

MINGA Summer Conference

CNG/NGV 101

What we will cover

Facts

Definitions

Measurements

Compression for CNG

NGV basics

Key Drivers of CNG Adoption

Barriers to Adoption

Facts about Natural Gas Vehicles*

- 120,000 NGVs on U.S. roads
- 14.8 million worldwide.
- 1,000 CNG fueling stations in the U.S.
- 30 manufacturers = 100 NGV models
- CNG 1.50–\$2.00 less than Gasoline/Diesel
- U.S. NGVs 360 million gallons of CNG rather than crude
- NGVs meet the strictest emission standards, including California's AT-PZEV standard.
- NGVs are safer than traditional gasoline or diesel vehicles.

* Courtesy of NGVAmerica

Natural Gas as a Transportation Fuel

Why use Natural Gas (NG)?

- Burns cleaner than gasoline or diesel
- Safer than gas or diesel (G/D)
- Delivers same fuel mileage & performance as G/D
- Unlike crude refinement processes, NG only needs a dryer to make ready for vehicle fuel (simpler)
- Pump price for NG projected to stay in the \$2.00 range as G/D projected to return to \$3.50-\$4.00
- Mature technology for vehicles and fueling

Natural Gas as a Transportation Fuel

What benefits do NGVs offer?

- Tail pipe Emissions significantly lower than G/D engines
- Engine oil remains clean up to 50% longer (reduces maintenance and extend engine life)
- Fuel cost savings 30% to 50% over G/D
- Using domestically produced CNG reduces our dependence on crude imports
- Supply chain taxes and profits stay in Mississippi's economy rather than flow out of state

Definitions

CNG – Compressed Natural Gas

LNG – Liquefied Natural Gas (-260 degrees)

NGV – Natural Gas Vehicle

GGE – Gas Gallon Equivalent

DGE – Diesel Gallon Equivalent

Slow Fill – Compressor directly fills NGV tank

Fast Fill – High pressure storage fills NGV tank

Measurement

1 cubic foot (cf) = 1,000 Btu

100 cubic feet (1 ccf) = 1 therm (approximate)

1,000 cubic feet (1 Mcf) = 1,000,000 Btu (1 MMBtu)

1,000 cubic feet (1 Mcf) = 1 dekatherm (10 therms)

1 million (1,000,000) cubic feet (1 Mmcf) = 1,000,000,000 Btu

1 billion (1,000,000,000) cubic feet (1 bcf) = 1 trillion Btu

1 trillion (1,000,000,000,000) cubic feet (1Tcf) = 1 quadrillion Btu

So

1ccf = Therm

1Mcf = Dekatherm

1Tcf = Quad

Measurements

GGE = 125 scf (126.67 scf or 5.66 lbs) and 125,000 btu

DGE = 140 scf (139.20 scf or 6.39 lbs) and 140,000 btu

GGE/DGE per hour – typical slow-fill rate

GGE/DGE per minute – typical fast-fill rate

3600 psi = standard “full” measurement for NGV tank @ 70 degrees

Compression

- Home Refueling Appliance (HRA)
 - Must meet National Fire Protection Association codes “52”
 - Must flow less than 5 scfm
 - Must be UL listed and certified
 - High maintenance cost
 - Output less than 1gge per hour
 - Direct fill with no storage
 - \$5,000 - \$8,000 per unit



Compression (cont.)

- Vehicle Refueling Device (VRD)
 - NFPA code 52 regulations
 - Inlet NG pressure 1-10psi
 - Output 2-12 gge per hour
 - Commercial applications
 - Low maintenance cost
 - Output up to 12 gge per hour
 - Can combine storage for quicker fills
 - \$12,000 - \$45,000



Compression (cont.)

- Skid based Fueling Systems
 - Compressor only for slow-fill
 - Compressor w/storage
 - Compressor w/ storage and dispenser



Compression (cont.)

