



Measuring Food Waste and Packaging Waste Impacts in WARM

EPA Reducing Wasted Food & Packaging Toolkit Webinar Series

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Bobby Renz – ICF International

Waste Reduction Model (WARM)

- **Goal** – To help solid waste planners and organizations track and voluntarily report greenhouse gas (GHG) emissions reductions from several different waste management practices



- **How WARM works**

- WARM calculates and totals the GHG emissions of baseline and alternative waste management practices— *source reduction, recycling, combustion, composting, and landfilling.*
- For example, a user can compare the GHG emissions from *recycling* a ton of aluminum cans instead of *landfilling* them

Material	Baseline Scenario				Tons Generated
	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	
Aluminum Cans	<input type="text"/>	<input type="text"/>	<input type="text"/>	N/A	0
Aluminum Ingot	<input type="text"/>	<input type="text"/>	<input type="text"/>	N/A	0
Steel Cans	<input type="text"/>	<input type="text"/>	<input type="text"/>	N/A	0
Copper Wire	<input type="text"/>	<input type="text"/>	<input type="text"/>	N/A	0
Glass	<input type="text"/>	<input type="text"/>	<input type="text"/>	N/A	0
HDPE	<input type="text"/>	<input type="text"/>	<input type="text"/>	N/A	0
LDPE	N/A	<input type="text"/>	<input type="text"/>	N/A	0
PET	<input type="text"/>	<input type="text"/>	<input type="text"/>	N/A	0
LLDPE	N/A	<input type="text"/>	<input type="text"/>	N/A	0
PP	N/A	<input type="text"/>	<input type="text"/>	N/A	0
PS	N/A	<input type="text"/>	<input type="text"/>	N/A	0

BACKGROUND

WARM Spreadsheet and Web Tools

For the use with the Food Waste Tool Kit, we recommend using the Excel spreadsheet version of WARM [available for download](#).

The Excel version allows the user to estimate the energy and GHG emissions from the full list of materials in WARM.

Version ID

Waste Reduction Model (WARM) -- Inputs

Use this worksheet to describe the baseline and alternative MSW management scenarios that you want to compare. The blue shaded areas indicate where you need to enter information.

- Describe the baseline generation and management for the MSW 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.
- Describe the alternative management scenario for the MSW materials generated in the baseline. Any decrease in generation should be entered in the Source Reduction column. Any increase in generation should be entered in the Source Reduction column as a negative value. (Make sure that the total quantity generated equals the total quantity managed.)

Material	Baseline Scenario				Tons Generated	Alternative Scenario				
	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted		Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Aluminum Cans				NA	0.0					NA
Aluminum Ingot				NA	0.0					NA
Steel Cans				NA	0.0					NA
Copper Wire				NA	0.0					NA
Glass				NA	0.0					NA
HDPE				NA	0.0					NA
LDPE	NA			NA	0.0	NA				NA
PET				NA	0.0					NA
LLDPE	NA			NA	0.0					NA
PP	NA			NA	0.0					NA
PS	NA			NA	0.0					NA
PVC	NA			NA	0.0					NA
PLA	NA			NA	0.0					NA
Corrugated Containers				NA	0.0					NA
Magazines/Third-class Mail				NA	0.0					NA
Newspaper				NA	0.0					NA
Office Paper				NA	0.0					NA
Phonebooks				NA	0.0					NA
Textbooks				NA	0.0					NA
Dimensional Lumber				NA	0.0					NA
Medium-density Fiberboard				NA	0.0					NA
Food Waste (non-meat)	NA			NA	0.0					NA
Grains	NA			NA	0.0					NA
Bread	NA			NA	0.0					NA
Fruits and Vegetables	NA			NA	0.0					NA
Dairy Products	NA			NA	0.0					NA

The [online WARM web tool](#) offers a simplified version using text boxes and a series of questions to guide the user through the analysis.

Wastes - Resource Conservation - WARM

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Waste Reduction Model (WARM)

NEW VERSION: Updated June 2014

(Version 13, 6/14)

EPA created WARM to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions and energy savings. Use this worksheet to describe the baseline and alternative MSW management scenarios that you want to compare. Please follow the step characteristics. For information on the definition of each of the WARM material types as well as data source and year of underlying life-cycle.

