

The Potential to Decarbonize the Gas Industry with Renewable Natural Gas / Biomethane

A Case Study
in Brazil

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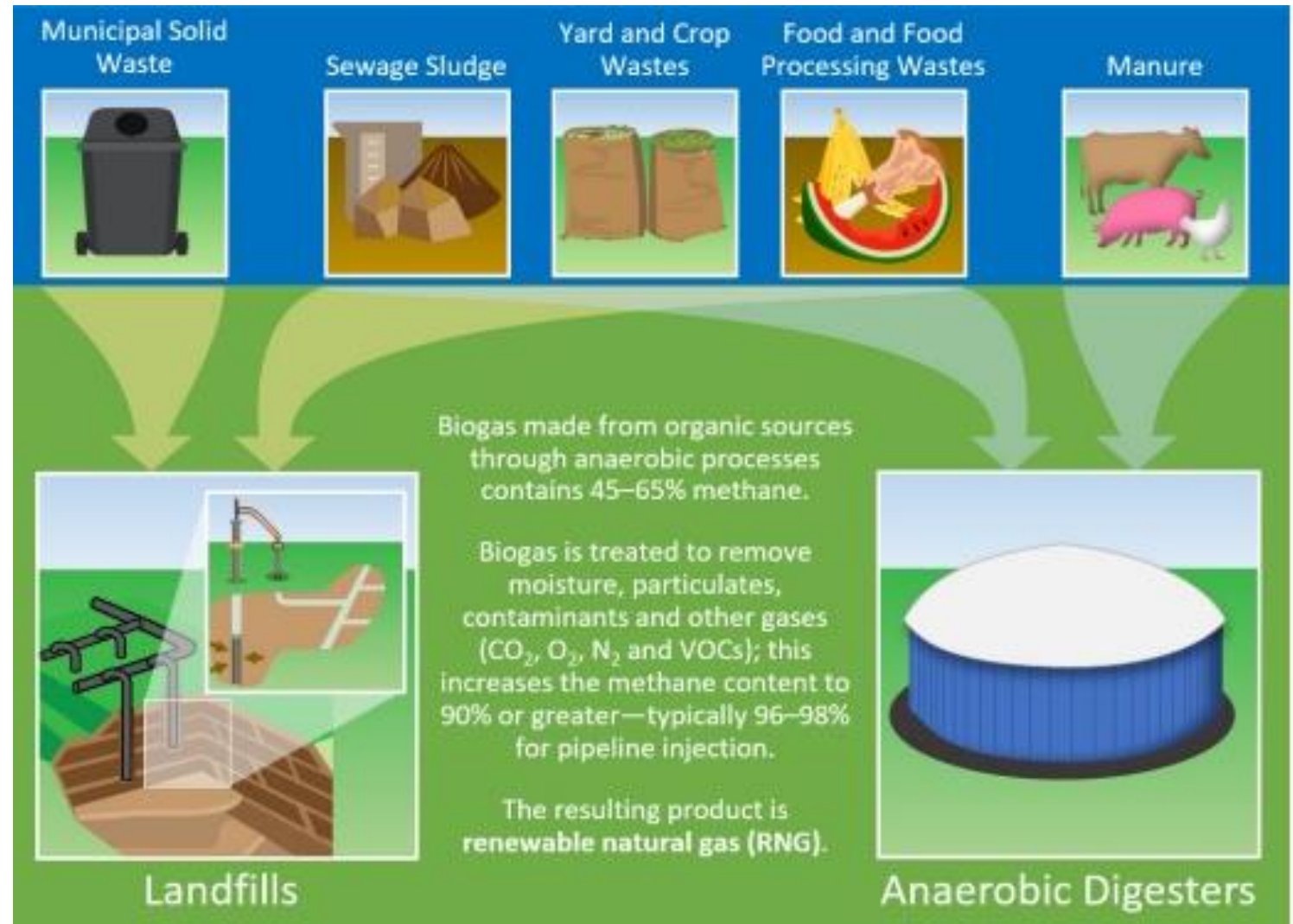
Agenda

1. Waste Types that Make RNG
2. Landfill Gas Collection
3. Landfill Gas Treatment
4. RNG Delivery
5. The Future of RNG
6. Q&A



