SERVING THE GLOBAL
NATURAL GAS VEHICLE INDUSTRY

PROUDLY PARTICIPATING IN

LNG 17

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NGV GLOBAL CHAIRPERSON

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Houston TX, USA
Presentation Overview

- Who is NGV Global?
- Why LNG and why now?
- Drivers of market interest
- Key segments:
  - Heavy duty trucks
  - Marine LNG
  - Rail
  - Heavy offroad
- Future potential & NGV Global 2014
Who is NGV Global?

- Established 1986 following inaugural meeting in Vancouver, Canada
- Incorporated as the International Association for Natural Gas Vehicles (IANGV), but re-branded to “NGV Global”
- Focus on CNG & LNG for transportation
  - 11 Regional and National associations
  - 26 Corporate members and sponsors
  - 239 Associate members
NGV Global Activities

- Special Consultative Status with UN ECE
- Engaged in harmonization, codes, standards and regulatory activities:
  - Co-Secretariat of the UN ECE Task Force on Liquefied Natural Gas vehicles (TF-LNG)
  - Secretariat of GFV Task Force on Heavy Duty Dual-Fuel (HDDF)
  - Liaison status with several ISO and OIML committees
  - Liaison with IGU Working Committee 5.3 (Utilization – Natural Gas Vehicles)
Why LNG & Why now?

Natural Gas Vehicle Growth Worldwide
Actual with Projections and Trendlines to 2015

Blue bars: Natural Gas Vehicles - Annual Total
Red bars: Growth projected in 2006
Exponential Trendline (based on Actual)
Linear Trendline (based on Actual)
5-Year Moving Average

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Drivers of Market Interest

- Fuel savings
- GHG reductions of 20-25% on a well-to-wheels basis
- Air quality benefits
- Quieter than diesel
- Ability to operate on renewable natural gas from waste
Heavy-Duty LNG Trucks

- Commercial engine technologies
- Meet all required certifications
- Increasing availability of factory-built models
- Range varies, but typically >600 miles
Marine LNG

LNG-Powered M/S Viking Grace Ready for Operations
January 11, 2013 | Finland

STX Finland Oy’s Turku shipyard has delivered a next-generation cruise ferry to Viking Line ABP. M/S Viking Grace, described by STX as the most environmentally friendly large cruise vessel ever built, uses Liquefied Natural Gas (LNG) as fuel. Building started at the STX Turku shipyard in September 2011 and the ship was floated out in August 2012, providing some 2,600 man-years of labour to the shipyard.

The ship’s emissions into the sea have been eliminated, and

‘Clean Sky’ Design for Bulk Carrier Vessels Incorporates LNG Fuel System
December 21, 2012 | United Kingdom, London

“LNG may be the ideal solution for meeting increased environmental performance without losing competitiveness.” (Golden Union)

Lloyd’s Register, international assurance provider, has provided approval in principle (AIP) for a new ‘Clean Sky’ bulk carrier design incorporating an LNG-as-fuel system. COSCO, Golden Union and Lloyd’s Register started the project in June 2011 to investigate the potential to develop a commercially viable bulk carrier design that incorporates the use of LNG.

Wartsilä to Supply Dual-fuel LNG Propulsion Package for Dutch Tankers
December 31, 2012 | Finland, Helsinki

Wärtsilä, a marine industry solutions and services provider, has been contracted to supply the complete LNG-powered dual-fuel propulsion package for two new Liquefied Ethylene Gas (LEG)/Liquefied Petroleum Gas (LPG) tankers being built for Anthony Veder, the Netherlands based shipping company specialised in gas transportation. The contract was signed with AV/IC-International Shanghai and Avic-Dingheng Shipbuilding Co. Ltd yard in September 2012. The ships are being built at the yard and they will operate in the North Sea area.

Caterpillar Extends Focus on LNG Marine Engines
December 19, 2012 | USA, Houston TX

Caterpillar, Inc. is developing a liquefied natural gas (LNG)-fueled, high-speed engine below 2 MW that will be designed primarily for electric propulsion with specific focus on offshore and ferry applications. The new project runs concurrent with the development the company’s MaK M 46 DF, a dual-fuel engine platform for the commercial marine industry, introduced December 2011 and available in 1st quarter 2014.

