



Is Natural Gas a Viable Alternative to Diesel for the Trucking Industry?

Natural gas is a fuel comprised mostly of methane, with small amounts of propane, ethane, helium and water. Like certain other alternative fuels, natural gas could be an acceptable fuel choice for certain applications within an industry as diverse as trucking. Natural gas engines can either be spark ignition or compression ignition with pilot injection (i.e., ~5% diesel injection to initiate combustion), with the later retaining the general properties of a diesel engine but requiring a dual-fueling system.

The transition to natural gas presents several significant challenges from economics to operability and poses significant refueling infrastructure hurdles. In the absence of a competitive natural gas refueling infrastructure, this alternative fuel is problematic for long haul trucking operations, but may be a viable alternative for some regional and local trucking applications.

Natural gas may be used as a transportation fuel in its compressed form (CNG) or liquefied form (LNG). Because of lower energy density, CNG is not practical for long-distance, heavy-duty truck applications. CNG is being successfully used in shorter range, heavy-duty applications such as refuse trucks, concrete mixers, straight trucks, and municipal buses.

LNG may present a viable alternative for certain trucking applications. LNG is cryogenically liquefied (i.e., converted to a liquid by reducing its temperature to approximately -260° F) and has higher energy content per volume than CNG (although still significantly lower than diesel). LNG's energy density makes it more acceptable for longer-range routes, although the lack of a competitive refueling infrastructure suggests that this alternative is not currently viable for long-haul applications.

Economic Issues:

Engine Costs – Natural gas trucks sell at a large premium (\$40,000 - \$70,000) compared to heavy duty diesel engines for Class 8 trucks.¹ Federal (and state) tax incentives may be available to purchasers of natural gas trucks to reduce the price differential between diesel and natural gas trucks; however, these incentives are not sufficient to completely offset the price differential.

Fuel Price – Natural gas prices fluctuate as does diesel fuel prices - LNG sold at a significant discount to ULSD throughout 2009 (approximately 75 cents to \$1/gallon cheaper than ULSD on a diesel gallon BTU equivalent basis).

Fuel Economy Penalty – Natural gas trucks are less fuel efficient than their diesel counterparts. Spark ignited natural gas engines have a reduced fuel economy of 7% to 10%, while compression-ignition natural gas engines have about a 1% fuel economy penalty.

Weight – LNG fuel tanks are constructed from ¼" thick stainless steel. A 119 gallon tank weighs approximately 500 lbs., while a 72 gallon tank weighs approximately 270 lbs., potentially affecting the amount of freight that a natural gas truck can legally carry.

¹ There are currently two natural gas engine classes: (1) spark ignition 320 horsepower version that sells at a \$40,000 premium to its diesel counterpart; and (2) a 450 horsepower compression ignition version that sells at a \$70,000 premium to its diesel counterpart.

Operational Challenges:

Operating Range – An LNG truck equipped with two 119 gallon tanks has an operating range of approximately 775 miles. A typical 119 gallon tank can hold 108 gallons of LNG. The difference in rated capacity and actual capacity is a result of the need to maintain vapor space in the tank.

Refueling Issues – LNG trucks must be refueled at specialized stations that are configured for the specific truck. Running out of gas on the side of the road is a significant challenge as LNG mobile refueling is not an option and the truck would have to be towed to the refueling station. Since the product is dispensed at -260 degrees Fahrenheit, employee training and the provision of personal protective equipment may be necessary. Compression-ignition versions require the operator to refuel with both LNG and diesel.

