Statement before the U.S. Senate Committee on Environment & Public Works
Avoiding, Detecting, and Capturing Methane Emissions from Landfills

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INTRODUCTION

Chairman Carper, Ranking Member Capito, and Members of the Committee: thank you for the opportunity to appear before you today.

My name is Tom Frankiewicz, and I lead Waste Sector Methane mitigation at RMI, an independent, non-partisan, nonprofit organization working to accelerate the clean energy transition and improve lives. Before joining RMI, I worked for more than sixteen years at the United States Environmental Protection Agency.

I am excited to speak with you today about the readily available, low-cost strategies to prevent and reduce landfill methane emissions. Fast action to curb landfill methane emissions will help to limit near-term warming, advance U.S. climate commitments, and deliver substantial benefits to local communities.

THE PROBLEM

Accelerated methane abatement is crucial to limit temperature rise over the near term and avoid the worst impacts of climate change. Methane is the second most abundant greenhouse gas after carbon dioxide, and the concentration of methane in the atmosphere has more than doubled over the past 200 years.[1] Scientists estimate that methane is responsible for about 30 percent of global warming since pre-industrial times.[2]

Methane has outsized impacts on near-term temperature rise. In the first twenty years after its release, methane has more than 80 times the heat-trapping power of carbon dioxide. But since methane only lingers in the atmosphere for about a decade, compared to centuries for CO_2, reducing methane emissions today provides an immediate opportunity to slow global warming and

[1] "Methane," NASA Global Climate Change, 2024, https://climate.nasa.gov/vital-signs/methane/.
[2] "Methane emissions are driving climate change. Here's how to reduce them.," United Nations Environment Programme (UNEP), August 2021, https://www.unep.org/news-and-stories/story/methane-emissions-are-driving-climate-change-heres-how-reduce-them.

limit the risk of dangerous climate tipping points.[3] Pairing decarbonization with mitigation measures targeting short-lived climate pollutants like methane can slow the rate of warming a decade or two earlier than decarbonization alone.[4]

Our methane strategy must target the waste sector, a major source of heat-trapping emissions. Globally, the waste sector is responsible for about 20 percent of anthropogenic methane emissions.[5] In the United States, municipal solid waste (MSW) landfills are the third-largest source of human-related methane emissions, accounting for 14 percent of the total.[6] In 2021, U.S. MSW landfills emitted an estimated 3.7 million metric tons of methane according to the U.S. Environmental Protection Agency (EPA)'s inventories, or about 295 million metric tons of carbon dioxide equivalent (MMT CO_2e) on a 20-year time horizon. That's equivalent to the annual greenhouse gas pollution from 66 million gas-powered passenger vehicles or 79 coal-fired power plants.[7] In 37 states, a landfill was the single largest industrial methane emitter reported to EPA's Greenhouse Gas Reporting Program (GHGRP) in 2021.[8]

Each year, more than 145 million tons of municipal solid waste (MSW) are sent to the roughly 1,200 open landfills across the United States for disposal.[9] As the organic fraction of this waste – which includes food waste, yard waste, and paper – decomposes without oxygen in the landfill, it generates methane. Food waste is the largest MSW component landfilled, responsible for an estimated 58% of fugitive methane emissions from U.S. MSW landfills.[10] Data reported voluntarily to EPA's Landfill Methane Outreach Program (LMOP) shows that 47% of reporting landfills (1,229 of 2,636) have a gas collection system in place to capture a portion of their methane emissions. Per LMOP, 487 landfills had energy projects as of July 2023, utilizing captured methane to generate electricity or upgrading it to renewable natural gas (RNG) for pipeline injection or transportation fuel.[11] Otherwise, collected methane is typically routed to a flare for destruction. Importantly, collection and control systems cannot capture all generated methane, as they are not installed in all areas of the landfill, experience downtime, and can malfunction. Large amounts of methane escape from landfills into the atmosphere, diffusely through the landfill surface and in more

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[3] "Control methane to slow global warming — fast," *Nature*, August 2021, https://www.nature.com/articles/d41586-021-02287-y.
[4] Gabrielle B. Dreyfus et al., "Mitigating climate disruption in time: A self-consistent approach for avoiding both near-term and long-term global warming," *Proceedings of the National Academy of Sciences* 119, 22 (May 2022), https://www.pnas.org/doi/full/10.1073/pnas.2123536119.
[5] *Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions,* United Nations Environment Programme and Climate and Clean Air Coalition, 2021, https://www.ccacoalition.org/resources/global-methane-assessment-full-report.
[6] "Basic Information about Landfill Gas," U.S. Environmental Protection Agency, August 2023, https://www.epa.gov/lmop/basic-information-about-landfill-gas.
[7] Preet Bains et al., *Trashing the Climate: Methane from Municipal Landfills*, Environmental Integrity Project, May 2023, https://environmentalintegrity.org/reports/trashing-the-climate/.
[8] "Don't Waste Our Future," Industrious Labs, 2024, https://dontwasteourfuture.org/.
[9] "National Overview: Facts and Figures on Materials, Wastes and Recycling," U.S. Environmental Protection Agency, November 2023, https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials#Landfilling; "LMOP Landfill and Project Database," U.S. Environmental Protection Agency, August 2023, https://www.epa.gov/lmop/lmop-landfill-and-project-database.
[10] Max Krause et al., *Quantifying Methane Emissions from Landfilled Food Waste,* U.S. Environmental Protection Agency Office of Research and Development, October 2023, https://www.epa.gov/system/files/documents/2023-10/food-waste-landfill-methane-10-8-23-final_508-compliant.pdf.
[11] "LMOP Landfill and Project Database," U.S. Environmental Protection Agency, August 2023, https://www.epa.gov/lmop/lmop-landfill-and-project-database.

concentrated hot spots, often due to cracks or gaps in the landfill cover, leaking gas wells, or the exposed working face. Landfill gas collection efficiency can vary widely by site, due in part to design and operational factors. While landfill emissions models often assume a default collection efficiency of 75%, studies show instances where collection efficiency can be much lower.[12]

Furthermore, recent airborne methane surveys suggest that landfill emissions may be higher and more persistent than previously expected.[13] Since 2016, airborne surveys conducted by Carbon Mapper and partners have detected high-emitting methane plumes at more than 200 U.S. landfills across 29 states.[14] In California, Carbon Mapper's flyovers found that a subset of landfills were the state's largest methane emitters (41 percent), with higher observed emission rates than the oil & gas or agriculture sectors.[15] Detectable methane plumes at California landfills often reached 1,000 kg/hr, ten times what EPA considers to be a super-emitter in the oil & gas sector.[16]

A recent study under review in *Atmospheric Chemistry and Physics* uses observations from the TROPOMI satellite instrument to quantify methane emissions from 70 landfills reporting to EPA's GHGRP across the contiguous United States. The authors find a median 77% increase in observed emissions (13 Gg/a), compared to reported emissions (7.2 Gg/a). At the 38 facilities that recover gas, the authors find a mean recovery efficiency of 0.50 (0.33 – 0.54) that is much smaller than the GHGRP mean of 0.61 and the default assumption of 0.75.[17] The authors attribute the discrepancy to two main factors: 1) over-estimated recovery efficiencies at facilities with gas collection systems and 2) under-accounting of site-specific operational changes across facilities.[18]

