



*Introduction to Dual Fuel  
Diesel Conversions*



# Growing High-Horsepower Dual Fuel Natural Gas Markets



Class 8



DF Gliders



Extreme Duty



Oil & Gas



Emergency  
Backup



Mine Haul



Marine



Rail





# Class 8 Natural Gas Engine Options

| Category                           | NG Engine                       | EPA NG Engine Approvals   | Models   |
|------------------------------------|---------------------------------|---------------------------|--|
| New Tractors                       | Dedicated (Spark-Ignited)       | 2                         | CWI 8.9L, 11.9L  |
| New Freightliner Dual Fuel Gliders | APG Dual Fuel (Factory Install) | 6                         | CAT ReMan<br>Cummins ReCon®<br>DD Reliablit®<br>C-15<br>ISX, ISM, N14<br>Series 60 12.7L, 14.0L  |
| Existing Tractors                  | APG Dual Fuel (Conversions)     | 457 (Pre-SCR)<br>17 (SCR) | CAT, Cummins, Detroit Diesel, Volvo, Mack<br><br>Volvo/Mack<br>Detroit Diesel<br>Cummins ISX<br>MaxxForce<br>D13, MP8 – EPA Approved<br>DD13, DD15 – EPA Approved<br>ISX 15- EPA Approved<br>In EPA Prep – July 2015 |

# APG Dual Fuel Highlights



- Turbocharged Natural Gas®
  - No fuel injectors
- No high-temp parts
  - Standard oil & maintenance
- Operate inside normal diesel engine specs
- Seamlessly can return to 100% diesel operation
- Net fuel savings
  - \$0.05 - \$0.20 per mile
- Diesel displacement
  - Peak 70%
  - Average 50% - 60%
- No loss of power & torque
  - Target 350HP – 600HP
- Non-invasive
  - Read-only J1939 interface
- Transferable system/tank
  - 20 year life
- Sustainability
  - Reduce diesel emissions
  - Reduce NOx & PM by 25% - 45%

# Turbocharged NG vs. Fuel Injected NG



## *APG's Turbocharged Natural Gas® Dual Fuel Technology*

- Non-invasive to OEM engine and CAN-bus system
- Introduces NG thru low-cost mixer into turbocharger
- Operates within OEM engine temperatures and pressure
- Uses normal OEM specified oil with extended oil life
- Universally adaptable to all 4-stroke engines
- No practical limit on horse power to be converted
- No loss of power or pulling torque
- Seamlessly returns to 100% diesel fuel when required
- Low cost of entry
- Can be transferred to another approved engine

## *Dedicated "Fuel Injected" Technologies*

- Invasive to OEM engine and CAN-Bus system
- Requires expensive custom fuel injectors
- Requires more expensive high-temp parts
- Requires special high-temp oil with shorter life
- Requires custom design to each engine model
- Current design limit around 400HP
- Power and pulling torque are compromised
- Dedicated to natural gas therefore subject to "range anxiety"
- Higher cost of entry
- Cannot be transferred to another engine

# APG Vehicular Dual Fuel Progress



## EPA Approvals

### CARB Executive Orders

|                 |                         |
|-----------------|-------------------------|
| MY 2009 & Older | 457 Engine Approvals    |
| MY 2010 & Newer | 17 Engine Approvals     |
| CARB EO         | 3 Engine Certifications |

## Dual Fuel Experience

500+ APG DF Conversions in operation  
75+ million road miles of DF experience  
Filling the 350HP – 600HP natural gas gap

## Customer Feedback

Fuel Savings of \$.05 to \$.20 per mile  
Reliable design with high uptime  
Standard oil & engine maintenance  
No loss of power or torque

## Sustainability

NOx & PM reductions of 25% - 45%  
Eligible for emissions reduction grants  
Increase market share with customer

# APG Customers: 50 Million Miles Of On-Road Dual Fuel Experience



| State         | Application               |
|---------------|---------------------------|
| Louisiana     | Forest Services           |
| West Virginia | Coal Mines                |
| Ohio          | Rolled Steel / Aluminum   |
| Georgia       | FedEx Ground Contractor   |
| Virginia      | For Hire: Double-Trailers |

