The Compelling Case For Natural Gas in Truck Fleet Applications

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What is the Compelling Case?

- Environmental, energy security and – now, more than ever due to domestic natural gas abundance - *economic* market drivers are behind the trend toward greater use of NGVs. While fleet fuel use has been the primary focus, potential consumer market is now spurring additional investment in infrastructure.

- A growing selection of light-, medium- and heavy-duty NGVs are available from OEMs and SVMs, delivering performance and reliability that are on par with gasoline and diesel counterparts.

- A variety of fueling options are available – LDCs, E&Ps, leasing companies, other customers and independent fuel retailers – both NGV-focused and, now, more traditional fuel retailers - are engaging to develop fueling infrastructure.

- Natural gas is America’s fuel: America’s resource, America’s jobs. Reduced reliance on volatile foreign oil supplies = Energy Security
• Transportation (on-road, off-road, rail, marine and aviation) = ~28% of all energy use
• ~71% of all oil is for transportation
• LDVs (~59%) + HDVs (~23%) account for ~60% of all petroleum use
Liquefied Natural gas (LNG)
- Cryogenically cooled natural gas @ ~-(260)°F,
  stored in liquid form onboard vehicle and vaporized before it enters engine cylinder
- Preferred by many heavy-duty fleets due to its energy density, space requirements
- Option for locations without pipeline gas.

Compressed Natural gas (CNG)
- Typically delivered via the local gas utility’s distribution system at low pressure, then compressed and stored on site for fast filling of vehicles …or compressed and distributed directly to vehicles’ onboard storage cylinders (time-fill applications)
Snapshot of US NGV Market Today

- Existing NGV inventory is estimated at ~135K
  - Pace of attrition of older LDVs is gradually declining; total counts are increasing
  - Steady growth in MDV/HDV inventory due to expanded truck OEM options
  - Consumer markets are burgeoning in areas with fueling infrastructure

- ~28-30,000 HDVs
  - 11,000 transit buses + shuttles
  - 5,000 school bus
  - 7,500+ refuse
  - 2,500 ports/regional haul
  - 3,000-3,500 municipal/F&B/Misc

- ~74-76,000 LDVs (fleet and consumer use vehicles)
  - Cars/SUVs, trucks/vans

- ~20-25,000 MDVs
  - 7,500-8000 gov’t
  - 1,500 package delivery
  - 1,700 airport shuttle
  - 1,000 community transit/CTAA
  - 6,500-8,000 utilities, F&B, commercial services, household goods, construction, misc
Independent Forecasts

• Frost & Sullivan:
  – By 2017: 8% of ~370,000 Class 6-8 truck market (30,000 trucks)
    • Doesn’t account for Class 3-5 market
      (step vans, small box trucks, c/c utility work trucks, shuttles)

• National Petroleum Council (NPC) study:
  – Under “aggressive” (high oil price case), NPC’s scenario shows, by 2050, NGV capturing:
    • 50 percent of LD market
    • Upwards of 35 percent of the class 3-6 truck market
    • Almost 50 percent of the class 7-8 truck market by 2050
Snapshot of US NGV Market Today

• Vehicular natural gas consumption: ~10-12% AGR past 6 years
  – 2005: ~200MM GGE
  – 2011: ~325MM GGE
  – 2012 ~350-375MM GGE

  – Medium- and Heavy-duty vehicle fuel use is growing dramatically
  – Growth rate will accelerate with new niche market successes, new platform availability for MD/HD truck sector…and consumer market?

  – Factors affecting timeframe include pace of worldwide economic recovery, petroleum-natural gas differential, vehicle choices…

  …vehicle and station tax credits, grants that accelerate adoption
Energy Use in On-Road Transportation

• Total on-road transportation energy usage: 21.97 Tcf (2010):
  – Light-duty: 16.7
  – Heavy-duty freight: 4.41
  – Commercial light trucks: 25% 0.59
  – Buses: 0.27

• US DOE EIA forecast

• Independent Forecasts (PIRA Consulting):
  – By 2030: 5.1 Tcf gas used in vehicles per year
  – Equal to 24% of today’s on-road energy use
Snapshot of US NGV Market Today

