

Bio-natural-gas for cleaner urban transport

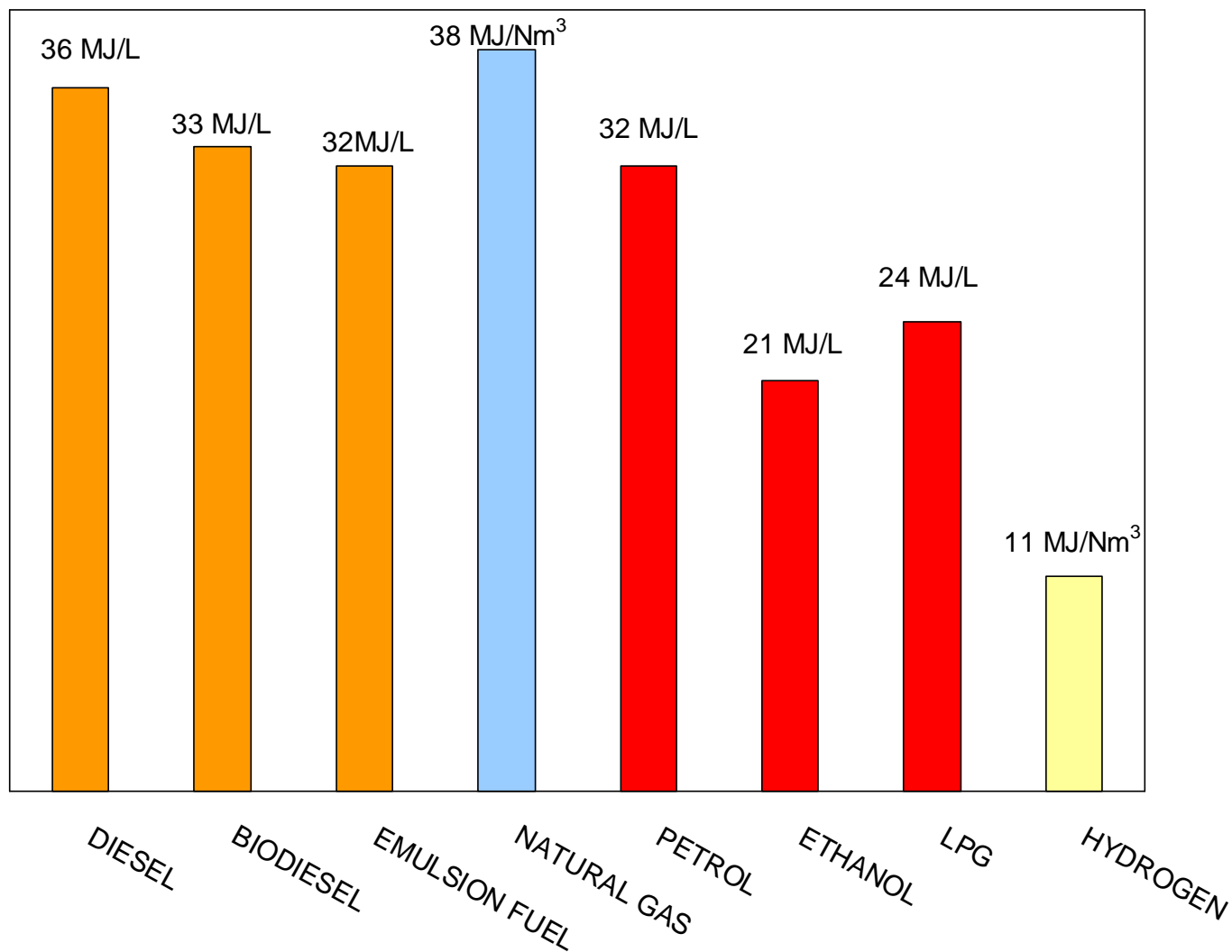
MICROPHILOX PROJECT

Biogas as a potential renewable energy source

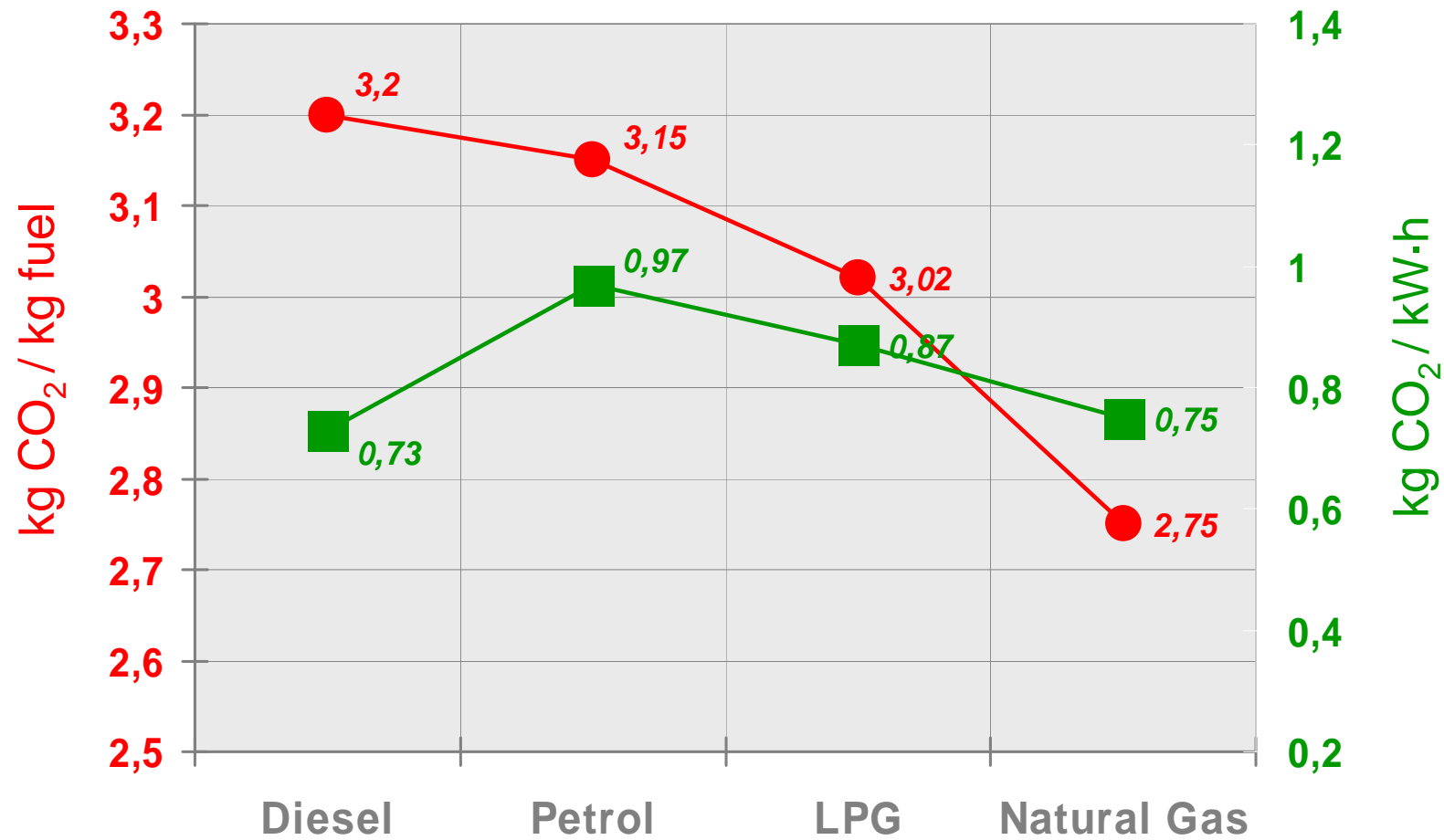
Barcelona. March 26, 2009

Manuel Lage
General Manager

Energy content of different fuels



CNG. CO2 emission



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

