Discarded Resources Management: An Environmental & Economic Comparison of Recycling, Composting, & Disposal (with energy recovery)

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Presentation Outline

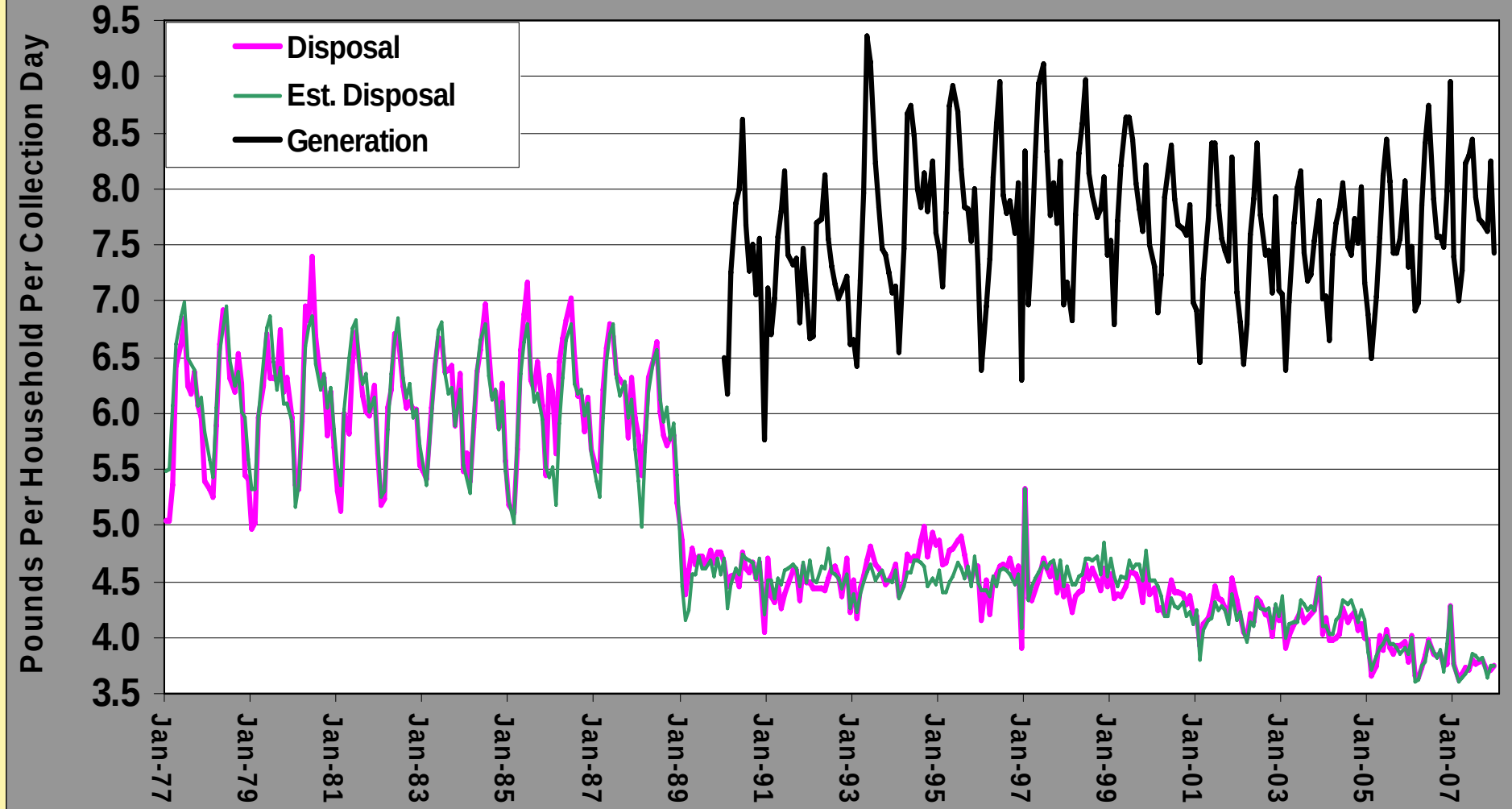
- Recent Developments in the US
- Life Cycle Analysis/Impact Assessment & Environmental Impacts of Discards Management
- Recycling Economics
- Societal Economics of Disposal
- Important Questions & Uncertainties

Recent Developments in the US

1. WA – Seattle & King County
2. CA – San Francisco & Los Angeles
3. MA – DEP Landfill Last Solid Waste Master Plan Review
4. Zero Waste – max 3Rs through incentives & new rules, EPR for problem materials, stabilize residuals
5. Climate Change & Emerging New Framework for Solid Wastes/Resources

Seattle Public Utilities

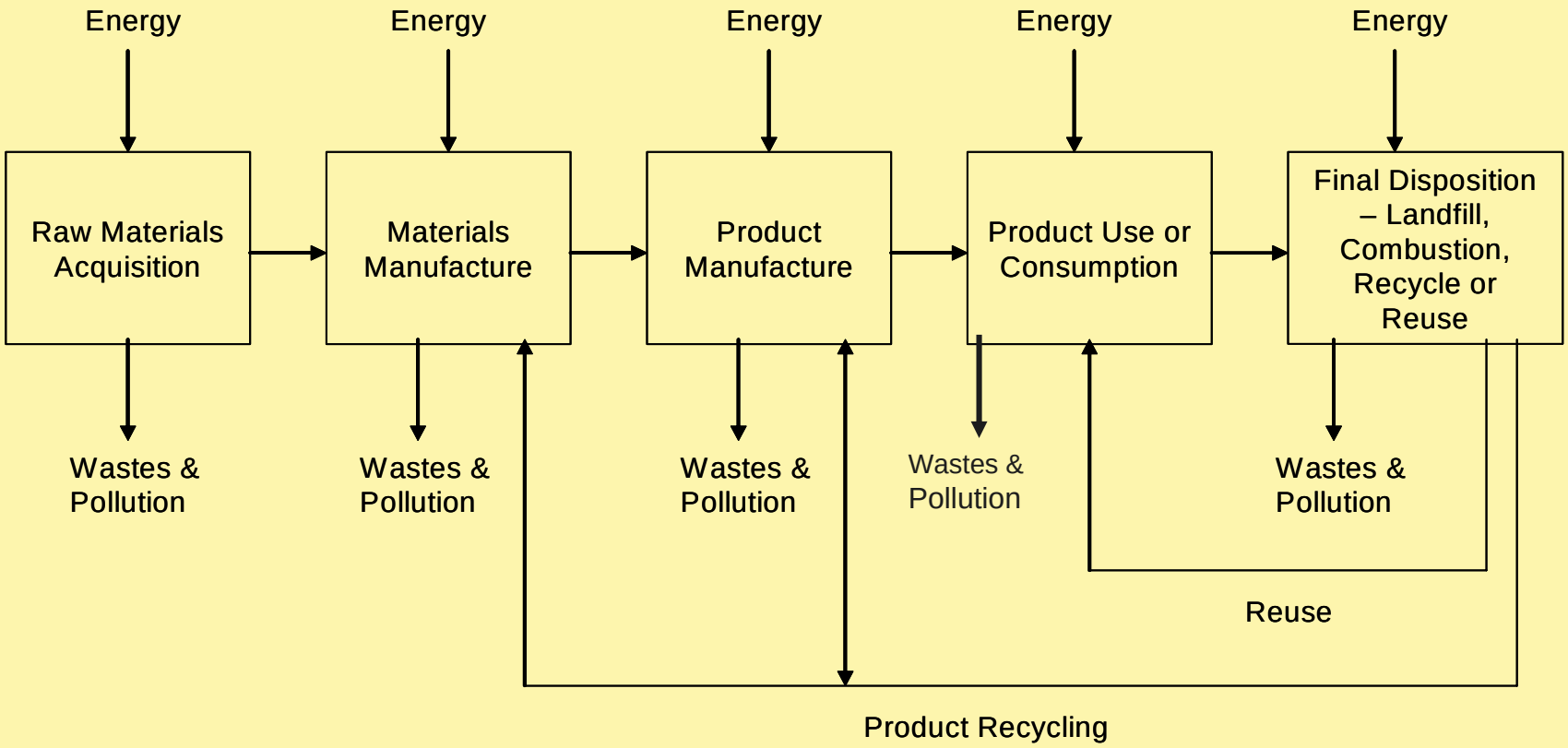
City of Seattle Residential Waste Generation & Disposal



Emerging Framework

1. GHG reductions likely imply smaller and lower Btu value disposal quantities
2. Higher energy prices likely imply higher prices for recycled materials
3. Natural resource depletion & ecosystems degradation likely provide push to replace virgin with recycled materials and to compost organics for use on farm land
4. Carbon constraints + high energy and commodity prices likely to create strong incentives for higher 3Rs levels.

Life Cycle Analysis (LCA)



One or limited number of return cycles into product that is then disposed – open-loop recycling. Repeated recycling into same or similar product, keeping material from disposal – closed-loop recycling.

