



LNG Creating New Market Alternatives

By David A. Franklin, Mustang Engineering

Just as shale and tight sands reservoirs have given producers a new horizon of investment opportunities through horizontal drilling and multistage completion technologies, liquefied natural gas (LNG) technology can open new opportunities on the marketing side of the business to maximize the value of the produced gas.

Natural gas vehicles (NGV), powered either by LNG or compressed natural gas (CNG), are a growing segment of the transportation fuels market. The benefits to the NGV customer include lower operating cost, lower emissions and smog reduction, favorable commercial regulations, tax rebates and fuel tax credits, and the ability to use 100 percent domestically produced fuels.

For natural gas producers interested in converting daily volumes to LNG or CNG for transportation fuel, the first challenge in developing a market is to locate local or regional fuel consumers

who could benefit from lower-cost LNG or CNG. What fleets and industries may be interested in NGVs powered by LNG or CNG? The characteristics could include:

- **Fleets with repetitive delivery and collection routes**—Examples are the U.S. Postal Service, the United Parcel Service, Federal Express, refuse trucks, drayage container operations, yard hostlers, container terminals, and rail yard switch engines.
- **Larger logistics fleets with regional distribution centers**—National retailers and commercial freight carriers would be candidates, including HEB, J.B. Hunt, K-Mart, Sysco, Wal-Mart, Yellow Freight, etc.
- **Transportation fuel suppliers**—Examples include national chains such as Flying J, Truck Stops of America, Petro, Love's, Pilot, etc.

Kenworth LNG powered truck with high-pressure direct fuel injection systems.

(Courtesy Kenworth)

■ **Commuters/mass transit**—Customers such as city buses, taxi services and other local transportation sources can provide a stable market for fuel.

■ **Off-road vehicles**—Mining and agricultural operations require a constant supply of fuel for vehicles.

A focused market analysis will reveal many additional potential industries and customers that are not readily apparent. One of the most comprehensive resources is the Natural Gas Vehicles for America's website at <http://www.NGVAmerica.org>.

Benefits and Supply Surety

LNG can provide economic and environmental benefits to the prospective client. Converting a fleet of trucks to an alternate fuel represents a significant logistical and financial commitment for a fleet owner, but may be partially offset by federal, state or local incentives. In order to be viable, the fuel alternative must offer sufficient cost savings to recover the investment and produce a satisfactory financial return.

Consideration should always be given to environmental regulations, such as exhaust emission standards and potential future carbon taxes that may adversely affect fleet economics. Natural gas fuel is recognized as a cleaner fuel alternative than petroleum-based fuels, so producers and fleet owners can improve their profitability while developing a new market and improving the environment.



Burlington Northern dual-fuel natural gas tandem with LNG tender in service hauling coal. Has range of 800 miles between refueling stops.

In addition to lower fuel costs or regulatory mandates, the fleet owner must have assurance that the fuel supplier is solvent, has a valid business model, has access to a constant supply of natural gas with alternative suppliers, can provide spare equipment to minimize disruptions, and maintains adequate fuel storage to cover potential outages.

U.S. utilities currently operate more than 100 LNG peak shaving units to liquefy pipeline gas and store it in large tanks when supply exceeds demand. During the winter months, when demand exceeds pipeline capacity, the utilities revaporize LNG and add it into the local utility grid, assuring critical gas supply to their customers. Some LNG peak shavers operate truck loading stations to serve remote community gas grids.

Part of supply assurance is having adequate gas to liquefy, either by having multiple producing wells with only a portion being liquefied, or by having a connection to a treated gas pipeline. Cross-production agreements with other LNG suppliers also can provide supply assurance, covering critical customers while their production is off line for service or repair. This option reduces the cost of spare facilities and improves the overall marketability of LNG for all suppliers.



Peterbilt truck consumes five percent diesel and 95 percent LNG with no loss of torque or power. (Courtesy Peterbilt)

Regulations and Incentives

For several years, Congress has supported natural gas as a transportation fuel. With legislation enacted within the past decade. The Natural Gas Act of 2010 is of particular interest. This bipartisan-supported bill would have extended benefits of prior legislation set to expire. However, the bill languished in committee and the 111th Congress adjourned without passing it.

If reintroduced and passed by the 112th Congress, the Natural Gas Act would:

- Extend a \$0.50/gallon fuel tax credit for LNG (vs \$0.85/gallon of diesel equivalent);
- Extend a tax credit for purchasing alternative fuel vehicles;
- Make certain tax credits transferable;
- Extend and increase the tax credit for natural gas-fueled vehicles;
- Create a bond program for governmental agencies to finance NGVs and fueling infrastructure;

- Allow NGV manufacturers to accelerate depreciation and apply for special loan guarantees for manufacturing equipment for alternative fuel vehicles;
- Provide tax incentives for installing alternative fuel refueling facilities;
- Require the federal government to purchase NGVs; and
- Mandate that the Environmental Protection Agency (EPA) streamline certification of aftermarket alternative fuel conversion kits.

The EPA also supports natural gas fuels initiatives. These include the Clean Agriculture Program, Clean Construction Program, Clean Ports Program and the SmartWay Transport Program.

Over-the-road and off-road fleet owners are facing new regulations with strict emissions requirements. LNG-fueled vehicles can offer owners not only the ability to comply with the new standards, but also reduce operating costs while taking advantage of significant tax incentives for purchases.

