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# EU Biofuels Situation

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06 December 2012

# Topics: with a focus on Diesel Fuels

- Legislative framework
- Vehicle emissions regulations
- Biofuel blending in EU countries
- CONCAWE/DGMK diesel fuel survey (May-October, 2012)
- Proposed RED Amendment (October, 2012)
- Implications for future biofuel blending

# EU Legislative Framework for Biofuels

- **Reduce Greenhouse Gas emissions from energy and transport**
  - Energy Efficient Road Transport Vehicles (2008)
  - Fuel Quality Directive (2008)
    - Fuel manufacturing: 6% reduction in GHG emissions by 2020 through refinery efficiency and biofuel blending
  - Emissions Trading Scheme (ETS)
  - Geological Storage of Carbon Dioxide (2008)

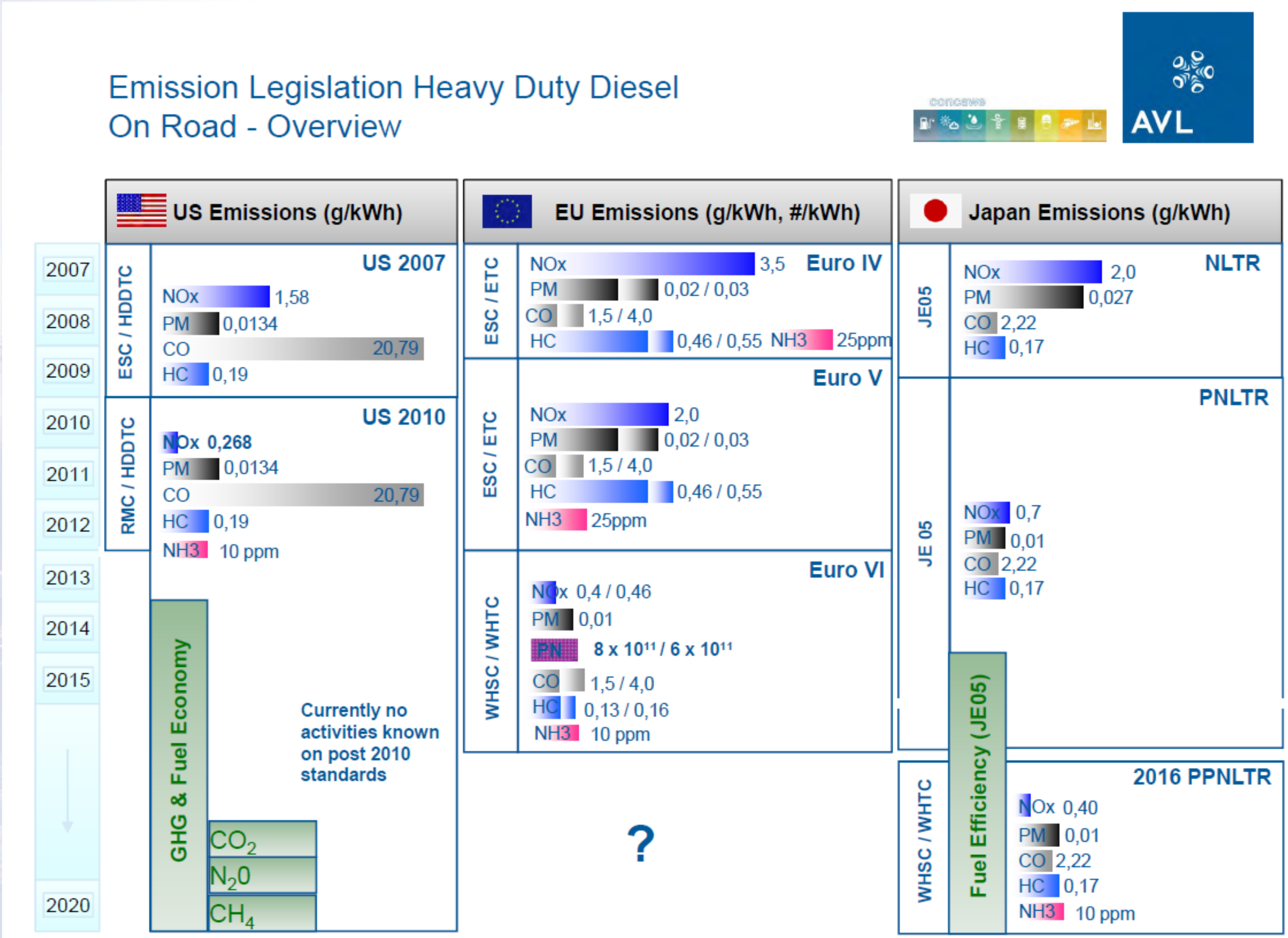
- **Encourage use of sustainably-produced renewable fuel products**
  - Fuel Quality Directive (2008)
    - Allow up to 10% v/v ethanol in gasoline (E10)
  - Renewable Energy Directive (2008)
    - 10% renewables (energy basis) in road fuels by 2020
      - Targets for 1st and 2nd Generation renewable fuels, including extra credits for renewable electricity, biogas
    - Intermediate targets in 2015 and a progress review in 2014
    - Member State strategies communicated through NREAPs

# Coming Decade for European Road Transport

- **Vehicles:**
  - More advanced engines & aftertreatment, diversification in engines and fleet
  - Fuel consumption of LD vehicles improving, HD diesel demand increasing
  - Increasing pressure on OEMs for $CO_2$ reductions with associated higher cost
  - Customer preferences potentially in conflict with mobility policies
- **Refineries:**
  - Increasing imbalance in diesel/gasoline demand ratio
  - Higher $CO_2$ emissions due to distillate demand and product specifications
  - Increasing pressure on $CO_2$ emissions reduction (FQD Art. 7a) with higher cost
- **Biofuels and other Renewables:**
  - Renewables in transport fuels mandated by RED to 10% (energy) by 2020
  - Conventional biofuels widely available but with sustainability/ILUC* concerns
  - Slower than expected pace of development for more advanced biofuels
  - National Renewable Energy Action Plans (NREAPs) show that pace/priorities differ across Member States, potentially leading to fuel diversification
  - CEN fuel specifications are struggling to keep pace with legislative mandates

