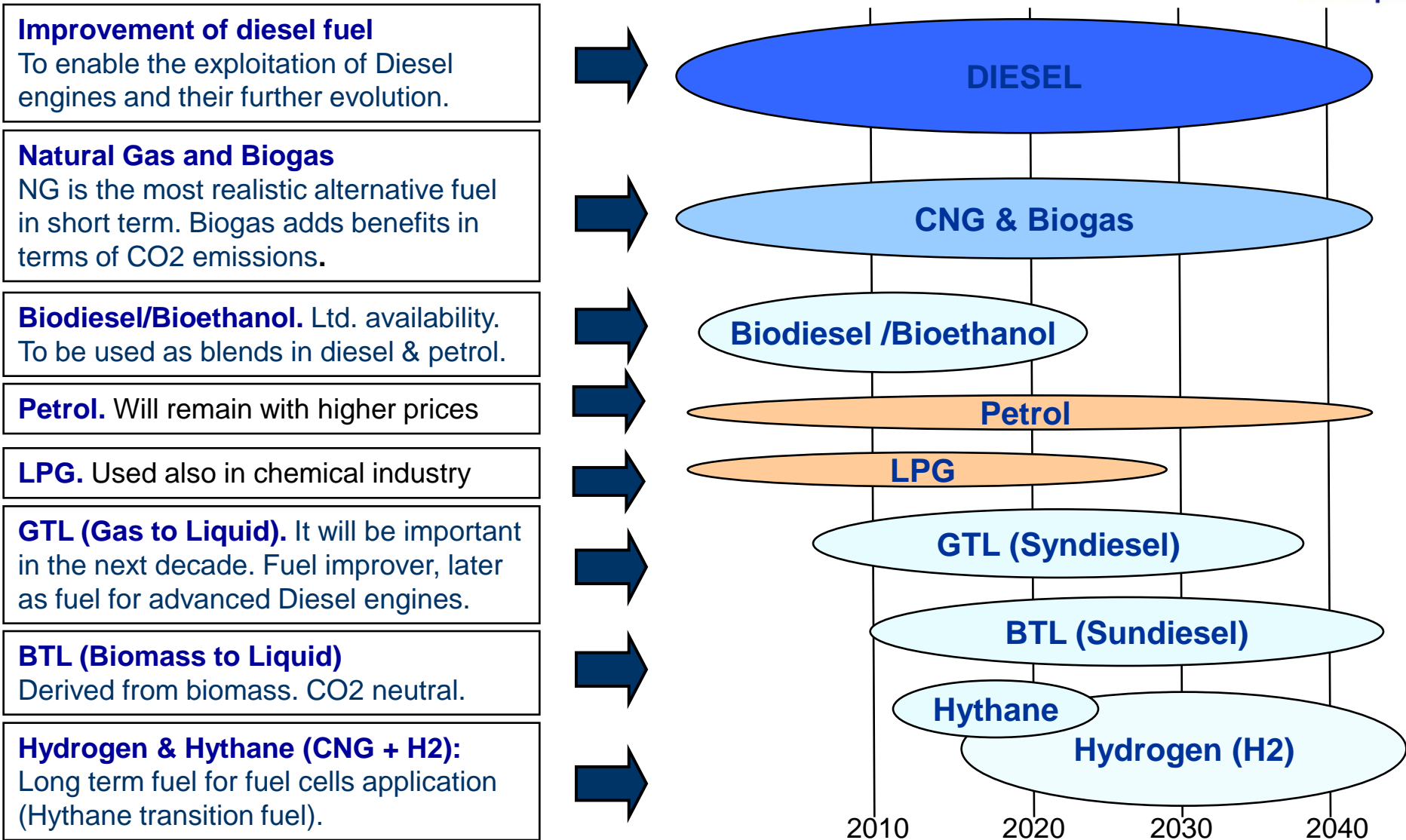


Gas natural Combustible alternativo para automoción

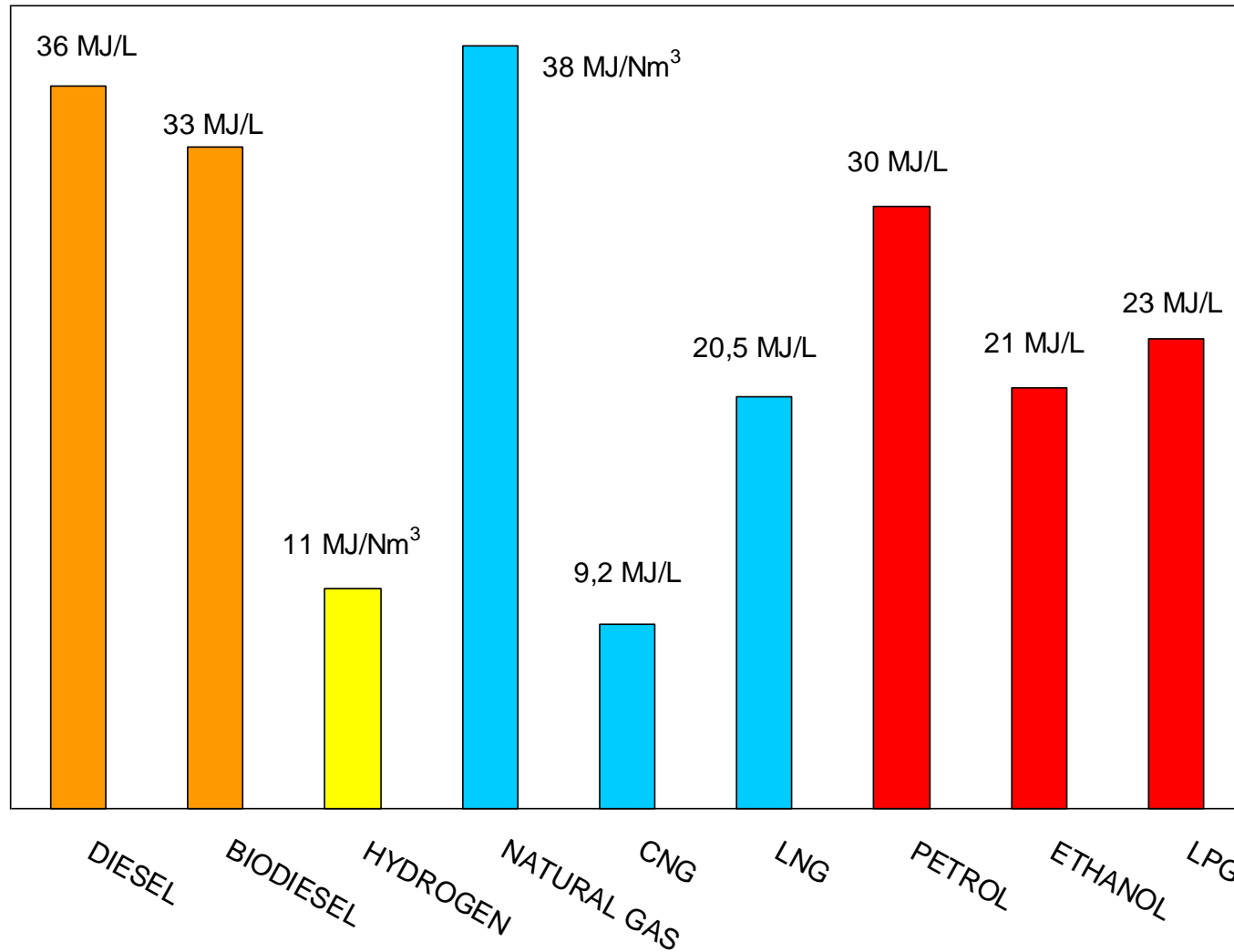
Ecoautomóvil. Marketing o realidad
Aranjuez. 27 de julio de 2010

Manuel Lage, Dr. Eng.
General Manager

Fuel road map



Energy content of different fuels