Advantages of CNG for city transportation



Both CNG engine combustion technologies used in trucks and buses: Lean Burn and Stoichiometric, offer very significant advantages:

- Much lower gaseous emissions
- Much lower noise
- Reduced CO₂ emission

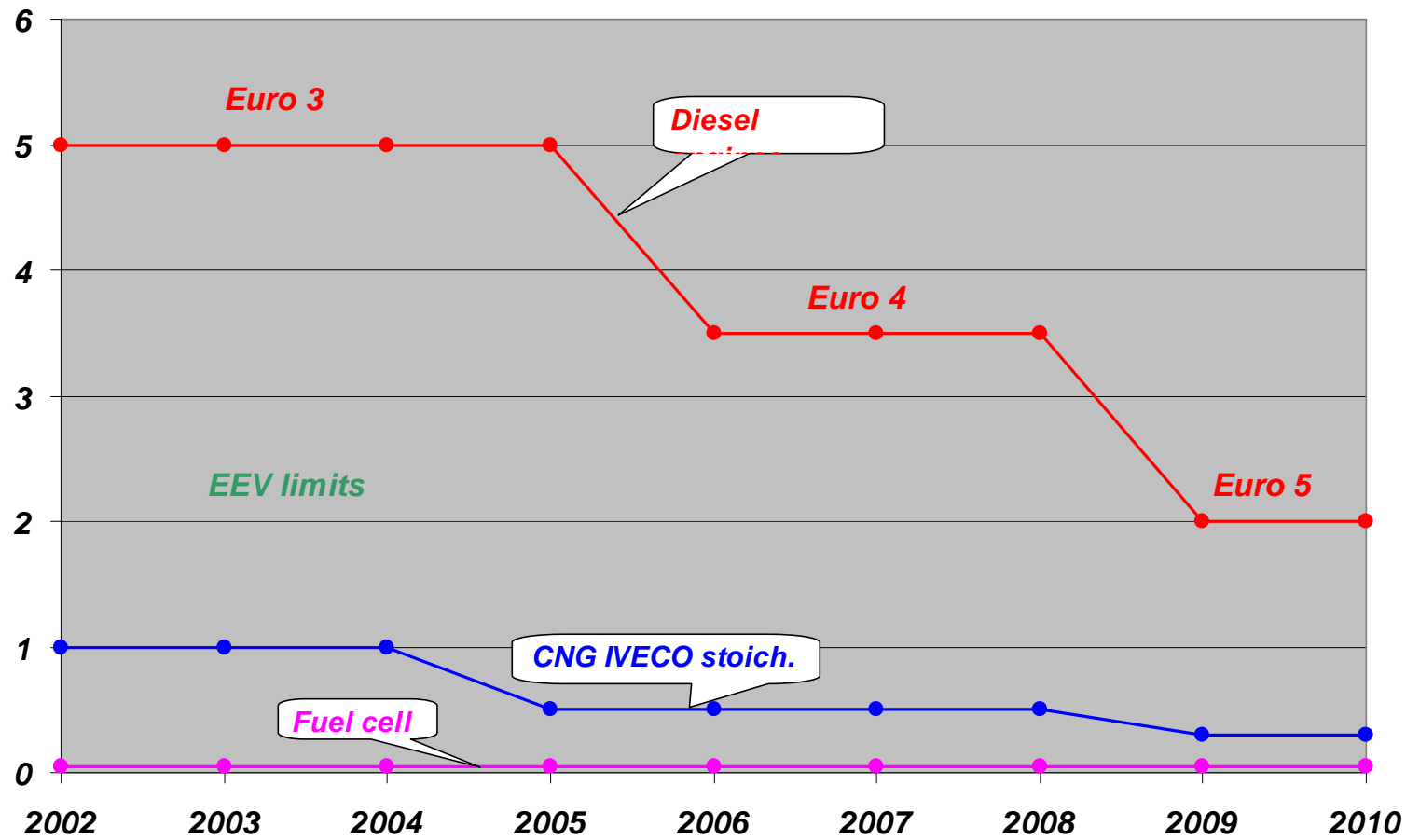
In the case of the stoichiometric mixture combustion, exhaust pollutants are very near the fuel cell level