*ILUC = Indirect Land Use Change*

# Heavy Duty Diesel Emissions Regulations

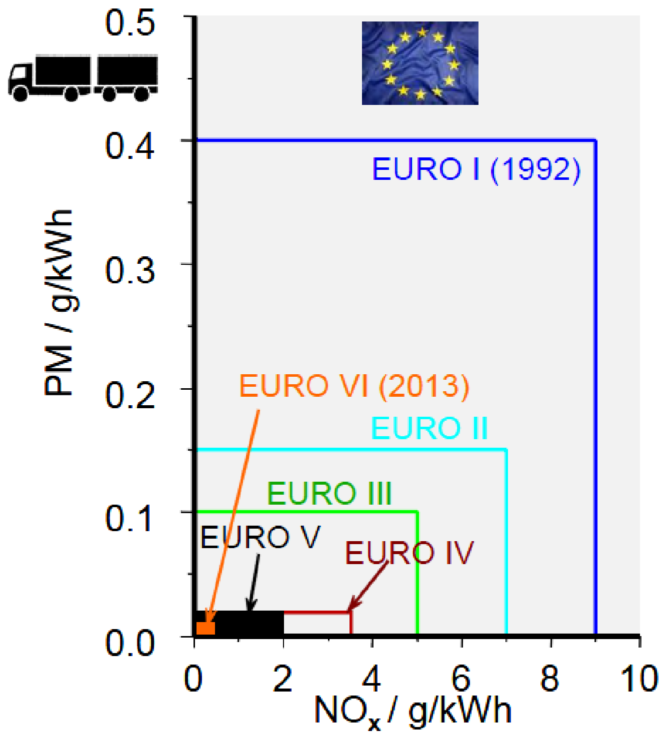



*Source: AVL (2012)*

# Heavy-Duty Engine Emission Legislation Europe
# PM / $NO_x$ Emissions

## Different emission concepts are followed up by OEMs for Euro 6

### European HD PM/NOx emission legislation



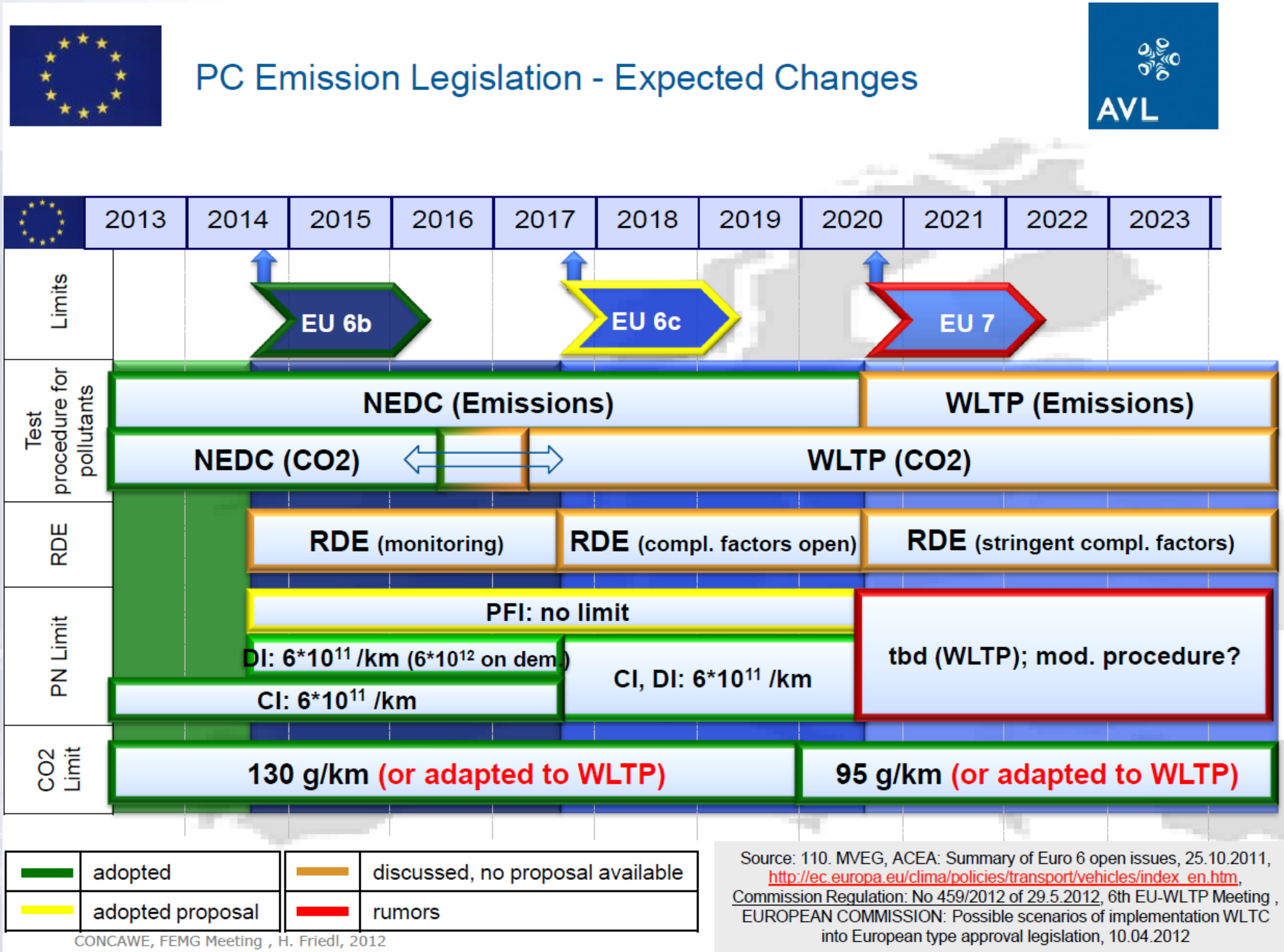

- Legislative test cycles have been changed from EURO I to EURO VI
- For EURO VI PM number limit in addition

### Comments

- Different approaches are actually followed up by OEMs to achieve Euro 6 emission targets for MD/HD engines
- All manufacturers use SCR and DPF for on-road Euro 6
- Most OEMs use cooled EGR in addition
- SCR only concept w/o EGR followed up by IVECO
- Concepts w/ non-cooled EGR followed up by some OEMs

*Source: FEV (2012)*

# Euro 6+ Passenger Car Emissions Regulations






*Source: AVL (2012)*

# EU6 Roadmap for Diesel Exhaust Aftertreatment - Possible Approaches / Evaluation

AVL

| | ROUTE 1 | ROUTE 2 | ROUTE 3 |
|---|---|---|---|
| **NOx Aftertreatment** | **no DeNOx** | **LNT** | **SCR / SDPF** |
| **Evaluation** | Risk market acceptance<br>Development efforts incr.<br>Not yet proven in SOP<br>Modifications on engine<br>Not for heavy vehicles<br><br>Market acceptance:<br>Ongoing $NO_2$ discussion.<br>Image like EU4 w/o DPF in the past. | Positive market acc.<br>Calibration eff. Incr.<br>Proven in SOP<br>No engine mod.<br>Limited efficiency<br>Easy packaging<br>FC increased | Positive market acc.<br>Calibration eff. Incr.<br>Proven in SOP<br>No engine mod.<br>Max in efficiency<br>Packaging challenge<br>FC neutral/beneficial<br>high system costs<br><br>Costs:<br>If costs change No.1 solution for $CO_2$ optimum |
| | No option for RDE | borderline for RDE | Optimum for RDE |

