



Deployment Roadmap - Natural Gas & Biomethane for Transportation

Biogas & Biomethane Conference
May 25th, 2011 - Montreal



Agenda for Presentation

1. About CNGVA
2. Transportation as a market
3. Merits of natural gas as an option
4. Deployment Roadmap
5. Deployment Roadmap next steps and opportunities for biomethane





About CNGVA

Advocate for natural gas vehicles, refuelling infrastructure, and renewable gaseous fuels for the benefit of Canada's economy and environment


Members

Producers & Utilities – ATCO Gas, Enbridge Gas Distribution, Encana, Gaz Metro, Terasen Gas

Equipment & Fuel Suppliers – Agility Fuel Systems, ATW Automotive, CanGas Solutions, Change Energy, Clean Energy, Cummins Westport, DMA Technical, ECO Fuel Systems, Ferus, Hi-Tec Fuel Systems, IMW Industries, Jenmar Concepts, Kraus Global, Westport Innovations, Viridis Technologies, Xebec Adsorption


Research Organizations – Powertech Labs, Saskatchewan Research Council



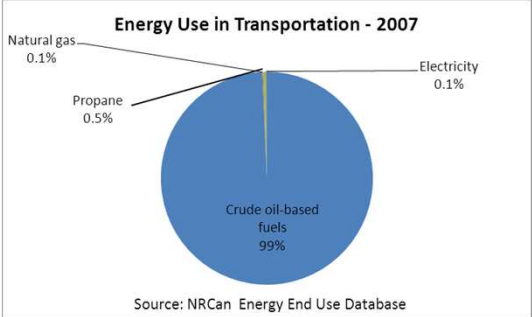



Transportation as a Market

- Significant energy demand that comprising about 29% of secondary energy use in Canada
- Growth in energy demand since 1990
 - Passenger + 18%
 - Freight + 71%
- Within Freight, heavy trucks are fastest growing for energy use: + 159% since 1990
- Changing landscape:
 - New regulations – carbon; fuel efficiency
 - Renewable fuel standards
 - Emerging technologies



Energy Use in Transportation




Energy Use in Transportation - 2007

Energy Source	Percentage
Crude oil-based fuels	99%
Propane	0.5%
Natural gas	0.1%
Electricity	0.1%

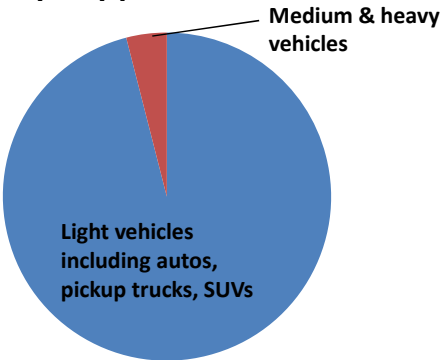

Source: NRCan Energy End Use Database

- Transportation 2nd largest user of energy
- 28% of secondary energy use in Canada
- Only sector that relies on a single energy source to meet demand



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Vehicles by Type



Light vehicles including autos, pickup trucks, SUVs


Medium & heavy vehicles

- Canada had > 20 million vehicles in 2009
- Medium & heavy vehicles are 4% of vehicles, but contributed 29% of greenhouse gas emissions from onroad in 2009

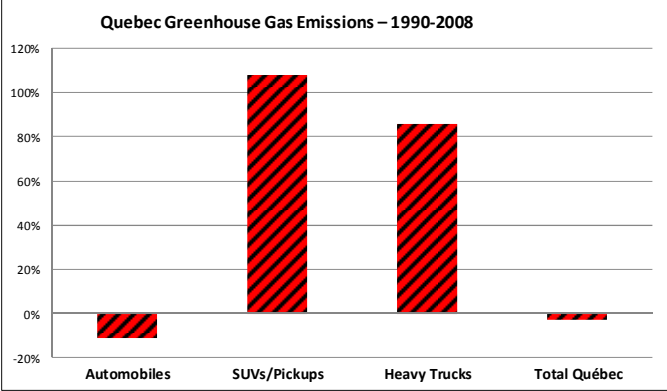


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Carbon Emissions




Quebec Greenhouse Gas Emissions – 1990-2008




Category	Change (%)
Automobiles	-10%
SUVs/Pickups	110%
Heavy Trucks	85%
Total Québec	-5%

Transportation - high growth area and largest source of greenhouse gas emissions in Quebec




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Why Natural Gas?




