American, Abundant... and *Affordable*?

A COST ANALYSIS OF NATURAL GAS VEHICLES (NGVS) AND FUELING INFRASTRUCTURE

An Alternative Fuel Fact Brief – Presented by:

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Abstract

With climate change and carbon emissions standards in the global spotlight, both customers and regulators are demanding environmental stewardship from organizations of all types.

In addition to increasing pressure to reduce greenhouse gas emissions, businesses, organizations and government agencies that operate vehicle fleets now face skyrocketing gasoline prices. Increasingly, fleet managers are considering alternative fuel choices to replace gasoline. However, they face a challenging educational curve when individual fuel advocates compromise consumer education and full disclosure in the interest of self-promotion.

Natural gas has been heavily publicized as an affordable vehicle fuel alternative to gasoline, but the total cost of implementation is extremely high. This fact is often overshadowed in industry promotional efforts that emphasize per-gallon fuel costs and echo the oft-heard rallying cry for domestic fuel. Outspoken advocates of natural gas constantly promote American-made energy, but contradict themselves by endorsing just one of many American-made alternative fuels.

This paper challenges the practicality of natural gas as *the* domestic alternative to gasoline by comparing it to propane autogas, another clean-burning, American-made vehicle fuel.

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NOTE:

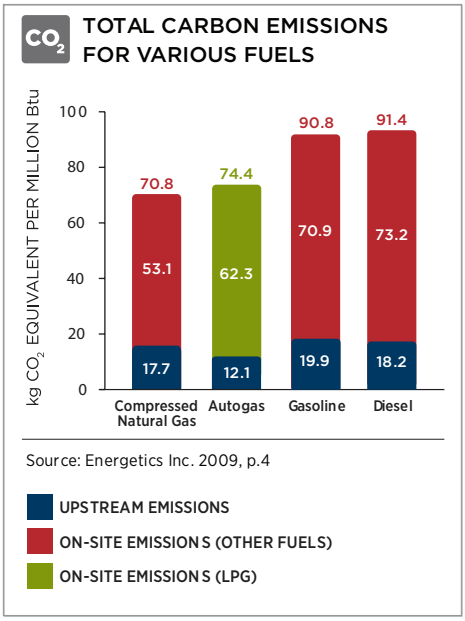
- This paper considers compressed natural gas (CNG) - as opposed to liquefied natural gas (LNG) - because CNG is the form of natural gas most commonly used for fueling vehicles (Whyatt, 2009, p. iii)
- Autogas is the term used globally to describe propane as a vehicle fuel

Currently, autogas is the third most widely used vehicle fuel in the world, behind gasoline and diesel. That makes autogas the world's leading alternative vehicle fuel (Knox, 2009).

Introduction

Natural gas is a clean-burning alternative fuel vying for national attention in the United States. Compared to gasoline vehicles, vehicles operating on natural gas or propane autogas achieve average emissions reductions of close to 20 percent. Like natural gas, autogas is an economical, domestically produced alternative fuel. Both fuels offer significant cost advantages at the pump when compared to gasoline or diesel, but autogas has a much lower overall cost of implementation than natural gas.

Natural gas proponents cite the Three A's – abundant, American-made and affordable. Natural gas satisfies the first two of these criteria, but the cost of implementing natural gas for a vehicle fleet can be prohibitive. Lower vehicle and fueling infrastructure costs make autogas a more practical choice for many fleet applications.