*Source: AVL (2012)*

## DeNOx Strategies of selected OEMs (published data)

AVL

| | |
|---|---|
| Audi | ▪ SCR for US market and EU6 (V6 3.0 TDI) |
| BMW | ▪ SCR for US market (IL6)<br>▪ LNT for EU market (IL6 and IL4 in future)<br>▪ SCR for EU 6 heavy vehicles |
| | ▪ SCR for US market (Tier2 BIN5)<br>▪ LNT (incl. SCR cat w/o dosing) for US TIER2 BIN8 |
| RENAULT | ▪ LNT for EU |
| | ▪ SCR as well as LNT for US TIER2 BIN5 (Jetta 2.0 TDI)<br>▪ SCR for EU (Passat EU6) |
| PSA PEUGEOT CITROËN | ▪ Published to go for SCR for the whole Diesel Fleet ($CO_2$ Optimum) |

*Source: AVL (2012)*

# Conclusions from a Recent JRC Report

**Table ES.1. Vehicle technologies evaluated**

| Tier 1 | Tier 2 |
|---|---|
| Internal Combustion Engine | Spark-ignition |
| | Compression ignition |
| | Low-T combustion |
| Hybrid | Mild |
| | Full |
| | Plug-In |
| Electric | Battery |
| | Fuel Cell |
| | Electric vehicle with internal combustion engine range extender |
| | Electric vehicle with fuel cell range extender |

- Sustainability Assessment of Road Transport Technologies (L.Ntziachristos & P.Dilara (2012))
  - '…there is no 'silver bullet' (vehicle) technology to replace existing ones in the near future'
  - 'The potential of conventional ICE vehicles is still substantial (offering) high cost-effectiveness and driving performance which can hardly be matched by alternative technologies.'
  - 'Electric vehicles have potential to offer substantial GHG and (pollutant) reductions over conventional technologies.'
  - 'However, cost, infrastructure needs, and battery capacity are still significant obstacles in their widespread penetration.'



http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/26092/1/0609_12-sustainability_online.pdf

# EU-27 Biofuel Blends

- Current European CEN Specifications:
  - Gasoline
    - Ethanol, for gasoline blending (EN15376)
    - Gasoline (EN228)
      - E5: 5% v/v ethanol and up to 2.7wt% oxygen: 'protection grade'
      - E10: 10% v/v ethanol and up to 3.7wt% oxygen: being rolled out
      - 'E10+': technical report completed on options and test methods
  - Diesel Fuel
    - Fatty Acid Methyl Esters (FAME, EN14214): revision balloted by CEN
    - B7: 7% v/v FAME in diesel fuel (EN590): revision balloted by CEN
    - B10: on hold awaiting clarification from European Commission
    - Generally no limits on advanced diesel blending components
      - Hydrogenated vegetable oils (HVO) and animal fats

- Member State Initiatives:
  - E10: Germany, France, Finland, Spain
  - E85: Sweden, Germany, Austria, France
  - B10: Germany (B7 plus 3% HVO)
  - B20-B100 for adapted vehicles: Germany, France, Poland, Czech Republic

# 2012 Diesel Market Fuel Survey: Objective

- The objective of this study was to measure the change in oxidation stability of market diesel fuels from service stations using the Rancimat and PetroOxy test methods
- FAME and ethyl-hexyl nitrate (EHN) cetane improver concentrations in each diesel fuel were also measured in order to better interpret the oxidation stability results
- Collaborative project with DGMK who were responsible for the sampling and testing of diesel samples in Germany

# Analyses Completed at One Analytical Lab

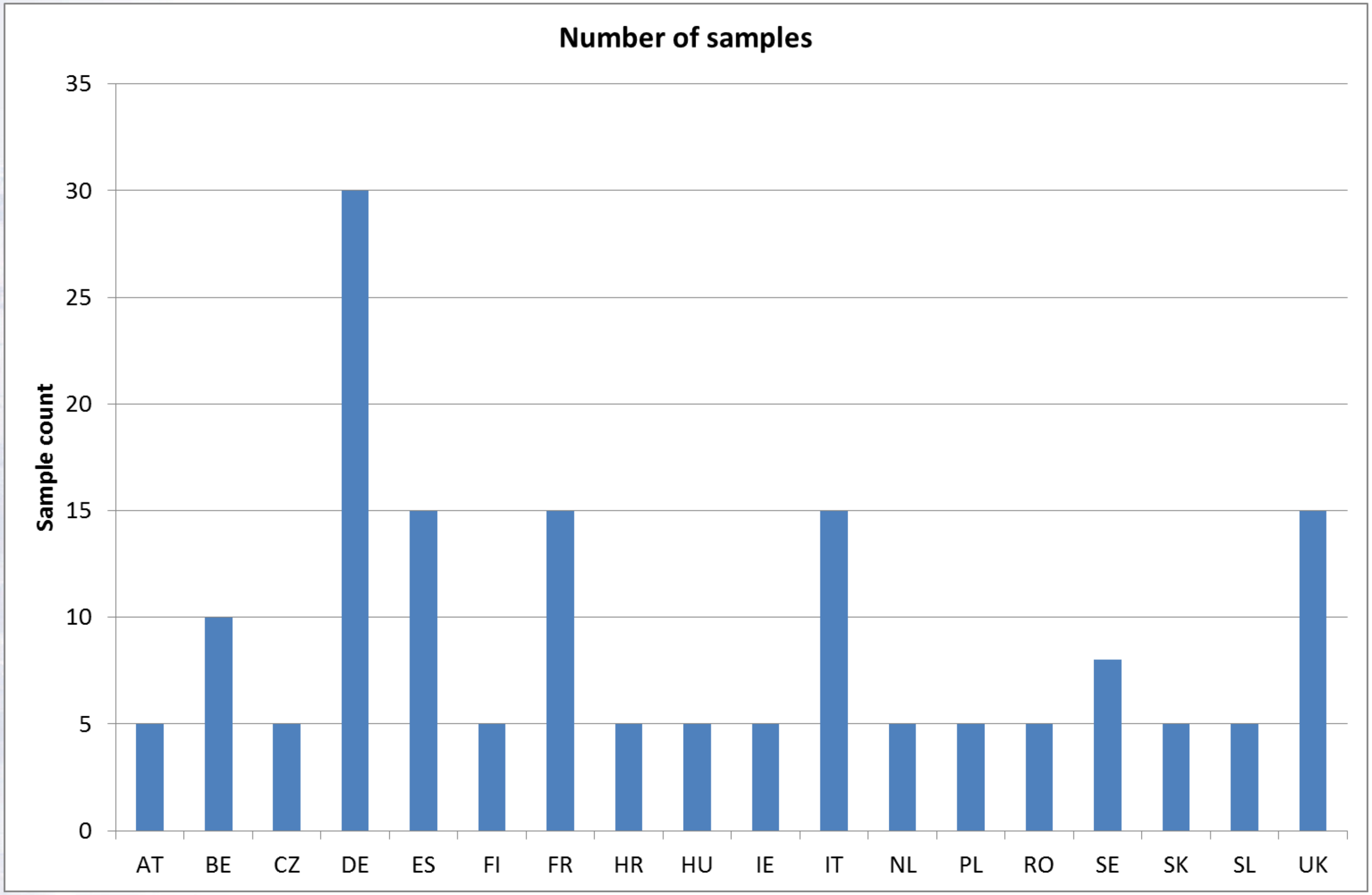
- Diesel fuels from European service stations in October, 2012
- Instructions provided to ensure representative samples
- Analyses completed at a single laboratory