Landfill emissions also threaten nearby communities. Beyond the planet-heating methane, landfills release harmful co-pollutants that adversely impact the health and well-being of nearby communities. Landfill gas contains hazardous air pollutants (e.g., vinyl chloride, 1,1,1-trichloroethane, 2-butanone, organic mercury compounds), precursors to ozone and particulate matter (PM) (e.g., VOCs), and odor nuisance compounds (e.g., H2S). These compounds have been

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[12] James Hanson and Nazil Yesiller, *Estimation and Comparison of Methane, Nitrous Oxide, and Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills Final Report*, Prepared for: The California Air Resources Board and The California Department of Resources Recycling and Recovery, March 25, 2020, https://ww2.arb.ca.gov/resources/documents/landfill-gas-research. Nickolas J. Themelis and A.C. (Thanos) Bourtsalas, "Methane Generation and Capture of U.S. Landfills," *Journal of Environmental Science and Engineering A* 10 (2021): 199-206. https://www.davidpublisher.com/Public/uploads/Contribute/61ad830cee8a6.pdf.
[13] *National Strategy to Advance an Integrated U.S. Greenhouse Gas Measurement, Monitoring, and Information System*, The Greenhouse Gas Monitoring and Measurement Working Group & The White House, November 2023, https://www.whitehouse.gov/wp-content/uploads/2023/11/NationalGHGMMISStrategy-2023.pdf.
[14] "Carbon Mapper Data Portal," Carbon Mapper, January 2024, https://carbonmapper.org/data/.
[15] Riley Duren et al., "California's methane super-emitters," *Nature* 575 (2019): 180-184, https://pubmed.ncbi.nlm.nih.gov/31695210/.
[16] Jason Schroeder, "Landfill Methane Research Workshop: Methane Remote Sensing for Leak Identification and Mitigation," California Air Resources Board, December 5, 2022, https://ww2.arb.ca.gov/sites/default/files/2022-12/Methane%20Remote%20Sensing.pdf.
[17] Hannah Nesser at al., "High-resolution U.S. methane emissions inferred from an inversion of 2019 TROPOMI satellite data: contributions from individual states, urban areas, and landfills," *EGUsphere* [preprint] (2023), https://egusphere.copernicus.org/preprints/2023/egusphere-2023-946/.
[18] Docket No. EPA-HQ-OAR-2019-0424, "Revisions and Confidentiality Determinations for Data Elements Under the Greenhouse Gas Reporting Rule," Hannah Nesser, July 27, 2023, https://www.regulations.gov/comment/EPA-HQ-OAR-2019-0424-0306.

found to contribute to urban smog and impact human health and the environment.[19] In addition, the leachate from landfills can contaminate nearby soil and groundwater. One study found that the typical emissions of ozone precursors from a single hypothetical landfill may result in persistent daytime additions to ozone of over 1 part per billion (ppb) by volume tens of kilometers downwind, and large leaks of landfill gas can enhance ozone pollution by over a tenth of a ppb. In Southeast Michigan, the combined influence of several landfills upwind of key monitoring sites may contribute significantly to observed exceedances of the U.S. ozone standard.[20] Studies have also shown that landfills can decrease neighboring residential property values.[21] Landfills are often sited near vulnerable communities. Analysis using the EPA's Environmental Justice Screening and Mapping Tool shows that 54 percent of MSW landfills reporting to the GHGRP have communities located within one mile that exceed the national average for either percent low-income or percent people of color.[22]

Across the country, journalists have documented the adverse impacts of landfills on nearby communities. Recent stories document the prevalence of cancer and kidney failure in the Snow Hill community near North Carolina's Sampson County landfill,[23] lung cancer clusters near New York's Seneca Meadows landfill,[24] and odor violations from California's Chiquita landfill that left some residents vomiting and with severe migraines.[25] A winner of U.S. EPA's 2023 EJ Video Challenge for Students, *Pollution to Prosperity: Tackling Landfill Impacts for a Thriving Future*, highlights the air quality, water, and health impacts of Virginia's first mega-landfill on the surrounding community in Charles City County, which has left some families boiling their tap water to avoid contaminants.[26] The film also proposes solutions, including water quality testing, air monitoring, community health surveys, and waste diversion.

THE SOLUTIONS

Solutions are available to better control emissions from landfilled waste *and* prevent future landfill methane generation. To maximize climate and community benefits, we must do both. Fortunately, there are a number of technically feasible, readily available strategies to reduce

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[19] *Understanding and Control of Municipal Solid Waste Landfill Air Emissions Request for Applications (RFA)*, U.S. Environmental Protection Agency, October 2022, https://www.epa.gov/research-grants/understanding-and-control-municipal-solid-waste-landfill-air-emissions-request.

[20] Eduardo P. Olaguer, "The Potential Ozone Impacts of Landfills," *Atmosphere* 12, 7 (2021): 877, https://www.mdpi.com/2073-4433/12/7/877.

[21] Richard Ready, "Do Landfills Always Depress Nearby Property Values?," *Journal of Real Estate Research,* 32, 3 (2010): 321-340. https://www.tandfonline.com/doi/abs/10.1080/10835547.2010.12091279

[22] Preet Bains et al., *Trashing the Climate: Methane from Municipal Landfills*, Environmental Integrity Project, May 2023, https://environmentalintegrity.org/reports/trashing-the-climate/.

[23] Cameron Oglesby, "A decades-long battle against North Carolina's largest landfill is ramping up," *Grist,* Jan 19, 2024, https://grist.org/accountability/a-decades-long-battle-against-north-carolinas-largest-landfill-is-ramping-up/

[24] Emma Misiaszek, "Activists rally against expansion of Seneca Meadows, NY's largest landfill," *CNYCentral*, Jan 23, 2024, https://cnycentral.com/news/local/activists-rally-against-expansion-of-seneca-meadows-nys-largest-landfill.

