

BIO ETHERS

THE ADVENT OF COBLENDING
HARVESTING THE ETBE ETOH SYNERGY

Dr. Walter R. Mirabella

*President of Renewable Sources Group - Federchimica
Board Member of Italian Biofuels Technology Platform
Chairman Biofuels of European Fuel Oxygenates Association*

2nd Green Refining & Petrochemicals Forum
Dubrovnik - Croatia – 17 June 2011



FEDERCHIMICA

AISPEC

GRUPPO FONTI RINNOVABILI



BioFuels: 3 Key Entities



**Italian
Biofuels
Technology
Platform**

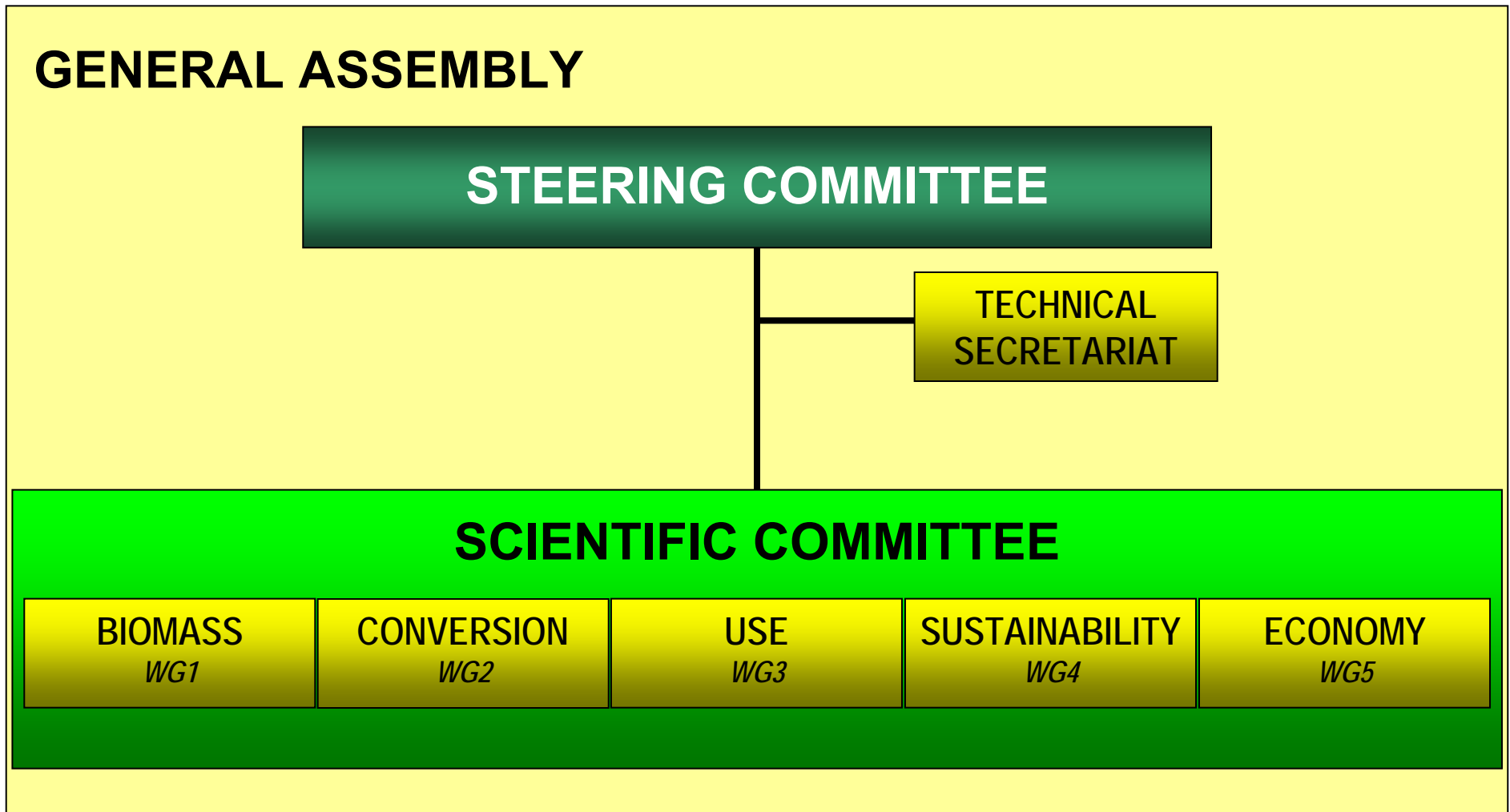
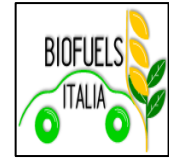


**Italian
Chemical
Industry
Federation**



**European
Fuel
Oxygenates
Association**

Italian Bio-fuels Platform: Organizational Structure



Federchimica and Italian Chemical Industry



Federchimica is the **National Federation of Chemical Industry.**

Chemical Industry Italy:

- Enterprises **2900**
- Production Units **3500**
- Turn-over (2009) (G€) **46**
- Employees **119.000**

Federchimica:

- Member Companies **1.300**
- Employees **90.000**
- Sector Groups **41**
- Associations **16**
- Enterprises w/i GFR **18**

