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Fuel Challenges and Fuel Testing Requirements for the Next Decade

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CONCAWE

Special CEC Planning Event, Brussels

22nd November, 2011

CONservation of

Clean

Air and

Water in

Europe

The Oil Companies' European Association
for health, safety and environment in
refining and distribution
(founded in 1963)

Active research in areas of importance to the European Refining Industry

Auto Emissions & Fuel Quality

Air Quality

Water/Soil Quality & Waste

Oil Pipelines

Safety

Refinery Technology Support

Health Science

Petroleum Products

Risk Assessment

Implementation of REACH & GHS

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- ▶ Open to companies that own refining capacity in Europe
- ▶ Currently 41 Members and Associates*
 - ▶ Representing ~100% of European refining capacity

AlmaPetroli
APC
api
BP
CEPSA
Chevron
ConocoPhillips
ENI
ERG
ExxonMobil
Galp Energia
Hansen & Rosenthal
Hellenic Petroleum
INA*

INEOS
IPLOM
Koch
KPI
LOTOS
LUKOIL
LyondellBasell
MOL
Motor Oil (Hellas)
Murco
Neste Oil
Nynäs
OMV
Petroplus

PKN Orlen
Preem
Repsol
Raffinerie Heide
Rompetrol
SARA
SARAS
Shell
SRD
Statoil
St1
Tamoil
TOTAL

- ▶ Not for profit Association, funded by Member Companies

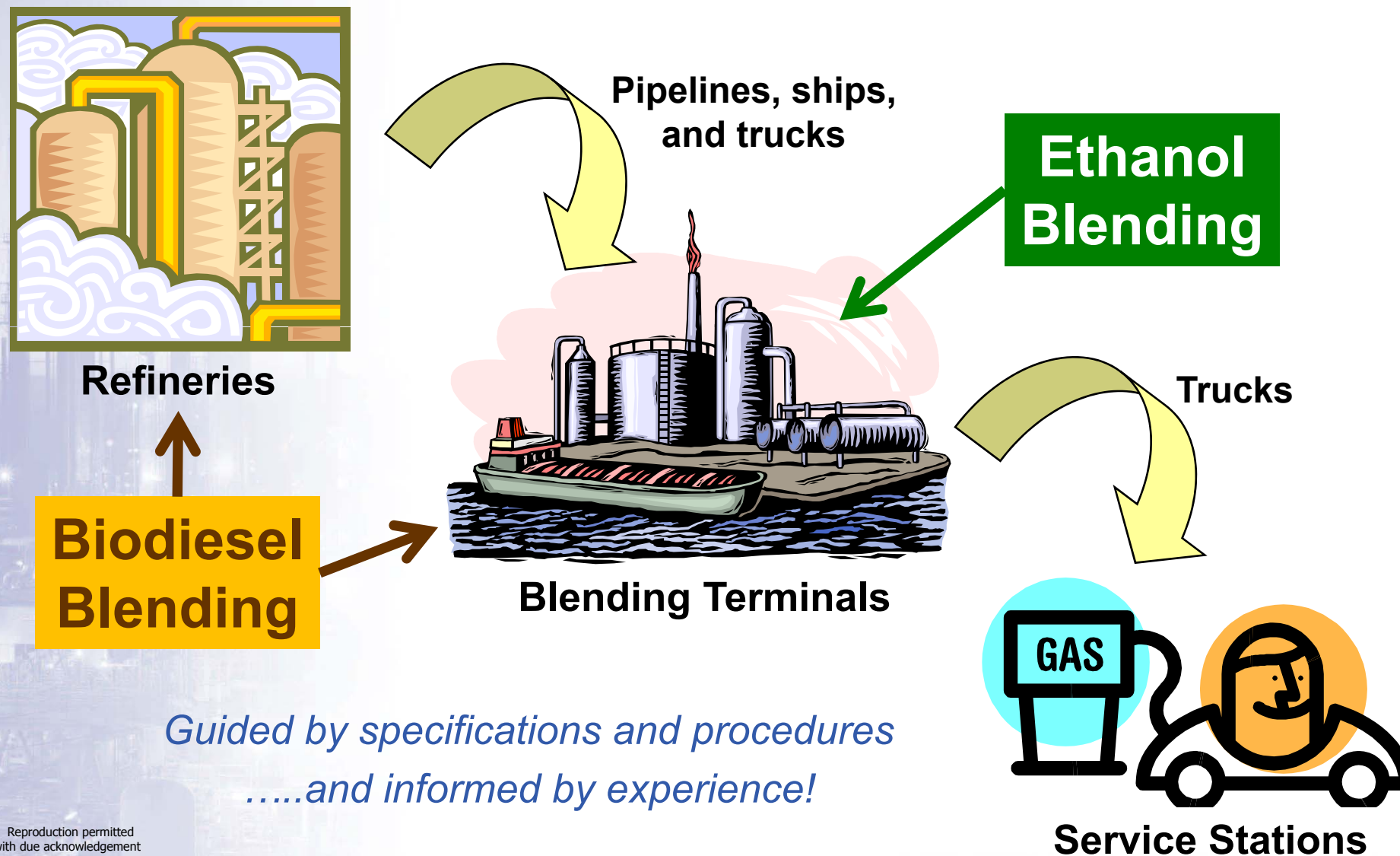
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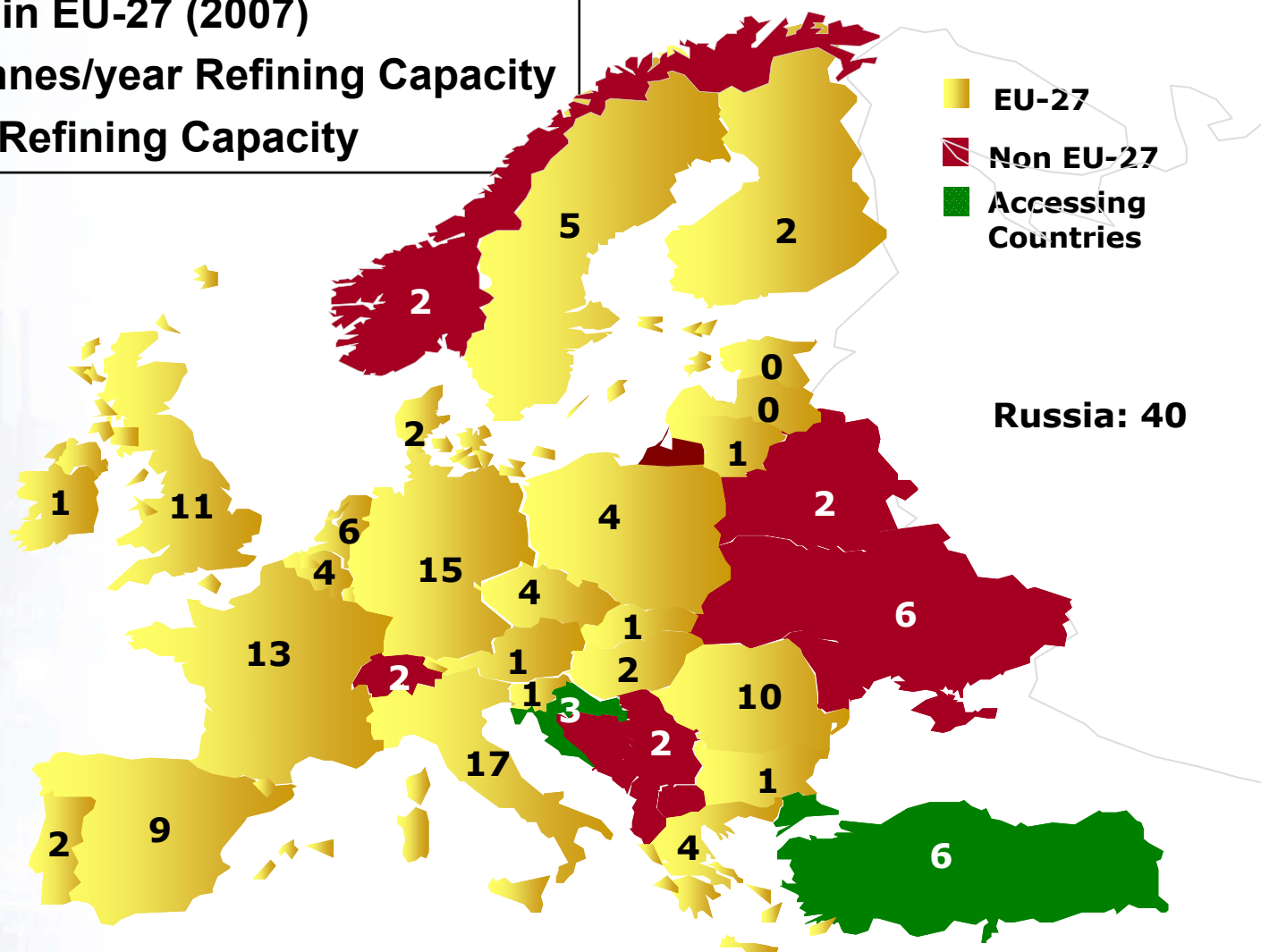
- ▶ High-level overview of the fuel manufacturing, supply, and distribution business
- ▶ Ensuring 'fit for purpose' fuels in the marketplace
- ▶ In the past, familiar requirements and familiar options
- ▶ In the future, new requirements and new options
 - ▶ Case study: unintended consequences from low-level fuel components and their impact on diesel injector deposits
- ▶ What lies ahead?

