Recycling and Composting Saves Money, Energy & Pollution Compared to Disposal Via Waste-to-Energy(WTE) Conversion

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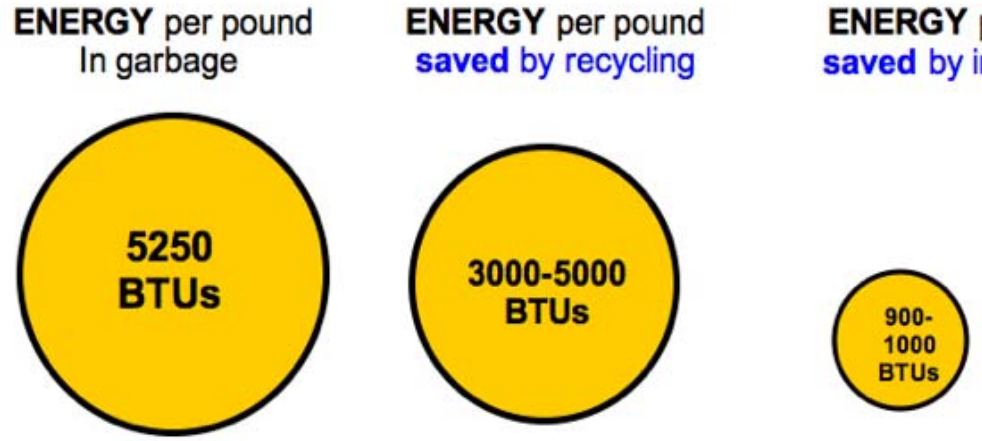
Energy Conservation by Recycling vs. Energy Generation by WTE

WASTE-TO-ENERGY IS A WASTE *OF* ENERGY



RECYCLING SAVES 3-5 TIMES MORE ENERGY THAN INCINERATION

Data Source: Jeffrey Morris

Climate Cooling Benefits of Recycling & Composting

Recycling + Composting = Not Driving

New research shows that a household recycling all of its readily recyclable and compostable waste reduces greenhouse gas emissions as much as if they stopped driving their cars.

Climate Cooling Benefits of Recycling (from WA CEI)

- **Gasoline & Diesel:** capturing 100% of household curbside recyclable materials equivalent to 60% cut in household vehicle fuel & oil use.

- **Electricity:** capturing 100% of household curbside recyclable materials equivalent to 10% cut in household electricity use.

- **Meat & Dairy:** capturing 100% of household curbside recyclable materials equivalent to 100% cut in household meat and dairy consumption.

Climate Cooling Benefits of Composting (from WA CEI)

- **Gasoline & Diesel:** capturing 100% of household compostable materials equivalent to 30% cut in household vehicle fuel & oil use.

- **Electricity:** capturing 100% of household compostable materials equivalent to 5% cut in household electricity use.

- **Meat & Dairy:** capturing 100% of household compostable materials equivalent to 50% cut in household meat and dairy consumption.

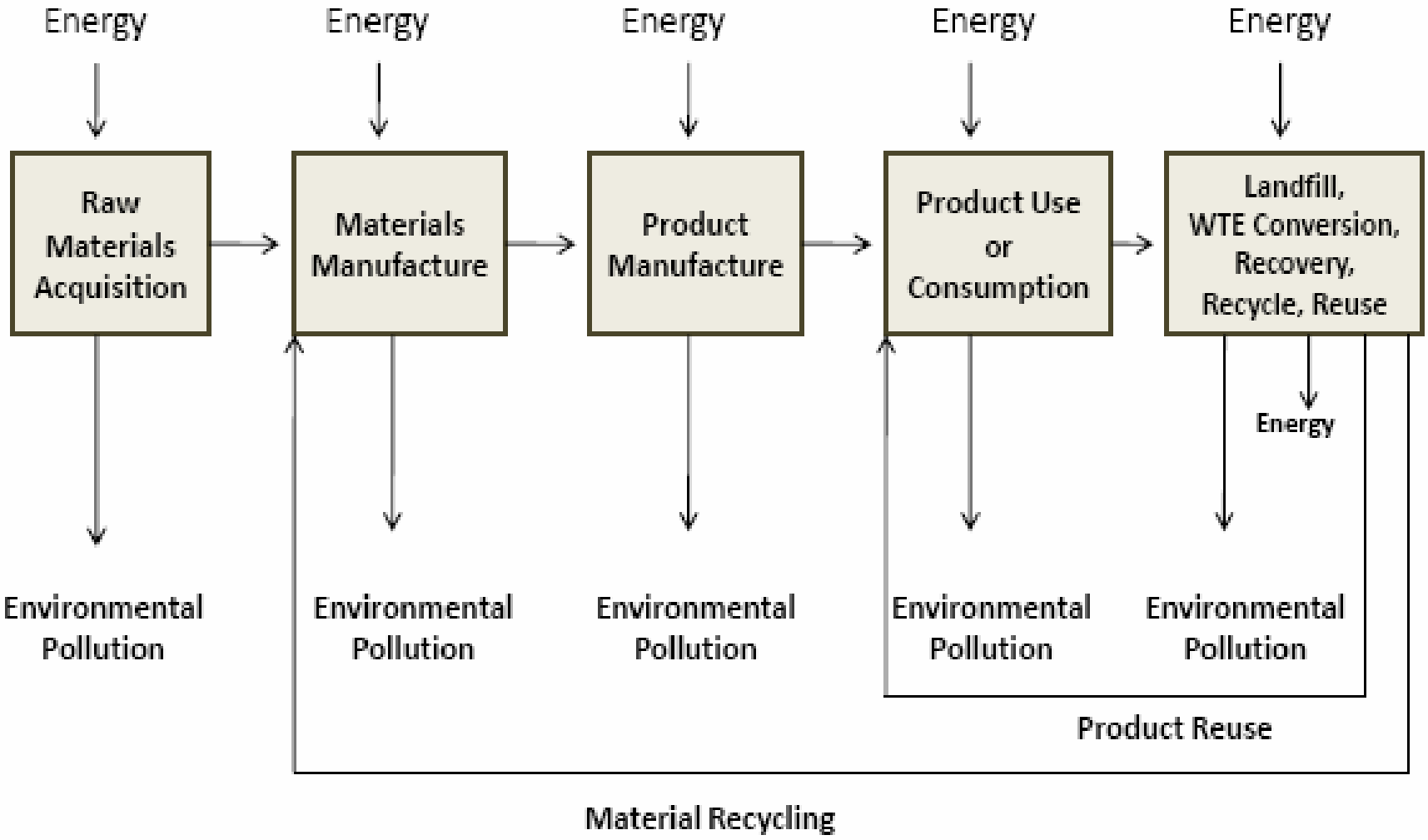
MSW Management GHG (Reductions)/Increase

MSW Management Method	Metro Vancouver (kg/MT)	State of Massachusetts (kg/MT)
Recycling & Composting	(1,790)	(1,920)
Landfill	(127) – (199)	(189)
WTE	203	16

Capital Costs for WTE Disposal

- **Metro Vancouver WTE** – $1.2 billion (1.5 million MT)
- **Montreal WTE** – $0.9 billion
- **King County (WA)** – US$0.6 billion (1 million tons)

Life Cycle Analysis



Life Cycle Impact Categories

- Climate Change
- Human Health – Particulates
- Acidification
- Eutrophication
- Human Health – Toxics
- Human Health – Carcinogens
- Ecosystems Toxicity
- Ozone Depletion
- Smog
- Habitat Disruption
- Biodiversity Depletion
- Ecosystem Services Degradation
- Resource Depletion

Available Models

1. **ICLEI Clean Air Climate Protection (CACP)** (www.iclei-usa.org/action-center/tools/cacp-software)
2. **U.S. EPA Waste Reduction Model (WARM)** (www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html)
3. **Municipal Solid Waste Decision Support Tool (MSW-DST)** (Research Triangle Institute)
4. **Carnegie Mellon Economic Input-Output Life Cycle Assessment (EIO-LCA)** (www.eiolca.net)
5. **National Institute of Standard and Technology Building for Environmental and Economic Sustainability (BEES)** (www.bfri.nist.gov/oae/software/bees/model.html)
6. **U.S. EPA Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI)** (www.epa.gov/nrmrl/std/sab/traci/)
7. **Morris Environmental Benefits Calculator (MEBCALC)** (Sound Resource Management website: www.zerowaste.com)
8. **National Recycling Coalition (NRC) Calculator** (www.nrc-recycle.org)
9. **Northeast Recycling Council (NERC) Calculator** (www.nerc.org)
10. **Consumer Environmental Index (CEI)** (www.zerowaste.com)

Additional Data Used in MEBCALC &CEI

- **EPA AP-42** emissions data (www.epa.gov/ttn/chief/ap4)
- **WA Department of Ecology** vehicle and home fuels air emissions data
- **MA Department of Environmental Protection** emissions data for existing MA WTE facilities and prospective conversion WTE facilities (gasification and pyrolysis)

