# Calculating the Emissions Impact of Recycling

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WASTE MANAGEMENT

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# Today's Speakers

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Chief Municipal Source Reduction Branch, **US EPA**
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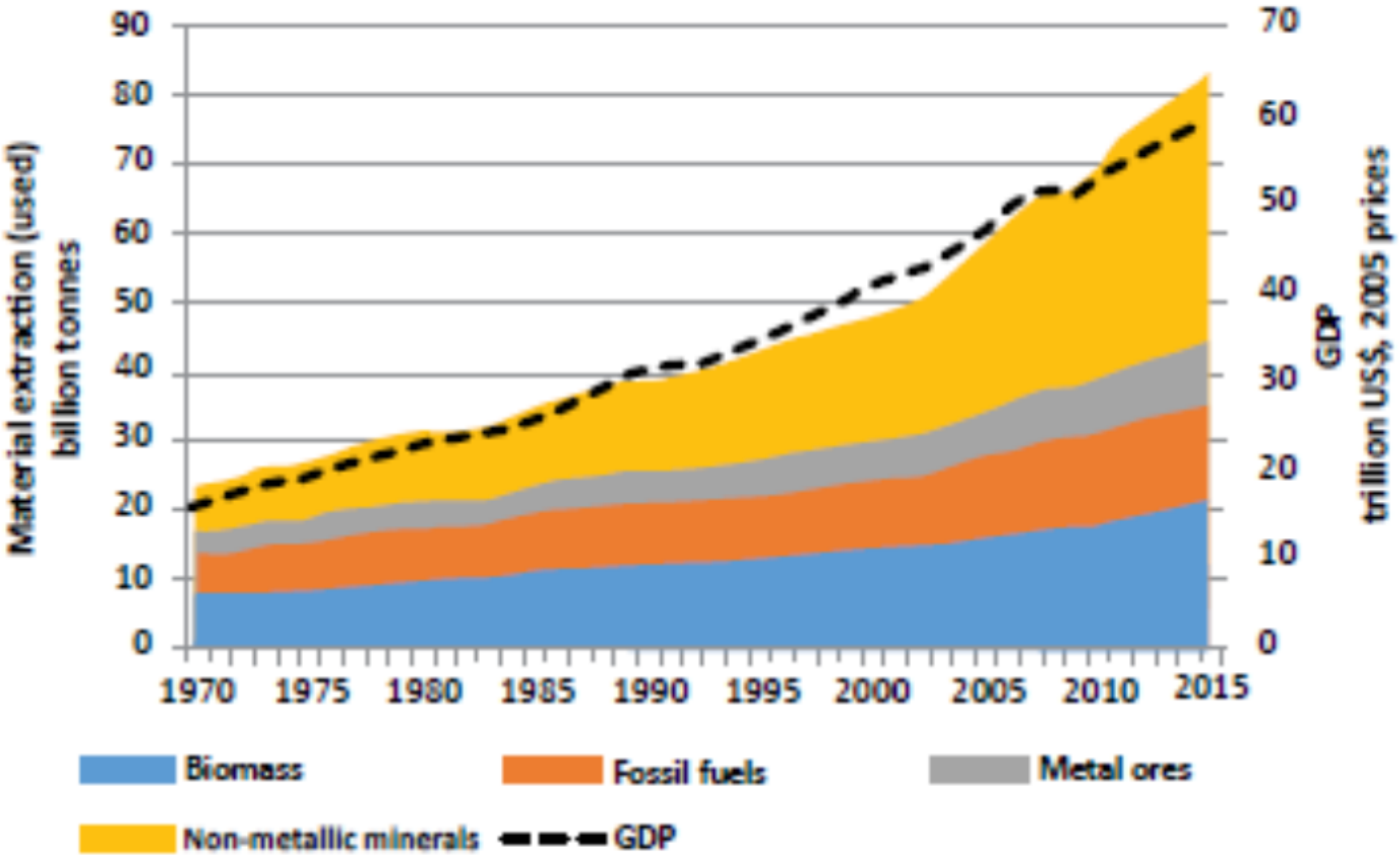
# What is Sustainable Materials Management (SMM)?

*"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)*

# Why is SMM so Critical? A Global Issue

Global material extraction and gross domestic product




Source: Material extraction data from UNEP (forthcoming in 2016b), GDP data from UNSD (2015).

**"One half to three quarters of annual resource inputs to industrial economies is returned to the environment as wastes within just one year."**

*Weight of Nations: Material Outflows from Industrial Economies, WRI*

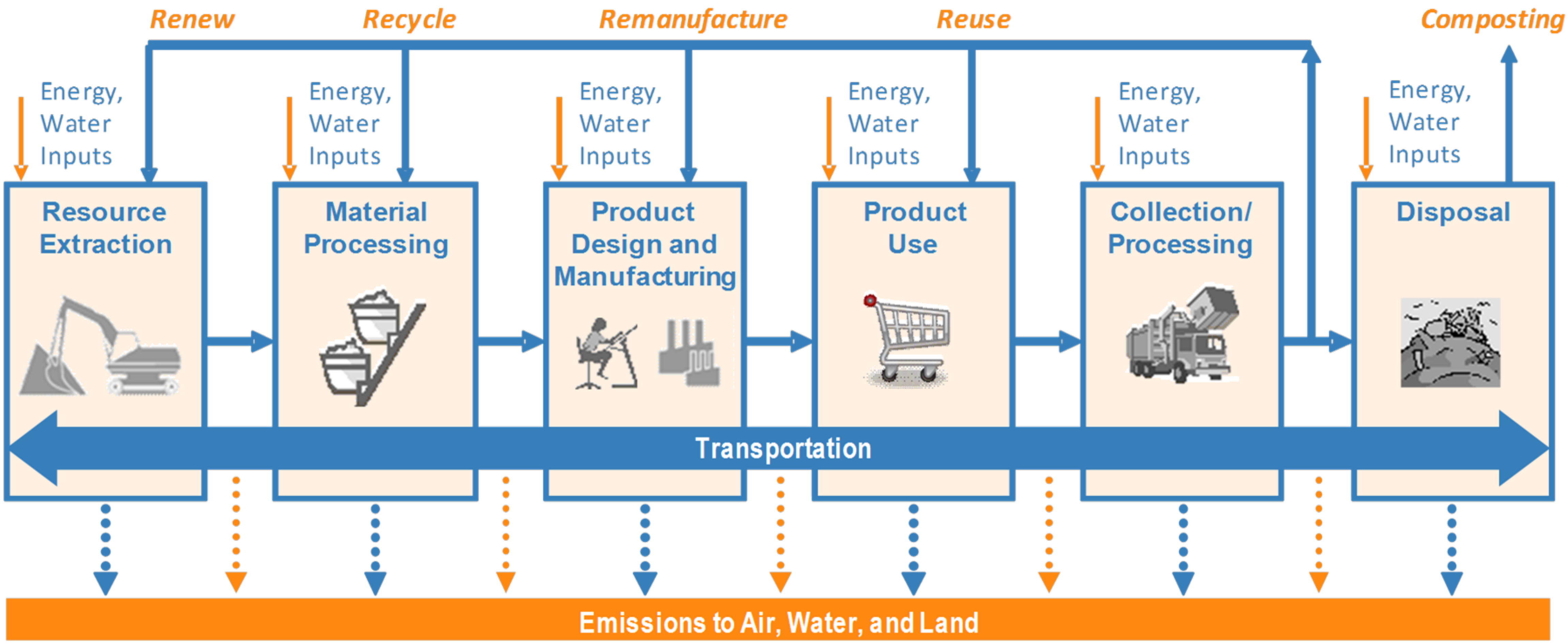
# SMM Offers New Opportunities to Address Climate Change

