NGV Aftermarket Retrofit/Conversion System Applications in the Work Truck Market

Balancing Regulation with Environmental Responsibility and Safety

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Snapshot of US NGV Market Today

- Existing NGV inventory is estimated at ~120K
  - 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

- ~25-26,000 HDVs
  - 11,000 transit
  - 4,000 school bus
  - 5,200+ refuse
  - 2,600 ports/regional haul
  - 2,800 municipal/F&B/Misc
- ~72-74,000 LDVs (fleet and consumer use vehicles)
  - 35,000 Cars/SUVs
  - 39,000 trucks/vans

- ~15-20,000 MDVs
  - 7,500 gov't
  - 1,800 package delivery
  - 1,700 airport
  - 1,000 transit/CTAA
  - 4, 500-6,000 utilities, F&B, commercial services, household goods, construction, misc

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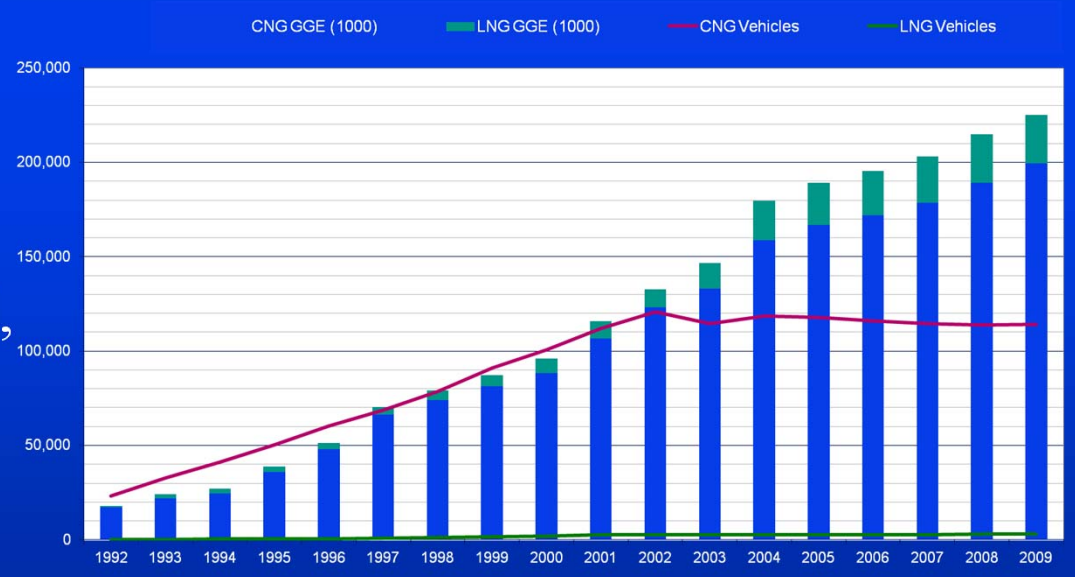
Snapshot of US NGV Market Today

- Vehicular natural gas consumption :~10-12% AGR past 6 years
  - In 2005, ~200 million GGE; In 2011: ~350 million GGE (44BCF)
  - 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-NG differential, vehicle and station tax credits, grants that accelerate adoption



