10 East Church Street
Bethlehem, Pa. 18018
eacbethlehempa@gmail.com

April 15, 2019

Michael Alkhal, Director, Department of Public Works
Kevin Livingston, Executive Director, Bethlehem Parking Authority
10 East Church Street
Bethlehem, PA 18018

Dear Mr. Alkhal and Mr. Livingston,

Many municipalities seeking to reduce greenhouse gas emissions have realized the benefit of utilizing electric vehicles (EVs). Attached is a cost analysis of electric vehicles versus gasoline vehicles for municipal operations for your consideration.

As we continue to move forward with the Climate Action Plan, we believe the integration of electric vehicles into the City's fleet could be a key component in reducing emissions, while demonstrating to the public the benefits of electric vehicles and our commitment to sustainability.

Respectfully yours,

Lynn Rothman

Lynn Rothman, Chair

On behalf of the Bethlehem EAC:

Elizabeth Behrend	Kathy Fox	Mike Topping
Elisabeth Cichonski	Brian Hillard	

cc: Mayor Donchez
City Council

Fleet Electrification Assessment

Brian Hillard
Bethlehem EAC
February 19, 2019

Executive Summary

As municipalities strive to promote sustainability, reduce their emissions, and improve the quality of life for their residents while still managing their budget, integration of electric vehicles into a municipal fleet has become common practice in many cities. With zero tailpipe emissions and reduced fueling and maintenance costs, electric vehicles have been demonstrated to help many cities achieve their sustainability goals.

As Bethlehem strives to push forward with the Climate Action Plan, integration of electric vehicles into the fleet could be a key component to reducing emissions, while demonstrating to the public both the benefits of electric vehicles and the City's commitment to sustainability.

It is also understood that every municipality has budgetary constraints, so any initiative the City undertakes must be economically feasible. If electric vehicles were to be introduced into municipal operations, an economic assessment should be done to ensure that they would not negatively impact the municipal budget.

The assessment that follows conducts this cost analysis. Based on the most current and trusted information available, the five-year cost of integrating an electric vehicle is nearly identical to that of vehicles being used today. It should be noted that this assessment focused on the use of Jeep Wranglers that are currently in use by the Bethlehem Parking Authority, which is a separate entity from the City of Bethlehem. The cost metrics are comparable, however, to a 2018 Ford Explorer, which the City recently acquired under lease for their Public Works department.

With these considerations in mind, it was found that the 5-year cost is favorable. It should also be understood that efficiency metrics were basic assumptions, and that real-world fuel economies for municipal use are expected to be lower, further increasing the cost benefits of electric vehicles.

Jeep Wrangler	5 Year Metrics	Chevy Bolt EV
$34,745	Initial Cost	$42,058
$7,200	Fuel Cost	$1,703
$10,360	Maintenance Cost	$490
$19,310	Trade-In Value	$11,436
$32,995	**Final Cost**	**$32,815**

Introduction

As municipalities seek to reduce emissions in the effort of climate change mitigation, many have realized the benefit to utilizing electric vehicles (EVs) to achieve reductions in transportation-based emissions. Barriers to EV integration have limited widespread adoption, one being the initial purchase cost. While most EVs' purchase cost is notably higher than their gasoline counterparts, their lower annualized cost is often not understood, clouding the benefits of EV integration. While all municipalities face budget constraints, *all* economic considerations should be taken into consideration to properly address their economic impact.

The purpose of this assessment is to ascertain the feasibility of utilizing an electric vehicle for municipal operations in lieu of an equivalent gasoline vehicle. This assessment will take into consideration:

- Initial purchase cost
- Annualized fuel costs
- Annualized maintenance costs
- End-of-life trade value

Each vehicle will be evaluated independently, and metrics for each cost classification will be provided. The initial cost of an electric vehicle will also include the installation cost of the necessary charging equipment.

While this assessment is founded upon the premise to reduce municipal emissions, emissive data will not be addressed here. As stated, initiatives such as this should prove economically feasible, so this assessment will focus solely on its economic feasibility.

It should also be noted that the purpose of this assessment will be to propose a pilot program for the transition of parking authority vehicles, which currently utilize Jeeps, to perform their tasks. Future assumptions will be made with this in mind.

Every attempt should be made to use the most complete and accurate data possible. However, it is recognized that some assumptions must be made in order to compose a complete assessment. Every effort should be made to ensure that assumptions are consistent with those used in other assessments.

The initial phase of this assessment will require gathering the data regarding city transportation costs. The focus will be on parking authority vehicles, and should include vehicles' initial cost, fuel and maintenance costs, end-of-life trade value, and other possible related expenses. The population of such data will be compiled in accompanying tables.

