Cape Fear Public Transportation Authority

Compressed Natural Gas Fuel Evaluation

September 2012

Introduction

In an effort to minimize the Authority's exposure to instability in the global crude oil market, Wave Transit has undertaken an effort to analyze vehicle propulsion fuel options. This analysis will lay a foundation for a long term policy to minimize the vulnerability of the Authority to dramatic swings in price and the possibility of unsustainable crude oil prices over the next ten to fifteen years.

Currently, fuel represents 15% to 25% of the Authority's annual operating budget. Intense fluctuations in the price of fuel in 2008 and again in 2011 have jeopardized the Authority's ability to meet budget projections. While accurate prediction of long term commodity pricing is impossible, steps can be taken to minimize the risk that rising fuel prices can have on the operation of Wave Transit.

The timing of this report is not coincidental. The Authority is currently in the design phase for a new forty year maintenance and operations center. The Authority also has a fleet replacement project scheduled for 2015 to replace 76% of its heavy duty bus fleet. The convergence of these two major capital projects warrants a detailed look at fueling options. The ability to integrate alternative fueling options in conjunction with the capital improvements will lead to lower costs for alternative fueling options. It will also allow the Authority to prepare a capital improvement program for vehicle replacement with multiple vehicle fueling options.

Overall analysis was undertaken by Authority staff with recommendation and concurrence by the Authority's Facilities Committee Chaired by Jeff Petroff, PE. Technical analysis was contracted to MCBH Engineers, PLLC of Wilmington, NC through Becker Morgan Group, Inc.

Scope

The analysis is being undertaken by various professionals in the fields of facility design, mechanical engineering, electrical engineering, natural gas delivery, transit vehicle manufacturing, vehicle propulsion engineering, commodity analysis and public transportation management. Several publications specific to the transit industry were also evaluated during the process. The scope is defined as follows:

Cape Fear Public Transportation Authority

- Review of Transportation Cooperative Research Program (TCRP) Report 146 *Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements*
- Projected fuel costs
- CNG vehicle cost analysis
- CNG vehicle maintenance cost analysis
- CNG limitations
- Budget impact analysis
- Recommendation

Consultant (Becker Morgan Group, Inc./MCBH Engineering)

- Investigate and document design modifications (both building and site) necessary to service CNG powered vehicles in conjunction with diesel powered vehicles
- Determine approximate financial impact to maintenance facility construction costs to service CNG powered vehicles in conjunction with conventional diesel powered vehicles
- Determine approximate costs for the installation of an outdoor CNG refueling facility
- Determine approximate annual cost for electrical service
- Determine approximate annual maintenance costs

TCRP Report 146 Analysis

The Federal Transit Administration provides a host of technical and programmatic reports to assist its grantees. These reports are typically commissioned by research organizations or universities that possess a level of expertise that would not normally be found in most transit agencies. The Authority based a significant amount of this analysis and the recommendations for policy decisions regarding vehicle propulsion on the TRCP report.

To begin the process, the Authority examined types of fuel available for bus propulsion, availability of fuel, equipment and maintenance costs, and capital costs. Currently, Wave Transit utilizes three of the nine types of fuel analyzed in TCRP report 146. These are diesel, gasoline and diesel hybrid. All three of these energy sources are petroleum based. The other types of fuels identified in the report may be available to the transit market. Compressed natural gas is the most utilized fuel in the transit market that is non-petroleum based. As mentioned in the introduction to this report, one of the goals for studying alternative fuels is to make the Authority less dependent on petroleum based fuels.

After analyzing all of the fuel options, the Authority identified compressed natural gas (CNG) as the preferred alternative for additional study. In addition to becoming less dependent on the global petroleum market, CNG is identified in the report as a more environmentally responsible fueling option. It should be noted that 2010 EPA diesel emission standards have minimized this advantage for CNG.