References

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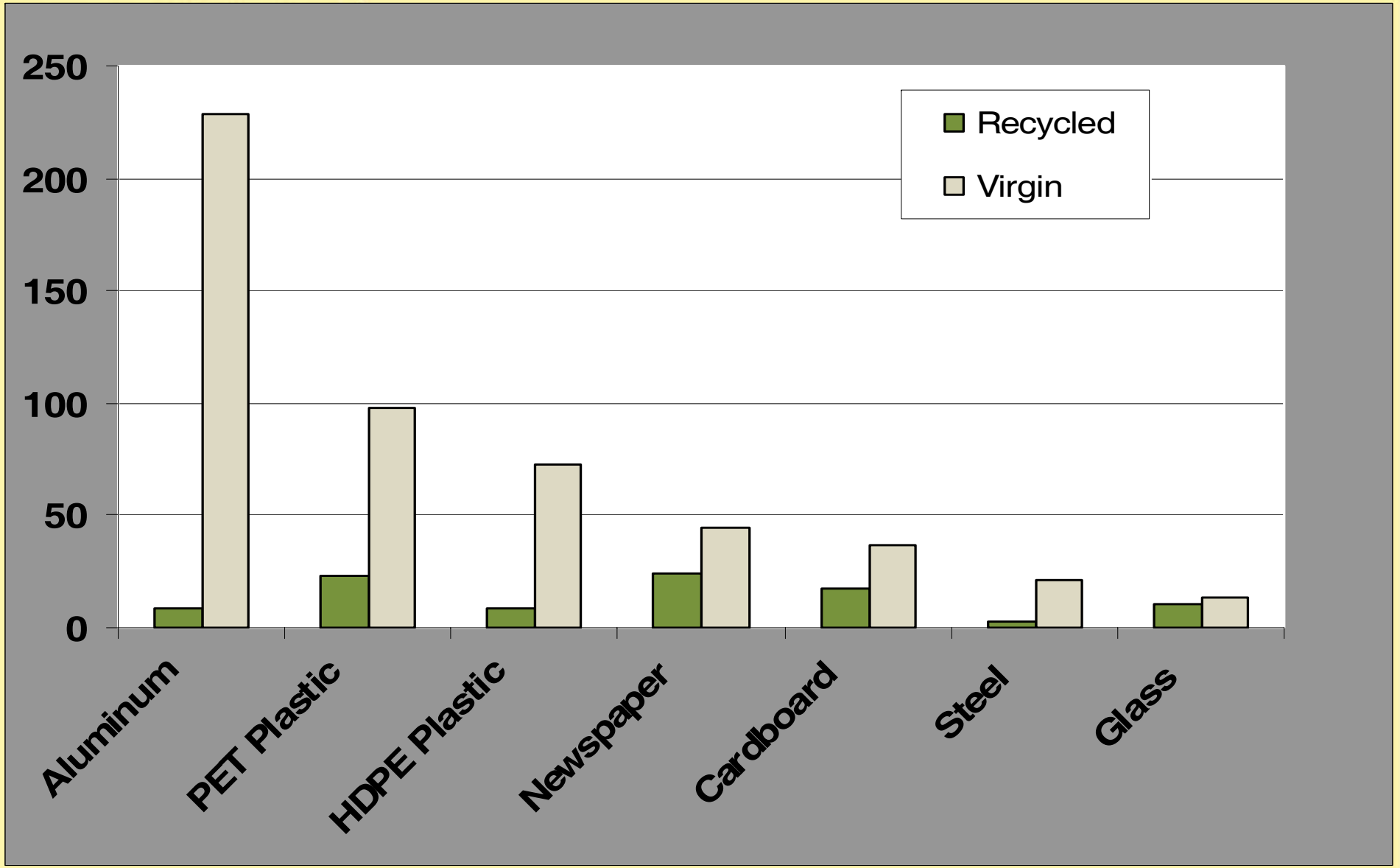
- Hendrickson, Chris T., L.B. Lave, H.S. Matthews, F.C. McMichael, H. MacLean, G. Cicas, D. Matthews, and J. Bergerson (2006). ***Environmental Life-Cycle Assessment of Goods and Services: An Input-Output Approach***. RFF Press, Washington, DC.
- Morawski, Clarissa, The New "Eco-Currency": New model monetizes environmental benefits and reveals new cost savings in waste diversion, ***Solid Waste & Recycling***, December/January 2008.
- Morris, Jeffrey (1996). Recycling versus incineration: An energy conservation analysis, ***Journal of Hazardous Materials*** 47 277-293.
- Morris, Jeffrey (2005). Comparative LCAs for curbside recycling versus either landfilling or incineration with energy recovery, ***International Journal of Life Cycle Assessment*** 10(4) 273-284.
- Morris, Jeffrey, and Jennifer Bagby (2008). Measuring environmental value for natural lawn and garden care practices, ***International Journal of Life Cycle Assessment*** 13(3) 226-234.
- R. W. Beck, Comparative Evaluation of Waste Export and Conversion Technologies Disposal Options, prepared for King County Department of Natural resources and Parks Solid Waste Division, draft 2007.
- Sound Resource Management, The Washington State Consumer Environmental Index (CEI), prepared for the Washington State Department of Ecology, July 31, 2007.

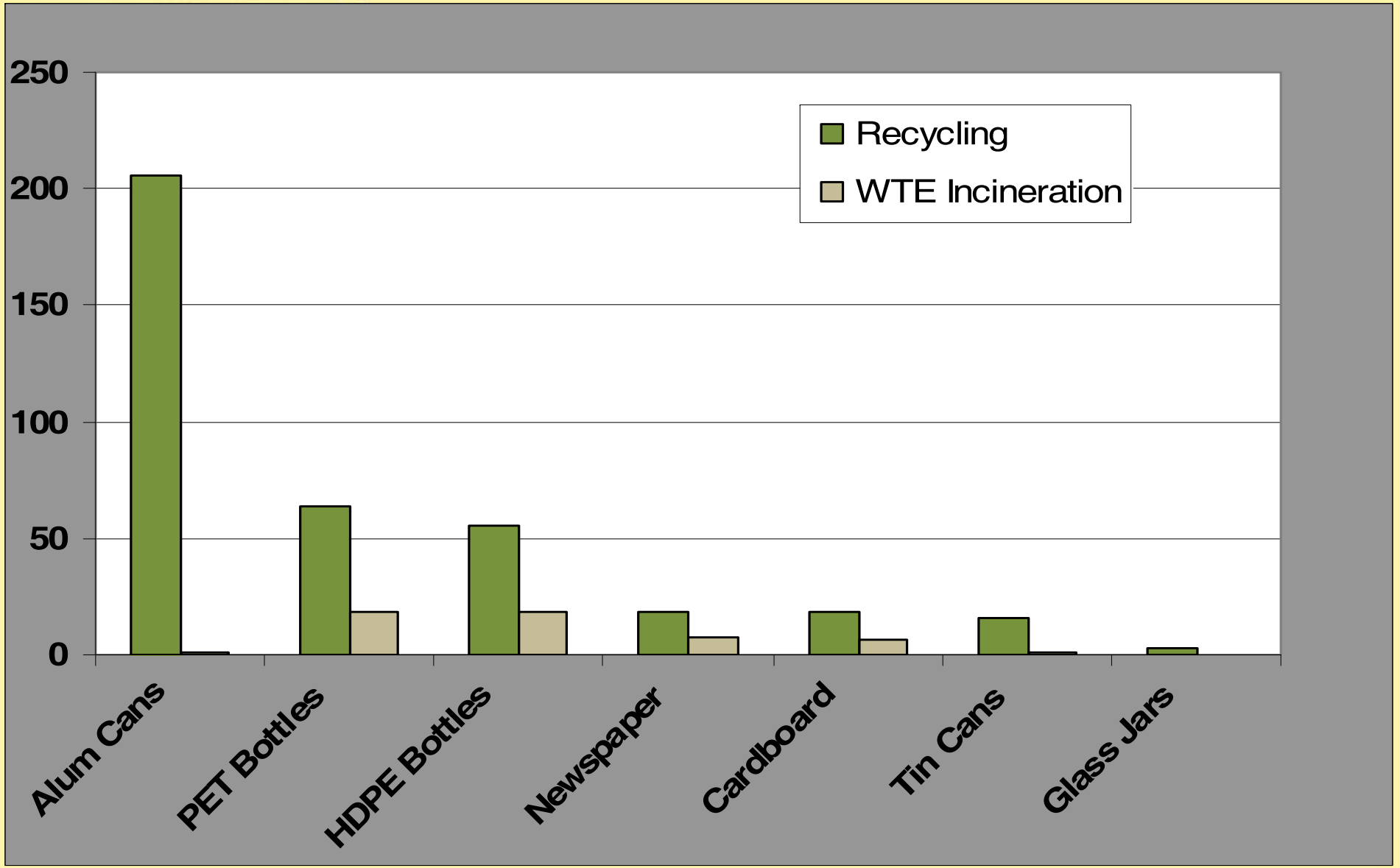
Definitions of Terms on Graphs

1. Recycling: closed loop material recycling
2. Composting: aerobic composting
3. WTE Incineration: mass burn thermal conversion/ advanced thermal recycling (offset to natural gas powered electricity generation)
4. Gasification/Pyrolysis: averages for advanced thermal conversion technologies (offset to nat. gas electricity)
5. Landfill+Energy: 75% methane capture & conversion to electricity via an internal combustion engine (offset to natural gas electricity)
6. Recycled: closed loop discarded-materials-content products
7. Virgin: newly extracted raw-materials-content products

