

THE SUCCESSFUL DEPLOYMENT OF HEAVY DUTY VEHICLES POWERED BY NATURAL GAS: THE RESULT OF COOPERATION BETWEEN STAKEHOLDERS IN THE NATURAL GAS VEHICLES MARKET

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1. Background

Jurisdictions around the world face energy, environmental and economic challenges and attempt to juggle these issues while maintaining a delicate balance to generate economic development and wealth in their own countries.

Existing technologies provide options for the use of various fuels in sectors such as power generation, residential, and transportation.

In the case of natural gas (NG), its use in transportation can help address numerous issues by providing economic benefits, emissions reductions and energy diversification. The deployment and adoption of natural gas vehicles (NGVs), its applications and technologies vary among jurisdictions but one trend remains: behind every successful natural gas vehicle (NGV) project, a strong strategic and comprehensive partnership exists among the different stakeholders.

This paper presents the results and recommendations of the “Natural Gas Use in the Canadian Transportation Sector: Deployment Roadmap”¹ prepared by the Natural Gas Use in Transportation Roundtable. While this document is the result of Canadian stakeholders, this Deployment Roadmap demonstrates that collaborative consultation and work in conjunction with strategic partnerships will lead to successful lasting NGV deployment. Therefore, the findings and recommendations presented in this paper are arguably applicable to numerous markets.

The case studies added to this paper will showcase the importance of partnerships among the key stakeholders such as the original equipment manufacturers (OEM), fuel providers, technology companies, fleet owners and government agencies, which all have a specific and strategic role to play in making these NGV projects a reality.

Finally, in early 2012, the Deployment Roadmap entered into its implementation phase by the creation of Working Groups responsible of implementing specific recommendations from the Deployment Roadmap: Outreach/Education and Codes/Standards. Key stakeholders in the NGV industry will continue their collaboration through these Working Groups to create and implement the strategic activities and initiatives.

¹ <http://oee.nrcan.gc.ca/transportation/alternative-fuels/resources/2888>

2. Aims

The global transportation sector 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, natural gas offers some important potential benefits, such as the ability 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 new carbon-related regulations enter the transportation sector.

Despite these potential benefits, market adoption for heavy-duty natural gas vehicles has been very limited to date. Operating risks associated with costs and technology performance, high upfront vehicle costs, a lack of widespread infrastructure, and non-economic issues, including scarce experience with heavy duty NGVs, insufficient information about the available technologies, and a lack of comfort with NGVs based on past history represent significant challenges associated with NGV deployment, most specifically for heavy-duty trucks.

To address the transportation sector's increasing energy demand and greenhouse gas (GHG) emissions, jurisdictions around the world need a comprehensive strategy to improve vehicle efficiency, increase the use of lower-carbon fuels, and enhance system efficiencies.

The increased use of natural gas in the transportation sector is one component of the overall solution. Due to the challenges associated with this deployment, a coherent, innovative and cooperative approach is required to overcome the barriers and enable a rapid market transformation. In this perspective, strategic partnerships with key stakeholders are necessary to successful deployment of NGVs.

This paper aims to demonstrate the inescapable ecosystem required to bring heavy duty NGVs on the road around the world and the need to create productive partnerships to generate the shift in energy philosophy.

3. Method

This paper and its findings are primarily based on our extensive experience in projects involving heavy duty vehicles powered by liquefied natural gas (LNG) in North America. These concrete examples of significant NGV adoption all required numerous stakeholders including, but not limited to, engine technology companies, vehicle manufacturers, fuel providers, end-users and government agencies.

This paper also includes market intelligence and lessons learnt from our partnerships and cooperation agreements with various stakeholders across the world (mainly North America, Europe, Asia and Australia). More generally, it reflects the expertise and experience gained from working more than fifteen years in the area of gaseous fuels and alternative-fuelled vehicles.

Another recent, valuable and innovative experience is the Natural Gas Use in Transportation Roundtable. This Roundtable — led by the Deputy Minister of Natural Resources Canada — was formed in March 2010 to identify the optimal use of natural gas in Canada's transportation sector. The Roundtable consisted of federal and provincial officials; industry representatives, such as natural gas producers, transporters, distributors, vehicle makers, equipment manufacturers, and end-users; and representatives from environmental non-governmental organizations and academia.

The *Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap* is the result of this Roundtable's work. This process provided a platform for this broad array of stakeholders 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.

This Deployment Roadmap is innovative in nature and distinguishes itself from technology roadmaps in three fundamental ways: 1) the detailed business modelling work that was performed to assess, analyze, and rank potential end-use applications in the medium- and heavy-duty portion of the transportation sector, 2) the consultations that were undertaken with various end-users that might adopt this technology, and 3) the significant contributions made by the Roundtable member organizations, which were fully engaged in the Roadmap development from the outset. The Roadmap's framework for assessing the true potential of NGV adoption could also be used by those considering other fuel or technology pathways.

