The Compelling Case For NGVs in Public and Private Fleets






Stephe Yborra

Director of Market Analysis, Education & Communications

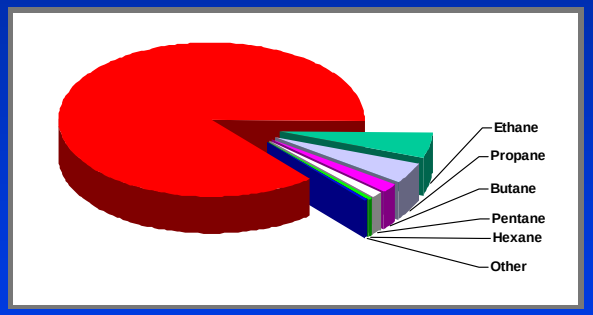
Clean Vehicle Education Foundation/NGVAmerica

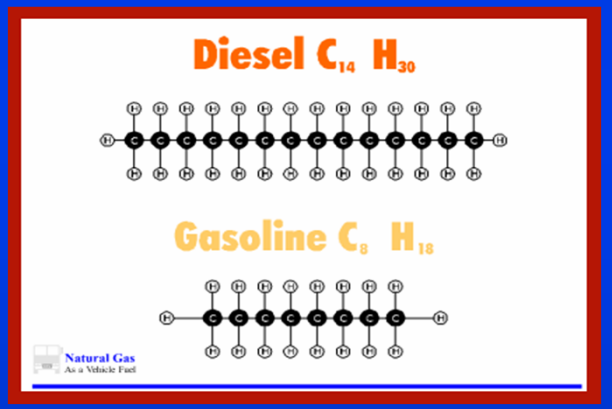
What is the Compelling Case for NGVs?

- Natural gas is America's fuel: America's resource, America's jobs. Reduced reliance on volatile foreign oil supplies – Energy Security.
- Natural gas engines emit far less GHGs than petroleum-fueled vehicles
- Significantly lower fuel / O&M costs provide fast payback of initial purchase premium, then generate substantial life-cycle savings.
- Unlike early generation NGVs, today's natural gas engines' performance match or exceed that of gasoline and/or diesel engines
- Growing variety of light-, medium- and heavy-duty vehicles from leading OEMs, Small Volume OEMs (SVMs), chassis mfrs. and body builders
- A vigorous NGV fueling industry is emerging, expanding options

Facts About Natural Gas

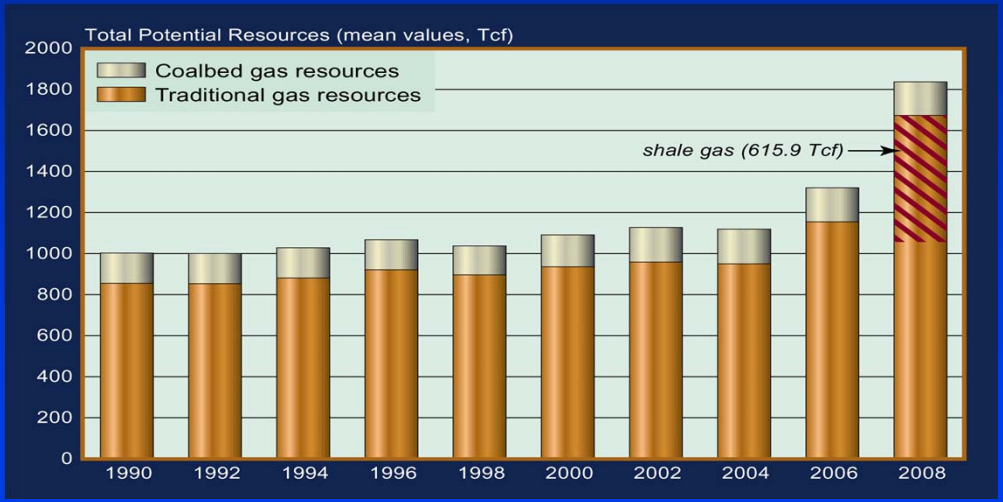
- Natural gas is an inherently clean fuel
  - Natural gas is mostly methane (CH4): low carbon fuel
  - (Diesel – C14H30; Gasoline – C8H18)
  - Less NOx (87% reduction)
  - Less PM (95+% reduction)
  - Less GHGs (HDV: 20-23% less; LDV: 26-29% less)
- Natural gas is very safe
  - Lighter than air… dissipates when released
  - High ignition temperature: 1000-1100F
  - Limited range of air/fuel combustion ratio (5-15%)
  - Colorless, odorless, non-toxic substance
  - Doesn't leak into groundwater
  - Comprehensive fuel tank, vehicle and station design/mfg codes & standards





Methane Molecule

Natural Gas is an Abundant Domestic Fuel



PGC Resource Assessments, 1990-2008

Shale Basins and the U.S. Pipeline Grid

Source: American Clean Skies Foundation.

