Environmental Research & Education Foundation™

Lighting the way towards a more circular economy

When does curbside recycling make sense?

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EREF History & Mission

History

- Began in 1992 as part of the Environmental Industry Assoc. (EIA)
- Independent in 1998
- Largest sources of research & scholarships in North America

Mission

To advance scientific research and create educational pathways that enable innovation in sustainable waste management practices.

Vision

To light the way towards a more circular economy.

EREF Charitable Status

501(c)3 charity

- Non-lobbying organization
- Not a membership organization or trade assoc.

EREF is recognized as a 4-star charity

Excerpted from November 4, 2021 Press Release

NWRA Applauds EREF's "Exceptional" Charity Rating

Arlington, VA – As part of our transparency project, the National Waste & Recycling Association (NWRA) wants to highlight the good work of the Environmental Research & Education Foundation (EREF) to which we make contributions and provide support. EREF was given an "Exceptional" rating with a total score of 90.78 by Charity Navigator.

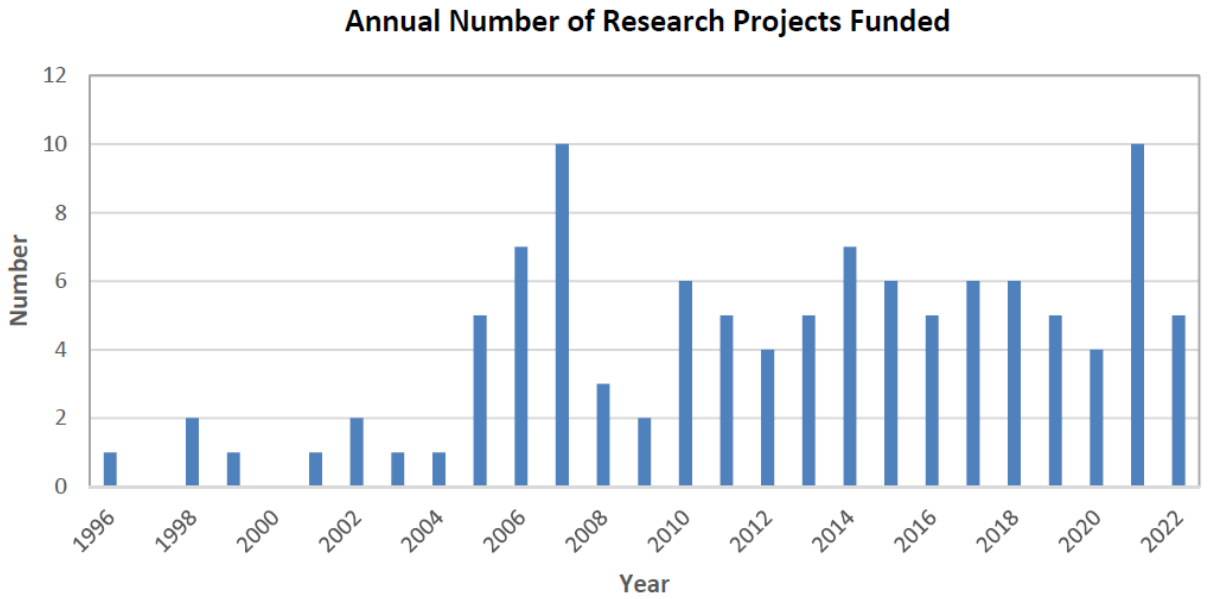
"There is a reason why NWRA considers EREF to be our charitable partner," said NWRA President and CEO Darrell Smith. "We are proud of EREF, which holds a higher rank than organizations like the American Cancer Society (score of 81), the American Red Cross (score of 88) and the Wounded Warrior Project (score of 86).

Other charities in the industry rated by Charity Navigator include Keep America Beautiful (score of 83) and the Solid Waste Association of North America (SWANA) (score of 73).

National Waste & Recycling Association℠
Collect. Recycle. Innovate.

Research Grants

- Total of 130 research projects have been funded since 1992
- Number of Active Projects = 34
  - Landfill Projects = 17 (50%)
  - Non-Landfill Projects = 17 (50%)
- New Projects Funded in 2022 = 3



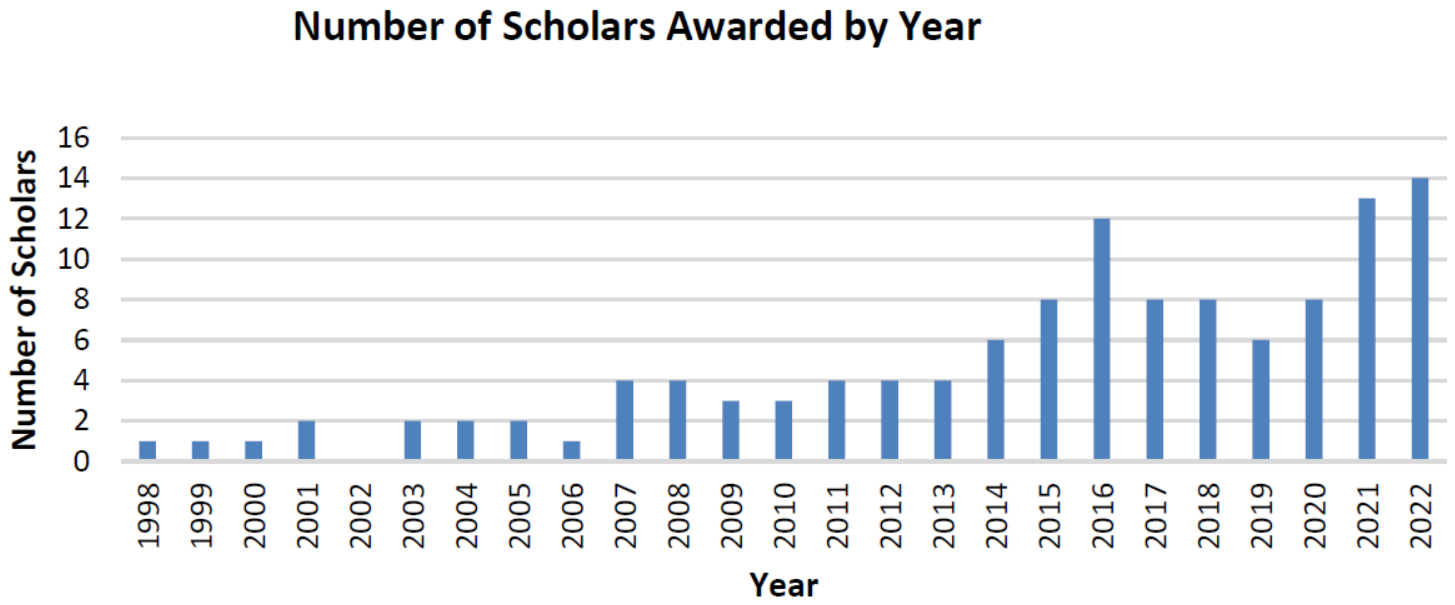
- Cumulative research funding through 2020 = **$17.51 million** (*est.)*

