Waste Reduction Model (WARM) Tool

User's Guide

WARM version: 14 (March 2016) Software version: 1.5 Guide version: March 2018

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1. Introduction

The Waste Reduction Model (WARM) was created by the U.S. Environmental Protection Agency (EPA) to help solid waste planners and organizations estimate greenhouse gas (GHG) emission reductions from several different waste management practices. The purpose of this document is to provide guidance to WARM users in downloading, installing, and using the WARM Tool, including an overview of the tool's key functions and capabilities.

WARM calculates GHG emissions for baseline and alternative waste management practices, including source reduction, recycling, combustion, composting, anaerobic digestion, and landfilling. The model calculates emissions in metric tons of carbon dioxide equivalent (MTCO₂E) and metric tons of carbon equivalent (MTCE) across a wide range of material types commonly found in municipal solid waste (MSW). Moreover, results of energy consumption in million British thermal unit (million BTU) are also calculated. The user can construct various scenarios by simply entering data on the amount of waste handled by material type and by management practice. WARM then automatically applies material-specific emission factors for each management practice to calculate the GHG emissions and energy use of each scenario. Several key inputs, such as landfill gas recovery practices and transportation distances to MSW facilities, can be modified by the user.

The GHG emission factors used in WARM are based on a life cycle perspective. The model documentation describes this methodology in detail. The WARM model was implemented in the free, open source life-cycle assessment (LCA) software called openLCA. The resulting openLCA database is used for the calculation of impacts in the WARM Tool described in this guide. The WARM version implemented in this software is WARM v14 (March 2016).

2. Installation

There are versions of the WARM Tool available for Windows (64 bit and 32 bit upon request) and Mac (64 bit and 32 bit upon request). In all cases, the tool is provided in a compressed file (*.zip, *.gz), which should be first downloaded and then its content extracted (i.e., right click on the file \rightarrow Extract...).

A folder "WARM" will be then generated. The file "WARM.exe" contained in it should be run to get the application started.



2.1 Hardware and software requirements

Hardware:

- 1 GB RAM
- 140 MB (Windows), 64 MB (Mac) free hard disk space

Software:

• Microsoft Visual C++ Runtime v10 needs to be installed on Windows 64 bit because the WARM Tool contains a browser engine for the display of modern HTML pages that requires this runtime. If you have not installed it before running the tool, a message like in Figure 2 would be shown. You can download this runtime <u>here</u>.

Warm cont	ains a browser engine for the display of modern
HTML page	s. It requires the Microsoft Visual C++ Runtime v10
to be instal case on you install this r	ed on Windows 64bit which seems to be not the ir system. In order to run WARM, it is necessary to untime.
Do not	how this message again



3. First start and overview

When first running WARM, the Home page is shown providing some information and tips about the tool.

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File	
	_
2 Home #	0
Waste Reduction Model (WARM)	
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.	
Use this program 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 list.	
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. 	
Report:	
 After clicking "Get started", fill out the baseline and alternative scenario tables on the page "Scenarios" as well as the information on the page "Further Characteristics", then select the "Calculation" button to create a summary of your project. The inputs in the "General information" tab are optional and may be used to customize your summary report. 	
Get Started	
Figure 3. Home tab	

If you click the button "Get Started", a new tab "Data Entry" appears, where the data for the analysis should be entered by the user. This tab consists of four steps: Scenarios, Further Characteristics, General Information and Calculation. You can navigate through them by clicking on the buttons on the top of the tab or on the "Back"/ "Next" buttons on the bottom of the page. You can also use the scrollbar in the right of the window to see the full content of each page. Detailed information about the "Data Entry" tab is provided in section 4 of this guide.