Hydrogen vs. Carbon ratios

- 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**

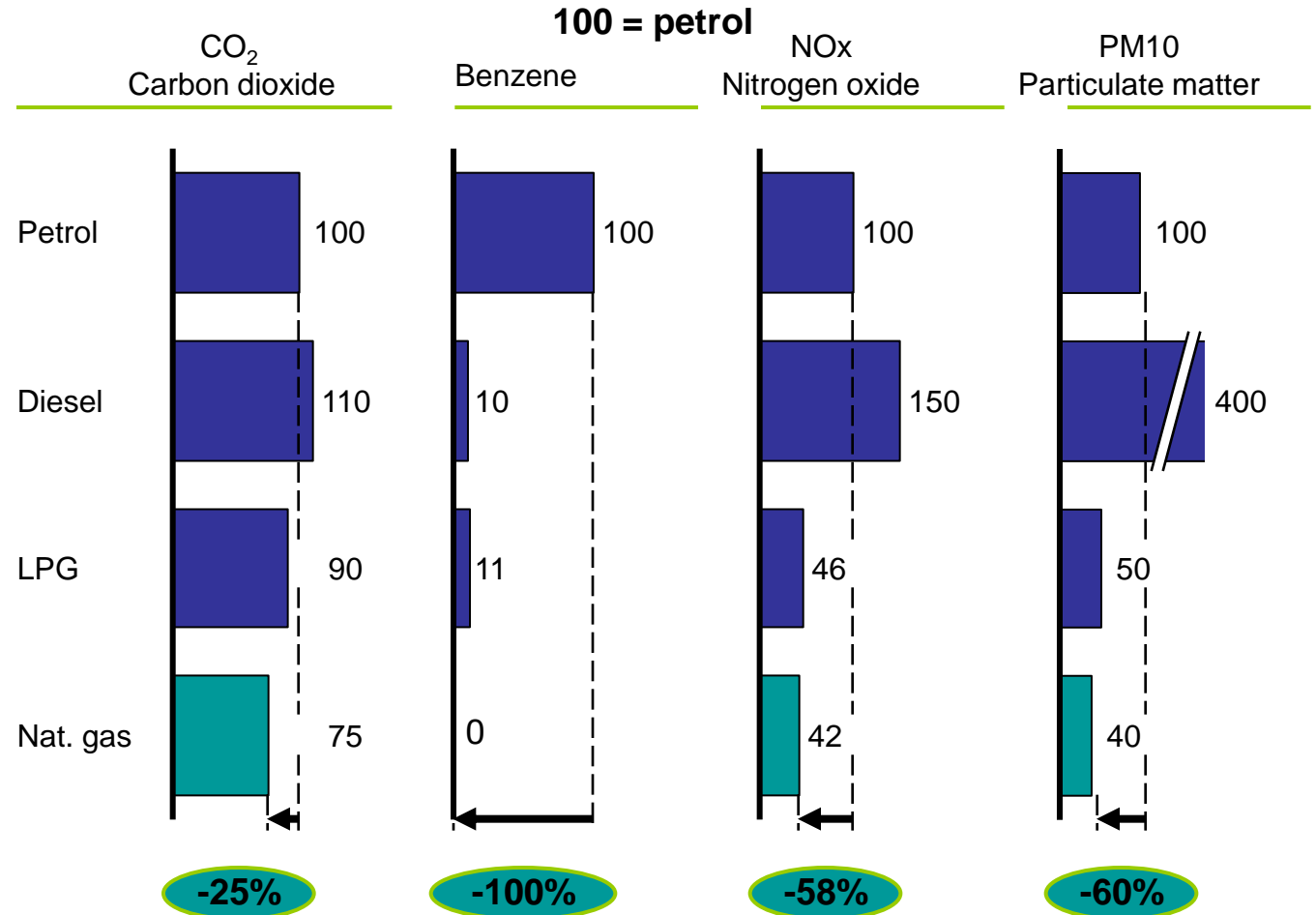
As a comparison,

- 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 CO₂ are particularly favourable in the engines running on natural gas.

