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Convegno Internazionale

"IL METANO NELLE POLITICHE DI SOSTENIBILITA' "

Ravenna, 2 Dicembre 2005

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Perspective of Conventional and Alternative Fuels in Europe

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Institute of Environment and Sustainability
Emissions and Health Unit

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The EU Institutions

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Court of Auditors

Court of Justice

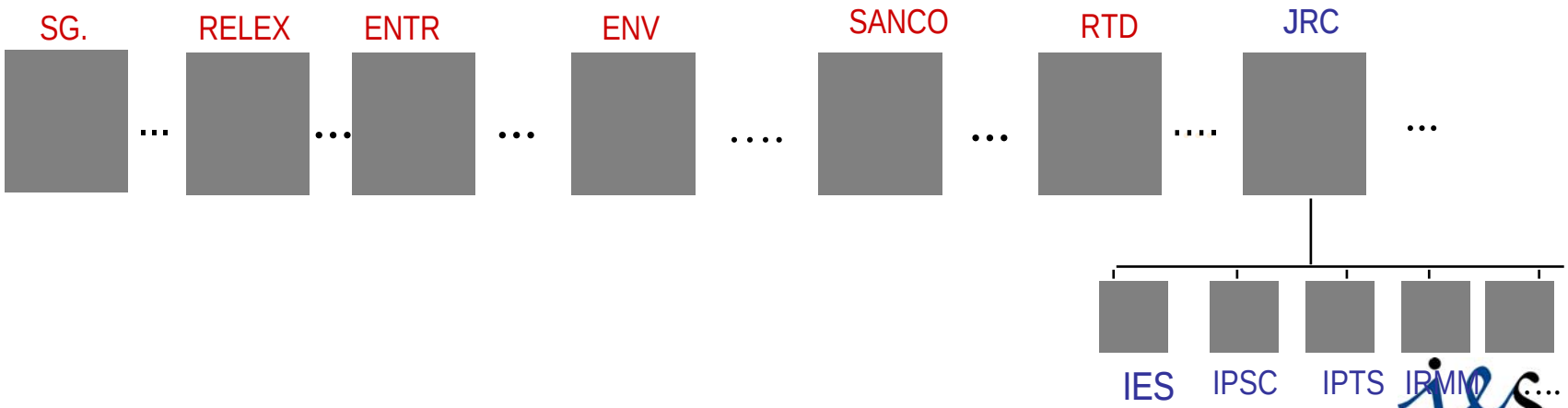
The European Parliament

The Council of Ministers

Committee of the Regions

Economic and Social Committee

The European Commission
(the 'College': 20 Commissioners)



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The JRC Mission is…

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… to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies …

…the JRC functions as a centre of science and technology reference for the EU…
…independent of special interests, whether private or national.

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Vehicle Emission Laboratories at JRC

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VELA 1

VELA 2

VELA 3

VELA 4+5

VELA 6

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Fuel Directive Review Process

The Directive 2003/17/EC set only the maximum sulphur content in the fuels:

- 50 ppm from 2005
- 10 ppm from 2009 (date to be confirmed for Diesel fuel)
- Fuels having a max content of 10 mg/kg have to be available on an appropriately balanced geographical basis from 01/01/2005

Review Process (to be completed by 31/12/2005)

- Effect of fuel quality on emissions from modern vehicles
- Final date for the entry into force of the 10 ppm S limit for diesel fuel (CO_2 balance)
- Additives (Metallic additives, detergents...)
- Bioethanol: impact on evaporative emissions
- Future engine technologies: fuel requirements
- .....

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Fuel Directive Review Process

- Final date for 10 mg/kg sulphur content in diesel fuel
  - Estimated CO2 balance: in 2009 the increase of CO2 emission from refineries will exceed the expected CO2 reduction due to the beneficial impact of ultra low sulphur fuel on fuel consumption
  - The Commission proposes to confirm the 2009 date for the benefits on pollutant emissions
- Other parameters than sulphur
  - Several studies show that fuel quality has a reduced effect on emissions in modern vehicles equipped with advanced after-treatment systems (latest TWC generation, particulate filters, SCR)
  - Non need of tightening limits on fuel properties relevant for the environment (high costs, reduced benefits)

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Fuel Directive Review Process

- Detergent additives
  - Mandatory use of detergent additives in gasoline and diesel fuel requested by the car manufacturers
  - Detergency requirements will be introduced in the legislation if:
    - ✓ Benefits for the environment are demonstrated (still unclear and not quantifiable)
    - ✓ A rapid and reliable test method for fuel detergency is available (current engine based test methods are very time consuming)