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S "Data Entry - Unsaved 25												
Waste R	Reduction	Mode	el (WA	RM)								
enarios -		2 Further Cl	haracteristics		3	General Informa	tion		4 Ca	cutation		
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ne Seenstie: Describe the h	aceline generation and	mananamant fo	r tha LICUI mater	risis listed balaur	If the material is a	ont nanocrated in	unit controlinity	or unu do not u	ant to analyze it	Issue if so 0		
he scenario: Describe the b	aseine generation and	management to	r the MSVV mater	nais isted below	in the material is r	iot generated in	your community	or you do not w	ant to analyze it	, leave it as 0.		
ative Scenario: Describe the	e alternative managemer	nt scenario for t	the MSW material	als generated in t	the baseline.							
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h input row will be validate	to sum up correctly	. The tons gen	erated in the b	e Tons Generate	rio must match ti d column, is equa	to the sum of to	ited in the alte	e Alternative Sci	enario columns.	For example, if the	he Baseline Sce	nario assumes
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h input row will be validate wis valid if the sum of tons er 100 tons of aluminum cans at	ed to sum up correctly Intered in the Baseline Sc re landfilled, this is the T	. The tons gen enario columns ions Generated	erated in the b , as shown in the value. To genera Baseline Scenai	paseline scenar e Tons Generate ate valid results, rito	rio must match ti d column, is equal all values entered	he tons genera to the sum of to t in the Alternativ	ted in the alte	e Alternative Scenar e Alternative Sc umns must add	io, enario columns, up to 100 tons tr Alternati	For example, if the original the Tons is t	he Baseline Sce Generated valu	nario assumes 9
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h input row will be validate wite valid if the sum of tons ex 100 tons of aluminum cans a Material Aluminum Cans Aluminum Ingot Steel Cans Copper Wire Glass HDPE	ter do sum up correctly intered in the Baseline Sc re landfiled, this is the T Tons Recycled 0 0 0 0 0 0 0 0 0 0 0 0 0	The tons gen cenario columns cons Generated Tons Landfilled 0 0 0 0 0 0 0	erated in the b as shown in the value. To general asseline Scenar Combusted 0 0 0 0 0 0	rio Tons Generate ate valid results, Tons Composted N/A N/A N/A N/A N/A N/A N/A	tio must match til d column, is equal all values entered Tons Anaerobically Digested N/A N/A N/A N/A N/A N/A N/A N/A N/A	to the sum of to in the Atternativ Generated 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Tons Source Reduced 0 0 0 0 0	e Alternative scenar e Alternative Sc umns must add i Tons Recycled 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	e. enario columns. up to 100 tons tr Atternati Tons Landfilled 0 0 0 0 0 0	For example, if the equal the Tons in the Scenario Tons Combusted 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Tons Composed N/A N/A N/A N/A N/A N/A N/A	Tons Anaerobica Digested N/A N/A N/A N/A N/A



Several "Data Entry" tabs can exist at the same time in the software (i.e., various assessments); for creating new ones, just go to the Home tab and click "Get Started". If you had closed it, you can open it again by clicking on the icon in on the toolbar.

After the calculation for the entered data is finalized, results will be shown in a new tab "Report". Detailed information about the results analysis is provided in section 5 of this guide.

It is also possible to save the data entered in the "Data Entry" tab for future assessments, as explained in section 6 of this guide.

4. Data entry

4.1. Generate scenarios

Baseline and alternative scenarios can be constructed by simply entering data on the amount of waste handled by material type and by management practice. There are fifty-four <u>material</u> <u>types</u> (rows) and six management practices available (columns): recycling, landfilling, combustion, composting, anaerobic digestion, and source reduction. This last practice is only included in the "Alternative Scenario", and refers to the decrease in waste generation compared to the waste handled in the baseline scenario.

There is an additional column "Tons generated" which is automatically updated by the tool and represents the total amount of waste handled in the baseline scenario, per material type. If data is introduced only for the alternative scenario, this field will remain as "0".

It is not necessary to enter data for all materials and management practices, only for those relevant for your assessment. When no data is added in a specific cell, the value remains as "0". In addition, not all management practices are available for all material types (e.g., food waste cannot be recycled). In those cases, "N/A" is written in the correspondent cell and no data can be entered by the user.

When scrolling down in the page view, the headers of the table columns will not be visible anymore. However, tooltips are available when typing in or hovering over each cell with information about the corresponding scenario and management practice.

		E	Baseline Scena	rio	
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested
Aluminum Cans	0	0	0	N/A	N/A
Aluminum Ingot	0 Base	scenario - Tons la	ndfilled 0	N/A	N/A
Steel Cans	0		0	N/A	N/A
Copper Wire	0	0	0	N/A	N/A
Glass	0	0	0	N/A	N/A
HDPE	0	0	0	N/A	N/A

Figure 5. Entering data on the "Scenarios" step of the "Data Entry" tab

The following requirements exist for entering the data:

- Amounts should be entered in short tons¹
- Only numbers can be entered (i.e., no formulas supported)
- "." should be used as decimal separator
- The total amount of waste handled in the baseline scenario has to equal the total amount of waste entered for the alternative scenario, per material. A validation is done for each material, and if there were divergences between the quantities generated in each scenario, that row is highlighted and an exclamation mark added to the left of the material's name.