• Station count is ~1250. Although less than the late 1990s peak of ~1350, the count has grown steadily in past 24 months and installed capacity is up significantly
  – Attrition of older stations built in 1990s is finished;
  – New investment/upgrades to older stations
  – New stations are based on better economics, either higher throughput with anchor accounts or aggregated loads and better sizing of equipment to loads

• While less than half of all stations are “public access” and most do not meet public expectations, emphasis today is on upgrading that experience
  • CNG able to handle local and some regional trucking
  • Increased LNG infrastructure for OTR trucking
  • Potential for 350+ new stations in 2013!
Multiple Stakeholders Are Engaging NGV Fueling Infrastructure

- Local Gas Dist Cos.
- NG Retailers
- NG Exploration & Production Cos.
- Leasing Companies
- Customers
- “Traditional” Fuel Retailers
Truck Stops Are Embracing Public-Access Fueling Infrastructure

• Pilot/Flying J is working with Clean Energy to develop LNG (and potentially L/CNG) stations at locations all across the country.

• Love’s is co-developing CNG locations in the Midwest. Love’s continues to develop backyard and front-of-store retail options.

• TravelCenters of America has partnered with Shell to install LNG capability at 100 locations.
C-Stores Are Embracing Public-Access Fueling Infrastructure

• Kwik Trip has installed LNG and CNG dispensing capability at its central warehouse/HQ in LaCrosse, WI and is deploying Class 7 & 8 trucks, LDVs. The company is adding CNG and/or L/CNG at additional 20+ retail locations throughout their 3-state trading area (KT’s fleet is serving as its own anchor)

• OnCue Express has built multiple locations in OK and AR…. focus is on retail consumer sales.

• Additional C-store chains are in process of evaluating similar options
Customers Are Embracing Public-Access Fueling Infrastructure

• Waste Management has been co-developing retail locations with PetroCard under the Clean-N-Green brand. WM fleet serves as anchor load inside the fence (primarily time fill) while promoting to public outside the fence (and extending their “green” messaging)

• Transit agencies, municipalities, F&B companies, small businesses are collaborating with other fleets to aggregate load to meet critical throughput thresholds.
Natural Gas is an Abundant Domestic Fuel

- 98+% of US gas consumption is supplied from North America (~88% from US)
- Well-developed distribution infrastructure:
  - ~300K miles of interstate pipeline
  - 1.2 million miles of LDC distribution lines
- Technology improvements are expanding our economically recoverable base so much so that the estimated supply is now @ 115+ yrs!
- Natural gas E&P activity is generating tens of thousands of quality jobs which gives direct and indirect economic boost to communities across America

Shale Basins and the U.S. Pipeline Grid
Source: American Clean Skies Foundation.
Translating Abundance into Savings

One MMBtu is ~8.0 GGE of (uncompressed) natural gas
One MMBtu is ~7.2 DGE of (uncompressed) natural gas.

If average MMBtu is ~$4.75; commodity % is $.59/GGE ($0.66/DGE) . Add LDC delivery, compression, maintenance, equipment amortization: ~$1.55-1.75/GGE ($1.74 -1.97/DGE) + fed and state taxes. LNG pricing derived differently but base stock gas cost is same.
Figure 34. U.S. spot market prices for crude oil and natural gas, 1997-2012
(2010 dollars per million Btu)

Crude oil (West Texas Intermediate)

Natural gas (Henry Hub)
Snapshot of US NGV Market Today

• On a Btu basis, natural gas and oil prices are now decoupled.
  – BBL : MCF ration ran over 40:1 for much of 2012;
  – Even when gas is at more sustainable $4.50/MCF, ratio tends to hover at ~20:1;
  – This “new norm” is up from long-time 7:1 ratio

• Currently, CNG savings in TN are $1.25 compared to gasoline and 1.50 compared to diesel.

