# Appendix C: Electric Vehicles

*Whatcom Transportation Authority*
*2017 Strategic Plan*

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# ELECTRIC VEHICLES

WTA is exploring the feasibility of incorporating electric buses into fixed-route service. Electric buses are gaining popularity in use around the country, and the Federal Transit Administration (FTA) is offering grant opportunities for low and no-emission vehicles. Grant opportunities will be important for WTA in the next several years, as WTA will have a backlog of bus replacement needs that will exhaust revenue available from Section 5307 capital grant formula funds. An alternate source of funding will help eliminate this shortfall.

Additionally, due to continued Environmental Protection Agency (EPA) mandates and the extreme technical sophistication needed to meet anticipated emissions standards, the stability of the diesel engine is in question for the future. WTA's current observed performance reflects a disproportionate failure rate of emissions tests in after-treatment components, which is also contributing to early engine failures and requiring engine rebuilds at 180,000 to 200,000 miles. The environmental factor and advantages of using electricity to fuel a transit fleet is also attractive in WTA's geographic area, where nearly 100% of power is derived from renewable power sources, including hydroelectric and wind.

For these reasons it is essential for WTA to analyze all currently technically feasible and ready-for-production vehicle and fuel resources to sustain operation and serve the community. This analysis focuses on fixed-route electric bus technology.

## OVERVIEW

Battery-powered electric vehicles are a propulsion technology that has made great strides in recent years, and electric vehicles have started to be implemented by a select number of transit agencies across the U.S. One west coast agency, Antelope Valley Transit Authority, has embarked on an ambitious plan to turn over their entire fleet (85 buses) within the next five years. Two specific case studies are presented in this chapter to provide insight into recent transit agency experience operating electric vehicles. Overall, there are several considerations that need to be evaluated for selecting appropriate route(s) for electric bus service:

- **Bus Range –** One of the challenges with electric vehicles is the distance a bus can travel before needing to be recharged. Although battery technology is improving, WTA would need to consider manufacturer recommendations and test results for the vehicle range under the worst case conditions (i.e., fully loaded with auxiliary loads such as heat or air conditioning).
- **Charging Station Locations –** Using electric buses also requires an investment in charging stations. Charging station locations need to be secured at appropriate locations along a route to take full advantage of battery charging opportunities. The number and location of charging stations needed on a route depend on maximum speed required along the route, number of stops, service hours, operating speeds, and driver shift schedules.

The success of electric bus implementation depends on the understanding of operations and maintenance personnel. The specific recommendations for personnel requirements include:

- **Bus Safety Review –** A safety review of the bus engineering and operational safeguards is a good practice. Reviewing how high voltage power lines are routed and identified in the engine bay is important to assuring the safety of operations and maintenance staff.

- **Maintenance Personnel Training –** A maintenance personnel qualification training program should be established to assure that only staff that have received the proper training are allowed to perform maintenance on the battery-powered buses.
- **Bus Operator Procedures Update and Training –** Bus operators have an impact on how well buses perform in service. Bus operating manuals/procedures need to be updated, and drivers must be trained on bus operating parameters including the operation of the charging system.

A summary of overall electric bus considerations is shown in Figure 1.

**Figure 1 Electric Bus Considerations**

| Pros | Cons |
|---|---|
| Zero mobile emissions | High initial capital costs (charging stations, vehicle price) |
| Energy to charge buses can be from renewable sources | Adequate layover time must be provided at charging station locations |
| Higher efficiency in stop-and-go driving | Routes must be scheduled so only one bus charges at a time |
| Silent and smooth ride has been credited with contributing to ridership increases | Technology is developed, but not fully refined. |
| Battery technology is continually improving | Battery life and full lifecycle cost is currently unknown |

Source: Nelson\Nygaard adapted from TCRP Report 146: Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements (2010)

## Charging Options

The electric bus market has developed two distinct options for charging, with some variations of these anticipated as the technology develops and matures:

- **Extended Range or Overnight Charging** – This option allows the bus to operate similarly to a standard diesel bus on-route. With bus manufacturers claiming 150 to 180 miles per charge, this generally equates to the daily mileage of most urban-service transit operations. Recently, one manufacturer has added the option of an on-route boost charge that can extend the range of the bus using the same technology as the quick charge option—essentially a smaller charger that gives the batteries a partial charge to extend the range.
- **Fast or Quick Charge** – This option allows the bus to travel 30 to 40 miles on a route and return to a station for a 10 to 15-minute recharge of the batteries. The charge time can vary with the distance the bus travels between charges. This option is also evolving with the ability to adjust the charge cycle to the distance of the route.