			1	Baseline Scena	rio					Alternativ	/e 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
1	Aluminum Cans	0	20	10	N/A	N/A	30	10	50	10	10	N/A	N/A
	Aluminum Ingot	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
!	Steel Cans	0	20	0	N/A	NA	20	10	100	10	0	N/A	N/A
	Copper Wire	0	0	0	N/A	N/A	0	0	0	0	0	N/A	N/A
	Glass	75.5	15	0	N/A	N/A	90.5	10.5	75	5	0	N/A	N/A
!	HDPE	0	0	0	N/A	N/A	0	3	0	0	0	N/A	N/A

Figure 6. Error of validation for several materials in the "Scenarios" step (i.e., baseline total amount \neq alternative total amount)

Once the data have been entered, you can continue to the next step clicking "2. Further Characteristics" (top of the page) or "Next" (bottom of the page). You can also navigate to other sections, like heading directly to the calculation if you want the keep all default options in the next sections. If the "Scenarios" step is left without having fixed possible invalid entries (i.e., total baseline \neq total alternative), a warning message is displayed informing of the user that these amounts are not equal. The calculation can be run anyway, but the user should be aware of the existing differences in total quantities between scenarios.

E	皆 Waste F	Reduction Model	Warning	×					
E		2. Further Characteristic	The total quantity generated in the alternative scenario does not equal the total quantity managed in the baseline scenario for one or more		on		4 Calculation	on	
		Baseline Sc	materials. Please be aware that the			A	ternative Scen	ario	
	Material	Tons Tons Recycled Landfilled C	baseline and alternative scenarios w not be correct if you proceed.	10	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
1	Aluminum Cans	0 20	10 N/A 30		10	50	10	10	N/A

Figure 7. Warning message displayed if any material has invalid data entries

4.2. Further characteristics

Several key inputs affecting the GHGs and Energy results can be modified by the user. These are:

• Locations: they affect the emission factors for those management practices consuming/avoiding electricity. The specific regional grid mix is used depending on the state selected by the user in the drop-down menu. The value by default is "National Average".

¹ 1 short ton = 2,000 lbs = 907.18 kg

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1 Scenarios	2 Further	Characteristics		3 General Information		4 Calculation
✓ Locations						
In order to account for the avoided electri your location	city-related emissions	in the landfilling and co	mbustion pathw	vays, EPA assigns the appropria	ate regional "margina	" electricity grid mix emission factor based (
Please select state or national average	National Average	v				
Region location: National Average						

Figure 8. Locations options in "Further characteristics" section of the "Data Entry" tab

• Waste Transport Characteristics: the distances covered between the location where the waste was collected and the correspondent management facility can also be modified. The value by default is 20 miles. You can select the option "Define distance" to enter new values (also in miles).

Scenaros 2 Furth	er Characteristics 3 General Information	4 Calculation
Waste Transport Characteristics		
missions that occur during transport of materials to the management nanagement options.	facility are included in this model. You may use default transport distances, 20 mile	es, or provide information on the transport distances for the various MSW
Use default distance		
Define distance		
Management option	Default Distance (miles)	Defined Distance (miles)
Landfill	20	
Combustion	20	
Recycling	20	
Recycling Composting	20 20	

Figure 9. Waste transport options in "Further characteristics" section of the "Data Entry" tab

 Source reduction: you can decide whether the material that is source reduced would have been manufactured from the current mix of recycled and virgin materials or from 100% virgin materials. The option by default is "Current mix".

1 Scenarios	2 Further Characteristics	3 General Information	4 Calculation
✓ Source reduction			
To estimate the benefits from source mission reductions from source massumption you want to use in the 100% virgin inputs. Consequently,	te reduction, EPA usually assumes that the material that is source reduc doution under the assumption that the material would have been manuu analysis. Note that for materials for which information on the share of re the source reduction benefits of both the "Current mix" and "100% virgit	eed would have been manufactured from the current n factured from 100% virgin inputs in order to obtain an exycled inputs used in production is unavailable or is n n° inputs are the same.	nix of virgin and recycled inputs. However, you may choose to estimate the upper bound estimate of the benefits from source reduction. Select which not a common practice; EPA assumes that the current mix is comprised of
Current Mix			
100% Virgin			

Figure 10. Source reduction options in "Further characteristics" section of the "Data Entry" tab

- Landfill characteristics: you can determine the:
 - I) Type of landfill: there are four options available: No landfill gas (LFG) recovery, LFG recovery for energy, LFG recovery and flared, and a "National Average" type which calculates emissions based on the proportions of the other three types in 2012. Depending on the selection, the other two options for landfill characteristics will be modifiable or not. For instance, if "No LFG Recovery" is selected, there are no further options to be chosen. On the other hand, if "National Average" is selected, the option "III) Moisture Conditions and Decay Rates" is also modifiable.