- Fast fill stations



NGV 101

Definitions

Dedicated = CNG powered only

Bi-Fuel = traditional fuel or CNG

Blended/Dual fuel = Combination of traditional fuel and CNG

Fogger kit = sprays CNG into intake air stream (blended or bi-fuel applications)

Injected kits = Electronic Fuel Injected (EFI)

NGV 101 (cont.)

- Gasoline engines can run on pure CNG without engine modifications
- Diesel engines require modification to run on pure CNG
- Honda produces the “Civic NGV” today
- Ford, GM, and Dodge offer NGV trucks/Vans
- Many “EPA approved” conversion kits

NGV 101 (cont.)

Medium/Heavy Duty trucks

- Repowered dedicated CNG engines for up to 400hp are available
- Repowered higher HP engines Q3 2012
- Blended EPA kits expected this year
- Current OEM's offer Garbage Trucks, Concrete Trucks, local delivery class 5-7 trucks, etc.
- Class 8 OTR trucks are LNG target

What are key drivers of CNG?

Carrot

- Low Natural Gas prices (spread sheets follow)
- Long-term projected pricing of Crude Oil
- Domestic commodity vs. International issues
- State tax incentives and grants

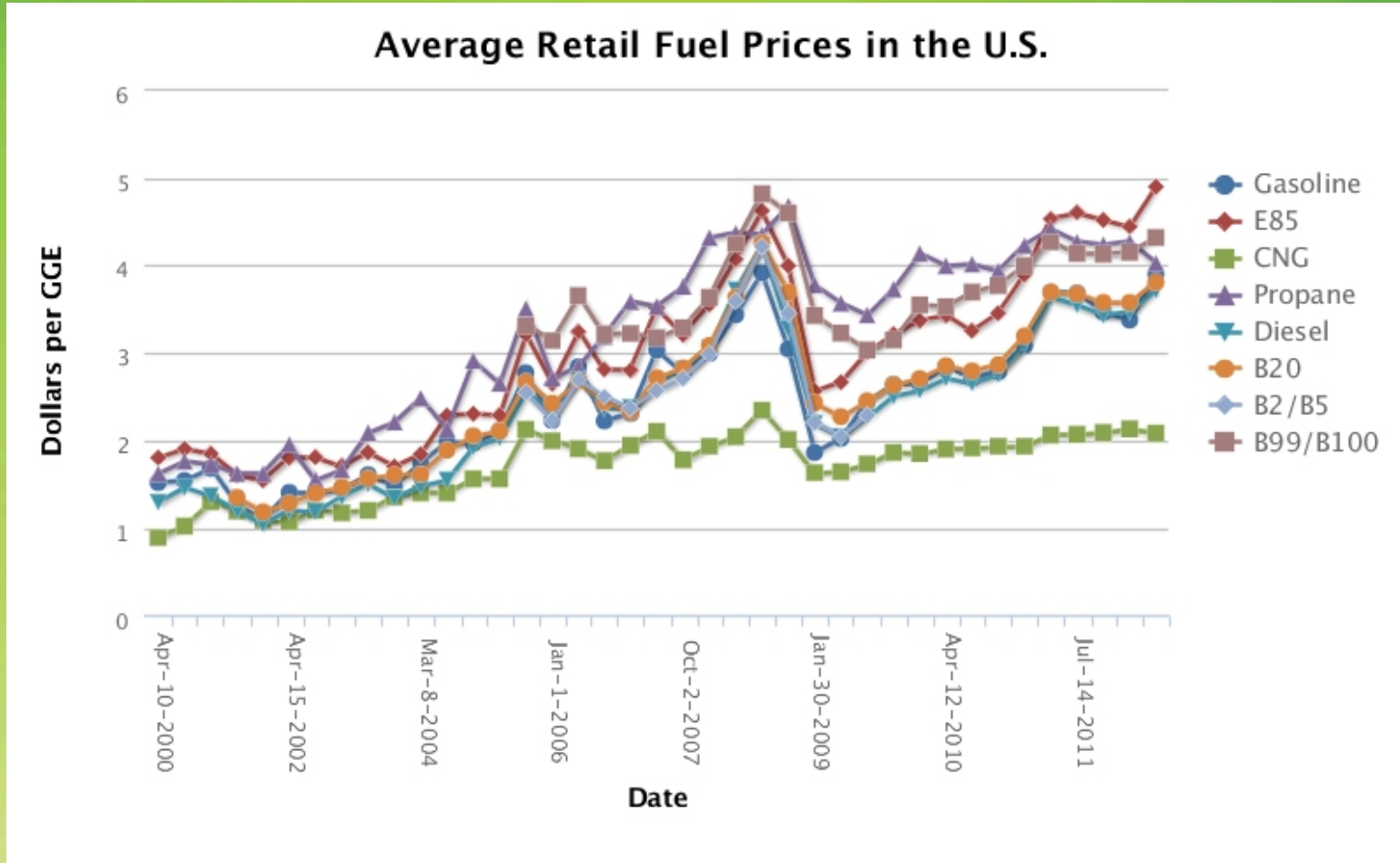
Stick

- EPA attainment or non-attainment zones
- Federal mandated areas (Stennis Space Center)

CNG vs Crude Spreadsheet

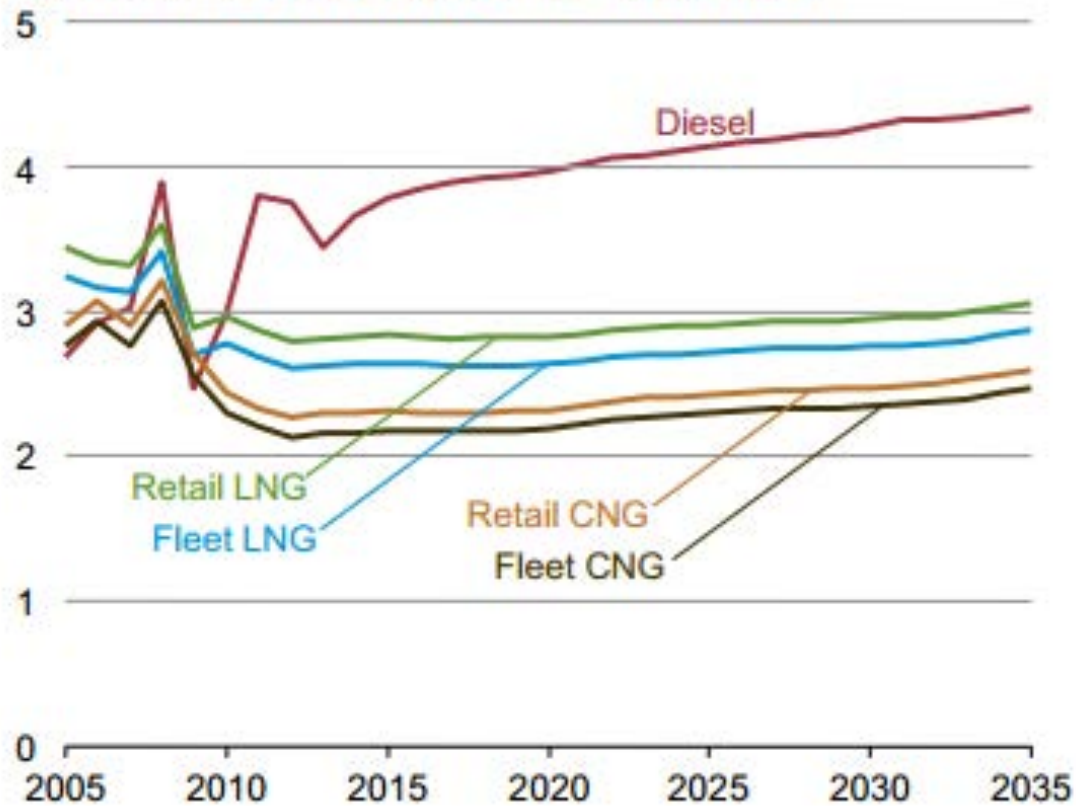
Number of vehicles	10	Cost of conversion CNG	\$ 22,000.00	
		Incentive credit	\$ -	
Vehicle Type	Waste trucks	Cost of compressor	\$ 45,000.00	
		Incentive credit	\$ -	
Est. vehicle life (years)	8	Commodity cost of 1 MCF NG	\$ 4.50	
				CNG price
Avg daily mileage	90			\$ 0.56 NG per GGE
				compression
Avg mpg of vehicle	2	Gasoline/Diesel	CNG	\$ 0.10 electricity
		\$ 3.50	\$ 0.82	\$ 0.15 Fed Road Tax
Gallons used daily	450	\$1,575	\$367	\$ 0.82 total gge cost
Gallons used weekly	2,250	\$7,875	\$1,837	
Gallons used monthly	9,675	\$33,863	\$7,900	
Gallons used annually(9 months)	87,075	\$304,763	\$71,097	
Gallons used in life-cycle	696,600	\$2,438,100	\$568,774	
			\$ 220,000.00	Conversion cost
			\$ 45,000.00	compressor cost
Life-cycle mileage	187,200 operated 260 days per year		\$ 1,604,326.10	Life-cycle savings over gasoline/diesel