Federchimica is member of **Confindustria** and **CEFIC**

www.federchimica.it

Renewable Sources Group^[*] of Federchimica: Represented Activities

| Renewable Sources ^[*] 18 Enterprises as per March 2011 | | |
|---|---|---|
| Energy Uses | Non-Energy Uses | |
| Bio-Fuels, and Bio-Components for Fuels, Production | Transformation of Renewable Raw Materials | Chemicals for Renewable Energy Industry |
| - [bio-alcohols (ethanol, buthanol)] | - Additives, Chemical Intermediates | - Biomass |
| - [bio-ethers (ETBE, TAEE)] | - Starch and Derivatives | - Wind power |
| - [bio-esters (FAME, FAEE)] | - Biorefineries | - Geothermal |
| - [BTL (Biomass To Liquid)] | - Oleochemicals | - Hydroelectric |
| | - Polimers | - Sea energy |
| | - Bio-cosmetics | - Solar |
| (complementary) Production of Energy from Renewable Sources | | |
| - Vegetable Oils | | |
| - Bio-gas | | |

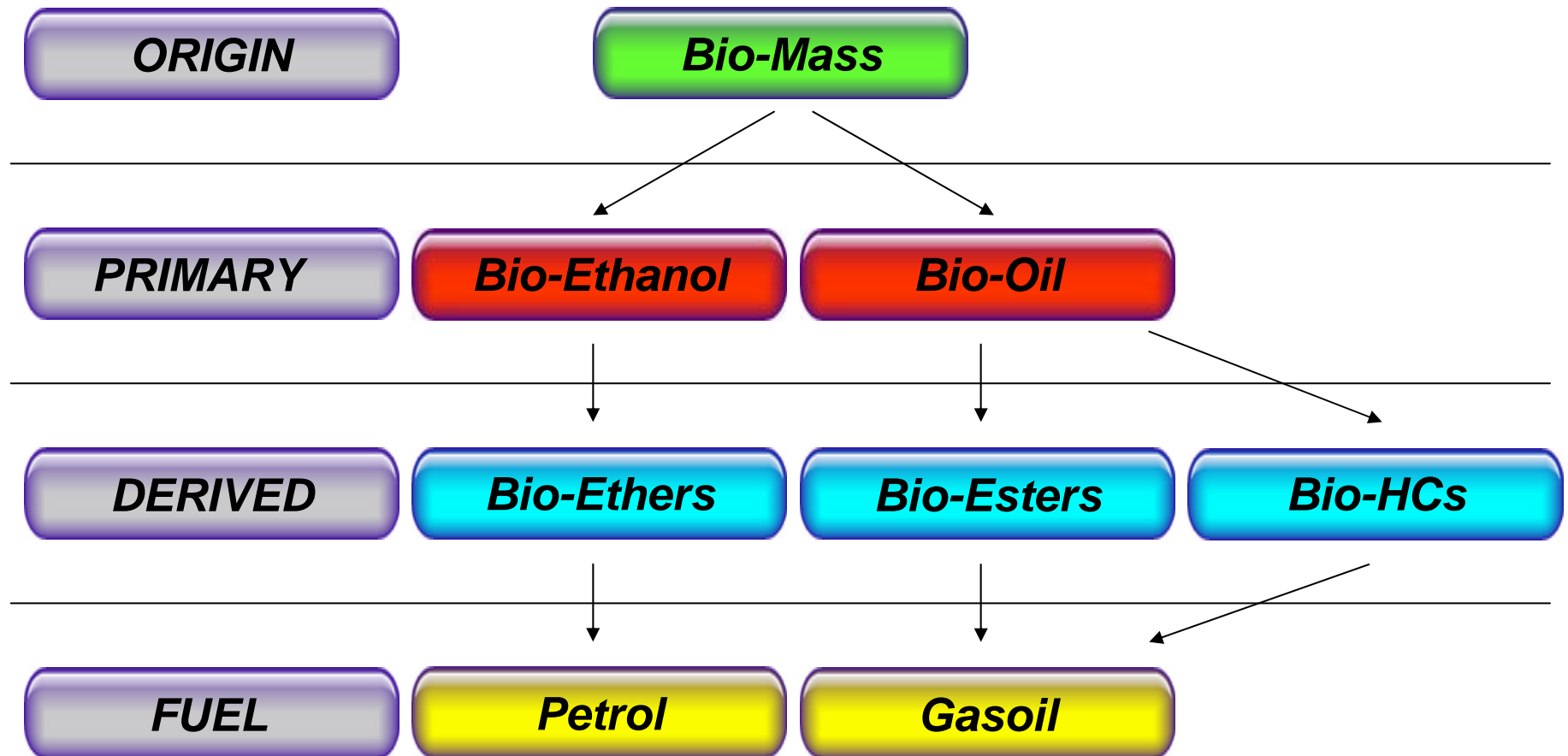
European Fuel Oxygenates Association