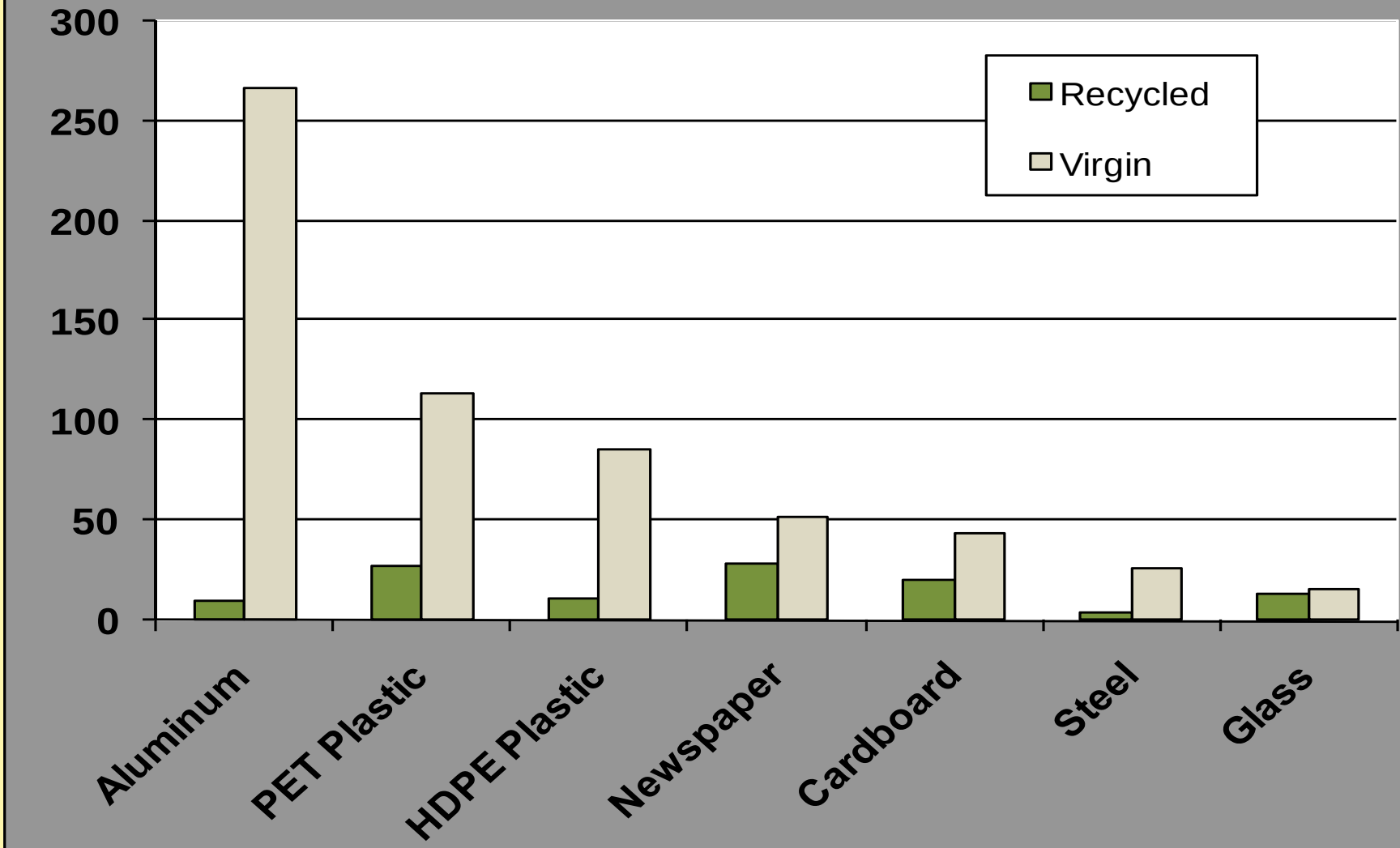
Data Sources

1. US EPA WARM model
2. US EPA MSW Decision Support Tool
3. Carnegie Mellon University Economic Input-Output Life Cycle Assessment model (www.eiolca.net)
4. Washington State Dept. of Ecology
5. Peer-reviewed journal articles

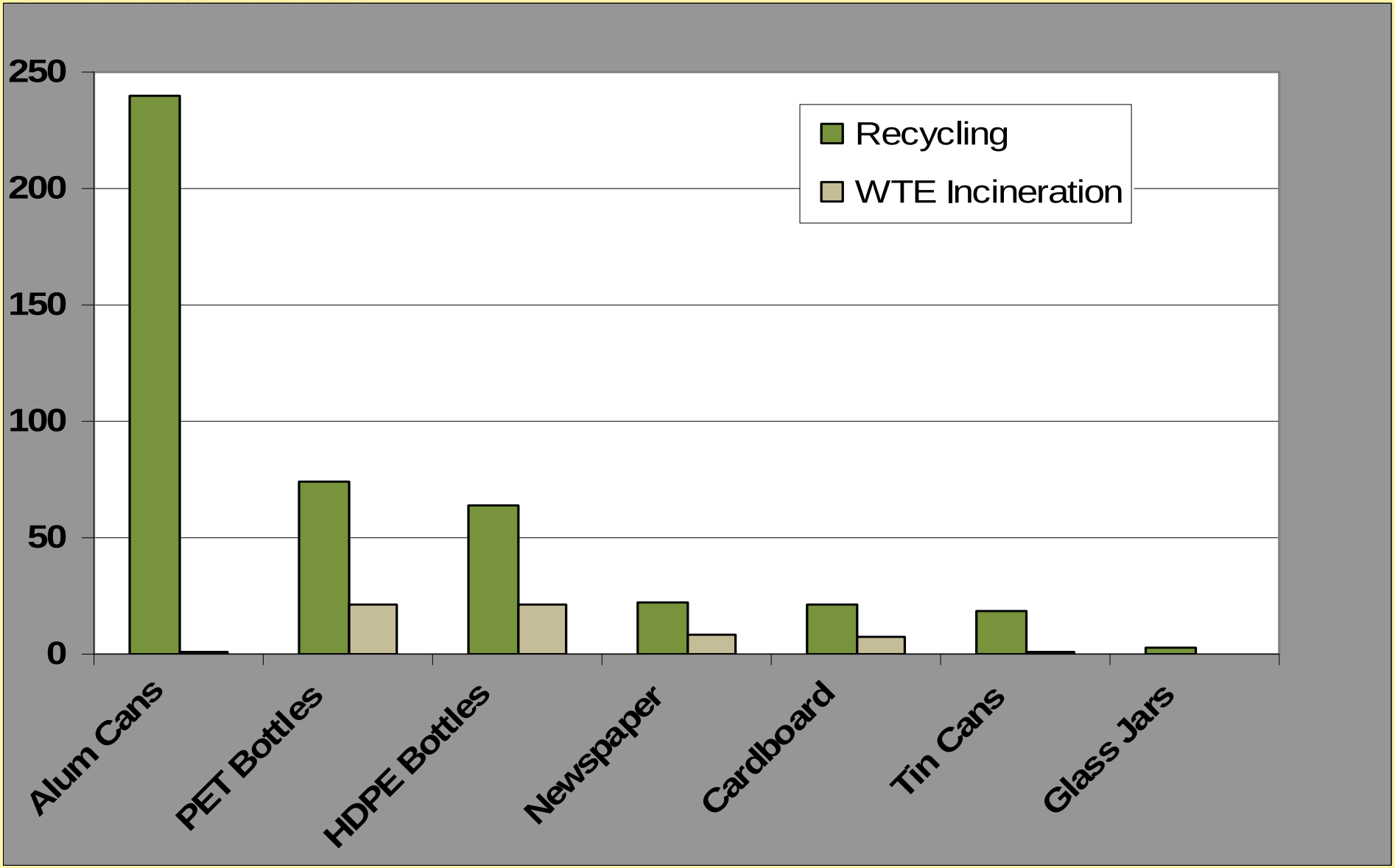
Definitions of Terms on Graphs

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

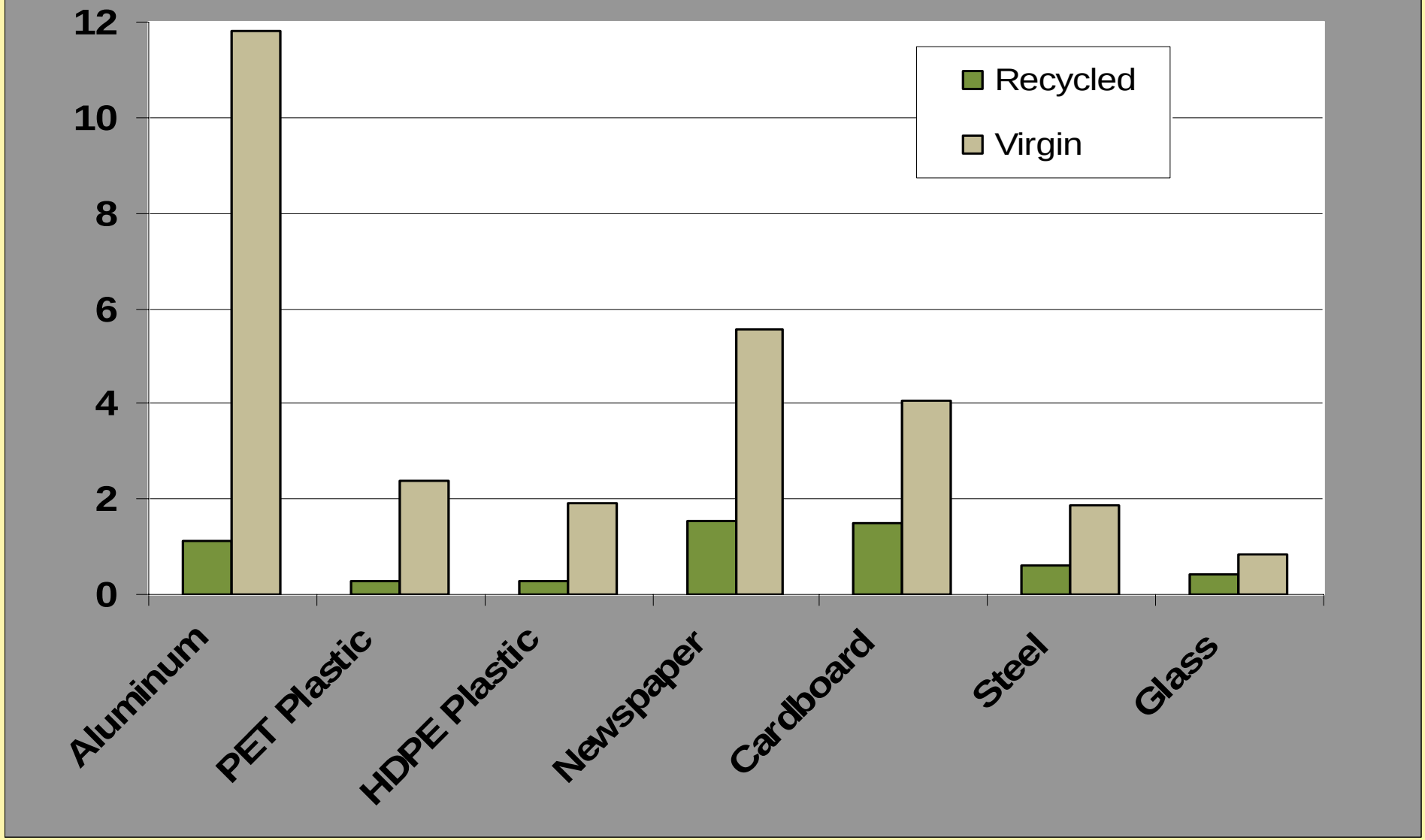
Energy Use: Recycled & Virgin Content Products (MJ/kg)