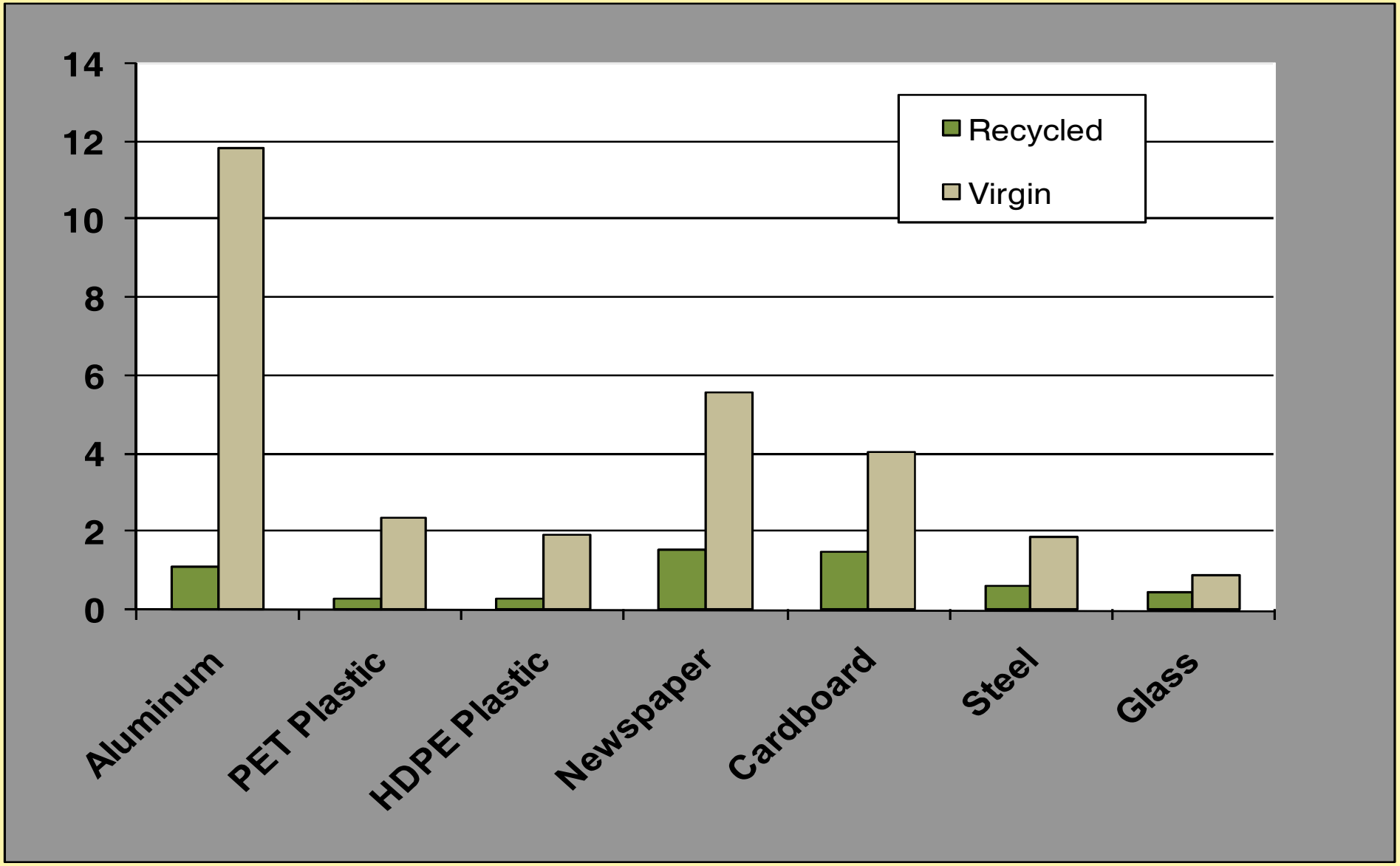
Energy Use: Recycled & Virgin Content Products (million Btus/ton)



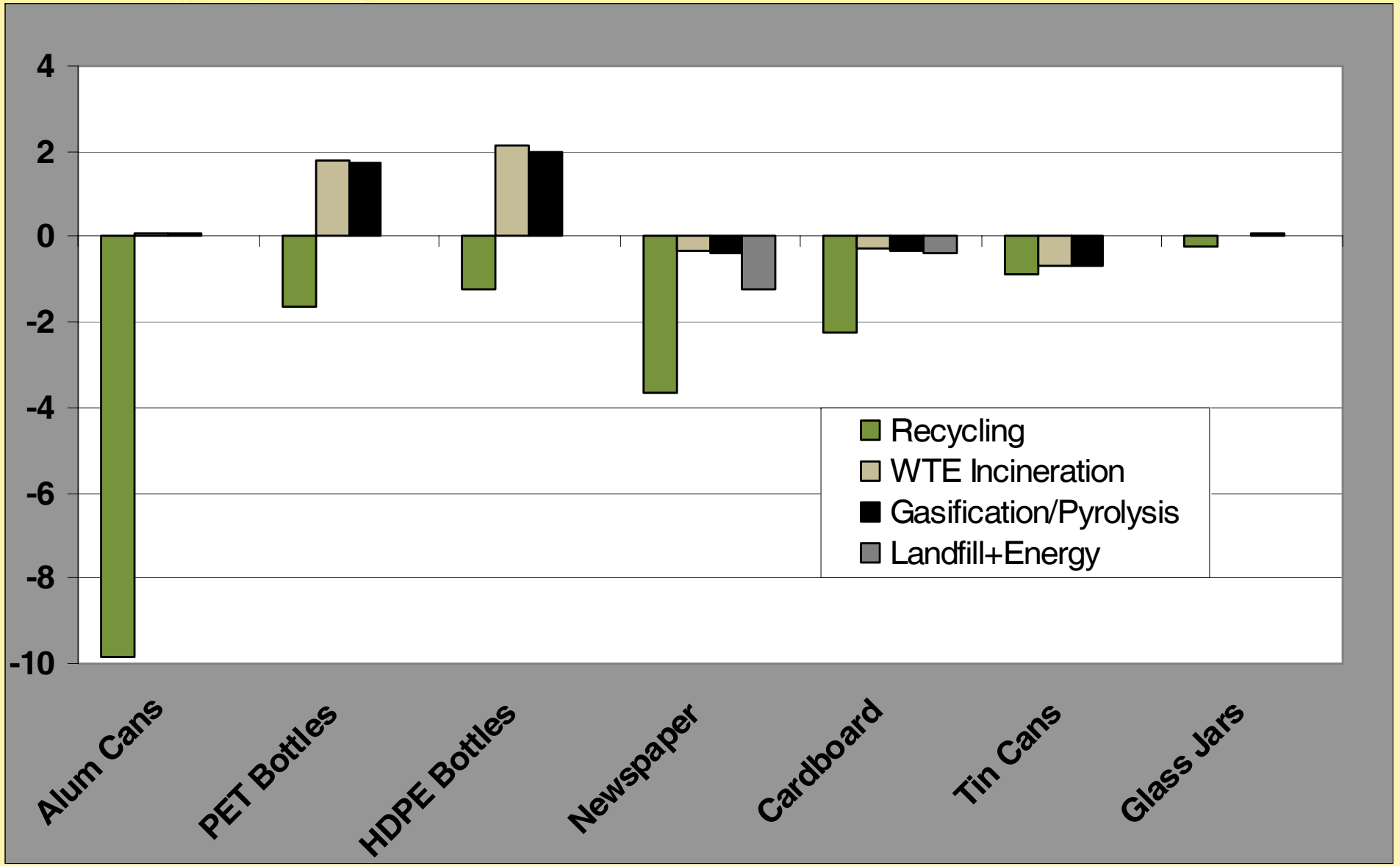
Energy Savings: Recycling vs. WTE Incineration (million Btus/ton)