Regulated emissions and CO2 comparison

Reduction % main pollutants of urban areas

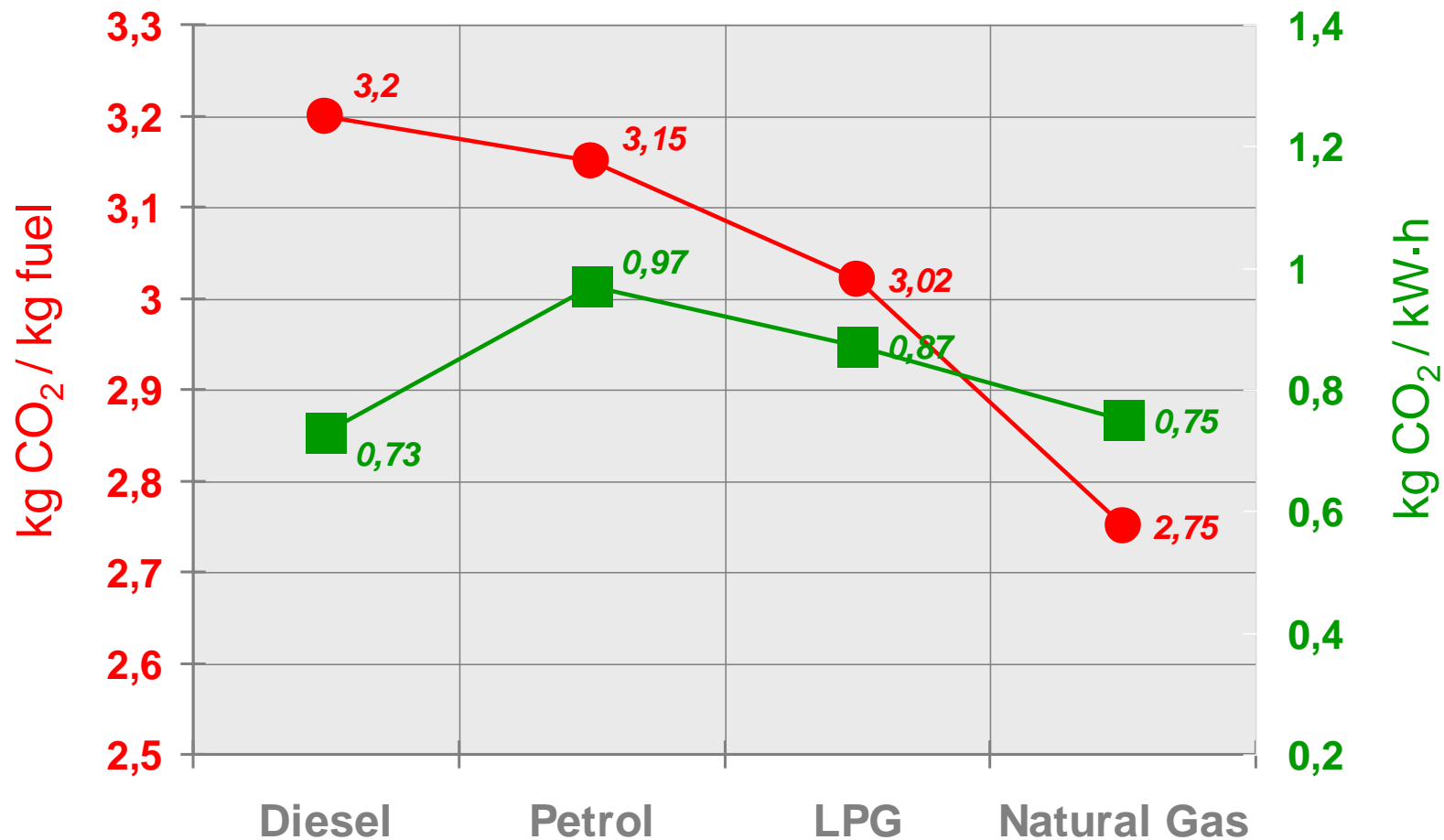


The use of CNG reduces substantially traffic pollution and contributes to the reduction of CO₂

Due to their availability through the network, It does not require road transport and storage

-90% vs. diesel

CNG. CO2 emission



Madrid. CNG Refuse collection fleet



FCC NATURAL GAS FLEET (TOTAL 445 UNITS)



FCC NATURAL GAS FLEET CONSUMPTION 10,500,000 m³

Yearly emission savings

Iveco CNG (EEV) vs. Diesel Euro 3 limits

NOx 132.391 kg

CO + HC + PM 703.000 kg

CO2 2.069.440 kg

Plus a 30% less fuel cost per kilometre!