In January 2012, working groups were formed from the participating roundtable stakeholders to execute the implementation of key recommendations most specifically on education/outreach and codes and standards.

4. Results

This paper demonstrates the unavoidable ecosystem required to bring NGVs on the road around the world and the need to create productive partnerships to generate the shift in energy paradigm.

The examined case studies highlight practices that help solving the so-called ‘chickens and eggs’ issue (no fuelling infrastructure, no vehicles and vice versa). These examples show how the access to both heavy duty NGVs and LNG fuelling infrastructure can be facilitated by a coordinated and strategic approach between all stakeholders. Such successful collaboration therefore drives the development of fuelling infrastructure, NG supply and NGV market penetration at the same time, in a model where all participants share the success.

The *Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap* is another interesting example of fruitful collaboration. As an initial step in developing the *Deployment Roadmap*, working groups assessed opportunities for new natural gas markets in the on-road transportation sector (including light-, medium-, and heavy-duty vehicles), as well as marine and rail applications. In the near term, medium- and heavy-duty vehicles were found to offer the greatest opportunities for increased natural gas use. The prospects for natural gas use in other applications, including light-duty vehicles, marine vessels, and locomotives, were also found to be promising. However the working groups’ subsequent work focused primarily on medium- and heavy-duty applications.

Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap - Recommendations

The results of the *Deployment Roadmap* were translated into a comprehensive set of recommendations that was developed in consultation with stakeholders representing all Roadmap working groups as well as Roundtable members. These recommendations reflect findings related to business modelling work; capacity-building needs; and research, development, and demonstration (RD&D) requirements.

Recommendations have been proposed in four key areas:

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

It is important to acknowledge that these recommendations, developed among Canadian stakeholders, could be applied to different jurisdictions around the world. While the players and specific issues may be different, the required shift in “energy philosophy” remains the same for all countries.

1) De-risking Investment and Early Adoption

- Analysis has demonstrated that investment in medium- and heavy-duty NGVs can provide environmental and over-vehicle-life economic benefits, but the upfront capital cost vehicle premium and the risks associated with operation costs and achieving ongoing fuel savings are barriers to adoption. Fiscal measures implemented on a temporary basis could address these barriers and de-risk decision-making for early fleet adopters.

- To introduce natural gas into the new market of over-the-road trucking, coordinated investments are needed to ensure that the development of key corridor infrastructure is consistent with projected demand, strategically located to support end-users, and installed in a timely manner across jurisdictions.
- Existing industry players could provide access to private onsite refuelling stations. Fleets could further improve the business case for natural gas adoption by allowing other fleets to use these stations via cardlock and other arrangements. However, there are implementation details (e.g. liability issues) that would need to be addressed by the parties involved.
- Demonstration of the use of natural gas is needed to address technical barriers, develop standards, and conduct feasibility studies and business cases

Rationale

Temporary fiscal measures would help de-risk adoption and lower economic barriers to market entry. End-users perceive early adoption as risky and, in particular, they attach uncertainty and risk to 1) the residual value of an NGV after the initial ownership period (e.g. four to five years for highway tractors), 2) the potential for ongoing fuel savings, and 3) the lack of refuelling infrastructure relative to diesel fuel infrastructure. Temporary fiscal measures would encourage early adoption of NGVs in larger quantities, which in turn would help the NGV industry achieve the economies of scale required to reduce the cost of vehicle systems. While there is a positive internal rate of return for several end-use applications, temporary fiscal measures would also be necessary to overcome the barriers to adoption if they are determined to be the result of market failure within the medium and heavy-duty portion of Canada's transportation sector. While there are many precedents for market intervention by governments to assist in developing scale and removing barriers to entry, over the longer term it will be important for natural gas as a transportation fuel to be able to compete on a level playing field with other fuels — based on its own merits. This principle should be considered by policy-makers in terms of the design and duration of any policies to move forward.

2) Addressing Information Gaps

- An education and outreach strategy would be needed to target end-users as well as market influencers and other key stakeholders. This strategy should consist of both a “top-down” and a “bottom-up” approach. A top-down approach would include a central website for all target audiences with local content tailored to specific jurisdictions. A bottom-up approach would feature a local support network for end-users and provide access to resources including workshops and case studies of local fleets.