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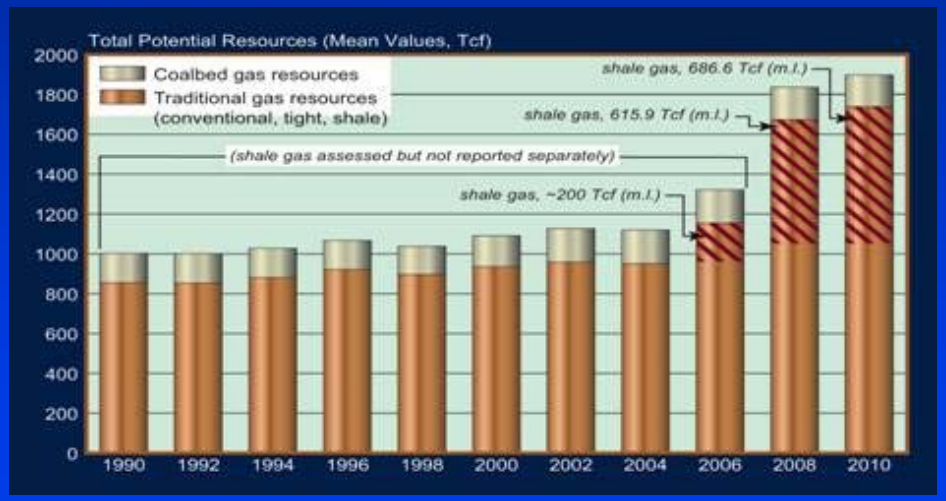
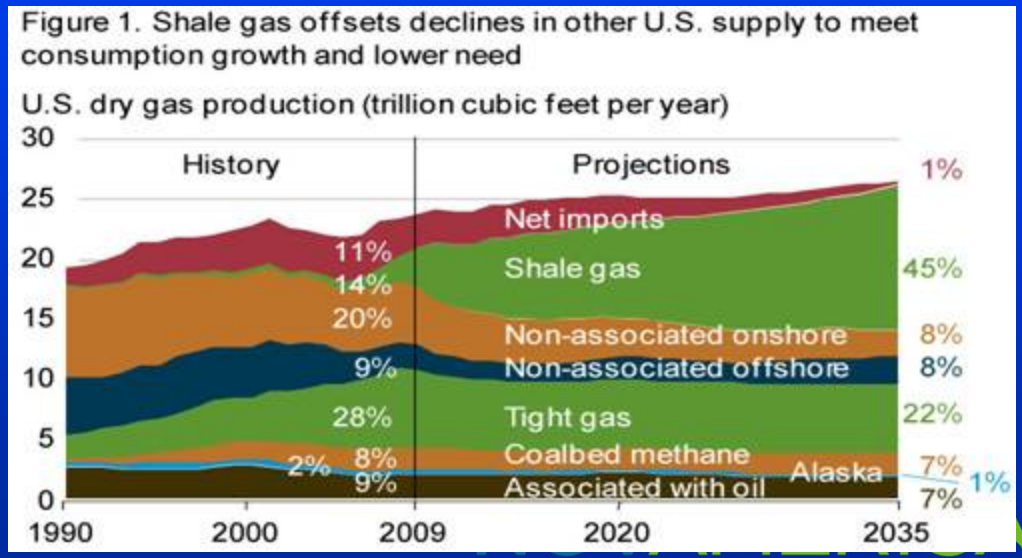
Natural Gas is an Abundant Domestic Fuel



PGC Resource Assessments, 1990-2010

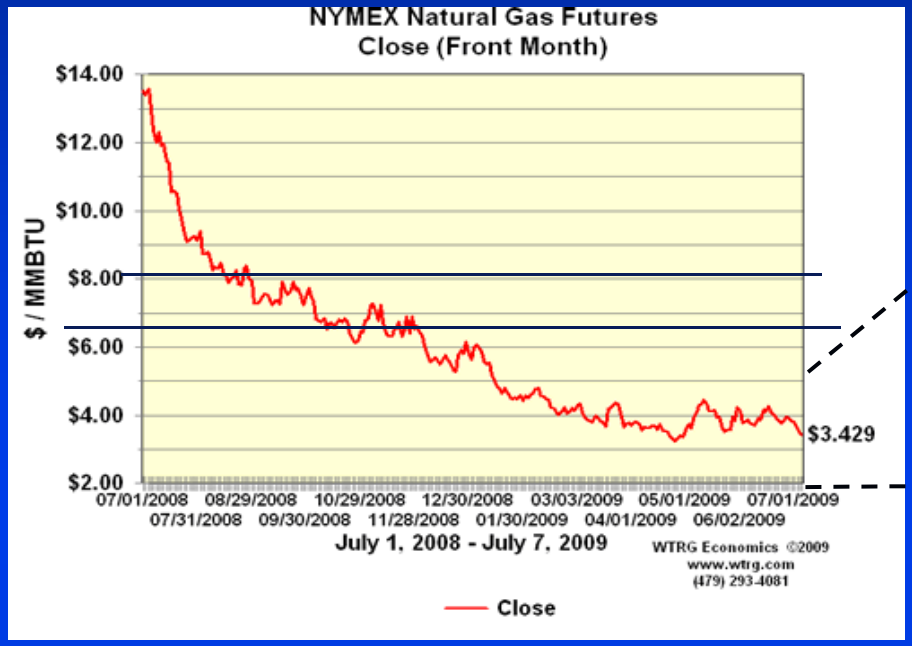
- 98+% from North America
- Well-developed distribution infra-structure;
  - ~300K miles of interstate pipeline
  - 1.2 million miles of LDC distribution lines
- Technology improvements expand recoverable base. Shale gas is major player
- Supply is now estimated @ 115+ years!

