



GTI ENERGY

solutions that transform

Methane Emissions

Landfills

&

Sustainable Aviation Fuels

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Municipal Solid Waste Landfills

Third largest source of anthropogenic methane in the U.S.¹

Typically, one million tons of landfill waste emit approximately 432,000 cubic feet of landfill gas per day

- Landfill gas is a combination of mostly methane, carbon dioxide, nitrogen, and hydrogen sulfide

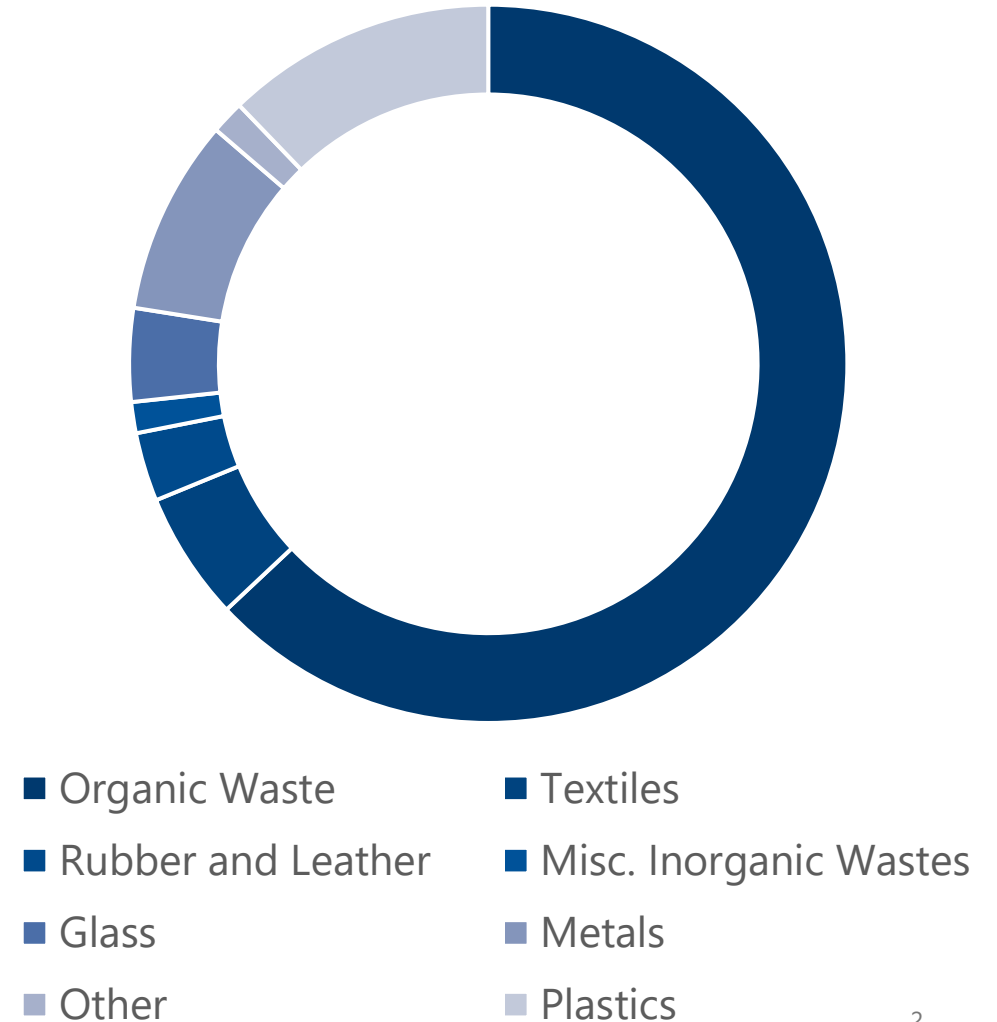
Organic material is the feedstock for methane generation

• **Over 60% of MSW landfills are organic material²**

• **Organic Waste:**

- Food Waste
- Paper and Paperboard
- Yard Trimmings
- Woody materials

Total MSW Generated (EPA, 2018)¹



Regulatory Aspects of Landfill Methane Emissions



Growing Guidance

August 2023- U.S. EPA's Memorandum on Mitigating Climate Change Initiative, National Enforcement and Compliance Initiatives

- Addresses the climate impacts of methane from landfills and states the need for increased compliance requirements in the future