Initial Purchase Cost

The baseline of this assessment begins with a comparative look at the initial investment cost of a vehicle, as well as any related expenditures. These would include charging station(s) needed to charge the electric vehicle(s). For the proposed vehicles, a mid-level trim will be used.

Any modifications made specific to its municipal use (installed equipment, official decaling, etc.) will not be addressed, as it is expected both vehicles will require identical modifications and would not have a difference in a comparative assessment.

As previously stated, the vehicles analyzed will represent what is currently in use, Jeep Wranglers, and a Chevrolet Bolt.

Jeep Wrangler	Vehicle	Chevy Bolt EV
2019 Jeep Wrangler Unlimited Sport S 4 door	Model / Trim	2019 Chevrolet Bolt EV Premier 4 door hatchback
$34,745[1]	Cost	$39,870[2]
n/a	Fueling Infrastructure	$2,188[3,4]
$34,745	Total Cost	$42,058

Fueling

In most forms of transportation, the cost of fuel represents a significant portion of a vehicle's expense. Fueling costs are affected by two factors: the cost of the fuel itself and the efficiency by which the vehicle uses the fuel. For the purposes of this analysis, the local cost of gasoline will be compared to the cost of electricity in Pennsylvania, and the fuel economy of each vehicle as reported on EPA's fuel economy site.

It should be noted that even though the two vehicles use different fuels, comparisons can still be made by cost per unit fuel – either miles per gallon or miles per killowatt-hour – and cost per unit of fuel.

According to the gasoline price comparison website GasBuddy.com, gasoline in the Lehigh Valley averaged approximately $2.40/gal[5] (as of February 19th, 2019). According to the U.S. Energy Information Agency, Pennsylvania electricity rate is $0.1013/kWh (10.13 cents/kWh)[6].

According to fueleconomy.gov, a 2019 Jeep Wrangler has a fuel economy of 20 miles/gallon[7]. Conversely, a 2019 Chevrolet Bolt EV consumes 28 kWh/100 miles[8], or

3.57 miles/kWh. It should be noted that these mileage assumptions are for normal driving conditions: 45% highway, 55% city driving.

In order to obtain an Annualized Fueling Cost, the total expected miles (12,000 for the purposes of this analysis) should be divided by its fuel efficiency to obtain the expected fuel consumed per year. This fuel is then multiplied by the cost per unit to obtain the expected cost of fuel per year.

Jeep Wrangler	Vehicle	Chevrolet Bolt EV
20 mi/gal[7]	Fuel Efficiency	3.57 mi/kWh
$2.40/gal	Fuel Unit Cost	$0.1013/kWh
12,000 mi	Miles (standard)	12,000 mi
$1,440	Total Fueling Cost	$340.50
$7,200	5 Year Fueling Cost	$1702.5

Over the long-term, electric-powered vehicles may prove much more cost-efficient to fuel than gasoline engines. In addition, electricity rates are much less susceptible to price fluctuations than gasoline prices, providing greater stability in municipal budgets.

It should be noted the rate at which the City obtains its gas and electricity could be lower than stated amounts. Many municipalities, like commercial and industrial consumers, obtain electricity and gas at commercial rates lower than residential rates. While this analysis utilizes on the retail / residential rate, City figures should be factored in to gain a more accurate cost.

Maintenance Costs

Jeep Wrangler	Vehicle	Chevrolet Bolt EV
$2072	Maintenance Cost – 12,000 miles/year	$78.94
$10,360	Maintenance cost – 5 year	$490

As with any mechanical device, routine maintenance is required in order to keep it in good operational condition. All vehicles will have moving parts that degrade over time. By design, however, electric vehicles have less complicated engine design, with simpler gearing and transmission systems, and subsequently require no routine maintenance. Comparative studies have shown an electric vehicle to have over $1500 less in maintenance costs compared to a similar model gasoline vehicle. The maintenance cost for the Chevrolet Bolt over 150,000 miles is estimated at $983 – if driven 12,000 miles a year, this averages $78.94 a year, or $490 over 5 years[9]. In addition, EV battery life has drastically improved, and the Bolt's battery is only expected to lose 8% of its life over 70,000 miles, and will still maintain a 200 mile range after 150,000 miles[10].

By comparison, Jeep Wranglers have a higher maintenance cost, both yearly and over a 5-year period. While Kelley Blue Book puts the 5-year maintenance cost at $1,761[11], Edmonds puts it at $3,419[12], both over 15,000 miles. This would equate to $1,408.80 to $2,735.20 for 12,000 miles, an average of $2072.