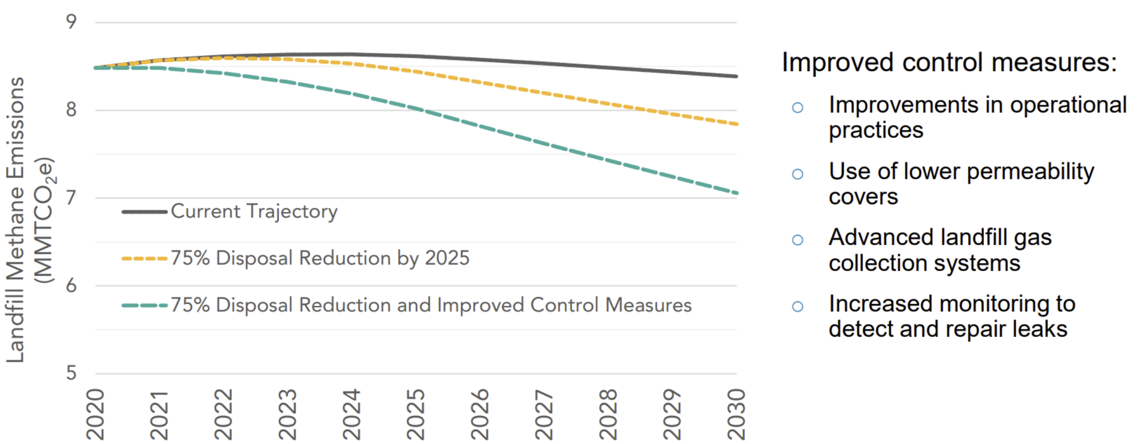
[25] "AQMD to address foul odor emitting from Chiquita Canyon Landfill," *KCAL News*, Sept 6, 2023, https://www.cbsnews.com/losangeles/news/aqmd-to-address-foul-odor-emitting-from-chiquita-canyon-landfill/

[26] Megan Salters, McKenna Dunbar, Sarah Murtaugh, "Pollution to Prosperity: Tackling Landfill Impacts for a Thriving Future," University of Richmond, February 2023, https://www.youtube.com/watch?v=HHzOuTfHNss.

landfill emissions today, at modest cost.[27] Modernizing landfill operations – through comprehensive leak detection and repair, expanded gas collection system coverage, and enhanced cover practices – can cut methane immediately from waste-in-place, while protecting nearby communities from co-pollutants. At the same time, scaling up efforts that keep organic waste out of landfills – through strategies like edible food donation and composting – will avoid future landfill methane generation and ensure organic materials are put to their highest and best use in the circular economy.

The volume of methane-generating waste already sitting in U.S. landfills dwarfs the amount of new waste landfilled each year.[28] For example, California found that the total degradable carbon that is accumulated from waste deposited in previous years is over 20 times greater than the amount added.[29] And while methane production typically begins within the first year after the waste is landfilled, methane generation can continue for 10 to 50 or more years as the degradable waste decomposes over time.[30] That's why climate-leading states, including California, Maryland, and Washington, are pursuing efforts to reduce organic waste disposal *and* to strengthen waste-in-place control measures, accelerating overall emission reductions.

California Air Resources Board: Waste Sector Strategies[31]



Waste-in-place controls are well understood and can be deployed quickly and at modest cost across a relatively small number of sources (i.e., there are 1,123 MSW landfills that reported to

[27] Heijo Scharff et al., "The impact of landfill management approaches on methane emissions," *Waste Management & Research: The Journal for a Sustainable Circular Economy* (2023), https://journals.sagepub.com/doi/10.1177/0734242X231200742

[28] *3.14. Methodology for Estimating CH4 Emissions from Landfills: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021 – Annex 3 Part B*, U.S. Environmental Protection Agency, 2023, https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Annex-3-Additional-Source-or-Sink-Categories-Part-B.pdf

[29] *2022 Scoping Plan for Achieving Carbon Neutrality,* California Air Resources Board, December 2022, https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf.

[30] *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021 – Main Report,* U.S. Environmental Protection Agency, 2023, https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf

[31] "Preliminary Concepts for Potential Improvements to Landfill Methane Regulation," California Air Resources Board, Public Workshop, May 18, 2023, https://ww2.arb.ca.gov/sites/default/files/2023-05/LMR-workshop_05-18-2023.pdf.

GHGRP in 2022).[32] A recent paper, *The impact of landfill management approaches on methane emissions,* calculated the emission reduction potential of different management choices relative to business-as-usual (BAU) scenarios at North American (NA) landfills. For a typical NA landfill implementing few best practices, early gas collection and reducing the landfill cell size can reduce methane emissions by 27% vs. BAU. For a typical landfill implementing some best management practices, early and extended gas recovery can reduce methane emissions by 38% vs. BAU. For a typical landfill implementing nearly all best management practices, early sealing of the landfill could reduce methane emissions by 44% vs. BAU.[33] According to the paper, these approaches entail "basic, standardized, technology that can be deployed swiftly and at moderate cost" to reduce methane emissions today.[34] Below, we describe in more detail specific strategies that can better control emissions from landfilled organic waste.

- **Earlier installation and expansion of wells to maximize gas collection system coverage:** According to EPA, 61% of methane generated by landfilled food waste is not captured by landfill gas collection systems and is released to the atmosphere as fugitive emissions. Because food waste decays relatively quickly, its emissions often occur before landfill gas collection systems are required to be installed or expanded.[35] However, it is technically feasible to install and expand the gas collection system within one year after waste is placed, rather than the more extended time frames currently allowed (up to 5 years). Analysis by the Environmental Integrity Project (EIP), based on Eastern Research Group (ERG)'s analysis for EPA's 2019 technology review process for the Sec 112 Clean Air Act standards, found that earlier expansion of gas control systems (after 1 year) could reduce methane emissions by 400,000 tons per year at a cost-effectiveness of about $140 per metric ton of methane reduced (or just ~$2/ton CO_2e using the 20-year global warming potential).[36] This is well below the threshold of $1,970 per ton of methane that EPA found to be reasonable for the oil and gas industry.[37] Using horizontal collectors during the disposal of waste can help capture gas as the lifts are being constructed. Optimizing wellhead spacing can also help ensure comprehensive coverage and reduce fugitive emissions.
- **More robust wellhead tuning and maintenance to boost gas collection system performance:** More frequent wellfield monitoring and adjustments to system vacuum can help increase landfill gas recovery and limit system downtime. For example, automated tuning systems adjust the vacuum continuously, as temperature, pressure, and weather

[32] "Number of reporters and emissions in the waste sector," U.S. Environmental Protection Agency, 2023, https://www.epa.gov/ghgreporting/ghgrp-waste.
[33] Heijo Scharff et al., "The impact of landfill management approaches on methane emissions," *Waste Management & Research: The Journal for a Sustainable Circular Economy* (2023), https://journals.sagepub.com/doi/10.1177/0734242X231200742
[34] Ibid.
[35] Max Krause et al., *Quantifying Methane Emissions from Landfilled Food Waste,* U.S. Environmental Protection Agency Office of Research and Development, October 2023, https://www.epa.gov/system/files/documents/2023-10/food-waste-landfill-methane-10-8-23-final_508-compliant.pdf.
[36] "Petition for Rulemaking to Revise the New Source Performance Standards and Emission Guidelines for Municipal Solid Waste Landfills," Environmental Integrity Project, June 2023, https://environmentalintegrity.org/news/groups-petition-epa-for-stronger-controls-on-methane-from-landfills/; Memorandum from E. Rsch. Grp., Inc. on Clean Air Act Section 112 (d)(6) Tech. Rev. for Mun. Solid Waste Landfills to Allison Costa and Andy Sheppard, EPA, Off. of Air Quality Planning & Standards, at 29-30, 31-32, 36- 41, 44-45 (June 25, 2019) https://www.regulations.gov/document/EPA-HQ-OAR-2002-0047-0082
[37] Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 87 Fed. Reg. at 74718.