Rationale

End-users identified gaps in their knowledge and awareness of NGVs as an option that could serve their needs. In addition, end-users with past experience using natural gas had additional information requirements related to recent NGV developments, particularly technological innovations. It would provide momentum if governments and other players were to provide essential information to enable markets to function efficiently, especially since there is no single private sector actor that operates across the entire spectrum of the NGV value chain. Governments are regarded as unbiased providers of information in the vehicle and fuel market arenas, and this neutrality is important to end-users. Benefits of this measure include the development of a broader understanding and increased awareness of the applicability of NGVs, which would facilitate adoption of these vehicles in greater numbers.

3) Increasing Capacity to Sustain Markets

- A “safety codes and standards” working group should be established to collaborate with existing Canadian Standards Association technical committees to address gaps and issues in existing codes and standards identified during the Roadmap process. Separate committees for liquefied natural gas (LNG) and compressed natural gas (CNG) may need to be formed to review existing codes and revise or develop new codes and standards. An umbrella committee is needed to ensure that codes and standards for CNG, LNG, liquefied compressed natural gas, and biomethane are coordinated and comprehensive.
- Appropriate training materials for stations, vehicle repairs, and NGV fleet operations, as well as for cylinder inspection, need to be developed and delivered.
- An NGV implementation body — consisting of Roundtable members and other key stakeholders — should be established to:
 - Support the implementation of the Roadmap’s recommendations and assess progress against key milestones;
 - Provide recommendations to stakeholders regarding how the natural gas community could respond to future developments, such as changes in market conditions and technological innovations.
 - Act as an umbrella organization for the local support network for end-users; and
 - Serve as a forum for stakeholders to discuss issues pertinent to the natural gas community.

Rationale

To encourage NGV adoption, end-users need to be supported during their purchasing decisions, and adequate codes and standards need to be in place to ensure a successful technology rollout. Over the past decade, very little work has been done in Canada to update CNG codes and standards, while LNG codes and standards require even more fundamental development. As NGV technology becomes increasingly available, fleets will require support, since this technology features specific maintenance and safety requirements that will necessitate training of operators and mechanics. An NGV implementation body is recommended as a way to coordinate the work of governments and stakeholders along the NGV value chain to ensure the successful deployment of this technology and mitigate the risks borne by end-users or by any individual player.

4) Ensuring Ongoing Competitiveness

- The NGV industry funds R&D activities at present. Further investment by others, including governments, has the potential to enhance the competitive position of the industry through targeted R&D investment. Priorities for future R&D include reducing or eliminating the cost differential between natural gas and diesel vehicles over the long term and maximizing NGVs’ operational and environmental benefits.
- Potential for natural gas use in other transportation applications should continue to be explored.

Rationale

While NGV technology is already mainstream and commercially proven, support for NGV R&D is needed to further reduce the incremental cost of NGV-related technologies. In addition, assistance is needed to sustain market development through the expansion of the

number of NGV offerings for end-users. NGV technologies would also benefit from R&D investments to reduce the incremental cost of these vehicles, which would ensure ongoing competitiveness for innovative low-emission Canadian technologies. By continuing to explore the potential for natural gas use in other transportation applications, the natural gas community will help expand the benefits of natural gas as a fuel and potentially leverage infrastructure and R&D investments made for the medium- and heavy-duty vehicle market.

Roles and Responsibilities

The stakeholders in Table 1 were identified as parties who could take on roles and responsibilities as they relate to moving the recommendations of this Roadmap forward. For many of these activities, numerous stakeholders could play a role; however, the table aims to provide a general overview of the roles that key stakeholders could play during the early stages of NGV market development.

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	■	■	■	■

Moving Forward

For governments and industry alike, the changing supply story for natural gas, projected high oil prices, and the need to reduce GHG emissions and criteria air contaminants have all contributed to renewed interest in natural gas as a transportation fuel. Now that market conditions are more favourable, Canada's natural gas community is well positioned to take a significant leap forward in deploying these vehicles in greater numbers. While natural gas is not the only solution for reducing GHG emissions produced by medium- and heavy-duty vehicles, it provides a particularly good set of benefits for return-to-base and corridor fleets. As a result of past research assistance from governments, several Canadian companies are now technology leaders in the areas of natural gas vehicles and fuelling infrastructure. There is also a sound base of codes and standards that the natural gas community can build upon. But perhaps the most important advantage for Canada's natural gas community is the new collaborative environment that has developed as a result of the Roadmap process. Such collaboration, which was essential during the Roadmap's development, will again be critical as Canada's natural gas community turns its focus to implementing the recommendations set out in this report.

Early 2012, the implementation phase of the Deployment Roadmap recommendations started with the creation of specific working groups. These working groups once again demonstrate the strong collaborative nature of this process among the different industry stakeholders.

