LNG for long distance road transport & ships

LNG High-Level Seminar
Constanta, Mamaia. 24 & 25 January 2013

Manuel Lage, Dr. Eng.
General Manager

Advantages of bio-natural gas

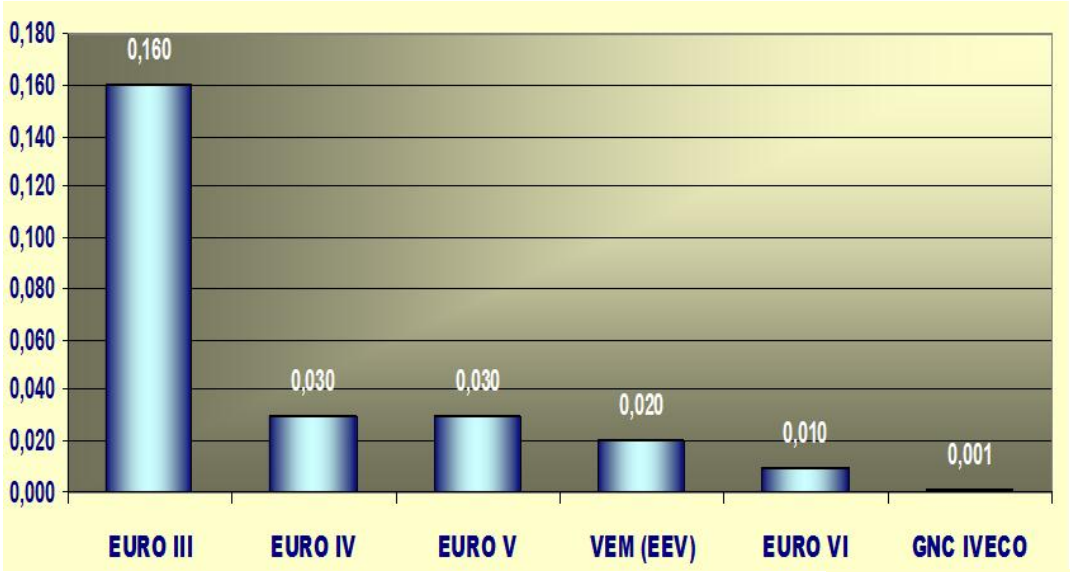
- Natural gas is an alternative fuel coming from natural wells. It is mainly methane (CH4)
- Biogas is also a methane rich gas, produced by the fermentation of the biomass, it is then a renewable fuel.
- **Methane contents 25% H and 75% C, in weight**

As a comparison,

- Petrol contents 13,5% H and 86,5% C
- Diesel oil contents 13,5% H and 86,5% C
- LPG contents 17,4% H and 82,6% C

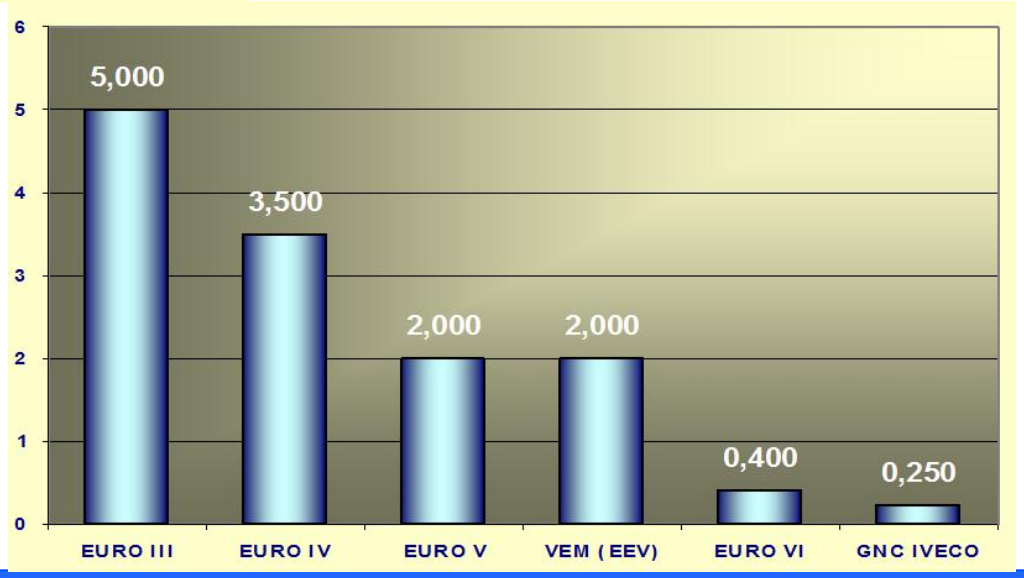
Due to its molecular advantage, regulated exhaust emissions and CO_2 are particularly favourable in the engines running on bio & natural gas.