The most relevant method of analysis in comparing CNG to diesel in the TCRP report is the pros and cons of CNG. While the pros are easily defensible, the cons were evaluated to ensure that they did not bind the Authority to a fuel that may not have relevance in the long term. The Authority is confident that the adverse impacts from implementing sixteen buses to CNG is subject to minimal risks. Fuel diversification also affords the Authority the opportunity to adjust its propulsion source based on market trends.

A copy of the TCRP report is available at the following URL:
http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_146.pdf

Projected Fuel Costs

Should the Authority commit to CNG as a fuel option, the obligation would be for a period of not less than twelve years, which is the depreciation on a heavy duty bus. Therefore, the Authority analyzed market projections for both diesel fuel and CNG over a fifteen year period. This would allow for bus acquisition and facility construction prior to the beginning of the twelve year useful life of the fleet beginning in 2015.

For the purpose of this report, the Authority examined historic costs of crude oil and natural gas. Image 1 depicts the trend in the cost of crude oil vs. natural gas over the past twenty-six years. Since 1986 the cost of natural gas has remained below the cost of oil with minor and brief exception. The current trend, a meaningful difference between crude oil and natural gas, is expected to continue as natural gas drilling techniques are refined and domestic sources are tapped. Continued uncertainty in the Mideast and other oil producing countries could also increase the price disparity.

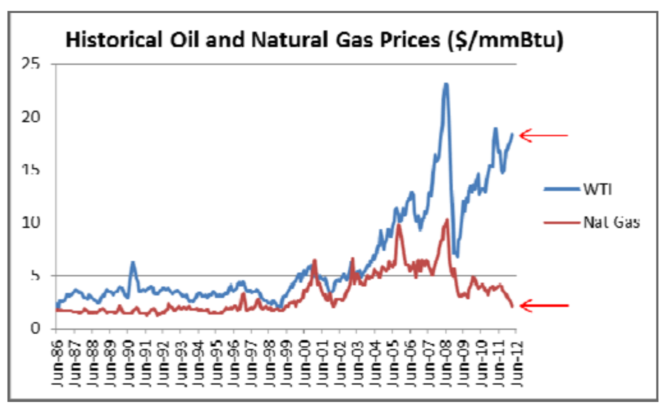

Image 1

Statistical review led the Authority to believe that the U.S. Department of Energy was the most reliable and impartial reference in commodity futures prediction. In their *Annual Energy Outlook 2012,* "oil prices [West Texas Intermediate (WTI)] rise from $79 per barrel in 2010 to about $117 per barrel in 2015 and $127

1. Image 1 http://avalonenergy.us/blog/?p=376
2. http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf p. 104

Projected Fuel Costs (cont.)

per barrel in 2020. From the 2020 level, prices increase slowly to $145 per barrel in 2035.[2]“ This represents a 70.59% rise in the price of crude oil. Although the rise in diesel prices do not necessarily equate to similar prices in crude oil, lacking a better quantifier, this report will assume a rise in the cost of diesel fuel in 2035 of 70.59% to $5.80 per gallon.

“As of January 1, 2010, total proved and unproved natural gas resources are estimated at 2,203 trillion cubic feet. Development costs for natural gas wells are expected to grow slowly. Henry Hub spot prices for natural gas rise by 2.1 percent per year from 2010 through 2035 in the Reference case, to an annual average of $7.37 per million Btu (2010 dollars) in 2035.[3]” The percentage increase in 2035 represents a 52.5% increase in the price of natural gas in 2035. The Henry Hub closed at $2.87 per MMBtu on September 05, 2012[4].

According to the *Annual Energy Outlook 2012,* DOE predicts that “after 2017, natural gas prices rise in the *AEO2012* Reference case more rapidly than crude oil prices, but oil prices remain at least three times higher than natural gas prices through the end of the projection. In the *AEO2012* Reference case, domestic natural gas production grows more quickly than consumption. As a result, the United States becomes a net exporter of natural gas by around 2022, and in 2035 net exports of natural gas from the United States total about 1.4 trillion cubic feet.[5]”

Continued advances in natural gas drilling is expected to yield increased natural gas production and keep natural gas prices well below crude oil prices. It is also important to note that as domestic natural gas becomes more plentiful, price volatility decreases.