- Materials management accounts for 42% U.S. GHG emissions.

- The gap in U.S. Intended Nationally Determined Contributions can potentially be addressed by systems-based approaches such as sustainable materials management.

- The manufacturing sector is the third largest near-term GHG abatement opportunity to achieve the U.S. GHG reduction commitment beyond the Climate Action Plan.
  - **Resource Efficiency and waste reduction are primary levers.**

# SMM: A Life-Cycle Perspective

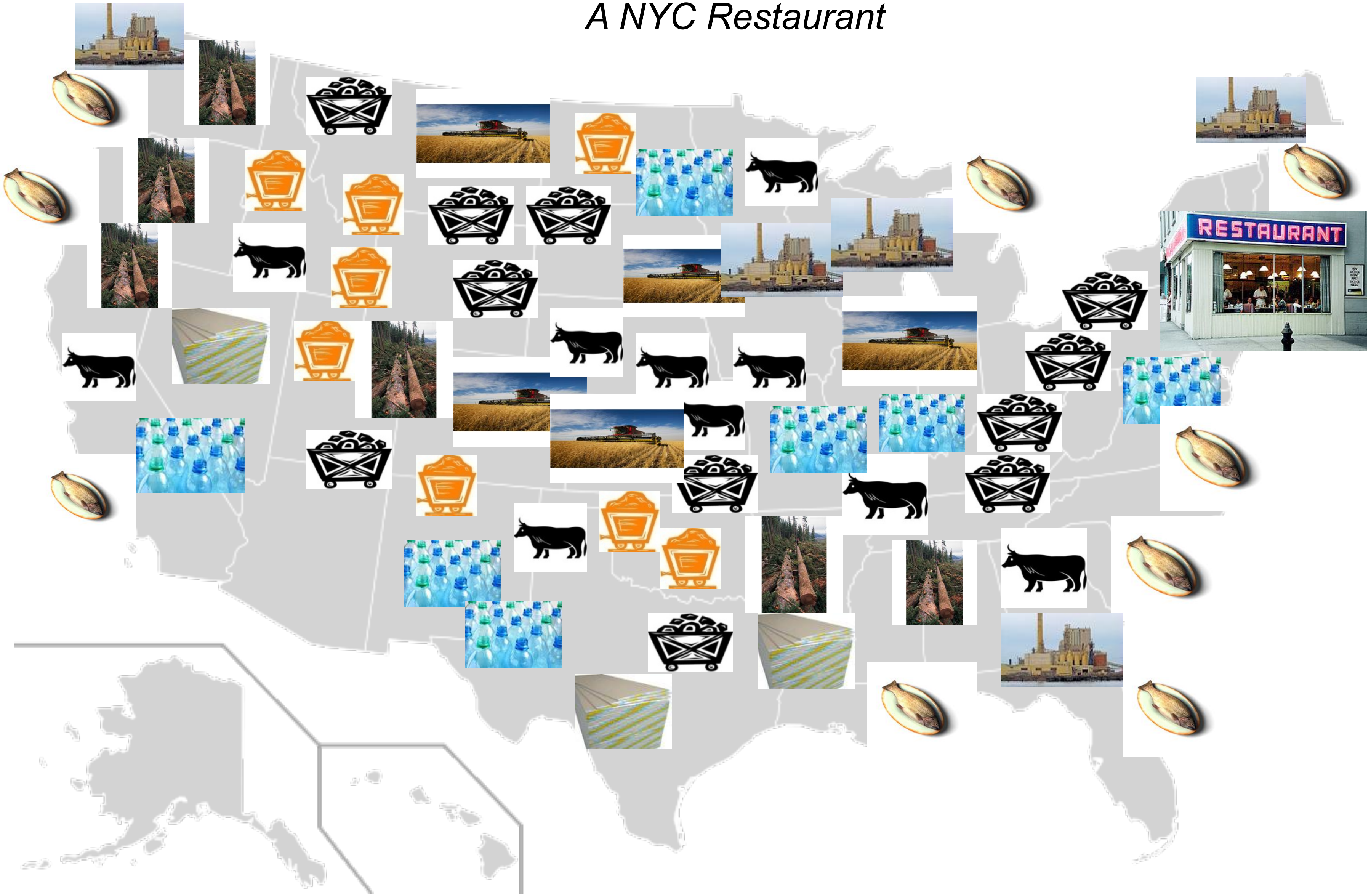


# Example: 3M

- Created a standardized handbook for designers to consider life cycle impacts
  - Standardizes the process and
  - Instills the importance of resource efficiency across the organization.
- Also
  - Included language about the importance of sustainability by leadership in the company mission statement,
  - Provided a dedicated LCA team that is available to anyone across the company, and
  - Participated in corporate sustainability indexes.

