1963–2013 concawe 50 years delivering science for Europe

European Fuel Quality and Performance over 50 Years

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10th CONCAWE Symposium
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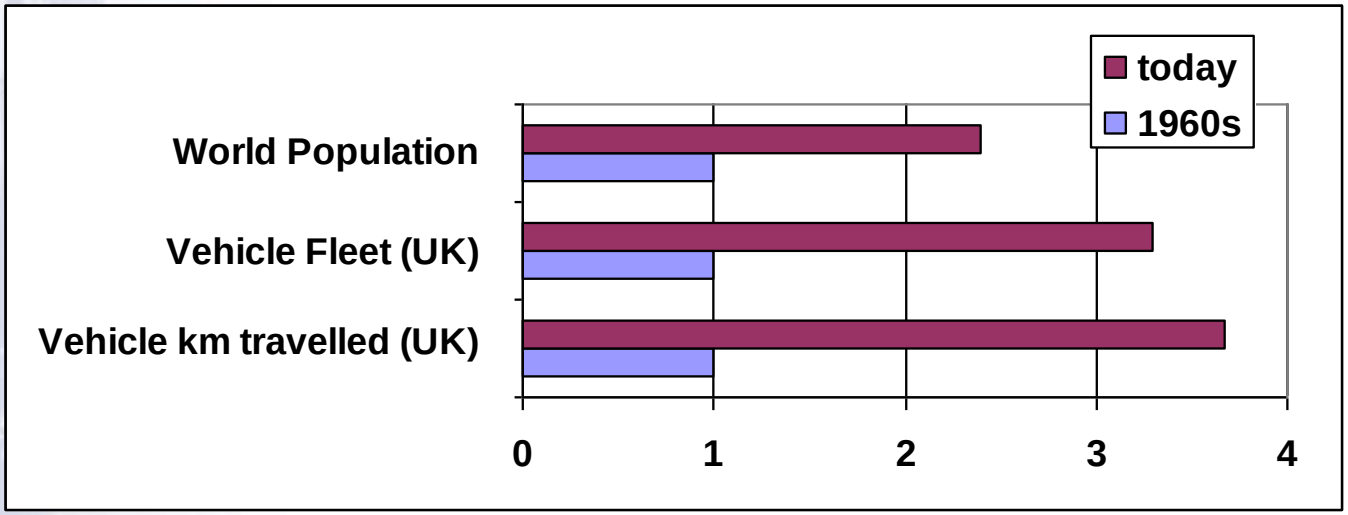
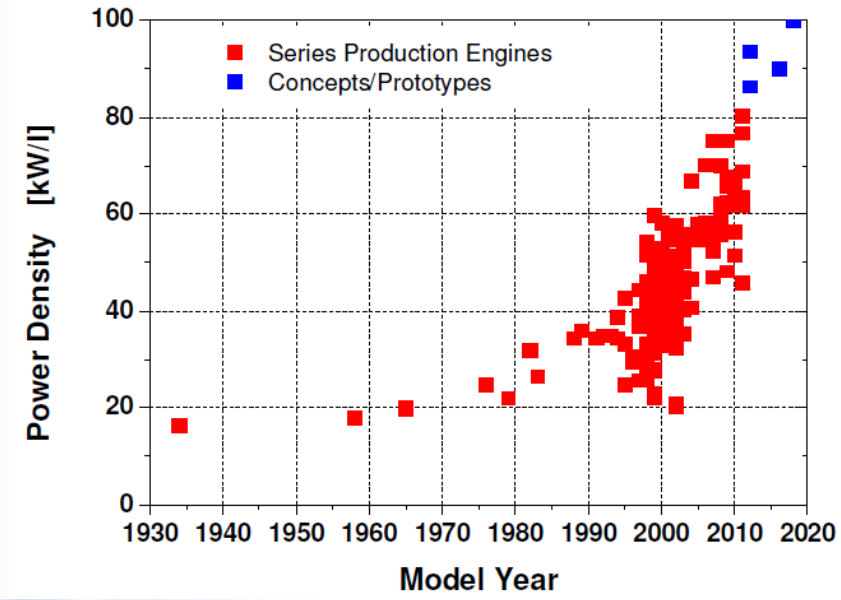
The World's a Busier Place