CNG Vehicle Cost Analysis

Compressed natural gas is becoming increasingly popular as a propulsion fuel in the transit bus market. According to Gillig Inc., the largest manufacturer of transit buses in the U.S., CNG represents approximately 20% of its new orders. The cost of a new Gillig low-floor CNG bus is currently 13.21% higher than a comparable diesel model. 2012 pricing for a low-floor 35 foot CNG bus scheduled for delivery in 2014 is $428,611.00. The premium for CNG propulsion is significantly less than the diesel-hybrid option which is currently 51.42% or $590,905.00[6].

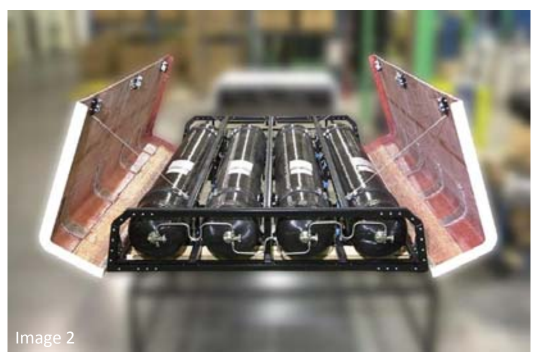
Image 2

Maintenance staff training would be a necessary requirement for a change in propulsion fuel. CNG is spark ignited while diesel is compression ignited. Spark ignition is the standard in gasoline engines and the current maintenance staff is trained in gasoline engine repair which would minimize the learning curve. Extensive training by the vehicle and engine manufacturer would be a condition of the procurement contract.

The Authority believes that the premium for vehicle acquisition is not a major impediment to converting to CNG and the increased cost of CNG buses is offset by fuel savings over the life of CNG vehicles. This assumption is magnified when the cost of capital reimbursement by FTA is added to the equation.

CNG Maintenance Cost Analysis

As outlined in TCRP Report 146, maintenance costs vary widely between bus types, models, sizes and propulsion fuel. A survey of transit operators using CNG and diesel fuel by TCRP revealed that CNG buses were

3. http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf p. 91
4. http://www.eia.gov/naturalgas/weekly/
5. http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf p. 91
6. Cape Fear Public Transportation Authority Consolidated Procurement Contract Pricing September 2012
7. Image 2 http://www.cfsinternational.com.au/photos/bus_fuel_storage.jpg

CNG Maintenance Cost Analysis (cont.)

less expensive to maintain than comparable diesel buses. For this report, the Authority surveyed transit operators using CNG to determine specific areas of vehicle maintenance that would impact annual maintenance costs. Two components exclusive to a CNG bus, CNG pressure sensors and ignition systems, seem vulnerable to failure. The parts necessary to repair these failures are relatively inexpensive and readily available. On site parts inventory of repair parts and replacement components is not believed to be cost prohibitive.

CNG station maintenance is another issue which required extensive study. Due to the high pressures of CNG and the complex nature of a CNG fueling station, in house maintenance of the CNG fueling station is not recommended. Daily observation of the station will ensure increased safety and reliability of the fueling components. Strict preventive maintenance by highly trained personnel is recommended. A contract maintenance program, with daily on site oversight, has been calculated as part of the cost of converting to CNG.

CNG Concerns

The use of CNG as a propulsion fuel is not necessarily limited, although the ability to power a fleet as large as Wave Transit's may be. As part of the engineering analysis contained in this report, the Authority evaluated both the slow fill and fast fill methods for refueling CNG vehicles. Both methods have their advantages and disadvantages. To fully power the Authority's fleet, several compressors and dozens of compressed storage containers would be required. This is not only costly but space and maintenance intensive.

Additionally, converting 100% of the Authority's fleet could prove problematic in the event of an evacuation. Until a network of CNG fueling facilities is available east of Interstate 95, refueling the fleet post evacuation could be difficult. Refueling CNG buses by a tanker truck is a possibility, but in the aftermath of a major evacuation, this option could be logistically burdensome.

