Minute No. 618
Report – Standing Policy Committee on Infrastructure Renewal and Public Works – October 13, 2009

Item No. 1 Electric Trolley Bus system for Winnipeg Transit
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COUNCIL DECISION:

Council concurred in the recommendation of the Standing Policy Committee on Infrastructure Renewal and Public Works and adopted the following:

1. That the report of the Director of Transit dated September 14, 2009 be referred to the Our Winnipeg Initiative, currently scheduled to be completed by Fall of 2010, for consideration within the transportation master plan.

2. That the Proper Officers of the City be authorized to do all things necessary to implement the intent of the foregoing.

Report – Standing Policy Committee on Infrastructure Renewal and Public Works – October 13, 2009

DECISION MAKING HISTORY:

Moved by Councillor Clement,

That the recommendation of the Standing Policy Committee on Infrastructure Renewal and Public Works be adopted by consent.

Carried

EXECUTIVE POLICY COMMITTEE RECOMMENDATION:

On October 21, 2009, the Executive Policy Committee concurred in the recommendation of the Standing Policy Committee on Infrastructure Renewal and Public Works and submitted the matter to Council.

STANDING COMMITTEE RECOMMENDATION:

On October 13, 2009, the Standing Policy Committee on Infrastructure Renewal and Public Works concurred in the recommendation of the Winnipeg Public Service and submitted the matter to the Executive Policy Committee and Council.

COUNCIL DECISION:

On July 22, 2009, Council granted an extension of time of up to 60 days be granted to enable the Winnipeg Public Service to report back, as directed by the Standing Policy Committee on Infrastructure Renewal and Public Works on May 12, 2009.

STANDING COMMITTEE RECOMMENDATION:

On May 12, 2009, the Standing Policy Committee on Infrastructure Renewal and Public Works referred the Council Motion dated April 29, 2009 to the Winnipeg Public Service for report back.

Report – Standing Policy Committee on Infrastructure Renewal and Public Works – October 13, 2009

DECISION MAKING HISTORY (continued):

COUNCIL DECISION:

On April 29, 2009, Council ruled automatic referral of the following motion to the Standing Policy Committee on Infrastructure Renewal and Public Works:

Moved by Councillor Wyatt,
Seconded by Councillor Lazarenko,

WHEREAS for every one penny increase in the price of diesel, it costs Winnipeg Transit and the City of Winnipeg an extra $150,000 per year;

AND WHEREAS it is widely expected that, with rising energy demands and reductions in oil supply (peak oil), the cost of non-renewal carbon fuels will increase at a rate higher than the rate of inflation;

AND WHEREAS our transit system is now reliant on one fuel source, namely diesel fuel, yet Manitoba produces and exports clean and renewable hydroelectricity;

AND WHEREAS the Province of Manitoba has made strong commitments to reaching climate change goals and has recently committed to fund both rapid transit in Winnipeg and cost share the operating expenses of Winnipeg Transit with the City of Winnipeg;

AND WHEREAS Manitoba Hydro is a stable, crown corporation, with plans to build more hydroelectric generating stations in the future and now supply's Manitobans with some of the most affordable electricity in North America;

AND WHEREAS the Electric Trolley Bus is a proven and reliable technology that produces zero- emissions with a whisper-quiet operation and is manufactured in Winnipeg;

AND WHEREAS the Electric Trolley Bus technology is operating in major centers around the world, including the City of Vancouver, BC.;

AND WHEREAS the 2005 "'Made in Winnipeg' Rapid Transit Taskforce Report" to Council concluded that Winnipeg should invest in a Bus Rapid Transit (BRT) system with the option to convert to rail (LRT) in the future;

Report – Standing Policy Committee on Infrastructure Renewal and Public Works – October 13, 2009

DECISION MAKING HISTORY (continued):

COUNCIL DECISION (continued):

THEREFORE BE IT RESOLVED THAT the Winnipeg Public Service review and report to Council on the feasibility of investing into an Electric Trolley Bus system for Winnipeg Transit, for both the Rapid Transit (dedicated lane) corridors and the existing bus route corridors;

AND BE IT FURTHER RESOLVED THAT the report shall include a long-term cost benefit analysis which will take into account estimates for future rising diesel fuel costs, the impact of the ongoing use of diesel fuel on our corporate contribution to greenhouse gases, and the low cost of present day borrowing for any new capital expenditures.

