



Larson Design Group ®

Natural Gas Vehicles & Infrastructure

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YOUR VISION. MADE REAL.

The Compelling Case For NGVs in Public and Private Fleets



CNG Focus Group Education Day
Larson Design Group - Williamsport, PA
April 6, 2011

The Compelling Case For NGVs in Public and Private Fleets



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Market Driver For NGVs

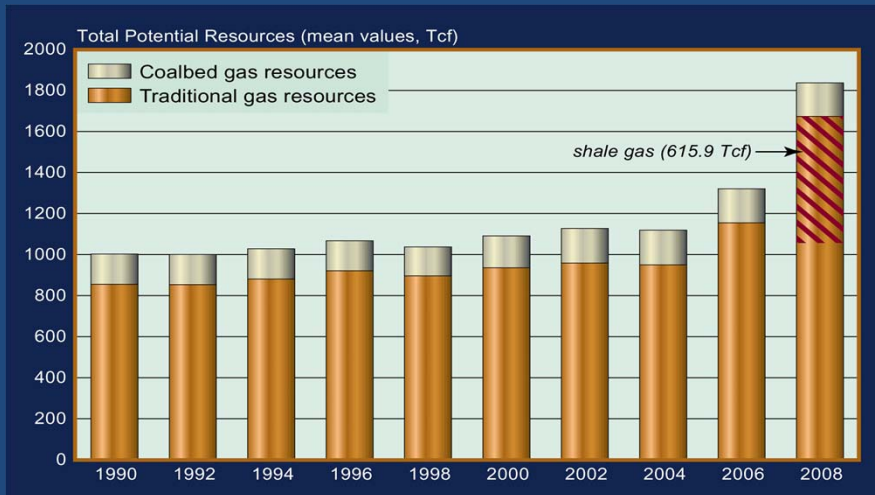
Energy Security and Economics

- 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; 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 will return. Are you prepared?
 - Traditionally ratio between MCF and barrel was 6/7-to-1. Now @ 25-to-1 and regularly hovers in this range!
- **CNG savings compared to diesel are currently \$.90-1.50 less per DGE depending on location, size of station, ownership/O&M arrangements**
 - **Differential was as high as \$2.50 in Spring '08**



Traffic in Shanghai China: Chinese vehicle ownership per capita is equal to where US was in 1919!

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 infrastructure; (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!

NGV EFFECT ON PA ECONOMY

- **Not many oil refineries in PA...Where do those \$ go?**
- **Multiplier Effect of Keeping some PA \$ in PA**
- **Jobs related to CNG Infrastructure:**
 - **Fueling station design & construction**
 - **PA manufacturing companies create CNG fueling station components**
 - **Vehicle upfitter shops to do CNG conversions**
 - **Specialized CNG mechanics develop**
- **Just plain savings at the pump for Pennsylvanians**



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AIR QUALITY BENEFITS OF NGVs

- **Reduced Carbon Dioxide emissions**
- **Reduced Carbon Monoxide emissions**
- **Reduced Greenhouse Gases**
- **Greatly reduced Particulate Matter**

Benefits of NGVs

- NGVs are proven and reliable
 - ~12 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),
 - ~4000 refuse trucks – new fleets transitioning, existing fleets expanding
 - ~3600-3800 + school buses
 - ~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
- NGV life-cycle costs are lower
 - Fuel costs are far lower! Maintenance costs are =/< than gas or diesel
 - Life-cycle cost advantage improves with federal tax credits

NGVs Are a “Good Fit” for Many Fleet Applications

- Local/State Government
 - All Departments
- Airports
 - Terminal Buses, Hotel/Parking Shuttles, Taxis, Door-to-Door services
- Refuse
 - Collection-Recycling/Transfer
- Transit
 - Buses, Maintenance, Supervisors
- School Districts
 - Buses, Admin. staff, Maintenance
- “Short-Haul” Delivery
 - Food & Beverage, Package, Port-Rail, Linen /Textile Services, Newspapers
- 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
- Orion
- Foton
- Gillig
- Elgin
- Allianz/Johnston
- Schwarze
- Tymco

OEMs

- Freightliner Truck
- Freightliner Custom Chassis
- International
- 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/Baytech Corp
- IMPCO Technologies
- Natural Drive
- NGV Conversions/Motori
- NatGasCar

- GM
- Ford
- Dodge
- Workhorse
- Isuzu
- FCCC

ROADBLOCKS TO IMPLEMENTATION IN PA

- **Crux of the matter: you need to build supply & demand and in two separate but linked fragmented sectors – Vehicle Manufacturing & Fueling Infrastructure**