- Metallic additives
  - Are metallic additives detrimental to emission control systems?
  - Commission proposal: definition of a test protocol for fuel additives
  - Opposite views of the relevant stakeholders (car manufacturer, oil companies, additive producers)

Fuel Directive Review Process

- Biofuels

  Directive 2003/30/EC: biofuels minimum market share of 2% by 2005 and of 5.75% by 2010

  - No major issue related to the use of bio-diesel

  - Bio-ethanol

    - RVP waiver requested (from 60 kPa to 70 kPa) to allow ethanol splash blending in gasoline
    - What is the impact on evaporative emissions?
    - CONCAWE/EUCAR/JRC joint test programme on going

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concawe

EUCAR
EUROPEAN COUNCIL FOR AUTOMOTIVE R&D

CONCAWE/EUCAR/JRC Joint Test Programme

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OBJECTIVES

- To assess the effects of ethanol and vapour pressure on evaporative emissions from a range of latest generation canister-equipped gasoline cars.

- To provide a firm technical basis for debates on gasoline vapour pressure limits in relation to ethanol blending for the Fuels Directive Review.

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Canister load to breakthrough (butane)

Driven on the chassis dynamometer

- Preconditioning drive
- Evaporative system conditioning-drive

Performed in the SHED

- Hot soak test 60 min
- Diurnal test 24 hours

- Evaporative emissions (in grams per test) are determined from the sum of hot soak and diurnal emissions
- Total duration of a full EVAP test: ~3 days

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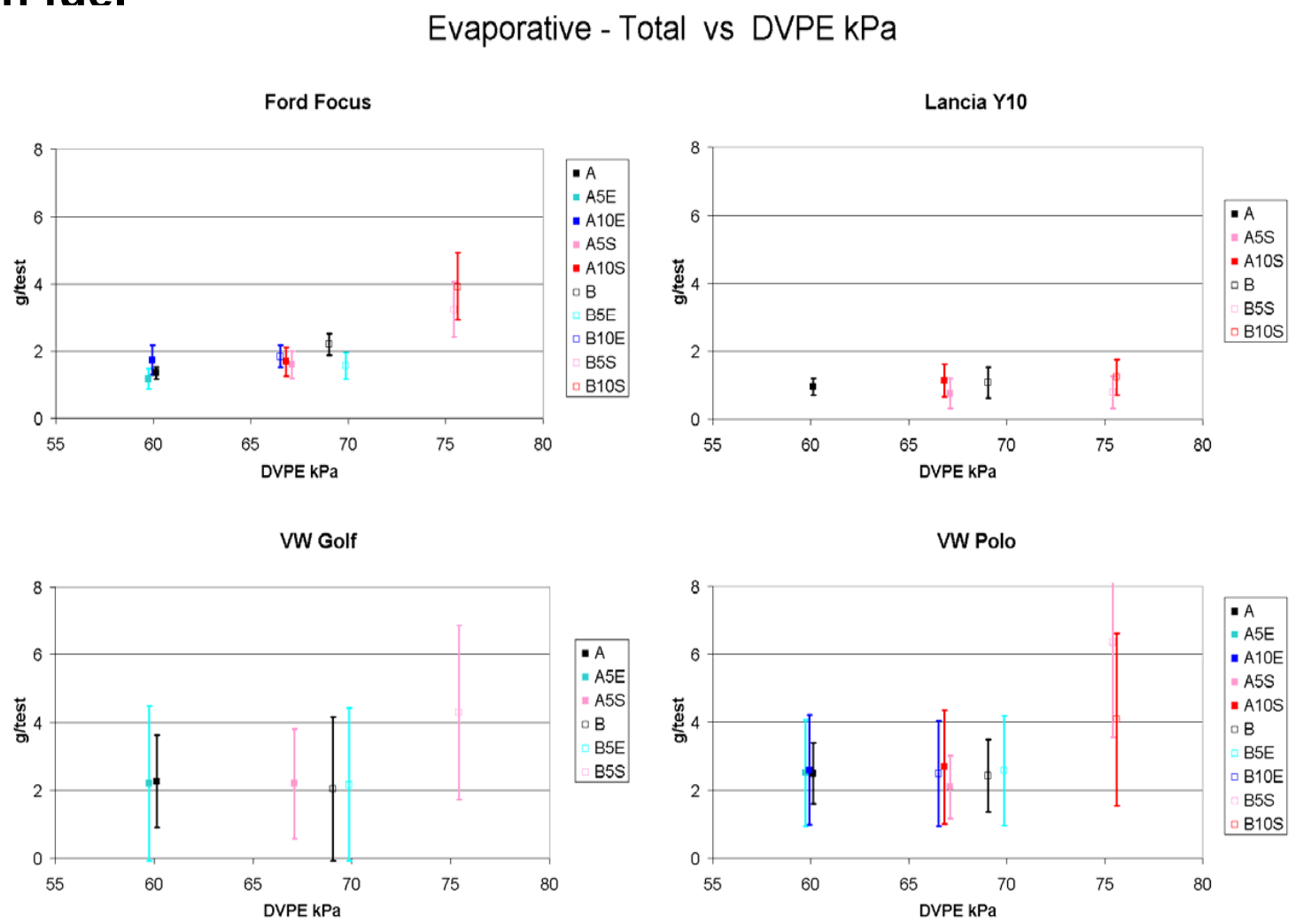
Preliminary Results – Evap Emissions - Means and error bars on each fuel