Case studies

The following case studies have been added to this paper to demonstrate the need and importance of strategic partnerships to successfully implement NGV projects. Regardless of the differences among markets, the interaction among partners and their individual roles and responsibilities remain essential to the effective deployment and adoption of NGVs.

Case Studies – Canada

Vedder Transport Transportation Group²

The Vedder Transportation Group remains a family owned and operated company with its head office located in Abbotsford, Canada. With its two trucking companies, Vedder Transport Ltd and Can-Am West Carriers Inc, the companies offer dedicated and irregular route highway less than truck load and truck load specialized and general freight services throughout Canada and between Canada and the United States. Today, the Vedder Transportation Group now operates a diverse fleet of 300 tractors and over 800 semi trailers, employing hundreds of people.

The company's commitment to excellence and the environment combined with its passion and integrity has led the company to adopt innovative solutions to continuously improve their business and customers service. In line with these corporate values, Vedder Transport Ltd. announced in December 2010 their purchase of 50 Peterbilt LNG trucks powered by Westport HD systems, the first operation of its kind in British Columbia

The new trucks, powered by Westport HD, are used on routes within Southern British Columbia primarily servicing the Bulk Food Grade Industry such as the British Columbia Dairy Producers and other liquid or dry state world wide agricultural organizations, making Vedder Transport Ltd. one of the world's most environmentally clean transporters servicing these markets.

Furthermore, FortisBC, the largest distributor of natural gas in British Columbia, fuels the Vedder Transport natural gas fleet through a LNG refuelling station in Abbotsford. In addition, FortisBC, through its Energy Efficiency and Conservation program, offsets the incremental cost of using LNG-powered trucks rather than their traditional diesel counterparts. This significant order for LNG trucks in Western Canada further demonstrates that natural gas is rapidly becoming a mainstream fuel solution for the trucking industry in Canada. With the Province's 33% carbon reduction target by 2020, substantial commitment from Vedder Transport and FortisBC to operate LNG trucks is helping the Province achieve this target.



² <http://www.westport.com/news/2010/vedder-transport-orders-50-peterbilt-lng-trucks-powered-by-westport-hd-systems>

Transport Robert³

Transport Robert is one of Canada's largest for-hire trucking companies with an estimated 1,100 tractors and 2,300 employees and remains a family owned company which was originally founded in 1946. The parent company, Groupe Robert Inc., is a logistics solution provider to Fortune 1000 companies throughout North America.

Transport Robert is also considered a leading carrier in Canada which has always been at the forefront of clean technology innovations in the trucking industry. Over the last decade, Transport Robert has worked to pioneer technologies which reduce green house gas emissions while simultaneously increasing fuel efficiency. As part of their unwavering commitment to the environment, the company announced in October 2010 its purchase of 180 Peterbilt LNG trucks powered with Westport HD systems.

Transport Robert has also partnered with Gaz Métro to supply clean burning LNG to their alternative fuel vehicles and to install LNG fuelling stations along the line haul routes between Montréal and Québec City, and Montréal to Toronto. Canada's first liquefied natural gas (LNG) fuelling station has opened in Boucherville, on Montreal's South Shore, in October 2011. As part of a \$5.4 million demonstration project, the LNG station is the first of many that are planned to open between Quebec City and the Greater Toronto corridor.

The Quebec Government is also a proponent of environmental initiatives, such as the use of alternative fuels to reduce emissions, and has therefore worked with the trucking industry to formulate policies that encourage the use of "green technologies" such as the accelerated depreciation rate for LNG trucks.

³ <http://www.westport.com/news/2010/robert-transport-orders-180-peterbilt-lng-trucks-powered-by-westport-hd-systems>

Case Studies – USA

While these aforementioned examples refer to Canadian projects, similar partnerships have been created among key stakeholders in the United States to create and implement these NGV projects.

UPS⁴

With more than 275,000 vehicles combined, UPS represents the largest private fleet in North America. With its purchase of LNG trucks powered by Westport LNG systems, UPS has demonstrated its leadership in advancing and developing future generations of delivery vehicles that significantly reduce fuel consumption and dependence on fossil fuels. UPS was the first private delivery company to purchase LNG trucks when 11 were deployed in 2000.

In 2010 UPS has deployed 245 new delivery trucks powered by CNG to cities in Colorado and California. The trucks, built from scratch as CNG vehicles, joined more than 900 CNG vehicles already in use by UPS worldwide.

In February 2011, UPS purchased 48 LNG trucks powered by Westport HD Systems to be used in interstate operations for the Ontario, California to Las Vegas, Nevada route. UPS will have a fleet of more than 1,100 natural gas trucks including compressed natural gas delivery vehicles powered by Cummins Westport engines and the recently purchased LNG tractors. These LNG trucks are expected to produce 25% fewer greenhouse gas emissions compared to the older diesel trucks and displace 95% of the fuel used by conventional diesel vehicles.