Regulations	EPA Greenhouse Gas Reporting Program	Compliance with RCRA Subtitle D
Applicability	if annual methane generation is \geq 25,000 metric tons of carbon dioxide equivalent (MTCO ₂ e) GHGRP Subpart HH	Requirement that measured methane content near onsite structures < 25% of the lower explosive limit (LEL)
Required Actions	These emissions are quantified in a predefined function of the collected waste - Mass Balance Calculations - Emission Inventories annually reported to EPA	Must establish a program to periodically check for methane emissions and prevent off-site migration. -Must collect and control landfill gas emissions -Purposing LFG for renewable fuel generation

Quantification of Landfill Methane Emissions

- Emissions quantification at landfills is still a developing field given the high topographic variability common with landfills
- Recent research suggests that methane emissions from landfills are inaccurately reported⁴

U.S. EPA 2024 Project, Understanding and Control of MSW Landfill Air Emissions

- UC Berkely with GTI Energy

How can cost effective stationary, mobile, aerial, and remote sensing technologies be combined to:

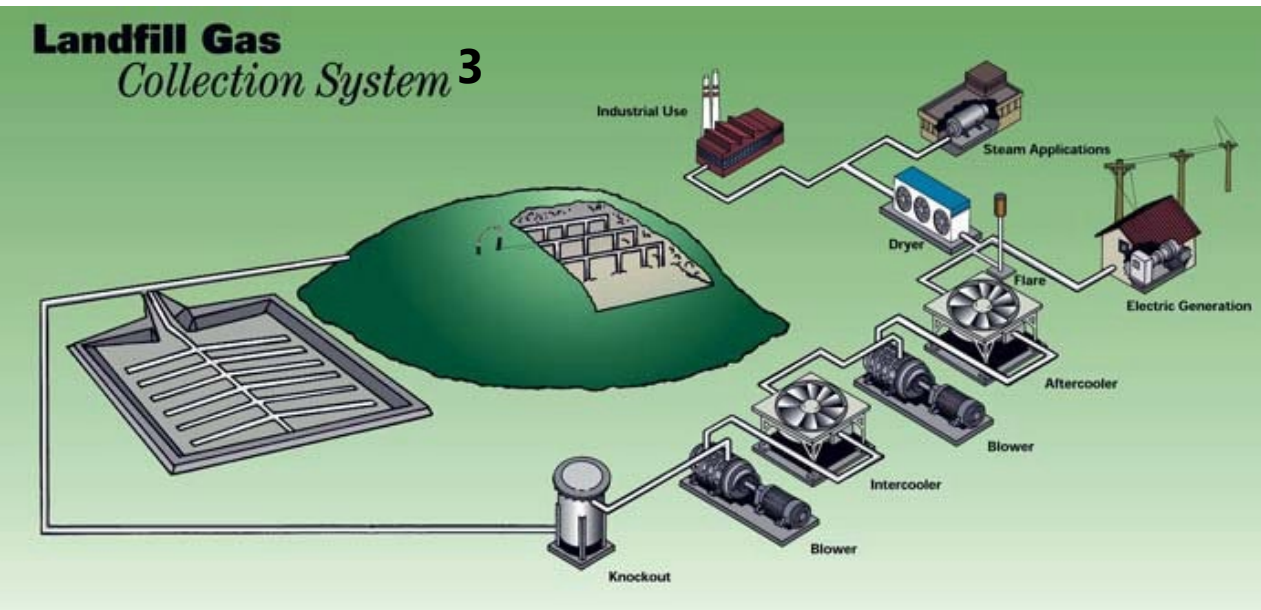
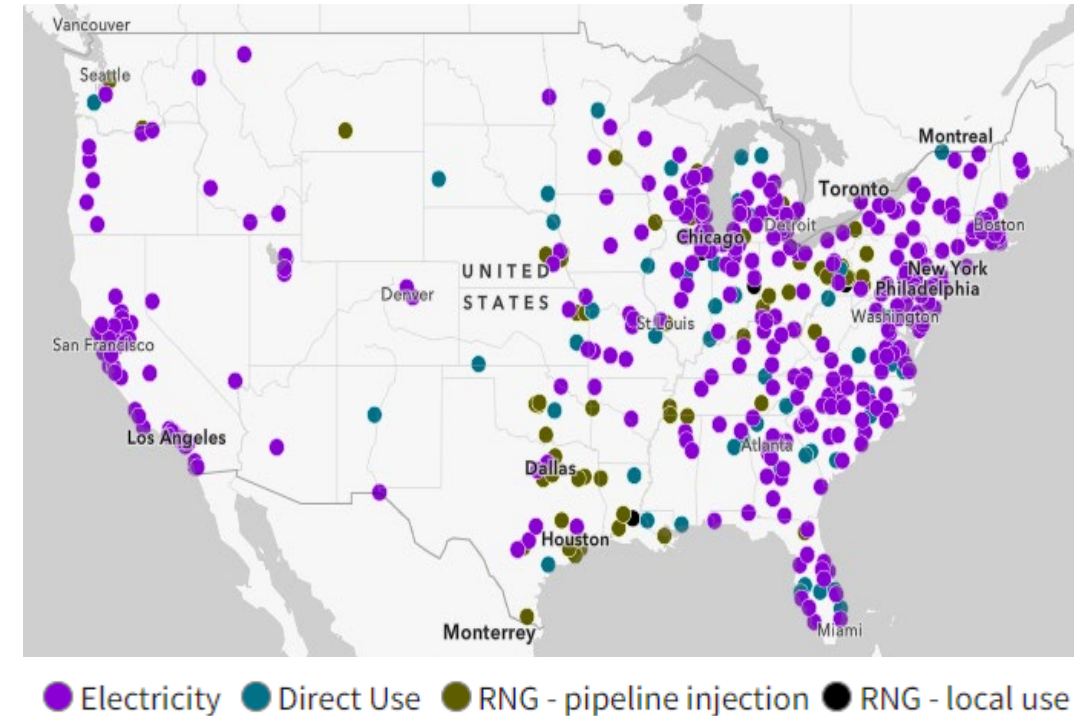
- more easily and accurately quantify landfill methane emissions
- increase ease of use and evaluate mitigation strategies and technologies to identify best landfill management practices
- GTI Energy will support this project by developing protocols for landfill methane measurement and quantification