Caterpillar says this focus on LNG engine technology demonstrates its ongoing commitment to develop

Hyundai Heavy Industries Wins Orders for 5 Dual-fuel LNG Carriers
December 31, 2012 | Source: E2News | South Korea

Hyundai Heavy Industries Group (HHI) and its affiliated shipyard Hyundai Samho Heavy Industries (HSHI) have won contracts to build five membrane-type liquefied natural gas (LNG) carriers, all powered by dual-fuel engines, which allows the ships to run either on marine diesel or natural gas. Reported by Korea’s Energy and Environment News, the sum of orders exceeds $1 billion.

Contracts Finalised to Build LNG-Powered Containerships
December 7, 2012 | USA, San Diego CA

General Dynamics NASSCO, a wholly owned subsidiary of General Dynamics, has finalized a contract with TOTE, Inc., for the design and construction of two 3,100 TEU Liquefied Natural Gas (LNG)-powered containerships, setting a new benchmark in green ship technology. When completed the 764-foot-long containerships are expected to be the largest ships of any type in the world primarily powered by LNG. Construction of the first

Source: NGV GLOBAL NEWS
Marine LNG Bunkering

TEN-T Project Supports Swedish LNG Floating-Bunker Feasibility Trial
January 11, 2013 – 11:00 pm | Sweden

The European Union will co-finance with €261,000 from the TEN-T Programme, a project to convert an existing vessel into a Liquefied Natural Gas (LNG) bunkering ship so that it may be used to refuel other ships. The project, which takes place in the Port of Stockholm and contributes to the realisation of the Motorways of the Sea (TEN-T Priority Project 21), aims to demonstrate the feasibility of using alternative fuels in shipping. Read More »

Zeebrugge Port Prepares for Small-Scale LNG Fuel Demand
December 20, 2012 | Belgium, Brussels

New terminal users have booked capacity at the Zeebrugge liquefied natural gas (LNG) terminal to load more than 200 small ships. This is a new step for the terminal in its development into a hub for supplying LNG as a ship fuel. The LNG terminal's ambitions are based on the benefits of using LNG as a reduced-emissions fuel for ships and long-haul trucks.

Last month Fluxys LNG gave potential customers the option to book long-term capacity at the second jetty currently under

Waller Initiates LNG Facility for Marine Fuel
November 17, 2012 | USA, Houston TX

Waller Marine, Inc., through its LNG development subsidiaries, Waller Energy Holdings, LLC and Waller LNG Services, LLC, (the Company) has initiated activities on its first natural gas liquefaction (LNG) facility to be constructed on a 175 acre site the Company has acquired at the entrance point of the Calcasieu Ship Channel in Cameron Parish in Southwest Louisiana. Using small-scale liquefaction technology, the Company plans to install nominal 500,000 gallon per day LNG

Gazprom and Gasunie to Cooperate on Small Scale LNG
October 24, 2012 | Russia, Moscow and Netherlands, Groningen

Following discussions during the St. Petersburg Economic Forum in June 2012 Gazprom Export (Russia) and Gasunie (the Netherlands) signed a Memorandum of Understanding on cooperation in the field of development of small scale LNG. The Memorandum was signed by Alexander Medvedev, General Director of Gazprom Export LLC and Paul van Gelder, Chairman of the Executive Board, CEO of Gasunie. The purpose is to make LNG available for distribution to marine bunkering and truck fuelling stations. In this way LNG can be used as a clean

Rotterdam-Gothenburg Port Alliance to Accelerate LNG for Marine Fuel
October 18, 2012 | The Netherlands, Rotterdam and Sweden, Gothenburg

The largest port in Europe, the Port of Rotterdam, and the largest port in Scandinavia, the Port of Gothenburg, have entered a new alliance. The aim is to speed up the establishment of liquefied natural gas (LNG) as a maritime fuel. A memorandum of understanding will be signed between the Port of Rotterdam and the Port of Gothenburg. Both ports are located within the Sulphur Emission Control Area (SECA) in northern Europe where stricter rules governing sulphur in maritime fuel are due to be introduced in 2015. The aim is to

Joint Industry Project on Assessing Requirements for LNG Bunkering in Australia
October 16, 2012 | Australia

