



Alternative Fuel
Information Series

Clean Cities Fact Sheet

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U.S. DEPARTMENT of ENERGY,
OFFICE of ENERGY EFFICIENCY and RENEWABLE ENERGY

Natural Gas Buses: Separating Myth from Fact

Introduction

Increasing numbers of transit agencies across North America are making the choice to convert their bus fleets to compressed natural gas (CNG), and even more are seriously considering it. Natural gas buses now account for at least 20% of all new bus orders. However, it becomes difficult for fleet operators to fairly evaluate the potential benefits of an alternative fuel program if they are confronted with misinformation or poor comparisons based on false assumptions.

This fact sheet addresses some of the most common misconceptions that seem to work their way into anecdotal stories, media reports, and even some poorly researched white papers and feasibility studies. It is an expanded version of information that was presented on behalf of the U.S. Department of Energy at the South Coast Air Basin Alternative Fuel & Electric Transit Bus Workshop in Diamond Bar, California, on March 15, 2000.

CNG Bus Myths and Facts

Myth 1: CNG buses emit the same amount of particulate matter (PM) as diesel buses.

Fact 1: CNG buses emit virtually no visible PM or black soot at the tailpipe. In chassis dynamometer testing conducted by West Virginia University, CNG buses consistently emit dramatically less PM than diesel buses. For example, testing of commercial buses in Boulder, Colorado, on the central business district (CBD) driving cycle demonstrated a 97% PM reduction and a 58% reduction in oxides of nitrogen (NO_x) with buses running on CNG rather than diesel. Note that the trace amount of PM associated with CNG is generally attributed to crankcase lubricating oil consumption, not the fuel.

Myth 2: CNG buses emit more ultra-fine particulates than diesel buses.

Fact 2: Although CNG buses emit over 90% less particulate mass than conventional diesels, the particulates that are emitted may be smaller in size. However, early studies that have compared CNG and diesel particulate matter (PM) size have reached contradictory conclusions. Techniques are being developed to better measure PM size distribution and understand how that distribution is affected by test procedures.

Myth 3: CNG buses create more greenhouse gases than diesel buses because they emit more methane, which is a greenhouse gas that is 20 times stronger than carbon dioxide.

Fact 3: Natural gas has inherently lower carbon dioxide emissions compared to diesel. Considering the total fuel cycle of both diesel and CNG including the emissions created during fuel production, CNG buses appear to have total greenhouse gas emissions that are very similar to, if not slightly better than, diesel buses, despite emitting higher levels of methane.



Commercial bus in Boulder, Colorado, being tested on West Virginia University's portable chassis dynamometer

Paul Norton, NREL/PTX 06651

Myth 4: CNG buses are much more expensive than diesel buses.

Fact 4: CNG buses cost about \$25,000 to \$50,000 more than a conventional diesel bus (depending on the model and any special equipment that might be ordered), but CNG fuel usually costs less than diesel fuel. At 25 cents per gallon savings, the typical CNG bus could pay for itself in just a little more than 3 years. And greater savings in fuel cost can result in even quicker paybacks. The incremental cost of diesel-hybrid buses is estimated to be about twice that of CNG buses, but payback analysis will be based on improved fuel economy alone since there will be no per-gallon cost savings with the continued use of diesel fuel.

Myth 5: Advanced emission control technology for diesel engines will make CNG buses unnecessary.

Fact 5: Diesel emissions from new buses have improved dramatically in the past 10 years, with most of the gains resulting from improved engine design. In the future, it's almost certain that diesel engines will have to rely on emission control devices to further reduce emissions. However, the durability of these emission control devices in use on diesel and diesel-hybrid buses depends greatly on fuel quality and is still to be determined. Should these devices degrade as the buses age and accumulate mileage, future emissions will be much higher . . . similar to those of the high emitters observed within the aging gasoline vehicle fleet on the road today. Also, diesel buses emit toxics (such as benzene and 1,3-butadiene) that CNG buses do not. Based on the testing available today, it appears that CNG buses will always have PM and toxic emission benefits over diesel buses

because natural gas combustion inherently produces lower levels of these emissions.