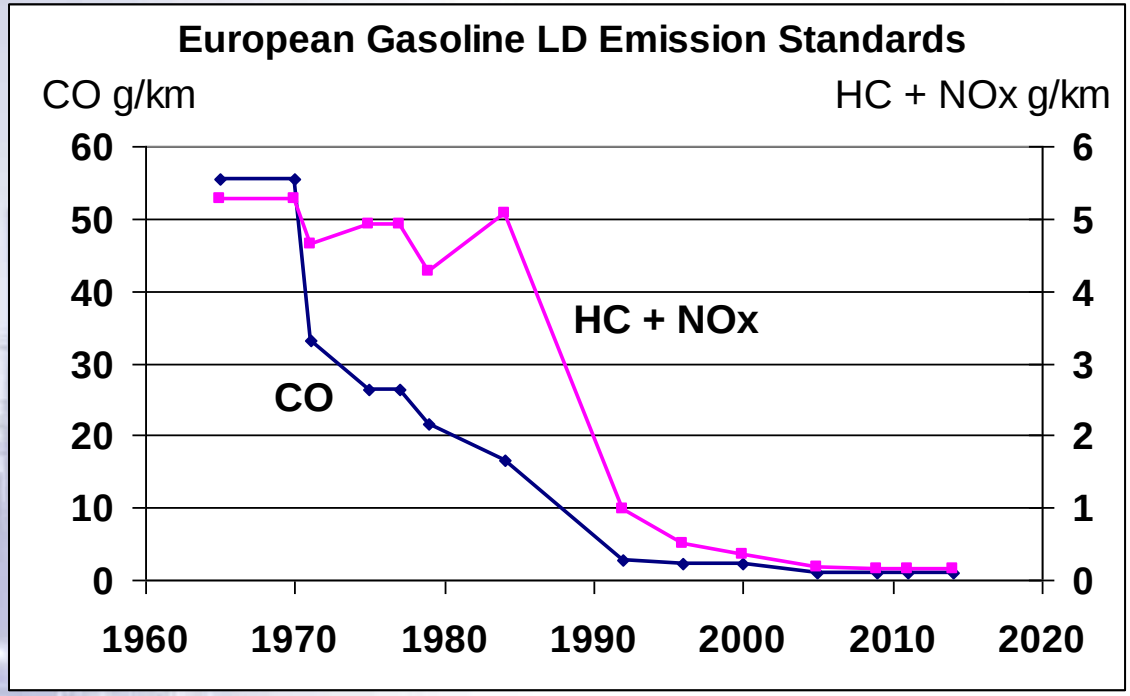
Tremendous Progress in Vehicle Technology



1963: Petrol - 10 L/100km

2012:
Petrol - 6.2 L/100km
Diesel - 4.2- 4.9 L/100km
D Hybrid - 3.6 L/100km

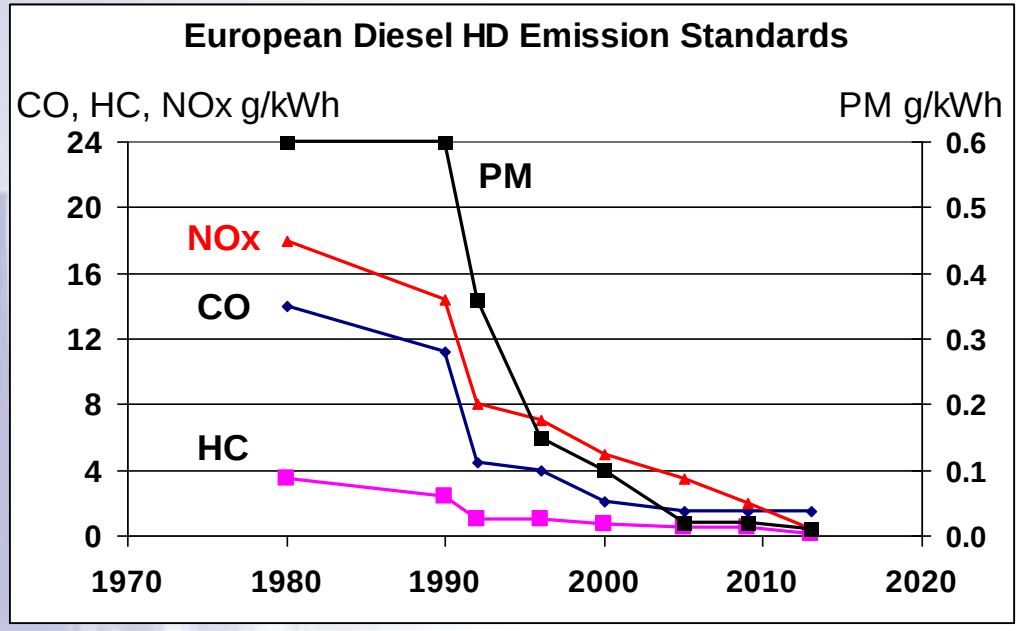
Early Days: Petrol Emissions and Air Quality