To date, no system in the U.S. has addressed the logistical needs of deploying electric buses in an entire network[1]. Buses that renew the electric charge through the service day currently seem to be the most popular option for deploying electric buses. At the same time, buses that use slow-discharge battery packs are continually gaining range. One electric bus manufacturer claims their buses will travel 200 miles in normal operations. This trend is worth watching, as it may be possible to begin electric bus deployment with on-line rapid charging stations and complete the changeover with slow-discharge battery packs where the buses are charged at the end of the

[1] An exception is the long-standing system in Santa Barbara, CA

service day. At this point, there are still many unknowns related to the future of electric vehicle batteries.

## CASE STUDY: KING COUNTY METRO

In Fall 2015, King County Metro (Metro) began testing a new quick-charging electric vehicle manufactured by Proterra. After several months of testing, Metro purchased three vehicles and put them into revenue service. The three vehicles use an overhead charging device that charges the vehicle after every trip during layover time. These vehicles require 10-15 minutes to quick-charge the battery.

Metro currently has one charging station located at the Eastgate Park-and-Ride in Bellevue. Trips with the new electric buses are scheduled so that they are never at the charging station at the same time, which is crucial to ensuring that recharging time does not lead to delays and poor on-time performance. The three new electric buses were purchased with an FTA Transit Investments for Greenhouse Gas and Energy Reduction (TIGGER) grant, which also included clean energy credits that Metro has used to purchase energy from Puget Sound Energy (PSE).

Metro reports overall satisfaction with the quality of the electric vehicles. The larger questions now are how electric buses fit within the larger transit network, evaluating appropriate routes for implementation, and how to best coordinate scheduling to maintain on-time performance. These considerations and more are discussed below.


Source: King County Metro

## Considerations

### Quick Charge versus Slow Charge

Today, there are two types of electric buses on the market: quick-charging vehicles and slow-charging vehicles. Quick-charging vehicles need to recharge frequently, but they can reenergize their battery in 10-15 minutes. A typical charging station can only accommodate one vehicle at a time, so layover time for electric buses must be carefully scheduled so that two buses are not at the charging station at the same time. The location of the charger also needs to be carefully planned; if the electric vehicles share space with diesel buses at a transit center, there must be enough space at the facility that the charging electric vehicles will not block other buses. In many cases, this might require a separate passing lane for buses to move around a charging bus.

Slow-charging buses require different infrastructure. Slow-charging buses can travel up to 100 miles (some agencies are now reporting as many as 200 miles per charge, but this is undocumented) before they need to recharge, but they require several hours to recharge their batteries. This means that the slow-charge electric buses need to be recharged overnight. Because the buses would be charging at the same time, collectively they would generate enormous energy demand—enough that a full fleet of slow-charging buses could require a dedicated power station. The concentrated demand of slow-charge electric buses was a compelling reason for Metro to invest in quick-charge buses where charging can be distributed, instead of slow-charge buses with more point-source loads.

### Integration with Existing Routes

The limitations of quick-charging vehicles were considered when Metro chose route assignments for the electric vehicles. Because the vehicles achieve the greatest efficiency when they charge after every round trip, each round trip needed to have its layover time scheduled at the Eastgate Park-and-Ride. This means that the vehicles could not be assigned to any interlined routes or through-routes that require layover time scheduled in other locations. This limitation is a challenge to the long-term and universal feasibility of quick-charging electric vehicles as a viable replacement for diesel buses. Conversation with Metro revealed that in the long term, the agency may consider pursuing a combination of quick-charging and slow-charging vehicles to match vehicle types to their various route requirements.

### Staffing

Metro provides specific training for each type of bus that it operates. The agency provided additional training to select drivers for the new electric vehicles. Drivers now are comfortable with the vehicles but have reported that they handle differently than traditional buses due to regenerative braking. Also, interfacing with the recharging station requires specialized training because of the spatial configuration of the recharging station. Representatives from Proterra have traveled to Seattle several times to help train staff in the operation and maintenance of the vehicles. No additional staff was hired to operate or maintain the vehicles.

