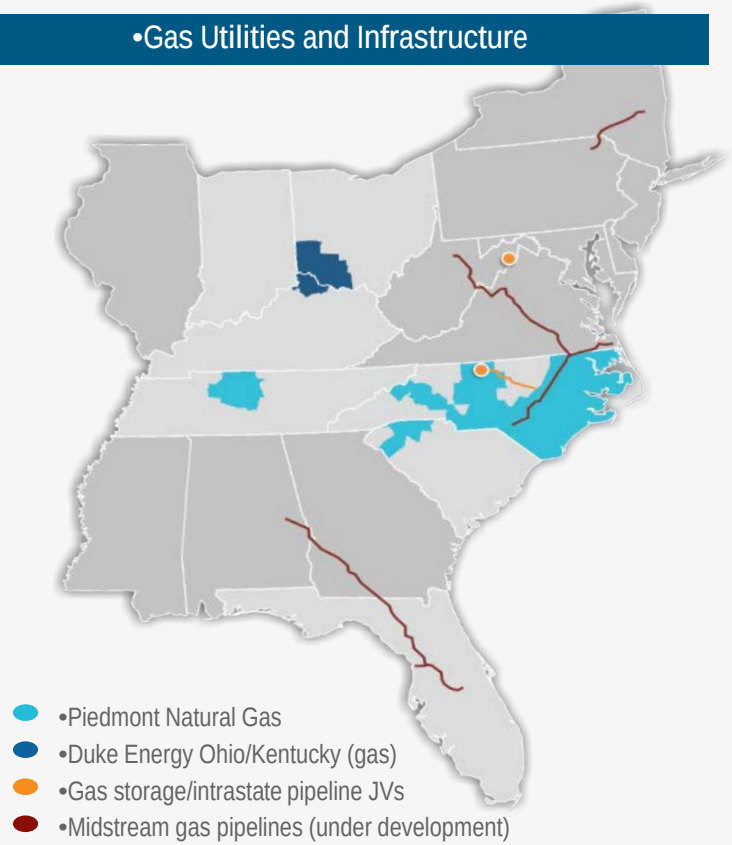
Piedmont Natural Gas

CNG / Natural Gas Vehicles - Overview and Opportunities

TN Sustainable Transportation Awards
23-May-2017

Piedmont Natural Gas Overview

•Gas Utilities and Infrastructure



	Piedmont	Duke	Total Gas
Customers	1.0MM	0.5MM	1.5MM
Distribution Pipeline	22,500 miles	7,027 miles	29,527 miles
Transmission Pipeline	2,920 miles	148 miles	3,068 miles
Compression	7 stations 72,000 hp	NA	7 stations 72,000 hp
Annual Capital Program	$425 - 825MM	$125 – 225MM	$550 - $1,050MM

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Natural Gas Overview

Natural gas is key to addressing our energy needs

- Clean, efficient, reliable and abundant domestic source of energy
- Cleanest-burning fossil fuel
- Safe, clean and affordable
- More than 95% of natural gas used in the U.S. comes from North America

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Natural Gas Facts

- There are more than 73 million residential, commercial and industrial natural gas customers in the US
- Natural gas is efficient: 92% of the natural gas produced is delivered to customers as usable energy
- The domestic natural gas supply is estimated to be large enough to meet the US energy needs for the next 90+ years
- There are nearly 2.5 million miles of pipelines that transport natural gas throughout the US
- Natural gas pipeline and utility companies spend approximately $22 billion per year to ensure safety and reliability of the pipeline infrastructure

Source: American Gas Association

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Natural Gas
Transportation Market