3 of 4 vehicles give clearly higher EVAP emissions than the other fuels when tested with B5S and B10S.

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Preliminary results: what has been found so far ?

- Fuels having a vapour pressure above 70 kPa give clearly higher evap emissions than the other fuels
- The other fuels could not be distinguished with this test procedure and these cars
- The absence of statistical significance does not mean that fuel effects do not exist, only that these effects are too small to be discerned in this particular series of experiments.
- Some evidence of carbon canister working capacity reduction due to ethanol accumulation – further investigation required

Alternative Fuels

- Green Paper "Towards a European strategy for the security of energy supply" (2000)
  - Target: replacement of 20% conventional fuels with alternative fuels by 2020
  - Rationale: reduction of dependency from oil of transport sector
  - Most promising options: biofuels in the short-medium term, natural gas in the medium-long term, hydrogen in the long term

- Biofuels promotion
  - Directive 2003/30/EC: biofuels minimum market share of 2% by 2005 and of 5.75% by 2010
  - Directive 2003/96/EC: regulates the fiscal incentives for biofuels promotion

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Natural Gas

- Reduction of emissions and dependency on oil are the main reasons for its use
  - Reserves-to-production ratio is about 63 years
  - Nearly zero sulphur level, no toxic components, low particulate emissions, negligible evaporative emissions
  - Low summer smog potential
  - Methane is not a volatile organic compound (VOC)

- Disadvantages
  - It requires dedicate catalysts with higher loading of active components
  - Storage and transportation of NG on board of a vehicle is complicated
  - Special refuelling stations; energy required to compress NG is about 0.2 Kwh/m3 corresponding to an additional 4% of CO2 emitted by the car
  - Inferior vehicle performance and limited driving range

EURO 5 and Natural Gas

Light duty vehicles

Category	CO (mg/km)		THC[1] (mg/km)		NOx (mg/km)		HC+NOx (mg/km)		PM[2] (mg/km)	
	PI	**CI**	**PI**	**CI**	**PI**	**CI**	**PI**	**CI**	**PI[3]**	**CI**
M	1000	500	75	-	60	200	-	250	5.0	5.0
Vs. Euro 4	0%	0%	-25%		-25%	-20%		-17%		-80%

(1) The Commission shall review the need to redefine the HC limit value to consider emissions of non-methane hydrocarbons and methane separately

(2) PM limit values relate to the existing measurement procedure. A revised measurement procedure shall be adopted once the PMP is complete and the limit value will be adjusted accordingly.

(3) Positive Ignition PM standards apply only to vehicles with direct injection engines that operate in lean burn mode

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Natural Gas: NMHC and THC

NMHC vs Methane emissions

- CNG: CH4 accounts from 60% to 96 % of THC.
  Lower percentages when engine-out measurements or no after-treatment devices, higher percentages when measuring tailpipe emissions with a catalyst installed.

- Gasoline: from 5% to 15% of THC emissions

- Diesel: from 5% to 16% of THC emissions

The Commissions is evaluating the possibility of introducing separated limits for non-methane hydrocarbons and methane. Another option is to account for methane emissions by increasing CO2 emissions of vehicle

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WTW Analysis

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Study Objectives

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- Establish, in a transparent and objective manner, a consensual well-to-wheels energy use and GHG emissions assessment of a wide range of automotive fuels and powertrains relevant to Europe in 2010 and beyond.
- Consider the viability of each fuel pathway and estimate the associated macro-economic costs.
- Have the outcome accepted as a reference by all relevant stakeholders.

