



4th Natural Gas for Transportation Roundtable  
Wisconsin Clean Cities January 29, 2013

*APG Turbocharged Natural Gas™ System  
Diesel Dual Fuel Conversions*

# Agenda

- Natural Gas Systems Fuel Injection vs. APG Turbocharged
- APG System and Components
- Dual Fuel Markets
- APG Case Studies
  - System with SCR
  - System with DOC / DPF
- Value Analysis Example
- APG National Roll-out with the WheelTime Truck Service Network and Inland Power Group
- Summary

# Natural Gas Engine Technologies

## *Custom Fuel-Injected*

- 85% - 100% Diesel Displacement
  - High Engine Temperatures
  - Lower Compression Ratios with NG

### Design Requirements:

- High-Temp Parts
- Custom High-Pressure Fuel Injectors
- High-Temp Oil
- Dedicated to Natural Gas Fuel
- Lengthy Custom Design Cycles
  
- **Primarily New / OEM Markets**

## *APG Turbocharged*

*“Pre-Turbo Methane Enriched Air”*

- <80% Diesel Displacement
  - Operate within OEM Temps & Pressures
  - Retain OEM Diesel Compression Ratios

### Dual Fuel Design Savings:

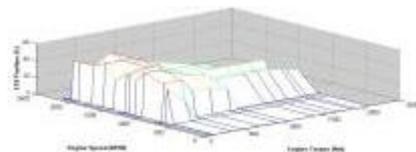
- Non-Invasive to OEM Engine
- Avoid all fuel-injector related costs
- Normal Oil and Maintenance Cycles
- Flexibility to return to 100% Diesel at Anytime
- Immediate Universal Design Applicability
  
- **Focused on Conversion Upgrades but developed with an OEM mentality**

# APG's Patented Third Generation Designed By Powertrain Leaders in Detroit



## Digital Dual Fuel Electronic Control Unit

- Software based control and emission strategy
- Read-only access of OEM CAN Bus system
- Maintains OEM temperatures & pressures via closed loop feedback
- Dynamic fuel control system



## 3D Natural Gas Software Mapping System

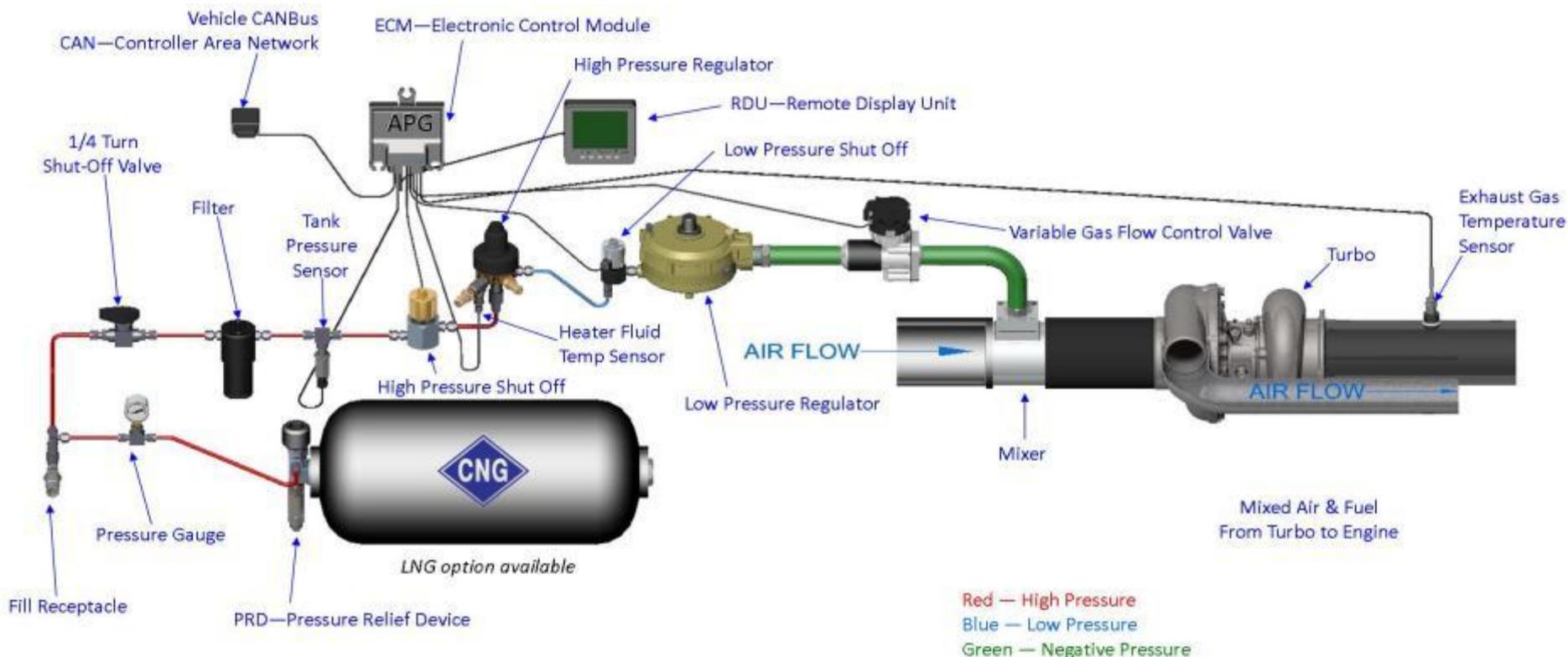
- Meet emissions – optimize displacement at all transient loads
- Hysteresis control strategies ensure seamless operation