Vehicle supply & Demand for vehicles

CNG Fuel Station Supply & Demand for CNG Fuel

- **Need Bi-Fuel Vehicles to Transition through this period of unbalanced growth in both vehicle stock & Fuel Station Infrastructure.**



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ROADBLOCKS TO IMPLEMENTATION IN PA

- **Bi-fuel CNG Vehicle Registration Nightmare in PA:**
- **The CARB (California Air Resources Board) statute was adopted in 1998 for PA when adopting a statute for air quality on vehicles. Specifically CARB did not allow bi-fuel CNG vehicles.**
- **Unknowingly, at the same time PA adopted CARB, we also adopted EPA for aftermarket CNG Conversions, and EPA covers Bi-fuel CNG applications for conversions.**

CRASHING THROUGH ROADBLOCKS TO IMPLEMENTATION!

- **Bi-fuel would be allowed with a letter clarification from Bureau of Air Quality**
- **The DEP Bureau of Air Quality is intending to issue a letter of clarification in a week to two weeks....soon. Should be any day now.**
- **Similar to a letter of clarification issued in NJ, a letter will be coming from PA DEP's Bureau of Air Quality that will allow for Bi-fuel CNG Vehicles.**

CRASHING THROUGH ROADBLOCKS TO IMPLEMENTATION !

Ouch! ...This is way too much red tape for *normal* folks to cut through!

- **So the current process to register a CNG Bi-fuel Vehicle in PA is this once the DEP clarification letter from BAQ is offered:**
 - **Purchase a new vehicle**
 - **Get the vehicle titled in your name (now CNG Conversion is considered aftermarket)**
 - **Convert it to Bi-fuel CNG**



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CRASHING THROUGH ROADBLOCKS TO IMPLEMENTATION !

Creating an Easier Path to Bi-fuel Vehicles

- **House Bill 1089 - Repeals California Air Resources Board (CARB) section 2030 to eliminate costly duplication of EPA and CARB certifications for natural gas vehicles**



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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



4.8L, 5.3L and
6.0L BiFuel and
Ded. GMC Sierra
+ Chevy Silverado
C/K 15/25/35



5.4L BiFuel and
Dedicated Ford
F150, (F250,
F350 '10); 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



5.3L BiFuel and
Dedicated Chevy
Avalanche



4.7L BiFuel and
Dedicated Dodge
Ram 1500,
Dakota,
Mitsubishi Raider

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



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 E150, E250, E350 cargo and passenger van (bi-fuel soon)



4.6L Dedicated VPG Auto MV-1 paratransit



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



6.8L 2V Dedicated Ford E350 and E450 cutaway vans



6.0L GMC and Chevy G4500 Cutaway

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



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 (in-line 6c, 2200 rpm engine), 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)

Buses, shuttles, trolleys

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

Sweepers

(Elgin, Tymco, Schwarze, Allianz-Johnston)

Work /Vocational Trucks

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



Emission Solutions Inc.

- 7.6L NG Phoenix (S.I.N.G. engine)
 - Based on International's DT466/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 Int'l dealers)
- OEM/factory-installed on WorkStar 7300/7400 at Garland TX plant (DuraStar in May 2011)
- Max rating: 300Hp/860 ft-lb torque



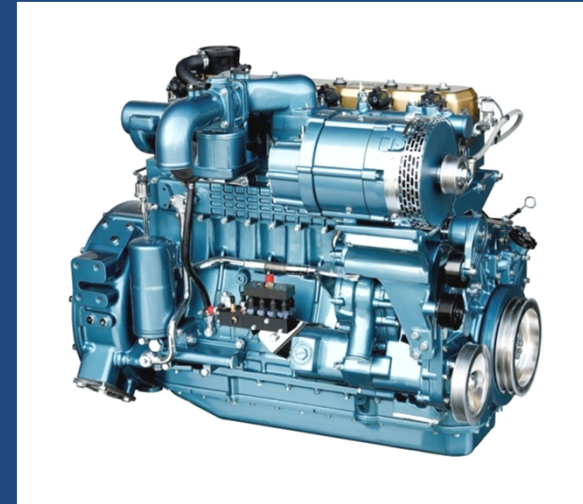
WORKSTAR



DURASTAR

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 332 CNG engines for LACMTA



LACMTA



Riverside

FUELING STATION INFRASTRUCTURE

- Where is my nearest fueling station?
- Currently you are on E and stranded in PA!
- Anchor tenant fleets build a CNG fueling station
- Open the station to the public – additional throughput is important for the ROI of the station
- PCTC – Pennsylvania Clean Transportation Corridor (as described in MSC's NGV Roadmap)

THE WAY FORWARD IS WITH FLEETS WHO SHARE!