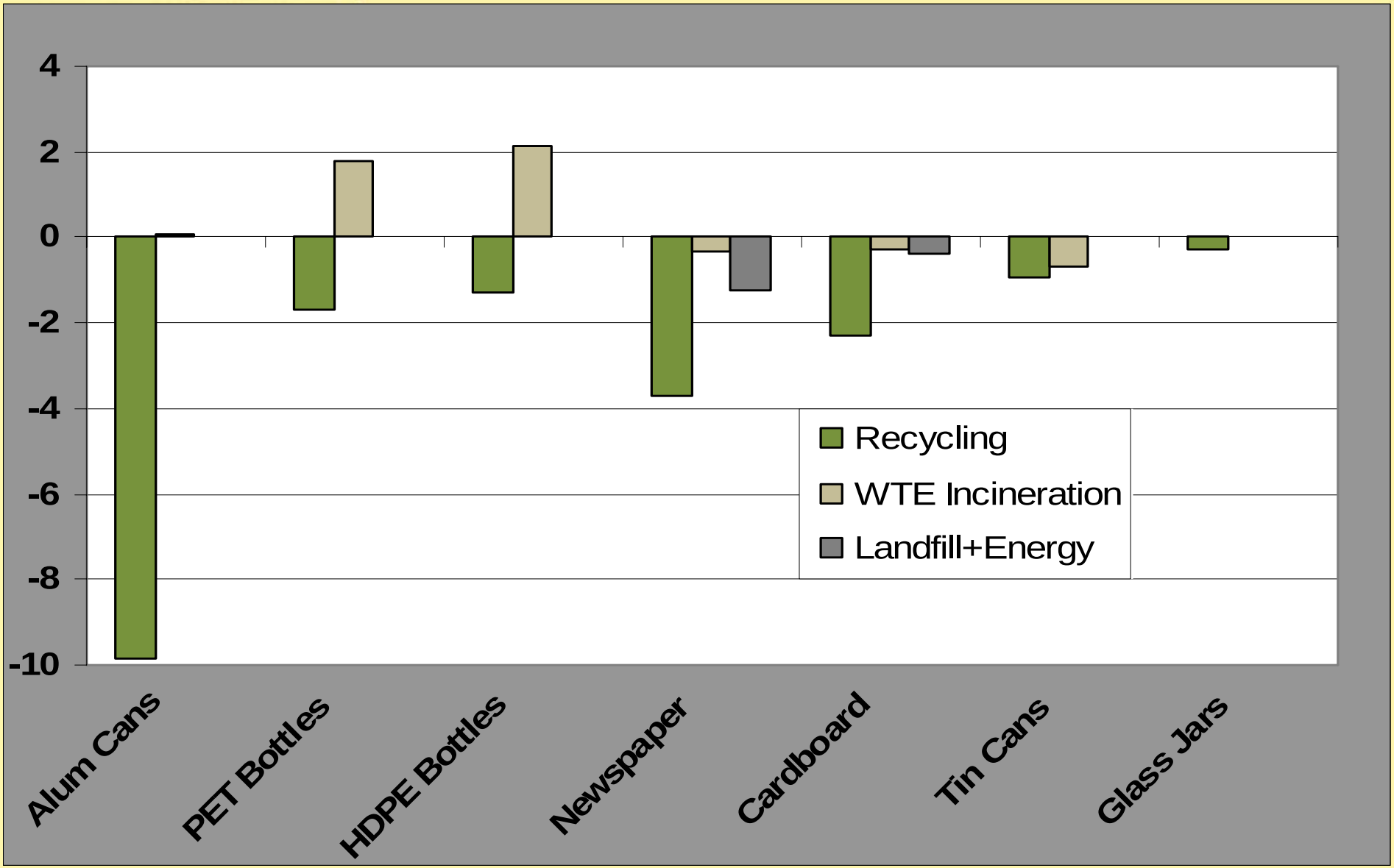
Energy Savings: Recycling versus WTE Incineration (MJ/kg)



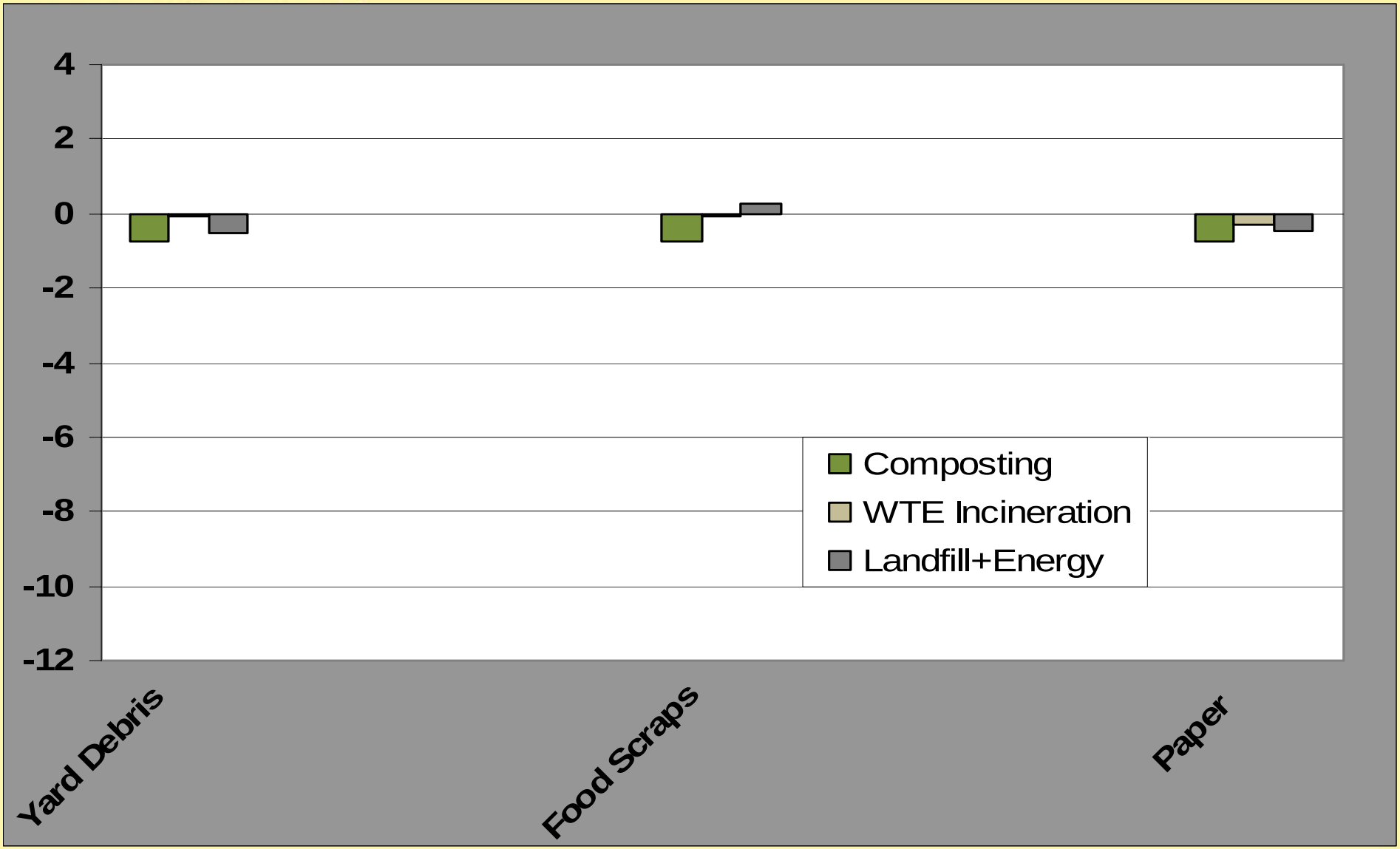
CO_2 Emissions: Recycled &Virgin Content Products (kg eCO_2/kg)



CO_2 Emissions: Recycling versus Disposal (kg eCO_2/kg)



CO_2 Emissions: Composting versus Disposal (kg eCO_2/kg)