### Durability

One important concern that accompanies any new capital investment is the durability of the asset. This is especially true for electric buses, because at this point no agency has owned one for its full 12-year lifespan. This means that there is no data yet on how wear and tear accumulated in the course of service will affect the performance of the bus or if long-term maintenance will require more resources than that of a traditional bus.

However, Metro reports that maintenance staff have been pleased with the buses so far, though they are still relatively new off-the-shelf vehicles. The electric vehicles are simpler mechanically than a traditional bus. This means that there is a lower risk of parts breaking and indicates that the electric vehicles should be easier to care for even as they age. This remains to be seen, however, and will require further study to verify.

It is worth noting that Metro has long maintained an extensive fleet of electric trolley buses. While somewhat more complex mechanically than a battery-powered bus, they share many more traits with battery buses than with diesel buses. The newest trolleys in the fleet also feature full off-wire capability, meaning they are also limited range battery-powered buses. Therefore, the learning curve for Metro's maintenance staff has been a very gentle slope as they are very well versed in electrically-powered buses.

### Cost

A full lifecycle cost analysis is not available for the vehicles because they are so new to the market that no agency has had them for the full standard life of 12 years. The current Metro electric vehicles were purchased with TIGGER grant funds. In the future, the relative cost-effectiveness of the buses will depend on fluctuations in prices for diesel fuel and the price of electricity provided by PSE. Currently the electricity prices set for Metro fluctuate based on the time of day. If Metro was to switch to an all-electric bus fleet, the agency would have to work closely with PSE to ensure that their new demand for electricity could be met by the existing electrical grid.

### Political Will and Environmental Benefits

Part of the reason that Metro has begun to implement an electric bus fleet is because there is substantial political interest in choosing more environmentally sustainable transportation options. The fact that the new buses produce no carbon emissions and that the electricity used to power the vehicles is mostly produced through hydroelectric mechanisms that also do not cause carbon emissions has gained traction politically. These environmental benefits and the political will around reducing greenhouse gas emissions has spurred continued interest in incorporating the new electric buses into Metro's fleet.

### Schedule Reliability

Metro expressed concern related to potential on-time performance issues because of charging requirements. Currently, a diesel vehicle running behind schedule can regain time by shortening a layover and continuing with scheduled service. In contrast, an electric vehicle always needs to charge for 10-15 minutes before proceeding with the next trip. Service planners at Metro want to avoid a situation where an electric bus running behind schedule will need additional scheduled layover time to accommodate vehicle charging.

### Storage and Charging Stations

As Metro's fleet of electric vehicles continues to grow, the agency will have to carefully manage electricity demand and plan routes around the location of charging stations. As stated earlier, charging stations require both space for maneuvering and a strong connection to the electrical grid. If Metro invests in slow-charge vehicles, the overnight bus base where the vehicles are stored will have to be able to accommodate high levels of electricity demand. These are questions that Metro will continue to work to solve in the next several years.

## Implications for WTA

While many of the challenges Metro has encountered in creating a scalable electric bus network will apply to WTA, WTA can also reap the same benefits from incorporating electric vehicles into its fleet. Depending on electricity prices and rate structure, charging an electric vehicle can be less expensive than purchasing fuel for a traditional bus. Additionally, electric vehicles produce no carbon emissions and thus will help reduce overall greenhouse gas emissions from transportation in Whatcom County.

Battery technology is rapidly improving and falling in price, and the quality and availability of vehicles available is improving. All but one North American bus manufacturer now has an electric bus in development. Given their current experience with electric buses, Metro staff gets the sense that electric bus technology will be fully proven and refined in approximately three more years—a potential timeline for WTA to consider.

If WTA decides to pursue electric vehicles, next steps will include evaluating the feasibility of implementing the technology and how to integrate it with the system. Short-range routes based out of Bellingham Transit Station or Cordata Station could be good candidates for electric vehicles. However, service planners will need to analyze the suitability of the stations for accommodating charging electric vehicles as well as implications for schedule reliability.