Scholarship Program

- 28 active scholars
- 122 scholars have been funded since 1998
  - 34% are Master's
  - 66% are PhD's

https://erefdn.org/scholarship-program/how-to-apply/

- Cumulative scholarship funding through 2022 = $2.93 million



Education Program

- Content via industry media channels (e.g. Waste 360)
- Online content
  - Recorded webinars
  - Solid waste textbook
  - Resource pages (current science on a range of topics)
- Technical Meetings
  - Summits (regional meetings on focused topics)
  - Global Waste Management Symposium
    (largest technical waste conference in North America)
- Science Sessions
  - PFAS in Waste-derived Compost
  - Emerging Contaminants in Organics
  - How to (Accidentally) Destroy a Forever Compound

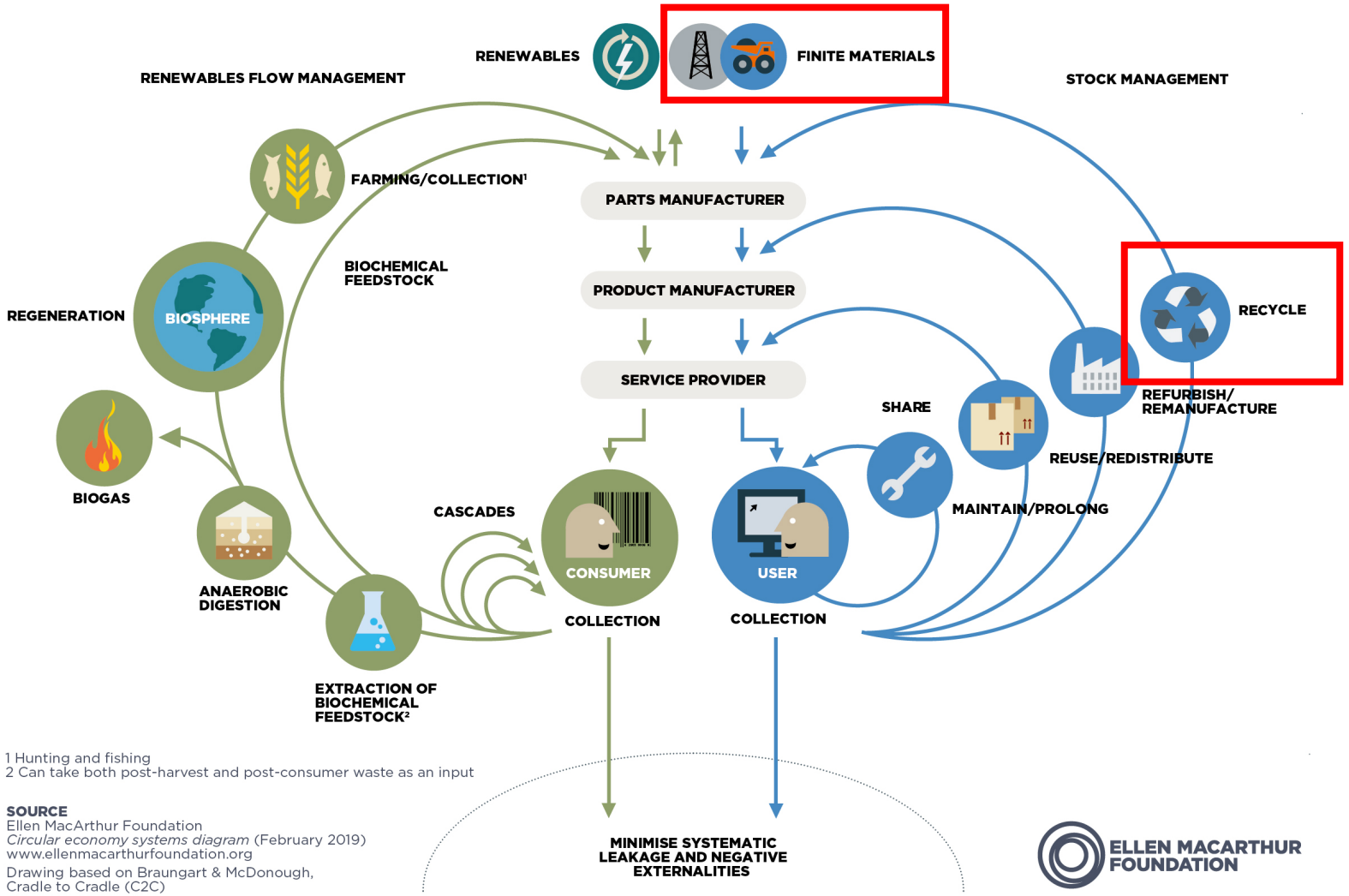
Data & Policy Program

- Program started in 2014
  - 22 reports published since start
- Number of Active Projects = 15
- Current Project Examples
  - State of Practice of Organics Management in the U.S.
  - Waste Collection Vehicle Fleet Management
  - Frequency and Cause of Fires at MRFs and Scrap Yards

Recent/Upcoming Reports

Publication Name	Status
State of Practice of Organic Waste Management and Collection in Canada	June 2021
Analysis of MSW Landfill Tipping Fees - 2021	Feb 2022
Life Cycle Assessment of Curbside Materials	June 2022
Analysis of MSW Landfill Tipping Fees - 2022	Mar 2023

Circular Economy



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

According to the Ellen MacArthur Foundation the **circular economy** is based on three principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems

Recycling keeps products and materials in use

Sustainable Materials Management (SMM)

According to the U.S. EPA **sustainable materials management** is a systemic approach to using and reusing materials more productively over their entire life cycles

