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Future Impact on Minnesota Transportation Revenue Collection of Commercial Fleet Conversion from Diesel Fuel to Natural Gas

The purpose of this TRS is to serve as a synthesis of pertinent completed research to be used for further study and evaluation by MnDOT. This TRS does not represent the conclusions of either CTC & Associates or MnDOT.

Introduction

While natural gas currently makes up only a small portion of the fuels used for transportation in the United States, there is significant potential for it to play a greater role in the future. There are several reasons for this, including new technologies that are increasing the supply of natural gas (and therefore reducing its price), combined with high prices for diesel fuel and gasoline, concerns about greenhouse gas emissions from traditional fuels, availability of new vehicle engines that run on natural gas, and a growing fueling infrastructure.

Photo courtesy of Clean Energy Fuels

In Minnesota, the fuel tax makes up nearly half of the Highway User Tax Distribution Fund. As a result, if a significant number of vehicles converted from traditional fuels to natural gas, highway funding could be affected if natural gas is taxed at a significantly different rate. There have been some indications that commercial trucking fleets may convert to natural gas more quickly than other vehicles.

MnDOT wanted to investigate the potential impacts of natural-gas-fueled trucks on fuel tax receipts. Specific topics of interest included:

- The extent to which commercial trucking fleets, especially in Minnesota, are converting from diesel fuel to compressed natural gas (CNG) and liquefied natural gas (LNG).
- The expected impacts of these conversions on Minnesota fuel tax revenues.
- How natural gas is currently taxed in Minnesota, and how that revenue is being directed.
- Concerns in Minnesota and other states regarding the conversion trend, including revenue losses.

- Actions being taken by other states to address issues related to conversion.
- Potential policy options for Minnesota.

To gather this information, CTC & Associates conducted a search of published research, state policies and industry white papers, and conducted interviews with representatives of the trucking industry and state transportation and revenue agencies in Minnesota, Wisconsin, Iowa and Indiana.

Summary of Findings

We did not identify any quantifiable projections of the impact of natural gas conversion on fuel tax receipts in Minnesota. However, it appears that the impact is likely to be small, because natural gas is currently taxed at approximately the same rate as diesel fuel and gasoline. Because natural gas engines are currently less fuel-efficient than diesel engines, an increase in trucks fueled by natural gas may even lead to a slight increase in fuel tax revenues. In addition, since natural gas engines are more expensive than traditional diesel engines, buyers pay more sales tax—another component of the state Highway User Tax Distribution Fund.

In addition, those we interviewed did not anticipate large increases in natural gas conversion in Minnesota in the immediate future.

Background

There are two forms of natural gas that can be used as engine fuel: liquefied natural gas (LNG) and compressed natural gas (CNG). CNG has traditionally been considered a better option for locally operated trucks that return to a base every night where they can be refilled overnight, while LNG offers better fuel efficiency and is more appropriate for long-haul operations.

Since a gallon of LNG or CNG will not provide the same energy or mileage as a gallon of conventional fuel, the federal government and many states tax natural gas on a diesel gallon equivalent (DGE) or gasoline gallon equivalent (GGE) basis. For example, 1.7 gallons of LNG equals 1 DGE, because 1.7 gallons of LNG contains the same amount of energy as 1 gallon of diesel fuel. If LNG is taxed so that 1.7 gallons is assessed the same tax as 1 gallon of diesel fuel, the tax rates would be equivalent, and vehicles converting from traditional fuels to natural gas would not impact fuel tax receipts. Minnesota's fuel tax structure uses these equivalents.

Natural Gas Conversion Rates and Anticipated Revenue Impacts

Minnesota's natural gas tax rates are very close to its diesel fuel and gasoline tax rates. Total state taxes are 28.2 cents per GGE for both LNG and CNG (29.1 cents per DGE), compared to 28.5 cents per gallon for gasoline or diesel.

While natural gas is growing in use as a fuel for trucks, there are some indications that it has not been growing as quickly as it had been predicted to only a few years ago. Natural gas currently makes up an extremely small percentage of the fuel used in trucking in Minnesota and other Midwest states—less than one-thousandth of a percent of the motor fuel sold in Minnesota. Glen Kedzie of the American Trucking Association noted that states that offer financial incentives for conversion, such as California and Texas, have seen a greater rate of adoption of natural gas trucks.

Many factors affect the conversion rate. Advantages of natural gas include lower fuel prices and emissions. Disadvantages include heavier engine weights and lower fuel efficiency, reduced operational range, limited availability of natural gas engines for trucks, limited natural gas fueling infrastructure, significantly higher engine purchase cost, and higher maintenance costs. Changes in these factors can cause conversion to natural gas to become more or less attractive financially.

We did not identify any documents that offered projections of future rates of natural gas adoption in Minnesota, and our interviewees also declined to make such predictions. Some reports do offer projections of future natural

gas truck sales or related data on a national scale. For example, the U.S. Energy Information Administration projects that in 2040, natural gas will provide 14 percent of the energy consumed by heavy-duty vehicles.