ADMINISTRATIVE REPORT

ISSUE: **Investigation of the Feasibility of Constructing a Trolley Bus System in Winnipeg as per Council decision of April 29, 2009.**

Critical Path: **SPC on Infrastructure Renewal and Public Works, EPC, Council**

AUTHORIZATION

Author	Department Head	CFO	CAO
T. Dreolini	D. Wardrop	M. Ruta	G. Laubenstein

RECOMMENDATIONS

That this report be referred to the Our Winnipeg initiative, currently scheduled to be completed by Fall of 2010, for consideration within the transportation master plan.

IMPLICATIONS OF THE RECOMMENDATIONS

None

HISTORY

On April 29, 2009, Council directed the administration to review and report on the feasibility of investing in an electric trolley bus system for Winnipeg Transit for both dedicated transit corridors and existing bus route corridors. The report was to include an assessment of the long term costs and benefits, the impact on the City's contribution to greenhouse gases and the cost of borrowing for any new capital expenditures.

Electric trolley buses (trolleys) are rubber-tired vehicles used to provide scheduled fixed route transit service. They are equipped with electric motors that draw current from a central power source through two trolley poles that must remain in contact with two overhead wires at all times during operation. Trolleys appeared in North America in the first few decades of the 20th

Century as the costs of track maintenance and construction associated with streetcar systems became prohibitive. Conversion to trolley operations allowed these cities to continue to benefit from the electrical infrastructure investments made in previous decades and reduce operating costs. However, by the 1950's, the development of reliable and cost effective diesel engine technology, in conjunction with the inherent inflexibility and high cost to maintain and extend trolley electrical networks, caused many cities to abandon trolley service.

Approximately 85 cities in Canada and the U.S. operated trolley fleets in the past. Winnipeg Transit operated trolleys between 1938 and 1970. Today, six of approximately 1600 Transit systems in Canada and the U.S. have retained their trolley infrastructure and continue to operate trolley service. At present, trolleys make up about one percent of the 83,000 vehicle transit bus fleet in the two countries. Vancouver is the only city in Canada that continues to operate trolleys. Edmonton discontinued trolley operations on May 2, 2009 as a cost saving measure after several years of testing the performance, costs and environmental benefits of trolleys.

Several cities have studied the feasibility of re-establishing trolley systems after abandoning them. The City of Winnipeg commissioned a detailed study on the feasibility of converting operations to non-petroleum power sources in 1981. The conclusion of the study was that trolleys were the most suitable non-petroleum alternative but they were not cost effective compared to diesel buses at that time. In recent years, environmental concerns and the rising cost of fossil fuels have prompted several cities to study the merits of trolley operations. Edmonton completed a study in 2008 and chose to cease trolley operations. Toronto completed a study in 2009 and chose not to re-establish trolley operations after abandoning them in 1993.

The impacts on the environment, operations and costs should be considered when assessing the feasibility of replacing diesel buses with trolleys.

Environmental Considerations

The major environmental benefit of trolleys is that they produce no local, on-street vehicle exhaust emissions. Emissions from burning fossil fuels include criteria pollutants that contribute to smog and acid rain such as oxides of nitrogen (NOx) and particulate matter (PM) and greenhouse gases (GHGs) such as carbon dioxide. Electricity produced by Manitoba Hydro is predominantly hydro with a small percentage from natural gas thermal generation. GHG emissions and criteria pollutants from these sources are minimal.

However, local reductions are only a part of the complete emissions picture. Increasing the consumption of electricity in Winnipeg would increase emissions generated outside of Manitoba because excess power generated by Manitoba Hydro is exported to the Midwestern United States to offset power generated by coal-fired thermal stations. Manitoba Hydro uses this global perspective when calculating the GHG emissions impacts of emerging energy technologies.

