COBLENDING ETBE AND ETHANOL
THE MOST FAVOURED MIX

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Chairman Biofuels of European Fuel Oxygenates Association

The European Fuel Conference
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Addressing RED & FQD EU Directives

- Ambitious Targets
- Multiple Challenges
- Limited Possibilities
- Existing Solution
Challenges (examples)

- FQD: Refiners Obligations vs. Actual “Control”
- RED: Petrol/Gasoil Supply/Demand Unbalance
- Balkanization of EU MS’s Implementation Rules
- Consumers Resistance to “High-Bio” Grades
- Fuel Specifications Limits
FQD & Refiners big Challenge: Full Obligation vs. Partial "Control"

- 4% of total
- 15% of total
- 100%
- 85%
- 1%
- 10%
- 4%

- Crude Production
- Fuel Refining
- Distribution Retail
- Engine Combustion
- Oil Ind.
- Automotive Ind.

- 6% of total, - 40% of O.I. bit, - 60% of Refining one!
Petrol/Gasoil - Supply/Demand Unbalance: EU Gasoil/Petrol Ratio Growing

- Refineries not designed/structured for current fuels demand ratio
- Petrol export & gasoil import impacting economics & CO₂ emissions (transport)
- Diesel production maximisation disoptimising refinery operations & increasing CO₂ emissions
- FAME content specification (7%v/v) limiting actual bio-blending in diesel

Balkanization of National Bio-Blending Obligations

IRELAND
5.75% (v/v)
Cumulative Target
Petrol + Gasoil

NETHERLANDS
5.25% (e/e)
Gasoil 3.5% (e/e)
Petrol 3.5% (e/e)

NORWAY
5.0% (v/v)
Parallel Targets
Petrol & Gasoil

FINLAND
6.0% (e/e)
Cumulative Target
Petrol + Gasoil

UNITED KINGDOM
4.5% (v/v)
Cumulative Target
Petrol + Gasoil

FRANCE
7.0% (e/e)
Parallel Targets
Petrol & Gasoil

BELGIUM
6.25% (e/e)
Gasoil 4.4% (e/e)
Petrol 2.8% (e/e)

GERMANY
Gasoil 6.0% (v/v)
Petrol 4.10% (v/v)

AUSTRIA
Gasoil 6.3% (e/e)
Petrol 3.4% (e/e)

BELGIUM
4.0% (e/e)
Parallel Targets
Petrol & Gasoil

ITALY
4.5% (e/e)
Cumulative Target
Petrol + Gasoil

BULGARIA
Gasoil 4.0% (v/v)
Petrol 2.0% (v/v)

CZECH REPUBLIC
Gasoil 6.0% (v/v)
Petrol 4.1% (v/v)

SLOVAKIA
5.75% (v/v)
Gasoil 5.2% (v/v)
Petrol 3.1% (v/v)

SLOVAKIA
Gasoil 5.2% (v/v)
Petrol 3.1% (v/v)

POLAND
6.2% (e/e)
Cumulative Target
Petrol + Gasoil

SLOVAKIA
Gasoil 5.75% (v/v)
Petrol 3.1% (v/v)

HUNGARY
4.0% (v/v)
Parallel Targets
Petrol & Gasoil

ROMANIA
Gasoil 5.0% (v/v)
Petrol 4.0% (v/v)
Consumers Psychological Resistance to E10

“*My car is on the E10 not-suitable list by OEM*”

“It might damage my car”

“It will compromise my vehicle warranty”

“It will worsen car performances”

“It would provoke engine efficiency loss”

“I buy litres, but I need energy (oxygen doesn’t burn)”

“If «they» discount it, there must be something dirty”

“High bio compete with food and feed”

“This thing is too new: let others be the guinea pigs”
Vehicle/Engines Compatibility/Operability

- Fuel filter blockage
- Galvanic corrosion
- Enleanment
- Drivability
- Deposit formation
- Material compatibility
Only Few Possibilities

- CO₂ Reduction Effectiveness of Bio-components
- High Bio-components Blending Percentage
- Exploitation of «best seller» Petrol Grade (E5)
Existing Solution

- Adopting Immediately Available Consolidated Options
- Maximizing Actual Bio-energy Blending within E5
- Optimizing Logistics & Operations
- Capturing Bio-components WTW CO₂ Saving Potential
- Harvesting Synergetic «Non-linear» Effects
COBLENDING ETBE AND ETHANOL
## European Fuel-Ethers Production Capacities 2011 (KT/Y)

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<tr>
<th>City</th>
<th>Production Capacity</th>
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<tr>
<td>Algeciras</td>
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### Planners

- MTBE
- ETBE
- TAME
- TAE
- Planned
ETBE: A Multifaceted Benefits Carrier
..and “Co-blending” further offers Additional Specific Benefits!