conditions fluctuate, and can improve methane recovery and reduce fugitive emissions by 10-20% compared to baseline.[38] These systems can also provide operators with real-time information on potential issues related to the gas collection system, such as flooded wellheads or cover integrity issues, to inform timely repairs. Incorporating the gas collection system into the leachate system, or using gabion cubes along the bottom landfill liner, can also help enhance drainage, prevent flooding, and limit downtime.[39]

- **Enhanced landfill cover practices to better control surface methane:** Increasing the thickness and compaction of daily and intermediate cover can allow for greater vacuum and lower surface methane emissions. Studies have shown that landfill methane emissions decrease when moving from areas of daily to intermediate to final cover; reducing lag times between these cover stages and minimizing the exposed surface area of the daily uncovered working face can help reduce fugitive emissions.[40] Applying a vegetative biocover as intermediate cover helps to enhance the microbial oxidation of methane escaping to the surface. A well-made biocover employing a large volume of aged compost can oxidize up to 35 or 40 percent of the methane in the gas passing through it.[41]
- **More comprehensive monitoring surveys to reduce fugitive methane:** The White House monitoring strategy acknowledges that walking surface emission monitoring (SEM) surveys "are not able to detect all anomalous emissions at a landfill that occur over a large footprint, some extending for hundreds of acres."[42] Maryland Department of Environment estimates that the more robust surface emission monitoring requirements in their recent rulemaking – which includes a tighter walking pattern – could reduce fugitive emissions by 10-40%.[43] Advanced methane detection technologies, such as drones, provide additional benefits relative to walking SEM approaches, including expanded coverage of the landfill surface area (including the active face, construction areas, and steep slopes), faster survey times, improved worker safety, and more objectivity and replicability. Using drones for SEM, which EPA approved in December 2022 as an alternative method, is cost-competitive with traditional manual surface emissions monitoring.[44] In addition to drone methods, continuous monitoring systems can be positioned throughout the landfill or around critical

[38] "Results," LoCI Controls: Methane Capture & Emission Reduction, 2024, https://locicontrols.com/results.
[39] Ebun Ayandele et al., *Key Strategies for Mitigating Methane Emissions from Municipal Solid Waste*, RMI, 2022, https://rmi.org/insight/mitigating-methane-emissions-frommunicipal-solid-waste
[40] James Hanson and Nazil Yesiller, *Estimation and Comparison of Methane, Nitrous Oxide, and Trace Volatile Organic Compound Emissions and Gas Collection System Efficiencies in California Landfills Final Report*, Prepared for: The California Air Resources Board and The California Department of Resources Recycling and Recovery, March 25, 2020, https://ww2.arb.ca.gov/resources/documents/landfill-gas-research; C. Douglas Goldsmith Jr. et al., "Methane emissions from 20 landfills across the United States using vertical radial plume mapping," *Journal of the Air & Waste Management Association* 62, 2 (2012): 183-197. https://www.tandfonline.com/doi/full/10.1080/10473289.2011.639480
[41] "Apply Biofilters or Biocovers," U.S. Environmental Protection Agency, July 2023, https://www.epa.gov/lmop/apply-biofilters-or-biocovers.
[42] National Strategy to Advance an Integrated U.S. Greenhouse Gas Measurement, Monitoring, and Information System, The Greenhouse Gas Monitoring and Measurement Working Group & The White House, November 2023, https://www.whitehouse.gov/wp-content/uploads/2023/11/NationalGHGMMISStrategy-2023.pdf.
[43] "Technical Support Document for COMAR 26.11.42 - Control of Methane Emissions from MSW Landfills," Maryland Department of Environment, December 15, 2022, https://mde.maryland.gov/programs/regulations/air/Documents/Technical%20Support%20Document%20-%20Control%20of%20Methane%20Emissions%20from%20MSW%20Landfills%20-%20Final%20w%20appendices.pdf.
[44] "Webinar: Detecting Landfill Methane Emissions with Drones," U.S. Environmental Protection Agency Landfill Methane Outreach Program (LMOP), September 28, 2023, https://www.epa.gov/lmop/webinar-detecting-landfill-methane-emissions-drones.

components to provide operators with real-time data to respond quickly to instances of elevated methane concentration and inform operational improvements. Environment and Climate Change Canada (ECCC)'s proposed regulatory framework for reducing Canada's landfill methane emissions incorporates both drone and continuous monitoring approaches, while providing flexibility for alternative monitoring methods with demonstrated performance equivalency.[45]

- **Leveraging remote sensing to fix large leaks fast:** Remote sensing technologies, like aircraft and satellites, can alert operators to large methane releases to inform fast investigation and effective remediation on the ground. For example, environmental agencies in California and Pennsylvania worked with third-party aerial monitoring providers to survey for methane leaks and alerted landfill operators of large detected plumes. Operators took voluntary action to locate and mitigate the leaks. Overflights conducted by the Pennsylvania Department of Environmental Protection, in partnership with Carbon Mapper, achieved a 37% reduction in observed methane emissions from landfills.[46]
- **High-efficiency flares to avoid methane slip during combustion**: Enclosed flares with high destruction efficiency (>99%) help avoid methane leakage during combustion. Analysis by EIP, based on ERG's report for EPA's 2019 NESHAP technology review, found that enclosed flares with a destruction efficiency of 99% could reduce methane emissions by 66,000 tons per year at a cost-effectiveness of about $250-$490 per ton of methane (or ~$3-$6 per ton CO_2e, GWP20).[47]

Installing a gas collection system carries capital and operational costs ($1.3 million for a 40-acre gas collection and control system, plus ~$5,500 in annual O&M costs per acre), which can be offset in part through revenue from beneficial use projects.[48] Otherwise, many of the strategies to reduce emissions from landfilled waste do not involve purchasing equipment but rather improving existing practices around landfill cover, wellhead tuning, and methane monitoring to minimize fugitive emissions. A well-managed landfill can also generate savings for operators over time, by minimizing system downtime and avoiding major compliance or repair costs. EPA notes that much of the potential landfill methane abatement in the U.S. can be achieved at break-even prices and in some cases generate incremental revenue for operators through increased methane capture.[49]

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[45] *Reducing Canada's landfill methane emissions: Proposed regulatory framework*, Environment and Climate Change Canada (ECCC), 2023, https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/reducing-landfill-methane-emissions.html.

[46] "Methane Overflight Study Overview," Pennsylvania Department of Environmental Protection, Air Quality Technical Advisory Committee, March 9, 2023, https://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Advisory%20Committees/Air%20Quality%20Technical%20Advisory%20Committee/2023/3-9-23/AIRBORNE%20METHANE%20AQTAC%20MEETING%20230309.pdf.