In order to fuel this fleet, UPS has signed in 2011 a long-term contract with Clean Energy Fuels Corp., the leading provider of natural gas fuel for transportation in North America. Clean Energy has made the commitment in 2011 to build the backbone network of 150 LNG fuelling stations for its America's Natural Gas Highway, providing LNG truck fuelling coast-to-coast and border-to-border in the United States.

The newest Clean Energy fuelling station on the Highway is located in Las Vegas nearby the UPS Depot and provides the link for trucking between Los Angeles and Salt Lake City, a vital goods movement corridor in the Southwest. The agreement between Clean Energy and UPS has a seven-year initial term with three one-year renewal options. Clean Energy owns the land and built the station with the combination of its own capital supplemented by funding from the federal government's ARRA (American Recovery and Reinvestment Act of 2009) program delivered through the South Coast Air Quality Management District (SCAQMD). The government program also provided funds to assist UPS in purchasing its new fleet of 48 natural gas-fuelled trucks based at the Las Vegas Depot.

UPS pledged to support the Administration's energy security efforts and to develop new alternative fuel technologies in tandem with the government. The combination of private sector innovation with public sector support is seen as a way to drive efforts to lower America's dependence on foreign oil while growing the domestic economy and contributing a significant cost-savings to companies.



⁴ <http://www.westport.com/news/2011/president-obama-visits-ups-truck-powered-by-westport-hd>

Heckmann Corporation⁵

Heckmann Corporation is a water solution company focused on water issues worldwide and, in particular, oil and natural gas exploration and production. The company was created to buy and build companies in the water sector, and through its acquisitions, the company became one of the largest handlers of produced water in North America, Heckmann is also a major supplier of Encana which provides the fuel to Heckmann for their operations, creating a vertical integration of the different aspects of the business.

In April 2011, Heckmann Corporation teamed up with Encana Natural Gas, Westport Innovations and Peterbilt Motors Company to employ the largest transport fleet of liquefied natural gas powered trucks in North America. With this purchase, Heckmann Corporation placed the single largest order for liquefied natural gas (LNG) trucks by a U.S. customer (200) and became the first major exploration and production company's supply chain transition to natural gas. This NGV fleet is also aimed at reducing Heckmann Water Resources' carbon footprint in Haynesville Shale area by up to 30% and dramatically reduce fuel cost.

Under the terms of the agreement, Encana will make fuelling services available where HWR operates its fleet of water transportation vehicles. HWR will also use the trucks to service its customer's natural gas wells and provide water handling services in conjunction with its system of pipelines and disposal wells.

When liquefied natural gas is deployed in upstream natural gas operations critical infrastructure is created and additional market demand for natural gas is stimulated in fleet transportation, including light-duty commercial fleets and other heavy-duty off-road operations, as well as natural gas drilling rigs, pressure pumping services and freight transportation. Beyond the natural gas sector, momentum also builds for increased natural gas use in other sectors, such as mining and construction, and the cumulative benefits of expanded natural gas use results in multiple economic and environmental benefits for society.

⁵ <http://www.westport.com/news/2011/heckmann-teams-up-with-westport-to-employ-largest-fleet-of-natural-gas-powered-trucks>

Shell –Westport⁶

In September 2011, Westport Innovations launched an innovative co-marketing program with Shell to develop a North American market for liquefied natural gas vehicles and fuels. This program is aimed at providing customers a better economic case when purchasing and operating liquefied natural gas-powered vehicles (LNGVs) by consolidating key value chain components such as fuel supply, customer support and comprehensive maintenance into a single, user-friendly package.

Under the terms of the agreement, both companies will leverage their industry-leading positions in liquefied natural gas (LNG) production and distribution for Shell and LNGV systems and technology for Westport, to deliver a superior integrated commercial solution to participating customers, initially in North America. Additionally, the companies will collaborate to develop industry standards for LNG as a new transportation fuel in support of their on-going efforts to maintain the highest health, safety and sustainable development practices.

This co-marketing program is a unique example of using commercial innovation to reshape the value proposition of a new technology to its customers while exemplifying the importance of strategic partnerships in bringing LNG trucks throughout the North American continent.

In parallel with this program, Shell has also announced in September 2011 its plan to open in 2012 a LNG pump at a Shell Flying J truck stop in Alberta, the first in a series of new refuelling facilities the company intends to build. This initiative is part of a broad-based effort that will also see Shell build a new LNG manufacturing plant outside of Calgary and work with the makers of natural gas truck, rail and marine engines to promote the technology. The plan is among the most ambitious attempts to date by an energy company to push natural gas into the transportation sector, which has become a key aim for an industry mired in low prices.

