About Clean Energy

Largest Natural Gas Fuel Provider in North America

- **400+** Natural Gas Fueling Stations
- **660+** Fleet Customers
- **25,000+** Natural Gas Vehicles
- **200 Million** Gallons Natural Gas

**Compressed Natural Gas (CNG)**
- Airport Vehicles
- Transit Buses
- Regional Trucking

**Liquefied Natural Gas (LNG)**
- Port Trucking
- LNG Tanker Trailer
- LNG Station

About Clean Energy
Clean Energy:
Vertically Integrated Solutions

- LNG Technology & Construction
- NorthStar
- Engineering & Construction
- Compressors & Equipment
- IMW
- Fueling Services
- Grants & Finance
- Service & Support
- Vehicles & Conversion
- BAF
Fueling Services
Engineering and Construction

CNG Time Fill
CNG Fast Fill
Fueling Services
Engineering and Construction

LNG
...the majority are not “Truck Friendly”
Compressors and Equipment
IMW
Vehicles and Conversions

BAF Technologies
LNG Technology and Construction
NorthStar
Clean Energy: Vertically Integrated Solutions
# CNG - Pros and Cons

## Advantages

- Greater infrastructure than LNG
  - Light and medium duty
- Simple fuel systems
  - Easy to fuel like gasoline
- No diesel, DPF, or SCR to manage (SI engines)
- Gas/Vapor instead of cryogenic
- No fuel loss if parked for an extended period of time

## Disadvantages

- Far less CNG infrastructure for trucks than LNG
- Fuel storage tanks
  - Heat of compression
  - Weight of storage tanks
  - Range limitations
  - More expensive than LNG
- Limited to 9L and 12L spark ignited engines
  - Cummins 15L in 2015
- Cost of compression
  - Energy and maintenance with a compression station
- LDC inconsistencies in NG composition (Methane # <75)
## LNG - Pros and Cons

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Greater fuel density/ volume</td>
<td>● Cryogenic tanks</td>
</tr>
<tr>
<td>- Greater range then CNG</td>
<td>● Special handling when fueling (PPE)</td>
</tr>
<tr>
<td>- Substantially lower weight of storage</td>
<td>● Pressure and temperature management of fuel to engine</td>
</tr>
<tr>
<td>● Faster fueling</td>
<td>● Potential boil off (use it or lose it) if vehicles are parked for extended period</td>
</tr>
<tr>
<td>- Fuels like diesel</td>
<td></td>
</tr>
<tr>
<td>- No impact to HOS</td>
<td></td>
</tr>
<tr>
<td>● Fuel costs less than diesel</td>
<td></td>
</tr>
<tr>
<td>● Lower GHG emissions than diesel</td>
<td></td>
</tr>
<tr>
<td>● Less expensive tanks</td>
<td></td>
</tr>
<tr>
<td>● NG composition is 97% CH₄</td>
<td></td>
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</tbody>
</table>
Dispensing LNG

http://www.cleanenergyfuels.com/video/Lngfueling.html
ANGH Station Rollout

America's Natural Gas Highway Station Deployment Plan

Legend

<table>
<thead>
<tr>
<th>Year Completed</th>
<th>Count</th>
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<tbody>
<tr>
<td>Completed</td>
<td>58</td>
</tr>
<tr>
<td>2012</td>
<td>12</td>
</tr>
<tr>
<td>TOTAL</td>
<td>70</td>
</tr>
</tbody>
</table>

Date: 11/26/2012

*Dates & Locations are subject to change. Please Contact Clean Energy*
America’s Natural Gas Highway
Las Vegas

Clean Energy's Las Vegas
LNG Truck Fueling Station
on America's Natural Gas Highway

http://www.cleanenergyfuels.com/products_services/trucking.html
ANGH Sites

Dallas, TX

Midway, FL

Smithton, PA

Knoxville, TN
ANGH Sites

- Hope Hull, AL
- Latta, SC
- Oklahoma City, OK
- Pearl, MS
ANGH Growing Network
ANGH Station Rollout
LNG Infrastructure
California
LNG Infrastructure
Texas
Fueling Infrastructure
Station Locator Application

http://www.cnnglngstations.com/
Total Cost of Operation
72,000 miles and $1.25/ DGE Spread
Total Cost of Operation
72,000 miles and $1.25/ DGE Spread

