



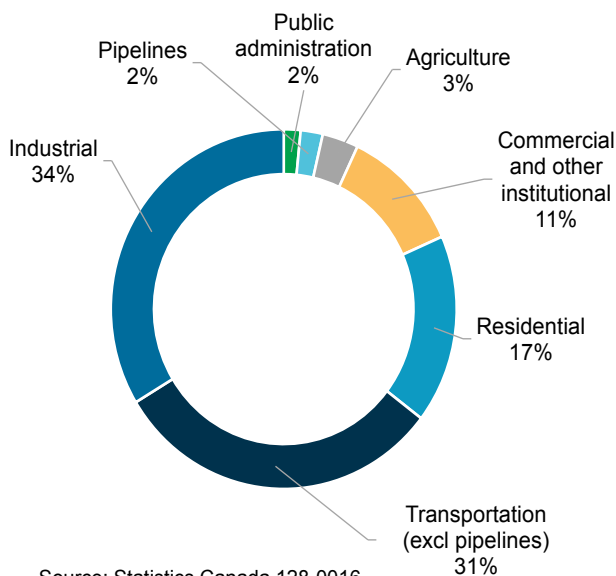
Natural Gas - A Clean and Affordable Transportation Fuel

ISSUE 6 2016

INTRODUCTION: THE TRANSPORTATION SECTOR TODAY AND THE NATURAL GAS OPPORTUNITY

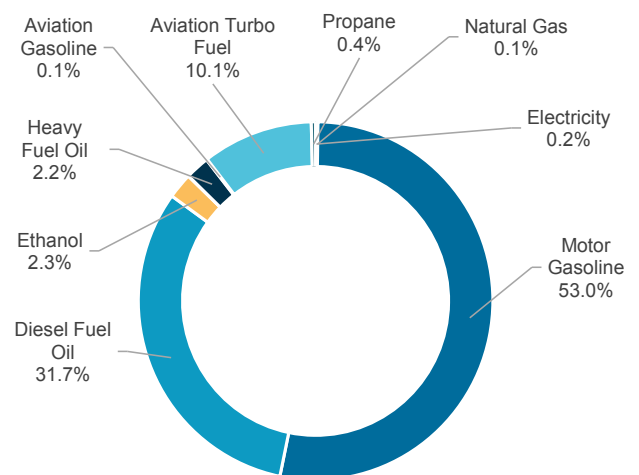
Over 30 per cent of all the energy used in Canada each year fuels modes of transportation – from road to rail to air to marine (see Figure 1). As illustrated in Figure 2, the dominant transportation fuels used are gasoline and diesel, which account for nearly 85 per cent of the market. Natural gas represents 0.1 per cent of the total fuel use in transportation today, concentrated in initiatives in heavy-duty truck or small fleet truck applications. At a time when conventional transportation fuel prices are expected to rise, and their emissions are a concern for governments seeking to reduce them, more attention is being focused on natural gas as an alternative. CGA member utilities are intent on growing the market share for this affordable, low-emitting transportation fuel option. In this background, CGA explains the opportunity for natural gas as a transportation fuel, offers some specific suggestions for government action to help realize it, and explains the role of utilities in supporting it.

Figure 1 Energy End Use - by sector (terajoules) - 2014



Source: Statistics Canada 128-0016

Figure 2 Transportation Fuel Use - by energy type

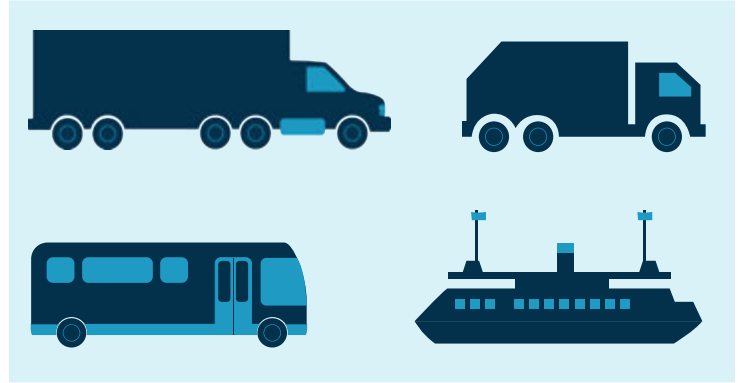


Source: NRCan End Use Database



HOW IS NATURAL GAS USED AS A TRANSPORTATION FUEL?

