# Advanced Powertrains in Europe
# Which fuels ?

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# Stakes Technologies Fuels

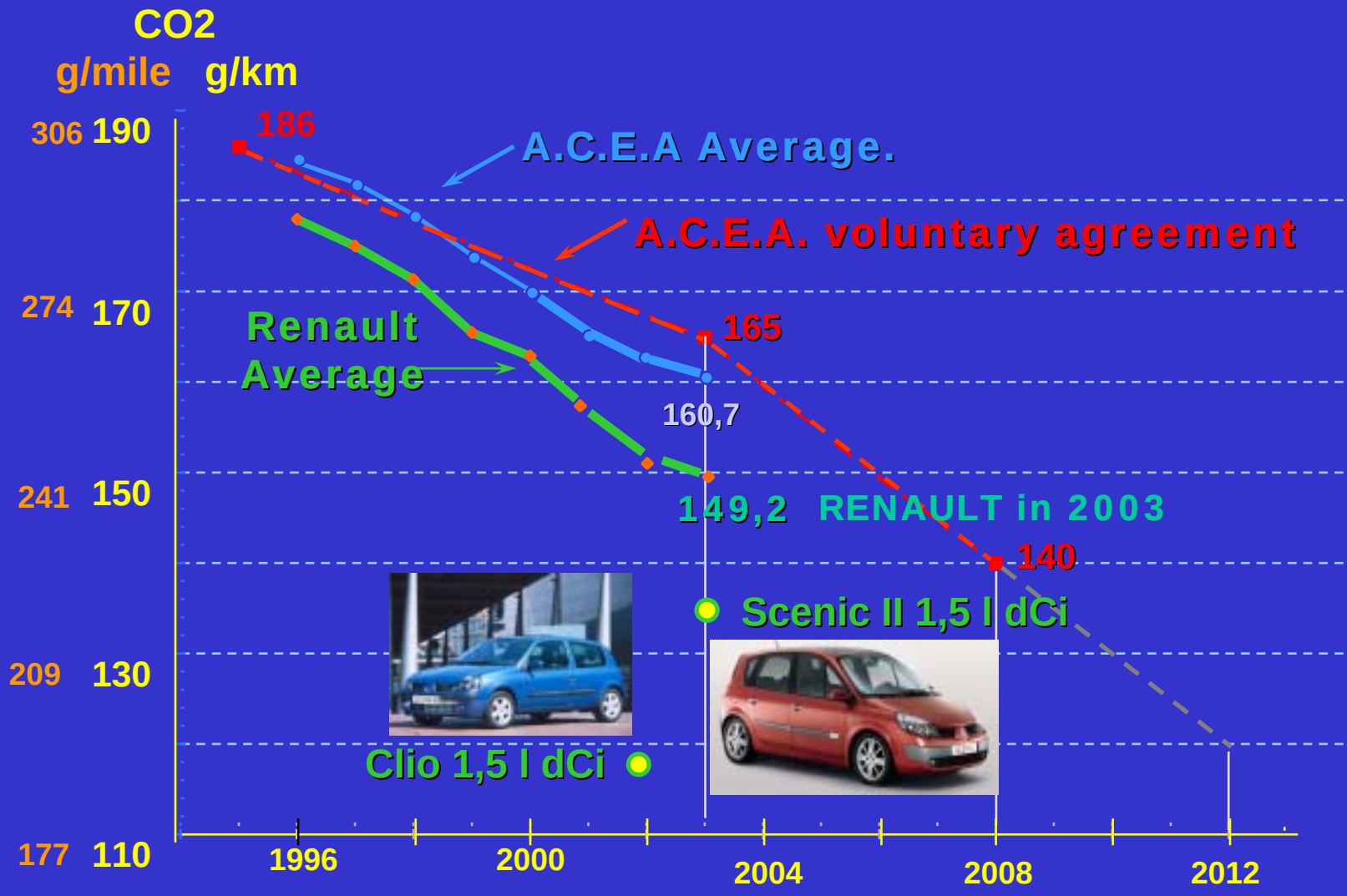
- Main driver : GreenHouse Gas impact (CO2….)
- Most stringent pollutants emission standards
- Fuel-vehicle reliability and durability

