



Natural Gas: Looking Forward

March 23, 2011

A Prelude to GFX 2011



Webinar Agenda

1. Natural Gas Use in the Canadian Transportation Sector – Deployment Roadmap
 - Alicia Milner, Canadian Natural Gas Vehicle Alliance
2. Utilities as Implementation Partners
 - Mike Tremayne, Enbridge
3. Green Bin Biogas to Fuel Project
 - Drew Shintani, City of Toronto
4. Wastewater Treatment Renewable Gas Project
 - Chris Hill, City of Hamilton
5. Question & Answer
6. Wrap Up



Why Look at Natural Gas Again?

- Drivers of renewed interest:
 - Improved natural gas supply outlook
 - Mature engine technologies for vehicles
 - Increased availability of factory-built vehicles
 - Emergence of renewable natural gas
- Transportation a high growth area for energy use and carbon emissions since 1990:
 - + 19% energy for passenger
 - + 71% energy use for freight
 - + 36% in carbon emissions from transportation

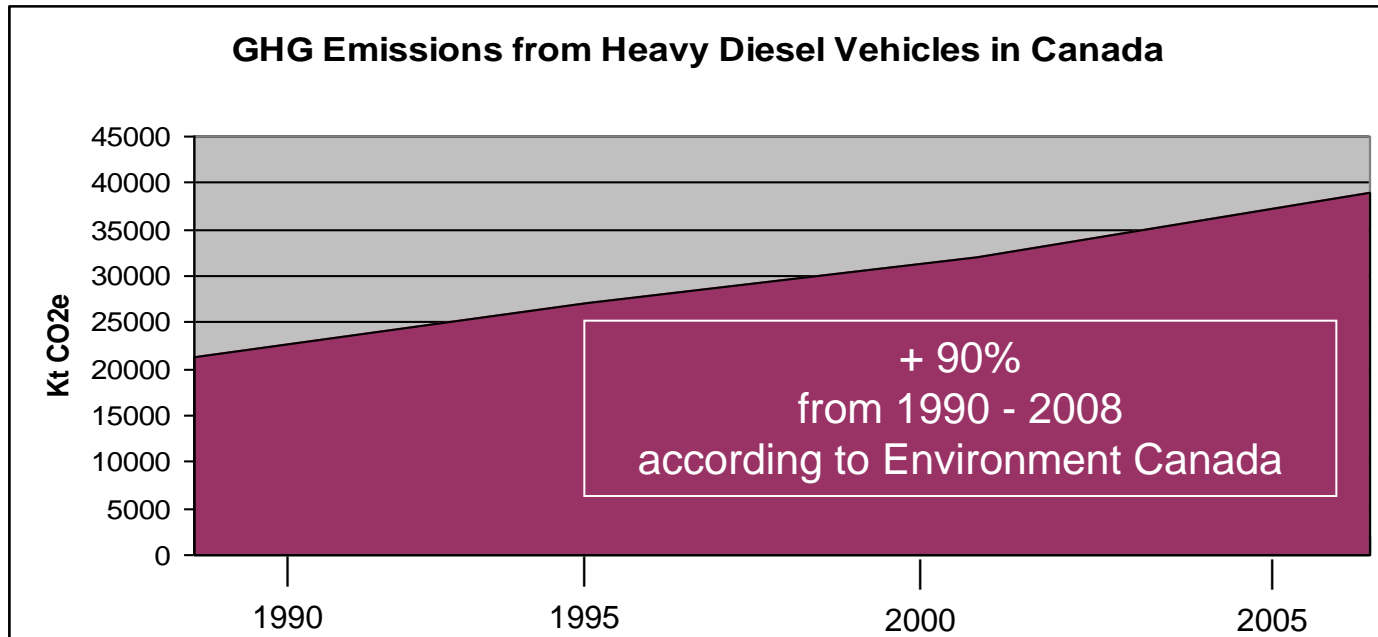


Natural Gas Deployment Roadmap

- Launched in March 2010 by NRCan Deputy Minister
- Consensus-based approach to identifying optimal uses of natural gas in transportation
- Diverse stakeholders:
 - Federal and provincial governments
 - Natural gas value chain and equipment suppliers
 - End users - private and public sector (CAMFM)
 - OEMs (Daimler)
 - Environmental groups
 - Academia
- Key finding: focus on medium and heavy vehicles in return-to-base and corridor fleets








Impact of Medium & Heavy Vehicles



Medium & heavy vehicles represent 4% of onroad vehicles:

- Contribute 34% of carbon from onroad sources
- Natural gas provides a 20-25% benefit
- Renewable natural gas 85-90% benefit

Scoping Opportunities – Heavy Vehicles

	Description	Status
Technology Availability	<ul style="list-style-type: none"> ▪ Mature certified engine and storage technologies ▪ Increased availability of OEM vehicles 	
Energy Use	<ul style="list-style-type: none"> ▪ H-D vehicles use a significant amount of energy – trend is growing ▪ Vehicle use is typically commercial, so limited potential for transportation demand measures to reduce energy consumption 	
Environment	<ul style="list-style-type: none"> ▪ May be enabler for achieving Heavy Duty GHG regulations (23% GHG reduction) ▪ Capable of meeting 2010 emissions regulations; simpler technology 	
Economics	<ul style="list-style-type: none"> ▪ Significant savings on fuel (e.g. \$16,000/ yr for a highway tractor) ▪ High internal rate of return but high initial investment ▪ Heavier vehicle fuel tanks add to vehicle weight and affect payload 	
Market Potential	<ul style="list-style-type: none"> ▪ Significant vehicle demand concentrated in a few corridors (3,750-15,000 between Windsor-Quebec City) ▪ Return-to-base and corridors linked to existing NG infrastructure 	

Increased Vehicle Availability

Bus (School)	Bus (Transit / Shuttle)	Bus (Inter-city)	Dump	Pumper / Utility	Refuse	Stake Bed or Cube	Street Sweeper	Tractor (Long Haul)	Tractor (Short Haul)	Wastewater / Sewer	Yard Spreader

Business Case Findings

- Strong internal rates of return for right type, scale of fleet
- Top ranking applications
 1. LNG highway tractor fleet
 2. LNG urban tractor fleet
 3. CNG transit bus fleet
 4. CNG refuse truck fleet
- All-in costs of ownership *including* infrastructure considered in analysis