When used as a transportation fuel, natural gas is either compressed (referred to as compressed natural gas or CNG) or liquefied (referred to as liquefied natural gas or LNG) to increase its energy density and allow for sufficient on-board storage to give the means of transportation an acceptable range of operation. The tables below illustrate which modes of transportation are best suited to use LNG and CNG. The Canadian Natural Gas Vehicle Alliance (CNGVA) provides valuable information for fleet owners and managers about LNG and CNG, visit www.cngva.org or www.gowithnaturalgas.ca.



COMPRESSED NATURAL GAS

CNG fueling process



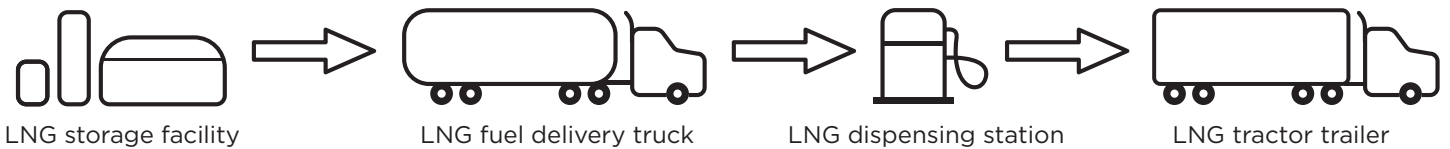
Source: FortisBC

CNG is a natural gas that is:

- Compressed at a high pressure to reduce its volume by up to 300 times compared with natural gas at a normal pressure.
- CNG is ideal for passenger cars, pick-up trucks, cube vans, buses, shuttles, short-haul tractor-trailers, dump trucks, medium and long haul trucks, and refuse trucks.

LIQUEFIED NATURAL GAS

LNG fueling process



Source: FortisBC

LNG is a natural gas that is:

- Cooled to a liquid state at -162 degrees Celsius to reduce its volume by 620 times compared with natural gas at normal pressure.
- LNG is ideal for ferries, ships, rail, long-haul trucks, mining applications and industrial uses.



THE BENEFITS OF NATURAL GAS FOR TRANSPORTATION

1) More Affordable Transportation Fuel

Natural gas for vehicle use is typically 10 to 25 per cent less expensive than diesel and gasoline. While part of this is because of the federal and provincial tax-exempt status natural gas enjoys, the main saving is a result of the lower commodity cost of natural gas, compared to other fuels. The affordability of natural gas has always been an advantage for the fuel in its conventional applications like home heating. The continuously improving supply picture has made its price advantage even greater, and accounts for the growing interest in it as a transportation fuel option.

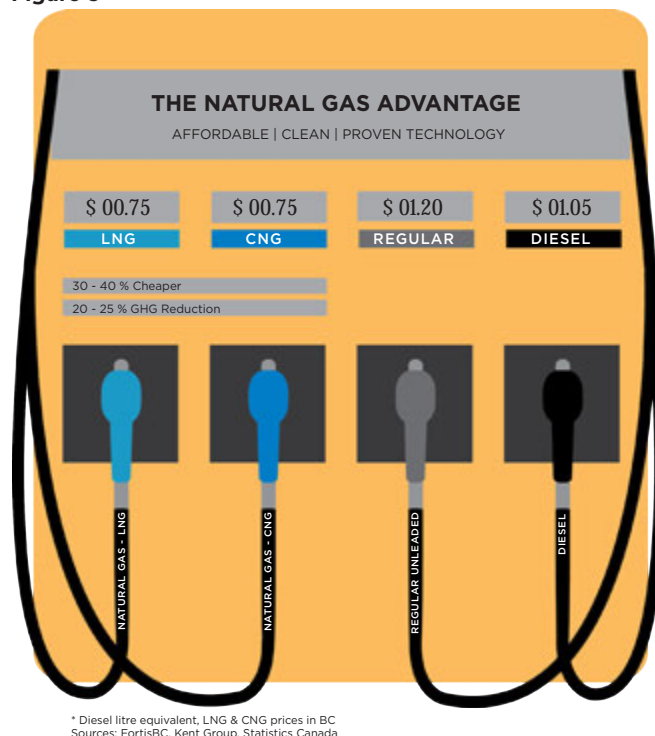
Figure 3 shows LNG and CNG prices in British Columbia - a market that is looking more aggressively than most at the opportunity of using natural gas as a transportation fuel. Prices shown are from FortisBC. As illustrated, the “pump price” of natural gas compared to competing fuel options in diesel litre-equivalent (DLE) ranges from approximately 20 to 55 cents per litre less. When looking at the price advantage of natural gas versus diesel for transportation, end users need to compare natural gas to diesel in DLE as DLE is the amount of natural gas it takes to have the same energy content as a litre of diesel. By using a DLE approach, it allows for an “apples to apples” price comparison of natural gas versus diesel. The pump price includes: the commodity cost of gas (similar to the commodity cost you would see on a natural gas bill); the conversion costs of compressing (for CNG) or liquefying (for LNG) the natural gas; and the infrastructure costs of the refuelling station.