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- 116 Refineries in EU-27 (2007)
- 767 Million Tonnes/year Refining Capacity
- 18% of Global Refining Capacity



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Source: Oil and Gas Journal (2007)



- 35,400 kilometers total length
- Total pipeline volume about 800 Billion Litres:
 - 500 Billion litres of crude oil (red)
 - 300 Billion litres of refined products (green)
- 159 pipeline systems
- 74 operating companies



map navigation



pipeline network

Select a country

Select a company

☒ all companies

refineries

☐ on/off

map details

☒ countries ☐ ocean/sea

☐ capital cities ☐ lakes/rivers

☐ urban area

legend

★ Refinery in Operation

★ Two or more Refineries in Operation

Pipelines: In Operation or Stand by

Crude Oil

Oil Products

reset map

print map

Refineries & Oil pipelines in Europe

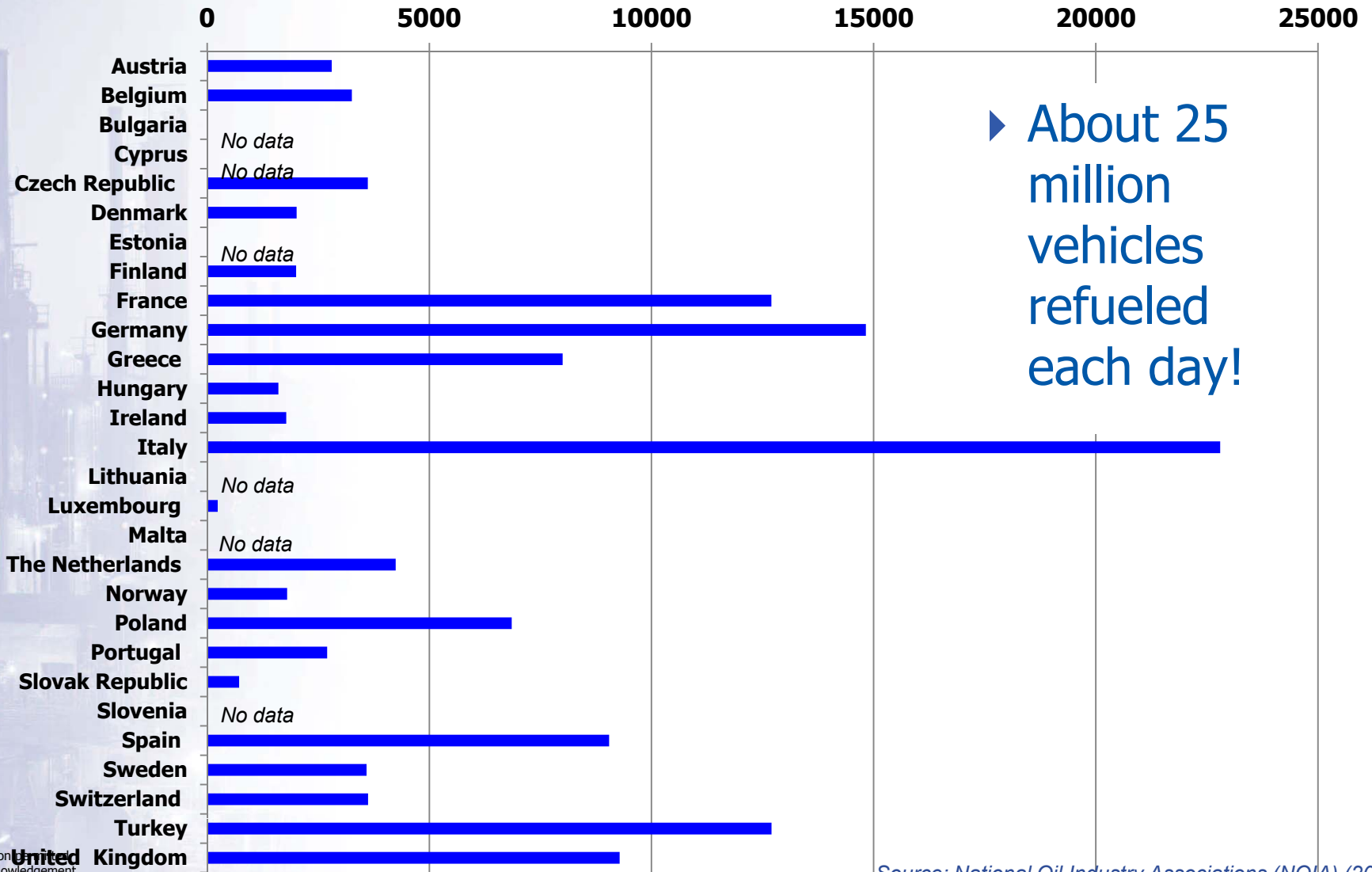
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Source: CONCAWE



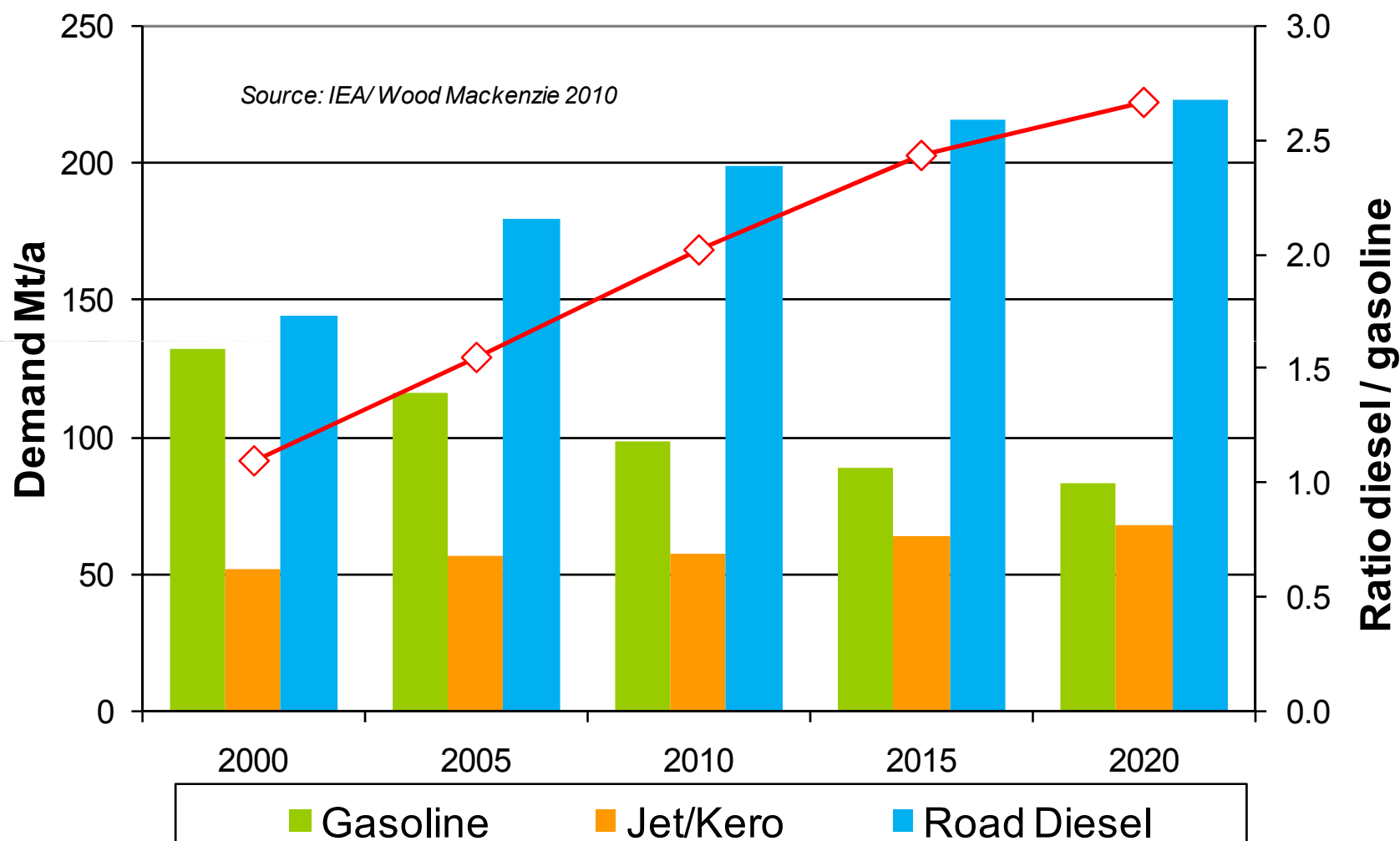
Service Stations by Country



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Source: National Oil Industry Associations (NOIA) (2009)





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concaawe How Much Fuel Is 300 Million Tonnes per Year?

➤ It's about 1 Billion litres per day!

■ OR

About 21 times the volume of
the Arc de Triomphe!