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1 Scenarios	2 Further Characteristics	3 General Information	4 Calculation
❤ Landfill Characteristic	s (I, II, III)		
✓ I) Landfill Type			
The emissions from landfilling "National Average", which calc is in place at your landfill, select	depend on whether the landfill where your waste is disposed h ulates emissions based on the proportions of landfills with LFG ct "LFG Recovery" and click one of the indented buttons to indi	as a landfill gas (LFG) control system. If yo 3 control in 2012. If your landfill does not ha icate whether LFG is recovered for energy o	u do not know whether your landfill has LFG control, select we a LFG system, select "No LFG Recovery". If a LFG system or flared.
 National Average 			
No LFG Recovery			
LFG Recovery			
Recover for energy			
Flare			

Figure 11. Landfill type options in "Further characteristics" section of the "Data Entry" tab

II) Landfill Gas Recovery: only relevant if any "LFG Recovery" option has been chosen previously. It represents four different gas collection efficiencies throughout the life of the landfill: typical, worst-case, aggressive, and California regulatory collections. Assumptions made for each option are explained in the tool.

ocenanos	2 Further Characteristics	3 General Information		4 Calculation
LFG Recovery				
 Recover for energy 				
○ Flare				
 II) Landfill Gas Recovery 				
For landfills that recover gas, the landfill g	as collection efficiency will vary throughout the life	of the landfill. Based on a literature review of	of field measurem	nents and expert discussion, a range of
For landfills that recover gas, the landfill g collection efficiencies was estimated for a unique and a typical landfill is an approxi- aggressive gas collection scenario include are assumed to collect gas aggressively.	as collection efficiency will vary throughout the life series of different landfill scenarios. The "typical" I nation of reality. The worst-case collection scenario es landfills where the operator is aggressive in gas The California regulatory collection scenario allows	of the landfill. Based on a literature review of landfill is judged to represent the average U. o represents a landfill that is in compliance collection relative to a typical landfill. Biorea s users to estimate and view landfill manage	of field measurem S. landfill, althoug rith EPA's New S actor landfills, whi ment results base	nents and expert discussion, a range of gh it must be recognized that every landfill is ource Performance Standards (NSPS). The ich are operated to accelerate decomposition ed on California regulatory requirements.
For landfills that recover gas, the landfill g collection efficiencies was estimated for a unique and a typical landfill is an approxi- aggressive gas collection scenario include are assumed to collect gas aggressively. Typical operation - DEFAULT	as collection efficiency will vary throughout the life series of different landfill scenarios. The "typical" I nation of reality. The worst-case collection scenario es landfills where the operator is aggressive in gas The California regulatory collection scenario allows Landfill gas collection efficiency (%) assumptions	of the landfill. Based on a literature review of landfill is judged to represent the average U. o represents a landfill that is in compliance s collection relative to a typical landfill. Biorea s users to estimate and view landfill manage	of field measurem S. landfill, althoug ith EPA's New Si ictor landfills, whi ment results base	nents and expert discussion, a range of gh it must be recognized that every landfill is ource Performance Standards (NSPS). The ch are operated to accelerate decomposition ad on California regulatory requirements.
For landfills that recover gas, the landfill g collection efficiencies was estimated for a unique and a typical landfill is an approxi- aggressive gas collection scenario includ are assumed to collect gas aggressively. Typical operation - DEFAULT Worst-case collection	as collection efficiency will vary throughout the life series of different landfill scenarios. The "typical" I nation of reality. The worst-case collection scenario es landfills where the operator is aggressive in gas The California regulatory collection scenario allows Landfill gas collection efficiency (%) assumptions. Typical Years 0-1.0%, Years 2-4. 50%, Years 5-14	of the landfill. Based on a literature review of landfill is judged to represent the average U, or represents a landfill that is in compliance w collection relative to a typical landfill. Bioreas users to estimate and view landfill manage 4.75%; Years 15 to 1 year before final cover. 82.5%;	of field measurem S. landfill, althoug ith EPA's New Si ictor landfills, whi ment results base Final cover: 90%	nents and expert discussion, a range of gh it must be recognized that every landfill is ource Performance Standards (NSPS). The ch are operated to accelerate decomposition ad on California regulatory requirements.
For landfills that recover gas, the landfill g collection efficiencies was estimated for a unique and a typical landfill is an approxin aggressive gas collection scenario includ are assumed to collect gas aggressively. Typical operation - DEFAULT Worst-case collection Aggressive gas collection	as collection efficiency will vary throughout the life series of different landfill scenarios. The "typical" I nation of reality. The worst-case collection scenario the California regulatory collection scenario allows Landfill gas collection efficiency (%) assumptions Typical. Years 0-1, 0%, Years 2-4, 50%, Years 5-1 Worst-case: Years 0-4, 0%, Years 5-9, 50%, Years Aggresse: Year 0. 0%, Years 5-9, 50%, Years	of the landfill. Based on a literature review of landfill is judged to represent the average U. or represents a landfill that is in compliance w collection relative to a typical landfill. Bioreas s users to estimate and view landfill manage 4.75%; Years 15 to 1 year before final cover: 82.5%; s 10.14.75%; Years 15 to 1 year before final cover: 82. 14.75%; Sears 15 to 1 year before final cover: 82.	of field measurem S. landfill, althoug ith EPA's New Si ictor landfills, whi ment results base Final cover: 90% 2.5%, Final cover: 90%	nents and expert discussion, a range of gh it must be recognized that every landfill is ource Performance Standards (NSPS). The ich are operated to accelerate decomposition ed on California regulatory requirements.

