bricks	NA		NA
	Concrete			NA
	Dimensional Lumber			
	Drywall			NA
	Fiberglass Insulation	NA		NA
	Fly Ash			NA
	Medium-density Fiberboard			
	Vinyl Flooring	NA		
	Wood Flooring	NA		

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

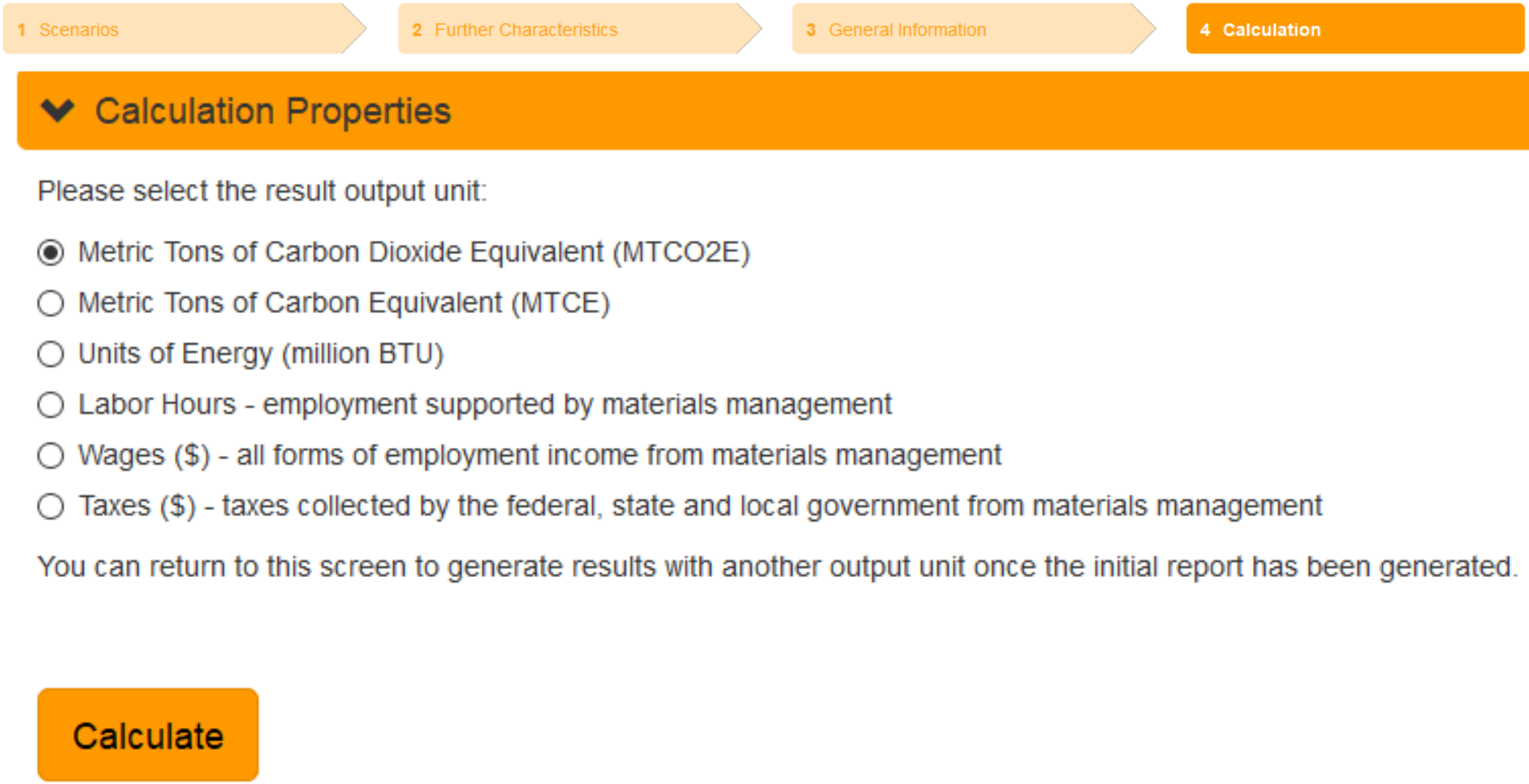
Management option	Default Distance (miles)	Defined Distance (miles)
Landfill	20	
Combustion	20	
Recycling	20	
Composting	20	
Anaerobic Digestion	20	

Source reduction

EPA United States Environmental Protection Agency

www.epa.gov/smm

WARM version 15 - screenshot



New for WARM version 15 - Economic Estimates

- 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" from 2011

WARM version 15 – Example #1

Scenario:
We are going to compare the GHG and energy benefits of New York state if they are able to meet their 2030 commitment to reduce food waste to landfills by 50%. The goal will be compared to a baseline of 2015 reported data.