Shale Basins and the U.S. Pipeline Grid



Source: American Clean Skies Foundation.

AbundanceTranslates into Savings



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

When MMBtu is ~$3.60; commodity portion is $.45/GGE (~$.50/DGE). Add regulated local gas company delivery tariff, compression energy, maintenance, equipment amortization and result is still ~$1.40-1.85/GGE. LNG pricing derived differently but base stock gas cost is same

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Growing Selection of NGVs from OEMs, SVMs

OEMs

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

OEMs

- Freightliner Truck
- Freightliner Custom Chassis
- Volvo
- International/Navistar
- Kenworth
- Peterbilt
- Mack
- ALF Condor
- Crane Carrier
- Autocar Truck
- Capacity

OEM/Repower Engines

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

SVMs (LDV/MDV/HDV)

- Altech-Eco
- BAF Technologies
- Landi Renzo USA / Baytech
- IMPCO Technologies
- NGV Motori USA
- NatGasCar
- Auto Gas America
- GoNatural CNG
- GreenKraft
- Parnell
- Westport LD
- Clean Air Power
- American Power Group
- EcoDual Group

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Background re: EPA Certification and OBD II Requirements on Retrofit-Conversion System SVMs

- 1974: EPA Mobile Source Enforcement Memo 1A

- 1994: EPA sets certification requirements for NGVs.
  - As OEMs' use of ECMs grew, there was concern about converted vehicle emissions; field sampling found significant number of converted vehicles with emissions *worse than* the original gasoline-powered vehicles

  - New guidelines applied to OEMs and, in the rulemaking process that followed (4/97), SVMs were given an alternative option (Memo1A - Option 3).
    - Comply with intent of earlier "EPA Memo 1A"
    - Document/maintain records of emissions performance testing for review *if requested*

  - Over next 5-6 years, dozens of "kit manufacturers" leave market

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Background re: EPA Certification and OBD II Requirements on Retrofit-Conversion System SVMs

- April 2002: Option 3 phased out for SVMs
  - SVMs had to meet EPA Certificate of Conformity (COCs) certification requirements similar to those required of OEMs; very costly, technically difficult , required expertise and $$$ equipment
    - Chassis and/or engine dynamometer testing of vehicle/engine representing full useful life (FUL) using various FTP protocols
    - Large volumes of data, thousands of hours of dyno time and/or use of aged catalysts to represent different mileage benchmarks
  - Few SVMs had the technical + financial resources necessary to meet these more challenging requirements; additional "kit suppliers" left
  - Due to relatively low sales volumes, certification and related RDD&D costs per unit escalated dramatically

Background re: EPA Certification and OBD II Requirements on Retrofit-Conversion System SVMs

- 2005-06: OBD II goes into effect for LD NGVs
  - Limited number of companies had the technical expertise to interface sufficiently with OEM ECM to meet OBDII and thus qualify for EPA COCs and/or California Air Resources Board (CARB) Executive Orders (EO).
  - Additional SVMs elect to abandon US market
- 2008-09: Market frustration leads to spate of non-compliant systems
  - Growing price differential between gasoline/diesel and natural gas fuels demand for more NGV models at lower cost.
  - In effort to balance public and political pressure with CAAA obligations, EPA agrees to revisit guidance and issue new regulations… 5/10 NOPR
  - Two issues: Emissions (EPA/CARB) and Safety (??? – NHTSA?, states?)
- 3/2011: EPA revises aftermarket certification rules