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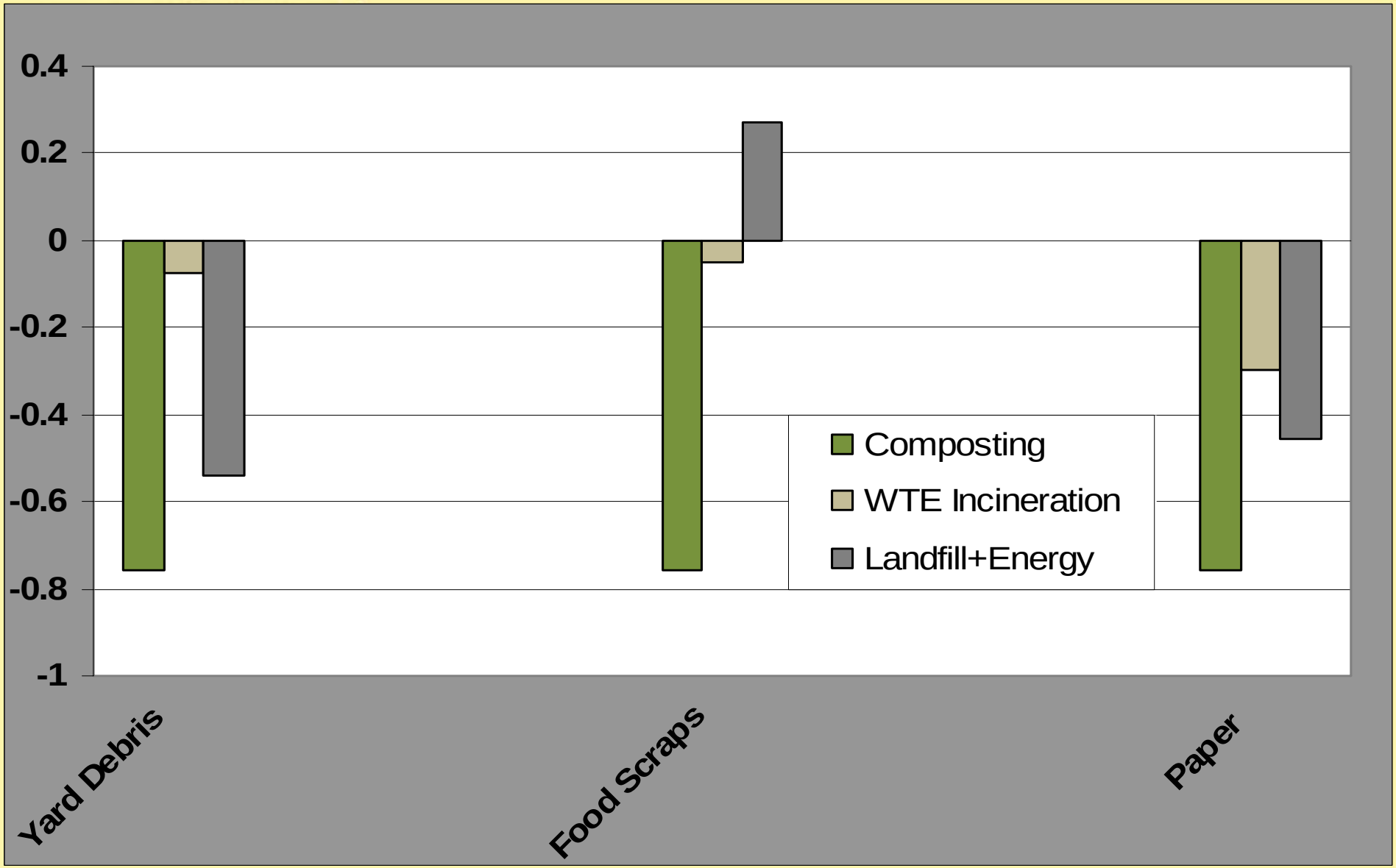
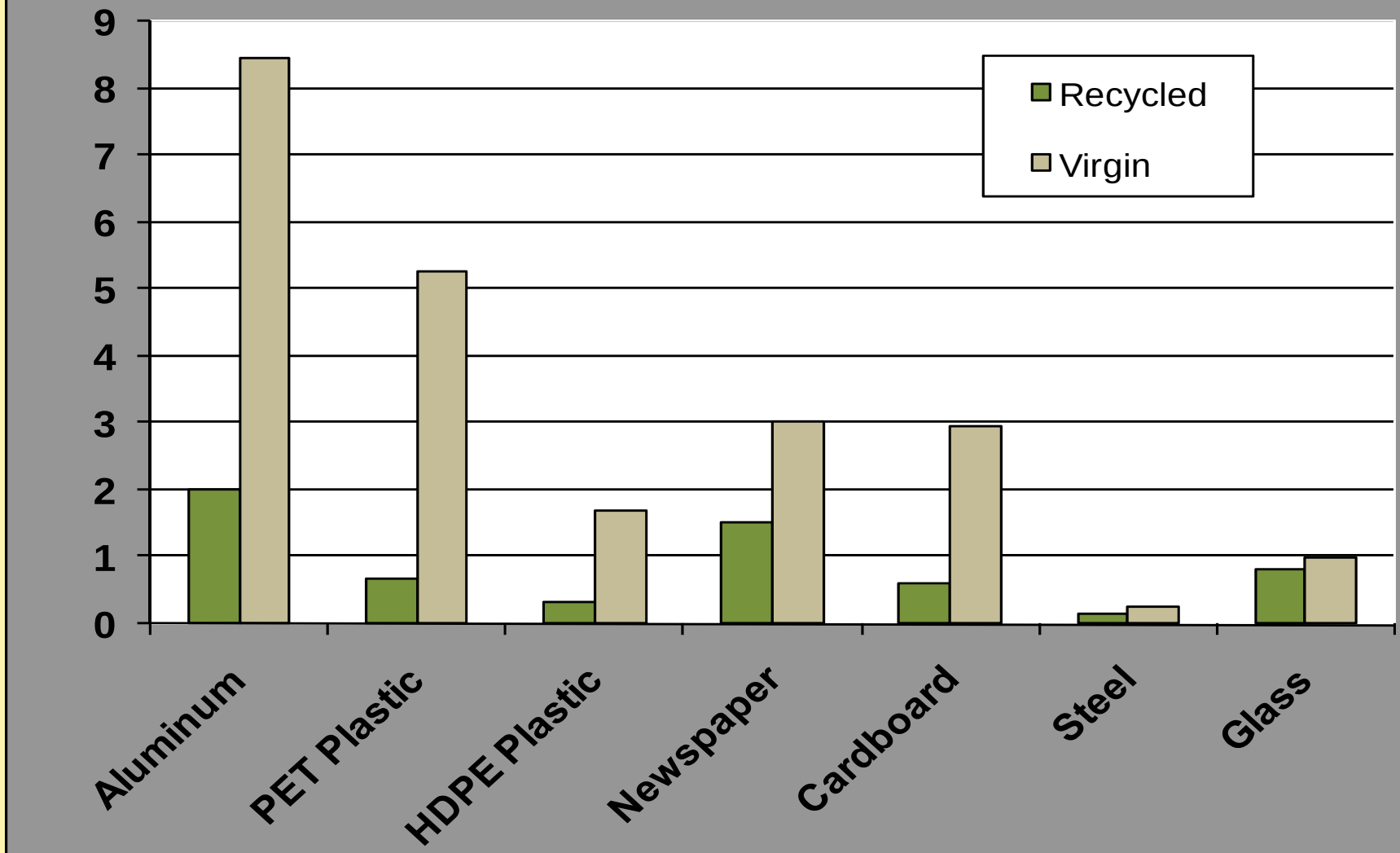


Toxics Emissions: Recycled & Virgin Products (kg eToluene/kg)



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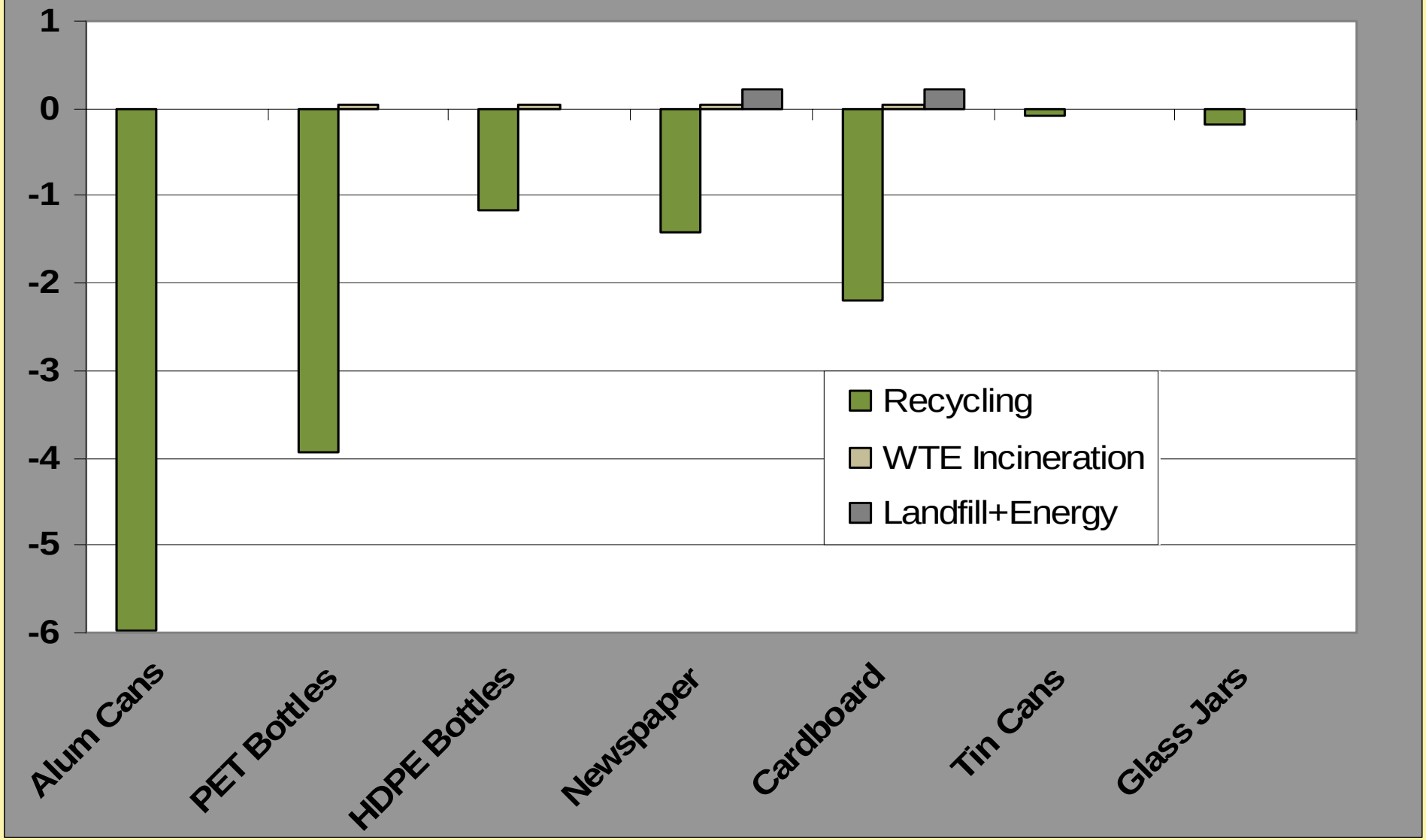

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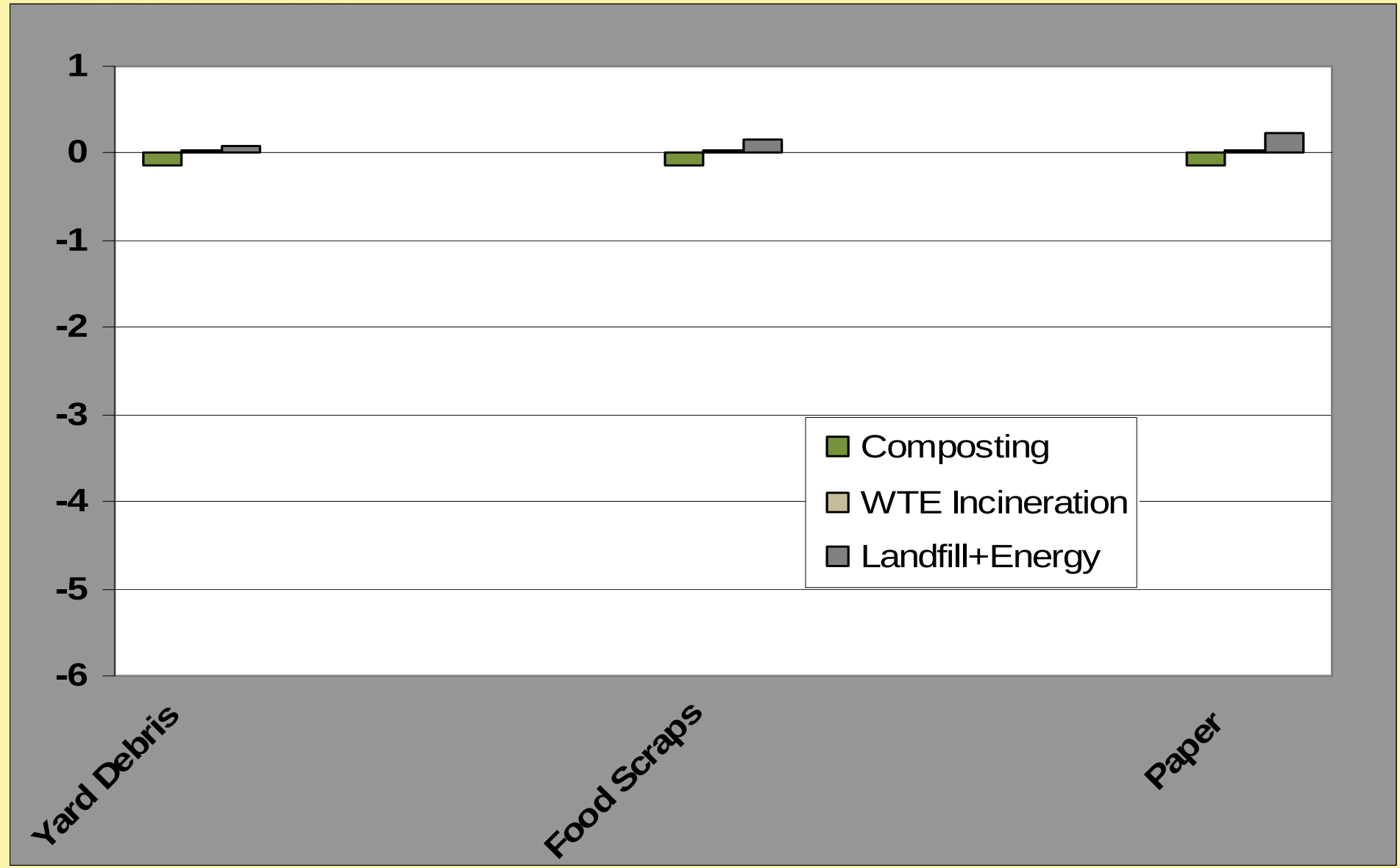