Image 3

Electricity, and lots of it, is required to compress natural gas for vehicle use. The cost of electricity to power the fleet has been included in the calculation comparing diesel fuel costs to CNG. Generators capable of powering the compressors in the event of a power failure would be included in the design of a facility with CNG capabilities. Emergency generators would be powered by diesel or gasoline which would be stored on site as an alternate propulsion fuel.

In the event of a failure by the contracted utility to deliver natural gas to the site, an agreement would need to be in place to ensure that offloading of fuel from a tanker to the vehicles is in place. The agreement could be with the utility or CNG station maintenance contractor.

When natural gas is compressed to 3,600 psi, safety is also an important consideration. As CNG has become more popular as a propulsion fuel, safety measures have improved dramatically. Although limited data is available comparing the safety of CNG buses to diesel buses, CNG is believed to be as safe as diesel.

Should the Authority commit to CNG, it is recommended that CNG vehicle purchases be limited to new vehicles engineered for CNG. Conversions from gasoline or diesel to CNG would increase the risk of failure in the CNG propulsion system which could lead to vehicle damage or injury to passengers or employees.

8. http://www.afdc.energy.gov/pdfs/48814.pdf p. 7
9. Image 3 http://www.fiedlergroup.com/wp-content/uploads/2012/03/City-of-Montebello-Celebrate-Opening-of-Bus-CNG-Fuel-Station.jpg

Wave Transit - CNG Facility Evaluation
September 6, 2012
(edited for clarity)

MCBH Engineers, PLLC
3808 Park Avenue
Wilmington, NC 28403
Phone : 910.791.4000
Fax : 910.791.5266
www.mcbheng.com

Background Information

As part of the design for the new Wave Transit Maintenance Facility, the option of converting the bus fleet to Compressed Natural Gas (CNG) operation is being explored. This report looks at the ramifications of the construction and operating costs of the maintenance facility and refueling station for CNG.

Natural Gas is a more environmentally clean and safer, alternate for gasoline, diesel or propane. CNG is natural gas stored at 3600 pounds per square inch (psi) and takes up less than 1% of the volume it occupies at standard atmospheric pressure. In response to rising fuel prices, CNG is increasingly being used in the transportation industry including transit and school buses. There are two main types of refueling, fast fill and time fill. Fast fill stations receive fuel from natural gas utilities at a service pressure (can range from as low as 5 psi to over 150 psi) and compress the gas onsite to its storage pressure. Once compressed the CNG moves to a series of storage vessels (ranging between 4500-5000 psi) so the fuel is ready for a fill similar in time to a typical gasoline filling. Fast fill stations are generally best suited for high demand, high fuel consumption operations such as trucking and high volume transit. Time fill stations also receive fuel from utilities at service pressure and compress the gas onsite to a storage pressure; however these compressors utilize the down time in operations to fuel the vehicles over some specific time period (typically 6 to 12 hours). The time it takes to fuel a vehicle, based on the Wave Transit fleet assumptions given later in this report, is generally assumed to be 8 to 10 hours. Time fill stations are generally best suited for transit fleet vehicles/ buses that fill at regularly schedule times, i.e. overnight.

The items below summarize the basic differences between the properties of gaseous and liquid fuels that influence the building design changes for Compressed Natural Gas (CNG) Maintenance Facilities and Refueling Station:

Natural Gas is lighter-than-air which allows the fuel to quickly rise and disperse in the event of a leak. Therefore, roofs and ceilings of CNG maintenance facilities must be designed without any unventilated “pockets” in the ceiling space that could trap gas.

Liquid fuels such as gasoline and diesel will form a pool of liquid with a vapor layer above. Liquid fuels remain in a concentrated form after a leak, causing on-going safety and environmental concerns.

Maintenance facilities must be designed to quickly and automatically remove the risk caused by a leak, using ventilation to exhaust any leaked gas.