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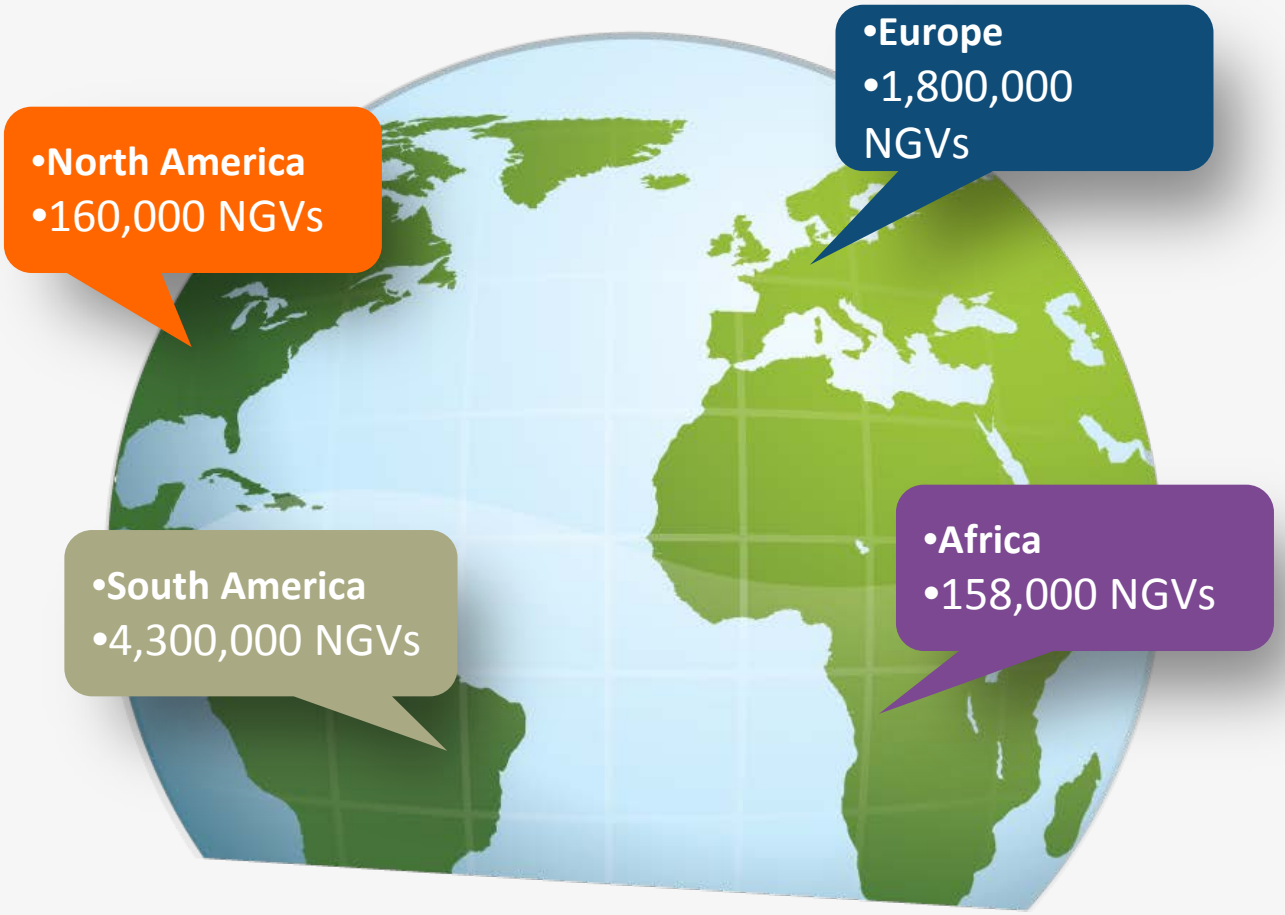
CNG Worldwide Market



There are over **15 million** natural gas vehicles on the road worldwide – but less than 165,000 are in the United States.

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NGVs Are a "Good Fit" for Many Fleet Applications

- Medium to heavy duty fleets well suited for CNG market:
  - Local/State Government
  - Airports
  - Refuse/Garbage Haulers
  - Transit Buses
  - School Districts
  - "Short-Haul" delivery
- Reasons for CNG:
  - Diversity of fuel options
  - Cost/emissions savings
  - Sustainability message

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Nashville Airport - CNG

- Operates 28 CNG parking lot shuttle buses
- Opened its first CNG private station at Airport

"Sustainability is always a top priority in every project the Airport Authority takes on. We officially transitioned to CNG-fueled shuttles in early January, so from a sustainability perspective, it only made sense that we also open and operate a compressed natural gas fueling station for our new fleet."

