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The pros and cons of transportation on the grid

By Richard Gilbert
Globe and Mail Blog

In these posts, I've been developing a case for more extensive grid-connected electric transportation (explained below). In two posts – here and here – I argued that the world has an imminent problem with oil prices or oil availability, or both, and that Canada east of the Manitoba-Ontario border is particularly vulnerable. Then, I argued that electricity is the best alternative transportation fuel. However, subsequent posts – here and here – suggested that reliance on batteries or on-board generation (e.g., from fuel cells) could prove to be unsatisfactory.

What's left is delivering electricity to vehicles while in motion, i.e., grid-connected transportation. This is a tried and true system of powering vehicles, used so far chiefly to power trolleybuses, streetcars, subways, and intercity electric trains. In this post, I'll write about the pros and cons of these electric vehicles. In later posts I'll explore how grid-connection could be applied to personal vehicles and freight vehicles.

Most rail services in Europe are electrically powered. One exception is the U.K., where less than half the rail track is electrified and diesel-fuelled locomotives are common. A 2009 U.K. government report noted these benefits of electrification: lower fuel and maintenance costs, higher vehicle reliability, reduced carbon and other emissions, quieter operation, more revenue-generating space per train, and reduced journey times - particularly under stop and start conditions.

For many routes, the financial benefits were found to more than offset the quite high costs of conversion over a 30-year amortization period, chiefly because fuel costs were found to be 50 per cent lower and

maintenance costs were about 20 per cent lower. As a result, the pace of rail electrification in the U.K. has been stepped up.

Last month, GO Transit – the regional rail service provider in the Toronto area – released a report on electrification of its system, now entirely diesel fuelled. It did not find any financial advantage to electrification, although a decision has nevertheless been made – without much enthusiasm – to move towards electrifying part of the system because of the other advantages.

The main reason for the difference between the conclusions of the U.K. and GO Transit reports is that the per-kilometre costs of conversion – not including new trains – were assumed to be more than three times higher in Toronto than in the U.K. ($7.9-million v. $2.1-million). This extraordinary difference is consistent with the estimates of the cost of new streetcar and subway routes in Toronto, which are far higher than elsewhere. Other reasons for the difference are that the cost advantages of lower maintenance requirements and of powering by electric motors rather than diesel engines were both given insufficient weight in the GO Transit study.

Why are our capital costs for transit so high? On the face of it, we could be wringing much more out of each dollar invested than we do.

As the use of oil products becomes more challenging, electricity's cost advantage is likely to increase. The advantage is illustrated by a Swedish study of comparable trolleybuses and diesel buses. Per unit of energy, electricity costs about 10 per cent more than diesel fuel in Sweden. However, because trolleybuses use only 40 per cent as much the energy to do the same amount of work, they finish up having a fuel cost per kilometre that is less than half that for diesel buses.

A study of the transit system in Solingen, Germany, found that lifetime costs, capital and operating, of trolleybus and diesel bus systems were about the same. Trolleybuses were 3 per cent cheaper than diesel buses if they were fitted with regenerative braking systems that convert energy of motion into electricity; they were 4 per cent more expensive if they were not so fitted.

Vancouver has figured this out. Recently Translink, the transit operator, replaced Vancouver's ageing trolleybus fleet with 262 state-of-the-art trolleybuses made in Winnipeg.

The problem with trolleybuses is their inflexibility. They must have overhead wires, which some find unsightly – although others welcome as evidence that a transit vehicle might be available. Vancouver's buses can operate on batteries for a few hundred metres. In Rome, trolleybus batteries are large enough to allow off-wire travel for several kilometres. In Quito, Ecuador, the trolleybuses have auxiliary diesel engines that allow more off-wire travel.

In my next post I'll begin to explore how the advantages of grid-connected electric traction could be applied beyond trolleybuses and trains.

Richard Gilbert is a Toronto-based consultant who focuses on energy and transportation. His latest book is Transport Revolutions: Moving People and Freight without Oil*, written with Anthony Perl.*