CNG urban buses



Irisbus Iveco CITYCLASS CNG 12 & 18 m
280 CV. Stoichiometric turbo engine. EEV certified



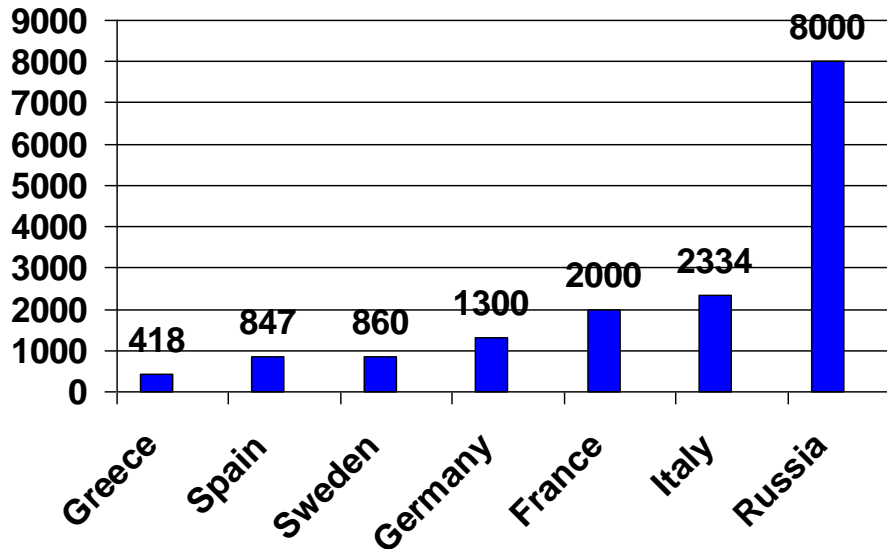
Mercedes Citaro CNG
250 HP. Lean mix engine turbocharged. EEV certified

CNG urban trucks and buses in Europe

CNG Garbage trucks in Europe

•France	approx. 600	Euro 2 - EEV
•Switzerland	approx. 20	Euro 3 - EEV
•Italy	approx. 600	Euro 3 - EEV
•Spain	approx. 1000	Euro 3-4-5 - EEV

CNG Urban buses in Europe

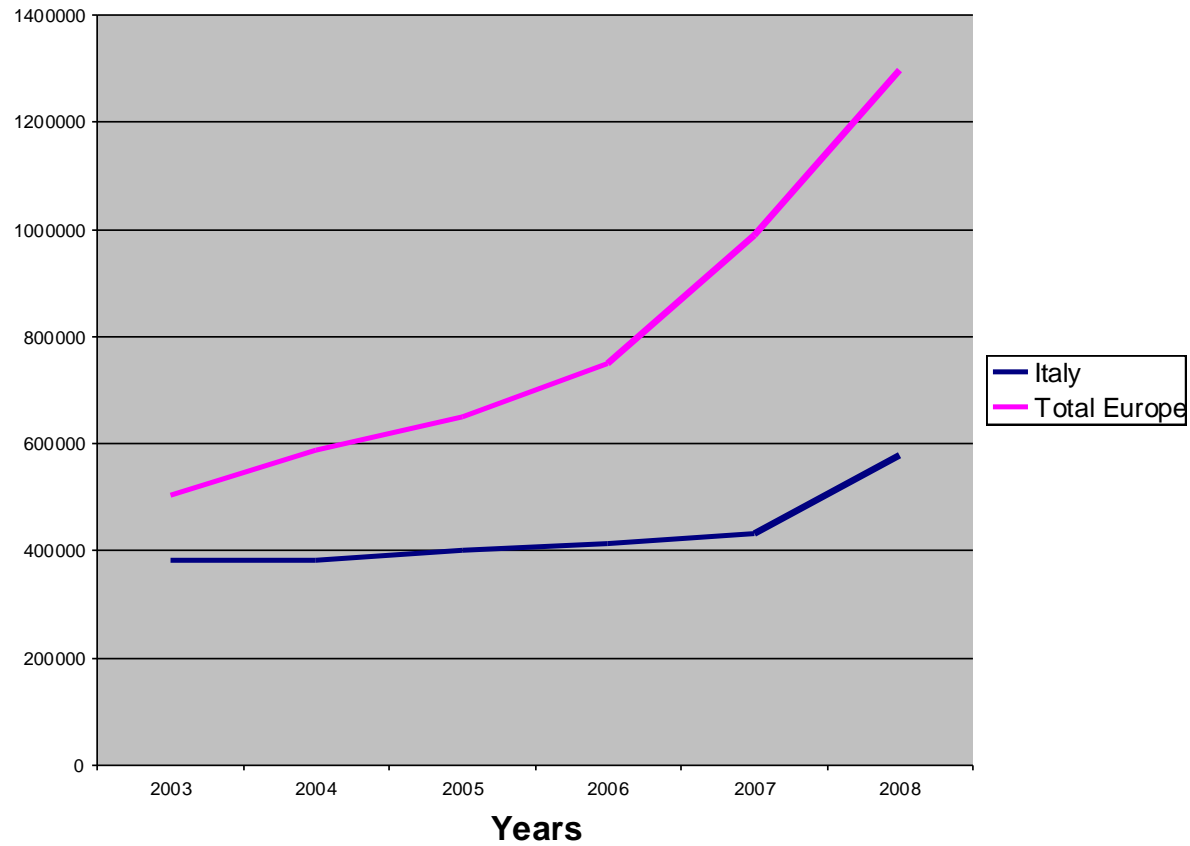


In Europe, most of the heavy vehicles running on NG are urban, using CNG/biomethane.