Aftermarket Conversion System Certification

- Revised EPA Regulations for Aftermarket Conversion Systems (http://www.epa.gov/otaq/consumer/fuels/altfuels/420f11006.htm) modify requirements for vehicles based on age or miles:
  - **"New or relatively new" vehicles** (MY >= current *calendar year* minus 1) continue under certification
    - Revised rules codified previous guidance, e.g., re engine family groupings
    - Allows chassis testing for vehicles between 8501-14,000 GVWR even if original certification was done as engine certification
    - Certification essentially becomes permanent - Manufacturers can sell systems after certificates expire; no need to submit additional paperwork and/or fees

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Aftermarket Conversion System Certification

- Revised EPA Regulations for Aftermarket Conversion Systems (cont):
  - **"Intermediate age" vehicles** (MY <= to current *calendar year* minus 2, < FUL) are still subject to EPA emission compliance requirements but now given a less burdensome "approval" process
    - Emissions testing and compliance still required; documented emissions must be as good as [or better than] original
    - Submit OBDII scan-tool-based report (versus more burdensome FUL test data) demonstrating that OBDII still works
    - No COC issued; approved systems are listed on EPA web site

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Aftermarket Conversion System Certification

- Revised EPA Regulations for Aftermarket Conversion Systems (cont):
  - **"Outside Useful Life - OUL" vehicles** are still subject to EPA emission compliance but now given far more flexible approach
    - Submit "sufficiently detailed description to show that the conversion technology is technically sound and is applied according to principles of good engineering judgment."
    - Submit OBDII scan-tool-based report demonstrating OBDII still works
    - No COC issued; approved systems are listed on EPA web site

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Aftermarket Conversion System Certification

- What is **"Outside Useful Life"**
  - LD spark-ignition engines/vehicles: ≤ 8,500; 120K mi./10 yrs (optional 150K mi./15 yrs
  - 2005 & Later HD spark-ignition vehicles >8501 ≤ 14,000: 110K mi./11 yrs
  - 2005 & Later HD spark-ignition engines > 14,000: 110K mi./10 yrs

  - 2004 & Later Light HD diesel engines: 8,500 < **LHDDE** < 19,500: 110K mi./10 yrs
  - 2004 & Later Medium HD diesel engines: 19,500 ≤ **MHDDE** ≤ 33,000: 185K mi./10 yrs
  - 2004 & Later Heavy HD diesel engines: **HHDDE** > 33,000: 435K mi./22K hrs/10 yrs

- Most OUL applications will likely be on trucks due to cost, fuel use, payback
  - American Power Group, Clean Air Power, EcoDual Group are first mfrs out of the shoot with EPA listed dual-fuel [diesel/NG] OUL-approved systems (C12, C15. and ISX)… more engines (and, likely, more players) expected soon

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State Regulation of Aftermarket Conversions

- CARB versus EPA certification requirements
  - Per US Supreme Court ruling, states may adopt CARB vehicle emissions requirements. In states that do not, EPA regulations apply. (16 states took/ are taking this option. Ex: Most northeast states are "CARB states").
  - Most "CARB states" are actually referencing the statutes regarding ***new*** vehicles (i.e. those produced by the OEMs for sale there). CARB regulations regarding ***conversions*** are completely separate and have no bearing outside CA unless a state specifically adopts CARB ***aftermarket conversion*** rules but bureaucrats in many "CARB states" are errantly enforcing CARB requirement on aftermarket conversions…. This precludes option for bi-fuel vehicles.
  - An NGV industry task force is addressing this problem. PA and NJ have clarified that EPA COCs are sufficient. More states are in process of issuing similar clarifications.

State Regulation of Aftermarket Conversions

- State regulation of conversion installations
  - There are no "federal installer certifications" required although several states have enacted basic testing/licensing requirements to address technician safety concerns.
  - NFPA is a model code, not a federal regulation. ASE and CSA have industry-developed testing and "certification" [recognition] programs but these are voluntary. Variety of NGV training providers (quality of curriculum varies widely)
  - NGV industry stakeholders working with government and auto/truck representatives to address how to promote legal, safe installations without undue extra financial burdens on burgeoning businesses and consumers

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