- **River Valley Transit Project – Williamsport, PA**
 - **30 Transit Buses Eventually Going CNG**
 - **Lycoming County Vehicle Fueling**
 - **City of Williamsport Vehicle Fueling**
 - **Other Neighboring Municipal Governments**
 - **Non-Profits (i.e. STEP will have access)**
 - **Private Fleets (i.e. Larson Design Group, Construction Companies, Trash Haulers, Gas Industry Service Vehicles, etc.)**
 - **Public Access for Average Joe... “Early Adopter”**



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Station Design/Cost Considerations



- Fueling Equipment Needs/Costs
 - Dispensers and Fuel Management:
 - Time fill posts? Or Fast Fill dispensers? Both?
 - Number and type to meet expected vehicle types/counts
 - Fuel metering/data capture, payment system?
 - CCs/pmt cards, training video (e.g. in CA)?



CNG Station Design Considerations

How Much Fuel in How Much Time?

- What is the projected number of vehicles per day and what is the required fuel per vehicle?
- What are the fueling patterns?
 - Are all fueled at once?
 - Can they be staggered throughout the day?
- What is the maximum daily flow and maximum hourly flow
 - This affects equipment selection and/or storage amount, especially when designing CNG station
- If CNG station, is backup fueling available nearby (even if only on an emergency basis) or is design redundancy required?



CONVERGENCE OF RIGHT LOCATION & INFRASTRUCTURE

- **Convergence of:**
 - **LDC Pipeline Infrastructure (with good line pressure & capacity)**
 - **The right Highways**
 - **Commercial access frontage or suitable location**
 - **The Right Fleets in vicinity**
- **Can PennDOT help facilitate?**
 - **Maintenance yards?**
 - **Rest stop areas?**



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Components of CNG Cost


- Gas Bill: \$.81-.89/GGE
- Electric compression costs: \$.10/GGE
- Maintenance/Repair/Service: \$.40/GGE
- Capital amortization of equipment: \$.35 -.65/GGE
- Net federal excise tax credit of either \$.317 or \$.50/GGE

- **Tax exempt makes and uses their own fuel for net \$1.16-1.54/GGE**

- **Taxable entity makes and uses fuel for net \$1.35-1.72**
 - Includes \$.183 fed excise tax but no state excise tax

DRIVERS FOR IMPLEMENTATION

- Economics of CNG Fuel



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CNG - FUEL COSTS WORKSHEET (CNG Replacing Gasoline)					
			Low End		High End
Cost per MCF	\$ 6.00	Gas Commodity + Pipeline	\$ 0.75 per GGE		\$ 0.75 per GGE
SCF per MCF	1000				
SCF per GGE	125				
GGE per MCF	8.0				
Cost per GGE	\$ 0.75				
Cost per MCF	\$ 2.00	Gas Marketer/Distribution	\$ 0.25 per GGE		\$ 0.27 per GGE
SCF per MCF	1000				
SCF per GGE	125				
GGE per MCF	8.0				
Cost per GGE	\$ 0.25				
0.1 Per KWH		Electric compression costs	\$ 0.10 per GGE		\$ 0.10 per GGE
		Maintenance/Service/Repair	\$ 0.40 per GGE		\$ 0.40 per GGE
		Amortization of Capital Equip	\$ 0.35 per GGE		\$ 0.65 per GGE
		Subtotal	\$ 1.85 per GGE		\$ 2.17 per GGE
		Deduct Federal Tax Credit	\$ 0.50 per GGE		\$ 0.50 per GGE
		TOTAL COST OF FUEL	\$ 1.35 per GGE		\$ 1.67 per GGE



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DRIVERS FOR IMPLEMENTATION

- Economics of CNG Fuel



CNG - FUEL COSTS WORKSHEET (CNG Replacing Diesel)

			Low End		High End	
Cost per MCF	\$ 6.00	Gas Commodity + Pipeline	\$ 0.84	per DGE	\$ 0.84	per DGE
SCF per MCF	1000					
SCF per DGE	140					
GGE per MCF	7.1					
Cost per DGE	\$ 0.84					
Cost per MCF	\$ 2.00	Gas Marketer/Distribution	\$ 0.28	per DGE	\$ 0.27	per DGE
SCF per MCF	1000					
SCF per DGE	140					
GGE per MCF	7.1					
Cost per DGE	\$ 0.28					
0.1 Per KWH		Electric compression costs	\$ 0.10	per DGE	\$ 0.10	per DGE
		Maintenance/Service/Repair	\$ 0.40	per DGE	\$ 0.40	per DGE
		Amortization of Capital Equipment	\$ 0.35	per DGE	\$ 0.65	per DGE
		Subtotal	\$ 1.97	per DGE	\$ 2.26	per DGE
		Deduct Federal Tax Credit	\$ 0.50	per DGE	\$ 0.50	per DGE
		TOTAL COST OF FUEL	\$ 1.47	per DGE	\$ 1.76	per DGE

Step Van

- Sample Applications (e.g., a laundry/uniform rental service using a Workhorse W42 or W62)
- 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



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
- 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

Refuse Truck



- 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: \$35-40,000
- 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.