Infrastructure Concerns:

- New infrastructure is required for refueling, as truck stops and gas stations do not have the ability to dispense LNG or CNG.
- Today, it is a challenge for over-the-road fleets will struggle to find LNG fueling outlets on the road without planning and scheduling routes. Many of the natural gas fuel stations in this country are owned and operated by municipalities. Prior arrangements must be made before "stopping by" for fuel.
- Building out a natural gas refueling infrastructure along key freight corridors will take time. While competition exists in the natural gas industry, the high barriers to entry for retail refueling stations may slow the development of a competitive refueling infrastructure and could result in higher prices for natural gas at public refueling stations.
- A competitive fuel model would require the presence of multiple entities selling LNG in the same geographic area.
- Natural gas may be a viable alternative for centrally-fueled fleets that return to their base of operations each day. An LNG filling outlet with a refill capability that is comparable to the time necessary to refuel a diesel truck costs over \$500,000. One ATA member reports spending almost \$800,000 on a fast fill refueling station that can handle 2 trucks simultaneously. There also may be permitting challenges associated with the construction of an LNG refueling system.

Environmental Implications:

Criteria Pollutants – PM and NOx emissions from LNG-fueled trucks are similar to post 2010 diesel trucks. Some natural gas engines comply with the EPA 2010 emission standards without the use of a diesel particulate filter or selective catalytic reduction aftertreatment system.

Ultra Fine Particulates – There is insufficient data to compare the emissions of ultra-fine particulate matter between natural gas and diesel engines.

Greenhouse Gas Emissions – Carbon emissions from a natural gas engine compares favorably to diesel engines. Depending upon the source of the natural gas and the liquefaction efficiency rate, natural gas can reduce CO2 emissions by 15%- 23%. Note, however, that methane is 20-times more potent than CO2 as a greenhouse gas. As LNG in fuel tanks warms, methane is released to the environment through a pressure relief valve. In fact, depending upon ambient temperatures, an LNG truck could vent most of its fuel over a 7-10 day period. The venting of methane from trucks parked over an extended period could result in a net increase in greenhouse gas emissions compared to diesel fuel.

Maintenance Issues:

Oil Change – Natural gas engines use a different type of oil than diesel engines. They require fewer oil changes – oil change intervals are three times longer than diesel engines.

Fuel Injector Replacement – Natural gas engines may require injectors to be replaced more frequently than diesel engines, approximately every 220,000 miles.

Spark Plugs – For spark-ignition natural gas engines, replacement of spark plugs, ignition modules and various sensors (O2, MAP) add additional maintenance costs.

Training – Natural gas engines operate differently than diesel engines and in-house mechanics will require approximately 60 hours of specialized training. Finding a qualified natural gas mechanic is more difficult than finding a diesel mechanic. The local OEM may not have the requisite experience, tools or parts to quickly perform repairs. As a result, some fleets report that downtime for repairs is significantly longer for natural gas engines.

Methane Exposure – Maintenance shops that will work on natural gas-fueled vehicles should include a methane detection system and a methane evacuation system. Recommendation on the safe operation and maintenance of natural gas vehicles are available from the National Fire Protection Association and the Society of Automotive Engineers. One ATA member reports spending over \$150,000 on infra-red sensors, modified lighting and electrical systems, and an air evacuation system.

LNG On-Board Tanks – Some fleets have experienced significant problems with LNG fuel tanks. These tanks are double-walled construction with a vacuum between the two walls (like a giant thermos bottle). The vacuum serves as a temperature barrier. In some cases, fleets reported a loss of the vacuum due to tank manufacturing issues that manifest themselves months and even years after being placed into service. The vacuum can be replenished, but the process is costly and is not a permanent solution. Impacting a tank (such as during a collision or accident) can also result in a lost vacuum. As vacuum pressure decreases, fuel temperature rises, causing internal tank pressure to rise. The pressure relief valve built into the tank vents natural gas into the atmosphere, which affects the amount of fuel available for use and offsets some of the advantages of using LNG.

Miscellaneous:

- Natural gas vehicles are a safe alternative with a proven track record.
- Engine durability is equivalent to diesel fuel engines.
- Natural gas vehicles run quieter than their diesel counterparts.
- Natural gas is a plentiful, domestically-produced energy source that could help to reduce our dependence on petroleum imports.