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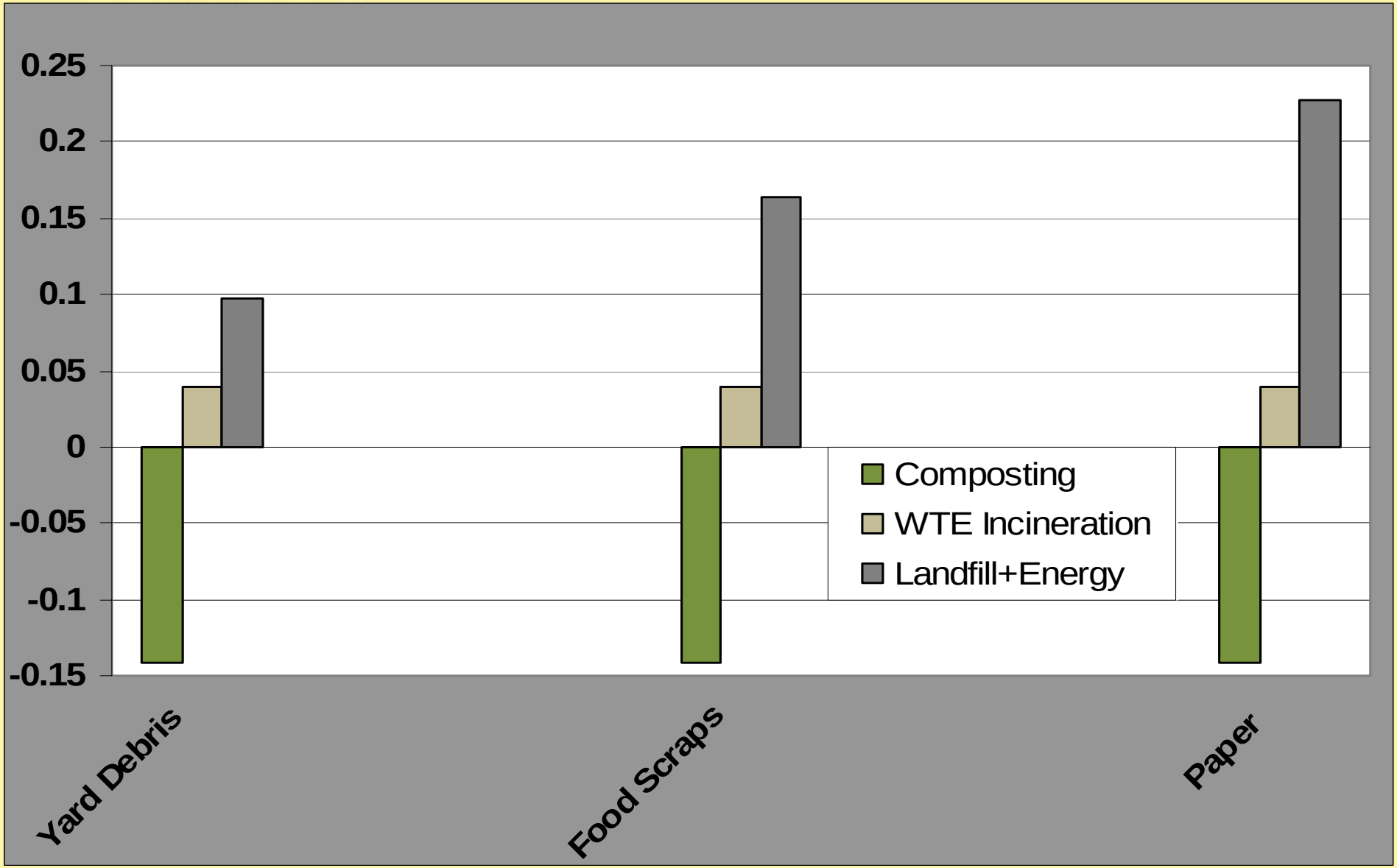
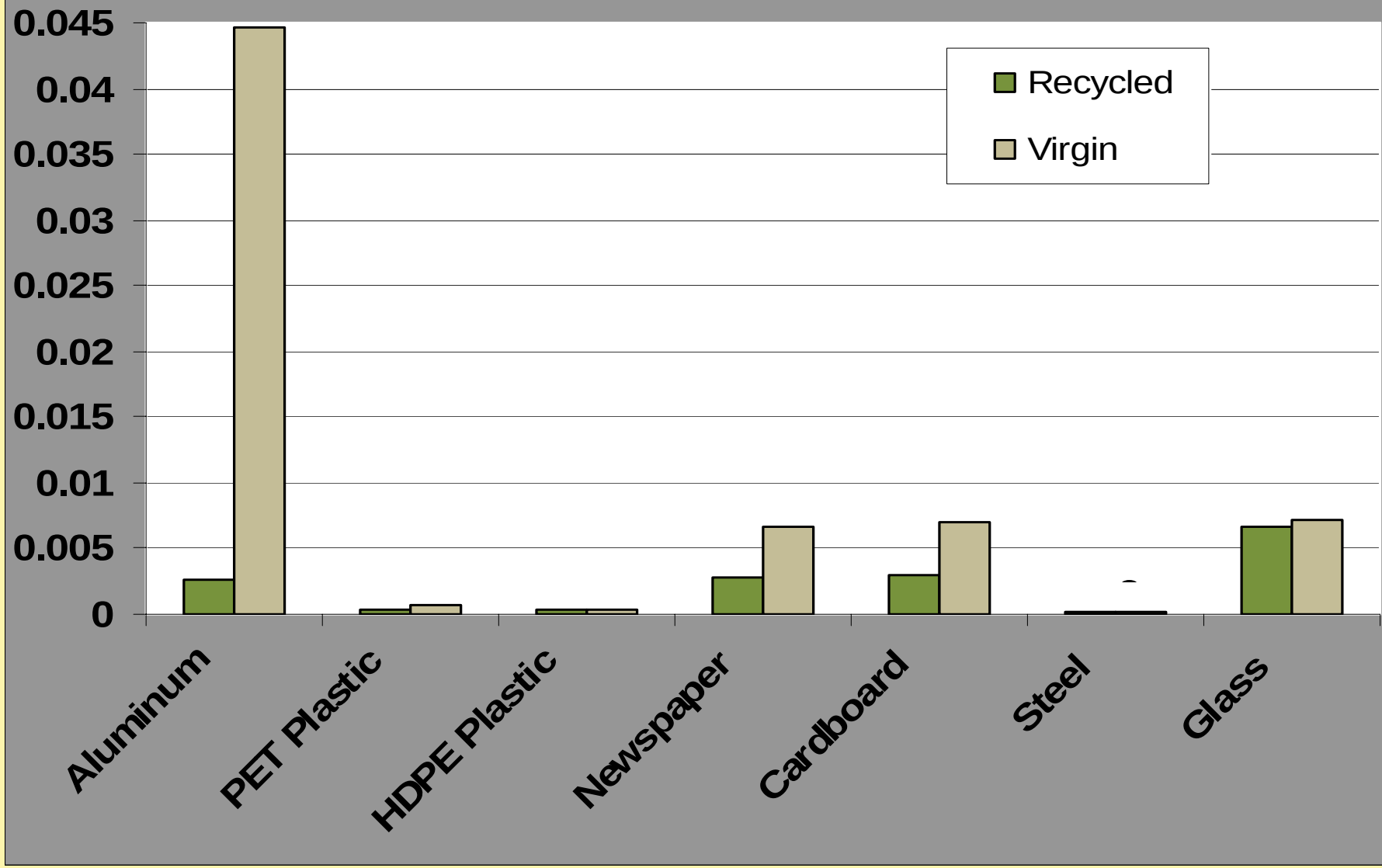


EcoToxics Emissions: Recycled & Virgin Products (kg e2,4-D/kg)



