



Lessons Learned on LCA Impact Assessments from Analysis of Wood & Carpet Discards Management

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LCA VIII Special Session on Industrial Ecology



Lessons Learned

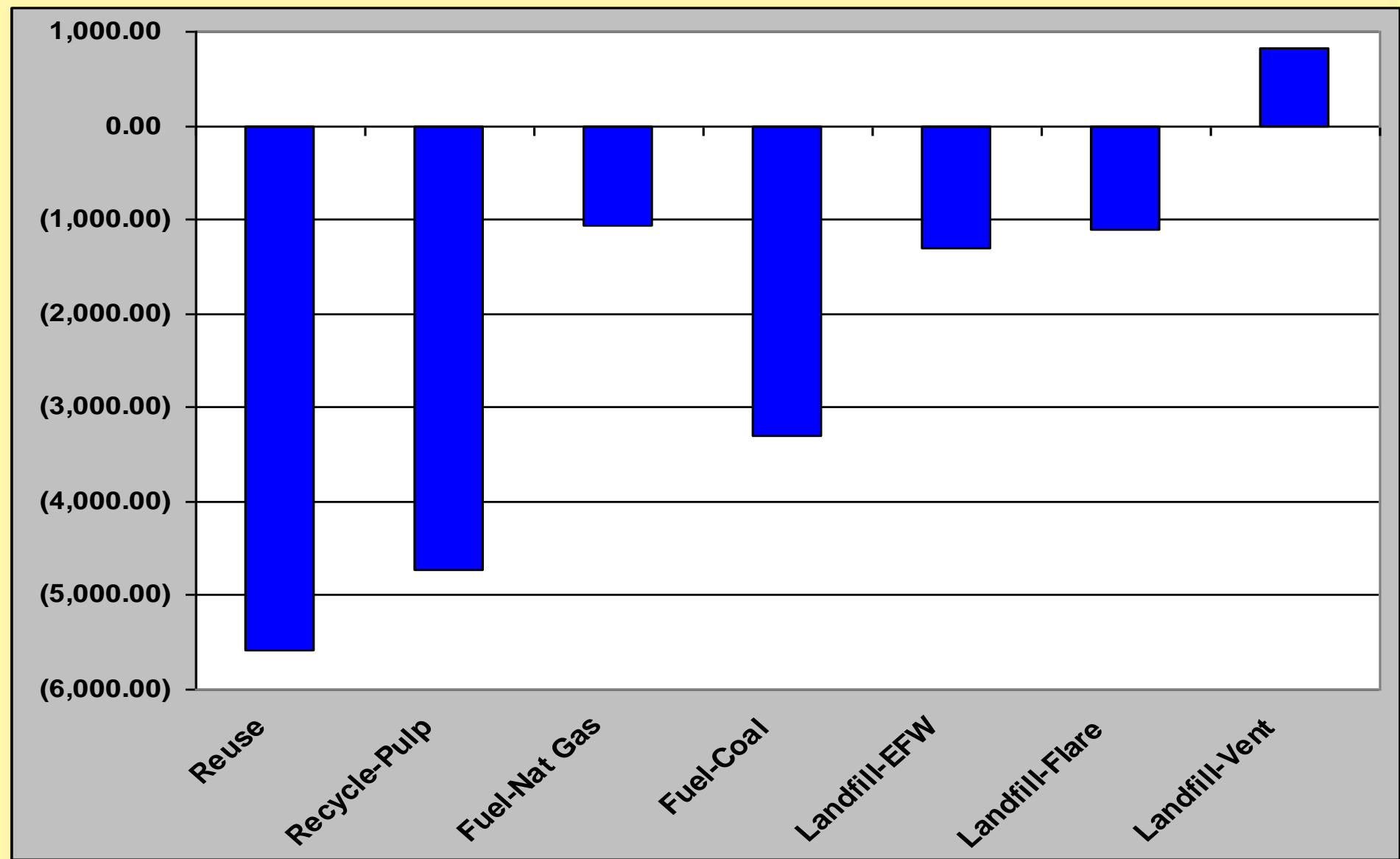
1. LCA requires details, details, details!
2. EIO modeling can provide a method for analysis when process specific data are not available.
3. Climate Change is not the only environmental impact.
4. Combustion facility emissions profiles may not be representative.
5. Transportation impacts are a very small piece of the puzzle, at least for discards management.
6. Relative impacts of different toxics and carcinogens (especially metals) on humans & ecosystems are subject of contentious ongoing debate.
7. Monetization as way to assess different impacts has promise, but valuing/costing the impact categories is subject to much uncertainty.
8. LCAs for waste management options typically evaluate the marginal (i.e., last) ton and ignore infrastructure impacts; for large scale system changes this may be misleading.