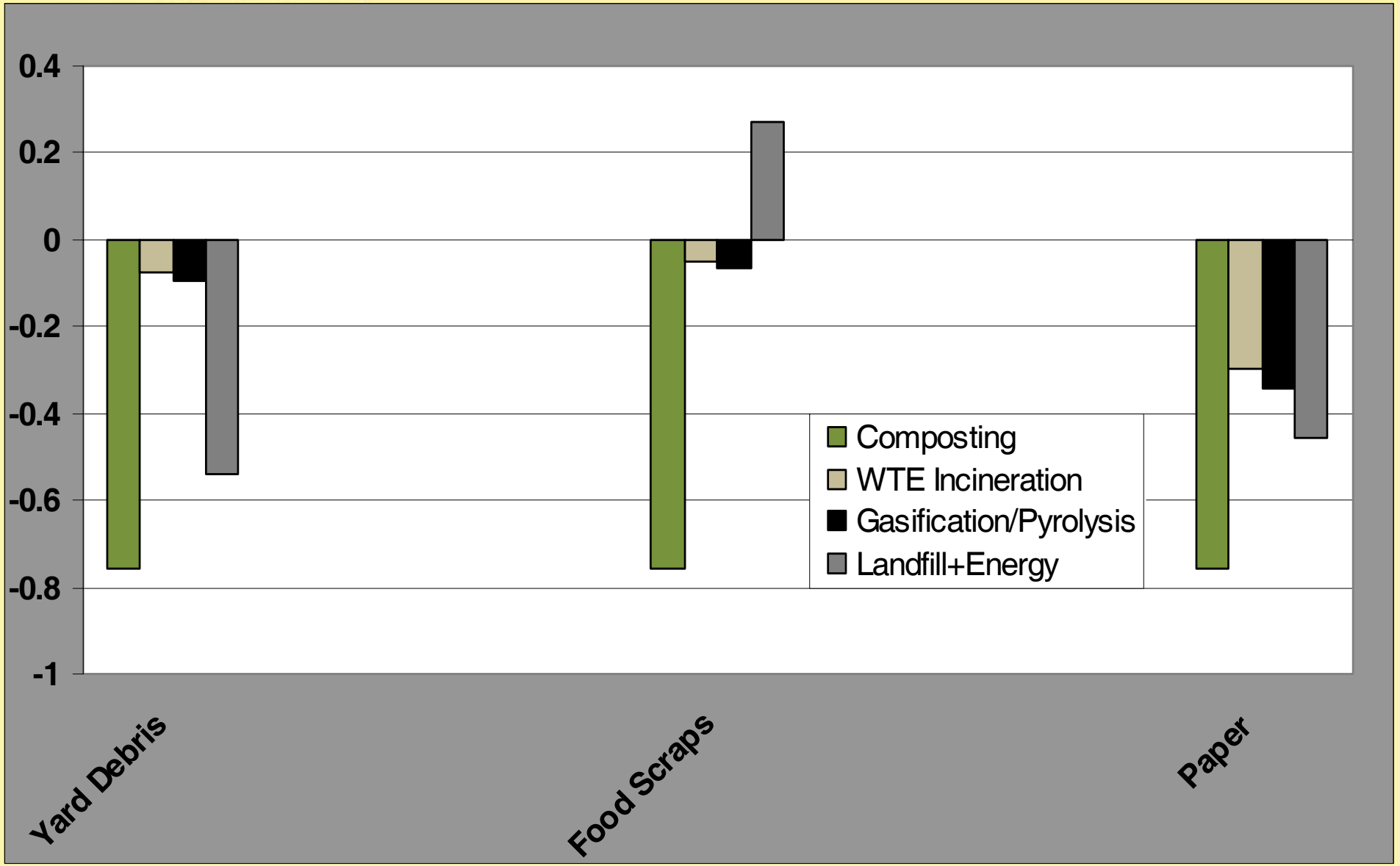
CO_2 Emissions: Recycled &Virgin Content Products ($MT\ eCO_2/MT$)



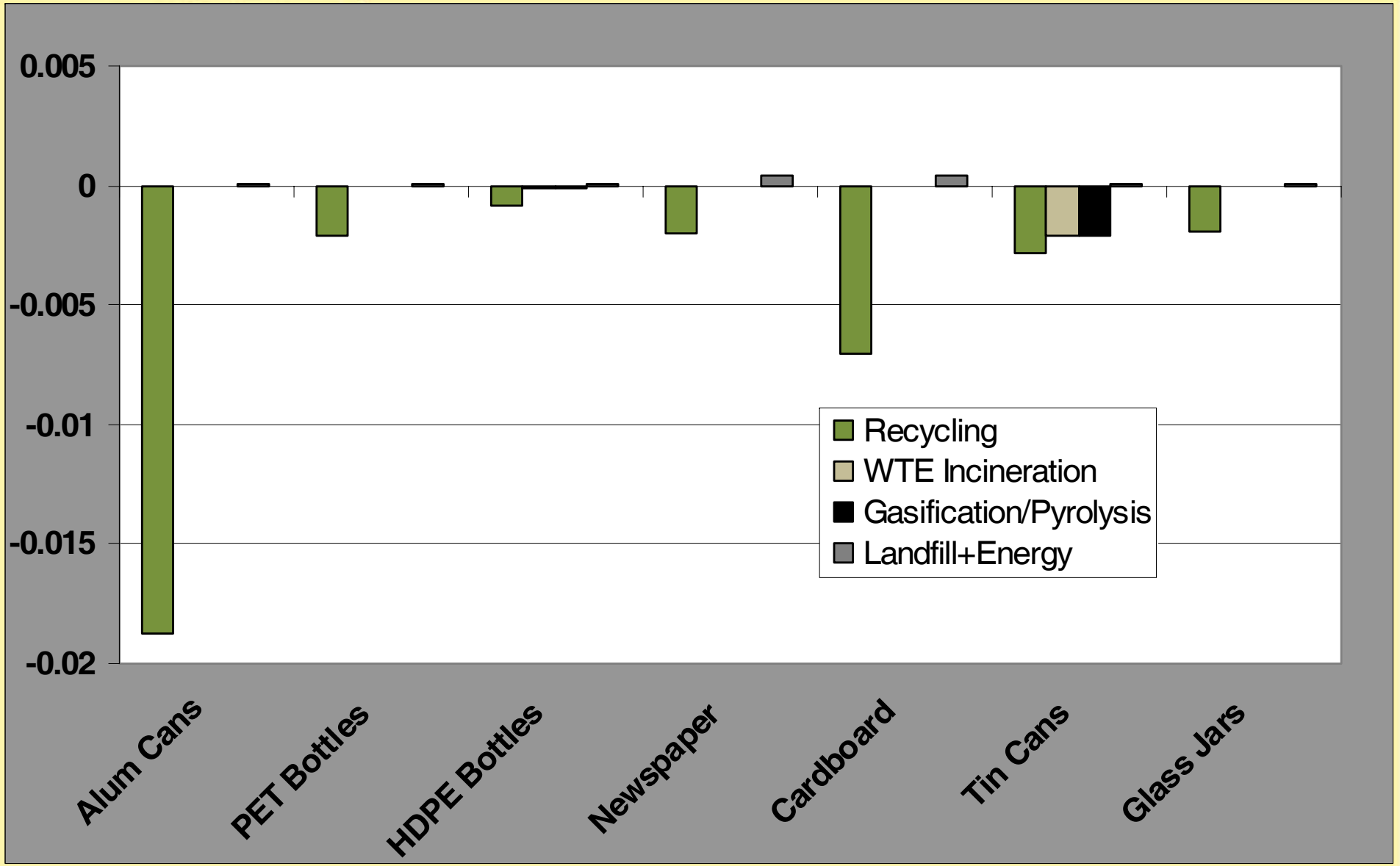
CO_2 Emissions: Recycling vs. Disposal (MT eCO_2/MT)