Rob Wigington, MNAA President and CEO

Source: MNAA website

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Natural Gas Fueling Stations

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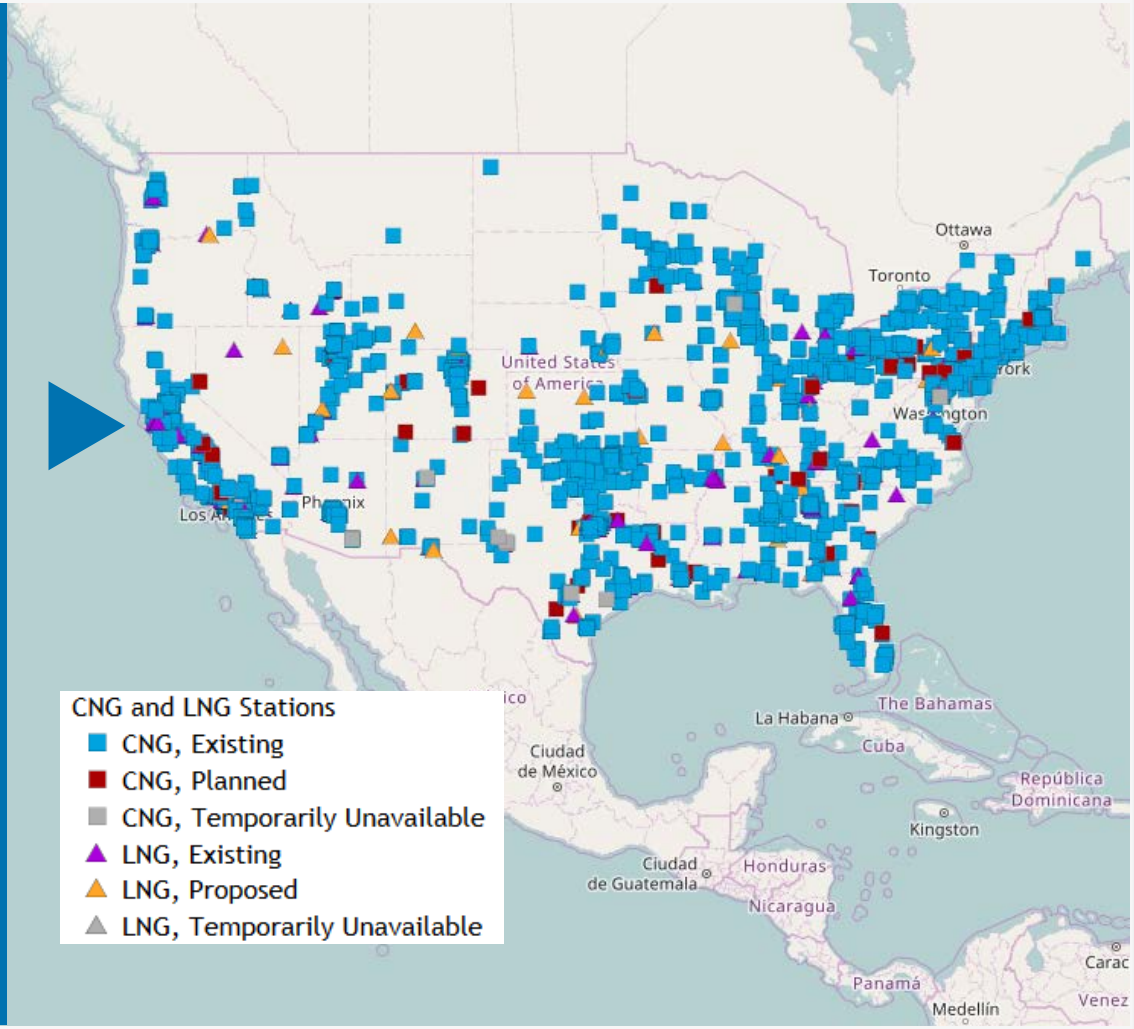
Natural Gas Fueling Infrastructure

Natural gas fuel station infrastructure is continually expanding

- **Over 1,800 Natural Gas Stations**
  - More than doubled past 5 years
  - 10-12+ new stations per month