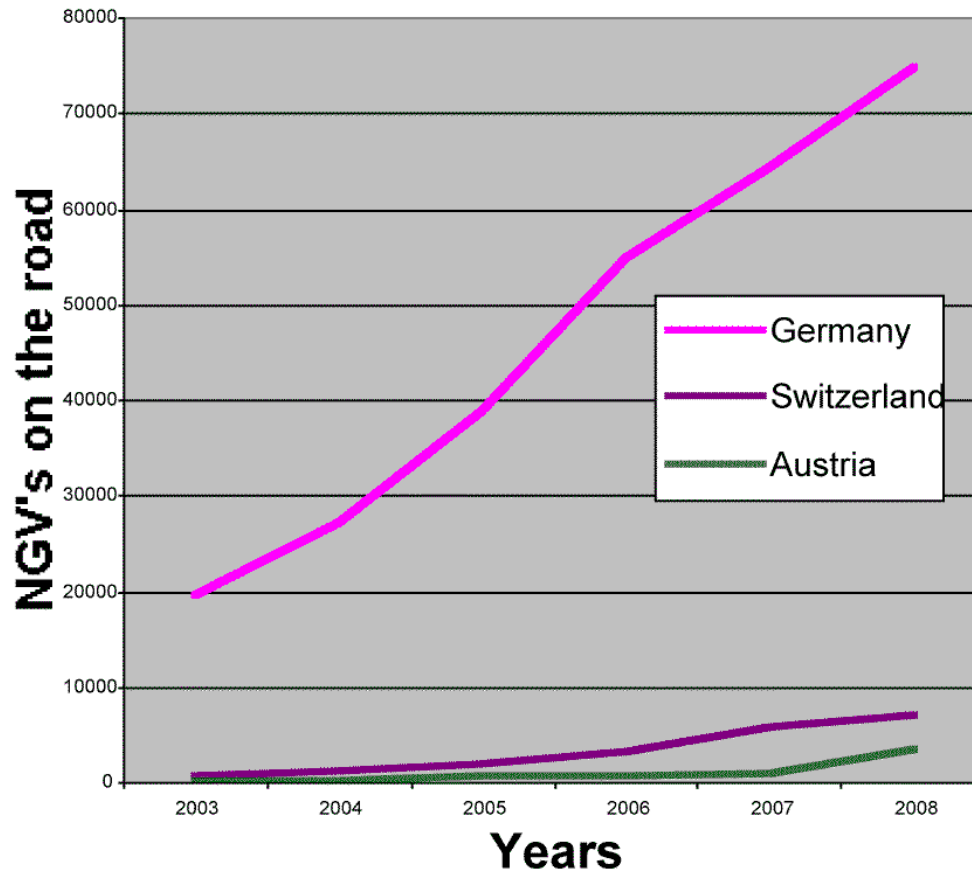
Volume and weight of the CNG tanks limit their use in road transport.

European CNG market. Italy

Italy and Total Europe



Countries with national NGV programs: Germany, Switzerland, Austria



Germany:

Mainly passenger cars, 1.300 buses

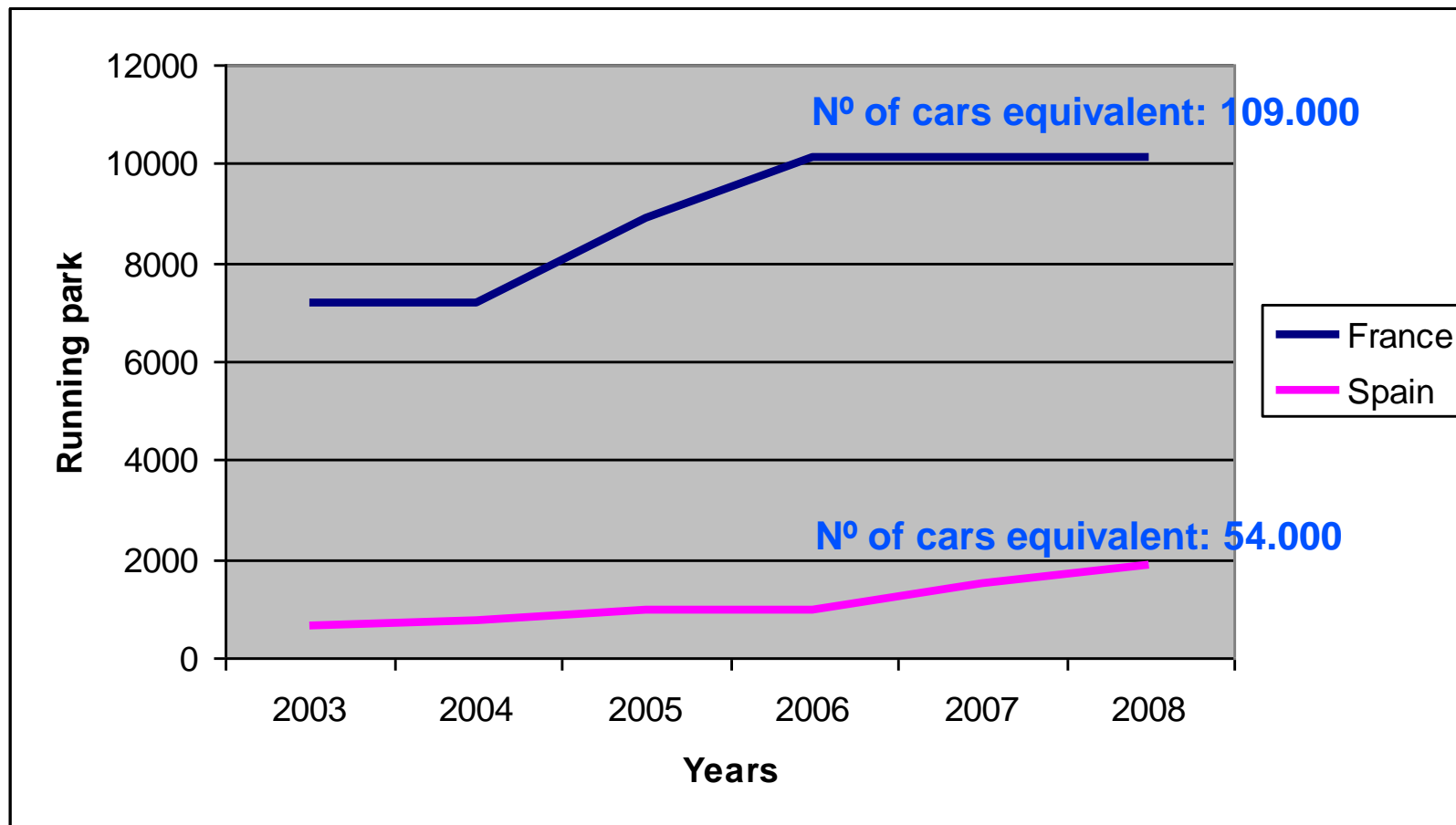
Switzerland:

Mainly passenger cars, 100 buses

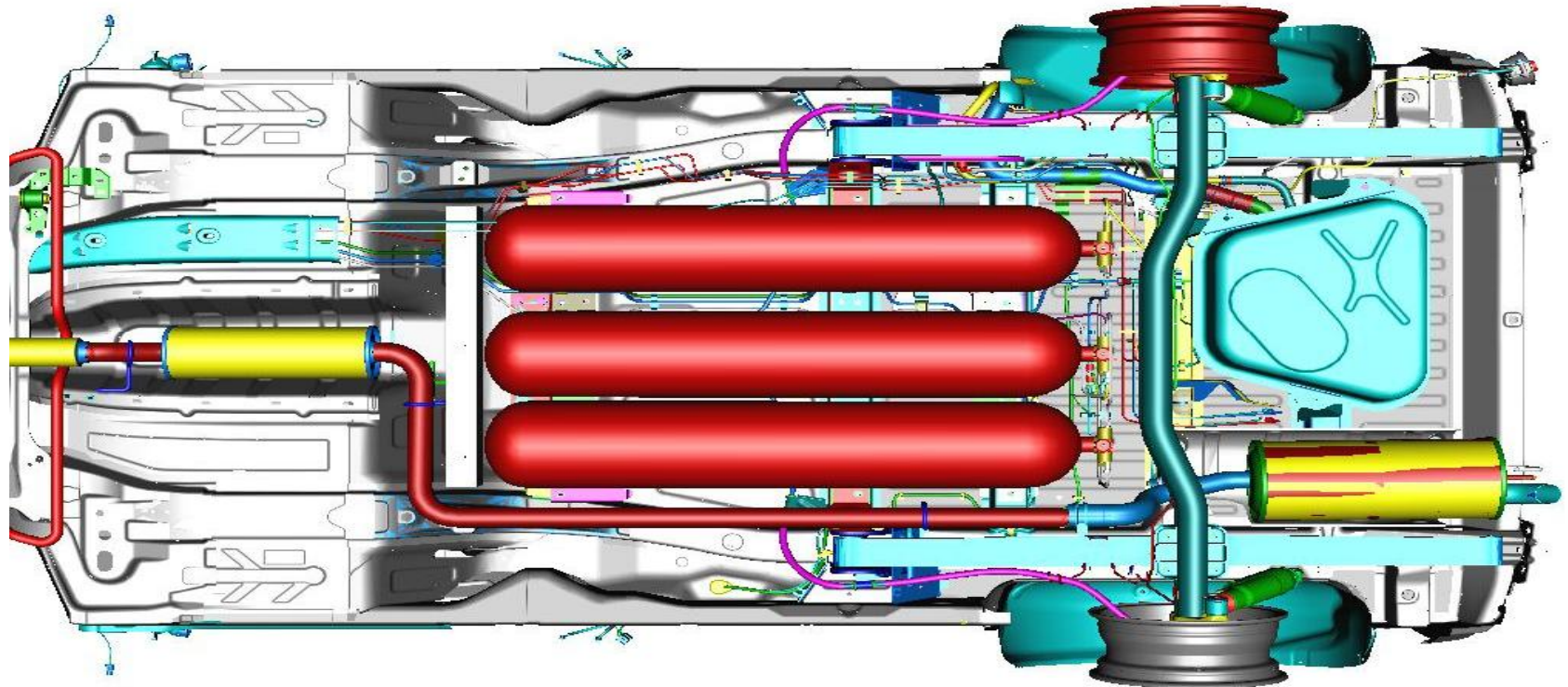
Austria:

Mainly passenger cars, 40 buses

Countries with vans, trucks and buses program on CNG: France and Spain



New CNG cars. Tanks underneath



NGVs – passenger cars & vans



Citroën



Citroën C3 1.4
Style bivalent



Citroën Berlingo
Multispace Plus
Bivalent

FIAT Fiat



Fiat Doblò 1.6 16V
Natural Power



Fiat Panda Panda 1.2 8V
Natural Power



Fiat Grande
Punto 1.4 8V
Natural Power



Fiat Doblò Cargo
SX 1.6. 16V
Natural Power



Fiat Doblò Cargo SX
Maxi 1.6 16V Natural
Power



Ford



Ford C-Max
2.0 CNG



Ford Focus
2.0 CNG



Ford Transit 2.3 CNG

NGVs – passenger cars & vans



Mercedes



Mercedes Benz
B170 NGT



Mercedes Benz
E200 NGT



Mercedes Sprinter
316 NGT + 516 NGT



Opel



Opel Zafira 1.6
ecoFLEX



Opel Zafira 1.6
ecoFLEX Turbo



Opel Combo Tour
1.6 ecoFLEX



Opel Combo 1.6 CNG
ecoFlex
Kastenwagen



Volkswagen



Volkswagen Caddy
Life 2.0 Ecofuel



Volkswagen Touran
1.4 TSI EcoFuel



Volkswagen Caddy Maxi Life
2.0 EcoFuel



Volkswagen Passat
1.4 TSI EcoFuel



Volkswagen Caddy
1.6 CNG Van

The development of NGV's in the medium term future, will follow five main lines:

- CNG Hybrid Vehicles
- Dual Fuel Technology for heavy duties
- Biogas
- LNG for trucks and buses
- Methane-Hydrogen mixtures

Next CNG Hybrid Vehicles, by AVIA



Hybrid 10 m. chassis & bus CASTROSUA TEMPUS

Avia Ingeniería y Diseño, S.L.