At minimal cost

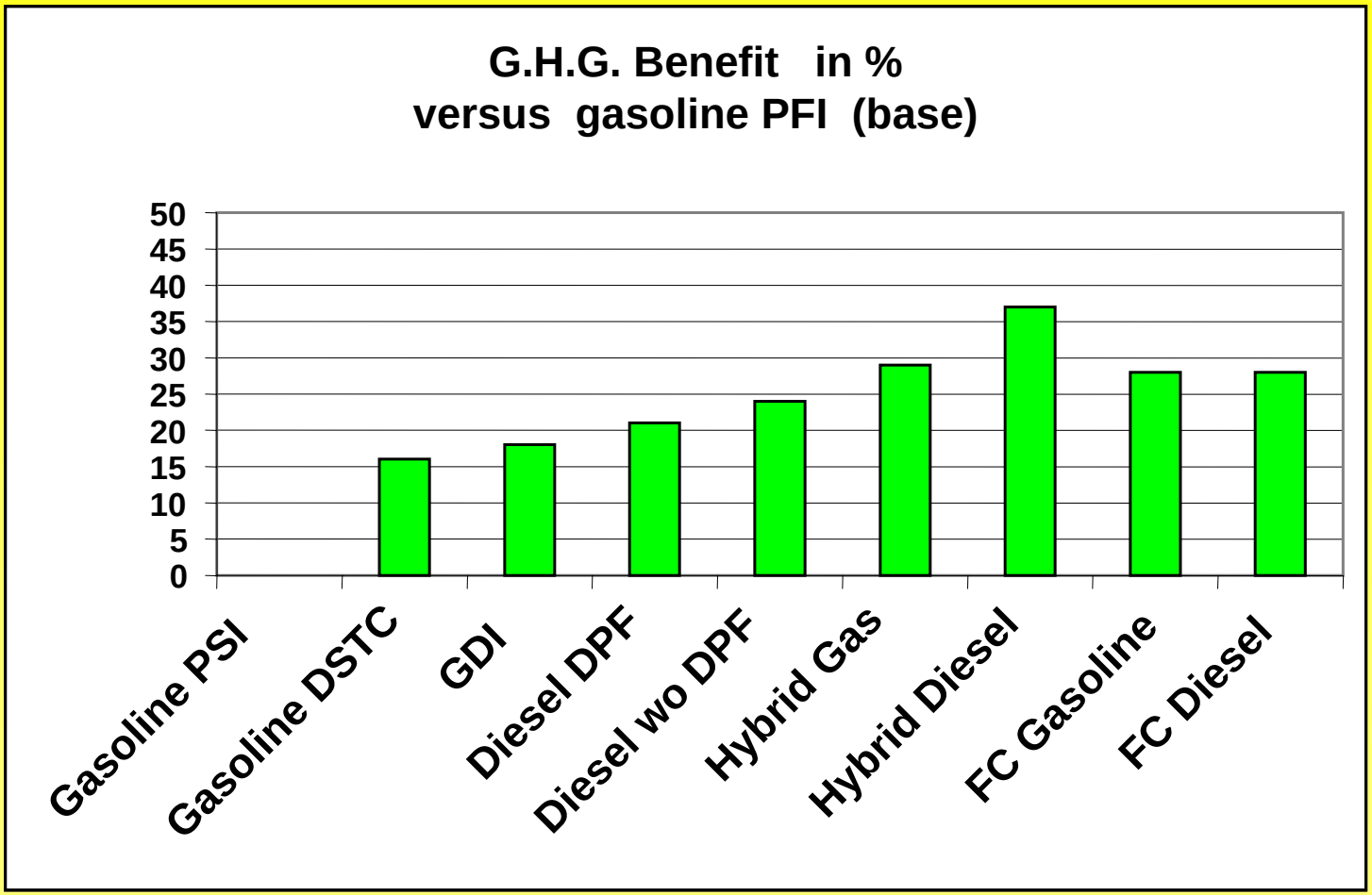
- Gasoline
  - Downsized turbo charged
  - Stratified Lean Burn Direct Injection
- Common Rail Diesel EU IV… EU V ?
  - Particle filter , NOx-Trap
  - HCCI Homogeneous Combustion
- Fuel Cells :
  - Hydrogen ?
  - With a Reformer ?
- Conclusion

# $CO_2$ EMISSION REDUCTION

## ACEA Self-commitment and Trends



# Weight of stakes per technologies[1]




**Ref [1] : "Well to Wheels analysis of future automotive fuels and Powertrain in the European Context**
**JRC -** EUCAR – Concawe December 2004

