

The Power of Organic Waste: Renewable Natural Gas

Shifting Paradigms & New Market Opportunities

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Energy Vision



- ▶ Mission: To advance the adoption of the low-carbon renewable energy sources, transport fuels, and new technologies needed for a sustainable future.
- ▶ Program: Primary focus on resource recovery and alternative vehicle fuels to reduce reliance on fossil fuels—especially petroleum use in transportation— through reports, workshops, education and outreach, partnerships and media.
- ▶ Impacts:
 - ▶ Published the first U.S. reports on natural gas for refuse trucks (Greening Garbage Trucks) and transit buses (Bus Futures)
 - ▶ Hosted the first national workshop on “Renewable Natural Gas” in 2010 with the U.S. Dept. of Energy (+ 12 regional workshops since)
 - ▶ Published dozens of case studies, articles and OpEds on the RNG opportunity, inspiring new projects and positive change

Why a Focus on “Waste” & Transportation?

- ▶ The U.S. generates more solid waste per capita and uses more petroleum per capita than any other country
- ▶ Within transportation, heavy-duty trucks and buses—many operating in urban centers—consume ~40 Billion gallons of diesel/year
- ▶ Turning organic waste into biogas (and ultimately RNG), is a proven, commercial, cost-effective strategy to address both our solid waste and transportation challenges



Biogas: Multiple End-Uses

- ▶ Biogases (60% methane; 40% CO₂) can be used generate heat or power on-site, when combusted.
- ▶ Refined biogases (removing moisture, CO₂ & impurities) become “renewable natural gas” (RNG) or biomethane, a fuel that can be used like fossil gas to cook, heat, generate electricity, or power vehicles





Biogas-to-Electricity



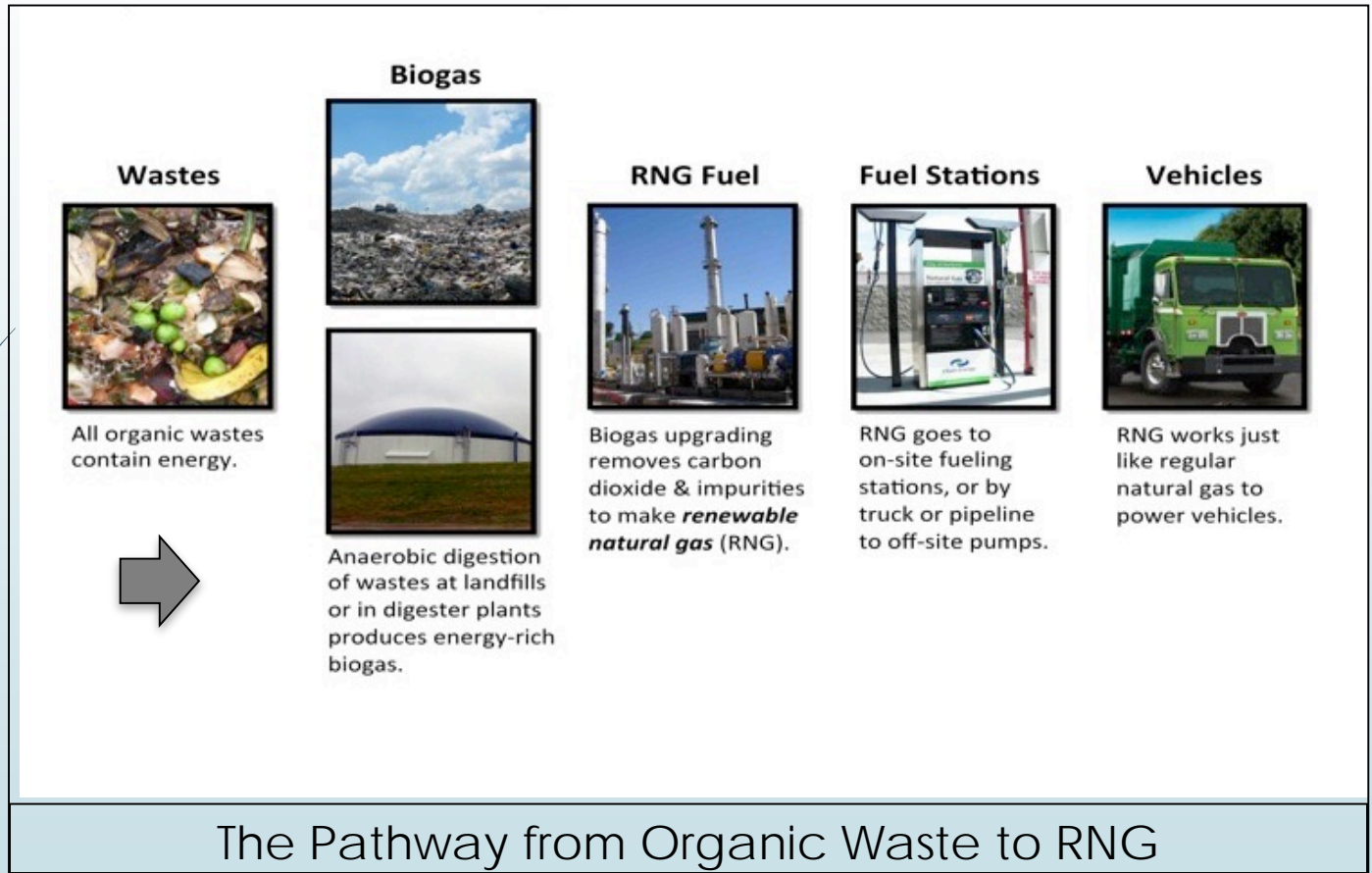
- ▶ Historically, biogas-to-electricity has been the norm, because of technology and policy:
 - ▶ Renewable Portfolio Standards
 - ▶ Feed-in Tariffs/Net-Metering
 - ▶ Investment Tax Credits
- ▶ Access to the above programs was restricted to generating renewable power