Available Vehicle and Engine Solutions

Understanding the available technology solutions and identifying LNG vehicle and engine manufacturers are paramount in selling and maintaining customers. There are several leaders in the LNG vehicle revolution.



*There are more than 860 CNG and almost 45 LNG refueling stations in the United States as of the end of 2010.
(Courtesy Northstar, Inc.)*

Westport Innovations offers LNG fuel systems and LNG-fueled engines to original equipment vehicle manufacturers. Westport’s unique GX™ technology is integrated into Cummins 15 liter, ISX™ diesel engines, a proprietary high-pressure direct injection system that consumes five percent diesel and 95 percent LNG for industry-leading emissions control without loss of power, torque or efficiency.

The engine operates in various applications, including port drayage, heavy haul, refuse transfer, dump trucks, roll-offs and line haul. Westport also offers smaller spark ignition engines for lift trucks, autos and light trucks.

Cummins has developed a line of spark-ignited natural gas engines that require no diesel or diesel particulate filter. Standard non-dosing catalytic converters achieve very low emissions. Power and torque are equivalent to or better than 12-liter class diesel engines.

Mack, Republic, Freightliner, Caterpillar and other vehicle and engine manufacturers are offering natural gas-fueled alternatives. Sterling has sold more than 1,000 of these trucks for drayage service in California.

Gas Composition Issues

Natural gas sources can have varying compositions and heating values. Natural gas from biogenic processes is composed primarily of methane (C1) and may include inert gases and water. Natural gas derived from oil and gas wells consists of methane along with various other hydrocarbon species, including ethane (C2), propane (C3), butane (C4), pentane (C5) and heavier components. It may also have sour contaminants such as hydrogen sulfide, inorganic and organic sulfur compounds, and carbon dioxide. Conventional gas processing is employed to remove the sour components and recover the heavy hydrocarbons in to meet pipeline heating value specifications.

Table 1: **Comparison of Pipeline, Tradition LNG and Transportation Quality LNG**

Components	Typical Pipeline	Tradition LNG	Transportation Quality LNG
C1	> 75%	> ~80%	> ~70%
C2	< 10%	Market HHV	Market MN
C3	< 5%	Market HHV	Market MN
C4	< 2%	Market HHV	Market MN
C5+	<0.5%	< 0.01 mol%	< 0.01 mol%
C6+	–	< 10 ppmv	< 10 ppmv
Nitrogen	< 2%	< 1%	< 1%
CO2	< 3-4%	< 50 ppmv	< 50 ppmv
H2S	< 4 ppmv	< 4 ppmv	< 4 ppmv
Total Sulfur	< 40 ppmv	< 20 ppmv	< 20 ppmv
Water	4–7 lbs/mmscf	< 0.1 ppmv	< 0.1 ppmv
Higher Heating Value HHV (Btu/scf)	1000–1075	1000–1150	1000–1300
Methane Number (MN)	> 90	> 85	>75

The natural gas specification for liquefaction is less stringent than pipeline specs for light hydrocarbons, but more stringent for sulfur, water, CO₂ and heavy hydrocarbons (Table 1). Water, CO₂ and heavy hydrocarbons (C₅+) will freeze and foul the cryogenic heat exchanger used in producing LNG and must be removed to assure good performance. All gas meeting U.S. pipeline specifications can be liquefied after removing components that can freeze. LNG easily can accommodate C₂, C₃ and C₄ hydrocarbons, but the producer must carefully tailor the hydrocarbon composition of the product to meet the specific needs of all customers.

If the LNG will be sold for use in a gas turbine, for example, the supplier must meet the heating value limitations of the gas turbine user.

Most spark-ignited natural gas engines can tolerate natural gas with higher heating values, as long as the methane number exceeds 75. The methane number of natural gas is similar to an octane number for gasoline. The higher the methane number, the less potential for detonation.

Shale gas often has an ethane content exceeding pipeline specifications, even after deep recovering C₃+ hydrocarbons. Significant ethane must be removed to meet pipeline-gas specifications.

In many cases, there is no convenient pipeline or market for the removed ethane, creating logistical problems for the gas producer. If the gas is sold as “transportation fuel grade” LNG, the ethane may be left in the fuel to improve the overall economics, capital

cost and product logistics. In all cases, the fuel composition limits should be specified in the fuel supply contract.

LNG Equipment and Service Providers

Once the customer’s costs, gas characteristics and compatible technologies have been identified, there are companies that can assist producers in project development. Mustang can provide technical consulting, process evaluation and selection, and feasibility services. Its parent company, Wood Group, offers various services related to selling LNG. Multiple suppliers can provide LNG technologies, construct fueling facilities, and supply storage tanks. Mustang has identified and works closely with many of these companies.

Summary

LNG and CNG increasingly are being used as vehicle fuels. Lower costs and reduced emissions make them appealing alternatives to traditional petroleum-based fuel. For fuel providers to take advantage of the opportunity to be a supplier, they must identify a potential customer base, provide a consistent fuel supply, and comply with relevant legislation and regulations.

Domestically produced gas in the form of LNG and CNG for transportation fuels provides an attractive new market for North American gas producers. This developing market will reduce fuel costs for U.S. industries and consumers while improving the environment, stimulating the nation’s economy and improving America’s energy independence.

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