CNG has an ignition temperature of around 900 to 1200 °F as opposed to Gasoline which is approximately 500°F to 800°F and diesel is less than 500°F. This relatively high ignition temperature for CNG is an additional safety feature. To ensure a safe environment in the maintenance garage, the surface temperature of equipment that could contact a gas leak is usually limited to 750°F.

Heating Equipment

Because a hydronic floor heating system would work well in a diesel or gasoline service garage, it lends itself to a flexible fuel situation. There are no hot surfaces in contact with fuels or vapors and liquid spills will evaporate quickly. Where there is a high air change rate the floor heating system provides a reasonable level of comfort.

Ventilation Equipment

Exhaust of the building must be at the highest point to insure removal of fuel gases. To maintain the facility at a negative pressure there should be no make-up fans. Make-up air shall be introduced around the periphery of the entire work space to avoid stagnant areas. A ventilation rate of 6 air changes per hour shall be maintained. This rate will also handle smoke extraction after a fire.

Electrical Equipment

Most new diesel garages utilize sealed lighting and other electrical fixtures that would be consistent with the equipment necessary for a CNG maintenance facility.

Due to the lighter than air properties, in a CNG maintenance facility, all likely sources of within 18" below the ceiling (switches, receptacles, motors, etc.) are either relocated or upgraded, but the electrical classification per the National Electrical Code in the area above the bus is the same electrical classification in a CNG maintenance facility as in a diesel bus maintenance facility, assuming the ventilation system outlined above is provided.

Electrical equipment below the roofline of a bus in a CNG maintenance facility is identical to equipment that would be installed in a diesel maintenance facility.

Standby power is typically provided in a CNG maintenance facility to back up the ventilation system, gas detection system and overhead doors. A new diesel maintenance facility will also typically include standby power to allow it to continue operations during a power interruption.

A properly designed CNG maintenance facility does not have a cost premium associated with electrical equipment, when compared to a typical new diesel maintenance facility.

CNG Refueling Station

This report was based on the following assumptions provided by Wave Transit and utility companies:

- Initial infrastructure is based on meeting the demands for 21 buses, 40 vans and 6 non-revenue vehicles.
- 21 CNG buses would initially comprise the transit fleet, and grow to 75 buses in the future.
- Fuel capacity per bus - 120 diesel equivalent gallons (96 gal per day usage).
- 6 days/week operation (5 full days, ½ day Saturday and Sunday).
- 52 weeks operation per year.
- Fast fill would require additional compression with additional storage; therefore a more cost effective time fill option was explored. However, storage can be added for an occasional fast fill for service vehicles and an occasional bus in this model.
- Daily fueling schedule is approximately half of the buses come in for fuel at 6:30PM, and approximately a quarter come in each at 7:30PM and 9:30PM.
- Cost of electricity - $0.09 per KWH per Progress Energy (includes KWH cost, customer fees, demand charge and was based on multiple accounts of similar size).
- Local utility available pressure of gas in the area of the site is 30 PSI in the winter and 70 PSI in the summer.
- Cost of natural gas - $0.9898per Diesel Gallon Equivalent (DGE) - as of September 2012 per Piedmont Natural Gas.

The following equipment is an example of what would be required for a refueling facility designed for 21 buses, with the capability of expanding to 75, based on the above assumptions:

- Two (2), skid mounted, compressors, 400scfm each to provide the required flow. Each skid is over 300 amps at 480 volts, 3 phase.
- Two high flow transit dispensers mounted on outdoor islands.
- De-fueling system.
- Skid mounted gas dryer.
- Computerized control and monitoring system.
- It is estimated that a 1000 amp, 480 volt, 3 phase electrical service and switchgear would be required for the refueling station.

The total footprint for the above equipment would be approximately 4,000 to 6,000 square feet. The construction cost is estimated to be in the $1,000,000+ range, this is based on a contracted bid price of a facility similar in size, with similar equipment needs.

Operations and Maintenance

Trillium CNG Company provided information regarding refueling station operation and maintenance services and costs. See exhibit 5 at the end of this section for a description for this service. The cost for operation, including this service, but excluding energy is approximately $206,000 per year for 21 buses, and $293,000 per year for 75 buses.