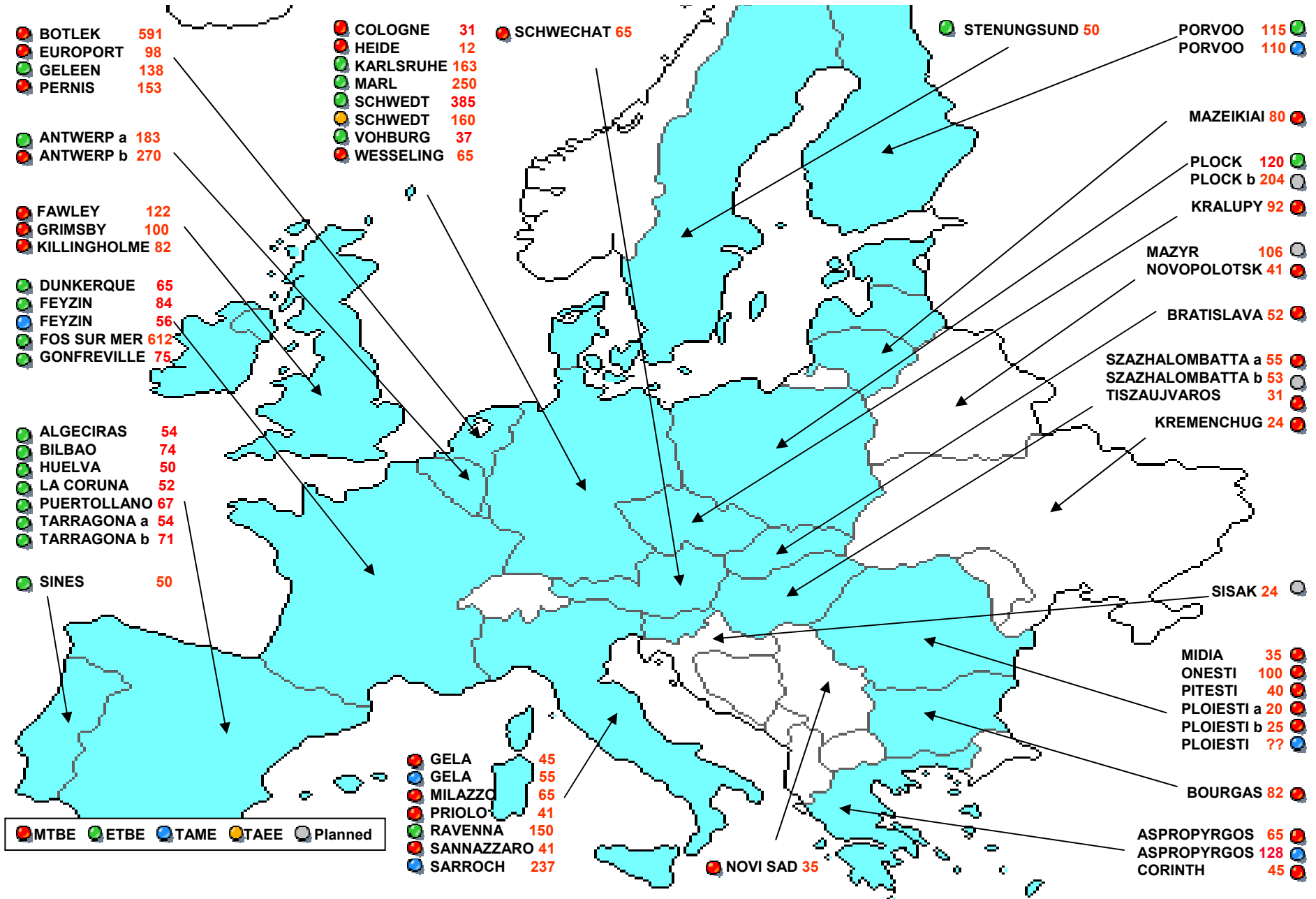
- Non-profit Technical Organisation
- Founded in 1985
- ~ 2/3rd of Total EU Etherification Capacity

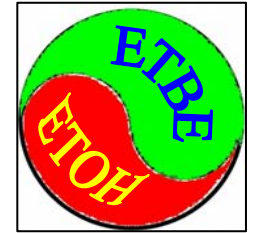
<http://www.efoa.eu>

Bio-Ether (ETBE) is for Petrol what Bio-Ester (FAME) is for Gasoil



European Fuel-Ethers Production Capacities 2011 (KT/Y)





**Co-blending ETBE & ETOH
Key Tool for EU Member States
to Address
Bio-energy Challenge:
The Example of Germany**



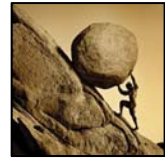
Legal “Bio-Drivers”



- EU Renewable Energy Directive (2020)
 - $\geq 10\%$ bio-energy in fuels
- EU Fuel Quality Directive (2020)
 - $\geq 6\%$ CO₂ emissions reduction in fuels WTW
- DE National Bio-energy Obligation
 - $\geq 2.80\%$ in Petrol (2009 – 2014)
 - $\geq 4.40\%$ in Gasoil (2007 – 2014)
 - $\geq 6.25\%$ in Petrol + Gasoil (2010 – 2014)
- DE Non-compliance Penalty (2011)
 - 43 €/GJ^[*] for Petrol
 - 19 €/GJ^[*] for both Gasoil and cumulative (P+G)