Historical Fuel Prices



US Energy Information Admin.

Figure 36. Diesel and natural gas transportation fuel prices in the HDV Reference case, 2005-2035 (2010 dollars per diesel gallon equivalent)

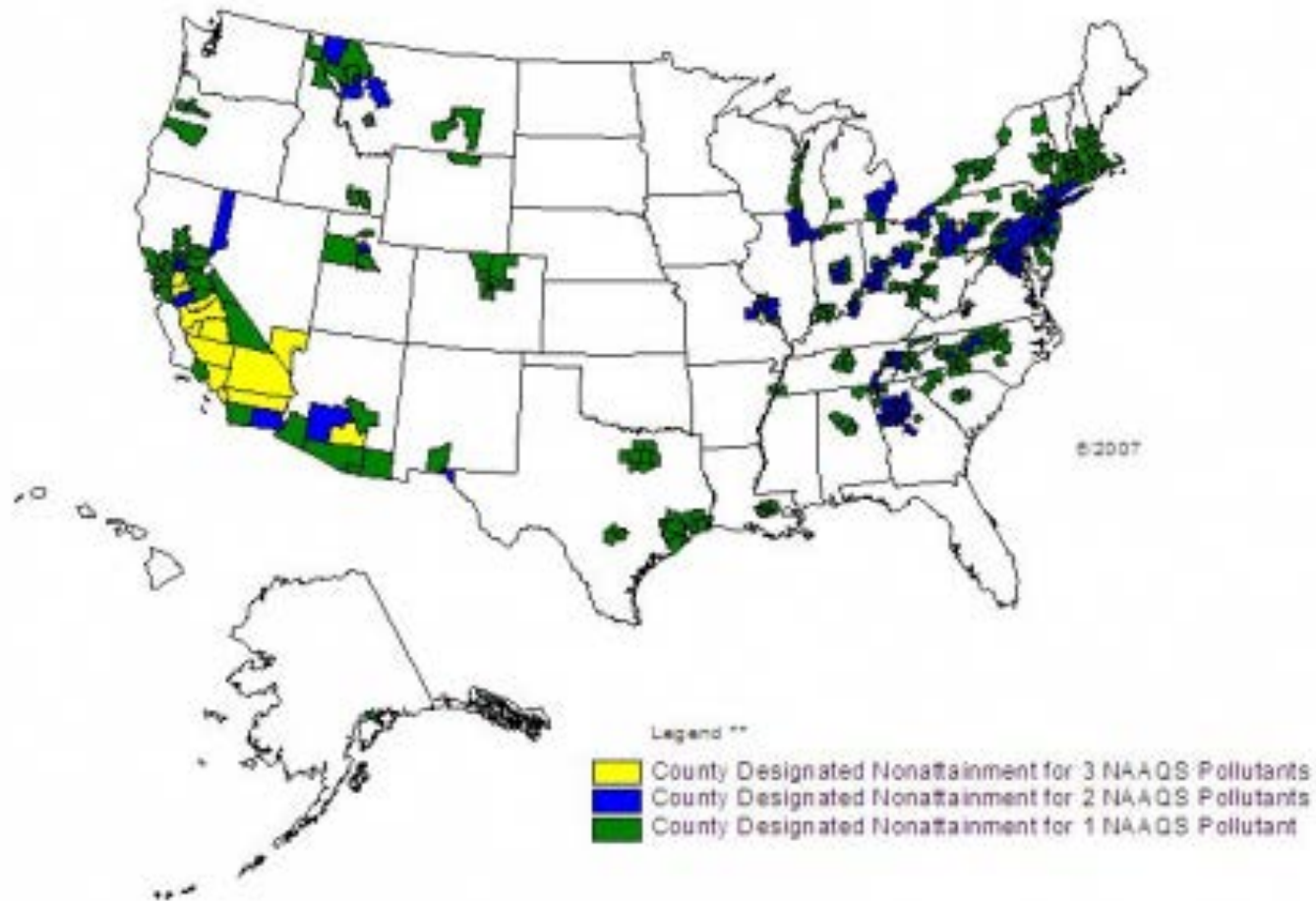


[http://www.eia.gov/forecasts/aeo/pdf/0383\(2012\).pdf](http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf)

Stick – EPA

Counties Designated "Nonattainment"

for Clean Air Act's National Ambient Air Quality Standards (NAAQS) *



Drivers of CNG in surround states

- Atlanta Gas Light - \$15 million from USF/PSC to seed build out of infrastructure
- Alagasco in AL – building private/public CNG stations at 6 of their locations
- Memphis Light & Gas – building private/public CNG stations at 6 of their locations
- AR and LA - aggressive tax incentives for building CNG stations and buying NGVs
- LA, AR, AL, TN, FL, and GA - have Clean Cities coalitions (DOE non-profits for legislation and grants)

Barriers to Adoption

- Lack of public fueling station (Chicken)
- Lack of OEM vehicles (Egg)
- Lack of education and knowledge
- Entry cost for fleet conversion
- Entry cost for fueling stations
- Lack of incentives (compared to other AFV)

In next session

- Types of NGVs
- Return to Base Fueling
- Over the Road Fueling
- Storage
- Compression for large fleets