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 Combusted	Tons Composted	Tons Source Reduced		Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	
Aluminum Cans				N/A	0					N/A	
Aluminum Ingot				N/A	0					N/A	
Steel Cans				N/A	0					N/A	
Copper Wire				N/A	0					N/A	
Glass				N/A	0					N/A	
HDPE				N/A	0					N/A	
LDPE	N/A			N/A	0		N/A			N/A	

Food Waste Materials

■ **Six food waste materials are available in the Excel version of WARM:**

- Bread
- Grains
- Dairy products
- Fruits and vegetables
- Beef
- Poultry

■ **Three mixed food waste categories are available in the Excel and online versions of WARM:**

- Food waste: a weighted average of the five main food type emission factors
- Food waste (meat only): a weighted average of the two meat food type emission factors
- Food waste (non-meat): a weighted average of the three non-meat food type emission factors (grains, fruits and vegetables, and dairy products)

- For guidance on the best approach for modeling materials not currently included in WARM, please refer to the guidance document on using proxies in WARM, available [here](#).

Packaging and Service Ware Materials

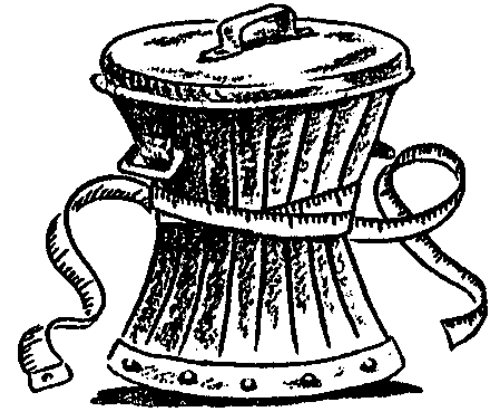
- **Numerous common food packaging and service ware materials are available in WARM, including:**
 - Aluminum cans
 - Aluminum ingot
 - Corrugated cardboard
 - Glass
 - Plastic resins (HDPE, LDPE, PET, LLDPE, PP, PS, and PVC)
 - PLA (polylactide biopolymer)
 - Steel cans
- **Several mixed material categories are available in WARM, including:**
 - Mixed metals
 - Mixed paper
 - Mixed plastics
 - Mixed recyclables
 - Mixed MSW

Management Practices

- The food waste and packaging emission factors include estimates of the GHG sources and sinks for five material management options: **source reduction, composting, recycling, combustion and landfilling**
- WARM allows users to model the change in energy and GHG emissions from moving from baseline management practices to alternative management practices
- Management practice options vary by material
 - Composting is available for food waste but not most packaging materials
 - Recycling is available for most packaging materials but not food waste

Management Practices (cont.)

- **Source Reduction** – This management practice captures the emissions impact from generating less waste materials, avoiding the emissions associated with creating the material and managing the post-consumer waste.
- **Composting** – This option for organic waste materials results in increased carbon storage when compost is applied to soil.
- **Recycling** – Recycled waste materials are transformed into either the same product or a secondary product, avoiding the need for some raw material inputs.



Management Practices (cont.)

- **Combustion** – Combusting waste results in direct GHG emissions for some materials and avoided utility electricity GHG emissions due to energy recovery from waste combustion.
- **Landfilling** – When many wastes are landfilled, methane is generated and released to the atmosphere.



Costco Wholesale Waste Example

- Food waste and packaging data have been gathered and tracked in the Reducing Wasted Food & Packaging Toolkit

Audit Data Summary									
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Week Starting Date:		3/2/2015	3/9/2015	3/16/2015	3/23/2015	3/30/2015	4/6/2015	4/13/2015	4/20/2015
Kitchen Food Waste	Protein	0	0	0	0	0	0	0	0
	Bread	1293	1114	1252	1507	864	932	927	976
	Grain	0	0	0	0	0	0	0	0
	Fruits and vegetables	5554	3660	2711	2605	3245	4407	5097	6084
	Dairy	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0
	Total	6847	4774	3963	4112	4109	5339	6024	7060
Week Starting Date:		3/2/2015	3/9/2015	3/16/2015	3/23/2015	3/30/2015	4/6/2015	4/13/2015	4/20/2015
Kitchen Packaging Waste	Paper	0	0	0	0	0	0	0	0
	Cardboard	24	17	20	22	13	37	22	18
	Aluminum	2	1	14	3	2	0	0	2
	Steel	0	0	0	0	0	0	0	0
	Container plastic	251	198	213	168	322	283	183	140
	Other plastic	0	0	0	0	0	0	0	0
	Glass	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0
	Total	277	216	247	193	337	320	205	160
Week Starting Date:		3/2/2015	3/9/2015	3/16/2015	3/23/2015	3/30/2015	4/6/2015	4/13/2015	4/20/2015
Plate Waste	Food waste	0	0	0	0	0	0	0	0
	Paper cups and straws	0	0	0	0	0	0	0	0
	To-go containers	0	0	0	0	0	0	0	0
	Disposable utensils	0	0	0	0	0	0	0	0
	Total	0	0	0	0	0	0	0	0
Week Starting Date:		3/2/2015	3/9/2015	3/16/2015	3/23/2015	3/30/2015	4/6/2015	4/13/2015	4/20/2015
Total Food and Packaging Waste	Total	7124	4990	4210	4305	4446	5659	6229	7220

