

Emerging Waves: Sustainable Materials Management

Ron Vance

Chief, Resource Conservation Branch
U.S. Environmental Protection Agency

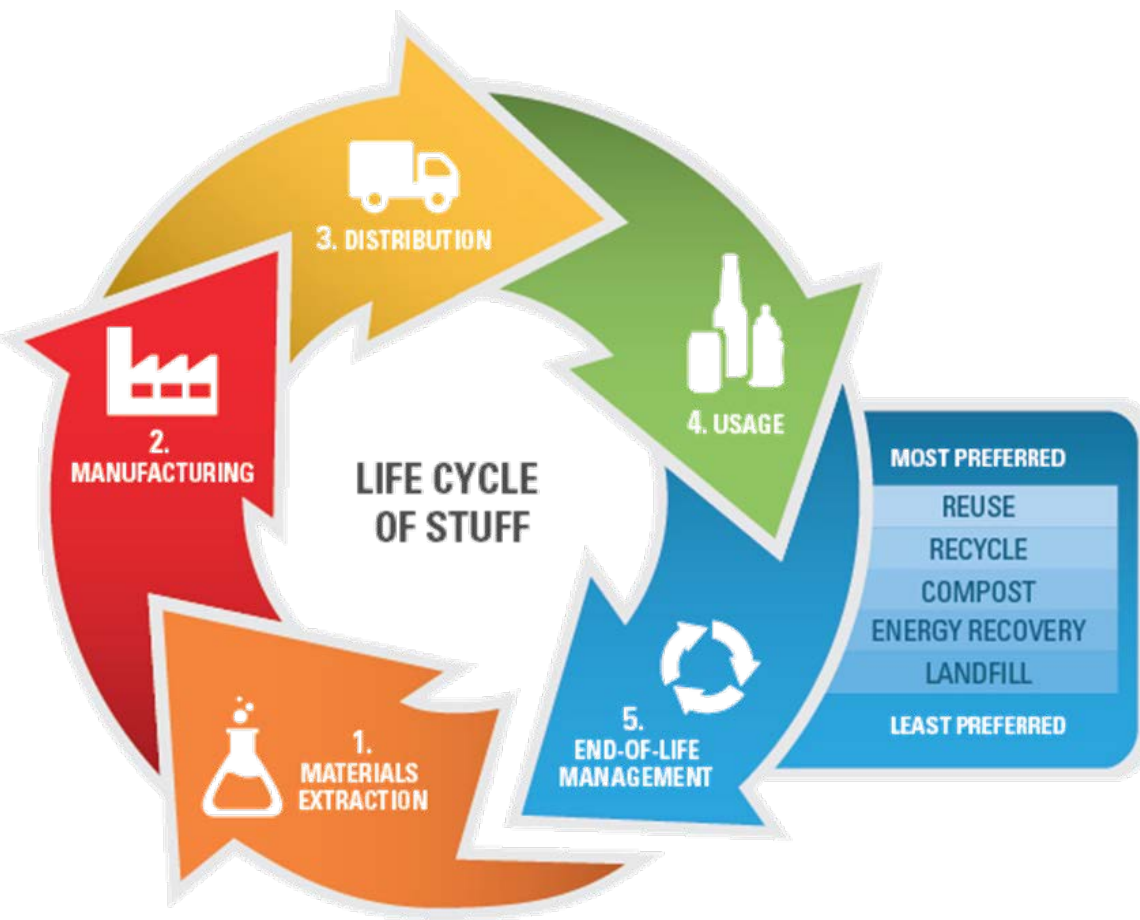
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What is Sustainable Materials Management (SMM)?



“An approach to serving human needs by using/reusing resources productively and sustainably throughout their life cycles, generally minimizing the amount of materials involved and all associated environmental impacts.”

Sustainable Materials Management: The Road Ahead, EPA (2009)



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Advantages of Life-Cycle Thinking