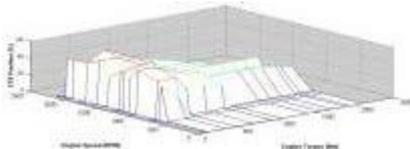
| State        | Application                   |
|--------------|-------------------------------|
| Illinois     | Food Grade Bulk Hauling       |
| Oklahoma     | Dairy & Ice Cream / C Store   |
| Texas        | Top 100 For-Hire Fleet        |
| Idaho        | Buses – National Research Lab |
| North Dakota | Oil & Gas Fields              |

# APG's Patented Third Generation Designed By Power-Train Leaders in Detroit



## Digital Dual Fuel Electronic Control Unit

- Non-Invasive Read-only access of OEM CANBus system
- Maintains OEM temperatures & pressures
- Dynamic fuel control system – no custom fuel injectors



## 3D Natural Gas Software Mapping System

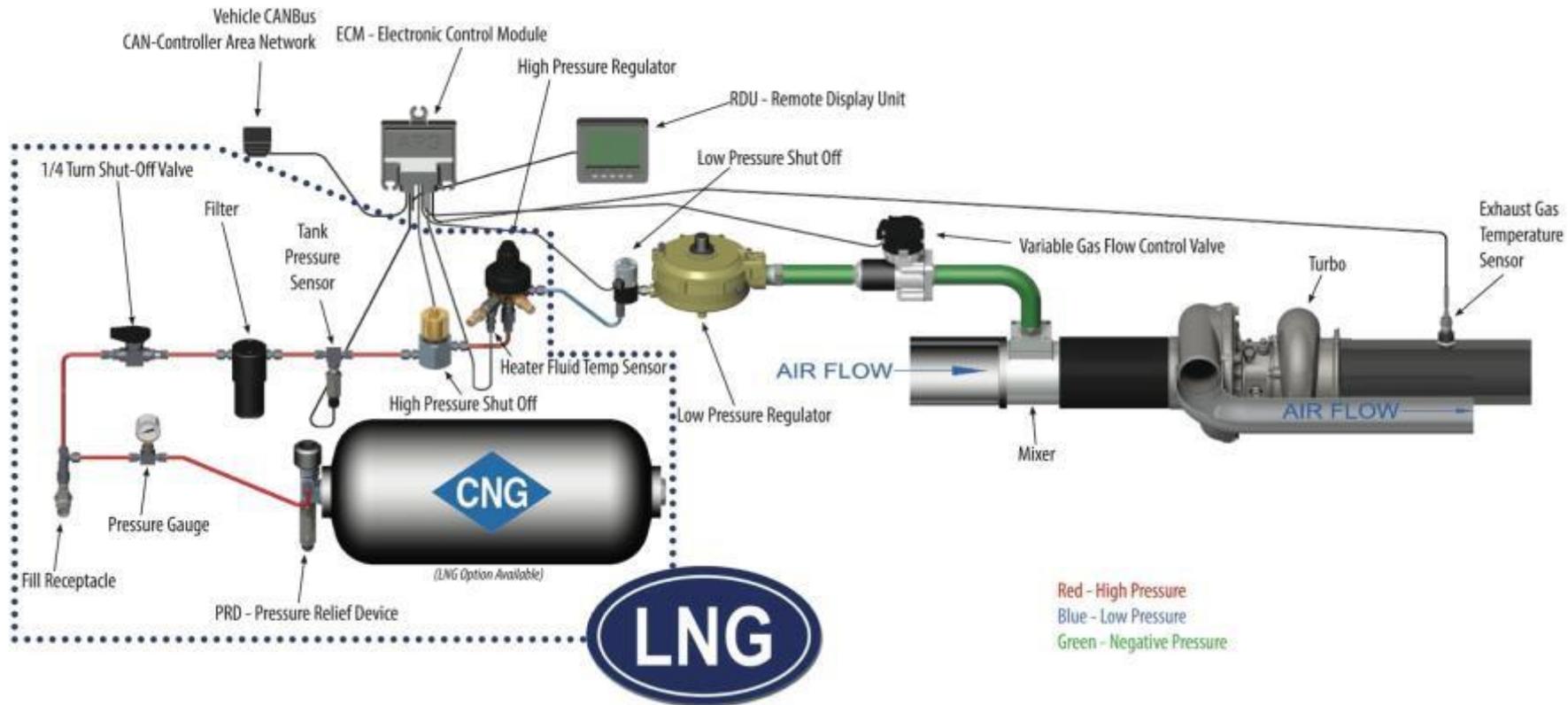
- Meet emissions – optimize displacement at all load ranges
- APG control strategies ensure seamless operation