⁶ <http://www.westport.com/news/2011/westport-to-launch-innovative-co-marketing-program-with-shell>

Case Studies – Europe

In North America, the deployment of LNG heavy duty trucks has started more recently than in Europe. However some examples already show that the Canadian Roadmap recommendations are also applicable in Europe – and are already being applied in some projects.

The European Commission adopted in March 2011 a comprehensive strategy (Transport 2050 roadmap) for a competitive transport system set out to remove major barriers and bottlenecks in many key areas across the fields of: transport infrastructure and investment, innovation and the internal market. Methane is part of the EU strategy for the future of transport outlined in the final draft of the report of the European Expert Group released on January 2011.

Following the main recommendations from the Expert Group of Future Transport Fuels, the European Commission officially introduced the 5th FP7 call for 2011/2012 research, innovation and demonstration projects. One of the transport related calls is on the “Demonstration of heavy duty vehicles running with liquefied methane” to promote LNG Blue Corridors on medium and longer distances. The overall objective is to perform large-scale demonstration in order to facilitate a broad market development for heavy duty trucks running with liquefied methane. The project is designed as a large scale project having a total EU funding of 8 million Euros. The project should involve cooperation between heavy duty vehicles manufacturers, fuel suppliers, fuel distributors and fleet operators.

Before the launch of this large scale demonstration project, there has been local and national initiatives to perform field trials and demonstrations of heavy duty LNG trucks in Europe and especially in the UK, the Netherlands, Sweden and Spain. Examples of fleets currently using one or several LNG trucks include:

- Coca-Cola Enterprises Ltd (CCE) is running trials of a 21-tonne Iveco Stralis delivery vehicle run on Gasrec’s sustainable liquid biomethane fuel operating from its Enfield and Sidcup depots in the UK.⁷
- Sainsbury’s uses Gasrec’s liquid biomethane for five of its trucks in the UK⁸
- Recent developments in Sweden are targeted primarily in the direction of use of liquefied methane and especially biomethane in heavy-duty applications. In 2010, Volvo Trucks initiated field testing of its new FM MethaneDiesel dual-fuel truck (13L engine, 460 hp) in the Netherlands, Great Britain and Sweden. In parallel, Business Region Göteborg, together with industry and transport authorities, has received SEK 23.95 million (US\$ 3.3 million) in Energy Agency funds for demonstration projects for long-distance biomethane trucks and bus. The project, which uses the term “BiMe” trucks, is described as having a unique potential to develop a market for heavy duty vehicles powered by liquid biomethane in Sweden and open up environmental technology export opportunities. The project’s goals include 67 long-distance heavy duty trucks being powered by liquid biomethane and at least three filling stations, one each in Göteborg, Stockholm and Malmö. Truck project participants are AB Volvo, along with the leading biogas suppliers in Sweden, AGA, Eon and FordonsGas. Business Region Göteborg, which includes Energas Sweden and Biogas West, is the project manager. The project is co-funded by the Västra Götaland region. Three filling stations for liquefied methane gas have been planned in Sweden to date. Besides the completed one in Göteborg, Aga will open a filling station in Stockholm, and Eon will

⁷ <http://www.ngvaeurope.eu/coca-cola-trials-gasrecs-sustainable-fuel-made-from-landfill-gas>

⁸ http://www.greenerliving.tv/news_detail.php?id=132



open one in Malmö. Volvo Trucks is a partner in all the projects. There are plans to build additional stations if demand increases.

- Vos Logistics, headquartered in the Netherlands, a specialist in a wide range of transport and customer-specific logistics services, is active throughout Europe. With 2,000 employees, it operates some 1,200 vehicles. In the bulk and volume transport markets, Vos Logistics is one of the largest road carriers in Europe. In Oss in the Netherlands, the first LNG filling station of North-Western Europe has officially started in September 2010. The filling station is a common initiative of Vos Logistics, Mercedes-Benz the Netherlands, LNG Europe, Van Gansewinkel and Indox Cryo Energy. The LNG station is located on the premises of Vos Logistics at the Waalkade 4 in Oss.⁹
- Volvo Trucks, the first manufacturer to introduce methane-diesel heavy duty trucks to Europe, has delivered the first FM model trucks in the Netherlands to logistics transporters Wezenberg Group and Dasko Group, and Jumbo Supermarkets.
- In Spain, Transportes Monfort is a clear example of the effort made by some European transport companies for diversifying to natural gas. The company has been using three LNG trucks since 2007. The first liquefied natural gas station in Valencian Community, inaugurated in March 2011, is an initiative of Transportes Monfort, through which it will supply its truck fleet and other commercial vehicles in the community.¹⁰
- Through the logistical operator Acotral (Compañía Logística Acotral, S.A), Spain's largest supermarket operator, Mercadona, has been using three tractor trailers powered by LNG since 2009. They were built by Mercedes and Iveco and operate between the port of Tarragona and the logistics block in Sant Sadurn d'Anoia (Barcelona).¹¹
- In France, the first test of LNG truck has been done in November 2011 by Mendy, a transport company based in the South-West of France. This trial has been done in cooperation between GNVert, a subsidiary of GDF Suez (leading natural gas provider in France) and Iveco.