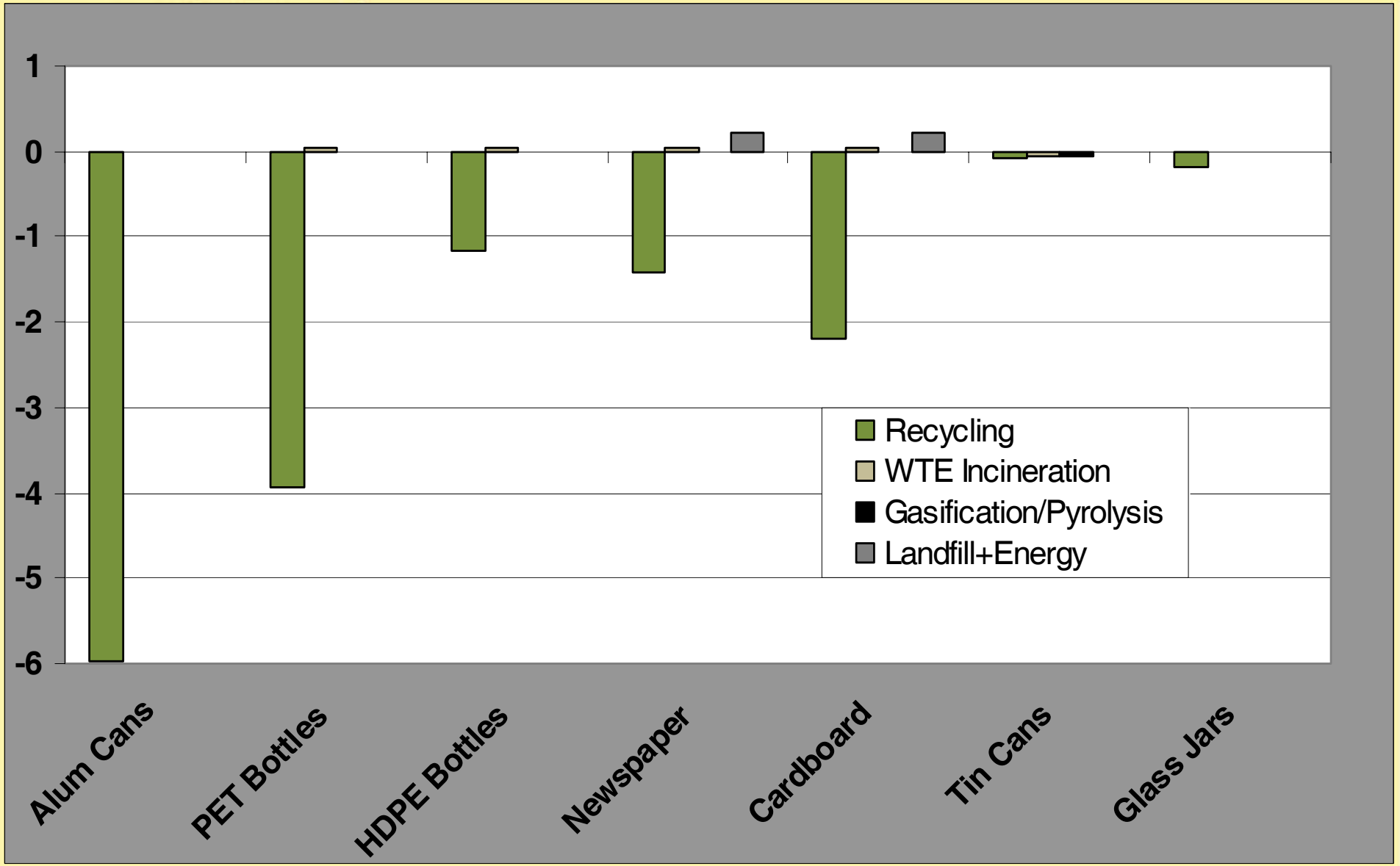
CO_2 Emissions: Composting vs. Disposal ($MT\ eCO_2/MT$)



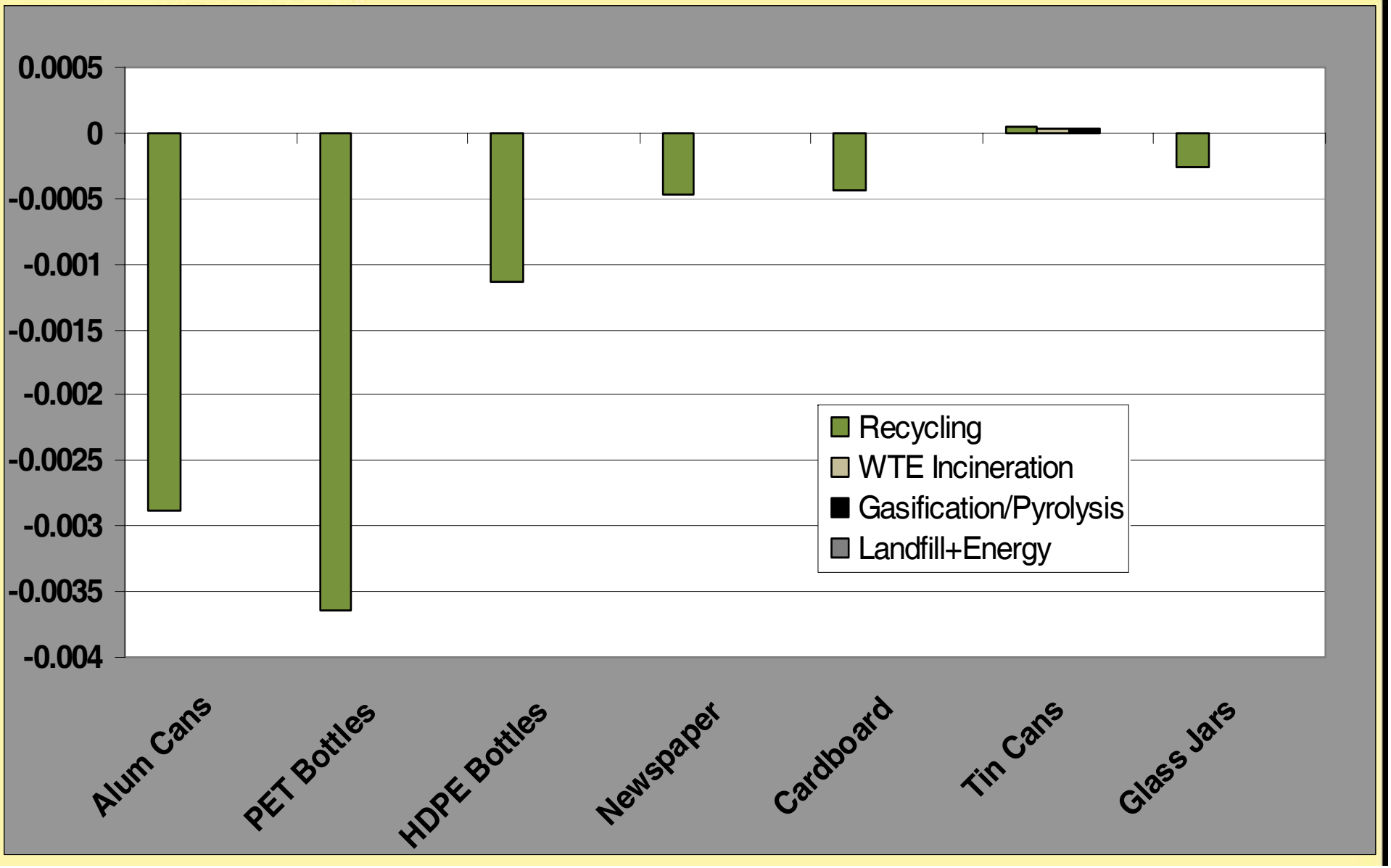
Particulate Emissions: Recycling vs. Disposal (MT ePM2.5/MT)



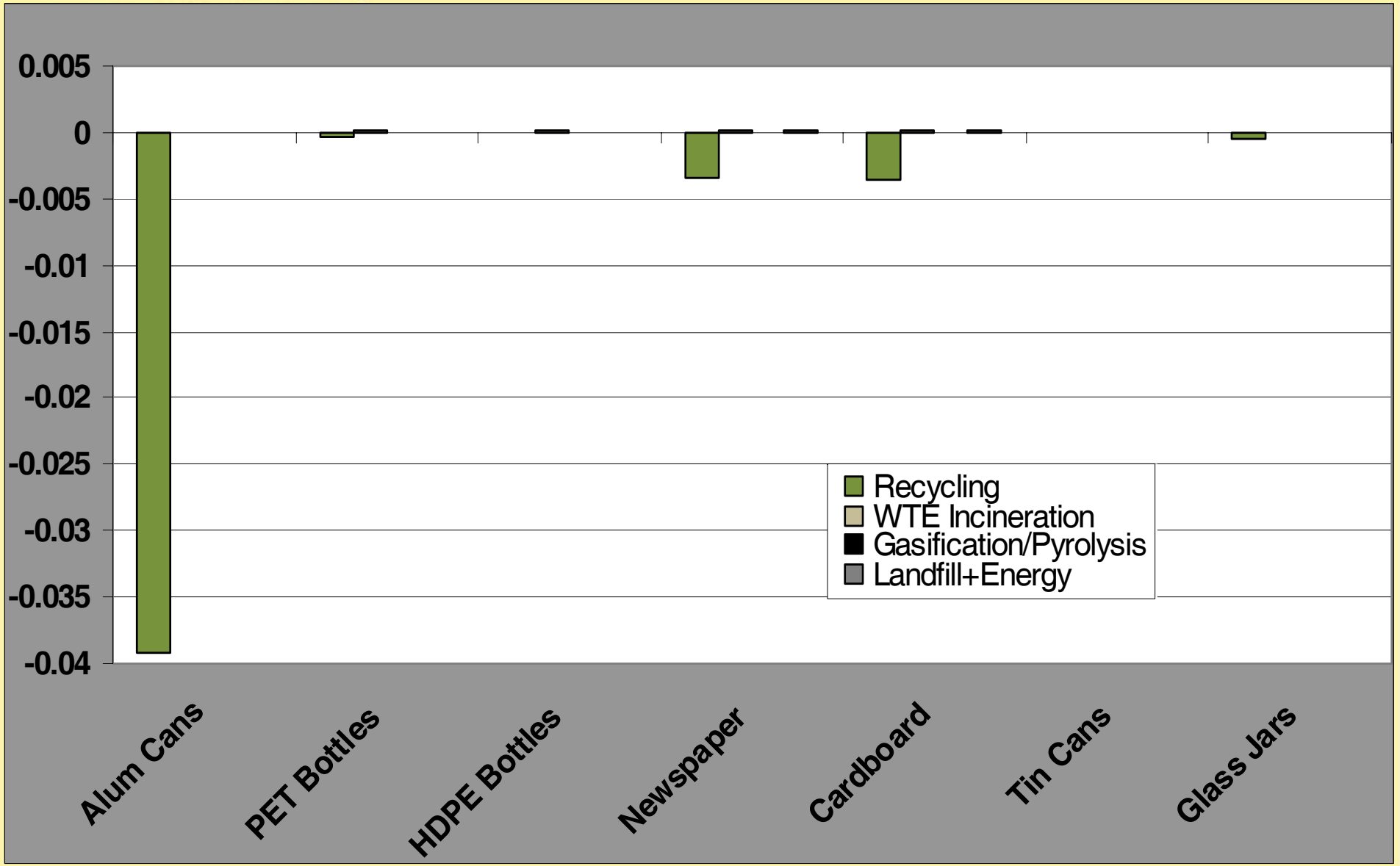
Toxics Emissions: Recycling vs. Disposal (MT eToluene/MT)