In the near term, those we interviewed did not anticipate large increases in natural gas conversion in Minnesota. John Hausladen, president of the Minnesota Trucking Association, said there have not been many fleets that have made significant investments in natural gas trucks in the state. "I think the ramp-up rate by carriers to purchase this technology is going to be negligible, at least in the next five years," he said.

Concerns About Natural Gas Conversion

Those we interviewed at state agencies offered only a few concerns related to natural gas conversion. Perhaps most serious was the potential for fraud via devices that would allow an end-user to tap into a natural gas supply to fill a vehicle's tank without paying tax. It is unclear, however, if such devices exist. Jeremy Neeck of the Minnesota Department of Revenue said that utility companies had informed him that only authorized installers are allowed to install home-fill units, and that the DOR licenses all retailers of alternative fuels or individual users who choose to acquire these fuels from other sources.

Kenneth Buckeye of MnDOT said he has heard concerns about the safety of natural gas vehicles because of the highly compressed fuel, but he said no serious incidents have occurred.

Policy Options

Beyond taxing natural gas on a DGE or GGE basis, neighboring states have made few policy proposals related to natural gas taxation. In Indiana, a new fee structure took effect in 2014 that charges vehicles based on their impact to the road rather than the fuel they consume. The state's fuel taxes are considered to be the equivalent of 7 cents per Equivalent Single Axle Load mile for the first 2.4 ESALs (80,000 pounds in a normal configuration) of a vehicle's weight. Heavier loads are assessed per-mile fees to bring their total payments to 7 cents per ESAL mile. In Wisconsin, Governor Scott Walker proposed replacing the per-gallon fuel tax with a sales tax that would be calculated based on total cost rather than quantity during his recent gubernatorial campaign. This idea has not been formally proposed, nor have details of this approach been released.

Detailed Findings

Background

Natural gas can be used to fuel specially made or converted truck engines. There are two forms of natural gas that can be used as engine fuel: liquefied natural gas (LNG) and compressed natural gas (CNG).

LNG is natural gas that has been converted to a liquid at extremely cold temperatures (about -162 ºC). According to Cummins Westport, one of the primary manufacturers of natural gas engines, fueling a truck's LNG tank takes about the same amount of time as filling a diesel tank. Operators must wear protective gloves and clothing due to the cold. (See http://www.cumminswestport.com/links/fuel-station-providers.)

CNG is natural gas that has been compressed to about 1 percent of its volume at standard atmospheric pressure. As described in a National Energy Policy Institute working paper, CNG is generally dispensed by connecting a fuel compressor to an underground natural gas pipeline distribution system. (See http://www.tagnaturalgasinfo.com/uploads/1/2/2/3/12232668/natural_gas_for_heavy_trucks.pdf.) CNG can be dispensed at fast-fill or time-fill (also known as slow-fill) fueling stations. Fast-fill stations use high pressure to dispense the CNG in about the same amount of time as it takes to fill a diesel tank, although the heat generated reduces the total fuel tank capacity. Time-fill stations use lower pressures and require vehicles to be plugged in for several hours, but many vehicles can be fueled simultaneously and a full fill is guaranteed.

According to a J.B. Hunt white paper, CNG has traditionally been considered a better option for trucks that operate locally and return to a base every night, where they can be refilled overnight in a time-fill setup. LNG, on the other hand, is typically considered a better solution for longer-haul operations because it has a smaller fuel economy penalty. However, CNG may become a more viable option for long-haul trucking as the availability of CNG fueling locations expands, and as anticipated technology improvements make lighter and cheaper CNG tanks available. (See http://www.jbhunt.com/files/0001723_NATURAL_GAS_WHITE_PAPER_022014.pdf, pages 2 to 3.)

Taxation of Natural Gas as a Motor Fuel

Motor fuels are taxed by both states and the federal government. State tax policies related to natural gas, however, vary widely. In a 2013 white paper, the East Tennessee Clean Fuels Coalition offers a detailed explanation of taxation approaches as an accompaniment to model taxation legislation that the organization encourages states to adopt.

State Motor Fuel Taxation: Compressed Natural Gas and Liquefied Natural Gas: The Case for Uniformity, East Tennessee Clean Fuels Coalition, October 2013.
http://fuelsfix.com/etcleanfuels/presentations/Model-LNG+CNG-Excise-Tax-State-Motor-Fuel-Taxation-Overview_Oct-2013.pdf
A simple volume comparison is not a logical method for comparing natural gas to conventional fuels, because a gallon of natural gas does not contain the same amount of energy (or provide fuel for the same mileage) as the same volume of diesel fuel or gasoline. As a result, many transportation organizations advocate taxing natural gas on a diesel gallon equivalent (DGE) or gasoline gallon equivalent (GGE) basis. Under these concepts, the amount of natural gas that contains the same amount of energy (as measured in BTUs) as a gallon of diesel fuel (or gasoline) would be taxed at the same rate as a gallon of diesel (or gasoline). Under IRS regulations, CNG is taxed on a GGE basis, where 126.67 cubic feet is considered the equivalent of 1 gallon of gasoline. The National Conference on Weights and Measures also offers a standard in which 5.66 pounds of CNG equals 1 GGE. The report says that these values are not precisely equivalent, but they are "close enough to be used interchangeably without raising concerns of unfair treatment."

