

Hamilton Street Railway – The World’s First CNG Transit Fleet

Hamilton Street Railway’s Don Hull, Director of Transit, and Mark Selkirk, Supervisor of Fleet Maintenance, were interviewed by Alicia Milner, President of the Canadian Natural Gas Vehicle Alliance, for this profile.

It was more than two decades ago when a forward-thinking Canadian partnership led to the creation of the world’s first compressed natural gas (CNG) transit buses. Hamilton Street Railway (HSR) collaborated with government partners to convert seven diesel buses to CNG operation in 1985. This effort launched the world’s leading alternative transit bus technology, a technology now in use for more than a quarter of a million transit buses, reducing greenhouse gas and air contaminant emissions in urban centres around the world.

How It Began

In the mid-1980s, municipally-owned transit provider HSR was transitioning from trolley buses and was looking for a lower emission alternative to diesel buses. Hamilton is an industrialized city located on Lake Ontario. The ninth largest city in Canada with a population of approximately 518,000, Hamilton is home to two major steel producers who manufacture 60% of all steel in Canada.

Incorporated in 1873, HSR has a long and rich history. Originally part of the local electrical company, the company began offering railway services in and around the Hamilton area in the late 1800s. Railcar propulsion was initially accomplished by animals with electrical propulsion introduced in 1892. Electric rail services were replaced by electric trolley buses in the mid-1900s. A funicular railway allowing passengers to travel directly up the Niagara Escarpment also operated from the late 1890s to the mid 1930s.

The conversion of seven diesel buses to CNG in 1985 was undertaken with funding and technical assistance from both the Province of Ontario and Natural Resources Canada. Grants of up to 75% of the vehicle cost and 100% of the station capital cost were provided. Support was also provided by the local natural gas distribution company, Union Gas, as well as by engine manufacturer Cummins and ORTECH, a provincial government research organization.

Hamilton’s lead with CNG transit was quickly followed by other Ontario municipalities including Toronto, London, Mississauga, and Kitchener-Waterloo. In addition, HSR went on to place the first production order for CNG buses with Ontario Bus Industries, a company acquired by the former DaimlerChrysler in 2000. HSR also developed a policy to support ongoing CNG bus purchases which eventually resulted in more than 100 CNG buses operating within the fleet. At present, HSR’s transit buses are used up to 22 hours/day and services are provided to 20 million passengers each year.

Why CNG?

Initial CNG interest at HSR was driven by a desire to find an environmentally friendly alternative to diesel buses. CNG had substantially better environmental performance with

the ability to significantly reduce diesel particulate emissions characterized by the dark exhaust plumes emitted by diesel buses. The CNG buses were used for demanding downtown routes where their lower exhaust emissions would provide maximum benefit. The greenhouse gas benefits of CNG were not even given consideration in the 1980s as air quality and public health issues dominated the public policy agenda.

The lower cost of natural gas compared to diesel was another benefit. A three-year, comparative cost analysis conducted by HSR between 1994 and 1996 found that CNG transit buses were less expensive to operate on a cost per kilometer basis before factoring in station capital and maintenance costs. Natural Resources Canada profiled HSR's success with CNG transit buses in a [FleetSmart report](#).

An additional benefit of pioneering and using CNG for transit was the positive public image that was created for HSR. In recognition of its leadership in using a lower impact transportation fuel, HSR was recognized by the Transportation Association of Canada receiving its first ever Environmental Achievement Award in 1995.

HSR Transit Fleet Use of CNG

Today, there are 94 CNG transit buses in HSR's fleet of 211 buses. In addition to the CNG buses, HSR operates 12 diesel electric hybrid (DEH) buses and 105 conventional diesel buses. The majority of buses are 40' in length. There are seven 60' articulated DEH buses in the fleet with another 18 - 60' DEH buses on order. All buses have been purchased from either New Flyer Industries in Winnipeg, MB or from Daimler Buses North America (Orion brand) in Mississauga, ON. As a result of a recent change, HSR now plans for a 12 year bus life rather than 18 years which was formerly the norm.

Buses are operated out of a single bus garage with a fast fill refuelling station supplied by IMW Industries of Chilliwack, BC. Responsibility for the eight year old fuelling station rests with the City of Hamilton's Fleet Services department, rather than with HSR itself. The station currently consists of two compressors which allow for CNG bus refuelling in 12-15 minutes/bus. Diesel buses are refuelled in 6-7 minutes/bus. A station upgrade would allow for CNG buses to be refuelled at the same rate as diesel buses and could support an expansion of the CNG fleet. Both diesel fuel and CNG are purchased on contract with responsibility for fuels procurement residing outside of HSR and within the City of Hamilton.

HSR has experience operating CNG buses with three of the four generations of natural gas engines. The current fourth generation Cummins Westport natural gas engine that meets 2010 diesel emissions standards is not in use in the HSR fleet.

CNG Engine Generation	Engine Manufacturer	CNG Engine Model	Status
1 st	Cummins	L10	Retired
2 nd	Detroit Diesel	8.5	84 onroad
3 rd	Cummins Westport	C Gas Plus	10 onroad
4 th	Cummins Westport	ISL G	-

CNG Transit Bus Operating Costs

Recent HSR analysis shows a higher maintenance cost for CNG buses of \$.93/kilometer compared to \$.66/kilometer for diesel buses. These figures reflect experience with the blend of CNG engine technologies noted above, and they do not include station operation and maintenance costs. The analysis also does not incorporate fuel pricing. CNG is typically 15-40% less expensive than diesel fuel in Canada.

A separate assessment of C Gas Plus CNG buses compared to diesel would likely show much closer costs for CNG and diesel according to Director of Transit Don Hull. In addition, the significant improvement in CNG engine efficiency associated with the current generation ISL G engine is not reflected in HSR's analysis as this engine is not in use in the fleet.