Det Norske Veritas (DNV) and nine key members of the Australian maritime, port and energy sectors have established a four-month study organized as a Joint Industry Project (JIP). This JIP’s intention is to facilitate the adoption of LNG fuelled vessels in Australian waters. Using LNG as marine fuel eliminates SOx and particulate matter emissions, nets a 15% reduction in GHG emissions and diminishes that of NOx by 85-90%. This addresses both local and global pollution issues.
LNG Locomotives

- Earlier stage on technology development
- World Record (Russia)
  - Largest load by a single locomotive of any fuel type
  - 16,000 tonnes, 170 rail cars

LNG-Powered GT1 Locomotive Sets New World Record
September 14, 2011 – 9:15 am | Russia, Moscow

The Russian-developed GT1-001 gas turbine-electric locomotive has successfully undergone further field tests in Moscow, in readiness for deployment on non-electrified freight-intensive areas of the railways. Hauling 16,000 tonnes in 170 rail cars, a new world record for a single prime mover with an internal combustion engine, the 300 tonne two-section GT1 combines a turbine and power unit with a separate section containing the 17 tonne liquefied natural gas (LNG) fuel tank. The engine can develop 8300 kW of power and when fully fuelled can drive the train 750 kms with a top speed of 100 km per hour.

Canadian National Railway Co. Tests Dual-Fuel Locomotives
September 28, 2012 | Canada, Edmonton AB

Canadian National Railway Company (CN) is testing two mainline diesel-electric locomotives fuelled principally by natural gas in revenue service in northern Alberta. Keith Creel, executive vice-president and chief operating officer, said, “CN launched this locomotive test to explore the use of natural gas as a potential alternative to conventional diesel fuel. This reflects CN’s continuing drive to look for ways to improve operating efficiency and advance the company’s sustainability agenda.”

*Natural gas has a lower carbon content compared with diesel

Source: NGV GLOBAL NEWS
LNG Locomotives (2)

- Work underway to develop purpose-built LNG locomotive engine
- LNG tender car design also needed

BNSF to Test LNG in Road Locomotives

March 6, 2013 | USA, Fort Worth TX

BNSF will begin testing a small number of locomotives using liquefied natural gas (LNG) as an alternative fuel later this year, says Matthew K. Rose, BNSF chairman and CEO. BNSF has been working with the two principal locomotive manufacturers, GE and EMD, a unit of Caterpillar, to develop the natural gas engine technology that will be used in the pilot. Read more »

Source: NGV GLOBAL NEWS
LNG for Heavy Offroad

• Earlier stage
• Engine technology development underway
• Expect commercial products starting in 2017
Is Aviation Next?

Boeing Delivers LNG-Fuelled Aircraft Concept to NASA

March 22, 2012 | Source: Aviation Week | USA

Will technological advances enable liquefied natural gas powered (LNG) aircraft to take to the skies by mid century, asked the US National Aeronautics and Space Administration (NASA). Boeing has addressed this question by submitting a concept study in February under NASA’s N+4 generation airliners program for 2040-2050, reports Aviation Week. Considered too immature a technology for the N+3 program, NASA believed LNG to be worthy of further investigation. Boeing’s study says it can be done.

The LNG project is named ‘SUGAR Freeze’ – SUGAR is NASA’s acronym for Subsonic Ultra Green Aircraft Research, a term inclusive of eco-fuel, fuel efficiency, reduced emissions and more efficient design. ‘Freeze’ refers to the cryogenic fuel storage.

Source: NGV GLOBAL NEWS
“We have decided to go all-in on gas. We are going to invest because we see a global market long term. Large engines are going gas. It’s not debatable; it’s our conclusion.”

- Joel Feucht, Director of Strategy - CATERPILLAR

"The use of liquefied natural gas as an alternative fuel is a potential transformational change for our railroad and for our industry."

- Matthew K. Rose, Chairman & CEO - BNSF
Southern California has been the epicenter of North American NGV market development for the last 20 years. With thousands of NGVs of every size and shape now operating in the region, it is home to many of the largest and most successful NGV deployment projects in the world.
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Web sites:
www.ngvglobal.org (Industry info)
www.ngvglobal.com (Weekly news)
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