There are two separate pricing structures for this service, Out of Network, and In Network. Initially, with the 21 bus scheme, the service would be charged at the Out of Network rate, however at 75 buses, the In Network rate would kick in, because the Diesel Gallons Equivalent (DGE) quantity will be sufficient for Trillium CNG to have a presence in Eastern North Carolina. See the exhibits below showing the expected volume for 21 Buses, expected volume for 75 buses, cost per year calculations for 21 buses (exhibit 3) and cost per year for 75 buses (exhibit 4):

Exhibit 3:

Cost of Operation and Maintenance (21 buses)

21	Buses
96	DGE/Day
6	Days/week
52	Weeks/Yr
628,992	DGE/Yr
205,331.86	$/yr
0.33	$/DGE

Exhibit 4:

Cost of Operation and Maintenance (75 buses)

75	Buses
96	DGE/Day
6	Days/week
52	Weeks/Yr
2,246,400	DGE/yr (from exhibit 2)
292,188.92	$/yr
0.13	$/DGE

Wave Transit – CNG Facility Evaluation

Exhibit 5 – Monitoring and Support Services Offered from Trillium CNG (excerpted from proposal from Trillium CNG for Wave Transit, see attachment at the end of this document).

Maintenance, Emergency Support and PM Costs for 24x7 Support

Many station builders offer a basic service plan, but few offer the level of expertise and value that is provided by Trillium.

Turnkey Maintenance Pricing

One of the certainties in operating a CNG station is that it is better to take the time to fix small issues to prevent them from becoming larger problems. Trillium CNG's service program is based on scheduled maintenance intervals that are defined by the equipment manufacturers, as well as our own extensive experience in operating CNG stations. This proactive approach to maintenance is covered by a per GGE fee which covers the total cost for parts, consumables, labor, all factory recommended service and repairs, emergency call outs, and management fee.

Services Include:

- Conduct visual site inspections
- Check for gas leaks
- Check for oil leaks
- Check and maintain oil levels
- Monitor and record station operation parameters
- Check equipment fault history
- Check for dispenser gas leaks
- Check hoses and nozzles for leaks and wear
- Drain oil from skid recovery system
- Drain dryer liquid
- Drain oil from the dispensers
- Scheduled Preventative Maintenance

After inspections, Trillium CNG technicians will spend the remainder of time repairing problems identified. If additional time is required to make repairs, Trillium CNG will seek owner approval prior to performing and additional used will be billed accordingly based upon the business model selected by Wave Transit.

Energy

The cost of natural gas is based on information provided by Piedmont Natural Gas Company, Inc. For natural gas vehicles there is a monthly $22 charge, plus the cost as of September 2012 is approximately $0.9936 per DGE. The cost per DGE for natural gas is subject to Federal, State and Local taxes.

Exhibit 6:

Cost of Natural Gas (21 buses)

264	$ Yearly Delivery Charge (from Piedmont for NG Vehicles)
0.9898	$/DGE (as of September 2012 from Piedmont)
628,992	DGE/yr (from exhibit 1)
622,848.63	$/yr natural gas cost

Exhibit 7:

Cost of Natural Gas (75 buses)

264	$ Yearly Delivery Charge (from Piedmont for NG Vehicles)
0.9898	$/DGE (as of September 2012 from Piedmont)
2,246,400	DGE/yr (from exhibit 2)
2,223,780.55	$/yr natural gas cost

The cost of electrical energy to operate the refueling facility, based on the assumptions in previous section, is expected to be approximately $37,000 per year for 16 buses (exhibit 8), and $174,000 per year for 75 buses (exhibit 9).

