EPA's Waste Reduction Model (WARM) and Recycled Content (ReCon) Tool

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Northeast Recycling Council (NERC) Webinar

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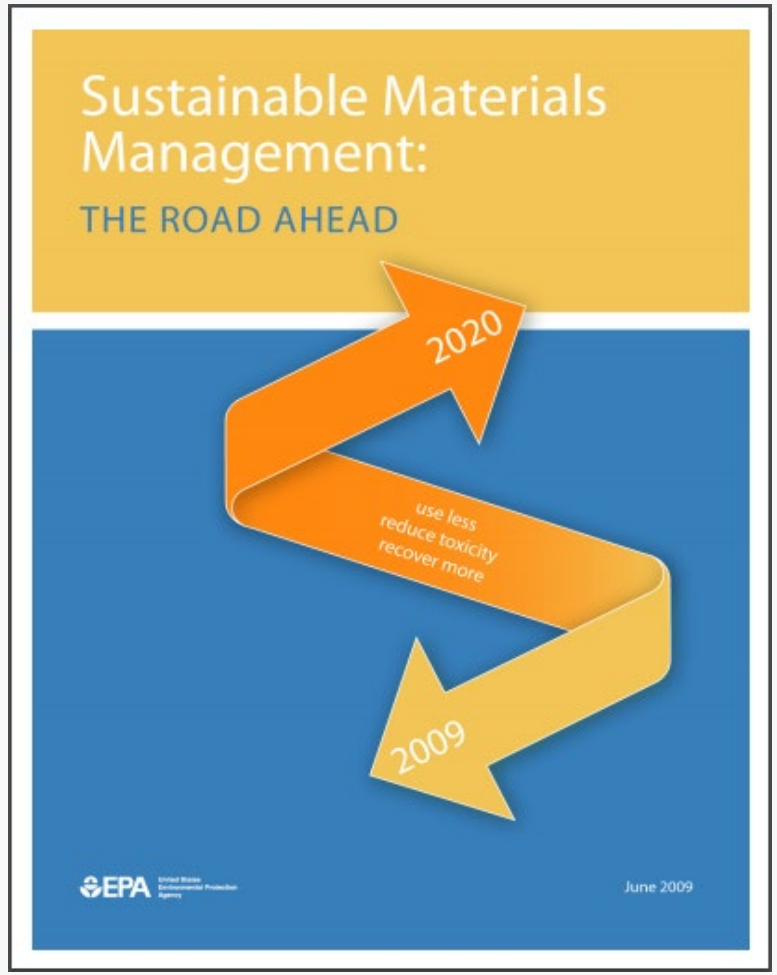
From Waste Management to Sustainable Materials Management



https://www.epa.gov/smm

WARM Overview

- WARM was created in 1998.
- **WARM version 15 is now available (updated November 2020).**
- 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 calculates the **economic impact** of some management practices.
- WARM has **60 materials** modeled (commonly found in MSW and C&D debris from paper to plastic to organics and building materials).

Who are the WARM stakeholders?

Municipal and state government employees

- How to plan, track, and make decisions about solid waste management

Students and educators

- Anywhere from elementary school to PhD

Industry groups

- Commodity/material specific groups provide data and use the tool

Waste reduction and waste management groups

- Composting council, recycling organizations, etc.

How to use WARM?

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 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 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	Tons Anaerobically Digested
Paper	Corrugated Containers				NA	NA	0.00					NA	NA
	Magazines/Third-class Mail				NA	NA	0.00					NA	NA
	Newspaper				NA	NA	0.00					NA	NA
	Office Paper				NA	NA	0.00					NA	NA
	Phonebooks				NA	NA	0.00					NA	NA
	Textbooks				NA	NA	0.00					NA	NA
	Mixed Paper (general)				NA	NA	0.00					NA	NA
	Mixed Paper (primarily residential)				NA	NA	0.00					NA	NA
	Mixed Paper (primarily from offices)				NA	NA	0.00					NA	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				
	Grains	NA					0.00		NA				
	Bread	NA					0.00		NA				
	Fruits and Vegetables	NA					0.00		NA				