CNG. NOx comparative emissions



Compared NOx emissions: Diesel vs CNG and Fuel Cell

(Source: IVECO)

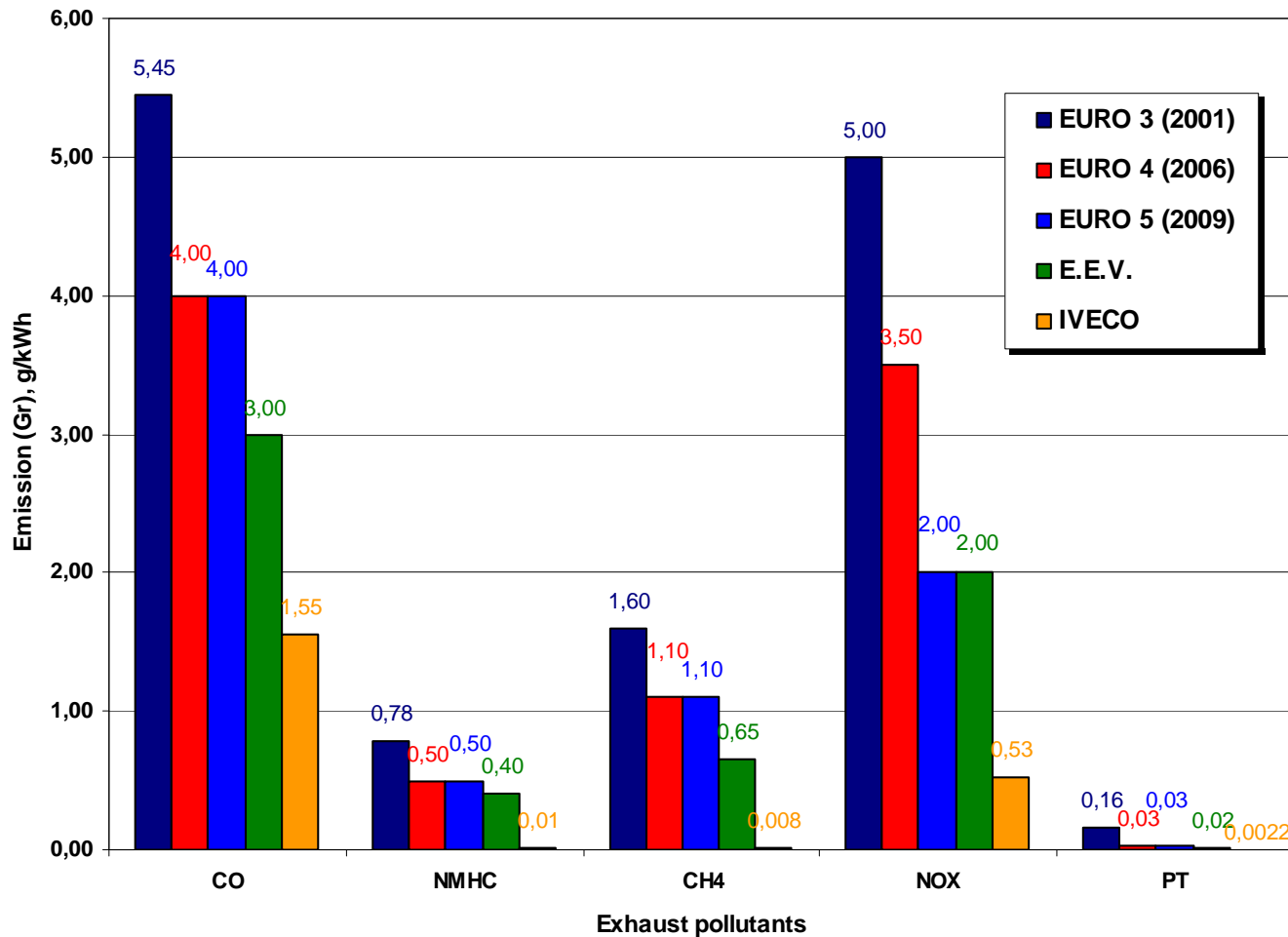