| Analysis | Method | Unit |
|---|---|---|
| Appearance | ASTM D 4176 | |
| Density at 15 ° C | DIN EN ISO 12185 | $kg/m^3$ |
| FAME content | DIN EN 14078 | % (v/v) |
| Cetane improver content, Ethyl-hexyl nitrate (EHN) | GC-MS | mg/kg |
| Rancimat oxidation stability at 110°C | DIN EN 15751 | h |
| Rancimat oxidation stability at 120°C | Analog DIN EN 15751 | h |
| PetroOxy oxidation stability at 140°C | prEN 16091 | h |

# Oxidation Stability Methods for FAME and Fuels

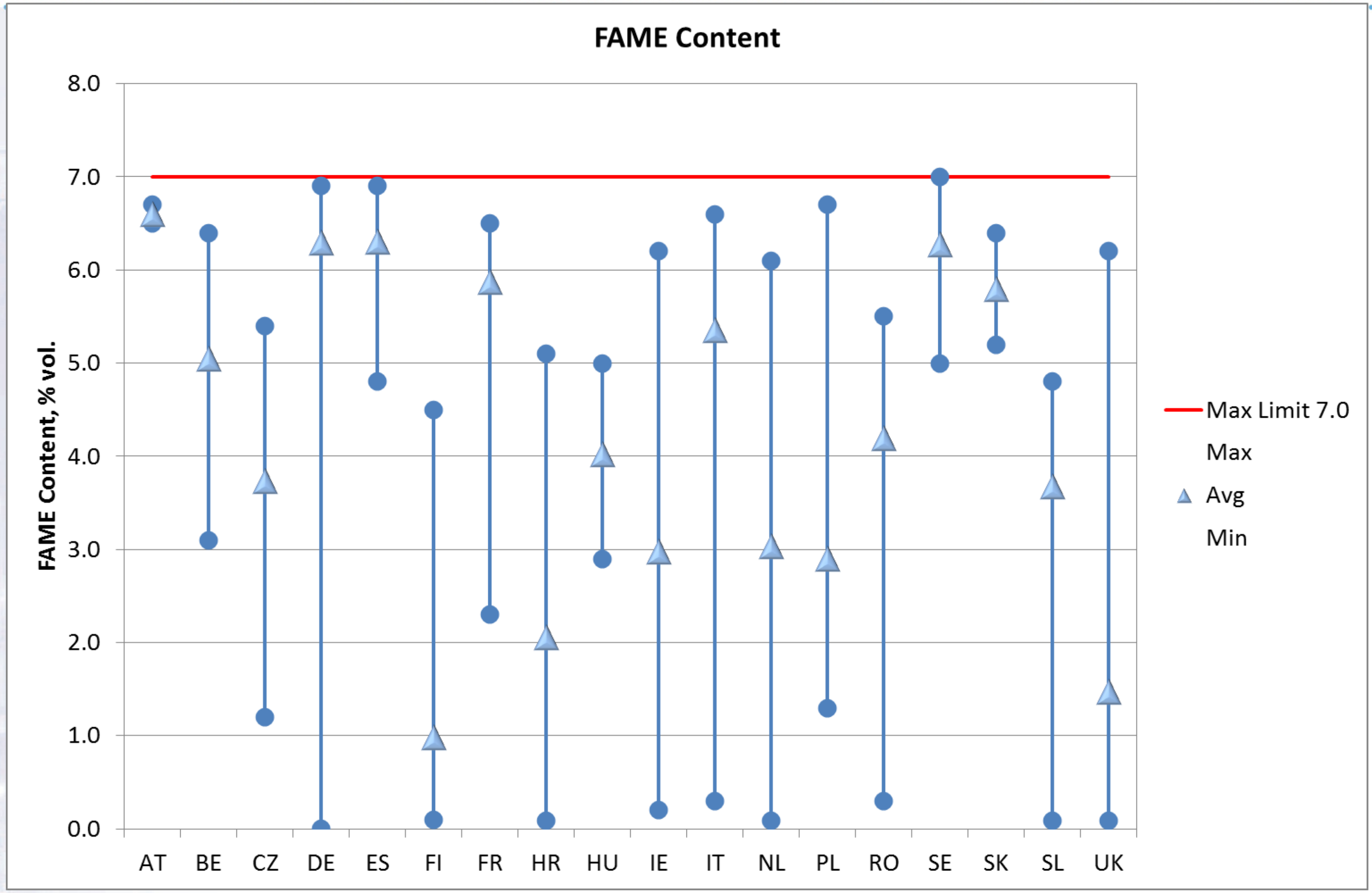
- Rancimat Oxidation Stability (at 110ºC and at 120ºC)
  - Originally developed for the food industry (50-220ºC range)
  - Measurement of the induction time using air to the rapid formation of volatile organic acids; result in many hours
  - 8-hr minimum for FAME; 20-hr minimum for fuels (>2.0% FAME)
  - CEN has also evaluated increasing the Rancimat measurement temperature to 120ºC to reduce testing time by about 50%
- PetroOxy Oxidation Stability (at 140ºC)
  - Measurement of the induction time using oxygen to the rapid formation of volatile organic acids; result in ~1 hour
  - Results influenced by thermal decomposition of cetane improver
- Total Acid Number (TAN) or Delta TAN (typically at 115ºC)
  - Induction time test measuring increase in acid value of oxidised fuel by titration
- Sludge formation in fuel (EN12205) (at 95ºC)
  - Filterable insolubles after 16 hrs oxidation with oxygen

# Diesel Fuels from Service Station Pumps




- 163 diesel fuel samples from 18 European countries

# FAME Content




- FAME content of all diesel fuels according to EN 590 specification requirements. In some cases diesel fuels without FAME (B0) observed