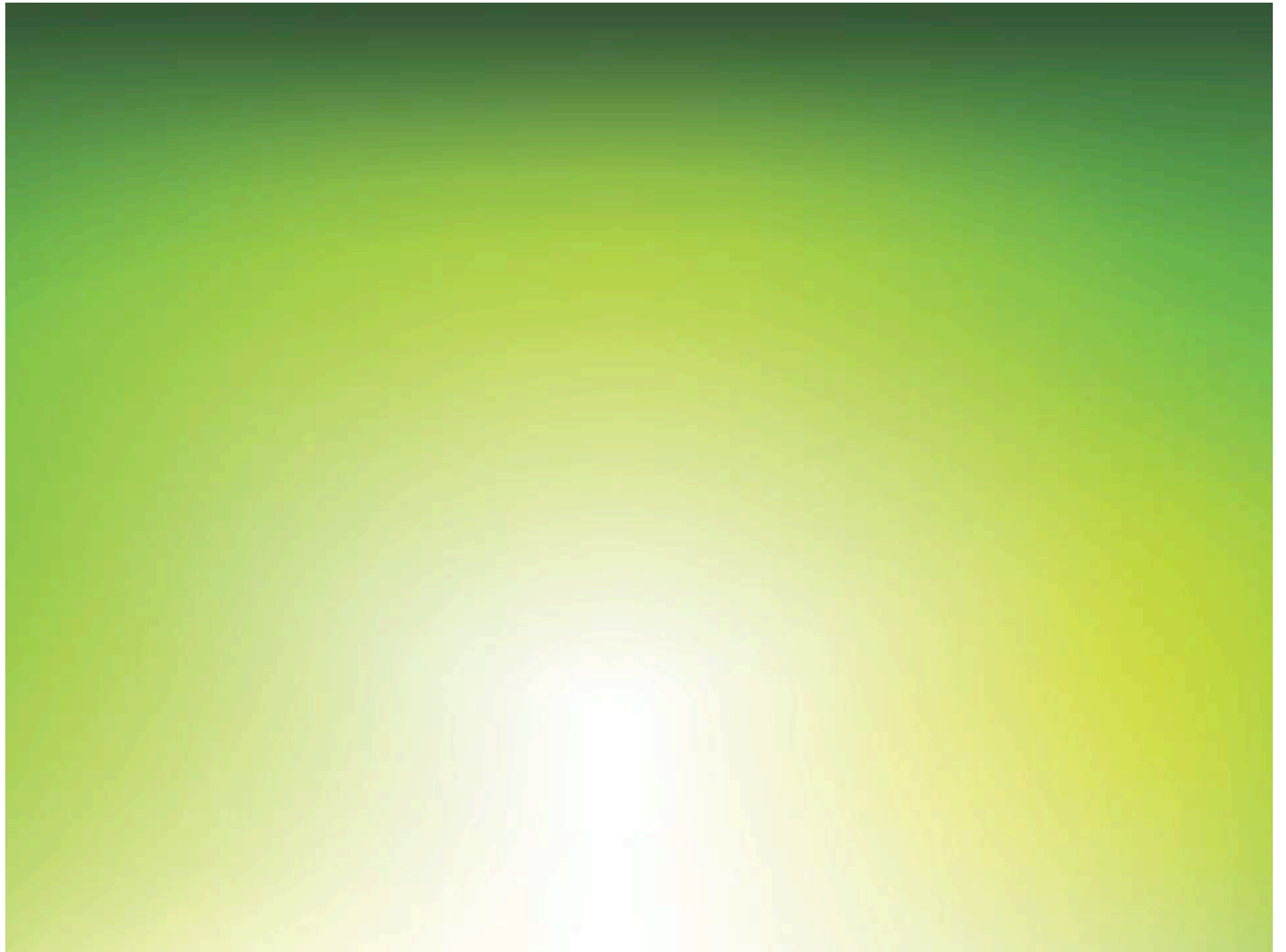
Thank you

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Fueling station



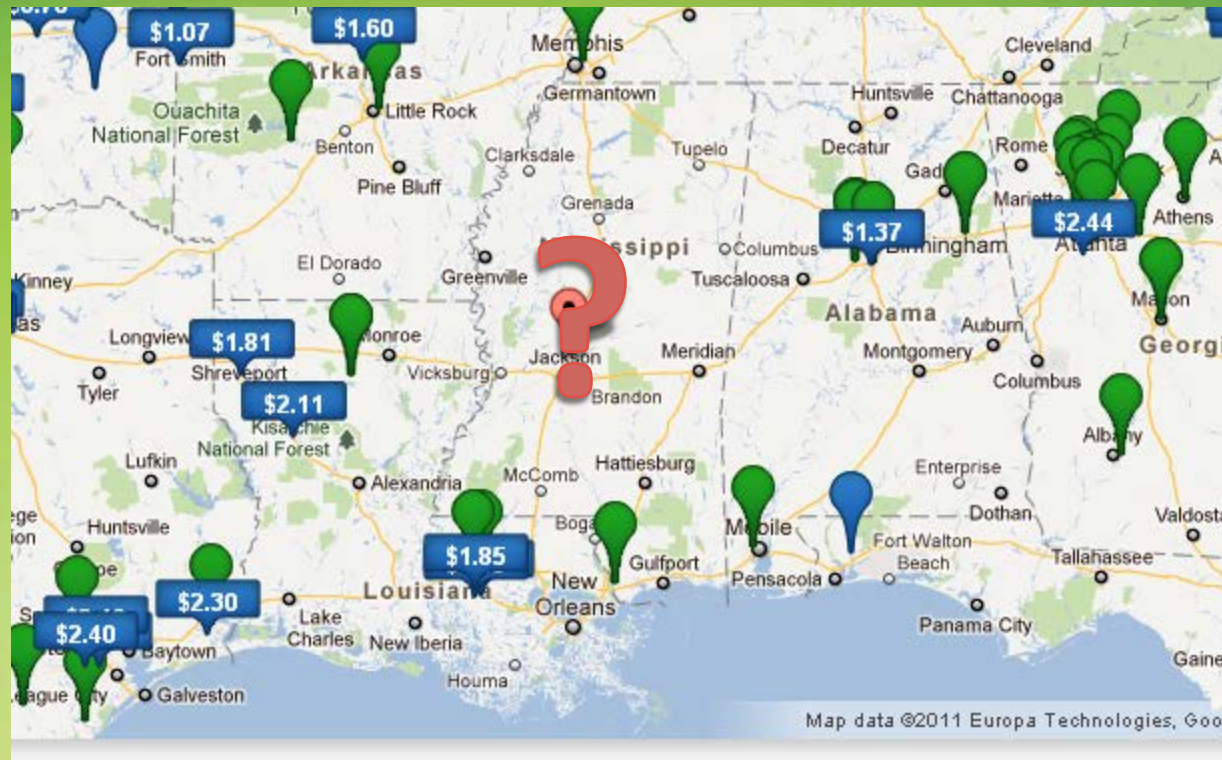
Natural Gas as a Transportation Fuel

- How the Natural Gas Vehicle (NGV) uses CNG?
 - CNG flows through a stainless steel line to a regulator that drops the pressure to around 400psi
 - A fuel injection system almost identical to a G/D engine feeds the CNG into the cylinders
 - Using the Factory On-Board sensors and computers the CNG is mixed with air for the combustion stroke of the engine
 - Therefore, with off-the-shelf kits, virtually all Gasoline light/medium duty vehicles can be converted to CNG (H/D diesel engines need major engine modifications)