## Variable Fuel Metering

- Optimize displacement through full RPM & load ranges

# V5000 Dual Fuel System Components



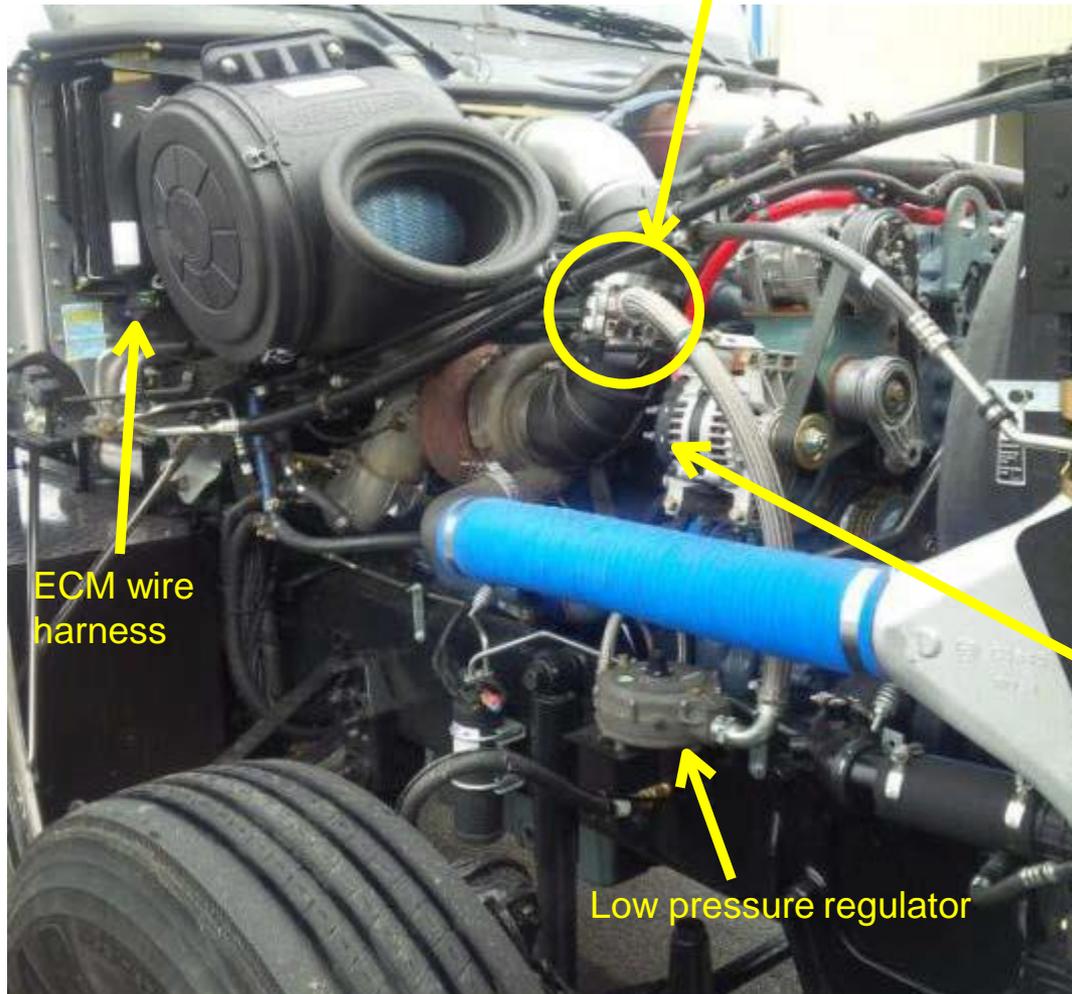
Dotted area represents components not present in V5000LNG Systems  
(\*Tank Pressure Sensor is present in both V5000CNG & V5000LNG systems)

# V5000 Engine Kit Installed



Venturi/Throttle Body Configuration Controls NG substitution %

Remote Display Unit



1-3% by volume of Natural Gas in the air induction system

LEL (Lower Explosion Limit requires 5-15% by volume)