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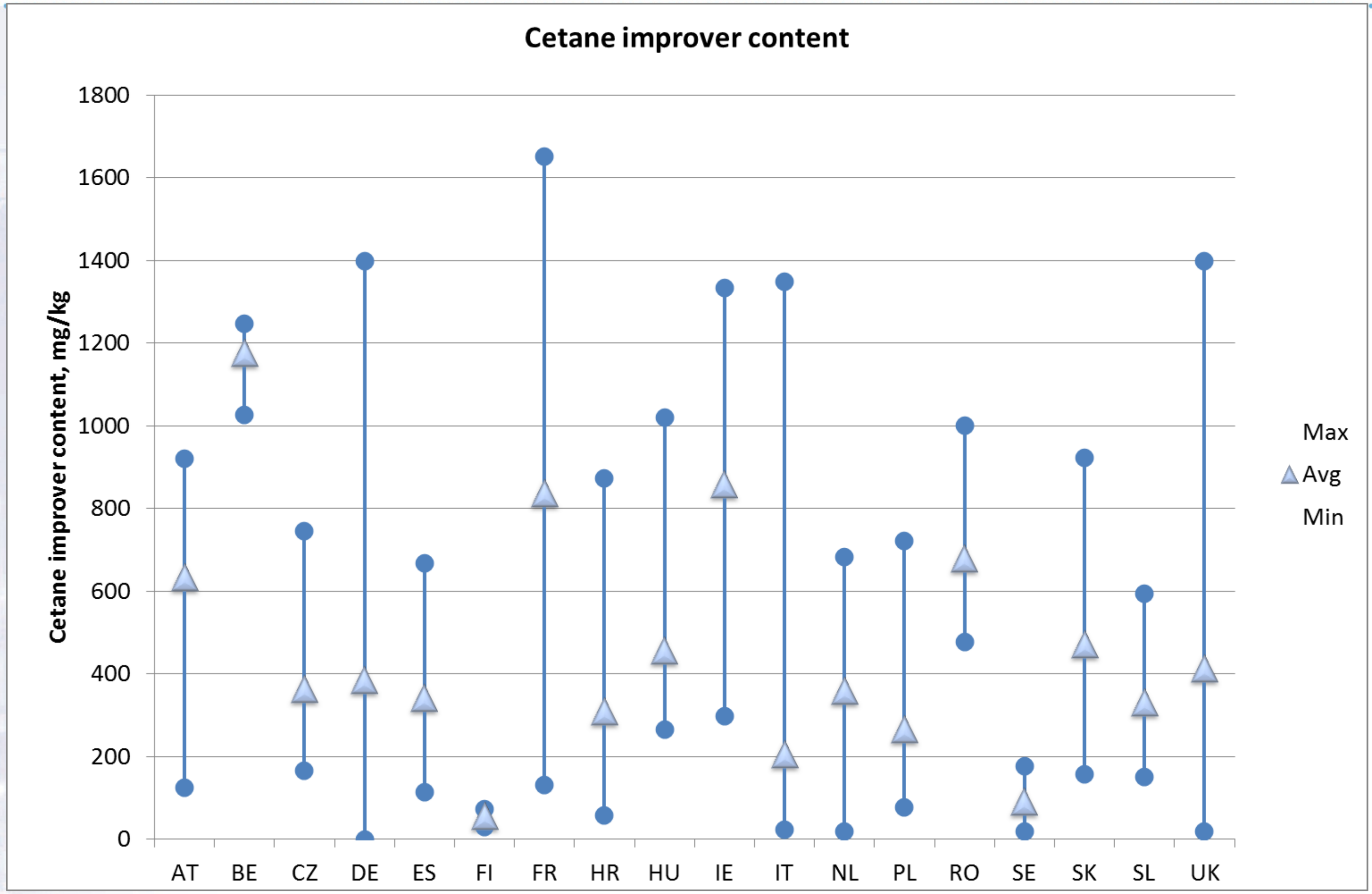
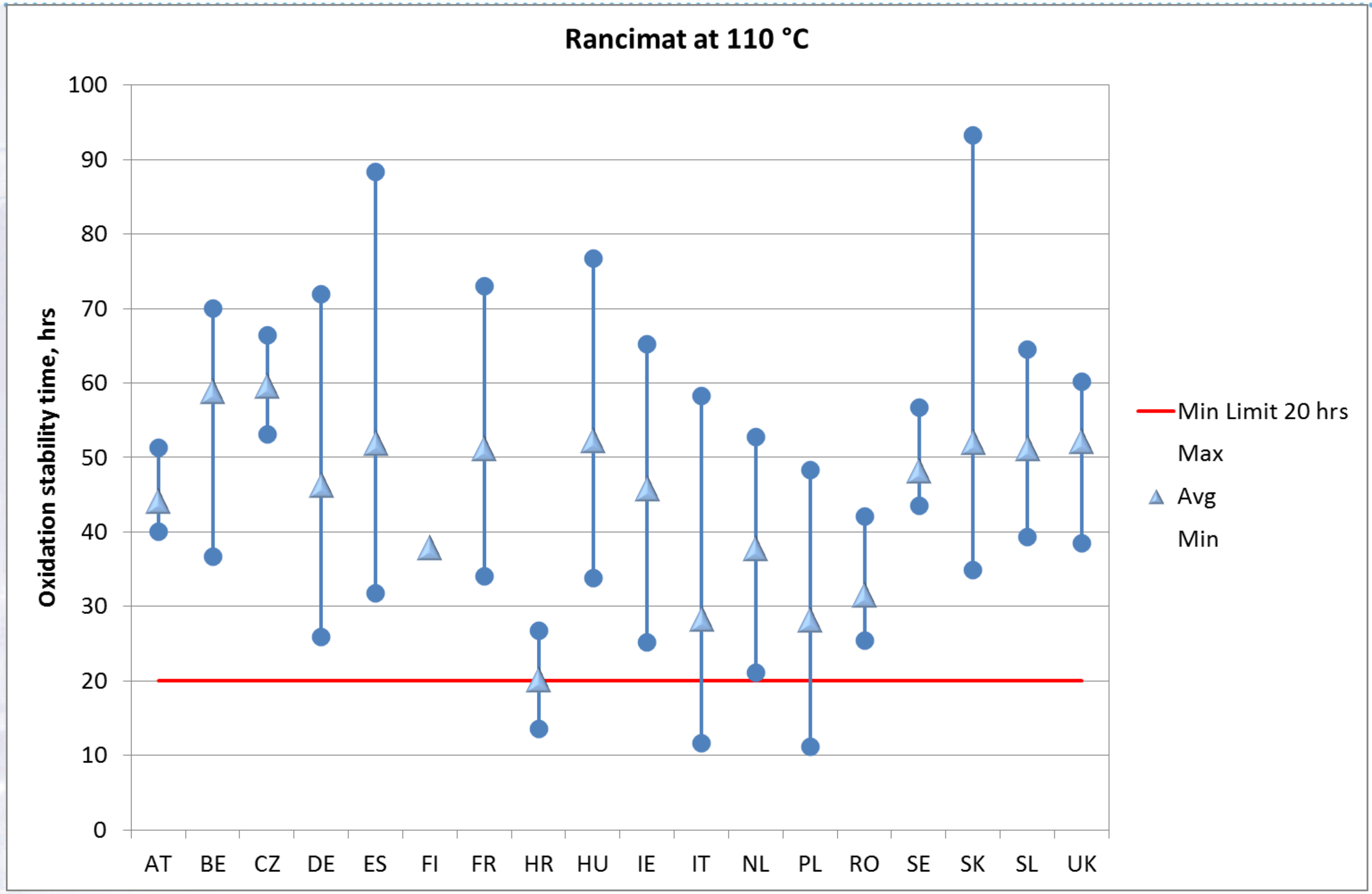
# EHN Cetane Improver in Diesel Fuels




