OFFICE OF THE NEW YORK STATE COMPTROLLER

DIVISION OF LOCAL GOVERNMENT
& SCHOOL ACCOUNTABILITY

A Comparison of Liquid Propane-Powered and Diesel-Powered School Buses

2011-MR-1

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Table of Contents

State of New York
Office of the State Comptroller

Division of Local Government
and School Accountability

May 2011

Dear District Officials:

A top priority of the Office of the State Comptroller is to help local school district officials manage government resources efficiently and effectively and, by so doing, provide accountability for tax dollars spent to support district operations. The Comptroller oversees the fiscal affairs of districts statewide, as well as compliance with relevant statutes and observance of good business practices. This fiscal oversight is accomplished, in part, through our audits, which identify opportunities for improving operations and school district governance. Audits also can identify strategies to reduce costs and to strengthen controls intended to safeguard district assets.

Following is a report of our audit entitled A Comparison of Liquid Propane-Powered and Diesel-Powered School Buses. This audit was conducted pursuant to Article V, Section 1 of the State Constitution and the State Comptroller's authority as set forth in Article 3 of the General Municipal Law.

This audit's results and recommendations are resources for district officials to use in effectively managing operations and in meeting the expectations of their constituents. If you have questions about this report, please feel free to contact the local regional office for your county, as listed at the end of this report.

Respectfully submitted,

Office of the State Comptroller
Division of Local Government
and School Accountability

EXECUTIVE SUMMARY

School districts incur substantial costs to operate their fleet of buses, including the costs to purchase, fuel and maintain these vehicles. Traditionally, school districts have purchased buses with diesel engines. Because diesel exhaust has been shown to cause or aggravate lung problems, the Environmental Protection Agency (EPA), pursuant to Federal law,[1] has placed increasingly stricter regulations on diesel fuel's formulation and the design of heavy-duty engines. Although the resulting changes have dramatically reduced emissions from diesel exhaust, more than a dozen school districts in the State have begun replacing their bus fleets with buses powered by liquid propane (LP). Of the six school districts we audited, Trumansburg and Bainbridge-Guilford School Districts purchased LP-powered buses during our audit period; Ithaca, Owego-Apalachin, Union-Endicott, and Vestal School Districts all purchased diesel-powered buses.

LP is approved by the EPA as a clean alternative fuel. LP commonly fuels warehouse forklifts primarily because LP allows safe indoor use without emitting gases that are harmful to people working in the enclosed area. According to the U.S. Department of Energy, LP is a nontoxic, non-carcinogenic, noncorrosive fuel and poses no harm to groundwater, surface water, or soil.

The New York State Energy Research and Development Authority (NYSERDA) has made grants available to districts to fund the difference in purchase price between diesel buses and higher-cost LP buses. In October 2006, the federal Energy Policy Act of 2005[2] allowed for a $.50 per gallon credit for LP, which would reduce by one-third the cost of LP fuel, currently priced at $1.50 per gallon. This credit was reinstated in December 2010, with an expiration date of December 31, 2011.

Scope and Objective

The objective of our audit was to determine whether there are financial or other advantages in using LP-powered buses rather than diesel-powered buses. Our audit addressed the following related question for the period July 1, 2008 to June 30, 2010:

- How do LP-powered buses compare to diesel-powered buses with respect to ownership and operating costs, and noise and safety concerns?

[1] http://www.epa.gov/otaq/regs/hd-hwy/2000frm/f00026.pdf

[2] Highway Act, Sec. 1113: "Volumetric Ethanol Excise Tax Credit for Alternative Fuels," known as the VEETC 50-cents-per-gallon credit, applicable to sellers of LP gas. It was effective October 1, 2006 through September 30, 2009 and extended through December 31, 2011.

Audit Results

We found that LP-powered buses can be a cost-saving alternative to diesel-powered buses with respect to purchase price, fuel, and maintenance costs, and that a district's outlay for LP infrastructure (fuel tank and dispensing equipment) costs can be reduced by a tax credit to the installer, with the balance prorated on a per-bus basis over time.