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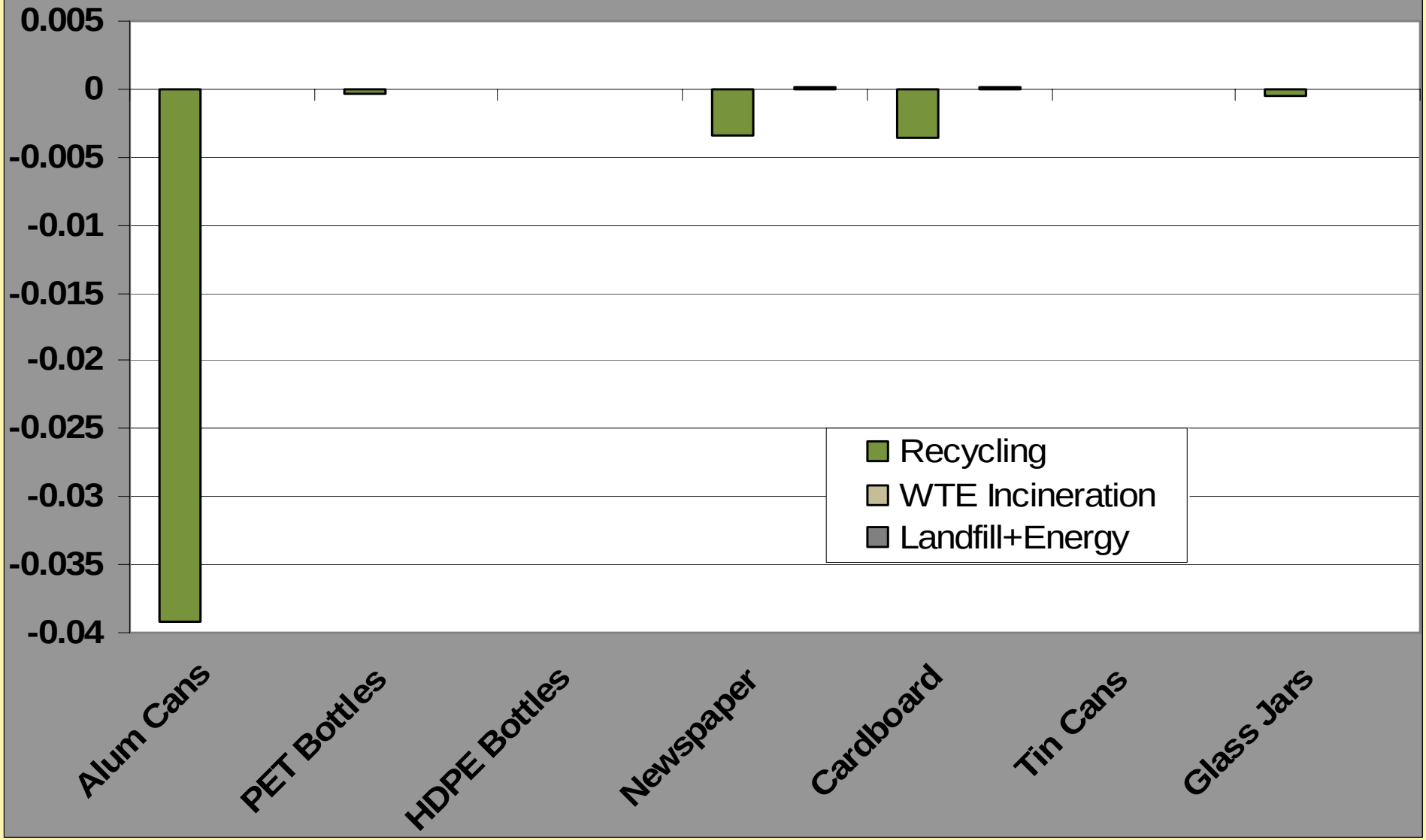

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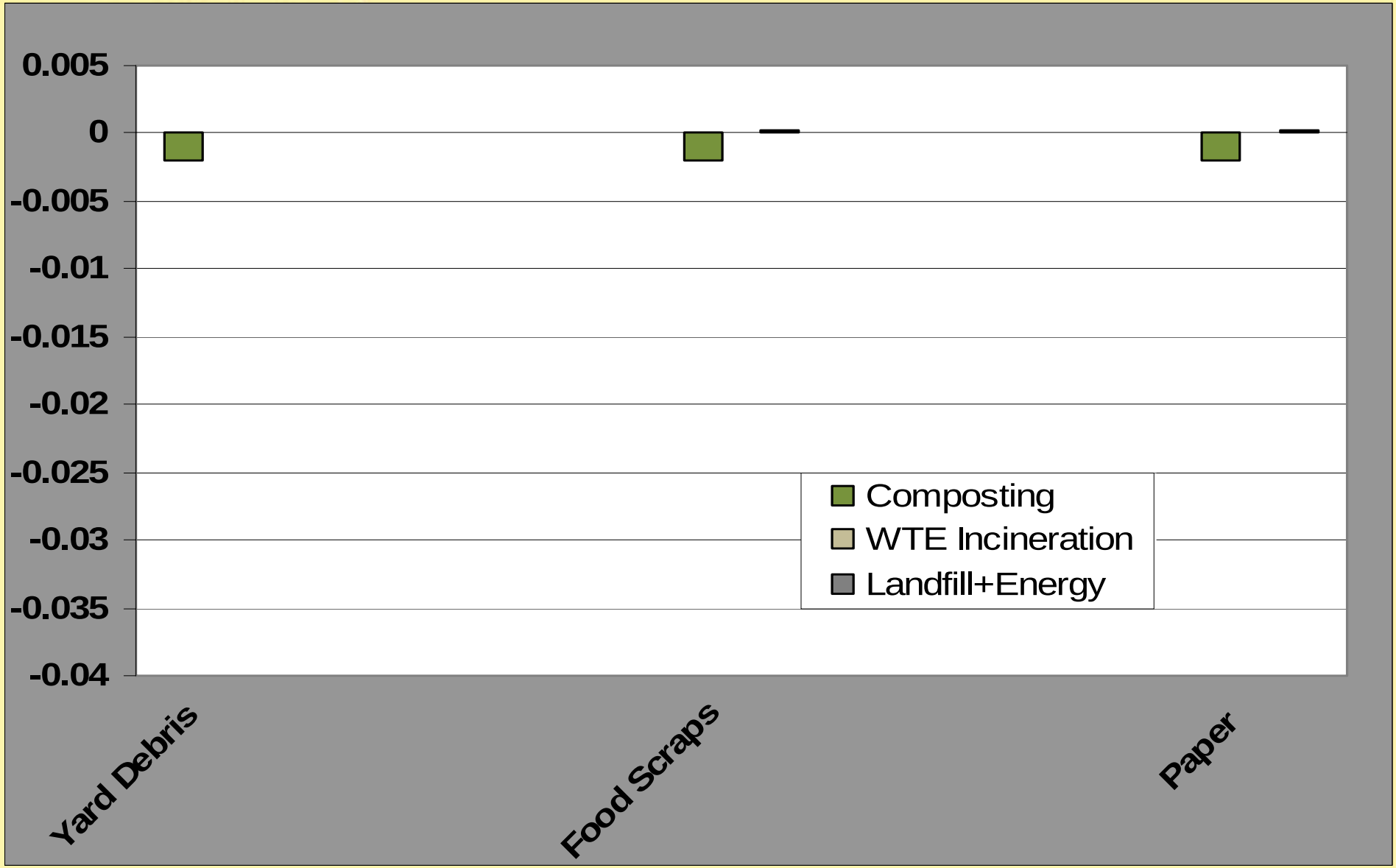