CO2 Emissions: Clean Wood Waste Management Options (pounds/ton)

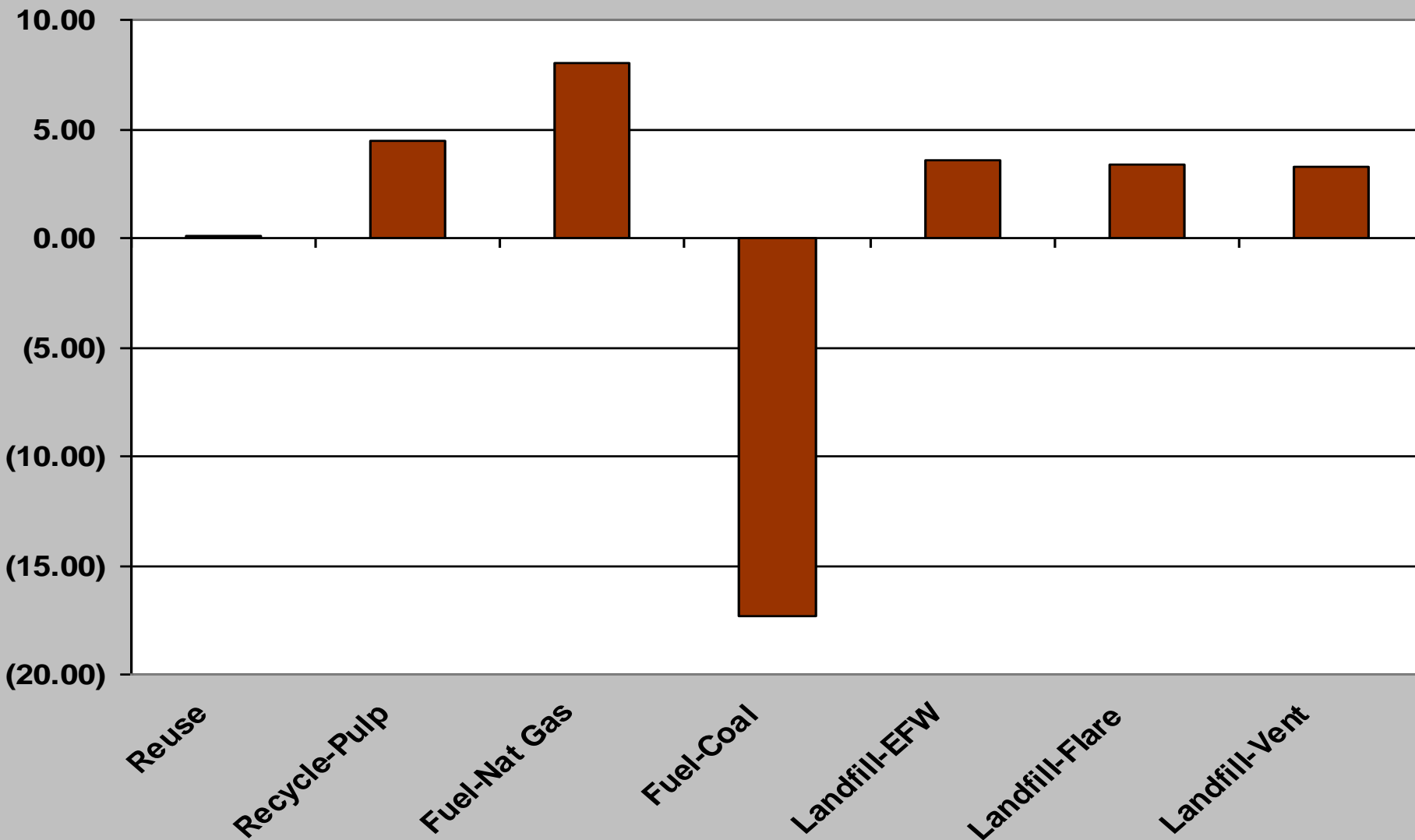
	Reuse	Recycle To Paper Pulp	Fuel Replace Nat. Gas	Fuel Replace Coal	Landfill Recover Energy	Landfill Flare LFG	Landfill Vent LFG
<u>Emissions</u>							
<i>New Wood Production</i>		.5*660 + .5*673 = 666	.5*660 + .5*673 = 666	.5*660 + .5*673 = 666	.5*660 + .5*673 = 666	.5*660 + .5*673 = 666	.5*660 + .5*673 = 666
<i>Processing & Chipping</i>		141	141	141			
<i>Chip Storage</i>		100	100	100			
<i>Hauling</i>	6	29	17	17	12	12	12
<i>Combustion</i>			68	68			
<i>Biodegradation</i>					647	647	2,587
<i>Internal Combustion Engine for Electricity Generating Equipment</i>					0		
<i>Landfill Gas (LFG) Flare</i>						0	
<i>Landfill Operations</i>					66	66	66
<u>Offsets</u>							
<i>Carbon Storage</i>	-2,878	-2,878			-2,506	-2,506	-2,506
<i>Tree Harvest</i>	-2,700	-2,700					
<i>Pulping Wood Production</i>		-92					
<i>Natural Gas Production & Combustion</i>			-2,066		-182		
<i>Coal Production & Combustion</i>				-4,299			
Net Emissions	-5,572	-4,733	-1,072	-3,306	-1,297	-1.115	825