⇨ Focus on 2010+

⇨ Marginal approach for energy supplies

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Well-to-Wheels Pathways

Resource

Crude oil

Coal

Natural Gas

Biomass

Wind

Nuclear

Fuels

Conventional Gasoline/Diesel/Naphtha

Synthetic Diesel

CNG (inc. biogas)

LPG

MTBE/ETBE

Hydrogen
(compressed / liquid)

Methanol

DME

Ethanol

Bio-diesel (inc. FAEE)

Powertrains

Spark Ignition*:*
Gasoline, LPG, CNG, Ethanol, H_2

Compression Ignition:
Diesel, DME, Bio-diesel

Fuel Cell

Hybrids: *SI*, *CI*, FC

Hybrid Fuel Cell + Reformer

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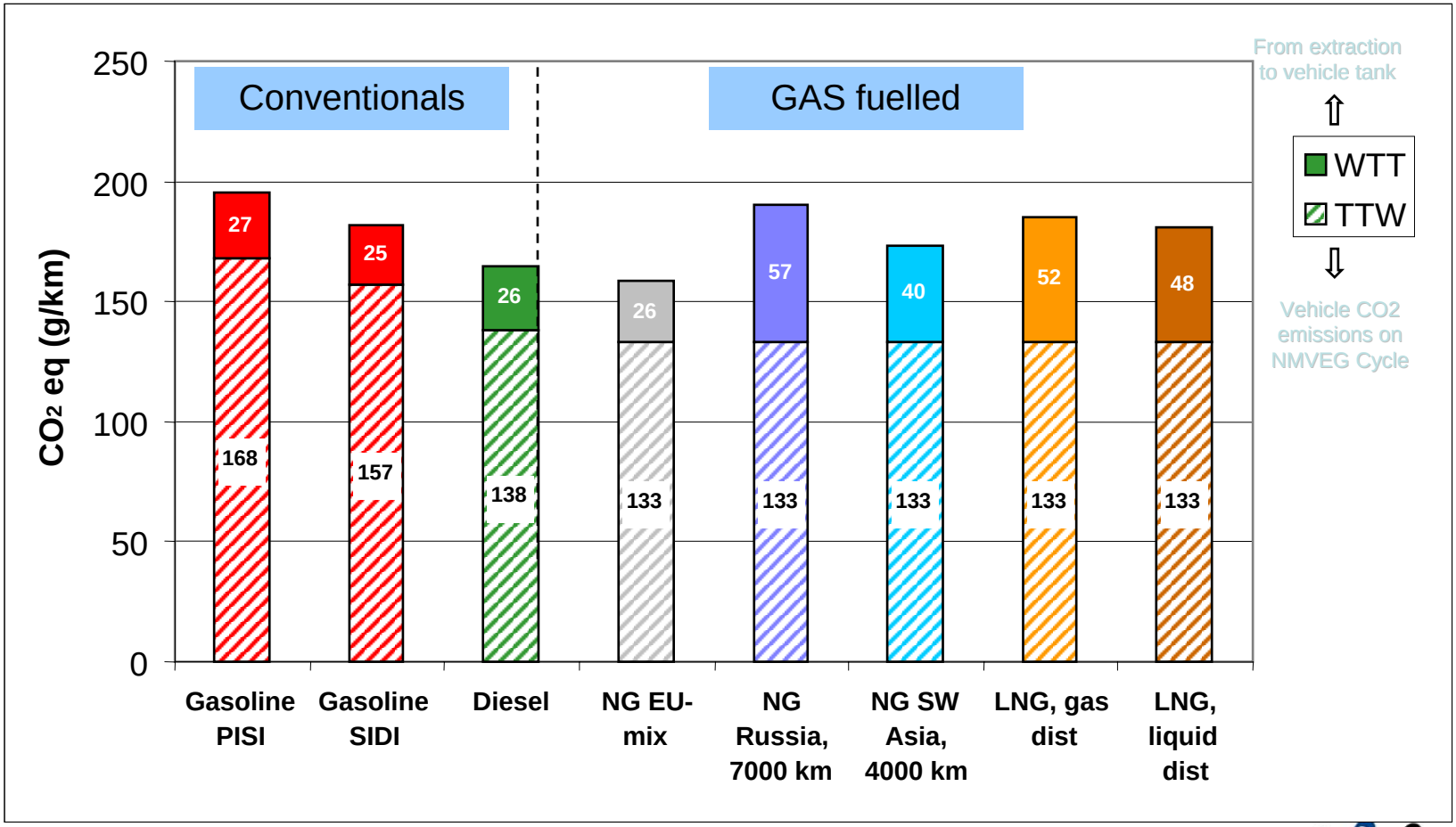
Well-to-Wheels analysis
Compressed Natural GAS vs CONVENTIONAL



