

Fleet Analysis on Alternative Fuels Implementation

Prepared for
City of Bettendorf, Iowa

Iowa Clean Cities Coalition is a program of



Background on Fleet Analysis Services

The Iowa Clean Cities Coalition (ICCC) is a program that coordinates education and technical assistance on alternative fuels and advanced vehicle technologies, incorporating a variety of public and private sector stakeholders. It is housed at the Iowa Economic Development Authority (IEDA) and a designated member of the United States Department of Energy's (US DOE) Clean Cities program. The Clean Cities program works to advance the nation's economic, environmental and energy security by supporting local actions to reduce petroleum consumption in transportation.

ICCC partnered with the Kansas City Regional Clean Cities Coalition on a US DOE grant-funded project to have a consultant design a fleet analysis program for several Midwest-based Clean Cities programs.

The Clean Energy Coalition based in Michigan was selected as the consultant who has successfully implemented a similar program called Fuel Forward. This consultant trained the ICCC staff and others in Kansas City and St. Louis on how to gather fleet data, run an analysis using calculator tools, and create a report of scenarios for alternative fuel vehicle adoption. Part of this training was selecting a fleet to receive the first "pilot" fleet analysis, which for Iowa was the city of Bettendorf.

Data and assumptions used for the analysis come from a variety of sources, including:

- EPA's Motor Vehicle Emission Simulator (MOVES), a modeling system that estimates emissions from mobile sources covering a broad range of pollutants.
- The DOE's Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) tool, which estimates petroleum use, greenhouse gas emissions, air pollutant emissions, and cost of ownership of light-duty and heavy-duty vehicles.
- Local and regional fuel prices.

City of Bettendorf: Context and Data for Analysis

Iowa Clean Cities worked with the city's fleet manager Mark Garrow for data collection and clarifications.

Current Fueling

Most of the city's vehicles refuel at the city's Public Works facility and this would be the preferred location of any new alternative fueling station. The current fueling station is also used and partially owned by the Pleasant Valley School District. There is room for expansion or additional refueling stations at this location. City vehicles are only used in town; therefore, the availability of particular alternative fuels outside of town is not a factor. Most vehicles return to the Public Works facility and park there overnight. Some of the city's vehicles are parked at locations other than Public Works, mostly at City Hall.

Fleet Data Utilization

Fleet data was provided spanning from July 2013 through June 2014. About forty vehicles were removed from the analysis, per recommendation of the city fleet manager. These included the Fire Department, some Parks Department off-road vehicles, and a few vehicles that are too new and would not be candidates for replacement or conversion. The result was 148 vehicles considered for the analysis. Since June 2014, new vehicles have been purchased that were not included in the analysis, but should be considered if the city decides to move forward on specific strategies.

Iowa Clean Cities analyzed which vehicle groups had highest number of annual miles and had at least 50,000 miles on the odometer. We were not able to precisely conform to the city's fleet replacement schedule/matrix due to its sophistication and time involved in that task. Additionally, if the city is to consider alternative fuel vehicles, it may be cost effective to just sell/replace vehicles before they are at the stage of replacement. If the city were to install conversion kits on existing vehicles, consideration would have to be made on whether those vehicles would have enough useful life remaining to justify the investment.

Iowa Clean Cities did not choose single vehicles in the fleet that might be candidates for alternative fuels, due to the focus on groups of vehicles. The city could explore those types further in the future, especially when looking specifically at a given alternative fuel and what other vehicles could be useful to add to a new station's capacity.

Fleet Baseline Report

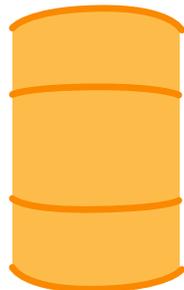
FROM
JULY 1, 2013
TO
JUNE 30, 2014



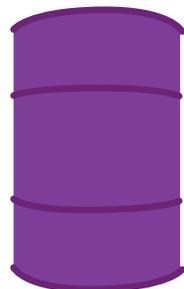
TRAVELED
1,169,836 MILES

TOTAL OF
148
VEHICLES

GASOLINE

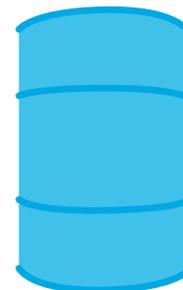


71,733
GALLONS
3,775
BARRELS
OF OIL



TOTAL
BARRELS
OF OIL
13,628

DIESEL



118,247
GALLONS
9,853
BARRELS
OF OIL

TOTAL FUEL
189,980
GALLONS



TOTAL
GHGs



2,609.3
TONS CO₂ EQUIVALENT

42 GALLON
BARREL OF CRUDE OIL
12
GALLONS OF
DIESEL FUEL
OR
19
GALLONS OF
GASOLINE



Alternative Fuels Overview

By using alternative fuels, fleets can significantly lower greenhouse gas emissions, reduce dependence on petroleum, lower maintenance costs, and in some cases, save money on fuel. When considering the addition of alternative fuels or advanced vehicle technologies, attention should be given to the infrastructure demands of each fuel, along with the complexities that new technologies can bring to maintenance and repair facilities. While some fleets will choose to include multiple fuels or technologies, they must also consider the cost of training and tools required to service new systems.