- Figure 12. Landfill gas recovery options in "Further characteristics" section of the "Data Entry" tab
 - III) Moisture Conditions and Decay Rates: relevant if "National Average" or any "LFG Recovery" option has been selected as landfill type. You can select here between five moisture conditions and associated bulk MSW decay rates (k) the one which best represents the conditions in your assessed landfill. The options are: National Average, dry (k=0.02), moderate (k=0.04), wet (k=0.06) and bioreactor (k=0.12). A higher average decay rate means that waste decomposes faster in the landfill.

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1 Scenarios	2 Further Characteristics	3 General Information	4 Calculation
Is in place at your landfill, select "LFG Ko National Average No LFG Recovery EFG Recovery Recover for energy Flare	scovery" and click one of the indented buttons to indic	ate whether L+G is recovered for energy of π	area.
> II) Landfill Gas Recovery			
✤ III) Moisture Conditions and	Decay Rates		
Which of the following moisture condition describe the rate of change per year (yr-	ns and associated bulk MSW decay rate (k) most accurate (k) most accurate (k) for the decomposition of organic waste in landfills.	rately describes the average conditions at the A higher average decay rate means that wast	e landfill? The decay rates, also referred to as k values, e decomposes faster in the landfill.
 National Average - DEFAULT Dry (k = 0.02) Moderate (k = 0.04) Wet (k = 0.06) Biorecator (k = 0.12) 	Meisture condition assumptions Dry (x=0.02). Less than 20 inches of precipitation per Moderate (x=0.04). Between 20 and 40 inches of prec Wet (x=0.06). Greater than 40 inches of precipitation Bioreactor (k=0.12). Water is added until the moisture National average: Weighted average based on the sho	year pitation per year er year content reaches 40 percent moisture on a wet weight i re of waste received at each landfill type	basis

Figure 13. Moisture conditions and decay rates options in "Further characteristics" section of the "Data Entry" tab

- Anaerobic Digestion characteristics: you can determine the:
 - I) Digestion Type: You can select either wet or dry digestion based on your digester type. Note that for grass, leaves, branches, yard trimmings and mixed organics, wet digestion is not applicable based on current technology and practices in the United States. Therefore, dry digestion is the only digestion type modeled in WARM for these materials. Only one type of digestion process (wet or dry) can be modeled at a time in WARM.

✓ Anaerobic Digestion
✤ Digestion Type
For anaerobic digestion of food waste materials (including beef, poultry, grains, bread, fruits and vegetables, and dairy products), please choose the appropriate type of anaerobic digestion process used. Note that for grass, leaves, branches, yaid timmings and more organics, wel digestion is not applicable based on current technology and practices in the United States. Therefore, dry digestion is the only digestion type modeled in WARM for these materials. Only one type of digestion process (weld orly) can be modeled at a time in WARM.
Wet Digestion Dry Digestion
Figure 14: Digestion Type options in "Further characteristics" section of the "Data Entry" tab

 Digestate Curing: You can select that the digestate is cured before land application or not cured.

✓ Digestate Curing
WARM assumes that digestate resulting from anaerobic digestion processes will be applied to land. In many cases, the digestate is cured before land application When digestate is cured, the digestate is dewatered and any liquids are recovered and returned to the reactor (when using a wet digester), liest, the digestate is aerobically cured in turned windrows, then screened and applied to agricultural fields. Select whether the digestate resulting from your anaerobic digester () liest, the digestate is aerobically cured in turned windrows, then screened and applied to agricultural fields. Select whether the digestate resulting from your anaerobic digester () liest.
Cured - DEFAULT
Not Cured

Figure 15: Digestate Curing in "Further characteristics" section of the "Data Entry" tab

You can collapse or expand each of these sections by clicking on the section's header area.