WARM Analysis

1. Describe the baseline generation and management for the waste materials listed below.
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Paper	Corrugated Containers				NA	NA	0.00					NA	NA
	Magazines/Third-class Mail				NA	NA	0.00					NA	NA
	Newspaper		100.00		NA	NA	100.00		100.00			NA	NA
	Office Paper				NA	NA	0.00					NA	NA
	Phonebooks				NA	NA	0.00					NA	NA
	Textbooks				NA	NA	0.00					NA	NA
	Mixed Paper (general)				NA	NA	0.00					NA	NA
	Mixed Paper (primarily residential)				NA	NA	0.00					NA	NA
	Mixed Paper (primarily from offices)				NA	NA	0.00					NA	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				
	Grains	NA					0.00		NA				
	Bread	NA					0.00		NA				
	Fruits and Vegetables	NA					0.00		NA				
	Dairy Products	NA					0.00		NA				
Yard Trimmings	Yard Trimmings	NA					0.00	NA	NA				
	Grass	NA					0.00	NA	NA				
	Leaves	NA					0.00	NA	NA				
	Branches	NA					0.00	NA	NA				
Mixed Plastics	HDPE				NA	NA	0.00					NA	NA
	LDPE	NA			NA	NA	0.00		NA			NA	NA
	PET				NA	NA	0.00					NA	NA
	LLDPE	NA			NA	NA	0.00		NA			NA	NA

WARM Emissions Factors

Per Ton Estimates of GHG Emissions for Baseline and Alternative Management Scenarios

Material	GHG Emissions per Ton of Material Produced ($MTCO_2E$)	GHG Emissions per Ton of Material Source Reduced ($MTCO_2E$)	GHG Emissions per Ton of Material Recycled ($MTCO_2E$)	GHG Emissions per Ton of Material Landfilled ($MTCO_2E$)	GHG Emissions per Ton of Material Combusted ($MTCO_2E$)	GHG Emissions per Ton of Material Composted ($MTCO_2E$)	GHG Emission per Ton of Material Anaerobically Digested ($MTCO_2E$)
Corrugated Containers	5.58	(5.58)	(3.14)	0.18	(0.49)	NA	NA
Magazines/third-class mail	8.57	(8.57)	(3.07)	(0.43)	(0.35)	NA	NA
Newspaper	4.68	(4.68)	(2.71)	(0.85)	(0.56)	NA	NA
Office Paper	7.95	(7.95)	(2.86)	1.13	(0.47)	NA	NA
Phonebooks	6.17	(6.17)	(2.62)	(0.85)	(0.56)	NA	NA
Textbooks	9.02	(9.02)	(3.10)	1.13	(0.47)	NA	NA
Mixed Paper (general)	6.07	(6.07)	(3.55)	0.07	(0.49)	NA	NA
Mixed Paper (primarily residential)	6.00	(6.00)	(3.55)	0.02	(0.49)	NA	NA
Mixed Paper (primarily from offices)	7.37	(7.37)	(3.58)	0.11	(0.45)	NA	NA
Food Waste	3.66	(3.66)	NA	0.50	(0.13)	(0.12)	(0.04)
Food Waste (non-meat)	0.76	(0.76)	NA	0.50	(0.13)	(0.12)	(0.04)
Food Waste (meat only)	15.10	(15.10)	NA	0.50	(0.13)	(0.12)	(0.04)
Beef	30.09	(30.09)	NA	0.50	(0.13)	(0.12)	(0.04)
Poultry	2.45	(2.45)	NA	0.50	(0.13)	(0.12)	(0.04)
Grains	0.62	(0.62)	NA	0.50	(0.13)	(0.12)	(0.04)
Bread	0.66	(0.66)	NA	0.50	(0.13)	(0.12)	(0.04)

WARM Analysis

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.

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Make sure that the total quantity generated equals the total quantity managed.