There are a variety of state taxation methods currently in use. Thirteen states tax CNG based on a GGE unit, either using 5.66 pounds or 126.67 cubic feet as the conversion factor, and 11 more tax CNG roughly on the GGE, even though they use different units when they levy the tax. (Minnesota is among the states that tax natural gas roughly on GGE and DGE units.) Similarly, eight states tax LNG on either a DGE or GGE basis, and eight more tax LNG in different units but at approximately the same rate.

Eighteen states tax LNG by its own volume rather than a DGE. (This may result in a tax rate less than, equal to or greater than that of conventional fuels.) Nine states impose no tax on either LNG or CNG or both, while 13 have lower tax rates for CNG, LNG or both than conventional fuels. Finally, 11 states impose sticker taxes. Some states fall into multiple categories, or offer options. For example, California truck owners and operators can choose to pay either an annual flat rate sticker tax or an excise tax based on gallons of LNG or cubic feet of CNG used.

Natural Gas Laws and Incentives, U.S. Department of Energy.
http://www.afdc.energy.gov/fuels/laws/NG
Minnesota's laws: http://www.afdc.energy.gov/fuels/laws/NG/MN
The U.S. Department of Energy's Alternative Fuels Data Center provides a listing of state and federal laws and incentives related to natural gas vehicles. It lists a total of 383 laws and incentives. Minnesota, however, has only three: the alternative fuel tax that establishes tax rates, and laws that require state agencies to purchase vehicles that use alternative fuels when feasible.

In our interview with Glen Kedzie of the American Trucking Association, Kedzie said that state incentives, such as those in California and Texas, have a significant impact on natural gas truck implementation. "Where there are state incentives, you're seeing upticks in sales," Kedzie said, because these incentives can reduce the amount of time needed to see a positive return on investment.

Minnesota Taxes

Alternative Fuel GGE and DGE Comparison, Minnesota Department of Revenue, July 1, 2012.
http://www.revenue.state.mn.us/businesses/petroleum/Documents/Alternative Fuel GGE Comparison 3.5 cpg surcharge.pdf
Minnesota's tax rates for natural gas are very close to those of diesel fuel and gasoline on a DGE/GGE basis. Both diesel fuel and gasoline are taxed at $0.285 per gallon. The total tax for CNG and LNG are both $0.282 per GGE—about 1.1 percent less than gasoline. Based on 1.7 gallons of LNG being equal to 1 DGE, Minnesota's total tax for LNG is $0.291 per DGE—2.1 percent more than diesel. (All figures include both the fuel's tax rate and a $0.035 per gallon surcharge.)

In Minnesota, LNG is taxed at $0.171 per gallon, and CNG is taxed at $2.474 per thousand cubic feet.

Related resource:

> **Minnesota Fuel Excise Tax Rates and Fees**, Minnesota Department of Revenue, July 1, 2014.
> http://www.revenue.state.mn.us/businesses/petroleum/Pages/Minnesota_Fuel_Excise_Rates_and_Fees.aspx

Impact of Natural Gas on Minnesota Fuel Tax Revenues

We found no published research that has attempted to predict, in a quantifiable way, the impact of natural gas conversion on future fuel tax revenues in Minnesota. However, several of the sources we interviewed provided their perspective on the general trends they have observed.

Kenneth Buckeye, program manager in MnDOT's Office of Financial Management, said the state has not yet seen any significant impact on fuel tax revenues due to natural gas conversions. "We're not putting it out of our mind, but it's still such a small percentage of fuels sold that we can't devote much time to worrying about it," he said. He added that LNG and CNG represent less than one-thousandth of a percent of the total amount of motor fuel sold in Minnesota.

Jeremy Neeck, principal revenue tax specialist with the Minnesota Department of Revenue, agreed that natural gas still represents a small percentage of motor fuels, but noted that "it has grown almost every month in the last year. It is becoming more available at retail locations, and people are becoming accepting of alternative fuels, and there seems to be an upward trend in the purchasing of alternative fuel vehicles."

Glen Kedzie of the American Trucking Association pointed out that taxing natural gas on a DGE or GGE basis is designed to be a revenue-neutral approach: a truck would pay the same amount of tax whether it was fueled by natural gas or diesel. Since Minnesota's natural gas tax rates are nearly equivalent to its taxes for diesel fuel and gasoline on a DGE or GGE basis, this suggests that natural gas conversion will have little impact on Minnesota's fuel tax receipts.

John Hausladen of the Minnesota Trucking Association said that fuel taxes related to natural gas are likely to be less of an issue than sales taxes. Natural gas trucks are significantly more expensive than those powered by diesel, so if a significant number of natural gas-powered trucks are purchased in the state, state motor vehicle sales taxes would increase. This sales tax represents about 20 percent of the Highway User Tax Distribution Fund (see http://www.dot.state.mn.us/funding/documents/transpfundsforecast2013.pdf), so natural gas vehicles may increase highway funds available even if fuel tax receipts decrease slightly.