•Source: NGVAmerica, January 2017

DOE Alternative Fuels Data Center

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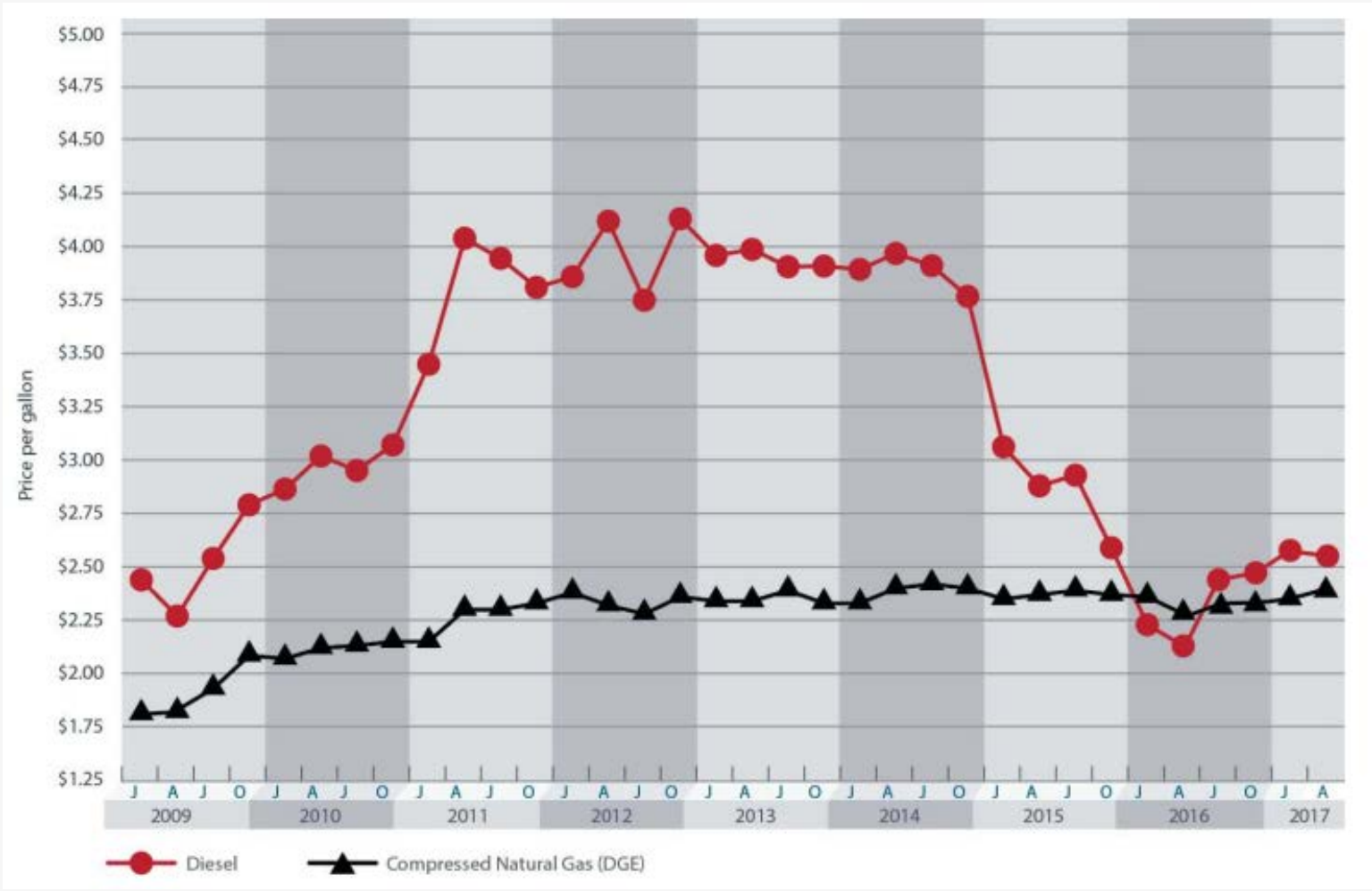
CNG PRICES VS DIESEL



Source: http://www.afdc.energy.gov/uploads/publication/alternative_fuel_price_report_april_2017.pdf