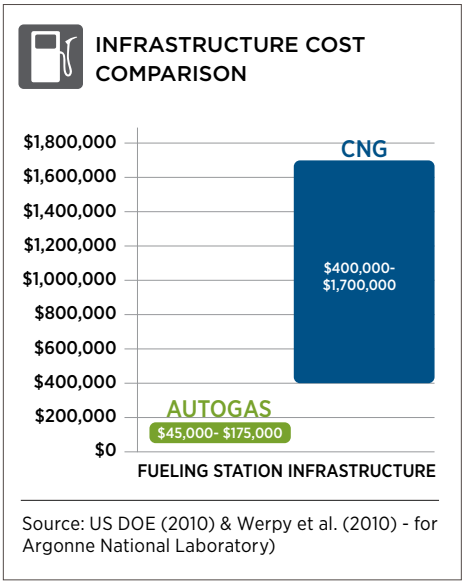


Nonetheless, recent special interest campaigns and legislative favoritism have further singled out natural gas, among American-made fuels, as the sole fuel beneficiary of incentives from the federal government. Such legislative isolation, epitomized by the recently introduced NAT GAS Act, fails to acknowledge the limits of natural gas as a practical alternative transportation fuel. Natural gas is a suitable alternative fuel for specific heavy-duty applications, but cannot compete with autogas for light- and medium-duty fleet applications.

Ten autogas fueling stations could be constructed for the same price as a single natural gas fueling station.

Refueling Infrastructure Costs – A is for ~~Affordable~~ Astronomical

One major hurdle faced by the natural gas vehicle fuel market is infrastructure cost. Natural gas fueling equipment is highly complex and very expensive, primarily due to the mechanics of pressurizing natural gas into compressed natural gas and then storing it at high pressure. Conversely, an autogas fueling station consists of comparatively simple construction and costs roughly 10 percent of the price of a comparable natural gas fueling facility.



Source: US DOE (2010) & Werpy et al. (2010) - for Argonne National Laboratory)

A small, fast-fill CNG station costs approximately $400,000, according to a 2010 Department of Energy study on the feasibility of natural gas vehicles. Fast-fill dispensers are the preferred option for most fleet and public fueling stations, as they provide similar fill times to gasoline pumps.

Most public and private vehicle fleets require a fueling process (including fill time and storage capacity) which is comparable to that for gasoline or diesel. Accordingly, larger fleets would require greater fueling capacities, necessitating construction of medium to large CNG stations, which can cost between $600,000 and $1.7 million (U.S. Department of Energy, 2010, 5.7).

According to a U.S. Department of Energy-sponsored study of the propane autogas vehicle market, a typical autogas station costs between $45,000 and $60,000, with a cap of $175,000 for a large public station. All autogas fueling infrastructure provides a fill time that is equal or better than the fill time of conventional gasoline pumps (Werpy, Burnham, & Bertram, 2010, p. 3). Additionally, propane suppliers, like Ferrellgas, and autogas networks, such as Alliance AutoGas, provide private autogas fueling infrastructure for fleets, often constructed at the fleet base. These onsite stations are typically installed at no upfront cost to the fleet in exchange for a fuel contract (Alliance AutoGas, 2010 and Ferrellgas, 2011).

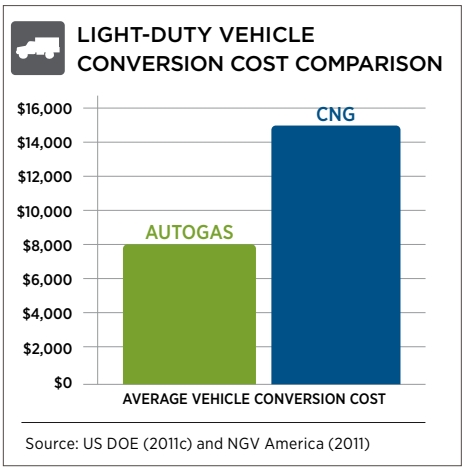
The chart above compares price ranges for CNG and autogas fueling stations. On average, 10 autogas fueling stations could be constructed for the same price as a single natural gas vehicle fueling station. This comparatively low cost makes autogas infrastructure more realistic for fleet implementation and also more easily scalable as demand increases.

