Seattle Route 48 Electrification Study

Business Case – Executive Summary

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EXECUTIVE SUMMARY

STUDY OVERVIEW

This study was conducted to establish (or refute) a positive business case for closing the overhead trolley wire gap on the southern portion of 23rd Avenue presently served by King County Metro Route 48. Closing this gap would allow the southern portion of Route 48 (Route 48S) to be served by electric trolley buses, while the northern portion of Route 48 (Route 48N) would remain a diesel bus route (hybrid bus assumed).

The study evaluated and compared the lifecycle costs and benefits of deploying diesel-hybrid (hybrid) or electric trolley buses (ETB or trolley bus) along the southern portion of Route 48 from NE 15th Avenue and NE 50th Street in the University District to Mount Baker Station, as shown in Figure ES-1. This portion of Route 48 currently has overhead wire infrastructure in place serving several other bus routes, with the exception of two gaps totaling approximately 1.7 corridor miles (shown in red). The analysis considered the incremental cost of installing and maintaining overhead wire on these new segments of wire.

Figure ES-1 Route 48 South Corridor and Overhead Wire Gaps

Source: Metro (LTK, Route 48 Electrification Project Conceptual Report, 2011)

POLICY CONTEXT

City of Seattle and King County Metro plans and policies support reducing GhG emissions, including actions to do so through vehicle technology that minimizes environmental impacts. These plans include the King County and King County Metro Strategic Plans, the King County Strategic Climate Action plan, and the City of Seattle Climate Action Plan. The latter plan includes an action to "collaborate with King County Metro to expand the electric trolley bus system to include more routes and more frequent service in areas identified in the Transit Master Plan by funding service, building infrastructure, and coordinating planning."[1]

LITERATURE REVIEW

The study included a review of the following reports or studies.

- TCRP Report 146: Guidebook for Evaluating Fuel Choices for Post-2010 Transit Bus Procurements, 2011.
- King County Metro Transit Hybrid Articulated Buses: Final Evaluation Results, 2006.
- King County Trolley Bus Evaluation, 2011.
- Final Report for Edmonton Transit System: Alternative Scenarios for Trolley Bus Replacement, 2008.
- Trolley Coaches and Diesel Hybrid Motor Coaches: Analysis of Existing Conditions and Future Operations at the SFMTA, 2011.
- Route 48 Electrification Project Conceptual Report (LTK), 2011.

OPERATING PLAN ASSUMPTIONS

The operating assumptions for the analysis included:

- About 45,100 annual service hours would be operated on Route 48S. Service hours for the hybrid bus scenario were assumed at 99.14% of trolley bus due to more efficient deadheading.
- Fourteen (14) peak vehicles would be required to operate Route 48S under either a hybrid or trolley bus mode.

The operating assumptions used to analyze Route 48S accounted for scheduling inefficiencies resulting from splitting the route, e.g., overlapping service on Route 48S and 48N in the University District. However, the Route 48S operating assumptions did not include any potential costs for increased inefficiency on Route 48N. A range of service scenarios are possible, ranging from a modest reduction in operating costs through more efficient interlining for Route 48N and increased reliability for both portions of the current route; no cost impact; or a potential increase of up to 15,000 annual service hours for Route 48N. Given the variety and complexity of rider needs and interlining scenarios that could be pursued for Route 48N, the financial implications (positive, neutral, or negative) are not included in the base analysis, but the least optimistic scenario of 15,000 additional service hours on Route 48N is framed in Appendix B of the study report as an upper bound case.

[1] Transportation Infrastructure and Service Action 4

LIFECYCLE COSTS AND BENEFITS

Figure ES-2 summarizes the lifecycle costs and benefits for the hybrid and trolley bus scenarios for Route 48S. The following sections itemize the costs and benefits considered.

Lifecycle Costs

The left portion of Figure ES-2 compares lifecycle costs for the hybrid and trolley bus scenarios. Lifecycle costs for trolley buses on Route 48S are about $363 million (2015 dollars), or about $18 million higher than for hybrid buses ($345 million) over a 30-year period, due to higher vehicle capital costs and trolley infrastructure costs. This is partially offset by lower fuel costs.