The intensity of the GHG emissions produced at these thermal stations is comparable to the emissions from diesel buses. Overall, Transit's diesel bus fleet produces approximately 1,700 grams of GHGs per km operated. Based on information provided by Manitoba Hydro, trolleys would indirectly produce approximately 30 grams of GHGs per km within Manitoba, but the

resulting increase in thermal generation in the U.S. would produce approximately 1,600 grams of GHGs per km. Therefore, establishing a trolley system in Winnipeg would have a minimal impact on the total production of GHGs compared to diesel buses when local and global sources are considered.

Another environmental benefit of trolleys is that their drive trains are quieter than diesel buses and they emit significantly less noise to the environment outside the bus. Depending on the types of buses and whether they are coasting or accelerating, trolleys can be up to 10 dBA quieter than regular diesel buses that generate sound levels in the 80 dBA range, 15 m from the bus.

One negative environmental impact of trolley operations is the additional visual clutter from the overhead wire, support poles and switches that must be installed along trolley routes. The greatest amount of clutter would occur at intersections where overhead switches would be required at points where trolleys turn, change lanes and cross paths.

Operational Considerations

One of the disadvantages of trolleys is that they must remain in direct physical contact with the network of overhead lines that supply their power. This lack of flexibility makes it difficult to adapt the transit route network to changes in travel demands and results in complexities in the operation of day to day transit service. Trolley routes cannot be easily modified or extended to accommodate changing travel pattern in neighbourhoods or to serve new developments due to the complexity and cost of installing the electrical infrastructure. This can result in less than optimal service by forcing passengers to transfer between diesel buses and trolley buses. Furthermore, it can result in a larger fleet size than would otherwise be necessary. At present, interlining (assigning buses to operate trips on more than one route) is used extensively to minimize fleet and operator requirements, thus minimizing vehicle acquisition and ongoing operating costs. Interlining would not be possible or would be significantly restricted with a trolley system.

A broad range of situations can disrupt trolley service on a day to day basis. These include vehicles parked in trolley lanes, traffic accidents, rough roads that could cause trolley poles to lose contact with the overhead wires, construction in trolley lanes, planned and unplanned power outages, wire damage from wind or ice, ice build up on wire during freezing rain or wet snow, etc. When in operation, Edmonton's trolley network was available approximately 80% of the time and additional diesel buses had to be maintained in its fleet to back up trolley operations. As a comparison, Winnipeg Transit operates at overall service reliability levels in excess of 98%.

Modern trolleys have incorporated design improvements to address some of these service reliability issues. Trolleys may now include an auxiliary power unit consisting of either a battery backup system or diesel-powered generator. The battery backup system allows short distance off-wire travel of up to one kilometre to avoid obstacles in the trolley lane. The diesel-powered generator allows longer distance, low speed, off-wire travel but generates GHGs while in this mode of operation. These auxiliary power units would be suitable for addressing minor emergency detours as they occur while in service but not system wide disruptions to power from

downed lines, ice build up, power failure or extended, long term detours caused by major construction projects.

Cost Considerations

North American cities that continue to operate trolleys are using the infrastructure installed in past decades. Establishing a trolley system where there is no existing infrastructure would be extremely costly. Firstly, trolley buses have a high initial price compared to new diesel buses; approximately $1.1 million versus approximately $400,000 per unit. This is due to the small volume of trolley production and the sophisticated control technology in modern trolleys. Secondly, a trolley bus system requires substantial electrical infrastructure including overhead wires, supports for the overhead wires and power substations along the entire route. Estimating the cost of establishing this infrastructure in Winnipeg would require a detailed engineering analysis and would depend on the geographic area covered, the service frequency and the number of turns, lane changes and wire crossings in the system. Published estimates range from $1 million to over $7 million per kilometre. There are few recent examples of North American cities extending trolley bus networks; however, an extension to Vancouver's trolley overhead infrastructure is currently underway and will cost approximately $1.4 million per kilometre to construct. Thirdly, maintenance and parking facilities designed to support trolley operations with close access to the system would be required as they do not exist in Winnipeg. The cost of a trolley facility would be dependent on the size of the fleet to be supported and location; however, based on recent Canadian experience, a facility to house a small fleet of trolley buses would cost a minimum of $10 million to construct.

