

The Compelling Case For NGVs in Public and Private Fleets



Stephe Yborra

Director of Market Analysis, Education & Communications
Clean Vehicle Education Foundation

Director of Market Development
NGV America



What is the Compelling Case?

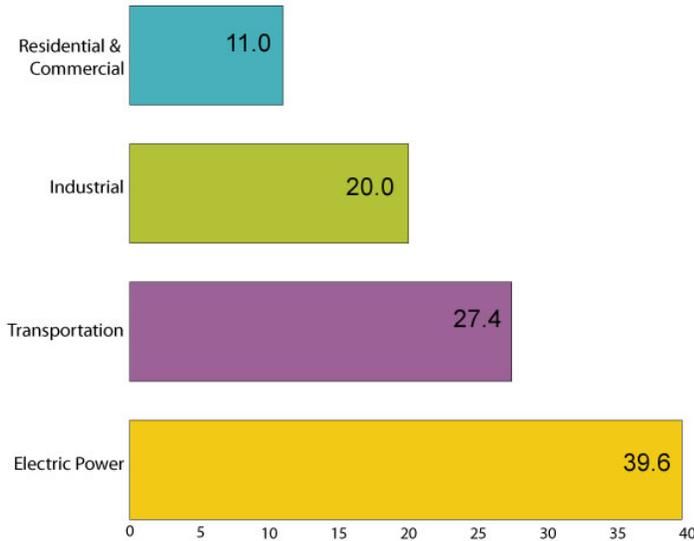
- Environmental, energy security and – now, more than ever due to domestic natural gas abundance - **economic** market drivers are behind the trend toward greater use of NGVs. While fleet fuel use has been the primary focus, potential consumer market is now spurring additional investment in infrastructure.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



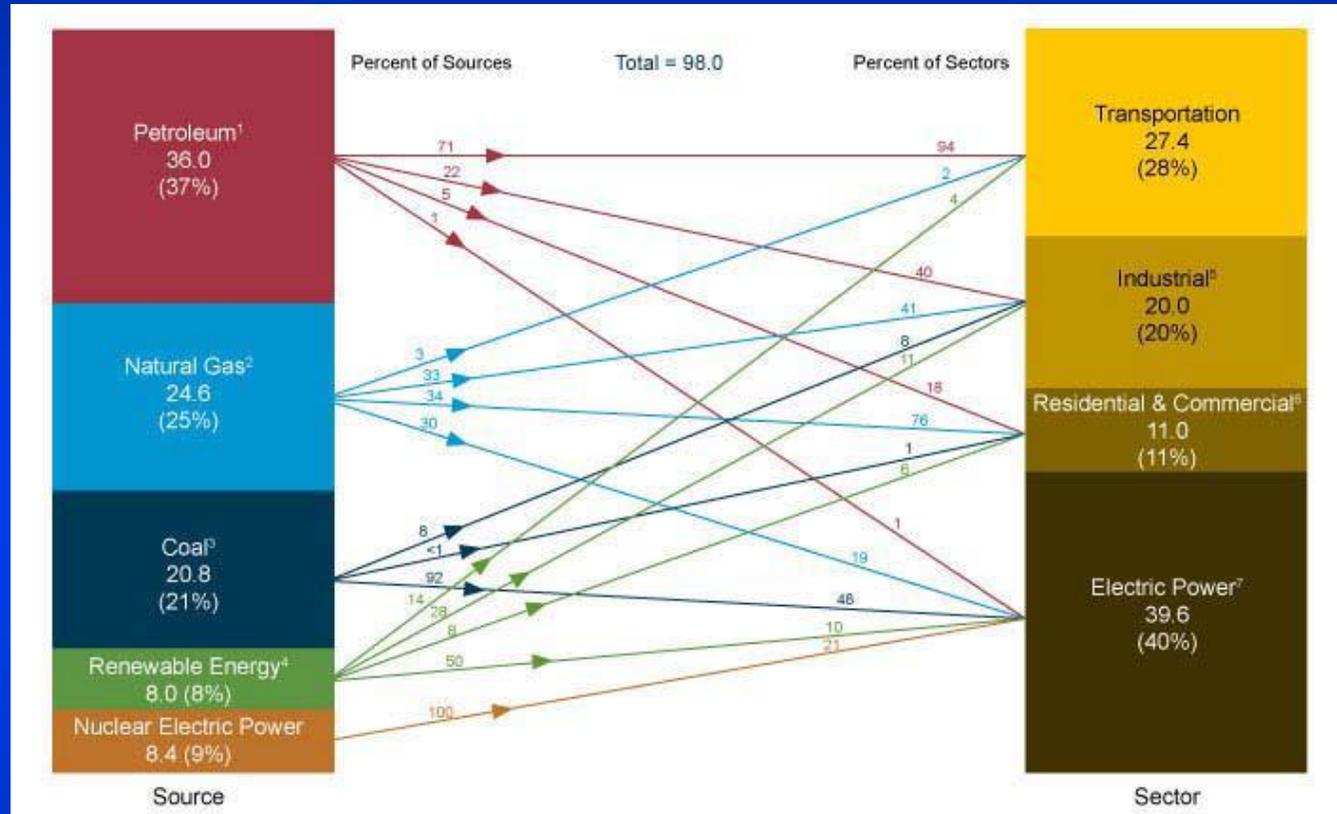
Snapshot of Energy Supply and End Use

Primary Energy Use by Sector, 2010

Quadrillion Btu



Source: U.S. Energy Information Administration, *Annual Energy Review 2010*, Table 2.1 (October 2011).



- Transportation comprises on-road, off-road, rail, marine and aviation
- ~65-70% of imported oil is for transportation
- LDVs :~58-60% of on-road use; HDVs: ~23-25% of on-road



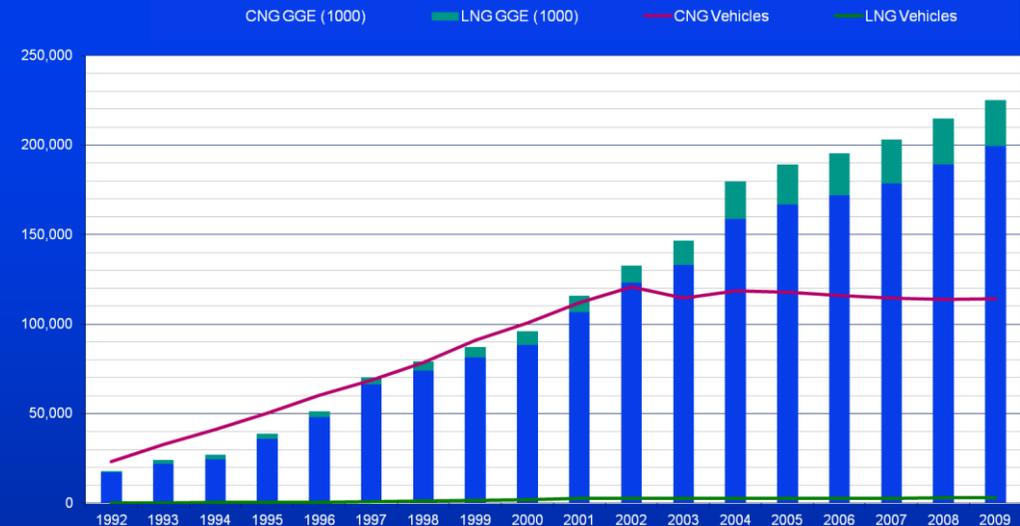
Snapshot of US NGV Market Today

- Existing NGV inventory is estimated at ~120-30K
 - 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
- ~27-29,000 HDVs
 - 11,000 transit buses + shuttles
 - 4,200 school bus
 - 6,200+ refuse
 - 2,800 ports/regional haul
 - 3,500-4,200 municipal/F&B/Misc
- ~18-22,000 MDVs
 - 7,500-8000 gov't
 - 1,500 package delivery
 - 1,700 airport shuttle
 - 1,000 transit/CTAA
 - 5,500-7,500 utilities, F&B, commercial services, household goods, construction, misc
- ~74-76,000 LDVs (fleet and consumer use vehicles)
 - Cars/SUVs, trucks/vans