Eiffel Tower
(300m x 100m x 100m)



Arc de Triomphe
(50m x 45m x 22m)

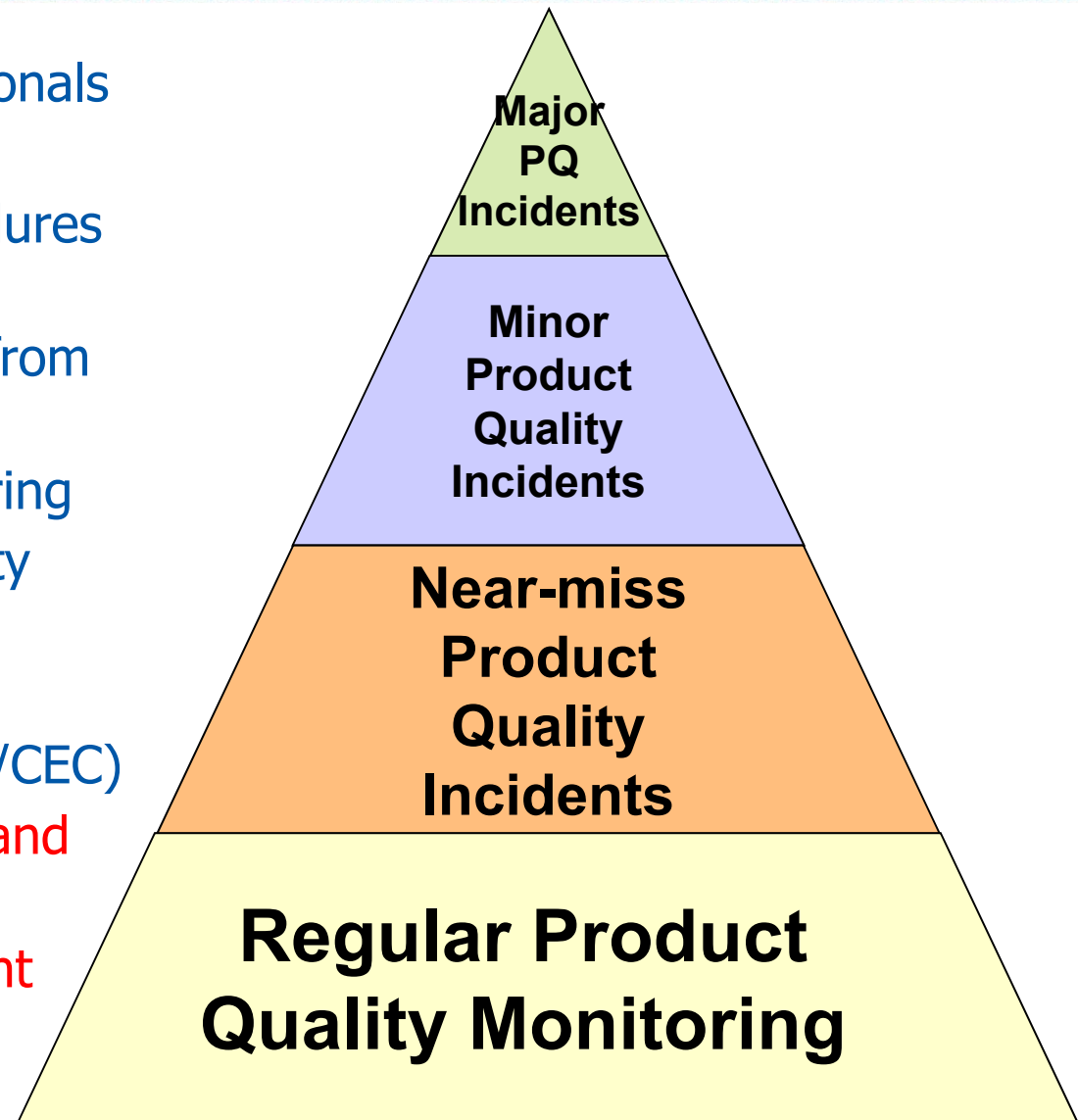
OR

About the same volume as
the Eiffel Tower!

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- ▶ Product Quality professionals
 - ▶ Properly trained
 - ▶ Supported by procedures and equipment
 - ▶ Constantly learning from field experience
- ▶ Regular product monitoring
 - ▶ European Fuel Quality Monitoring System
 - ▶ Marketplace surveys
- ▶ Fuel specifications (CEN/CEC)
 - ▶ Performance-based and technically robust
 - ▶ Supported by relevant and statistically valid test methods



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- ▶ **Regulatory** driven changes impacting refineries
 - ▶ Permit changes reducing environmental emission levels
 - ▶ EU Emissions Trading Scheme & CO₂ allowances
 - ▶ Fuels Quality Directive & refinery energy efficiency
- ▶ **Quality** driven changes to petroleum products
 - ▶ Sulphur reduction in transport fuels, especially marine bunker fuel
 - ▶ Renewable Energy Directive increasing biofuel blending
 - ▶ Euro 4, 5, 6, & ? Plus vehicle CO₂ emissions reduction
- ▶ **Demand** driven changes affecting fuel production
 - ▶ Reduction in overall demand due to greater energy efficiency
 - ▶ Substitution of biofuels for refinery fossil fuels
 - ▶ Increasing demand for diesel & decreasing demand for gasoline
 - ▶ Possible changes in future exports and imports
- ▶ **Marketing** driven changes affecting product differentiation
 - ▶ Product lines and advertising strategies

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Guiding Principles for European fuel quality specifications:

- ▶ Enable regulatory priorities and vehicle improvements
- ▶ Ensure "fit for purpose" fuels and blending components
- ▶ Based on relevant, technically robust, and statistically valid engine, rig, and analytical methods
- ▶ Provide an appropriate margin for supply and distribution
- ▶ Developed with extensive stakeholder participation
- ▶ Anticipate transitions from today to tomorrow

CEC helps the fuel producers ensure these Guiding Principles:

- ▶ Identify the fuel qualities that enable new vehicle and aftertreatment technologies to meet today's emissions standards and to anticipate tomorrow's
- ▶ Provide reliable data for potential marketing opportunities
- ▶ Ensure common understanding of current and future problems

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CEC activities include:

- (a) Devising test procedures and protocols;
- (b) Establishing precision, reliability and constancy of such procedures and arising data and correlation to end-use applications;
- (c) Publishing test methods, codes of practice and technical information related to or arising from CEC activities. These publications are available to CEC members and non-members throughout the world;
- (d) Monitoring of the efficacy of CEC test methods and codes of practice both in terms of evolving technology and as applied by users;
- (e) Amending or withdrawing methods and codes of practice which are judged to be no longer useful.

