Generating Material-Specific Emission Factors from WARM for the Diversion Potential and Greenhouse Gas Emissions Reduction Analysis or Zero Waste Analysis Tool

What are Emission Factors?

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.[1] For the Zero Waste Analysis Tool, the pollutant is carbon dioxide or the equivalent, and the activity is either production, source reduction, recycling, landfilling, combustion, composting, and anaerobically digested. The factors are generated from the US EPA WARM Tool[2] (current version is 15),[3] showing greenhouse (GHG) emissions (produced or reduced) based on 1 ton of materials managed in different ways. GHG emissions produced are a positive number, and GHG emissions reduced or saved are negative or shown using parentheses (). There are 60 materials in the WARM Tool, and the GHG emissions in WARM are modeled as one metric ton of carbon dioxide equivalent (MTCO2E).

For the Zero Waste Analysis, material-specific emissions are **generated** in the WARM Tool based on the type of destructive disposal,[4] location, and management at the facility (e.g., landfill gas recovery for energy or flare). See below for how to generate material-specific emissions. Then the material-specific emissions will be **calculated** based on the emissions generated and the destructive disposal pathway for the municipality. See below for how to calculate emission factors.

The emission factors needed for the Zero Waste Analysis are material specific (i.e., we need an emission factor for all the material types listed in a material characterization study, such as cardboard, PET, glass, etc.; thus, they are referred to as **material-specific emission factors** (for this document will refer to them as factors).

Since the Zero Waste Analysis is a scenario planning exercise, the factors show planning level changes (savings or reduction) in GHG emissions when Zero Waste initiatives (policies, programs, and infrastructure) are implemented. Therefore, the Zero Waste Analysis results show the amount of GHG emissions produced or reduced by material type. Those are added to show the total GHG emission saved after implementing all the Zero Waste initiatives.

Generating Material Specific Emissions

The emissions are generated by inputting destructive disposal specific information based on the baseline scenario in the WARM Tool in the ==Analysis Input== tab of the Excel file.[5] To generate the emission needed to calculate the material-specific emission factors, go to the ==Analysis Input== tab in the WARM version 15 Excel file.[6] Then scroll down to question 3 and choose the state where the incineration facility is located (e.g., Pennsylvania). If you know the distance to the incinerator facility, click *Provide Information* for 9a. Then in 9b, input the number of miles to the incinerator facility. If that is unknown, keep it at the national average.

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[1] US EPA Basic Information about Air Emission Factors
[2] US EPA WARM Tool
[3] US EPA WARM Tool Version 15
[4] Destructive disposal is either landfill or combustion, and it describes how the materials are managed in the municipality being analyzed in the baseline scenario.
[5] The following steps outline generating factors for incineration (combustion) and landfilling. When information is unknown, keep it at the national average.
[6] Current WARM Tool is Version 15 – click on Excel-Based Tool to download it.

There are many more customizable questions related to landfilling than incineration. If anything is unknown, leave it as *National Average*. To generate landfill emissions, go to the <mark>Analysis Input</mark> tab in the WARM version 15 Excel file,[7] and input the following information.

- Question 3 - Choose the state where the landfill facility is located (e.g., California).
- Question 4 - Keep as *Current Mix*
- Question 5 – If the landfill has Landfill Gas Recovery (LFG), choose *LFG Recovery*. If not, select *No LFG Recovery*. If unsure, choose *National Average*.
- Question 6 – If your landfill has gas recovery, choose the pathway for recovery – *Recover for energy* or *Flare*.
- Question 6b – If your landfill recovers gas, answer appropriately. Use the *Typical operations - DEFAULT* if you're unsure. Use the *California regulatory collection* option if your landfill is in California.
- Question 7 – Moisture conditions at the landfill – Choose *National average – DEFAULT* if this is unknown.
- Questions 8a and 8b – Refer to anaerobic digestion and generally don't apply to this analysis, so don't change from the default.
- Question 9a – If you know the landfill's distance, click *Provide Information*.
- Question 9b – Provide the number of miles to the landfill facility

The emission results are in the fourth tab (<mark style="background-color:#00FF00">Analysis Results MTCO2E</mark>) tab in the WARM Tool Excel file. These are the emissions you will use to calculate material-specific emission factors.

Calculating Material-Specific Emission Factors

Material-Specific Emission Factors (factors) are needed to evaluate the impact of how materials are managed with the new Zero Waste initiatives versus how they were managed in the current or baseline situation of landfilling or incineration. The factors are represented in metric tons of carbon dioxide equivalent (MTCO2E), showing the net benefits of source reduction and recycling or composting.