2) A Cleaner Transportation Fuel Option

The use of natural gas as a transportation fuel provides several environmental benefits. Natural gas is clean burning. Once it is processed to pipeline standards, burning it creates minimal SO_x, NO_x, Mercury and particulate emissions. Further, natural gas use does not pose any risk to soil or groundwater in the case of a leak. As a gas, it is lighter than air, (as conventional gas or CNG it dissipates quickly) and as a liquid when released into the atmosphere it evaporates virtually immediately, leaving no contaminants.

Vehicles fuelled by natural gas can also use renewable natural gas (RNG). This is natural gas sourced from landfills, waste water treatment plants, agricultural waste,

Figure 3



Note: The gasoline and diesel prices are approximate and vary depending on region.

forest residue and other biomass. Like any other natural gas supply, once it is processed, RNG can be converted to CNG or LNG. RNG can be blended with other natural gas supplies (like ethanol is blended into gasoline) or used as the primary supply. An RNG-fuelled vehicle is 100 per cent renewable and offers the additional environmental benefit of using what would otherwise be a wasted resource.

3) A Lower GHG Emission Fuel

Canadian governments, federal and provincial, have targets for lower GHG emissions, and the transportation sector is a big focus for reduction efforts. Natural gas for transportation promises significant GHG reductions of up to 25 per cent over conventional fuels, depending on the application. Heavy duty trucks, rail engines, off-road heavy vehicles (for mine sites and other remote applications), and marine vehicles are all examples of vehicles that could use natural gas to reduce fuel costs and reduce emissions.

A report completed in August 2016 by ICF International titled *The Canadian Natural Gas Opportunity: GHG*



THE BENEFITS OF NATURAL GAS FOR TRANSPORTATION

Reduction Potential to 2030 examined the GHG emission reduction benefits associated with expanding the use of natural gas in Canada. The study assessed the abatement potential in the following areas:

- collection and distribution of Renewable Natural Gas (RNG);
- CNG/LNG as a replacement for refined fuels in the transportation sector;
- LNG as a replacement for propane, oil and refined fuels in communities and industrial sites without access to natural gas infrastructure;
- the potential for reducing natural gas consumption through deep energy efficiency measures in homes, buildings and industry; and
- natural gas-fired electricity generation as a replacement for coal-fired generation and enabler of intermittent renewable electricity generation.

5.6 MtCO₂e in GHG emissions reductions per year nationally by 2030 could result from using CNG/LNG as a replacement for refined fuels (mostly diesel) in the transportation sector.

“The Canadian Natural Gas Opportunity: GHG Reduction Potential to 2030”, ICF International

The report estimates that through the expanded use of natural gas in the areas noted above, a total of over 47.8 MtCO₂e in reductions per year nationally by 2030 could be achieved. Of this, over 5.6 MtCO₂e in reductions per year nationally by 2030 could result from using CNG/LNG as a replacement for refined fuels (mostly diesel) in the transportation sector. The report notes that this conversion potential is contingent on technological advances in the natural gas fired engine (especially engine capacity needed in the mountains), investment in continental infrastructure, and long term policy certainty.

THE NATURAL GAS TRANSPORTATION SUPPLY AND RE-FUELLING INFRASTRUCTURE IN CANADA TODAY

Canada has extensive natural gas transportation and distribution pipeline infrastructure. In recent years, there have been modest investments in new LNG and CNG supply infrastructure and refuelling stations to stimulate some first movers from conventional fuels to natural gas. The map on page 5 provides a cross-Canada snapshot of existing and planned infrastructure, including:

- Existing natural gas pipeline distribution areas: The underground pipeline infrastructure and storage facilities owned by utilities across Canada represent a strong framework upon which a natural gas transportation re-fuelling system could be built.
- LNG production plants: There are six existing LNG liquefaction plants in Canada: two in Quebec (Montreal and a landfill gas to LNG plant in Rivière du Loup), one in Ontario (Hagar), one in Alberta (Elmworth) and two in BC (Vancouver Island and Vancouver Metro). LNG plant expansions or new

facilities are being considered in many provinces including Quebec, Ontario, Alberta and BC.