► Key elements of the CEC process:

- Quality requirements for test laboratories (ISO 9001, ISO 17025)
- Reference Fuels Group, Statistical Development Group, Rating Group
- Web-based test monitoring scheme

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Modern Engine Systems

- Spark Ignition
 - + *Sequential Fuel Injection*
 - + *Gasoline Direct Injection*
- Compression Ignition
 - + *Direct Injection*

Modern Fossil Fuels

- 10 ppm Sulphur Fuels
 - Vapour Pressure
 - Cetane Number
- Additive Technology

Urban Air Quality

(CO, HC, NOx, Ozone, Noise)

Requirements change (emissions, performance, etc.)

Engine and vehicle technology responds to change

Fuel and additive technology responds to vehicle change

Corrective measures implemented based on predictive test methods

Problems mitigated

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Test Method	Engine Type	Fuel Product	Test For:
F-05-93	M102E	Gasoline	Inlet valve cleanliness
F-16-96	VW Wasserboxer	Gasoline	Inlet valve sticking
L-54-96	MB M111 FE	Gasoline	Lubricant fuel economy effects
F-06-96 (U)	HFRR Rig Test	Diesel	Diesel fuel lubricity
F-20-98	MB M111 EVO	Gasoline	Intake valve and combustion chamber deposits
F-23-01	PSA XUD9A	Diesel	Injector nozzle coking, indirect injection systems
F-98-08	PSA DW10	Diesel	Injector fouling, direct injection systems
M-92-03	Code of Practice	Gasoline	Starting problems with combustion chamber deposits
P-017-97	Reference Fuels Manual		

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U: test no longer supported by CEC Working Group



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**Urban
Air Quality**

(CO, HC, NO_x, Ozone, Noise)

and

**Energy/GHG
Reduction**

(CO₂, CH₄, N₂O)

**Alternative Engines
and Powertrains**

- Advanced Combustion
 - + *HCCI, CAI*
- Plug-in Hybrids & Hybrids
 - Battery Electrics
 - + *Hydrogen and Fuel Cells*
- Advanced Aftertreatment

Alternative Fuels

- Bio-fuels
 - + *1st and 2nd Generation*
- Compressed Gases
 - + *LPG, CNG*
 - + *DME, Biogas, H₂*
- Advanced Aftertreatment

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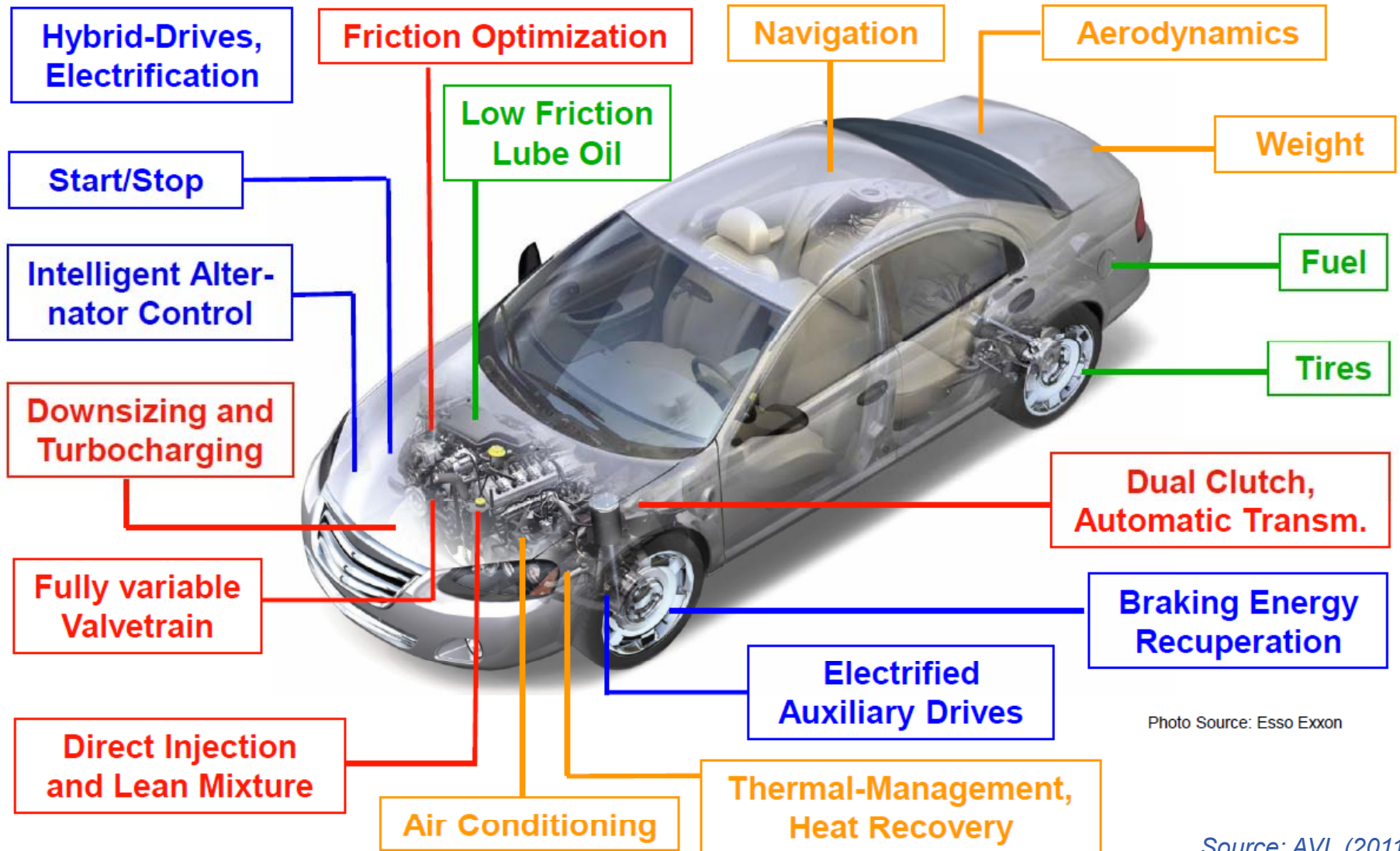