Exhibit 8:

Cost of Electrical (21 buses)

0.86	KWH/DGE (from exhibit 10)
0.09	$/KWH
0.0774	$/DGE
628,992	DGE/Yr (from exhibit 1)
48,683.98	$/yr electrical cost

Exhibit 9:

Cost of Electrical (75 buses)

0.86	KWH/DGE
0.09	$/KWH
0.0774	$/DGE
2,246,400	DGE/yr (from exhibit 2)
173,871.36	$/yr electrical cost

Exhibit 10:

Total Estimated Cost per DGE (21 and 75 buses)

	21 buses ($/DGE)	75 buses ($/DGE)
Fuel	0.9898	0.9898
Electric	0.0774	0.0774
Maintenance	0.33	0.13
Total Cost per DGE	$1.3936	$1.1973

Exhibit 11:

Total Estimated Cost per Year (21 and 75 buses)

	21 buses ($/yr)	75 buses ($/yr)
Fuel	622,848.63	2,223,780.55
Electric	48,683.98	173,871.36
Maintenance	205,331.86	292,188.92
Total Cost per DGE	$876,864.47	$2,689,840.83

Engineering Analysis (cont.)

Summary

A maintenance facility designed for CNG vehicles, with much of the equipment virtually identical in performance for a diesel facility, can be done at essentially the same design and construction cost.

The larger cost differences appear to be in construction and operation of the CNG refueling facility. As indicated above, the initial construction cost of over $1,000,000, and the operation costs for both 21 and 75 buses are very significant. Based on the costs outlined above the total yearly cost for fuel, maintenance and electricity costs for 21 buses is over $879,000 and for 75 buses is around $2,690,000. The price per DGE per year for each scenario is $1.40 for 21 buses, and $1.20 for 75 buses. These prices are based on current energy prices and are subject to change due to the volatile nature of energy costs.

Our recommendation is to design the maintenance facility to CNG standards and depending on Wave Transit's future CNG strategy, design the site for a future CNG fueling facility. The design should be coordinated with a gaseous energy firm experienced in the design and construction of CNG facilities. Further direct consultation between Wave Transit and a CNG consultant, such as Trillium CNG is recommended.

The information contained in this report is intended to be general in nature and representative of typical conditions and costs and is intended to reflect current industry practice. This document is not a design/construction document and may not address all safety or operational requirements of a particular facility or local or state code—therefore, this document shall not be used for bidding or construction purposes.

Budget & Return on Investment Analysis

To ensure accurate comparison, diesel gallon equivalent (DGE) has been calculated to equal 135 scf of gas or 1.35 therms. CNG efficiency has been calculated as 30% less efficient as diesel.

Cost of Fuel CNG vs. Diesel 16 Buses

Assumptions:

- 60 Gallons of Diesel/bus/day (312 days)
- Cost - $3.50/gallon
- Annual Consumption 300,000 gls
- CNG gallon equivalent $1.68682
- Electric $.13072
- Maintenance/yr $ 205,331.86 - Fixed Cost

	CNG	Diesel	Savings
Fuel	1.68682	3.50	
Electric	0.13072		
Maint	0.68444		
Total	2.50198	3.50	

	CNG	Diesel	Savings
Fuel	506,046.00	1,050,000.00	
Electric	39,216.00		
Maint	205,331.86		
Total	750,593.86	1,050,000.00	**299,406.14**

Example 1

Cost Benefit Analysis 16 Buses Included

Estimated Annual Savings:

(Assuming data from Example 1)

Annual fuel savings	$ 299,406.14
Added cost for CNG buses	$ 800,000.00
Years to recapture initial investment	**2.67**

Example 2

Cost Benefit Analysis 16 Buses & Fueling Station Included

Estimated Annual Savings:

(Assuming data from Example 1)

Annual fuel savings	$ 299,406.14
Added cost for CNG buses	$ 800,000.00
Added cost for CNG fueling station	$ 1,000,000.00
Years to recapture initial investment	**6.01**

