



Why Transportation?

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Roundtable on Natural Gas Use in the Canadian
Heavy-duty Transportation Sector

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Given increasing energy demand and greenhouse gases (GHGs), a key market is transportation sector...

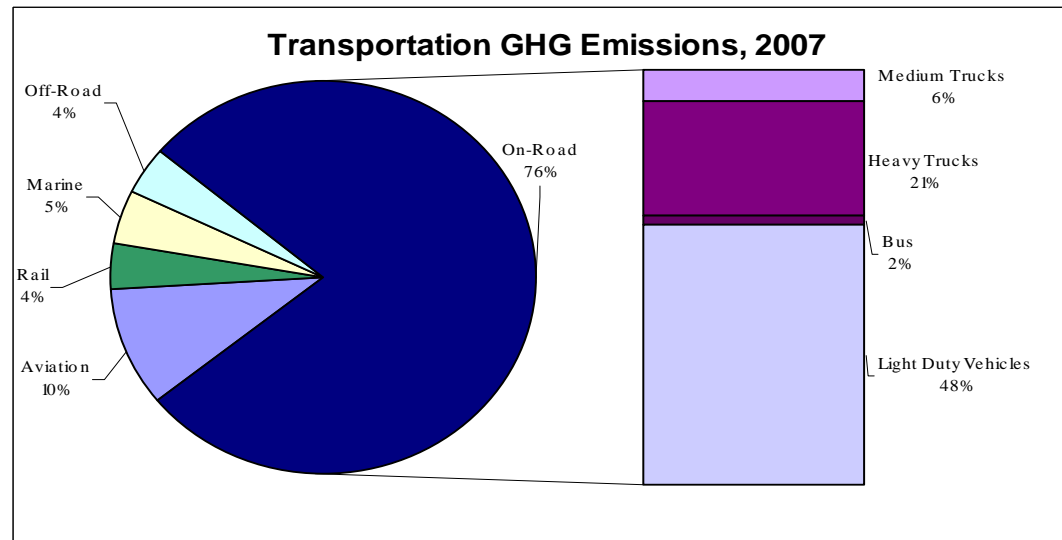
- **2nd largest energy user in Canada (~30% of total demand)**
 - 95% energy used for transportation is from petroleum sources
 - Primary end-user (90%) of gasoline and diesel
- **Energy use makes this sector the largest GHG emitter**
 - On-road transportation alone is responsible for 28% of Canada's GHG emissions
- **Conventional natural gas results in less environmental impact than other fossil fuels**
 - GHG emissions related to conventional NG combustion are ~30% cleaner than oil
- **Transportation energy use has grown ~40% with a corresponding GHG increase (since 1990) and is expected to grow by ~31% from 2006 to 2020**
 - Innovations have improved energy efficiency and reduced GHGs but gains have been eclipsed by increased demand

A complex market in need of sustainable solutions



Specific focus on medium- and heavy-duty vehicles....

- Less than 4% of on-road vehicles contribute an estimated 1/3 of GHG emissions from on-road sources
- Growth in emissions from diesel vehicles increasing at a rapid rate with heavy diesel vehicles contributing almost half of growth in GHG emissions from on-road sources since 1990
- Increasingly stringent diesel engine emissions standards have had no impact on carbon emissions



Problem getting bigger – need to explore all opportunities

Widespread NGV Use Across the Globe...



- **China:**
 - Ample NG supply and significant and increasing energy demand
 - Need to address air quality concerns
- **India:**
 - Air quality concerns have led the Government to issue mandates (national exhaust emission standards)
 - Supreme Court decision mandates creation of a NGV program for Delhi
- **Iran:**
 - Large indigenous gas reserves and lack of higher value domestic or export market
 - Incentive to minimize oil-related imports
- **Italy:**
 - Concern over PM emissions led to regulations and incentives to support NGVs
- **Pakistan:**
 - Limited domestic supply of petroleum products; NG supplies ample and existing gas infrastructure available
- **US:**
 - NOx non-attainment areas beginning with Los Angeles, CA have been a major driver
 - Energy security concerns associated with imported oil are a current driver of interest



Natural gas technologies used globally to address multiple concerns; air quality, GHG ↓ and energy security

Past Programs

• Federal Programs/Policy

- First vehicle and station grant programs in 1983 under National Energy Program (NEP): Market Development Incentive Program (MDIP)
- Waiver of gasoline excise tax on alternative fuels
- NGV codes and standards, safety testing
- R&D program
- Cooperation on demonstrations with California, US DOE, NYSERDA, provinces
- Post-NEP deregulation of natural gas industry
- Climate Change funding in Budget 2003 provided incentives on passenger vehicles

• Provincial Programs

- Canada-Alberta Accord provided framework for remaining MDIP funding for NGV
- Complementary policy in provinces for vehicle grants and waiver of fuel tax
- Ontario implemented strong NGV program, particular emphasis of transit buses
- BC initially provided strong NGV support. Federal funding for BC outside of MDIP

→ NGV programs worked best in regions where federal support was coupled with strong provincial and utility support



Lessons Learned....