It answers the question: **What do we do with the waste we currently have?**

It's why we might want to…

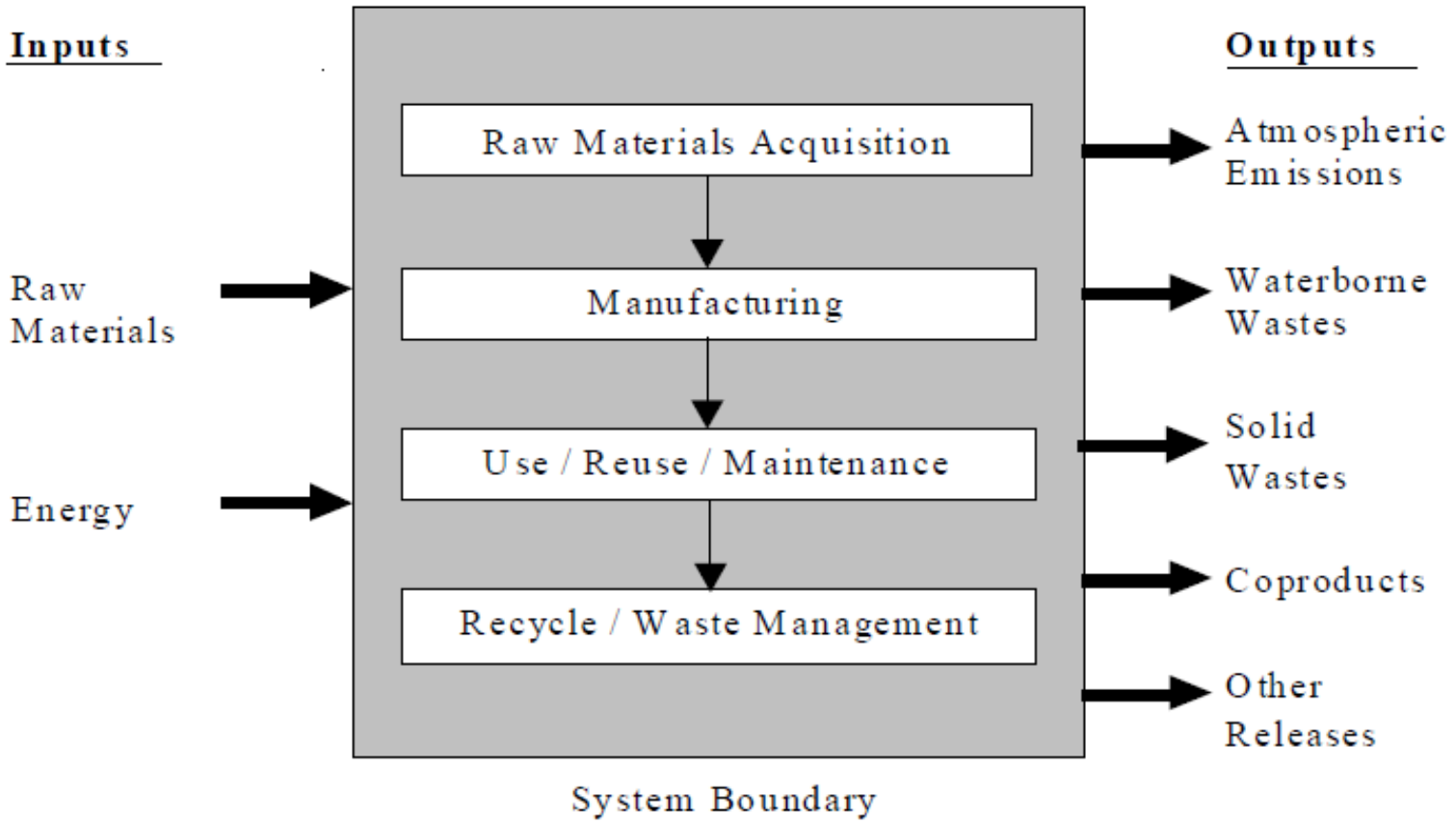
- recycle
- divert materials from landfills
- minimize waste
- maximize waste to resources
- choose a particular end-of-life option over another

What is Life-Cycle Assessment (LCA)?

LCA is a framework for examining, identifying, and evaluating the:

- energy,
- material, and
- environmental implications

of a process, product, or system across its life span from cradle to grave.



Source: EPA (2006) – LCA: Principles and Practice

LCA Helps Us Ask Questions about Systems

1. Why do we recycle?
2. When does recycling make sense?
3. What materials should we recycle?
4. Can recycling worse than landfilling?
5. How can we improve recycling?
6. What is Sustainable Materials Management (SMM)?

Does recycling always make sense?

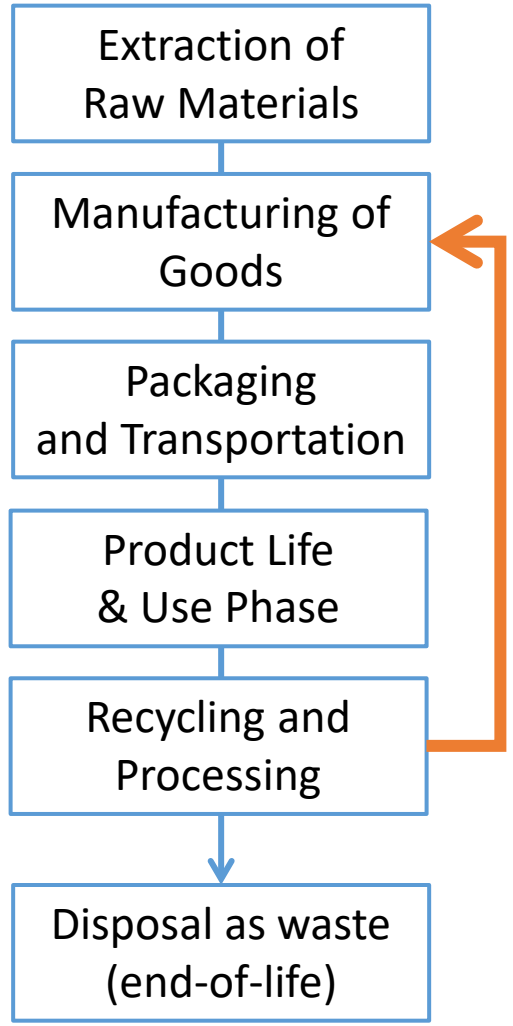
In addition to the benefits…

Recycling has environmental "costs"

- Collecting, processing, and transporting recyclables to end users
- Processing and manufacturing by users

Recycling makes sense from an LCA perspective when:

Benefits > Costs



Does recycling always make sense?