## CASE STUDY: FOOTHILL TRANSIT

In October 2010, Foothill Transit evaluated the potential of using electric buses by commissioning three Proterra 35-foot quick-charge electric buses. Foothill Transit was interested in evaluating the technology to determine if it could meet service requirements at the same level as compressed natural gas (CNG) buses. Foothill Transit found that the electric buses could be used on already-existing routes and that the vehicles met or exceeded all performance metrics, as well as having lower operations and maintenance costs than CNG buses of the same model year.

As a result of the pilot program's success, Foothill Transit purchased an additional 12 electric buses in 2014 with the goal of fully electrifying Route 291. Foothill Transit chose Route 291 because it has scheduled layover time at the Pomona Transit Center (PTC) on both inbound and outbound trips. The agency installed an overhead on-route fast-charging station at the PTC because it is the midpoint of the route, it is close to a transformer, and has extra space for a charging station. Also, if Foothill Transit chooses to expand the electric bus fleet in the future, the charging station can be used by other routes that have scheduled layover time at the PTC. The placement of the charging station is a critical piece of system design because it determines the geographic extent of electric bus service.


Source: California Transit Association

## Performance Analysis

During the first year of operation, the electric buses performed well when compared to CNG vehicles of a comparable make and model. The electric buses averaged 2,333 miles per month and were available an average of 90% of all scheduled work days. The electric buses exceeded agency targets for both categories. Maintenance staff reported that the buses were easier to work on than CNG buses because they have fewer moving parts.

Electric buses are also much more fuel-efficient than CNG buses. The National Renewable Energy Laboratory (NREL) evaluated the fuel consumption of Foothill Transit's electric bus fleet and found that the buses had an overall average efficiency of 2.15 kWh per mile, which equates to 17.48 miles per Diesel Gasoline Equivalent (DGE).[2] In comparison, the CNG buses have an average fuel economy of 4.51 miles per DGE. This indicates that the electric buses have an average fuel economy that is nearly 4 times higher than that of the CNG buses.

## Operations and Maintenance Cost Analysis

During the evaluation period, electricity cost averaged $0.18 per kWh, which amounts to $0.39 per mile fuel costs for the electric bus fleet. During the same period, CNG fuel cost averaged $0.93 per DGE, amounting to $0.23 per mile. While fuel cost for the electric buses was higher than fuel cost for the CNG buses, it is important to note that electric vehicles are quickly making gains in efficiency, so newer generations of electric buses may be more cost efficient.

Although both the CNG and electric buses were new and still under warranty, the electric buses had a lower total maintenance cost per mile ($0.16) than the CNG buses ($0.18). However, the

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[2] DGE is a metric used to compare energy efficiency across different fuel types

electric buses did have a substantially higher unscheduled maintenance cost per mile ($0.09 compared to $0.04). Preventative maintenance accounted for 44% of total maintenance costs for the electric vehicle fleet, and a further 24% of maintenance costs were the result of issues with tires. It is noteworthy that during the first year of operation, propulsion-related maintenance costs (i.e., exhaust, fuel, engine, battery modules, electric propulsion, air intake, cooling, electrical, and transmission systems) were 73% lower than that of the CNG buses.

## Implications for WTA

After thorough review, Foothill Transit found that electric vehicles could replace medium-duty and heavy duty-vehicle fleets that operate on fixed routes because the upfront costs of purchasing vehicles and installing charging infrastructure become more economical as savings were achieved through lower operations and maintenance costs.

However, it should be noted that large-scale deployment of electric vehicles can create power quality and power cost issues. If a large fleet of electric vehicles is using one station as a quick-charge facility, there is the potential that electricity prices will rise due to the increase in peak demand. Because the economic efficiency of the fleet is closely tied to electricity prices, it may be possible that increasing the size of the electric vehicle fleet actually decreases the economic efficiency of transit operations.

# ELECTRIC VEHICLE COSTS

Presently, electric vehicles are more expensive to purchase than conventionally powered vehicles and also require a significant investment in capital facilities. However, electric vehicles continue to fall in price and offer considerable benefits in fuel economy and environmental sustainability. A high level analysis of capital and operational costs associated with electric vehicles compared to standard diesel vehicles for WTA is summarized in Figure 2 and Figure 3.