Compressed Natural Gas (CNG) is a widely available, domestically produced fuel. CNG is sold in gasoline gallon equivalent units (GGE). One GGE has the same energy as one gallon of unleaded gasoline so if a vehicle travels 15 miles per gallon of gas, it will travel about 15 miles per GGE of CNG. Vehicles can be converted to run exclusively on CNG (dedicated), or on either gasoline or CNG (bi-fuel). CNG is compressed to 3,000-3,600 pounds per square inch (psi) and dispensed into high-pressure tanks on the vehicle. The cost of CNG at a private station in this region is around \$0.80 - \$0.90/GGE. The price of CNG is not tied to the price of crude oil.

Liquefied petroleum gas (LPG), also known as propane or autogas, is a widely available byproduct of natural gas and oil refining processes. Propane is compressed to between 100 and 200 psi, at which point it becomes a liquid fuel that is dispensed into tanks on the vehicle. It has a higher octane rating, but up to 20% of reduced energy density per gallon than gasoline, resulting in lower fuel economy. Fueling infrastructure is relatively inexpensive compared to CNG (anywhere from \$10,000 to \$400,000 per station, depending on specifications). Many propane suppliers offer fleets the option to lease dispensing infrastructure and roll the cost into the per-gallon purchase price. Like CNG, LPG is cleaner burning than petroleum and can prolong vehicle life. The price for LPG has some fluctuation tied to the price of crude oil, which can be mitigated somewhat by locking in a price contract with a vendor.

Biodiesel is a renewable fuel produced from vegetable oils or animal fats. It is blended with diesel fuel and results in a cleaner-burning fuel than standard diesel fuel. Newer diesel engines can burn blends up to 20% biodiesel (B20) without any conversions or modifications. There are no noticeable impacts on vehicle performance and most manufacturers approve blends up to B20 under warranty conditions.

Ethanol is a renewable fuel made from fibrous plant material. Any flexible fuel vehicle can use E85, which is a blend of 85% ethanol and 15% gasoline. The fuel is cleaner burning and has lower greenhouse gas emissions than gasoline but has a lower energy density, resulting in lower fuel economy.

Plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV) must be plugged in periodically to charge the on-board battery. PHEVs combine the range benefits of conventional gasoline engines with the fuel economy benefits of electric vehicles. Electric-only range for a PHEV depends on the specific vehicle, but is generally around 40 miles. Once the vehicle travels past its electric-only range, the vehicle can run on gasoline, resulting in an overall range of around 350 miles. BEVs (often referred to as just EVs) do not have an internal combustion engine, and instead rely purely on an electric motor.

Analysis Summary

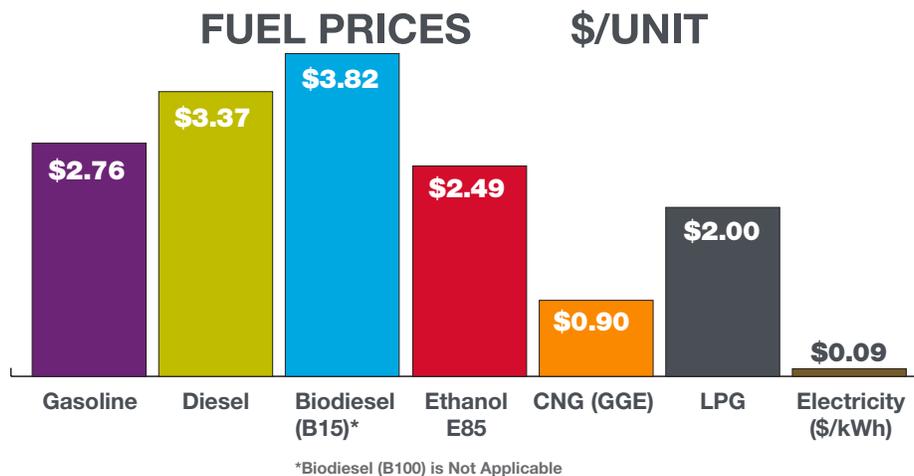
Iowa Clean Cities chose three groups of vehicles to run scenarios on alternative fuel adoption:

- 16 Chevy Tahoe vehicles being used primarily by the police department
- 10 Transit Buses (All Model Year 2010 IHC)
- 3 Refuse Trucks (All Model Year 2011 IHC 7500)

These were chosen as priorities based on a number of factors, most importantly being annual fuel used or miles driven; the higher the use, the quicker the simple payback. The simple payback is the cost savings per year divided by the initial, incremental cost of a new vehicle or cost of existing vehicle conversion.

The following fuels and prices were used to analyze options:

Fuel Inputs



Fuel prices were based on a variety of sources, including:

- What the city paid for gasoline and diesel in February 2014
- The US Department of Energy's Alternative Fuel Price Report for the Midwest
- Rough estimates from vendors on typical private station (not retail) costs

It is possible that biodiesel blends such as B15 or B20 could be offered at a different price per gallon by a vendor but that information was not available for this analysis. Running diesel vehicles on biodiesel blends would require minimal changes to vehicles and equipment. The city would need to check on engine manufacturer warranties related to biodiesel blends.