CO2 Emissions: Clean Wood Waste Management Options (lbs. eCO2/ton)



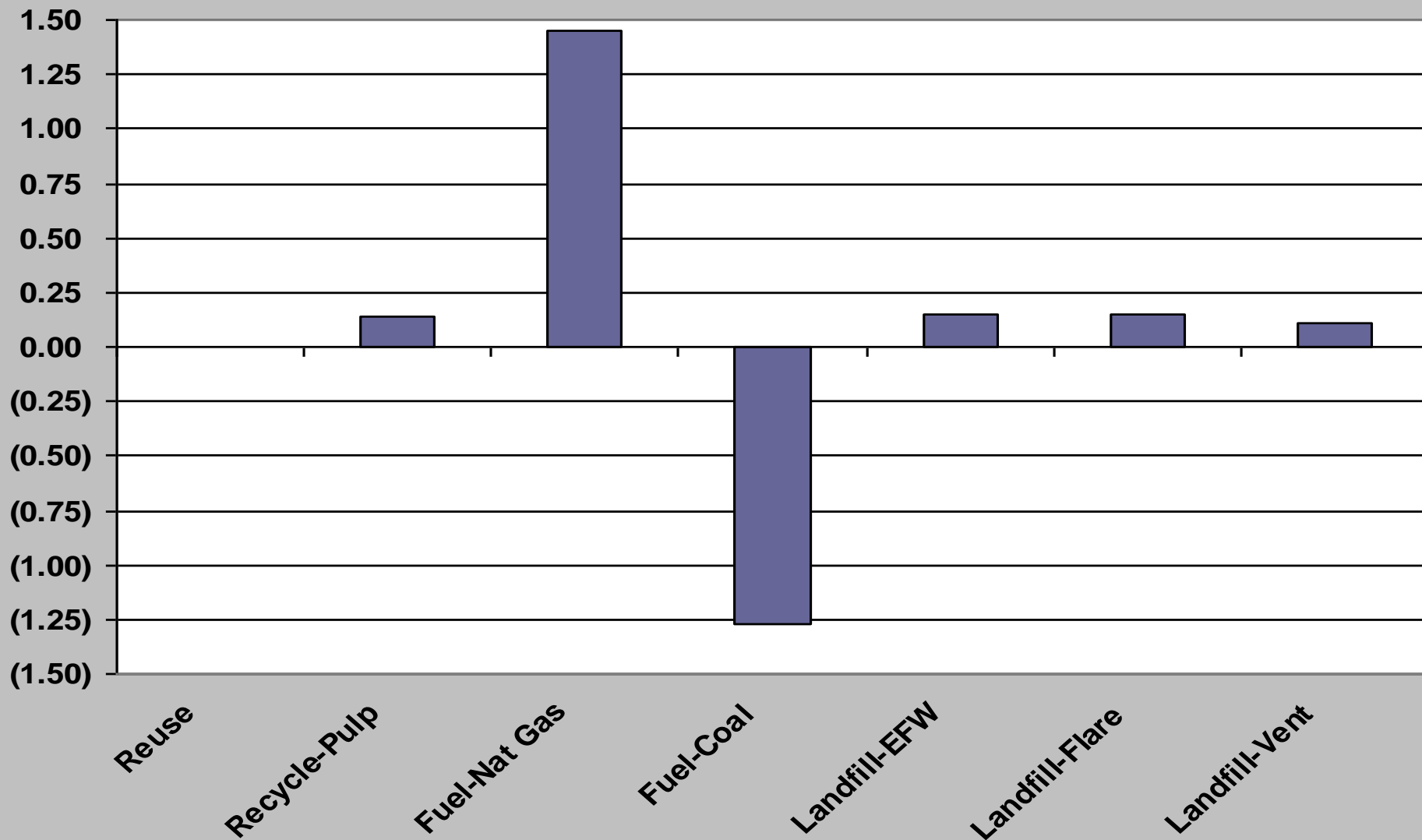


Acidification: Clean Wood Waste Management Options (lbs. eSO₂/ton)

