Transit Vehicle (Trolley) Technology Review

Recommendation:
1. That the trolley system be phased out in 2009 and 2010.
2. That the purchase of 47 new hybrid buses to be received in 2010 be approved with funding identified in the 2009 – 2011 Capital budget process.
3. That the decommissioning of the remaining trolley infrastructure in 2010 be approved.

Report Summary
In 2004 City Council directed that Edmonton Transit continue to operate its fleet of trolley buses. Council also authorized the Administration to test new hybrid bus and trolley bus technology and to report back in 2008. This report summarizes the results of our tests and includes recommendations dealing with the existing trolley bus fleet.

Previous Council/Committee Action
On July 27, 2004, City Council passed the following motions:
- That Edmonton Transit continue to operate trolleys until 2008.
- That Administration arrange to have a demonstration of low-floor trolley and hybrid buses to be utilized within the system for information gathering.
- That expansion of the trolley fleet to Northgate be considered in the 2006 budget.
- That a report be provided to Council in 2008 regarding continuation of trolleys based on:
  1. service levels
  2. environmental concerns in light of the demonstration of low-floor trolley and hybrid buses, and other options.
- That Administration continue to look at ways to maximize the cost-benefit of trolleys.

Vehicle Technology Reviewed
In undertaking this assessment Administration focused upon three types of transit vehicle technology: trolley, clean diesel and hybrid.

Trolley buses use an electric propulsion system with the electric power being carried to the vehicles through the overhead trolley line infrastructure. In Alberta most of the power that is utilized is generated at one of the coal fired generating plants located throughout the province. Including Edmonton, there are seven transit systems in North America that currently operate trolley bus systems. Vancouver has received 228 new trolley buses since 2006, and
plan to order 34 additional trolley buses in 2008.

Clean diesel is the most recent version of diesel engine technology. It is the standard type of technology that is used in the Edmonton Transit fleet, as well as transit fleets across North America. These engines comply with 2007 Transport Canada and the United States Environmental Protection Act standards for diesel emissions. Contributing to lower emissions is the use of ultra-low sulphur fuel, and post-combustion converter technology to capture some of the emissions before they leave the tailpipe.

Hybrid buses combine electric and diesel technology. The vehicle carries its own set of batteries which provide power to an electric motor for some of the propulsion needs, while the diesel responds to the rest. While this technology is relatively new for the public industry, a large number of systems across North America are ordering these types of vehicles as part of their own environmental initiatives. According to the American Public Transit Association, over 4,000 of these buses have been delivered or are on order for 2008. Translink (Vancouver) have an order in for 141 hybrids and Toronto Transit Commission has ordered 400 hybrids.

**Project Process**

Consultant specialists were hired to undertake the assessment of the technologies.

The issue was assessed from a micro vehicle level as well as a macro system perspective. Dr. David Checkel, of the University of Alberta, who is a recognized authority in the field of vehicle fuel and emission technologies, was hired to conduct the micro vehicle technical evaluation of the options, assess the results of the emissions tests that were carried out independently by Environment Canada and undertake noise testing.

The macro fleet wide analysis was conducted by Booz Allen Hamilton Consultants. Their approach to the analysis was to review data from other transit systems and various published technical references.

Booz Allen Hamilton is one of the world's largest technology and management consulting firms. They are specialists in urban mass transportation with expertise in bus technology.

The macro analysis included an update of the original report from 2004 to reflect the current Edmonton Transit fleet.

Environment Canada was hired to test the three types of vehicles to determine the differences in emission generated in the Edmonton environment.

A comprehensive process was implemented to obtain input from a number of public perspectives. This work is summarized in the section on 'Public Consultation'.

**Assessment Results – Transit Service Levels**

In terms of transit service there would be no impact on what is provided to customers. The service provided by a large bus is not impacted by the type of propulsion technology that is utilized by the vehicle.
However, with trolley buses eliminated, the use of hybrids or clean diesels will provide more opportunity to introduce service efficiencies through changes to route designs since the restriction of the overhead infrastructure will be gone.

As well hybrids would likely be assigned to those routes for which they are best suited (i.e. congested routes with a lot of stop and go traffic).

**Assessment Results – Operating Costs**

The assessment of the new hybrid buses indicated that their vehicle maintenance costs are similar to those of the clean diesels that Edmonton Transit is operating. The current vehicle maintenance costs of the trolley fleet are not useful for any comparison as these vehicles are almost 30 years old and at the end of their life cycle. Vehicle maintenance costs on the new trolley bus were marginally higher over the short period in service in Edmonton. It is assumed that maintenance costs are similar for all three types of buses.

Energy costs of the trolley bus are approximately 50% less than the diesel bus. The hybrid used 15% to 20% less fuel than the diesel bus.

Annual overhead system maintenance is $2.2 million to provide for routine inspections and repairs.

While the energy costs for a trolley bus itself are substantially below those of either the clean diesel or the hybrid, when you add the costs of annually maintaining the overhead system and substations, the cost of running a trolley bus is approximately double those of the other two technologies.

**Assessment Results – Capital Costs**

The estimated capital cost to purchase each vehicle type in 2010 is:

- **Clean Diesel** $425,000
- **Hybrid** $650,000
- **Trolley Bus** $950,000

In purchasing 47 buses, hybrid bus purchases would be $14.1 million less than trolley.