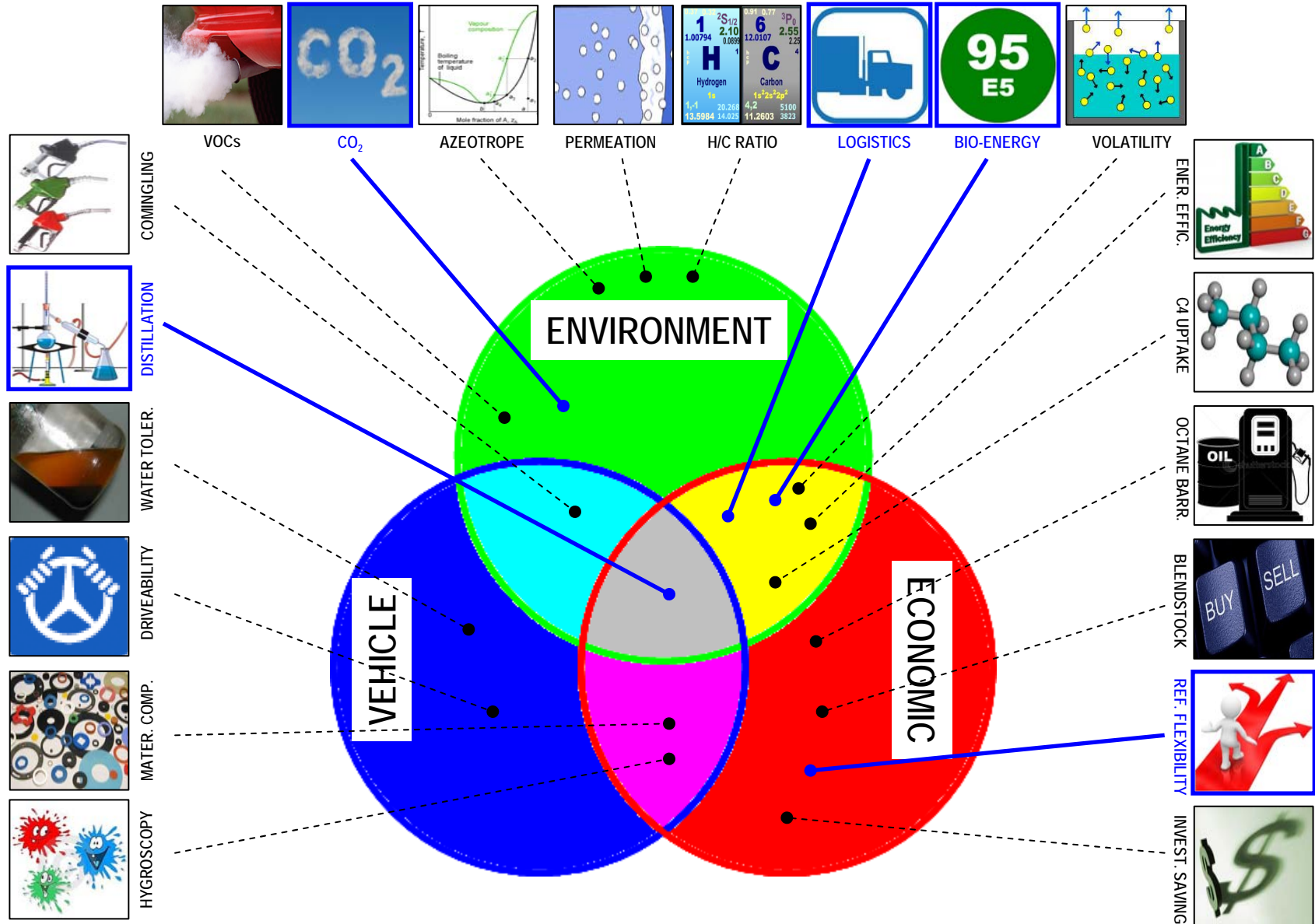
[*] bio-energy blending shortfall

Addressing RED & FQD EU Directives Challenge



| | |
|-----------|---|
| What | 10% Bio-energy in Fuels (RED) |
| | 6% CO ₂ Saving (FQD) |
| How | CO ₂ Reduction Effectiveness of Bio-components |
| | High Bio-components Blending Percentage |
| | Exploitation "best seller" Petrol Grade (Protection Grade) |
| Challenge | Consumers Acceptance of High-Bio Grades (E10) |
| | Existing Vehicle/Engines Compatibility/Operability |
| | Fuel Specifications Limits (Oxygenates/Oxygen/FAME) |
| | Financial Implications (Costs/Economics) |
| Solution | Adopting Consolidated Solutions (Fuel-Ethers) |
| | Maximizing Actual Bio-energy Blending within E5 |
| | Optimizing Logistics & Minimizing Investments (ETBE-BOB) |
| | Capturing Bio-components' Well-to-Wheels CO ₂ Saving Potential |
| | Harvesting Bio-components' Synergetic "Non-linear" Effects |

ETBE: A Multifaceted Benefits Carrier



..and “Co-blending” further offers Additional Specific Benefits!



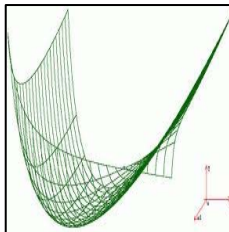
**Blending more Bio-energy within
Petrol Specs Limits**