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Paper	Corrugated Containers				NA	NA	0.00					NA	NA
	Magazines/Third-class Mail				NA	NA	0.00					NA	NA
	Newspaper		100.00		NA	NA	100.00		100.00			NA	NA
	Office Paper				NA	NA	0.00					NA	NA
	Phonebooks				NA	NA	0.00					NA	NA
	Textbooks				NA	NA	0.00					NA	NA
	Mixed Paper (general)				NA	NA	0.00					NA	NA
	Mixed Paper (primarily residential)				NA	NA	0.00					NA	NA
	Mixed Paper (primarily from offices)				NA	NA	0.00					NA	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				
	Grains	NA					0.00		NA				
	Bread	NA					0.00		NA				
	Fruits and Vegetables	NA					0.00		NA				
	Dairy Products	NA					0.00		NA				
Yard Trimmings	Yard Trimmings	NA					0.00	NA	NA				
	Grass	NA					0.00	NA	NA				
	Leaves	NA					0.00	NA	NA				
	Branches	NA					0.00	NA	NA				
Mixed Plastics	HDPE				NA	NA	0.00					NA	NA
	LDPE	NA			NA	NA	0.00		NA			NA	NA
	PET				NA	NA	0.00					NA	NA
	LLDPE	NA			NA	NA	0.00		NA			NA	NA

WARM Results

Waste Reduction Model (WARM) -- Results

Total GHG Emissions from Baseline MSW Generation and Management ($MTCO_2E$):	(84.61)
Total GHG Emissions from Alternative MSW Generation and Management ($MTCO_2E$):	(270.83)
Incremental GHG Emissions ($MTCO_2E$):	(186.21)

$MTCO_2E$ = metric tons of carbon dioxide equivalent

Waste Reduction Model (WARM) -- Results

Total Energy Use from Baseline MSW Generation and Management (million BTU):	6.75
Total Energy Use from Alternative MSW Generation and Management (million BTU):	(1,648.60)
Incremental Energy Use (million BTU):	(1,655.35)

BTU = British thermal unit

WARM Results

Waste Reduction

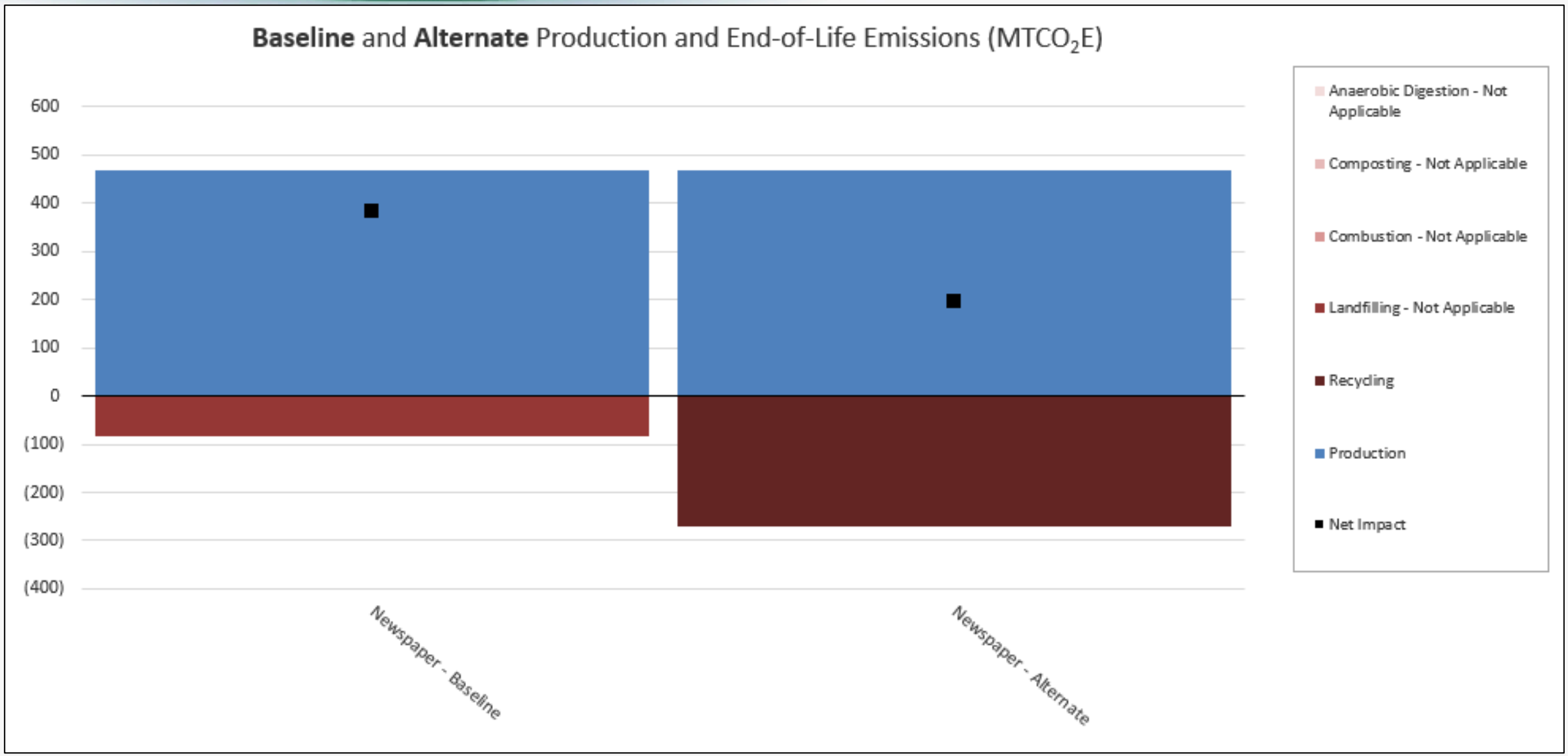
Total Employment from Baseline MSW Generation and Management (Labor hours):	137
Total Employment from Alternative MSW Generation and Management (Labor hours):	725
Incremental Employment (Labor hours):	588