The estimated capital cost to upgrade the overhead system and substations for the life of an 18 year trolley bus is $66.3 million.

Replacing trolley buses with hybrid buses would avoid costs of $99.7 million.

(Attachments 1 and 2 Lifecycle Cost Comparison Details).

**Assessment Results – Emissions**

The analysis of emissions was undertaken from two different perspectives:

- **Micro** – each of the three vehicles were tested locally. Estimates were added to those measurements to represent emissions generated by the extraction of the base fuel and the manufacture of the fuel.

- **Macro** – fleet wide estimates were generated through 2027 utilizing industry numbers for the different vehicles under consideration. Emission
estimates for electric power generation were provided by EPCOR.

- Booz Allan Hamilton used the Greenhouse Gases Regulated Emissions and Energy use in Transportation (GREET) model to calculate well to wheel emissions.

The findings from the field testing done by Environment Canada and used by Dr. Checkel are comparable to the results presented by Booz Allan Hamilton.

The trolley bus itself does not have any emissions. From a route perspective these vehicles are emission free. However, from a regional perspective the fuel (coal burning) ultimately results in emission levels that, with the exception of PM10, are higher than hybrids or clean diesels. And if the emissions (well to wheel) associated with getting the feedstock out of the ground and to the refinery or generating plant are included, total emissions associated with use of trolley buses is higher in all categories.

The hybrid bus offers the best overall emission reduction opportunity (Attachment 3).

**Assessment Results – Noise**

All the buses tested fall within the safe limits for exposure. The 2006 diesel buses were at the highest levels. The trolley bus had the lowest noise levels although only marginally less than the hybrid bus.

**Policy Environmental**

Edmonton Transit System is governed by the City's Environmental Policy (C512). Edmonton Transit is working towards being ENVISO ISO 14001 certified by year end. The aspect of these include prevention of pollution, continual improvement in emissions reductions, and meeting or exceeding regulatory and voluntary emissions regulations.

The City is a member of the Federation of Canadian Municipalities (FCM) Partners for Climate Protection (PCP) program. PCP methodology requires that greenhouse gases produced in the generation of electrical power for City use be included in the City's greenhouse gas emissions inventory.

**Focus Area**

The report recommendations meet City Council's 2007 Strategic Direction in the focus areas of:

- Healthy Ecosystem and,
- Balanced Infrastructure

**Public Consultation**

A multi-faceted consultation program was developed to obtain input from the general public, transit riders, specific stakeholder groups, Edmonton Transit System Advisory Board, and transit operating staff. Input was obtained from:

- general public via City-wide telephone survey
- transit riders through surveys at transit centres
- internal survey of transit maintenance staff and operators
- one day stakeholder workshop

In addition, all technical reports were shared with stakeholder groups and the Edmonton Transit System Advisory Board.
Board. In addition, a workshop was scheduled with representatives of these groups and the consultants who prepared the reports to facilitate a discussion of assumptions, background information, methodologies and conclusions.

The results indicated 62% of the general public and users suggest purchasing hybrid buses. ETS operators (66%) prefer diesel buses with hybrid second at 28% and the trolley at 2%.

Key stakeholder groups were generally cautious about eliminating trolleys, but foresaw hybrids as an option for the future.

### Budget/Financial Implications

#### Capital

**2010 and 2011 One Time Requirements**
- $30.6 million in 2010 to purchase 47 hybrid buses.
- $11.0 million in 2010 - 2011 to take down remaining trolley infrastructure.
- The funding source of the $41.6 million will be identified in the 2009 - 2011 Capital budgeting process.

**2012 and Beyond Savings Opportunity**
- Elimination of difference of $44.5 million (unfunded) for trolley infrastructure rehabilitation.

#### Operating

**2010**
- Savings of $1.0 million in overhead maintenance.

**2011 and Beyond (annual)**
- Savings of $2.2 million in overhead maintenance.
- Savings of $0.4 million in vehicle maintenance.

### Justification of Recommendation

1. The current trolley system is outdated and expensive to maintain and operate.
2. Hybrid buses best meet all of the City’s criteria; functionally, operationally, financially and environmentally to replace the existing trolley system. Replacing trolley buses with hybrid buses avoids costs of $99.7 million.
3. The trolley infrastructure must be removed in order to realize identified savings and maintain safety.

### Attachments

1. Lifecycle Cost Comparison Details (chart).
2. Lifecycle Cost Comparison Details (graph).
3. GHG Emissions (graph).

### Others Approving This Report

- J. Tustian, Deputy City Manager
- H. Crone – Acting General Manager, Corporate Services
## Lifecycle Cost Comparison

**Based on 47 Vehicles**

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*Traffic Poles associated with trolley wire will still have to be replaced*

**O/H Decommission includes $1M for Epco Inventory and $0.8M for salvage**
Lifecycle Cost Comparison
(Based on 47 Vehicles)

Trolley: $172.7M
Hybrid: $73M
Diesel: $64.2M
GHG Emissions

- Cln Diesel: 1.97 kg/km
- Hybrid 1: 1.73 kg/km
- Hybrid 2: 1.58 kg/km
- New Trolley: 1.93 kg/km