CNG. Other Emissions Comparison

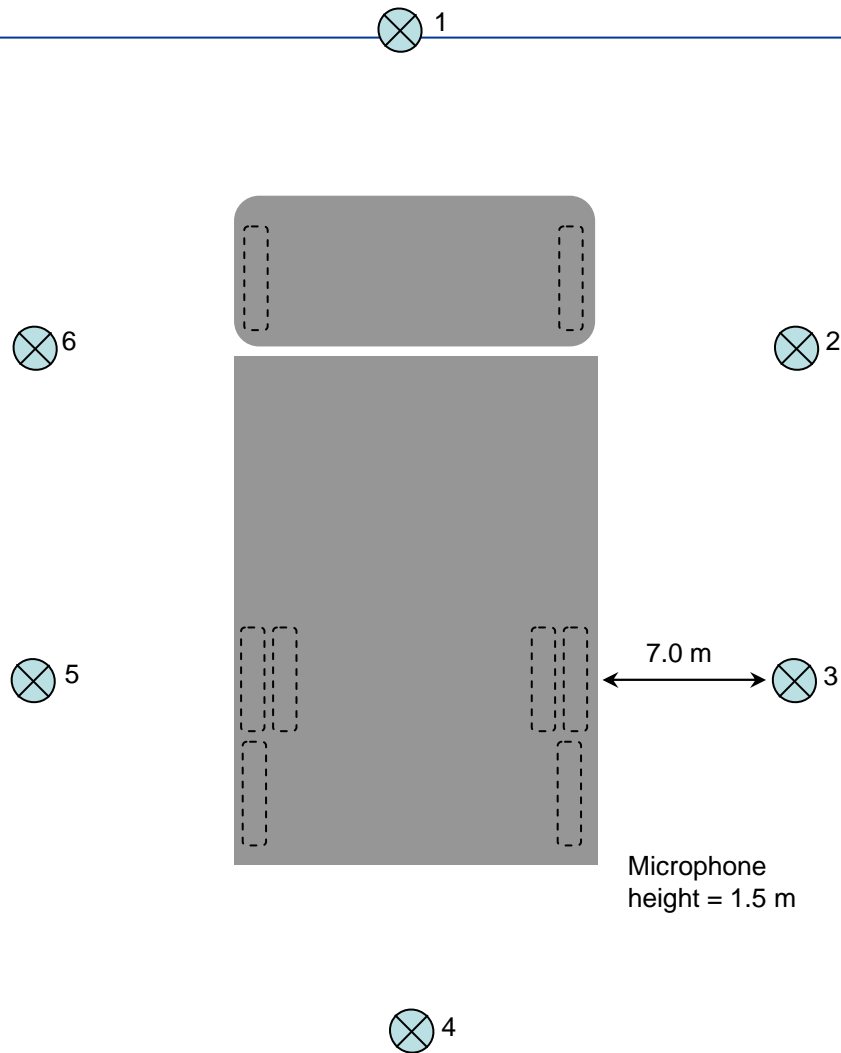


Emissions IVECO CURSOR 8 CNG engine vs present and future Euro limits

(Source: IVECO)