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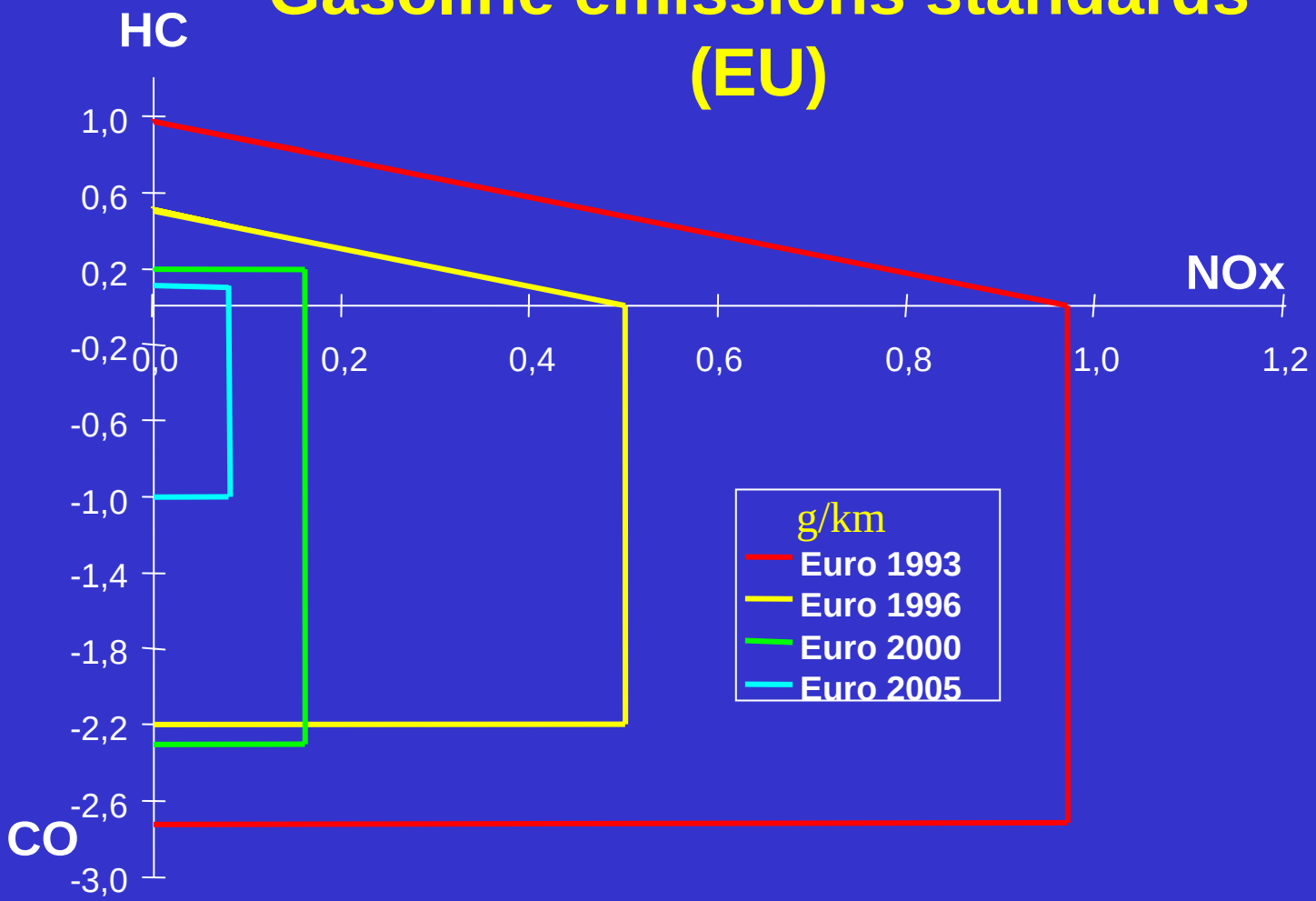
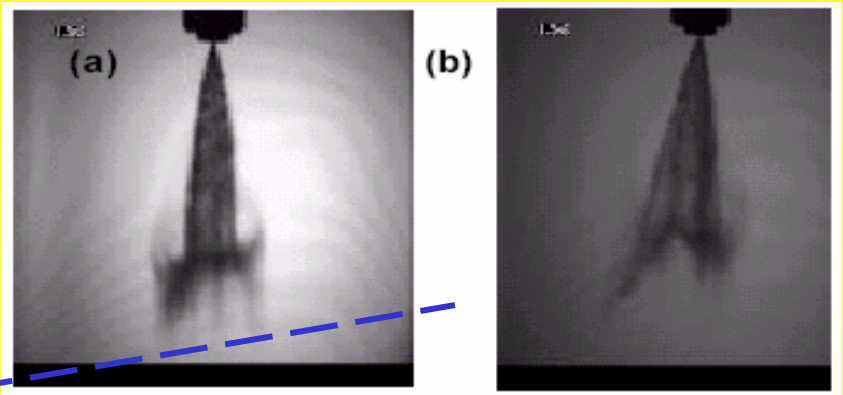
# Gasoline emissions standards (EU)



# Gasoline needs for
## $CO_2$ & Emissions Reduction

| *Ways, technologies* | *Fuel requirements* |
|---|---|
| 1- **Downsizing (turbocharged)**<br>❖ MPI λ=1 **(15 %)**<br>❖ GDI lean burn **(18 %)** | ❖**High octane (RON&MON)**<br>❖**Detergent additives** |
| 2- **Aftertreatment systems** :<br>❖ 3-way cat. / close coupled cat.<br>❖ **NOx trap** | ❖**No metallic additives**<br>(next slide)<br>❖ **S<10 ppm** |