Related resource:

Transportation Funds Forecast, MnDOT, February 28, 2014.
http://www.dot.state.mn.us/funding/documents/transportationfundforecasts-feb2014.pdf
MnDOT forecasts fuel tax receipts for the next several years in its Transportation Funds Forecast, which is released every February and November. This forecast is based on predictions from the U.S. Energy Information Administration and by Global Insight. MnDOT's most recent forecasts are $871 million in Fiscal Year 2014, $860 million in FY 2015, $860 million in FY 2016, and $859 million in 2017 (see page 4). The report notes that natural gas is a component of the fuel tax but does not estimate future consumption of natural gas or its impact on fuel tax receipts.

Factors Impacting Future Fuel Tax Receipts

Based on our research and interviews, several factors are likely to affect the impact of trucks' conversion to natural gas on state fuel tax revenues:

- The relative tax rate of natural gas compared to diesel fuel.
- Anticipated truck traffic.
- The relative fuel economy of natural gas and diesel trucks.
- The conversion rate of trucks to natural gas.

The documents in this section either make projections for these factors directly or project other data that may be able to serve as surrogates for these factors.

Relative Tax Rates of Natural Gas and Diesel

As noted above, Minnesota's tax rates for natural gas are very close to those of diesel fuel and gasoline on a DGE/GGE basis. The total tax for CNG and LNG are both $0.282 per GGE—about 1.1 percent less than gasoline. Based on 1.7 gallons of LNG being equal to 1 DGE, Minnesota's total tax for LNG is $0.291 per DGE—2.1 percent more than diesel. These are current tax rates that may change at some point in the future, both in absolute terms and in the relative rates of natural gas and conventional fuels. We did not find any evidence of current proposals to change these tax rates, however, nor of any significant advocacy efforts to change them.

Anticipated Truck Traffic

Annual Energy Outlook 2013 with Projections to 2040, U.S. Energy Information Administration, April 2013.
http://www.eia.gov/forecasts/aeo/pdf/0383%282013%29.pdf
In 2011, heavy-duty vehicles consumed the DGE of 3.5 million barrels of diesel per day nationwide, while in 2040, they are projected to consume the DGE of 5.0 million barrels per day. In other words, heavy-duty vehicles are projected to consume 42.8 percent more energy nationwide in 2040 than they did in 2011 (see page 80 of the report).

These projections may inform projections of future truck traffic in Minnesota, although it is unclear if the state's truck traffic levels will follow the projected nationwide pattern. Recent data on Minnesota's fuel tax revenue is provided below.

Minnesota Revenue Motor Fuels Tax, Minnesota Department of Revenue, January 2014.
http://www.revenue.state.mn.us/legislativeupdate/Documents/Motor_Fuels_Tax.pdf
Minnesota collected approximately $863 million in fuel taxes FY 2013 from all motor fuels, including natural gas. Most of this, 97 percent, is dedicated to the Highway User Tax Distribution Fund, which funds trunk highways, county state aid highways, and municipal state aid streets. Another 0.1 percent is dedicated to the

Special Revenue fund for boat and forest road usage, and 2.9 percent is dedicated to the Natural Resources Fund for snowmobile, all-terrain vehicle, and off-road vehicle usage.

The $863 million in total fuel taxes in Minnesota comes from all vehicles, rather than just trucks. In 2008, 79 percent of revenues came from gasoline, while the other 21 percent (approximately $181 million) was "mostly from diesel and special fuel sales." (See http://www.dot.state.mn.us/information/funding2008/highwayfinances.pdf.)

Relative Fuel Economy of Natural Gas and Diesel Trucks

Many analyses assume that a truck will travel as far on 1 DGE of natural gas as it will on a gallon of diesel. While those measures each contain the same amount of energy, in practice natural gas trucks are currently somewhat less efficient than diesel trucks.

In our interviews, Kenneth Buckeye of the MnDOT Office of Financial Management mentioned the issue of fuel efficiency, noting that since natural gas in Minnesota is taxed at nearly the same rate as diesel fuel on a DGE basis, truck conversions should have almost no impact on fuel tax receipts as long as natural gas trucks are equally as efficient as diesel trucks. As discussed below, natural gas trucks generally currently get slightly less mileage for the same amount of energy as diesel. This suggests that natural gas conversion could actually increase fuel tax receipts slightly.

What Set of Conditions Would Make the Business Case to Convert Heavy Trucks to Natural Gas?—A Case Study, Anna Lee Deal, National Energy Policy Institute, May 1, 2012.
http://www.tagnaturalgasinfo.com/uploads/1/2/2/3/12232668/natural_gas_for_heavy_trucks.pdf
Most natural gas engines are spark-ignited, rather than compression-ignited as diesel engines are. According to this paper (see page 8): "Spark-ignited natural gas engines are not able to achieve the high compression ratio (and associated efficiency) or horsepower of a diesel engine because of the need to prevent pre-ignition and engine damage. Most spark-ignited natural gas engines on the market today suffer a fuel penalty of about 10 percent, but this is improving." The paper also states that there are compression-ignited engines available that run on LNG (but not CNG) that do not have the fuel penalty of spark-ignited engines (see page 5).