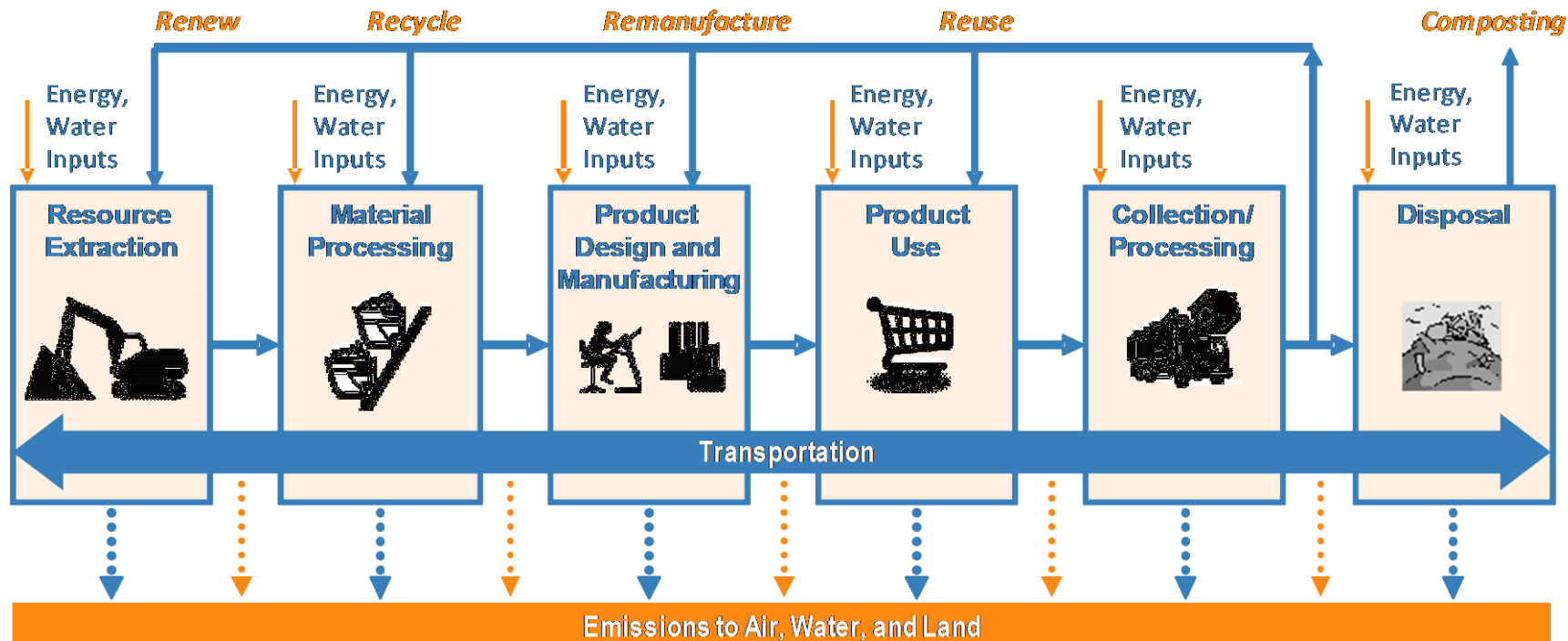
Life cycle information offers greater “return on investment.”

- Prioritizing and strategic planning.
- Challenging preconceived ideas about how materials can and should be managed avoiding unintended consequences.
- It’s not always about recycling or landfilling, it’s about finding the best use/place for the material.



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Material/Product Life Cycle



Where are the opportunities to extend material use?



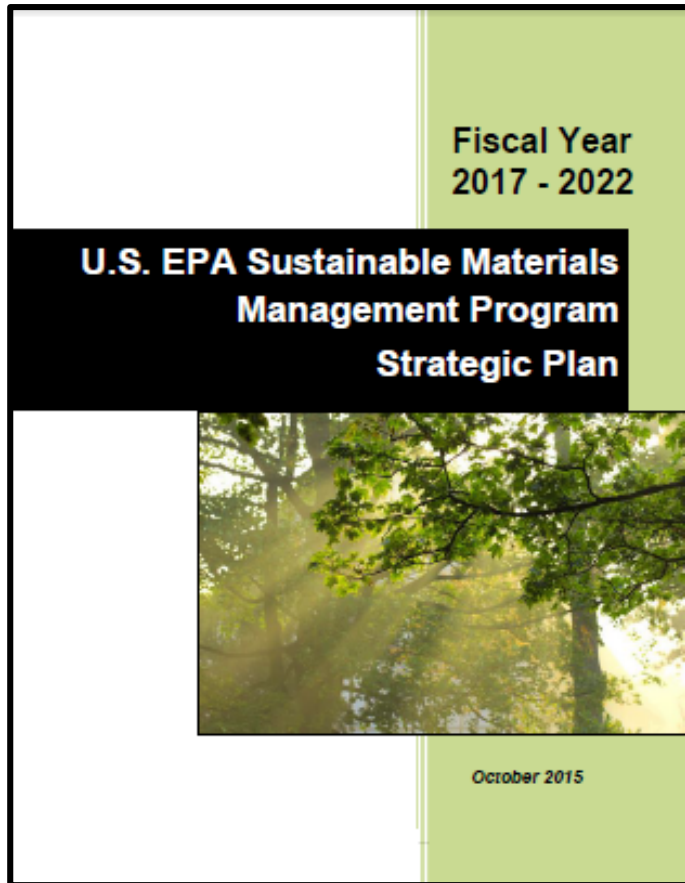
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Measuring SMM

U.S. Top Ten Most Impactful Goods and Services

Rank	Goods & Services	HCa n	HHNonC an	HHRes p	EcoTo x	GW'r m	OzDe pl	Smo g	Acid d	Eutr o	Energy	Lan d	Water	Matl	Waste	Rank Value
1	Electric power generation, transmis...	6.9	3.0	14.3	1.3	15.1	<1	11.7	15.8	1.2	12.8	<1	14.4	2.0	1.5	35.4
2	Residential permanent site single- ...	3.7	3.7	3.5	2.2	3.1	2.0	4.6	2.3	<1	4.1	5.9	1.6	16.1	9.2	22.0
3	Animal (except poultry) slaughterin...	<1	<1	2.8	<1	2.3	<1	1.1	3.9	4.3	1.1	15.4	3.2	<1	7.6	18.8
4	Poultry processing	<1	<1	<1	<1	<1	<1	<1	1.6	16.2	<1	1.3	1.1	<1	3.7	16.8
5	Waste management and remediation se...	6.0	6.6	<1	12.2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	15.2
6	Greenhouse, nursery, and floricultu...	<1	<1	3.3	<1	<1	14.1	<1	<1	<1	<1	<1	<1	<1	<1	14.5
7	Food services and drinking places	3.9	3.3	3.2	3.1	3.4	2.1	2.8	3.1	3.9	3.8	4.0	5.6	1.0	6.7	14.2
8	Light truck and utility vehicle man...	5.9	9.6	1.2	5.0	2.1	3.1	1.9	1.2	<1	1.7	<1	<1	<1	2.6	13.5
9	Retail trade	4.4	4.5	3.4	4.7	3.9	3.2	3.8	3.3	1.6	4.9	1.7	3.4	<1	3.7	13.4
10	Truck transportation	<1	<1	1.3	<1	<1	<1	8.9	3.0	<1	2.9	<1	<1	<1	<1	9.9