⁹ <http://www.nggm.com/nieuws/2/1/lng-filling-station-started-in-the-netherlands.html> and [http://www.voslogistics.com/News%20and%20Information/News/Vos%20Logistics%20opens%20first%20LNG%20filling%20station%20in%20the%20Netherlands/\\$id1984](http://www.voslogistics.com/News%20and%20Information/News/Vos%20Logistics%20opens%20first%20LNG%20filling%20station%20in%20the%20Netherlands/$id1984)

¹⁰ <http://www.ngvjournal.com/en/stations/item/4367-spain-first-liquefied-natural-gas-station-in-valencian-community-is-inaugurated->

¹¹ <http://descargas.mercadona.com/memorias2009/ING/Report09.pdf>

In a limited number of European transport companies, the use of LNG has already been expanded to a more significant number of vehicles – between five and twenty-five trucks until now depending on the project. Each of these projects has required a strong cooperation – including coordinated investments, education efforts, etc. – between several partners, usually consisting of at least a vehicle manufacturer, a fuel provider and an end-user. Some of these examples are presented hereafter.

Huybregts, The Netherlands¹²

Transport company Gebr. Huybregts now uses 10 Iveco Stralis tractor units running on liquid biogas for in city goods distribution for Albert Heijn supermarkets in the Netherlands (project launched end of 2010 / beginning of 2011).

Gebr. Huybregts Group is one of the largest logistics service providers in the distribution of food and non-food to major retailers in the Netherlands.



The liquid biogas is made from landfill gas and has a methane content of 98 % assuring a high energy density.

Rolande LNG, the LNG specialist in the Netherlands, is currently rolling out the necessary filling station infrastructure to enable the increase of the number of trucks running on liquid biogas. The support from both governmental and local authorities is essential; in fact they control the speed of the roll out of the filling stations. As the Iveco Stralis is still not available ex. works in LNG execution the truck has to be converted from CNG operation to LNG operation. This is done by one of the main Iveco dealers in the Netherlands, in close cooperation with Rolande LNG supported by Iveco Netherlands.

The result of this cooperation is that, according to Iveco Netherlands, it is now possible to offer a competitive business proposition compared to diesel trucks. The fuel costs are lower which enables a good return of investment to compensate for the current higher investment costs.

Moreover the use of biogas in transport is supported by a Dutch subsidy scheme. The Dutch Ministry of Transport has granted a subsidy of 3.000 €, per commercial vehicle (max 100.000 € per project per company) purchased between the 1st of July 2011 and 31st of December 2011 and which is using higher blends of biofuel and biogas or “greengas” as combustible.

¹² <http://www.ngvaeurope.eu/trucks-from-dutch-transport-company-gebr-huybregts-are-running-on-liquid-biogas>

Chr. Vermeer Transport B.V., The Netherlands¹³

In 2010, Rolande LNG B.V. (Rolande), a Kaatsheuvel-based specialist in supplying liquefied natural gas (LNG) and liquefied biogas (LBG) for road transport applications, has facilitated what has been the first heavy-duty mono-fuel truck in Europe to run on liquid biomethane.

Working in close cooperation with IVECO in the Netherlands, Rolande brought the concept to reality by converting an IVECO Stralis CNG to run on LNG/LBG. Rolande provided technical expertise and the cryogenic tanks and heat exchanger necessary to use LBG as a fuel.

The truck has been bought by Chr. Vermeer Transport B.V. in Dongen. It is currently being used to demonstrate and convince the transport industry of the many advantages of using LBG as fuel.

Arnold Suhr Netherlands B.V., a company specialized in the ingredients supply chains for Food & Beverages, Health & Personal Care and Chemical products, has been working with Chr. Vermeer Transport to forward its goods for more than 30 years. Arnold Suhr is supporting this innovation, which protects the environment.



Tesco, United Kingdom¹⁴

In July 2010 Tesco has commissioned 25 Iveco EcoDaily light commercial vehicles fuelled by sustainable Liquid Biomethane for its online grocery shopping and delivery service tesco.com. The fuel is made by UK company, Gasrec (the first commercial producer of Liquid Biomethane in Europe), and is created by extracting naturally occurring methane from organic waste in landfill sites and converting it to a high quality, clean fuel.