**Capturing Bio-components' Well-to-
Wheels CO₂ Saving Potential**

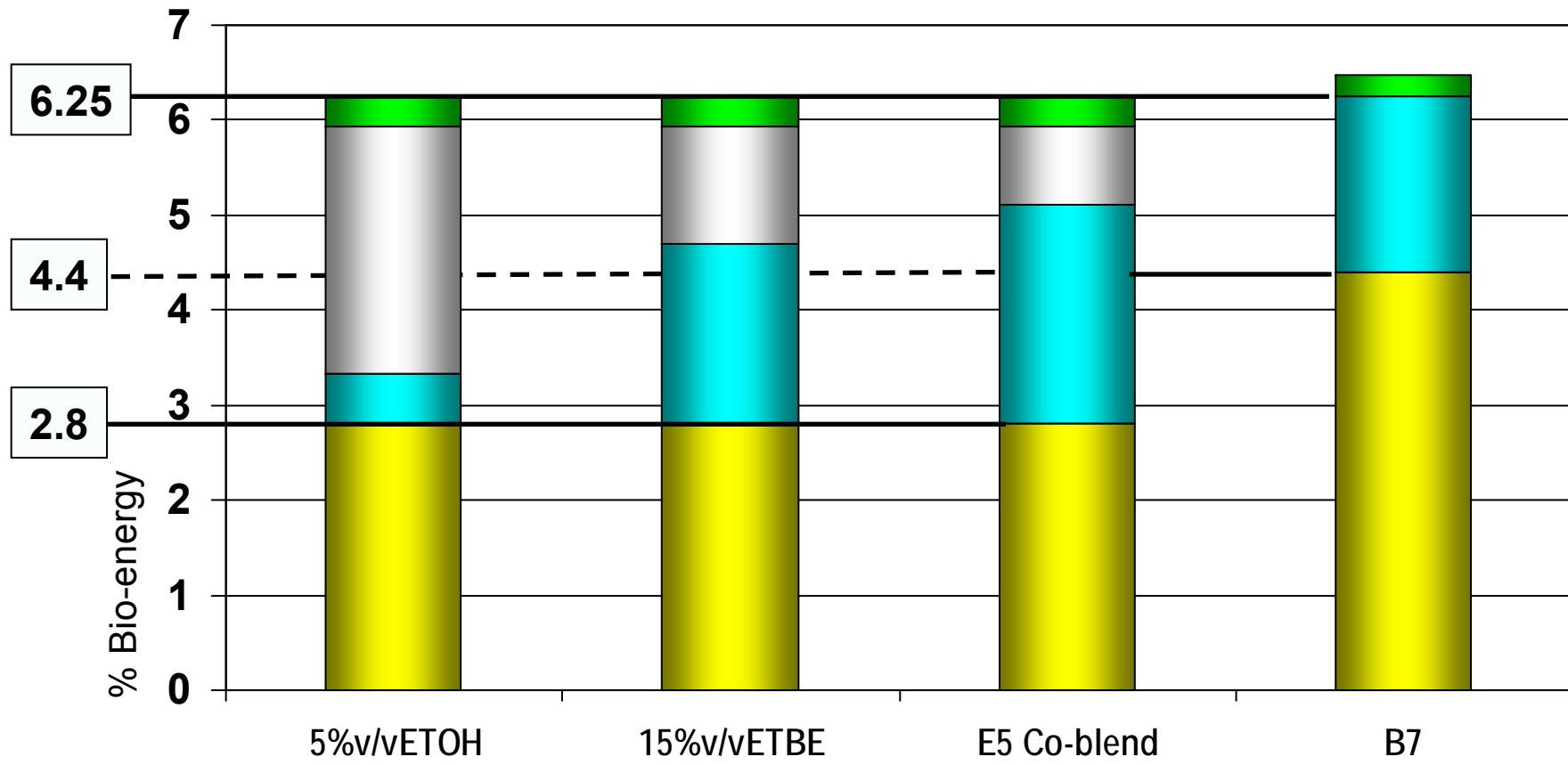


**Minimizing Quality “Give-away” and
fossil base-stock cost, via ETBE-
containing “Dual BOB” for E5/E10**



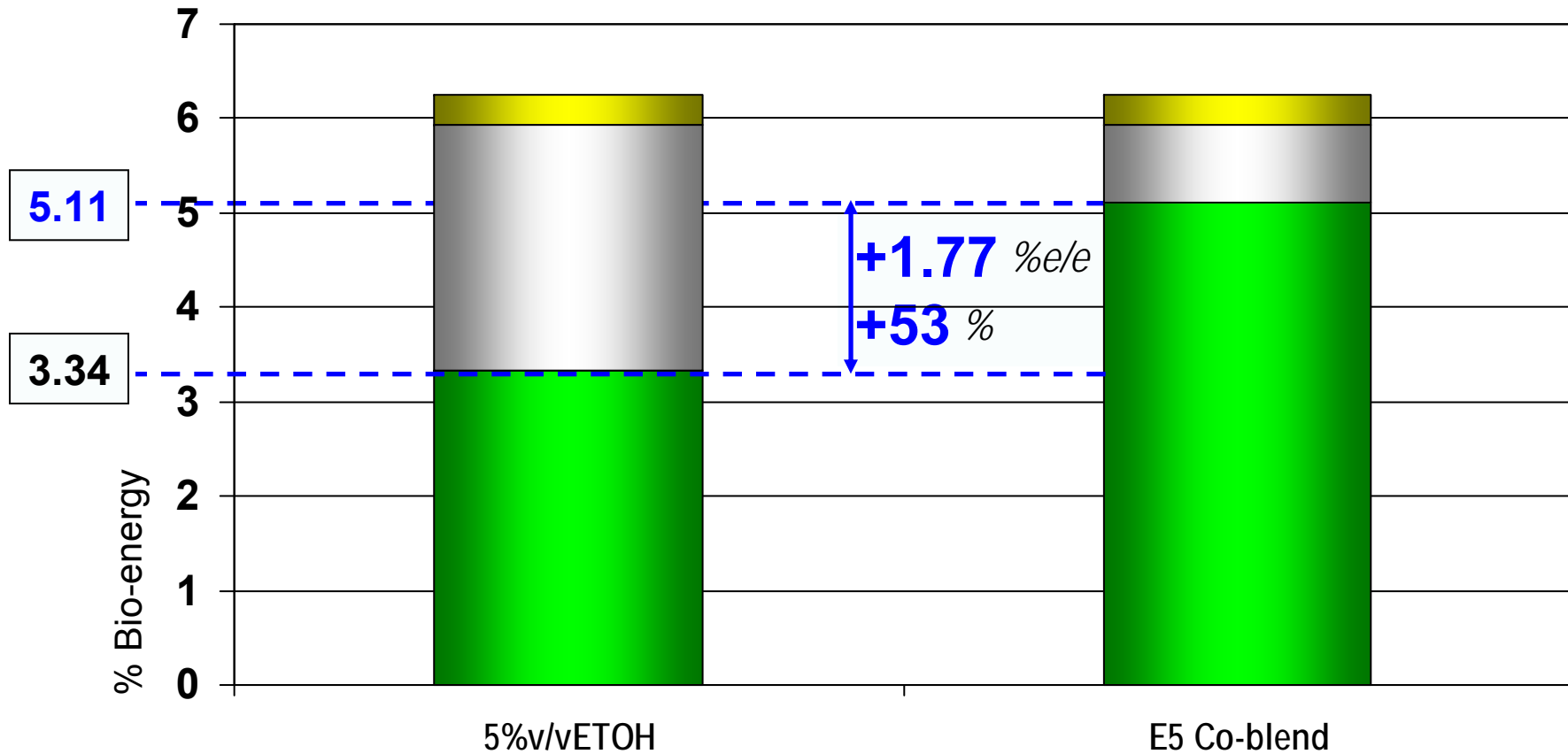
**Harvesting Synergetic "Non-linear"
Effects of Bio-components**