98+% from North America
(~87% US, ~12% Canada, ~1-2% imported LNG)

Well-developed distribution infra-structure; (290K miles of interstate pipeline provides gas to 1.2 million miles of LDC distribution lines)

American fuel = American jobs

Consistent buffer of supply in proved reserves, technology improvements keep expanding recoverable base.

Improved technologies have made shale gas economically viable and significantly bumped our supply base. Supply now estimated @ 115+yrs!

Types of Vehicular Natural Gas

- Liquefied Natural Gas (LNG)
  - Cryogenically cooled to liquid @ ~(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
  - Most vehicular LNG used today is produced at limited number of plants and trucked to fleets' onsite storage vessels.
  - Transport distance/costs are major determinant of economic feasibility
  - Growing interest in small- and medium-scale liquefaction plants located nearer to point of end-use; likely higher production cost/gallon but lower transportation cost.
  - Gas supply from pipeline, landfills, sewage/agri-waste digesters

Types of Vehicular Natural Gas

- Compressed Natural Gas (CNG)
  - Gas delivered to site by local gas utility and compressed and stored onsite and/or distributed directly to vehicles….or
  - L/CNG - LNG made on-site or delivered to site, then compressed to higher pressure and passed thru evaporator/heater to turn to vapor stage, then dispensed into onboard storage
  - Onboard 3600psi vehicle cylinders; All 4 types of onboard cylinders meet same standards
    - Type I (all metal)
    - Type II (metal liner, partial wrap)
    - Type III (metal liner, full wrap)
    - Type IV (plastic liner, full wrap)

Facts About NGVs

- NGVs are proven and reliable
  - More than 11 million NGVs in use worldwide; ~110K operating on US roads
  - Fleets are best **(high fuel use, central fueling, local routes/op. areas)**
    - 11,000+ transit buses (1 in 5 on order),
    - Nearly 4000 refuse trucks – new fleets transitioning, existing fleets expanding
    - 3800 + school buses
    - 17-20,000 MDVs in shuttle and wide variety of work truck applications,
    - 25-30,000+ LDVs in federal, state local government fleets; private fleets
- NGVs are quiet
  - HD NGVs are 80-90% lower db level than comparable diesel-powered units
  - 10 NG-powered buses make less noise at idle than 1 diesel-powered bus
- NGV life-cycle costs are lower
  - Fuel costs are far lower! Maintenance costs are =/< than gas or diesel
  - **Life-cycle cost advantage improves with new federal tax credits**

Key Attributes and Best Prospects

- High fuel use vehicles with return-to-base (RTB) operations or repetitive route or pre-set geographic operating areas

  Examples:
  Freight truck – 16-20K GGE (57-74K liters)
  Transit buses – 12.5-15K GGE (46-55K liters)
  Refuse trucks – 7.5-10K GGE (28-37K liters)
  Municipal sweeper – 5-6K GGE (19-22K liters)
  Airport shuttle service – 5.5-7.5K GGE (20-28K liters)
  Restaurant Supply, Textile Services , Beverage Delivery, Furniture/Appliance Delivery – 3-5K GGE (12-18K liters)
  Taxi - 4.5-5.5K GGE (17-20K liters)
  Courier sedan, newspaper van, utility/ telecom van, public works pick-up truck – 1.2-1.5K GGE (4.4-5.6K liters)

- Consumer market tends to follow infrastructure*

NGVs Are a “Good Fit” for Many Fleet Applications

- Local/State Government
  - All Depts.
- Airports
  - Terminal Buses, Hotel/Parking Shuttles, Taxis, Door-to-Door
- Refuse
  - Collection/Transfer
- Transit
  - Buses, Maintenance, Supervisors
- School Districts
  - Buses, District personnel, Maint.
- “Short-Haul” Delivery
  - Food & Bev., Port-Rail, Linen Svc,
- Utilities
  - Gas/Electric/Water, Communications

