

Managing Biogenic Materials: Store or Burn Carbon, or Both?

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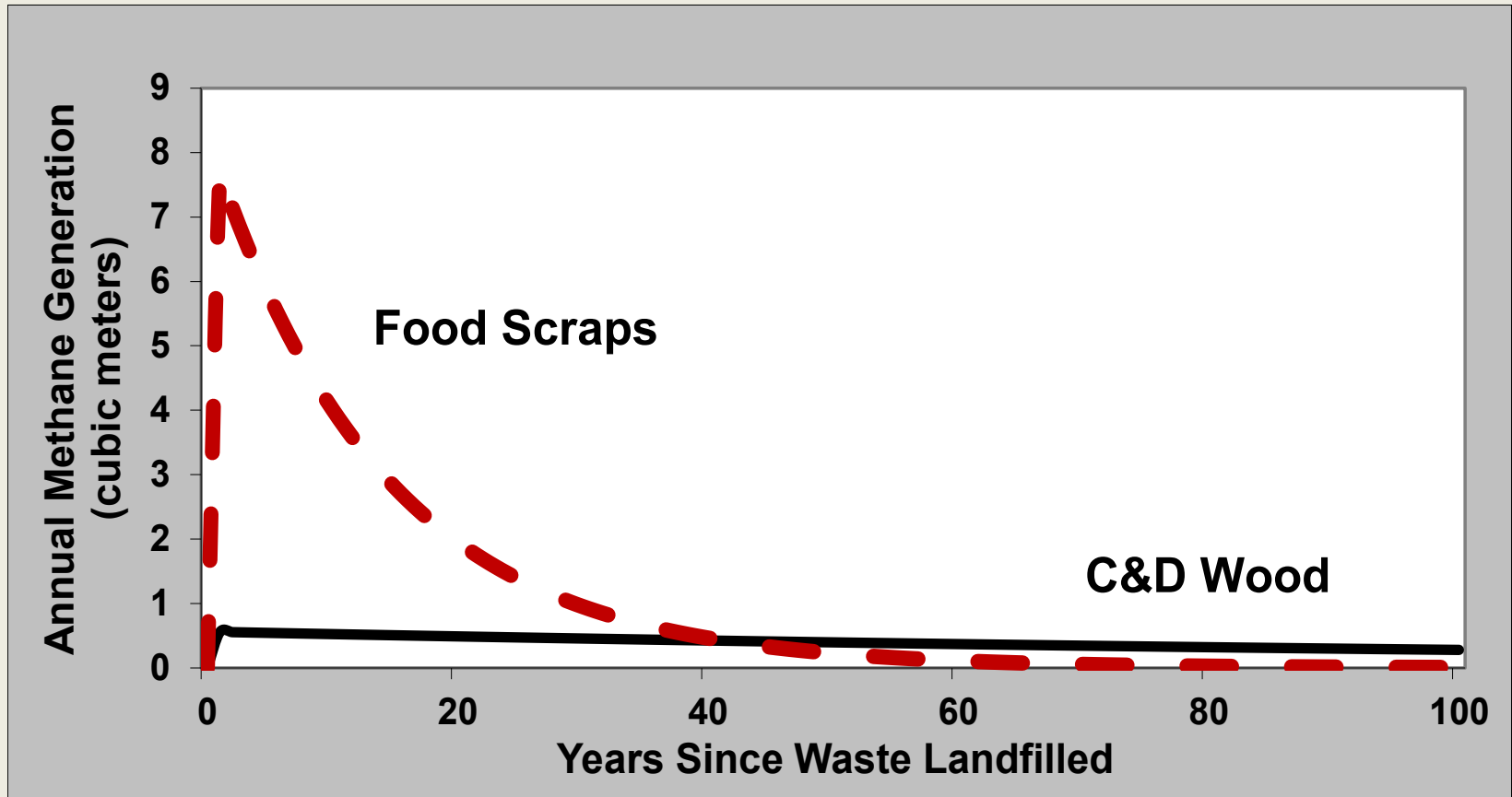
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Landfill (LF) Carbon Storage & Potential Life Cycle Carbon Emissions from Waste-to-Energy (WTE) & Landfill Disposal Facilities