Snapshot of US NGV Market Today

- Vehicular natural gas consumption :~10-12% AGR past 6 years
 - 2005: ~200MM GGE; 2011: 330MM GGE ; 2012 ~385MM GGE
 - Medium- and Heavy-duty vehicle fuel use is growing
 - Early models of consumer adoption show promise
 - Growth rate expected to accelerate in next several years as successes in niche markets build confidence.
- Factors affecting growth include pace of worldwide economic recovery, petroleum-natural gas differential, vehicle and station tax credits, grants that accelerate adoption



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, higher throughput with anchor accounts or aggregated loads (multiple fleets, consumers)
- While less than half of all stations are “public access” and many do not meet high volume expectations, emphasis today is on upgrading that experience
- Increased interest in LNG and L/CNG
- New players / new business models
- Potential for 200+ 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



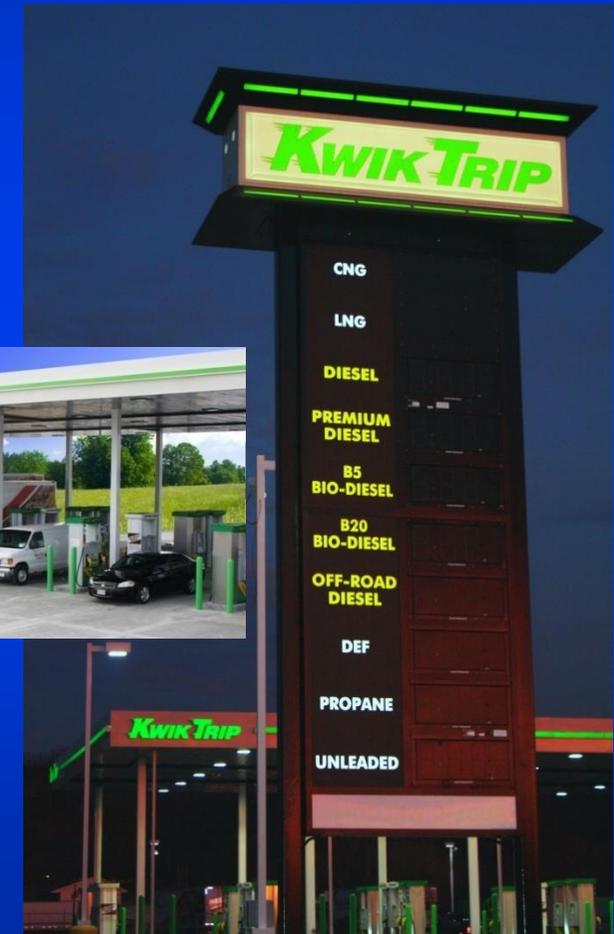
Truck Stops Are Embracing Public-Access Fueling Infrastructure

- Pilot/Flying J is working with third party natural gas fueling retailer Clean Energy to develop LNG and L/CNG stations at locations all across the country.
- Love's is working with Chesapeake Energy to co-develop CNG locations in the Midwest. Backyard and front-of-store retail options are both in the mix.
- 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. Working with Chesapeake Energy, focus is on retail consumer sales.
- Additional C-store chains are in process of evaluating similar options



NGVAMERICA

Natural Gas Vehicles for America



Kwik Trip Station Roll-Out Plan

- Just completed twelfth station opening and eight more on track to open by early summer
- Sturtevant station exceeded 1000 GGE/day before any comprehensive fleet outreach plan was been implemented
- Kwik Trip goal is to populate Chicago-Twin Cities corridor and supplement other Midwest corridor activities



Source: C. Hollett ppt; Kwik Trip – 10/2012

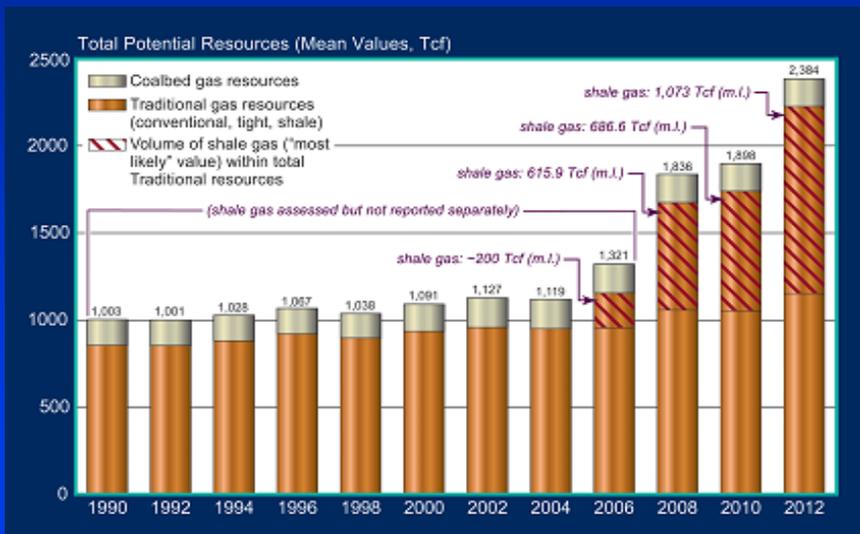


Customers Are Embracing Public-Access Fueling Infrastructure

- 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



PGC Resource Assessments, 1990-2012

- 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.

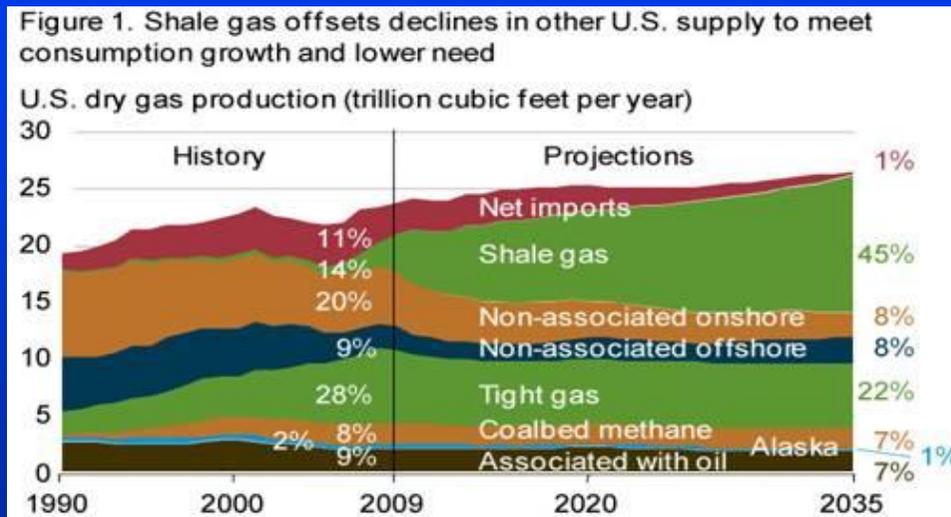
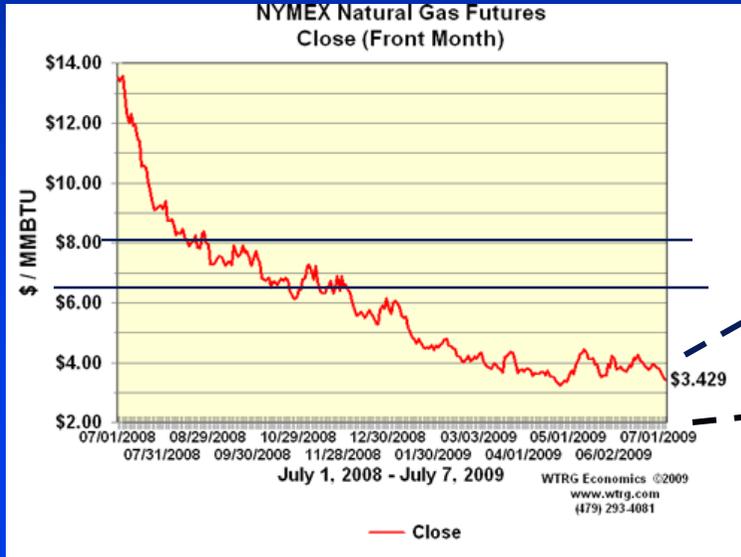