4.3. General Information

This page is included with documentation purposes. You can include your organization's name, your name, the reporting period and a description of the assessment in the existing text fields. The data typed in here will be shown in the report generated after the calculation.

1 Scenarios	2 Further Ch	aracteristics	3 General Information	4 Calculation		Ĩ
The following input are optional a	and may be used to customize your	summary report.				
Organization:						
Name:						
Reporting period:	to					
Description:						
					Back	Next
Figure 16 "Cener	al Information" se	ction of the "C	ata Entry" tab			

4.4. Calculation

Three types of calculations can be performed in the WARM tool:

- GHGs emissions in metric tons of carbon dioxide equivalent (MTCO2E)
- GHGs emissions in metric tons of carbon equivalent (MTCE)
- Energy consumed in million BTU

1 Scenarios	2 Further Characteristics	3 General Information	4 Calculation
❤ Calculation Properties	S		
Please select the result output u	init:		
Metric Tons of Carbon Dioxid	de Equivalent (MTCO2E)		
 Metric Tons of Carbon Equiv. 	alent (MTCE)		
 Units of Energy (million BTU))		
You can return to this screen to	generate results with another output unit once the initial r	report has been generated.	



Figure 17. "Calculation" section of the "Data Entry" tab

After selecting the preferred calculation option, click on "Calculate" to get the results in a new tab "Report". You might need to wait a bit longer for the calculation to complete for the initial run.

5. Results

There are two sub-tabs within the "Report" tab created after the calculation: summary and analysis. They can be found in the bottom left corner of the "Report" tab.

Summary Analysis

Figure 18. Detail of tabs found at the bottom of the "Report" screen

How to interpret the results presented in them? If a GHG emission value is negative, it means that those emissions have been avoided during the management of that specific material type and/or scenario. Likewise, if an energy consumption is negative, it means that the modelled scenario avoids the consumption of that amount of energy. If the total change between the alternative and baseline scenario is negative, then the alternative scenario will result in fewer GHG emissions or energy consumption than the baseline, and vice versa.

Only those materials for which data has been entered on the "Scenarios" step will be presented in the results.

As in the "Scenarios" step, there are also tooltips for each cell/bar of the different results' tables containing information about the data displayed in them.

5.1. Summary

This sub-tab contains a table similar to the one in the "Scenarios" step but also includes the GHG emissions/Energy consumption per material and scenario. In addition, there is a column on the right side with the change between the two scenarios (i.e., Alternative minus Baseline) for the metric selected in the calculation properties.

Moreover, there are equivalencies in the bottom right of the page for the resulting total change. For example, WARM includes the amount of passenger vehicles' annual emissions equivalent to the total change in GHG Emissions. Depending on the sign of the total change, this equivalency will be presented as removal of annual emissions (if the sign is negative) or adding of emissions (if the sign is positive).



Figure 19. "Summary" sub-tab of the report

5.2. Analysis

This sub-tab contains four sections:

• Emission factors: this table contains the emission factors (in the selected metric) per relevant material type and management practice. The tons specified per material and management practice are multiplied by these factors to obtain the GHG emission/Energy consumption results.

Total GHG E Total GHG E Incremental	missions from Baseline MSW Generati missions from Alternative MSW Gener GHG Emissions (MTCO2E): -6.68	on and Management (MTCO2E ation and Management (MTCO2) -20.57 (E) -26.16			
MTCO2E = me	tric tons of carbon dioxide equivalent					
	and a second					
Emission fai	tors Emissions from Baseline			ve		
Material	GHG Emissions per Ton of Material Source Reduced (MTCO2E)	GHG Emissions per Ton of Material Recycled (MTCO2E)	GHG Emissions per Ton of Material Landfilled (MTCO2E)	GHG Emissions per Ton of Material Combusted (MTCO2E)	GHG Emissions per Ton of Material Composted (MTCO2E)	GHC Emissions per Ton of Material Anaerobically Digested (MTCO2E)
Glass	-0.53	-0.28	0.02	0.03	N/A	N/A
a) For explanatio	n of methodology see the EPAWARU Docum	aentation				

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

Figure 20. "Emission factors" section in the "Analysis" sub-tab of the report

• Emissions from Baseline: this table contains the tons managed and the resulting GHG emission/Energy consumption per relevant material and management practice, as well as the totals per material, for the baseline scenario.

