Westport™
INNOVATIONS (AUSTRALIA) PTY LTD

Submission to the

Australian Energy Market Commission

With respect to the Request for Advise from the Ministerial Council on Energy Regarding Natural Gas Vehicles

Project Reference Code EMO0022

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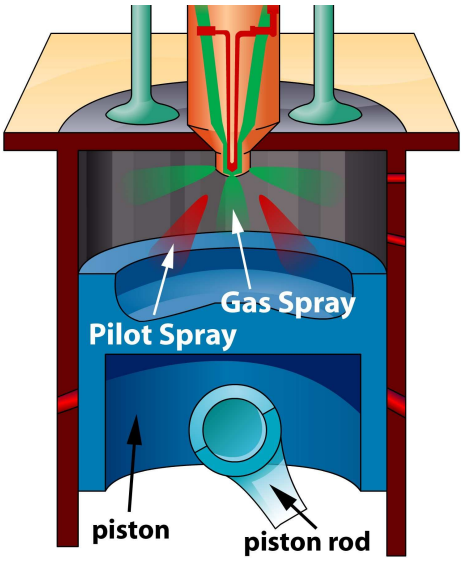
Introduction

Westport Innovation (Australia) Pty Ltd provides marketing, sales, parts and service support for the unique Westport HD high-pressure direct injection (HPDI) natural gas engine and fuel system for heavy duty trucks in the Australian market. The currently available Westport HD product is available as a factory-equipped option through Kenworth Trucks in Australia. There are several other truck OEM's interested in offering direct-injection natural gas engines in the Australian heavy-duty truck sector, and Westport has several initiatives to apply HPDI to larger HHP (high horsepower) engines used in mining, marine, and locomotive applications in the future.

Westport Power Inc., the Canadian parent company to Westport Australia, has working arrangements with some of the largest transportation OEM's in the world, including Volvo, Caterpillar, Cummins, Wiechai, Ford, and GM. We have also established strong ties with LNG fuel providers, such as Shell globally, Wesfarmers LNG, and BOC in Australia. Westport has also participated in a number of government studies interested in the role of natural gas in transportation for enhancing energy security, carbon reduction, and economic efficiency.

Step 1 – Technology

Westport HD technology is based on the HPDI principal using the Diesel Cycle combustion process to replicate the high performance and efficiency of the diesel engine, but with the primary fuel energy provided by injection of natural gas at high pressure late in the compression stroke. Due to the higher energy required for auto-ignition of natural gas versus diesel, a small amount of diesel pilot is injected to initiate combustion. Diesel substitution ratios are in the range of 94-97% natural gas in a wide variety of applications and duty cycles.



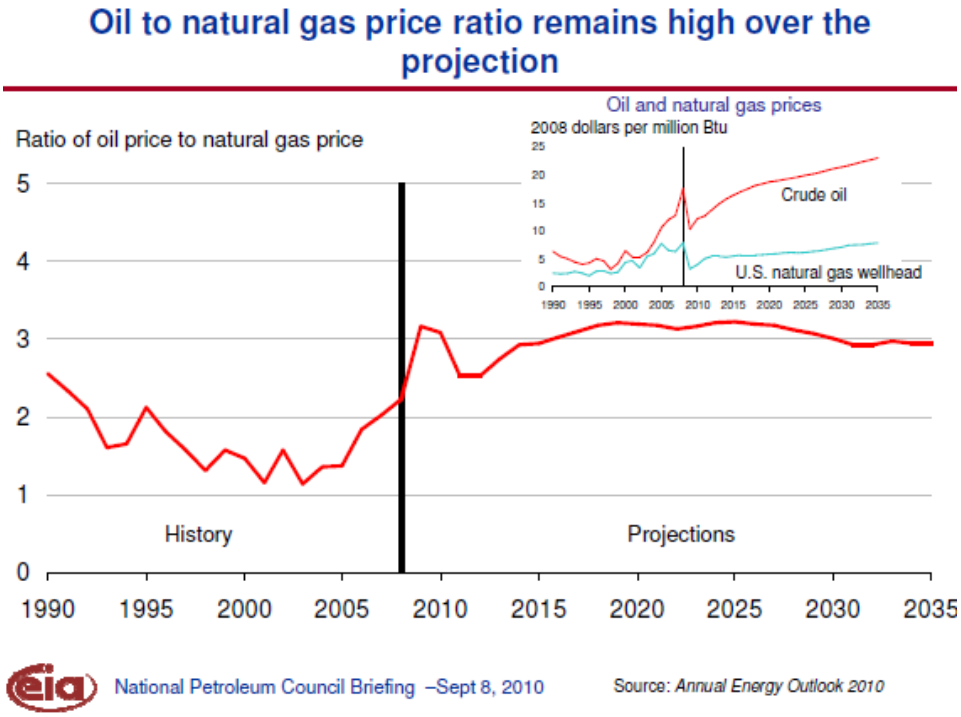
The primary benefits of HPDI are the matching of the diesel engine's power and torque curves and transient response without increasing heat rejection, while allowing 95% natural gas fuel substitution and 25-29% greenhouse gas reduction from the base diesel levels. The high natural gas usage allows for substantial fuel cost reductions for operators in areas where natural gas is substantially lower price than diesel fuel. The substantial natural gas substation also provides benefits to countries concerned with energy security and diversification, and use of abundant domestic supply of natural gas in many regions of the world.