Trade In Value Assessment

If there is one drawback to electric vehicles in this assessment, it is that their resale values do not yet compete with traditional vehicles.

Given the short history of electric vehicles, end-of-life or resale value can be elusive. Many sources have given the resale value of EVs notably lower than traditional vehicles. This can be attributed to the nature of rapidly emerging technologies. As newer technologies evolve, the value of previous iterations of technology are diminished as newer, more advanced versions have greater value.

In a recent study from the University of Michigan[13], it was found that electric vehicles, on average, retained 30.5% of their resale value after 5 years, compared to traditional internal combustion engine vehicles retaining 37.1%.

2014 Jeep Wrangler Unlimited Sport S SUV 4D*	Vehicle	2017 Chevrolet Bolt EV LT Hatchback 4D
$26,800[14]	Initial Purchase Price	$37,495[15]
$19,310[16]	Trade-In Value – Dealer	$11,436
$7,490	Depreciation Value	$26,059
72%	Percentage Value Retained	30.5%**

*Year: 2014, 60,000 miles, Unlimited 4 door, "good" condition

** Assumed from study[12]

In this comparison, the Jeep Wrangler holds a significant advantage over the Bolt, losing $18,569 less in value and holding 19.7% more of their value.

While there is a lack in documentation for aftermarket valuation of electric vehicles, it can be understood that lifecycle costs of EVs can outweigh the depreciation loss. Additionally, as aftermarkets develop for EV technology, trade-in value may be expected to rise.

Final Cost Comparison

In order to calculate a final cost comparison, the initial cost, fuel, and maintenance costs must be added, and then the trade-in value subtracted to give the cost of ownership over the specified period. There will be certain allowances, as this assessment measures the present day cost of purchasing of either vehicle. It would be impossible to evaluate the trade-in value of a car purchased today; so historical brand valuation must be used, in the case of the Jeep Wrangler. Given that the Chevrolet Bolt has a short history, the 5-year trade value is not available; thus, technology-specific market trends will need to be used.

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While the initial costs and trade-in values of EVs currently struggle to compete with traditional internal combustion engines, the fuel and maintenance savings make up for these costs and demonstrate that the 5-year costs are nearly equivalent.

Final Considerations

There are a few final considerations that should be included, even if they cannot be quantified in the framework of this assessment.

The fuel economy data presented, via fueleconomy.gov, is under the assumption of 45% highway, 55% city driving[17]. The purpose of this assessment is to measure the costs for the City of Bethlehem's Parking Authority vehicles. By nature, Parking Authority vehicles are used inefficiently, typically idling for minutes at a time while enforcement officers issues tickets. Conversely, electric vehicles consume very little energy (if any) while motionless. This would mean that notable increases in efficiency could be realized beyond what is measured in this assessment.

In addition, it is noted that the jeep Wranglers do have a unique utility function that an electric vehicle does not possess. While a Chevrolet Bolt would be able to function in most conditions, inclement weather might limit its ability. However, Chevrolet has announced the introduction of a van version of the Bolt[18], which would allow for an increased utility capacity. It is unknown whether the handling ability would be improved as well.

Finally, there might be the consideration to postpone decisions on emerging technology until greater assurances on its reliability are available. This consideration is unwarranted, however, as electric vehicles have established themselves on the market as some of the safest and well-designed vehicles available. Chevrolet has a long history of providing vehicles of the highest quality, with the Bolt earning 5 stars from Car and Driver[19]. The investment of an electric vehicle is as sound as any other vehicle.

Conclusion

As the City of Bethlehem pushes forward with its Climate Action Plan, there will be many decisions to make as to how to reduce emissions while providing for its residents and maintaining government services. While many of these decisions could require tough decisions in regard to cost and practicality, the decision to integrate EVs into the municipal fleet should not be one. As demonstrated, the cost comparison is very favorable, especially with respect to unmeasured efficiency gains. In addition, there have been numerous assessments as to how air pollution can negatively affect children's neurological development[20], so there are considerable benefits that lie outside the scope of this assessment.

The City of Bethlehem has a history of providing its residents with a healthy and vibrant community, including environmental stewardship, which enhances our quality of life. In considering the integration of electric vehicles into its fleet, Bethlehem shall continue to exemplify what climate action planning means.

Resources

1. https://www.edmunds.com/jeep/wrangler/2019/options/?legacy=true
2. https://www.edmunds.com/chevrolet/bolt-ev/2019/st-401761130/options/?legacy=true#step1
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