***clean injector*** ***fouled injector***

**Sulfur is a poison for NOx Trap conversion efficiency**

**NOx conversion is a « sine qua non » requisite of Gasoline D.I.**

# Emission System Information - US vs Cdn

*Customer Vehicles*

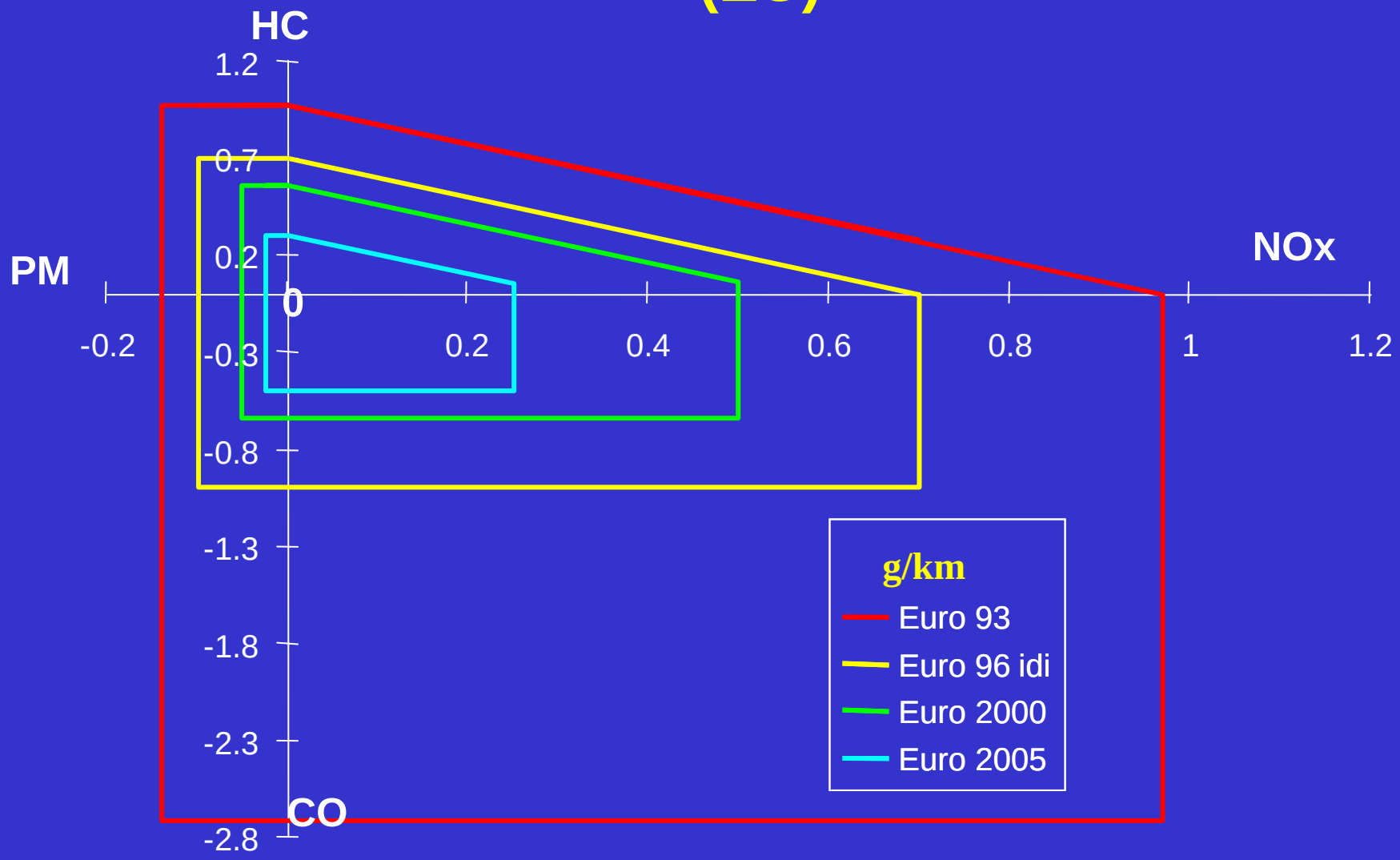
**in-use 80,000km US market**

**in-use 78,400km Cdn market**

*2001MY vehicle representative of Tier 2 emission technology

*BOTH 600 CPSI*

# Diesel emissions standards (EU)



# Diesel needs for
## Emissions & $CO_2$ Reduction

| *Ways, technologies* | *Fuel requirements* |
|---|---|
| ❑ **Engine :**<br>❖ Common Rail 1600 bar, piezo Injectors<br>❖ EGR : high precision calibration<br><br>❑ **Fuel :**<br>❖ Particulates reduction | ❖ **Lubricity**<br>❖ **Fuel cleanliness**<br>❖ **Detergent additives**<br><br>❖ **Low Aromatics** |
| 2- **Aftertreatment systems** :<br>❖ NOx trap, PM trap | ❖ **S<10 ppm, no ashes** |
| 3- **New Combustion Mode** :<br>❖ Example : HCCI<br>**Avoid DPF & NOx Trap ?** | **Study in progress :**<br>❖ **High volatility ?**<br>❖ **Strong or low cetane ?**<br>❖ **Customized fuels** |