Diesel costs were assumed to be $2.36 per gallon. A demand charge for electricity usage is assumed in calculating estimated operating costs, equating to a cost of $0.41 per mile. However, it should be noted that the more miles and vehicles that utilize the charging station, the lower the cost per mile will be since the demand charge is a fixed amount for a given electrical service.

**Figure 2 Capital Cost Summary**

| Capital Cost | Diesel | Diesel Local Match | Electric | Electric Local Match |
|---|---|---|---|---|
| New Vehicle Cost (Each) | $550,000 | $110,000 | $900,000 | $180,000 |
| Charging Station (Each) | - | - | $350,000 | $70,000 |
| Charging Station Installation (Each) | - | - | $250,000 | $250,000 |

Source: WTA and Proterra

**Figure 3 Systemwide Annual Operating Cost Summary**

| Operating Costs | Diesel Fleet Annual Operating Costs | Electric Fleet Annual Operating Costs | Electric Fleet Annual Operating Cost Savings |
|---|---|---|---|
| Fuel/Propulsion Cost | $861,000 | $749,000 | $112,000 |
| Estimated Vehicle Maintenance Cost[3] | $292,000 | $164,000 | $128,000 |
| Estimated Facility Maintenance and Operations Cost[4] | $329,000 | $238,000 | $91,000 |
| **Total Operating Cost** | **$1,482,000** | **$1,151,000** | **$331,000** |

Source: Proterra, WTA, National Transit Database, Foothill Transit, U.S. Department of Energy Efficiency and & Renewable Energy, and TCRP Report 146: Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements (2010)

Note: Annualized savings and costs based on 1,826,686 vehicle revenue miles, the amount operated by WTA in 2015 for the fixed-route system. Diesel costs were assumed to be $2.36 per gallon, and electric bus costs were assumed to be $0.41 per mile.

[3] Limited data available; full lifecycle costs are currently unknown

[4] Limited data available; full lifecycle costs are currently unknown

The 20-year implications of capital and operating costs for diesel and electric buses were also considered. Figure 4 provides a cost-benefit scenario in which WTA's entire fixed-route fleet is converted to electric buses. The capital costs for electric buses include 45 vehicles and nine charging stations. Vehicle life is assumed to be 12 years, in keeping with FTA minimum requirements. Additionally, the analysis in this section assumes that 80% of vehicle and infrastructure costs (excluding installation for charging stations) will be funded through grants. After 20 years, operating electric vehicles would cost an additional $2.6 million compared to diesel vehicle operation at a fleet-wide level.

It should be noted that there is no attempt to include societal costs of carbon production/emissions into the cost-benefit analysis. It should also be noted that these costs are sensitive to the relative cost of fuel, which, particularly for petroleum fuels, is volatile.

**Figure 4 WTA Systemwide 20-Year Operating and Capital Costs**

| | Diesel | Electric |
|---|---|---|
| Estimated 20-Year Operating and Capital Cost | $39,543,000 | $42,096,000 |
| **Estimated 20-Year Additional Cost** | **-** | **$2,553,000** |

Source: Proterra, WTA, National Transit Database, Foothill Transit, U.S. Department of Energy Efficiency and & Renewable Energy, and TCRP Report 146: Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements (2010)

Note: Twenty-year costs include replacing the fixed-route bus fleet in peak operation (45 vehicles), facility conversion, fuel, system maintenance, and facility maintenance and operations. Electric bus capital costs include nine charging stations estimated to cost $350,000 each, including installation. Electric vehicle life is assumed to be 12 years.

# VARIABLE COST ENVELOPE

This section provides an envelope of diesel costs to illustrate the effects of variable diesel price per gallon on total operating cost. The cost of diesel creates a wide range of operating cost differential compared with electric vehicles, as shown in Figure 5.

Figure **6** demonstrates fuel cost per mile based on variable diesel prices. When diesel prices increase above $2 per gallon, the fuel cost per mile to operate diesel vehicles is more expensive than the $0.41 demand charge assumed for electric vehicles. If diesel prices continue to increase in the future, there is opportunity to achieve even greater cost savings through the use of electric vehicles.

When considering variable costs, an additional consideration related to electric vehicles is the working life of battery packs. Since the technology is only beginning to be implemented, the costs associated with maintaining battery packs is an unknown cost variable at this time, though anecdotal evidence suggests that maintenance costs will be lower than traditional diesel vehicles.