Figure 1. Shale gas offsets declines in other U.S. supply to meet consumption growth and lower need



Translating Abundance into Savings



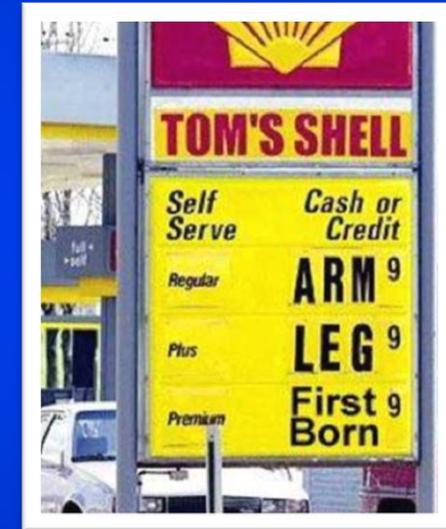
One MMBtu is ~8.0 GGE of (uncompressed) natural gas
One MMBtu is ~7.2 DGE of (uncompressed) natural gas.

If average MMBtu is ~\$5.00; commodity % is \$.63/GGE (\$0.70/DGE) . Add LDC delivery, compression, maintenance, equipment amortization: ~\$1.80-2.10/GGE. + fed and state taxes LNG pricing derived differently but base stock gas cost is same



Snapshot of US NGV Market Today

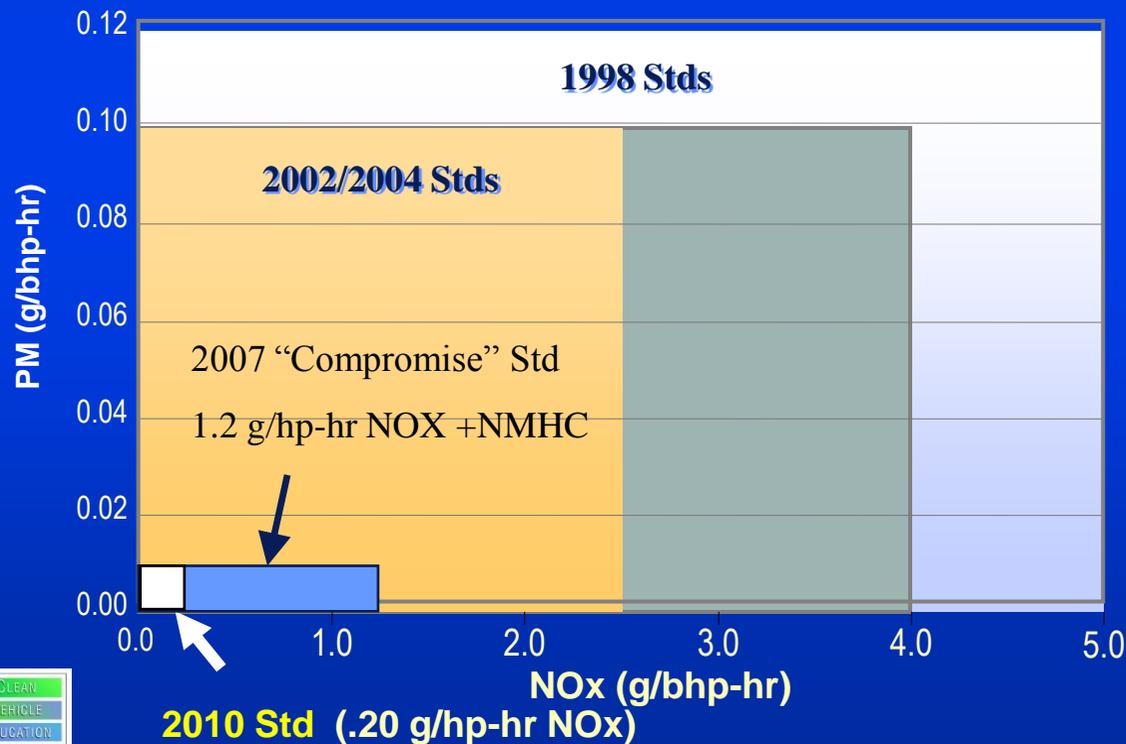
- On a Btu basis, natural gas and oil prices are now decoupled.
 - BBL : MCF ration ran over 40:1 for much of 2012;
 - Even when gas is at more sustainable \$4/MCF, ratio tends to hover at ~24:1;
 - This “new norm” is up from long-time 7:1 ratio
- **Currently, CNG savings compared to gasoline are \$1.25-1.75 (vs diesel: 1.50+) (even more, in some areas) .**
- 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 (NO_x, 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 NO_x 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