Emission	factors E		Baseline Emis	sions from All	emative increm	nental Emissions	from Alternative					
Material	Baseline Generation of Material (Tons)	Baseline Recycling (Tons)	GHG Emissions from Recycling (MTCO2E)	Baseline Landfilling (Tons)	GHG Emissions from Landfilling (MTCO2E)	Baseline Combustion (Tons)	GHG Emissions from Combustion (MTCO2E)	Baseline Composting (Tons)	GHG Emissions from Composting (MTCO2E)	Baseline Anaerobic Digestion (Tons)	GHG Emissions from Anaerobic Digestion (MTCO2E)	Total GHG Emissions (MTCO2E)
Glass	90.50	75.50	-20.88	15.00	0.30	0.00	0.00	N/A	N/A	N/A	N/A	-20 57
a) For explan	ation of methodo	logy, see the El	NAWARM Documentation	on								

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

Figure 21. "Emissions from Baseline" section in the "Analysis" sub-tab of the report

• Emissions from Alternative: it contains the tons handled and the resulted GHG emission/Energy consumption per relevant material and management practice, as well as the totals per material, for the alternative scenario.

Emissio	n factors	Emissions Nom Bi	tseline Emissio	ns from Alterna	dive Increm	nental Emissio	as from Atternat	ive.						
Material	Baseline Generation of Material (Tons)	Alternative Source Reduction (Tons)	GHG Emissions from Source Reduction (MTCO2E)	Alternative Recycling (Tons)	GHG Emissions from Recycling (MTCO2E)	Alternative Landfilling (Tons)	GHG Emissions from Landfilling (MTCO2E)	Alternative Combustion (Tons)	GHG Emissions from Combustion (MTCO2E)	Alternative Composting (Tons)	GHG Emissions from Composting (MTCO2E)	Alternative Anaerobic Digestion (Tons)	GHG Emissions from Anaerobic Digestion (MTCO2E)	Total GHG Emissions (MTCO2E)
Glass	90.50	10.50	-5.52	75.00	-20.74	5.00	0.10	0.00	0.00	N/A	N/A	N/A	N/A	-26.16

a) For explanation of methodology, see the EPAWARM Documentation b) Emissions estimates provided by this model are intended to support voluntary GHG measurement and reporting initiatives.

Figure 22. "Emissions from Alternative" section in the "Analysis" sub-tab of the report

• Incremental Emissions from Alternative: it contains the differences between the alternative and baseline scenario regarding tons handled and GHG emissions/Energy consumption per relevant material and management practice, as well as the total incremental results per material.

Emissio	factors E	missions from Basel	ine Emission	s from Alternativ	e Incrementa	al Emissions from	Alternative						
Material	Source Reduction (Tons)	Incremental GHG Emissions from Source Reduction (MTCO2E)	Incremental Recycling (Tons)	Incremental GHG Emissions from Recycling (MTCO2E)	Incremental Landfilling (Tons)	Incremental GHG Emissions from Landfilling (MTCO2E)	Incremental Combustion (Tons)	Incremental GHG Emissions from Combustion (MTCO2E)	Incremental Composting (Tons)	Incremental GHG Emissions from Composting (MTCO2E)	Incremental Anaerobic Digestion (Tons)	Incremental GHG Emissions from Anaerobic Digestion (MTCO2E)	Total Incremental GHG Emission (MTCO2E)
Glass	10.50	-5.52	-0.50	0.14	-10.00	-0.20	0.00	0.00	N/A	N/A	N/A	N/A	-5.58

a) For expansion or metrodology, see the EPK Week Locamentation
 b) Emissions estimates provided by this model are intended to support voluntary GHG measurement and reporting initiatives



5.3. Report export

All the content of the "Report" tab can be exported as HTML by clicking on the icon d of the toolbar. The exported file can then be opened in any modern web browser. The only difference

with the view in the WARM Tool is that the report's sub-tabs, "Summary" and "Analysis", are included in the exported file as buttons in the top-right of the page.