Exhaust pollutants limits



PM limits

NOx limits
NO_2 is not measured

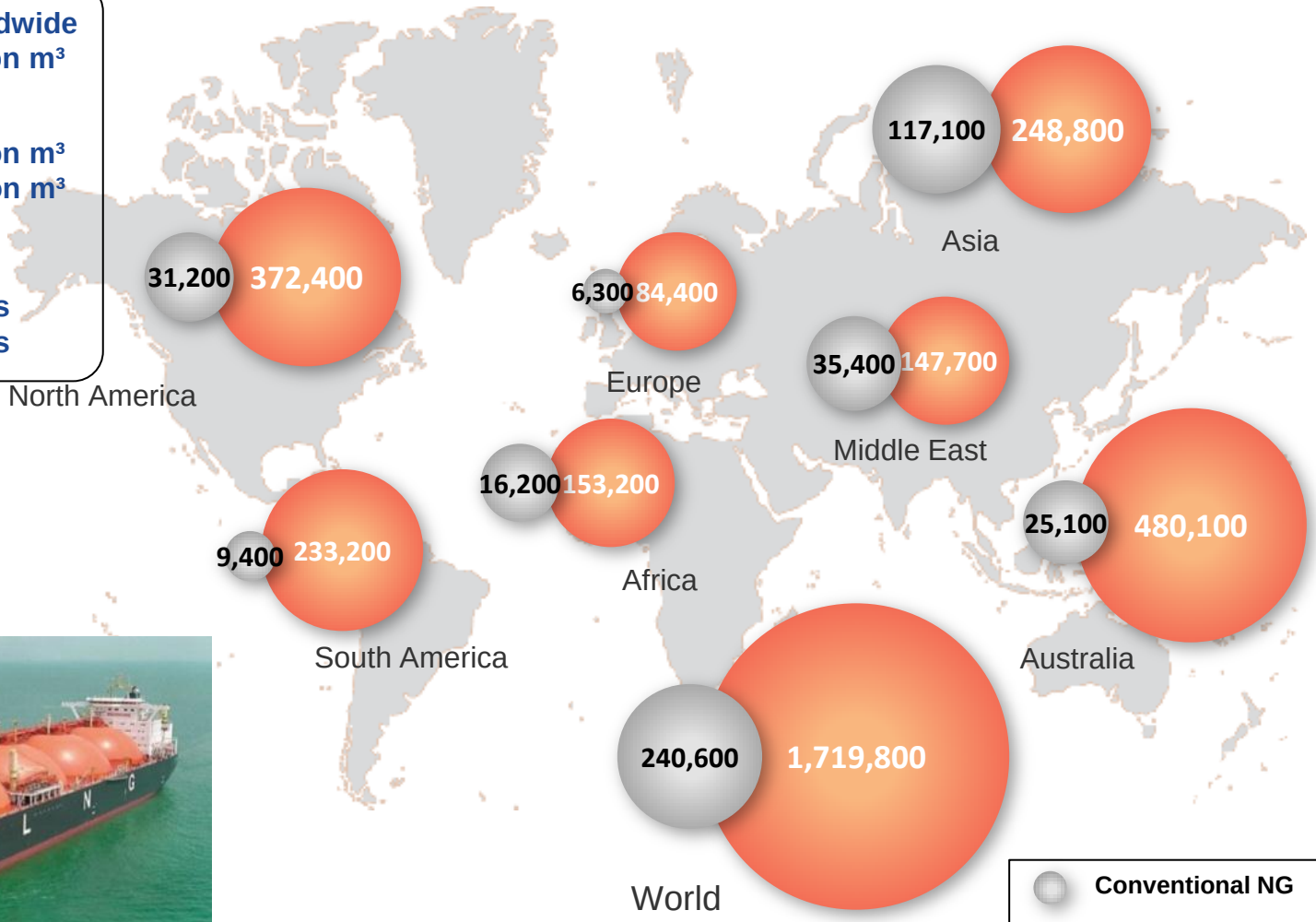


Worldwide gas reserves (unit=10^9 m³)