# What Are The Roles Of Policy And Decision-makers Under SMM?

*A NYC Restaurant*



# Food Services and Drinking Places Impacts

(identified using environmentally-extended Input-Output analysis)

**Food Services and Drinking**


## Significant Cradle to Gate Impacts

Human Health Cancer (3.3%)
Human Health Noncancer (3.2%)
Human Healt h Respiratory (3.6%)
EcoTox (3.1%)
Global Warming (3.9%)
Ozone Depletion (2.5%)
Smog (3.1%)
Acidification (4.1%)
Eutrophication (6.9%)
Land Use (5.4%)
Energy Use (3.9%)
Water Use (6.6%)
Material Use (2%)
Waste (5.2%)

***Significant Direct Impacts***
*Energy Use*

## Impacts Bought

(rank order)

**Electricity**
*(HR. GW. Smog, Acid, Energy, Material)*
*(HC, HNC, Water)*

**Waste Management**
*(HC, HNC, Ecotox)*

**Meat**
*(Land)*
*(HR, GW, Smog, Acid., Eutro., Energy, Water, Material, Waste)*

**Poultry**
*(Eutro)*
*(HR, Acid, Land, Material, Water)*

**Fish**
*(Water)*
*(Energy, Waste)*

**Grains**
*(Waste)*
*(HR, Water, Material)*

**Soft Drinks and Ice**
*(HC)*
*(HNC)*

**Polystyrene Foam Products**
*(Ozone Dep)*

**Urethane and Other Foam Products**
*(Ozone Dep)*

**Cheese**
*( )*
*(HR, GW, Acid., Land, Material, Waste)*

## Source of Impacts in Supply chain (Hotspots)

*(more finished product -----------→ raw material)*

1. **Electricity** *(HR, GW, Smog, Acid., Energy)* *(HC, Water)*
2. **Grain Farming** *(Material, Waste)* *(HR, Eutro., Land, Water)*
3. **Waste Management and Remediation** *(HC, Ecotox)* *((HNC)*
4. **Poultry and Egg Production** *(Eutro)* *(Acid.)*
5. **Alumina Refining and Primary Aluminum Production** *(HNC)* *(HC, Ecotox)*
6. **Fishing** *(Water)*
7. **Cattle Ranching And Farming** *(Land)* *(GW, Acid., Waste)*
8. **Food Services and Drinking Places** *(Energy)* *(GW)*
9. **Aluminum Product Manufacturing** *(HC)*
10. **Coal Mining** *(Material)*

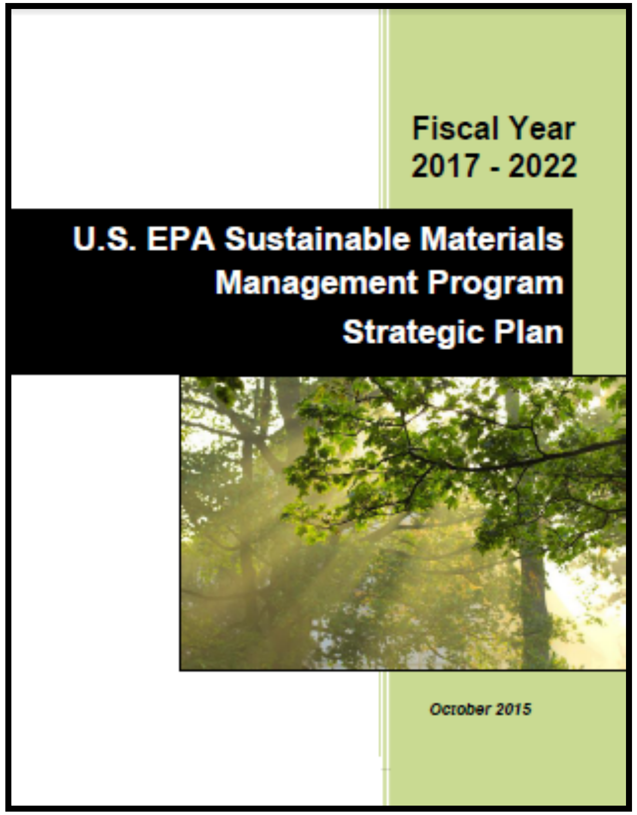
11. Urethane and Other Foam Products *(Ozone Dep)*
12. Logging *(Land)*
13. Truck Transportation *(Smog, Acid., Energy)*
14. Polystyrene Foam Products *(Ozone Dep)*
15. Fruit Farming *(Ozone Dep)*

# SMM Policy Approaches

- Advancing Life Cycle Assessment and Life Cycle Thinking
- Life cycle-based standards (e.g., NSF sustainability standard; EPEAT (electronics) standard)
- Green Servicizing (service models)
- Convening to achieve SMM
- Regulations

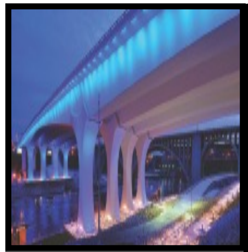
# SMM Strategic Plan for FY2017 – FY2022

3 Strategic Priority Areas


Fiscal Year
2017 - 2022

U.S. EPA Sustainable Materials
Management Program
Strategic Plan

October 2015



The Built Environment

(buildings, roads, bridges, infrastructure)

Sustainable Management of Food

Sustainable Packaging

***Additional Emphasis Areas:*** Sustainable Electronics Management; Lifecycle Assessment; Measurement; and International Efforts

# SMM and the G7 Alliance on Resource Efficiency

*"We will work with business and other stakeholders to improve resource efficiency with the aim of also fostering innovation, competitiveness, economic growth and job creation. We encourage all countries to join us in these efforts."* – G7 Leaders Declaration, May 2016

G7 Leaders' Summit June 2015 established the Alliance on Resource Efficiency to:

- Serve as a forum to share knowledge and create information networks on a voluntary basis.

- Collaborate with businesses and other relevant stakeholders to advance opportunities offered by resource efficiency, promote best practices and foster innovation.

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# The economics of GHG emission reductions in the Environmental Services Industry