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

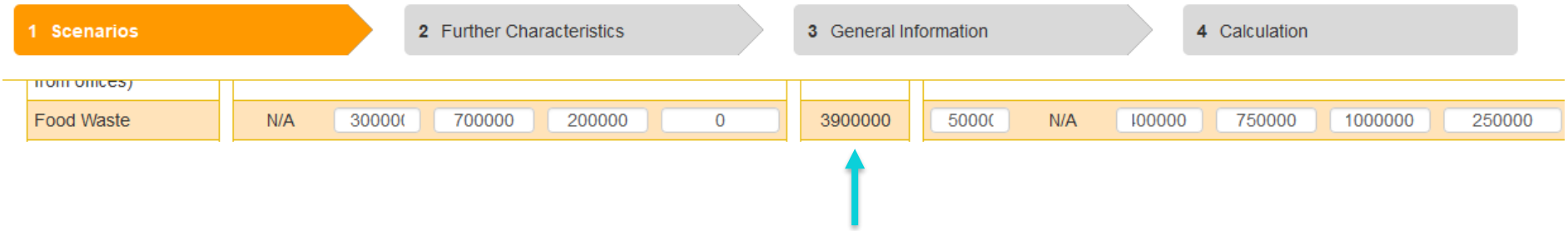
WARM version 15 – Example #1

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

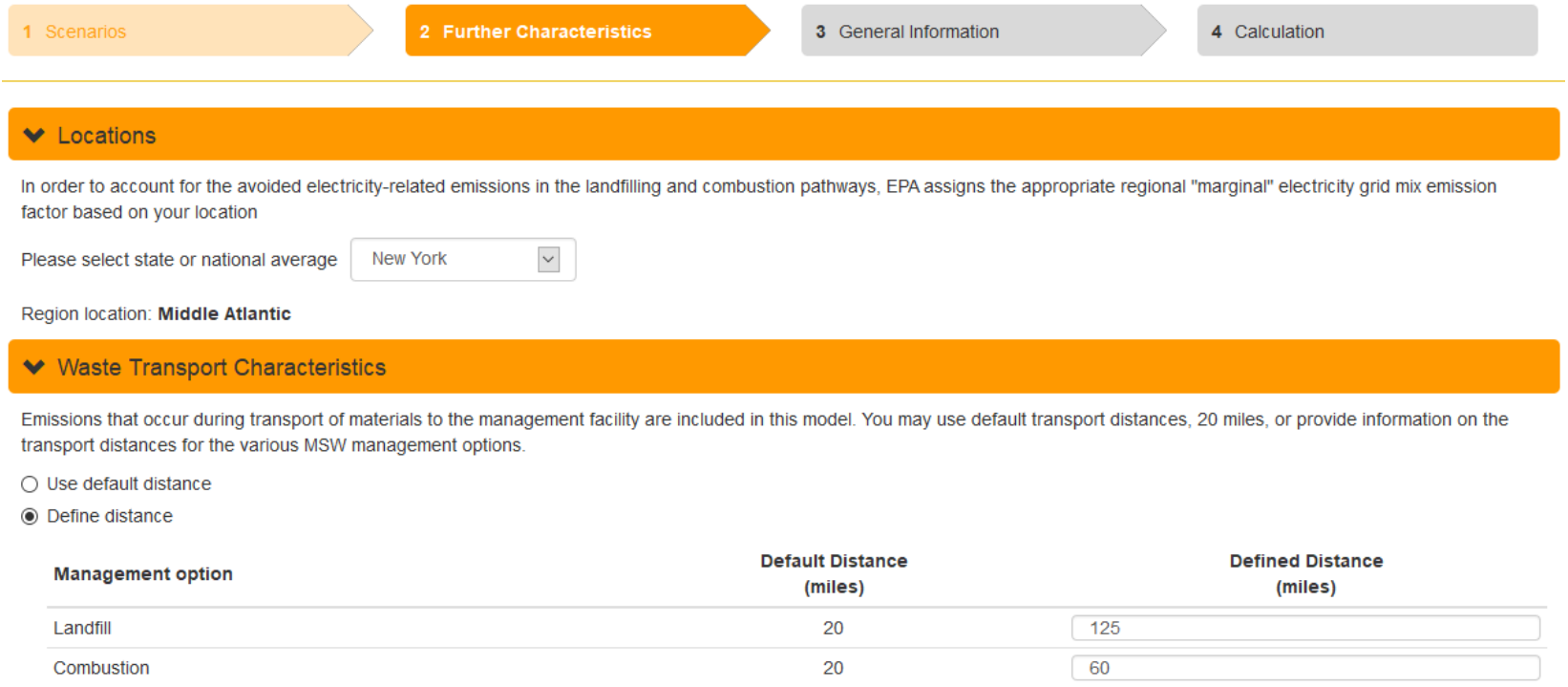
Alternative	2030 Goal in million tons
Generated	3.4
Source Reduced	0.5
Composted	1.0
Anaerobically Digested	0.25
Combusted	0.75
Landfilled	1.4