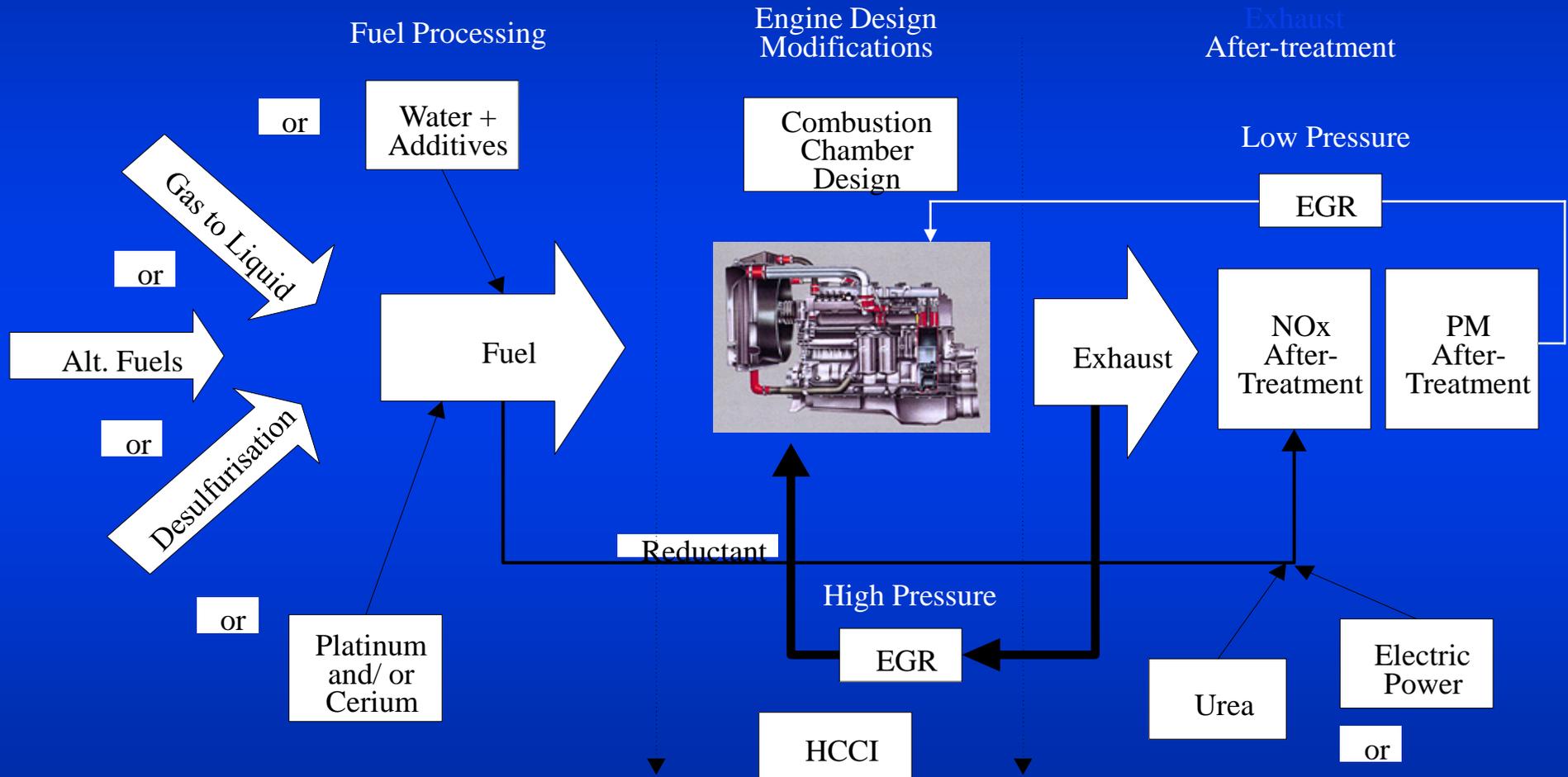


Diagram Courtesy of TIAX LLC

NGVAMERICA

Natural Gas Vehicles for America



Market Driver for NGVs

Lower Greenhouse Gases (GHG)

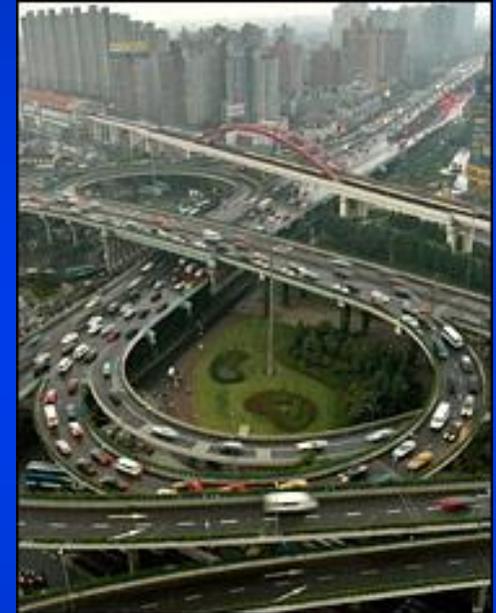
- The Environmental, Economic and Political Realities of Global Warming and Greenhouse Gases
 - Issue is gaining traction internationally and here in US
 - New LDV GHG requirements are already phasing in and EPA and NHTSA are phasing in HDV GHG/fuel economy requirements (2014)
- **Natural gas vehicles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



Traffic in Shanghai
China: Chinese vehicle
ownership per capita is
equal to where US was
in 1920!

Are you prepared?



NGVAMERICA

Natural Gas Vehicles for America

Market Driver For NGVs

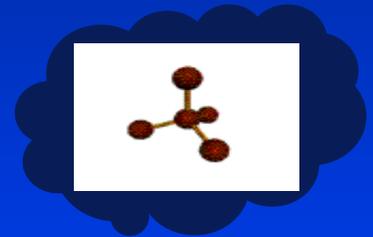
Energy Security and Diversity

- 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)

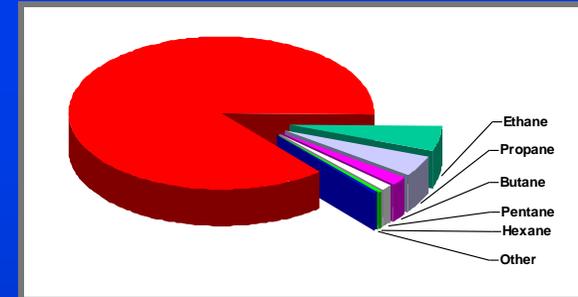


Natural Gas and the Hydrogen Future

- 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



Methane
Molecule



Liquefied Natural Gas (LNG)

- Cryogenically cooled to liquid @ $\sim(260)F$, 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. However, new LNG plant development has been committed to based on demand
- Another application for LNG is L/CNG stations which dispense LNG (e.g., for OTR truck fleets) and have additional option to compress LNG and flash evaporate to provide CNG. This is also an option for locations without pipeline natural gas.



Additional LNG Supply Opportunities

Potential peak-shaving capacity available in some markets

- Dozens of supply points in areas that currently do not have LNG supply
- Does capacity exceed cold weather needs and will PSC allow (i.e. how will it treat regulated recovery of investment)

Growing interest in small-/mid-scale liquefaction plants

- Locate nearer to point of end-use to reduce transportation cost.
- Gas supply may be from pipeline, landfills, sewage, agricultural waste digesters



Compressed Natural Gas (CNG)

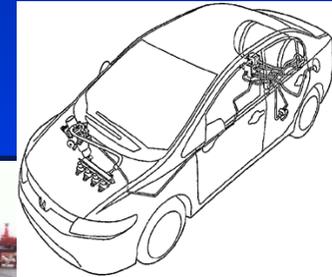
- Natural gas is delivered to the fueling site via the local gas utility's underground distribution system at low pressure, then compressed and stored on site for fast filling of vehicles



...or compressed and distributed directly to vehicles' onboard storage cylinders (time-fill applications)

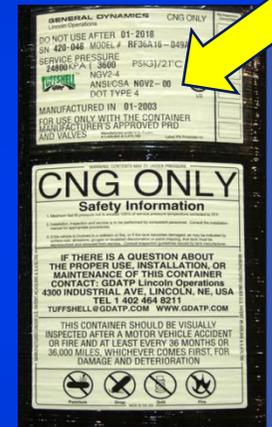


Onboard CNG Storage



CNG Cylinders

- Most onboard vehicle cylinders in service today operate at 3600psi
- 4 types of onboard cylinders; although of different materials and construction methodologies, all meet same stringent safety standards.
 - Type I (all metal)
 - Type II (metal liner, partial wrap)
 - Type III (metal liner, full wrap)
 - Type IV (plastic liner, full wrap)
- FMVSS 304 requires label detailing end-of-useful life date at which point they must be removed from service and decommissioned (no recertification process)
 - Current life spans may be 15, 20 or 25 years; old cylinders had 15 year life
- Label also states that cylinders should be visually inspected every 36 months or 36K miles (whichever is earlier) or after accident or fire. Inspection should be performed by “Qualified” or “CSA-certified” personnel

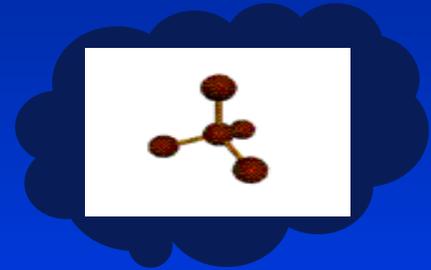


End-of-life decommissioning and disposal; venting, purging, destroying

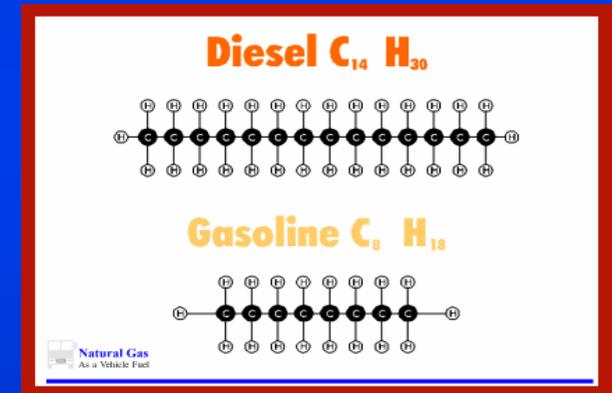


Benefits of Natural Gas/NGVs

- Natural gas is an inherently clean fuel
 - Natural gas is low-carbon fuel (CH₄)
 - Less NO_x, 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