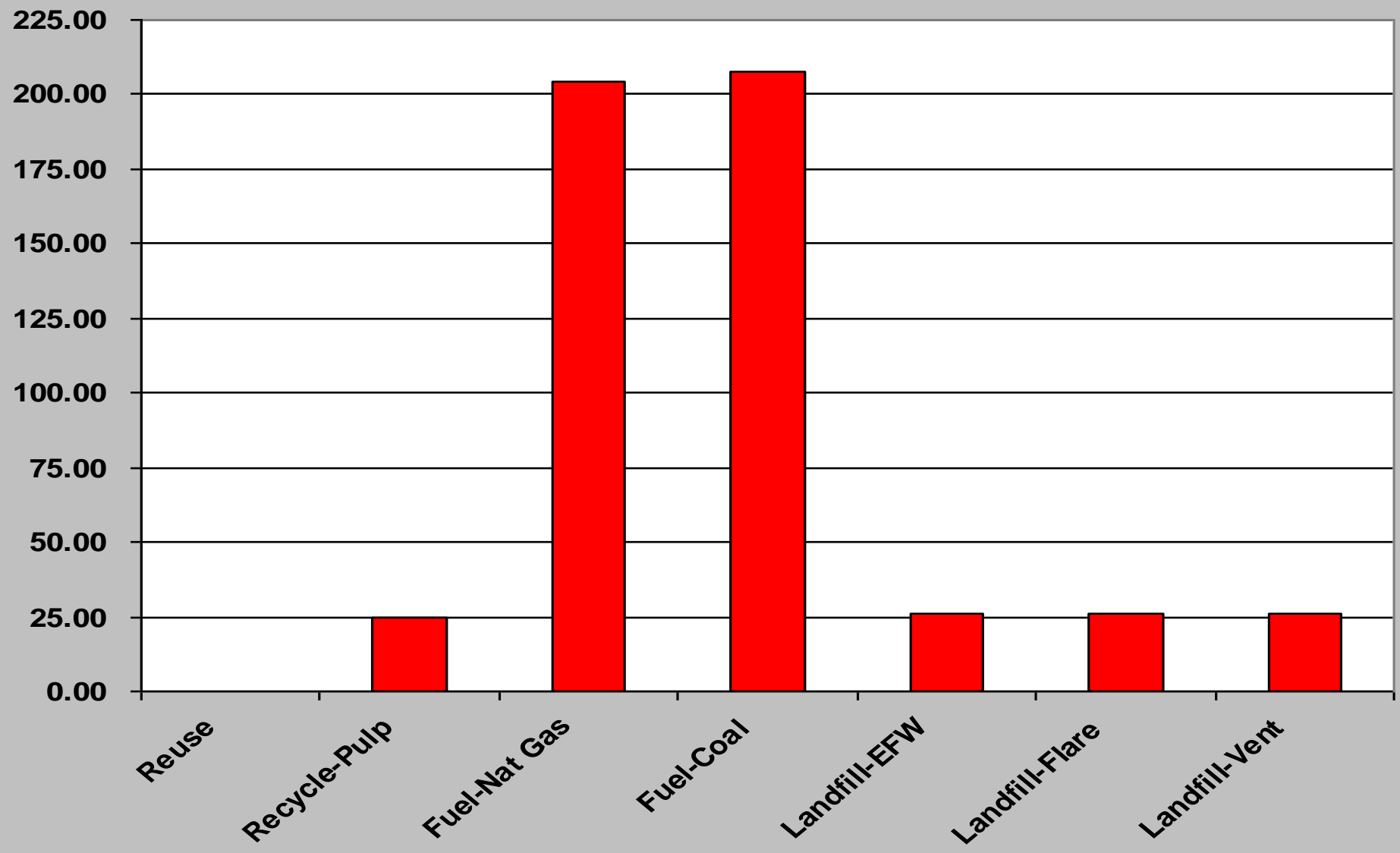




EcoToxics: Clean Wood Waste Management Options (lbs. e2,4-D/ton)