• Favorable fuel cost differential between natural gas and petroleum is expected to improve further as economy recovers because fundamentals of oil supply-demand have not changed
Market Driver of Change
Emissions/Improvement in AQ

- AQ Goals, NAAQS and EPA Vehicle Emissions Requirements
  - CAAA drives local/regional govts to reduce criteria emissions (NOx, PM)
  - EPA and CARB vehicle/engine emissions requirements impact OEMs’ product offerings, vehicle performance and fuel economy

- 2004 and 2007 diesel emissions strategies hurt fuel economy and performance and increased purchase price and O&M cost; added complexity.
- 2010 NOx reduction strategies using SCR technology further increased cost, complexity and O&M costs. “DEF” systems and usage
- 2014 phase-in of GHG and fuel efficiency requirements
The Price of Progress: OUCH!

Complexity, Confusion and Cost

Fuel Processing
- Water + Additives
- Gas to Liquid
- Alt. Fuels
- Desulfurisation
- Platinum and/or Cerium

Engine Design Modifications
- Combustion Chamber Design
- Low Pressure EGR
- NOx After-Treatment
- PM After-Treatment
- High Pressure EGR
- Urea
- Electric Power

Exhaust After-treatment

Diagram Courtesy of TIAX LLC
Market Driver for NGVs
Lower Greenhouse Gases (GHG)

- The Environmental, Economic and Political Realities of Global Warming and Greenhouse Gases
  - Issue is gaining traction internationally and here in US
  - New LDV GHG requirements are already phasing in and EPA and NHTSA are phasing in HDV GHG/fuel economy requirements (2014)

- Natural gas vehicles reduce GHGs significantly
  - According to CEC study, between 20-29%
    - For HDVs, about 20-23%; for LDVs, 26-29%
    - Depends on comparative vehicles and duty cycles
  - 2012 EPA GREET model being revised based on new data
    - Estimates expected to be in 15-25% range
Market Driver For NGVs
Energy Security and Impact at Fuel Pump

- Global oil supply-demand imbalance getting worse, which pushes fuel prices up
  - US = <5% of world pop but 25% of oil use
  - Asian economies compete for oil supply;
  - Demand outpacing supply; New oil discoveries lag growth;
  - Political instability in key producer regions will only further exacerbate volatility of crude oil prices
  - Existing refinery capacity is at/or near peak – new capacity is lengthy process
  - Barrel of oil topped $145 in late spring 2008! Slump in world economy pushed prices down but higher prices are already returning. Barrel currently ranges between $85-100.

Are you prepared?
Market Driver For NGVs
Energy Security and Diversity

- Diversifying America’s Transportation Fuel Portfolio
  - Electricity
    - All-electric
    - Hybrids, PHEVs
  - Bio-diesel (B100) and blends
  - Ethanol
    - E85 (limited production/distribution – majority is in Midwest market)
    - Oxidant additive to gasoline (e.g. E10 gasoline – perhaps to be increased)
  - Propane
  - Natural Gas
    - CNG for light and medium duty and LNG for heavy duty vehicles
  - Hydrogen
    - Internal combustion engines (H/CNG blends like Hythane)
    - Fuel cells (eventually)
Natural Gas and the Hydrogen Future

• Natural gas and NGVs are the logical energy pathway and technology bridge to the hydrogen transportation energy future
  – Natural gas is 87-95% Methane
  – Methane is CH4 - 80% Hydrogen
  – Reform at station or on-board
  – H/CNG blending in internal combustion engines is likely precursor to wider use of H2
  – Market acceptance of gaseous fuel compression, storage vessels, engine maintenance
  – NGV industry is spearheading Codes & Standards development

• Still a LONG way to go before H2 vehicles are commercially viable and represent significant impact
Benefits of Natural Gas/NGVs

- Natural gas is an inherently clean fuel
  - Natural gas is low-carbon fuel (CH4)
  - Less NOx, PM and GHGs
- Natural gas is very safe
  - Lighter than air; Limited combustion ratio (5-15%)
  - High ignition temperature: 1000+F
  - Colorless, odorless, non-toxic substance
  - Doesn’t leak into groundwater
- NGVs are proven and reliable
  - 15+ million worldwide;
- NGVs are quiet
  - HDVs are 80-90% lower db than comparable diesel
- NGV life-cycle costs are significantly lower
  - Fuel costs are far lower!
  - Maintenance costs are =/< than gas or diesel
Key Attributes and Best Prospects