Gas consumption worldwide (2010): 3.200 billion m³

Europe:
Total 522 billion m³
NGVs 1,8 billion m³

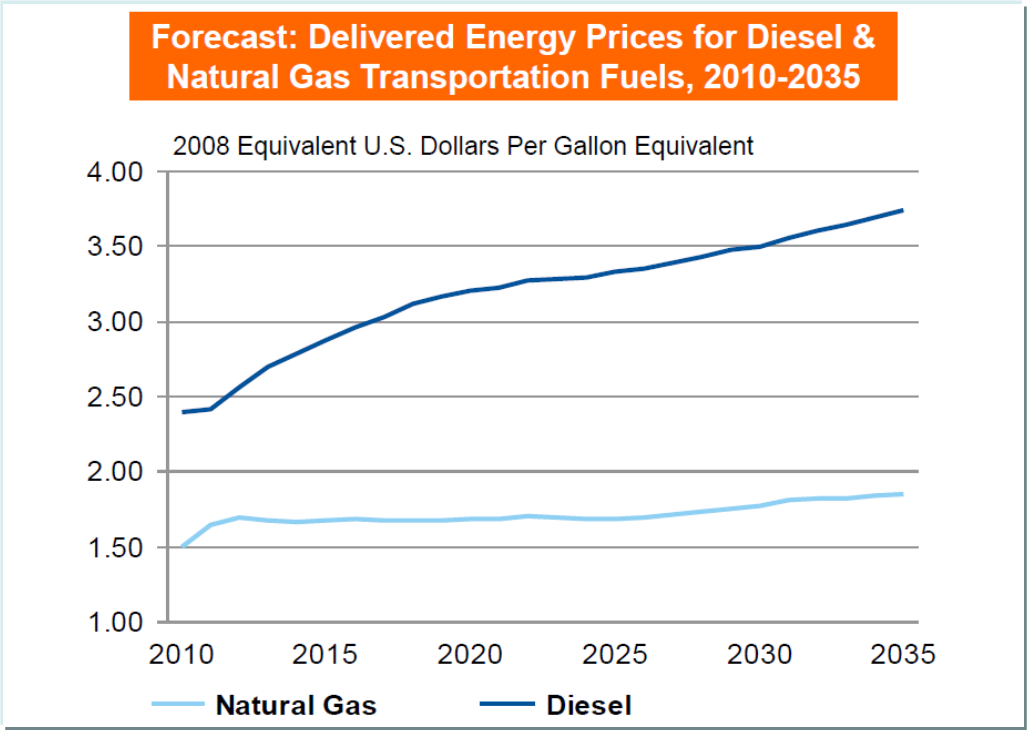
Reserves:
World: 537 years
Europe: 161 years





Source: data BGR, graph works NGVA Europe

USA, unconventional (shale) LNG exporter



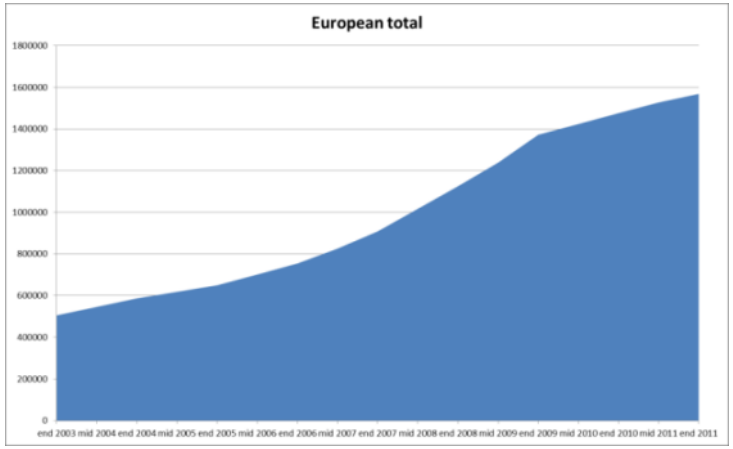
Source: U.S. Energy Information Administration, Annual Energy Outlook 2010

In 2008, non conventional gas meant 8% of the total US gas consumption.

In 2035 EIA estimates unconventional gas could reach 57%!

US EIA forecasts prices for diesel and gas will continue being decoupled.

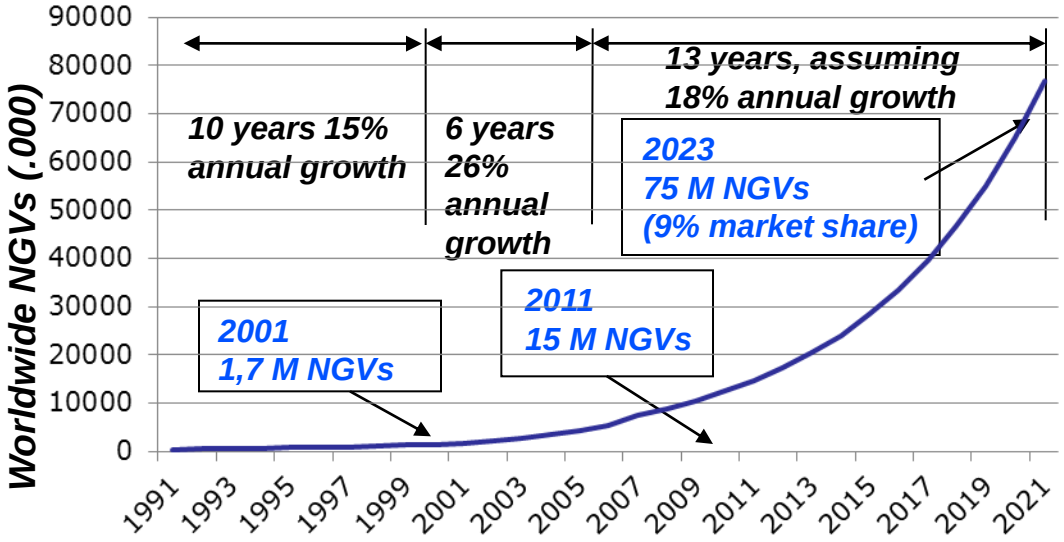
NGVs in the world
1991 to 2020 growth and forecast



Europe:
16% growth (2006-2011)

World:
70+ M NGVs in 2020!