LP-powered buses do cost more than diesel-powered buses. However, New York State currently provides NYSERDA grant funds to subsidize the difference in cost. Trumansburg received a NYSERDA grant of $36,600 to subsidize the $12,200 difference in cost (diesel vs. LP) for each of the three LP-powered buses the district purchased. We also found that LP fuel costs are lower when the Federal tax credit is applied. Our tests showed that LP would cost from about $997 less than diesel annually when the State contract fuel prices are adjusted to reflect the $.50 cent per gallon credit. In addition, a district could save a minimum of $230 a year in maintenance for LP-powered buses because their engines require less oil and do not need block heaters in cold weather.

Paying for LP infrastructure (fueling stations) could add to a district's start-up costs for using LP buses. However, the $15,000 to $20,000 cost per fueling station, each one of which can service about 26 buses, can be reduced by a tax credit the installer receives. The balance of the investment cost could be prorated on a per bus basis over the 10-year life of the equipment.

We also found that the noise level of LP-powered buses was comparable to that of diesel-powered buses. In addition, LP is safer to use and store because it vaporizes and disperses very quickly and is a nontoxic substance.

Comments of District Officials

The results of our audit and recommendations have been discussed with district officials and their comments, which appear in Appendix A, have been considered in preparing this report.

Appendix B contains our comment on one issue raised in a district's response.

Introduction

Background

School districts in New York State that operate and maintain their own fleets of school buses drive, on average, more than 200 million miles per year transporting students. School districts incur substantial costs to operate their fleet of buses, including the costs to purchase, fuel and maintain these vehicles.

Traditionally, school districts have purchased buses with diesel engines. Because diesel exhaust has been shown to cause or aggravate lung problems, the Environmental Protection Agency (EPA), pursuant to Federal law,[3] has placed increasingly stricter regulations on diesel fuel's formulation and the design of heavy-duty engines, like those in school buses. The changes brought about because of the EPA's program have dramatically reduced emissions from diesel exhaust.

In 2008, a bus powered by liquid propane (LP) became available on the market, and other manufacturers have announced plans to produce LP-powered bus models in 2011. LP has long been recognized as a viable energy source for many applications. Current LP-fueled engines emit fewer noxious emissions[4] than gasoline engines or diesel engines. LP is approved by the EPA as a clean alternative fuel without the need to change vehicle emission systems. In fact, LP commonly fuels warehouse forklifts primarily because LP allows safe indoor use without emitting gases that are harmful to people working in the enclosed area. Further, according to the U.S. Department of Energy, LP is a nontoxic, non-carcinogenic, noncorrosive fuel and poses no harm to groundwater, surface water, or soil.

Apart from the engine design and function, LP-powered buses are identical to diesel-powered buses. Over a dozen school districts in New York State have begun replacing their bus fleets with LP-powered buses. Of the six school districts we audited, Trumansburg and Bainbridge-Guilford School Districts purchased LP-powered buses during our audit period; Ithaca, Owego-Apalachin, Union-

[3] http://www.epa.gov/otaq/regs/hd-hwy/2000frm/f00026.pdf

[4] While no data is currently available that compares the emissions of LP-powered school buses with diesel-powered buses, the New York State Department of Transportation is currently pursuing the proposal of a study to specifically compare the tailpipe emissions for a sample of both the diesel and LP-powered buses included in our audit.

Endicott, and Vestal all purchased diesel-powered buses. Table 1 shows the number and types of buses the districts purchased and placed in service during our two-year audit period.