- High fuel use vehicles with return-to-base operations or repetitive route or pre-set geographic operating areas
  
  - Regional / long haul freight truck – 18-22K DGE
  - Transit buses – 11-13K DGE
  - Refuse/Concrete trucks – 7.5-10K DGE
  - Municipal sweeper – 5-6K DGE
  - Airport shuttle service – 5.5-7.5K GGE
  - Local goods/svcs: F&B, Textiles etc – 7K DGE
  - Taxi - 4.5-5.5K GGE
  - School Bus – 2.5-3K GGE
  - E&P pick-up 2-2.5K GGE
  - Courier sedan, newspaper van, utility/ telecom van, public works pick-ups – 1.2-1.5K GGE

- Consumers have already shown that they will adopt given sufficient infrastructure
Expanding Infrastructure: “Hub and Spoke” and Corridor Development

Hub and spoke:  ○
Local fleets with predictable “limited” range needs (CNG or L/CNG).

Corridor:  ○—○
Lanes that connect the hubs (CNG or LNG, depending on range)

Hypothetical sample: TN
## Growing Selection of NGVs from OEMs, SVMs

### OEMs
- American Honda
- General Motors
- Chrysler Ram Trucks
- Thomas Built Bus
- Blue Bird Bus
- Optima/NABI
- El Dorado
- New Flyer
- MCI -Motor Coach Ind.
- Gillig
- DesignLine
- Elgin
- Johnston
- Schwarze
- Tymco

### HD OEM/Repower Engines
- Freightliner Truck
- Volvo
- International/Navistar
- Kenworth
- Peterbilt
- Mack
- ALF Condor
- Crane Carrier
- Autocar Truck
- Capacity
- Freightliner Custom Chassis*
- Isuzu Truck North America*

### HD OEM/Repower Engines
- Cummins Westport
- Westport Innovations

### SVMs (LDV/MDV/HDV)
- Altech-Eco
- Landi Renzo USA / Baytech
- IMPCO Technologies
- Westport/BAF Technologies
- NGV Motori USA
- NatGasCar
- Auto Gas America
- Go Natural CNG
- Greenkraft
- PowerFuel Conversions
- EcoDual
- American Power Group
- Peake Energy Solutions
- Clean Air Power

Retrofits of GM, Ford, Dodge, VW, Mitsubishi, Mazda, Workhorse, Isuzu, JAC, Utilimaster, FCCC; Cummins, Daimler/MB, Cat.
LDVs Available from OEMs

Honda Natural Gas Civic Sedan (dedicated)

General Motors Express/Savana Cargo Van (dedicated)

General Motors Silverado/Sierra pick-up (bi-fuel)

Ram 2500 dual-cab pick-up (bi-fuel)
Vehicles Available Through SVMs
Vehicles Available Through SVMs
Vehicles Available Through SVMs
# OEM HD Natural Gas Powertrains

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<th>Fuel Type</th>
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<th>Additional Notes</th>
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Aftertreatment Comparison

ISL9
(diesel)

- Heated DEF Tank
- DEF Dosing Control Unit
- SCR Catalyst
- Particulate Filter
- ECM

ISL G
(natural gas)

- Three Way Catalyst
- Cummins TWC
Transit and School Bus Platforms
Vocational/Specialty/Work Truck
Local-Regional Haul/Line Haul
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Dual Fuel Technologies: Re-emerging Opportunity

- Dual fuel technology is making a comeback, primarily being marketed to “Intermediate Use (IUL)” and “Out of Useful Life (OUL)” HD engine applications; one company has “new” COC. Could see this option in trucks offered by OEMs
  - Varying amounts of diesel is displaced by natural gas during duty cycle
- 3/11 - EPA established a lower cost “approval” process that reduced cost and data burden thus making this dual fuel retrofit system option economically attractive to legacy fleets
- “Approval” process requires technical paper, supporting documentation, field data
- Took 6-8 months to see first “EPA listing.” Presently, 400+ engine families have been approved and more are added each month
  - E.g., EcoDual, APG, Clean Air Power, Peake Energy, NGV Motori
Dollars and Sense