## Variable Fuel Metering

- Optimize displacement through full RPM & transient load ranges

# V5000 Dual Fuel System Components



**Proven Components – ECU, pressure regulators, sensors, gas flow control valve are all in production and have proven durability**

# Customer Value Proposition

- Net Annual Fuel Savings: Savings of 20%-45% over existing diesel fuel expense
- Cost & Payback: Lowest total cost of ownership – Payback 3-18 months
- Performance: No loss of power or torque - easy to operate
- Maintenance: High uptime – normal diesel oil & maintenance cycles
- Emissions: EPA Approved/Compliant – reduction in CO, NOx, NMHC, & PM
- End of Life: Sell as “green” diesel engine or transfer to another engine

# Addressed Market Applications



Diesel Trucks

250 – 600 HP

Est. 3-4 million Class 8 trucks

Multi-billion dollar addressable market

APG EPA Approvals stand at 88 engine families & growing



Oil & Gas Drilling Rigs

750 – 1500 HP

Diesel Engines

Typical 3 engines per rig spread

Thousands of engines in operation



Oil & Gas Fracturing Rigs

2000 – 2500 HP

Diesel Pumps

Typical 20 engines per rig spread

Thousands of engines in operation



Industrial/Mining

1MW – 12 MW

Generators

Another multi-billion dollar addressable market

# APG Dual Fuel – Energy & Power Installations – Oil & Gas

**Drilling Rigs: Typically three 1500HP units per rig**



**Hydraulic Fracturing:**

Typically up to twenty 2250-2500HP diesel pumps per rig  
Field testing and production orders with top E&P corporations  
EPA Memo 1A Emission Testing on major engine families  
- CAT, Cummins, MTU/DD



## Emerging Trend: LNG for Hydraulic Fracturing



**PROMETHEUS**energy



- Full 20 trailer rig
- MTU 12V4000
- Marcellus Shale

American Power Group  
*Turbocharged Natural Gas™ System*

# New EPA Clean Alternative Fuel Engine Conversion Regulations For Heavy-Duty Trucks

Age Category	EPA Requirement	EPA Testing
New (< 2 years old)	Full Certification	FTP Data / EVAP Data / OBD Data
Intermediate (> 2 years old and <435,000 miles)	On-line Approval	Engine Dyno Meets Standards / OBD Scan by Engine Family
Outside Useful Life (> 10 years old or any age greater than 435,000 miles)	On-line Approval	Chassis Dyno – Road Test Technical Description / OBD Scan by Engine Family

# APG Engine Family Status for EPA Approvals

## APPROVED

OUL:				
<b>Caterpillar</b>	C15	2006 – 2004		
	C13	2006 – 2004		
	C11	2006 – 2004		
	C-16	2002 – 1998		
	C-15	2003 – 1998		
	C-12	2003 – 1998		
	C-10	2003 – 1998		
	<b>Cummins</b>	ISM	2006 – 2002	
		ISX	2006 – 2002	
	<b>Detroit Diesel</b>	DD15 14.8L	2009 – 2008	
	DD13 12.8L	2009		
	MBE 4000 12.8L	2009 – 2008		
		2006 – 2004		
	Series 60 14.0L	2009 – 2002		
	Series 60 12.7L	2006 – 2002		