Table 1: Buses Purchased by Six Districts

District	Diesel-Powered Buses	LP-Powered Buses	Total
Bainbridge-Guilford	1	1	2
Trumansburg	2	3	5
Ithaca	13	0	13
Vestal	10	0	10
Union-Endicott	7	0	7
Owego-Apalachin	7	0	7
Total	**40**	**4**	**44**

The Federal and State governments have provided several incentive programs, mostly in the form of tax credits, for the purchase of LP-powered buses and LP fuel[5] to help districts offset their LP bus costs. The New York State Energy Research and Development Authority (NYSERDA) has funded the difference in purchase price between diesel buses and higher-cost LP buses to districts, like Trumansburg, that applied for the credit. In October 2006, the Energy Policy Act of 2005 allowed for a $.50 per gallon credit for propane used in a motor vehicle. If districts apply the $.50 per gallon Volumetric Ethanol Excise Tax Credit for Alternative Fuels (VEETC) to the cost of LP fuel, currently priced at $1.50 per gallon, they could see cost savings of up to one-third of their current LP fuel costs. This credit was reinstated in December 2010, with an expiration date of December 31, 2011.

Objective

The objective of our audit was to determine whether there are financial or other advantages in using LP-powered buses rather than diesel-powered buses. Our audit addressed the following related question:

- How do LP-powered buses compare to diesel-powered buses with respect to ownership and operating costs, and noise and safety concerns?

Scope and Methodology

We examined the transportation records for six school districts, including expenditures for their most recently purchased buses, for

[5] Highway Act, Sec. 1113: "Volumetric Ethanol Excise Tax Credit for Alternative Fuels," known as the VEETC 50-cents-per-gallon credit, applicable to sellers of LP gas. It was effective October 1, 2006 through September 30, 2009 and extended through December 31, 2011.

the period July 1, 2008 to June 30, 2010. These districts included the Ithaca City School District, Trumansburg Central School District, Owego-Apalachin Central School District, Bainbridge-Guilford Central School District, Union-Endicott Central School District, and Vestal Central School District.

We conducted our audit in accordance with generally accepted government auditing standards (GAGAS). We limited our analyses to buses that were purchased and placed in operation during our audit period. More information on such standards and the methodology used in performing this audit is included in Appendix C of this report.

Comments of District Officials and Corrective Action

The results of our audit and recommendations have been discussed with district officials and their comments, which appear in Appendix A, have been considered in preparing this report.

Appendix B contains our comment on one issue raised in a district's response.

Comparison of School Buses

Boards and district officials get the most for their transportation dollars when they select school buses that provide school bus transportation for the lowest cost, with the fewest emissions, in compliance with safety regulations. When we compared LP-powered buses to diesel-powered buses, we found that LP-powered buses do cost more than the diesel alternative. However, New York State currently provides NYSERDA grant funds to bridge the difference in cost. We also found that LP fuel costs – with help from a Federal tax credit – are lower, and that maintenance of LP buses is less expensive. However, paying for LP infrastructure (fueling stations) could add to a district's start-up costs for using LP buses. To determine whether an investment in LP buses is an economical and practical choice, board and district officials must analyze the comparative costs and benefits of diesel- and LP-powered buses in their own districts to make an informed decision. If government tax credits for LP-powered buses continue to be available, and if surcharges on diesel-powered buses continue to increase, LP-powered buses can be a lower-cost alternative to diesel-powered buses. LP fuel is also safer to use and store than diesel fuel.

Financial Impact

Board and district officials must pay careful attention to overall costs – including purchase price, fuel, infrastructure, and maintenance – when comparing transportation alternatives, and use this information to make the most economical choice. We compared all these aspects of school bus costs for diesel and LP-powered buses purchased during our audit period at the six districts we audited and determined that LP-powered buses could be a cost-saving alternative to diesel-powered buses. LP-powered buses currently cost $7,500 more than diesel-powered buses, but a State grant could fund the cost difference. In addition, LP fuel costs, with an existing tax credit, are lower than diesel costs; fuel storage and dispensing costs, like other start-up costs, can be prorated on a per bus basis over 20 years; and maintenance costs are lower. Appendix C shows the potential cost savings the six districts could achieve by using LP-powered buses.