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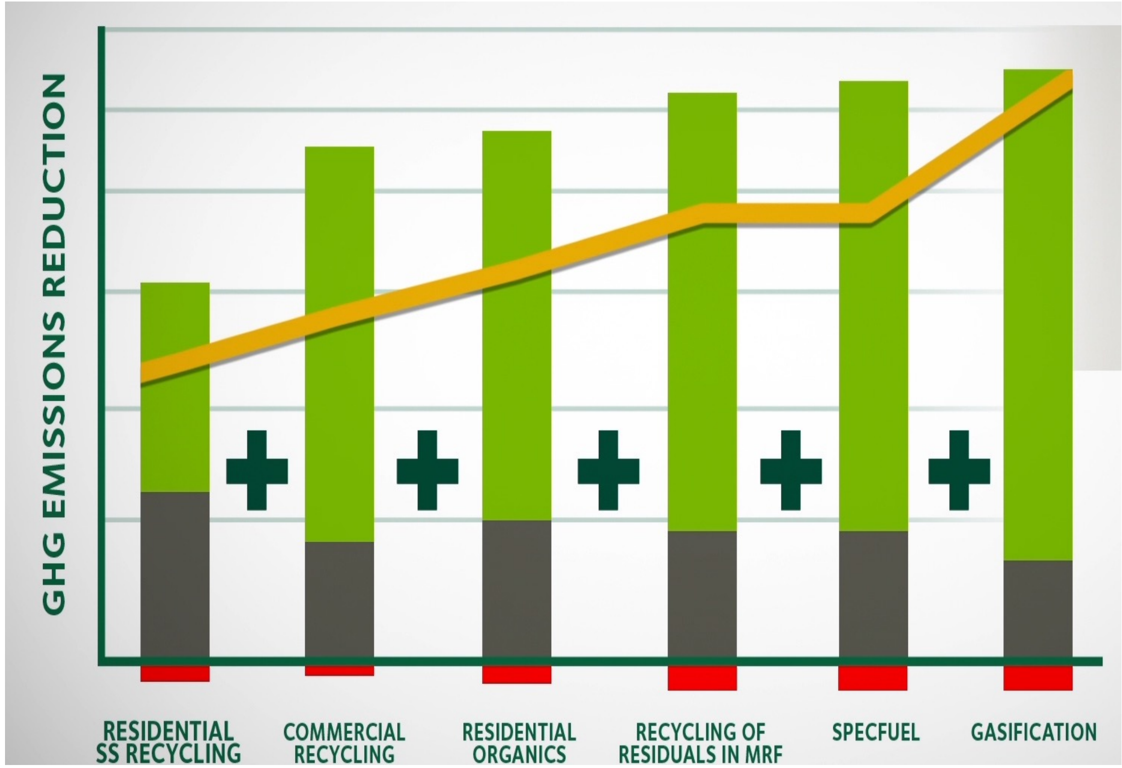

# Project Overview

- Evaluated a range of environmental services, creating scenarios for each
- Analyzed $CO_2$ emissions for each service
- Evaluated cost per ton of emissions for each service
- Used mostly public information and industry-accepted data
- Created a “carbon abatement curve” for the solid waste/recycling industry.

Goal:
To review all services we provide to evaluate environmental impacts of the services we provide and cost of reducing emissions

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# Assumptions


- US EPA 2013 Facts & Figures
- 214 million ton base
- Best practice recycling = 85%
- Food recovery = 50%

- US EPA WARM Model
- GHG emissions focus

- National average disposal cost
- WM collection & processing cost
- 10-year average recycling values

- Assumed Best Practice success for each scenario
- Assumed traditional recyclables = bottles, cans and paper
- Recognized differences between residential and commercial

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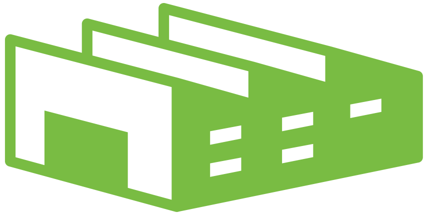
# Scenarios



- **Base scenario:** 72% of MSW tons to landfills with LFGTE, 13% flare and 15% to LF with no LFG capture
- **Best Case Landfill scenario:** 100% of MSW to landfills with LFGTE with better gas capture.

- **RSS:** Residential single stream recycling of 85% paper, cans and bottles
- **CSS:** Commercial singles stream recycling of 85% paper, cans and bottles
- **YW:** 85% composting of yardwaste
- **FW:** 50% composting / AD of foodwaste.

- **RMRF** Process all residual tons after recycling
- **Gasification:** All suitable post-recycling residuals material to gasification

Landfill → Landfill + w/ gas to energy (LFGTE) → Add Residential Recycling → Add Commercial Recycling → Add Residential Yardwaste → Add Foodwaste → Add post recycling residual recycling → Add Gasification

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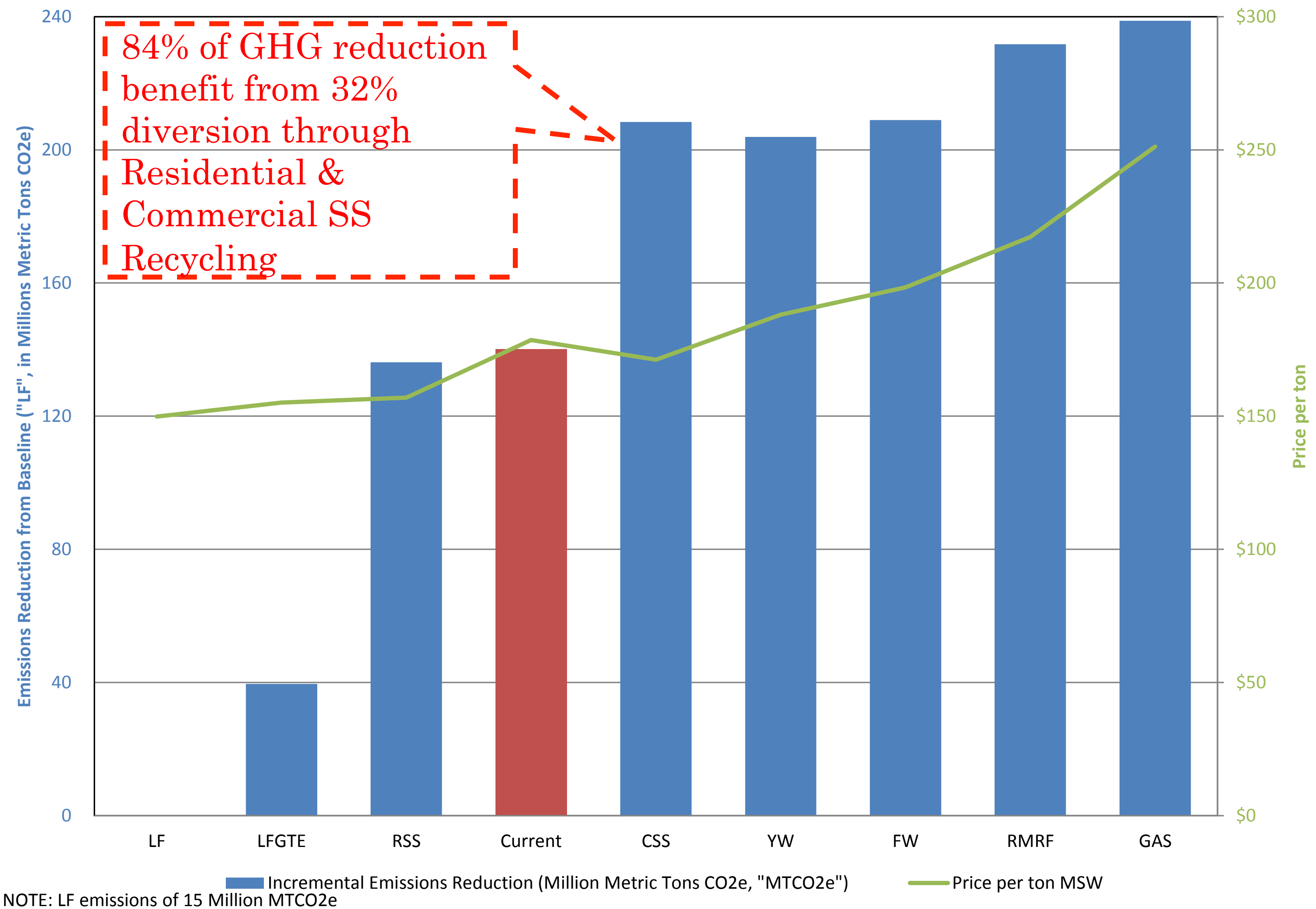
## Overview of GHG emissions and cost