The direct costs of repairing and servicing trolley buses are reportedly similar to the per kilometre costs of diesel buses. However, the trolley system electrical infrastructure requires ongoing maintenance and inspection to ensure the system remains safe and reliable. Annual electrical infrastructure maintenance costs are reportedly in the range of $15,000 to $20,000 per kilometre.

The cost of energy is lower for trolleys than diesel buses. Based on reported power consumptions from other cities and current electricity rates in Winnipeg, trolley electricity could be expected to cost $0.114 per kilometre travelled. The average diesel bus in Transit's fleet uses approximately $0.469 in diesel fuel per kilometre at current diesel prices.

Long Term Cost and Benefits of Trolley Operations

The costs and benefits of constructing a trolley bus system are evaluated using two scenarios. Scenario 1 represents the lowest capital cost means of establishing some minimal level of trolley service. It is based on replacing diesels with trolleys on the Route 12 William between City Hall and the Tecumseh bus loop. This section of the route is straight, short, relatively uncongested with structures and would require one bus. As a one bus system, new facilities would not be required and training costs would be minimal. The trolley is assumed to be equipped with a diesel powered auxiliary power unit to allow it to operate between the garage and the route without overhead power to minimize capital costs. While operating on diesel backup power, the trolley is assumed to produce similar levels of emissions as a regular diesel bus.

Scenario 2 is based on replacing 28 diesel buses on the Route 60 Pembina with trolleys. This route is used for evaluation because it is heavily used, it terminates at the University of Manitoba and will not likely need to be extended in the future and it could make use of the Southwest Rapid Transit Corridor.

The evaluation is based on the City's current long term cost of borrowing of 6.5%. Results are detailed in Appendix 1 and both scenarios yield substantial increases in annual costs and require significant initial capital expenditures to construct the infrastructure required by trolleys. The total annual costs of operating trolleys would exceed diesels by over $250,000 in total or $12.20 per kilometre travelled for Scenario 1 and by over $3.4 million or $3.75 per kilometre for Scenario 2. Capital outlays for the trolley infrastructure are over $3.3 million for Scenario 1 and over $55.7 million for Scenario 2.

In both scenarios, the initial capital costs of establishing the trolley system far outweigh the energy savings and these results are not highly sensitive to changes in the cost of borrowing or the cost of energy. Reducing the cost of borrowing to 0% per year still yields cost increases of nearly $7.00 and $2.00 per kilometre for Scenarios 1 and 2 respectively. The cost of diesel fuel must exceed $6.80 per litre with no change in electrical costs for the annual cost of Scenario 2 to break even with diesel.

Both trolley scenarios provide modest total reductions in GHGs estimated at 1.3 tonnes for Scenario 1 and 64.4 tonnes for Scenario 2. The costs of achieving these reductions are estimated to exceed $192,000 and $53,000 per tonne for Scenarios 1 and 2 respectively. As a comparison, one tonne of carbon dioxide equivalent GHG is currently valued at approximately $21 Cdn. on the European Climate Exchange. In Europe, major GHG producers participate in emissions trading to meet emission reduction requirements as an alternative to directly implementing emissions reducing technologies.

Conclusions

Replacing diesel buses with trolleys would result in a small overall reduction in GHGs produced by Winnipeg Transit operations. The impact of this reduction would be negligible in comparison to total GHGs produced by all urban transportation in Winnipeg. This would also be an extremely costly means of achieving this environmental benefit. The energy savings from converting to electricity from diesel fuel would be extremely low in comparison to the high capital costs of the trolley infrastructure. The resulting high cost per tonne to generate small GHG reductions indicates that there are much more cost effective ways to achieve this environmental goal. In addition, the limits imposed by the trolley electrical infrastructure on the design of the transit route network and on the flexibility to interline buses would introduce inefficiencies that would result in a larger overall transit fleet, increased operating costs and decreased service reliability.