EREF LCA of Material Recovery Study

- Project objective: evaluate municipal solid waste (MSW) management system options to understand and compare environmental impacts

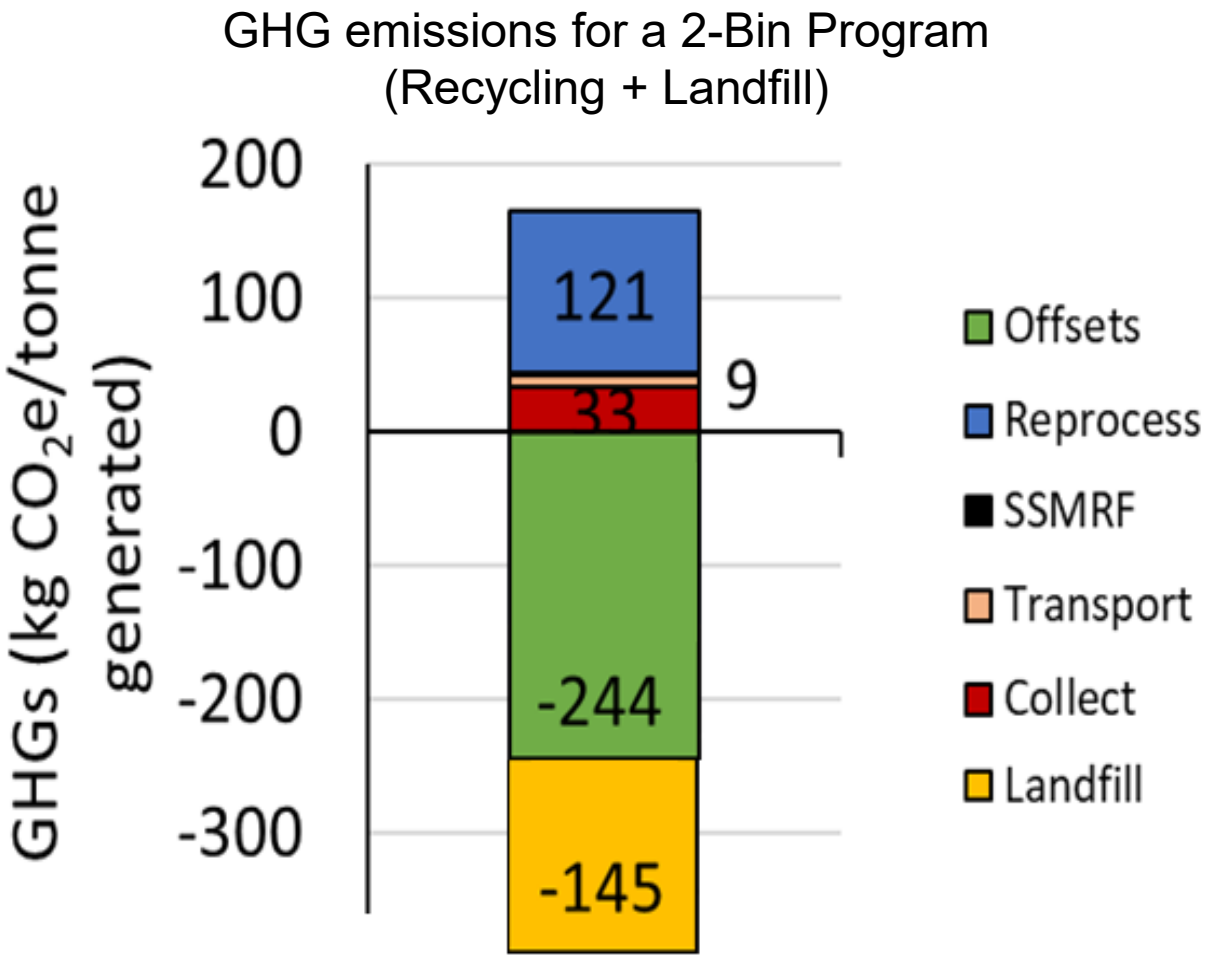
Collection Scenarios & Frequency (times per week)

Scenario	Landfill	SS-MRF	Compost (YW)	Compost (YW+FW)
1 Bin (LF)	2x	-	-	-
2 Bin (LF+R)	1x	1x	-	-
3 Bin (LF+R+YW)	1x	1x	1x	-
3 Bin (LF+R+YW/FW)	1x	1x	-	1x

When Does Recycling Make Sense?

Recycling makes sense from an LCA perspective when:

Benefits > Costs



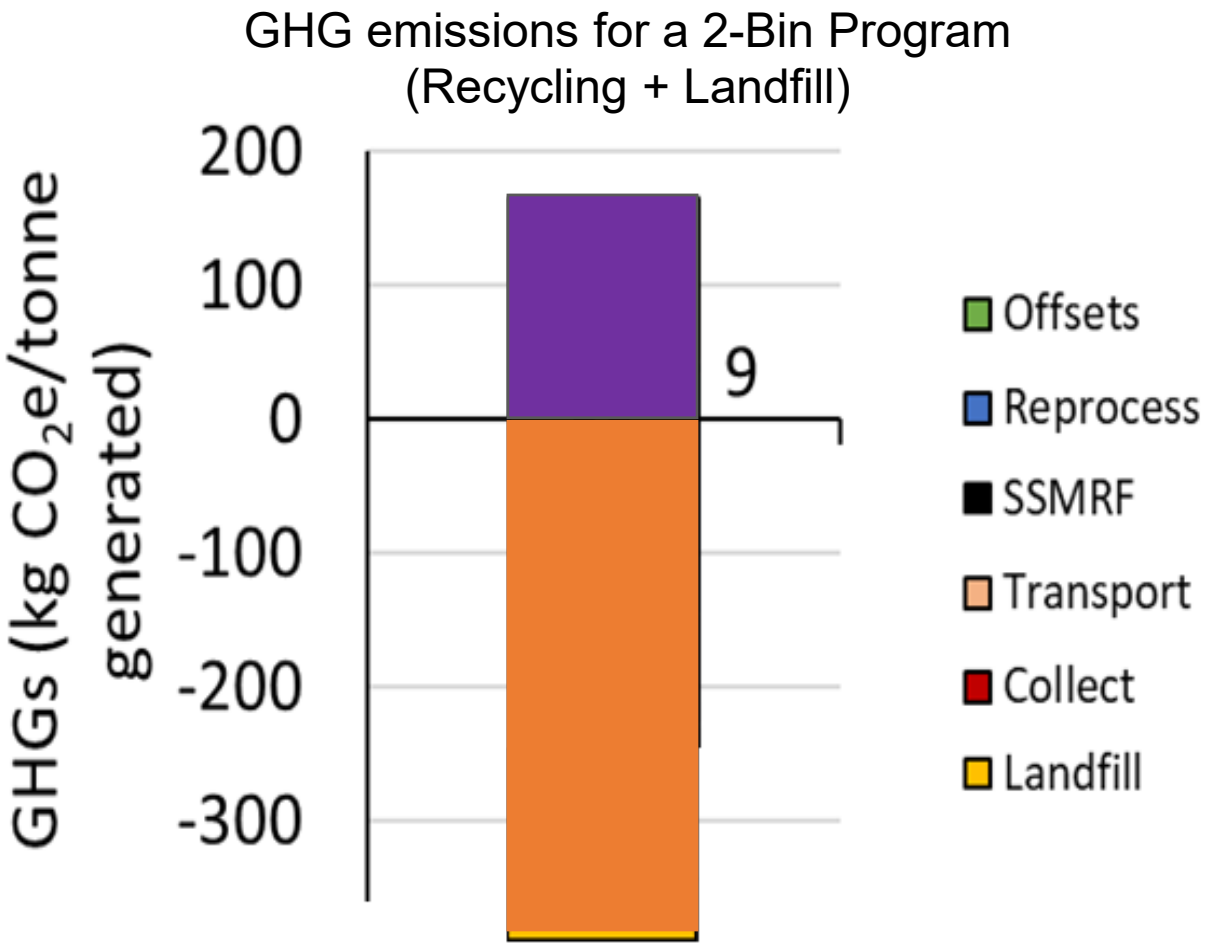
Source: EREF (2019)- LCA of Curbside Material Recovery

When Does Recycling Make Sense?

Recycling makes sense from an LCA perspective when:

Benefits > Costs

YES



Source: EREF (2019)- LCA of Curbside Material Recovery

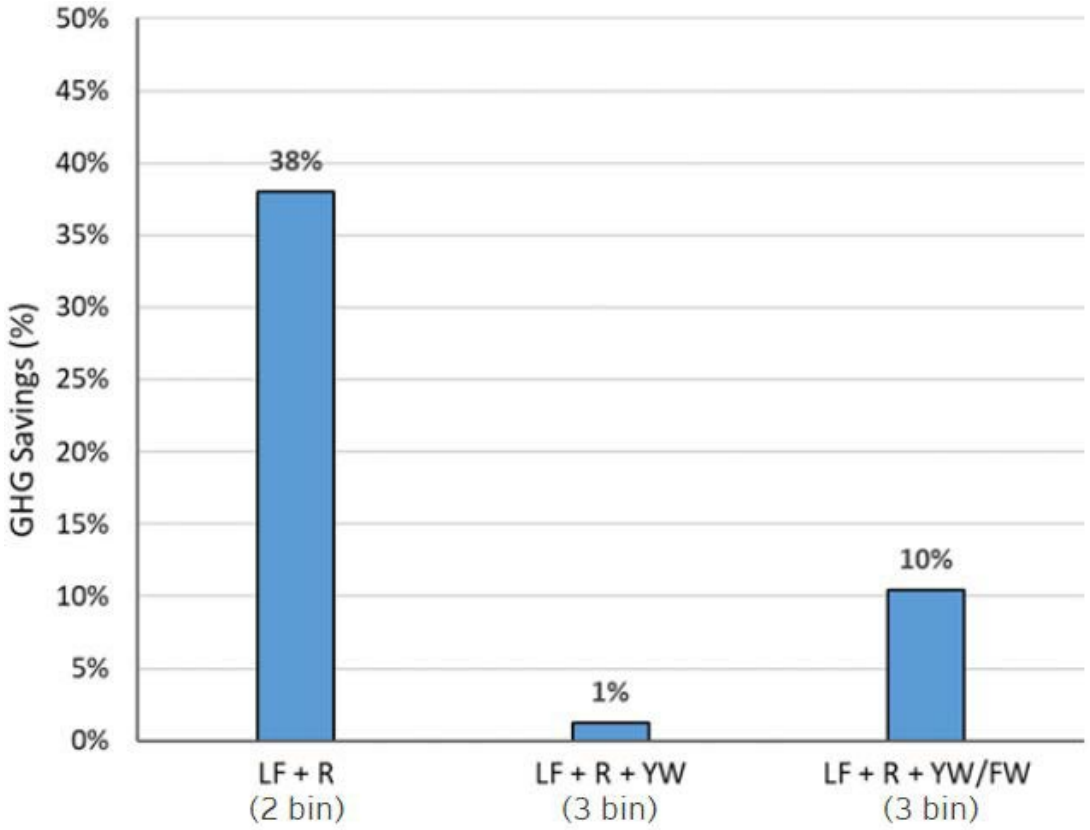
When Does Recycling Make Sense?

Recycling makes sense from an LCA perspective when:

Better than the Alternative(s)

YES

GHG Savings Compared to Landfill w/ Gas to Energy System (1 bin scenario)