Purchase Price — We determined that the six school districts we audited spent between $85,000 and $120,000 per bus for school buses during our audit period and that all the school buses were purchased from a New York State Office of General Services (OGS) State contract vendor. According to OGS staff and district

officials, an LP bus and a diesel bus have the same base price until charges related to the power plant are added. Districts that purchased diesel-powered buses manufactured before December 31, 2009 were charged an additional $6,200 per bus to meet 2007 emission requirements; for diesel-powered buses manufactured after January 1, 2010, districts paid an additional $13,100 per bus to meet the 2010 emission requirements. Districts that purchased LP-powered buses paid an additional $18,400 per bus for the propane engine option for buses manufactured before December 31, 2009, and $20,600 more per bus for vehicles manufactured after January 1, 2010. Therefore, the LP-powered buses purchased between 2007 and 2009 cost $12,200 more per bus than diesel-powered buses; the additional cost dropped to $7,500 per bus for buses purchased in 2010 and thereafter.

We verified that Owego, Vestal, Union-Endicott, Ithaca, Bainbridge-Guilford, and Trumansburg paid a $6,200 surcharge fee for each of the 40 diesel-powered buses they collectively purchased in 2008-2009 and/or 2009-2010. Bainbridge-Guilford and Trumansburg paid an additional $18,400 per bus for each of the four LP buses they purchased in 2009-2010. Trumansburg officials applied for and received a grant from NYSERDA for $36,600, which subsidized the $12,200 difference in cost (diesel vs. LP) for each of the three LP-powered buses the district purchased. Bainbridge-Guilford officials did not apply for this grant because they determined that grant funding was no longer available at the time of their purchase.

If the cost of the diesel surcharge continues to increase at a faster rate than the cost of LP engines, the purchase price of LP-powered buses will become more competitive with diesel-powered buses. Further, if the NYSERDA credit remains available to encourage school districts to purchase LP-powered buses, district officials may find that LP-powered buses are no more expensive than the diesel-powered alternative.

Fuel Costs — We determined that the 40 diesel-powered buses purchased during our audit period by the six school districts were driven a total of about 625,000 miles, and that the districts paid about $219,000 for diesel fuel these buses used. Therefore, it cost these districts approximately $.35 per mile to fuel their diesel buses. In comparison, the four LP-powered buses purchased during our audit period were driven about 21,500 miles, and the two districts paid about $10,000 for LP fuel, resulting in a $.46 per mile fuel cost. However, the price the districts paid, as shown in Table 4, is higher than it would be currently because

the VEETC had expired (in September 2009), and not yet been reinstated (December 2010) when the districts purchased their LP fuel. Further, the districts' cost included a premium for use of the vendor-provided fueling station (See Fuel Storage and Dispensing), a cost that districts could reduce in a number of ways.

The fuel consumption for both diesel and LP-powered buses in our audit varied widely. We found that diesel-powered buses ranged from 5.4 miles per gallon (MPG) to 8.5 MPG, or an average of 6.8 MPG. Fuel consumption for LP-powered buses ranged from 3.2 MPG to 4.4 MPG for an average of 3.7 MPG. Variances were likely caused by such factors as the terrain, the frequency of stops on the routes for each specific bus, the number of students riding the bus, and the driving habits of the bus driver. Given the number of variables, we could not perform true side-by-side comparisons of buses.

We compared the average MPG achieved by the LP-powered buses to the average MPG achieved by the diesel buses during our audit period. As shown in Table 2, we found that LP would cost $997 less than diesel annually when the State contract fuel prices ($1.50 per gallon during our audit field work) are adjusted to reflect the $.50 cent per gallon VEETC.

Table 2: LP vs. Diesel with VEETC	
Average LP Fuel Cost per Mile	$0.27
Average Diesel Cost per Mile	$0.35
Cost (Increase)/Decrease	$0.08
Annual Miles Driven	12,503
Annual Fuel Cost Savings	**$997**

However, if LP fuel costs did not include VEETC or a similar Federal tax credit, school districts could potentially pay about $693 more for LP than they would for diesel. Details are shown in Table 3.