Waste Reduction Model (WARM) -- Results

Total Wages from Baseline MSW Generation and Management ($):	$4,615.00
Total Wages from Alternative MSW Generation and Management ($):	$21,814.06
Incremental Wages ($):	$17,199.06

Waste Reduction Model (WARM) -- Results

Total Taxes from Baseline MSW Generation and Management ($):	$1,712.00
Total Taxes from Alternative MSW Generation and Management ($):	$6,537.93
Incremental Taxes ($):	$4,825.93


Baseline and Alternate Production and End-of-Life Emissions ($MTCO_2E$)
600
500
400
300
200
100
0
(100)
(200)
(300)
(400)
Newspaper - Baseline
Newspaper - Alternate
Anaerobic Digestion - Not Applicable
Composting - Not Applicable
Combustion - Not Applicable
Landfilling - Not Applicable
Recycling
Production
Net Impact

Next Steps on WARM

Future WaRM Enhancements:

- Model improvements
  - Wood flooring, soil carbon storage, food waste
- Economic impacts update
- Web-based user interface
- Addition of more environmental impact categories

https://www.epa.gov/warm

EPA's Recycled Content (ReCon) Tool

ReCon Tool

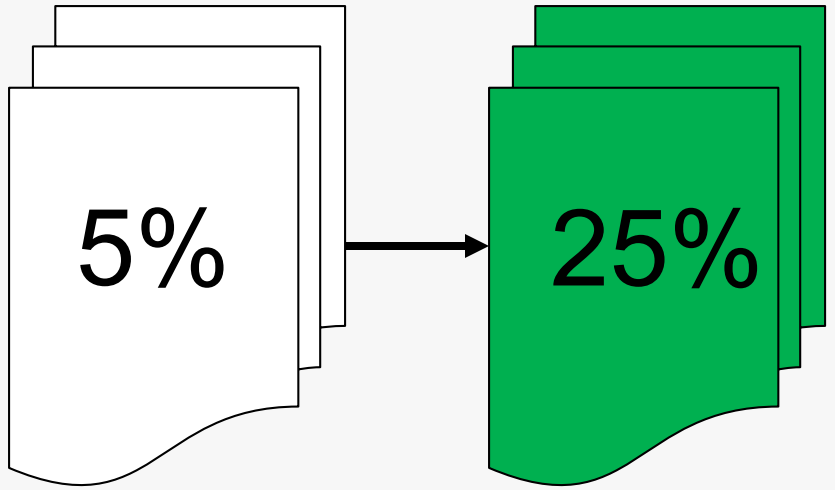
- ReCon = Recycled Content Tool
- Estimates environmental impacts from purchasing and/or manufacturing materials with post-consumer recycled content
- Uses a life-cycle perspective
- Updated with data from WARM, version 15