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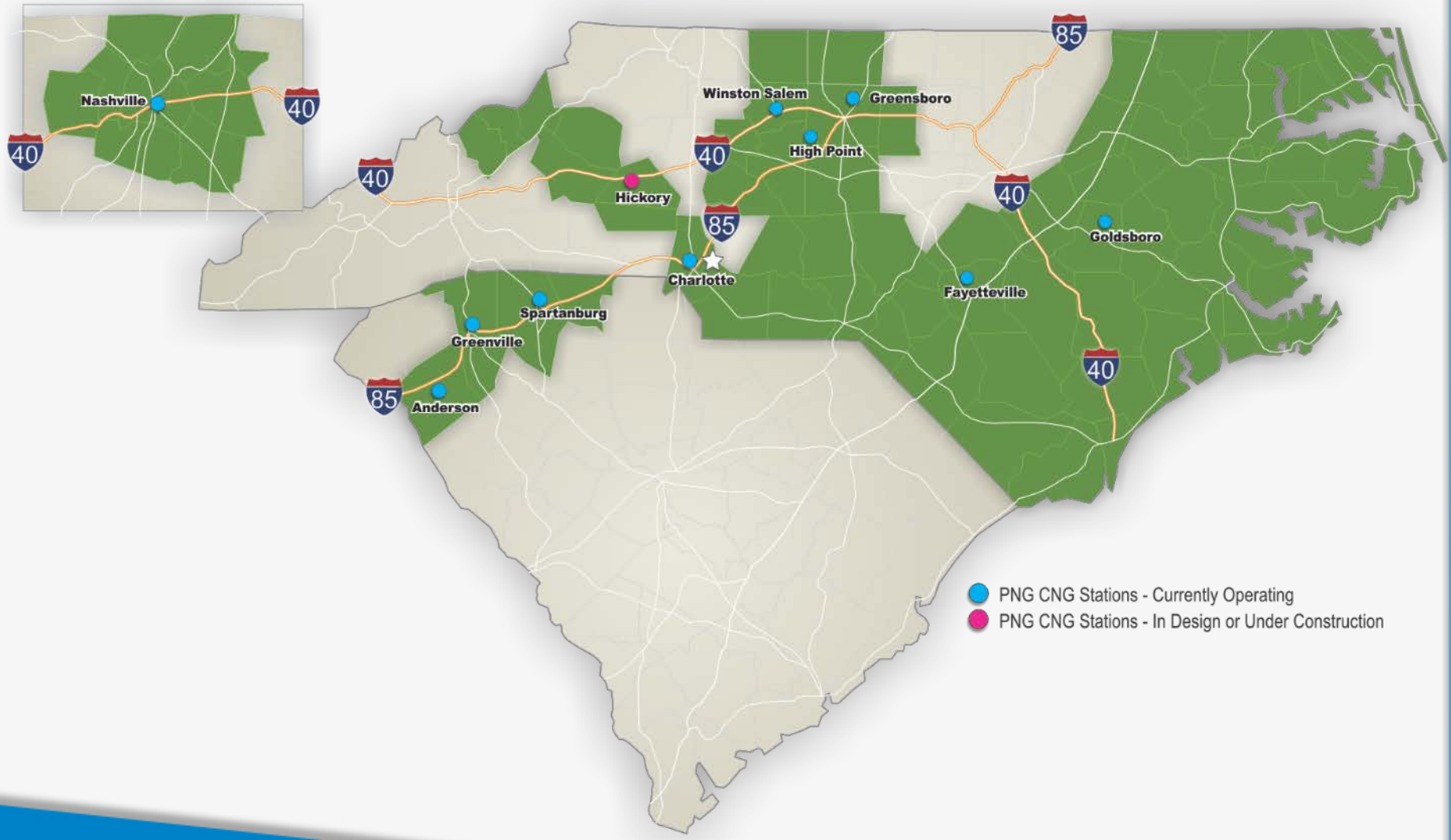
Current Public CNG Stations



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What Helped Jump-Start Piedmont's Growth

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Charlotte CNG Station

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Publicly-Accessible CNG Stations

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Nashville CNG Station

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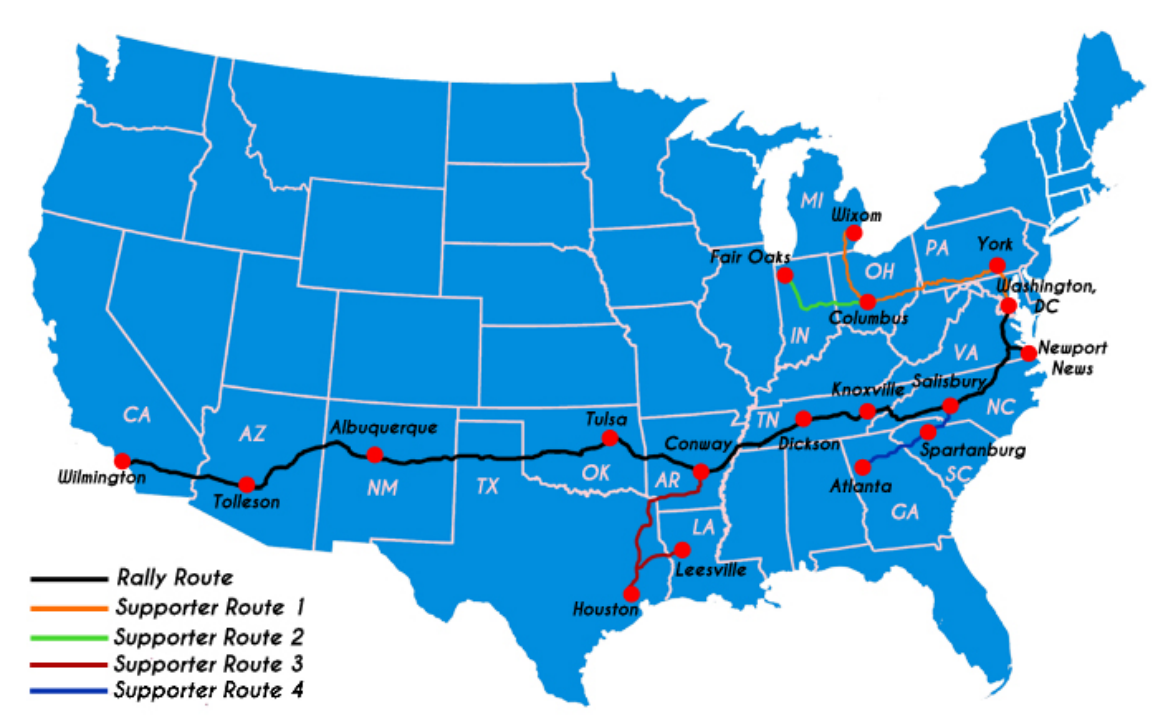
NGV Road Rally Across America