In the case of ethanol E85, it was unknown whether any of the city's existing vehicles were Flex Fuel Vehicles capable of running on E85 or mid-level ethanol blends. If this was the case, the city could investigate the cost of a blender pump and fuel cost for higher ethanol blends, as there may be long-term savings with this option.

The City's primary goal was to look at cost-saving measures in the analysis. The goal for the scenarios was to see a simple payback in less than five years. This occurred in all three scenarios with CNG, not taking into account infrastructure costs or facility upgrades, if applicable. With LPG, this simple payback within five years was achieved with the transit buses.

Based on the vehicle types selected for scenarios and corresponding alternative fuel options, the alternative fuels that were examined most closely were LPG (Liquefied Propane Gas or Propane Autogas) and CNG (Compressed Natural Gas).

Scenario 1 : Chevy Tahoes

The analysis for sixteen Chevy Tahoes demonstrated that by using equivalent CNG vehicles, there would be a simple payback between 4-5 years and an annual savings of approximately \$30,000. The vehicles are mostly used by the Police Department, with the exception of a couple used by the city's Community Development Department. There are conversion kits available for Chevy Tahoes that could enable the existing vehicles to be converted to CNG.

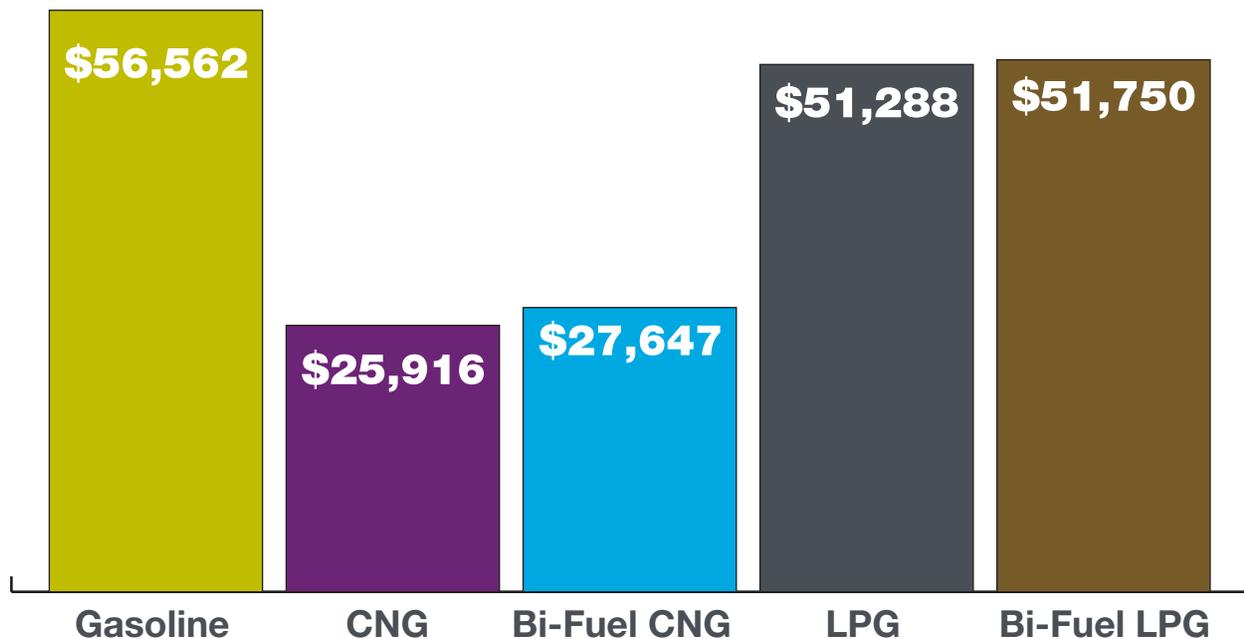
Scenario 1 Baseline

| | |
|--------------------------------|----------|
| Fuel Type | Gasoline |
| Number of Vehicles | 16 |
| Annual Miles Traveled/Vehicle | 14,866 |
| Annual Gallons/Vehicle | 1,932 |
| Miles Per Gallon | 15 |
| Maintenance Cost/Mile Estimate | \$0.05 |
| Vehicle Life (Miles) Estimate | 70,000 |
| Payback Goal (Years) | 5 |