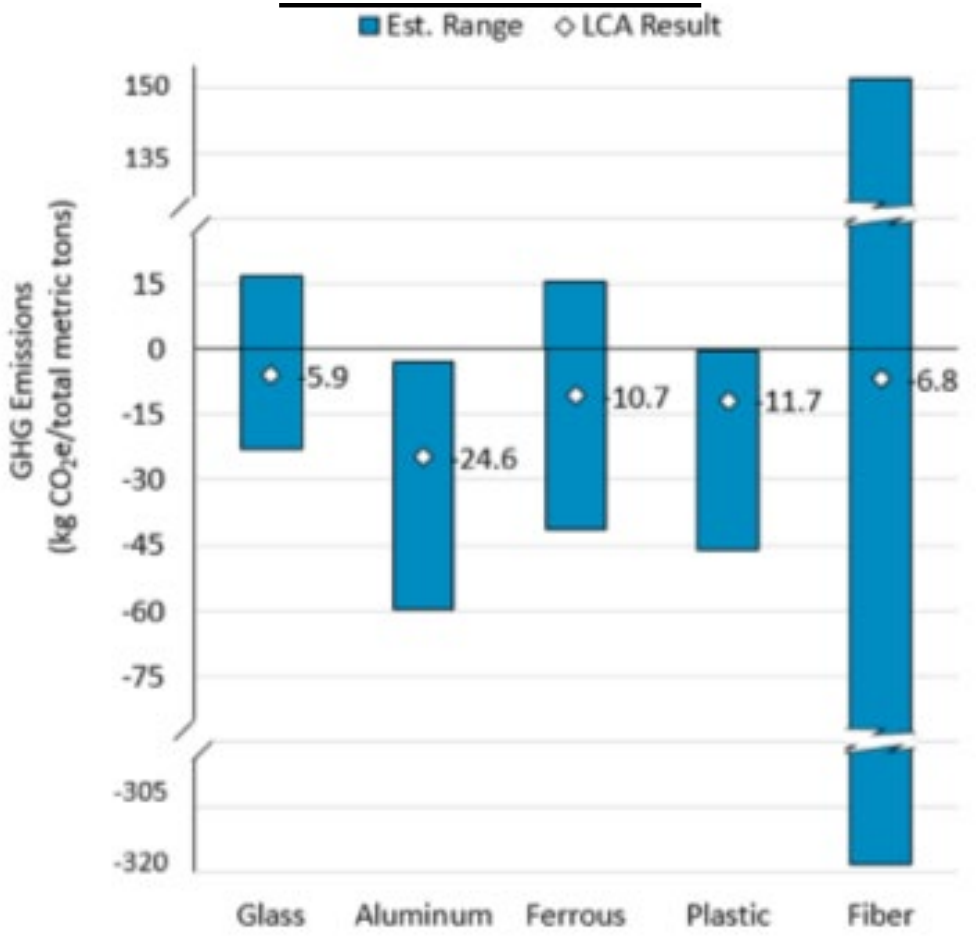


Source: EREF (2019)- LCA of Curbside Material Recovery

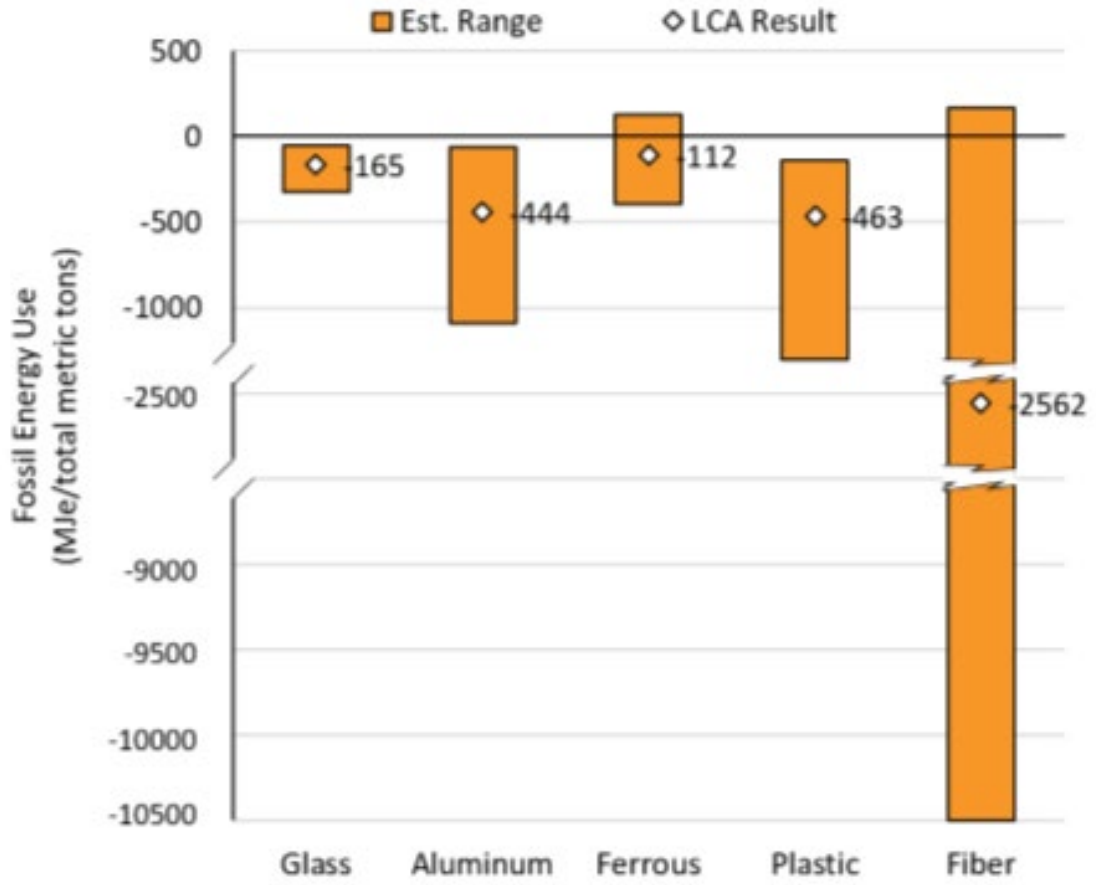
Can Recycling Make Sense for Every Material?

Impacts of GHG Emissions and Energy Use for Specific Recyclable Materials

GHG Emissions



Energy Use



Source: EREF (2019)- LCA of Curbside Material Recovery

Can Recycling Be Worse Than Landfilling?

Are there scenarios where recycling doesn't make sense?