Photo Source: Esso Exxon

Source: AVL (2011)

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concawe Case Study: Internal Injector Sticking Deposits

- Field problems identified with sticking diesel fuel injectors through customer complaints and warranty problems
- OEMs and Fuel Injector Suppliers brought this problem to the attention of CEN Work Group 24 (May 2011) and a multi-stakeholder Task Force was immediately formed to investigate

Business Sectors	Contributing Organisations to WG24 Task Force
OEMs	Daimler, Ford, Opel, PSA, and Renault
Fuel Injector Suppliers	Bosch, Delphi, and Denso
Fuel Suppliers	BP, CONCAWE, ExxonMobil, Repsol, Shell, Statoil, and Total
Additive Suppliers	Afton, BASF, Infineum, and Lubrizol
Biodiesel Producers	ADM and the European Biodiesel Board (EBB)
Other Contributors	CLH Pipeline Company (Spain) Unione Petrolifera (Italian Oil Industry Association)

Problem
Identified

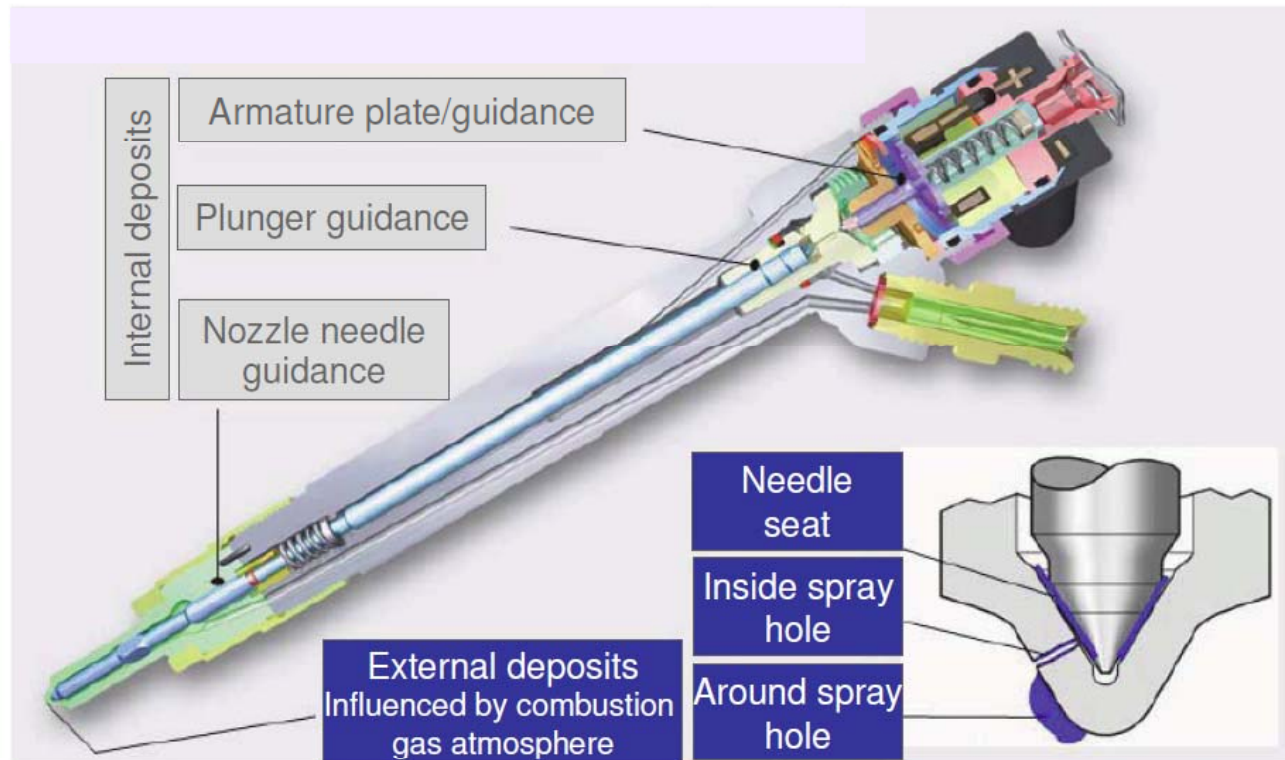


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graph LR; A[Problem Identified] --> B[ ]; B --> C[ ]; C --> D[ ]
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Injector Design and Location of Deposits

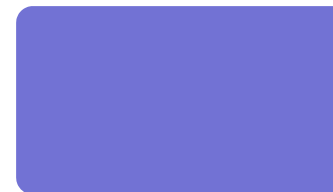


Source: Bosch

Problem
Identified



Data
Gathered



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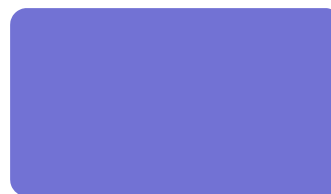


- ▶ Two new types of deposits identified inside diesel fuel injectors through detailed analytical investigations
 - ▶ Carboxylate soaps and amide deposits
 - ▶ All major OEMs and injector suppliers affected
- ▶ More injector sticking cases reported in wintertime
 - ▶ Deterioration of fuel injector performance is most apparent to drivers under cold starting and operating conditions where precise control of the fuel injection is required
- ▶ Both Solenoid and Piezo actuated injectors are affected
 - ▶ Small component clearances and more complicated injection profiles requiring very precise control of the injector needle, making these technologies particularly sensitive to internal injector deposits