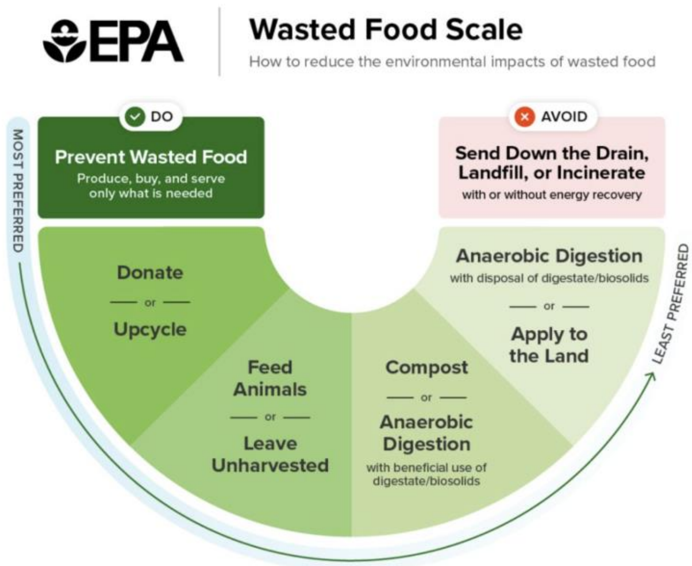
[47] "Petition for Rulemaking to Revise the New Source Performance Standards and Emission Guidelines for Municipal Solid Waste Landfills," Environmental Integrity Project, June 2023, https://environmentalintegrity.org/news/groups-petition-epa-for-stronger-controls-on-methane-from-landfills/; Memorandum from E. Rsch. Grp., Inc. on Clean Air Act Section 112 (d)(6) Tech. Rev. for Mun. Solid Waste Landfills to Allison Costa and Andy Sheppard, EPA, Off. of Air Quality Planning & Standards, at 29-30, 31-32, 36- 41, 44-45 (June 25, 2019) https://www.regulations.gov/document/EPA-HQ-OAR-2002-0047-0082

[48] *LFG Energy Project Development Handbook*, U.S. Environmental Protection Agency Landfill Methane Outreach Program, January 2024, https://www.epa.gov/system/files/documents/2024-01/pdh_full.pdf.

[49] "Waste Overview, U.S. State-level Non-CO_2 Greenhouse Gas Mitigation Potential: 2025-2050," U.S. Environmental Protection Agency, 2019, https://cfpub.epa.gov/ghgdata/nonco2/usreports/#page7.

Reducing organic waste disposal at landfills prevents future methane generation and captures the value of materials. This approach includes efforts to reduce and redistribute surplus organics and recycle the remaining organic waste, while avoiding landfilling and incineration. Minimizing waste on farms, improving food inventory management, and donating excess edible food to shelters or converting it to animal feed all help to keep organics out of the waste stream. The remaining organic waste can then be separated and processed into compost, biogas, or other beneficial end products.

U.S. EPA's Wasted Food Scale[50]



Sending organic waste to a composting facility or anaerobic digester avoids the generation of methane in landfills, while preventing organic waste from becoming waste in the first place avoids additional emissions across the supply chain. In a recent report, *From Field to Bin: The Environmental Impacts of U.S. Food Waste Management Pathways*, EPA compares the lifecycle greenhouse gas emissions of different food waste management pathways (kg CO_2e per metric ton of food waste). EPA found that source reduction had order-of-magnitude greater global warming potential benefits than any other pathway, by reducing the amount of additional food that must be produced. Landfills tend to have the highest global warming potential values, while food donation, upcycling, animal feed, AD, and composting can achieve substantial relative emissions reductions with beneficial or near neutral global warming potential.[51]

[50] "Waste Food Scale," U.S. Environmental Protection Agency, October 2023, https://www.epa.gov/sustainable-management-food/wasted-food-scale.

[51] Shannon Kenny et al., *From Field to Bin: The Environmental Impacts of U.S. Food Waste Management Pathways,* U.S. Environmental Protection Agency Office of Research and Development, October 2023, https://www.epa.gov/land-research/field-bin-environmental-impacts-us-food-waste-management-pathways.

U.S. EPA Global Warming Potential of Waste Food Pathways[52]

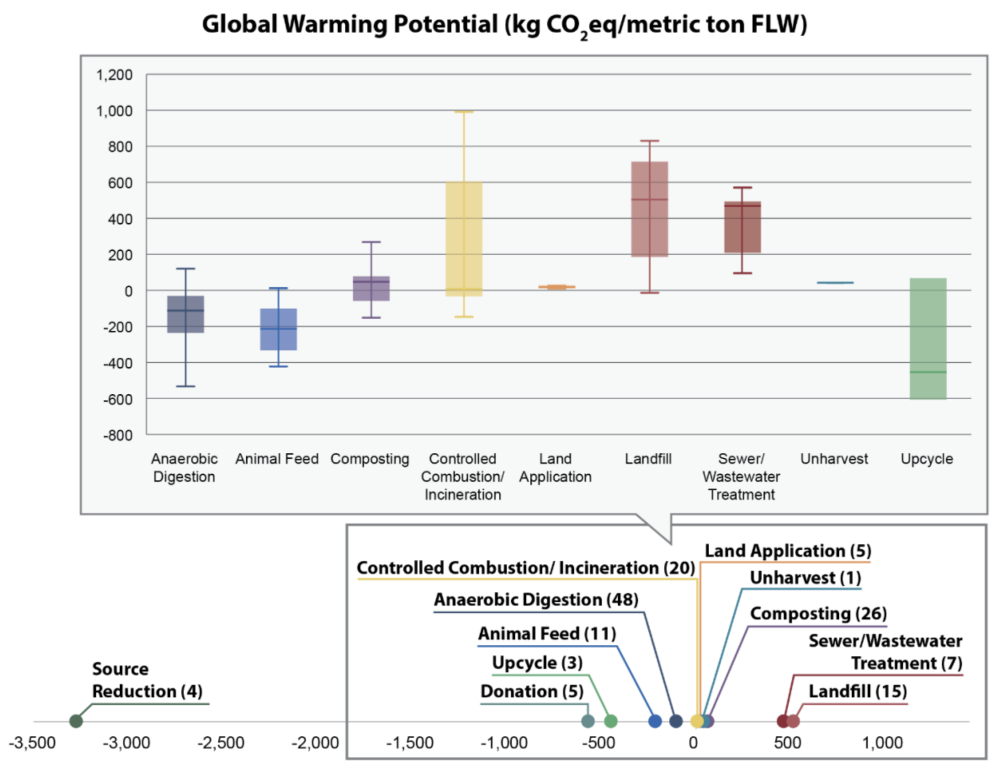


FIGURE 3-3. COMPARISON OF GLOBAL WARMING POTENTIAL OF WASTED FOOD PATHWAYS ACROSS LCA STUDIES

AD data assumes land application of digestate or biosolids. Sewer/WWT studies varied in assumptions about biosolids' destination. Carbon sequestration not consistently assumed for some pathways. See Table 3-4 for details. Donation excluded from boxplot because the range extends an order of magnitude below the next lowest value in the boxplot. See Appendix Table D-1 for data and sources.