Natural Gas in Transportation, J.B. Hunt, February 2014.
http://www.jbhunt.com/files/0001723_NATURAL_GAS_WHITE_PAPER_022014.pdf
Not all sources agree that the fuel efficiency of spark-ignition engines is improving. According to this J.B. Hunt white paper, "We currently observe an approximate 15 to 20 percent fuel mileage reduction on the 12L natural gas trucks" (referring to the 2013 Cummins Westport 11.9-liter engine).

"24 Crucial Things to Know About Running Natural Gas Trucks," *Today's Trucking*, October 2013.
http://www.todaystrucking.com/24-crucial-things-to-know-about-running-natural-gas-trucks
This article reports on experiences from Canadian trucking companies Bison Transport and Robert Transport in implementing natural gas trucks. Bison reported that its LNG trucks had a larger mileage penalty (17 to 18 percent) than the 10 percent it expected.

Commercial Fleet Conversion to Natural Gas

Industry and Government Expectations of Conversion Rates

The individuals we spoke to in the trucking industry and at Midwestern state agencies were consistently hesitant about making predictions of future adoption rates of natural gas in trucking. All agreed that natural gas vehicles currently represent only a small portion of the market. Some noted that adoption rates have been lower than anticipated a few years ago, and that several factors make a near-term increase in adoption rates appear less likely.

John Hausladen, president of the Minnesota Trucking Association, said there have not been many fleets that have made significant investments in natural gas trucks in the state. "I think the ramp-up rate by carriers to purchase this technology is going to be negligible, at least in the next five years," he said.

Glen Kedzie, vice president and energy and environmental counsel for the American Trucking Association, said natural gas implementation among trucks in 2014 has not met forecasts from one to two years ago. He noted that a September 2014 report from ACT Research, *NG Reality Check: Moving from Infancy to Adolescence*, predicted 2014 nationwide sales of natural gas trucks of 11,000 units. This represents growth in natural gas truck sales, but slower growth than prior projections. The natural gas truck sale growth rates are in line with the overall growth in all truck sales. (See http://www.actresearch.net/act-research-ng-reality-check-moving-from-infancy-to-adolescence/ for more on the report.)

Kedzie also cited a *Wall Street Journal* article that reported Power Systems Research's expectations of 10,480 heavy-duty natural gas truck sales in 2014. While this was up 20 percent from 8,730 natural gas truck sales in 2013, it fell short of previous forecasts of 16,000 sales. (See http://online.wsj.com/articles/natural-gas-trucks-struggle-to-gain-traction-1408995745; registration required.)

He added that the first phase of new federal fuel economy standards (which will require a 6 percent improvement by 2017) took effect this year. An improvement in diesel fuel engine efficiency would reduce the impact of the cost differential between natural gas and diesel, possibly inhibiting the adoption of natural gas.

As mentioned above, Kedzie also pointed out that states that offer financial incentives for conversion to natural gas tend to see higher rates of adoption.

Kedzie noted that it is difficult to know exactly which vehicle classifications are converting to natural gas, since sales figures lump trucks together with buses and refuse trucks. "I would love to have a site that breaks out by type of truck and year purchased, but it doesn't exist," Kedzie said. However, he said CNG is being implemented more rapidly than LNG. Using natural gas in long-haul trucks, which would typically be fueled by LNG, requires significant planning to ensure that the truck routes will be able to be served by fueling infrastructure. Many CNG trucks have hub-and-spoke routes, where the vehicles return to a terminal at night to be refueled for the next day.

In Iowa, Shawn Majors, transportation planner in the Iowa DOT Office of Transportation Management, said there has been little implementation of natural gas so far. Based on monthly fuel summaries, "We can say for certain that CNG has jumped up a bunch from a couple years ago, but it's still small relative to diesel and everything else," he said. He and Matt Chambers, also a transportation planner in the Office of Transportation Management, said October 2014 was the highest level of CNG usage on record, with tax levied on 63,000 gallons generating about $10,000 in revenue. However, approximately 50 million gallons of diesel are consumed monthly, so CNG consumption is about 1/800th of diesel consumption.

Majors added that Iowa DOT is monitoring natural gas developments, and that he has read articles about trucking companies considering natural gas conversion. However, there is currently very limited fueling infrastructure in the state.

In Wisconsin, Thomas Rabaglia said the Department of Transportation does not have a sense of how many trucks have converted to natural gas. Jacek Cianciara of the Wisconsin Department of Revenue said that agency also has not investigated the potential impacts of natural gas conversion on state tax revenues.

Published Predictions of Natural Gas Conversion Rates

We did not find any documents quantifying the number of natural gas trucks currently on the road in Minnesota, although some sources estimate the total number of natural gas trucks in the United States. We also identified nationwide predictions of natural gas truck sales. Several sources also offer anecdotal evidence about natural gas

conversion rates, and other sources offer predictions for factors that are closely tied to natural gas trucks. This data is outlined below.

Annual Energy Outlook 2014 with Projections to 2040, U.S. Energy Information Administration, April 2014.
http://www.eia.gov/forecasts/aeo/pdf/0383%282014%29.pdf
Annual Energy Outlook 2013 with Projections to 2040, U.S. Energy Information Administration, April 2013.
http://www.eia.gov/forecasts/aeo/pdf/0383%282013%29.pdf
The U.S. Energy Information Administration predicts that medium- and heavy-duty vehicles will become the largest consumers of CNG and LNG in the United States by 2040 (2014 edition, page MT-15). These vehicles (defined as tractor trailers, vocational vehicles, pickups and vans with a gross vehicle weight rating of 10,001 pounds or more) will consume more than 55 times more LNG and CNG (as measured by BTU output) in 2040 than they did in 2012, from 11 trillion BTU in 2012 to 613 trillion BTU in 2040.