# Wear

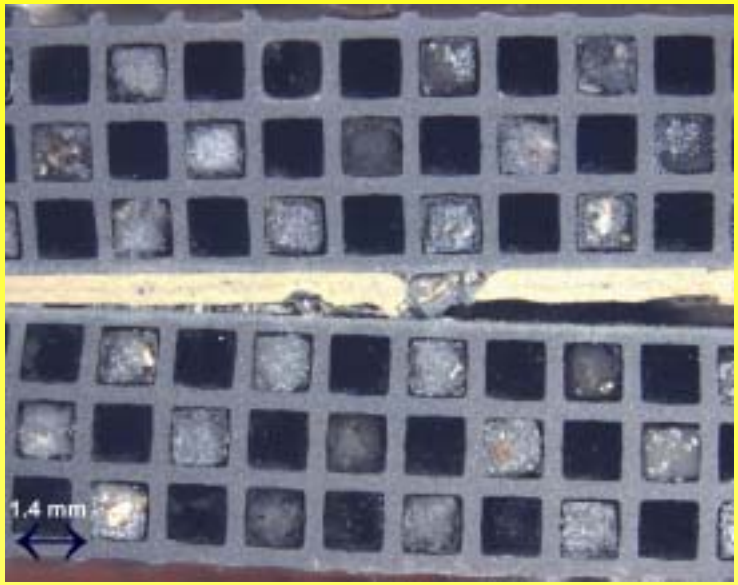
**Abrasion causes injector ball seat wear.**
**Fuel “return flow” grows up to a point when the control system stops the engine, diagnosed as an out leakage**


**Lubricity**

**Cleanliness**

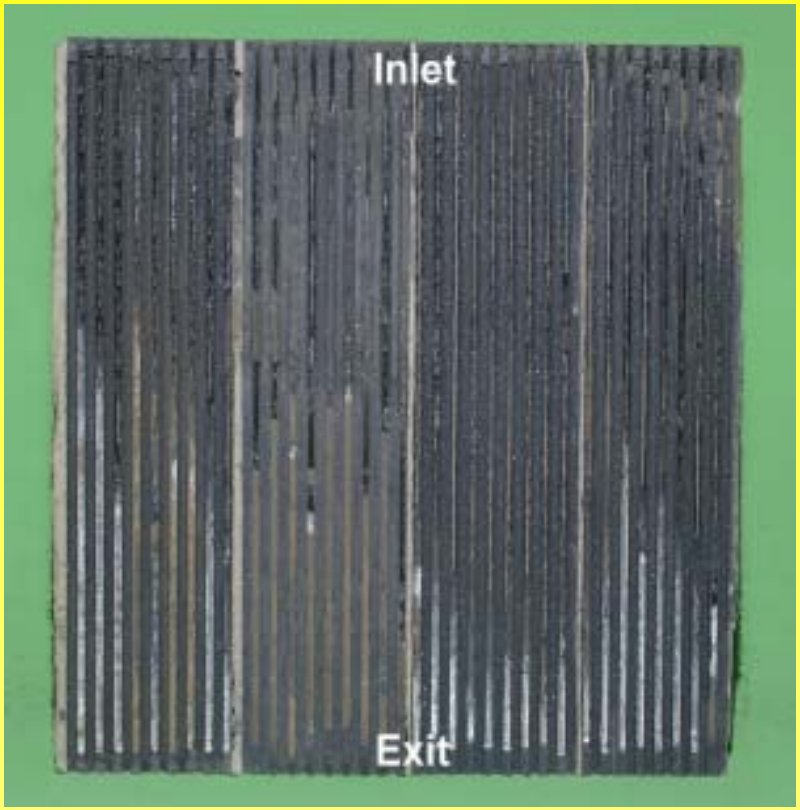
**Detergent additives**

# D.P.F.
# (Ashes clogging )




Vertical cut near filter end.