- LNG refuelling stations: There are currently 14 LNG refuelling stations across Canada from Quebec to BC. In addition, there are numerous CNG stations across Canada.
- Northern communities using CNG and LNG: There are a select number of communities and a mine in remote or northern areas of Canada using or planning to shift in part to LNG for power generation and/or residential and commercial heating.

To date, the build-out of LNG and CNG infrastructure has followed two corridors - one in the east and one in the west. The east corridor spans from Rivière du Loup (northeast of Quebec City) to Windsor, while the west corridor spans from Edmonton to Calgary and west to Vancouver. Further corridors are expected as more trucks



THE NATURAL GAS TRANSPORTATION SUPPLY AND RE-FUELLING INFRASTRUCTURE IN CANADA TODAY

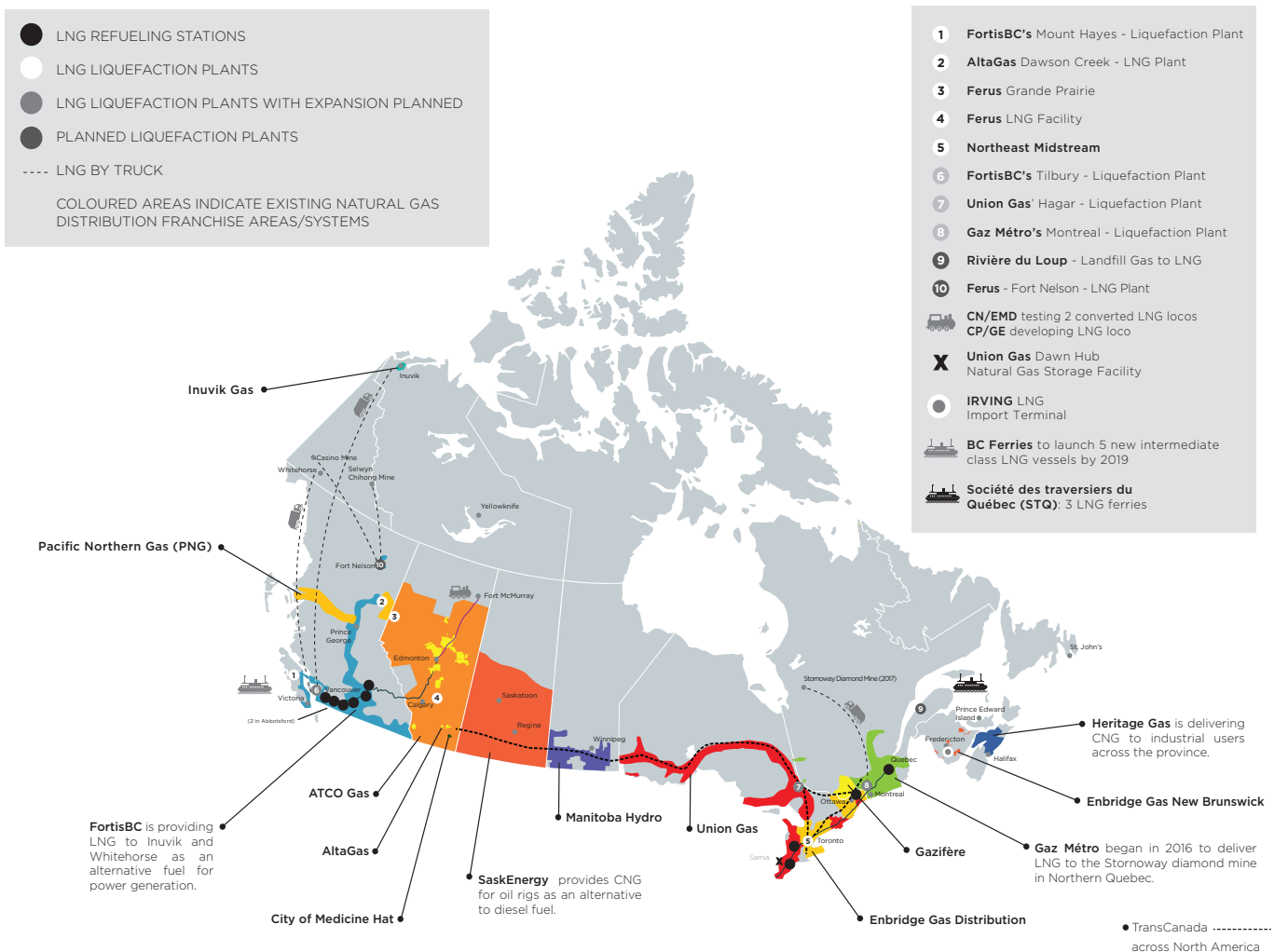
and other transportation modes - namely rail and marine - shift to natural gas.