Emissions Control with Landfill Methane Recovery

July 2023

- 532 landfill gas collection projects in the U.S.
 - 310 Biogas to Electricity Projects
 - 73 Direct Use Projects (Thermal purposes)
 - 66 RNG LFG Projects
 - 103 Planned/ Under Construction

U.S. Landfill gas projects (EPA LMOP, 2023)



³[Energy Engineering Journal 5 \(2003\)](#)

Landfill gas to Sustainable Aviation Fuels from MSW



While RNG from landfill gas is a developed market, emerging federal credits and industry interest to decarbonize have made SAF an end fuel of interest.

Sustainable aviation fuels: aviation fuels produced from renewable sources

- SAFs can be produced from several types of waste

GTI Energy's Air Quality of Sustainable Aviation Fuels project (LCRI, 2023)

- SAFs can improve air quality and reduce lifecycle GHG emissions

2021- United Airlines commitment to purchasing 1.5 billion gallons of SAF from Alder Fuels⁶

SkyNRG- Landfill Off-gas To Ultra-low carbon intensity SAF⁷

- Novel process to utilize landfill gas as a feedstock for SAF production

Methane emissions are being presently addressed with improvements to quantification and reduced with renewable fuels.

Thanks!

Sources:

- 1 EPA, 2023. Basic Information on Landfills. [Basic Information about Landfill Gas | US EPA](#)
- 2 EPA, 2023. National Overview: Facts and Figures on Materials, Wastes and Recycling. [National Overview: Facts and Figures on Materials, Wastes and Recycling | US EPA](#)
- 3 NY State. Important Things to Know About Landfill Gas, 2023. [Important Things to Know About Landfill Gas \(ny.gov\)](#)
- 4 National Academies of Sciences, 2018. [Improving Characterization of Anthropogenic Methane Emissions in the United States | The National Academies Press](#)
- 5 [Fact Sheet | Landfill Methane | White Papers | EESI](#)
- 6 United, 2021. [United to Become First in Aviation History to Fly Aircraft Full of Passengers Using 100% Sustainable Fuel - Dec 1, 2021 \(mediaroom.com\)](#)
- 7 SKYNRG, 2021. Landfill Off-gas To Ultra-low carbon intensity SAF, [2396-1570 SkyNRG Americas Inc Summary.pdf \(energy.gov\)](#)