EPA's SMM Strategic Plan



- Built Environment (buildings, roads, bridges, infrastructure)
- Sustainable Management of Food
- Sustainable Packaging
- Sustainable Electronics Management
- Life Cycle Thinking
- Measurement
- International Efforts



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Advancing SMM Through Policies and Tools

- Applied Research
- Business Models
- Convening Stakeholders
- Procurement Practices
- Voluntary Standards (life-cycle based)
- Tools (WARM)




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WARM openLCA version 14

Goal: This update made the WARM Tool more standardized and interoperable with other LCA tools.


- New background database and user interface.
- Same functionality as WARM version 14.
- Flexible for future updates.



The Waste Reduction Model (WARM) tool and LCI database built on openLCA

Cristina Rodriguez¹, Wesley Ingwersen², Sebastian Greve³, Bobby Renz³, Tiffany Kollar²

¹GreenDelta GmbH, Muellerstrasse 136, 13368, Berlin, Germany, ²United States Environmental Protection Agency
NCF International, 630 Third Avenue, 11th Floor, New York, NY 10017



www.epa.gov/research


www.grendelta.com

What is WARM?

WARM calculates GHG emissions and energy consumption of waste management practices—source reduction, recycling, composting, anaerobic digestion and landfilling for 54 material types, including those commonly found in municipal solid waste, as well as others such as construction waste. The model calculates emissions in the following: metric tons of carbon dioxide equivalent (MTCO₂E), metric tons of carbon equivalent (MTC), and energy units (million BTU).

Who should use it?

- State and local governments,
- Solid waste planners,
- Students,
- Small businesses, and
- Other organizations interested in the energy and GHG impacts for materials management decisions.



WARM & openLCA

Goal: to make EPA life cycle tools more standardized and interoperable with LCA practice and tools. Method: The WARM spreadsheet was converted into an inventory database in openLCA. The LCI database is used in the background by a new standalone application.

The openLCA WARM database

- It includes over 1500 process data sets inventorying the GHG emissions and energy consumption from the 6 main waste management practices in the U.S. and the 54 materials considered in WARM.
- Electricity grid mixes are regionalized for different regions in the U.S.
- Exchanges are parameterized, if possible (>1000 different process and global parameters used).
- The effect of carbon storage in soils, forests, etc. in the overall GHG emissions is also inventoried.
- Different landfill characteristics are considered (i.e. landfill type, gas recovery, moisture conditions and decay rates), leading to over 20 different landfilling processes per relevant material in the database.
- Multiple scenarios can be compared using the database in openLCA.




Figure 1. Excerpt of WARM database in the navigation pane, openLCA 1.3

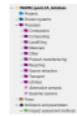
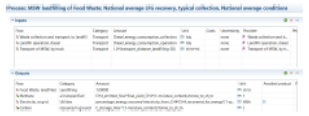


Figure 2. Input/Output in the process editor of MSW landfilling of Food Waste, openLCA 1.3



WARM standalone tool

1 Scenarios The user can define a baseline and alternative scenario including all or some of the 54 materials listed in the user-friendly UI.

Each input will be related to every scenario. The tool generates the baseline scenario used in the generation of the alternative scenario.

A table will list the input of the baseline scenario. Inputs to be used in the alternative scenario must include the amount of material used. Materials to be included in alternative Scenario: "Recycling", "Composting", "Anaerobic Digestion", "Energy Recovery", "Landfilling", "Source Reduction".

Material	Baseline Scenario				Alternative Scenario			
	Mass	Site	Location	Scenario	Mass	Site	Location	Scenario
Steel Appliances	0	0	0	MSW	0	0	0	MSW
Landfill	MSW	MSW	MSW	MSW	MSW	MSW	MSW	MSW
Other Organic	MSW	MSW	MSW	MSW	MSW	MSW	MSW	MSW

Figure 3. Excerpt of the "Scenario" tab of the WARM tool, showing 1 of the 54 materials included, and containing the amount of food waste per treatment and scenario used in the example.

Example: Impact of U.S. 2030 Food Loss & Waste Reduction Goal on GHG emissions and energy consumption

95% of the 37 million tons of food waste generated yearly in U.S. is discarded to landfills or incinerated. The effect of an alternative scenario with 50% of food waste source reduced, as aimed by the "U.S. 2030 Food Loss and Waste Reduction Goal", was assessed with the WARM tool. Default transport distances of 20 miles and National average electricity mix and landfill characteristics were used in both scenarios.