- Majority of countries are using ethyl-hexyl nitrate (EHN) cetane improver

# Rancimat Oxidation Stability at 110° C




- Majority of diesel fuels complied with EN 590 specification, only a few diesel fuels from Croatia, Italy and Poland below 20-hr limit

Note: samples containing <2.0 % vol. FAME not included in Rancimat evaluation

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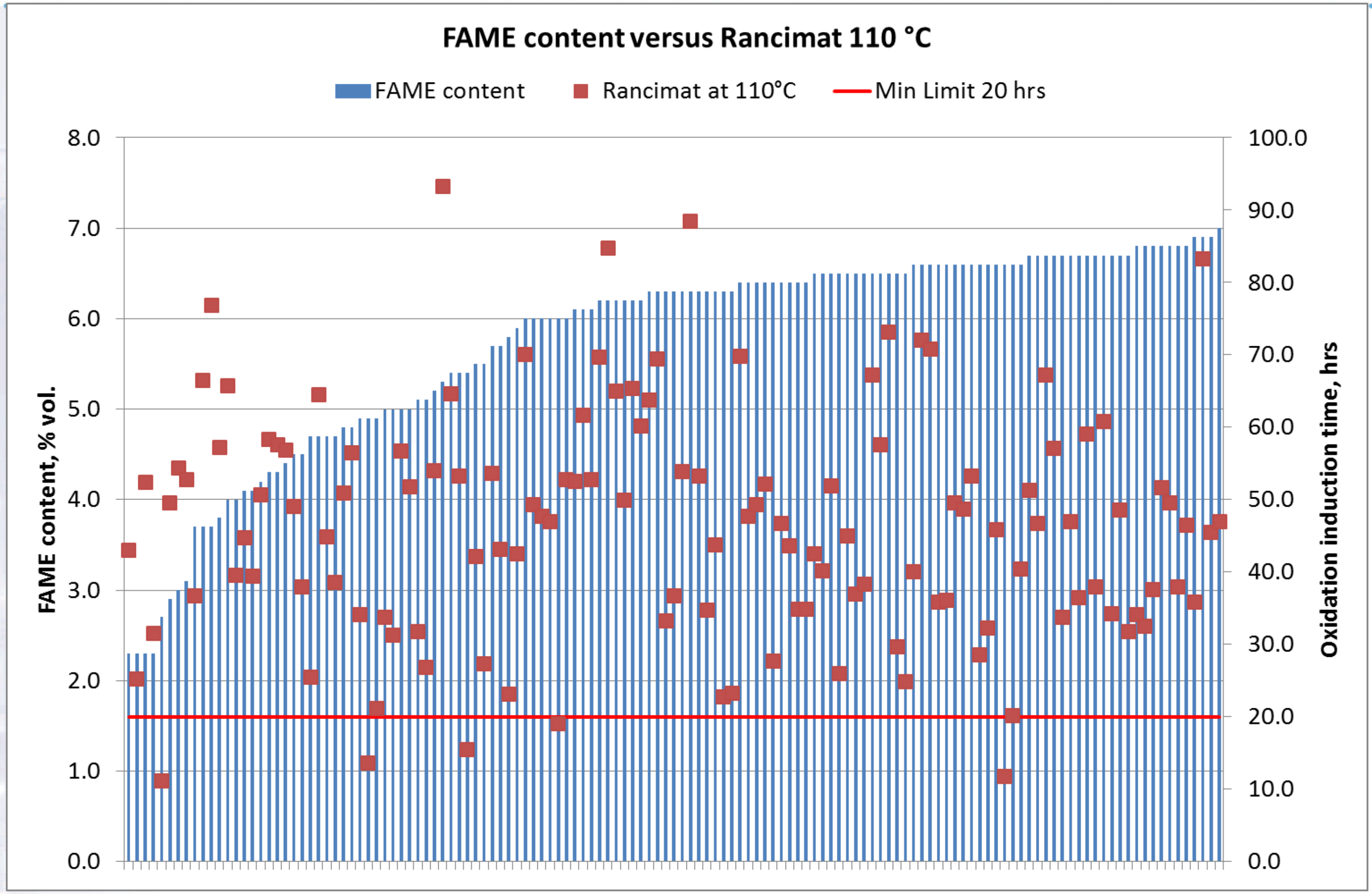
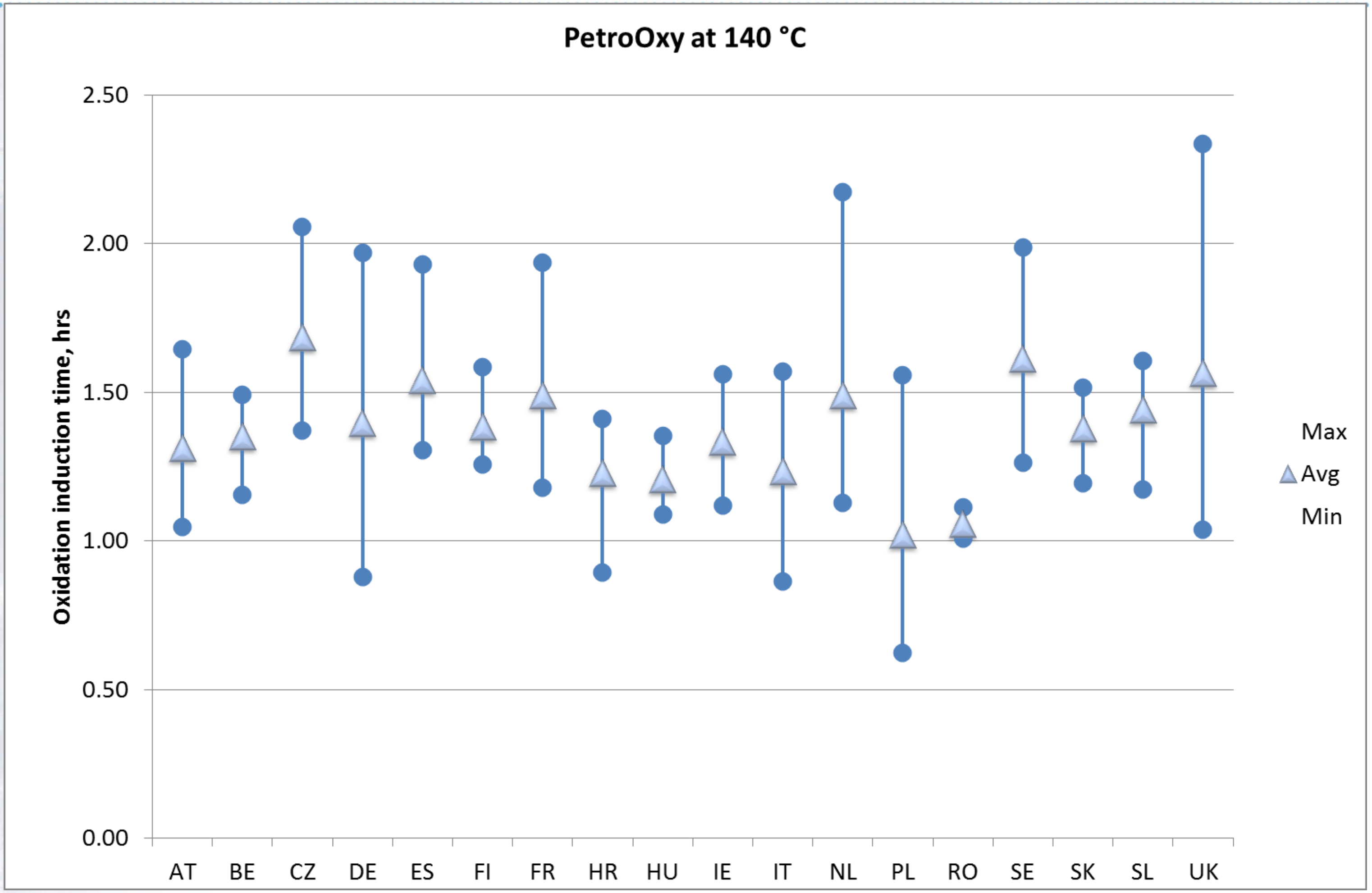
# FAME Content vs. Rancimat Oxidation Stability