Successful organics diversion programs typically require a combination of policy support (e.g., organics bans, pay-as-you-throw policies), behavioral change, investment in organics collection, processing, and recycling infrastructure (including favorable permitting), and healthy end markets for products and commodities made from diverted organics (e.g., compost procurement plans).

From an economic standpoint, preventing and reducing organic waste saves consumers money and avoids the costs associated with managing discards. Organics recycling projects, such as composting and anaerobic digestion, typically come with incremental capital costs to invest in new infrastructure, but the revenue from valorized end products (e.g., compost, biogas, digestate) can make projects economically viable and in some instances more favorable than landfilling over time – which can be passed on to consumers through lower rates.[53] Organics recycling and food recovery also bring significant benefits to communities and ecosystems, discussed further below.

[52] Ibid.

[53] Alex Badgett and Anelia Milbrandt. "Food waste disposal and utilization in the United States: A spatial cost benefit analysis," *Journal of Cleaner Production* 314, 10 (2021), https://www.sciencedirect.com/science/article/abs/pii/S0959652621022757; Olivia Alves et al., "Your trash deserves better. These three cases show what's possible." RMI, No 17, 2023, https://rmi.org/your-trash-deserves-better-these-three-cases-show-whats-possible/.

STATE & LOCAL EXAMPLES: COSTS & BENEFITS

State policies and programs to reduce landfill methane emissions show compelling cost-benefits. Analyses of state rulemakings have found – for both stronger landfill emission controls and organics diversion mandates – that the cumulative economic, public health, and climate benefits generally exceed the implementation costs. There is growing momentum around state rulemakings to control landfill methane, as governments strive to address the climate crisis and meet their state-wide targets. Maryland, Oregon, and Washington have proposed or finalized strong landfill methane control rules in the past three years, and California, whose landfill methane regulation has been on the books since 2010, is now considering improvements to its nation-leading standard. The state rules make several improvements to landfill design, operational, monitoring, and reporting requirements to increase methane capture and reduce fugitive emissions.

- **Oregon:**[54] In October 2021, the Oregon Environmental Quality Commission adopted new rules to regulate landfill gas emissions. In their staff report, the Department of Environmental Quality (DEQ) estimates that covered landfills could incur annual reporting and O&M expenses ranging from about $8,000 to about $400,000, with some landfills subject to a one-time investment of $1-3 million to upgrade or install a landfill gas collection system. However, DEQ found that the rule would provide for future reduced costs to the general public from the reduction of greenhouse gas emissions and the impacts of climate change. Table 3 below provides an estimate of the reduced social cost of carbon, thanks to the lower thresholds and higher destruction efficiency required for landfill gas collection and control systems at four theoretical landfills. DEQ's report also underscores public health improvements due to the capture and destruction of more landfill gas, including toxic gases.

Table 3: Avoided social costs from gas collection system requirements

Size (acres)	Annual waste acceptance (ton/yr)	Control	Average annual methane destroyed 98% destruction (million ft^3)	Average annual methane destroyed 99% destruction (million ft^3)	Avoided social costs[2]	
					Increased destruction [3]	Lower GCCS threshold [4]
20	75,000	Direct-use	2,084	2,106	NA	$67M
50	150,000	RNG	4,168	4,211	NA	$134M
100	800,000	Turbine	22,232	22,459	$7M	NA
300	2,000,000	CHP Engine	55,580	56,147	$18M	NA

1 Assume 10-year life span and 75% collection efficiency.
2 https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf
3 Current federal regulations require 98% destruction while the proposed rules require 99% destruction.
4 The proposed rules will require some landfills to install GCCS that would not be required under federal rules. It is assumed the two largest landfills presented would be required to install a GCCS under federal rules while the two smaller landfills would not.

[54] "Staff Report for Oregon Environmental Quality Commission Meeting: Rulemaking, Action Item I - Landfill Methane Rules," State of Oregon Department of Environmental Quality, October 2021, https://www.oregon.gov/deq/EQCdocs/100121_I_LandfillMethane.pdf.

- **Maryland:**[55] Maryland's landfill rule (COMAR 26.11.42), finalized in June 2023, is projected to deliver an estimated 25-50% reduction in landfill gas emissions from covered landfills when fully implemented, according to estimates from the Maryland Department of Environment (MDE). MDE estimates that the 32 MSW landfills subject to the rule could incur annual expenses in the same range as Oregon's rule (~$8,000-$400,000) with some landfills subject to a one-time investment of $1-3 million to upgrade or install a landfill gas collection system. MDE notes that for landfills with energy projects, the revenue generated from increased landfill gas capture could help offset costs associated with the proposed regulation and could also create jobs and local economic benefits. Furthermore, MDE concludes that the rule would be of benefit to the public and the environment as methane is reduced and minimized, helping to combat the adverse and costly impacts of climate change in Maryland. The total climate and social benefits of MDE's rule are estimated to be between $22 million and $45 million in 2030 (100-year GWP).
- **California:**[56] California finalized its nation-leading landfill methane regulation in 2010. The regulation requires owners and operators of certain uncontrolled municipal solid waste landfills to install gas collection and control systems, and for existing and newly installed gas and control systems to operate in an optimal manner. In its 2009 Initial Statement of Reasons (ISOR) for the proposed rulemaking, California Air Resources Board (CARB) estimated the rule to have a cost-effectiveness of about $9 per metric ton of CO_2e reduced. CARB noted the regulations could create and expand businesses and jobs in landfill methane mitigation. CARB also noted that the regulation would provide benefits to both urban and rural communities in the state, helping to combat the adverse impacts of climate change and better control toxic co-pollutants in landfill gas and odors. In its annual report to the Joint Legislative Budget Committee on Assembly Bill 32, CARB estimated that its regulation reduced methane emissions by 1.8 MMT CO_2e in 2021.[57] In May 2023, CARB hosted a public workshop to present preliminary concepts for potential improvements to the Landfill Methane Regulation, leveraging the latest research and technological advances to increase effectiveness of methane emissions control measures.[58]
- **Washington:**[59] In October 2023, Washington Department of Ecology released a preliminary analysis of its proposed rule (Chapter 173-408 WAC) to reduce landfill methane emissions. Across 26 landfills, Ecology estimates the rule will result in one-time costs of around $10M and ongoing annual costs of $846-$871K. The total cost over the 20-year period is

[55] "Technical Support Document for COMAR 26.11.42 - Control of Methane Emissions from MSW Landfills," Maryland Department of Environment, December 15, 2022, https://mde.maryland.gov/programs/regulations/air/Documents/Technical%20Support%20Document%20-%20Control%20of%20Methane%20Emissions%20from%20MSW%20Landfills%20-%20Final%20w%20appendices.pdf.

[56] "Staff Report: Initial Statement of Reasons Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills," California Air Resources Board Stationary Source Division Emissions Assessment Branch, May 2009, https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2009/landfills09/isor.pdf.