- 2nd annual “From Sea to Shining Sea” NGV Road Rally Across America



Natural Gas Vehicle Deployments and Benefits

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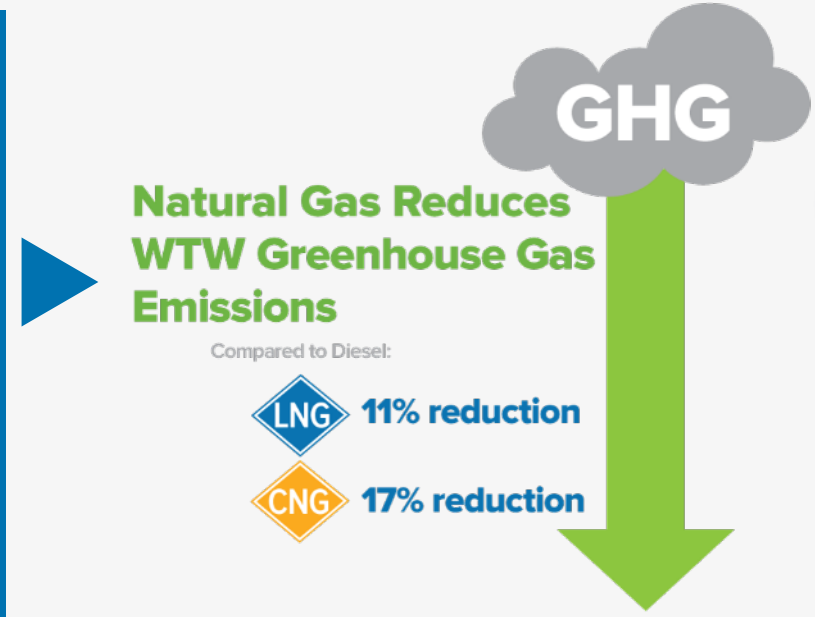
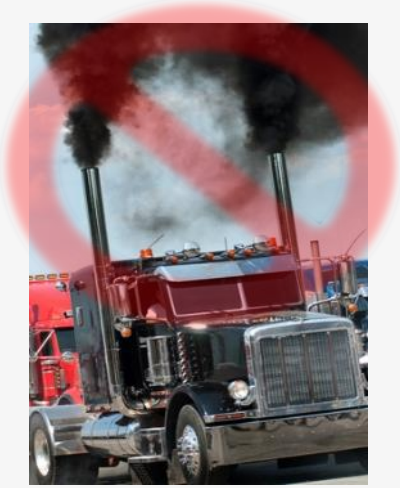
Vehicle Emissions