to 1970	Uncontrolled	
1971	ECE15	ECE
1975	ECE15-01	ECE
1977	ECE15-02	ECE
1979	ECE15-03	ECE
1984	ECE15-04	ECE
1992	Euro 1	ECE+EUDC
1996	Euro 2	ECE+EUDC
2000	Euro 3	NEDC
2005	Euro 4	NEDC
2011	Euro 5	NEDC
2015	Euro 6	NEDC

- Early CONCAWE Reports:
  - **03/1973**: Effects of gasoline aromatics on exhaust emissions
  - **06/1974**: Effects of gasoline aromatics on polynuclear aromatic emissions
  - **10/1977**: Automotive emission regulations: impact on refinery operations
  - **14/1977**: Evaluation of methods for measuring emissions of polycyclic aromatics (PCA)

Early Days: Diesel Emissions and Air Quality

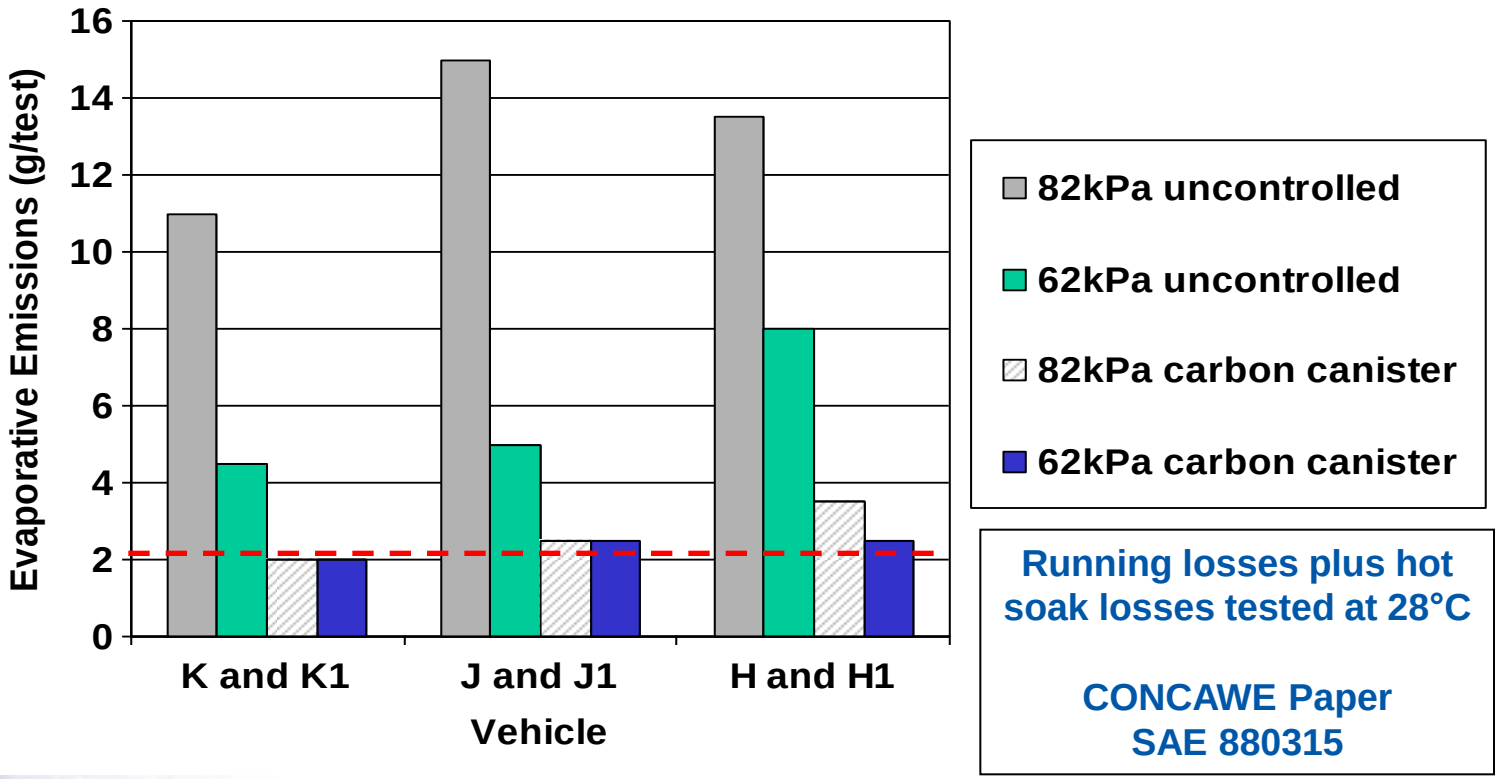


pre 1980	ECE R24	
1980	ECE R49	ECE R49
1990	88/77/EEC	13 mode
1992	Euro-1	13 mode
1996	Euro-2	13 mode
2000	Euro-3	13 mode
2005	Euro-4	13 mode
2009	Euro-5	ESC
2013	Euro-6	WHSC

- CONCAWE Reports:
  - **1986/65:** The relationship between diesel fuel and engine performance
  - **1986/71:** Future diesel fuel quality
  - **10/1989:** Costs to reduce the sulphur content of diesel fuel
  - STF3 compilation of emission regulations and fuel specifications

Gasoline Evaporative Emissions

- Evaporative emissions are of concern for their contributions to oxone formation, and direct emissions of benzene
- Work by CONCAWE showed that closing the gasoline fuel system is more effective than reducing vapour pressure alone

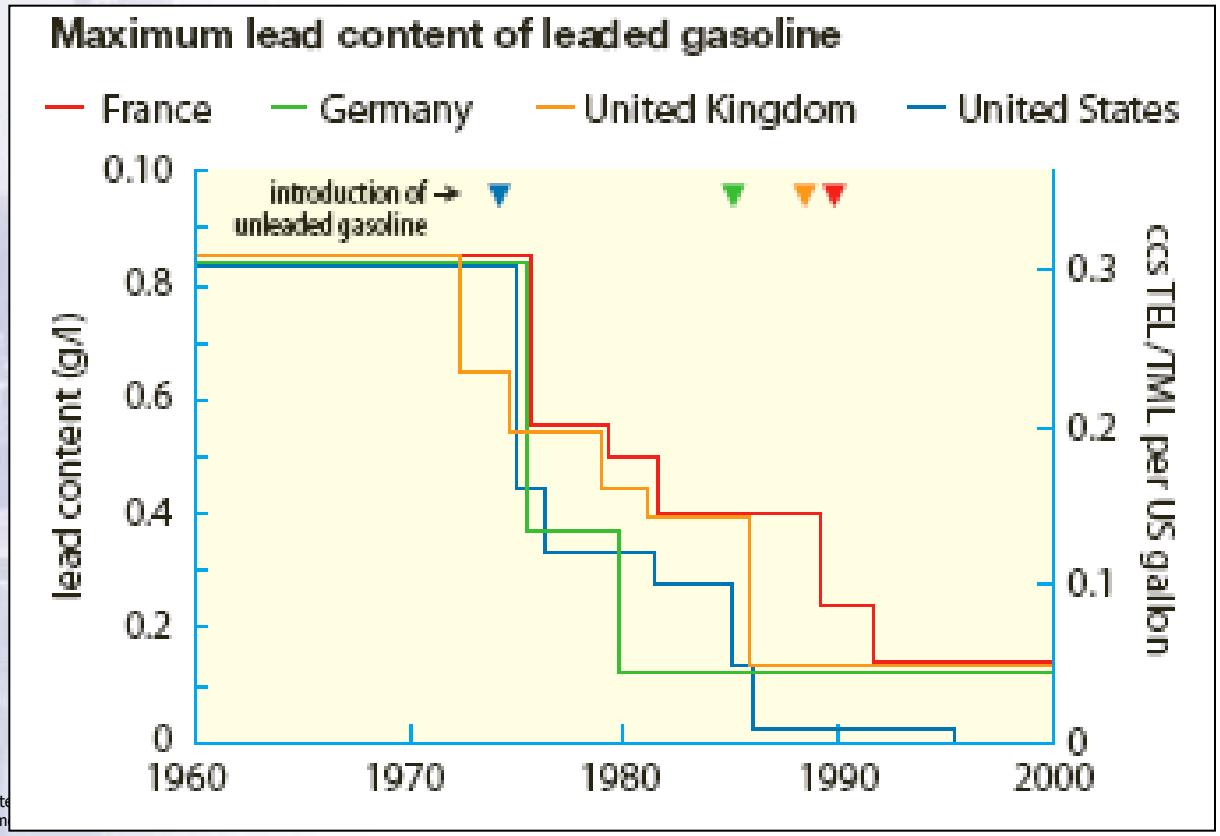


Running losses plus hot soak losses tested at 28°C

CONCAWE Paper
SAE 880315

Lead Removal and Unleaded Gasoline

- Health effects of lead first reviewed in CONCAWE Report 24/1970
  - Concluded that more research needed on long term effects of lead
- Lead-free gasoline and compatible vehicles available from 1989
- European lead phase-out completed in 2000