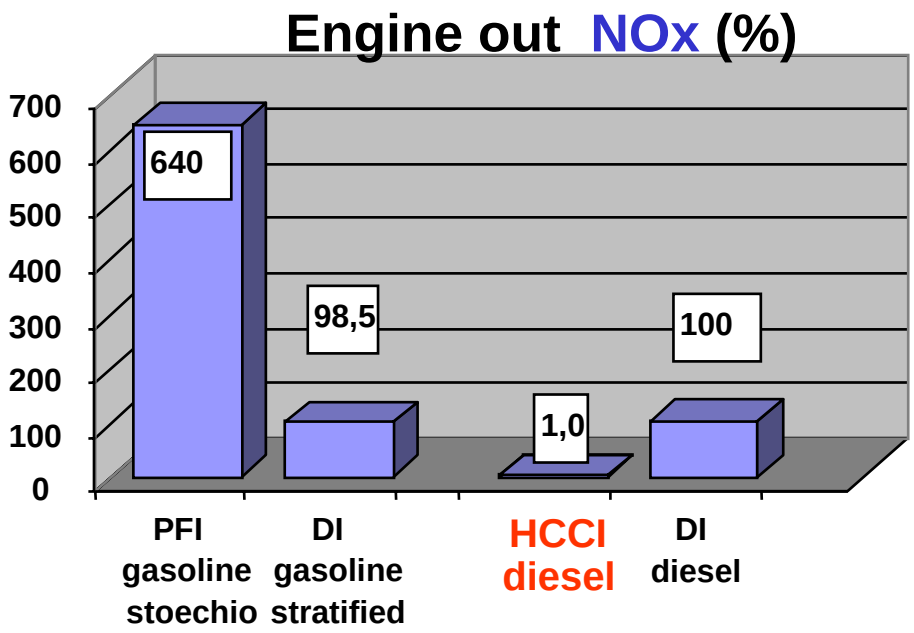
Right: Horizontal cut.



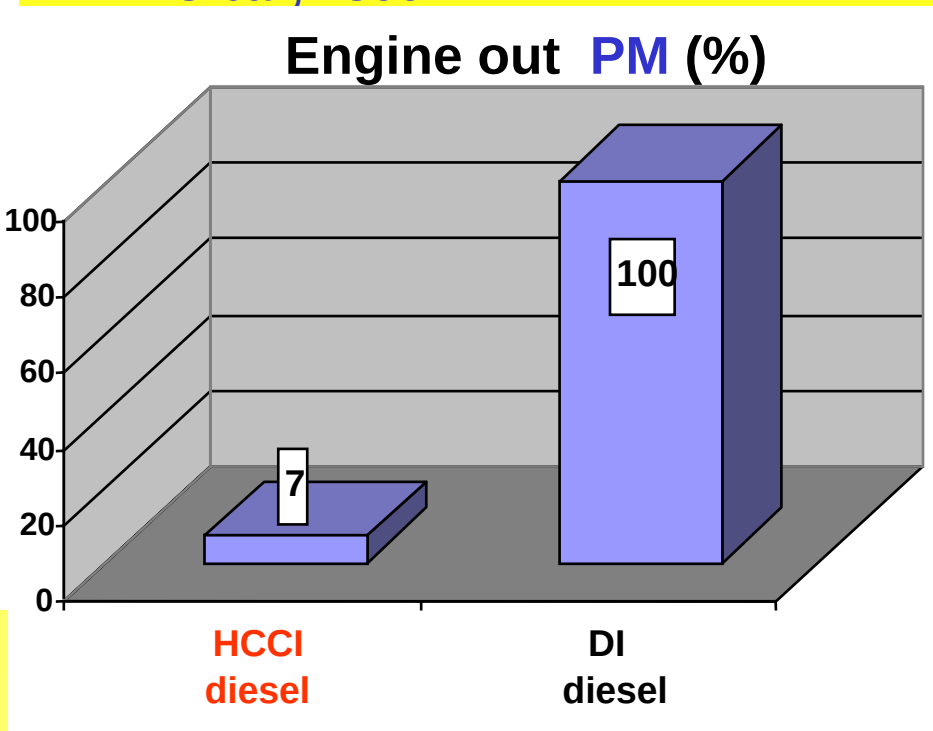

**Counterpressure OBD sensor stops the vehicle……**

**Low aromatics**
**S < 10 ppm**
**No ashes**

# HCCI combustion mode




BMEP 3 bar, 1500 RPM




**If operable in HCCI mode over the whole load-speed range, without noise, HC and CO, such Diesel engine would need:**

**no DPF, no NOx trap**

**High volatility ?**
**Strong or low cetane ?**
**Customized fuels**
**“Naphtha” ?**

# FUEL Cells

- Fuel Cells have to be fed with Hydrogen
  - either stored in tanks : LH2 (20 °K) or CH2 (HP vessels)
  - or produced on board from liquid fuels (by a reformer)

- From liquids : (Gasoline, Diesel, Alcool……)
  - the Reformer is a catalytic device :
    - No Sulfur, No Additives (lubricant, foam….)
    - No toxicity
    - High Hydrogen content per unit volume
    - Minimal ReformingTemperature (W efficiency)