NOTE: LF emissions of 15 Million MTCO2e

- Scenarios build upon each other
- 84% GHG benefit from aggressive LFG capture & use + recycling 32% of MSW
- More processing = high incremental cost for low incremental GHG reduction

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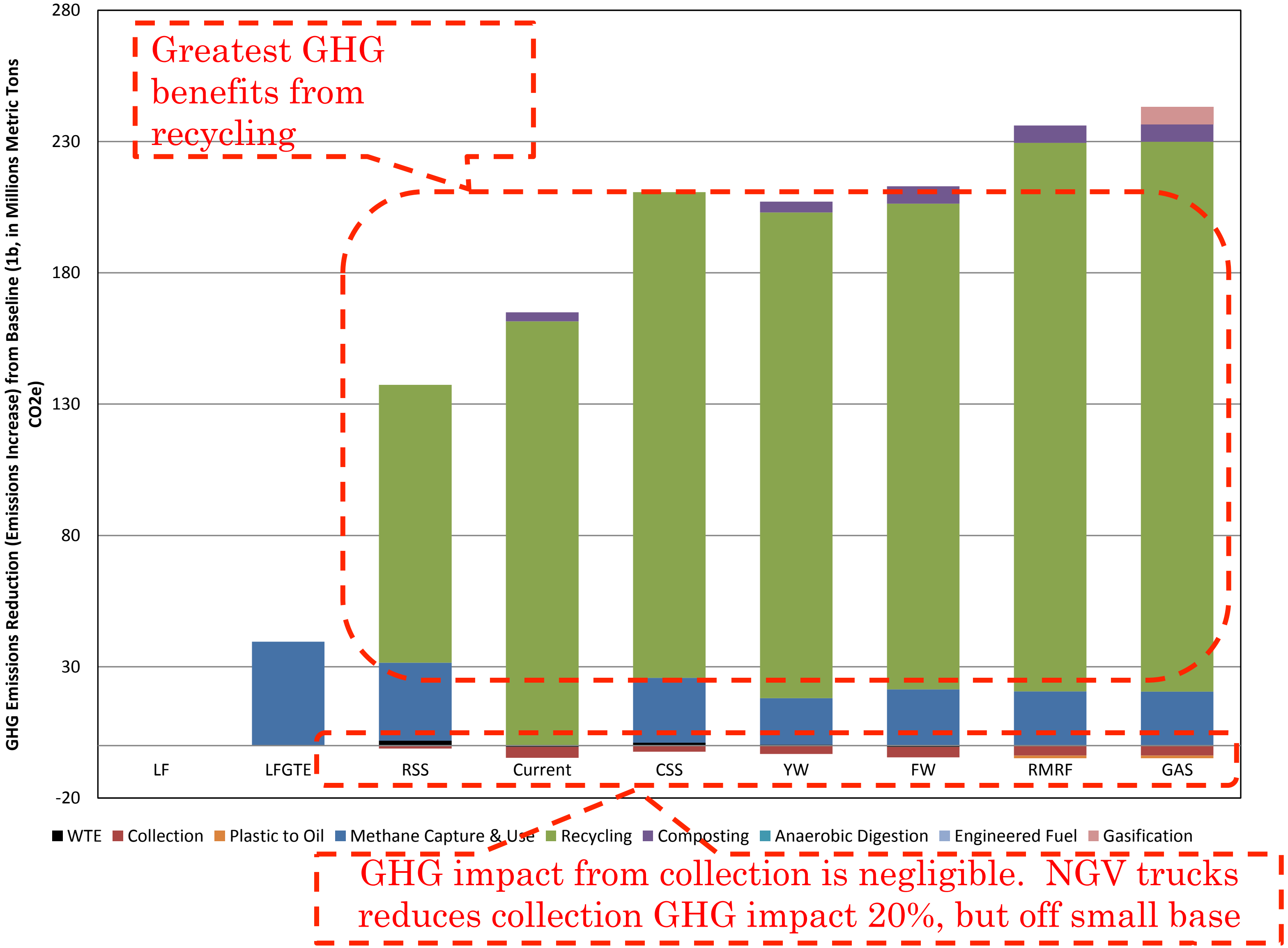
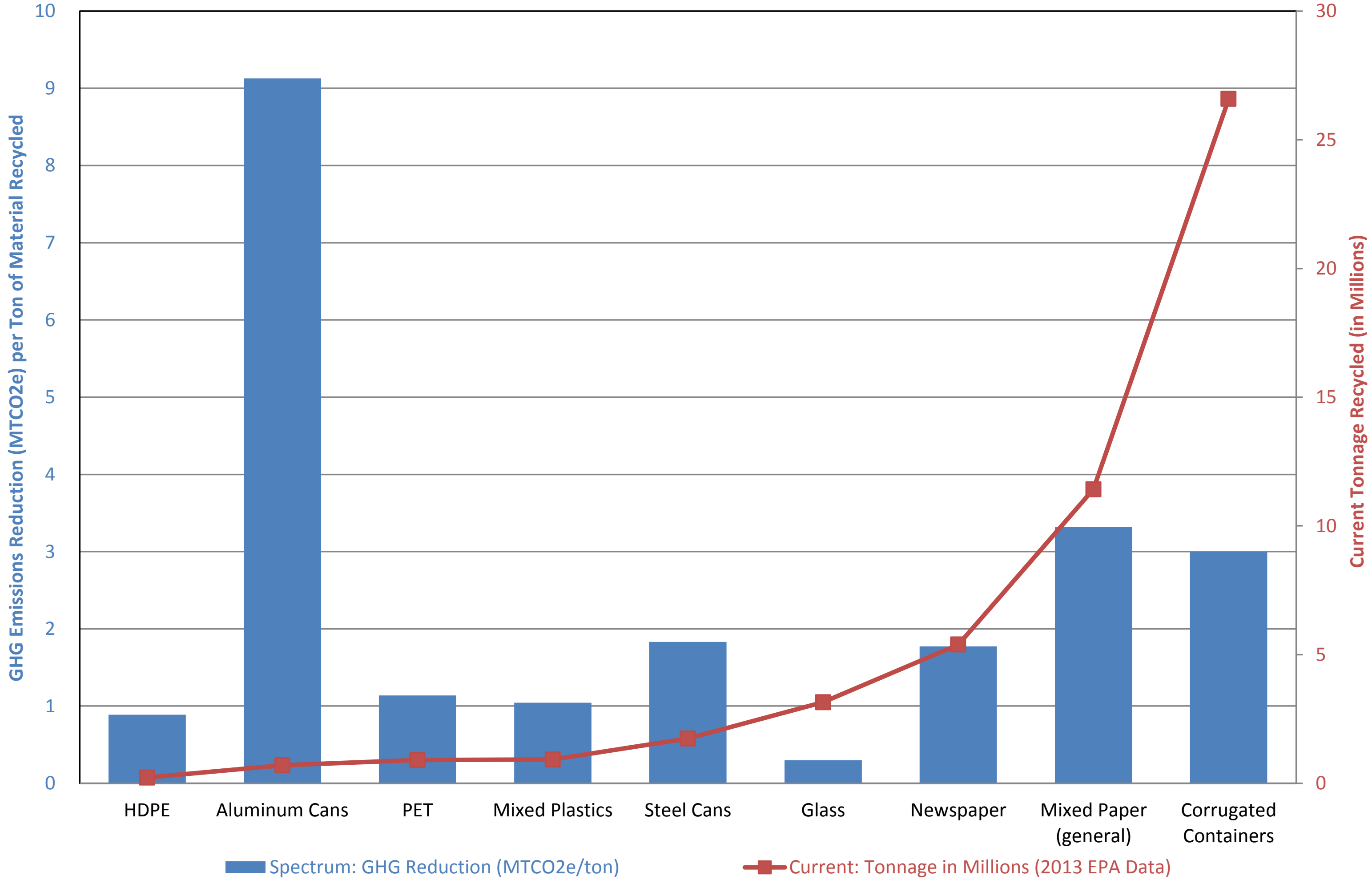
# Recycling drives significant reduction of GHG