FAST FILL vs. SLOW FILL CNG STATION: For an apples-to-apples comparison, the figures included in this document are for fast fill CNG stations. Natural gas fueling infrastructure costs which reflect figures lower than $400,000 apply to a time-fill station. Time-fill is the industry term used to describe the slow alternative to fast fill. Fleets that can allocate 8 to 12 hours per vehicle for fueling, or that can allow vehicles to refuel overnight, have the option of building time-fill stations (Whyatt, p. 5.2)

Vehicle and Conversion Costs

Fleets or individuals interested in operating CNG- or autogas-powered vehicles have two options: aftermarket conversion of existing vehicles or the purchase of new vehicles already equipped to use an alternative fuel (U.S. Department of Energy, 2011b).

Typically, aftermarket conversion is the more cost effective option for fleets interested in beginning an alternative fuel program, as it does not require the purchase of new vehicles. Original Equipment Manufacturer (OEM) vehicles are purchased new at a dealership, and OEM alternative fuel vehicles incur an additional cost compared to their gasoline-powered counterparts. Purchasing or retrofitting vehicles to run on CNG is significantly more expensive than available autogas options.



AFTERMARKET CONVERSIONS

Natural Gas Vehicles for America (NGVA) estimates that converting a light-duty vehicle to run on CNG costs $12,000-$18,000 (Natural Gas Vehicles for America, 2011), whereas the cost of vehicle conversion to autogas averages about half that.

Average autogas conversion costs for light-duty vehicles range from $4,000-$12,000 (U.S. Department of Energy, 2011c). Available for a variety of vehicle makes and models, autogas conversion systems are offered in both bi-fuel and mono-fuel applications. Costs vary based on engine and vehicle specifications, as well as manufacturer. Bi-fuel conversion systems, like those available from Alliance AutoGas, enable the vehicle to operate on either autogas or gasoline (gasoline system remains on board with autogas system added). Mono-fuel systems, such as those provided by CleanFUEL USA are “dedicated” (autogas only).

The natural gas-powered Honda Civic GX has a range of approximately 40-43 percent less than a traditionally powered Civic.

OEM VEHICLES

Currently, the Honda Civic GX is the only OEM passenger vehicle available in the United States that runs on a mono-fuel CNG system. The manufacturer estimates that the car incurs $6,935 in additional costs compared to a similarly-equipped gasoline-fueled Civic, for a total price of $26,050 (Whyatt, p. 2.17). The Civic is not commonly used in fleet applications and the limited range of the GX makes it impractical for fleet use.

OEM-equivalent, light- and medium-duty autogas conversions are available from ROUSH CleanTech through a partnership with Ford Motor Company. The ROUSH Ford F-150 LPITM averages an $8,096 incremental cost in addition to the base cost of the truck. The ROUSH Ford F-250 or F-350 conversion system costs $9,995 and the Ford E-150, E-250, and E-350 cargo and passenger van system is priced at $10,900 over the vehicle base cost (ROUSH, 2011). Because the ROUSH system is technically aftermarket, these cost figures are included in the conversion cost differential chart above.

The system cost fluctuates relative to the size of the vehicle and engine platform. Previously, a credit of up to 50 percent toward the incremental cost of an alternative fuel vehicle was available for qualified alternative fuel vehicles. ROUSH autogas vehicles were eligible for this credit, which was not renewed at the end of 2010.

RANGE: Another disadvantage associated with light-duty natural gas-powered vehicles is range. CNG vehicle fuel tanks are extremely heavy because they require a storage pressure of 3,600 psi – 10 times the required pressure for autogas tanks (Whyatt, p. 2.2). Moreover, natural gas has a significantly lower energy density per volume of fuel than both gasoline and autogas (Whyatt, E.1 and Ingersoll 1996, pg. 97). Because it requires storage pressure of only 200 psi to be liquefied (California Energy Commission, 2011 and Ferrellgas, 2011), the average autogas vehicle provides more fuel per unit of volume than CNG.

These factors – equipment weight and energy content per unit of volume – are the primary reasons that CNG vehicles suffer from drastically reduced range. For example, the Honda Civic GX (which is the only OEM natural gas-powered passenger vehicle available in the U.S.) has a range of approximately 40-43 percent less than a gasoline-powered Civic (American Honda Motor Co., 2011).