The 2013 edition of this report predicts that natural gas will provide 14 percent of the energy consumed by heavy-duty vehicles in 2040 (page 80).

U.S. and Canadian Natural Gas Vehicle Market Analysis: Heavy-Duty Vehicle Ownership and Production, America's Natural Gas Alliance, undated.
http://anga.us/media/content/F7D3861D-9ADE-7964-0C27B6F29D0A662B/files/Heavy-Duty%20Vehicle%20Ownership%20and%20Production.pdf
This undated report (although it was likely produced in early 2011, as the most recent publications it cites are from November 2010) is perhaps the closest thing to a census of natural gas trucks. It attempts to quantify the size of the heavy-duty natural gas vehicle market by surveying vehicle and engine manufacturers about their production and capacity. In this survey, 11 heavy-duty vehicle manufacturers reported annual production of natural gas vehicles totaling approximately 3,835 units, while 4 heavy-duty engine manufacturers reported annual production of approximately 3,000 to 3,500 units (pages 39-41). This report is limited by the fact that it collected this information via survey and therefore relies upon the willingness and ability of survey recipients to respond. It also acknowledges that "there are uncounted heavy-duty fleets across North America; obtaining feedback from a high percentage of these fleets was not feasible for this study" (page 1). The age of the report is also a concern, as the technology for natural gas truck engines is evolving rapidly, which may have a major impact on the potential market for such vehicles.

For Fleets, Natural Gas Vehicles for America, October 2014.
https://www.ngvamerica.org/vehicles/for-fleets/
According to Natural Gas Vehicles for America, an industry group promoting the use of natural gas vehicles, there are currently 33,000 to 35,000 heavy-duty natural gas vehicles on the road. This figure includes buses, refuse trucks, and municipal vehicles, although NGVA says that it also includes 5,000 regional haul trucks. It also cites predictions from the National Petroleum Council that natural gas could fuel 35 percent of all medium-duty trucks, and 50 percent of all heavy-duty trucks by 2050. However, NGVA acknowledges that these are the NPC's most aggressive scenarios; as NGVA is an advocacy group, it may be motivated to present the most optimistic predictions rather than the most realistic ones.

Natural Gas in the Trucking Industry, Ruan Transportation Management Systems, May 2013.
https://www.ruan.com/filesimages/New%20PDFs/White_paper_CNG_513.pdf
This white paper includes a prediction that 930,000 medium- and heavy-duty natural gas trucks will be sold by 2019.

Natural Gas Trucks and Buses (Executive Summary), Navigant Research, 4th Quarter, 2013.
http://www.navigantresearch.com/wp-assets/uploads/2013/12/NGTB-13-Executive-Summary.pdf
According to this report, the market for natural gas vehicles grew sharply in late 2013 as new engines became available, and that trend is expected to continue. Emissions regulations and expanding fueling infrastructure is likely to contribute to growth in the market. Globally, Navigant predicts a total of 1.9 million natural gas trucks on the road by 2022. However, much of that will be in Asia; North America is predicted to consume 12.7 percent

of the market, or approximately 240,000 vehicles. Another Navigant report predicts 4,128 North American sales of LNG trucks in 2020; see http://www.navigantresearch.com/wp-assets/uploads/2013/06/MD-NGV-13-Executive-Summary.pdf.

What Set of Conditions Would Make the Business Case to Convert Heavy Trucks to Natural Gas?—A Case Study, Anna Lee Deal, National Energy Policy Institute, May 2012.
http://www.tagnaturalgasinfo.com/uploads/1/2/2/3/12232668/natural_gas_for_heavy_trucks.pdf
This working paper models the business conditions that would lead to natural gas truck conversion providing a 20 percent return on investment. When the price differential between natural gas and diesel is less than $0.75 per DGE, an attractive ROI is impossible because the number of miles needed to be profitable would be greater than the number of miles that could be driven annually. At a $2.50/DGE differential, vehicles would need to travel only 30,000 to 40,000 miles for conversion to become an attractive option (pages iii-iv).

Factors Affecting Conversion Rates

There are several benefits and drawbacks to converting vehicles to natural gas. These will naturally impact the extent to which fleets choose to convert their vehicles. In addition to the relative prices of natural gas and diesel and the "fuel penalty" that have been discussed above, the factors that are likely to impact conversion rates are:

- Emissions.
- Engine availability.
- Fueling infrastructure.
- Cost of engines.
- Maintenance costs.