Due to the high fuel consumption of heavy-duty trucks, mining vehicles, and locomotives, most applications will tend toward on-board energy storage in the form of LNG, although some niche applications may be able to use CNG. LNG energy density is approximately three times greater than CNG (at 200 bar), but is only 60% that of diesel fuel on a volume basis.

Step 2 – Market Potential

Westport believe that market penetration in areas with compelling natural gas pricing relative to diesel and strategic corridor LNG refuelling capacity can reach 20% of the on-road heavy-duty transport sector, and 40% of the off-road mining and locomotive markets in 10 years. In Australia, that represents a total potential shift of 145 Petajoules of energy from petroleum to natural gas by 2022[1]. While this is a substantial shift toward an abundant domestic resource with major gains in energy security and diversification, it represents only 6% of the projected domestic natural gas use, or only 5% of the LNG expected to be exported from Australia in 2022[2]. Given the anticipated increase in low-cost LNG exports from North America and other areas with abundant shale gas reserves, the diversion of LNG into domestic transportation markets may help stabilize natural gas pricing somewhat, although likely to be at lower pricing than today.

The projected price for natural gas and oil from the US Department of Energy shows an increasing pricing gap in dollars per unit energy between the two commodities over the timeframe through 2035, achieving and maintaining a 3:1 ratio for the price of oil to natural gas in the US market.



For the on-road heavy-duty transportation market in Australia, a 20% market penetration would mean approximately 25,000[3] prime movers on LNG by 2022. To achieve this level of penetration would require sales of approximately 200 units in 2012 and a 45% compounding annual growth rate. As of 2011, there are less than 200 LNG trucks in the Australian market, and sales of new LNG trucks are less than 50 units per year.

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[1] Based on ABARES Energy Update 2011 data for 2009-2010 energy consumption by sector, assuming a 2.5% per annum increase in energy consumption (average growth from 1990 to 2010)

[2] Based on ABARES Energy Update 2011 data of 972 PJ of LNG exported in 2009-10, assuming 11.0% CAGR (5-year average annual growth rate).

[3] Based on Australian Bureau of Statistics, Motor Vehicle Census, 31 Jan 2011 for articulated trucks (85,965 registered in Jan 2011) and average annual growth rate of 3.8% (2006-2011 data for articulated trucks).

Step 3 – Cost and Benefits

Transformation of the transportation energy mix to support natural gas involves cost in the following main areas:

- LNG fuel production (liquefaction and storage)
- LNG fuel distribution (tankers)
- LNG dispensing stations (storage, pumping, and metering)
- LNG vehicle application engineering and development
- LNG trucks/equipment capital cost increment
- Service facility upgrades (ventilation, electrical classifications)
- Service training and certification
- Parts supply (inventory and distribution)

In Canada, *"The Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap"*[4] initiative, published in December 2010 by Natural Resources Canada (NRCan), brought together stakeholders from governments, industry and representatives from environmental non-governmental organizations and academia to discuss the potential for natural gas use across the medium- and heavy-duty transportation sector, explore strategies for overcoming barriers associated with its use, and develop recommendations for deployment.

According to this Roadmap, Canada's transportation sector, like Australia's, could benefit from expanding the use of lower-emission technologies and fuels such as natural gas. For medium and heavy-duty vehicles that operate in return-to-base and corridor fleets, the Roadmap identified the following important potential benefits for natural gas to:

- Diversify energy use in the transportation sector and meet increasing energy demand;
- Reduce carbon emissions from the transportation sector;
- Introduce into a new market a cost-effective fuel that has historically traded at a discount to crude oil-based fuels on an energy equivalent basis;
- Provide an alternative compliance option as carbon-related regulations enter the transportation sector.