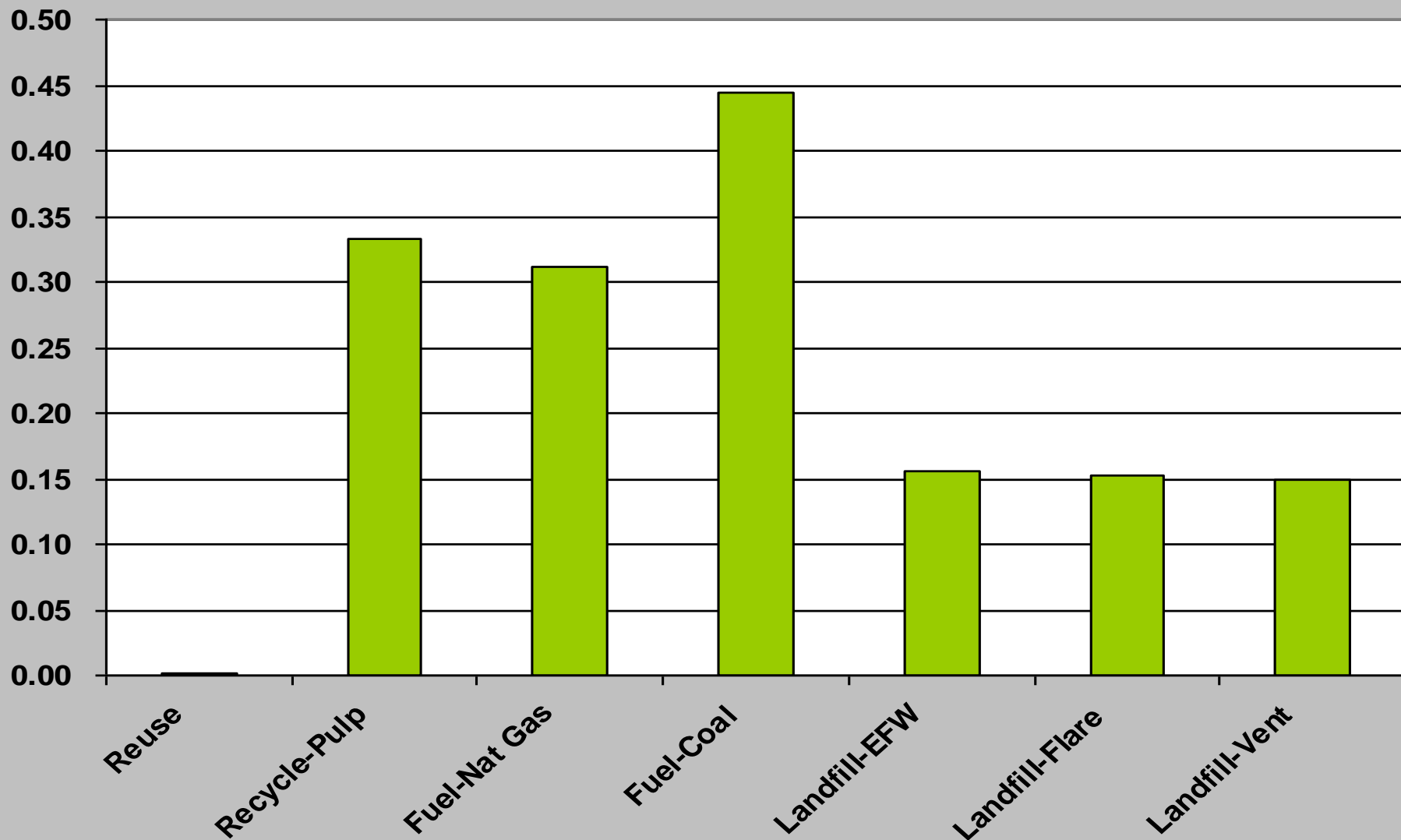


Human Toxics: Clean Wood Waste Management Options (#s eToluene/ton)





Eutrophication: Clean Wood Waste Management Options (lbs eN/ton)





Value of Pollution Reductions

LCA Impact	Economic Cost (US\$/ton)
Climate Change	\$36 eCO ₂
Human Health - Particulates	10,000 ePM _{2.5}
Human Health - Toxins	118 eToluene
Human Health - Carcinogens	3,030 eBenzene
Ecosystems Toxics	3,280 e2,4D
Acidification	661 eSO ₂
Eutrophication	4 eNitrogen

Environmental Value for Wood Waste Management Options

Pounds of Impact Category Emissions Released/(Reduced) Per Ton of Wood Waste