Both vehicles are now Diesel, but
CNG versions are in development

Hybrid 15 t truck FCC- AVIA-IVECO

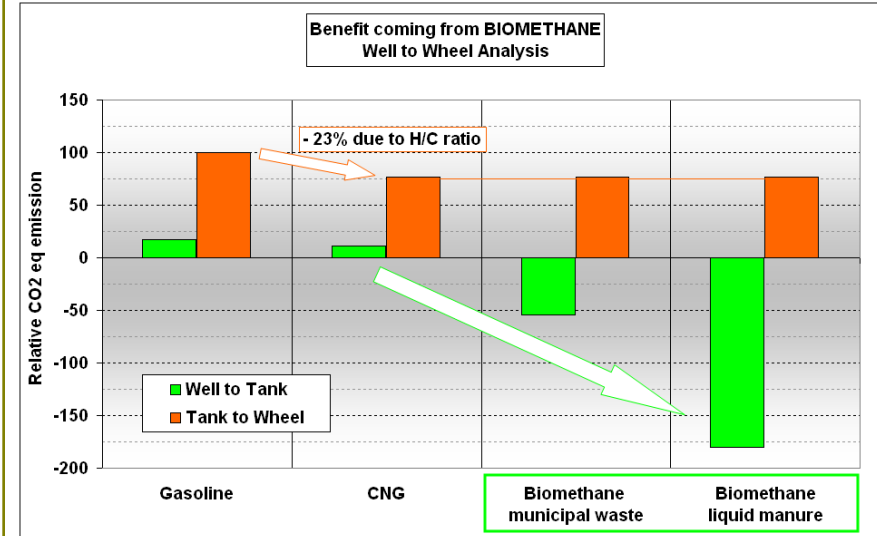
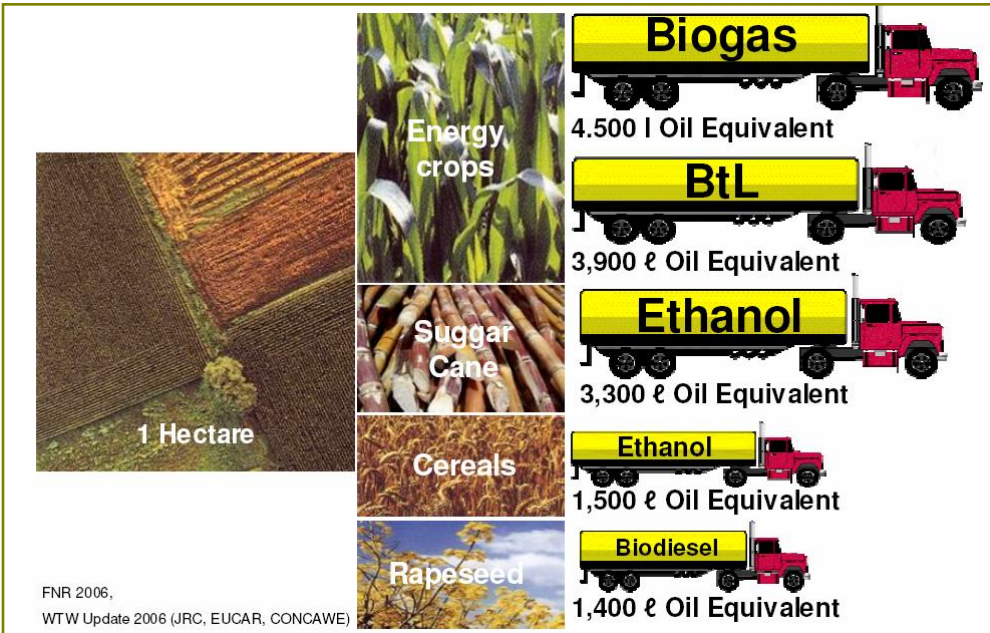


- Renewed interest in this diesel-natural gas combustion technology
- CO2 important reduction. Diesel cycle maintained
- Target market: heavy duty trucks and buses
- Retrofit market considered too for EURO 2 and 3 vehicles
- Options: full diesel operation when no CNG is available

Biogas. Another source of Natural Gas

- Biogas comes from fermentation processes of biomass (organic waste, landfills, vegetable and animal feedstock), which produces methane rich gases.
- Biogas brings together the advantages of natural gas with the environmental benefits of renewable energy sources.
- Due to the wide different types of sources: forestry, landfills, agricultural; there is a large and wide potential for biogas production in Europe, where it is expected to grow significantly in the coming years.

Biogas production potential



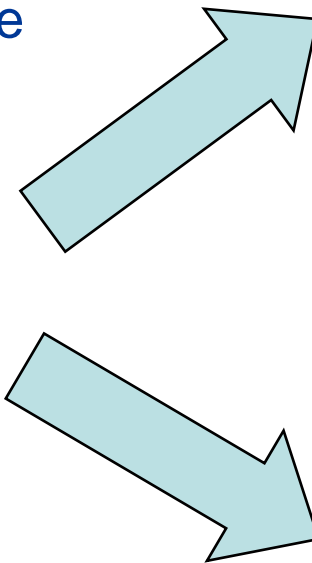
Among the different options of biofuels, biomethane presents the higher efficiency per hectare of land.