Entering Data into WARM

- Enter the data into WARM to estimate the difference in energy and GHG emissions from moving to different management practices.
- Using Costco data, we will demonstrate two scenarios for annual waste generation:



Packaging Waste Disposal

Amount: 5.71 tons of mixed plastics

Baseline: 100% landfilled

Alternative: 100% recycled



Food Waste Disposal

Amount: 108.43 tons of fruits and vegetables
28.81 tons of bread

Baseline: 100% landfilled

Alternative: 50% composted
25% source reduced
25% landfilled



Packaging Disposal Scenario – Baseline and Alternative Scenarios

- To enter the data, open the Excel version of the WARM model and click on the “Analysis Inputs” tab. The left section of columns represents the baseline management scenario. The right section of columns shows the alternative management scenario.

Version 13

Waste Reduction Model (WARM) -- Inputs

Use this worksheet to describe the baseline and alternative MSW management scenarios that you want to compare. The blue shaded areas indicate where you need to enter information.

- Describe the baseline generation and management for the MSW 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.
- Describe the alternative management scenario for the MSW materials generated in the baseline. Any decrease in generation should be entered in the Source Reduction column. Any increase in generation should be entered in the Source Reduction column as a negative value. (Make sure that the total quantity generated equals the total quantity managed.)

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Generated	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Mixed Paper (general)				NA	0.0					NA
Mixed Paper (primarily residential)				NA	0.0					NA
Mixed Paper (primarily from offices)				NA	0.0					NA
Mixed Metals				NA	0.0					NA
Mixed Plastics		5.7		NA	5.7		5.7			NA
Mixed Recyclables				NA	0.0					NA
Food Waste	NA				0.0	NA	NA			
Mixed Organics	NA				0.0	NA	NA			

User's Guide | **Analysis Inputs** | Summary Report (MTCO2E) | Analysis Results (MTCO2E) | Summary Report (energy) | Analysis Results (energy) | Summary Report (MTCE) | Analysis Results (MTCE)

Packaging Disposal Scenario – Data Input

- Enter the short tons of Mixed Plastics landfilled under the baseline scenario in the “Tons Landfilled” column and the short tons recycled under the alternative scenario in the “Tons Recycled” column. The total weight of waste under both scenarios must equal each other as shown in the “Tons Generated” column.

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Waste Reduction Model (WARM) -- Inputs

Use this worksheet to describe the baseline and alternative MSW management scenarios that you want to compare. The blue shaded areas indicate where you need to enter information.

1. Describe the baseline generation and management for the MSW 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 MSW materials generated in the baseline. Any decrease in generation should be entered in the Source Reduction column. Any increase in generation should be entered in the Source Reduction column as a negative value. (Make sure that the total quantity generated equals the total quantity managed.)

Material	Tons Recycled	Tons Landfilled	Tons Comusted	Tons Composted	Tons Generated	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Comusted	Tons Composted
Mixed Paper (general)				NA	0.0					NA
Mixed Paper (primarily residential)				NA	0.0					NA
Mixed Paper (primarily from offices)				NA	0.0					NA
Mixed Metals				NA	0.0					NA
Mixed Plastics		5.7		NA	5.7		5.7			NA
Mixed Recyclables				NA	0.0					NA
Food Waste	NA				0.0		NA			
Mixed Organics	NA				0.0	NA	NA			

Packaging Disposal Scenario – Results

- To view the GHG emissions results, click on the “Summary Report (MTCO₂E)” tab. The model displays the baseline emissions and alternative emissions based on the user inputs. It also calculates the change in GHG emissions between the baseline and alternative scenarios.
- Diverting 5.71 short tons of Mixed Plastic from landfilling to recycling leads to a reduction in GHG emissions of 6 metric tons of CO₂ equivalent (MTCO₂E).