WARM version 15 – Example #1

1) Enter tonnage value in baseline and alternative:



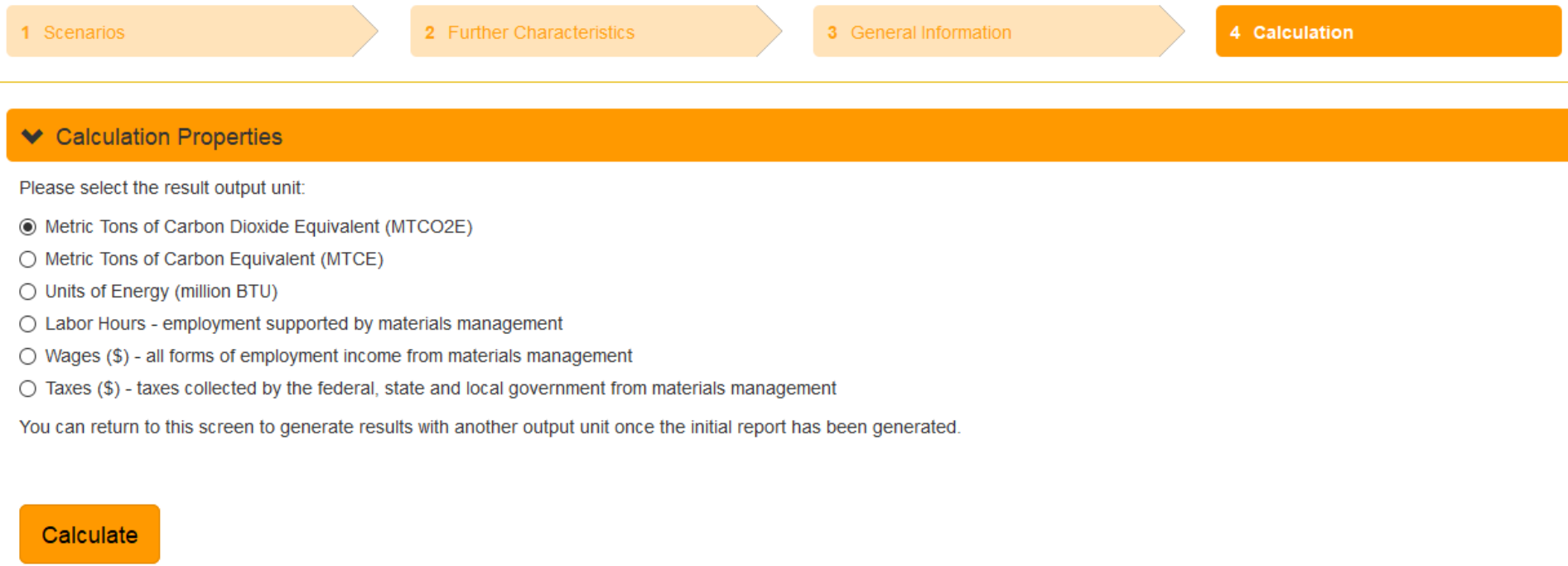
2) Enter case-specific information, if relevant:



WARM version 15 – Example #1

3) Enter organization information (optional)

4) Choose unit for results:



WARM version 15 – Example #1

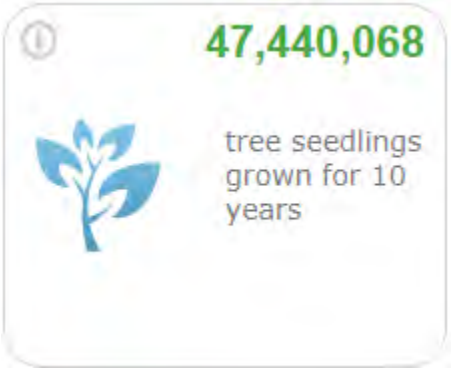
Results:

