The Contribution of Advanced Renewable Transport Fuels to Transport Decarbonisation in 2030 and beyond
Biofuels and vehicle compatibility

Transport decarbonisation workshop

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Outline

• Definitions and terminology
• Alternative ways to introduce biofuels
• Legislation and standardization
  - Why are there limits for certain biocomponents?
• Fuel markings and biofuels on the market
• Activities aimed at updating European fuel standards
• Summary
Definitions and terminology

- **Material compatibility**: the fact that the material withstands exposure to the fuel (type) without negative effects concerning the durability and performance of the exposed material if the fuel (type) would be used.
  
  **COMMENTS**: 'functioning' needs to be prescribed as being, at least, durability & performance of the material(s) as exposed to any amount of continuous or intermittent use of the fuel (type).

- **Tolerance**: compatibility based on lifetime running on the fuel (type) without compromising vehicle safety or performance issues when using the fuel (type).

- **Vehicle compatibility**: guarantee that the vehicle is declared to be tolerant for the use of the fuel (type) and fulfils vehicle manufacturer defined conditions in respect of customer expectations for day-to-day vehicle operation.

- **Compliance of a vehicle**: when using the fuel (type) the vehicle fulfils all EU regulatory requirements concerning pollutant emissions and safe vehicle use assessed on the basis of tests using regulated reference fuels for the fuel (type).

Source: Andreas Kolbeck/Shell Global Solutions, ACEA
Definitions and terminology

• ”Blending wall”
  - technical limitations for component concentrations to secure e.g., vehicle and infrastructure durability, vehicle emission performance and vehicle operability
  - In Europe, currently max 10 % ethanol in petrol (E10) and max 7 % in diesel (B7)

• ”Drop-in” fuel
  - A fuel that is compatible with the existing refuelling structure and existing vehicles even at high concentrations without any need for modifications (e.g. paraffinic fuels like BTL and HVO)

• ”Adapted or dedicated vehicle”
  - A vehicle that has been adapted to high concentration alternative fuels
  - Monofuel, bi-fuel, dual-fuel or flex-fuel
  - New vehicles and new refuelling infrastructure needed
How to introduce biofuels for the vehicle fleet?

Three major options:

1. Low level blending of traditional biocomponents (e.g., EtOH, FAME within existing fuel standards)
   - Simple solution, but limited impact, typically only 10 – 15 % energy replacement

2. Drop-in type components for high level blending
   - Simple solution, impact can be high, up to 100 % replacement
   - Paraffinic diesel (HVO, BTL) is a kind of silver bullet for diesel
   - No really good options available for petrol, bio-petrol HC compounds tend to have low octane

3. Dedicated fuels for dedicated vehicles
   - Gaseous fuels, high concentration alcohol fuels
   - “Chicken and egg” dilemma, what comes first, infrastructure or vehicles?
Prerequisite for the success of alternative fuels:
Everything has to work together!
Legislation and standardisation

• First level: Laws, Directives (EU) and regulations, legally binding, e.g.,
  - US Code of Federal Regulations
  - For EU, the Fuels Quality Directive 2009/30/EC and regulation concerning vehicle emissions

• Second level: Standards
  - Industry practice
  - Representing a consensus among all interested parties
  - E.g., ISO, ASTM and EN fuel standards
  - Add parameters related to functionality, e.g., vehicle durability (lubricity, corrosion, ash, sediments, oxidation stability...) and cold operability
  - Not legally binding (although national legislation can refer to fuel standards)

• Third level: “Code of practice” documents and recommendations, e.g.:
  - CEN and Concawe guidelines
  - Worldwide Fuel Charter, the “wish list” of the auto manufacturers
  - Fuel quality recommendations by region
Reference fuels for emission certification

- Can be special certification fuels (reflecting market quality) or fuels fulfilling a certain standard

- International level, UNECE WP.29, Regulation 83
  - Special certification fuels
  - E5, E10, E85, E75 (“winter quality E85”), B5, B7, gaseous fuels

- US EPA emission certification fuels

- EU basically falls back on UNECE, specs for certification fuels included in the regulations, in some cases a reference is made to EN fuel standards
  - Euro VI requires HD engines to be certified on the fuel they will be running on
  - Possible alternatives e.g., B20/B30, B100, 100 % paraffinic diesel and also ED95
Fuel Quality Directive 2009/30/EC - Petrol

Parameters directly related to oxygenated biocomponents:

- Oxygen content (3.7 % m/m)
  - Air-fuel ratio control

- Ethanol (10 % v/v)
  - Oxygen content (10 % v/v ethanol equals 3.7 % m/m oxygen)
  - Material compatibility
    - Ethanol is corrosive and polar, can attack metals and elastomers

- Methanol (3 % v/v)
  - Material compatibility (methanol worse than ethanol)

- Higher alcohols and ethers (12...22 % v/v)
  - Oxygen content, less material issues than with ethanol
Fuel Quality Directive 2009/30/EC - Diesel

Parameters directly related to biocomponents:

• FAME content (7 % v/v)
  - Some material issues
  - High end of distillation temperature
    - Possible issues with engine oil dilution

A limit for the fatty acid methyl ester (FAME) content of diesel is required for technical reasons. However, such a limit is not required for other biofuel components, such as pure diesel-like hydrocarbons made from biomass using the Fischer-Tropsch process or hydro-treated vegetable oil.