German Bio-energy Targets and E5 Blend "Options"



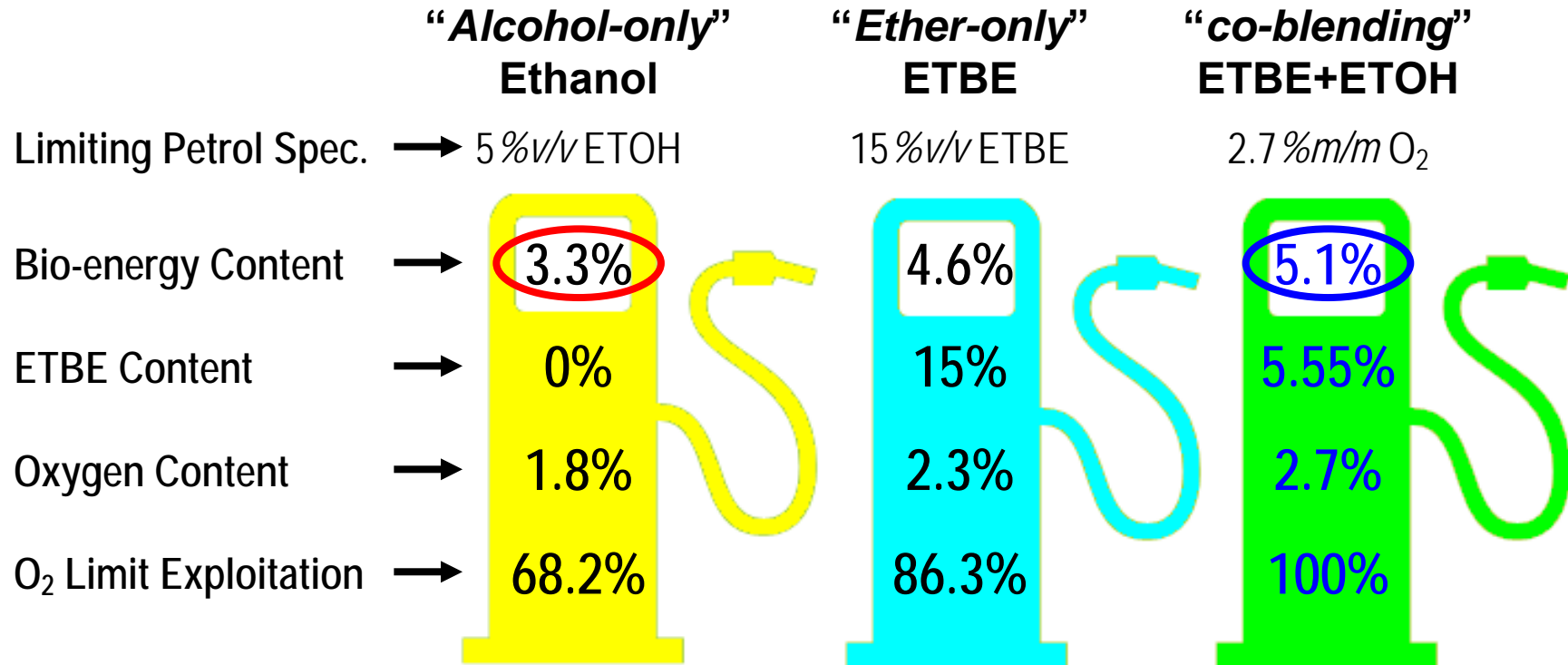
- Fuel-type-specific target
- Maximum bio-energy contribution above minimum target
- Excess from B7 available for petrol (excluding B100 contribution)
- Residual Gap to cumulative target (excluding B100 and E85 contribution)

53% more bio-energy into E5 via “Co-blending”