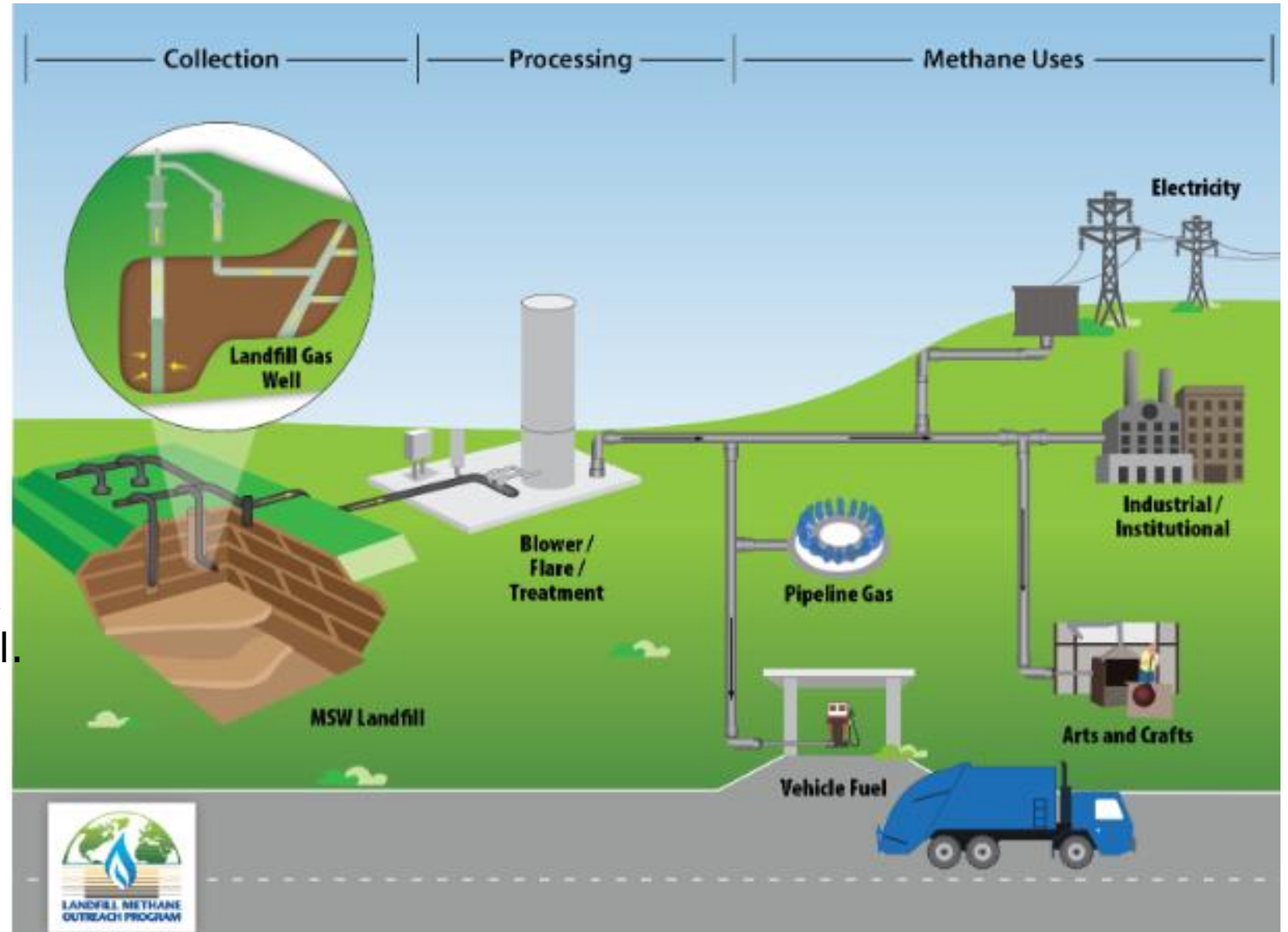
Waste types used to make RNG

Renewable Natural Gas, often called RNG or biomethane, is a term used to describe biogas that has been upgraded for use in place of traditional fossil natural gas.