- **Operating and Maintenance Costs** are slightly lower for trolley buses (average annual costs of $7.0 million compared to $7.4 million) including:
  - **Direct operating costs** per service hour: slightly lower for hybrid buses (due to more efficient deadheading).
  - **Fleet maintenance costs**: slightly lower for trolley buses.
  - **Incremental trolley overhead wire maintenance costs** on a per-mile basis: applicable only to trolley buses.
  - **Fuel and energy consumption and costs:** lower for trolley buses. A medium level of diesel fuel costs was assumed, but sensitivity to diesel fuel costs was analyzed.
- **Vehicle Capital Costs** are about $578,000 higher per vehicle for a trolley bus, including soft costs such as Washington State sales tax. Despite a longer assumed trolley bus vehicle life of 20 years (compared to a hybrid bus life of 15 years) annualized vehicle costs are higher for trolley buses.
- **Non-Vehicle Capital Costs** include the addition of overhead wire, additional traction power substations, installing OCS poles on the I-90 lid, and overhead wire to expand layover facilities at each end of the line, although off-wire capabilities in new trolley bus vehicles may reduce layover-related infrastructure costs.

Lifecycle Benefits

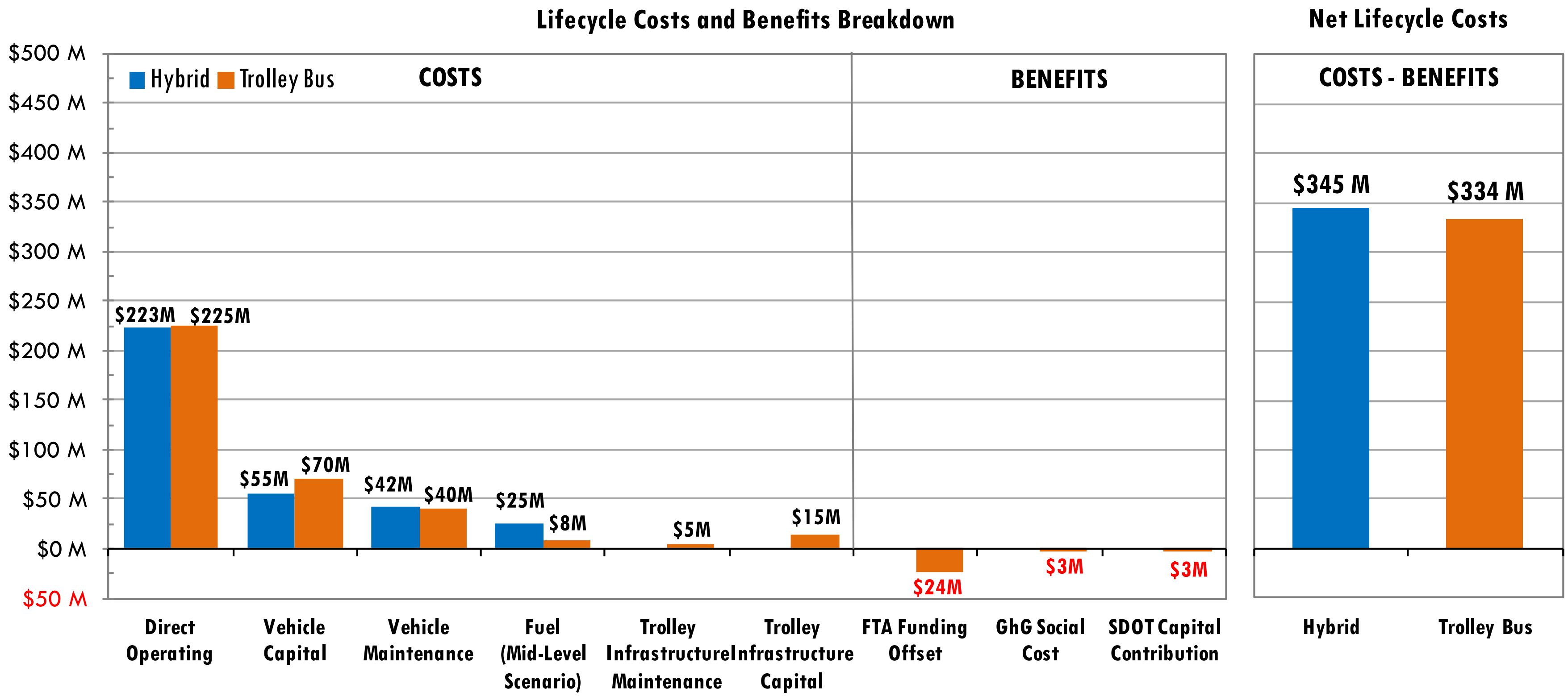
The middle portion of Figure ES-2 identifies cost offsets, or benefits, for the trolley bus scenario that are not captured in the lifecycle cost comparison. These include the availability of federal fixed guideway funding for trolley buses, the positive social cost of reducing GhG emissions, and the City of Seattle's $3.0 million commitment toward the capital cost of electrifying this corridor through the FY 2014 budget. Benefits total about $29 million.