Example 3

CNG Overview

PROS	CONS
• Diversification	• Refueling post evacuation
• Reduced dependency on petroleum based fuels	• Increased electrical demands
• Lower fuel costs	• Redundancy in the event of supply interruption
• Long term fueling options	• Minimum twelve year commitment
• Funding for CNG fueling station currently available	• Increased facility cost
• Proven technology in transit industry	• Increased vehicle costs
• Environmentally friendly	• Fueling station is maintenance intensive
• Expandable beyond Wave Transit	• Slightly less performance than diesel
• Increased funding opportunities	• Safety concerns
• Reduced pressure on operating budget	• Higher onboard fuel capacity requirement

Facilities Committee Recommendation

As depicted in Image 3, CNG as a transit bus fuel propulsion source is relatively common. In 2007, 14,000 transit buses used CNG as a primary fuel source, nearly 22% of the overall transit bus fleet in the U.S. This number has increased over the past five years. The data contained in this report, combined with the construction of a new maintenance facility and the procurement of sixteen new heavy duty buses in 2015 create an ideal situation for the Authority to diversify its fuel propulsion options. Data compiled by the Authority once the initial CNG vehicles are in service, as well as the global oil market and natural gas prices will determine the extent to which the Authority should expand its foray into the CNG market.

Figure 7.1 Number of Operating Natural Gas Buses in the United States, 1996 - 2007

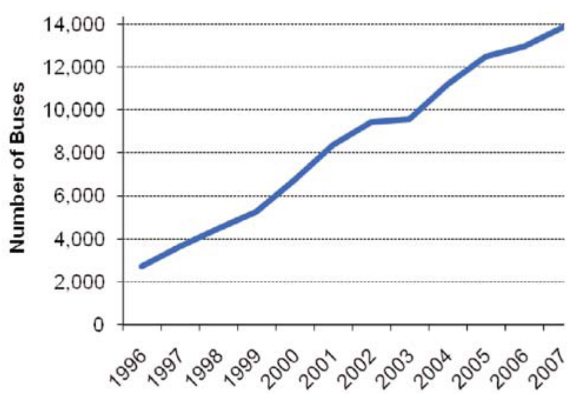

Image 3

Less dependency on single fuel source offers the Authority increased options well into the future. Undertaking the initiative during the construction of a new maintenance and fueling facility will minimize the cost for facility upfit, the CNG fueling station and allow for improved engineering for CNG fueling capabilities. Multiple fueling capabilities will afford the Authority a wide range of propulsion options for many years to come without burdensome and expensive modifications to the facility. Vehicle fueling options are currently more expansive than ever and this trend is expected to continue as technology improves.

Funding for the new maintenance facility is sufficient to support CNG, diesel and gasoline fueling options. Funding for replacement buses in 2015 is currently in development and the Authority is confident that the additional cost of CNG buses could be secured. It is the recommendation of this report that the Authority maintenance facility include CNG fueling capabilities and that future vehicle purchases utilize CNG as a propulsion source when feasible and available.

10. Image 3 TCRP Report 146 p. 7-3

Authority Members & Staff

The Cape Fear Public Transportation Authority is governed by eleven members appointed by the Wilmington City Council and the New Hanover County Commissioners. The Authority employs a staff of over 130 direct and contract employees led by a senior staff of four directors.

Authority Members

Honorable Jonathan Barfield, Jr.
New Hanover County Board of Commissioners

Honorable Kevin O'Grady
Wilmington City Council

CAPT David R. Scheu USN (Ret.)
Chairman

Henry "Hank" Adams
Vice Chairman

Don Betz
Secretary

Linda Pearce
Human Service Representative

William "Bill" Bryden

Euran Daniels

George Dolan

Julius "Chris" Hawkins

Jeffrey B. Petroff, PE

Staff

Albert Eby
Executive Director

Megan Matheny
Director of Planning & Development

Joseph Mininni, CPA, MBA
Director of Finance & Administration

Jean M. Smith
Director of Operations

For additional information about this publication or any of the services provided by Wave Transit, please contact:

Albert Eby,
Executive Director
(910) 202-2035
aeby@wavetransit.com

Cape Fear Public Transportation Authority
P. O. Box 15630
505 Cando Street
Wilmington, NC 28405-0130
(910) 343-0106
(910) 343-8317 *fax*