- Blending more Bio-energy within Petrol Specs Limits
- Capturing Bio-components' Well-to-Wheels CO₂ Saving Potential
- Minimizing Quality “Give-away” and fossil base-stock cost, via ETBE-containing “DBEB”[*] for E5/E10
- Harvesting Synergetic "Non-linear" Effects of Bio-components

[*] Dual Blend-stock for Ethanol Blending
53% more bio-energy into E5 via “Co-blending”

Limiting Petrol Spec. → 5%v/v ETOH
Bio-energy Content → 3.3%
ETBE Content → 0%
Oxygen Content → 1.8%
O₂ Limit Exploitation → 68.2%

“Alcohol-only”
Ethanol

“co-blending”
ETBE+EETH
E5: “Co-blending” Enables Significant Non-compliance Penalty Saving
(German Example)

“Alcohol-only” Ethanol

“co-blending” ETBE+ETOH

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<td>E5: E5</td>
<td>0</td>
<td>0</td>
<td>3.3</td>
<td>0</td>
<td>0</td>
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<tr>
<td>+54 E5: ETBE+ETOH</td>
<td>+54</td>
<td>+1.8</td>
<td>1.8</td>
<td>+54</td>
<td>+1.8</td>
<td>+14.0</td>
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[1] On top of what achievable with 5%v/v ETOH directly blended into E5 “Protection Grade”
[2] Example based on an average refinery petrol production of 1.5 million tons per year
Co-blending vs. Ethanol only: 1) The Flow

**Co-Blending**

- HCBS$_1$: 94.15%v/v ETBE: 5.85%v/v
- DBEB

**Ethanol-Only**

- ETOH: 95%v/v 5%v/v 95%v/v
- E5: 92.21%v/v 7.79%v/v
- E10: 10%v/v
- HCBS$_2$: 90%v/v

HCBS = HydroCarbon Blend-Stock
DBEB = Dual Blendstock for Ethanol Blending
Co-blending vs. Ethanol only: 2) E5 Bio-energy

Co-Blending

HCBS\textsubscript{1} (94.15\% v/v) ETBE (5.85\% v/v) → DBEB

Ethanol-Only

ETOH (95\% v/v) E5 (5\% v/v)  ETBE (5\% v/v) → HCBS\textsubscript{2} (95\% v/v)

Bio-energy Content

5.1 \% e/e  3.3 \% e/e

HCBS = HydroCarbon Blend-Stock
DBEB = Dual Blendstock for Ethanol Blending
Co-blending vs. Ethanol only: 3) Dual-BOB quality

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<th>Ethanol-Only</th>
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<tr>
<td>HCBS₁</td>
<td>HCBS₂</td>
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Motor Octane Contribution Saving \((a, b)\)  

- **Co-Blending:** 1.8 MON  
- **Ethanol-Only:** 0.6

Vapour Pressure Compensation Need \((a, c)\)  

- **Co-Blending:** 6.3 kPa  
- **Ethanol-Only:** 7.8

E5 RVP «Give-Away» \((a, c)\)  

- **Co-Blending:** 0 kPa  
- **Ethanol-Only:** 1.84

- **Co-Blending:** 0 %  
- **Ethanol-Only:** 3.06

(a) vs. Finished Petrol Specs  
(b) The Higher the Better  
(c) The Lower the Better

HCBS = HydroCarbon Blend-Stock
ETBE Further Reduces CO₂ Emissions

HART July 2007

“The use of bio-ETBE reduces refining crude-oil need and processing intensity, requires less fuel and, implying relevant petrol composition changes, allows the reduction of carbon factor and lesser CO₂ emissions”

CE-Delft October 2007

“This study indicated that, when bio-ETBE is used, the resulting modification of refinery operations determine a significant reduction of greenhouse gases emissions”

IFEU August 2008

“Best results by far are obtained when ethanol is converted to bio-ETBE. The use of ETBE can allow the saving of 4 times the primary energy required to produce its fossil alternative. IFEU recommends to exploit the whole potential of bio-ETBE”
ETBE: Two Relevant CO₂ Saving Contributions

65% UPSTREAM  +54% DOWNSTREAM  35%[1] 100% FIELD-TO-TANK

0.618  0.335  = 0.953

Key ETBE blending properties, like vapour pressure, distillation characteristics and octane contribution, affecting fuel formulation, reduce refinery operations’ CO₂ emissions, by reducing carbon and aromatics content as well as the use of refinery fuel.

[1]
The whole is more than the sum of its parts.

Aristotle, *Metaphysica*
Harvesting Synergetic "Non-linear" Effects of Bio-components

- Increasingly stringent technical and environmental petrol specifications, makes it relevant and urgent to try and fully exploit all the positive characteristics of various blend-stocks used by refiners for formulating finished fuels;

- Several studies have already demonstrated that co-mixing different blend-stocks can yield a better-than-linear blending performance;

- A specially interesting and relevant case is the co-blending of ethanol and ethers (ETBE), considering the key role that these two bio-components play in recent bio-fuels policies;

- Some of the chemical-physical reasons for the distinct synergetic blending effect of those oxygenated molecules comes from their polar nature, as well as from the hydrogen-bonding effects;

- New ad hoc studies are currently under going to better quantify and qualify those effects;

- Petrol specifications that benefit from the «co-blending effect» include volatility (BRVP), distillation curve (E70), octane performance (MON & RON) and water tolerance.
Several studies confirmed synergy

- “Synergies Between Ethanol and TAME as Gasoline Oxygenates”. Sasol. 2002
- “Addition of an azeotropic ETBE/ethanol mixture in eurosuper-type gasolines”. Federal University of Rio Grande do Sul. 2006
- “Volatility and phase stability of petrol blends with ethanol”. Institute of Chemical Technology of Czech Republic. 2009
Conclusion

Harvesting the synergy of co-blending bio-ETBE and bio-Ethanol, represents an effective, immediate and practical avenue to address both EU and MSs ambitious bio-fuel targets. It actually enables significantly higher bio-energy content, while both enhancing environmental benefits and improving operators flexibility.