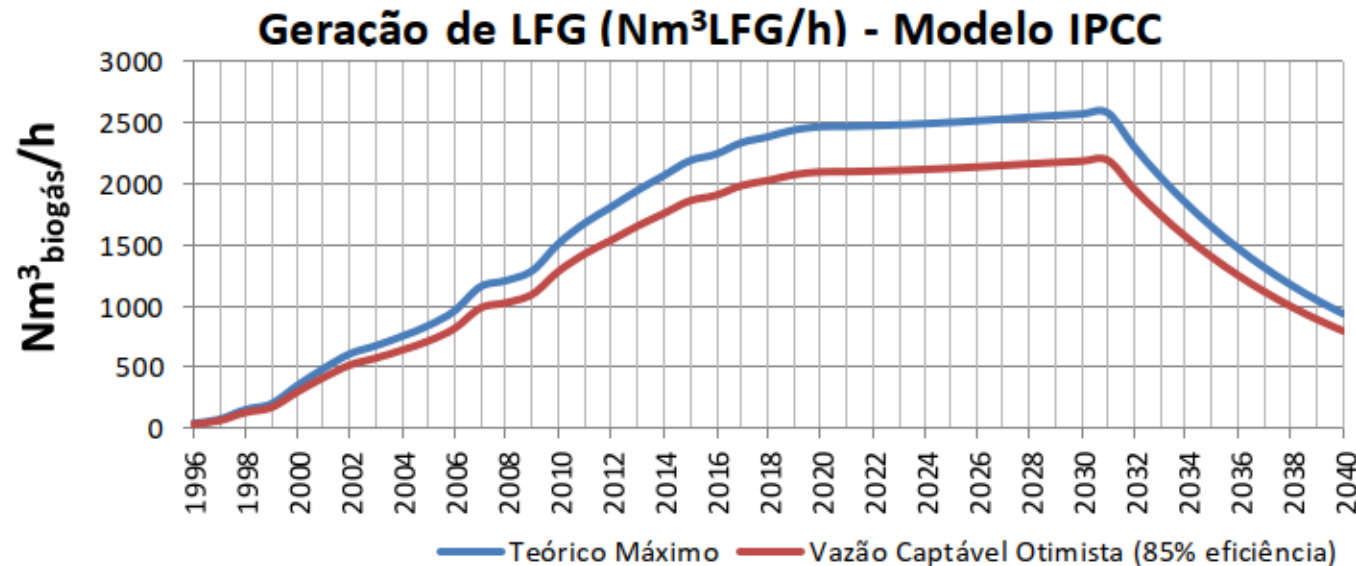
Waste types used to make RNG (Cont.)

RNG can be used for thermal applications, electricity generation, bio-plastic feedstock or vehicle fuel.



LFG Gas Basics

- LFG 50% methane ~50% CO₂
- Waste acceptance 1,000 t/day to 4,000 t/day
- Landfill sizes 10,000,000 to 70,000,000 m³
- Organics fraction in waste is much higher than typically we see in North America
- High Temperature and moisture
- LFG generation based on a first order decomposition rate
- LandGem (US EPA model) was found less representative, IPCC models were used
- Smaller plants ~2,000 m³/hr
- Larger plants >10,000 m³/hr
- RNG >95% methane



LFG Collection Efficiency and Recovery

Not all LFG can be collected for the beneficial use facility.

LFG Collection Efficiency can be affected by:

- Density of wells
- Well connection to gas collection network
- Compaction of waste
- Condensate management
- Surface covering layer
- Well tuning



Landfill Gas Collection

The decomposition of municipal solid waste (MSW) under anaerobic conditions at landfill sites produces biogas.