Source: NGVA Europe



Global market for NG trucks is expected to grow at a Compound Annual Growth Rate of 14% between 2012 and 2019, while NG buses are expected to grow at 19% during the same period.

This growth is being fueled by:

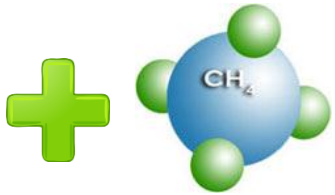
- economic growth following the global slowdown of the last few years
- increased vehicle availability
- environmental benefits
- and the desire for increased energy security.

Pike Research, September 2012

The time for gas is now!
CNG cars & vans for fleets and cities



Revolutionary: only 2 cylinders, less cubic capacity, more power!















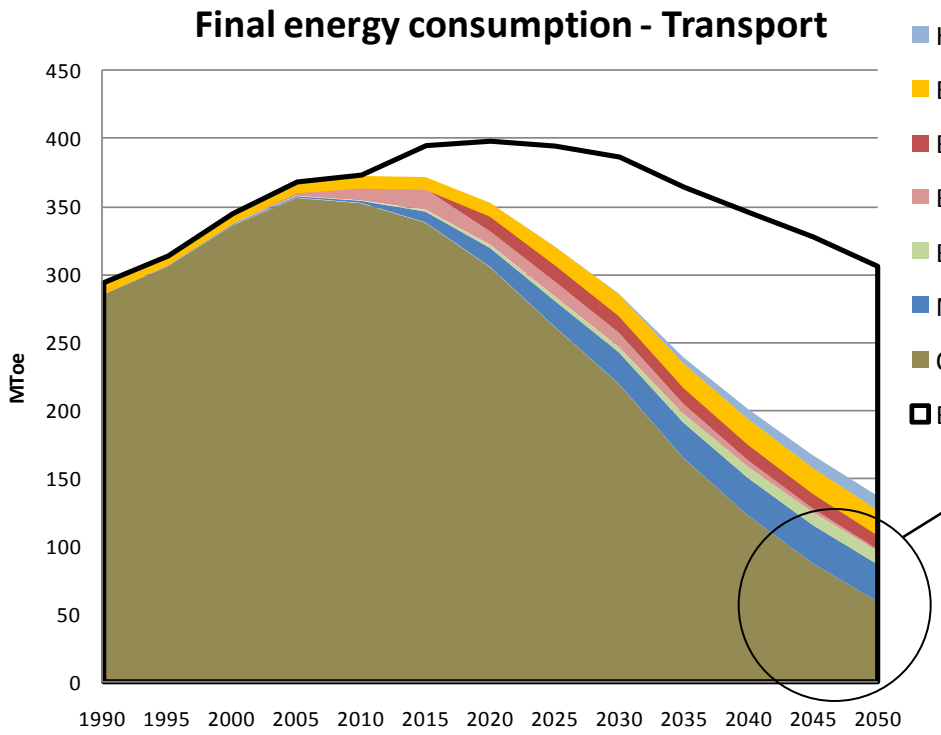


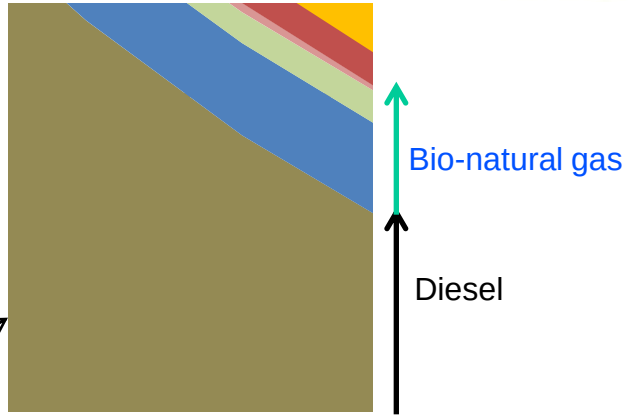


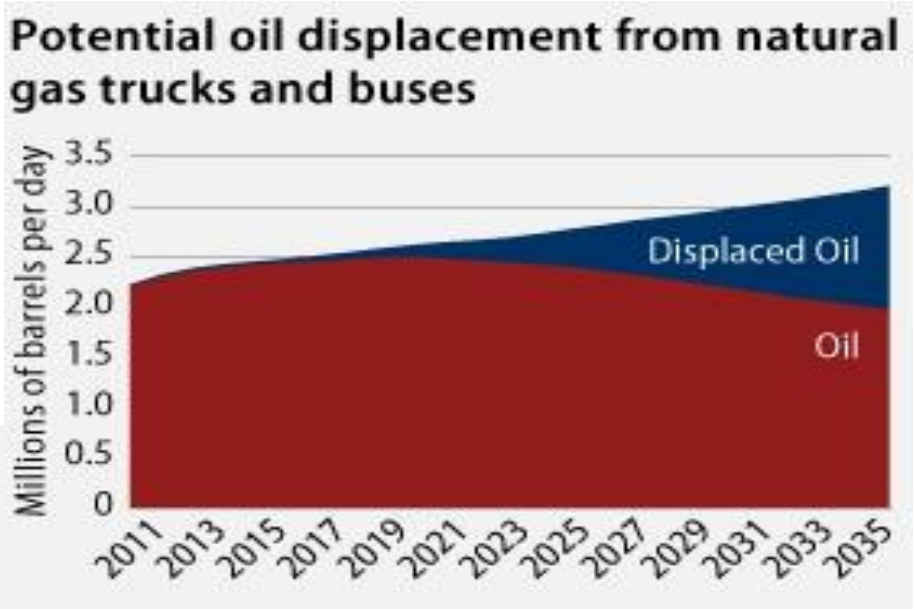




Eurogas Roadmap 2050 (10/2011)
Expected market share: 9% in passenger, 33% freight







North American forecast: 37%

Sources: Energy Information Administration, Annual Energy Outlook 2010, Supplementary Tables 46 and 67, available at: http://www.eia.doe.gov/oiaf/aeo/supplement/sup_tran.xls#set3.1118a!C170 and http://www.eia.doe.gov/oiaf/aeo/supplement/sup_tran.xls#set3.1118a!C2275

CNG urban trucks and buses in Europe

70.000 urban buses give service in the main European cities (Italy, France, Germany, Spain, Sweden, Greece, Portugal, Netherlands)
9.000 (13%) are CNG.

20.000 garbage trucks in service in Europe (France, Spain, Italy, Greece)