Data Needed to Use ReCon

- Amounts of Materials Purchased or Manufactured
- Baseline (or current) post-consumer recycled content (as a percentage) of each material
- Increase or change in the recycled content of materials purchased or manufactured that is to be evaluated by the tool

Example: Paper Purchasing

- Let's say our business:
  - Purchases 100,000 pounds of office paper each year
  - Current (baseline) recycled content: 5%
  - New (alternative) recycled content: 25%



- What are the GHG and energy benefits of making this change?

How to use the ReCon Tool

Step 1

- **Description of materials (optional)**
- **Amounts purchased in pounds (tons calculated automatically)**

Recycled Content (ReCon) Tool

View GHG Output | View Energy Output | Unit Converter

Material Purchased	Corresponding Material (or Surrogate)	Amount Purchased (pounds)	Amount Purchased (tons)	Example Materials for Which This Material can be Used as a Surrogate
	Aluminum Cans			Any type of aluminum product
	Aluminum Ingot			Ferrous and non-ferrous metals, iron
	Steel Cans			Electrical conductors, aluminum product cuttings, joinings and weldings, and consumer durable products
	Copper Wire			Electrical copper wire of varying gauges
	Glass			Glass-based products
	HDPE			HDPE
	PET			PET
	Corrugated Cardboard			Cardboard, boxboard, kraft paper

How to use the ReCon Tool

Step 1

- **Description of materials (optional)**
- **Amounts purchased in pounds (tons calculated automatically)**

	Corrugated Cardboard			Cardboard, boxboard, kraft paper
	Magazines/Third-class Mail			Coated paper
	Newspaper			Newspaper
	Office Paper	100,000	50	Office paper, high grade paper
	Phonebooks			Phonebooks
	Textbooks			Textbooks
	Dimensional Lumber			Any solid wood materials
	Medium-density Fiberboard			Fiberboard