¹³ <http://www.ngvglobal.com/rolande-introduces-europes-first-mono-fuel-lbg-truck-0415> and http://www.arnoldsuhr.com/news/1/44_chr-vermeer-transport-bv-on-biogas.html

¹⁴ <http://cnch4.com/mediadetails.php?ID=21>

Gasrec initially supplies fuel for the 25 Liquid Biomethane-fuelled 5.3 tonne vans to Tesco's dedicated regional distribution centre for its Tesco.com home delivery service, at Greenford. If the vehicles prove successful, then Tesco has said it will consider rolling out Gasrec biomethane-powered vehicles across more of its Tesco.com fleet.

Gasrec's Liquid Biomethane is created by extracting the natural gas produced from biomass in landfill. The gas is then converted to Liquid Biomethane, which is then used to fuel dedicated gas-powered or duel-fuel vehicles; or for decentralised (off grid) power generation. Gasrec is providing a refuelling facility for the Greenford site through its partner, Gas Container Services (GCS) which provides infrastructure for sustainable gas-based fuels.

Waitrose, United Kingdom¹⁵

In August 2010, after a six month successful trial, supermarket chain Waitrose has signed up to run five of its home delivery vans (Mercedes NGT Sprinters) on liquid biomethane produced from landfill gas. The liquid biomethane fuel for these five vans that Waitrose uses to deliver groceries is being supplied by UK company Gasrec.



These five Mercedes NGT Sprinters have been acquired in February 2011. They weigh 3.5 tons each and are equipped with Hubbard refrigeration units and insulated bodies created by Gray & Adams.

The Waitrose vehicles refuel from a Gasrec-run refuelling facility based in Camden, north London, where Gasrec ran a successful six month trial of a Gasrec-fuelled Iveco Daily 65C14G cage tipper.

¹⁵ <http://www.clickgreen.org.uk/news/national-news/121447-waitrose-cuts-delivery-van-emissions-with-sustainable-fuel.html>

5. Summary/Conclusions

The use of natural gas in transportation can help address numerous issues by providing economic benefits, emissions reductions and energy diversification to numerous jurisdictions around the world. Energy leaders will therefore need to consider natural gas for transportation as both a solution of global energy challenges and an attractive market potential.

The list of drivers for leading stakeholders to expand natural gas use in the transportation sector is compelling. Individual stakeholders can realize benefits, if and only if the other stakeholders agree to participate in developing the market. One of the key success factors is the extensive collaboration between stakeholders including those involved in vehicles and engine technologies, fuel supply and infrastructure, the end-users and governments.

The Deployment Roadmap and the case studies demonstrated that behind every successful natural gas vehicle (NGV) project, a strong strategic and comprehensive partnership exists among the different stakeholders.

As highlighted by the *Natural Gas Use in the Canadian Transportation Sector Deployment Roadmap*, each of these stakeholders has a specific – and complementary – role to play in each of the categories of activities required at the early stages of NGV market development.

All of the stakeholders have a share of responsibilities in “de-risking investment and early adoption” of NGVs. Vehicle and engine technology companies will be more focused on vehicle cost aspects whereas fuel suppliers and infrastructure providers will ensure the consistency between fuel availability (including infrastructure) and demand, and governments will provide fiscal measures.

All together, they have to demonstrate the environmental and over-vehicle-life economic benefits of medium- and heavy-duty NGVs. They also have to coordinate their actions and investments.

Similarly, each stakeholder has a complementary role to play in “addressing information gaps” (except for end-users, who are usually the beneficiaries of the information). Indeed, each one should be able to provide basic information on all aspects related to NG (supply and infrastructure) and NGVs and is best positioned to educate the market on its core competencies. Again, coordination is important so that all parties deliver the same key messages.

In addition, it is obvious that all stakeholders should be involved in “increasing capacity to sustain markets” (development of safety codes and standards, etc.) and “ensuring ongoing competitiveness” (R&D activities, etc.). In these activities too, each stakeholder will bring its own skills, which will all complement each other.

In conclusion, natural gas has the potential to play an important role in the transportation sector in the next decades. We believe that, if all stakeholders play the game in the deployment of this market, LNG heavy duty trucks can already represent >10% of the total heavy duty trucks fleet by 2020 in major North American, European and Asian markets. The market potential for LNG used in the transportation sector therefore looks promising.

It is very encouraging to see that such fruitful collaborations do already exist, particularly in North America where they have facilitated the implementation of significant heavy duty LNG vehicles projects. They now need to be taken one step further – become more global, with a more systematic approach – in order to enable a faster market growth that will benefit all stakeholders.