3.000 (15 %) are CNG.

On top of the great advantages in exhaust emissions, Natural Gas vehicles offer a very silent operation, much appreciated in urban centres.





Biogas is the perfect fuel for food distribution and other urban activities



Deliveries of Coca Cola UK in London for the Olympic Games will be done exclusively with CBG trucks.



Some garbage collection companies in Switzerland are also using biogas.

CBG buses in Nijmegen (NL)



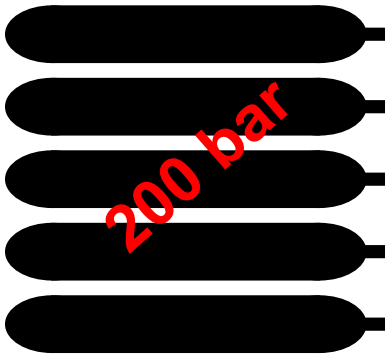
CNG Net, a subsidiary of the NGVA Europe member Ballast Nedam, is set to deliver 12 million m3 of biomethane for all 225 city buses of Connexxion in the city area of Arnhem/Nijmegen in the Netherlands, from the end of 2012.
This will be the largest public transport concession for biomethane in the Netherlands and unique in Europe.

LNG trucks for long distance transport



Diesel vs CNG & LNG.
Autonomy equivalence

1 liter Diesel oil



CNG

5 litre

-162ºC at 1 bar
-125ºC at 10 bar

LNG/LBG

1,8 litre



Two engine technologies are available for heavy engines:

- Dedicated, using 100% natural gas
- Dual fuel, using diesel injection for ignition and natural gas as the main fuel

LNG opened the way for the medium and long distance road transport

European LNG heavy duty tractors





European LNG park:

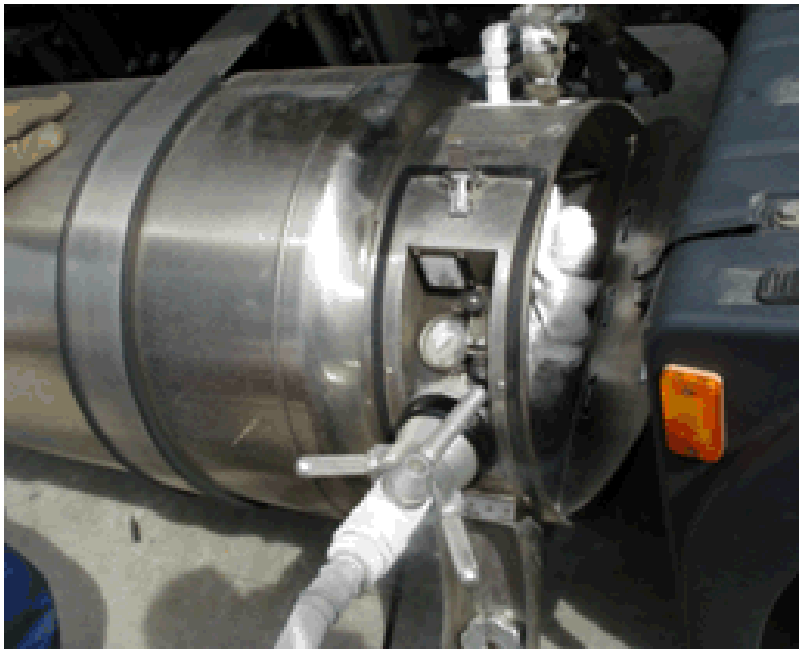
200 LNG vehicles
25 filing stations (end 2012)