- Using CNG can improve local air quality and reduce greenhouse gases

Fueling with natural gas reduces CO_2 and greenhouse gas emissions





•Source: NGVAmerica Emissions Whitepaper based on CARB LCFS

•**Numbers compared to diesel emissions (well-to-wheel)*

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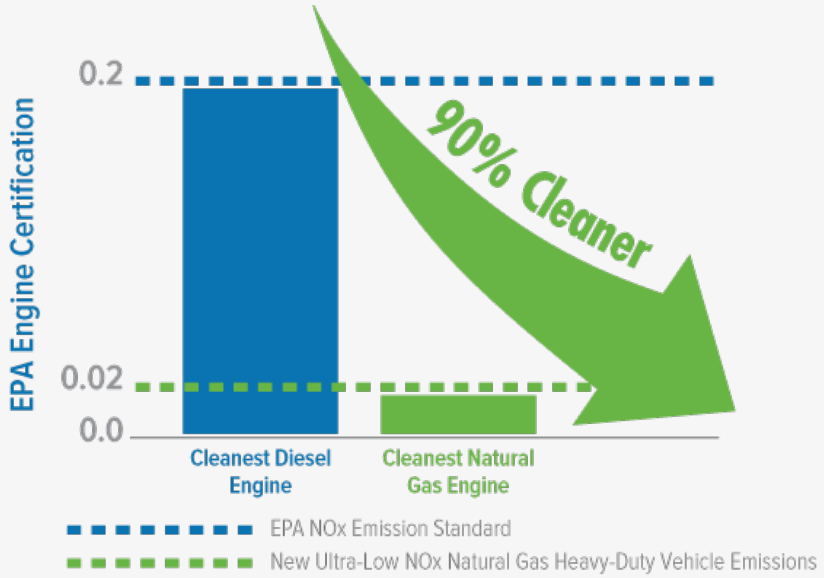
Vehicle Emissions

The cleanest heavy-duty truck engine in the world is powered by natural gas

- Certified in 2015 by the U.S. Environmental Protection Agency and California Air Resources Board



•The Cummins Westport Ultra-Low NOx engine is certified to a 0.02 g/bhp-hr standard, which is:

- 90% cleaner than the EPA's current NOx standard
- 90% cleaner than the latest available diesel engine

Source: NGV America

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Vehicle Emissions

Cummins Westport Optional Near Zero Product Line

•ISB6.7 G

•6.7L

- Spark Ignited, SEGR, TWC
- Peak Rating: 260 hp
- 660 lb-ft torque
- 33,000 lb. GVW
- School bus/Shuttle bus/Sweeper/Yard spotter
- **0.1 g/bhp NOx Available Now**

•ISL G

•8.9L

- Spark Ignited, SEGR, TWC
- Peak Rating: 320 hp
- 1000 lb-ft torque
- 66,000 lb. GVW
- Refuse/Transit/Regional P&D Truck/Mixers
- **NZ Available Now**

•ISX12 G

•11.9L

- Spark Ignited, SEGR, TWC
- Peak Rating: 400 hp
- 1450 lb-ft torque
- 80,000 lb. GVW
- Regional Haul Truck/Tractor/Refuse
- **NZ Available Q1 2018**

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Research & Development

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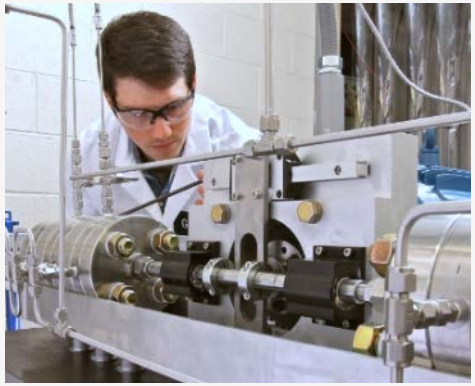
Piedmont R & D Funding

- Funding through GTI's Utilization Technology Development program
- Program funding sectors:
  - Transportation, Residential, Commercial, Industrial, Commercial Food Service, Distributed Generation

gti GAS TECHNOLOGY INSTITUTE



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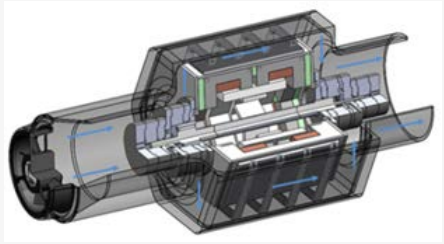
Examples of Transportation R&D Projects

Engine & Component Development

- Advanced Plasma Ignition- Enerpulse/Ricardo/PSI Engine
- Development of Dedicated 6.7 liter CWI Medium-duty Engine
- Low Cost Engine Senor Development
- Near-zero Emissions Engine –8.8 liter/Ricardo

Fueling Infrastructure & Home Refueling

- Full Fill CNG Dispenser Development
- Development of Timed Fill CNG Metering System / Controls
- Station Evaluation of Compressor/Booster 2 Bank Storage System
- Free Piston Linear Motor Compressor Development
- CNG Fuel Quality- Detection & Prevention