LNG (Liquefied Natural Gas) NG with a high energy density

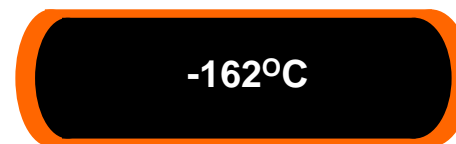
Diesel vs CNG & LNG
Autonomy equivalence



1 litre



CNG
5 litre



LNG
1,8 litre

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

CNG vs LNG. Tank configuration



8 tanks of 80 lt. 640 lt. CNG
eq. to 128 lit. diesel



1 single LNG 360 lt. tank
eq. to 200 lt. diesel (56% more)

LNG tractor units from MB and IVECO



MB Econic 280 CV



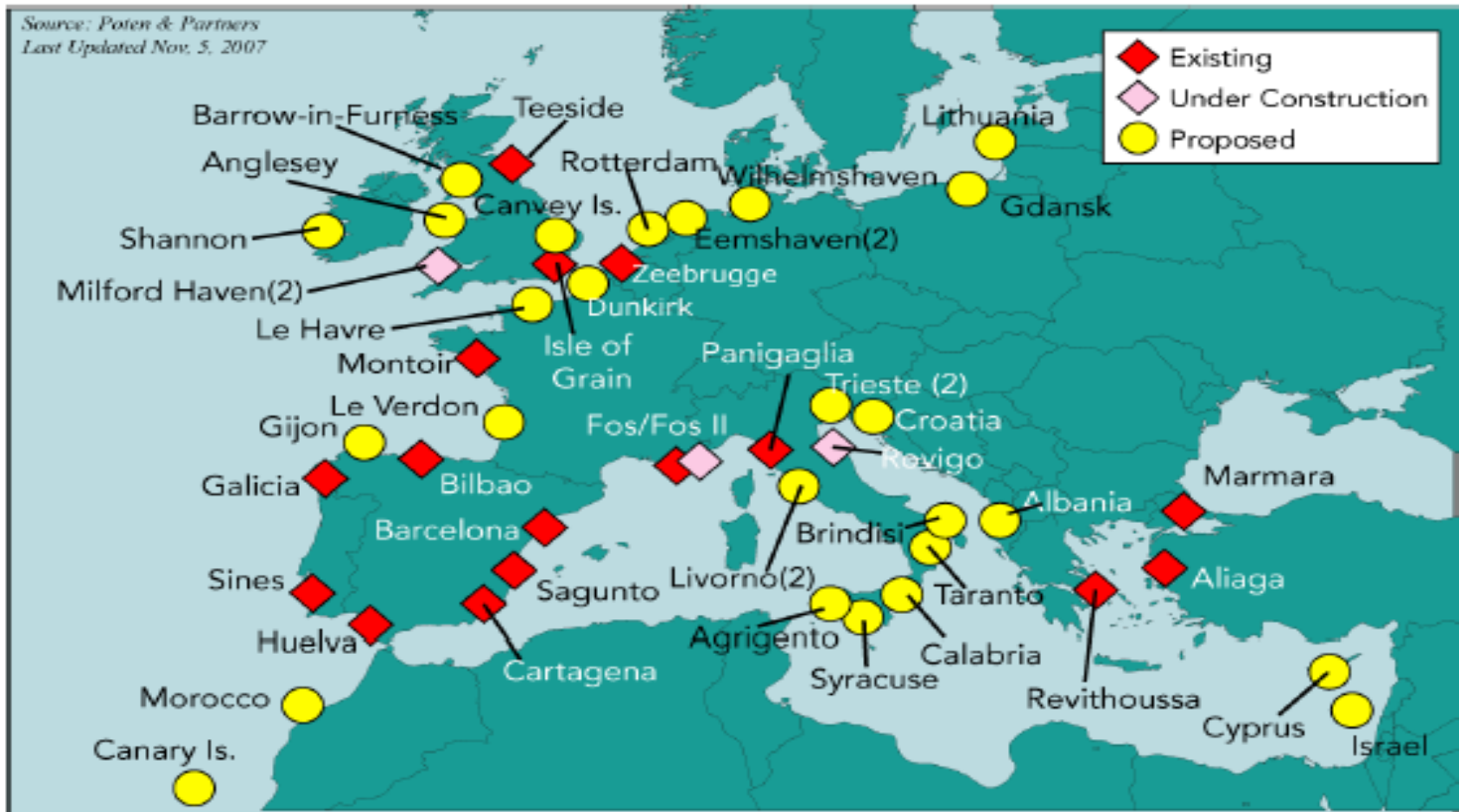
IVECO Stralis 280 & 330 CV

Refueling Stations LCNG Lleida - Spain



LNG supply to Europe

Figure 2 - European LNG Terminals



Source: Poten & Partners, Inc. 2008.

Methane/Hydrogen mixtures

Methane/Hydrogen mixture (*Hythane, Idrometano*) offers a number of significant advantages as a bridge solution for a future hydrogen fuelled transport:

- It can be used in the existing NGV engines and vehicles with minor engine resetting
- The inboard fuel storage uses the same type of tanks and fittings, with some specification changes in materials
- The H2 content considered (~20%) does not alter the autonomy of the vehicles
- There is an immediate impact as CO2 emission reduction
- The use of compressed H2 in a “large” basis will push ahead the development of the hydrogen production and logistics

The Hythane® buses



Hythane: Natural gas / Hydrogen (80% - 20% by volume)

GDF SUEZ: Project Coordinator
GNVert: Refuelling station buider and operator
INERIS: Safety studies
IVECO France: Buses adaptation
Ecole Centrale de Marseille: engines studies

City of Dunkerque
H ₂ Développement: local coordinator
Communauté urbaine de Dunkerque: local authority
Société des Transports de Dunkerque et Extension: buses operators/users
Hydrogenics: supplier of the Hythane® station

In service since July 2009

Two units IRISBUS-IVECO with Cursor 8 engine 270 CV.
 Gas tanks: 8 x 155 litres each from Dynetek
 Autonomy: 300-400 km



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