<table>
<thead>
<tr>
<th>Variables</th>
<th>Base Truck</th>
<th>Incremental Cost</th>
<th>FET</th>
<th>Sales Price</th>
<th>Sales Tax</th>
<th>Amount Financed</th>
<th>Interest Rate</th>
<th>Term</th>
<th>Truck Monthly Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nat Gas</td>
<td>$100,000</td>
<td>$40,000</td>
<td>$16,800</td>
<td>$156,800</td>
<td>$11,200</td>
<td>$168,000</td>
<td>3.5%</td>
<td>60</td>
<td>$3,056</td>
</tr>
<tr>
<td>Diesel</td>
<td>$100,000</td>
<td>0</td>
<td>$12,000</td>
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<table>
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<tr>
<th>Variables</th>
<th>Miles Driven A Year</th>
<th>Miles/Month</th>
<th>Estimated MPG</th>
<th>Fuel Usage (DGE/Mo)</th>
<th>Estimated Cost Per Gallon</th>
<th>Monthly Fuel Cost</th>
<th>Monthly (Payment + Fuel)</th>
<th>Fuel Cost Per Mile</th>
<th># Trucks in Fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nat Gas</td>
<td>72,000</td>
<td>6000</td>
<td>6.1</td>
<td>984</td>
<td>$2.75</td>
<td>$2,705</td>
<td>$5,761</td>
<td>0.451</td>
<td>37</td>
</tr>
<tr>
<td>Diesel</td>
<td>72,000</td>
<td>6000</td>
<td>6.7</td>
<td>896</td>
<td>$4.00</td>
<td>$3,582</td>
<td>$5,783</td>
<td>0.597</td>
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<thead>
<tr>
<th>Fixed Costs</th>
<th>Diesel Trucks</th>
<th>Natural Gas Trucks</th>
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<tbody>
<tr>
<td></td>
<td>Annual</td>
<td>Monthly</td>
</tr>
<tr>
<td>Truck Payment</td>
<td>$26,406</td>
<td>$2,200</td>
</tr>
<tr>
<td>Collision Insurance</td>
<td>$5,700</td>
<td>$475</td>
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<tr>
<td></td>
<td>$2,640</td>
<td>$220</td>
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Total Cost of Operation
140,000 miles and $1.25/ DGE Spread
Total Cost of Operation
140,000 miles and $1.25/ DGE Spread

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### Total Cost Analysis Prepared for UM CTS 140k $40k

<table>
<thead>
<tr>
<th>Based on Annual Miles Per Truck of</th>
<th>Analysis Shows a Savings of</th>
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<tbody>
<tr>
<td>140,000</td>
<td>$ 0.073 Per Mile</td>
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<tr>
<td></td>
<td>$ 10,198 Per Truck/Year</td>
</tr>
<tr>
<td></td>
<td>$ 377,343 Per Fleet/Year</td>
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<tr>
<td></td>
<td>Per Truck $50,992 Per Fleet $1,886,715</td>
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### Variables

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<tr>
<td>Nat Gas</td>
<td>140,000</td>
<td>11667</td>
<td>6.1</td>
<td>1913</td>
<td>$2.75</td>
<td>$5,260</td>
<td>$8,316</td>
<td>0.451</td>
<td>37</td>
</tr>
<tr>
<td>Diesel</td>
<td>140,000</td>
<td>11667</td>
<td>6.7</td>
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Natural Gas Solutions for Transportation
December 7, 2012
Clean Energy’s Standard LCNG Station Design

Industry’s First
Natural Gas Heavy Duty Market

CNG

LNG
Compressed Natural Gas (CNG) Basics

- Light, medium, and some heavy duty applications
  - <50 DGE/Truck/Day
- NG delivered by Gas Co pipeline to fueling station
- Dried, compressed & stored at 4,500 psi and dispensed to vehicle at 3,600 psi
- Dispensed at similar speed (gpm) to gasoline
- Stored in cylinders onboard the vehicle
CNG Time Fill

- Complete fill because we can dissipate heat
  - 3 to 6 hour fill period
  - Increase Range

- Lowest cost installation
  - Best value
CNG Fast Fill

- Large capital investment
  - >2X compared to LNG
  - $5+ million for 4 lanes dispensing at 12 gpm at the same time
- High heat gain during fueling
  - >30% loss of storage
- Industrial Utility Services
  - NG, both pressure & flow
  - 2MW electrical demand
Liquid Natural Gas (LNG) Basics

- Heavy-duty vehicles
  - >50 DGE/truck/day
- Store 2X (energy)/volume as CNG (3,600 psi)
- Pipeline gas cooled to -260 F
- Produced at LNG plants & delivered to LNG station & stored in cryogenic trailers
- Dispensed at 12+ DGE/minute
LNG Fast Fill Fueling

- Transparent to diesel fueling
  - Typically, not site constrained
- Mitigate truck weight resulting from heavier & multiple NG tanks
### Natural Gas Truck Tanks Storage Capacity and Weight Impact

