FEASIBILITY OF FUEL CELL RAILWAY LOCOMOTIVES:
A STUDY OF ENERGY ALTERNATIVES

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Executive Summary

Transportation accounts for approximately 25 percent of Green House Gas (GHG) emissions in Canada and is forecast to account for approximately 50% of the increase in GHG output. As a signatory to the Kyoto accord, Canada has an obligation to mitigate global warming by reducing GHG emissions established in Kyoto targets. This study assesses the feasibility of fuel cell railway locomotives and the potential that they present to reduce GHG emissions.

The primary market drivers for fuel cell development are; 1) global warming concerns, 2) criteria air pollutants, and 3) global oil availability. In North America, the most stringent emission standards are set in southern California to deal with their air pollution problems. In the transportation sector the automotive industry is leading the fuel cell development process to build cars that will meet these stringent standards. Automobile emission standards are short term driving factors in fuel cell development. The availability of oil and oil pricing present a longer-term problem for the transport industry. Railway emission standards are effectively set by the United States Environmental Protection Agency as the majority of freight locomotives working in the US and Canada are built by US manufacturers.

A fundamental point about rail transportation must be noted in the assessment of a fuel cell locomotive. The railway locomotive presents the most energy and emission efficient mode of moving freight today. Although significant improvements are expected in the truck engine, the lower rolling resistance of steel on steel will make rail transport less polluting because less energy per ton mile is required.

Fuel cell technology is advancing rapidly, however, in the transportation market, the industry is only at the demonstration project stage. Commercial development of vehicles is several years away. A recent survey of fuel cell experts indicated that fuel cells will capture a significant initial market share sooner in the transit market than in the passenger vehicle market. They cite a variety of reasons including infrastructure, cost, integration of the fuel cell onto the vehicle platform, government subsidy and regulatory drivers. The most significant reason is the number of vehicles needed to attain a market share to justify commercial production. In the North American context this would be an annual production of 250 vehicles for transit versus 850,000 for passenger vehicles. In response to a question asking when fuel cell vehicles would capture a significant initial market share of 5%, a majority of respondents predicted that fuel cell transit vehicles might reach 5% of the market by 2008-2010. When penetration of the auto market was considered, most auto manufacturers predicted it would happen after 2010 with a range extending as far as 2020 for one manufacturer.

The leading research reports on fuel cell locomotives clearly identify that fuel cell technology will only be applied to the locomotive when the fuel cost and operating efficiency of fuel cell locomotives meets or exceeds the existing diesel-electric technology. Railways in North America, are bottom line driven and will not invest in technology that increases operating costs. Fuel cell locomotives are several decades away from matching the efficiencies of the diesel-electric locomotive.
A report from the International Union of Railroads questioned whether any energy efficiency gains can be obtained from fuel cells when considering the full energy chain. This study examined the total energy chain including the production of the hydrogen for the fuel cell. In the European context, much of the energy required to produce the fuel is fossil fuel driven. In North America, only a few geographic areas have abundant hydro (renewable resource) energy. In fact, the primary areas driving emission reduction in the United States are energy deficient. This report reaffirms that fuel pricing is the determining factor for the economic viability of fuel cell vehicles but it also raises the problem of fuel pricing being politically driven in many jurisdictions. Any economic comparison would have to be made on a non-subsidized, unbiased basis.

Our survey of the North American rail industry that included rail system operators, locomotive engine manufacturers, the Canadian and American railway associations and the leading fuel cell developer in Canada, indicated that they are not pursuing the application of fuel cells in locomotives. At the present time, the industry is not planning on initiating specific activity on this application in the near future. The industry generally believes that with time and money the engineering hurdles could be surmounted and a fuel cell locomotive could be built. However, the practical limitations of fuel cell locomotive implementation will preclude significant activity in the short and medium term.

The technology development companies and the marketplace have identified where fuel cell technology should be most appropriately applied and are aggressively pursuing their applicable strategies. The application of fuel cells to railway locomotives is not a leading priority. The potential fuel cell locomotive market is too small to allocate development dollars and better options exist to alleviate GHG emissions in the transport sector. The technology development companies and the railway industry are not investing in locomotive applications and have no plans to do so in the near future. Government resources to accelerate locomotive fuel cell applications would be unlikely to stimulate industry interest.

The executive summary from the report by NAVC (a recent survey of fuel cell experts) identified two points that are relevant to conclusions and recommendations drawn from this report. They are:

- The majority opinion was that hydrogen storage technology should be the focus of R & D dollars. Breakthroughs in storage technology would have the biggest impact in accelerating the acceptance and commercialization of fuel cell vehicles.

- Hundreds of millions of dollars are being spent on fuel cell research and development both for stationary and mobile applications. The technology choices are advancing rapidly with new companies participating all the time, and a paradigm shift in the technology can happen at this stage with storage and infrastructure.

It is our recommendation that the federal government delay any initiatives for fuel cell railway locomotive technology applications. The marketplace would be unreceptive to this development at this time. As suggested in much of the literature, technological
breakthroughs in fuel cells for auto and bus sectors will be directly applicable to the railways. The auto and bus sector is the focus of private sector research and development investment.

Any allocation of resources to fuel cell development could be applied to storage and infrastructure development as suggested in the NAVC report. As the technology develops and the breakthroughs occur, there will be a natural evolution to additional applications.

Fuel cell research for vessel applications presently being conducted by the United States and German navies is within the high power range required for railway locomotives. Naval fuel cell applications could eventually extend to the commercial shipping sector. However, fuel cells for marine applications are not constrained by space and it may be several decades before the technology is compact enough to fit on a railway locomotive platform. The railway locomotive, naval and commercial marine sectors could create synergies in the long run future to justify accelerating R & D for these markets.