| **Utilization Method** | **NOₓ Emissions** | **CO Emissions** | **Dioxin/Furan Risk** | **Energy Generation** |
| --- | --- | --- | --- | --- |
| Flaring (open flare) | Moderate (baseline)​ | Moderate-High (incomplete combustion) | Moderate (some risk if halogens present)​ | None (wasted heat) |
| IC Engine Generator | High (~2–5× flare NOₓ)​[energyjustice.net](https://www.energyjustice.net/files/lfg/factsheet-lfg.pdf#:~:text=gas%29,but%20lower%20carbon%20monoxide%20emissions) | Low (controlled combustion)​[energyjustice.net](https://www.energyjustice.net/files/lfg/factsheet-lfg.pdf#:~:text=gas%29,but%20lower%20carbon%20monoxide%20emissions) | Higher (burn at lower temp, more chance) | Yes – Electricity  (~30% eff.) |
| Boiler for heat | Low (lowest NOₓ) | Low | Moderate (if halogens, but can be controlled) | Yes – Direct heat (~80% eff.) |
| Gas Turbine | Moderate (mid-range) | Moderate | Moderate | Yes – Electricity (~25–30% eff.) |
| RNG Pipeline Injection | Negligible (on-site) | Negligible | Low (most combustion off-site at end use) | Yes – Methane sold (uses >85% of energy) |

U.S. EPA – **Landfill Methane Emissions and Trends**. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2022*. (Data indicating MSW landfills are ~14.4% of U.S. methane emissions in 2022, ~120 MMTCO₂e)​  
[epa.gov](https://www.epa.gov/lmop/basic-information-about-landfill-gas#:~:text=Municipal%20solid%20waste%20,use%20a%20significant%20energy%20resource)​  
[wastedive.com](https://www.wastedive.com/news/epa-ghg-2022-inventory-landfill-methane-emissions/713019/#:~:text=,country%27s%20emissions%20for%20the%20year).

U.S. EPA – **New Source Performance Standards (NSPS) for MSW Landfills**. *Summary of August 2016 Final Rule*. (Details on lowering the NMOC threshold to 34 Mg/yr and required gas controls for landfills ≥2.5 million Mg capacity)​  
[epa.gov](https://www.epa.gov/sites/default/files/2016-09/documents/lmopquickreference.pdf#:~:text=The%20NSPS%20and%20EG%20established,reconstructed%20after%20July%2017%2C%202014).

U.S. EPA – **Resource Conservation and Recovery Act (RCRA) Subtitle D - Criteria for MSW Landfills**. 40 CFR Part 258 (1991). (Established requirements for liners, groundwater monitoring, closure, and gas migration control for landfills)​  
[epa.gov](https://www.epa.gov/sites/default/files/2016-09/documents/lmopquickreference.pdf#:~:text=Criteria%20for%20MSW%20Landfills%20,closure%20requirements).

California Air Resources Board – **Landfill Methane Regulation (2010)**. (State rule under AB32 requiring gas collection at qualifying landfills, stricter than federal rules)​  
[ww2.arb.ca.gov](https://ww2.arb.ca.gov/resources/documents/landfill-methane-regulation#:~:text=Methane%20Emissions%20from%20Municipal%20Solid,CARB%29%20in%202010).

U.S. EPA Landfill Methane Outreach Program (LMOP) – **Landfill and LFG Project Database** (2024). (Records of 542 operational LFG energy projects and 444 candidate landfills, illustrating the scope for new projects)​  
[epa.gov](https://www.epa.gov/lmop/basic-information-about-landfill-gas#:~:text=As%20of%20September%202024%2C%20there,are%20good%20candidates%20for%20projects).

ATSDR – **Landfill Gas Primer** (Chapter 5: Landfill Gas Control Measures). Agency for Toxic Substances and Disease Registry, 2001. (Discussion of LFG control options; notes that IC engines produce more NOₓ and may face permitting challenges in ozone nonattainment areas)​  
[atsdr.cdc.gov](https://www.atsdr.cdc.gov/hac/landfill/html/ch5.html#:~:text=The%20choice%20of%20which%20type,using%20an%20internal%20combustion%20engine).

Energy Justice Network – **Landfill Gas Energy Facts**. (Compilation citing that NOₓ and CO emissions are highest from internal combustion engines and lowest from boilers, with flares and turbines intermediate)​  
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U.S. EPA – **AP-42 Emission Factors for Landfills** (1998). (Provides emission factors for flares, engines, etc., used as background for comparing emissions profiles of LFG utilization technologies).

Waga Energy Press Release (2024) – *WAGABOX® Project in Steuben County, NY*. (Example of RNG project injecting ~207,000 MMBtu/year into pipeline, supplying ~4,000 households)​  
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Solid Waste Authority of Central Ohio (SWACO) – *Landfill Gas to Energy Project*. (Case study: Franklin County landfill RNG project supplying ~13,000 homes)​  
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U.S. EPA – **Inflation Reduction Act 2022 – Renewable Energy Incentives Summary**. (Confirms a 30% Investment Tax Credit and $0.0275/kWh Production Tax Credit for biogas and landfill gas energy projects, enhancing project economics)​  
[epa.gov](https://www.epa.gov/green-power-markets/summary-inflation-reduction-act-provisions-related-renewable-energy#:~:text=Through%20at%20least%202025%2C%20the,projects%20over%201%20MW%20AC).

New York State Dept. of Health – *Investigation of Cancer Incidence Near Landfills* (1998). (Epidemiological study linking higher cancer incidence to residents near landfills with gas migration issues)​  
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