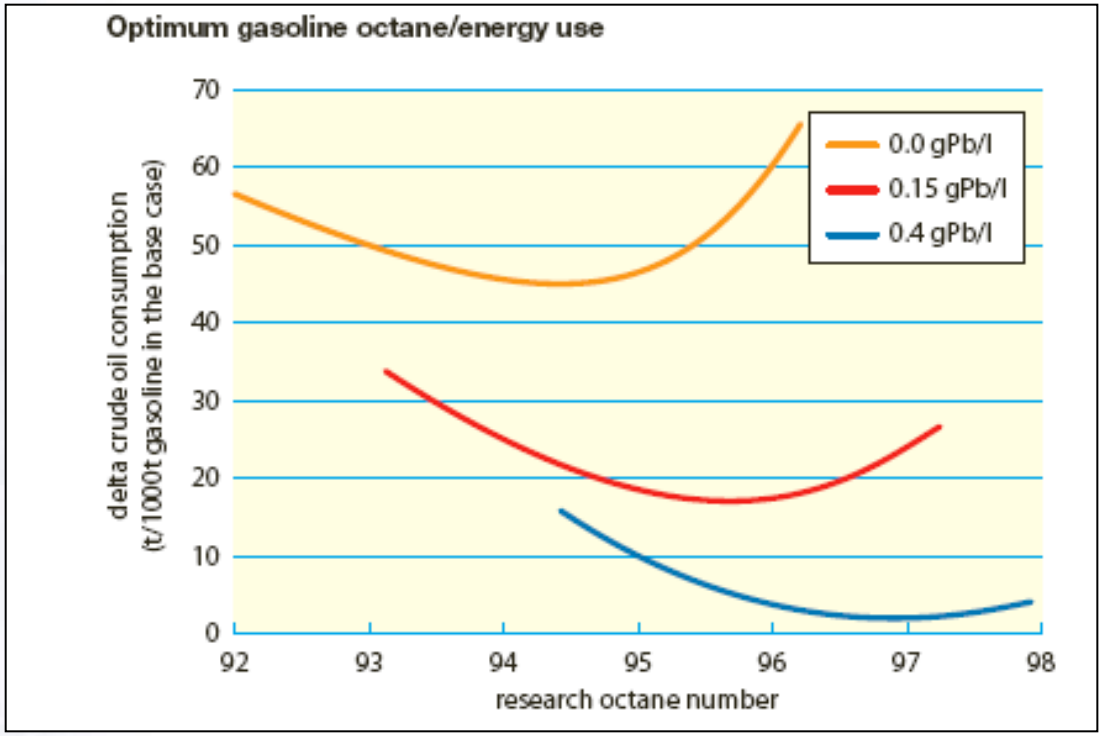


CONCAWE Report 02/1984:

Effects of the introduction of unleaded gasolines on the Gasoline storage and distribution system

Unleaded Gasoline and RUFIT

- EEC Energy Directorate asked the oil and auto industries to study the effects of octane on overall energy consumption
  - CCMC ➔ effect of octane number on fuel consumption
  - CONCAWE ➔ refinery energy consumption
- RUFIT led to a minimum 95RON European petrol grade