Table 3: LP vs. Diesel without VEETC	
Average LP Fuel Cost per Mile	$0.41
Average Diesel Cost per Mile	$0.35
Cost (Increase)/Decrease	($0.06)
Annual Miles Driven	12,503
Annual Fuel Cost Savings	**($693)**

Fuel Storage and Dispensing — Fuel storage and dispensing systems are different for LP than for diesel. The OGS State contract price for LP includes the cost of the storage tank and related hardware. However, it does not include the cost of the dispensing (fueling station) equipment. Purchase and installation of dispensing equipment can cost between $15,000 and $20,000 per fueling station, and could be expected to last approximately 10 years. Thus, it is reasonable to allocate an additional $2,000 per year per district for such equipment.

The two school districts that used LP-powered buses in our audit paid a price per gallon that was higher than the OGS price in exchange for use of the vendor's dispensing equipment. Although the premium paid by each school was different, both paid an aggregate price that was about $2,000 more than the standard OGS price. However, these districts had very few LP-powered buses: just three buses in one district, and only one bus in the other. The more LP-powered buses a district uses, the lower the infrastructure cost per bus would be. One fueling station could reasonably service about 24 district buses.[6] Therefore, if the district had 24 LP-powered buses, this cost would drop to $83 per year per bus. It is also important to remember that these infrastructure costs are not unlike start-up costs associated with the diesel fuel storage and dispensing system that districts would purchase to fuel their diesel-powered buses at their transportation garage.

Although the OGS State contract price for LP includes the cost of the storage tank, districts with a number of LP-powered buses could decide to purchase their own LP storage tank and dispensing equipment. A Federal tax credit of 30 percent of the cost of the refueling property[7] is currently available to the installer of the tank if the installer notifies the district of the credit. Therefore, the installer's cost of the tank and dispensing equipment – and the cost charged to the district – should be reduced by the amount of the tax credit. Districts that had their own storage tanks could pay a lower cost for fuel because the OGS contract price could be reduced by that portion of the price related to a district's use of OGS-provided storage tanks.

[6] Based on our review of the average number of buses and fueling stations used by the six districts in our audit, it appears that each fueling station could fuel approximately 24 buses. However, this figure could change based on the number of gallons pumped and the flow rate of the diesel pump.

[7] The credit allows for up to 30 percent of the costs of installation of fueling equipment not to exceed $30,000 for equipment placed into service in 2011. See more details at http://www.afdc.energy.gov/afdc/laws/law/US/351.

The transportation supervisors for both districts told us they entered into the arrangement with the LP gas vendor as they were considering LP-powered buses on a trial basis. They did not want to invest fully until they evaluated the results of the switch to LP. At the conclusion of our audit, both transportation supervisors were renegotiating their pricing with their respective LP gas vendors.

Maintenance Costs — Our audit also found that districts could realize savings on maintenance costs of an LP-powered bus compared to an equivalent diesel-powered bus. Based on discussions with transportation personnel and review of maintenance records, we determined that districts pay $.013 per mile to perform an oil change on a diesel-powered bus, but only $.004 per mile for an LP-powered bus. A typical oil change on a diesel bus engine requires 23 quarts of oil, while the LP engine uses only 10 quarts. Over the maintenance-life of the LP engine, a district would use less oil, resulting in average annual savings of about $118.

In addition, the six districts on average spent $109 for electricity to operate auxiliary heaters (block heaters) to help ensure diesel buses start during winter month periods of cold temperature. The block heaters help raise engine temperature and make initial engine ignition easier. According to district officials who operate LP-powered buses, they do not require block heaters, which results in energy savings.

Furthermore, officials at the districts using LP-powered buses told us they were concerned with the increasing cost of maintaining complex equipment required to ensure that diesel-powered buses meet the increasingly strict emission standards. District officials expressed concerns about servicing the additional equipment and paying for diesel additives. Trumansburg and Bainbridge-Guilford officials told us they believed LP-powered buses would be less expensive to operate because they were not equipped with expensive diesel particulate filters or diesel exhaust fluid designed to reduce emissions from diesel engines.

Noise and Safety Issues

Beyond financial impacts, we compared LP-powered buses with diesel-powered buses for other relevant factors. These included noise production and safety, including the safety of fuel storage. We found that the noise level of LP-powered buses was comparable to that of diesel-powered buses, and that LP fuel was safer to use and store. We also addressed district transportation supervisors' concerns, as expressed to us, and other common

misperceptions about the operation and safety of LP-powered buses in Appendix D of this report.