In addition to transportation, there are other markets that will drive development of CNG and LNG supply infrastructure and refuelling stations. These non-transportation energy users includes northern and remote communities, and large industry (such as mines) that are not currently connected to the natural gas pipeline system due to their distance from the existing system. LNG, and in some cases CNG, can be delivered by truck to communities and industries currently relying

on aging diesel infrastructure, and to other applications where LNG offers a cost and emissions savings.

Currently, there are projects in three Northern cities - Inuvik (NWT), Watson Lake (YK) and Whitehorse (YK) - that are substituting or planning to use LNG to offset or replace diesel for part, or all, of their energy needs. In addition to communities, large mining operations are looking to LNG. By way of example, the Stornoway diamond mine in Quebec will save between \$8-10 million per year by choosing LNG over diesel.

The Natural Gas Opportunity: Key Infrastructure





CHALLENGES TO DEVELOPMENT OF THE NATURAL GAS FUEL FOR TRANSPORTATION MARKETPLACE

1. Vehicle Costs

Maintenance costs, efficiency, and performance of NGV's are similar to those of diesel vehicles. The single biggest hurdle for fleet operators wanting to adopt natural gas is that factory-built NGVs have a higher initial cost than the diesel alternatives. In the case of tractor trailers and refuse trucks the additional vehicle cost is approximately \$75,000 at the high end for large long haul trucks. However, the higher upfront cost is typically recovered from fuel cost savings within three to four years. If tax or financial incentives are available, the payback timing is further reduced.

2. Access to LNG/CNG Supply

As noted above, Canada has extensive natural gas transmission and distribution systems, and a modest level of LNG and CNG supply infrastructure has been built and announced. However, to see natural gas more broadly available as a transportation fuel choice, and to fully capitalize on the opportunity to deliver more affordable and clean natural gas to northern and remote communities, more LNG and CNG supply infrastructure needs to be built in strategic locations across Canada. Supportive policy, tax and program measures have been put in place at the national and state level in the United States and this has resulted in significantly more CNG and

LNG infrastructure buildout than has occurred in Canada – creating a competitive disadvantage on the Canadian side of the border.

3. Status of Federal and Provincial Tax for CNG/LNG

As mentioned above, natural gas for vehicle use is typically 10 to 25 per cent less expensive than liquid fuels. Part of the savings results from natural gas being a lower-cost commodity compared to crude oil – even at current oil prices. Another part of the savings comes from natural gas being exempt from federal and provincial fuel taxes. The tax exemptions typically account for less than half of the savings on a cost-per-diesel-litre equivalent basis, but uncertainty of the continuation of these exemptions is a concern for fleet operators considering a transition to natural gas.

CURRENT STATUS OF GOVERNMENT SUPPORT

The potential for more heavy-duty vehicles to use natural gas is apparent. Governments that see greater natural gas use as key to meeting their objectives have begun to extend support mechanisms to encourage engagement. This is important, particularly if governments are going to be extending support to other technologies. Market participants need to see that natural gas is viewed as favorably as the other supported options.