RUFIT

Rational

Utilisation of

Fuels

In

Transport

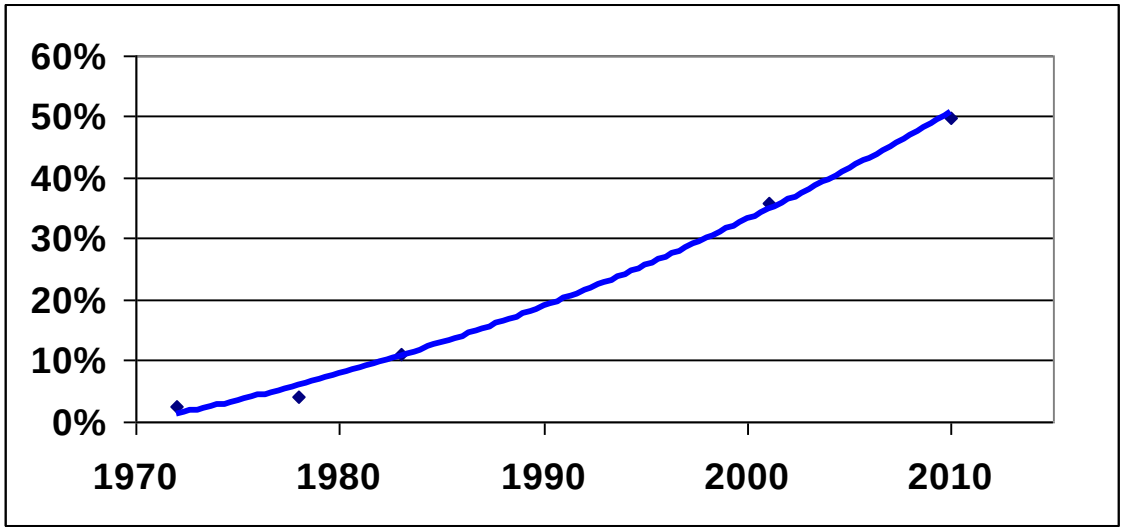
CONCAWE Report 11/1983R

CCMC - **C**omité des **C**onstructeurs d'automobiles du **M**arché **C**ommun

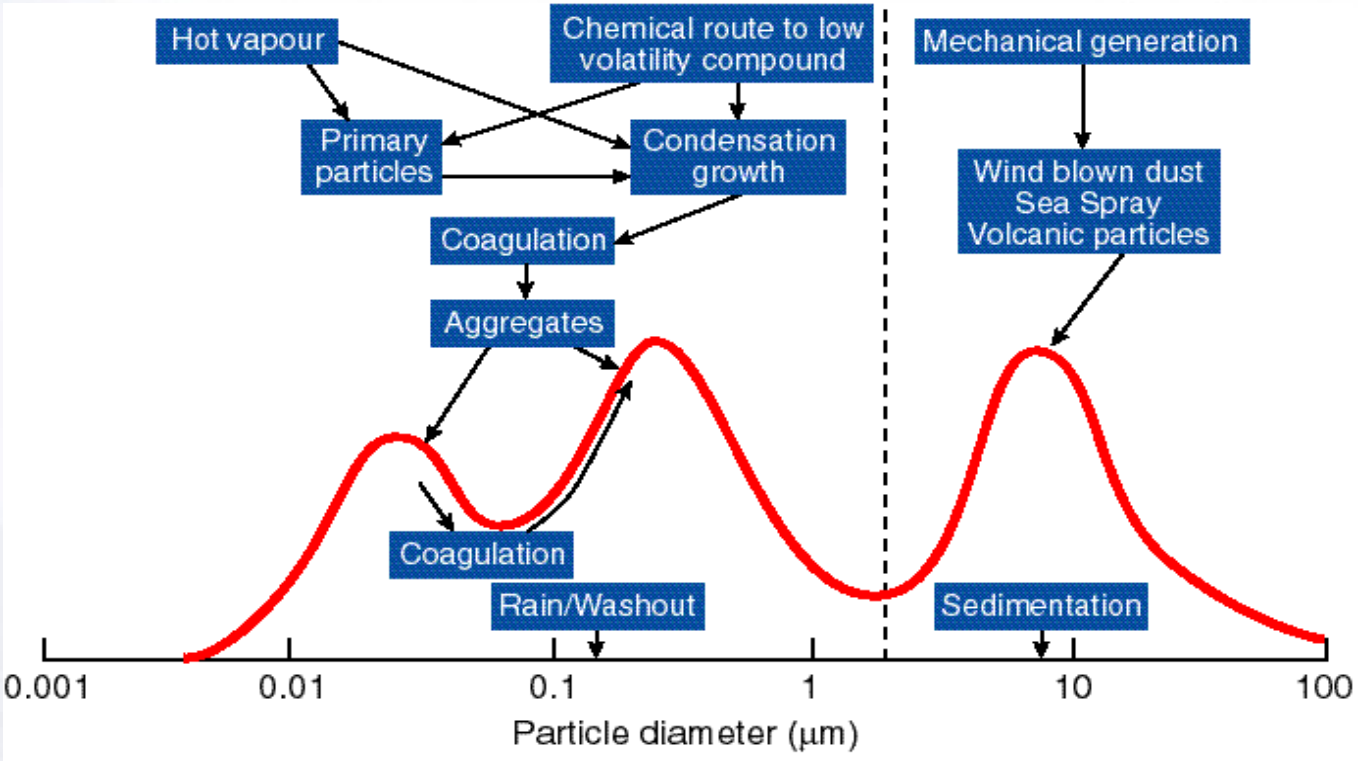
1980s: Growing Interest in Diesel Cars

- Oil crises in 1973/1979 heightened interest in more efficient cars
- Diesel engine technology also rapidly developing in early 1980s
  - VW introduced Golf diesel with a 1.5L naturally aspirated engine
  - Turbo-diesels began to appear
  - Peugeot introduced new XUD series of engines
- Turbocharged Direct Injection engines appeared in 1987
  - Fiat Croma, Austin Montego
- Electronic controls started introduced in the 1990s