Su	aste Reduc mmary Repo	tion Mod rt (MTCO2	el (WARN E)	1)								Summary Rep	ort Ar	nalysis Rep
GHG Emi GHG Emissions Prepared by: (na Project Period fo	SSIONS Analy Waste Management Ime) r this Analysis: (from	/sis - Sun Analysis for (or 1) to (to)	nmary Rep ganization)	port										
			Baseline	Scenario					Alt	ernative Scenar	io			
Aaterial	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	Chang (Alt- Base MTCO
ilass	75.50	15.00	0.00	N/A	N/A	-20.57	10.50	75.00	5.00	0.00	N/A	N/A	-26.16	-5.58
						20.57							-26.16	
 For explanation of) Emissions estimate http://doi.org/ 1/me-GHG-emission bite GHG emission bite G	methodology, see the EP is provided by this mode a results estimated in W I-Q emissions from the w 2-I-Q implications may as a as occurring all in one slues included in the box	A WARM Docume I are intended to su ARM indicate the fi aste management corue over the long year, but rather thin to the right were o	nlation upport voluntary GH ull life-cycle benefits pathways, (e.g., av sterm. Therefore, or ough time. eveloped based on	G measurement an wastle martagemen olded landfilling and se should not interp the EPA Greenhou	d reporting t alternatives. Due t increased rat the GHG te Gas		Total Change in I This is equivalen Removing annua Conserving 628 Conserving 202	GHG Emissions I to Il emissions fror Gations of Gast Cylinders of Pro	(MTCO2E): -5.1 n 1 Passenger \ line pane Used for F	sa Tehicles Iome Barbeques				

Figure 24. WARM Report exported as HTML opened in a web browser

6. Saving data

All the entered data and selected options from the "Data Entry" tab can be saved in a file with the extension *.warm and be opened again in the tool for further assessments. To do this, select "File" in the menu bar and choose between any of the existing options (i.e., "Save", "Save as", "Save all"). For opening an existing file, select the option "Open...". The files with extension *.warm can only be opened from within this WARM Tool.

8			
File			
Ľ	Open		$\left \right $
	Save	Ctrl+S	e
	Save As		
R	Save All	Ctrl+Shift+S	
	Close	Ctrl+W	
	Close All	Ctrl+Shift+W	
	Exit		

Figure 25. "File" menu options

The save/open functions are also available in the toolbar.

All the tabs that remain opened when closing the application will be displayed again the next time the tool is run. If you want to close permanently any tab, use the "Close" and "Close All" options of the "File" menu or click on the white cross in the right of the tab's header.

7. Other features

You can display several tabs at the same time in the tool by dragging and dropping the tabs into different positions in the window. Please, note that if the size of the window is too small, some elements might not be displayed properly (e.g., data entry tab).

of 22	۵.								
of 21									
									🟠 Home 🗧 🔁 "Data Entry - Unsaved 🔯
Su	laste l	Reduct y Repor	tion Mo	del (WA 2E)	RM)				Waste Reduction Model (WARM)
GHG En	nissio	ns Ana	lysis - S	ummary	Report				1 Scenarios
3HG Emission Prepared by:	ns Waste I (name)	Managemen	it Analysis for	(organization	n)				2. Further Characteristics
Project Period	d for this A	nalysis: (fro	om) to (to)						3. General Information
			Baselin	e Scenario					4 Calculation
aterial Re	Tons icycled L	Tons andfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total MTCO2E	Tons Source Reduced	Tons Recycled I	✓ Locations
ass 7	75.50	15.00	0.00	N/A	N/A	-20.57 -20.57	10.50	75.00	In order to account for the avoided electricity-related emissions in the landfiling and combustion pathways, El "marginal" electricity grid mix emission factor based on your location
or explanation Emissions esti	n of methods imates prov	ology, see the ided by this m	EPA WARM Doc	cumentation ed to support vol	luntary GHG	[Total Char	nge in GHG Er	Please select state or national average National Average Region location: National Average
he GHG emiss nagement alter	sions result matives. Dr	ts estimated i ue to the timin	n WARM indicati g of the GHG en	e the full life-cycl nissions from th	e benefits waste e waste		This is eq Removing	uivalent to annual emiss	❤ Waste Transport Characteristics
nagement path plications may a issions implica	hways, (e.g. accrue over ations as o	, avoided land the long-term courring all in	filling and incre a. Therefore, one one year, but rat	ased recycling), e should not inte ther through time	the actual GHG rpret the GHG b.		Conservin Conservin Barbeque	ig 628 Gallons ig 232 Cylinde s	Emissions that occur during transport of materials to the management facility are included in this model. You r miles, or provide information on the transport distances for the various MSW management options.
The equivalency eenhouse Gas I uivalencies. Adi	cy values inc Equivalence Iditional equi	luded in the t les Calculato ivalencies ca	iox to the right w r and are preser n be calculated	rere developed b nted as an exam using WARM res	ased on the EPA ple of potential suits at the	l			Use defauit distance Define distance
eenhouse Gas	Equivalenc	ies Calculato	r website or usir	ng alternative dal	ta sources.				Management option Default Distance (miles)

Figure 26. Display of two tabs simultaneously in WARM

8. Contact

If you have any feedback, comments or questions, please contact us.

9. Acknowledgments

WARM is developed by the U.S. EPA with support from GreenDelta, CSC, and ICF.