- The FAME content cannot be used to predict the Rancimat oxidation stability at 110° C

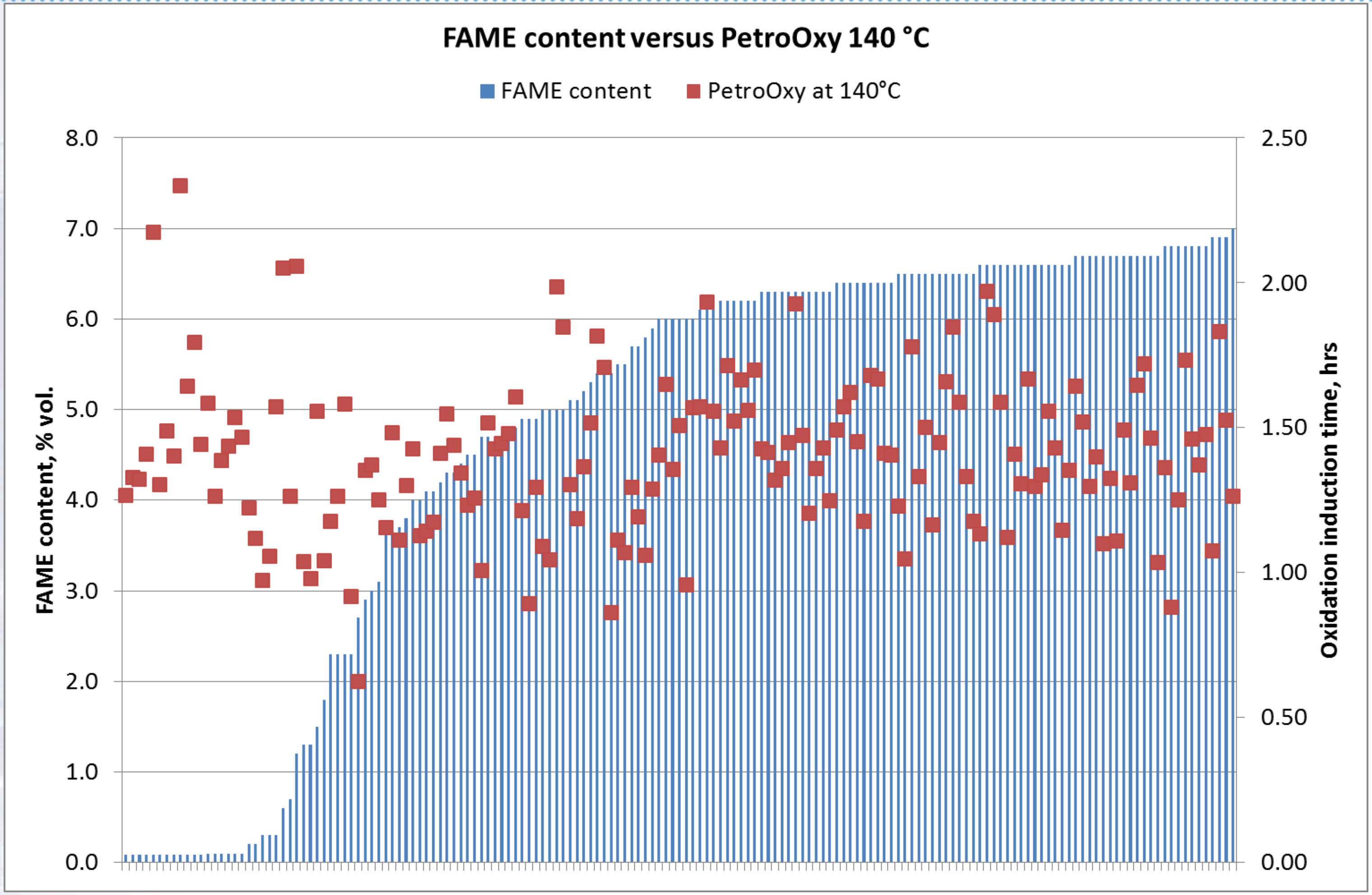
Note: samples containing <2.0 % vol. FAME not included in Rancimat evaluation