Noise — We contacted an Industrial Hygienist from the Public Employee Safety and Health Bureau of the New York State Department of Labor to measure the amount of sound produced by a diesel-powered bus and an LP-powered bus under various operating circumstances (e.g., starting, acceleration, highway speed, etc.). His comparison found that noise levels were very comparable in decibels (dBA) produced in all situations. The diesel-powered bus produced an actual time-weighted average 57.7 dBA during a 42-minute bus run, whereas the LP-powered bus produced a 56.3 dBA reading for the same 42-minute run. Furthermore, the tests determined that both buses produced noise levels well below Federally permissible exposure limits.[8]

Safety — The tanks on LP-powered vehicles are constructed from carbon steel and are 20 times more puncture resistant than a typical gasoline or diesel tank. LP engine fuel systems are fitted with safety devices and shut-off valves that function automatically in the rare case of a fuel line rupture. LP fuel also vaporizes and disperses very quickly, and it has the lowest flammability range of all alternative fuels, including natural gas and ethanol.

LP fuel is also safer to store. For example, the New York State Department of Environmental Conservation (DEC) does not require stringent monitoring of LP tanks, like it does for diesel tanks, because DEC does not consider LP to be a petroleum-based fuel. According to the Federal Department of Energy, LP is a nontoxic, non-carcinogenic, noncorrosive fuel and poses no harm to groundwater, surface water, or soil. LP is also naturally odorless and colorless; an odorant is added to enable leak detection.

Recommendation

1. When considering the purchase of new school buses, district officials should analyze the comparative costs and benefits of diesel- and LP-powered buses to determine if LP-powered buses can provide better overall long-term value in meeting the district's transportation needs.

[8] The Occupational Safety and Health Administration's (OSHA) standard for permissible noise exposure is 105 dBA in a one hour time period. More information on OSHA's standards can be found at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9735

APPENDIX A

RESPONSE FROM DISTRICT OFFICIALS

We provided a draft copy of this global report to all six school districts we audited, and gave each district the opportunity to respond. We received a response letter from only one district, Bainbridge-Guilford Central School District (District). That response can be found on the following pages.

District officials generally agree with our findings and recommendation. Our comment on one issue raised in the District's response can be found in Appendix B.

BAINBRIDGE-GUILFORD CENTRAL SCHOOL DISTRICT
18 JULIAND STREET — BAINBRIDGE, NEW YORK 13733-1097

Middle-High School (607) 967-6300
Telefax (607) 967-4231
Guilford Elementary School (607) 895-6700
Administrative Offices (607) 967-6321
Business Offices (607) 967-6335
Greenlawn Elementary School (607) 967-6301

Comments on Propane Bus Audit

The purpose of the Comptroller's Office as stated in the Authority Letter is to "...identify opportunities for improving operation and school district governance."

The B-G district had already made a decision to utilize liquid propane (LP) buses prior to the audit viewing it as an opportunity. The district was also careful to make a conservative and limited decision to add LP buses to the fleet in an attempt to take advantage of the best qualities of the technology without making an overly aggressive commitment. The Energy Policy Act credit allowance was the impetus, but one of the important reasons for considering liquid propane was the issue of gelling diesel fuel for district buses which are housed overnight outside the garage facility. Another reason was concern for the safety of passengers when diesel buses lost power in frigid weather and had to pull to the side of the road. Additionally, the district has promoted environmental issues while increasing energy savings across a broad spectrum of actions within our buildings. Concern over the environmental impact of buses has had a connection to that effort and reducing exhaust emissions by use of LP buses became a natural extension.