Impact Category	<u>Lumber Reuse</u>	<u>Recycling to Paper Pulp</u>	<u>Fuel Sub for Natural Gas</u>	<u>Fuel Sub for Coal</u>	<u>Landfill - LFG Energy</u>	<u>Landfill - LFG Flare</u>	<u>Landfill - LFG Vent</u>
Climate Change (eCO2)	-5,572.18	-4,732.40	-1,072.24	-3,306.48	-1,296.94	-1,115.18	824.89
Acidification (eSO2)	0.05	4.42	8.04	(17.35)	3.58	3.35	3.30
Eutrophication (eN)	0.00	0.33	0.31	0.44	0.16	0.15	0.15
Particulates (ePM2.5)	0.01	3.10	6.72	0.49	3.09	3.03	3.02
Human Toxics (eT)	0.00	24.37	204.49	207.66	26.02	26.03	26.02
Human Carcinogens (eB)	0.00	0.00	0.16	0.15	0.00	0.00	0.00
Ecosystems Toxicity (e2,4-D)	0.00	0.14	1.45	(1.27)	0.14	0.15	0.11
Environmental Benefit/(Cost)	\$100	\$67	(\$32)	\$52	\$5	\$2	(\$33)
-- with metals emissions	\$100	\$26	(\$699)	(\$563)	(\$39)	(\$41)	(\$75)