Upgrading Biogas to Pipeline & Vehicle Quality

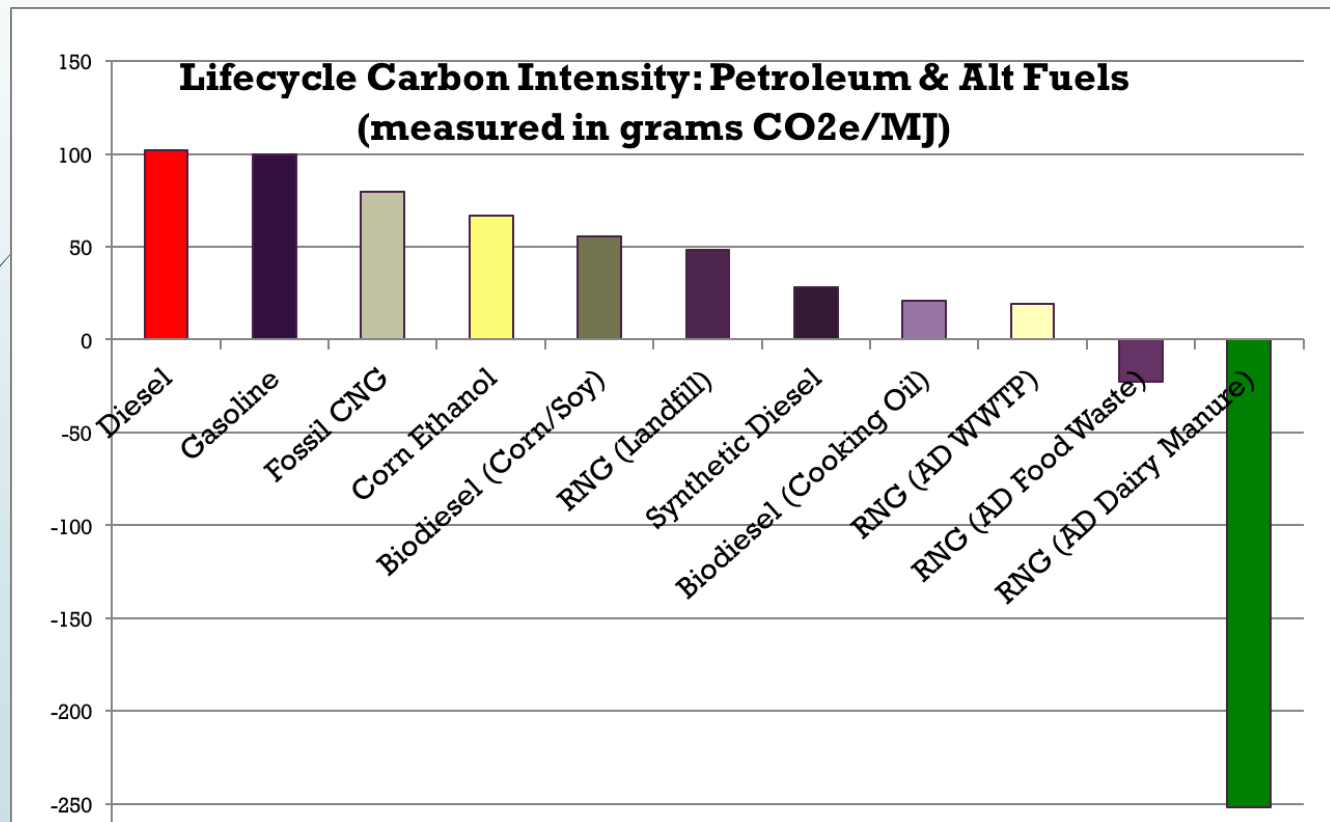
- Heating/Cooling/Cooking
- Power Generation
- Industrial Uses
- Transportation (use in Natural Gas Vehicles)