[57] *Annual Report to the Joint Legislative Budget Committee on Assembly Bill 32 (Chapter 488, Statutes of 2006),* California Air Resources Board, 2021, https://ww2.arb.ca.gov/sites/default/files/2021-06/AB32-JLBC-2021-Report.pdf.

[58] "Preliminary Concepts for Potential Improvements to Landfill Methane Regulation," California Air Resources Board, Public Workshop, May 18, 2023, https://ww2.arb.ca.gov/sites/default/files/2023-05/LMR-workshop_05-18-2023.pdf.

[59] "Preliminary Regulatory Analyses for Chapter 173-408 WAC, Landfill Methane Emissions," Washington Department of Ecology, October 2023, https://apps.ecology.wa.gov/publications/documents/2302112.pdf.

estimated at about $26 million. Ecology notes that the benefits attributable to the proposed rule are greater than the costs and predominantly take the form of decreased methane emissions with additional benefits from the collection and destruction of odiferous or toxic compounds. Using the California rule as a proxy, Ecology estimates an estimated increase of roughly .02 MMT of methane controlled annually due to the proposed rule. With a social cost of methane of $1,500 per ton, the estimated benefits attributable to the proposed rule are $32.3 million annually with a net present value of nearly $595 million over the 20-year planning frame of the proposed rule.

When it comes to keeping organics out of landfills, nine states have policies in place as of 2023 to limit organic waste disposal. Connecticut, Massachusetts, New York, Rhode Island, New Jersey, Maryland, Vermont, Washington, and California have all adopted state organic waste bans in the past decade.[60] While these rules require new investments in collection, processing, and recovery infrastructure, they also bring significant benefits: avoiding landfill methane generation, boosting food donation, creating green jobs, and stimulating local economic growth. We provide a few examples of the costs and benefits of organics diversion policies at the state level, with more information available in the Zero Food Waste Coalition's State Policy Toolkit.[61]

- **Massachusetts**:[62] Massachusetts' commercial food waste disposal ban, in place since October 2014, has significantly increased food waste diversion from landfills, from a baseline of 100,000 tons to 360,000 tons in 2022. At the same time, food rescue of fresh and perishable foods has grown by more than 50%, the number of businesses separating food scraps from disposal has increased from 1,350 in 2014 to 3,100 in 2022, and Massachusetts' capacity to manage food waste has increased substantially. Furthermore, a study on the economic impact of Massachusetts' organic waste ban found that the policy created over 500 jobs and stimulated $175 million in economic activity during its first two years.[63]
- **Vermont:** Vermont's Universal Recycling Law, initially passed in 2012, encourages people to follow the Vermont Food Recovery Hierarchy, which prioritizes food waste reduction, food donation, feeding animals, and then composting and anaerobic digestion as the highest uses for food. In Status Reports, the Vermont Agency of Natural Resources highlights benefits of the law, including reducing greenhouse gas emissions, strengthening the local economy by building green businesses and jobs, feeding Vermonters through food donation, and boosting soil health with compost application.[64] Vermont saw food donation triple at the Vermont Foodbank after implementing its universal recycling law, along with

[60] *Achieving Zero Food Waste: A State Policy Toolkit*, Zero Food Waste Coalition, May 2023, https://zerofoodwastecoalition.org/state-toolkit/.
[61] Ibid.
[62] "Organics Action Plan," Massachusetts Department of Environmental Protection, November 2023, https://www.mass.gov/doc/massachusetts-organics-action-plan-november-2023/download.
[63] *Massachusetts Commercial Food Waste Ban Economic Impact Analysis*, ICF, December 2016, https://www.mass.gov/doc/massachusetts-commercial-food-waste-ban-economic-impact-analysis/download.
[64] *Vermont's Universal Recycling Law Status Report,* Vermont Agency of Natural Resources. Department of Environmental Conservation, January 2019, https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/Universal-Recycling/2019.Universal.Recycling.Status.Report.pdf.

significant growth in transfer stations, composting facilities, and food scrap haulers in the state.[65]

- **California**:[66] California's SB 1383 aims to divert 75% of organic waste from landfills below 2014 levels by 2025. Jurisdictions must provide organics collection to residents and work with counties to build out organic waste recycling infrastructure, food recovery capacity, and establish procurement plans. CalRecycle has established an additional target that not less than 20% of currently disposed edible food is recovered for human consumption by 2025. Initial regulatory analysis found that the cumulative economic, public health, and climate benefits associated with recovering organic waste exceed the cost of the investments required. The successful implementation of the regulations will create thousands of green jobs, generate billions in economic activity and benefits, and protect Californians from immediate and long-term health and environmental impacts, also valued in the billions of dollars. These benefits cannot be achieved without substantial investments in new collection, processing, and recovery infrastructure.[67] While California failed to achieve its interim 2020 diversion target, giving jurisdictions more time to comply, organic waste processing capacity in California has increased by more than 400,000 tons in the past few years. So far, 75% of California Communities report they have residential organic waste collection in place and 242 million meals worth of unsold food have been sent to people in need. California now has 206 organic waste processing facilities and is building 20 more.[68]

Furthermore, some local governments in states without organics policies are stepping up with organics diversion targets, collection services, and organics recycling plans. About 15 million U.S. households have access to food waste collection, and local governments are leveraging federal funds, such as the Solid Waste Infrastructure for Recycling (SWIFR) Program and the Composting and Food Waste Reduction (CFWR) Cooperative Agreements, to invest in organics diversion programs.[69]

In addition to cutting planet-heating methane, addressing landfill emissions creates local benefits. Improving landfill methane capture also better controls for emissions of hazardous air pollutants, smog-forming compounds, and odors, while reducing explosion hazards. This all helps to improve **air quality, safety, public health, and quality of life** for communities near landfills. Expanding landfill methane monitoring and implementing best management practices can also create local jobs in methane mitigation, as well as economic benefits through productive use of

[65] Kevin Gaiss, "Vt. sees boom in food scrap haulers from last year's compost law," *WCAX3,* July 2021, https://www.wcax.com/2021/07/01/food-scrap-haulers-benefit-over-past-year/; Angela Evancie, Myra Flynn, "How's Vermont doing with composting?," *Vermont Public*, January 6, 2022, https://www.vermontpublic.org/podcast/brave-little-state/2022-01-06/hows-vermont-doing-with-composting

[66] "California's Short-Lived Climate Pollutant Reduction Strategy," CalRecycle, 2024, https://calrecycle.ca.gov/organics/slcp/.

[67] "Appendix A Cost Update: Initial Statement of Reasons (ISOR) for the Short-lived Climate Pollutant: Organic Waste Reduction regulations," CalRecycle, October 2019, https://calrecycle.ca.gov/laws/rulemaking/archive/2020-2/slcp/.

[68] "California's Climate Progress on SB 1383," CalRecycle, 2024, https://calrecycle.ca.gov/organics/slcp/progress/.