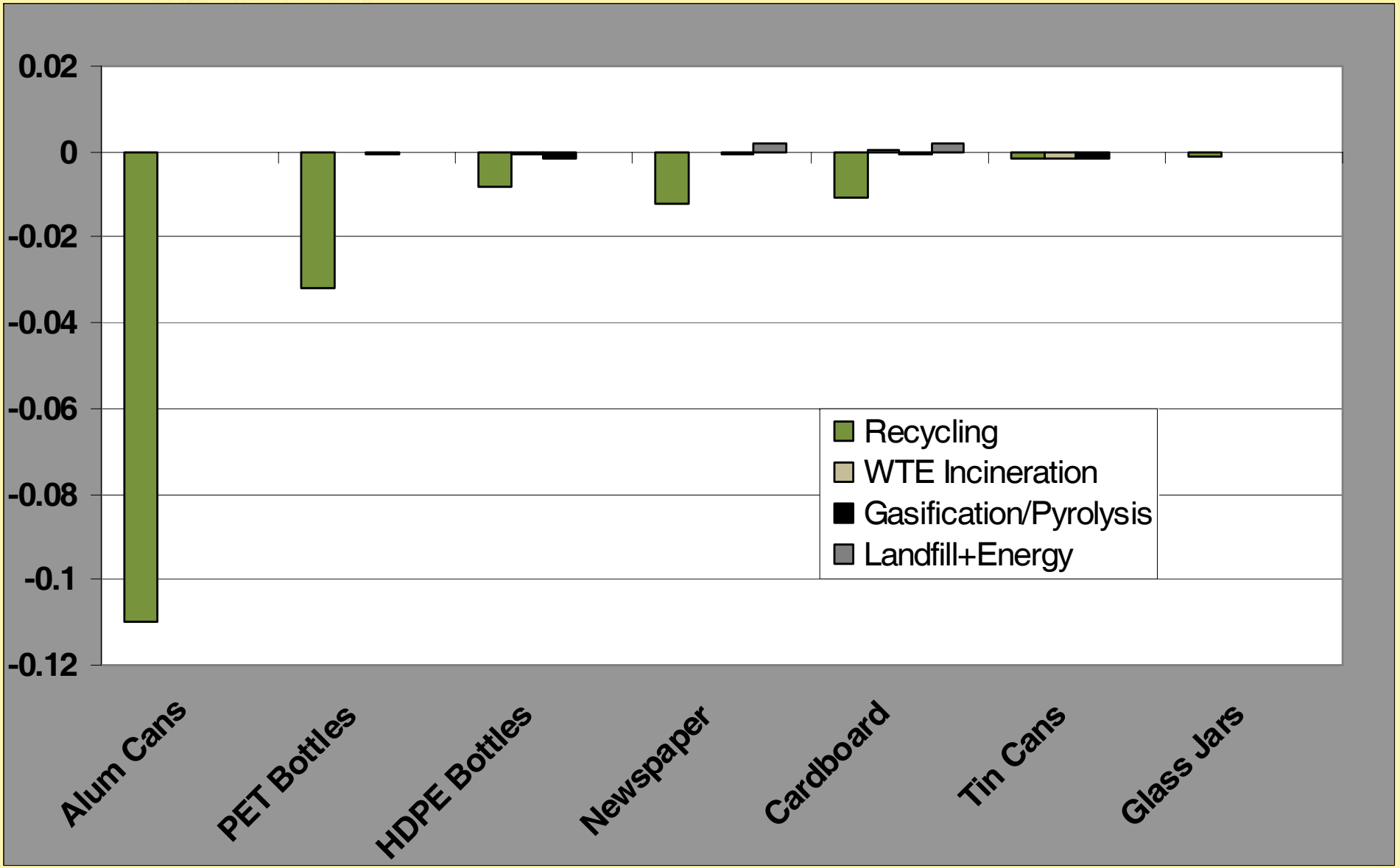
Carcinogenic Emissions: Recycling vs. Disposal (MT eBenzene/MT)



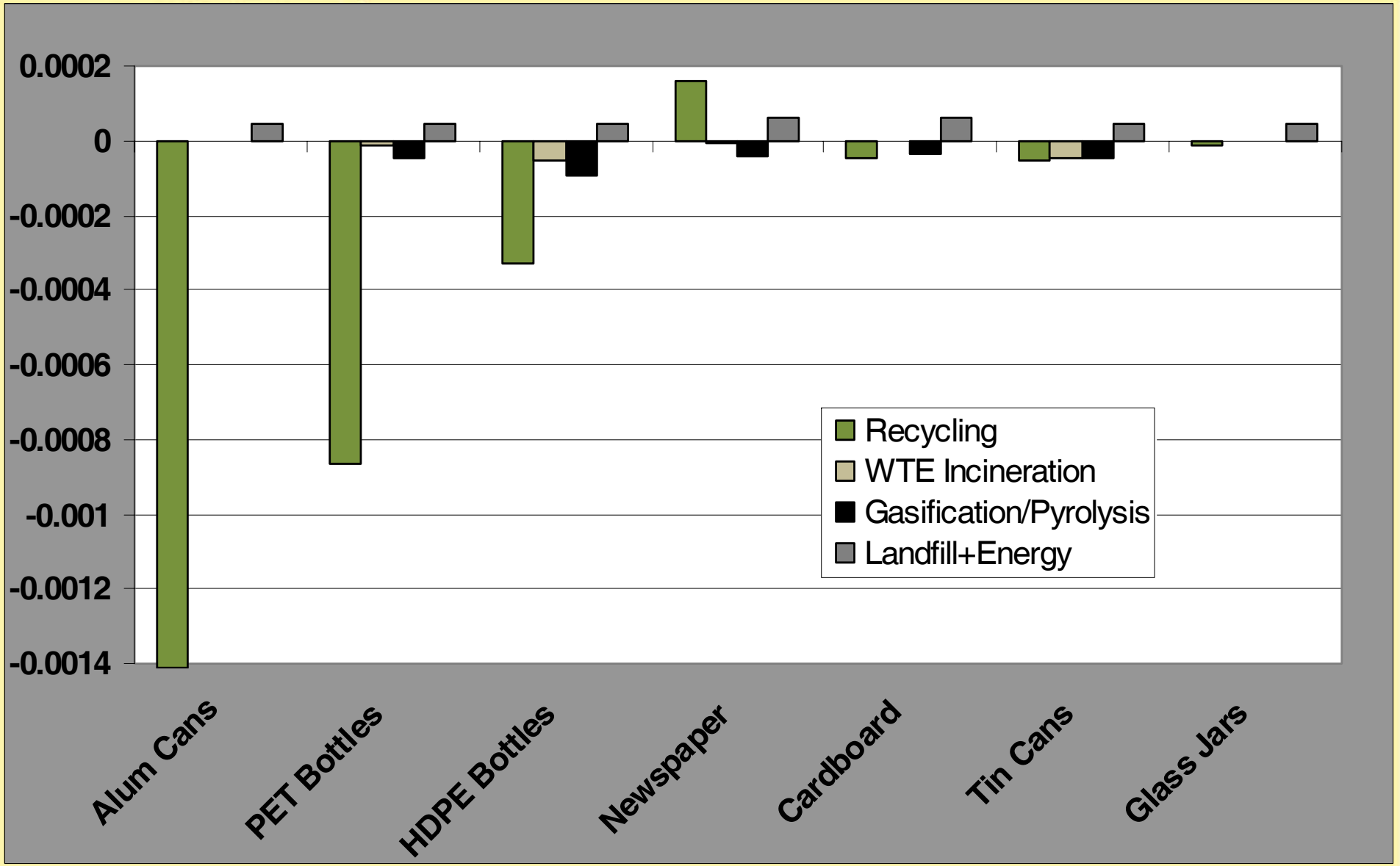
EcoToxics Emissions: Recycling vs. Disposal (MT e2,4-D/MT)