CNG Transit Bus Operating Experience

In order to integrate CNG transit buses into its fleet, HSR staff were trained in CNG transit bus maintenance, refuelling, and safe workplace procedures. Mechanics were required to take a course on maintaining internal combustion natural gas engines. Service line staff responsible for refuelling buses were trained and certified as compressor operators. The local government authority with jurisdiction fuels requires that a compressor operating engineer must be on site for each operating shift.

CNG fuel storage cylinders are visually inspected. There is no separate hydrostatic cylinder test requirement as cylinder life is specified to exceed the vehicle life. HSR had early experience with premature pressure relief device (PRD) failures attributable to missing and ultraviolet-degraded protective caps. As a result, as part of annual vehicle inspections, HSR now ensures that all protective caps are visually inspected and replaced if there are signs of degradation.

In HSR's experience, CNG buses require preventative maintenance tune ups every four months and, compared to diesel buses, the maintenance schedule must be strictly followed to ensure good performance and vehicle reliability. HSR has experienced more mechanical problems with its CNG buses, particularly in extreme weather conditions. The CNG engines typically run at higher temperatures and, on very hot days, there can be issues with re-starting the older CNG buses. Coupled with municipal anti-idling bylaw requirements, this high temperature issue can be a challenging one for HSR drivers to manage.

HSR has found that there are noise level differences between CNG and diesel buses with some CNG buses being noisier and experiencing more vibration. Industry experience suggests that this increase in noise was attributable to first generation L10 powered buses and to their hydraulic cooling systems. Drivers have also commented on reduced power when climbing hills with fully loaded CNG transit buses.

Lessons Learned

In pioneering the development of CNG transit bus and engine technology, HSR has clearly led the way for transit operators around the world. HSR has also gained a wealth of operational experience and, in this regard, can point to many lessons learned.

1. There are operational differences with CNG transit buses and these differences can be effectively managed.

HSR had to adapt and modify its operational procedures in several ways to accommodate CNG buses in its fleet. For example, HSR's experience with CNG transit bus and station maintenance has led it to carry a higher ratio of spare parts, so as to ensure that maintenance tasks are not constrained by parts supply. Additional training requirements were integrated with other staff training needs. Bus refuelling was consolidated at a single garage to simplify and streamline operations.

Provincial funding conditions that restricted transit fleets to applying a "First In, First Out" policy for vehicle replacements had made it more difficult to manage fleet issues. When this restriction was lifted, HSR found they had greater flexibility which helped with managing early generation CNG bus issues.

2. Government needs to be engaged and actively support alternatives over the long term.

At present, there is no permanent funding for transit bus purchases in Canada. In the past, the Province of Ontario provided incentive funding for CNG buses equal to one-third of the capital cost of the bus. With the end of this provincial funding, HSR lost a significant support for their decision to continue to choose CNG for transit buses.

With governments focused on air quality, carbon reduction, and setting greenhouse gas reduction goals, reinstating funding support for lower carbon alternatives like natural gas directly support public policy objectives and reward fleets like HSR who choose to integrate lower emission technologies into their fleet operations.

3. Ongoing recognition for fleets is an important element of a successful permanent transition to lower emission fuels and technologies.

Developing lower emission fuels and technologies is just the first step. Supporting early adopter fleets throughout the vehicle lifecycle is critical to creating real world change. Alternatives to the status quo may introduce greater complexity for fleet operations. Fleets need recognition and

support from all levels including their own communities in order to stay the course once a change has been made.

HSR is looking to 2010 and wondering how the performance and maintenance of diesel bus technology will change. Until now, HSR's experience suggests that managing their CNG fleet has been the more complex task with early generation technology continuing to pose challenges related to spare parts, and station and vehicle maintenance costs. As diesel technology incorporates increasingly more complex systems to meet the new emission standards, the differences associated with natural gas may be less of an issue. Natural gas engine technology is much improved and only requires maintenance free catalyst aftertreatment to meet the 2010 emissions regulations.

Leveraging the CNG fleet as a means to introduce very low emission fuels such as hydrogen or biomethane produced from waste biomass are not under consideration at present at HSR. Bus procurements over the next two years will focus on conventional diesel and DEH buses.

For the natural gas vehicle industry, the impact of HSR's contribution to natural gas transit bus technology development has been positive and significant. It can also be said that HSR's experience in transitioning from the early adoption raises several important questions for the natural gas vehicle industry:

- How to ensure that there is ongoing funding support for vehicles and for station equipment and upgrading?
- Who manages the relationship with the customer (fleet) in a deregulated natural gas distribution environment?
- How to ensure that transit fleets like HSR receive the support of their transit industry colleagues to network and share operational information regarding natural gas bus operations?
- What is the best means to communicate up-to-date information about the economic and environmental performance of natural gas transit buses?
- How can local allies whose focus includes air quality, public health and carbon reduction goals be cultivated and engaged at the community level to support a fleet's choice to use a lower emission fuel like natural gas?
- How to ensure that all appropriate municipal contacts (transit fleet, fleet services, fuel procurement, planning and environmental) are engaged at an early stage to build broad understanding of the positive economic and environmental case for natural gas for transit?

The CNGVA would like to congratulate HSR for its leadership and vision in creating the world's first clean air urban transit fleet based on lower emission natural gas transit bus technology. Hamilton led and the world has followed!

HSR CNG Transit Photos
- Courtesy of Cindy Slinn, HSR



New Flyer bus with Cummins Westport C Gas Plus engine



CNG bus refueling at HSR bus garage



CNG bus refuelling at HSR bus garage



HSR CNG transit bus