- Above x-axis = emissions reductions
- Recycling is bulk of the potential GHG emissions reductions

## Total GHG reduction from recycling is driven by specific commodity tonnages times GHG reduction per ton




NOTE: Tonnage assumes 2013 EPA data, base-case landfill with LFG Recovery for Energy & Aggressive Gas Collection

- Bars are per ton GHG emissions benefits of each material types
- Red line: total tons
- Aluminum: high benefit but low tons
- Cardboard: high tons and good benefit

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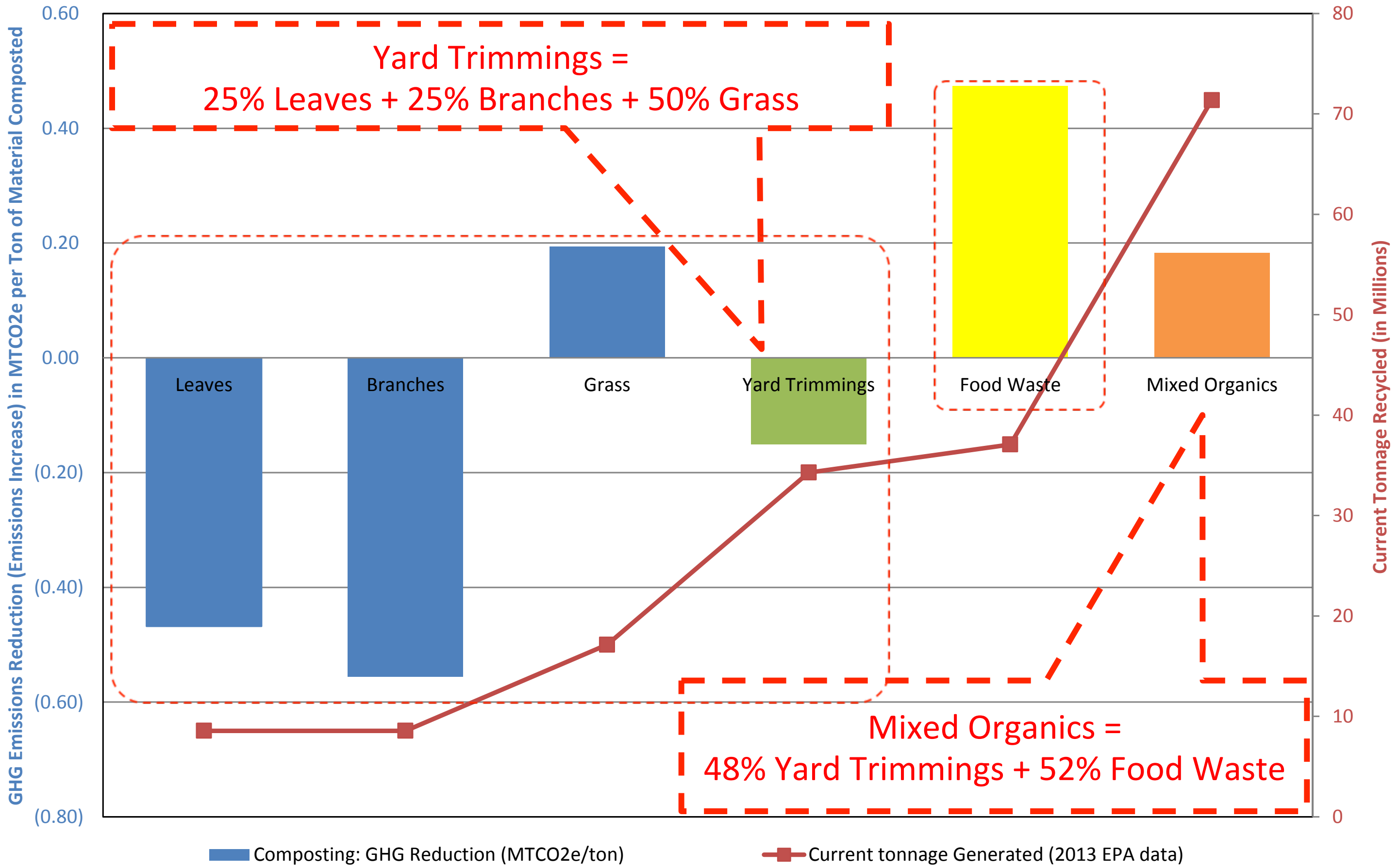
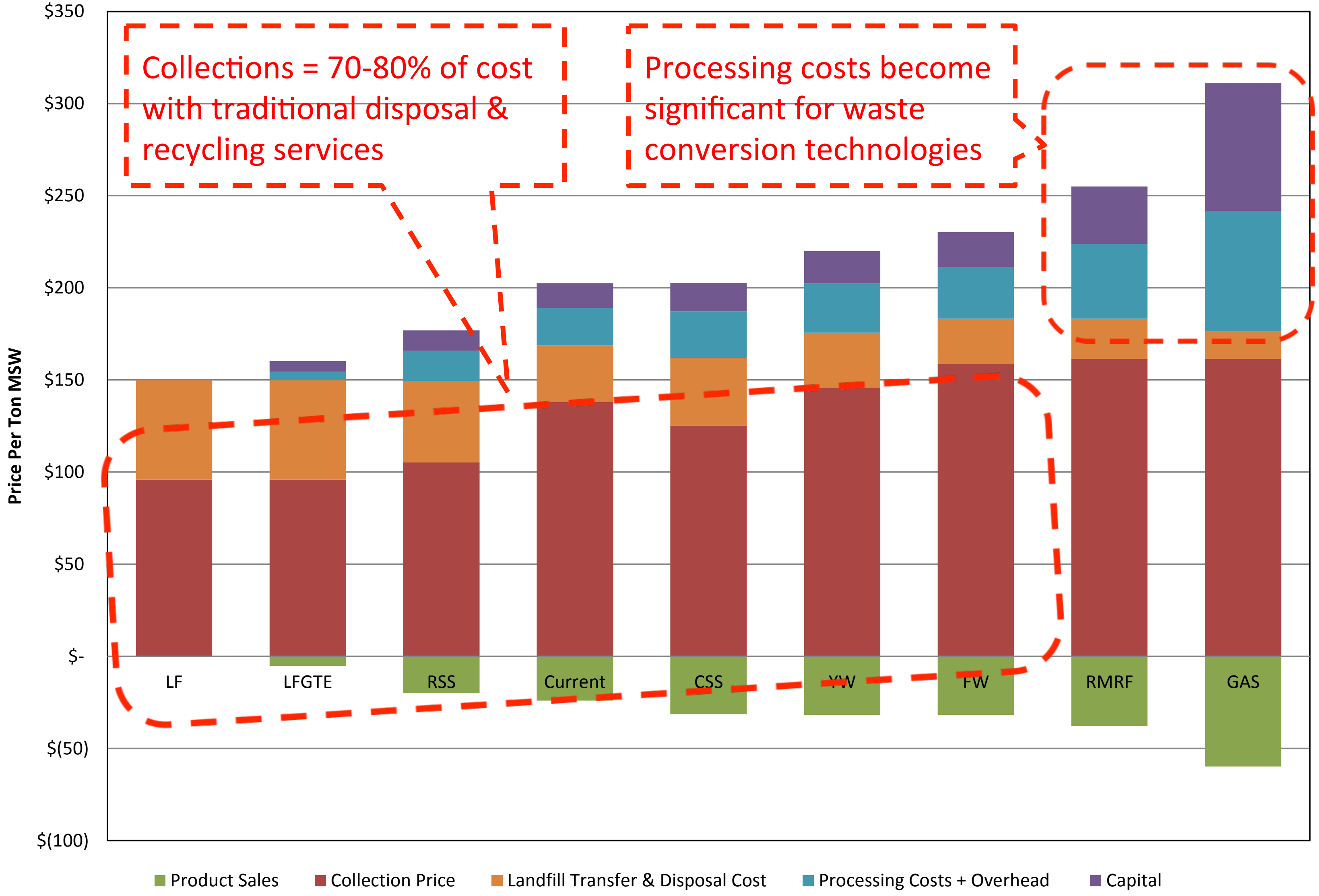
## GHG impact from composting organics depends on specific material; Total impact driven by tonnages times GHG reduction per ton