Comparison of GHG emissions between baseline and alternative scenarios

Scenario	Energy Intensity (MTCO ₂ E/ton)	Baseline Scenario				Alternative Scenario			
		MSW	MSW	MSW	MSW	MSW	MSW	MSW	MSW
Baseline	10000	10000	10000	10000	10000	10000	10000	10000	10000
Alternative	5000	5000	5000	5000	5000	5000	5000	5000	5000

Figure 4. Incremental GHG emissions from alternative scenario in MTCO₂E (i.e. negative values refer to avoided GHG emissions compared to baseline scenario).

2 Further characteristics Some settings of the model can be changed: location, transport distances, type of material source reduced (i.e. virgin, current mix), and landfill and anaerobic digestion characteristics.

3 Landfill Characteristics v.1.0

MSW Landfill Type

The emissions from landfilling depend on whether your waste is disposed into a landfill, a LFG collection system. For an incineration plant per landfill, the National average energy intensity and emissions depend on the operational conditions and the type of waste. The LCI database in openLCA is based on the "National Inventory" and the data of the United States Environmental Protection Agency (USEPA).

• National average
• No LFG Recovery
• LFG Recovery
• No Energy
• Energy

Figure 5. "Landfill type" options in the tab "Further characteristics" of the WARM tool

Change in Energy Use in the alternative scenario

Scenario	Energy Intensity (MTCO ₂ E/ton)	Baseline Scenario				Alternative Scenario			
		MSW	MSW	MSW	MSW	MSW	MSW	MSW	MSW
Baseline	10000	10000	10000	10000	10000	10000	10000	10000	10000
Alternative	5000	5000	5000	5000	5000	5000	5000	5000	5000

Figure 6. Excerpt of "Energy Analysis - Summary report" of the WARM tool

Energy saved: **2.35 million Households** **2.08 billion Gallons** **44.6 million Barrels of Oil**


Conclusions & Outlook

- The WARM tool includes a user-friendly UI and multiple result visualizations that facilitates the comparison of baseline and alternative scenarios using different waste management practices for 54 material types.
- By using the WARM LCI database in a LCA software like openLCA, users can benefit from additional features and analysis available in the software, as well as from combining it with other LCI databases.
- This new version of WARM is currently being updated to align with WARM v14 and will replace the former WARM web calculator on the EPA WARM website.

DISCLAIMER: The U.S. EPA through its Office of Research and Development collaborated in the research described here. It has not been subject to Agency review and does not necessarily reflect the views of the Agency. No official endorsement should be inferred.