NGV Economics:
Components of CNG Cost,
Calculating Simple Payback
and
Life-Cycle Cost Savings
Components of CNG Cost

- **Gas Bill:**
  - Unregulated portion associated with purchasing gas
  - Regulated local gas utility distribution company (LDC) services

- **Compression**
  - Electric motor KWH and KW ...OR engine driven unit’s natural gas use

- **Station Maintenance**
  - Normal PM, scheduled replacement of parts, compressor rebuilds

- **Capital /equipment amortization**
  - Amortized cost of equipment or cost of capital factored into GGE price

- **Federal, state and local excise fuel taxes (if applicable)**
  - Tax is paid by the fuel seller; tax status of buyer determines

- **Margin**
Historical crude and U.S. diesel prices

Relationship between crude and diesel prices

Ratio of raw commodity contributions to pump prices
Components of CNG Cost

- Gas company bill (unregulated portion)
  - Commodity:

  Gas is drawn from wells, gathered/ pooled, stripped of impurities and “heavy” gases, then transported to “hubs” where it is available on the commodities market. Henry Hub (Louisiana) is used for NYMEX pricing.

US DOE and industry long term price forecasts (prior to the economic collapse) pegged NYMEX natural gas at $6.50-8.00/MCF. Impact of shale gas is being reevaluated for next forecast.

Future market projections for gas are still up in the air now that shale gas has changed the equation.
Components of CNG Cost

Gas company bill (unregulated portion):

**Gas Commodity:**

- One cubic foot = ~1000 BTUs (Note: cf = volume, BTU = energy)
- One Mcf = 1000 cubic feet
- One Mcf = 1000x1000 = ~1,000,000 Btus (MMBtu or decatherm)
- US Gov’t says 124,800Btu/GGE and 138,700Btu/DGE…therefore….

**One MMBtu = roughly 8.0 GGE of (uncompressed) natural gas**

**One MMBtu = roughly 7.2 DGE of (uncompressed) natural gas.**

- When NYMEX MMBtu was $6.00, commodity portion of CNG was $.75/GGE
- When NYMEX MMBtu was $2.00; commodity portion of CNG was $.25/GGE
- NYMEX MMBtu is ~$3.43; commodity portion of CNG is $.43/GGE ($.48/DGE)
- Your local gas company buys gas at various prices and uses weighted formula to pass along commodity at cost….commodity cost is PART OF the purchased gas adjustment (PGA).
Components of CNG Cost

• Gas company bill (unregulated portion):
  – In addition to commodity costs, Purchased Gas Cost Adjustment (PGC/PGA) includes costs associated with getting gas to LDC’s gate.
    • Gas acquisition
    • Pipeline capacity and transmission; “balancing” charges
    • Storage to supplement pipeline flows during heaviest demand periods
  – These costs vary across the country but may range from $.75-$2/MMBtu
    • Storage is often about half that fee

– Commercial and industrial customers with steady gas loads often elect to buy their own gas through a broker/marketer and “transport” via the LDC, thus eliminating/reducing fees associated with storage.
  • Commercial/industrial customers with process loads (e.g., bakeries, bottlers, dairies, laundries, manufacturing plants)
  • Fleets (regardless of their facility load)
Components of CNG Cost

• Gas company bill (regulated portion):
  - Local utility distribution system charges a regulated tariff for delivery of gas from their city gate to your meter. This is a per-unit cost, not tied to the PGA. Rate typically includes:
    • Recovery of distribution system investment/depreciation
    • System operations and maintenance
    • Meter set / customer services
    • Administrative G&A
    • Other mandated fees / assessments
  - These tariffs are often stepped (i.e. larger volumes often earn lower rates)
  - Customers that do not meet minimum load requirements to qualify for ‘transportation” rates buy “bundled” gas service from their LDC. Those with sufficient load can opt to buy their own gas and pay LDC to transport.
    • Minimum amount required to qualify for transportation rate varies widely from one utility area to the next... as little as 10,000 DGE/year to as much as 150,000 DGE/year
Components of CNG Cost

Sample case: commercial baking company with 20 tractors, each traveling ~375-400 miles/day, utilizing ~75DGE