Methane Molecule



Key Attributes and Best Prospects



- High fuel use vehicles with return-to-base operations or repetitive route or pre-set geographic operating areas
 - Regional freight truck – 16-20K GGE
 - Transit buses – 12.5-15K GGE
 - Refuse/Concrete trucks – 7.5-10K GGE
 - Municipal sweeper – 5-6K GGE
 - Airport shuttle service – 5.5-7.5K GGE
 - Taxi - 4.5-5.5K GGE
 - F&B, Textile Svcs, Household Goods – 3-5K 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

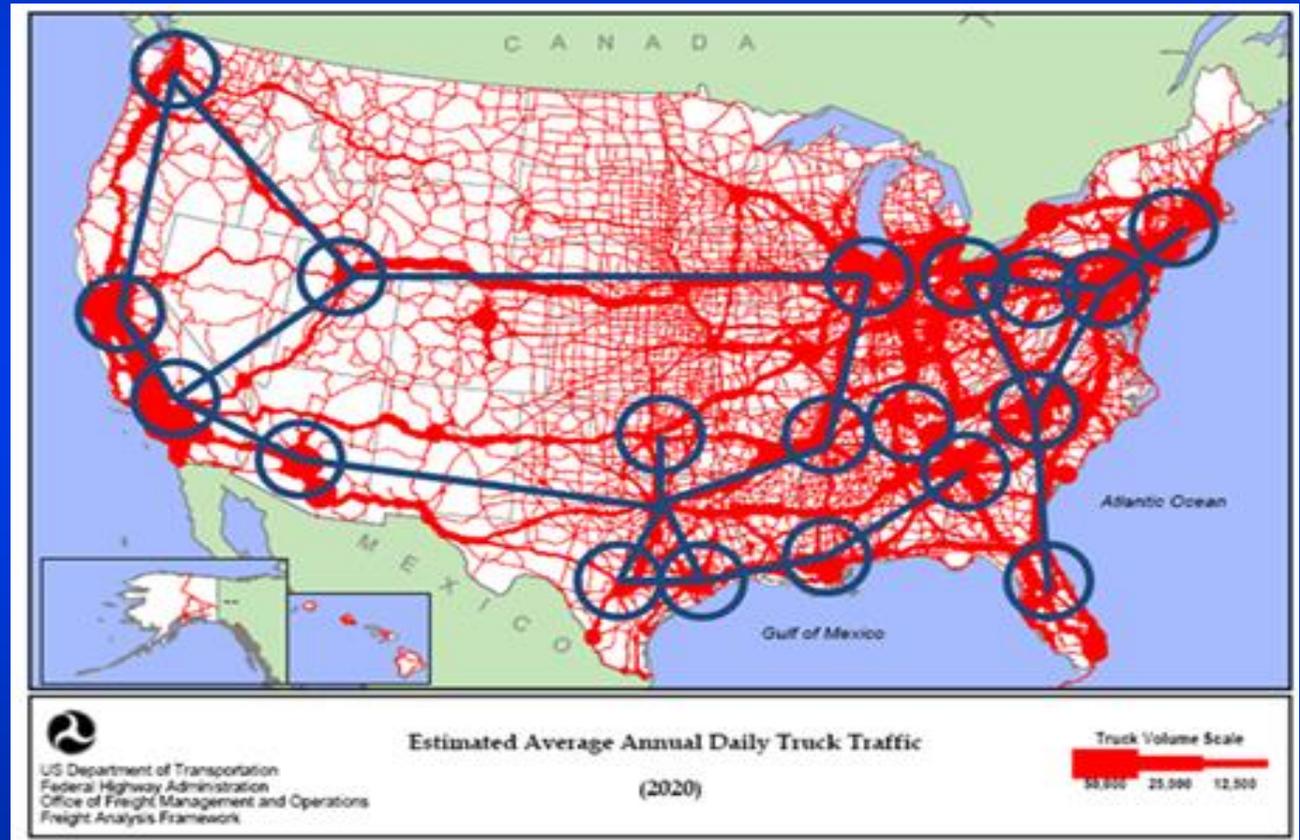
Expanding Infrastructure: “Hub and Spoke” and Corridor Development

Step 1:

Serve local/regional fleets with hub+spoke operations. Build confidence for local consumer adoption.

Step 2:

Serve lanes that connect the hubs



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
- Motor Coach Industries
- Gillig
- Elgin
- Allianz/Johnston
- Schwarze
- Tymco

OEMs

- Freightliner Truck
- Volvo
- International/Navistar
- Kenworth
- Peterbilt
- Mack
- ALF Condor
- Crane Carrier
- Autocar Truck
- Capacity
- Ottawa
- Freightliner Custom Chassis*
- Isuzu Truck North America*

HD OEM/Repower Engines

- Cummins Westport
- Westport Innovations

SVMs (LDV/MDV/HDV)

- Altech-Eco
- BAF Technologies
- Landi Renzo USA / Baytech
- IMPCO Technologies
- Westport LD
- 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

NGVAMERICA

Natural Gas Vehicles for America



EPA Certification Requirements of NGVs

- 1994: EPA sets certification requirements for CNG.
 - OEMs use of ECMs; concern about conversion emissions;
 - OEMs began complying to new standard; SVMs given alternative (Memo 1A Option 3).
 - Dozens of “kit manufacturers” leave market (“good”; quality/reliability was a mess)
- April 2002: Option 3 phased out
 - SVMs must certify; very costly, technically difficult , requires expertise and \$\$\$ equipment; further differentiated the quality engineered retrofit systems from “kits”
- 2006: OBD II goes into effect for LDVs
 - Limited number of companies with the technical expertise to meet requirements necessary to get EPA Certificates of Conformity (COC) / CARB Executive Orders (EO)
- March 2011: EPA revised aftermarket certification rules
 - Relaxed rules apply primarily to vehicles “outside useful life” although less burdensome data submittals are available for vehicles that are “intermediate age” (IUL) defined as current year minus 2; e.g. 2011MY vehicles or older may now apply for IUL listing. Both OUL and IUL still require EPA review of data/technical documentation



American Honda Civic Natural Gas Sedan



- Dedicated NGV; 1.8L 4-cylinder engine; 8 GGE tank: 225-250 mile range
- American-made – (OEM mfd: Greensburg, IN - 70% US-sourced parts)
- Fleet applications: sales reps, project supervisors, document and medical lab couriers, transit route supervisors, social service workers, code officials, parking enforcement, non-pursuit police/security.
- Originally offered only through Honda fleet sales dealer network, now available via growing number of “retail” Honda dealers to consumers
- Consumer adoption is increasing in areas with public access infrastructure.



General Motors



- Dedicated CNG 2500/3500 Express/ Savana cargo vans introduced 02/11
- LC8 6.0L V8 Vortec engine features hardened exhaust valves and hardened intake and exhaust valve seats
- Two tank configurations available
 - 4 -- 23GGEs; 3 – 16GGEs
- 5 year/100K mile warranty

- Bi-Fuel 2500HD Silverado/ Sierra extended cab pick-up introduced 03/12
- Proven LC8 6.0L V8 Vortec engine
- 2x/4x, Short and Long bed options
- Single Type III tank 17.2GGE CNG fuel package complements 36 gallon gasoline system
- 5 year/100K mile warranty



Chrysler Group



- Bi-Fuel Ram 2500 CNG crew cab 4x4 w 8' bed pick-up truck premiered 03/12
- 5.7L HEMI engine with factory engineered and installed CNG systems.
- 2 Type I cylinder fuel storage system provides 18.2GGEs (~255miles), supplementing 8 gasoline gallons (~112miles) for total range of 367 miles ; option available for standard 34 gallon gas tank.
- Production began July 2012



Vehicles Available Through SVMs



Vehicles Available Through SVMs



Vehicles Available Through SVMs



OEM Natural Gas Powertrains

CWI
8.9L ISL-G



- Spark Ignition
- CNG or LNG
- Peak Rating:
 - 320 hp / 1,000 ft-lbs

Westport
HD 15.L



- Dual Fuel Ignition
 - LNG+5-10% Diesel
- LNG Only
- Peak Rating:
 - 475 hp / 1,750 ft-lbs

