Biogas Development: Challenges & Drivers
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Expansive Commodity Coverage

**Refined Products**
Heating Oil, Gasoline, Diesel, Crack Spreads, 3:2:1, Various Grades of Refined Products

**Chemicals**
LLDPE, LDPE, HDPE, PGP, PP, Eth, RGP

**Ethanol & Agricultural Products**
Corn, Soybeans

**Crude**
WTI, Brent, major global grades, Canadian Heavy, WTI%, WTI differential, Physical, Financial, Options

**Power**
Transact in all North American ISOs/RTOs; commodity swaps, standards and exotic options for electricity, heat rates and spark spreads

**Natural Gas Liquids**
C2, C3, C4, IC4, C5, Conway, MtB, Edmonton, WTI%, ARA, FEI

**Natural Gas**
NYMEX, trades at most Platts pricing points

**Biogas**
RIN & LCFS generation from landfill biogas
Gas Solutions for the Transportation Sector

We are active in RINS & LCFS generation from landfill biogas.

We deliver transport fuels in addition to associated environmental credits, and we optimize value for both buyers and sellers.

We provide credits to customers to meet sustainability initiatives.

- Active at state/federal levels
- Understand regulatory and reporting requirements
- Offer innovative structures
- Strong balance sheet
- A- credit rating (S&P)
- Appetite for risk
- Web of assets to fulfill requirements

300,000+ Compliant LCFS Credits

130+ Million Renewable Identification Numbers (RINS)

15+ Registered Biogas Pathways

70+ CNG & LNG Fueling Stations
What is Biogas?

- **Biogas** is a mixture of methane & other gases produced from the decomposition of organic materials. It is produced naturally in landfills and from the processing of animal waste, sewage, crop waste and cellulosic and non-cellulosic crops.

- **Biomethane** is a pipeline-quality natural gas-substitute produced by purifying biogas.
Demand for Biogas:
Federal / State / Voluntary Green Initiatives Create Demand

<table>
<thead>
<tr>
<th>Federal Program</th>
<th>State Programs</th>
<th>Voluntary</th>
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<tr>
<td><strong>Renewable Fuel Standard</strong></td>
<td><strong>California AB 32</strong></td>
<td><strong>Corporate Responsibility</strong></td>
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<td>• Importers and Refiners are obligated to produce an allocated amount of transportation fuel from renewable sources</td>
<td>• Reduce statewide emissions to 1990 levels by 2020&lt;br&gt;• 9/8/16 – Climate programs extended to 2030</td>
<td>• Corporations define parameters and value</td>
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Renewable Identification Numbers (RINs) | Carbon Allowances (CCAs) / Carbon Offsets (CCOs) | No obligation = No Currency

Low Carbon Fuel Standard Credits (LCFS) | Renewable Energy Credits (RECs) | Walmart

NewLight Tech | Google

SAFEWAY | Apple
RNG = Best GHG Reduction on Lifecycle Basis

![Carbon Intensity Scores for Heavy-Duty Truck Pathways](image)

**Note:** using the new “NZ” NG engine (0.02 g/hp-hr) will further reduce the CI scores of these RNG pathways by about 4 gCO₂e/MJ (closed crankcase ventilation reduces methane by 70%).

*Source: California Air Resources Board, “LCFS Illustrative Fuel Pathway Carbon Intensity Determined using CA-GREET2.0,” discussion presented by staff on 9/17/15 and/or CARB LCFS Final Regulation Order, Table 6; note that “HSAD pathway is EER-adjusted by the CARB formula (-22.93 base CI divided by EER of .9), even though this improves its CI score.*
How Low Can We Go? ULNOX Engines

Volume Weighted Average Emissions: 0.018 g/bhp-hr

How Much Can We Produce?

- 2016 GGEs sold: 120mm
- 2017 Industry Estimate: 250mm GGEs of RNG sold
- 2018 Industry Estimate: 400mm GGEs of RNG sold
- CA rapidly approaching 100% RNG for CNG/LNG vehicle fuel demand
- In 2013: 14mm GGEs sold (rapid, exponential growth)
- UC Davis estimates sufficient biomass for 1.8 billion GGEs of RNG in CA alone (60% of diesel use)
- NPC estimates 35 billion GGEs nationwide possible – 1.2 times total diesel consumed by freight trucks

Source: 2016-2018 information from Coalition for Renewable Natural Gas, EPA data. CA RNG use from LCFS data provided by California Air Resources Board.
Challenges

• **COST:** Cost of RNG Production is Significantly Higher than Long Term Natural Gas Prices
  - Economically sustainable production depends on long term monetization of environmental attributes at price sufficient to close gap or breakthrough in production
  - Regulatory programs (LCFS, RFS, RPS programs) drive market and are inherently uncertain

• **DEMAND:** We need more RNG trucks on the Road
  - “With Friends Like These…..” Increasingly vocal portion of the environmental community opposes any programs that involve internal combustion engine which will hamper efforts to build RNG vehicle fuel demand

• **INFRASTRUCTURE:** Infrastructure Challenges: connecting the biomass feedstocks for RNG to existing distribution systems is expensive and unclear who will provide the capital to do so in a cost effective way