- Gas Bill: $.95/DGE
  - Gas costs: ~$.66/DGE (based on estimated wellhead price of $4.00/MMBtu + $.75/MMBtu associated fees for transportation and services up to LDC city gate)
  - LDC’s regulated city-gate-to-meter services: $.29/DGE (~$.0.21/therm) (transportation rate)
Components of CNG Cost

• Gas Bill: $.95/DGE

• Electric compression costs
  – Gas delivered to the customer has to be compressed.
  – Most stations use electric motors although many larger stations use natural gas engine-drive compressors (depends on local regs).
  – Be sure to factor in both KWH consumption and KW demand
  – Estimated @ 1.1 fully-loaded KWh/DGE – a bit less for larger stations and more for small stations
  – Varies significantly from one utility area to the next
  – Nat’l range:$.04 -.30/KWH – : ~$.13/DGE
Components of CNG Cost

- Gas Bill: $.95/DGE
- Electric compression costs: $.13/DGE
- CNG stations require regular preventative maintenance/service and occasional rebuilds of compressors and replacement of other parts.
- Cost per DGE will vary based on total throughput (generally, larger throughput = less cost/DGE due to economies of scale)
- Maintenance/Repair/Service: $.25-.55/DGE: $.35/DGE*
Components of CNG Cost

- **Gas Bill:** $.95/DGE
- **Electric compression costs:** $.13/DGE
- **Maintenance/Repair/Service:** Assume average of $.35/DGE
- **Capital amortization of equipment:** $.30-.65/DGE
  - Station cost divided by total DGE over life of equipment
  - Depreciation term will affect this cost (5 yrs, 7 yrs, 10 yrs, 10+?)
  - Cost of capital
  - Utilization factor (what % of capacity is actually utilized)

**Ex 1:** 20 veh. x 75 DGE/day x 6 days/wk = 9000 DGE/wk =~465,000 DGE/yr
- 465,000 DGE/year x 7 yrs = 3,255,000 DGE
- If fast-fill station cost is $1.5M, then **$.46/DGE**

**Ex 2:** 25 veh. x 75 DGE/day x 6 days/wk = 11,250 DGE/wk = ~585,000 DGE/yr x 7 years = 4,095,000 DGE
- Same station, then **$.37/DGE**
Components of CNG Cost

- Gas Bill: $.95/DGE
- Electric compression costs: $.13/DGD
- Maintenance/Repair/Service: $.35/DGE
- Capital amortization of equipment: $.45/DGE

**SUB-TOTAL:**
- $1.88/DGE (use by or sales to tax exempt entities)
- $2.23/DGE (use by or sales to taxable entities)
  - Federal motor fuels excise tax: $0.183/GGE = ~$.205/DGE
  - Tennessee Motor Fuels Excise Tax on CNG: $.13/GGE = ~$.146/DGE
Components of CNG Cost

- What if NYMEX MMBtu cost rose to $8.00/MMBtu?
  - Gas Bill: $1.51/DGE
    - Gas acquisition cost: $1.215/DGE ($8.00+.75 = $8.75/7.2)
    - LDC transportation tariff remains: $.29/DGE
  - Electric compression costs: $.13/DGE
  - Maintenance/Repair/Service: $.35/DGE
  - Capital amortization of equipment: $.45/DGE

- Tax exempt fuel sales: $2.44/DGE
- Taxable fuel sales: $2.79/DGE

- At $8.00/MMBtu, oil is very likely to be well over $200+/barrel… easily equates to $5+ for diesel!
Step Van

- **Sample Applications** (e.g., textile rental service, comm. bakery)
- **MPG**: 6.0, 95mpd x 6 dys/wk, 30K/yr
- **Fuel Use**: 16DGE/day; 5000GGE/yr
- **CNG Premium**: $25,000
- **Without grant, simple payback** = 3.3 years; **LCC savings** = $50,250
  (based on 10 yr life and 1.50 savings/DGE)
- **Grant**: $15,000
- **Remaining premium**: $10,000
- **Simple Payback**: 1.3 yrs; **LCC savings**: $65K !!!
Refuse Truck
(LCF model)