Problem
Identified



Data
Gathered



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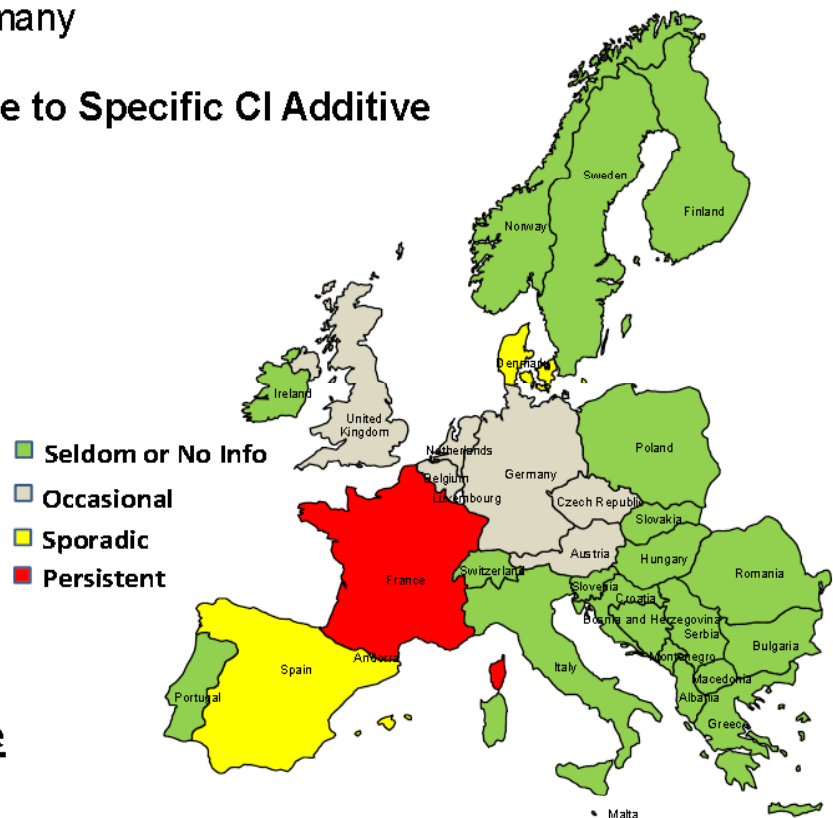


France Most Affected Followed by Spain

- Transient issues in Germany

Denmark Issue Probably Due to Specific CI Additive

Qualitative Ranking of IID Issues in Europe



Problem
Identified



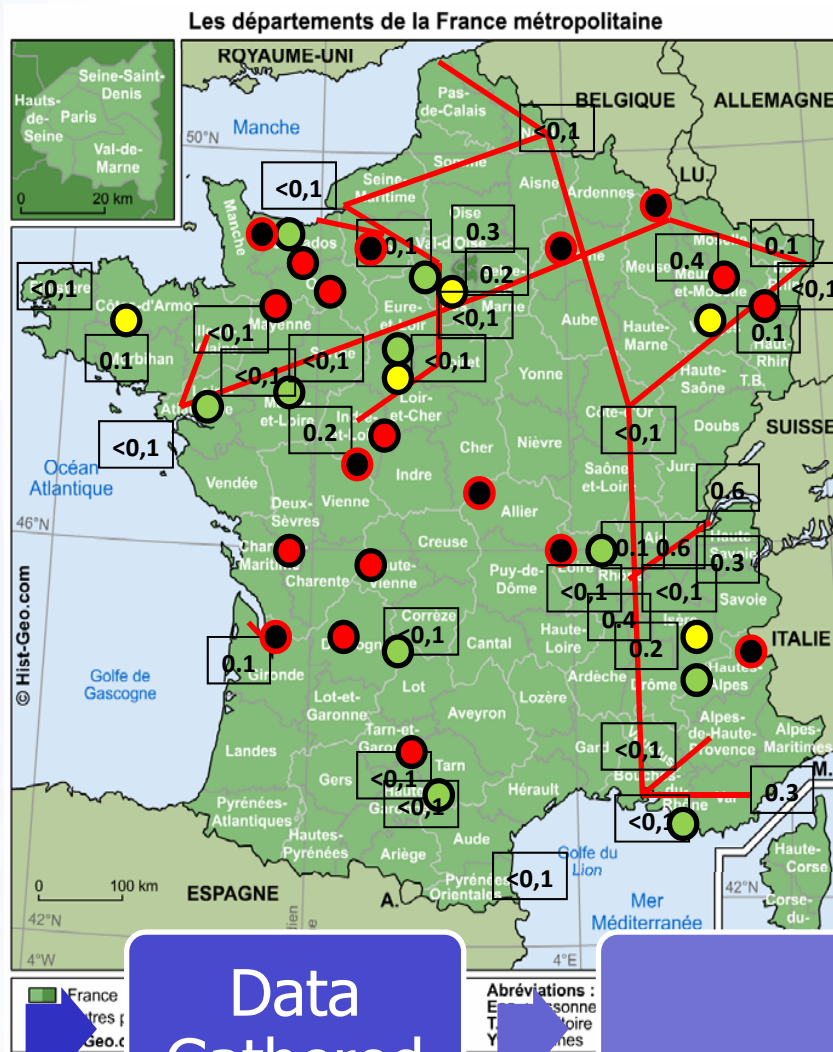
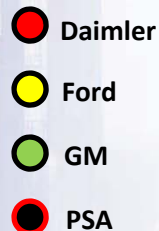
Data
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Source: CONCAWE, SGS,
ACEA – 2010/2011 data



- 'Hot spots' identified by comparing:
 - Locations of vehicle problems
 - Sodium levels in market fuels
 - Pipeline distribution system
- Highest sodium levels only about 0.6ppm, most levels less than 0.1ppm

Problem
Identified

Data
Gathered

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- More stringent Euro 4 and 5 vehicle emissions standards
 - ▶ Higher fuel injection pressures (1800 bar)
 - ▶ Very small fuel injector nozzles
 - ▶ Higher operating temperatures
 - ▶ Need for more precise control of fuel injection
- Sulphur free diesel
 - ▶ Change in solvency
- Higher biodiesel blending up to 7% Fatty Acid Methyl Ester (FAME)
 - ▶ Additional source of dissolved cations and weak acids
- Fuel distribution system
 - ▶ Potential for inadvertent pick-up in pipeline transit