LNG truck refueling process



Single hose filling,
low working pressure, 7-10 bar **(Chart)**



Double hose for filling and venting,
high working pressure, 18 bar **(Indox)**

(MB to adopt to 7-10 bar shortly)

LNG vs Diesel in Euro VI

Cost difference between a Diesel and a LNG powertrain (including aftertreatment) will be dramatically reduced in Euro VI.

Reference:
«TNO report 06.OR.PT.023.2/NG. Euro VI technologies and costs for Heavy Duty Vehicles»

Forecasted cost increase from Euro IV to Euro VI. Emissions scenario nº 5

Diesel engine:	+ 13.486 €
Stoichiometric NG engine:	+ 1.825 €
Lean-burn NG engine:	+ 4.025 €

Delta cost reduced in 11.660 € !!

North American and Australian LNG trucks







Autocar
International
Freightliner
Peterbilt
White
…



More than 6.000 LNG heavy trucks already running in USA!

Chinese NG trucks



Foton



Shaanxi

Sinotruk



Dong Feng



Today: 23.000 LNG heavy trucks & buses in service and 300 LNG fuel stations!

2015 (5-year-plan target): 200.000 LNG vehicles and 1.500 fuel stations!!

Types of vehicles and alternative fuels

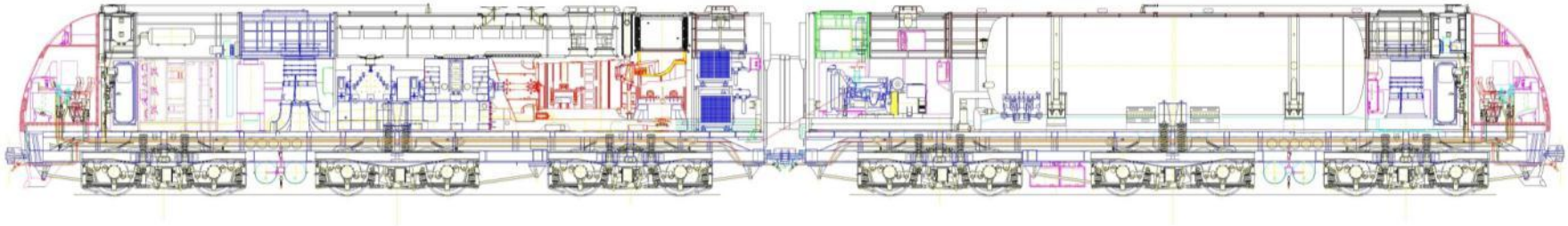
Vehicle type	Present fuel	LPG	Liquid biofuels	Full electric	Hybrids (energy recuperation)	Bio-natural gas (CNG & LNG)
Three wheelers	Petrol	Yes (mostly converted)	Yes (%)	No	No	**Yes (CNG)**
Cars	Petrol & diesel	Yes (mostly converted)	Yes (%)	Yes (city cars)	Yes	**Yes (CNG)**
Vans & delivery trucks	Diesel	Yes (vans), mostly converted	Yes (%)	Yes (city use only)	Yes	**Yes (CNG)**
Heavy urban trucks	Diesel	No	Yes (%)	No	Yes	**Yes (CNG)**
Suburban & urban buses	Diesel	No	Yes (%)	Yes, small Yes (wired)	Yes	**Yes (CNG/LNG)**
Coaches	Diesel	No	Yes (%)	No	No	**Yes (LNG)**
Heavy on road trucks	Diesel	No	Yes (%)	No	No	**Yes (LNG)**
Heavy off road trucks	Diesel	No	Yes (%)	No	No	**Yes (CNG/LNG)**
Railway locomotives	Diesel & electric	No	Yes (%)	Yes (wired)	No	**Yes (LNG)**
Ships	Diesel	Short sea (converted)	Yes (%)	No	No	**Yes (LNG)**
Aircraft	Diesel Jet A-1	No	Yes (%)	No	No	**Yes (LNG)**

LNG in railways



Russian locomotive with 8.300 kW gas turbine engine running on LNG.

In daily service since 2009.