Growing Selection of NGVs from OEMs, SVMs

OEMs

- American Honda
- General Motors
- VPG/MV-1
- Thomas Built Bus
- Blue Bird Bus
- Optima/NABI
- El Dorado
- New Flyer
- Daimler/Orion
- Gillig
- Foton America
- Elgin
- Allianz/Johnston
- Schwarze
- Tymco

OEMs

- Daimler/Freightliner
- Kenworth
- International Truck
- Peterbilt
- Mack
- American LaFrance Condor
- Crane Carrier
- Autocar Truck
- Capacity

OEM/Repower Engines

- Cummins Westport
- Emission Solutions Inc
- Westport Innovations
- Doosan America

SVMs

- Altech-Eco
- BAF Technologies
- Landi Renzo/Baytech Corp
- IMPCO Technologies (incl. Natural Drive, EvoTek)
- NGV Conversions/Motori
- NatGasCar
- GoNatural CNG
- CNG Store/Auto Gas Store
  - Ford
  - GM
  - Dodge
  - Workhorse Chassis
  - Isuzu
  - Freightliner Custom Chassis

1.8L Dedicated Honda Civic GX (OEM @ factory).

3.5L and 3.9L BiFuel and Dedicated Impala, Malibu, Lucerne and G6

2.0L BiFuel and Dedicated Ford Focus

4.6L Dedicated Ford Crown Vic, Lincoln Town Car and Mercury Grand Marquis

2.3L and 2.5L BiFuel and Dedicated Ford Fusion and Mercury Milan

See “Available Natural Gas Vehicles and Engines” for specific model year and EPA/CARB certification status

5.3L and 6.0L BiFuel and Dedicated GMC Sierra + Chevy Silverado 15/25/35

5.4L BiFuel and Dedicated Ford F150, F250, F350 6.2L Super Duty F250, F350 soon

5.4L Dedicated Ford Expedition and Lincoln Navigator.

4.8L and 5.3L BiFuel and Dedicated Chevy Tahoe

5.3L Dedicated Chevy Colorado and GMC Canyon

5.3L Chevy BiFuel and Dedicated Suburban, GMC Yukon/Yukon XL

6.0L BiFuel and Dedicated Chevy or GMC 2500HD, 3500 Series Cab & Chassis

5.3L BiFuel and Dedicated Chevy Avalanche

2.0L BiFuel and Dedicated Ford Transit Connect

4.8L, 5.3L and 6.0L BiFuel and Dedicated Chevy Express and GMC Savana vans

5.4L Dedicated Ford E250, E350 cargo and passenger van

4.6L Dedicated VPG Auto MV-1 paratransit

6.0L Chevy or GMC G3500 Series Cab & Chassis and Van Cutaway

6.8L Dedicated Ford E450 cutaway.

6.0L GMC and Chevy G4500 Cutaway

Isuzu NPR and NPR HD cab-over chassis w GM 6.0L engine

Workhorse W42 Chassis step-van chassis w GM 4.8L engine, and Workhorse W62 with GM 6.0L engine; FCCC MT45 chassis with GM 6.0L (soon)

GMC C 6500/7500/ 8500 Topkick Series with 8.1L GM engine (**retrofits of existing stock only)**

GMC C4500/5500 Series Cutaway w 8.1L GM engine **(retrofits of existing stock only)**

Ford F450 and F550 with 6.8L 3V engine

Ford F59 strip chassis with 6.8L 3V engine

See “Available Natural Gas Vehicles and Engines” for specific model year and EPA/CARB certification status

Cummins Westport Inc

- 8.9L ISL-G, Stoichiometric engine w cooled EGR and maintenance-free 3-way catalyst exhaust system
- 2010 certified; 250/260/280/300/320HP; 660-1000 ft-lb torque

Factory OEM/DOEM via:

Refuse collection trucks
(Crane Carrier LET, Autocar Xpeditor, ALF-Condor, Peterbilt LCF 320 and Mack TerraPro; many 2nd stage upfitters)

Work /Vocational Trucks
(Freightliner M2 tractor and straight truck; Kenworth T440, T470, W900; Peterbilt 384 and 365Autocar and Capacity hostlers;)

Buses, shuttles, trolleys
(NABI, New Flyer, Orion, Thomas, ElDorado, Blue Bird, Optima, Gillig, Foton, variety of shuttle 2nd stage up-fitters)

Sweepers
(Elgin, Tymco, Schwarze, Allianz-Johnston)







Emission Solutions Inc.