**FUEL TYPE
GASOLINE**



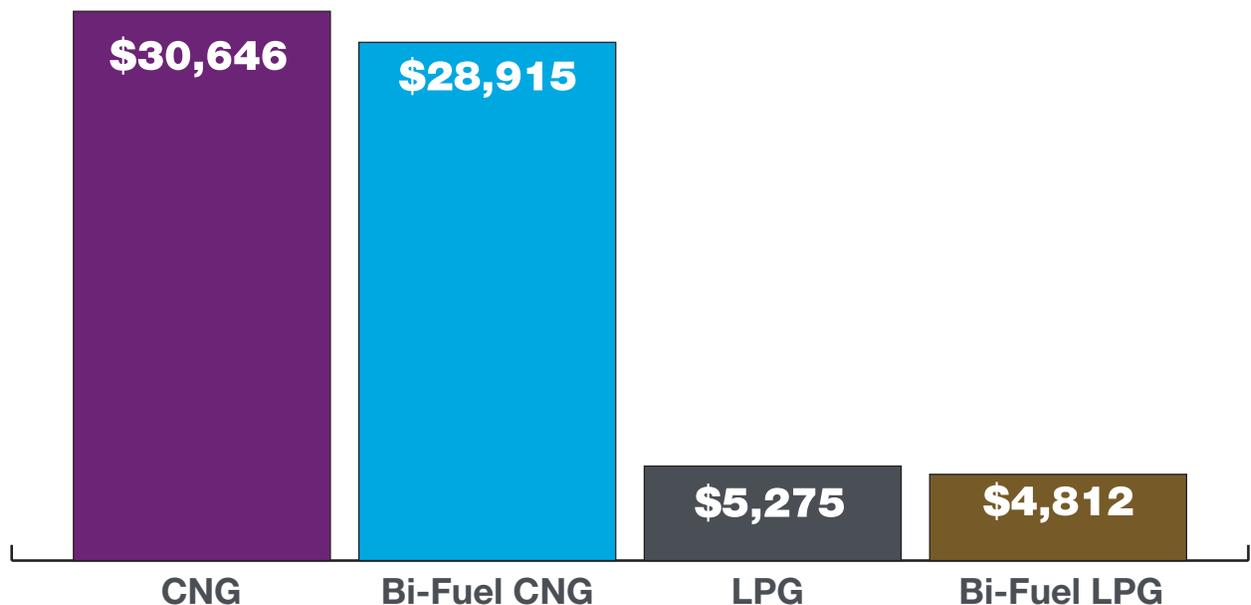
TOTAL ANNUAL COSTS



Scenario 1 Outcomes

| | Gasoline | CNG | Bi-Fuel CNG | LPG | Bi-Fuel LPG |
|-------------------------------------|----------|---------------|---------------|------------------|------------------|
| Fuel Cost | \$2.76 | \$0.90 | \$0.90 | \$2.00 | \$2.00 |
| Annual Fuel Costs | \$43,766 | \$14,271 | \$15,746 | \$39,643 | \$39,849 |
| Annual Fuel Savings | | \$29,494 | \$28,019 | \$4,123 | \$3,917 |
| Maintenance Cost/Mile | \$0.054 | \$0.049 | \$0.050 | \$0.049 | \$0.050 |
| Annual Maintenance Costs | \$12,797 | \$11,645 | \$11,901 | \$11,645 | \$11,901 |
| Annual Maintenance Savings | | \$1,152 | \$896 | \$1,152 | \$896 |
| Total Annual Costs | \$56,562 | \$25,916 | \$27,647 | \$51,288 | \$51,750 |
| Total Annual Savings | | \$30,646 | \$28,915 | \$5,275 | \$4,812 |
| Incremental Costs/Vehicle | | \$8,400 | \$8,400 | \$7,200 | \$7,200 |
| Simple Payback (Years) | | 4.39 | 4.65 | No Return | No Return |
| Simple Payback (Miles) | | 65,196 | 69,098 | No Return | No Return |
| Petroleum Footprint (Barrels) | 342.2 | 1.7 | 18.8 | 84.6 | 97.4 |
| Percent Reduction | | 99% | 95% | 75% | 72% |
| GHG Emissions Footprint (Tons CO2e) | 197.72 | 10.10 | 10.21 | 8.02 | 8.24 |
| CO | 0.0385 | 0.0279 | 0.0284 | 0.0385 | 0.0385 |
| NOx | 0.0031 | 0.0026 | 0.0026 | 0.0031 | 0.0031 |
| PM10 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| PM2.5 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| VOC | 0.0010 | 0.0006 | 0.0006 | 0.0012 | 0.0011 |
| % CO2e Reduction | | 95% | 95% | 96% | 96% |

TOTAL ANNUAL SAVINGS



Scenario 2: Transit Buses

Ten transit buses, all model year 2010 manufactured by IHC, demonstrated that both CNG and LPG would achieve attractive simple paybacks. CNG buses would have a payback of a little over 2 years, whereas LPG buses would have a payback of less than 2 years. LPG was attractive in this case due to the up-front incremental cost of a smaller LPG bus being much less in comparison to the larger CNG buses available. The analysis wasn't able to cover whether the city would need to purchase more of the smaller LPG buses to meet the demand for transit.