# FUEL Cells . 2

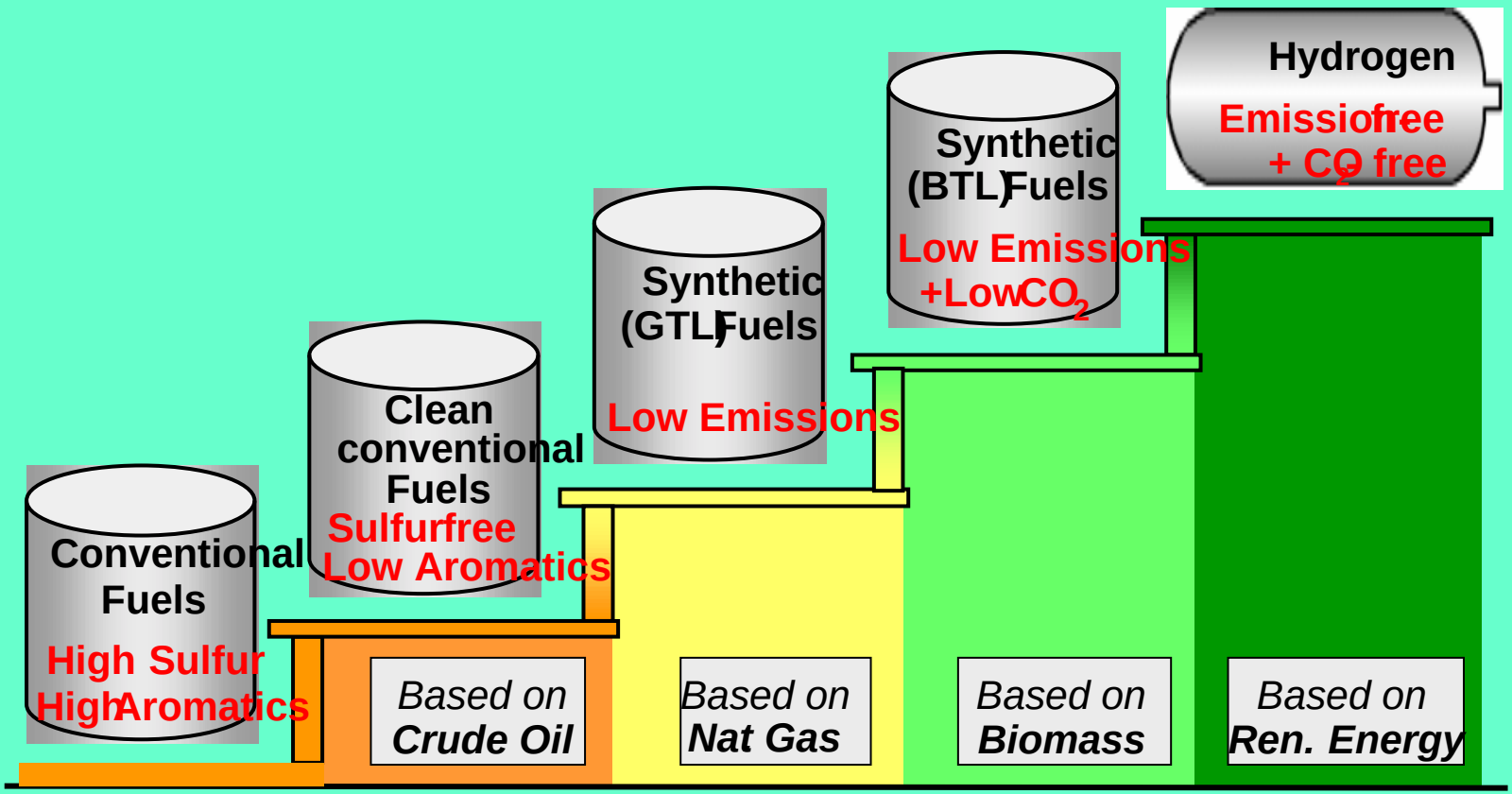
- **Fuel Cells fed with on-board stored Hydrogen**
  - **CO content < 100 ppm (E.M.E. efficiency)**
  - **Formic acid prohibited (E.M.E. lethal poison)**
  - **Cost to store 1 MJ $H_2$ from NG (85 %) on-board :**
    - **Compressed (70 MPa) Energy : 0.5 MJ $CO_2$ : 99.4 g/MJ**
    - **Liquifyied ( - 252 °C) Energy : 0.8 MJ CO2 : 134.2 g/MJ**

**Hydrogen, as a propulsion fuel should be a part of the future, but :**

- **Is not, by itself a *« CO2-free »* panacea**
- **Its global « Whell to Wheels » GHG impact is strictly dependant of the renewability of feedstock and process pathway**