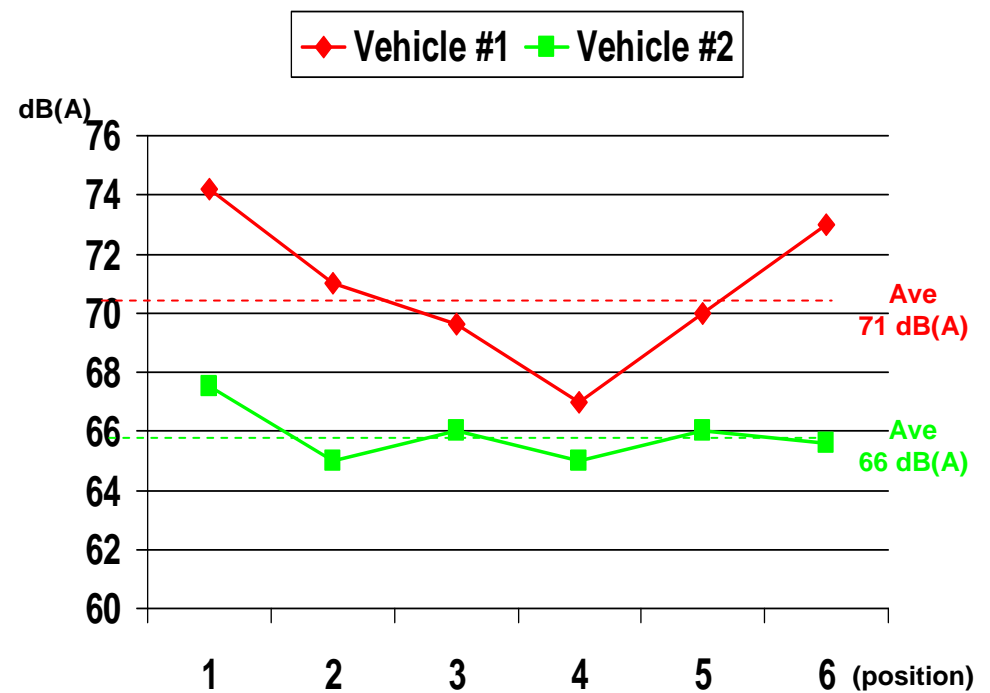


Noise emitted by the truck



Vehicle #1: IVECO 240E25 6x2 RSU
Vehicle #2: IVECO 240E26 6x2 RSU CNG (EEV)

Refuse collection chassis cab with body
Vehicles laden and compacting
Vehicles stationary



Madrid CNG Refuse collection fleet



FCC NATURAL GAS FLEET (TOTAL 445 UNITS)



FCC NATURAL GAS FLEET CONSUMPTION 10,500,000 m³

Yearly emission savings

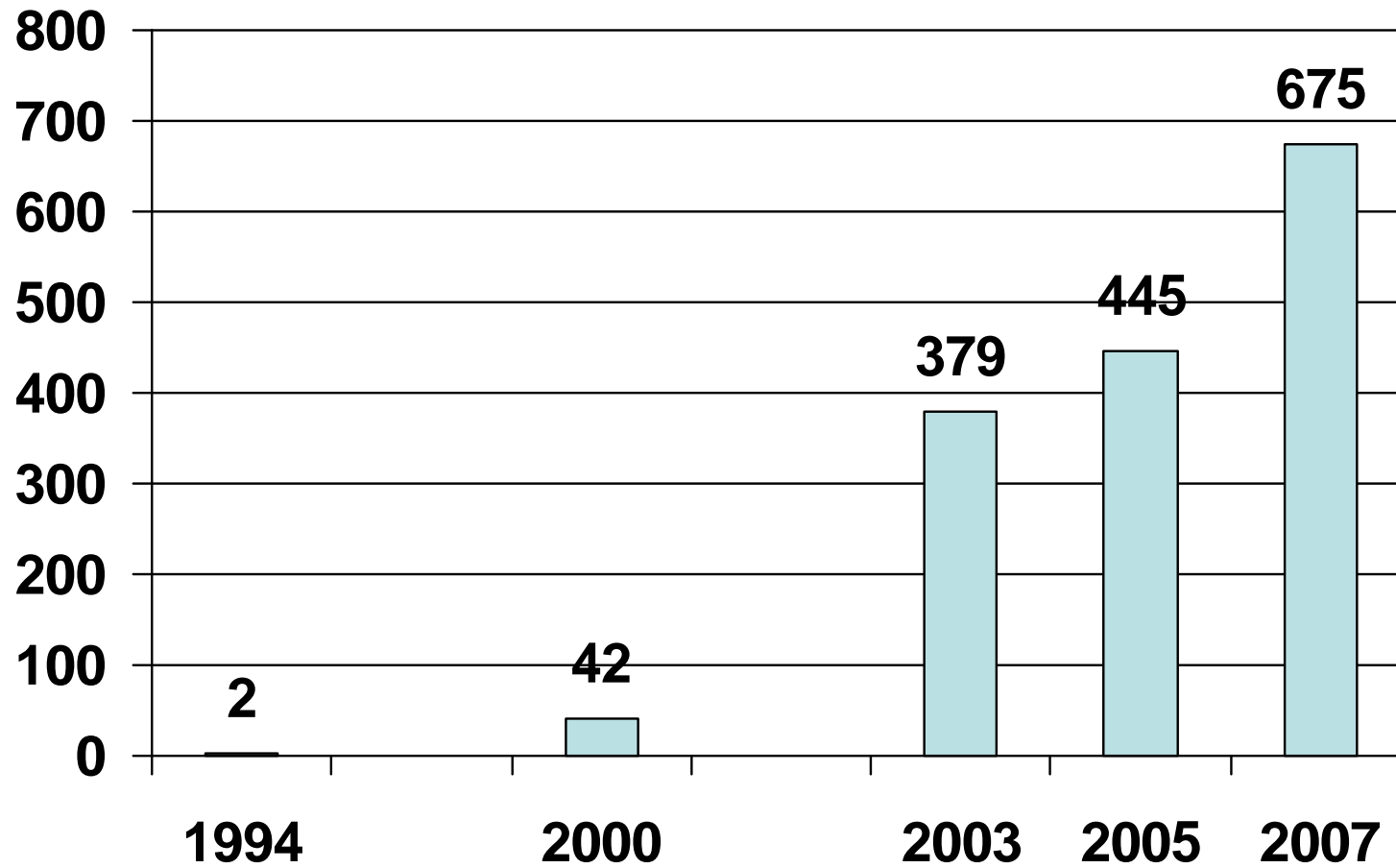
Iveco CNG (EEV) vs. Diesel Euro 3 limits