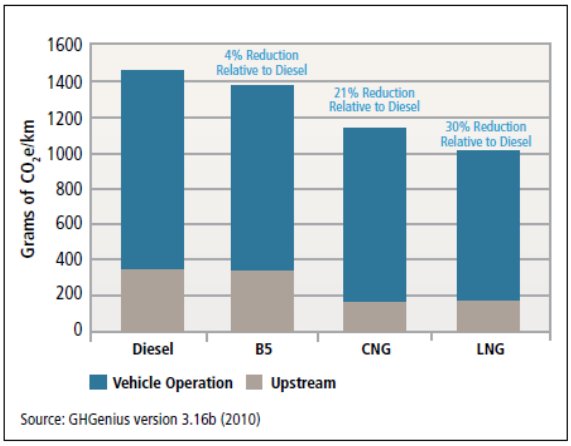


FIGURE 2 Alternative Fuel Options to Reduce GHG Emissions from Heavy-Duty Trucks

Extract from NRCan Roadmap

Despite these potential benefits, market adoption for medium- and heavy-duty natural gas vehicles (NGVs) in Canada (and Australia) has been very limited to date. The significant challenges associated with NGV deployment, include:

- operating risks associated with costs and technology performance
- high upfront vehicle costs
- lack of widespread infrastructure
- non-economic issues, including scarce recent experience with NGVs
- insufficient information about current technology
- lack of comfort with NGVs based on past history.

[4] "The Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap" can be downloaded at http://oee.nrcan.gc.ca/transportation/alternative-fuels/resources/roadmap.cfm

To address these barriers, the Roadmap's Working Groups and Roundtable's members developed a set of recommendations which reflected findings related to business modelling work; capacity-building needs; and research, development, and demonstration (RD&D) requirements. The recommendations can be categorized into four key areas:

1) De-risking Investment and Early Adoption
2) Addressing Information Gaps
3) Increasing Capacity to Sustain Markets
4) Ensuring Ongoing Competitiveness.

The following table identifies the recommendations and the roles and responsibilities assigned to the different stakeholders in implementing these recommendations.

TABLE 1 Natural Gas Use in Transportation: Roles and Responsibilities

		GOVERNMENTS	NG PRODUCERS, TRANSPORTERS, AND DISTRIBUTORS	INFRASTRUCTURE AND VEHICLE SUPPLY STREAM	END-USERS
De-risking Investment and Early Adoption	Vehicle Premium	■	■		■
	Corridor Infrastructure	■	■	■	
	Return-to-Base Infrastructure		■	■	■
	Demonstrations	■		■	■
Addressing Information Gaps	Education and Outreach	■	■	■	
Increasing Capacity to Sustain Markets	Codes and Standards	■	■	■	
	Training	■	■	■	
	Implementation Committee	■	■	■	■
Ensuring Ongoing Competitiveness	R&D	■		■	
	Use of NG in Other Applications	■	■	■	■

Extract from NRCan Roadmap

As mentioned previously, the benefits of a 20% penetration of LNG into on-road transport and 40% into mining and locomotives could achieve a 145 Petajoule shift from oil to natural gas by 2022, providing substantial energy security and diversity for Australia. This additional usage of natural gas could be supplied completely from domestic resources, at the expense of roughly 5% of the expected LNG export market. This assumes that LNG exports grow at the 5-year average growth rate of 11% per annum (2004-05 through 2009-10 average), but rapidly growing coal-based methane and shale gas resources could provide much stronger natural gas production that could alone meet or exceed the transportation, mining, and locomotive natural gas utilization.

Step 4 – Natural Gas Regulatory Environment to Facilitate Economically Efficient Uptake of NGV's

The adoption of LNG trucks and locomotives is most heavily influenced by the economic returns and risk to the end user. Fuel price differential between diesel and LNG has the highest degree of influence on the overall economic returns to the operators of LNG vehicles, and the degree of risk is a relationship between the amount of capital deployed (for LNG vehicles) and the economic returns (fuel savings). Two standard risk measures used by operators is payback

time (years to payback incremental capital deployed with annual operating cost savings) and net present value (NPV) of the lifecycle cost savings (operating cost savings after repayment of incremental capital over the operating life).