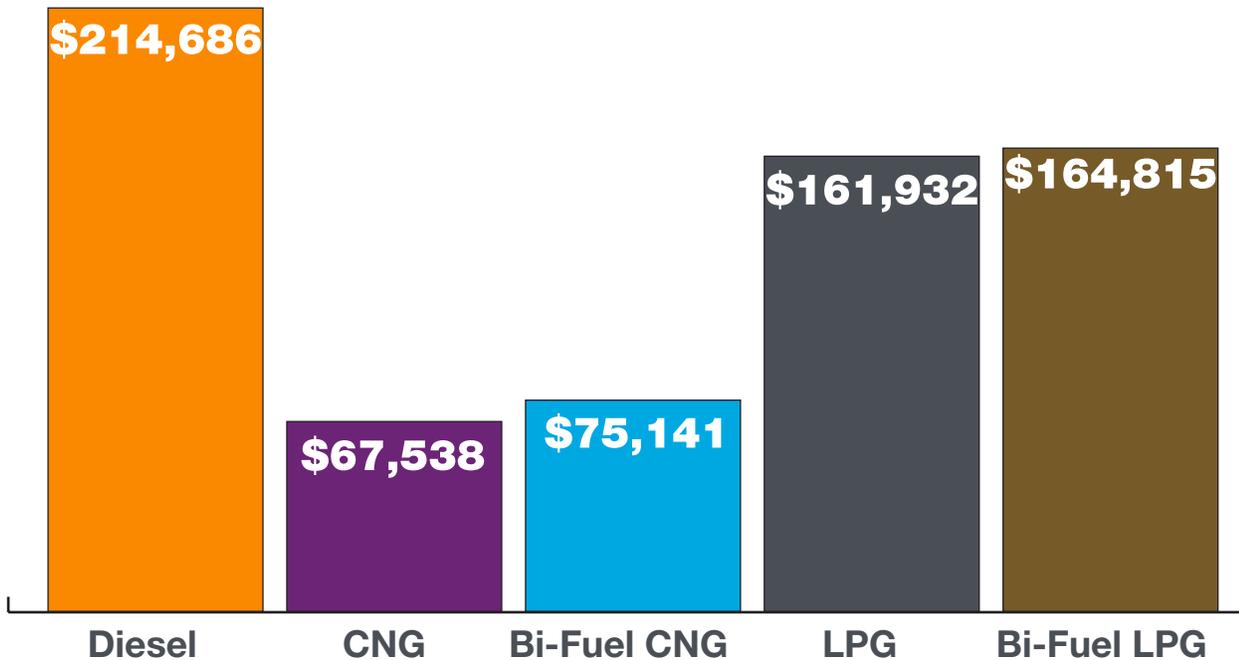
Scenario 2 Information

| | |
|--------------------------------|---------|
| Fuel Type | Diesel |
| Number of Vehicles | 10 |
| Annual Miles Traveled/Vehicle | 29,498 |
| Annual Gallons/Vehicle | 5,251 |
| Miles Per Gallon | 5 |
| Maintenance Cost/Mile Estimate | \$0.05 |
| Vehicle Life (Miles) | 100,000 |
| Payback Goal (Years) | 5 |