NOTE: Tonnage assumes 2013 EPA tonnage data & best-case landfill with LFG Recovery for Energy & Aggressive Gas Collection

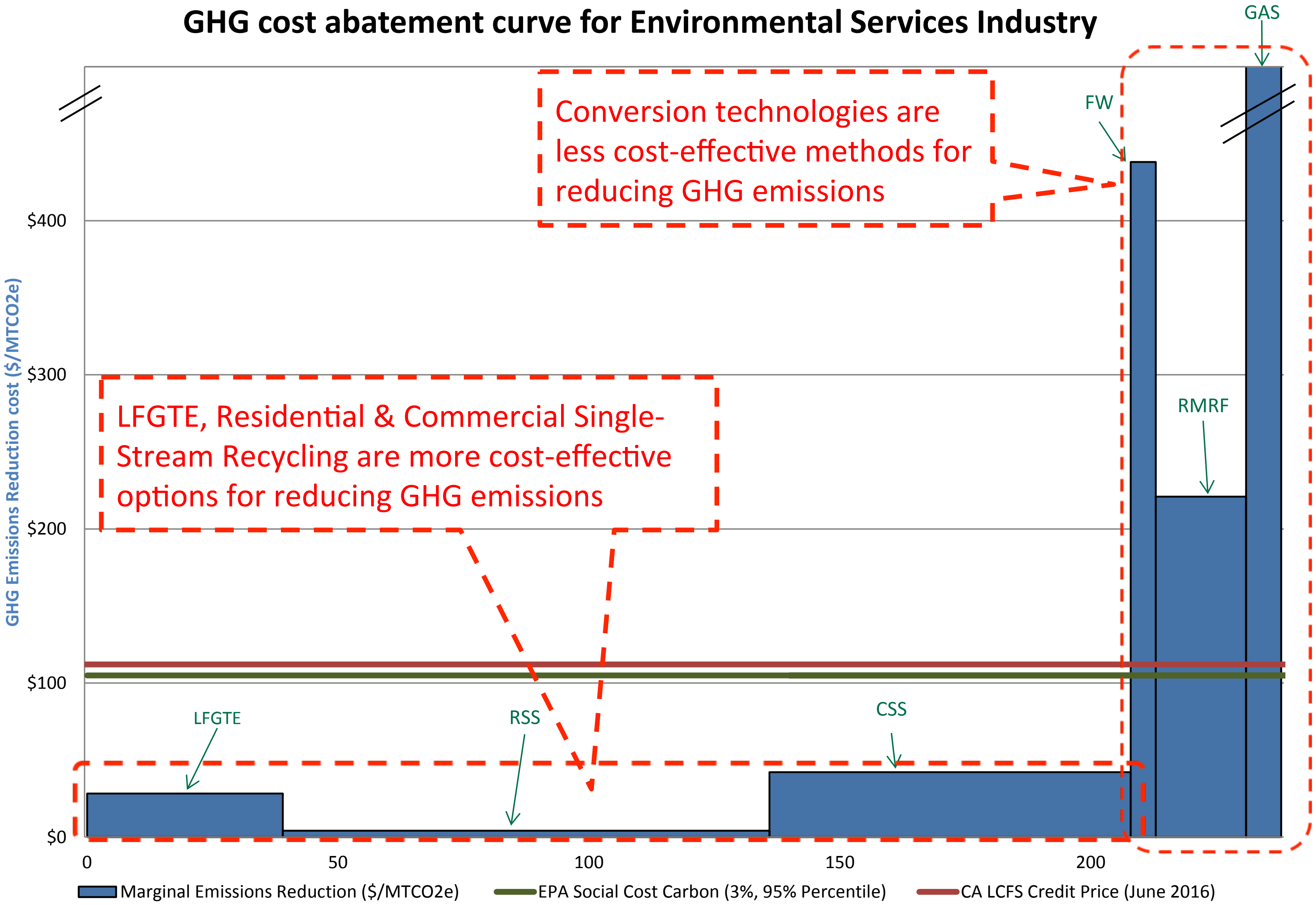
- **Not all organics are created equal in US EPA's latest version of WARM:**
  - ✓ Foodwaste composting: greatest emission reduction potential; grass is next.
  - ✓ Leaves and branches: less emissions in Best Practices landfill (EPA)
- **Mixed Organics in EPA WARM averages all types of organics**:
  - **YW** = grass, leaves & branches **FW** = all FW, including produce, diary, meats