RNG for Transportation



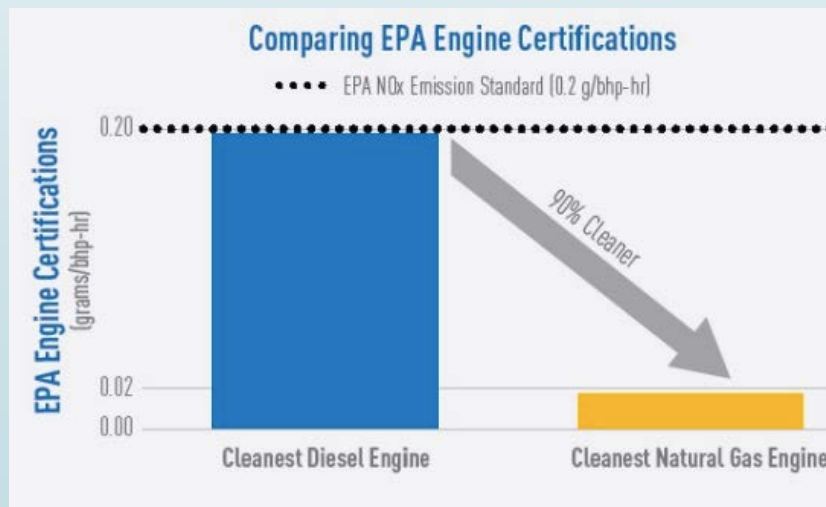
The Climate Case for RNG in Vehicles



Source: CARB LCFS Pathway Data

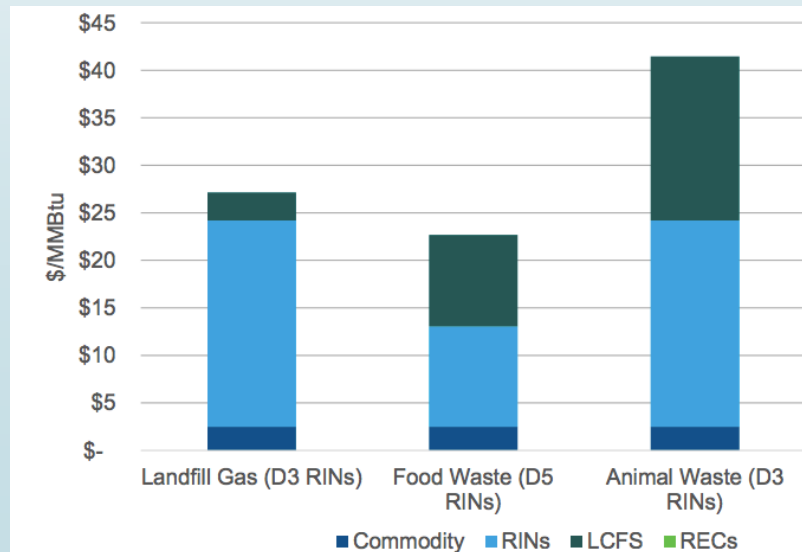
The Clean Air Case for RNG in Vehicles

- ▶ 90% reduction in smog-forming NOx compared to EPA 2010 standard (certified by EPA/CARB at .02 g/bhp)
- ▶ Up to 90% reduction in health-threatening PM emissions
- ▶ 80% reduction in CO emissions



The Business Case for RNG in Vehicles

- Existing Refueling Infrastructure (+1,500 stations)
- Growing Heavy-Duty Vehicle Market (60% of new refuse trucks; ~25% of transit buses)
- State & Federal Renewable Fuel Production Incentives = RNG at parity with competitively priced natural gas*



Source: ICF

Who Else Wants Renewable Natural Gas?