CWI
11.9L ISX-G



- Spark Ignition
- CNG or LNG
- Peak Rating:
 - 400 hp / 1,450 ft-lbs



Transit and School Bus Platforms



Vocational/Specialty/Work Truck



Local-Regional Haul/Line Haul



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, ~100 engine families have been approved but more are added each month
 - E.g., EcoDual, American Power Group, Clean Air Power, Peake Energy Solutions



Dollars and Sense

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

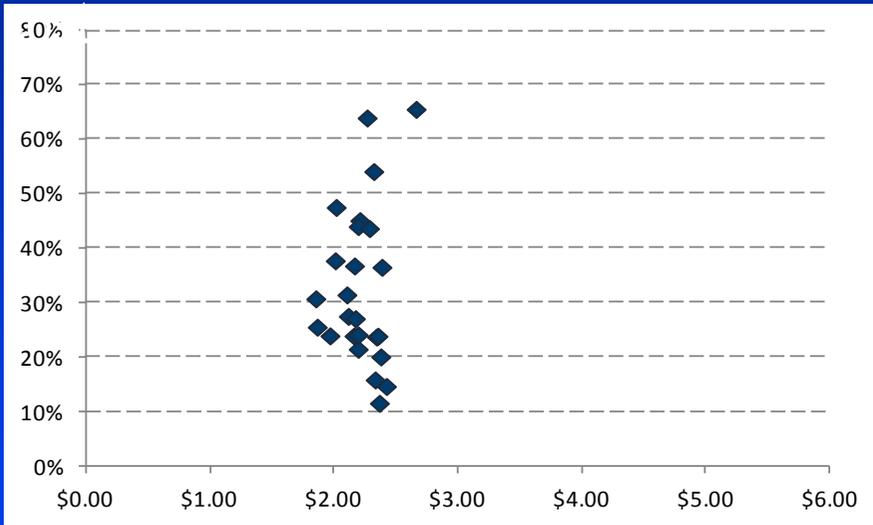


Components of CNG Cost

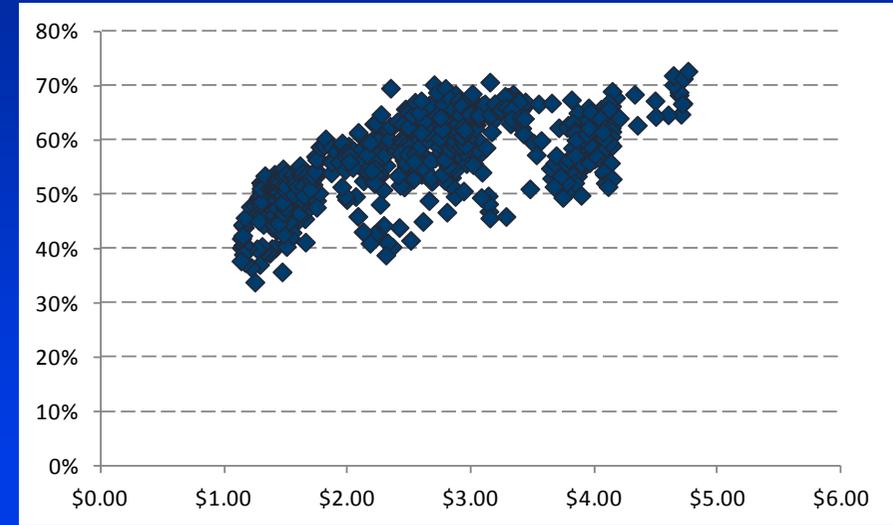
- Gas Bill:
 - Unregulated portion associated with purchasing gas
 - Regulated local gas utility distribution company (LDC) services
- Compression
 - Electric motor KWH and KW ...OR engine driven unit's natural gas use
- Station Maintenance
 - Normal PM, scheduled replacement of parts, compressor rebuilds
- 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



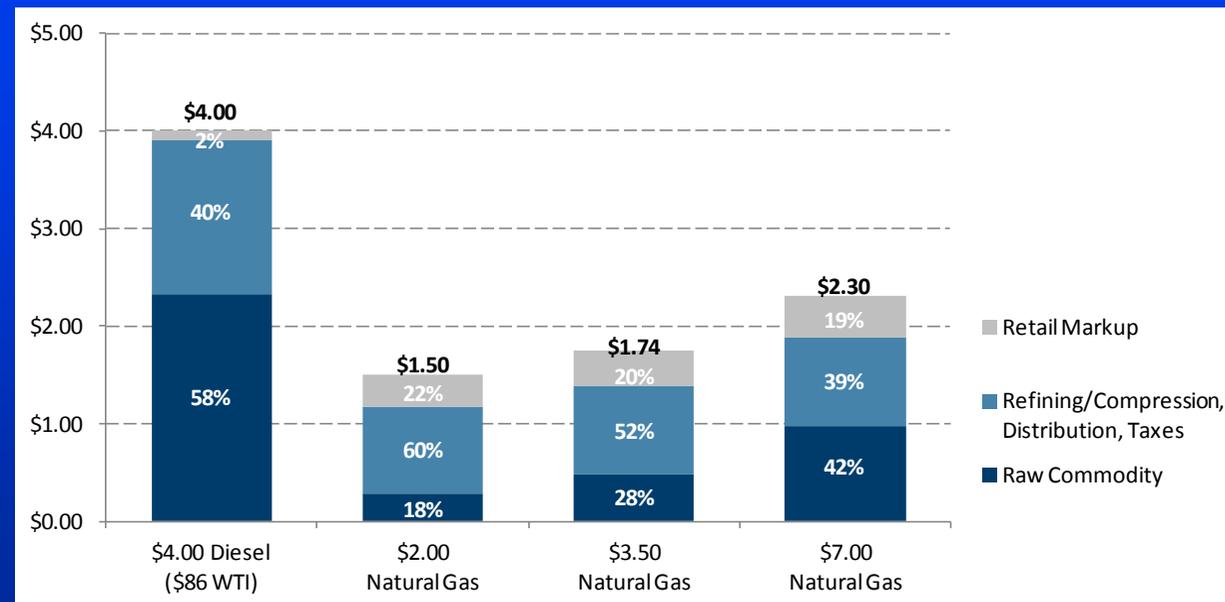
Historical natural gas contribution to CNG



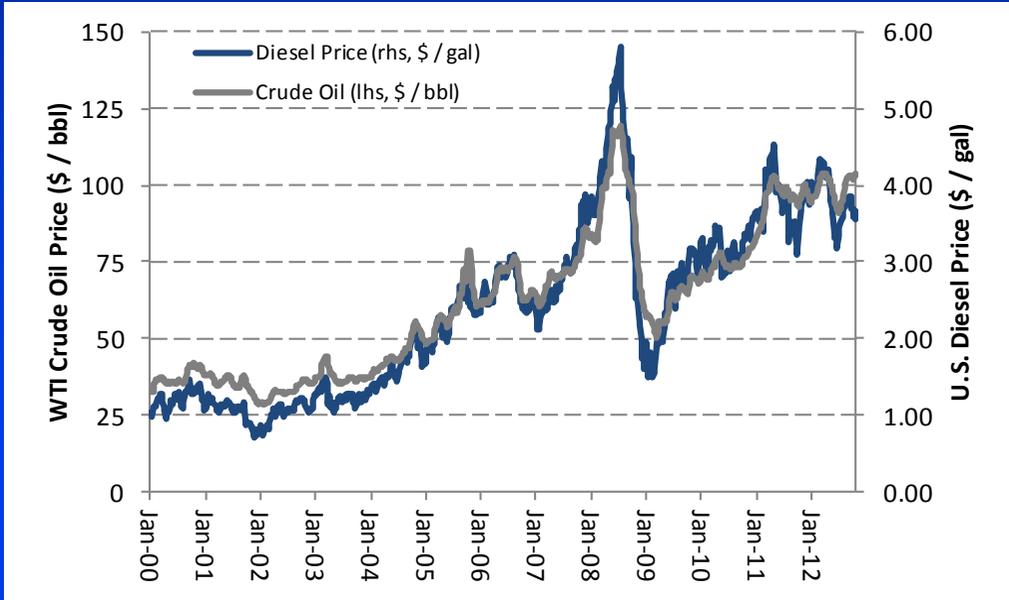
Historical crude contribution to diesel cost