Figure ES-3 compares the costs and benefits of electrifying Route 48S to operating the route using hybrid buses, including both tangible costs and benefits that can be quantified and others that are stated qualitatively. The most significant benefits positively affecting the trolley bus mode include FTA fixed-guideway funding and GhG emissions. Benefits of trolley buses also include air quality, reduced noise, and operation on hills.

Net Lifecycle Costs

Taking into account benefits, net lifecycle costs of implementing trolley buses on the southern portion of Route 48 are about $11 million lower than operating hybrid buses, as shown in the right portion of Figure ES-2.

Figure ES-2 Net Lifecycle Costs and Benefits Summary



Note: Costs are in 2015 dollars.

Figure ES-3 Summary of Route 48S Costs and Benefits for Hybrid and Trolley Bus Modes

Benefit Category	Benefit	Favors Hybrid Bus	Favors Trolley Bus
Capital Costs	Initial Capital Cost	**X**	
	Lifecycle Cost	Dependent on sensitivity factors	
Operating Cost	Fuel Cost		**X**
	FTA Fixed Guideway Funding		**X**
Maintenance Costs	Vehicle		**X** (Slight benefit)
	Trolley Overhead Wire and Power	**X**	
Environmental	GhG Emissions		**X**
	Air Quality		**X**
	Noise		**X** (particularly on hills)
	Visual Quality	**X**	Most of Route 48S is already electrified
Operational	Operation on hills	May be partly mitigated by newer hybrid buses	**X**
	Flexibility (Route)	**X**	Partly mitigated by APUs allowing off-wire travel
	Flexibility (System)	**X** (Decreases scheduling/interlining flexibility)	Addition of wire may enable future restructuring/efficiency opportunities
	Regenerative Braking	**X**	**X**
	Road wear (weight)		**X** (Slight benefit)
	Vehicle Reliability	Undetermined	

KEY FINDINGS

Key conclusions of the analysis are:

- Purely from an operating cost perspective, not including any capital costs or benefit offsets, the cost of operating ETBs in the Route 48S corridor is lower than the operating costs of hybrid buses for all but the lowest projected future diesel fuel costs. In that instance the operating costs are approximately equivalent.
- Annualized lifecycle costs (operating and capital) for electrifying Route 48S are higher than for hybrid bus under the base assumptions used in this analysis, except the case of "high" level diesel fuel prices versus lower electricity consumption rates for ETBs; in this case, costs are equal when offsetting benefits are not included.
- When benefit offsets are included in the calculation, the lifecycle costs of electric trolleys are less than hybrid buses in most cases. The exception is if diesel fuel prices fall below the market trends of the past decade, but even then the lifecycle costs are very close.
- Under current federal funding formulas embedded in MAP-21, use of electric trolley buses is financially beneficial. This advantage has been in place for several re-authorizations of the Surface Transportation Act, but recent formulaic and programmatic changes have accentuated the financial benefit of this mode.
- From a public policy perspective the benefits of ETB support conversion of Route 48S to a full ETB route. GhG emissions are significantly reduced with a trolley bus mode, equivalent to eliminating daily per-capita VMT for 480 vehicles over a year. A range of intangible benefits also generally favor the trolley bus mode, including noise and air quality. The City of Seattle adopted policy is to encourage deployment of ETB. Consistent with that policy the City has budgeted $3.0 million toward the non-vehicle capital cost of electrifying this corridor. This action further tips the scale in favor of moving to ETB in the corridor as the appropriate financial decision.
- Lifecycle costs for trolley bus are higher than for hybrid buses under the low-cost and mid-cost diesel fuel price scenarios if MAP-21 fixed-guideway funding were to be eliminated as a consideration. While there are no guarantees on the precision of projecting future energy costs, two emerging factors offer some insight:
  1.) The cost of fossil fuels continues to be unstable and on an upward trend. Any disruption in the relatively finite production capacity results in significant price swings. Given that no new production facilities are likely to be available in the next decade, this is likely to continue as a trend affecting fossil fuel supply and, therefore, costs.
  2.) Alternative electricity generation costs have continued to decline. That decline, coupled with a trend of increasing alternative electricity production, is assisting to stabilize the costs of electric power.

  From these trends it appears justified to consider the influences on the business case of higher future fuel costs.
- Given the tangible and intangible benefits, the increment of fleet necessary to accomplish this conversion, and the relative adjacency of the Mount Baker Station to Metro's operating base for ETB's, the business case for converting Route 48S takes on a positive perspective. Of many places where a route could be electrified, this particular corridor has, perhaps, the greatest opportunity given the relative simplicity and short length of the required infrastructure.
- SDOT is applying for grant funding from the Puget Sound Regional Council (PSRC) to complete the Route 48S electrification project. Initial feedback on this project has been favorable.

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