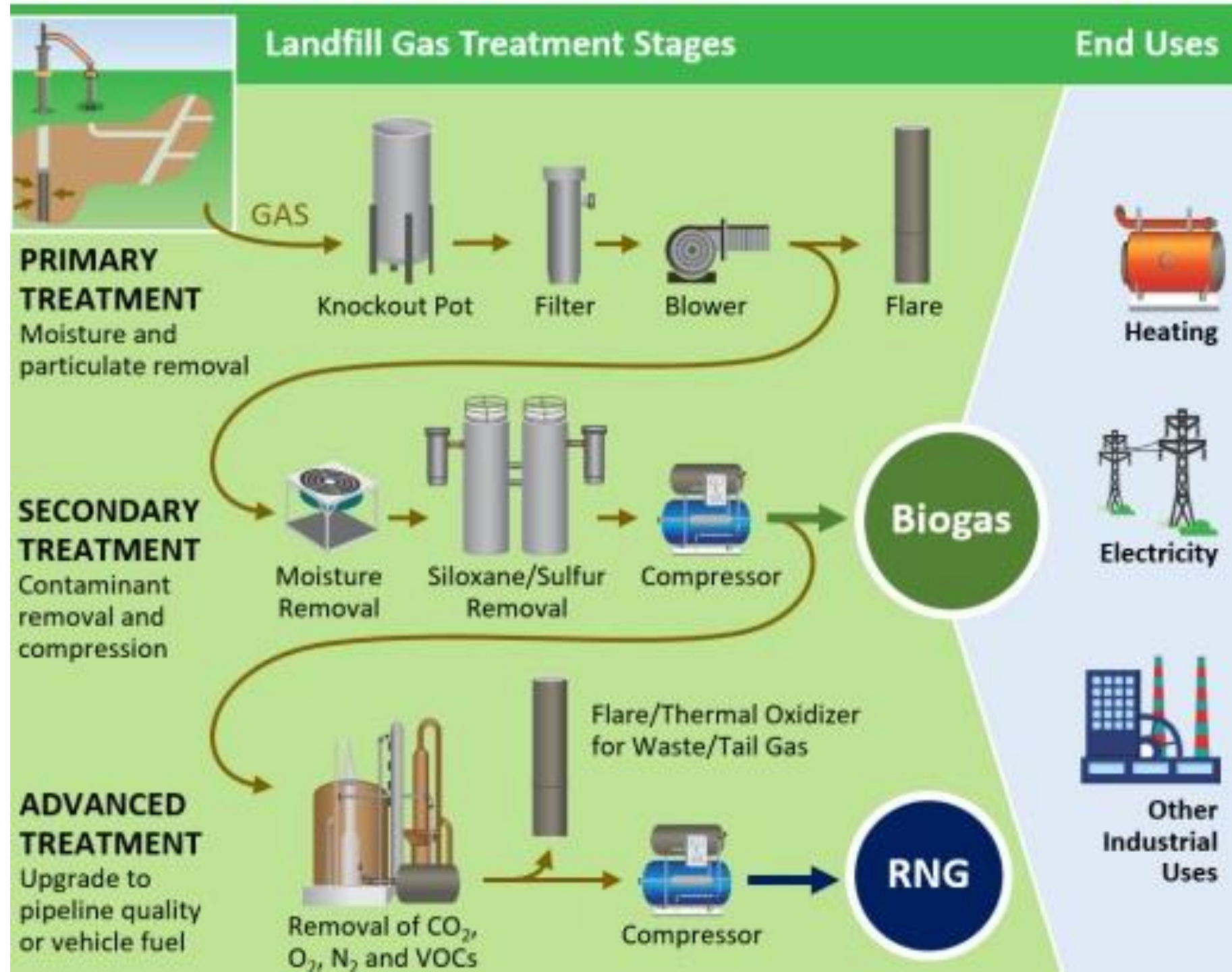


LFG Gas Collection



Landfill gas treatment stages

To upgrade biogas to RNG, the methane content is increased by removing water vapor, carbon dioxide, hydrogen sulfide and other impurities.



LFG Processing Primary Treatment

Primary treatment consists of basic moisture and particulate removal from the raw biogas. The gas passes through a knockout pot, filter and blower to remove moisture.

LFG Processing Secondary Treatment- Purification

Secondary treatment consists of additional moisture removal, contaminant removal and compression. The process first uses an after cooler to condense and remove additional moisture, then removes contaminants such as siloxanes and sulfide.