- From 2000, common rail systems became the norm

Diesel Share of New Car Sales in the EU



Combustion Particle Size Distribution



Combustion Particles ⟷

Width of Human Hair ⟷

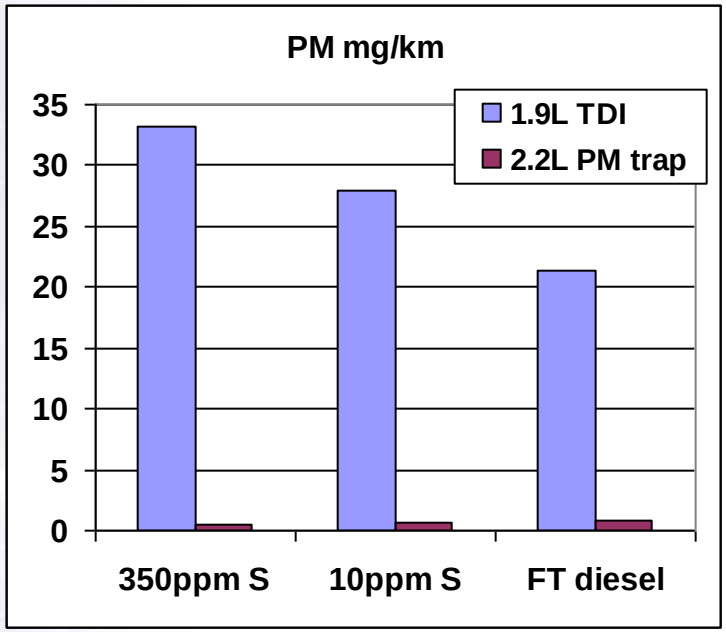
Bacteria ⟷

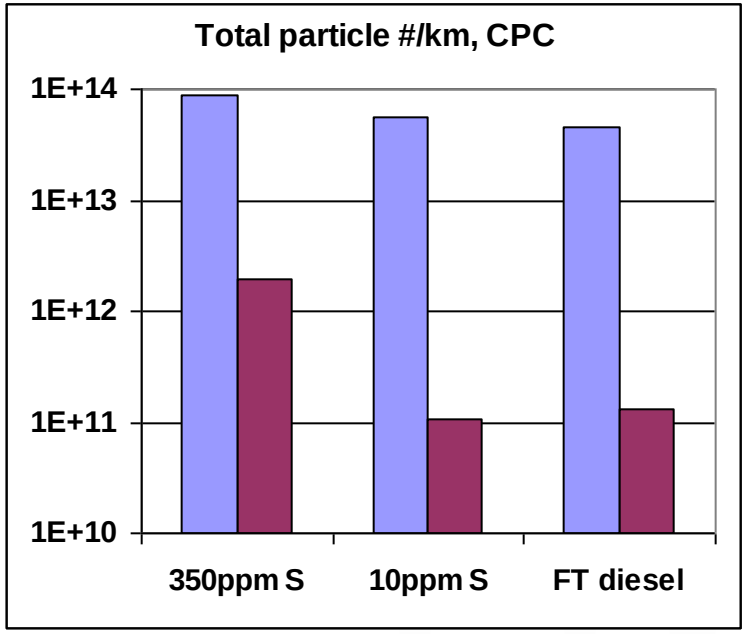
Virus ⟷

Major Collaborative Programmes

- UK DETR/SMMT/CONCAWE Particulate Programme 1998-2001
  - CONCAWE Reports 1998/51 and 2001/51
  - Summary Report No. DP01/0515, Ricardo Consulting Engineers Ltd.
- DG TREN 'Particulates' Consortium:
  - Fuel effects on the characteristics of particle emissions from advanced engines and vehicles (CONCAWE 2001/05)
  - Includes aftertreatment - CRT/SCR, and gasoline vehicles