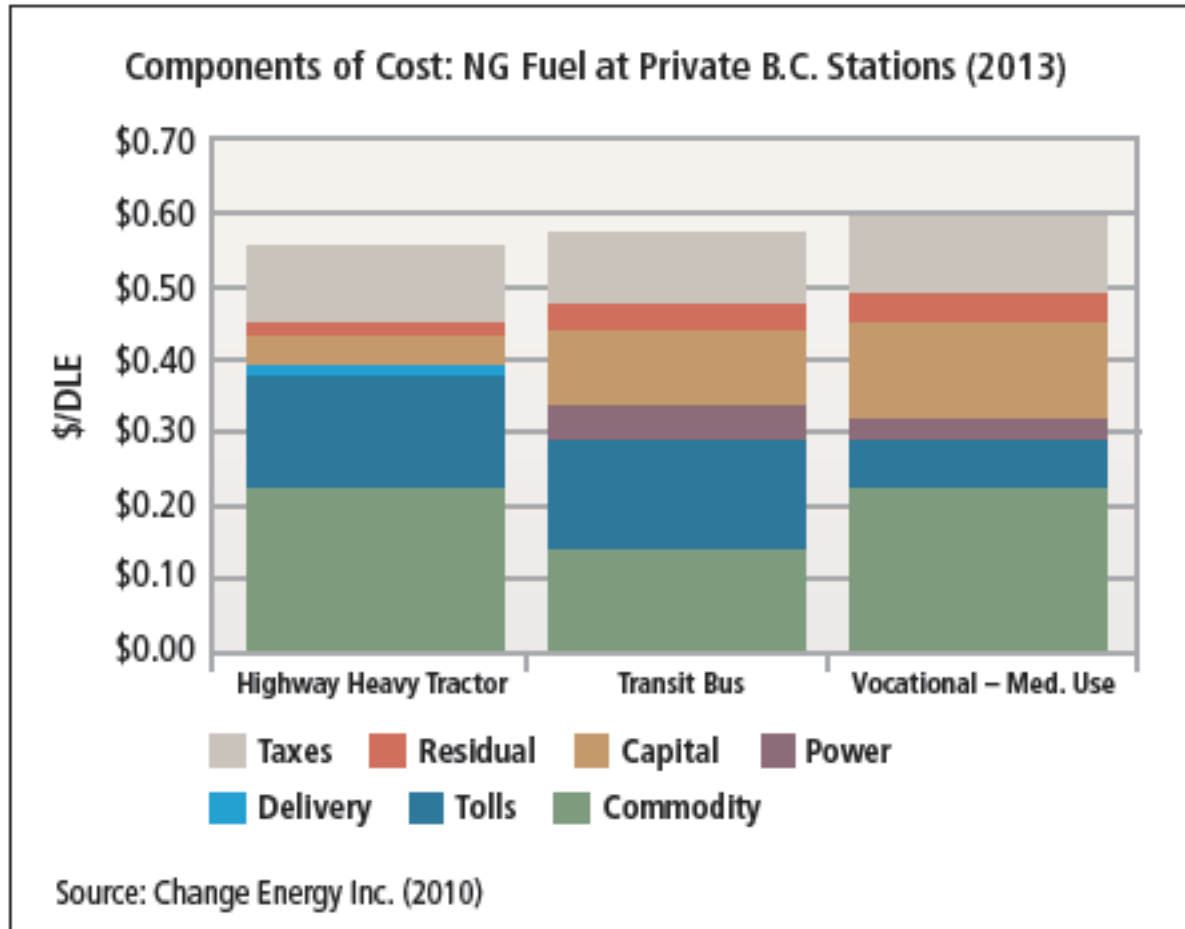


Fleet Examples - Key Assumptions

	HIGHWAY HEAVY TRACTOR	TRANSIT BUS	VOCATIONAL – MEDIUM USE
Station capital cost	\$0.820 million	\$1.6 million	\$0.545 million
Fleet size	Small – 30	Small – 35	Small – 25
Annual mileage per vehicle	200,000 km	55,000 km	30,000 km
Annual fuel use	2,220,000 DLE	1,160,000 DLE	325,000 DLE
Vehicle-related costs (\$/DLE)	\$.235/DLE	\$.538/DLE	\$1.404/DLE
FVI for given year	1.58	1.02	0.56
Vehicle premium	\$75,000 LNG tractor	\$50,000 CNG bus	\$50,000 CNG truck



Elements of Cost Analysis



Energy Content

1 m³ natural gas =
35,300 Btu

1 litre diesel =
34,210 Btu

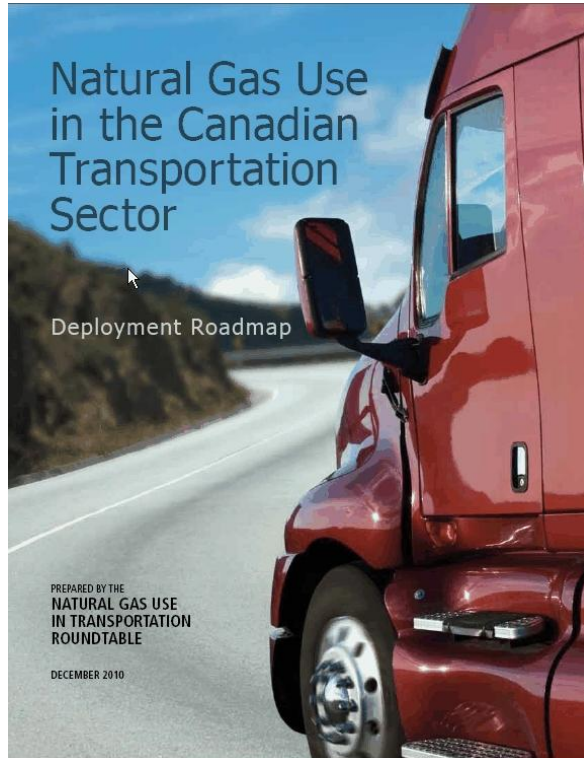
1 m³ natural gas =
1.032 litres diesel

Engine Efficiency

Westport LNG
tractor matches
diesel

Cummins
Westport CNG or
LNG truck within
10% of diesel

Roadmap Report



- Download at: www.alternativefuels.gc.ca
- Currently working on 3 capacity building activities with NRCan:
 - (a) Codes & Standards Workplan
 - (b) LNG Code
 - (c) Education & Outreach Communications Plan

Issued in January 2011 -

Canadian Market Update

- 3 major projects recently announced
 - Robert Trucking – 180 LNG tractors with stations in Montreal, Mississauga, Quebec
 - Vedder Transport – 50 LNG tractors in Abbotsford, BC
 - Waste Management – 20 CNG refuse collection trucks in Lower Mainland, BC
- Lowering vehicle acquisition cost triggered purchase decision in each case
- Interested provided barriers can be addressed



Waste Management - Coquitlam, BC



- 20 CNG front loaders
- Time fill system with some fast fill capability
- Site piped for up to 100 refuelling posts
- Waste Management [media release](#)