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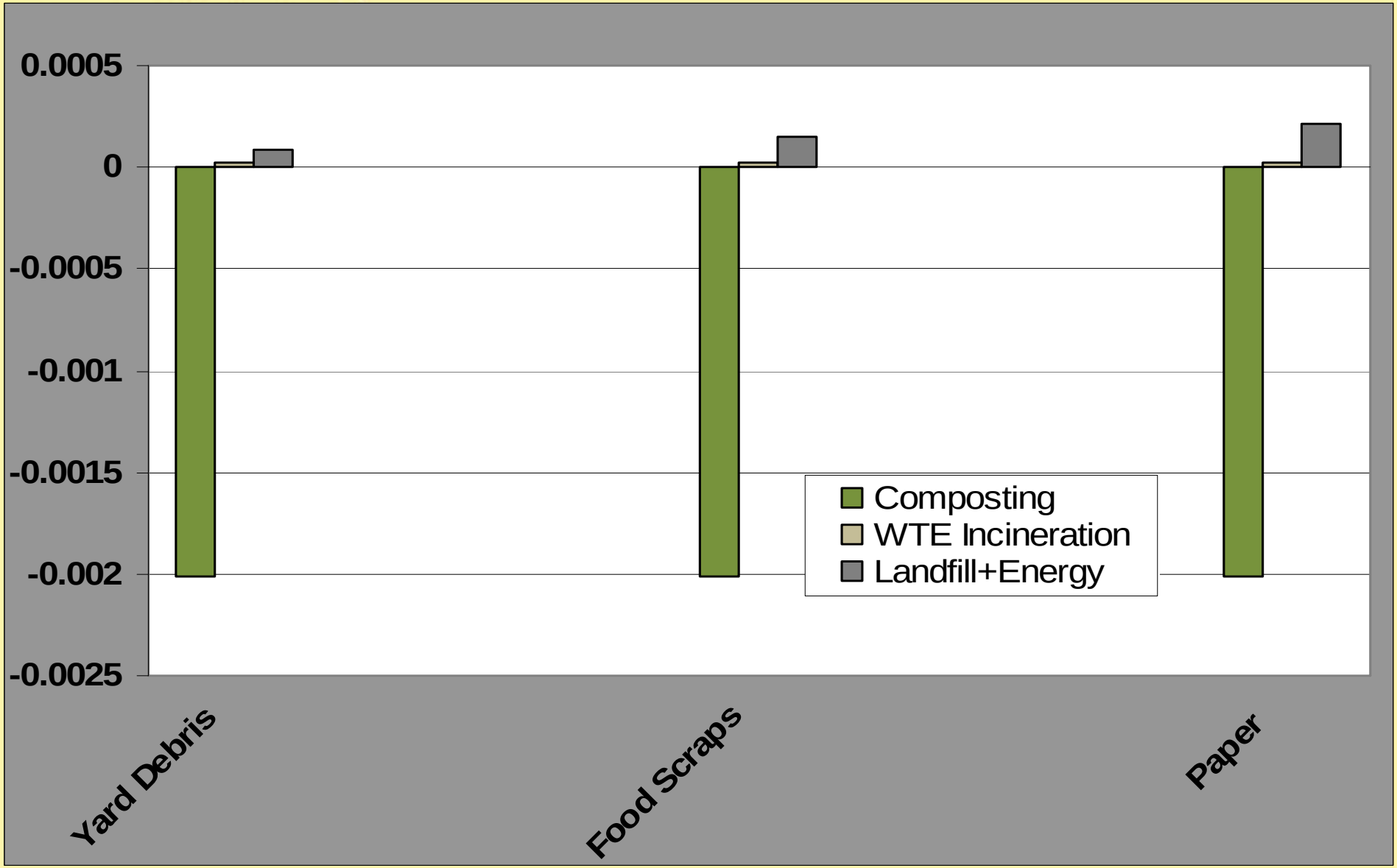
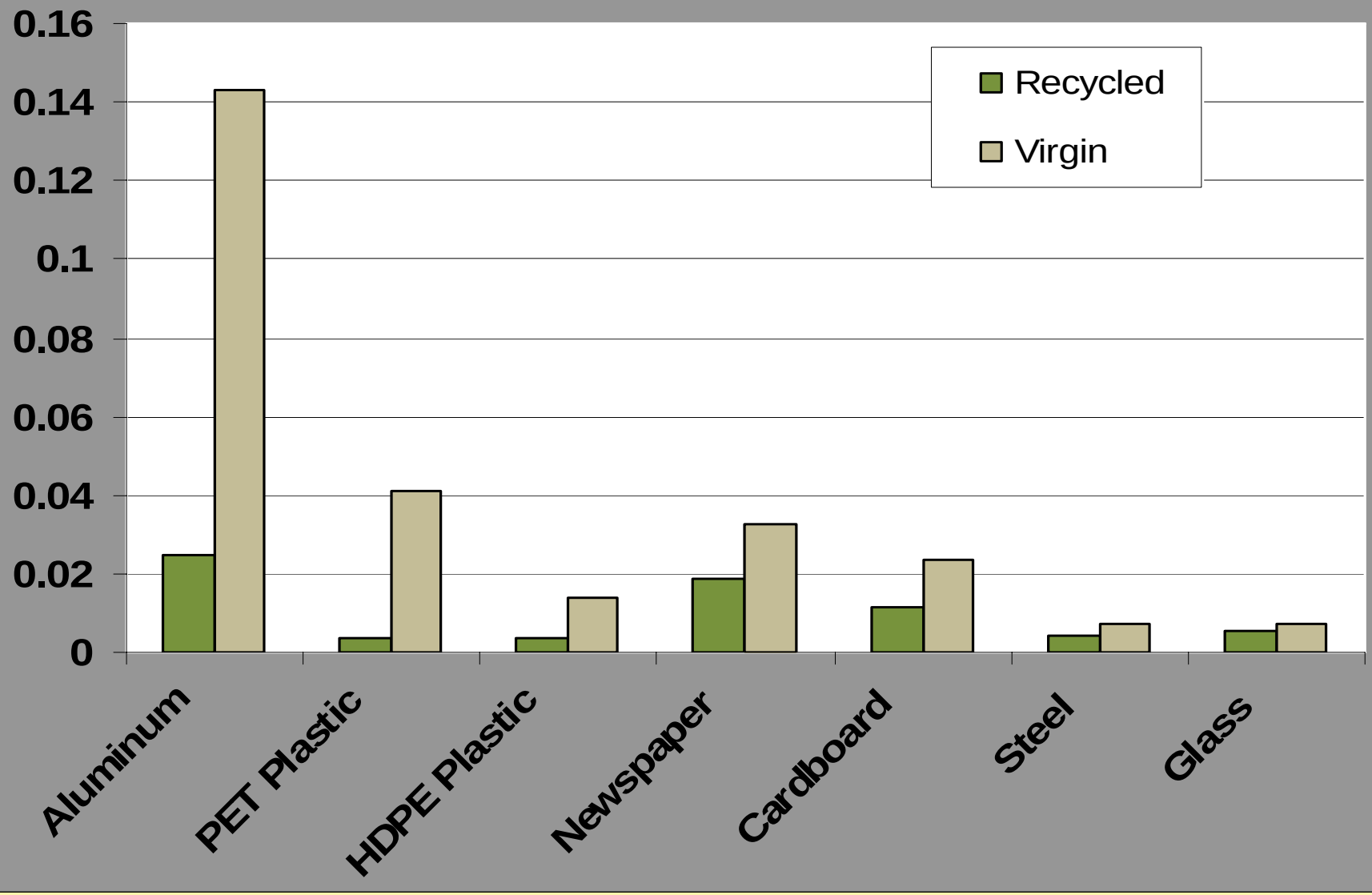


Acidifying Emissions: Recycled & Virgin Products (kg eSO2/kg)



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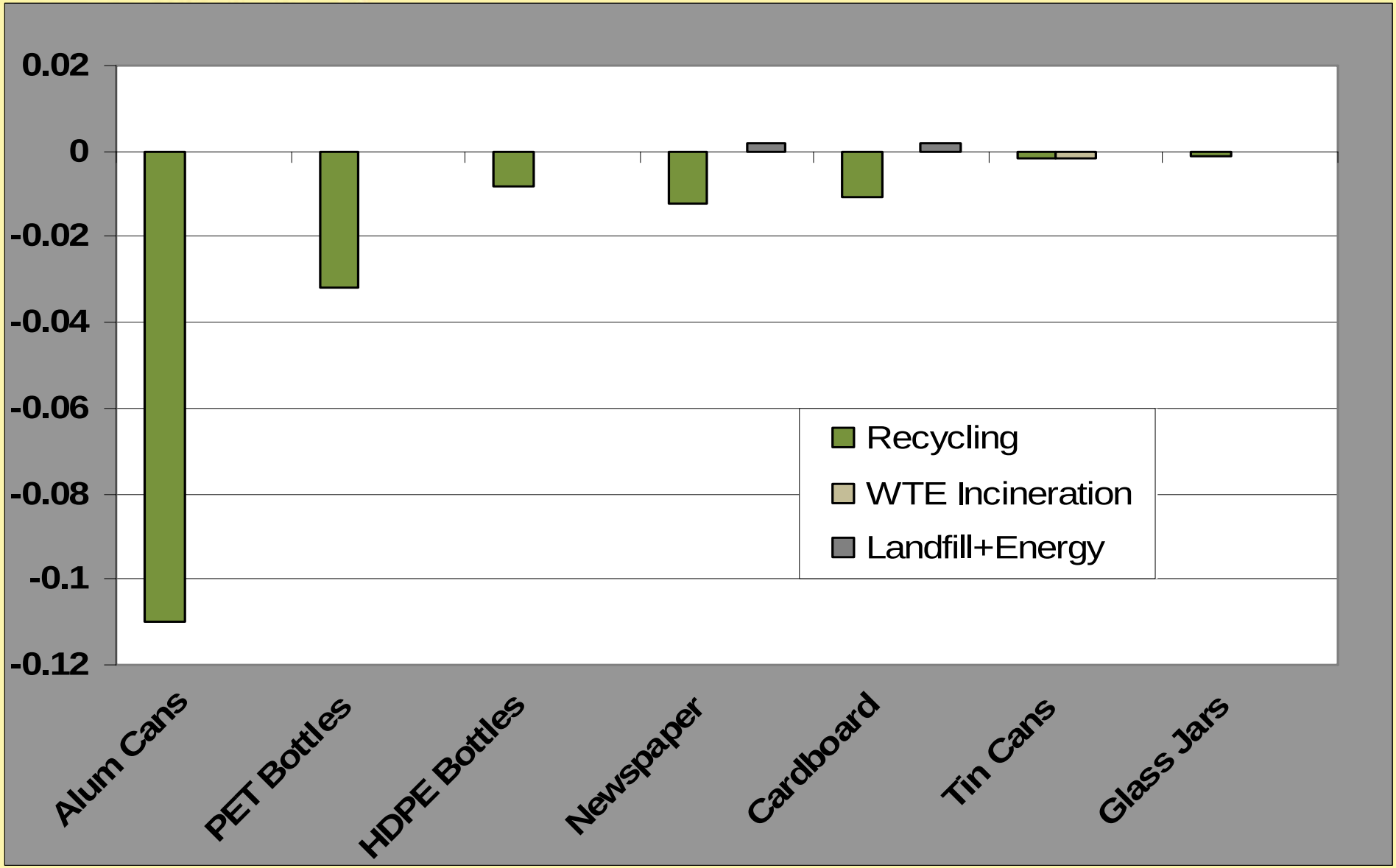

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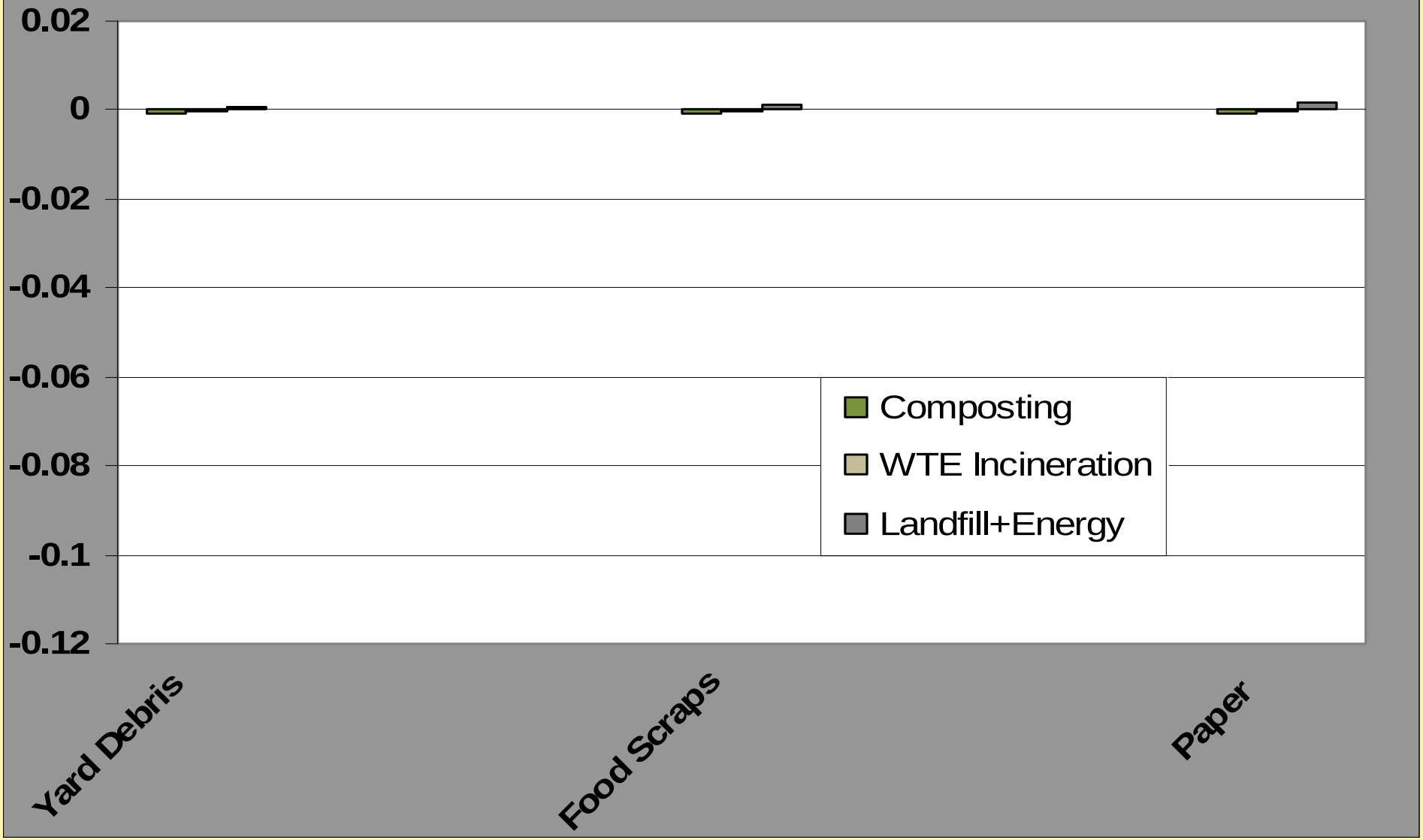