<table>
<thead>
<tr>
<th>LNG Tanks Nominal Size (Gal)</th>
<th>Effective Size (Gal)</th>
<th>Effective Diesel Gallon Equivalents (DGE)</th>
<th>Dry Weight (lbs)</th>
<th>Wet Weight (lbs)</th>
<th>Diesel Weight (lbs)</th>
<th>NET Weight (NG - Diesel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>119</td>
<td>102</td>
<td>60</td>
<td>495</td>
<td>870</td>
<td>1,026</td>
<td>(156)</td>
</tr>
<tr>
<td>150</td>
<td>128</td>
<td>75</td>
<td>620</td>
<td>1,093</td>
<td>1,146</td>
<td>(53)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CNG Tanks Configuration</th>
<th>Nominal Size (DGE)</th>
<th>Effective Size (DGE)</th>
<th>Dry Weight (lbs)</th>
<th>Wet Weight (lbs)</th>
<th>Diesel Weight (lbs)</th>
<th>NET Weight (NG - Diesel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Tanks</td>
<td>75</td>
<td>60</td>
<td>1,650</td>
<td>2,025</td>
<td>1,026</td>
<td>999</td>
</tr>
<tr>
<td>2 Tanks - Rail Mount</td>
<td>82</td>
<td>66</td>
<td>1,200</td>
<td>1,650</td>
<td>1,074</td>
<td>576</td>
</tr>
</tbody>
</table>

Notes:
1. LNG tanks have a vapor space that reduces effective storage volume in converting from nominal to effective.
2. 1.7 gallons of LNG = 1 DGE = 1 gallon of diesel on an equivalent energy basis.
3. Westport GX LNG storage tanks have effective volume of 58DGE due to pump displacement plus allowing for 5% diesel mixture.
4. CNG tanks have heat of compression during fueling and residual fuel at low pressure in converting from nominal to effective.
5. Diesel Weight includes diesel tank, equivalent amount of diesel fuel + DPF + SCR + Urea Storage with solution.
6. DPF + SCR + Urea Storage with solution is 546lb (industry standard).
Station Assumptions Comparing CNG & LNG

- Stations require 4-8 fueling lanes
- Simultaneous & random fueling
- Typical fill is 50-100 DGE
- Similar rate to diesel
- CNG & LNG must cost less than diesel
- Everyone needs to make money

POLB LNG Station = 9,700 SCFM
LNG Station Design

LNG Tanks

LNG Pump 25HP

12 GPM

12 GPM

12 GPM

Capital Cost:
< $2M including Utilities

= 6,500 SCFM
CNG Fast Fill Station Design

Gas Supply:
- Dedicated 6-12” Service
- $500K/mile

Gas Compressors:
- 6,500 SCFM
- 2,500 hp
- 2MW Power Supply

Storage
- 12 GPM
- 12 GPM
- 12 GPM

Electrical Service:
- $1M+

Capital Cost:
- 2,500 hp x $2,000 = $5 Million + Utilities

Demand charge:
- 2,000kw x $15.00 = $30,000/ month

Demand charge:
- 2,000kw x $15.00 = $30,000/ month
<table>
<thead>
<tr>
<th>Description</th>
<th>CNG Station</th>
<th>LNG Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>4 Trucks @ 12 DGE per Minute</td>
<td>4 Trucks @ 12 DGE per Minute</td>
</tr>
<tr>
<td>Gas Utility Connection</td>
<td>Dedicated Service: $500K/mile (if available)</td>
<td>None</td>
</tr>
<tr>
<td>Electrical Service</td>
<td>2MW (Large Industrial) $1 Million+ (if available)</td>
<td>200 Amp (Residential) 480 Volt, 3 phase</td>
</tr>
<tr>
<td>Electrical Demand Charge</td>
<td>$30,000/Month +</td>
<td>Negligible</td>
</tr>
<tr>
<td>Scalable</td>
<td>Maybe</td>
<td>Yes</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>&gt; $5 Million</td>
<td>&lt; $2 Million</td>
</tr>
<tr>
<td>Capital Cost of ANGH Fuel Cost</td>
<td>$1B Initially more than Diesel</td>
<td>$250M $1.00 to $1.50 less than Diesel</td>
</tr>
</tbody>
</table>
CNG Range Check Assumptions

- Heavy-Duty Vehicle
  - 6 MPG
  - CNG Cylinders (120 DGE)
  - Distance should be 720 miles
Temperature Pressure Chart

Temperature Compensation
Nominal Fill Pressure ~ 3600 psig @ 70°F

Code prohibits exceeding 125% of nominal fill pressure. A 3600 psi systems allows maximum pressure of 4500psi.
Temperature Rise During CNG Fast Fill (HDV)

Assuming 80° F Ambient Temperature

Temperature at Gas Utility is normally within 10° ambient

CNG Compressor Industry standard is 20° above ambient

Storage

Heavy duty vehicle fill rate >10 DGE/M +120°

4300 PSI
Did we get 720 miles?

Temperature Compensation
Nominal Fill Pressure ~ 3600 psig @ 70º F

- Target pressure 5600 / 4300 = 23%
- Min tank pressure 400 psi = 11%
- 6 MPG X 80 gals = 480 Miles
CNG Station Reality

...the majority are not “Truck Friendly”