[69] Nora Goldstein, Paula Luu and Stephanie Motta, "BioCycle Nationwide Survey: Residential Food Waste Collection Access In The U.S.," *BioCycle*, September 2023, https://www.biocycle.net/residential-food-waste-collection-access-in-u-s/.

captured methane, which can in some cases displace more expensive fossil fuels. Strategies to prevent and divert organic waste from landfills can also help reduce landfill odors, minimize leachate generation and associated groundwater pollution, and prevent landfill expansion.

Reducing organic waste disposal in landfills has several other community benefits for **local food systems, ecosystems, climate resilience, and job creation**. Expanding surplus food donation can help to address local food insecurity, while composting can improve soil health and support local food production. Compost application has several additional benefits for local ecosystems and can boost local climate resilience; it sequesters carbon, prevents soil erosion, aids in reforestation and wetlands restoration, and assists in stormwater management and water conservation by better controlling and retaining runoff through soils. Finally, organics recycling can create jobs and workforce development opportunities in the circular economy at a higher rate per ton than landfills or incinerators. For example, one study found that for every $10 million invested, composting sites can support 21.4 full-time jobs, while landfilling supports 8.4 and incineration supports 1.6.[70]

Some landfill operators are taking voluntary steps to reduce their methane emissions, underscoring the feasibility of stronger controls. Large private landfill operators, such as Waste Management (WM), Republic Services, and GFL, have set targets to reduce their Scope 1 and 2 greenhouse gas emissions, most of which are attributable to landfill methane emissions. In their sustainability reports, these companies reference adoption of advanced technologies for fugitive emissions monitoring and other practices to increase methane capture. WM, for example, is investing in new technologies to monitor their emissions and improve the performance of their gas collection systems, with the goal of having a comprehensive landfill emissions measurement system in place by 2025.[71] In addition, some cities with municipally operated landfills have included measures in their climate action plans to improve methane capture by implementing best management practices.[72]

FEDERAL OPPORTUNITIES

Federal action is needed to reduce landfill methane emissions nationwide. Examples from states, local governments, and the private sector underscore that the solutions to address landfills are viable and cost-effective today. But federal standards and support are critical to help scale up these solutions, achieve major methane reductions, and protect communities across the country.

EPA regulates MSW landfills under the Clean Air Act and has broad authority to set design and work practice standards that achieve emissions reductions. The agency is statutorily required to revisit

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[70] Brenda Platt, "Composting Makes ene: Jobs through Composting & Compost Use," Institute for Local Self-Reliance, May 2013, https://ilsr.org/composting-sense-tables/. Clarissa Libertelli, Brenda Platt, Megan Matthews, *A Growing Movement: 2022 Community Composter Census,* Institute for Local Self-Reliance, Mar 2023, https://ilsr.org/composting-2022-census/.

[71] *2023 Sustainability Report,* Waste Management, 2023, https://sustainability.wm.com/downloads/WM_2023_SR.pdf.

[72] "Example Government Climate Action Plans that Address Materials Management and Waste," U.S. Environmental Protection Agency, January 2024, https://www.epa.gov/smm/example-government-climate-action-plans-address-materials-management-and-waste.

its Section 111 standards for municipal solid waste landfills in August 2024, and should seize this opportunity to develop an ambitious framework that reflects the latest best practices in methane monitoring and control discussed above, while advancing organics diversion.[73] EPA can build from recent efforts to improve methane monitoring and control in its final Oil and Gas Methane Rule[74] and updates to the Greenhouse Gas Reporting Program.[75] EPA can also draw from state programs described above, Canada's recently proposed landfill methane regulatory framework,[76] and EPA's 2020 NESHAP rulemaking[77] for municipal solid waste landfills, which have already identified landfill methane mitigation measures that can achieve significant emissions reductions at relatively low cost.

New EPA standards would slash planet-warming methane, help achieve our domestic climate goals, and demonstrate leadership under the Global Methane Pledge that the U.S. helped launch in 2021. Robust landfill standards would also advance the waste sector targets set with Mexico and Canada at the North American Leaders' (NALS) summit, the 2030 U.S. food waste reduction goal, and help close the remaining gap on our economy-wide emission reduction targets under the Paris Agreement.

Stronger standards to reduce landfill methane emissions are particularly important in light of new incentives for renewable natural gas (RNG) in the Inflation Reduction Act. Incentivizing landfill energy production can put more sustainable waste management alternatives with lower lifecycle emissions, such as composting, at a relative disadvantage. EPA acknowledges in its RNG Operations Guide that "fugitive emissions of methane, depending upon their magnitude, can negate the climate and environmental benefits of RNG projects."[78] Therefore, any incentives for RNG should ensure best practices and monitoring requirements are in place at the landfill to minimize fugitive emissions and capture generated methane to the maximum extent practicable. Setting time bounds around incentives for landfill energy (e.g., limited to gas from waste already-in-place) can help limit the landfilling of organic waste and encourage diversion to lower-emitting disposal methods, like compost.

[73] "Petition for Rulemaking to Revise the New Source Performance Standards and Emission Guidelines for Municipal Solid Waste Landfills," Environmental Integrity Project, June 2023, https://environmentalintegrity.org/news/groups-petition-epa-for-stronger-controls-on-methane-from-landfills/

[74] "EPA's Final Rule for Oil and Natural Gas Operations Will Sharply Reduce Methane and Other Harmful Pollution," U.S. Environmental Protection Agency, December 2023, https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-operations/epas-final-rule-oil-and-natural-gas.

[75] "Rulemaking Notices for GHG Reporting," U.S. Environmental Protection Agency, September 2023, https://www.epa.gov/ghgreporting/rulemaking-notices-ghg-reporting.

[76] *Reducing Canada's landfill methane emissions: Proposed regulatory framework*, Environment and Climate Change Canada (ECCC), 2023, https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/reducing-landfill-methane-emissions.html.

[77] "Municipal Solid Waste Landfills: National Emission Standards for Hazardous Air Pollutants (NESHAP)," U.S. Environmental Protection Agency, 2024, https://www.epa.gov/stationary-sources-air-pollution/municipal-solid-waste-landfills-national-emission-standards.

[78] *Renewable Natural Gas: Facility Operation Best Practices to Create a More Climate-Friendly Project,* U.S. Environmental Protection Agency, 2022, https://www.epa.gov/system/files/documents/2022-11/RNG_Operations_Guide.pdf.

Beyond EPA standards, Congress can provide funds to catalyze landfill methane reductions, building on the success of the Bipartisan Infrastructure Law and the Inflation Reduction Act. Additional grant programs could help fund local waste prevention programs, food recovery and organics recycling infrastructure, and technologies to improve methane capture at municipal landfills. In particular, there are few federal incentives for composting, despite its methane reduction potential and substantial benefits for soil health, nutrient recycling, regenerative farming, and job creation. The Farm Bill presents an exciting opportunity to advance funding for food waste, composting, and organics recycling.[79]

[79] *Opportunities to Reduce Food Waste in the 2023 Farm Bill,* Zero Food Waste Coalition, April 2022, https://chlpi.org/wp-content/uploads/2022/04/2023-Farm-Bill-Food-Waste.pdf.