In response to an audit finding that implies the district was unaware of a grant toward the purchase of an LP bus, it should be said that the district did research the availability of a NYSERDA grant but, in fact, the information given to the district through the Transportation Supervisor was that the grant was no longer available at the time of investigation. Since that time, the district has been additionally researching the possibility of a fuel storage and dispensing system to take advantage of lower supplier costs, and has a locked in a BOCES bid price for 2011-12 that is very favorable to the district. The district views the limited purchase of two LP buses as a way to take advantage of a form of dollar cost averaging with the diesel portion of the fleet. This puts the district in a favorable position, leveling the overall fuel expenditure when the cost of diesel is high and Liquid Propane is low. Attached is a chart of the fuel cost comparisons based on our 2011-12 fuel bid prices.

See Note 1 Page 17

In summary, the Bainbridge-Guilford Central School District has acted in a conservative fashion at a time when other districts are only beginning to consider the option of LP buses. The B-G district thoroughly researched and studied all factors prior to making the decision to purchase any LP buses and the information in the audit offers another benchmark for the assessment of data.

Karl L. Brown
Superintendent of Schools

Updated Cost Comparison Chart

Based on 2011-12 Cooperative Fuel Bid pricing

LP Cost Savings vs. Diesel		
	With VEETC	No VEETC
Average LP MPG	4.40	4.40
Price per gallon	$ 1.31	$ 1.81
LP Fuel Cost per mile	$ 0.298	$ 0.411
Average Diesel MPG	6.47	6.47
Price per gallon	$ 3.35	$ 3.35
Diesel Fuel Cost per mile	0.518	0.518
Annual Fuel Cost Savings	**0.22**	**0.11**
Average Annual Miles Driven	9,846	9,846
Annual Fuel Cost Savings	**$ 2,167**	**$ 1,048**
Other Savings:		
Oil Changes	$ 68	$ 68
Electric Use	$ 41	$ 41
Total Annual Savings per Bus	**$ 2,276**	**$ 1,157**
Number of buses in the audit period	2	2
Cumulative savings / costs	**$ 4,551**	**$ 2,313**

APPENDIX B

OSC COMMENT ON DISTRICT OFFICIALS' RESPONSE

Note 1

We have amended our report to state that District officials determined that the grant funding was not available at the time of the purchase.

APPENDIX C

AUDIT METHODOLOGY AND STANDARDS

As part of our audit procedures, we examined the districts' school bus records and interviewed appropriate district staff to determine the types of full-sized school buses purchased in the audit period. We also contacted appropriate third parties, including staff of other New York State agencies, and district officials from districts that had recently purchased LP-powered school buses. We determined the replacement price for the districts' buses, as well as their fueling and maintenance costs, based on data obtained from vendor invoices and State contracts. We then compared those cost estimates to identify any savings.

- We interviewed appropriate district officials to gain an understanding of their bus fleet and maintenance and fueling operation.
- We determined the purchase price of buses purchased in the audit period based on review of vendor invoices and compared to the Office of General Services (OGS) contracts.
- We calculated the average fuel mileage of the 40 diesel school buses by dividing the number of gallons of diesel consumed into the number of miles driven in a school year.
- We examined two years of the six districts' fuel purchases of diesel to determine the average price per gallon.
- We calculated the amount per mile it cost to fuel a bus for all six districts.
- We calculated the average price of LP fuel per gallon by reviewing OGS State contract prices in the counties covered by the audit.
- We calculated the cost to fuel LP-powered school buses by dividing a range of potential average fuel mileage figures into the average cost of LP fuel per gallon.
- We calculated the average annual maintenance cost of buses based on review of the districts' services records.
- We relied on the work of other agencies for sound testing.
- We calculated the cost of electric block heaters for diesel buses based on discussions with district officials and the average cost per kilowatt-hour
- We reviewed available Federal, State and IRS credits for alternative fuel vehicles.

We conducted our performance audit in accordance with generally accepted government auditing standards (GAGAS). Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

APPENDIX D

COST SAVING ESTIMATES OF AUDITED DISTRICTS

The information below is based on the audited districts' records and reports for fueling, mileage, maintenance, and utility costs. For comparability, we used the average State contract LP fuel price for the county in which the district bus garage is located.