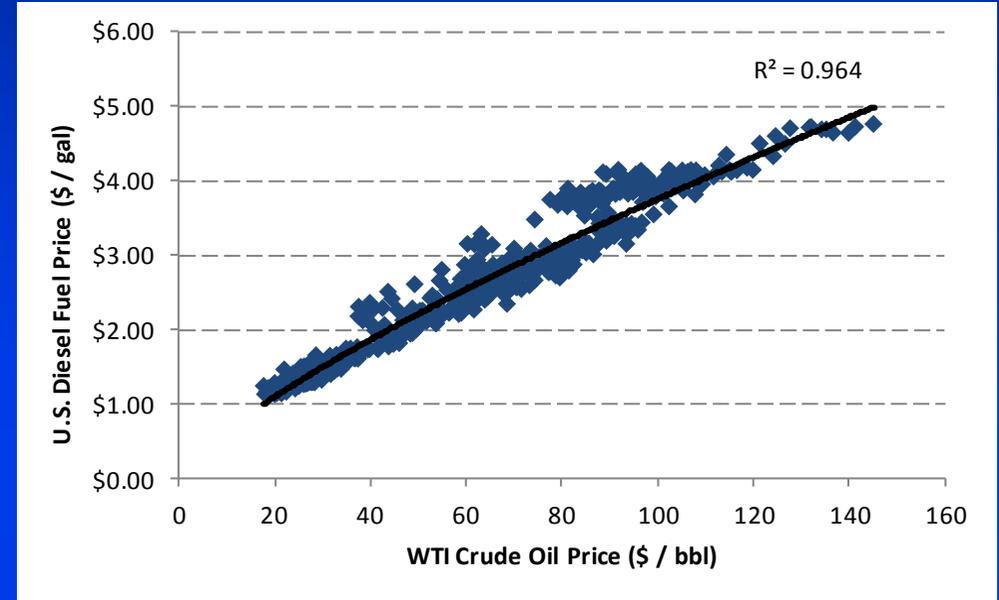
Comparison of raw commodity contributions to pump prices



Historical crude and U.S. diesel prices



Relationship between crude and diesel prices



Components of CNG Cost

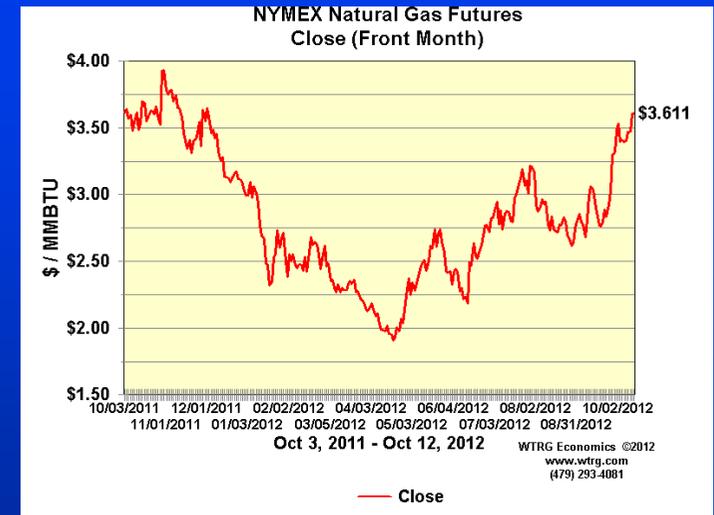
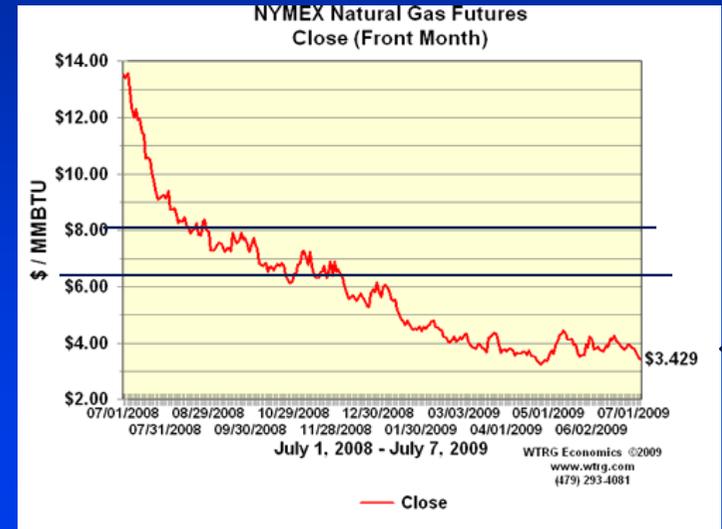
- Gas company bill (unregulated portion)

 - 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 ~\$4.32; commodity portion of CNG is \$.54/GGE
- 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 \$1-2/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.....
EX: Can be as low as 1000 MCF (8000 GGEs) to 10,000 MCF (80,000 GGEs)



Components of CNG Cost

Sample case: commercial baking company with 20 step vans

- Gas Bill: \$.95/GGE
 - Gas costs: ~\$.64/GGE
(based on estimated wellhead price of \$4.00/MMBtu + \$1.00/MMBtu associated fees for transportation and services up to LDC city gate)
 - LDC's regulated city-gate-to-meter services: ~\$0.31/GGE



Components of CNG Cost

- Gas Bill: \$.95/GGE
- 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 fully-loaded KWh/GGE – 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 – : **~\$.25/GGE**



Components of CNG Cost

- Gas Bill: \$.95/GGE
- Electric compression costs: \$.25/GGE
- CNG stations require regular preventative maintenance/service and occasional rebuilds of compressors and replacement of other parts.
- Cost per GGE will vary based on total throughput (generally, larger throughput = less cost/GGE due to economies of scale)
- Maintenance/Repair/Service: \$.25-.50/GGE.: **\$.35/GGE***



Components of CNG Cost

- Gas Bill: \$.95/GGE
- Electric compression costs: \$.25/GGE
- Maintenance/Repair/Service: Assume average of \$.35/GGE
- **Capital amortization of equipment: \$.30-.60/GGE**
 - Station cost divided by total GGE 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: 20 veh. x 15 GGE/day x 5 days/wk = 1500 GGE/wk = ~80,000 GGE/yr
 - 80,000 GGE/year x 10 yrs = 800,000 GGE
 - If 100 scfm 10-post/20-hose time-fill station cost is \$400K, then \$.50/GGE
 - Ex 2: 20 veh. x 20 GGE/day x 6 days/wk = 2400 GGE/wk = ~125,000 GGE/yr
 - Same 100 scfm station, then \$.32/GGE



Components of CNG Cost

- Gas Bill: \$.95/GGE
- Electric compression costs: \$.25/GGE
- Maintenance/Repair/Service: \$.35/GGE
- Capital amortization of equipment: \$.50/GGE

SUB-TOTAL:

- **\$2.05 (use by or sales to tax exempt entities)**
- **\$2.24 (use by or sales to taxable entities)**
 - Federal motor fuels excise tax: \$0.183;



Components of CNG Cost

- **What if NYMEX MMBtu cost rose to \$8.60/MMBtu?**
- **Gas Bill: \$1.51/GGE**
 - **Gas acquisition cost: \$1.20/GGE (\$8.60+1.00 = \$9.60/8)**
 - LDC tariff remains: \$.31/GGE
- Electric compression costs: \$.25/GGE
- Maintenance/Repair/Service: \$.35/GGE
- Capital amortization of equipment: \$.50/GGE