Myth 6: The availability of ultra-low sulfur diesel fuel and diesel hybrid-electric bus systems will negate the emissions benefits of CNG buses.

Fact 6: Testing of prototype hybrid buses using advanced emission control technologies and experimental ultra-low sulfur diesel fuel has shown particulate matter emissions levels close to those of natural gas engines, which need only a minimal amount of exhaust emission control. However, NO_x emissions from these buses were higher than those from CNG buses. In addition, the special diesel fuel required if these emission control systems are to function properly on diesel engines is not expected to be commercially available nationwide for 5 years or more (and then it will cost more than conventional diesel fuel). Further, even with the use of ultra-low sulfur diesel fuel, natural gas emission control devices will most likely be less expensive and longer lived than those for diesel engines simply because there is inherently less NO_x and PM to control with natural gas and because natural gas has fewer contaminants that degrade these devices.

Myth 7: CNG bus fuel tanks are prone to explode.

Fact 7: The technology for making CNG tanks is well known and mature. In the event of a vehicle collision, CNG fuel tanks are much stronger and safer than either diesel or gasoline fuel tanks. The few instances of CNG tank failures were studied carefully, and the problems, mostly involving support strap failure or tank abrasion during normal operation, have been remedied.

These CNG cylinders power a transit bus in Tacoma, Washington.





Warren Gretz, NREL/PTX 05813

"CNG Power Delivers Clean Rocky Mountain Air" in the Denver metro area.

Myth 8: CNG buses are unsafe.

Fact 8: CNG buses have some different safety concerns than diesel fuel buses, but overall, there is no evidence that CNG buses pose any greater risk of fire or explosion than diesel buses. Natural gas buses have on-board gas detectors and other safety equipment specially designed to ensure safe operation.

Myth 9: CNG bus maintenance garages and refueling facilities are more dangerous than diesel facilities.

Fact 9: There's no evidence to support this claim. Both natural gas and diesel fuels are flammable—that's why they are useful as fuels. Each requires handlers to use safety and fire protection equipment designed specifically for that particular type of fuel. However, diesel bus facilities typically store much larger quantities of fuel on site than CNG facilities (usually 100,000 gallons or more, usually in large underground tanks; typically only 500 gallons or so of CNG fuel is stored on site). Ground soil contamination from leaking diesel tanks is another concern that CNG facilities do not face.

Myth 10: Natural gas vapors are toxic to breathe.

Fact 10: Natural gas vapors (which might escape in the event of a leak) are odorless and nontoxic to breathe. The familiar natural gas smell is actually an odorant that is added to the gas as a safety feature. Gasoline and diesel vapors, however, do contain toxics that are dangerous to ingest or breathe. And any fuel vapor that builds up in an enclosed space can cause asphyxiation.

Myth 11: Hybrid technology will make CNG buses obsolete.

Fact 11: CNG buses provide greater emissions benefits today than diesel-hybrid buses using ultra-low sulfur diesel fuel, at much lower cost (as a result

of lower incremental bus prices and the lower price of natural gas). CNG engines can be used in hybrid applications as well as diesel engines, with similar reductions in fuel consumption and even lower emissions.

Myth 12: CNG engines will be too expensive to use in hybrid buses.

Fact 12: Although CNG tanks are more expensive than diesel fuel tanks, fewer of them are needed in a hybrid application. In addition, the emission controls necessary to meet future emission standards are likely to cost less for CNG than for diesel engines. And CNG is less expensive than the ultra-low sulfur diesel fuel required for advanced diesel engine emission control devices. If we examine their costs on a life-cycle basis, it's likely that CNG hybrid buses will be competitive in cost with diesel-hybrid buses.