FUEL TYPE DIESEL



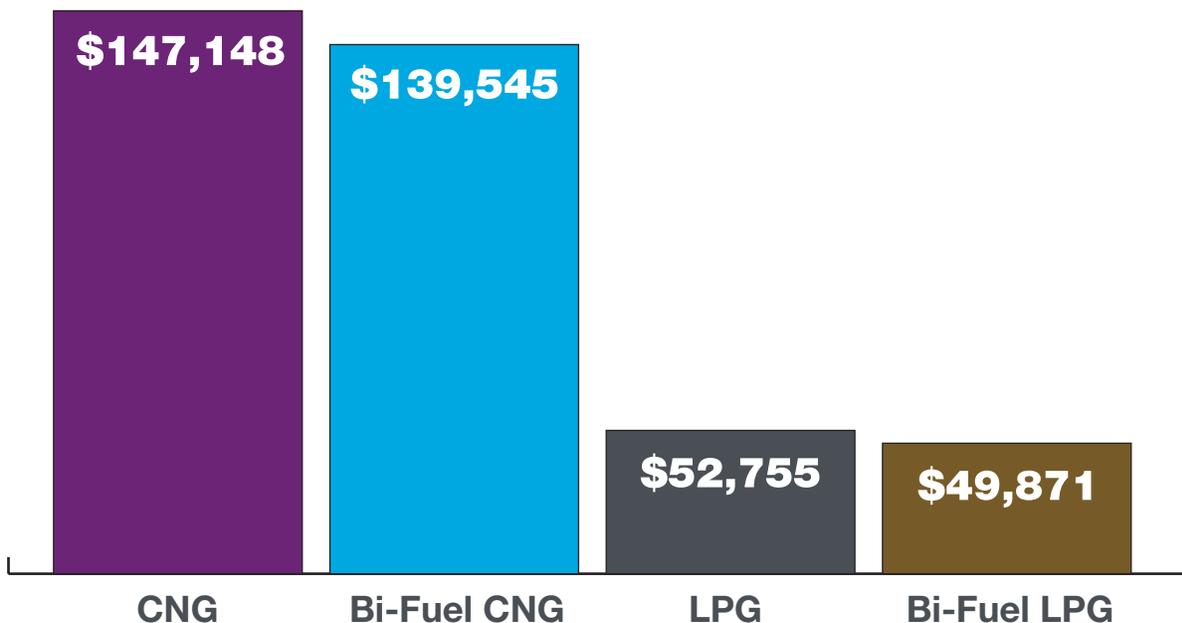
TOTAL ANNUAL COSTS



Scenario 2 Outcomes

| | Diesel | CNG | Bi-Fuel CNG | LPG | Bi-Fuel LPG |
|-------------------------------------|-----------|---------------|---------------|---------------|---------------|
| Fuel Cost | \$3.37 | \$0.90 | \$0.90 | \$2.00 | \$2.00 |
| Annual Fuel Costs | \$198,817 | \$53,096 | \$60,382 | \$147,490 | \$150,056 |
| Annual Fuel Savings | | \$145,720 | \$138,434 | \$51,327 | \$48,760 |
| Maintenance Cost/Mile | \$0.054 | \$0.049 | \$0.050 | \$0.049 | \$0.050 |
| Annual Maintenance Costs | \$15,870 | \$14,442 | \$14,759 | \$14,442 | \$14,759 |
| Annual Maintenance Savings | | \$1,428 | \$1,111 | \$1,428 | \$1,111 |
| Total Annual Costs | \$214,686 | \$67,538 | \$75,141 | \$161,932 | \$164,815 |
| Total Annual Savings | | \$147,148 | \$139,545 | \$52,755 | \$49,871 |
| Incremental Costs/Vehicle | | \$30,000 | \$30,000 | \$9,000 | \$9,000 |
| Simple Payback (Years) | | 2.04 | 2.15 | 1.71 | 1.80 |
| Simple Payback (Miles) | | 60,139 | 63,416 | 50,324 | 53,234 |
| Petroleum Footprint (Barrels) | 1,513.8 | 7.2 | 82.5 | 314.6 | 374.6 |
| Percent Reduction | | 100% | 95% | 79% | 75% |
| GHG Emissions Footprint (Tons CO2e) | 855.58 | 60.10 | 61.37 | - | - |
| CO | 0.0268 | 0.7147 | 0.6803 | - | - |
| NOx | 0.0297 | 0.0208 | 0.0213 | - | - |
| PM10 | 0.0005 | 0.0005 | 0.0005 | - | - |
| PM2.5 | 0.0005 | 0.0005 | 0.0005 | - | - |
| VOC | 0.0026 | 0.0257 | 0.0245 | - | - |
| % CO2e Reduction | | 93% | 93% | 100% | 100% |

TOTAL ANNUAL SAVINGS



Scenario 3: Refuse Trucks

There were three refuse trucks, all Model Year 2011 IHC 7500, in service that had high enough usage to be prioritized for a scenario analysis. Only CNG was examined for this vehicle type due to the wide range of CNG refuse trucks and applications currently available. There are not any LPG refuse-specific trucks on the market. There is a hybrid electric refuse truck and a hydraulic hybrid refuse truck available on the market, but these were not included in the analysis due to limited variety of available manufacturers and models.

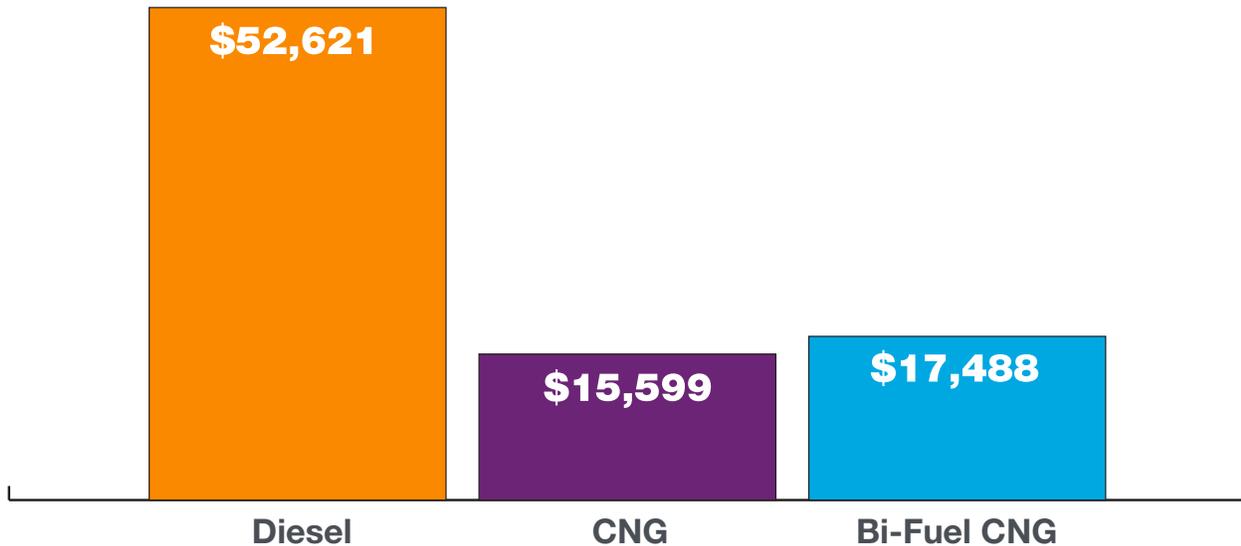
Scenario 3 Information

| | |
|--------------------------------|---------|
| Fuel Type | Diesel |
| Number of Vehicles | 3 |
| Annual Miles Traveled/Vehicle | 15,091 |
| Annual Gallons/Vehicle | 6,042 |
| Miles Per Gallon | 3 |
| Maintenance Cost/Mile Estimate | \$0.05 |
| Vehicle Life (Miles) | 100,000 |
| Payback Goal (Years) | 5 |