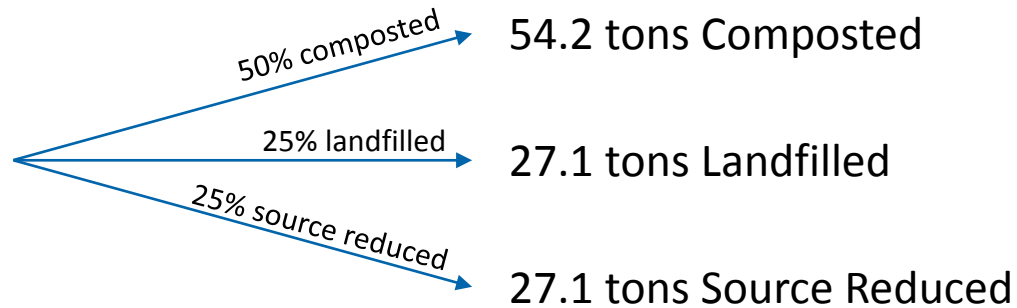
Baseline Emissions						Alternative Emissions						Change in Emissions	
GHG Emissions Analysis -- Summary Report Version 13 GHG Emissions Waste Management Analysis for Prepared by: Project Period for this Analysis: 01/00/00 to 01/00/00 <i>Note: If you wish to save these results, rename this file (e.g., WARM-MN1) and save it. Then the "Analysis Inputs" sheet of the "WARM" file will be blank when you are ready to make another model run.</i>													
GHG Emissions from Baseline Waste Management (MTCO ₂ E): 0						GHG Emissions from Alternative Waste Management Scenario (MTCO ₂ E): (6)							
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO ₂ E	Material	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO ₂ E	Change (Alt - Base) MTCO ₂ E
Mixed Plastics	-	5.7	-	NA	0.2	Mixed Plastics	-	5.7	-	-	NA	(6)	(6)

Navigation: User's Guide | Analysis Inputs | **Summary Report (MTCO₂E)** | Analysis Results (MTCO₂E) | Summary Report (energy) | Analysis Results (energy) | Summary Report (MTCE) | Analysis

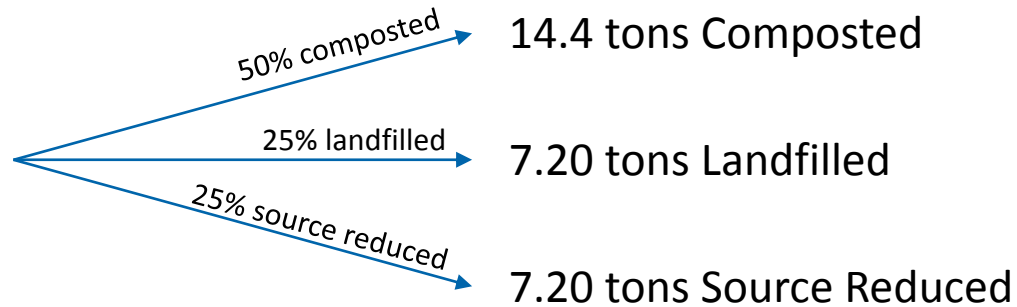
Food Waste Disposal Scenario

- After recording baseline food waste generation data with all waste landfilled, we assume an alternative scenario where 50% of food waste is composted, 25% is source reduced, and the remaining 25% is landfilled.

108.4 tons of Fruits and Vegetables



28.8 tons of Bread



Food Waste Disposal Scenario – Data Input

- On the “Analysis Inputs” tab, enter the short tons of food waste landfilled under the baseline scenario in the “Tons Landfilled” column and the short tons source reduced, landfilled, and composted under the alternative management scenario in the “Tons Source Reduced”, “Tons Landfilled” and “Tons Composted” columns.

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Waste Reduction Model (WARM) -- Inputs

Use this worksheet to describe the baseline and alternative MSW management scenarios that you want to compare. The blue shaded areas indicate where you need to enter information.

1. Describe the baseline generation and management for the MSW 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 MSW materials generated in the baseline. Any decrease in generation should be entered in the Source Reduction column. Any increase in generation should be entered in the Source Reduction column as a negative value. (Make sure that the total quantity generated equals the total quantity managed.)

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Generated	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Beef	NA				0.0		NA			
Poultry	NA				0.0		NA			
Grains	NA				0.0		NA			
Bread	NA	28.8			28.8	7.2	NA	7.2		14.4
Fruits and Vegetables	NA	108.4			108.4	27.1	NA	27.1		54.2
Dairy Products	NA				0.0		NA			
Yard Trimmings	NA				0.0	NA	NA			
Grass	NA				0.0	NA	NA			

Food Waste Disposal Scenario – Results

- To view the GHG emissions results, click on the “Summary Report (MTCO₂E)” tab.
- Diverting a portion of food waste from landfilling to composting and source reduction leads to a reduction in GHG emissions of 101 MTCO₂E.