The GAS source is critical

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WTW energy requirement and GHG emissions for conventional and CNG pathways

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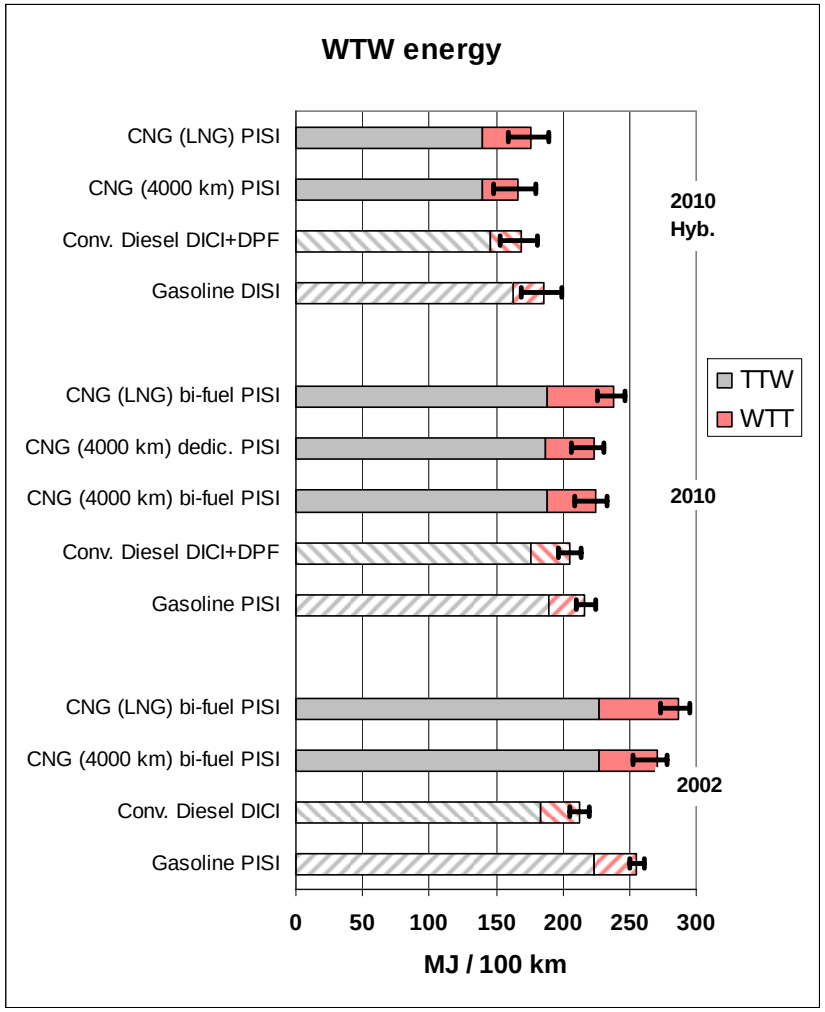