Problem
Identified



Data
Gathered

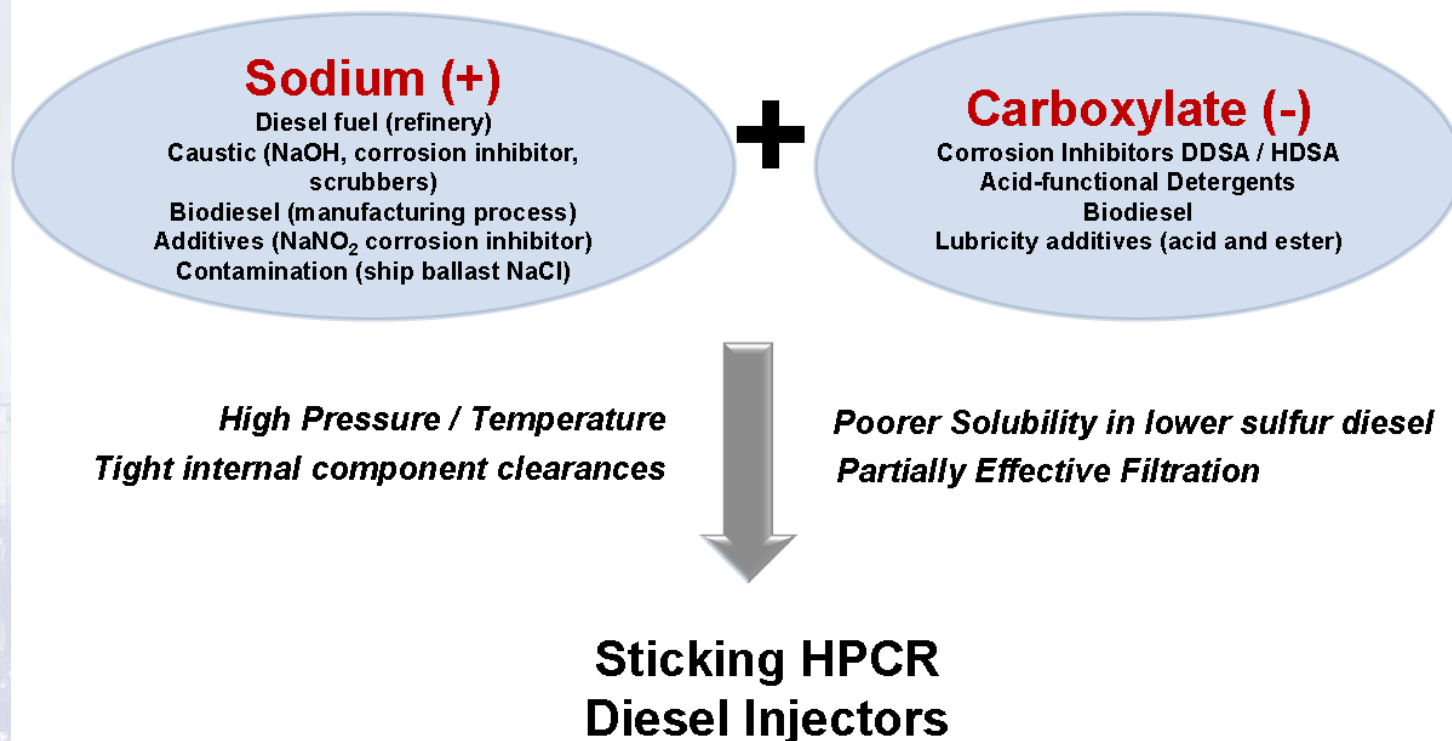


Causes
Identified



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Passion for Solutions™

Problem Identified



Data Gathered



Causes Identified



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- Task Force has raised forensic evidence with those responsible for fuel supply and distribution
 - ▶ Particular types of pipeline corrosion inhibitors can contribute to higher sodium levels
 - ▶ Combination of sodium-based inhibitors and traces of carboxylic acids result in higher levels of diesel injector sticking incidents
- Alternative inhibitor technologies have been recommended and are being considered for deployment, followed by monitoring
- A light-duty diesel engine has been offered as a CEC test candidate that is known to be sensitive to internal diesel injector deposits
- OEM in-house test procedure has also been proposed to evaluate fuels and additives for IDID problems and mitigation
- Prompt actions on IDID provide a good model for future developments

Problem
Identified



Data
Gathered



Causes
Identified



Solutions
Initiated

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- ▶ Regulatory requirements
 - ▶ Lower vehicle emissions performance & enhanced durability
 - ▶ Penalties for unsatisfactory performance
 - ▶ Mandates for fuel suppliers to use biofuels and reduce CO₂
- ▶ Engines, vehicles, and aftertreatment
 - ▶ Pushing technology boundaries:
 - ▶ higher pressures
 - ▶ higher operating temperatures
 - ▶ tighter tolerances
 - ▶ increasing sensitivity to previously insignificant changes
 - ▶ Diversification of vehicle strategies, hardware, and fuel types
- ▶ Fuels and additives
 - ▶ More diverse blending components
 - ▶ Increasing reliance on additive solutions
- ▶ Evaluation and implementation cycle
 - ▶ Insufficient time to anticipate and correct potential problems
 - ▶ Increasing fixes based on what has worked well in the past

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- ▶ All CEC stakeholders are interested in happy customers!
 - ▶ Customers, like you and me, expect fit for purpose products that are conveniently available and provide good value for money
- ▶ Changes in vehicle requirements drive innovation and change in engines and aftertreatment technologies
 - ▶ This can be expected to continue, even accelerate, in the future!
- ▶ Changes in vehicle technologies drive continuous re-evaluation of fuel and fuel additive requirements
 - ▶ This can be expected to continue, even accelerate, in the future!
 - ▶ Increasing biofuel blending and diversification in fuel types will require continued vigilance, communication, and testing
- ▶ The CEC process and CEC-developed test methods provide a valuable means to ensure current and future performance

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CONCAWE is happy to congratulate



The Coordinating European Council

for the Development of Performance Tests for Fuel, Lubricants and other Fluids

on its 10th re-Birth Day!

**For fuel products,
and all consumers of fuel products,
your past contributions have been valuable
and will continue to be in the future!**