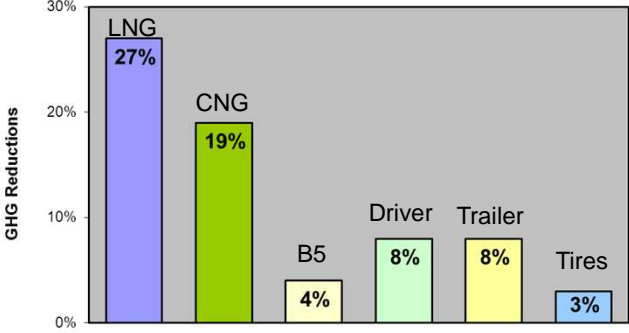
- Transportation needs cost effective, lower carbon options – role for natural gas
- There is no one size fits all alternative for transportation
- Convergence of factors for natural gas:
 - Abundance of domestic resource
 - Affordability of fuel - dispensed CNG/LNG is 30-35% less expensive than diesel fuel
 - Maturity of vehicle technologies
 - Increased availability of factory-built vehicles
 - Emergence of carbon-based regulations



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Options for Class 8 Trucks






Option	GHG Reductions (%)
LNG	27%
CNG	19%
B5	4%
Driver	8%
Trailer	8%
Tires	3%

- Range of options available to reduce GHGs
- Magnitude of benefit suggests a role for natural gas in a carbon-constrained future




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Merits of Natural Gas Use



- Diversifies energy use in a sector of economy that remains 99% reliant on single energy source
- Reduces carbon by 20-25% on well-to-wheels basis (*Natural Resources Canada modelling*)
- Enhances fleet competitiveness through use of lower fuel cost
- Provides economic benefits for Canada in the fuel, vehicle, and station supply chain
- Investments in vehicles and stations can be leveraged with future use of biomethane for near zero carbon emissions



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Natural Gas – Current Status

- < 1 Bcf/year or 0.1% of energy used in Canadian transportation sector is natural gas
- Vehicles & stations:
 - 12,000 natural gas vehicles
 - 50 public stations, 15 private stations
 - 350 vehicle refuelling appliances
- All CNG vehicles; LNG vehicles coming in 2011
- Continued challenges for public refuelling stations due to decreasing fuel volumes
- Some negative views among early adopters; other end users have no experience with or knowledge of natural gas vehicles



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Deployment Roadmap

- March–Sept 2010 under direction of Deputy Minister of Natural Resources Canada
 - Diverse stakeholders, consensus approach to identifying optimal uses of natural gas in transportation
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- Unique aspects of work:
 - Focus on end users
 - Business case analysis to confirm economic value proposition
 - Report available at www.alternativefuels.gc.ca



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Roadmap Scoping- Heavy Vehicles

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"> ▪ Vehicles use a significant amount of energy and energy use is increasing ▪ Vehicle use typically commercial, so limited potential for transportation demand measures to reduce energy use 	
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 fuel tanks add to weight and affect payload 	
Market Potential	<ul style="list-style-type: none"> ▪ Significant vehicle demand concentrated in a few corridors (e.g. Windsor to Quebec City) ▪ Return-to-base and corridors linked to existing NG infrastructure 	

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Roadmap Scoping - Light Vehicles

Technology Availability	<ul style="list-style-type: none"> ▪ Conversion technology widely available ▪ Public infrastructure sparse 	
Energy Use	<ul style="list-style-type: none"> ▪ Individually, private vehicles do not tend to be high energy consumers (fleet applications may differ) - would need significant numbers to justify infrastructure investments 	
Environment	<ul style="list-style-type: none"> ▪ Approx. 20% reduction in GHGs compared to gasoline ▪ Natural gas light-duty vehicles face stiff competition for consumers wishing to reduce their carbon footprint (advanced gasoline engines, diesels, electric, etc) 	
Economics	<ul style="list-style-type: none"> ▪ Long payback periods due to limited mileage of light-duty vehicles as compared to other market segments ▪ Advancements in the on-board diagnostics systems increase cost of compliance for NG vehicles 	
Market Potential	<ul style="list-style-type: none"> ▪ Only 1 OEM-built vehicle currently available but more on the way – limited OEM support channels ▪ Private use requires extensive refuelling networks ▪ Consumer purchase decision not based on price signals 	