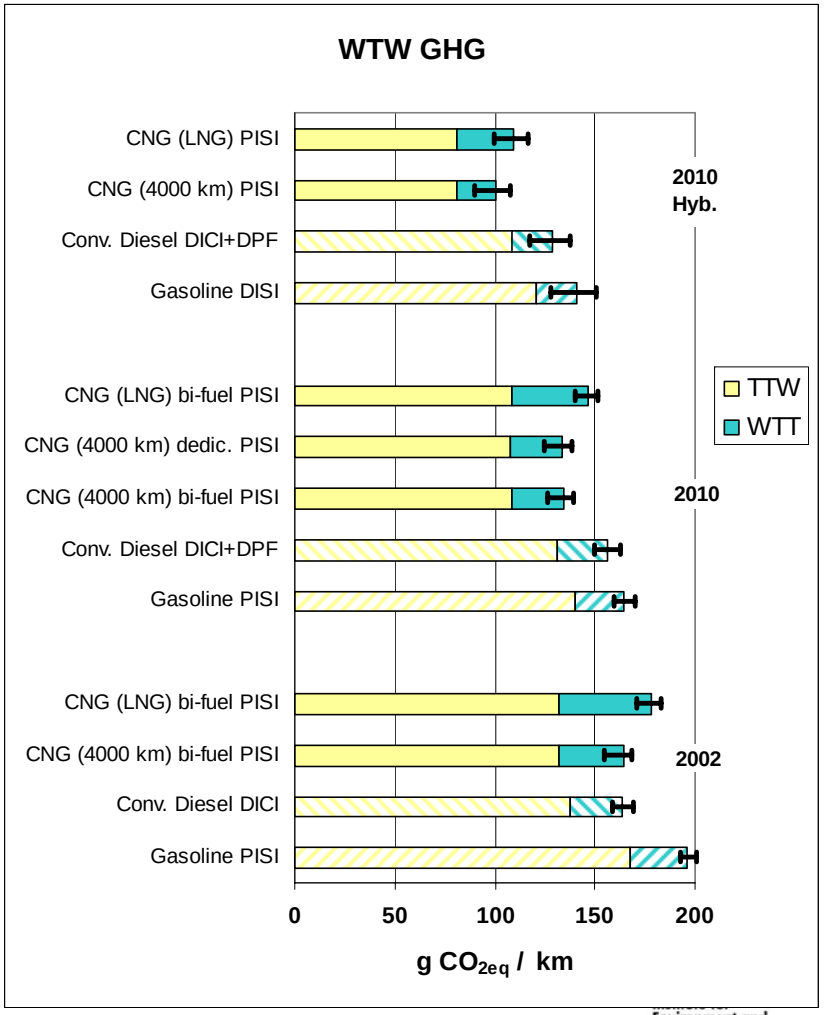

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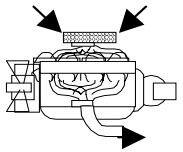
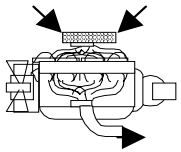
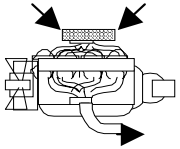
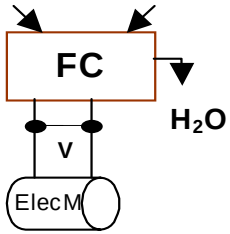
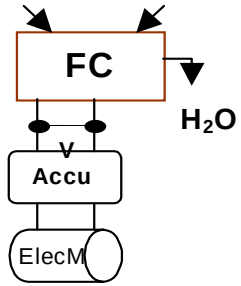
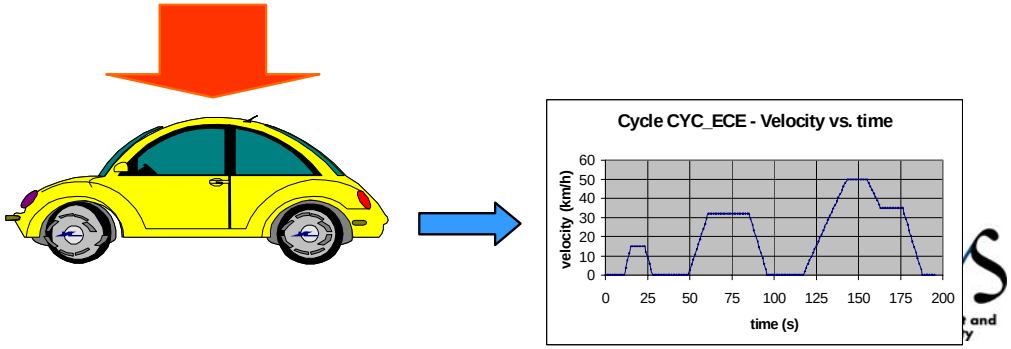
Hydrogen from NG : ICE and Fuel Cell

H2 from NG 4.000 KM

Well-to-Wheels analysis

H2 from NG: H2 ICE & FC vs 'Best' Conventional Pathways

ICE Diesel CIDI	ICE CNG SI	ICE H_2 SI	FC H_2	Hybrid FC H_2
N_2+O_2 $C_x H_y$  CO_2 NO_x H_2O	N_2+O_2 $C H_4$  CO_2 NO_x H_2O	N_2+O_2 H_2  H_2O NO_x	O_2 H_2  H_2O	O_2 H_2  H_2O



Source: WTW Report, Figures 8.4.1-1a/b & 8.4.1-2a/b

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Hydrogen from NG : ICE and Fuel Cell