## Next Up (OUL)

Cummins ('07-09)  
Mack E7 & MP7  
Volvo D12/D13  
Pre-EGR engines

## Next Up (IUL)

Cummins  
Detroit Diesel  
Volvo  
Mack



**IUL:** University of Houston Diesel Test Cell – In Process

# Fuel Tank Options – Trade-Off Weight, Range, Cost

## CNG Tanks



Type 1 & 2

Steel Only and Carbon Wound Steel

Type 3

Aluminum/Carbon Cross-Wound

Type 4

Gas Tight Plastic /Carbon Cross-Wound

Approved:

All DOT Approved

Dual Fuel Range:

Depends on Tank Size

**Average range of 200 to 400 miles**

## LNG Tanks / Heat Exchanger



Can store natural gas fuel cryogenically at -260° F as a liquid

Use Heat Exchanger to gasify liquid to usable state.

Dual Fuel Range:

Depends on Tank Size

**Average range of 500 to 600 miles**

**Select fuel and tank(s) based on fuel availability, route, range, and truck packaging space**

## Case Study 1 – Euro 4 Emissions with SCR

- 19 tractors in Australia successfully running on APG LNG conversion upgrades
- Cat, Cummins, Detroit & Volvo engines 2000 – 2010, (12.7L – 16L) with triple-trailer loads of 120,000 – 300,000 lbs.
- APG Turbocharged System outperformed fuel-injected systems in 2011/2012 field test trials
- Over 1,000,000 kilometers accumulated as of November 2012
- Multi-year distribution agreement with Wesfarmers EVOL LNG
- Averaging 60% - 65% Diesel Displacement with Natural Gas On Long Hauls





# Case Study 2 – US07 Emissions with DOC / DPF / EGR

- 2008 Detroit Diesel 903 CID 14.8L (DD15) in a Freightliner Vehicle successfully running on APG EPA Approved NG conversion in US, owned by Paper Transport
- Running since July 2011, ~2000 miles a week / 150,000 miles total accumulated
- Averaging 48% - 50% Diesel Displacement in dual fuel mode at Paper Transport
- 50% reduction of diesel fuel usage is a typical value seen with APG dual fuel for Class 8 long-haul
- Lesson-learned from demo – Be sure to maximize NG storage on-vehicle

November 2012

Michael Schiltz, VP of Operations  
 American Power Group, Inc.  
 2503 E Poplar Street  
 Algona, IA 50511

RE: Dual Fuel System Reference

Dear Mr. Schiltz,

We have been operating American Power Group, Inc.'s 50000 Dual Fuel Turbocharged Natural Gas™ System on a 2008 DD15 14.8L Class 8 engine and are very pleased with the system's performance. The Freightliner upgraded with the Dual Fuel system has been in normal operation since it's immediate re-entry into the fleet.

As an aftermarket technology, APG's system has met our expectations and we recommend their Turbocharged Natural Gas™ technology to other over-the-road trucking firms looking to reduce fuel costs by utilizing natural gas as a fuel.

Our truck is currently in operation and is unavailable for demonstration purpose, however we are more than happy to answer questions from pre-qualified prospective customers via email at [ddsp@papertransport.com](mailto:ddsp@papertransport.com).

Sincerely,

*D. A. Duppel*  
 Dan Duppel  
 Director of Maintenance and Procurement

Paper Transport  
 Letter of Reference



	Emissions, g/bhp-hr				
	CO2	kNOx	CO	NMHC	PM
Ave of Two Baseline Runs:	<b>498</b>	<b>4.0</b>	<b>0.1</b>	<b>0.01</b>	<b>0.00</b>
Ave of Two Mixed-Fuel Runs:	<b>467</b>	<b>3.1</b>	<b>0.1</b>	<b>0.00</b>	<b>0.00</b>