# PetroOxy Oxidation Stability at 140ºC



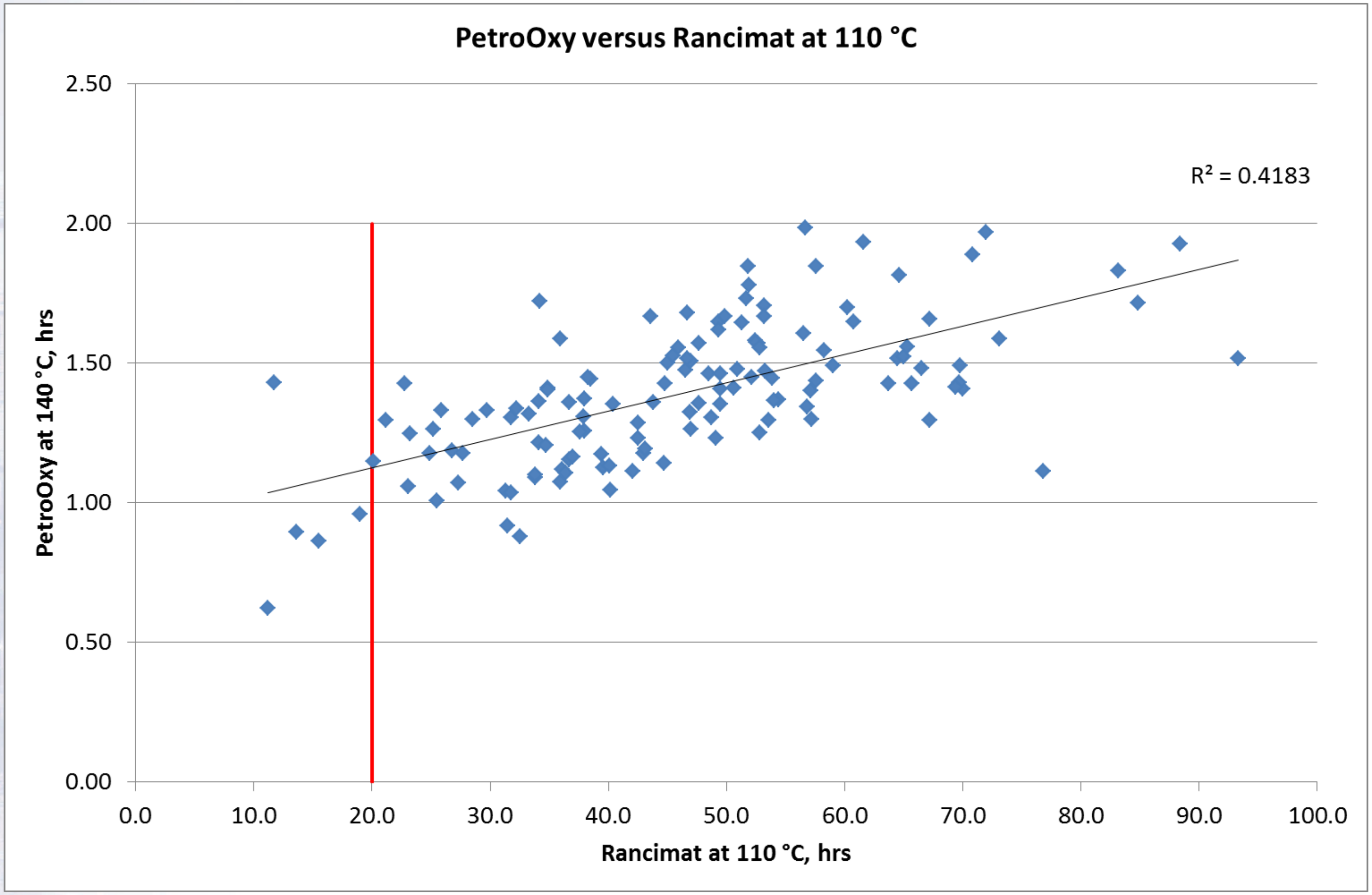

- Oxidation induction times starting from 0.62 hrs (37 minutes) observed with PetroOxy at 140° C

# FAME Content vs. PetroOxy Oxidation Stability




- The FAME content cannot be used to predict the PetroOxy oxidation stability

# PetroOxy vs. Rancimat at 110° C




- Correlation between Rancimat at 110° C and PetroOxy at 140° C

Note: samples containing <2.0 % vol. FAME not included in Rancimat evaluation

# Conclusions on Specifications

- 163 diesel fuel samples analyzed from 18 countries
- FAME content of all diesel fuel samples according to EN 590 specification requirements. In some cases diesel fuel samples without FAME (B0) observed.
- Majority of countries using EHN cetane improver
- Majority of diesel fuel samples according to EN590 specification requirement for Rancimat oxidation stability at 110° C, only a few diesel fuels from Croatia, Italy and Poland were off spec on oxidation stability
- Oxidation stability measured by Rancimat at 110° C and 120° C are strongly correlated (as expected)
- FAME content in diesel fuels cannot be used to predict the oxidation stability measured by Rancimat or PetroOxy

# Proposed RED Amendment (October, 2012)

## Key aspects - both RED and FQD

- To qualify for sustainability[1], the direct (i.e. not including ILUC) biofuel GHG savings must:
  - for old plants (pre-1.7.2014): exceed 35% savings now, 50% from 2018
  - for new plants (post 1.7.2014): exceed 60%
- COM view: subsidies for all biofuels produced from food crops to disappear as of 1.1.2021 (but MS will have to decide)
- 2014 review on achievability of targets (both FQD and RED)
- Estimated indirect land-use change emissions to be included in the reporting for both RED and FQD:
  - 12 $gCO_2$/MJ if from cereals
  - 13 $gCO_2$/MJ if from sugars
  - 55 $gCO_2$/MJ if from oil crops

➢NO ILUC impact included in the calculation of the FQD target (-6% GHG fuel intensity)

(1) And therefore to qualify for subsidies and for counting toward RED and FQD targets

# Proposed RED Amendment: New Counting Rules

- EC's Amendment Proposal:
  - **5% accounting cap** on "conventional" biofuels (those competing with food and feed). But no prohibition to use them more than 5%
  - **Quadruple counting** (quantity x 4) for municipal solid waste, aquatic material, agricultural, aquaculture, fisheries and forestry residues and renewable liquid and gaseous fuels of non-biological origin
  - **Double counting** (quantity x 2) for other waste and non-food ligno-cellulosic and ligno-cellulosic materials from non-residues
  - Substances **intentionally modified** do not qualify as wastes

- Used cooking oils and animal fats are the main resources for multiple counting
  - Potentially available quantities estimated to be 0.95 and 2.25 Mtoe, respectively
  - Total volume not expected to grow dramatically in the coming decade
  - Assumed that about 1/3 of the available resource (1 Mtoe) to be used in transport in 2020
  - Biofuels from this resource count double (2 Mtoe) toward the 10% RED target
  - Source: information received from European Commission's DG ENER

# Overall Conclusions on RED Proposal

- **Biethanol (produced from food crops):**
  - Without ILUC accounting, bioethanol does not have an advantage compared to biodiesel and also must compete within the 5% blending cap for RED
  - Bioethanol can increase only if it is cost competitive with fossil fuel
  - If MS subsidies end in 2021 (or earlier), EU ethanol will be less competitive compared to imported ethanol
- **Biodiesel (produced from food crops):**
  - Generally categorised as sustainable ONLY if from an existing plant.
  - Little possibility to increase unless it becomes cost competitive with fossil fuel
  - Biodiesel from food crops most likely to become unsustainable in the post-2020 time period
- **Strong incentive (at least in the COM intention) for "unconventional" biofuels that do not compete with food** but multiple counting raises concerns (1) and may be ineffective in stimulating unconventional biofuel industry
- **Achieving 10 % RED: increasingly unlikely given biofuel cap and blending**
- **Achieving 6 % GHG reduction: very unlikely with biofuel blending**
- **With ILUC reporting, almost no GHG reduction likely from biofuel blending**

(1) e.g. abuse of rules as in Used Cooking Oil, future arbitrary changes in counting rules