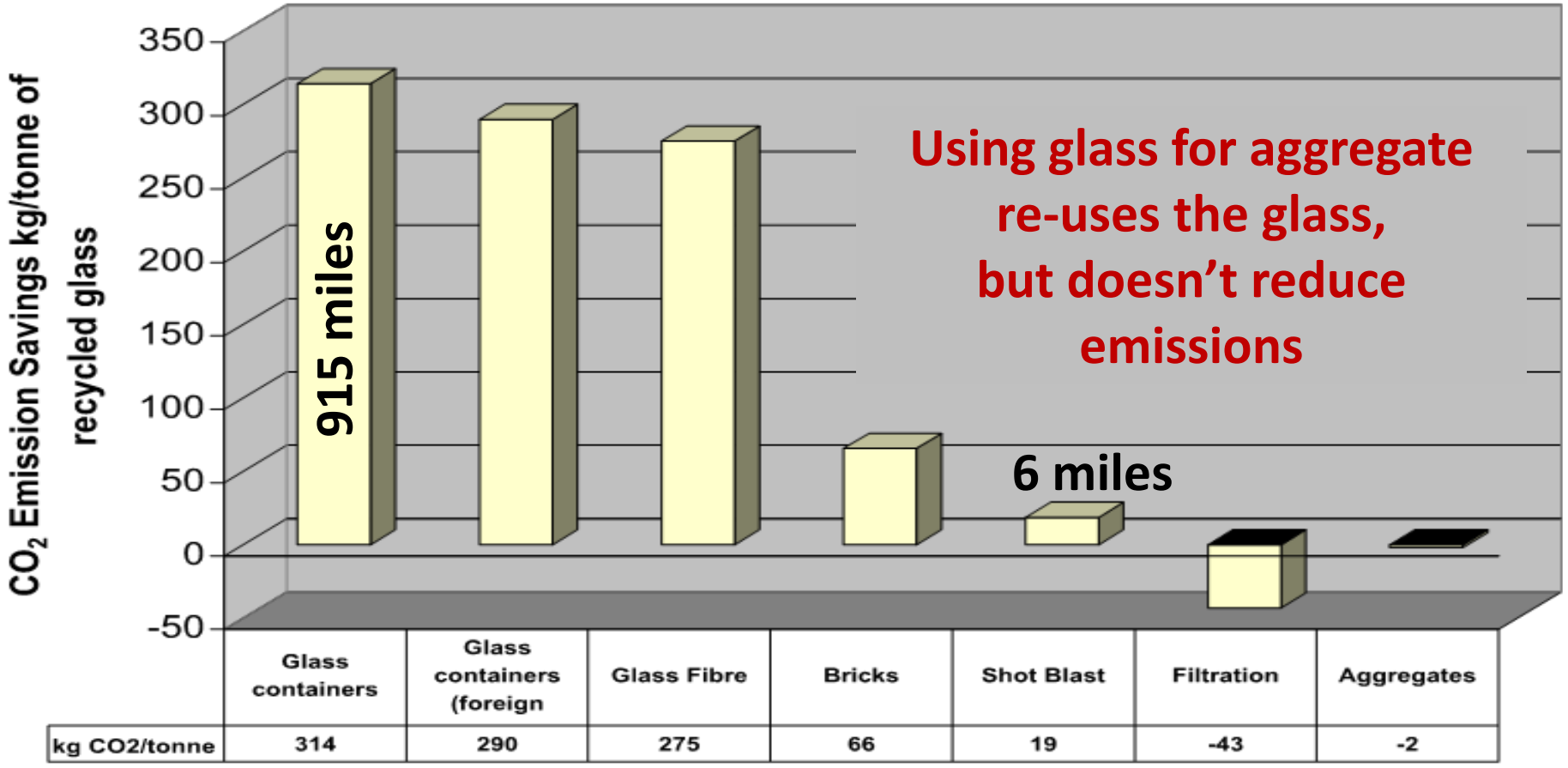
Benefits < Costs

- End use is key to realizing environmental benefits of recycling
- Not all end uses have the same level of environmental benefit(s)

Material End Use Impacts Sustainability

End-use of materials is key to realizing the potential environmental benefits

- Not all end uses provide equivalent GHG benefit
- LCA models assume closed loop or best benefit recycling
  - likely overestimates benefits of recycling on average
- Need to better understand material end uses



Source: Enviros Consulting, 2004

LCA of Material Recovery

1. The 2 Bin Scenario (Landfill + Recycling) has lowest total GHG emissions

2. Higher diversion from landfill does not correlate to greater emissions reduction.

Collection Scenario	GHG Emissions (kg CO_2e/metric ton)	Landfill Diversion Rate	Rank
LF + R (2 bin)	-225	21%	1
LF + R + YW (3 bin)	-165	30%	3-Tie
LF + R + YW/FW (3 bin)	-180	38%	2
LF only (1 Bin)	-163	0%	3-Tie

3. Curbside recycling may not provide energy or emissions savings in all situations.
   - Offsets from recycling (aka. by not using virgin materials) primarily dictate energy/emissions savings
   - As a result, variables such as end use and energy grid significantly impact recycling benefits

4. LCA results represent an "ideal" case (e.g. glass bottle-to-bottle recycling) and likely overestimate recycling benefits.
   - So far, the closed-loop or bottle-to-bottle assumption does not appear to represent where the majority of material is going (glass, PET)

Theoretical Maximum Recycling Rate Project

What if we could recover 100% of every possible recyclable material from the waste stream?

- This would effectively remove the effects of consumer behavior and waste management operational efficiency.