# Price breakdown - by Category




- Collections is 70-80% of integrated costs until post processing options
- Infrastructure cost of new technologies is very high
- Commodity revenue is based on 10-year average blended value

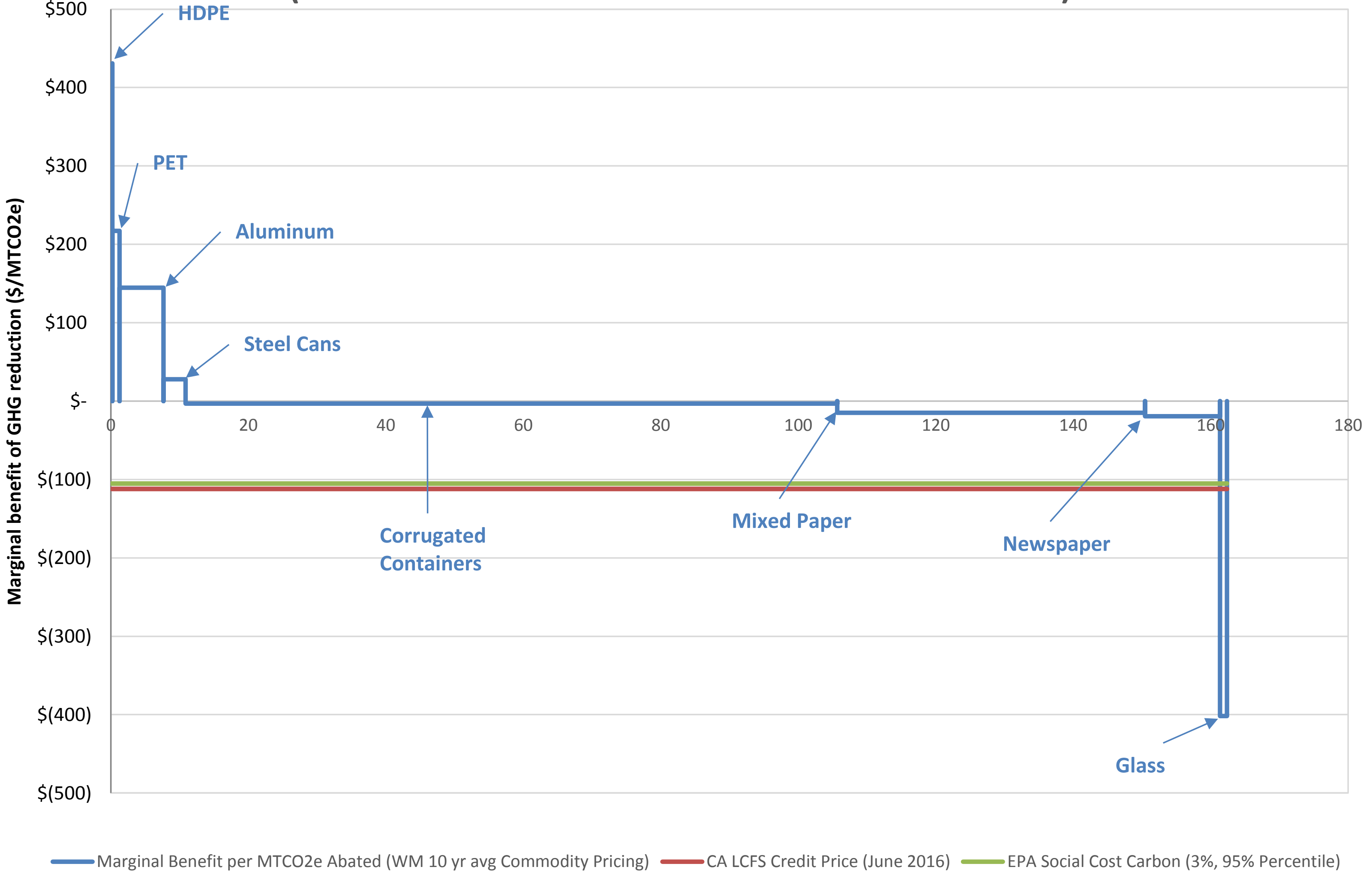
# GHG cost abatement curve for Environmental Services Industry




EPA Social Cost of Carbon: http://www3.epa.gov/climatechange/EPAactivities/economics/scc.html
CA LCFS Credit Price History: http://www.arb.ca.gov/fuels/lcfs/lrtmonthlycreditreports.htm

- Costs plus environmental benefits create a single metric = $/ton of GHG
- Width is amount of GHG reduction, height is cost of GHG reduction
- Also includes LCFS & EPA social cost of carbon as proxies

# Marginal GHG reduction benefit by material type (COLLECTION + PROCESSING + AVOIDED DISPOSAL)




Assumes: WMRS variable processing cost by material type, 10 yr avg WM commodity pricing, 2013 EPA recovered tons & LF Baseline for GHG calculations

- Environmental benefits & cost per ton of carbon reduction for recycling only
- Includes collection, processing and commodity values
- Results show the benefits of recycling paper, metal and plastic bottles

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