U.S. Environmental Protection Agency
Office of Research and Development

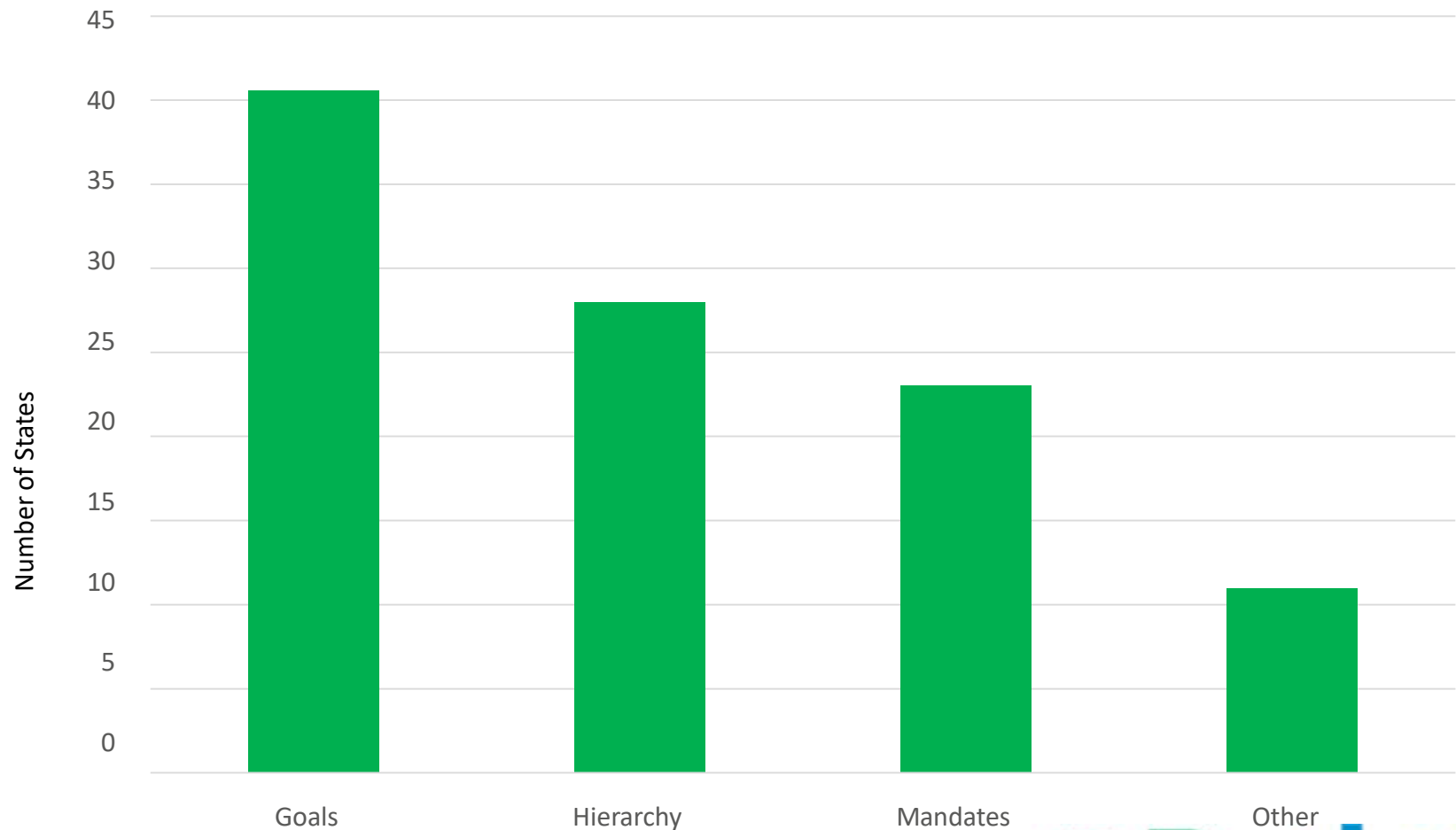
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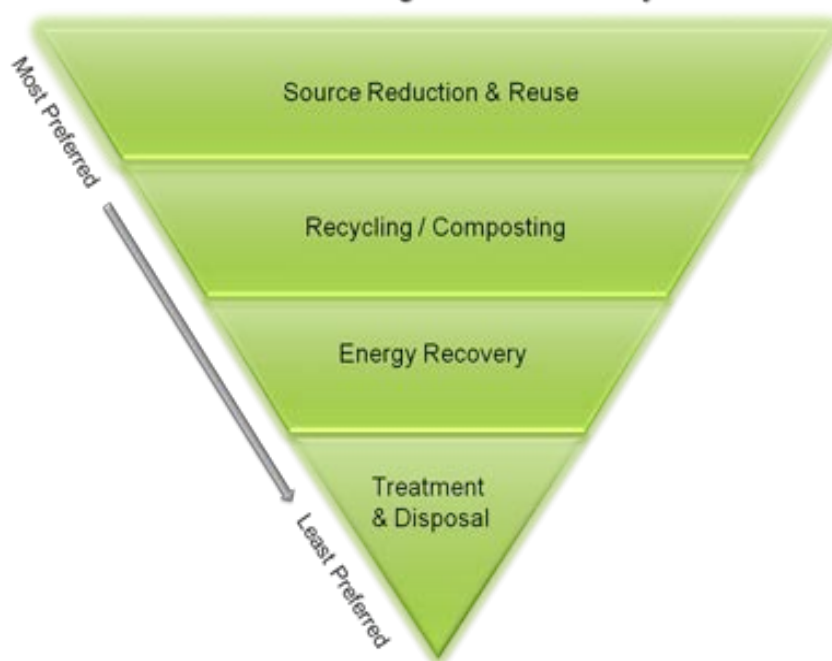
Key Drivers of State Programs



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Waste Hierarchy

Waste Management Hierarchy



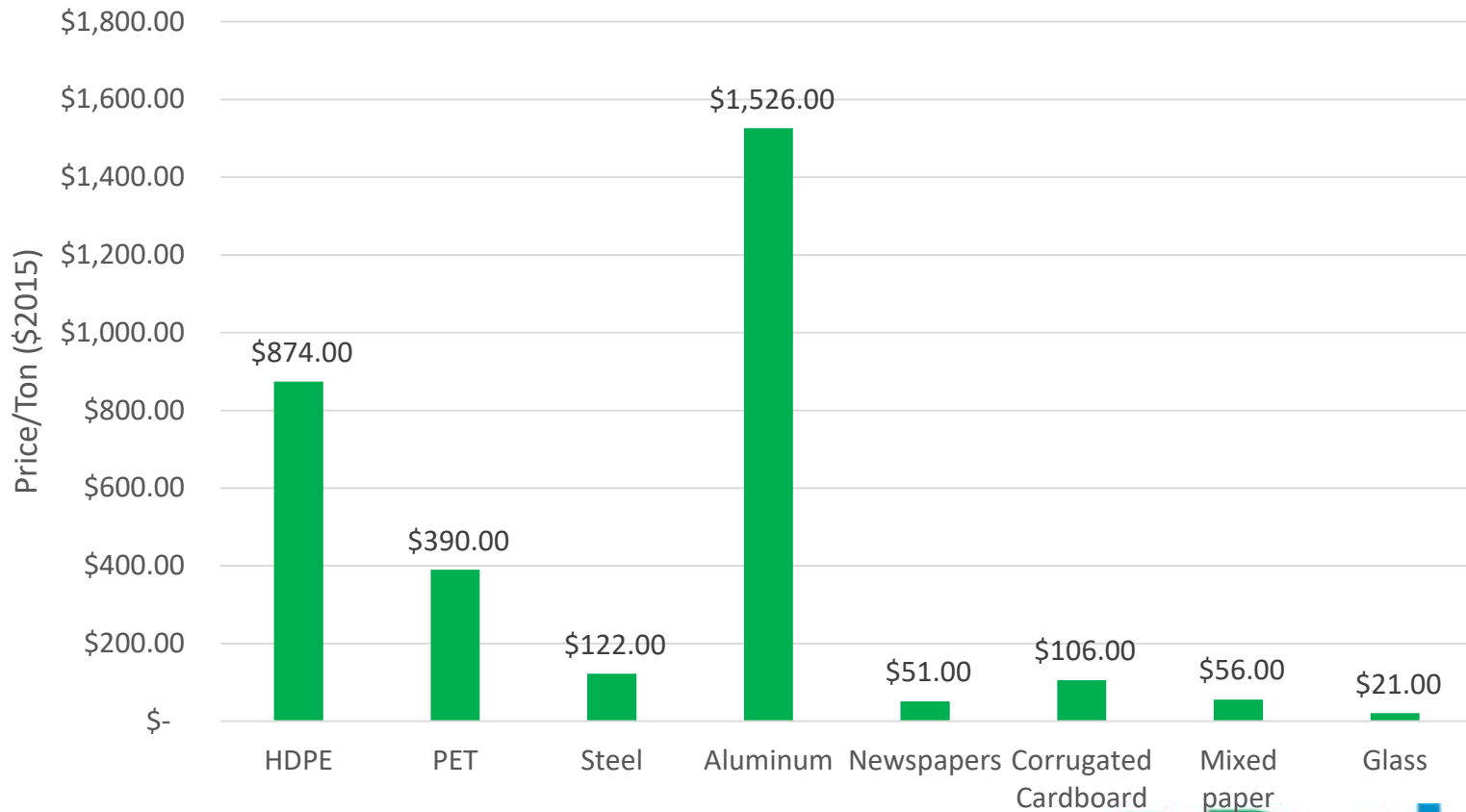
- Goal is set at one tier – Recycling
- What about:
 - Generation
 - Landfilling (Zero Waste)