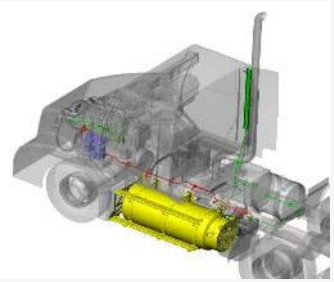


Storage Technology

- Conformable and Modular Storage Study
- NGV2- CNG Cylinder Cycle Test Cost & Time Reduction

Codes, Standards, and Analysis

- CNG Contamination Gas Analysis and Troubleshooting
- CNG Fueling Station Best Practices Guide & Audit Kit
- High Volume CNG Off-road Applications Study
- Methane Fugitive Emissions Review and Analysis



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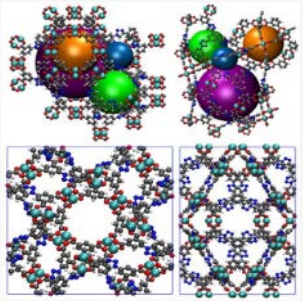
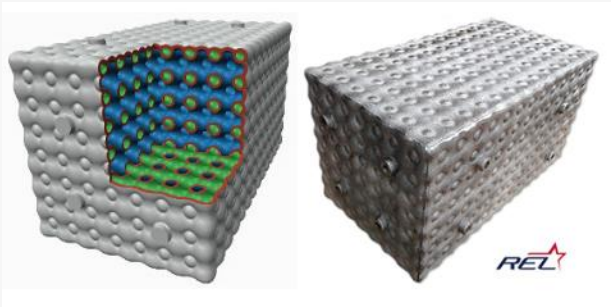
CNG Storage Tank Innovation

- **UTD supported development** of 3M/Hypercomp CNG cylinders with advanced 3M nanoparticle-enhanced matric resin technology
  - Commercially introduced in 2013, now marketed through Momentum Fuel Technologies
  - 30, 40, and 45 DGE tank sizes
- Active UTD research includes conformable tank developments
- Significant research performed on adsorbed natural gas (ANG) materials





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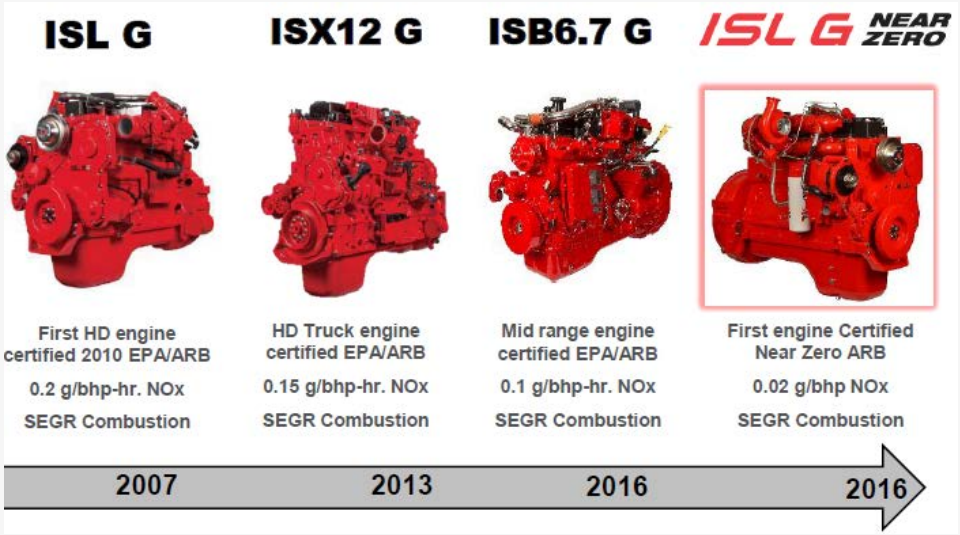
Long-Term Support for Cummins-Westport NGV Engines

- Multiple UTD projects over 10+ years supporting engine development and demonstration, in cooperation with CEC, SCAQMD, SoCalGas, others
- CWI has delivered 60,000+ natural gas engines worldwide
- New ISB6.7G engine for medium-duty and vocational vehicles
- New ISL G NZ has certified NOx emissions as low as a 100% battery truck using electricity from a modern combined-cycle natural gas power plant!



www.cumminswestport.com

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Thanks for your time!

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