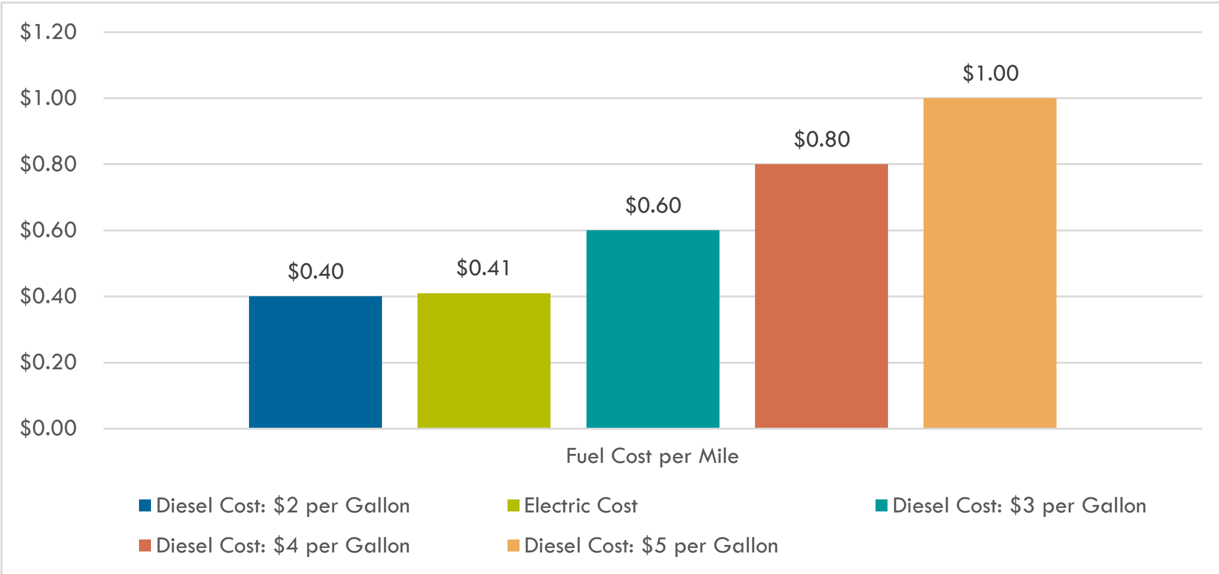
**Figure 5 Variable Total Operating Cost Summary**

| Operating Costs | Diesel Cost: $2 per Gallon | Diesel Cost: $3 per Gallon | Diesel Cost: $4 per Gallon | Diesel Cost: $5 per Gallon | Electric Vehicle Cost |
|---|---|---|---|---|---|
| Diesel Fuel/Propulsion Cost | $731,000 | $1,096,000 | $1,461,000 | $1,827,000 | $749,000 |
| Vehicle Maintenance Cost | $292,000 | $292,000 | $292,000 | $292,000 | $164,402 |
| Facility Maintenance and Operations Cost | $329,000 | $329,000 | $329,000 | $329,000 | $237,469 |
| **Total Annual Operating Cost** | **$1,352,000** | **$1,717,000** | **$2,082,000** | **$2,448,000** | **$1,151,000** |

Source: WTA, National Transit Database, Foothill Transit, U.S. Department of Energy Efficiency and & Renewable Energy, and TCRP Report 146: Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements (2010)

Note: Annualized savings and costs based on 1,826,686 vehicle revenue miles, the amount operated by WTA in 2015 for the fixed-route system.

**Figure** 6 **Variable Cost per Mile Summary**




Source: WTA

Note: Cost per mile is based on total fuel cost and 1,826,686 vehicle revenue miles, the amount operated by WTA in 2015 for the fixed-route system.

## GREEN AND GOLD GOLINE ANALYSIS

This analysis assumes using quick charge Proterra buses on the Green GoLine and Gold GoLine (Route 232 and 331) through Bellingham. This is an urban route that returns to both Bellingham Transit Station and Cordata Station hourly, which is ideal for the quick-charge option. Charging could occur at either location.