Enbridge as a Partner

Overview

- Enbridge promotes use of natural gas vehicles
- Provides natural gas fuelling – both at retail locations and private on-site
- Promotes OEM manufacturers of natural gas vehicles to our customers
- Convert light / medium duty vehicles to operate on natural gas

Enbridge Fleet

- Largest natural gas vehicle fleet in Canada
 - 525 light duty vehicles
 - 6 dump trucks – balance of 185 non-natural gas medium and heavy duty trucks to be done in the future
 - On site natural gas fuelling at almost all of our offices and yards – card lock operations



Miller Waste Project

First CNG Refuse Truck – Private Fleet

- Peterbilt CNG refuse truck delivered in Summer 2010
- Purchased vehicle to evaluate natural gas in their fleet
- Vehicle has been placed into normal, full time operation
- Enbridge installed a natural gas fuelling system at their site:
 - Equipment maintained and monitored by Enbridge
- Price of natural gas approximately \$.58 per diesel litre equivalent
- Enbridge interested in working with other refuse fleets



Enbridge Dump Truck Experience

CNG Dump Trucks

- 6 natural gas dump trucks in 2010:
 - 2 factory-built Freightliners with Cummins Westport 8.1 litre ISL G engines
 - 4 converted International trucks with 7.6 litre Emissions Solutions Phoenix engines
 - Fill at on site fuelling facilities at Enbridge yards
 - Range of the trucks 500+ km
 - Drivers indicate comparable performance to diesel when fully loaded towing trailer
- Fleet contacts welcome to visit our facilities to learn more



Renewable Natural Gas Interest

Biogas

- Raw biogas is produced from natural decomposition of waste organic material or from the gasification of biomass
- Biogas composition depends on source, but typically includes:
 - Methane (CH_4), Carbon dioxide (CO_2),
 - Trace trace amounts of oxygen (O_2), nitrogen (N_2), hydrogen sulphides (H_2S)



Renewable Natural Gas

- Created by removing unwanted compounds and upgrading raw biogas to pipeline standard
- Enbridge evaluating a number processes to create renewable natural gas that could be directly injected into Enbridge's system.



Toronto's Green Bin Biogas Project

- Cogeneration vs Pipeline gas comparison under environment, financial and risk
- Reviewed 2 projects of a similar scale
- Pipeline gas higher environment and financial returns with more risk (technical, project execution, contract management)

A North American first: converting biogas to natural gas



Let organics fuel your tank

THE City is going to turn Green Bin organics into fuel to operate Toronto's solid waste collection trucks. A pilot program aims to convert the biogas produced from Green Bin material into refined natural gas for distribution across Enbridge's system. In essence, Toronto will be making its own natural gas, which in turn will replace the diesel fuel currently used to operate collection trucks.

Creating natural gas from kitchen waste will be a first in North America. Unlike conventional

composting, the anaerobic (without oxygen) digestion system at Toronto's Dufferin plant produces both compost and biogas. When the biogas is refined, it becomes natural gas.

Natural gas has less environmental impact than other fossil fuels, which will help decrease the environmental impact of the fuel used by the City.

Ultimately, this natural gas will fuel 300 collection vehicles, replacing the 4 million litres of diesel fuel currently used each year by Toronto Solid Waste vehicles. Enough gas will be left over to heat some City buildings.

The City is also adding a second Green Bin/biogas facility and will be expanding and upgrading the Dufferin plant.

So, keep feeding your Green Bin. Using kitchen waste to fuel our trucks is exactly what contributes to Toronto's international reputation as a large, eco-friendly, green and sustainable city.



toronto.ca/recycle

Toronto's First CNG Packer



- Freightliner M2 112 with Labrie body
- Behind cab fuel storage (50 diesel gallon equivalent)

City of Hamilton Biogas Project



- Purify methane from wastewater treatment plant
- Inject into Union Gas system
- Use compressed natural gas for fleet vehicles at Public Works yards

Green Fleet Expo VI – June 2-3, 2011

Canada's premier showcase for advanced fleet technology

Day 1 Presentations and Speakers
Green Fleet Leadership Awards
Government of Ontario Speakers
AT: Courtyard Marriott Hamilton

Day 2 Green Fleet Exhibition
Ride and Drive
50+ Exhibitors
AT: Canadian Warplane Heritage Museum

TO REGISTER: [Green Fleet Expo](#)



Thank You & Contact

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