NGV images

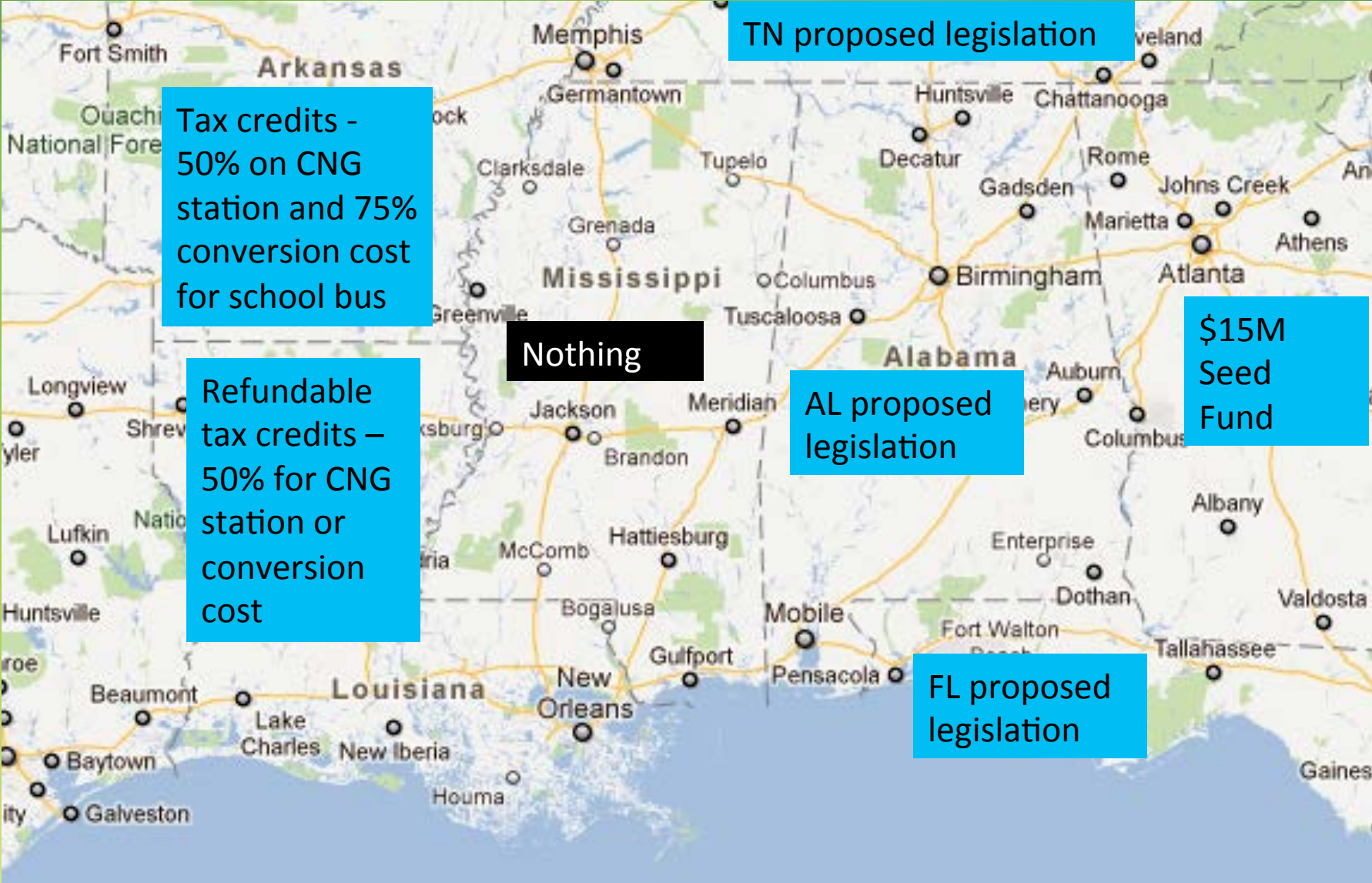


Where is CNG available today



Additional CNG Stations Planned for 2012/13 – 6 in AL, 3 in the FL panhandle, 5 in Memphis, 8 in LA, and 5 in AR

State Incentives for Infrastructure



Barriers to NGV adoption

- Regulations - Onerous EPA requirement for Conversion can add \$8,000 - \$20,000 to each vehicle
- Low production numbers – Kits & Tanks not built in mass (are dropping as demand increases)
- Only one Honda builds an assembly line produced NGV (Civic)
- Lack of CNG station fueling options

Barriers to CNG stations

- Long ROI on speculative stations
- Station equipment in high demand and production time can reach 6 months
- Public offerings vs. Private fleet security
- Many small fleet slow-fill units are built outside USA and must be retro-fitted to meet our standards
- Lack of NGVs to fuel

Needs for success in MS

- Level the playing field “economically” - competitive incentives to attract private investments in the infrastructure build out like surrounding states
- Commitment by Public/Private Fleets to convert to use CNG (attracts station operators)
- Adopt life-cycle reviews before purchasing State Fleet vehicles (NGV are cheaper)

Benefits for Mississippi

- Cut fuel budgets by 30%-50%
- Creates new economy with electrician, plumbing, compressor packagers, construction companies, station design, control systems, mechanical technicians, vehicle sales, conversion shops, etc.
- New market for MS produced Natural Gas (keeps our Oil/Gas economy on track)

Additional Benefits

- Schools can redirect fuel savings to classroom
- Law enforcement directs fuel savings to additional officers
- Small business can use savings to expand
- Money from CNG “stays home” rather than funding nations that hate us and seek to harm
- Keeps MS air clean and free from stricter EPA regulations