- Crane Carrier LET, Autocar Xpeditor, Peterbilt LCF 320, Condor, Mack TerraPro
- MPG: 2.5 – 3.0 (lots of idle and PTO time)
- Fuel Use: 35-40gge/day; 10,500DGE/yr
- CNG/LNG Premium: $30,000
- If no grant, payback is 1.9 years and Life-Cycle Cost savings = $96+K
  (based on $1.50 savings/DGE and 8 year life)
- Grant $15,000
- Remaining Premium: $15K
- Simple Payback: 0.95 years; LCC savings: $110K
Grocery Truck

- Volvo VNM/VNL, Freightliner M2/Cascadia
- MPG: 5.6 miles/DGE; 100K miles /year
- 17,850 DGE/yr
- CNG Premium (w 84 DGE capacity): $60,000
- If no grant, payback is 2.25 yrs
- Life-cycle cost savings: $127K
  (based on $1.50/DGE savings, 7-year /700K life before resale)
- Grant $25K; Remaining Premium: $35K
- Simple Payback: $26,775 yr savings = 1.3 yrs
  (based on 1.50 savings /DGE )
- Life-cycle cost savings: $152+K
Fill’er Up

Natural Gas Fuel Station Types

Development, Ownership and Operations Options

Sizing/Design Considerations
CNG Fuel Station Types

- **Time-fill capability**
  CNG is dispensed slowly directly to vehicles’ onboard storage tanks. Lower cost station investment. Best for fleets that return to central lot and sit idle overnight or for extended periods and do not need fast fill capability. Home fueling devices are time-fill applications.

- **Fast-fill capability**
  Similar to liquid fueling station, same fill rates and times. A MUST for public access. Also good for larger fleets where fueling turn-around time is short.

- **Combo-fill capability**
  Comprises both time-fill and fast-fill. Often good for fleets that can fuel on time-fill but need occasional “top off” or want/need ability to provide public access.
Natural Gas Fuel Station Options

• **Offsite – use existing public access station**
  – Station may be operated by independent retailer, utility or another fleet
  – Development usually driven by anchor fleet and/or the ability to “pool” fleets to achieve fuel use needed to warrant investment

• **Onsite - private access** (e.g., only for the fleet operator)
  – Many existing large fleets (e.g., transit, refuse) or fleets with restricted access sites (e.g., federal property such as military bases) still operate private-access-only stations. Time-fill-only stations are always private access.

• **Onsite - public access** (often “outside the fence” pump)
  – Growing trend: public access pump installed at fleet location - located adjacent to or “outside the fence” of fleet’s secure fueling area. Takes advantage of economies of scale, promotes greater public network
Q: How Do We Solve The “Chicken & Egg” Conundrum? (A: Make a chicken-egg omelet*)

- Throughput (sales volume) is key to generating economies of scale for the public access station owner, thus allowing pump price differentials that drive reasonable payback and life-cycle savings for customers.

- Minimum load thresholds vary based on a variety of factors including: station type, station size, fuel price differential, ability to amortize maintenance costs, equipment depreciation, grants …..ROI expectations.

- Achieve minimum load thresholds by:
  - Identifying an anchor fleet that justifies the investment…or
  - Aggregate several semi-anchor fleets’ loads if their depots or operating areas are geographically acceptable…or
  - Create retail public access for small fleets and consumers….or
  - All of the above
Fleet owns & operates station

- Fleet takes responsibility for building and then operating its own station. Fleet works with vendors or design consultant, manages build-out and takes responsibility for PM (parts, etc).

- Applies to small-to-mid sized fleets that do not have offsite options nearby, b/c their fuel use does not meet the threshold required by most LDCs or independent developers to invest in developing, owning and operating station for them.