FUEL TYPE
DIESEL



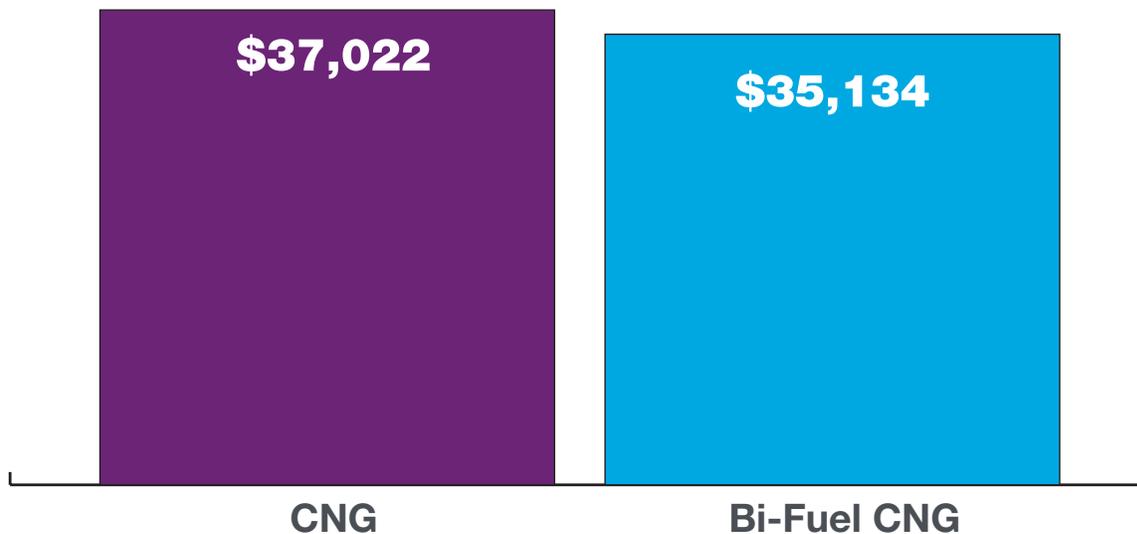
TOTAL ANNUAL COSTS



Scenario 3 Outcomes

| | Diesel | CNG | Bi-Fuel CNG |
|-------------------------------------|----------|---------------|---------------|
| Fuel Cost | \$3.37 | \$0.90 | \$0.90 |
| Annual Fuel Costs | \$50,216 | \$13,411 | \$15,251 |
| Annual Fuel Savings | | \$36,805 | \$34,965 |
| Maintenance cost/mile | \$0.054 | \$0.049 | \$0.050 |
| Annual Maintenance Costs | \$2,405 | \$2,189 | \$2,237 |
| Annual Maintenance savings | | \$216 | \$168 |
| Total Annual Costs | \$52,621 | \$15,599 | \$17,488 |
| Total Annual Savings | | \$37,022 | \$35,134 |
| Incremental Costs/Vehicle | | \$30,000 | \$30,000 |
| Simple Payback (Years) | | 2.43 | 2.56 |
| Simple Payback (Miles) | | 36,224 | 38,171 |
| Petroleum Footprint (Barrels) | 382.3 | 1.8 | 20.8 |
| Percent Reduction | | 100% | 95% |
| GHG Emissions Footprint (Tons CO2e) | 216.10 | 50.60 | 51.67 |
| CO | 0.0073 | 0.0953 | 0.0909 |
| NOx | 0.0174 | 0.0122 | 0.0125 |
| PM10 | 0.0004 | 0.0004 | 0.0004 |
| PM2.5 | 0.0003 | 0.0003 | 0.0003 |
| VOC | 0.0014 | 0.0046 | 0.0045 |
| % CO2e Reduction | | 77% | 76% |

TOTAL ANNUAL SAVINGS



Considerations and Next Steps

This analysis was performed with basic estimates, and if the city chooses to further explore any of the options contained within, more detailed information and analysis could be performed by industry vendors based on costs, quantities, and the most up to date pricing. The city would also need to consider and implement its own procurement policy and procedures.

This analysis chose vehicles that would have the quickest payback on the city's up-front investment. If the city was to pursue incentives for vehicle replacement and/or infrastructure, it would be especially advantageous to consider adding other vehicles to the replacement or conversion list. If the city decides to pursue a CNG station for their property, it may be necessary to add more vehicles to the list for replacement, or a phased approach, in order to achieve the most desirable return on investment for the station.