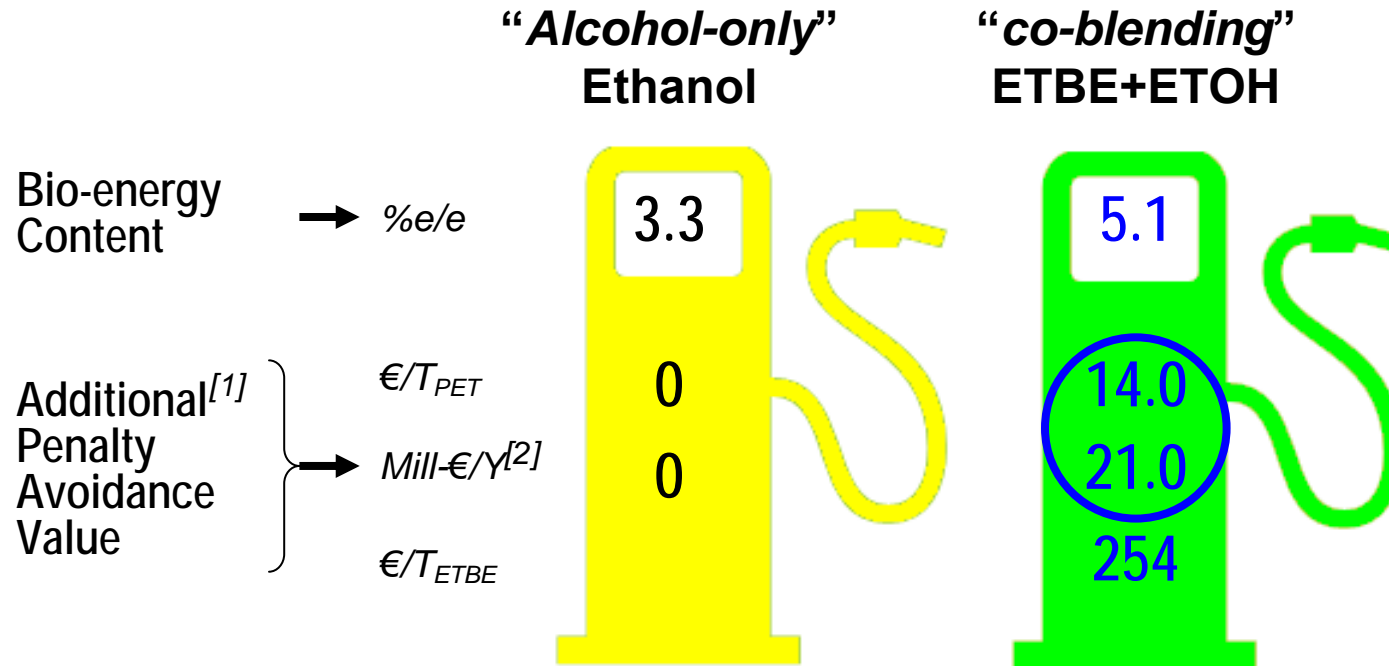


- Residual contribution from biodiesel exceeding bio-energy cumulative target in gasoil (B7)
- Maximum bio-energy contribution
- Residual Gap to cumulative target (excluding B100 and E85 contribution)

53% more bio-energy into E5 via “Co-blending”



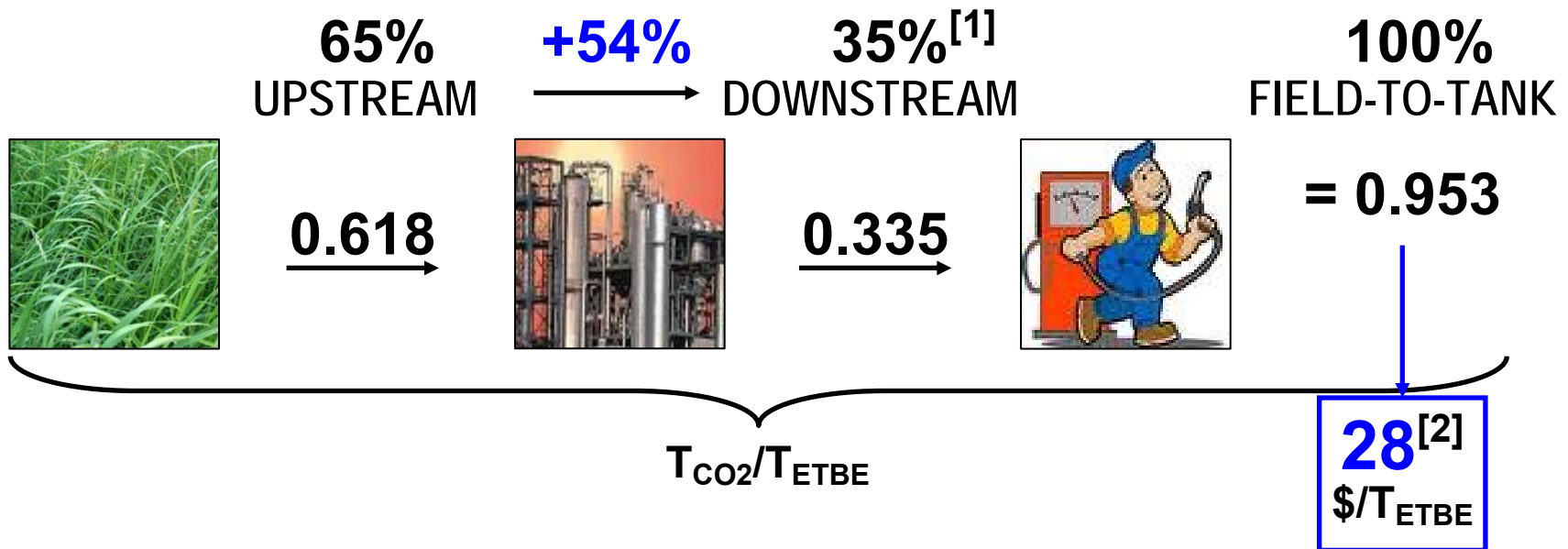
E5: “Co-blending” Enables Significant Non-compliance Penalty Saving



[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

ETBE: Two Relevant CO₂ Saving Contributions



[1] 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.