- **Continuous Development of NGV Technology needed for Future Market Success in North America**

- Fast-changing emission standards and dropping oil prices hurt NGV in the mid-1990s
 - NGV R&D did not keep pace, costs of compliance rose, original equipment manufacturers (OEMs) pulled out
- NGV must adapt to emerging vehicle and engine technology
 - Huge OEM and government effort to improve new vehicle GHG and criteria air contaminants (CAC) emissions
 - Natural CAC advantage of NG diminishing with new rounds of emission standards
 - More drivetrain competition in all markets - hybrids, plug-in hybrid electric vehicles, diesel, gasoline direct injection and variants

- **Market Conditions**

- Fuel availability, fuel price differential and stability are key drivers
- Lack of competition, low market volume and high US incentives leads to high prices for NG vehicles - this depresses market interest in Canada
- New markets can be primed by well planned technology demonstrations with suppliers and users

Market transformations take time and must be built with long-term investments and commitments from all stakeholders



Lessons Learned (continued)

Fuel providers (Utilities and partners)

- Turnkey projects can ease market entry for fleets
- Visible marketing campaign and financing programs to overcome lack of awareness and perceived risk of NGV opportunity
- Coordinate rollout of fueling infrastructure with vehicle fleet growth

Technology providers

- NGV technologies need to perform seamlessly with current sophisticated automotive systems
- Challenge of scaling up production and vehicle offerings
- Component costs controlled by others have a large impact on economics of NGV, e.g. fibre-wound tanks and LNG tanks

Bottom line: Users (fleet operators) must be provided with a coordinated supply-side offering



Snapshot - Canadian Market & Capabilities

• Vehicles and Infrastructure

- Less than 10,000 onroad CNG vehicles left in Canada and approximately 80 public stations in five provinces
- There are no LNG vehicles or fueling infrastructure in use in Canada
- 150 urban transit buses - Canadian market in rapid decline - poor experience of some transit companies with older technology
- 45 school buses - this market used to be large in Prairies (diesel competition in recent years and few gasoline engine options available for conversion)
- Majority of private stations are for off-road applications (forklift, ice resurfer) with only a few private stations servicing transit and light duty fleet operations

• Capacity

- HD NG engine industry located in Vancouver (Westport, Cummins Westport)
- CNG refuelling infrastructure capabilities in Chilliwack (IMW Industries), Toronto (FTI Group), Winnipeg (Kraus Global), Markham (Viridis Technologies)
- Component capacity for CNG cylinders in Calgary (Dynetek Industries), heavy vehicle fuel systems in Kelowna (Enviromech Industries)
- Biogas upgrading equipment manufactured in Blainville (Xebec Adsorption)



Many prospects exist ...



•Line haul trucking (fleets)

- Windsor-Quebec City corridor concept (interest in other areas as well)



•Refuse trucks

- One of fastest growing adoption areas in U.S. with public and private sector fleet interest
- Allows for use of biomethane derived from landfill gas allowing fleets to generate their own source of fuel



•Return-to-base trucks

- Allows for central refuelling of fleets – avoids need to duplicate existing and extensive infrastructure network
- Ensures viability of infrastructure based on anchor fleet's fuel requirements
- Ability to leverage infrastructure as a central refuelling hub and enhance economic



•Transit buses

- A popular market in the past – improved technology exists and is being deployed worldwide with Canadian engine technology supporting North American market
- Carbon benefits will remain and municipal access to biomethane may be strategic



Barriers to overcome for renewal of market in Canada...

- NG supply and demand
- Ensuring fuel price differential
- Technology readiness and R&D
- Articulation of value proposition
- Business models, risk sharing, and role definition in supply chain
- Codes and standards
- Information and awareness



Natural Gas Roadmap will outline a deployment process for the increased use of natural gas across the transportation sector