Myth 13: Diesel buses are easier to maintain than CNG buses and require no special training for the maintenance staff.

Fact 13: Mechanics must be highly skilled to maintain both types of buses. The mechanics must be familiar with the properties of each fuel type and must be properly trained on each system (just as diesel mechanics must receive different training than those who work only on gasoline vehicles). Advanced technology diesel propulsion systems—such as hybrid-electric-diesel systems and the exhaust emission control systems required for achieving significant emissions reductions with diesel engines—are much more complex than standard diesel power trains. These advanced technology systems will require additional special training, tools, and test equipment beyond that required for regular diesel or CNG bus mechanics.



Pierce Transit/PTX 04036

In 1986, Pierce Transit made a commitment to the future of the transportation industry and to the environment by deciding to put buses powered by CNG into everyday service.



AGL Resources/DOE

MARTA's natural gas buses in Atlanta, Georgia, have helped to improve the region's air quality every day since they were introduced in 1996.

Myth 14: *Maintenance costs are much higher for CNG than for conventional diesel or hybrid-electric diesel buses.*

Fact 14: CNG engines are spark ignited, and thus require periodic ignition maintenance (spark plugs, wires, etc.). Diesel engines do not use spark plugs, so this type of maintenance is unnecessary. Diesel-hybrid buses must also contend with periodic replacement of electric battery systems, which have significant costs and waste disposal requirements. Because of CNG's cleaner combustion process, contamination of engine lubricating oil is greatly reduced compared to diesel. As a result, some engine manufacturers have essentially doubled the recommended oil change interval for CNG engines. Transit properties that monitor their oil quality through independent analysis substantiate this performance. Fewer oil changes result in savings in the cost of bulk oil, filters, hazardous waste disposal, and labor. This cleaner internal operation results in less engine wear. Some transit agencies have reported CNG engines with no signs of needing \$3000 to \$4000 mid-life rebuilds (as is customary with diesel engines). Clean-up in the shop, engine compartment, and bus parking areas can also be less because CNG use does not result in heavy PM deposits.

Myth 15: *CNG buses are so much heavier than diesel or hybrid-electric diesel buses that tires, brakes, and other systems will wear out much quicker.*

Fact 15: CNG buses do weigh more than conventional diesel buses, but less than hybrid-electric diesel buses. This is due to the extra weight of the CNG fuel tanks. However, CNG tanks made of carbon fiber composite materials are standard equipment on many buses today and are considerably lighter than the metal tanks used on earlier buses. The extra weight of hybrid-electric diesel buses is due to the battery packs (mostly lead-acid at this point

in time). Additional wear and tear for either of these heavier bus systems, however, has not borne out in actual practice. The tires, braking systems, and other equipment are all designed and sized to accommodate the load rating of the entire bus and passenger payload. Modern engine-transmission speed retarder systems on conventional diesel and CNG buses and regenerative braking systems on the hybrid-electric buses provide deceleration assistance. Transit operators report that buses assigned to routes with poor road conditions, steep grades, and drivers with aggressive braking habits manifest the greatest wear patterns, regardless of bus fuel type.

Conclusions

Sound bites comparing natural gas buses and diesel buses are often oversimplified and may be misleading—dig in and study the details!

Here are a few of the highlights. Current natural gas buses offer emissions benefits in comparison to diesel buses and even diesel-hybrid buses. Natural gas buses do cost more to buy than conventional diesel buses, but less than advanced technology diesel-hybrid buses. Some CNG bus fleets have documented operating costs equal to or lower than diesel buses. Because fuel costs can make a BIG difference, make sure your analysis reflects current market conditions and up-to-date fuel prices.

It takes a very conscientious effort to implement a clean bus program. Every decision must be based on factual information and not sensational headlines or industry folklore.

For more information visit the Alternative Fuels Data Center at www.afdc.doe.gov or contact the U.S. Department of Energy's National Clean Cities Program at 1-800-CCITIES.



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