



BEST PRACTICES AND STATE OF THE ART OF TECHNOLOGY AND BREAKTHROUGH TECHNOLOGIES

Joint presentation of IGU WOC 5
Study Group 5.3 (NGVs) members and partners

In the name of the S.G 5.3 presented by
Dr. Olivier Bordelanne – GDF-SUEZ

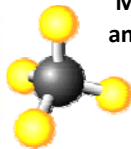
Committee Session 5.3: Methane – A Global Eco-Efficient Mobility Solution



Introduction

- Interesting NGV related technologies and ways of methane utilization in transport sector will be presented to illustrate the following postulate:

Methane and bio-methane can be a valid solution for transport needs and can replace traditional liquid fuels in almost all transport segments



- Since traditional road applications are already commercially available only slight overview is made to complete the picture
- Emphasis is put on other interesting ways of methane in transport utilization as part of the global solution
- This presentation is based solely on contributions provided by WOC 5 S.G 5.3 members and partners

Committee Session 5.3: Methane – A Global Eco-Efficient Mobility Solution



ON-ROAD APPLICATIONS

- Light and Heavy Duty OEM NGVs
- Turbocharged CNG engines entering market (OEMs)
- NGV can benefit from hybridizing
- OEM vehicles coping with gas quality differences
- NGV buses and trucks (Medium and Heavy Duty) commercially available
- Dual Fuel systems reaching high level of sophistication

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- New VW Passat Estate TSI EcoFuel model powered with turbocharged CNG engine
- 1.4-liter TSI 110 kW (148 hp) emitting 119 – 124 g CO₂ / 100 km
- With average consumption of 4.4 - 5.2 kg/100 km and 21 kg reservoir possible range with one filling is around 450 km

Turbocharged CNG engines



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- **EcoFuel World Tour – Guinness record:** CNG Around The World Tour: 26 countries, 5 continents, 45 000 km in 6 months → solely on natural gas → **coping well with gas quality differences**
- **Asia-Tour – from Berlin to Bangkok** also fulfilled successfully



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NGV can benefit from hybridization



Provided by: Olivier Bordelanne – GDF-SUEZ - olivier.bordelanne@gdfsuez.com

- Toyota Prius Hybrid CNG
- 78 g CO₂/km on NEDC cycle
- 25% reduction on CO₂ emissions compared to the gasoline reference
- Gold Medal at Bibendum Challenge

CNG hybrids



Provided by: Olivier Bordelame - GDF SUEZ

SMART mild-hybrid NGV

- Mild hybrid: Stop and Start system + braking energy recovery
- Downsizing
- 80 g CO₂/km - comply with Euro 5
- Autonomy: 200 km



Source: www.italiancar.net

FIAT Panda Natural Power

- Autonomy: 300 km

CNG in small scale LDVs



Image source: ENGVA 11th Annual European NGV Conference - Bolzano / Italy 7-12 June 2005

- CNG scooter (Italy)

CNG in small scale LDVs



On the opposite side ...



Provided by Manuel Lage: iveco - manuel.lage@iveco.com



Provided by Olivier Bordelanne - GDF-SUEZ

OEM CNG Trucks

← Goods & Food
distribution in Paris →



Medium and Heavy Duty CNG



Provided by Manuel Lage: iveco - manuel.lage@iveco.com



Provided by Peter Seidinger - OMV Gas & Power GmbH



Provided by Olivier Bordelanne - GDF-SUEZ



Provided by: Brett Jarman and David Perry - IANGV
bjarman@iangv.org dperry@iangv.org

OEM garbage trucks in Madrid and Paris

Compact CNG street sweepers



Provided by: Pavel Novak: Czech Gas Association - novak@cgoa.cz

OEM garbage trucks and street sweepers in Prague – Czech Republic



Mobile CNG filling station



OEM CNG trucks



(on the left)

- LCNG applications – LCNG fast speed vaporizer / compressor
- Filling pressure 200 bar; filling speed 1 000 Nm³ per hour; can fill three NGVs simultaneously

Provided by Eugene Pronin – Gazprom / NGVRU: E.Pronin@adm.gazprom.ru

On road CNG – LCNG applications in Russia



Source: Hardstaff



- LNG gas storage on tractor unit + CNG storage on trailer
- Autonomy with tractor unit approximately 480 km (LNG) plus additional 515 km (CNG storage in trailer) \approx 1 000 km total autonomy on gas (dependent upon Diesel substitution ratio)

Dual Fuel trucks



Provided by: Brett Jarman and David Perry - IANGV: bjarman@iangv.org / dperry@iangv.org
Image source: IANGV

- 120 tonne LNG/diesel dual-fuel 'Road Train'
- Hauling mining ore in Australia
- Similar units now hauling > 150 tonne GVM!
- On-board LNG storage of 1 000 litres and 700 litres of diesel

Dual Fuel trucks



OFF-ROAD APPLICATIONS

- Forklifts
- Agriculture machinery
- Application in ski resorts
- Trains
- Ships
- Airplanes

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CNG forklifts



CNG agriculture machinery

Lawn Mower



- The Dixie Chopper CNG/LNG Lawn Mower → aimed at reducing the US EPA estimate of 5% of total U.S. emissions from home lawn-mowing