LFG Processing Secondary Treatment



LFG Processing Treatment



LFG Processing Secondary and Advanced Treatment



Filters to remove siloxanes or H₂S



Compressors to inject RNG



Treatment towers to remove CO₂

LFG Processing Advanced Treatment



Biomethane (also known as “renewable natural gas”) is a near-pure source of methane produced either by “upgrading” biogas (a process that removes any CO_2 and other contaminants present in the biogas) or through the gasification of solid biomass followed by methanation



LFG Transportation



RNG Delivery

It can then be injected and transported via natural gas pipelines and used as a substitute for natural gas. RNG is essentially indistinguishable from natural gas but is derived from biological materials rather than from fossil fuel deposits.

RNG Delivery Options



RNG End Uses



Vehicle Fuel



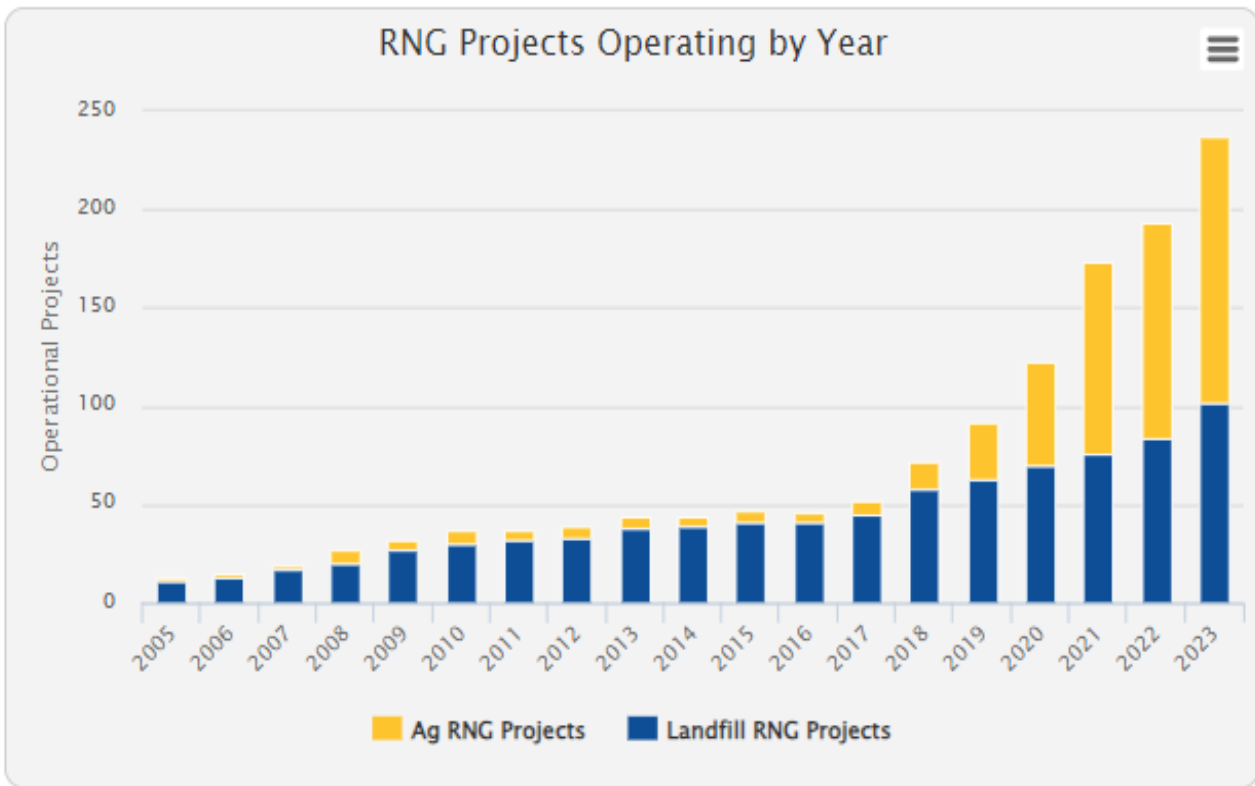
Electricity



Thermal Applications

The Future of RNG/ Biomethane

Landfill and Agriculture RNG Projects in the United States (2005-2023)



- RNG market growth – supply 30% of NG demand by 2040 in US
- LFG to RNG – largest and lowest cost RNG producing resource

- Benefits:
 - ✓ Waste to renewable, sustainable source of energy
 - ✓ Fuel diversity/ local economic
 - ✓ Improve air quality
 - ✓ GHG emission reduction



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