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Measurement Focus: Value (\$)

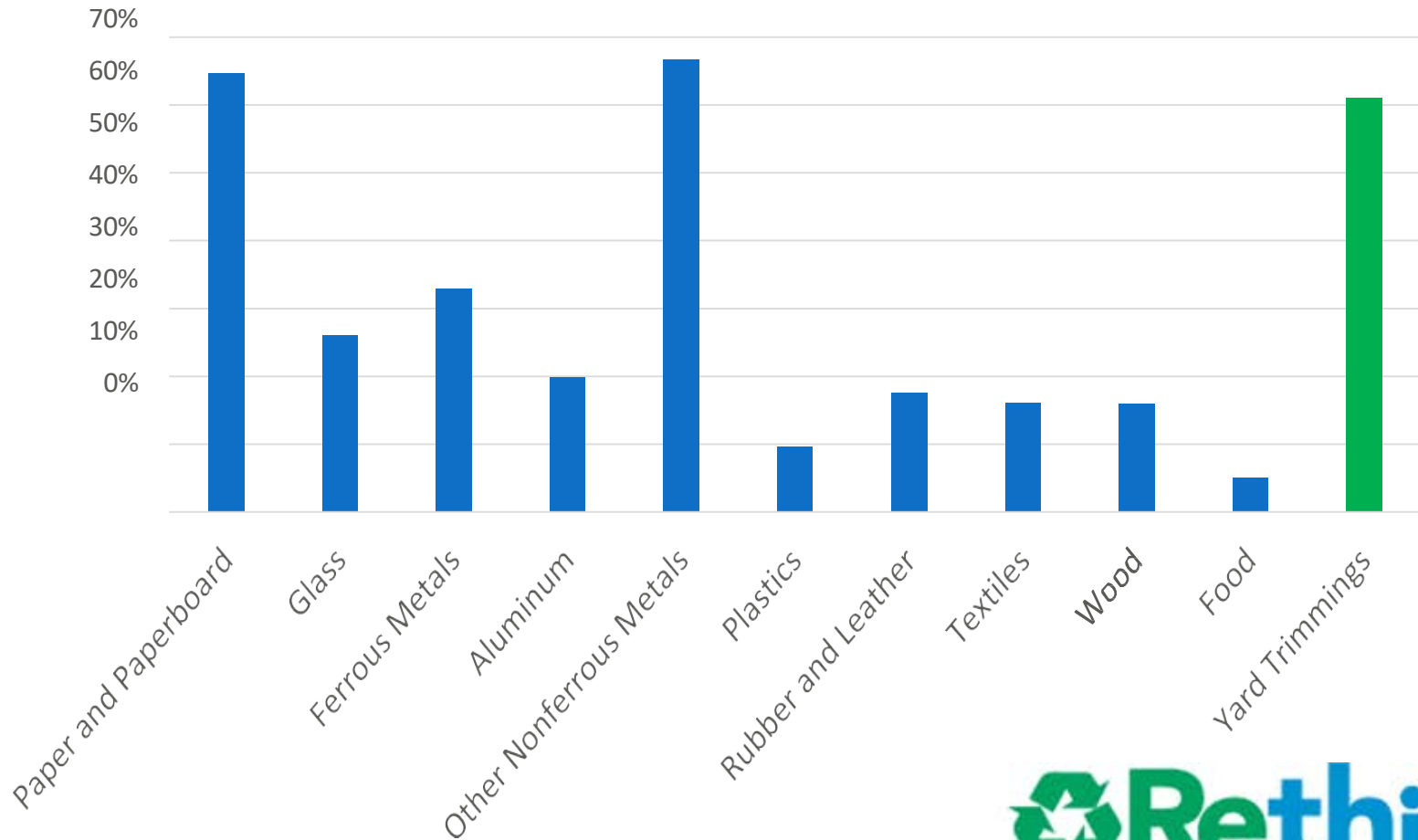
Material Commodity Values/Ton



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Measurement Focus: Recycling Rates