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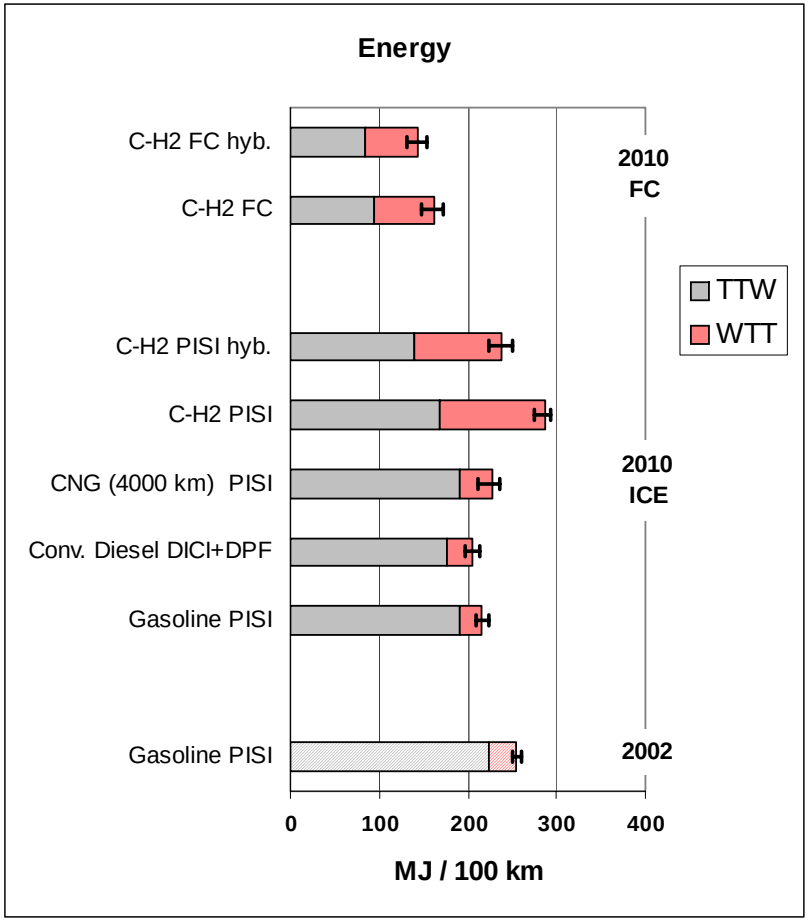

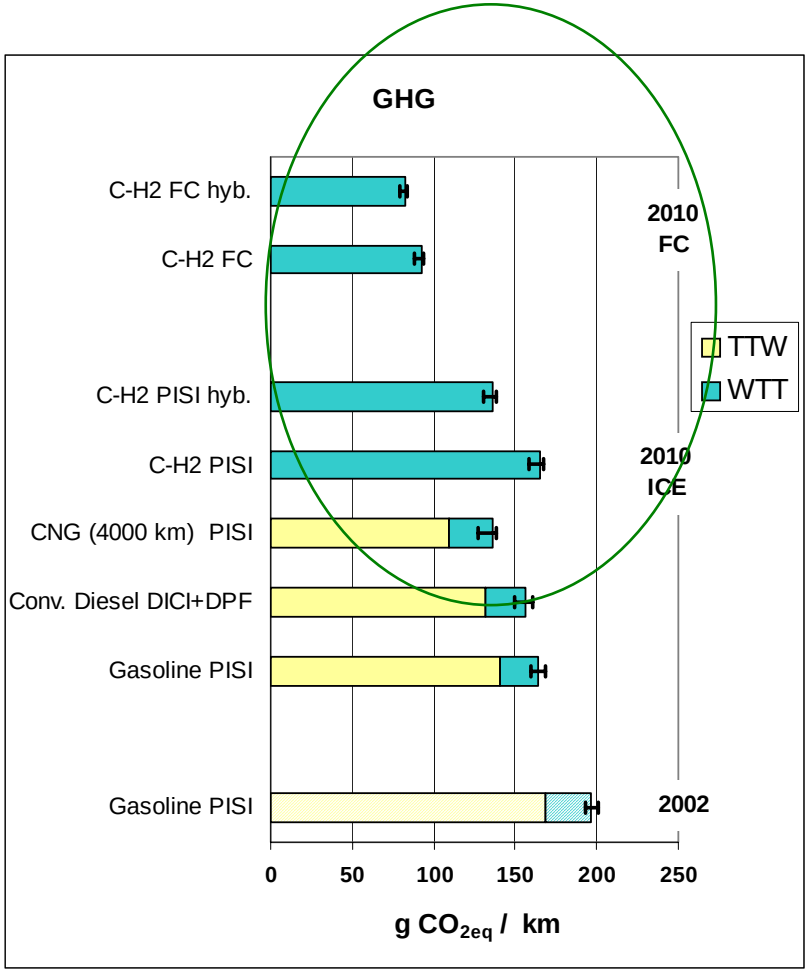

If hydrogen is produced from NG, GHG emissions savings are only achieved with fuel cell vehicles

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Source: WTW Report, Figures 8.4.1-1a/b & 8.4.1-2a/b