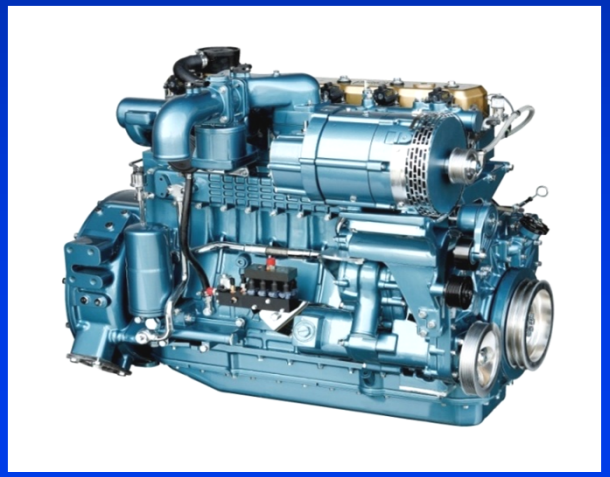
- 7.6L NG Phoenix, stoichiometric engine, no EGR, 3-way catalyst exhaust system)
  - Based on International's DT466 and MaxxForce DT block
  - EPA-/CARB- 2010 certified @ .2NOx / .01PM
  - Food/beverage delivery, refuse trucks, school buses, utility/public works trucks

- Repower DT466 (308 2V and 313/326 4V) with 225-300Hp /460-900 ft-lb torque (done through ESI partners including some International dealers)

- OEM/factory-installed on WorkStar 7300/7400 at Garland TX plant (DuraStar in July/Aug '11)
- Max rating: 300Hp/860 ft-lb torque

Doosan Infracore America

- GK12 11L lean-burn engine
- 2010-compliant using SCR (no EGR)
- Excellent low-end torque
  - 290 HP @ 2200 rpm
  - 905 ft-lb torque @ 1260 rpm
- Demo projects with transit
  - Valley Vista
  - RTA
  - LACMTA
  - WMATA
  - MARTA
- 2010 bid award for CNG repowers of LACMTA



LACMTA

Riverside

Westport Innovations, Inc.

- GX (formerly known as ISX-G)
  - Based on Cummins ISX platform
  - 15L engine, 400-475 HP
  - High-Pressure Direct Injection (HPDI) technology: Diesel pilot fuel (1-10%) ignites natural gas (LNG) @ 99-90%
  - CARB certification @ .2NOx (w SCR)/.01PM
- GX is now available in the Kenworth T800 and the Peterbilt 386 and 367
- Initial units deployed in Long Beach/LA Ports' fleets. Additional drayage, LTL and niche fleets deploying in select markets.

Kenworth T800

Filler' Up:
Addressing the "Chicken & Egg" Conundrum

Natural Gas Fuel Station Types
Development, Ownership and Operations Options
Sizing/Design Considerations

CNG Station Design/Cost Considerations

- Myth: CNG stations cost $1 million
  - Station costs can range from $15K – $6.5 million
  - Anchor fleets (airports, refuse, transit) or ‘pooled loads’ create economies that eliminate chicken & egg challenge. Outside-the-fence access adds load.

- Station Size and Design Considerations
  - What’s needed? Time-Fill, Fast-Fill, Combo Fill
  - Number of vehicles per day, vehicle fueling patterns, maximum daily flow, maximum hourly flow
  - Available back-up fueling or need for redundancy?
  - Dispensing/Metering/Data Capture/Payment needs?
  - Modular approach adds capacity as fleet grows

CNG, LNG and L/CNG Station Options

- Station Location Options:
  - Offsite – use existing public access station if available, convenient and of sufficient capacity. May be operated by LDC, another fleet or independent retailer. Initial development usually driven by ‘anchor’ fleet that justifies investment.
  - Onsite - private access only
  - Onsite - with public access “outside the fence”

- Different ownership & operations options available depending on throughput, funding:
  - Fleet owned & operated station
  - Outsource station O&O entirely via independent fuel provider and contract gas price
  - Fleet owned/leased station but contracted out operations for a fee (usually on a GGE basis)

Federal Tax Credits for Vehicles, Stations and Fuel

- Vehicle income tax credit *(for buyer)* covers 50-80% of incremental cost or conversion cost. Applies dedicated vehicles only.