Provided by: Brett Jarman and David Perry - IANGV: bjarman@iangv.org / dperry@iangv.org
Image source: Dixie Chopper

Off-road applications



- CNG Radrak
- Application in ski resorts
- Protected and sensitive natural areas (Austria)

Info provided by: Peter Seidinger – OMV Gas & Power
peter.seidinger@omv.com Source: <http://adc-lungau.at>

Off-road applications



Vale Green Train

- Vale is the largest mining company in Brazil
- Logistic operations burns 544 million liters of diesel fuel annually
- LNG Dual Fuel (NG : Diesel = 70:30)
- 1 200 km without refueling
- Expected total CO₂ reduction of 73 000 tons per year

Provided by: R. Fernandes: Praxair / ALGNV: R._Fernandes@praxair.com

Off-road applications



Source: Russian Railways, Moscow, Russia
 Provided by: Eugene Pronin - Gazprom / NGVRUS: E.Pronin@adm.gazprom.ru

LNG gas turbine locomotive in Russia

- Latest development
 → started in 2009
- LNG turbine drives the locomotive's power generator
- Locomotive has set a new world record for a single rail-way engine
 → successfully tested with a load of 15 200 tons
- 30% savings on fuel costs

Off-road applications - trains



Provided by: R. Fernandes: Praxair / ALGNV: R. Fernandes@praxair.com



Provided by Eugene Pronin - Gazprom / NGVRUS: E.Pronin@adm.gazprom.ru

- Bahia "Ivete Sangalo" - NG ferry Itaparica Island, close to City of Salvador
- CNG ferry in Thailand
- Using exchangeable CNG storage
- The 'Moscow-4' Dual Fuel CNG / Diesel River Boat



Provided by: Punnachai Footrakul - PTT Public Company Ltd, Bangkok, Thailand - punnachai.f@pttplc.com



Off-road applications – ships and ferries



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Image source: ENOVA 11th Annual European NGV Conference – Bolzano / Italy 7-12 June 2005

Off-road applications - boats



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CNG luggage tractor



CNG Ground Power Unit (GenSet)



CNG aircraft tractor



Source: AERGAS Project

Provided by: NGVA Europe / Manuel Lage: manuel.lage@ngvaeurope.eu

Off-road applications – Airport machinery - example: Madrid airport (AERGAS project)



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- CNG aircraft tractor in operation

Source: AERGAS Project Provided by: NGVA Europe / Manuel Lage: manuel.lage@ngvaeurope.eu

Off-road applications – Airport machinery - example: Madrid airport (AERGAS project)



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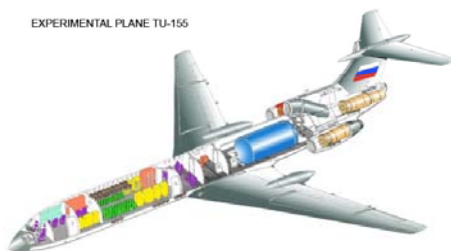
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- TU-155 LNG aircraft (flying lab)

LNG filling equipment for the
TU-155 LNG aircraft ↓

EXPERIMENTAL PLANE TU-155



Provided by Eugenia Pronin – Gazprom / NGVRUS: E.Pronin@adm.gazprom.ru

Off-road applications - aircrafts



CNG light aircrafts

- Natural gas light airplane prototype (conversion) presented officially in July 2005, in Curitiba, Brazil
- Bravo 700 model, advanced ultra light model, with 2 seats
- Manufactured in Brazil, equipped with 80 hp Rotax 912 engine, imported from Austria
- Conversion cost is around US\$ 1 000 and the modification can be made within a day
- Possible flight autonomy with one filling is around 40 minutes

Information on this project provided by R. Fernandez: ALGNV / Praxair - R_Fernandes@praxair.com



Bravo 700 ultra light aircraft model *
Source : Airliners.net; Copyright : Juliano Damasio

* Aircraft on the picture is NOT the described CNG model, but just an illustration how the BRAVO 700 model looks like

Off-road applications - aircrafts



SPORTS APPLICATIONS

- Pushing to the limits



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Source: OMV Gas & Power

- Retrofitted CNG Subaru
- February 2009 - 2nd place in the Austrian championship

Sports applications



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Provided by: Brett Jarman and David Perry - IANGV: bjarman@iangv.org / dperry@iangv.org
Image source: OneEightTurbo

- The Scirocco GT24-CNG wins alternative power trains (AT) category and finishes 17th overall at Nürburgring (2009)
- Also competing in motorsports events in Sweden

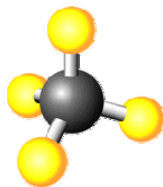
Sports applications



- At 364.6 km/h, the world's fastest Ultra Power passenger car running on CNG (700 hp!)

Provided by: Brett Jarman and David Perry - IANGV: bjarman@iangv.org / dperry@iangv.org
Image source: www.engineerlive.com

Sports applications



Conclusions

- CH₄ and bio-CH₄ can already be a Global Eco-Efficient Mobility Solution
- This is proven technology of today and a pathway to better tomorrow

Thank you!