Table 4: Potential Cost Savings: LP- vs. Diesel-Powered Buses (with VEETC)

Cost	Bainbridge-Guilford	Trumansburg	Ithaca	Owego-Apalachin	Vestal	Union-Endicott
Cost per Mile: LP						
LP Average MPG	4.40	3.40	4.00	4.00	4.00	4.00
LP Average State Contract Price	$1.02	$0.99	$0.99	$1.04	$0.96	$0.96
LP Cost per Mile	**$0.23**	**$0.29**	**$0.25**	**$0.26**	**$0.24**	**$0.24**
Cost per Mile: Diesel						
Diesel Average MPG	6.47	8.02	7.16	6.98	6.28	6.04
Diesel Average Price per Gallon	$2.23	$2.44	$2.39	$2.43	$2.34	$2.31
Diesel Cost per Mile	**$0.34**	**$0.30**	**$0.33**	**$0.35**	**$0.37**	**$0.38**
Cost Savings With LP						
Per Mile	$0.11	$0.01	$0.09	$0.09	$0.13	$0.14
Average Annual Miles Driven	9,846	9,837	13,000	17,436	16,667	10,715
Annual Fuel Cost Savings	**$1,111**	**$129**	**$1,122**	**$1,537**	**$2,210**	**$1,526**
Purchase and Maintenance						
Annual Oil Changes	$68	$180	$19	$264	$120	$51
Annual Electricity Use	$41	$41	$64	$228	$49	$228
Engine Cost Allocation[a]	($750)	($750)	($750)	($750)	($750)	($750)
Fuel Infrastructure Cost[b]	($333)	($333)	($333)	($333)	($333)	($333)
Total Annual Savings per Bus	**$137**	**($734)**	**$122**	**$945**	**$1,296**	**$722**

[a] We calculated additional Engine Cost associated with a propane bus based on the current incremental cost of a propane bus, $7,500, over the estimated 10 year life of a school bus.

[b] We calculated additional Fuel Infrastructure Cost by dividing the estimated cost of the LP fuel station and dispensing equipment, $20,000, by its estimated life of 10 years, and the assumption that a district had six buses.

APPENDIX E

MISPERCEPTIONS ABOUT PROPANE-FUELED BUSES

1. Propane buses are unreliable and won't start in cold weather.

   Although LP buses using older technology did have difficulty starting in colder weather, the current technology involving Liquid Propane Injection has addressed starting issues in cold weather. Transportation personnel interviewed during our audit stated that LP buses have always started during the coldest of temperatures. Furthermore, district officials cited LP powered buses ability to start in cold weather as an advantage over diesel buses which may require fuel additives and block heaters to start during winter months.

2. The current propane power plant will no longer be available.

   Although the current 8.1 liter motor may no longer be manufactured, Blue Bird (a bus manufacturer) and PERC (Propane Education Research Council) jointly purchased over 1,000 of these engines so there was no lapse in the propane offering. Although a successor engine will not be named until all the 8.1L GM engines are gone, industry personnel have stated that the LP technology will work with any available gas engine.
   http://www1.eere.energy.gov/cleancities/pdfs/propanepaper09_final.pdf

3. LP buses the lack power needed for a full sized school bus.

   The motor in the LP bus produces 325 hp compared to the 210-220 hp produced by most diesel engines in our audit. Furthermore, transportation personnel told us that their LP-powered buses obtain speeds on steep climbs compared to similarly equipped diesels buses.

4. Fueling an LP-powered vehicle is dangerous.

   Although, it is recommended to wear rubber gloves as a precaution while fueling LP buses, we were told by transportation personnel that no safety issues had occurred while pumping propane and that their vendor provided training on how to safely dispense the fuel. In addition, training on how to safely dispense propane is provided by the supplier.
   http://www.propanesafety.com/workforce-training-programs/certified-employee-training-program/

5. Propane is explosive.

   Liquid propane has a very low range of flammability compared to diesel and gasoline. Flammability range is significantly less than gasoline and diesel fuel. The ignition point for propane is 940 degrees F compared to 430 degrees F for gasoline.

6. Propane buses are not safe.

   Propane buses meet all conventional bus safety standards plus additional safety standards for alternative fuels.

APPENDIX F

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