MSW Material	Carbon Content (%)	Kilograms (kg) Carbon per Metric Ton	Landfill Carbon Storage (%)	Potential CO ₂ & CH ₄ Life Cycle Emissions (kg CO ₂ e per Metric Ton)		LF Methane (CH ₄) Capture for Breakeven Emissions vs. WTE (%)
				WTE	LF	
Film Plastic	66%	660	100%	2,420	0	0%
Newspaper	46	460	81	1,687	1,793	<10
C&D Wood	42	420	>80	1,540	1,637	<10
Leaves	34	340	77	1,247	1,604	20
Evergreen Trimmings	55	550	72	2,017	3,159	35
Yard Debris	19	190	60	697	1,559	55
Cardboard	45	450	55	1,650	4,154	60
Grass	12	120	25	440	1,846	75
Food Scraps	15	150	15	550	2,615	80

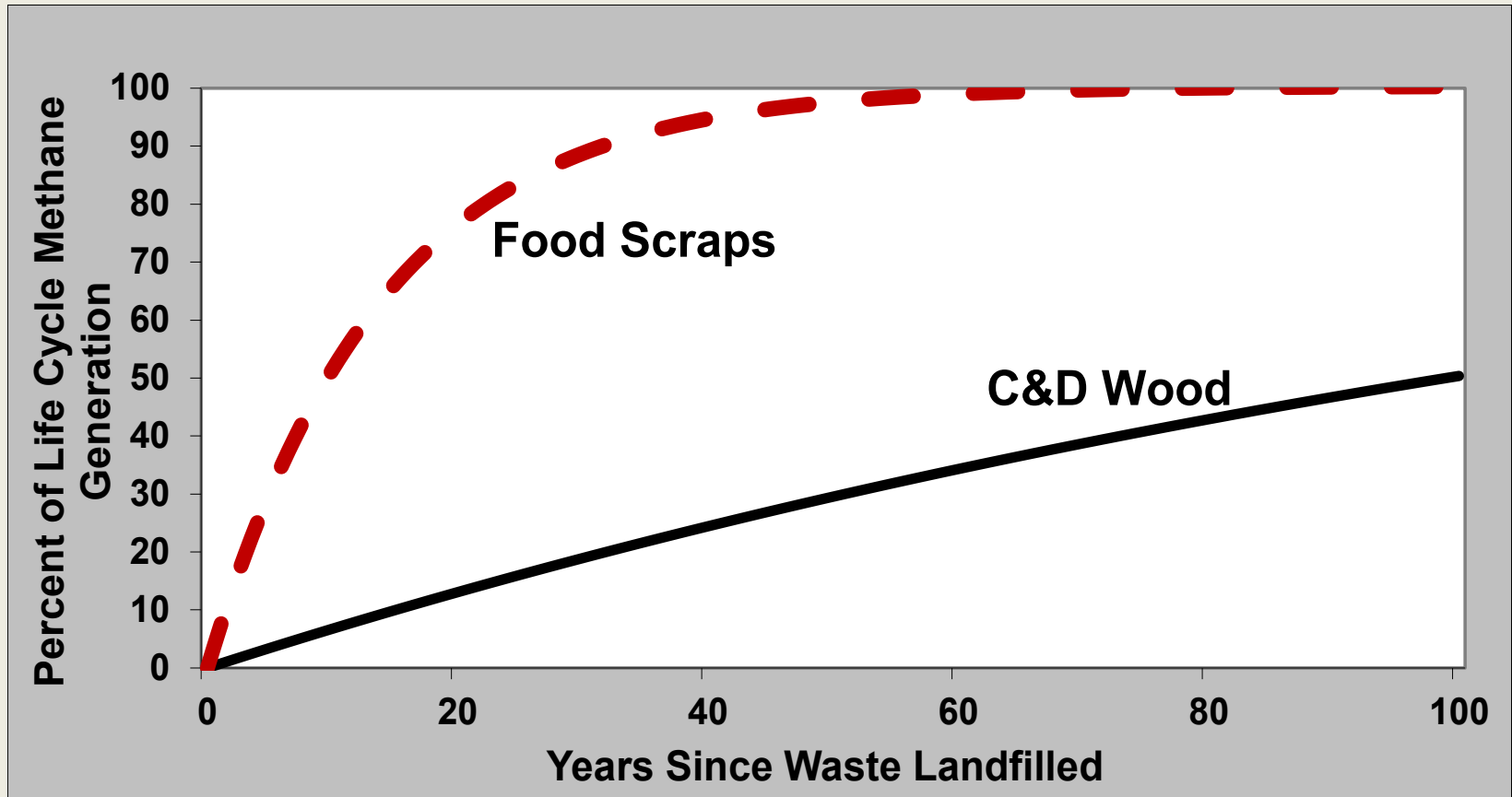
Sources: De La Cruz, F. B., Barlaz, M. A., 2010. Estimation of waste component-specific landfill decay rates using laboratory-scale decomposition data. *Environmental Science & Technology* 44 (12): 4722-4728; Morris, J., 2010. Bury or burn North American MSW? LCAs provide answers for climate impacts & carbon neutral power potential. *Environmental Science & Technology* 44 (20): 7944-7949; Wang, X., Padgett, J. M., De la Cruz, F. B., Barlaz, M. B., 2011. Wood biodegradation in laboratory-scale landfills. *Environmental Science & Technology* 45: 6864-6871, and Morris, J., 2017. Recycle, bury, or burn wood waste biomass? LCA answer depends on carbon accounting, emissions controls, displaced fuels, and impact costs. *Journal of Industrial Ecology*, 21 (4) 844-856.