LNG fuelled ships are growing rapidly





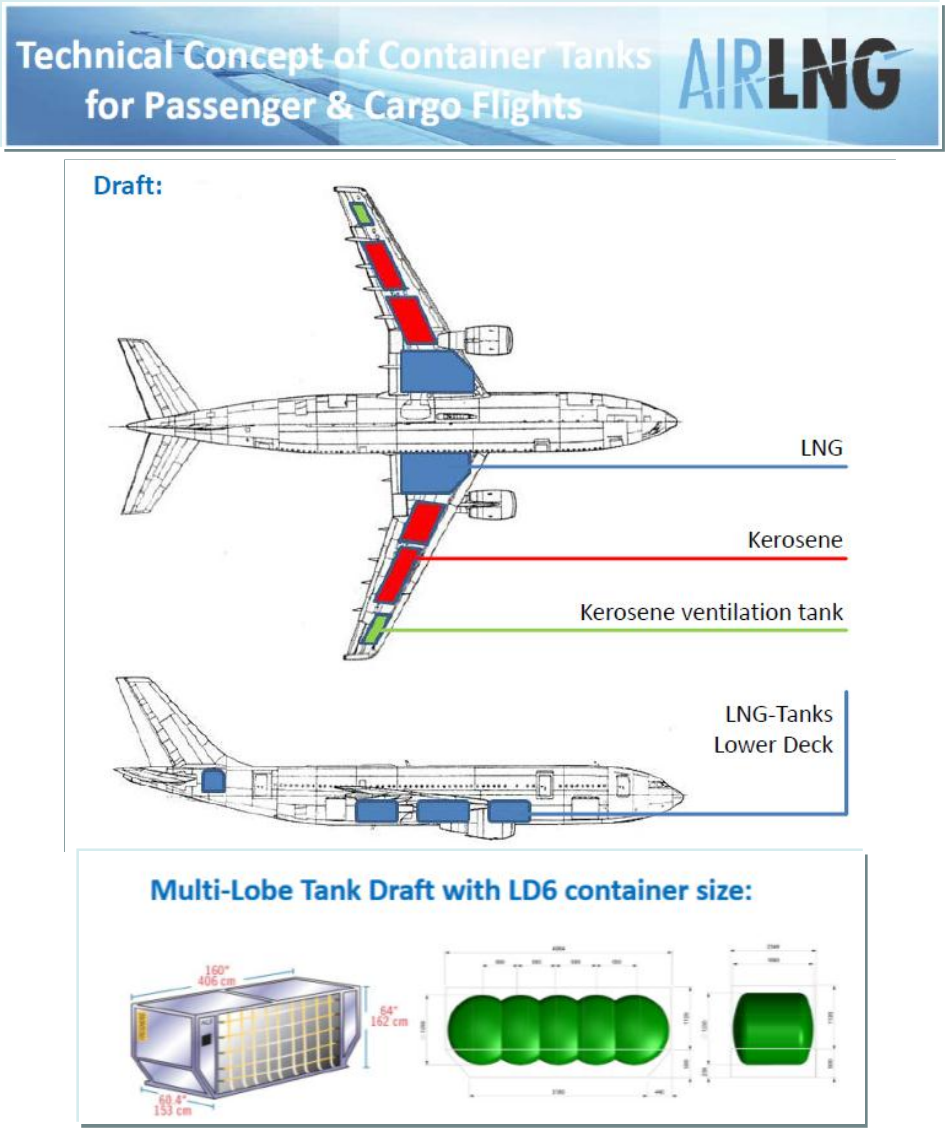


Nov. 1st, 2011. Japan's Ministry of Land, Infrastructure, Transport and Tourism had indicated its intention to develop safety standards for vessels powered by **liquefied natural gas (LNG) which it expects will largely supersede oil-fueled marine transportation**, reports L-News.

JPY 647 M (€ 6,2 M) has been set aside in the 2012 budget for **the creation of comprehensive safety measures pertaining to marine renewable energy.**

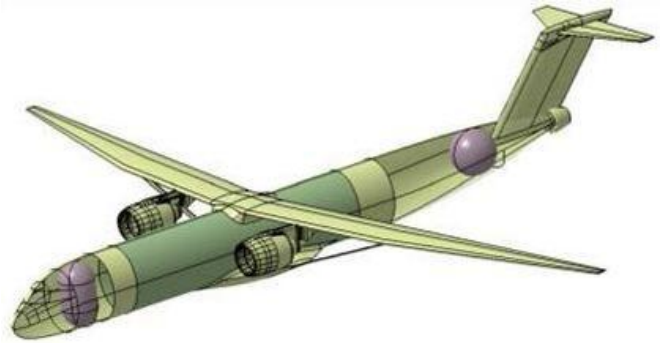
November 29, 2011 | Norway: **"We believe 500 LNG fuelled ships will be on order by 2015, several thousands by 2020,"** Mr. Remi Eriksen, COO of Det Norske Veritas Asia Pacific & Middle East