- **Tax exempt fuel sales: \$2.61/GGE**
- **Taxable fuel sales: \$2.793/GGE**

- **At \$8.60/MMBtu, oil is very likely to be well over \$200+/barrel... easily equates to \$5+ for gasoline and even more for diesel!**



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: \$15,000
- Grant: \$ 7500
- Remaining premium: \$7500
- Simple Payback: 0.85-1.05yrs
- Life-cycle cost advantage: \$27K – 35+K
(based on 5yr life and \$ 1.50/GGE savings at retail station)
- Without grant, simple payback 1.7 – 2.1years



Medical Lab Courier Service



- Honda Civic Natural Gas sedan
- MPG: 19/30 City/Hwy, 30K miles/year
- Fuel Use: 4-6 GGE/day; 1000-1575GGE/yr
- CNG Premium: \$6500
- Grant: \$4000
- Remaining premium: \$2500
- Simple Payback: 1.05 – 1.65 yrs
(based on \$1.50/GGE savings at retail station)
- Life-cycle cost advantage: \$5000 – \$9330
(based on 5yr life)
- Without grant, simple payback = 2.75 – 4.3yrs



Step Van

- Sample Applications (e.g., textile rental service, comm. bakery)
- MPG: 5.0 – 6.5, 75-90mpd x6 dys/wk, 26-28K/yr
- Fuel Use: 13-16DGE/day; 4200-5000GGE/yr
- CNG Premium: \$25,000
- Grant: \$15,000
- Remaining premium: \$10,000
- Simple Payback: 1.2-1.4 yrs
- Life-cycle cost savings: \$62-75K !!!
(based on 10 yr life and 1.70 savings/DGE fleet contract price)
- Without grant, simple payback = 2.9 – 3.5 years



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; 8500-10,000dge/yr
- CNG/LNG Premium: \$32,000
- Grant \$16,000
- Remaining Premium: \$16K
- Simple Payback: 0.95 -1.1 years
(based on 1.70 savings /DGE)
- Life-cycle cost savings: \$99 - \$120K+
(based on 8-year life)
- If no grant, payback is 1.8 – 2.2 years.

Grocery Truck



- Volvo VNM, Freightliner M2, etc
- MPG: 5.6 miles/DGE; 68K miles /year
- 12,150 DGE/yr
- CNG Premium (w 84 DGE capacity): \$60,000
- Grant \$25K
- Remaining Premium: \$35K
- Simple Payback: \$20,655 yr savings = 1.7 yrs
(based on 1.70 savings /DGE)
- Life-cycle cost savings: \$130+K
(based on 8-year /550,000 mile life before resale)
- If no grant, payback is 2.9 yrs
- Life-cycle cost savings: \$105+K
(based on 8-year /550,000 mile life before resale)



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, grantsROI 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



Natural Gas Station Development and Ownership-Operations Options: #1

- 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).
 - FTA Clean Fuels Grants, TIGER, TIGGER for transit projects
 - FAA Voluntary Airport Low Emission Program (VALE)
 - DOE Clean Cities grants
 - DOE Block Grants for Energy Efficiency and Conservation
- State/local grant programs – more on this from NYSERDA and CCCs



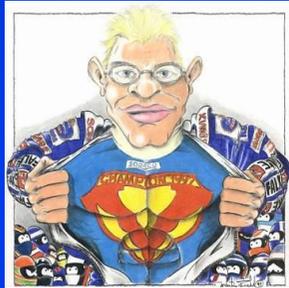
5 Tips that Make Some Grant Applications More Successful Than others

- 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

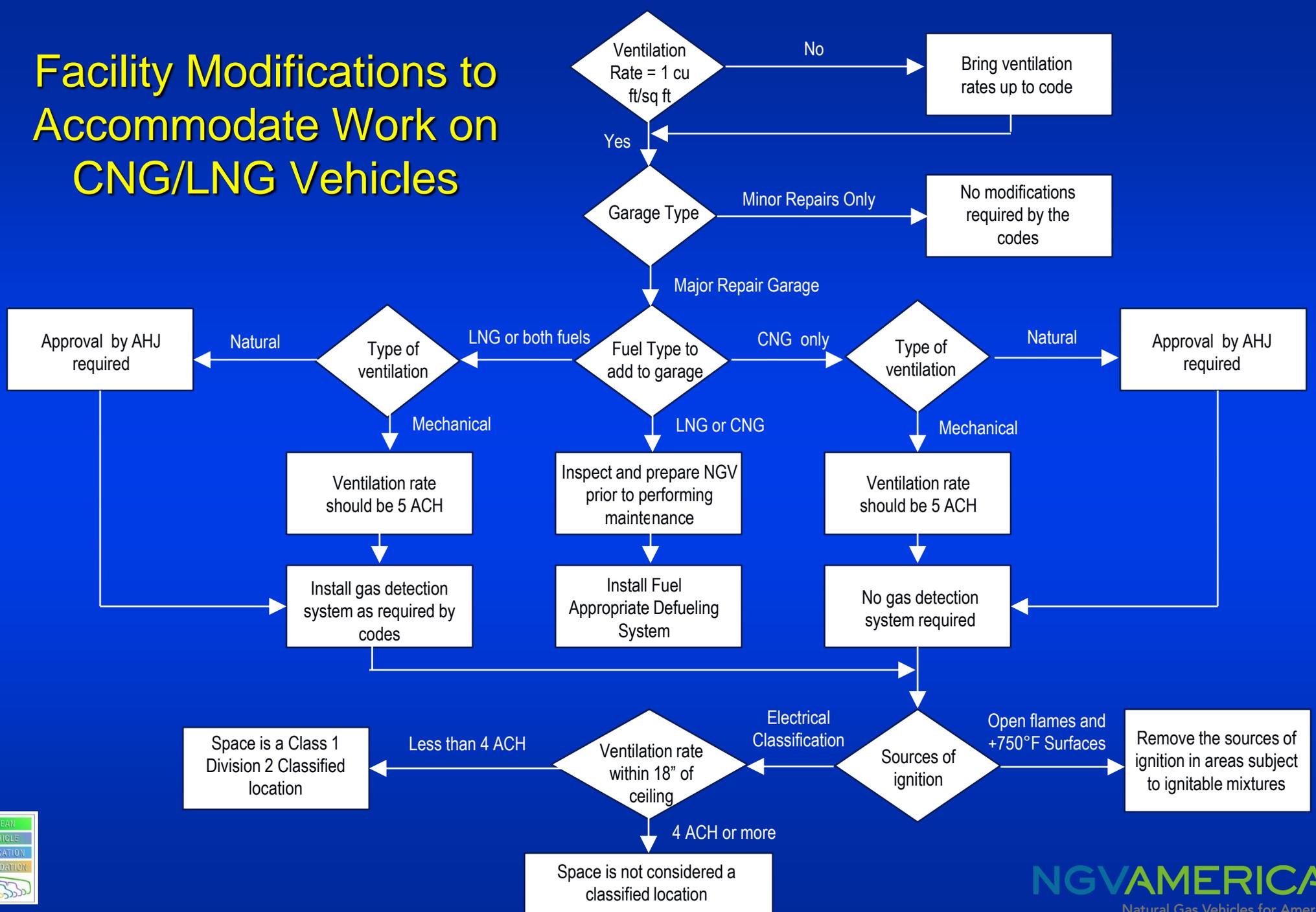
- Maximize use of OPM while it is available. Investigate other creative financing/leasing and station operation options. Learn how to purchase gas to lower fuel costs.



- 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!



Facility Modifications to Accommodate Work on CNG/LNG Vehicles



For more information please contact:

Stephe Yborra

Director of Market Development

NGV America

400 N. Capitol Street, NW - Suite 450
Washington, DC 20001

Director of Market Analysis, Education and Communications

Clean Vehicle Education Foundation

6011 Fords Lake Court
Acworth, GA 30101

syborra@ngvamerica.org / syborra@cleanvehicle.org

(301) 829-2520