Infrastructure Considerations

This analysis was done with the assumption that refueling would take place at the city's Public Works facility fueling station. It will be important for the city to consider refueling infrastructure and long-term fueling capacity needs of a station. More upfront planning would be needed for a CNG station, which is harder to add on capacity in a cost effective manner. This is not an issue with propane, since it is easy to add tanks to an existing station.

- LPG: Most propane delivery companies who deliver propane for vehicle fuel will place the refueling infrastructure free of charge with an annual guaranteed fuel contract. The fleet would be responsible to pay for anything that the propane company cannot physically pick-up and take away, for example concrete and permitting fees. The delivered LP is charged to the customer based upon their commitment to an annual fuel contract.
 - Existing propane retailers in the region are likely accustomed to responding quickly in the instance of equipment technical issues.
- CNG: The city would either have to lease land to a private CNG station owner to sell the city fuel, or purchase refueling infrastructure to fuel from the city's own natural gas pipeline. Depending upon whether you choose to time-fill (refuel your vehicles over night) or fast-fill (refuel at approximately the same rate as a regular petroleum pump) the cost of the refueling equipment and installation varies a significantly. These costs can range from around \$25,000 to more than \$1.5 million. Some time-fill stations can also provide an occasional fast-fill function in cases of emergency.
 - There is public CNG refueling in Davenport at Kwik Star, which could be helpful in the case of private CNG fueling needing maintenance.

Vehicle Maintenance Cost Considerations

- Propane fuel tanks are less expensive than CNG tanks, and maintenance costs are also less than CNG.
- CNG tanks must be inspected every 3 years or 12,000 miles (whichever comes first) due to how they are highly pressurized (unlike propane). Estimate for a tank inspection is \$50-\$75. It is not difficult to become certified as a CNG tank inspector, therefore it is highly possible to certify a staff member to perform your inspections.
- Maintaining CNG and/or propane vehicles at the city's maintenance facility may require some retrofits to meet fire code and safety standards (gas detection, ventilation, etc). The city can consult with the neighboring city of Moline, IL about how they addressed retrofitting and associated costs. These costs were not estimated or taken into account in this analysis for the city of Bettendorf.

Vehicle Considerations

There are three types of alternative fuel vehicles applicable to the scenarios in this report:

- **Dedicated:** These vehicles are designed to run only on alternative fuel (CNG or LPG).
- **Bi-fuel:** These vehicles have two separate fueling systems that enable them to run on either natural gas or gasoline.
- **Dual-fuel:** These vehicles are traditionally limited to heavy-duty applications, have fuel systems that run on natural gas, and use diesel fuel for ignition assistance.

The city could purchase new alternative fuel vehicles from original equipment manufacturers (OEMs), convert their existing vehicles, or convert newly-purchased vehicles to alternative fuels. Many OEMs offer alternative and advanced vehicles. However, the availability of certain models, fuels, and technologies can vary. This makes vehicle and engine conversions a good option to explore.

- More information on the basics of vehicle conversions:
www.afdc.energy.gov/vehicles/conversions.html
Information on Manufacturers for EPA-Compliant Alternative Fuel Conversions:
www.epa.gov/oms/consumer/fuels/altfuels/altfuels.htm#4
Keep in mind that some of these manufacturers will have specifications/restrictions on who can install the conversion system or perform maintenance on that system in the future.
- More information on new alternative fuel vehicles can be found using the US Department of Energy's Advanced Vehicle Search tool: www.afdc.energy.gov/vehicles/search/

The vehicle options related to the scenarios discussed in this report are as follows:

- For Chevy Tahoes, there are no comparable new CNG or LPG models available for any type of SUV, and converting the existing Chevy Tahoes would be the implementation option. Conversion of the existing vehicles was also emphasized here since they are not all due for replacement soon.
- For refuse trucks, there are many models of new CNG refuse trucks on the market, which is often the preferred option by fleets. With the high number of miles associated with these vehicles' use, converting existing vehicles may not have as good of a payback within the vehicles' useful life. Conversion systems may also be available, but are less prevalent.
- For transit buses, there are many models of new CNG buses on the market being used by fleets, although conversions may be available as well. For LPG, new "off-the line" transit buses are not available, but many fleets will purchase new vehicles and immediately have them converted with manufacturers such as ROUSCH or ICOM North America.

Next Steps

The following next steps would help the city further consider these scenarios and alternative fuel options:

- Reach out to Pleasant Valley School District to assess their interest in alternative fuel options since it would be pertinent to future refueling at the shared site.
- Work with Iowa Clean Cities Coalition to contact industry vendors who could provide further information and analysis on vehicles and infrastructure to the city and school district. There are a handful of relevant vendors located in Iowa and others in neighboring states.
- Identify a grant writer who could assist the city in pursuing funding through 1) the Iowa Clean Air Attainment program at Iowa DOT, and 2) the Diesel Emission Reduction Program at EPA, which would enable replacement or conversion of existing diesel vehicles. Expected application due dates for these programs are in October and June of each year.

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Des Moines, Iowa 50309

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Mid-America Collaborative for Alternative Fuels Implementation



Iowa Clean Cities Coalition is a program of



www.metroenergy.org

Metropolitan Energy Center

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