DRIVERS FOR IMPLEMENTATION

- Economics of CNG Vehicles

FUEL COST TABLE			
Assumptions	UNITS	Gasoline (\$/GGE)	Diesel (\$/DGE)
Avg Fuel Cost	(\$/gal)	\$4.00	\$4.00
Avg CNG	(\$/xGGE)	\$1.67	\$1.76
Applicable Fed. Fuel (Excise) Tax Credit	(\$/gal)	\$0.50	\$0.50
Est. Fuel Cost Savings	(\$/gal)	\$2.83	\$2.74

VEHICLE & FINAL NUMBERS TABLE			
			Transit Bus
	<i>type of conversion - compared to -</i>		<i>dedicated diesel</i>
MPG	(mi/gal)		3.27
Miles/Yr	(mi/yr)		30,000
Annual Fuel Use (gallons/yr)	(gal/yr)		9,174
Life-cycle (life of vehicle - years)	(yrs)		12
Number of vehicles could be replaced	(#)		30
Annual Fuel Cost Savings (per vehicle)	(\$/yr)		\$25,138
Annual Fuel Cost Savings (all vehicles)	(\$/yr)		\$754,128
Life-cycle Fuel Cost Savings (per vehicle)	(\$/life)		\$301,651
Life-cycle Fuel Cost Savings (all vehicles)	(\$/life)		\$9,049,541
CNG Premium, per vehicle	(\$)		\$60,000
QAFMV (Purchase) Tax Credit, per vehicle	(\$)		\$0
Grant Funding, per vehicle	(\$)		\$0
Transportation cost, per vehicle	(\$)		\$2,000
Incremental Cost to City (w/o grant funding)	(\$)		\$62,000
Incremental Cost to City (with grant funding)	(\$)		\$62,000
CNG Premium Simple Payback (w/o grant funding)	(yrs)		2.47
CNG Premium Simple Payback (with grant funding)	(yrs)		2.47



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DRIVERS FOR IMPLEMENTATION

- **CNG Fueling Station + Right Anchor Fleet = Cost Competitive Fueling System**
- **Need to look at Life Cycle Costs of entire system over time**
- **Comparison of CNG system to Conventional fueling should be: \$/mile for CNG vs \$/mile for conventional**
- **Having CNG Fuel actual throughput matched to the initial assumptions of GGEs / DGEs used for amortizing capital equipment costs is critical to paying back the investment for the CNG fueling station**
- **Breakeven Analysis**



FOCUS GROUP

www.larsondesigngroup.com/cngfocusgroup

Introduction & Kick-Off



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CNG FOCUS GROUP - What is it?

- Creating a regional forum to share best practices
- Group of interested stakeholders for Natural Gas Vehicles & Infrastructure (E&P, LDC, Fleets, Auto Dealers, Planners, Engineers, etc.)
- Purpose: Create alternative transportation fueling opportunity in the region using natural gas

CNG FOCUS GROUP - Mission

- The mission of the CNG FOCUS GROUP is to foster learning, collaboration, and action on CNG vehicle fueling and infrastructure on an ongoing basis as it relates to the Marcellus Shale in North Central Pennsylvania.
 - Share information, build trust, partner on an ongoing basis
- Provide Pennsylvania with a model organization of grassroots efforts working in conjunction with national organizations in fostering NGVs & Infrastructure



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CNG FOCUS GROUP – Organizing it

- **Key Point: Work with partnering stakeholders and industry groups: Clean Cities, Clean American Transportation Alliance, Marcellus Shale Coalition, NGV America, Clean Vehicle Education Foundation**
- **Opportunity to provide a regional example that could be replicated across the state by other CNG focus groups**
- **For more information, visit www.larsondesigngroup.com/cngfocusgroup**



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RESOURCES TO CONSIDER

- **“Business Case for Compressed Natural Gas in Municipal Fleets” – NREL Publication June 2010**
- **“NGV Roadmap For Pennsylvania Jobs, Energy Security, and Clean Air – Marcellus Shale Coalition Publication April 2011**
- **Clean Vehicle Education Foundation – Compelling Case Presentation (full version)**

QUESTIONS AND ANSWERS



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