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
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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 S 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

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
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

NGV can benefit from hybridization

- 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
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

FIAT Panda Natural Power
- Autonomy: 300 km

CNG in small scale LDVs

CNG scooter (Italy)

CNG in small scale LDVs
On the opposite side ...

OEM CNG Trucks

Goods & Food distribution in Paris

Medium and Heavy Duty CNG

OEM garbage trucks in Madrid and Paris

Compact CNG street sweepers
OEM garbage trucks and street sweepers in Prague – Czech Republic

Mobile CNG filling station

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

OEM CNG trucks

On road CNG – LCNG applications in Russia
- 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) = 1000 km total autonomy on gas (dependent upon Diesel substitution ratio)

Dual Fuel trucks

- 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 1000 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

Lawn Mower

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

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

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

Off-road applications

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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)
- 1200 km without refueling
- Expected total CO₂ reduction of 73,000 tons per year

Provided by: R. Fernandes: Praxair / ALGNO: R_Fernandes@praxair.com

Off-road applications
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

- Bahia “Ivete Sangalo” - NG ferry Itaparica Island, close to City of Salvador
- CNG ferry in Thailand
- Using exchangeable CNG storage

Off-road applications – ships and ferries

- The “Moscow-4” Dual Fuel CNG / Diesel River Boat

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

Provided by: Punnachai Footrakul – PTT Public Company Ltd, Bangkok, Thailand – punnachai.f@pttplc.com
Off-road applications - boats

CNG luggage tractor
CNG Ground Power Unit (GenSet)
CNG aircraft tractor

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

- CNG aircraft tractor in operation

Off-road applications - aircrafts

- TU-155 LNG aircraft (flying lab)

LNG filling equipment for the TU-155 LNG aircraft
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

![Bravo 700 ultra light aircraft model](image)

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

Sports applications

- 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!)

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!

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