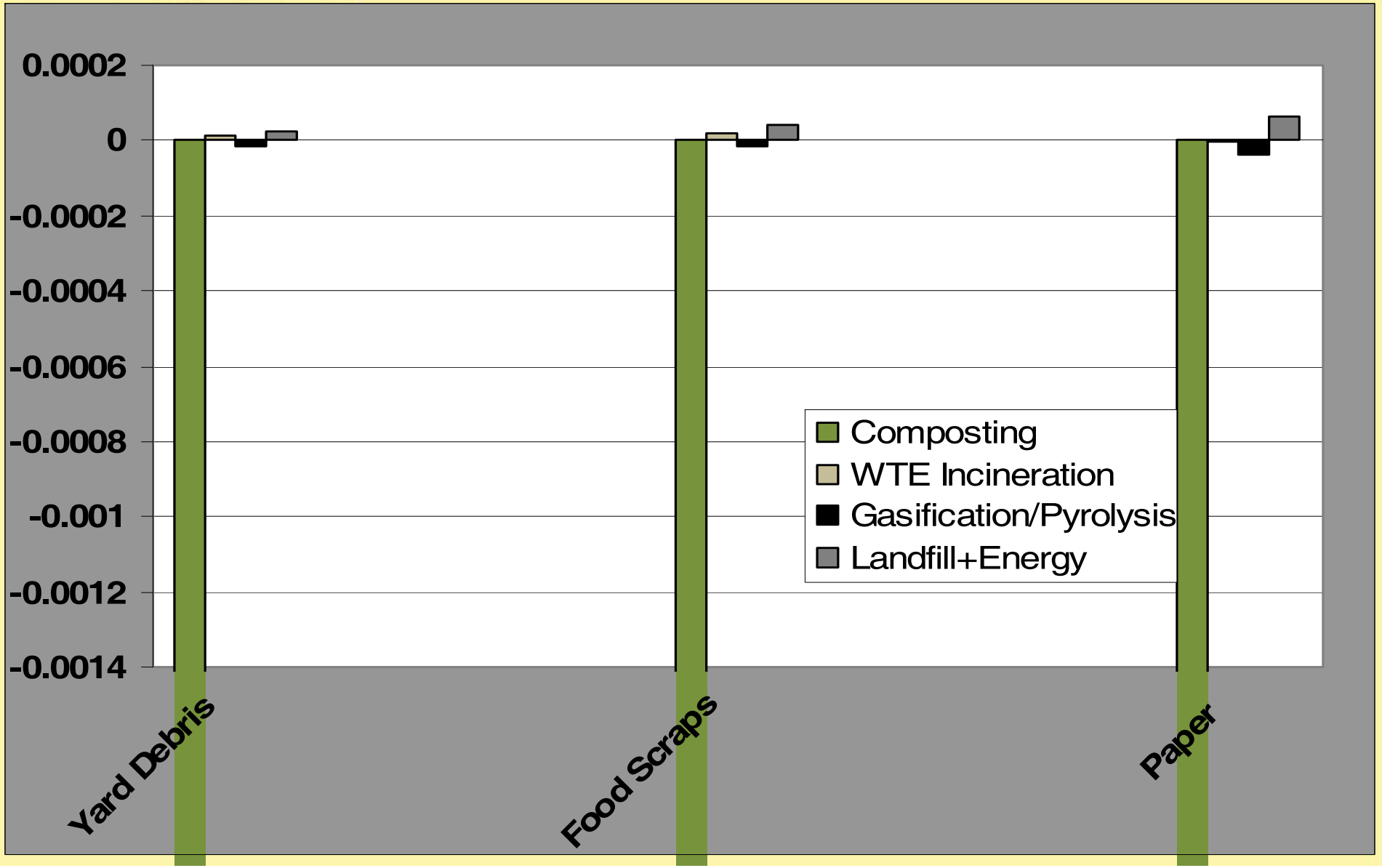
Acidifying Emissions: Recycling vs. Disposal (MT eSO2/MT)



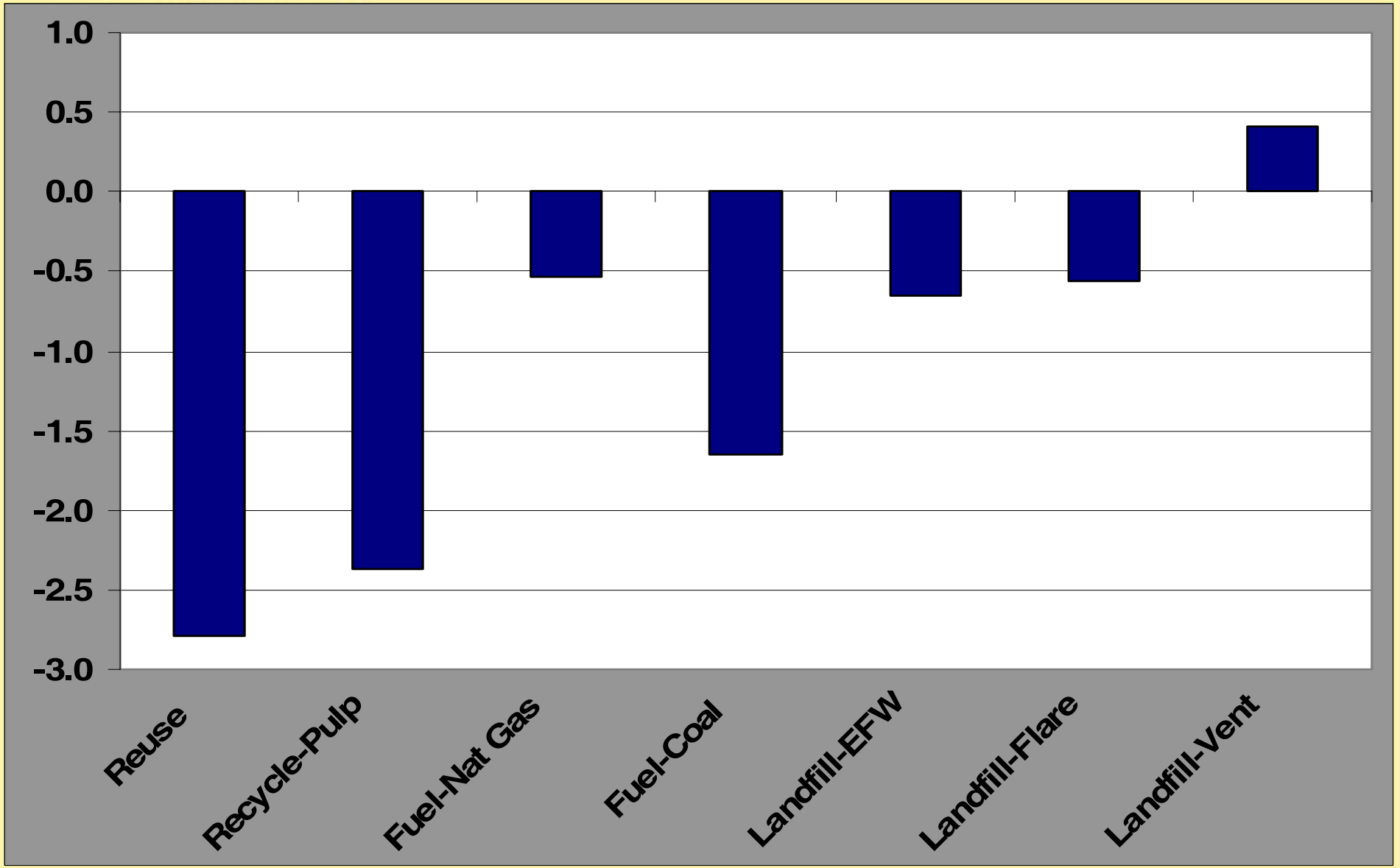
Eutrophying Emissions: Recycling vs. Disposal (MT eN/MT)