# Many EPA Approved Class 8 Engine Families

## 474 EPA APPROVALS

|                       |                       |             |
|-----------------------|-----------------------|-------------|
| <b>Caterpillar</b>    | C11, C13, C15         | 2006 – 2004 |
|                       | C-16                  | 2002 – 1997 |
|                       | C-10, C-12, C-15      | 2003 – 1993 |
| <b>Cummins</b>        | ISX, ISM, ISL, ISC    | 2009 – 1998 |
|                       | N14, M11, L10, C8.3   | 2001 – 1991 |
| <b>Detroit Diesel</b> | DD15, DD13            | 2012 – 2008 |
|                       | DD13 12.8L            | 2009        |
|                       | Series 60 14.0L       | 2009 – 1999 |
|                       | Series 60 12.7L, 11.1 | 2006 – 1987 |
| <b>Daimler</b>        | MBE 4000 12.8L        | 2009 – 2001 |
|                       | OM457LA, OM460LA      | 2003 – 2000 |
| <b>Volvo</b>          | D11, D12, D13, D16    | 2012 – 2004 |
|                       | VE D12                | 2002 – 1996 |
| <b>Mack</b>           | MP7, MP8, MP10        | 2012 – 2002 |
|                       | E7                    | 2006 – 1996 |
|                       | EM7                   | 2002 – 1996 |

## APPROVED SCR ENGINES

|                       |  |
|-----------------------|--|
| <b>Volvo/Mack</b>     | D13/MP8 (2010 – 2012)                              |
| <b>Detroit Diesel</b> | DD15 (2010 – 2012)<br>DD13 (2010 – 2012)           |
| <b>Cummins</b>        | ISX (2010-2013)                                    |
| <b>Navistar</b>       | MaxxForce (Est. FEB)<br>2013 MY Approvals – (Feb.) |

## CA CARB EO

|              |                                       |
|--------------|---------------------------------------|
| <b>Volvo</b> | D13 (2010 – 2012)                     |
|              | <i>More certifications in process</i> |

*Note: Some engines may not have been produced in each year shown above and some horsepower ratings may not be included. Contact the Dual Fuel System manufacturer or an authorized distributor of the system for more details*



# APG Dual Fuel Emissions Reductions Based on EPA OUL & IUL Testing



|      | SCR*<br>2013 – 2010 | DOC/DPF<br>2009 – 2007 | EGR<br>2006 – 2004 | Pre-EGR<br>2004 – 1987 |
|------|---------------------|------------------------|--------------------|------------------------|
| CO   | 99.9%               | 0.00%**                | 96.9%              | 83.3%                  |
| NMHC | 99.3%               | 100.0%                 | 100.0%             | 100.0%                 |
| NOx  | 42.5%               | 22.5%                  | 42.4%              | 27.1%                  |
| PM   | 77.0%               | 0.00%**                | 37.5%              | 25.0%                  |

\* SCR results measured to EPA 2010 baseline. Balance are measured to EPA approved diesel engine baseline

\*\* Diesel baseline and Dual Fuel results are either at zero or non-measurable



# Tank Sizing and Range



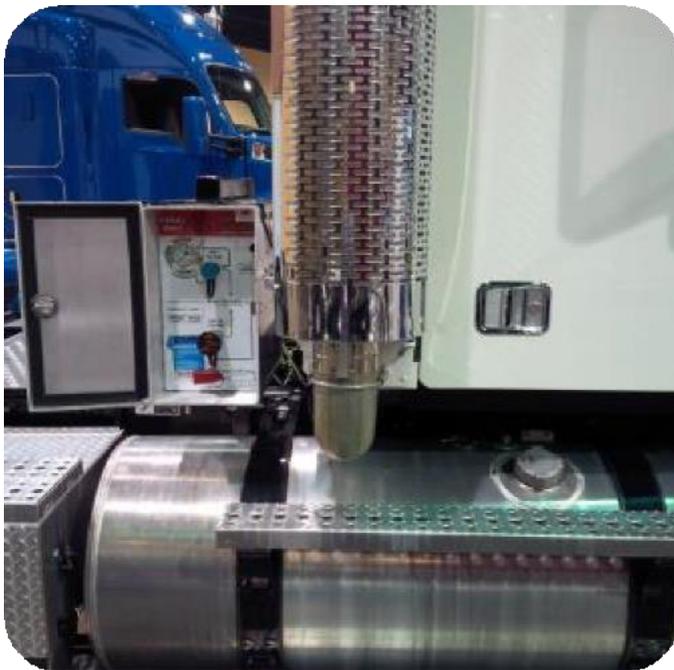
|                | Typical Tank Size | Rated DGE | Estimated Useable DGE | Dedicated NG Engine Mileage @ 6 MPG* | Assume Average Dual Fuel NG Engine Mileage @ 6 MPG (50% Diesel + 50% NG) |
|----------------|-------------------|-----------|-----------------------|--------------------------------------|--|
| CNG Boss Mount | 25" x 60"         | 30.2      | 24                    | 145                                  | 290  |
|                | 25" x 80"         | 41.2      | 33                    | 198                                  | 396  |
|                | 25" x 90"         | 46.5      | 37                    | 223                                  | 446  |
| CNG BOC        | 25" x 80" (x3)    | 123       | 98.4                  | 590                                  | 1,180  |
| LNG            | 26" x 75"         | 55        | 55                    | 330                                  | 660  |
|                | 26" x 90"         | 69        | 69                    | 414                                  | 828  |
|                | 26" x 116"        | 89        | 89                    | 534                                  | 1,068  |