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Roadmap Scoping - Marine


	Technology Availability	<ul style="list-style-type: none"> Gas propulsion technology is commercially available today LNG supply poses current constraint 	
	Energy Use	<ul style="list-style-type: none"> High unit consumption, 1 ship = 50 highway tractor trailers 	
	Environment	<ul style="list-style-type: none"> GHG reductions - TBD Economic option for upcoming low-sulphur fuel regulations High CAC emissions benefits due to less stringent regulation requirements for diesel use for short-sea shipping 	
	Economics	<ul style="list-style-type: none"> Routes adjacent to trucking corridors allow common infrastructure use Higher volume vehicle fuel tanks could force cargo reductions Very high acquisition costs (\$40-\$50 million) Fuel costs/savings transferred to customers 	
	Market Potential	<ul style="list-style-type: none"> Low turn-over rates (ship life = 25 to 40 years) 	

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Factory-Built Natural Gas Vehicles


	<p>Phoenix NG 7.5L 7.5 liter engine 175 - 245 horsepower 400+ cu ft range Manufactured by Phoenix "The world's best" "the world's best"</p>
	<p>ISL G 8.8 liter engine 200 - 300 horsepower 400 - 1,000 cu ft range Manufactured by Cummins Westport</p>
	<p>Westport EEX 11 liter engine 200 - 375 horsepower 400 - 1,270 cu ft range Manufactured by Westport</p>
	<p>Westport (TEC) 11.5 liter engine 400 horsepower 1,500 cu ft range Manufactured by Cummins Westport</p>


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Roadmap Analysis Findings


- Near term recommendation:
 - Focus on medium and heavy vehicles in return-to-base, regional corridor fleets
- 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* station below diesel for right scale of fleet


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Implications of Findings

- Market not acting on potential returns
- Three key impediments
 1. Out-of-date and incomplete information
 2. Perceived performance risk with technology
 3. Incremental vehicle cost and concerns regarding financial risk
- Roadmap recommendations
 - Targeted education and outreach to fleets
 - Demonstrate technology to create confidence
 - De-risk adoption via temporary fiscal measures
 - Reduce vehicle costs via targeted R&D, scale
 - Build capacity to execute


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Canadian Market Update

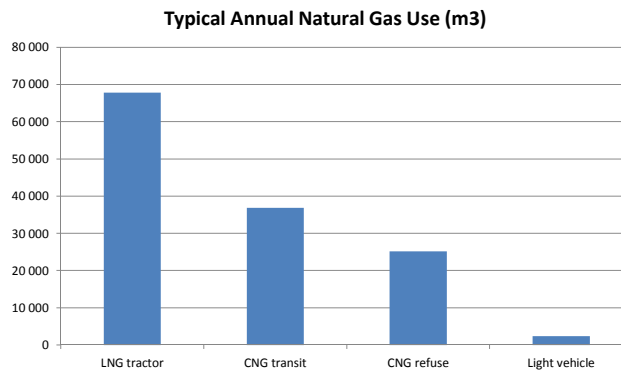
- 3 major projects:
 - Robert Trucking - 180 LNG tractors with stations in Montreal, Mississauga, Quebec
 - Vedder Transport - 50 LNG tractors in Abbotsford, BC
 - Waste Management - 20 CNG refuse collection trucks in Lower Mainland, BC
- As natural gas vehicle use increases, will create opportunities for biomethane as a vehicle fuel



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Typical Energy Use



- Approximately 36,000 new medium and heavy vehicles purchased annually
- Intersect vehicle replacement cycle



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Market Potential

- Total transportation 2,464 Bcf in 2008
- Medium/heavy 10 year scenarios

NG Penetration of New Truck & Bus Sales	# of NG Vehicles	Estimated NG Usage/Year
1%	3,600	8.2 Bcf
5%	10,800	40.8 Bcf
10%	36,000	81.7 Bcf

- Infrastructure anchored by medium/heavy vehicles can be used for other fleets – US experience

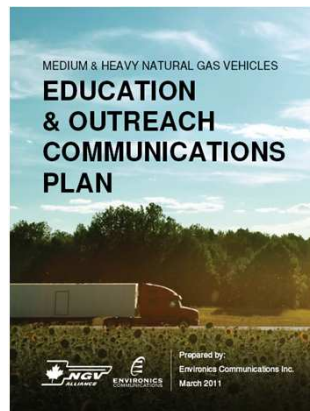


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Next Steps for Roadmap

- Expect implementation group to be organized within next month or so



- Early stage activities under way:
 - Addressing codes and standards gap and issue areas
 - Planning for implementation of Education and Outreach Communications Plan
- Natural gas vehicles as an enabler of biomethane use will be an important opportunity to highlight



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