Bloomenergy



Middlebury
College



L'ORÉAL

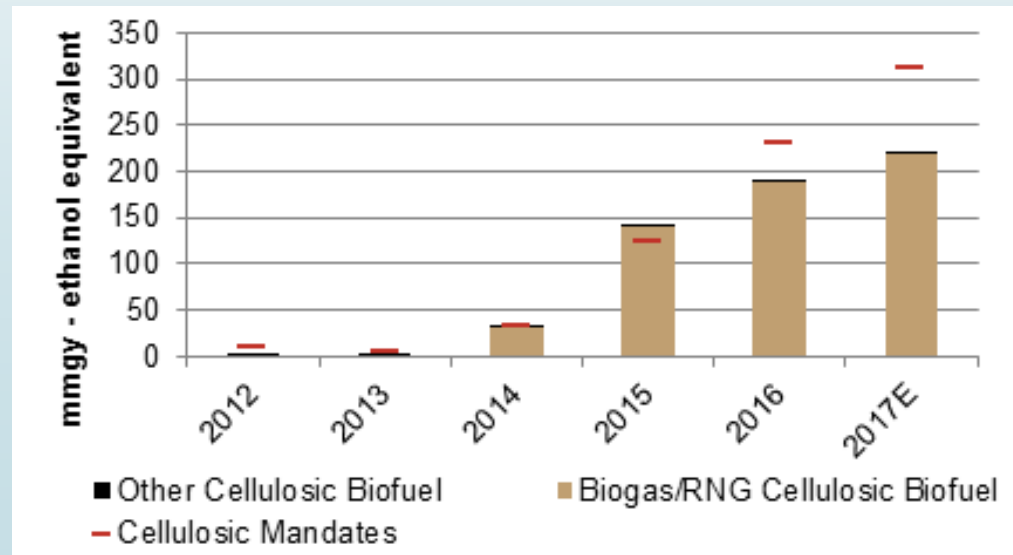


NW Natural



US RNG Industry Growth: 2011-2018

- ▶ In 2017, Energy Vision completed a comprehensive RNG project database in collaboration with DOE/Argonne.
- ▶ There are now 60+ RNG projects and another 25 in development; 40+ deliver gas to transportation



Source: Stratas Advisors, EPA EMTS Data

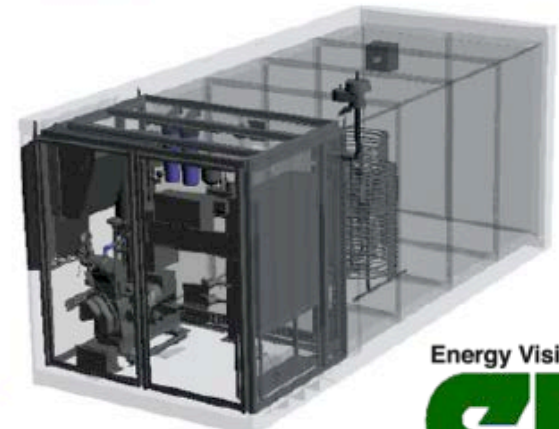
Emerging On-Site Organics Management Options Coming to a City Near You