*\*Actual mileage range will vary based on tank size, load, idle time and route profile*



# Tank Installation Options

Side Rail



Back of Cab (BOC) = 98.4 DGE (useable)

# Estimated Change in Net Weight When Tanks are Full



| <u>Configuration:</u>                  | <u>100% Diesel</u> | <u>CNG Dual Fuel</u> | <u>LNG Dual Fuel</u> | <u>CNG Dual Fuel BOC</u> |
|--|--------------------|----------------------|----------------------|--------------------------|
| Tanks: Diesel                          | Two 120 Gallon     | One 120 Gallon       | One 120 Gallon       | One 120 Gallon           |
| Natural Gas                            | N/A                | One 25" x 90"        | One 26" x 90"        | Three 25" x 80"          |
| Rated DGE:                             | 240 DGE            | 46.5 DGE             | 69 DGE               | 123.6 DGE                |
| Effective DGE:                         | 240 DGE            | 37 DGE               | 69 DGE               | 98.9 DGE                 |
| DF Range @ 6.0 MPG & 50%               | 1,560 miles        | 440 miles            | 828 miles            | 1,170 miles              |
| <u>APG System Weight:</u>              | N/A                | 38 lbs               | 38 lbs               | 38 lbs                   |
| <u>Tank/Brackets/Fill Box Weight:</u>  |                    |                      |                      |                          |
| Diesel                                 | 424 lbs            | 212 lbs              | 212 lbs              | 212 lbs                  |
| Natural Gas                            | N/A                | 720 lbs              | 935 lbs              | 1,600 lbs                |
| <u>Fuel Weight – Full:</u>             |                    |                      |                      |                          |
| Diesel @ 7.02lbs/DGE                   | 1,685 lbs          | 843 lbs              | 843 lbs              | 843 lbs                  |
| CNG @ 6.2lbs/DGE                       | N/A                | 229 lbs              | N/A                  | 613 lbs                  |
| LNG @ 6.06 lbs/DGE                     | N/A                | N/A                  | 418 lbs              | N/A                      |
| <u>Estimated Total Weight at Full:</u> | 2,109 lbs          | 2,042 lbs            | 2,446 lbs            | 3,306 lbs                |
| <u>Estimated Net Weight Change:</u>    | 0                  | 67 lbs lighter       | 337 lbs heavier      | 1,197 lbs heavier        |



# How Much Can I Save?

Assumptions: 120,000 miles/year @ 7.0mpg = 17,100 diesel gallons/year

100,000 miles/year @ 6.0mpg = 16,700 diesel gallons/year

Use 17,000 diesel gallons/year – assume displace 55%-60% with natural gas

|                | <b>Diesel / NG</b> | <b>Price Spread</b> | <b>Annual Diesel Cost</b> | <b>Est Annual Dual Fuel Savings</b>     | <b>Savings Per Mile</b> |
|----------------|--------------------|---------------------|---------------------------|---|-------------------------|
| FY 2014        | \$3.90 / \$2.25    | \$1.65              | \$66,300                  | <u>\$15,400 - \$16,800</u><br>23% - 25% | \$0.13 - \$0.17/mile    |
| Last Year      | \$2.60 / \$2.00    | \$0.60              | \$44,200                  | <u>\$5,700 - \$6,100</u><br>12% - 14%   | \$0.05 - \$0.06/mile    |
| Est. 2016      | \$3.40 / \$2.10    | \$1.30              | \$57,800                  | <u>\$12,100 - \$13,300</u><br>21% - 23% | \$0.10 - \$0.13/mile    |
| Est. 2017/2018 | \$4.25 / \$2.25    | \$2.00              | \$72,250                  | <u>\$18,700 - \$20,400</u><br>26% - 28% | \$0.16 - \$0.20/mile    |