<p>Federal Government</p> <ul style="list-style-type: none"> Budget 2016 provided \$62.5 million over two years, starting in 2016-17 to Natural Resources Canada to support the deployment of alternative transportation fuel infrastructure including natural gas re-fuelling stations. 	<p>Quebec</p> <ul style="list-style-type: none"> Since November 2013, the QC government has provided a subsidy of 30 per cent of the additional cost for the purchase of CNG or LNG vehicles.
<p>British Columbia</p> <ul style="list-style-type: none"> In 2012 the Government of BC introduced a regulation that allowed utility companies to deliver natural gas transportation programs until March 31, 2017 that offer incentives to fleets that could use natural gas; to build and operate natural gas fuelling stations. BC also has a \$14.3 million Clean Energy Vehicle Program from 2011 to offer direct grants up to \$2500 to purchasers of CNG vehicles. In June 2016, BC and the federal government went into an agreement under the Public Transit Infrastructure Fund to provide \$160 million in combined funding for BC Transit projects, including more support for CNG-fuelled buses 	<p>Ontario</p> <ul style="list-style-type: none"> Climate Change Action Plan introduces a Green Commercial Vehicle Program to launch in 2017. Program provides \$170 million in incentives for adopting electric and natural gas commercial vehicles. Provides \$75 to 100 million towards a province-wide natural gas fuelling network. Ontario Government has also provided \$100 million in cap-and-trade proceeds to the development of renewable natural gas.



THE MARKETS FOR NATURAL GAS AS A TRANSPORTATION FUEL

Outlined below is a summary of current fleets using natural gas (LNG or CNG) as a transportation fuel.

On The Road

High kilometer, large fuel-consuming vehicles including highway tractor trailers and return-to-base vehicles with scheduled daily operations, offer the most economic and near-term opportunities.

However, there is a challenge unique to Canada. Here, there is a higher weight allowance for trucks compared to the United States and Canadian trucks tend to travel longer distances and over steeper terrain, particularly in Western Canada. As a result, trucks in Canada need a higher horsepower engine to accommodate greater weights and more difficult terrains. Companies including Cummins Westport and Volvo started to develop a high horsepower engine solution fueled by natural gas several years ago. Both projects were halted as a result of company assessments that the market size didn't warrant further development, particularly without signals from government that the development was desired. If governments want to reduce GHGs from this, the transportation vehicle segment with the highest proportion of on-road GHGs and polluting emissions, then there will be a need to encourage the development of a natural gas high horsepower engine.

Current Fuel: Diesel or Diesel Hybrid/Biodiesel

Solution: CNG or LNG

Payback Period: 2-5 years

GHG Savings: 20-25 per cent

In Canada, the combined activities of numerous companies (including Waste Management, Emterra Group, and others) have put approximately 500 heavy-duty trucks and 1,000 refuse trucks using natural gas on the roads. In addition, a number of municipalities across Canada are using CNG for transit fleets. Several municipalities in British Columbia, including Kamloops, Nanaimo, Surrey and Squamish to Whistler are using CNG-fuelled transit buses. In Hamilton, ON, Union Gas and the municipality partnered to develop a CNG station in order to fuel the city's transit bus fleet. Hamilton was one of Ontario's first municipalities to use CNG buses, including 24 40-foot buses and 18 60-foot articulated buses. The City of Hamilton intends to replace approximately 18 buses per year with CNG until 2020.





THE MARKETS FOR NATURAL GAS AS A TRANSPORTATION FUEL

For Rail

The primary driver for using LNG to fuel rail fleets remains fuel cost savings at a time of rising operating expenses.

Current Fuel:	Diesel
Solution:	LNG or CNG
Payback Period:	5-10 years
GHG Savings:	30 per cent

Manufacturers like General Electric and Caterpillar have been piloting LNG or CNG locomotives. Westport has created a Canadian-made technology called a Westport high-pressure direct injection (HPDI) that provides a small diesel pilot spray to start the combustion for natural gas to be directly injected. Several rail companies, including CN in Canada, have tested the technology and/or are considering future pilot projects.



For Off-Road

Off-road vehicles such as mining trucks currently run on diesel and the large fuel use profile of these vehicles means they are ideally suited for LNG.

Current Fuel:	Diesel
Solution:	LNG
Payback Period:	5-10 years
GHG Savings:	20 per cent

Westport is developing technologies for off-road engines, including large mine trucks, with 95 per cent substitution of diesel with natural gas. In the first case of its kind, Teck Resources Ltd., a Canadian mining company, has started a pilot project to use LNG (provided and transported by FortisBC to fuel six of its haul trucks at the Fording River steelmaking coal operation in southeast British Columbia). With this pilot project, there is the potential to eliminate approximately 35,000 tonnes of CO₂ emissions annually at the operation site and reduce fuel costs by more than \$20 million annually by adopting this hybrid fuel.