Gross Vehicle Weight Rating	Incremental Cost Cap (ICC)	50% Credit At ICC	80% Credit at ICC
Less than 8500 lbs.	$5000	$2500	$4000
8501 to 14,000 lbs.	$10,000	$5000	$8000
14,001 to 26,000 lbs.	$25,000	$12,500	$20,000
More than 26,000	$40,000	$20,000	$32,000

SUSPENDED

- Station income tax credit (*for buyer*) equal to 30% of the cost of CNG and LNG refueling equipment, up to $30,000. One-time credit per location.

- Motor fuels excise tax credit (*for fuel seller)* equal to $.50/GGE or LNG gallon. IRS guidance: owner of fuel as it is dispensed into vehicle gets credit, regardless of who owns equipment or compresses fuel.

Components of CNG Cost

Relating Your Gas Bill to Gasoline Gallon Equivalents (GGE) and Diesel Gallon Equivalents (DGE)

- 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 138,700 Btu/DGE…therefore….
- **One Mcf = roughly 8 GGE or 7.2 DGE of (uncompressed) natural gas**.

- When NYMEX Mcf was $8.00, commodity component of CNG was $1.00/GGE
- When NYMEX Mcf was 3.20, commodity component of CNG was $.40/GGE
- Currently NYMEX Mcf is ~$4.64; commodity component of CNG is $.58/GGE
- Your local gas company buys gas at various prices and uses weighted formula to pass along commodity at cost….purchased gas cost adjustment (this helps eliminate extreme swings in market price)

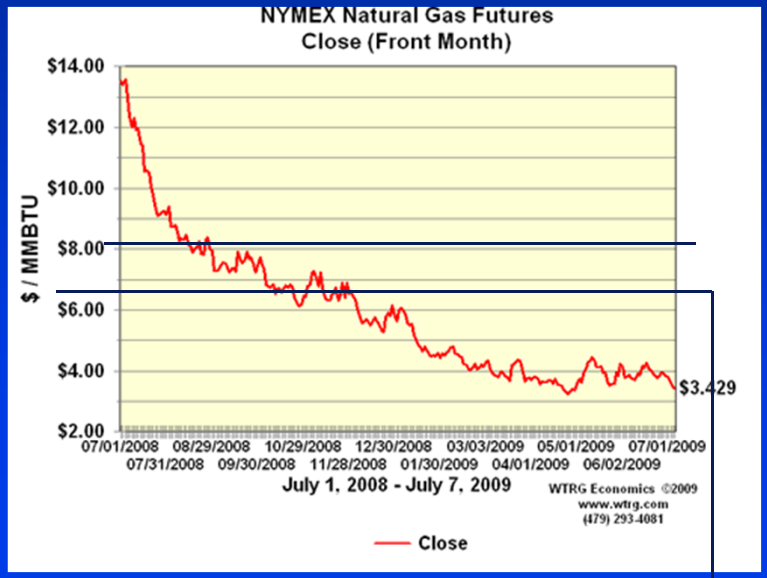
Components of CNG Cost

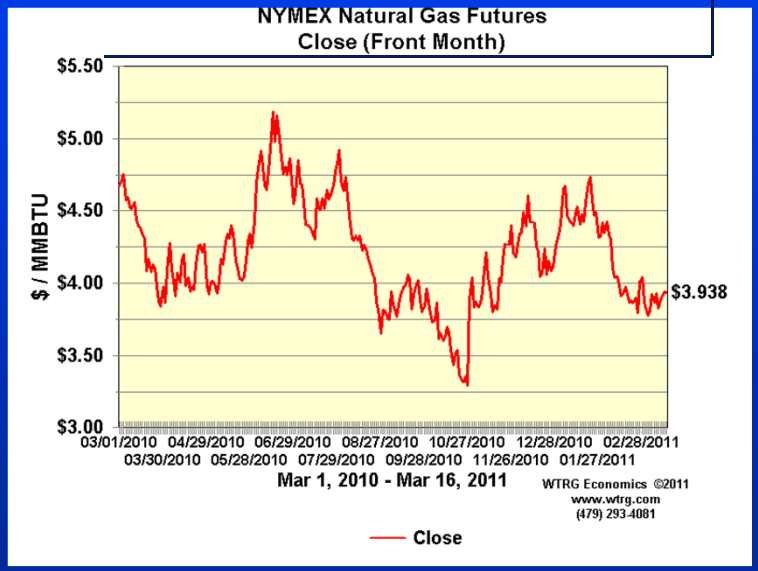
- Gas Bill:
  - Gas Commodity:

    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 Bill: (roughly $.77-.85/GGE but could be lower /higher in different markets)
  - Gas Commodity (.70/GGE @ “weighted average” cost of $5.60/MCF)
  - Pipeline transportation/services to utility “city gate” and then delivered under regulated tariff by your local utility to your meter as uncompressed gas ($.07 - .15)
- Compression - Rule of thumb: One fully-loaded kWh/GGE ($.15-20/GGE)
- Station Maintenance - Normal PM, repair/replace parts, rebuild ($.25-.60/GGE)
- Equipment amortization ($.35 - .65)
  - Cost of equipment or cost of capital factored into each GGE over life of station equipment , typically amortized over 10 years
- Station operator profit (if you’re buying from a retail provider)
- Add federal motor fuels excise tax / Apply credit
  - Tax = $.183; credit = $.50…..net credit = ($.317)/GGE for taxable entities

Passenger van for Limo

- Ford E-350 passenger van, Chevy/GMC 3500 passenger van
- MPG: 13/15 City/Hwy, 75-90K miles/year
- Fuel Use: 16-19 GGE/day; 4700-5800gge/yr
- CNG Premium: $15,500
- Grant: $ 8000
- Remaining premium: $7500
- Simple Payback: 1.0-1.25yrs
- Life-cycle cost advantage: $16.2K – 22K
  (based on 4yr life and $ 1.25/GGE savings at “retail” station)
- Without grant, simple payback 2.0 – 2.5 years

Medical Lab Courier Service

- Honda Civic GX
- MPG: 19/30 City/Hwy, 30K miles/year
- Fuel Use: 4-6 GGE/day; 1000-1575GGE/yr
- CNG Premium: $6500 (before tax credits)
- Grant: $4000
- Remaining premium: $2500
- Simple Payback: 1.3 - 2.0 yrs
  (based on $1.25/GGE savings at retail station)
- Life-cycle cost advantage: $3750 – $7250
  (based on 5yr life)
- Without grant, simple payback = 3.3 – 5.1 years

Step Van

- Sample Applications (Bakery/Snack Food, Linen)
- Workhorse W42
- MPG: 5.0 – 6.5, 75-90mpd x6 dys/wk, 26-28K/yr
- Fuel Use: 13-16DGE/day; 4200-5000GGE/yr
- CNG Premium: $29,000
- Grant: $20,000
- Remaining premium: $9000
- Simple Payback: 1.2 - 1.4 yrs
- Life-cycle cost savings: $54-66K !!!
  (based on 10 yr life and 1.50 savings/DGE at O&O station)
- Without grant, simple payback = 3.8 - 4.6 years

School Bus

- Blue Bird All American RE or Thomas Built Saf-T-Liner HDX
- MPG: 6.0.- 7.0 / DGE (avg 18,000 miles per year)
- Fuel Use: 2650DGE/yr
- CNG Premium: $37,000
- Grant: $25,000
- Remaining premium: $12,000
- Simple Payback: 3.0 yrs
- Life-cycle savings: $39,750
  (based on 13 yr life @ 1.50/DGE savings)
- Without grant, simple payback = 9 years

Refuse Truck

- Crane Carrier LET, Autocar Xpeditor, Peterbilt LCF 320 , Condor , Mack TerraPro), Freightliner M2, Kenworth T8SH/T440
- MPG: 2.5 – 3.0 (lots of idle and PTO time)
- Fuel Use: 35-40gge/day; 8500-10,000dge/yr
- CNG/LNG Premium: $40,000
- Grant $20,000
- Simple Payback: 1.3 - 1.6 years
  (based on 1.50 savings /DGE)
- Life-cycle cost savings: $81,600 - $100,000
- (based on 8-year life)
- If no grant, payback is 2.6 – 3.2 years.

Summary

- Environmental, energy security and economic market drivers are very favorable to fleets' use of NGVs. Developing fleet market will spur eventual consumer market….walk before running.
- Many light-, medium- and heavy-duty NGVs are available from a growing number of OEMs and SVMs
- Variety of fueling options available – vendors have stepped in to partner with LDCs to develop market
- Federal tax credits and grants further improve NGVs' already favorable life-cycle advantages

For more information please contact:

Stephe Yborra - Director of Marketing & Communications
syborra@ngvamerica.org / syborra@cleanvehicle.org
(301) 829-2520

NGVAmerica
400 N. Capitol Street, NW - Suite 450 - Washington, DC 20001
www.ngvamerica.org

Clean Vehicle Education Foundation
6011 Fords Lake Court - Acworth, GA 30101
www.cleanvehicle.org