Methane Generated Each Year Since Waste Landfilled



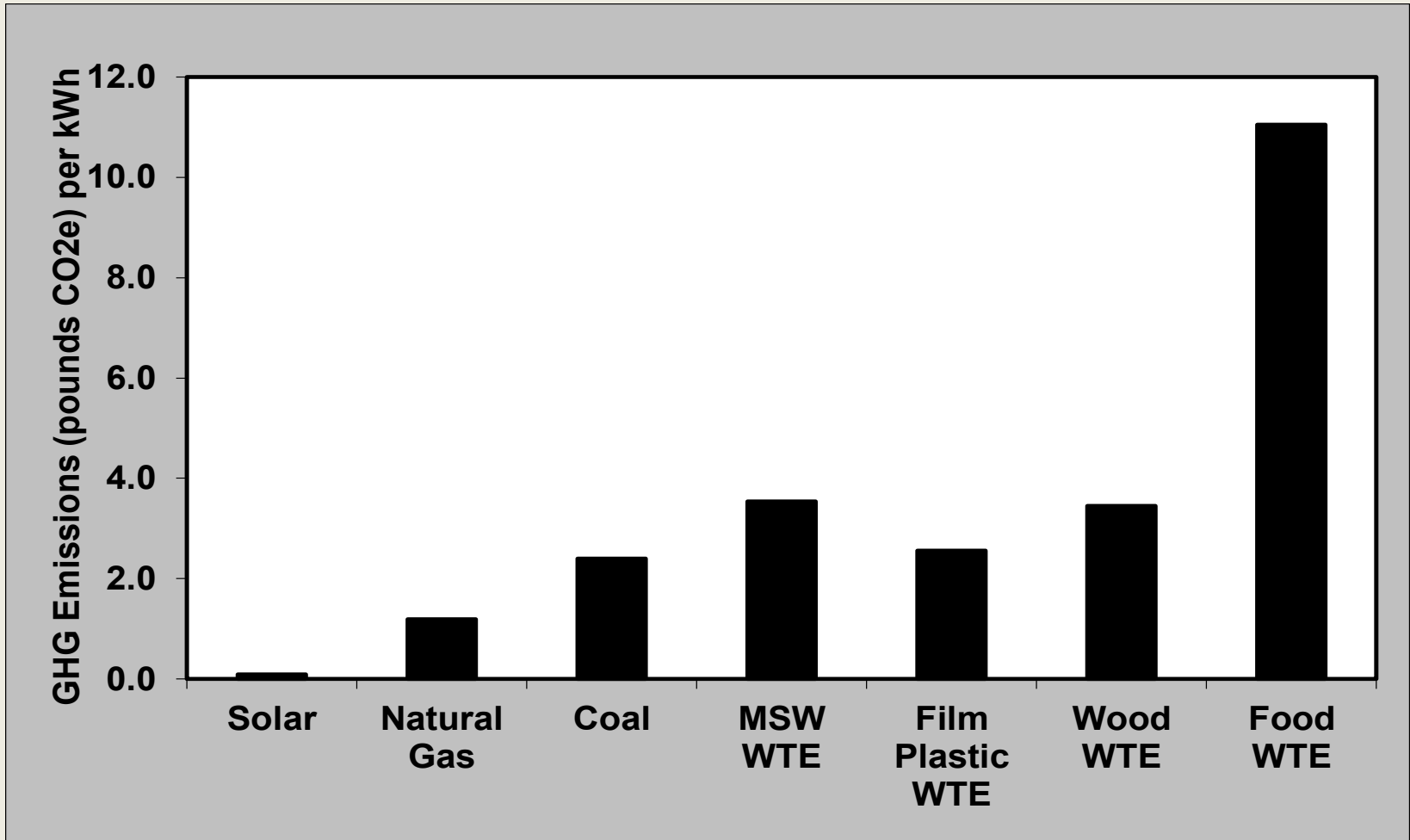
Sources: U. S. Environmental Protection Agency, 2005. *Landfill Gas Emissions Model (LandGEM) Version 3.02 User's Guide*. EPA-600/R-05/047, EPA: Washington, DC; De La Cruz, F. B., Barlaz, M. A., 2010. Estimation of waste component-specific landfill decay rates using laboratory-scale decomposition data. *Environmental Science & Technology* 44 (12): 4722-4728; Morris, J., 2010. Bury or burn North American MSW? LCAs provide answers for climate impacts & carbon neutral power potential. *Environmental Science & Technology* 44 (20): 7944-7949; Wang, X., Padgett, J. M., De la Cruz, F. B., Barlaz, M. B., 2011. Wood biodegradation in laboratory-scale landfills. *Environmental Science & Technology* 45: 6864-6871, and Morris, J., 2017. Recycle, bury, or burn wood waste biomass? LCA answer depends on carbon accounting, emissions controls, displaced fuels, and impact costs. *Journal of Industrial Ecology*, 21 (4) 844-856.