TABLE 1 Potential Policy Tools to Support NGV Market Development

TOOL	DESCRIPTION/ROLE/RATIONALE	EXAMPLES

Fiscal Measures	▪ Fiscal measures reduce the main economic barrier to market entry by reducing financial risk.
	▪ End-users perceive early adoption as being risky and, in particular, they attach uncertainty and high risk to:
	  ▪ The residual value of an NGV after the initial ownership period of, for instance, four to five years for highway tractors; and
	  ▪ The lack of refuelling infrastructure relative to diesel fuel infrastructure.
	▪ Fiscal measures may lower upfront vehicle cost, guarantee residual vehicle values, assist with access to refuelling infrastructure, or ensure fuel savings relative to incumbent fuels.
	▪ Increased early adoption of NGVs in larger quantities would help industry achieve the economies of scale required to bring down the cost of vehicle systems.
		▪ Tax measures (e.g. accelerated capital cost allowances and investment tax credits) and cash rebates that may apply to the vehicle, refuelling infrastructure, or fuel price differential.
		▪ In its 2010 budget, the Province of Québec announced adjustments to its accelerated capital cost allowances in support of LNG Class 8 trucks. The capital cost allowance measure allows for asset write-down within a significantly reduced time frame compared with a conventional truck, with the goal of de-risking upfront capital investment for the fleet.
		▪ Cash rebates have been provided in the past to reduce the incremental cost of the vehicle.

Regulation	▪ Regulation for GHG reduction is being developed for medium- and heavy-duty vehicles in the 2014 period. With careful design, these regulations could recognize and include the GHG benefits of natural gas vehicles. ▪ The rationale for regulating these vehicles is similar to that for light-duty vehicle regulation – most major governments have intervened with fuel economy or GHG standards to overcome the market failure of consumers not valuing fuel savings beyond the three-year period. ▪ Benefits of regulation include market certainty in terms of acceptable levels of environmental performance and equal treatment of technologies, as all must meet the same standard. ▪ With regard to another regulatory issue, governments could provide assistance by addressing regulations governing vehicle weights and dimensions to allow some overweight margin for LNG-fuelled trucks.	▪ Fuel economy and GHG regulations for light-duty vehicles. ▪ Low-carbon fuel standards as implemented in California and British Columbia and under consideration in Ontario.
Information	▪ End-users identified gaps in terms of information and awareness concerning NGVs as an option that could serve their needs. ▪ It is also the responsibility of governments to provide essential information to enable markets to function efficiently, especially where there is the absence of a single private sector actor that operates across the entire spectrum of the natural gas vehicle value chain. ▪ Governments are regarded as unbiased providers of information in the vehicle and fuels market arena, and this is important to end-users. ▪ Benefits of these measures include the development of a broader understanding of the benefits and commercial applicability – and therefore a greater consideration/adoption of – NGVs.	▪ Websites and fleet information hubs. ▪ Examples of these initiatives already in progress include the Clean Cities Program in the United States.
RD&D	▪ RD&D assistance for NGVs can leverage existing private sector spending and help position Canadian technologies to be more competitive and, ultimately, generate regional economic benefits. ▪ Diesel technologies have been assisted by substantial R&D funding over the past decade to meet more stringent tailpipe standards; R&D assistance for natural gas technologies would extend similar treatment and help level the playing field. ▪ End-users have identified the need for a greater range of natural gas products from which to choose, and targeted R&D investment can assist market development by increasing model availability. Production-oriented R&D investments could reduce the incremental cost of NGVs and break through the low volume/high upfront cost barrier faced by innovative lower-emission technologies trying to enter the market.	▪ The National Renewable Energy Laboratory's Natural Gas Engine Research and Development Program.

Extract from NRCan Roadmap

According to the NRCan Roadmap, policy tools are needed to both address market barriers and ensure the industry becomes self-sustaining and competitive over the long term. The preceding table extracted from the Roadmap describes the potential policy tools that could support the development of the NGV market.

With strong economic conditions for LNG vehicles with manageable risk levels, LNG infrastructure will be rapidly deployed by energy companies providing that regulatory complexity and delays are minimized.