How to use the ReCon Tool

Step 2

- **Baseline recycled content %**
- **Alternate recycled content %**

Step 2. Baseline and Alternate Recycled Content

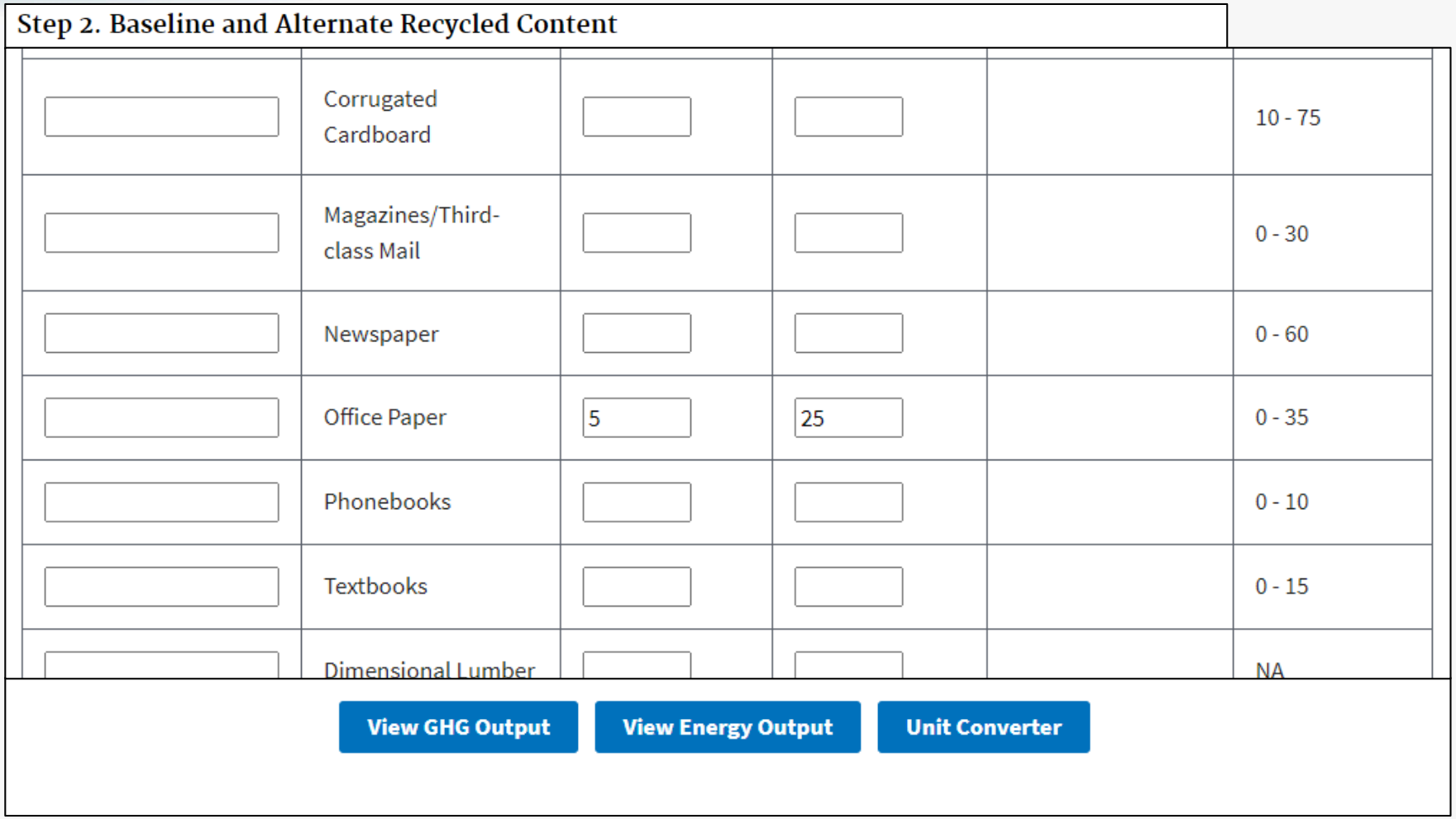
Material Purchased	Surrogate Material	Baseline Recycled Content (percent)	Alternate Recycled Content (percent)	Use Default for Baseline Recycled Content [set all]	Recycled Content Range (percent)
	Aluminum Cans				32 - 100
	Aluminum Ingot				0 - 100
	Steel Cans				20 - 50
	Copper Wire				0 - 10
	Glass				5 - 30
	HDPE				0 - 15

View GHG Output | View Energy Output | Unit Converter

How to use the ReCon Tool

Step 2

- **Baseline recycled content %**
- **Alternate recycled content %**



ReCon Calculations – GHG Emissions

	MTCO2E	MTCE
The life-cycle greenhouse gas emissions for the baseline manufacturing scenario are:	**37.83**	**10.32**
The life-cycle greenhouse gas emissions for the alternate manufacturing scenario are:	**-5.71**	**-1.56**
The greenhouse gas benefit associated with increasing the fraction of recycled inputs is: Note: negative value indicates GHG emission reductions, i.e., benefit.	**-43.53**	**-11.87**
The greenhouse gas benefit in terms of passengar cars not driven for one year:	**9.24 cars**	

ReCon Calculations – Energy Consumption

The life-cycle energy consumption for the baseline manufacturing scenario is:	**1,822.16 MMBtu**
The life-cycle energy consumption for the alternate manufacturing scenario is:	**1,652.6 MMBtu**
The energy benefit associated with increasing the fraction of recycled inputs is: Note: negative value indicates energy savings, i.e., benefit.	**-169.55 MMBtu**
The energy benefit in terms of gallons of gasoline not consumed:	**1,407.63 Gallons**

Thanks! Questions?

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https://www.epa.gov/smm

https://www.epa.gov/warm

https://www.epa.gov/warm/recycled-content-recon-tool