Emissions

Natural Gas in the Trucking Industry, Ruan Transportation Management Systems, May 2013.
https://www.ruan.com/filesimages/New%20PDFs/White_paper_CNG_513.pdf
Natural gas produces 30 percent less carbon dioxide than other fossil fuels, according to this white paper. It can also be produced from landfill gas, wastewater treatment and farm animal waste, which can also reduce carbon emissions. If federal and state governments enact tighter emissions regulations, it may encourage natural gas conversion. However, diesel engine manufacturers have met standards enacted by the U.S. Environmental Protection Agency in 2010 by implementing selective catalytic reduction, which has also improved the fuel efficiency of diesel engines, somewhat reducing the benefit of natural gas's lower fuel costs.

Engine Availability

Natural Gas in Transportation, J.B. Hunt, February 2014.
http://www.jbhunt.com/files/0001723_NATURAL_GAS_WHITE_PAPER_022014.pdf
According to this white paper, the use of LNG in freight trucks was until recently inhibited by the lack of a suitable natural gas engine. However, the report notes that "The 12-liter Cummins Westport engine is now available in truck models from practically all truck manufacturers. These trucks performed well in tests throughout 2013, according to our industry contacts... Orders for these trucks are now routinely placed and fulfilled in a timely manner."

Fueling Infrastructure

Alternative Fueling Station Locator, U.S. Department of Energy, Alternative Fuels Data Center.
http://www.afdc.energy.gov/locator/stations/
U.S. Alternative Fueling Stations by Fuel Type, U.S. Department of Energy, Alternative Fuels Data Center, January 2014.
http://www.afdc.energy.gov/data/10332
The U.S. Department of Energy's Alternative Fuels Data Center offers two sets of figures for the number of natural gas fueling stations nationwide. Both sources agree that there are nine CNG stations in Minnesota (four in the Metro area, four in southeast Minnesota, and one in Duluth), and no public LNG stations (although there is one near the Minnesota border in La Crosse, Wisconsin). However, the two sources disagree about the number of stations nationwide; the Locator says there are 758 public CNG stations and 64 public LNG stations in the United States, while the graph of fueling stations by fuel type reports 1,263 public CNG stations and 81 public LNG stations.

Natural Gas in Transportation, J.B. Hunt, February 2014.
http://www.jbhunt.com/files/0001723_NATURAL_GAS_WHITE_PAPER_022014.pdf
This J.B. Hunt white paper says that "Finding an adequate natural gas station to support an operation is usually the biggest obstacle we encounter on this topic today." While some companies are working to implement LNG and CNG at their filling stations, most public stations are not currently large enough to accommodate a class 8 tractor and trailer, and they cannot fill a large tractor in a reasonable amount of time.

Clean Energy 2013 Annual Report, Clean Energy, April 2014.
http://files.shareholder.com/downloads/CLNE/3616346868x0x744186/ecf3f19f-62c6-4d2b-b5e0-ca628ff9bf5c/Clean_Energy_revised_2013_Annual_Report_web_ready_4-7-14.pdf
As reported in its Annual Report, Clean Energy Fuels is endeavoring to build "America's Natural Gas Highway," a nationwide network of LNG and CNG stations for trucks. It built 55 CNG stations and 19 LNG stations in 2013. However, this network does not currently extend into Minnesota. (See http://www.cnglngstations.com/ for a current map of the network.) A June 26, 2014, article in the *Journal of Commerce* reported that the network is extending slowly, and that 60 planned LNG stations have been delayed due to lack of demand for LNG as a fuel for over-the-road trucks. (See http://www.joc.com/trucking-logistics/trucking-equipment/trucking%E2%80%99s-natural-gas-%E2%80%98highway%E2%80%99-still-under-construction_20140626.html.)

Cost of Engines

Effects of Natural Gas Vehicles and Fuel Prices on Key Transportation Economic Metrics, Kevin Heaslip, Ryan Bosworth, Ryan Barnes, Ali Soltani Sobh, Michael Thomas, Ziqi Song, Washington State DOT, June 2014.
http://www.wsdot.wa.gov/research/reports/fullreports/829.1.pdf
Natural gas engines are significantly more expensive than comparable gasoline or diesel engines. The premium for a CNG engine varies with the size of a vehicle. In 2012, a heavy-duty pickup truck from GM that could run on either CNG or gasoline cost about $11,000 more than a gasoline-only option. Larger trucks have greater premiums—up to $70,000 for the largest CNG engines, intended for work trucks and line-haul applications (page 24).

Natural Gas in Transportation, J.B. Hunt, February 2014.
http://www.jbhunt.com/files/0001723_NATURAL_GAS_WHITE_PAPER_022014.pdf
The J.B. Hunt white paper reports that a 12-liter LNG tractor would add $50,000 to $90,000 to the cost of a truck, depending on tank specifications.

Maintenance Costs

Natural Gas in Transportation, J.B. Hunt, February 2014.
http://www.jbhunt.com/files/0001723_NATURAL_GAS_WHITE_PAPER_022014.pdf
There is a lack of facilities to repair natural gas tractors, and existing facilities would need to be retrofitted due to venting requirements in order to allow indoor work on natural gas tractors. Modifications would cost $50,000 to $150,000, depending on shop size and layout; the paper estimates that additional maintenance costs would range from 2 to 4 cents per mile.