- Some large fleets also opt for this but many do not have experience nor want responsibility for station operations and maintenance
Natural Gas Station Development and Ownership-Operations Options: #2

- Outsource station development, ownership, O&M to independent fuel provider
  - Fleet serves as anchor for independent operator’s station, contracts long term fuel agreement with set price(s) and expected throughput for duration.
  - One stop shop. All capital investment and O&M risks are borne by independent fuel provider while fleet focuses on core competencies.
  - Fleet usually provides low-cost lease for property – important to making deal work - land is costly!
  - Often allows fuel provider option to create public access as well – sometimes a “royalty” paid back to fleet for retail sales from premises
Natural Gas Station Development and Ownership-Operations Options: #3

• Fleet owns/leases station but contracts out operations for a fee (e.g., monthly fee or GGE basis)
  – Option used by many large fleets that need/desire ownership of their own station equipment but want to reduce risk, assure best O&M practices, etc
  – Contract is often (but not always) awarded to the firm that builds station; usually a 5-7yr contract.
  – Some fleets that initially Own & Operate their own stations decide that they want to delegate to others – put out RFP for O&M contract
  – Decision weighs pros/cons of “leaving $ on table” versus potential downtime risks, maintaining parts inventories, updated training of techs, etc
CNG Station Design Considerations

- **How Much Fuel in How Much Time?**
  - Vehicles/day, fuel/vehicle, fueling patterns
  - Maximum *daily* flow, maximum *hourly* flow, targeted fueling time per hose
  - Back-up fueling availability? Redundancy

- **Real estate concerns**
  - Proximity to major travel routes
  - Vehicle needs (entry/egress patterns)
  - Equipment footprint
  - Site development issues

- **Equipment needs/performance/cost**
  - Balance of compression and storage
  - Gas service (volumes/pressures, moisture)
  - Electric service (kVA, etc)
  - Dispensers and fuel management needs
Gaseous Fuel Vehicle/Infrastructure Incentives

• Federal grants are usually dispersed through state and/or local channels
• Federal grants of particular interest to AFV programs:
  • DOT Congestion Mitigation & Air Quality (CMAQ) grants
  • EPA Supplemental Environment Project and DERA grants (National “Clean Diesel”, Clean School Bus USA, SmartWay programs).
  • DOE Clean Cities grants
• State/local grant programs (stay in touch with your Clean Cities office)
5 Tips that Make Some Grant Applications More Successful Than others

• Speak to the area of interest/evaluation criteria of the funding agency

• Clearly spell out the proposed benefits, the criteria by which you plan to measure those benefits, the action plan and the proposed processes in place to manage resources/take corrective action mid-stream to achieve the goal(s).

• Leverage funding of multiple stakeholders.

• Communicate succinctly and effectively

• Meet the administrative requirements
Implementation: How do we transition?

• Communicate benefits to your staff to get their “buy in” and to create feedback mechanisms that keep your program on track. Tell your customers; show environmental stewardship.

• Identify your internal champion, assemble stakeholders and resources; learn from others’ successes, don’t repeat mistakes… Use the resources of your Clean Cities Coalition

• Maximize use of OPM while it is available. Investigate other creative financing/leasing and station operation options. Learn how to purchase gas to lower fuel costs.

• Connect with your Clean Cities Coalition and fed/state agencies. Prepare fleet inventory replacement schedule and fuel use projections. Contact LDC, vehicle, fuel station development and/or equipment providers. Get started!
For more information please contact:

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Facility Modifications to Accommodate Work on CNG/LNG Vehicles

Ventilation Rate = 1 cu ft/sq ft

Yes

No

Bring ventilation rates up to code

Garage Type

Major Repair Garage

Minor Repairs Only

No modifications required by the codes

Type of ventilation

Natural

Mechanical

LNG or both fuels

CNG only

Fuel Type to add to garage

Approval by AHJ required

Ventilation rate should be 5 ACH

Inspect and prepare NGV prior to performing maintenance

Ventilation rate should be 5 ACH

Install gas detection system as required by codes

Install Fuel Appropriate Defueling System

No gas detection system required

Install Fuel Appropriate Defueling System

Sources of ignition

Ventilation rate within 18” of ceiling

Open flames and +750°F Surfaces

Remove the sources of ignition in areas subject to ignitable mixtures

Electrical Classification

4 ACH or more

Less than 4 ACH

Space is a Class 1 Division 2 Classified location

Space is not considered a classified location

LNG or CNG

Natural

Approval by AHJ required

Type of ventilation

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Minor Repairs Only

No modifications required by the codes

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