THE MARKETS FOR NATURAL GAS AS A TRANSPORTATION FUEL

For Marine

Using LNG can be a cost savings for operators and is a way to comply with current and future international regulations governing emissions from marine vessels. According to a 2014 report entitled [LNG: A Marine Fuel for Canada's West Coast](#), developed by a variety of public and private sector groups, LNG in marine vessels can lower SOx emissions from ships by 90 per cent and NOx by 35 (for diesel cycle engines) to 85 (for Otto cycle engines) per cent. Using LNG as a marine fuel can also reduce particulate matter by 85 per cent, CO₂ by 29 per cent and GHGs by 19 per cent on a CO₂-equivalent basis.

Current Fuel:	Diesel
Solution:	LNG
Payback Period:	5-10 years
GHG Savings:	36 per cent



BC Ferries is upgrading its five Spirit Class vessels so they can operate on LNG, starting in 2017, with the project to be completed in 2019. With these upgrades, the company expects a CO₂ emissions reduction of 12,000 tonnes annually. It has also started the construction of three new Salish-Class vessels that can operate on LNG. Gaz Metro Transport Solutions will be supplying LNG to new ferries ordered by Soci t  des Traversiers du Quebec. Larger ocean going vessels are also looking at LNG for retrofit and new build applications.



RECOMMENDATIONS FOR GOVERNMENT

Greater use of natural gas as a transportation fuel could be realized with government support including:

- Financial or tax measures to de-risk incremental natural gas vehicle costs such as a financial contribution to cover half of the incremental truck costs.
- Financial support for clean energy infrastructure including the development of natural gas refuelling stations across Canada
- Encouragement for private investment in refuelling infrastructure through provincial regulatory measures
- Financial or tax support for new LNG and CNG supply

sources such as accelerated capital cost allowance increases for LNG and CNG plants from 8 to 30 per cent.

- Assurance around maintaining the current federal fuel tax exemption on LNG and CNG.
- Support for RNG as transportation fuel.

These measures would provide fleet operators – from refuse to marine – with increased financial security to support the transition to natural gas. They would also send a signal to LNG and CNG suppliers that there is a strong market for their products.



ROLE OF CANADA'S NATURAL GAS DISTRIBUTION INDUSTRY

Across Canada, natural gas utilities are investing in infrastructure and programs to support greater use of natural gas as a transportation fuel. From the \$105 million incentive program in British Columbia that is being managed by FortisBC, to early adoption of heavy duty trucks using LNG in Quebec that is being rolled out by Gaz Métro Transport Solutions, utilities are at the forefront of this important opportunity.

The case is strong for natural gas utility involvement in natural gas for transportation, particularly given the long-standing history with their customers including homeowners, commercial business owners, industrial facilities and power plants. The extension of the affordable, clean, safe, reliable service of natural gas delivery to new transportation customers is a natural next step for utilities intent on meeting customer needs.

In addition to the existing relationship with customers, utilities operate in a regulated environment where costs and investments in new businesses are examined closely by independent regulatory bodies. In many cases, utility investments in transportation infrastructure are 'rate-based' or financed by utility consumers. Therefore, these costs must pass regulatory approval which ensures fair value for all consumers on the gas utility pipeline system. In addition to rate-based models, other utilities are opting to pursue niche transportation business lines outside of the regulated model - indicative of the financial flexibility of utility operations.

Investments made by a utility is long term in nature with 30 to 40-year payback periods. This 'patient capital' approach assists in developing emerging markets such that private capital and investment can be secured and mobilized. This makes utilities ideal partners to provide initial investment needed to support emerging markets such as in transportation which require extensive infrastructure.

Canada's natural gas utilities are already leading in support for RNG through their set target of five per cent RNG-blended natural gas by 2025 and 10 per cent by 2030. Through the use of existing gas pipeline infrastructure and equipment, these companies have been strengthening Canada's capacity in RNG without significant new investment. This leadership, along with key partnerships with provincial and municipal governments has helped bring online nine RNG projects by the end of 2016 that will produce enough renewable fuel to meet the energy needs of 51,000 homes.

Emissions from transportation form a large part of Canada's GHG footprint. At a time when governments are looking to reduce this across the board, natural gas can provide a solution that will make a significant impact. Support from government in order to build partnerships and capacity in this arena will drive investment in natural gas for transportation so that Canada can see the economic and environmental paybacks.

For more information on natural gas as a transportation fuel and Canada's natural gas distribution industry, visit www.cga.ca.

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