Fuel Costs

Autogas and natural gas do share one economic advantage: price at the pump. A dramatic increase in known natural gas reserves and a subsequent surge in gas production have resulted in very low per-gallon natural gas prices over the past few years (Krauss, 2011).

Despite the high up-front capital costs associated with natural gas infrastructure, the lower per-gallon price has made CNG an attractive option for some fleets, particularly for heavy-duty applications like city buses or garbage trucks. These heavy-duty vehicle applications can support the significant weight addition and bulky tanks associated with natural gas vehicle technology, but often experience reduced payload as a consequence.

To compare the cost-effectiveness of CNG and autogas by the gallon, prices are calculated in terms of gasoline gallon equivalent (GGE). This is an apples-to-apples comparison because it factors in energy and efficiency loss of alternative fuels into the listed price – showing cost based on the amount of alternative fuel required to equal the energy equivalent in one gallon of gasoline.

According to the AFDC and the US Energy Information Administration, January 2011 nationwide prices averaged:

- CNG $1.93 per GGE
- Gasoline $3.15/gallon

The average autogas price for January 2011 was:

- Autogas $2.54 GGE[1]

As recognized alternative fuels, autogas and CNG qualify for the federal 50-cent-per-gallon tax credit for alternative vehicle fuels, currently set to expire at the end of 2011. With the 50-cent-per-gallon credit, **both fuels achieve savings of more than $1.00 per gallon versus gasoline.** Since January, gasoline prices have continued to climb, reaching a national average of $3.80 (April, 2011) and increasing the cost savings available with alternative fuels like autogas.

SUPPLY: Approximately 60 percent of U.S. propane supply comes from natural gas refining, indicating that propane has potential to increase in abundance alongside domestic natural gas supply (Werpy, et al., 2010, p.18).

1 Note: Figure derived from http://www.allianceautogas.com/why-autogas/save-money/. January 2011 price used and multiplied by 1.11 to account for a 10 percent loss in fuel content compared to gasoline. The Clean Cities Alternative Fuel Price Report that listed $1.93/GGE for CNG does not report credible figures for propane as a motor fuel, because the price listed is derived from residential heating prices per-gallon. Several members of the propane industry have outlined this discrepancy and provided more accurate figures. An explanation of this issue by Autogas for America Founder Stuart Weidie is available at http://blog.ctnews.com/connecticutpostings/2011/04/11/the-price-of-propane-autogas/.

Natural Gas in Legislation

The T. Boone Pickens-backed NAT GAS Act was introduced in the U.S. House of Representatives in March 2011, after similar legislation failed to pass in 2010. The latest incarnation of this bill is scaled back in scope, but one thing remains the same: it excludes all other American-made alternative fuels. Commonly known as the NAT GAS Act, H.R. 1380 would increase previous infrastructure credits for the construction of a new CNG or LNG fueling station to 50 percent of the total cost (up to $100,000) (H.R. 1380, 2011). This credit, though seemingly generous, represents only a fraction of the true cost of natural gas infrastructure.

Despite the competitive pricing of both CNG and autogas relative to traditional fuels, the NAT GAS Act-proposed extension of the 50-cent-per-gallon federal excise tax credit would only apply to natural gas, excluding all other fuels (the credit is currently available for all federally recognized alternative fuels through December 2011).

This legislation is still under review in the U.S. House of Representatives. Whether or not legislators will embrace multiple alternative fuels remains uncertain. Legislative cherry picking like the NAT GAS Act skews market forces in favor of specific technologies, limiting alternatives for consumers and businesses.

Summary

Natural gas is an excellent energy source for many applications and is vital to American energy security. However, total cost of implementation makes it impractical as an alternative transportation fuel for most on-road vehicle applications.

The comparison provided above reveals autogas as a more economically viable alternative fuel than natural gas for most transportation applications. Autogas and natural gas share the ability to significantly reduce harmful vehicle pollutants and greenhouse gas emissions. They are both abundant and American-made. And while affordability is subjective, it is clear that autogas is a more realistic option for America's public and private vehicle fleets.

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