The factors needed for this analysis are source reduction and recycling or composting. Source reduction factors show an estimated change in emission (reduction) by material type for the materials associated with the initiative being analyzed. The source reduction factors show the amount of emissions per ton by material type that are reduced based on the amount of emissions produced when that material is created. In other words, when a Zero Waste initiative reduces a material from being made through a product policy (e.g., single-use plastic bag ban) or a reuse program (e.g., reusable foodware program), the results show an estimated reduction in GHG emission for the appropriate material types.

Calculating source reduction emission factors

The source reduction emission factor formula combines the emission associated with the destructive disposal type (e.g., landfilling or incineration) with the emissions associated with source reduction. This is the formula because, in this analysis, we want to know the emission saved when we alternate from the material going to destructive disposal (baseline scenario). Instead, it is source reduced (an alternative scenario).

Source Reduction Emissions Factor Formula for Glass (**Landfill**) = **(0.56) MTCO2E per ton**

(Source reduction emissions x 1 short ton/1 short ton) – (emissions from landfilled x 1 short ton/1 short ton) = Source Reduction Emissions Factor[8]

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[7] Current WARM Tool is Version 15 – click on Excel-Based Tool to download it.
[8] US EPA WARM Tool Emission Factor Calculations

Example: (-0.53 MTCO2E * 1 / 1) – (0.03 MTCO2E * 1 / 1) = -0.56 MTCO2E

Source Reduction Emissions Factor Formula for Glass (**Incineration**) = **(0.55) MTCO2E per ton**

(Source reduction emissions x 1 short ton/1 short ton) – (emissions from incineration x 1 short ton/1 short ton) = Source Reduction Emissions Factor

Example: (-0.53 MTCO2E * 1 / 1) – (0.02 MTCO2E * 1 / 1) = -0.55 MTCO2E

The recycling or composting emission factor formula combines the emissions associated with the destructive disposal type with the emissions associated with either recycling or composting (the material type dictates if it has a recycling or composting management pathway – e.g., PET plastic is recycled, and food waste is composted). This is the formula because, in this analysis, we want to know the emissions saved when we alternate from the material going to destructive disposal (baseline scenario). Instead, it is recycled or composted (alternative scenario).

Recycling Emissions Factor Formula Glass (**Landfill**) = **(0.30) MTCO2E** per ton

(Recycling emissions x 1 short ton/1 short ton) – (emissions from landfilled x 1 short ton/1 short ton) = Recycling Emissions Factor

Example: (-0.28 MTCO2E * 1 / 1) – (0.02 MTCO2E * 1 / 1) = -0.30 MTCO2E

Recycling Emissions Factor Formula for Glass (**Incineration**) = **(0.30) MTCO2E per ton**

(Recycling emissions x 1 short ton/1 short ton) – (emissions from incineration x 1 short ton/1 short ton) = Recycling Emissions Factor

Example: (-0.28 MTCO2E * 1 / 1) – (0.03 MTCO2E * 1 / 1) = -0.30 MTCO2E

Composting Emissions Factor Formula Food Waste (**Landfill**) = **(0.61) MTCO2E**

(Composting emissions x 1 short ton/1 short ton) – (emissions from landfill x 1 short ton/1 short ton) = Composting Emissions Factor

Example: (-0.12 MTCO2E * 1 / 1) – (0.55 MTCO2E *1 / 1) = (0.61) MTCO2E

Composting Emissions Factor Formula Food Waste (**Incineration**) = **0.0 MTCO2E**

(Composting emissions x 1 short ton/1 short ton) – (emissions from incineration x 1 short ton/1 short ton) = Composting Emissions Factor

Example: (-0.12 MTCO2E * 1 / 1) – (-0.12 MTCO2E *1 / 1) = 0.0 MTCO2E

Material-Specific Emissions Factors will be created for all material types modeled in WARM (there are 60). The ones used in your analysis will depend on the materials listed in the material characterization study used in the Zero Waste Analysis. Most material characterization studies include materials that WARM does not model. Proxies[9] can be used for some material types, but there will not be a factor available for some material types.

Zero Waste USA created this document to help users understand the factors used in the Zero Waste Analysis planning tool. This is a companion document to the Zero Waste Analysis Handbook. Contact amanda@zerowasteusa.org with questions.

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[9] Using WARM Emission Factors for Materials and Pathways Not in WARM