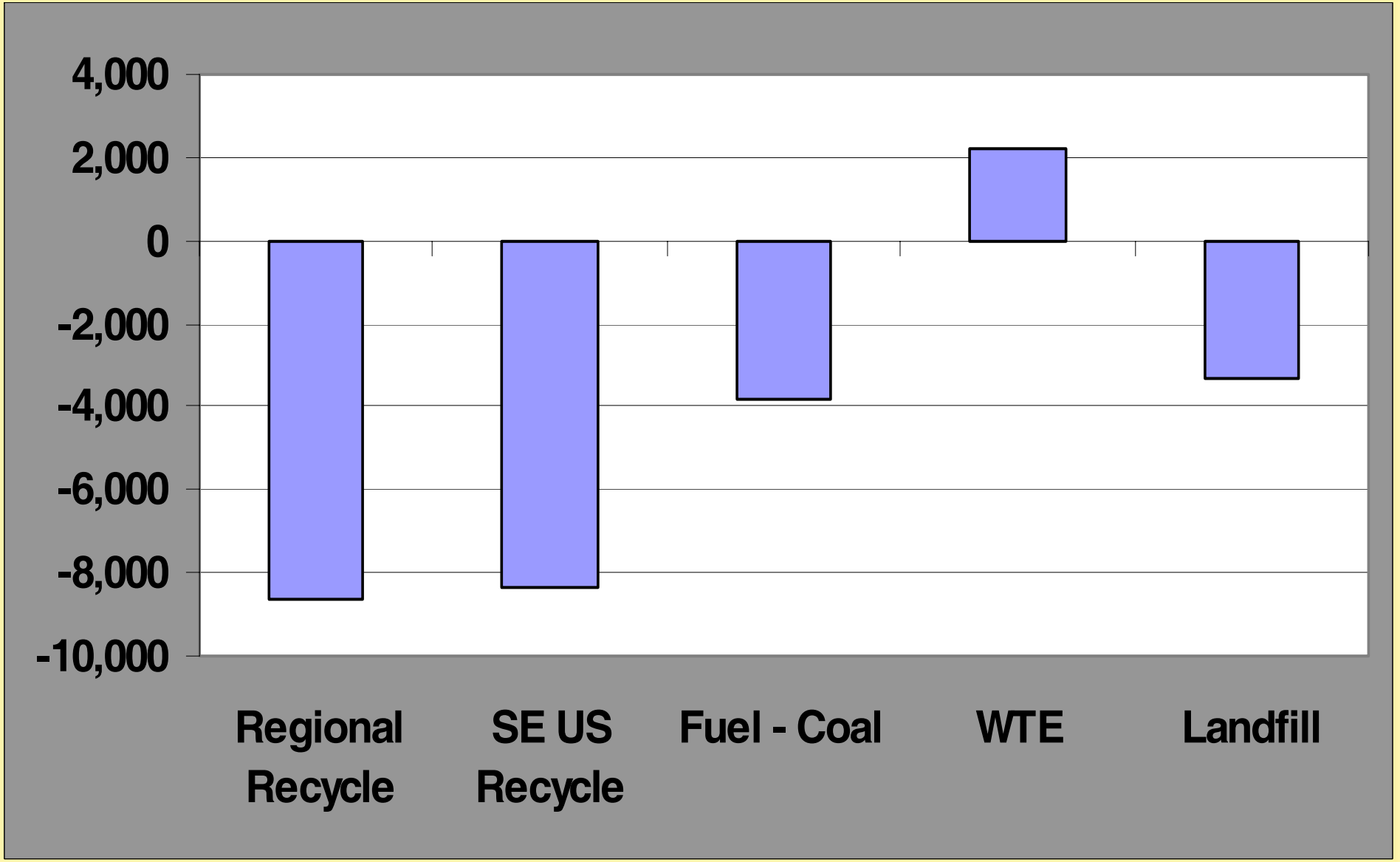
Eutrophying Emissions: Composting vs. Disposal (MT eN/MT)



CO_2 Emissions: C&D Wood Scraps Management Options (MT eCO_2/MT)



CO_2 Emissions: Scrap Carpet Management Options (lbs. eCO_2/ton)



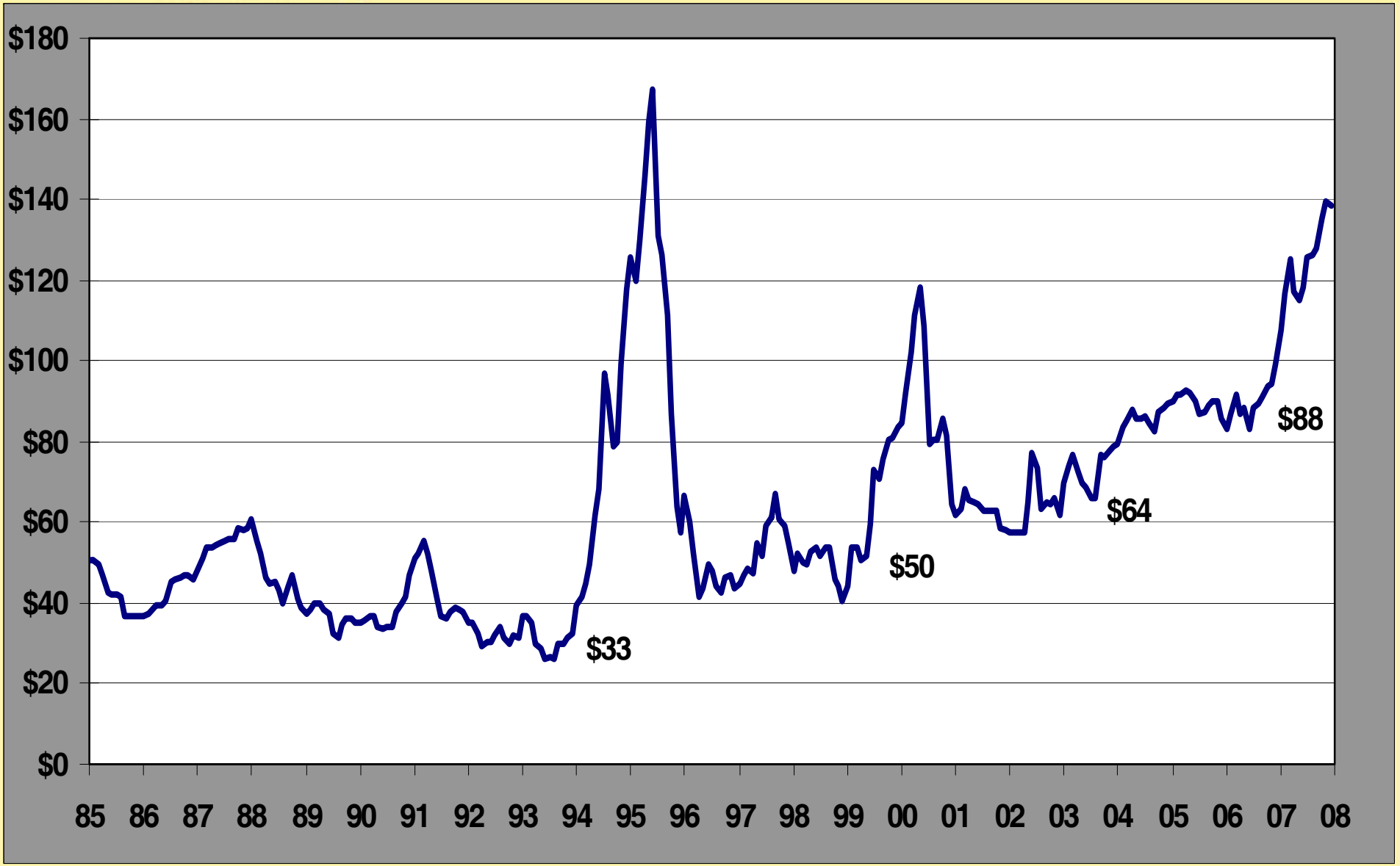
Value of Pollution Reductions

LCA Impact	Economic Cost (US$/ton)
Climate Change	$36 eCO2
Human Health - Particulates	10,000 ePM2.5
Human Health - Toxins	118 eToluene
Human Health - Carcinogens	3,030 eBenzene
Ecosystems Toxics	3,280 e2,4D
Acidification	661 eSO2
Eutrophication	4 eNitrogen

Value of Pollution Reductions from Recycling & Composting

Discard Type	Environmental Value (US$/ton)
Newspapers	$328-332
Cardboard	424-449
Mixed Paper	156-178
Glass Containers	53-54
PET Plastics	578-646
HDPE Plastics	202-279
Other Plastics	202-279
Aluminum Cans	1,456
Ferrous Cans & Scrap	14-63
Food Scraps	59-97
Yard & Garden Debris	58-67
Compostable Paper	49-71

Market Value of Recyclables – US Northwest (US$ per ton)



Net Social Costs: Landfill & WTE

Costs Per Metric Ton	Netherlands (Euros) Landfill	Incineration	Inc +/(-) Lnd	Northwest US (US$) Landfill	Incineration	Inc +/(-) Lnd
Gross private costs	40	103	63			
Energy recovery revenue	(4)	(21)	(17)			
Material recovery revenue	0	(3)	(3)			
Net private costs	36	79	43	20 - 23	80 - 111	57 - 91
Gross Environmental Costs	26	46	20			
Energy recovery offset	(4)	(22)	(18)			
Material recovery offset	0	(6)	(6)			
Net Environmental Costs	22	18	(4)			(10)
Net Social Costs	58	97	39			47 - 81

The End

Thank you.