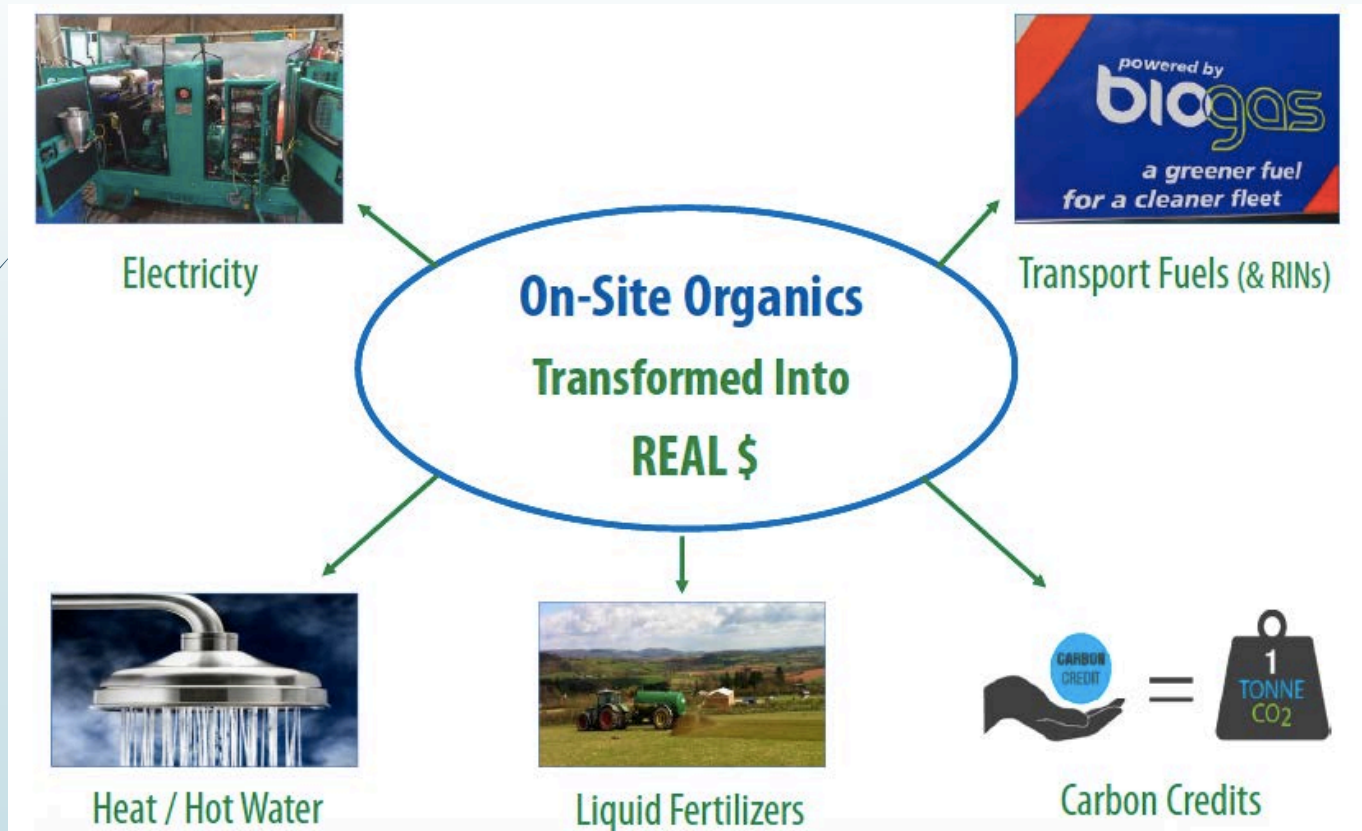
It's About Going From Here



To Here



Eliminate the Hauler & Turn a Liability into an Asset



Case Study 1: Wastewater Facility

- **Persigo Wastewater Biogas Project (CO)**
- In 2015, the City of Grand Junction, Colorado (pop. 60,000) installed a small system to convert biogas into vehicle-quality fuel at a cost of \$2.8M USD
- The City and County now fuel 38 natural gas buses and refuse trucks with locally-produced RNG, displacing ~170,000 gallons of diesel/year



See PBS NewsHour Story:

www.youtube.com/watch?v=ASoXPy8RWIQ

Case Study 2: Large Landfill

- **Seneca Meadows Landfill (NY) and Aria Energy & Clean Energy Renewables**
- 3,000 scfm of landfill gas refined and injected into natural gas pipeline at Seneca Meadows (Progressive Waste landfill)
- Capacity to produce ~25,000 GGE's/day of RNG (9M GGEs/yr)
- 60% delivered to SMUD in Sacramento; 40% is delivered to the transportation market in California through a partnership with Clean Energy





Additional RNG Resources

- ▶ Energy Vision RNG Case Studies:
<http://energy-vision.org/resources/project-profiles/>
- ▶ Argonne National Labs/NREL:
<https://www.afdc.energy.gov/case>
- ▶ The Coalition for Renewable Natural Gas:
<http://www.rngcoalition.com/>
- ▶ The American Biogas Council:
<https://www.americanbiogascouncil.org/>



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