This analysis considers initial implementation of one charging station and five electric vehicles. Today, nine peak vehicles operate on these two routes; however, a second charging station would be required to facilitate this number of vehicles. Additional vehicles and a second charging station could be added in a subsequent phase of electric vehicle implementation if the first phase described here is successful as forecast. The charger will require a dedicated 500 kW power service from PSE that could also simplify analytics for operational costs.

Figure 7 provides an estimation of annual operating savings through using electric vehicles on Green and Gold GoLine services, and Figure 8 considers the 20-year costs and benefits. Capital costs in this scenario account for purchase of five vehicles and installation of one charging station. A demand charge for electricity usage (totaling $0.41 per mile) is assumed, as well as a 12-year useful life for all vehicles in keeping with FTA minimum requirements. Electric vehicle operation would offer a small savings compared to diesel vehicles after 20 years.

**Figure 7 WTA Green and Gold GoLine Annual Operating Cost Summary**

| Operating Costs | Diesel Fleet Annual Operating Costs | Electric Fleet Annual Operating Costs | Electric Fleet Annual Operating Cost Savings |
|---|---|---|---|
| Fuel/Propulsion Cost | $170,000 | $148,000 | $22,000 |
| Vehicle Maintenance Cost | $58,000 | $32,000 | $25,000 |
| Facility Maintenance and Operations Cost | $65,000 | $47,000 | $18,000 |
| **Total Operating Cost** | **$293,000** | **$227,000** | **$65,000** |

Source: Proterra, WTA, National Transit Database, Foothill Transit, U.S. Department of Energy Efficiency and & Renewable Energy, and TCRP Report 146: Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements (2010)

Note: Annualized savings and costs based on 360,600 vehicle revenue miles. Diesel costs were assumed to be $2.36 per gallon, and electric bus costs were assumed to be $0.41 per mile.

**Figure 8 WTA Green and Gold GoLine 20-Year Operating and Capital Costs**

| | Diesel | Electric |
|---|---|---|
| Estimated 20-Year Operating and Capital Cost | $6,952,000 | $6,664,000 |
| **Estimated 20-Year Cost Savings** | - | **$288,000** |

Source: Proterra, WTA, National Transit Database, Foothill Transit, U.S. Department of Energy Efficiency and & Renewable Energy, and TCRP Report 146: Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements (2010)

Note: Twenty-year costs include replacing vehicles serving the Green and Gold GoLine routes (five vehicles), facility conversion, fuel, system maintenance, and facility maintenance and operations. Electric bus capital costs include one charging station estimated to cost $350,000, including installation. Vehicle life is assumed to be 12 years.

# RECOMMENDATION FOR WTA

There could be great gains in WTA's carbon footprint strategy through deploying electric buses. In recent years, battery technology has vastly improved, and costs of electric bus technology are continually decreasing. Furthermore, deployment of electric vehicles aligns with the sensibilities of Bellingham and Whatcom County in terms of environmental sustainability. Generally, many of the routes operated by WTA are well suited to electric bus operations—including relatively short alignments, transit centers at one or both termini, and varied topography (regenerative braking and downhill power generation helps with battery charging). However, the complexity of using electric buses successfully will be determined by understanding the performance limits and incorporating them into WTA's service design.

In the U.S., battery powered buses are experiencing a very quick ramp up. In Washington State, several agencies have already placed orders for battery powered buses, and the joint procurement contract available through WSDOT includes battery buses as a procurement option. No/low emission grants for procuring electric buses have been available, but so far the amounts available from the FTA have been much less than the potential demand, and the grants have been highly competitive. This trend bears watching over the next two to three years, as WTA could use FTA no/low emission grants or other sustainable energy grants to offset the continual draw on FTA 5307 funds.

With this in mind, it is recommended that WTA conduct the following activities to prepare for electric bus implementation:

- Conduct service and scheduling analysis
- Determine scope and scale of deployment
- Seek grant funding opportunities
- Evaluate potential local funding sources, including undesignated cash reserve and/or Bellingham TBD funds
- Continue working with PSE to achieve a more balanced approach to power costs
- Incorporate electric charging facilities into the Bellingham Station expansion

In addition to integrating electric vehicles, WTA is currently investigating incorporating propane paratransit vehicles and hybrid staff vehicles into the fleet. WTA should continue to pursue options to incorporate other alternative fuel vehicles in addition to electric fixed-route vehicles, in keeping with Washington state rules.