NOx 132.391 kg

CO + HC + PM 703.000 kg

CO2 2.069.440 kg

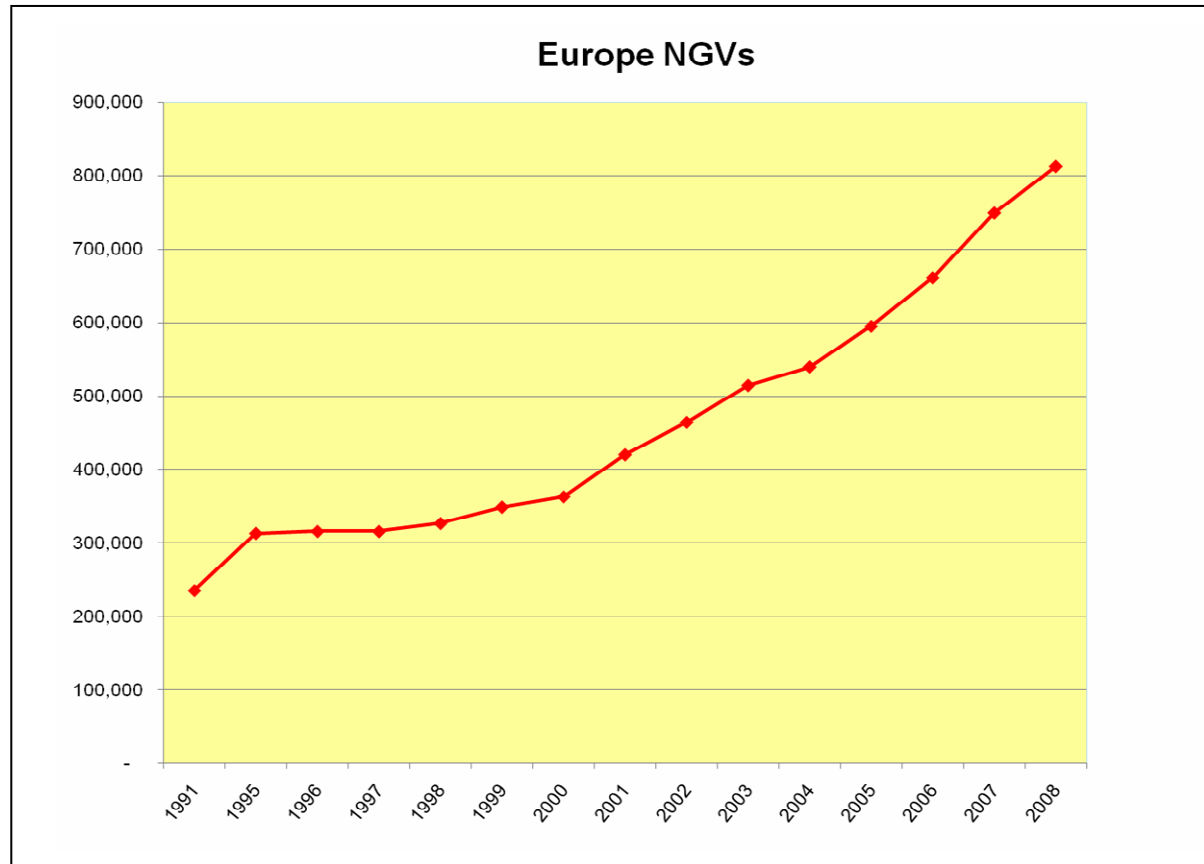
Madrid CNG Refuse collection fleet



CNG truck for food distribution



Europe. Market Growth



The steady European growth is driven by the cleaner emissions of NGVs

IVECO Irisbus CNG Urban buses



Irisbus Iveco CITYCLASS CNG 12 m

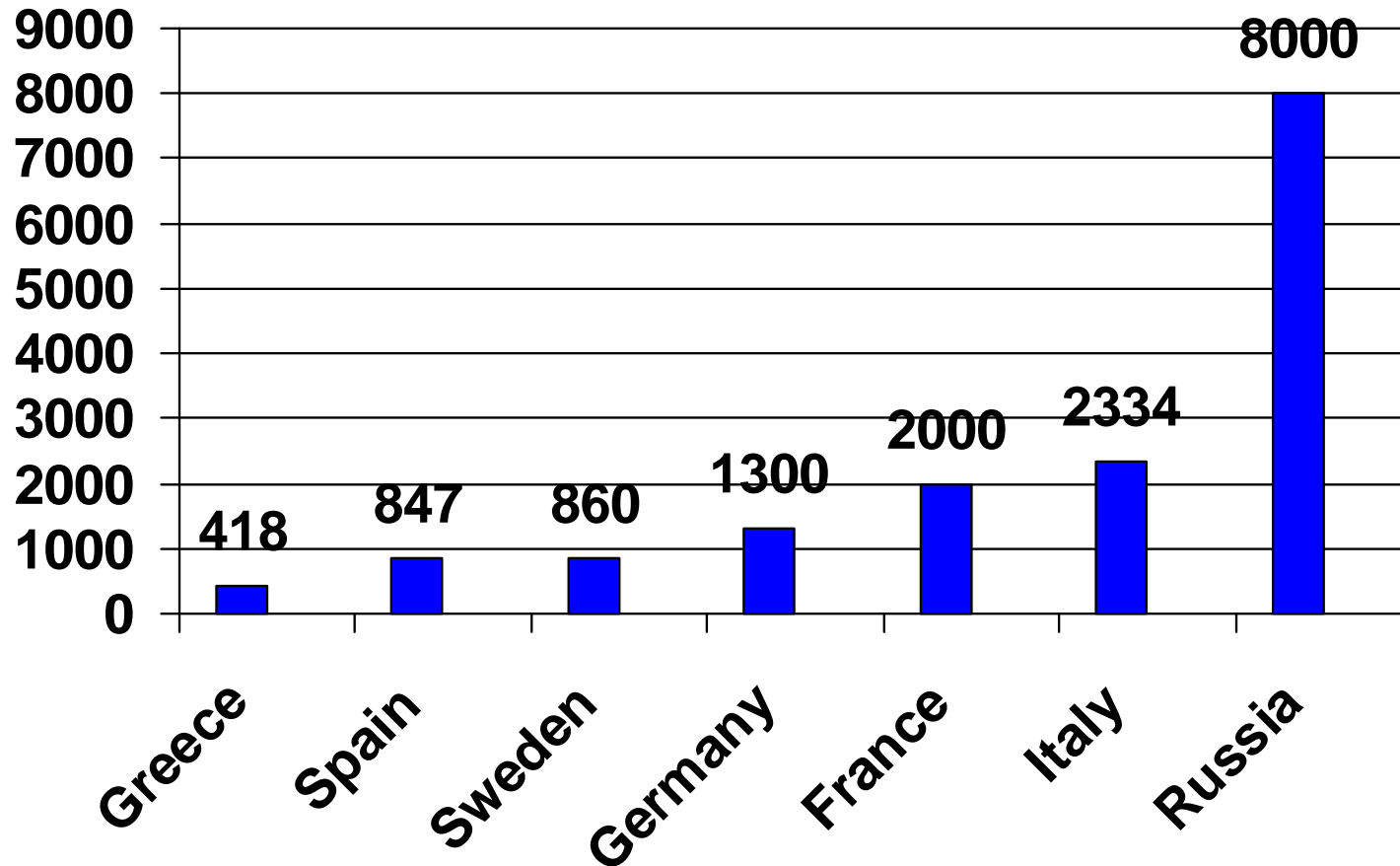


Irisbus Iveco CITYCLASS CNG 18 m



BEIJING BUS, IVECO TECTOR CNG engine

CNG urban buses in Europe



Biogas. Another source of Natural Gas (1)



- 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 range of sources there is a large potential for biogas production, which, in Europe, is expected to grow significantly in the coming years.

Biogas. Another source of Natural Gas (2)



- The raw biogas composition is variable depending upon different factors like garbage origin, humidity, temperature, etc., but it normally contains 50-55% of methane (CH₄) and 40-42% of carbon dioxide (CO₂).
- The depuration of this gas means:
 - avoiding the emission of CO₂ to the atmosphere
 - reusing the CO₂ as a commercial product
 - eliminating other pollutants like Cl₂, F₂, SH₂
 - the purified biogas will have a 90-95% methane content
- In terms of use in vehicles, the advantages of natural gas are increased with a much better balance of total CO₂ due to the renewable origin of biogas.

Big cities. Gas use vs biogas potential

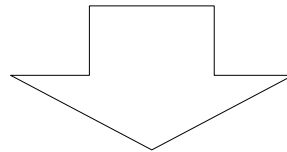


The yearly biogas production of the city is of about 40 MM cubic meter, that once refined would mean:

- **22 MM cubic meter of biomethane**

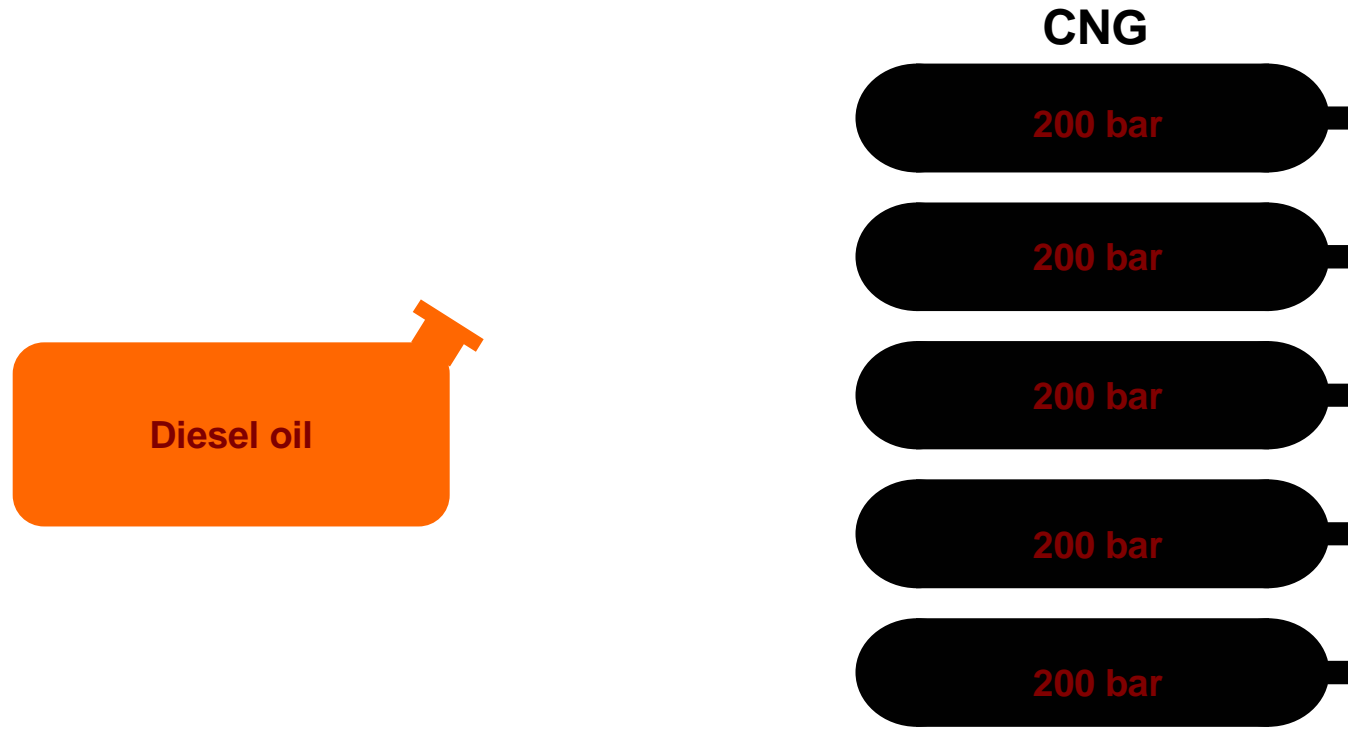
The yearly consumption of natural gas of the complete fleet of 445 garbage collection trucks is:


- **10.5 MM cubic meter**



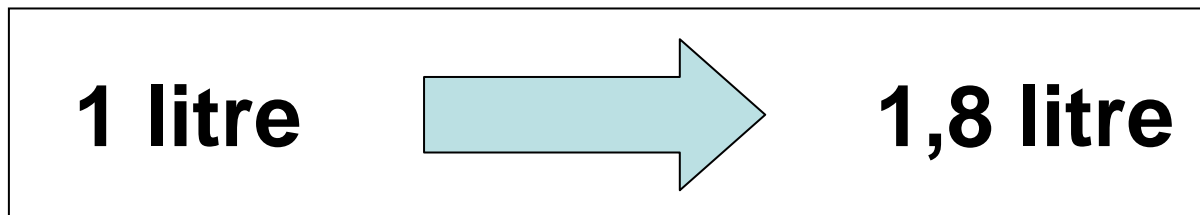
This volume is enough to fuel the full fleet of garbage collection (445 units) plus a similar figure of urban buses (25% of the total fleet of 2.000 units)

CNG vs Diesel. Autonomy equivalence



1 litre  **5 litre**

LNG vs Diesel. Autonomy equivalence



LNG opens the way for the medium-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)

CESPA LNG Station. Barcelona



Nº vehicles (end 2009): 158 Uds
Yearly gas consumption: 2.700.000 Nm3
Yearly emission reduction:
NOx: 34.000 kg/year
CO+HC+PM: 181.000 kg/year
CO2: 523.000 kg/year



New LNG plant near Poznan



- NG comes from a well near POZNAN. This NG has 17% of nitrogen, making it unable to be used directly in NGV's
- The liquefaction process eliminates most of nitrogen, enriching the methane content of the LNG and facilitating its transport.
- LNG availability through road distribution will allow to have filling stations able to supply both CNG and LNG.
- The new plant, built by INDOX Cryo Energy (Spain), will have a production of 100 Ton/day of LGN. It will be inaugurated in the second quarter 2009.

Conclusions



- Natural gas (methane) is an excellent energy vector, with the lowest Carbon to Hydrogen ratio of all the hydrocarbons
- Additionally natural gas is an alternative fuel, having a different origin from the traditional oil derived diesel, petrol and GPL
- Natural gas can be used in the existing internal combustion engines, with minor additional investments, taking advantage of a well known and mature car & commercial vehicle technology
- Natural gas has been used so far as CNG mainly for urban applications. The availability of LNG will spread its use for medium distances road transport
- The increasing production of biomethane, both from urban waste and from agricultural staff is giving natural gas the new and valuable consideration of a renewable fuel
- NG vehicles constitute an economic, up-to-date and dependable alternative to improve acoustic and gaseous emissions simultaneously