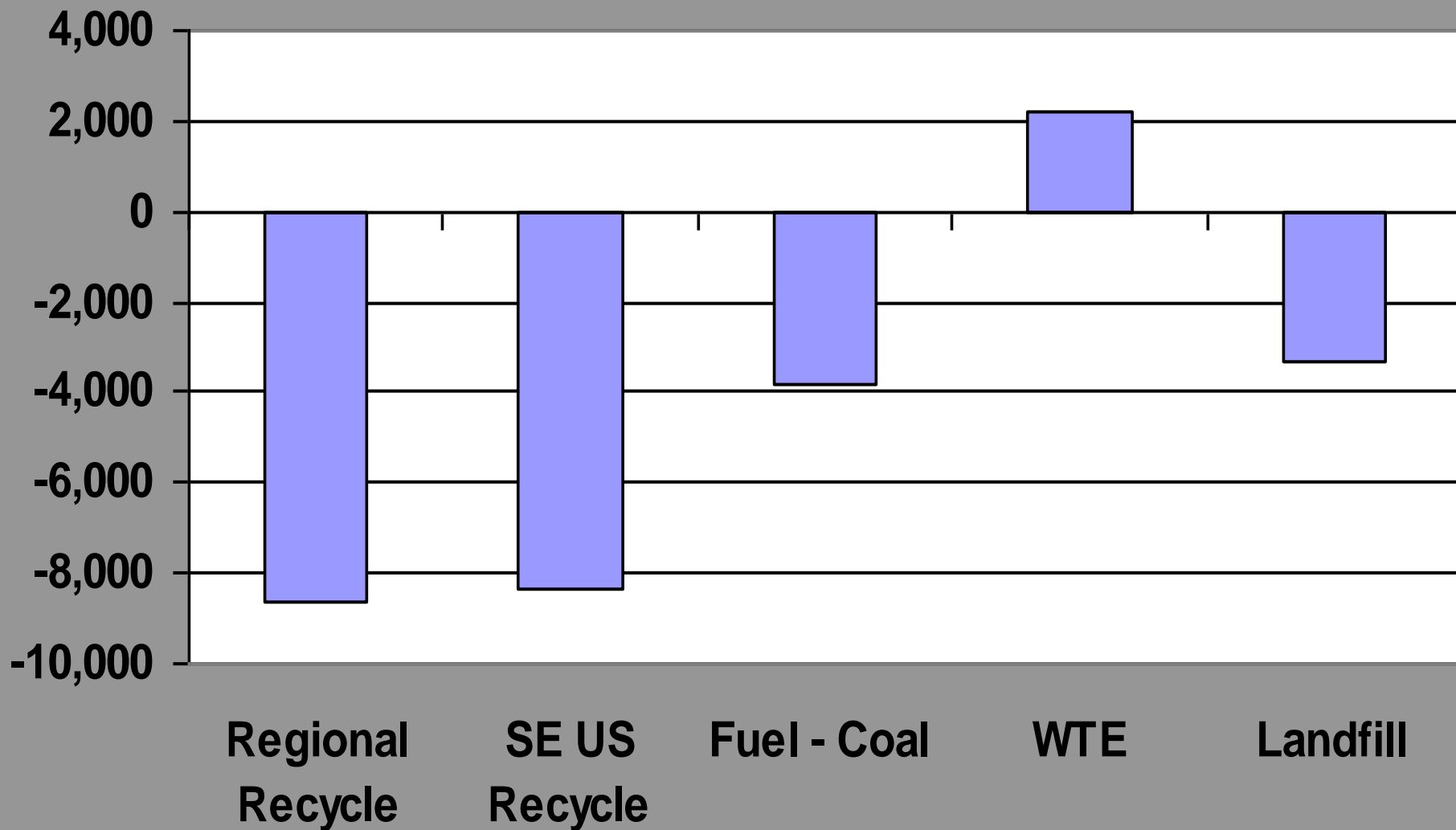


CO2 Emissions: Scrap Carpet Management Options (pounds/ton)

	Recycle	Fuel Replace Coal	WTE Incineration	Landfill
<u>Emissions</u>				
<i>Processing & Use in Manufacturing Recycled-Content Products</i>	2,932			
<i>Hauling – Regional Market</i>	58	58	12	12
<i>Hauling – Southeast Market</i>	349			
<i>Combustion (incl. Facility Operations)</i>		3,940	3,866	
<i>Landfill Operations</i>				66
<u>Offsets</u>				
<i>New Virgin-Content Product Manufacturing</i>	-8,213			
<i>Coal Production & Combustion in Industrial Boilers</i>		-7,806		
<i>Natural Gas Production & Combustion for Electricity</i>			-1,673	
<i>Biogenic Carbon Storage</i>	-3,395			-3,395
Net Emissions	-8,327 to -8,618	-3,808	2,205	-3.317



CO2 Emissions: Scrap Carpet Management Options (lbs. eCO2/ton)





Upstream Environmental Value for Scrap Carpet Recycling

Environmental Benefit/(Cost)	<u>eCO2</u>	<u>ePM2.5</u>	<u>eToluene</u>	<u>eBenzene</u>	<u>eN</u>	<u>eSO2</u>	<u>e2,4-D</u>	<u>Total</u>
-- without metals	\$95	\$24	\$105	\$0	\$0	\$5	\$2	\$232
-- with metals	95	24	407	4	0	5	420	956



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)**
(available through 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)**
(available through Sound Resource Management)
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)



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The End
Thank you.