NEDC tests on Euro 3 diesel cars, with an without PM trap





European Auto/Oil Programme: EPEFE

- 1991: The European Commission asked the motor and oil industries to evaluate the best way to control engine and fuels to reduce emissions
- European Programme on Emissions, Fuels and Engine Technologies (EPEFE) was an ambitious programme to generate data
- Test vehicles (prototype Euro II) provided and tested by OEMs
- Test fuels required separation of the key variables
- EPEFE results published in 1995 with SAE Papers in 1996

EPEFE: The Results

- A very intense process
  - Established the principles of cost-benefit analysis and 'integrated approach' between oil and auto industries
- EPEFE, via the Auto-Oil programme led to
  - Euro III vehicle emission standards for 2000
  - New fuel specifications for 2000
  - Good test procedures, a wealth of data
- It led to a new understanding
  - Fuels and vehicle should be developed together as a common system
- But, it did not forsee the challenges of the next decade
  - Auto-oil II and the Sulphur Review followed in quick succession

Fuels Directive 98/70/EC → Auto-Oil II & Sulphur Review (1998 – 2000) → Sulphur-free fuels (<10 ppm S)

Alternative Fuels: Well-to-Wheels Study

Crude Production
~7 %

Refining
~9 %

Distribution &
Retail ~1%

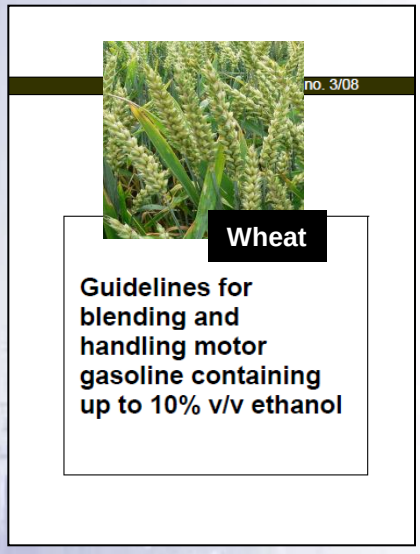
Combustion of
unit of energy ~83%

Well-to-Tank (WTT)
***~17%* (production side)**

Tank-to-Wheels (TTW)
***~83%* (consumption side)**

- Growing interest in Greenhouse Gas (GHG) emissions and biofuels led to a joint Well-to-Wheels study (the JEC Study)
  - JRC: EC's Joint Research Centre (Alternative fuels and availability)
  - EUCAR: European Council for Automotive R&D (Vehicle modelling)
  - CONCAWE (Fuel production pathways)
- Widely regarded as an objective, rigorous assessment for Europe
- Version 1 issued in Jan 2004: Version 4 will be published soon

The Rise of Biofuels



- Low-level biofuel blends successfully introduced
  - EN228: E5, E10, ETBE
  - EN590: B7
- CONCAWE is involved in many ways
  - WTW analysis helps identify those pathways that maximise GHG emission reductions
  - Effects on refining have been studied
  - Handling guidelines issued for ethanol and biodiesel
  - Specification and test procedure development through CEN/ISO, CEC to respond to vehicle performance issues
- Key issues with renewable fuels are:
  - Ethanol: changes gasoline volatility in a non-linear way
    - 2011: volatility specification changed for E10 gasolines
  - Biodiesel: oxidation stability and vehicle after-treatment
- Advanced biofuels offer greater GHG emission reduction
  - But slow to enter production

CONCAWE Coordinates Oil Industry Input

- FE/STF-24 provides technical input to discussions on CEN standards for gasoline and diesel
  - Implementation of 'environmental' fuel parameters
  - Standard European gasoline volatility classes
  - Inclusion of oxygenates in fuel specs
- FE/STF-27 provides similar service for aviation/marine fuels
- New or improved test procedures are often required
  - Diesel fuel lubricity, biodiesel stability and cold flow performance
- Board Member on the Coordinating European Council (CEC)
  - Standard reference fuels
  - Engine tests e.g. DW10 DI diesel injector cleanliness
- Market fuel surveys
  - Recent data on metals content, oxidation stability
- Global interactions through the Associations Fuels Network

What Have We Learned?

- CONCAWE has contributed constructively to fuel quality discussions throughout its history
- The world has changed a lot in 50 years
- And will change even more in the next 50 years
- Fuels and vehicles must be considered in an 'integrated approach'
  - Cooperation is vital: Oil-Vehicle-EU-Biofuel
- The future is always different from what we imagine it will be
  - and probably more exciting!