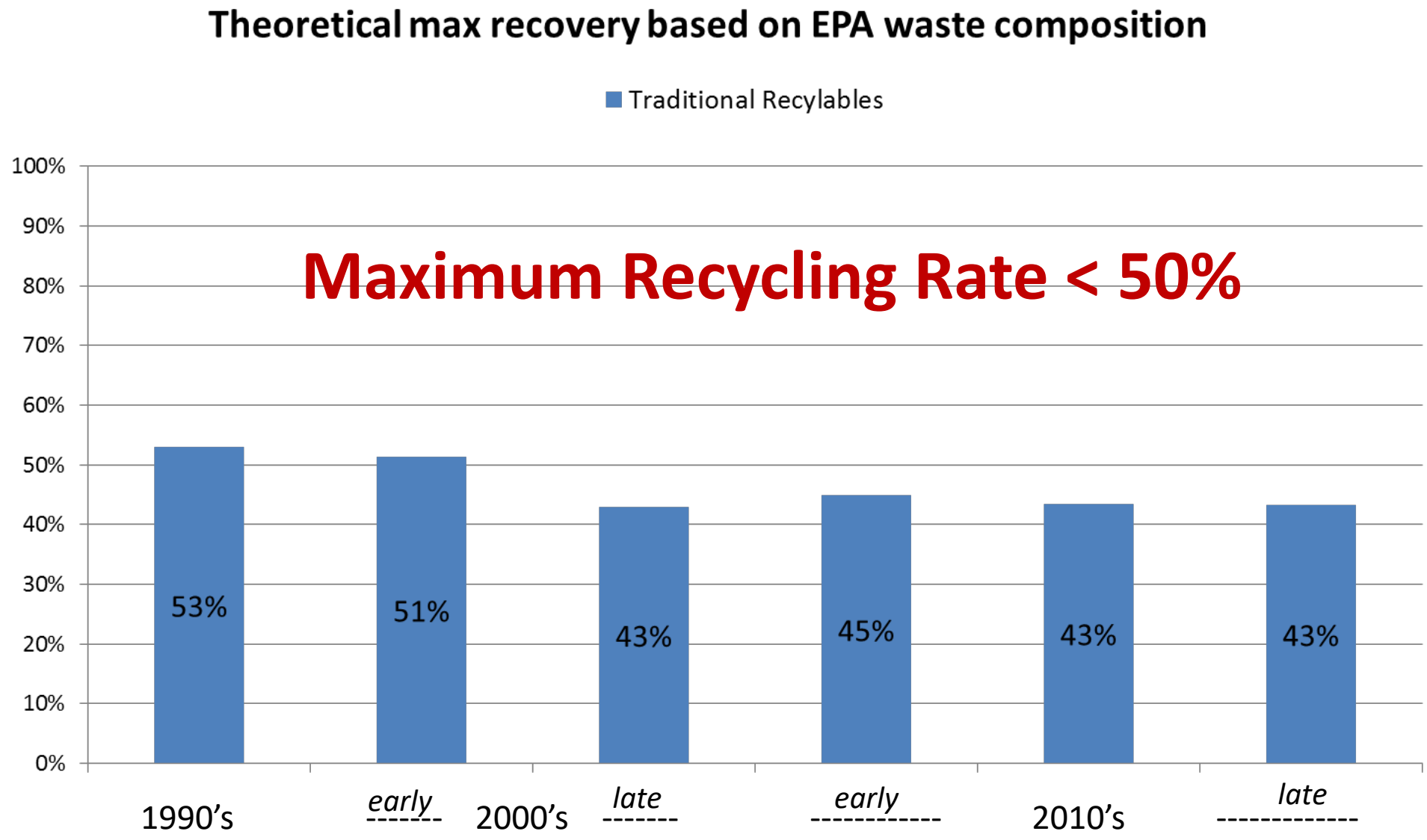
- It would reflect the recyclability potential of generated waste, providing the maximum recycling rate possible for a given waste composition.

- Quantify mass of applicable waste components
  - Paper
  - Plastic
  - Metal
  - Glass
  - Textiles

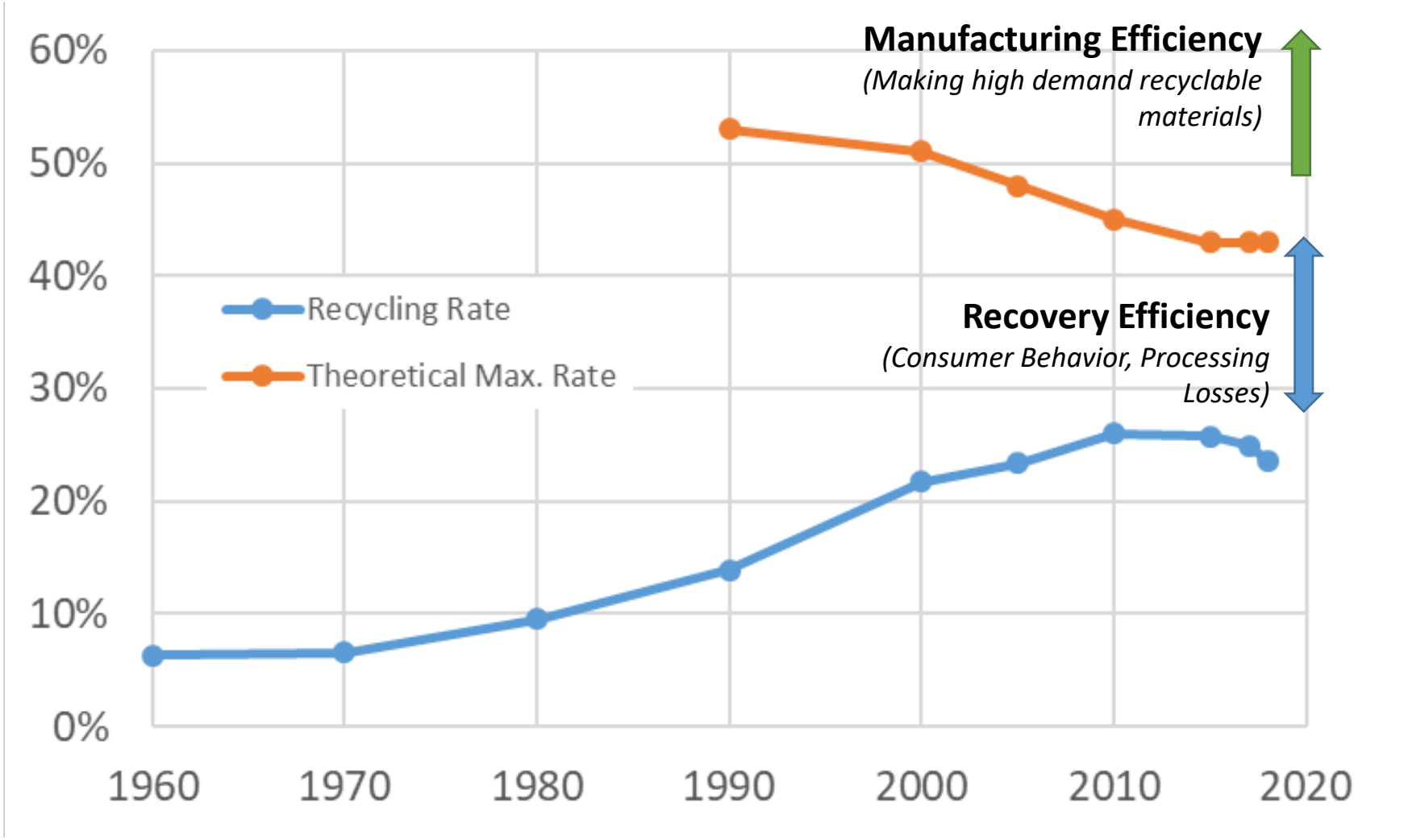
Excludes non-recoverable materials

This is essentially the **maximum recycling rate** that could be achieved with a given waste composition.

Maximum Recycling Rate



Trends in Recycling Rates and Efficiencies



Based on US EPA data.

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Thank You!