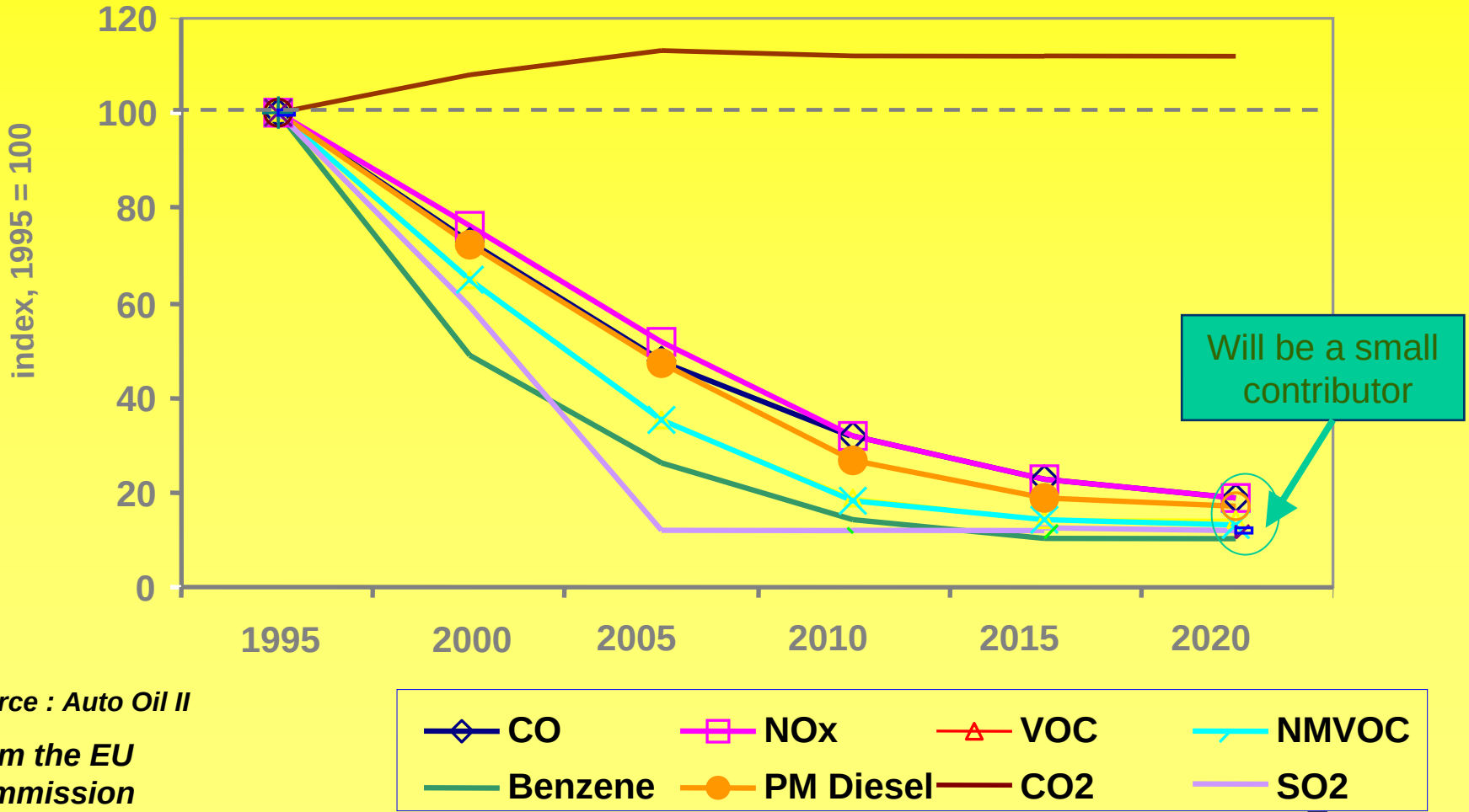
# Century 21st will be multifuel or….

(from A.M. 1987)



# Back – up slides

# With already decided regulations, problem of toxic emissions from road transport almost solved in the EU




***Source : Auto Oil II***

***From the EU Commission***

Very realistic hypothesis on vehicle population

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# Conclusions

- Equipment, vehicle manufacturers, with the fuel industry, achieved a huge and continuous progress to lower emissions.
- Fuel, combustion and aftertreatment together reach a very low level of pollutants compared to other sources
- Meanwhile, a strong, increasing constraint towards low CO2 emissions conflicts with new requests about comfort, noise, emissions, safety
- Additional fuel quality parameters / controls are needed to ensure mechanical and emission durability.

# Technos – Energy- GHG
# Vehicle out

| | | W | Ecart | GHG | Ecart |
|---|---|---|---|---|---|
| | GHG benefit % | | | | |
| Gasoline PSI **(now)** | 0 | 224 | Ref | 167,5 | Ref |
| Gasoline DSTC | 15 | 190 | -0,15 | 140 | -0,15 |
| GDI | 18 | 188 | -0,16 | 138 | -0,18 |
| Diesel DPF | 21 | 179 | -0,20 | 133 | -0,21 |
| Diesel wo DPF | 24 | 172 | -0,23 | 128 | -0,24 |
| Hybrid Gasoline | 29 | 161 | -0,28 | 119 | -0,29 |
| Hybrid Diesel | 37 | 141 | -0,37 | 105 | -0,37 |
| FC Gasoline | 28 | 162 | -0,28 | 120 | -0,28 |
| FC Diesel | 28 | 162 | -0,28 | 121 | -0,28 |