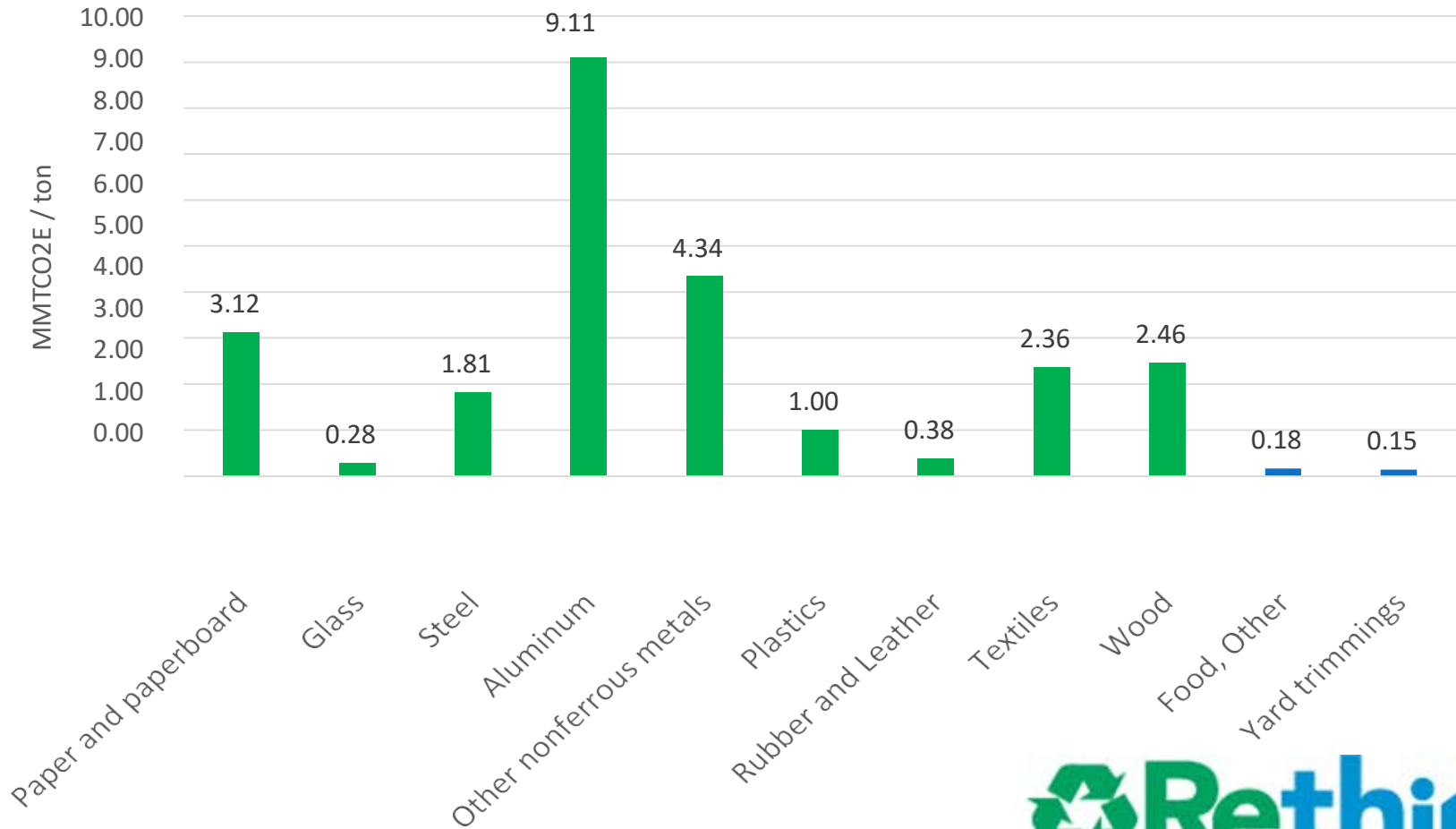
Material Recycling Rate



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Measurement Focus: GHGs

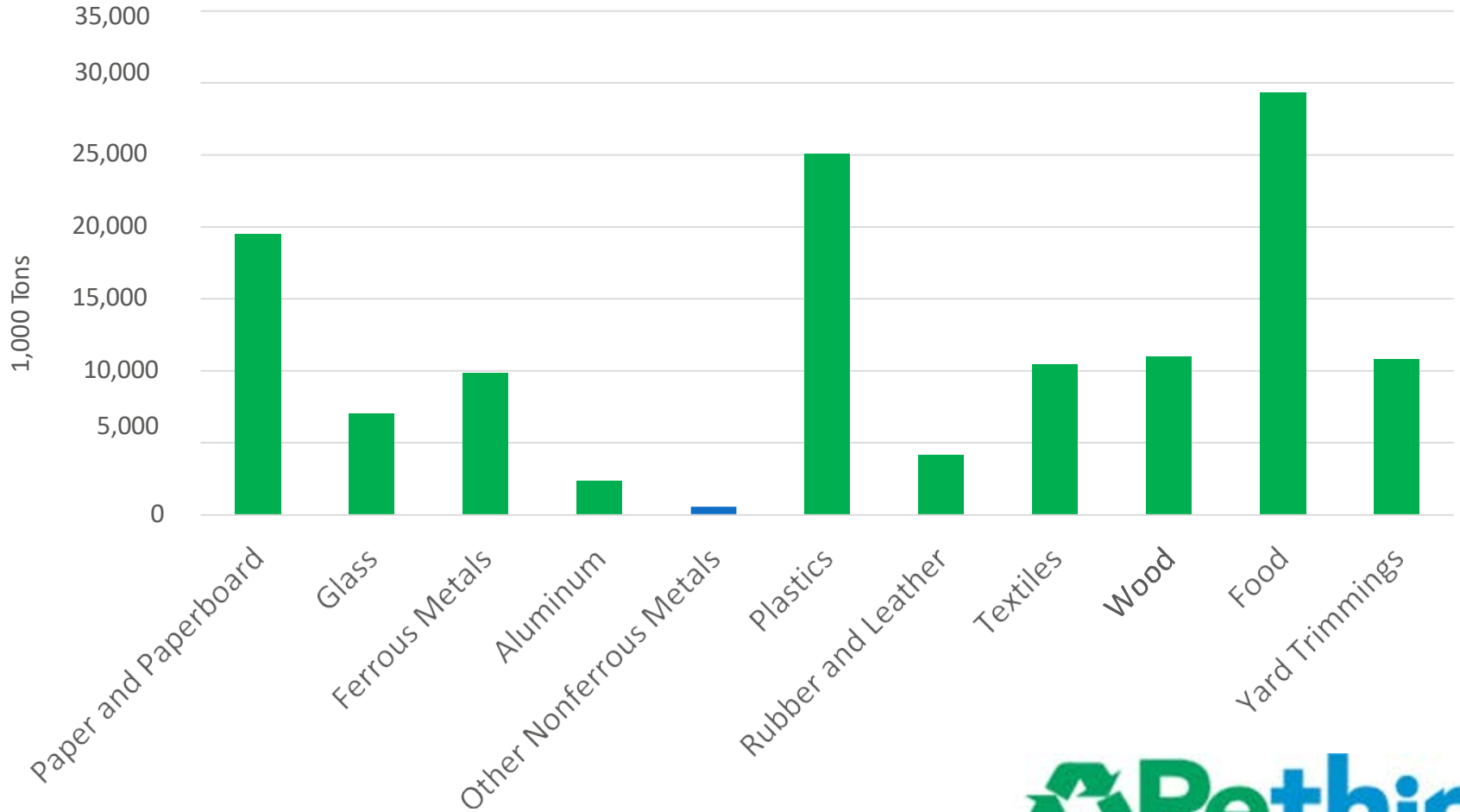
GHG emissions reduced /ton recycled



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Measurement Focus: Tons

Material Landfilled



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Recycling System Performance Measures

- Capacity (Collection, Processing, & Reutilization)
- Utilization of Capacity (Participation Rate & Capture Rate)
- Contamination (Collection & Final Bale)
- Processing Efficiency & Effectiveness (Yield, Loss, Residual)
- Economics (Market Value, Collection & Processing Costs)



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State SMM Efforts

- Oregon
- Vermont
- New York
- Maryland
- Florida



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Vermont's Materials Management Plan: Moving from Solid Waste towards Sustainable Management

- For the last 10 years, the amount of waste generated per person increases, while diversion has stagnated in the mid-30% range
- Goals:
 - To prevent waste from being generated,
 - To promote sustainable materials management, with a preference for highest and best uses,
 - To minimize reliance on waste disposal (landfilling and incineration), and
 - To conserve resources, minimize energy consumption, and reduce greenhouse gas (GHG) emissions and other adverse environmental impacts



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New York State's Beyond Waste Plan

- Shift from “end-of-the-pipe” waste management to “upstream” focus
- How materials can be more sustainably managed through the state's economy.
- Reduce the amount of waste New Yorkers dispose by preventing waste generation and increasing reuse, recycling, composting and other organic material recycling methods.
- Seeks a progressive reduction in the amount of MSW destined for disposal to reach the goal of reducing disposal to 0.6 pounds per person per day by 2030.



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Maryland Waste Reduction and Resource Recovery Plan Executive Order

- Comprehensive, collaborative approach to materials management
- Takes into account the full life cycle of materials
- Replaces the older concept of zero waste which focuses too narrowly on the end-of-life portion of material life cycles and imposing top-down goals.



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Florida

- Florida's recycling rate will likely fall short of the 2020 goal of 75%.
- To reach the weight-based 75% recycling goal would require funding and statutory mandates, as well as building additional Waste to Energy facilities that are costly to build.
- A shift toward SMM would refocus the goal to reduce the life cycle environmental impacts of materials.
- Evaluating the implications of shifting from a weight-based recycling goal to SMM.



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Thank you!

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epa.gov/smm



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 **Rethink**

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