LNG in aircraft



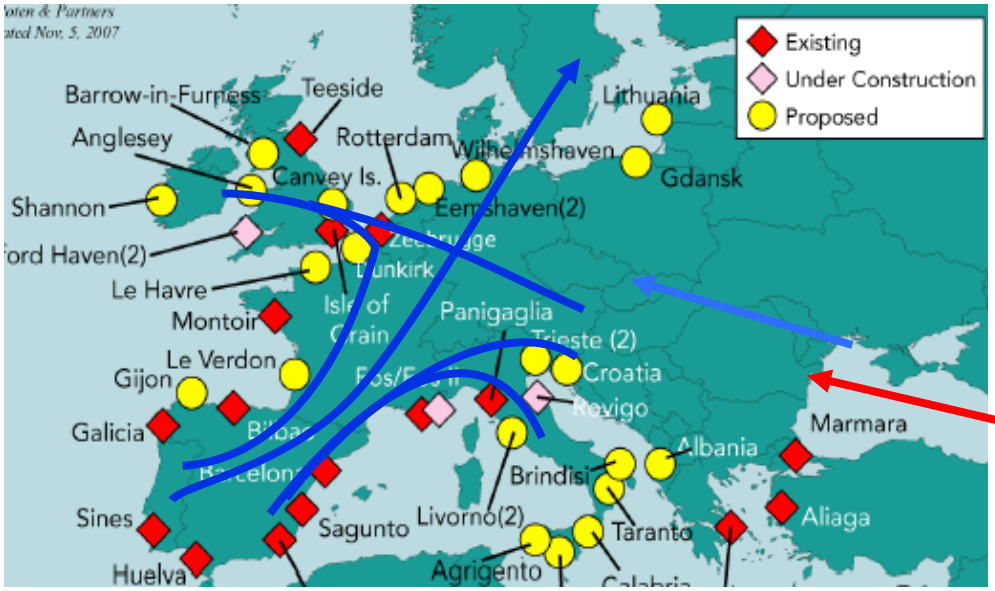
Boeing's proposal is an efficient airliner design, LNG fuelled, the company submitted to NASA in 2010 as part of the Subsonic Ultra Green Aircraft Research project (SUGAR Freeze).

The company says it could reduce fuel burn by 60 percent compared to a typical 737-800 used today.





The LNG Blue Corridors Project



These initially proposed Blue Corridors will also develop with connection to other LNG distribution initiatives as:

- Danube Inland Waters Blue Corridor, from Romania to Viena
- AGRI (Azerbaijan-Georgia-Romania-Interconnection) project to transport LNG from Azerbaijan to the EU through Georgia and Romania.

NGVA Europe has presented a project to the FP-7, to develop the concept of **European LNG Blue Corridors**

The intention is to define four initial pan European routes with strategically placed LNG filling stations that would allow the heavy, long distance truck transport throughout Europe:

- Portugal-Spain to France, Netherlands, UK and Ireland
- Portugal-Spain to France, Germany, Denmark, Sweden
- Mediterranean arch to Italy and with another branch to Croatia
- Ireland-UK to Austria

Existing and proposed LNG filling stations (March 2012)



Existing LNG stations:
Spain: Abrera (Barcelona), Olaberría (Guipúzcoa), Lleida, Castellón, Guadalajara, Guadalajara (2012), Madrid, Zaragoza (2012), La Jonquera (Girona, 2012), Tarragona, Valencia (2012).
Portugal: Mirandela, Maia (2012)
Italy: Poirino (Torino)
Holland: Oss
Sweden: Goteborg, Järna, Malmo (2012), Jönköping (2012)

Proposed:
Lisbon (Portugal)
Sines (Portugal)
Irún (Guipúzcoa), Spain
Lyon (France)
Paris (France)
La Crèche (France)
Metz (France)
Antwerpen (Belgium)
Ventimiglia (Italy)
Piacenza (Italy)
Palmanova (Italy)
Roma (Italy)
Karlsruhe (Germany)
Berlin/Postdam (Germany)
Hannover (Germany)
Munich (Germany)
Split (Croatia)
Örebro (Sweden)
Sundsvall (Sweden)
London Orbital M25 (UK)
South Wales M4 (UK)
Manchester M6 (UK)
Watford Gap (UK)
Dublin (Ireland)

LNG demonstration project

GC.SST.2012.2-3. Demonstration of heavy duty vehicles running with liquefied methane

Call: FP7-TRANSPORT-2012-MOVE-1

Content and scope:

- 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 specific objectives for the project should be:
  - To **optimize the complete powertrain and storage system of LNG heavy duty vehicles** with respect to energy efficiency and pollutant emission, by fully utilizing the technical potential of liquefied methane in an optimized fuel-engine system.

L-CNG infrastructure in Europe



L-CNG filling station in Göteborg (Sweden)

In the proposal for a:
Directive of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, presented in Brussels on January 24th, 2013 it is requested that in 2020 the main European roads should offer CNG filling stations every 150 km and LNG filling stations every 400 km. This new and wide L-CNG infrastructure will allow the EU to reduce significantly the oil dependence.





L-CNG filling station in Lleida (Spain)



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