Notwithstanding the requirements of Annex II, Member States may permit the placing on the market of diesel with a fatty acid methyl ester (FAME) content greater than 7 %.
Current European fuel standards
Much more detail than in the FQD

Actual fuel specification standards

- **Captive fleets only**
- **Use as a blending component**

1) Not covered by CEN/TC 19

C. Vigneron/O. Costenoble 6/2019
New fuel marking

- Aimed at avoiding confusion for consumers and businesses
- Markings on fuel pumps as well as on vehicles
- Stems from Directive 2014/94/EU on deployment of alternative fuel infrastructure
- Guarantees compatibility, not necessarily bio content

**Gasoline-type fuels**: circle. E5, E10, etc. ("E" stands for specific bio-components present in petrol);

- E5
- E10
- E85

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**Diesel-type fuels**: square. B7, B10, XTL, etc. ("B" stands for specific biodiesel components present in diesel, the XTL stands for synthetic diesel and indicates that it is not derived from crude oil);

- B7
- B10
- B20
- B30
- B100
- XTL

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**Gaseous-type fuels** (e.g. CNG, LNG, LPG and hydrogen): diamond.

- CNG
- H2
- LNG
- LPG

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Examples of fuels with biocomponents on the market

Bioenergy content in brackets

• Brazil
  - E27 (19 %), E100
  - B15 (14 %)

• Europe
  - E5 (3.5 %), E10 (7 %), E85 (78 %)
  - B7 (6.5 %), B10 (9 %), B20/B30 for captive fleets (18/28 %), B100, XTL100 (HVO)
  - Biogas

• US
  - E15 (11 %), E85 (78 %)
  - B20 (18 %)
European activities to facilitate uptake of biofuels

Work executed by NEN on behalf of CEN, the European Standardization Committee, under a specific EC Horizon 2020 call under the Secure, clean and efficient energy programme: B.2.5. "Engine tests with new types of biofuels and development of biofuel standards under Framework Partnership Agreement with CEN-CENELEC".

Overall objectives

1) E20/25 gasoline fuel (1,77 M€)
   Study the sensitivity of the RON and MON relationship, to changing octane level and volatility sensitivity for a possible mid-blend oxygenate gasoline. Develop an emission testing plan for future acceptance

2) CI concepts using gasoline/oxygenate blends (1,05 M€)
   Demonstrate feasibility of a CI engine using ignition assist (spark plugs or glow plugs) to make high octane fuels ignitable and the combustion controllable over a wide operational window

3) Stability and robustness of actual FAME (245 k€)
   Make FAME standard EN 14214 more robust to ensure B7 is fit for purpose and in case of higher blends B10 - B30

4) BTL and HVO drop-in high blends' effects (172 k€)
   Check whether a latest engine concept might present issues regarding quality requirement (durability, driveability) for paraffinic diesel (blends) to present data on density lowering possibilities for EN 590

CEN/NEN conclusions

E20/25:

• According to a literature review, manufacturers suggest that the majority of cars produced from 2011 onwards are E20 tolerant

• The key OEMs consider the introduction of E20 more suitable than the introduction of E25

• Investigations do not identify any bottlenecks preventing steps towards a mid-blend oxygenate specification development (E20)

• The first step would be to increase the oxygen/oxygenates concentration limits in the FQD, enabling CEN to initiate a fuel specification process
CEN/NEN conclusions

FAME:

• Diesel fuels containing FAME have caused problems in the field, e.g., filter blocking
• However, some B30 fuels have shown good cold driveability and behavior
• Undistilled biodiesels tend to cause filter plugging
• A new filter rig test predicts cold condition behavior of biodiesel fuels
• Proposals for modifications to the testing of biodiesel fuels
CEN/NEN conclusions

BTL & HVO:

• Density of diesel fuel can be lowered without compromising emissions or vehicle behavior
• The recommendation is to lower EN590 minimum summer grade diesel density from 820 to 800 kg/m3
• No modifications would be needed to vehicles or fuel supply system
• Despite of lowering density down to 800 kg/m3, all other EN590 specifications will still be met

Comment: Minimum density 800 kg/m3 would allow blending up to 50 % paraffinic components to EN590 diesel
Summary

- Compatibility of biofuels means that the fuels do not in any way compromise the emission performance, operability, safety and durability
- You cannot choose freely what fuel you operate a vehicle on
- For a road vehicle to be operated on roads, the vehicle needs to be certified for emissions and safety for a certain type of fuel
- Prerequisite for certification is that a defined reference fuel or a fuel standard exists
- In the case of Europe, the Fuel Quality Directive, legally binding, sets the minimum quality requirements for petrol and diesel
- The FQD is complemented by a number of standards, defining additional fuel parameters and also additional fuel options
- A new labelling system for fuel pumps as well as for vehicles is aimed at reducing confusion
- When aiming at increased uptake of biofuels, legislation and standards have to be in congruence with the objectives
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More information: https://iea-amf.org/content/news/TD-WS
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