Baseline Emissions

Alternative Emissions

Total Emissions Reductions

GHG Emissions Analysis -- Summary Report

Version 13
 GHG Emissions Waste Management Analysis for
 Prepared by:
 Project Period for this Analysis: 01/00/00 to 01/00/00
Note: If you wish to save these results, rename this file (e.g., \AFM-MN) and save it. Then the "Analysis Inputs" sheet of the "\AFM" file will be blank when you are ready to make another model run.

GHG Emissions from Baseline Waste Management (MTCO₂E):

98

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO ₂ E
Bread	NA	28.8	-	-	20.5
Fruits and Vegetables	NA	108.4	-	-	77
					0
					0
					0
					0

GHG Emissions from Alternative Waste Management Scenario (MTCO₂E):

(3)

Material	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO ₂ E
Bread	7.2	NA	7.2	-	14.4	(2)
Fruits and Vegetables	27.1	NA	27.1	-	54.2	(1)
						0
						0
						0
						0

Change (Alt - Base) MTCO ₂ E
(22)
(78)
0
0
0
0

Total Change in GHG Emissions (MTCO₂E):

(101)

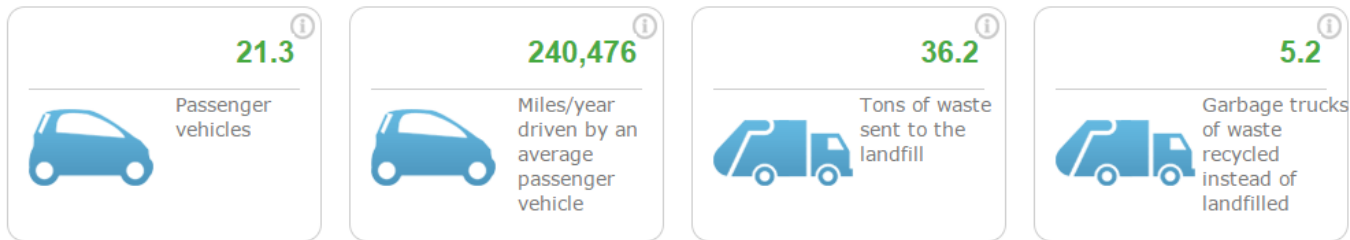
(101)

Note: a negative value (i.e., a value in parentheses) indicates an emission reduction; a positive

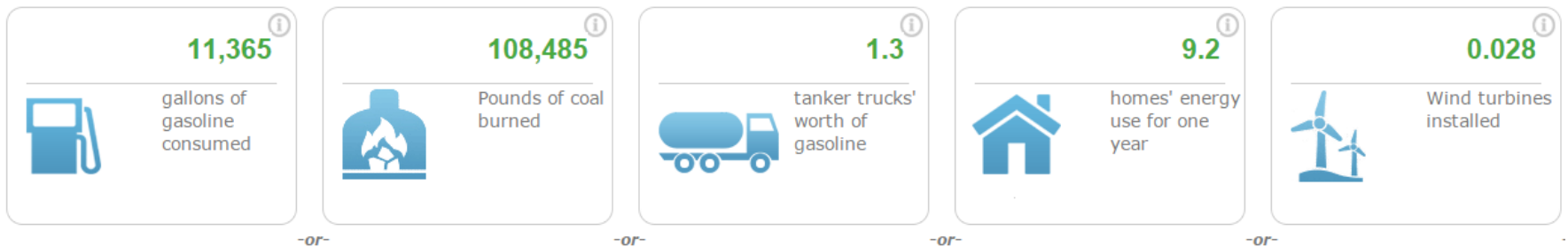
Greenhouse Gas Equivalencies

- Once you have calculated the emissions reductions results, use EPA's [Greenhouse Gas Equivalencies Calculator](#) to put the results in context.
- Taking the results from our food waste scenario, the annual greenhouse gas emissions calculated are the equivalent of:

Annual greenhouse gas emissions from



CO₂ emissions from



Key Points

- WARM allows the user to quantify the energy and GHG emissions from different materials management scenarios
- The Greenhouse Gas Equivalencies Calculator can help the user communicate the impact in units more relevant to a general audience.
- In the case of comparing Costco's annual data to its baseline data, reducing a portion of their food waste generated and diverting a portion from landfilling to composting decreases their annual emissions by 101 MTCO₂e, which is equivalent to the annual GHG emissions from 21.3 passenger vehicles

Future Updates to WARM

- EPA is currently developing methods for modeling anaerobic digestion and food donation in WARM

Questions?