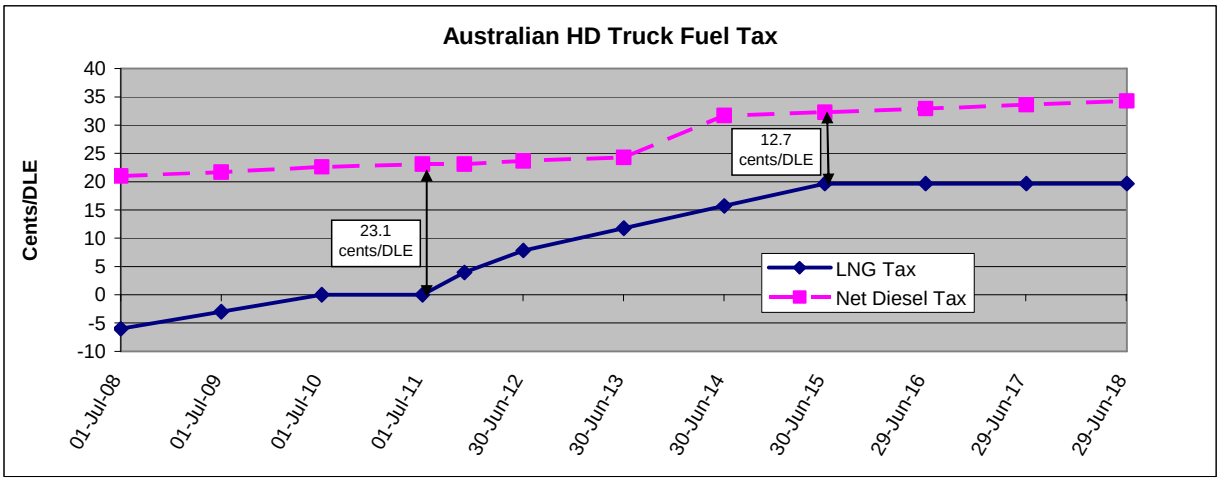
Step 5 – Changes Required to Natural Gas Regulations to Achieve Efficient Uptake of NGV's

From a regulatory viewpoint, the following environment would facilitate an economically efficient uptake of natural gas vehicles:

- Tax or incentive advantages provided to LNG fuel relative to diesel fuel. This can be achieved by lower excise or fuel tax on natural gas (such as Canada's exemption of fuel and excise tax on CNG and LNG), or implementation of a special fuel credit for natural gas (such as the USD$0.50 per gallon credit provided to LNG retailers in the US).
- Reduced consumer tax or stamp duty on purchase of new LNG trucks/equipment.
- Incentives or credits directed at reducing the incremental capital for purchasing natural gas vehicles. This option allows for performance-based differentiating credits based on vehicle technology related to greenhouse gas reductions, percentage of natural gas utilized (impact on energy security), or other environmental or national benefits.
- Adjustment of vehicle weight and length restrictions to accommodate the inherent physical requirements driven by the lower volumetric energy density of natural gas and mass of the fuel storage. This measure can be implemented to provide equality with diesel trucks, or as a low cost means of providing an additional benefit to natural gas vehicles.
- Streamlined regulatory and permit policies for rapid growth of LNG production facilities, LNG transport and distribution, LNG dispensing station facilities, and CNG compression and dispensing stations.
- Accelerated or enhanced depreciation allowances for natural gas vehicles/equipment and LNG infrastructure, including LNG vehicle production facility upgrades and R&D
- Uniform national natural gas vehicle, infrastructure, service facilities, and service training standards
- Incentives or offsets for training of qualified personnel to build and service natural gas vehicles/equipment and infrastructure

It is important to recognise that the current Australian fuel taxation and rebate policies would add roughly 10.5 cents per diesel litre equivalent[5] (DLE) additional tax cost to LNG used in heavy duty trucks relative to diesel trucks by 2015. This picture worsens to over 17 cents per DLE additional tax on LNG relative to diesel if the current plan for adding carbon tax to diesel fuel 1 July 2014 is not implemented. **Current Australian fuel tax and rebate policies are a significant disincentive to the adoption of natural gas for transportation that should be reviewed in conjunction with any new policies for natural gas use in transportation**.

[5] Diesel litre equivalent (DLE) is the amount of energy in lower heating value (LHV) of one litre of diesel fuel, and is used to allow comparison of LNG and diesel fuel on a common basis. Regulatory policies and metering of LNG should be on a mass (kg) basis.



LNG pricing at today's low truck/fuel volumes, worsened by the impending introduction of excise taxation on LNG starting in December 2011, provides challenging economic conditions for most truck fleets to adopt LNG fuel with the current economic and regulatory environment and risks.

Conclusions

Natural gas use for transportation in on-road heavy duty trucks, off-road mining vehicles, rail, and marine, offer significant energy security and greenhouse gas advantages to Australia, especially considering the vast conventional and non-conventional (coal-seam and shale gas) domestic resource base. However, to realize a meaningful shift to implementation of natural gas, all stakeholders must contribute to increasing the viability of the economic and regulatory climate for adoption.

The findings of *"The Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap"* published by Natural Resource Canada has been cited in several places in this document and an electronic copy is included with this submission. We believe this Roadmap offers valuable multi-stakeholder insight to the issues and potential solutions that could be considered and applied in the Australian context.

Australia has a unique opportunity to adopt policies to stimulate the adoption of natural gas as a transportation fuel, which would generate significant energy security and carbon benefits for the nation and encourage clean technology innovation and economic growth.