# Leverage Sustainability Options: Diesel Reduction per Invested Dollar



Base Diesel Assumption:

100,000 miles per year @ 6MPG = 16,700 gallons/year



OR



| <u>Option</u>  | <u>Capital Investment</u> | <u>Diesel Reduction</u>                 |
|--|---------------------------|---|
| New Dedicated NGV<br>Total Over 5 Years  | \$180,000                 | 16,700 gal/year<br>83,500 gal/year      |
| Convert 6 Existing<br>Trucks to DF @<br>55% Displacement<br>Total Over 5 Years | Same \$180,000            | 55,110 gal/year<br><br>275,555 gal/year |

**3.3x higher diesel displacement**



# APG Dual Fuel 20-Year Life Cycle Return

## Base Assumptions:

- Assume 100,000 miles per year @ 6 mpg = 16,700 of diesel fuel consumed per year
- Assume dual fuel displacement of diesel with natural gas averages 55%
- Assume re-flash to a new tractor engine every five years - 20 year life on NG tanks & core APG system

| Diesel to NG Price Spread               | Investment | \$1.00 Per DGE | \$1.25 per DGE | \$1.50 Per DGE |
|---|------------|----------------|----------------|----------------|
| Annual Dual Fuel Savings                |            | \$9,185        | \$11,481       | \$13,777       |
| Fleet Ownership:                        |            |                |                |                |
| Years 1 – 5                             | \$30,000   | \$45,925       | \$57,405       | \$68,885       |
| Years 6 – 10                            | \$5,000    | \$45,925       | \$57,405       | \$68,885       |
| Years 11 – 15                           | \$5,000    | \$45,925       | \$57,405       | \$68,885       |
| Years 16 – 20                           | \$5,000    | \$45,925       | \$57,405       | \$68,885       |
| Life Cycle Investment & Savings         | \$45,000   | \$183,700      | \$229,620      | \$275,540      |
| Payback on Investment                   |            | 4.1X           | 5.1X           | 6.1X           |
| At 120,000 Miles & 6MPG – Total Savings | \$45,000   | \$220,000      | \$275,000      | \$330,000      |
| Payback on Investment                   |            | 4.9X           | 6.1X           | 7.3X           |

## Announces Factory Installed Class 8 Natural Gas Dual Fuel Glider Kits by American Power Group



Cascadia



Coronado



Columbia



122SD



- Freightliner/Western Star Dealer
- Freightliner's New Truck Warranty
- Total Lowest Cost of Ownership
- Engine Options:
  - DD Reliablit® Series 60 | Cummins ReCon® N14, ISM, ISX | Caterpillar ReMan C-15
- Factory Installed APG DF System
- Day Cab or Sleeper Units
- Lighter Weight than SCR Engines

# New Freightliner Severe-Duty Glider Kit



Severe Duty 122SD Natural Gas Dual Fuel Glider  
*(Oil & Gas ~ Logging ~ Mining ~ Oversized Loads)*



# APG's Dual Fuel Solution

Customer

Hassle-Free One-Stop-Shop Dual Fuel Purchase Experience

## Engine Technology

APG Conversions

APG Dual Fuel  
Gliders

## CNG/LNG Tank Packaging

Determine Route  
Profile

Select CNG or LNG

Tank Sizing: Frame  
Rail or Back of Cab

## Certified Installation

APG  
Certified  
Network

- APG System
- LNG & CNG  
Tanks

## CNG/LNG Fill Station

On-Route  
Availability

Class 8 Accessible

GPM Fill Rate

One Stop Fill Hoses



# Benefits of Dual Fuel

## Economics

- Save \$0.05 to \$0.20 per mile in fuel savings / normal maintenance costs
- Convert 6 existing trucks for same price as a new dedicated NG truck
- Non-invasive & lowest total cost of ownership

## Performance

- No loss of power or torque compared to diesel
- Operates within normal diesel temps & pressures
- Handles extreme heavy-duty loads

## Flexibility

- Can return to 100% diesel when needed
- Protection against future price spread changes
- Can transfer system & tanks to another truck – 20 year asset life

## Environmental

- Reduce diesel-related emissions – increased emphasis on lowering NOx and PM
- Meet sustainability goals – increase market share



Thank you



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