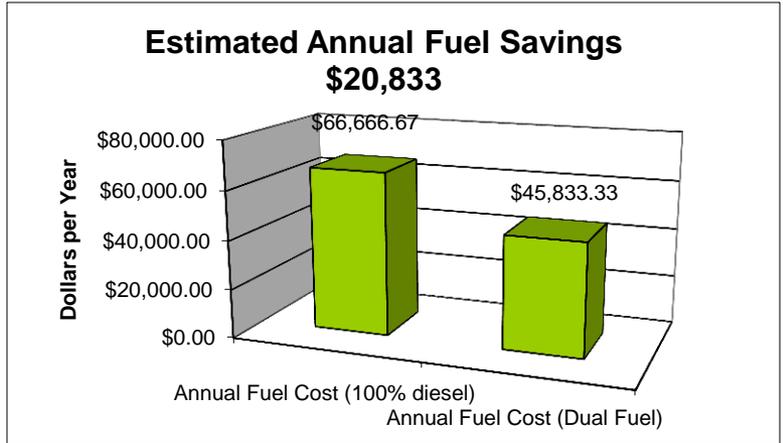
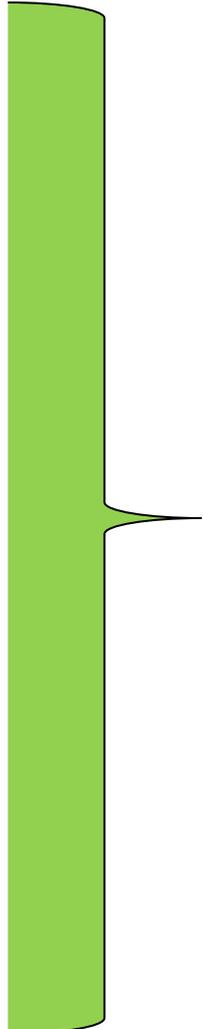


# Value Analysis Example - \$1.50 per DGE CNG

**Original APG System Cost  
Including Tank, Fill Box & Installation  
\$25,000 to \$30,000**

## Usage Assumptions

- Mileage: 100,000 miles / year or 400 miles per day
- Baseline fuel economy on diesel: 6.0 MPG
- Price of diesel fuel: \$4.00 / gallon
- Price of natural gas (CNG) in Diesel Gallon Equivalent: \$1.50 / DGE, an average of different regional prices.
- Average diesel substitution: 50% (from case study 2)
- Installation cost: Range as above
- Uninstall / reinstall on second engine: \$5000 - \$6000



## Payback First Install

- Low range system / install cost: ~14 months
- High range system / install cost: ~17 months

## Second Install Payback

- Low range system / install cost: 3 months
- High range system / install cost: 3.5 months

• Note – 0% discount rate



# American Power Group Signs National Distributor & Master Marketing Agreement with WheelTime Network LLC

18 Regional Company Members with USA / Canada coverage



<p>WheelTime Objective:</p>	<ul style="list-style-type: none"> <li>• WheelTime Network has identified a strategy to become recognized as a center of excellence in natural gas systems installation and service</li> <li>• Selected and endorsed APG's Dual Fuel Conversion Technology as "Best in Class"</li> <li>• Will establish a North American network to market and install APG's technology</li> </ul>
<p>WheelTime Capabilities:</p>	<ul style="list-style-type: none"> <li>• WheelTime Network has been recognized as North America's Highest Quality Truck Service Network             <ul style="list-style-type: none"> <li>• Nearly 200 service centers in 50 States and Canada</li> <li>• 2,800 service bays</li> <li>• 3,000 factory-trained technicians with 30 training facilities</li> </ul> </li> <li>• WheelTime members understand all levels of diesel engine performance</li> </ul>
<p>American Power Group:</p>	<ul style="list-style-type: none"> <li>• Accelerates a North American roll-out of consistent installation service levels</li> </ul>



# Knowledgeable, local service



- **Over 50 Years Experience**
- **Grille to Taillight Repair & Service**
- **6 Midwest locations, including Milwaukee, Green Bay, Rockford & UP-MI**
- **250,000 s.f. of facilities, including 88 service bays, supported by \$18 Million Inventory**
- **283 Employees, 143 technicians**
- **24/7 Emergency Support**
- **Your local WheelTime network member**





# Summary and Closing

- Elegant Low-Cost Design
- Safe
- Fuel Cost Savings
- Field Tested
- Highest Quality Truck Network
- EPA Approved
- Reliable
- Excellent Payback
- Reduce Emissions
- National Coverage



Game-Changing Technology: Dual fuel gives current fleet owners a flexible transition to natural gas with a safety net of returning to 100% diesel operation at anytime