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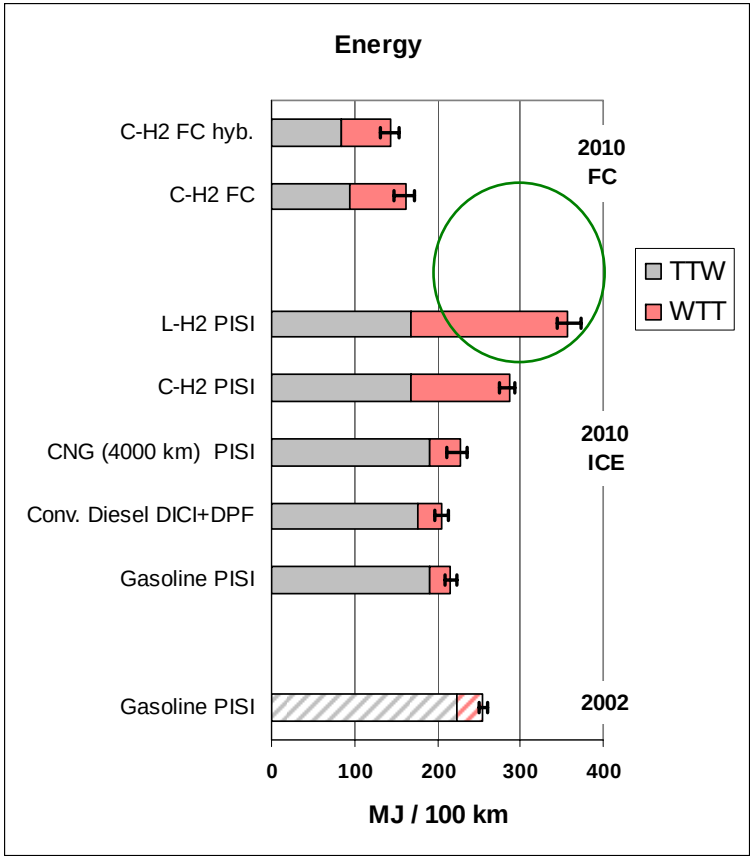
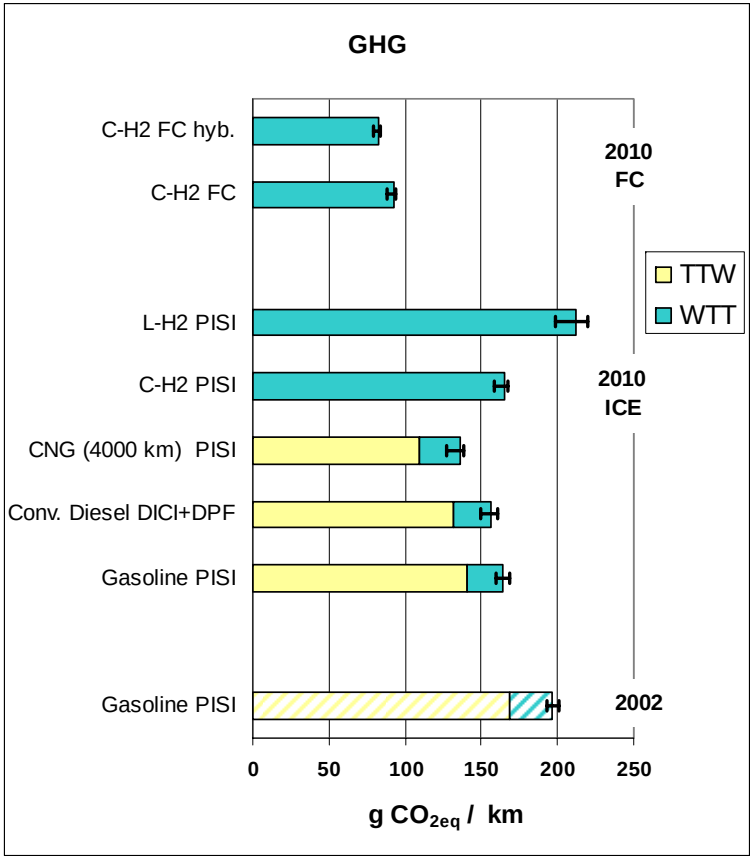
Hydrogen from NG : ICE and Fuel Cell





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Liquid hydrogen is less energy efficient than compressed hydrogen

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Source: WTW Report, Figures 8.4.1-1a/b & 8.4.1-2a/b

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Well-to-Wheels analysis of future automotive fuels and powertrains in the European context

The study report will be available on the WEB:

http://ies.jrc.cec.eu.int/WTW

For questions / inquiries / requests / notes to the consortium,

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infoWTW@jrc.it

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