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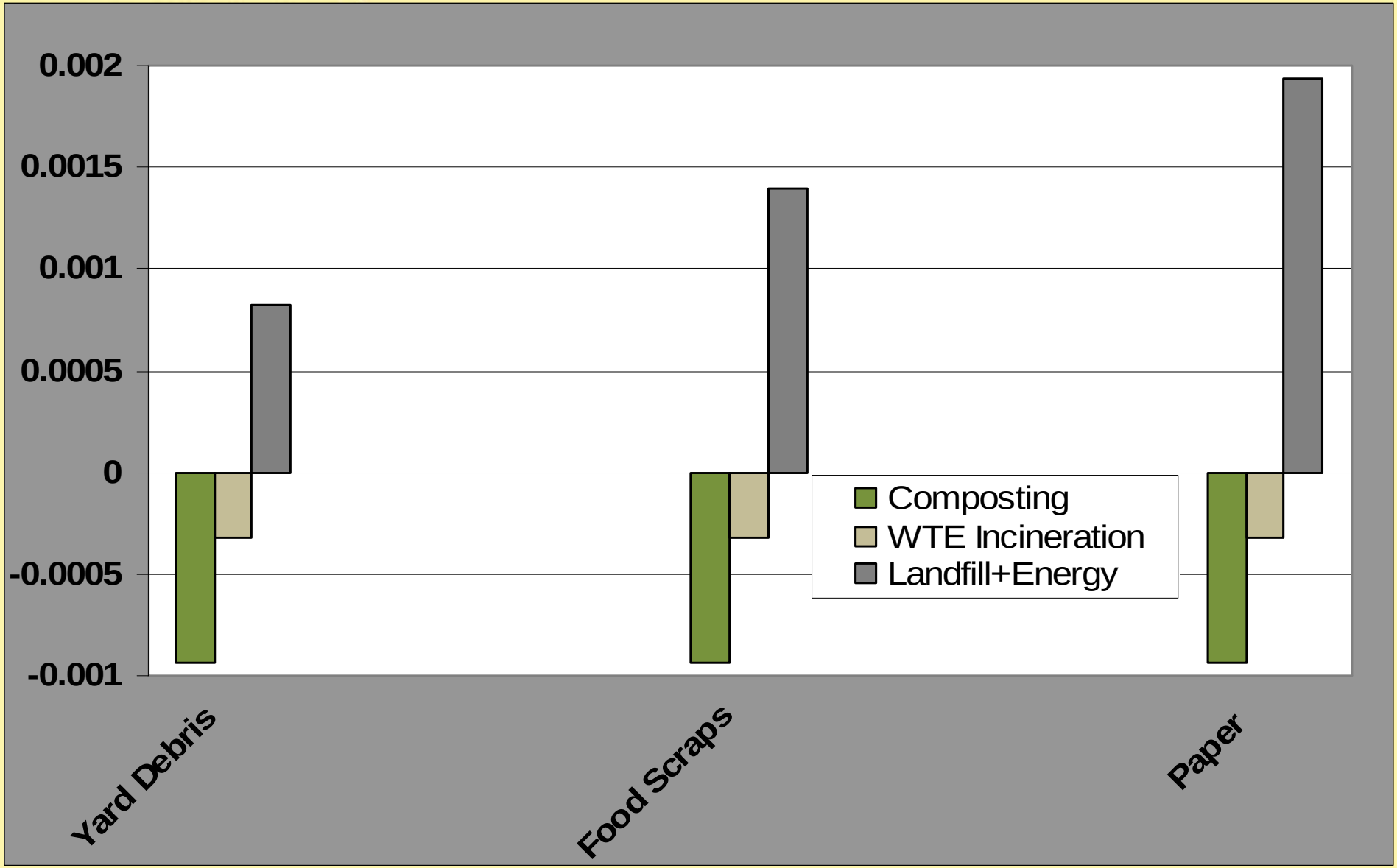
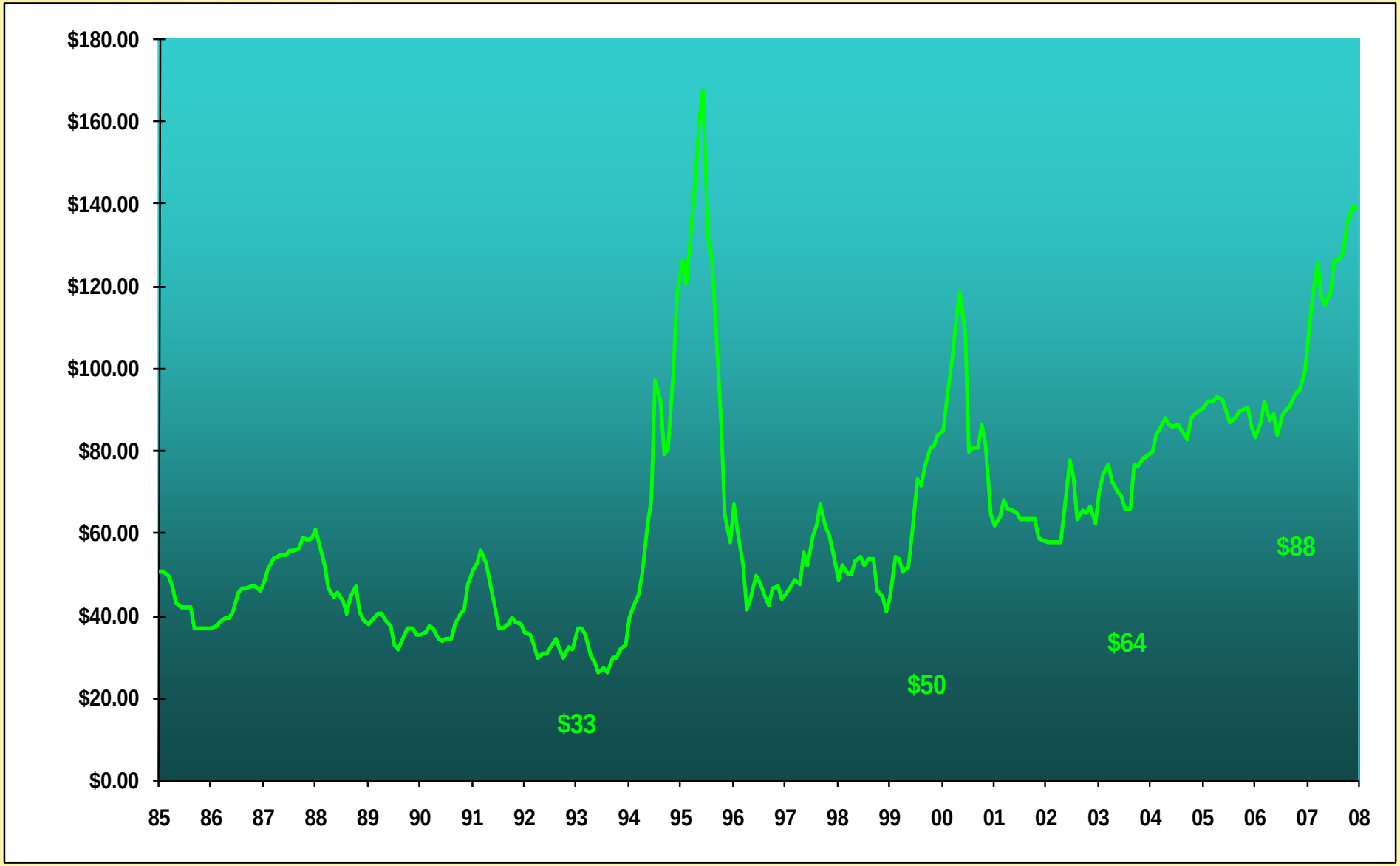


Market Value of Recyclables – US Northwest (US$ per short ton)



Value of Pollution Reductions

LCA Impact	Economic Cost (US$/metric ton)
Climate Change	$40 eCO2
Human Health - Particulates	11,023 ePM2.5
Human Health - Toxins	130 eToluene
Human Health - Carcinogens	3,340 eBenzene
Ecosystems Toxics	3,616 e2,4D
Acidification	729 eSO2
Eutrophication	4 eNitrogen

Value of Pollution Reductions from Recycling & Composting

Discard Type	Environmental Value (US$/metric ton)
Newspapers	$363-367
Cardboard	467-496
Mixed Paper	172-197
Glass Containers	61
PET Plastics	639-712
HDPE Plastics	224-310
Other Plastics	224-310
Aluminum Cans	1,607
Ferrous Cans & Scrap	18-72
Food Scraps	62-107
Yard & Garden Debris	61-74
Compostable Paper	52-78

Net Societal Costs of Landfill and Incineration Disposal

Costs per Metric Ton	Netherlands (Euros)			Northwest US (US$)		
	Landfill	Incineration	Inc +/(-) Lnd	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)			(9)
Net Societal Costs	58	97	39			48 - 82

Important Questions

1) Who bears facility investment costs and risks of tonnage shortfalls?
2) Do tip fees vary directly with disposal tonnage, or is there some sort of put-or-pay guarantee?
3) How will tip fee commitments affect waste reduction, recycling & composting?
4) Who bears pollution risks & closure/post-closure costs for facilities (including ashfill)?
5) What will be the effects of climate change and higher energy & commodity prices?

References

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2) 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.
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6) Rand, T., J. Haukohl, U. Marxen, Municipal solid waste incineration: A decision maker’s guide, The World Bank: Washington, DC (June 2000).
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Recycling & WTE Incineration GHG Impacts (pounds eCO2/ton)