Cumulative Percentage of Life Cycle Methane Generated Since Waste Landfilled



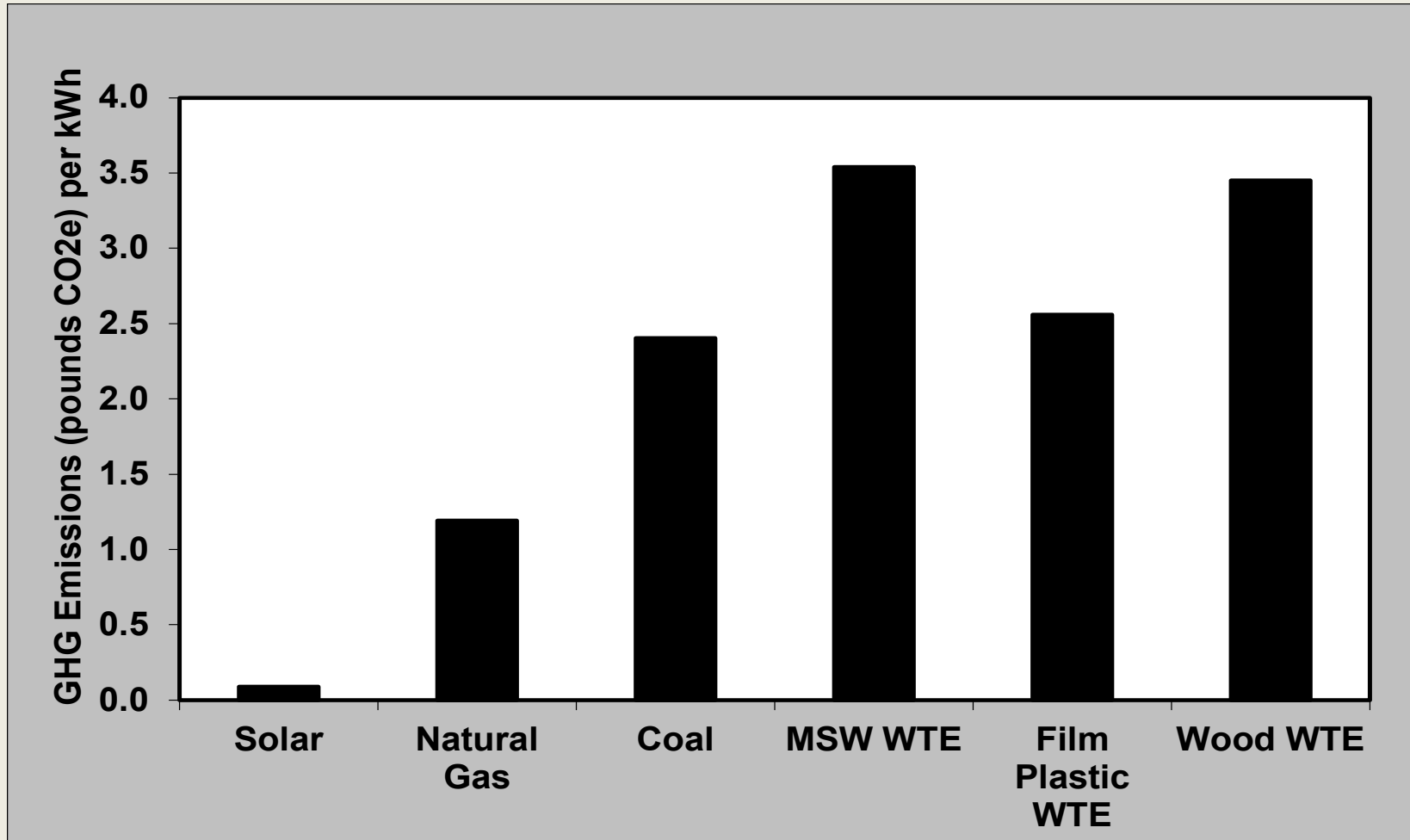
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Carbon Footprints for Electricity Generation



Sources: Kim, H. C.; Fthenakis, V.; Choi J-K.; Turney, D. E., 2012. Life Cycle Greenhouse Gas Emissions of Thin-film Photovoltaic Electricity Generation – Systematic Review and Harmonization. *Journal of Industrial Ecology* 16 (S1): S110-S121; Morris, J., 2010. Bury or burn North American MSW? LCAs provide answers for climate impacts & carbon neutral power potential. *Environmental Science & Technology* 44 (20): 7944-7949; Morris, J., 2017. Recycle, Bury, or Burn Wood Waste Biomass? LCA answer depends on carbon accounting, displaced fuels, emissions controls, and impact costs. *Journal of Industrial Ecology*, 21 (4) 844-856; and Whitaker, M. B.; Heath, G. A.; Burkhardt, III, J. J.; Turchi, C. S., 2013. Life Cycle Assessment of a Power Tower Concentrating Solar Plant and the Impacts of Key Design Alternatives. *Environmental Science & Technology* 47 (): 5896-5903.