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

- Negative result indicates net reduction in GHG emissions

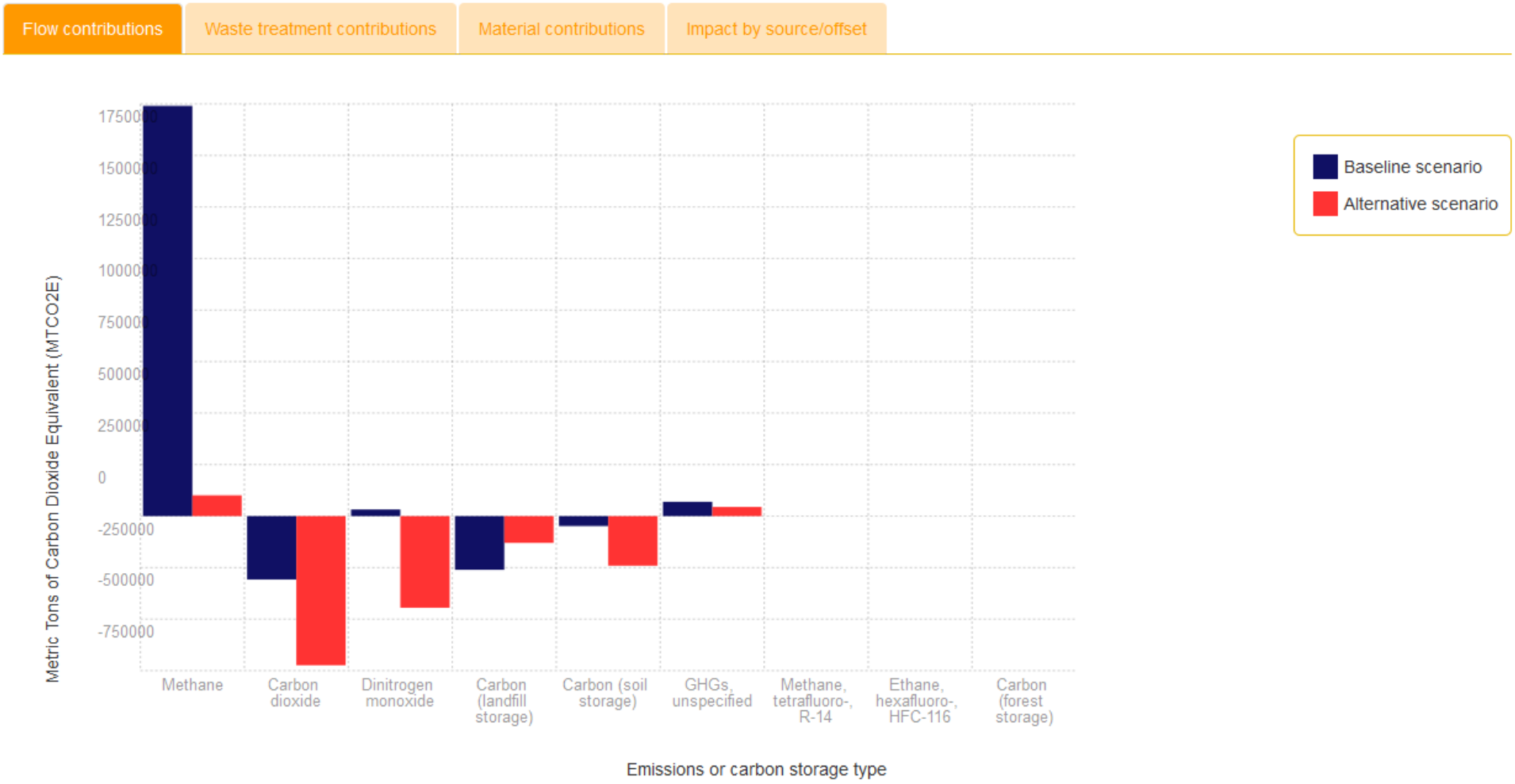
	Baseline Scenario						Alternative Scenario						
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E
Food Waste	N/A	3000000.00	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:



WARM version 15 – Example #1

Charts:



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
- Municipal Solid Waste Decision Support Tool
- Greenhouse Gas Equivalencies Calculator
- Center for Corporate Climate Leadership Greenhouse Gas Inventory Guidance (Scope 3)

Questions?

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