"24 Crucial Things to Know About Running Natural Gas Trucks," *Today's Trucking*, October 2013.
http://www.todaystrucking.com/24-crucial-things-to-know-about-running-natural-gas-trucks
The Canadian trucking company Bison Transport reported that maintenance of its LNG trucks cost 7 to 8 cents per mile, compared to the 3 to 4 cents per mile it had anticipated when it purchased the vehicles.

Concerns About Natural Gas Conversion

While state agencies' primary concern regarding natural gas conversion is its potential impact on fuel tax revenues, the sources we spoke to also raised a few additional concerns, including the potential for fraud.

"One of the things we were cautious about is the ability for vehicles to convert to CNG without our ability to know it and collect the motor fuel taxes," said Kenneth Buckeye, program manager for the MnDOT Office of Financial Management. He said he attended a promotional seminar a few years ago that suggested that there were aftermarket devices available that would allow a user to tap into a natural gas supply to fill a vehicle's tank without paying tax. He was uncertain, however, if such devices actually exist.

Jeremy Neeck of the Minnesota Department of Revenue said via email that the DOR has reached out to utility companies to learn about the existence of home fill units. "We were told that only authorized installers can pipe these units into existing home pipelines," he said.

He also said that the DOR monitors fueling stations within the state. Retailers of alternative fuels must be licensed with the state to dispense alternative fuels into a motor vehicle; individual users can also be licensed if they choose to acquire alternative fuels from sources other than a licensed retailer. Natural gas is taxed when it is dispensed into a motor vehicle fuel tank, rather than at a wholesale level.

Buckeye also said there have been some concerns about safety of natural gas vehicles due to the highly compressed fuel in a gas tank. However, he added that he has heard of no serious accidents related to the compressed fuel. "We're watching it, but we're not alarmed by it yet," he said.

Thomas Rabaglia of Wisconsin DOT said that fuel tax revenues have been dropping in Wisconsin, although the state doesn't know if implementation of natural gas vehicles is a significant cause relative to better fuel efficiency and less driving overall. Jacek Cianciara of the Wisconsin Department of Revenue said that the DOR has not investigated any potential impacts on state tax revenues due to natural gas. (According to the DOR, both CNG and LNG are taxed in gallons, but the tax rate for both is calculated based on the GGE, which suggests that natural gas implementation would have only a small impact on fuel tax revenues. See http://www.revenue.wi.gov/faqs/ise/altfuel.html.)

Potential Policy Options

Nearby states have made only a few proposals of policy options to address issues related to natural gas conversion. As previously discussed, the trucking industry typically advocates for natural gas to be taxed on a diesel gallon equivalent or gasoline gallon equivalent, in which the amount of natural gas that contains the same amount of energy as a gallon of diesel fuel (or gasoline) would be taxed at the same rate as the conventional fuel. Minnesota's taxes for LNG and CNG are currently very close to equal (28.2 cents per GGE, compared to 28.5

cents per gallon of diesel). It may be possible to equalize these completely, although the impact would be relatively small.

In Indiana, Kimmerling said the DOT was asked to figure an appropriate fee structure for natural gas trucks and opted for an Equivalent Single Axle Load (ESAL) structure that would charge vehicles based on their impact on the road surface rather than the fuel they consume. "We think that's the fairest way to charge," Kimmerling said.

Under this scheme, Indiana's current tax ($0.16 per gallon of diesel or per diesel gallon equivalent of LNG) is considered the equivalent of 7 cents per ESAL mile for vehicles up to 2.4 ESALs (80,000 pounds in a normal configuration). Heavier vehicles are assessed a per-mile fee to approximate a total tax of 7 cents per ESAL mile. (See http://www.in.gov/dor/files/osowhandbook.pdf, page 26.) Kimmerling noted that this is a preliminary plan for Indiana. "We may adjust rates as needed. We'll see how they affect hauling and revenue," he said. Studies currently underway are evaluating the impact of the law, which took effect in 2014.

Kimmerling also said that the DOT offers an incentive for trucks to convert to natural gas by offering annual permits to allow natural gas trucks to exceed maximum weight limits by 2,000 pounds. A relatively small number of vehicles have taken advantage of that incentive, however.

Thomas Rabaglia of Wisconsin DOT noted that during his 2014 reelection campaign, Governor Scott Walker proposed replacing the current per-gallon fuel tax structure with taxation on a sales tax basis, in which the tax would be calculated based on the total cost of the gas purchased rather than the quantity. According to an October 14, 2014, article in the *Wisconsin State Journal*, Walker claimed that option would provide an equitable way to tax actual usage of roads, regardless of how a vehicle is powered. (See http://host.madison.com/news/local/govt-and-politics/gov-scott-walker-floats-replacing-gas-tax-to-fix-transportation/article_828d9e30-0098-5158-a035-6053559cead1.html.) The article said that there are few specifics about the plan or its ultimate impacts. Governor Walker won re-election, but this approach has not been formally proposed as policy, and no further details on this tax structure are available.

Shawn Majors of Iowa DOT said that last year the state passed legislation that changed the units of the tax rates for natural gas from cubic feet to gallons. This did not affect tax rates; it merely simplified distribution by using familiar fuel units.

Jacek Cianciara of the Wisconsin Department of Revenue said the state is not considering any policies regarding natural gas conversion.

Contacts

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