FINANCIAL IMPACT

Financial Impact Statement **Date:** September 16, 2009

Project Name:
Investigation of the Feasibility of Constructing a Trolley Bus System in Winnipeg.

COMMENTS:

As this report is for information purposes only, there is no financial impact.

Original Signed by Carrie Erickson
Acting Manager of Finance & Administration

CONSULTATION

In preparing this Report there was consultation with:
Manitoba Hydro, Energy Policy and Emissions Trading

SUBMITTED BY

Department	Transit
Division	Plant and Equipment
Prepared by:	T. Dreolini
Date:	September 14, 2009

Attachment(s): Council Minute – April 29, 2009

STANDING POLICY COMMITTEE ON

INFRASTRUCTURE RENEWAL AND PUBLIC WORKS

MOTIONS

Minute No. 347
Moved by Councillor Wyatt,
Seconded by Councillor Lazarenko,

WHEREAS for every one penny increase in the price of diesel, it costs Winnipeg Transit and the City of Winnipeg an extra $150,000 per year;

AND WHEREAS it is widely expected that, with rising energy demands and reductions in oil supply (peak oil), the cost of non-renewal carbon fuels will increase at a rate higher than the rate of inflation;

AND WHEREAS our transit system is now reliant on one fuel source, namely diesel fuel, yet Manitoba produces and exports clean and renewable hydroelectricity;

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AND WHEREAS the 2005 "'Made in Winnipeg' Rapid Transit Taskforce Report" to Council concluded that Winnipeg should invest in a Bus Rapid Transit (BRT) system with the option to convert to rail (LRT) in the future;

Appendix 1 Trolley Long Term Cost and Benefit Evaluation

Item	Units	Scenario 1		Scenario 2	
		Route 12, City Hall to Tecumseh		Route 60	
		Trolley Bus	Diesel Bus	Trolley Bus	Diesel Bus
Assumptions					
Route Length	kms	2.3	2.3	14.9	14.9
Number of Buses		1	1	28	28
Annual Bus Kilometers in Service	bus-kms	19,000.00	21,000.00	920,000.00	920,000.00
Annual Bus Kilometers using Auxiliary Power	bus-kms	2,000.00			
Electrical Infrastructure Construction	$/km	$1,000,000		$1,000,000	
Bus Cost	$	$1,100,000	$400,000	$1,100,000	$400,000
Bus Service Life	years	18	18	18	18
Infrastructure Service Life	years	30		30	
Energy Cost	$/bus-km	$0.114	$0.469	$0.114	$0.469
Electrical Infrastructure Maintenance	$/km	$15,000		$15,000	
GHG Estimate	grams/bus-km	1,630	1,700	1,630	1,700
Long Term Cost of Borrowing	%	6.5%	6.5%	6.5%	6.5%
Capital Costs					
Bus		$1,100,000	$400,000	$30,800,000	$11,200,000
Electrical Infrastructure		$2,300,000		$14,900,000	
Facilities				$10,000,000	
Annual Costs					
Energy		$3,104	$9,849	$104,880	$431,480
Overhead Maintenance		$34,500		$223,500	
Amortization of Capital					
Buses		$99,005	$36,002	$2,772,133	$1,008,048
Electrical Infrastructure		$165,379		$1,071,365	
Facilities				$719,037	
Total Annual Costs		$301,987	$45,851	$4,890,916	$1,439,528
Total Annual GHG Generated	tonnes	34.4	35.7	1499.6	1564.0
Total Annual GHG Reduction	tonnes	1.3		64.4	
Total Annual Cost Increase	$	$256,137		$3,451,387	
Cost per Tonne of GHG Reduced	$/tonne	$192,584		$53,593	
Total Annual Cost Increase per Kilometre	$/km	$12.20		$3.75	