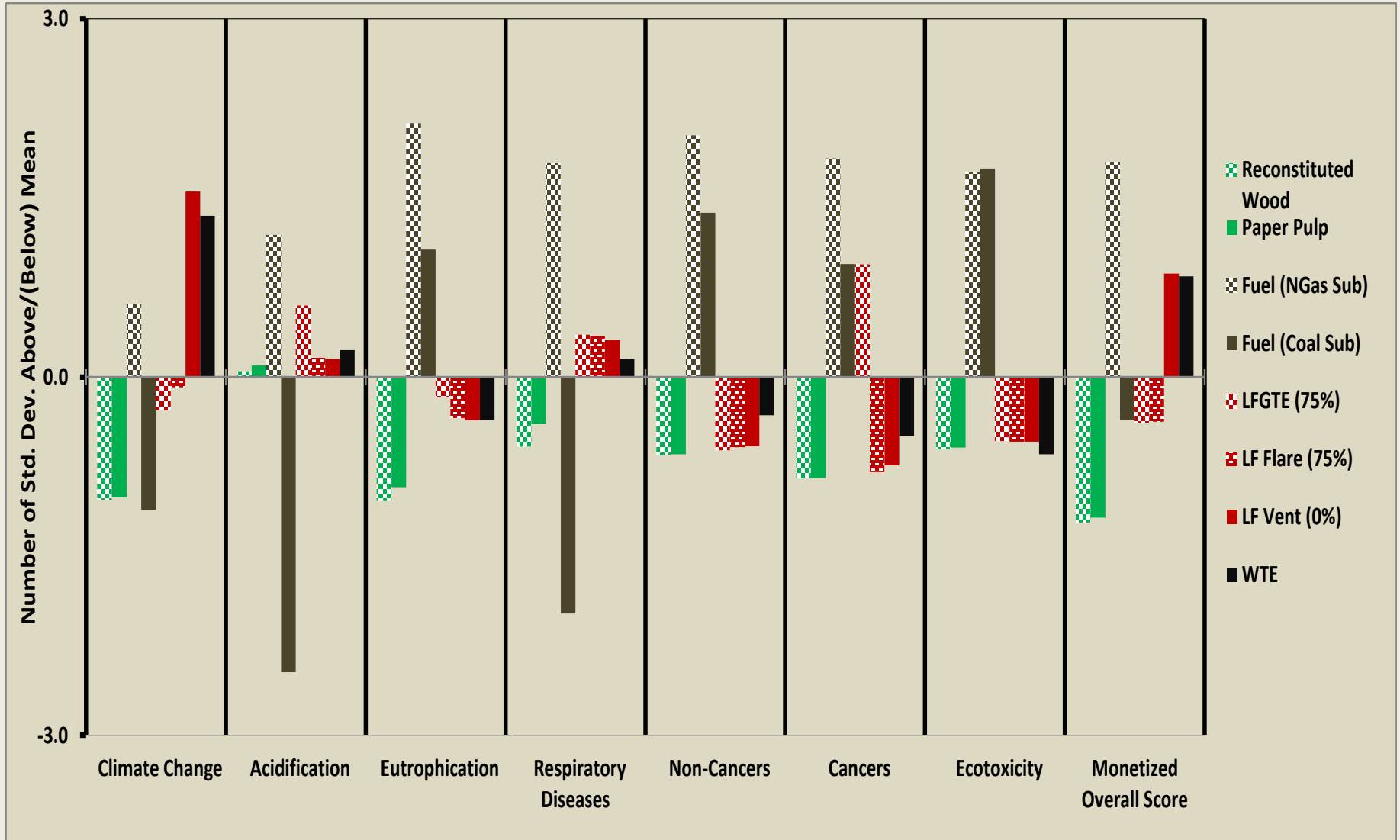
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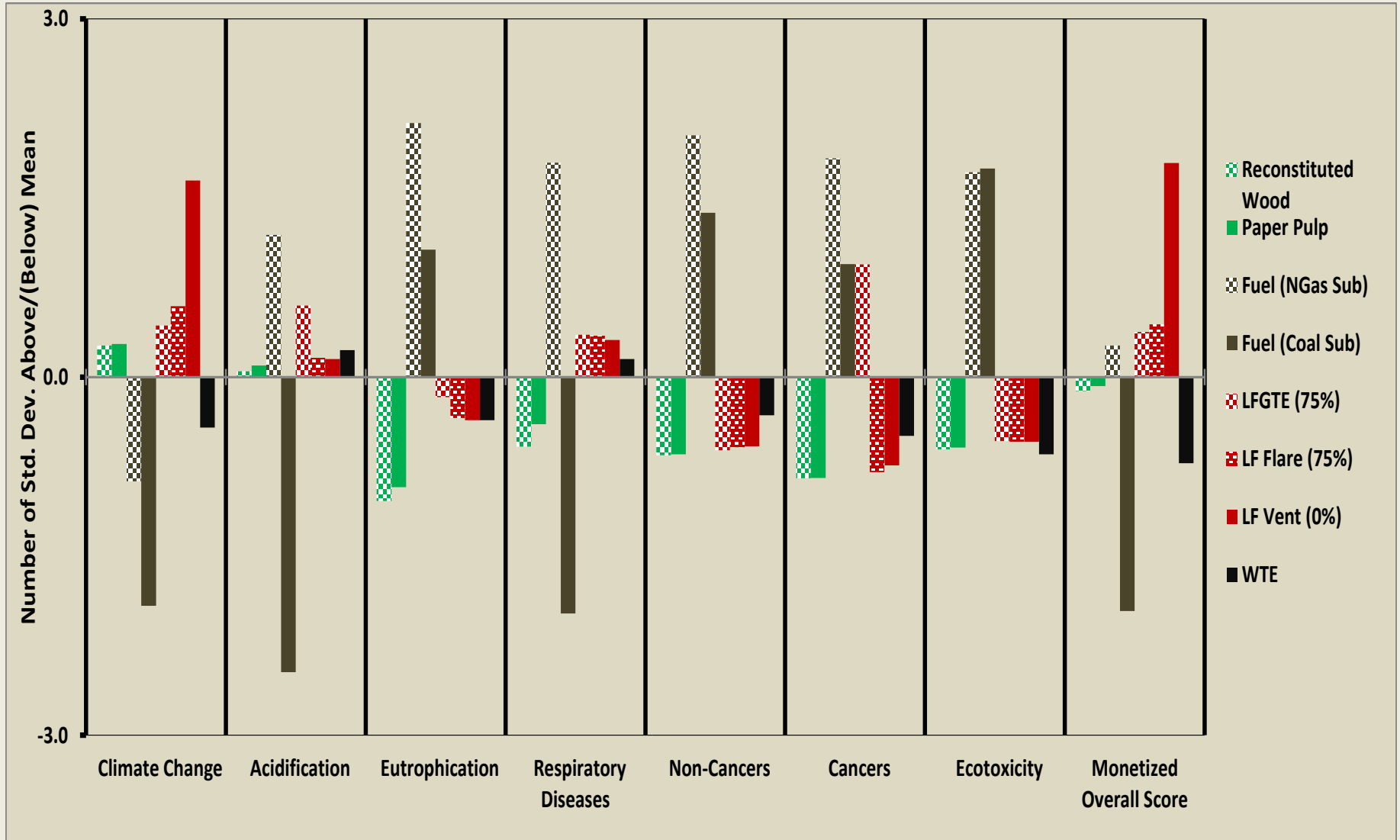
LCA Impacts for Clean C&D Wood Waste

Biogenic CO₂ Emissions Counted as GHGs



LCA Impacts for Clean C&D Wood Waste

Biogenic CO₂ Emissions Ignored



Rankings from Harmonization & Qualitative Assessment of Food Waste Treatments

Treatment	Climate	Energy	Soil Carbon	Fertilizer Replacement	Water Conservation	Plant Yield Increase
Aerobic Composting	2	4	1	2	1	1
Anaerobic Digestion	1	2	2	1	2	1
In-Sink Grinding	3	1	3	3	3	3
Landfill	4	3	4	4	4	4

Main Sources

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- Morris, J., 2017. Recycle, bury or burn wood waste biomass? LCA answer depends on carbon accounting, emissions controls, displaced fuels, and impact costs. *Journal of Industrial Ecology*, 21 (4): 844-856.

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