[2] Based on CO₂ cost at current ETS value of 20 €/T_{CO₂}

ETBE Further Reduces CO₂ Emissions



HART July 2007

**Study on Relative CO₂ Savings
Comparing Ethanol and ETBE
as a Gasoline Component**

Submitted by:
Hart Energy Consulting

Hart Energy Consulting
1616 S. Yess, Suite 1000
Houston, Texas 77057, USA

Terence Higgins
Executive Director, Refining & Special Studies
Hart Energy Consulting
+1.703.891.4815
thiggins@hartenergy.com

HART
Relative CO₂ Savings Comparing Ethanol and ETBE as a Gasoline Component - All rights reserved - Hart Energy Consulting www.hartenergy.com

“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

CE Delft
Solutions for environment, economy and technology

Oude Delft 180
2611 HH Delft
The Netherlands
tel: +31 15 2 150 150
fax: +31 15 2 150 151
e-mail: ce@ce.nl
website: www.ce.nl
KvK 27251086

**ETBE and Ethanol:
A Comparison of CO₂ Savings**

Report
Delft, October 2007

Author(s): Harry Croezen
Bettina Kampman
Gerdien van de Vreede
Maartje Sevenster

“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

ifeu
Institut für Energie- und Umweltforschung Heidelberg gGmbH

Bioenergie aus Getreide und Zuckerrübe: Energie- und Treibhausgasbilanzen

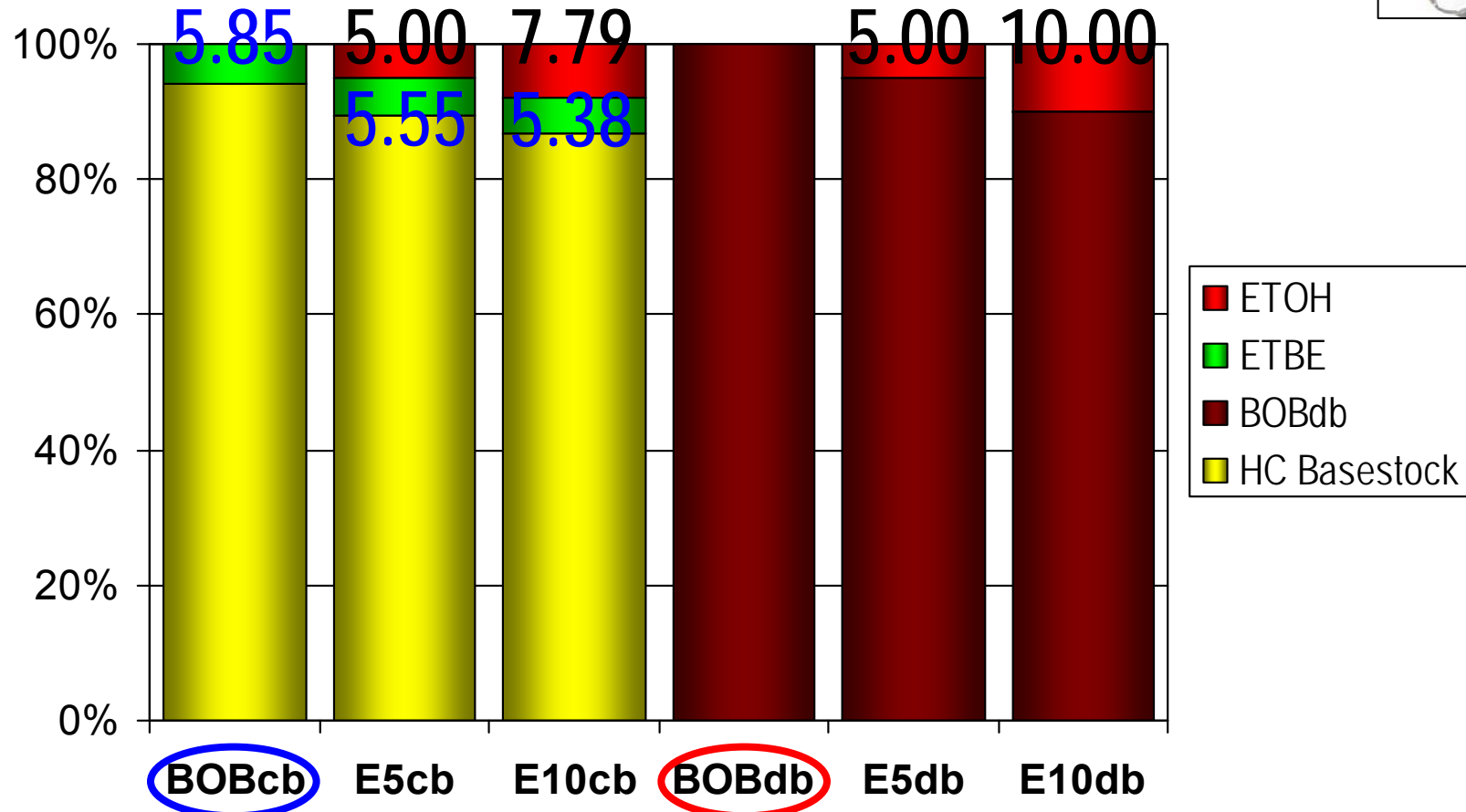
Endbericht (Kurzversion)

Im Auftrag des
Verbandes Landwirtschaftliche Biokraftstoffe e.V. (LAB), Berlin

Heidelberg, 13. August 2008

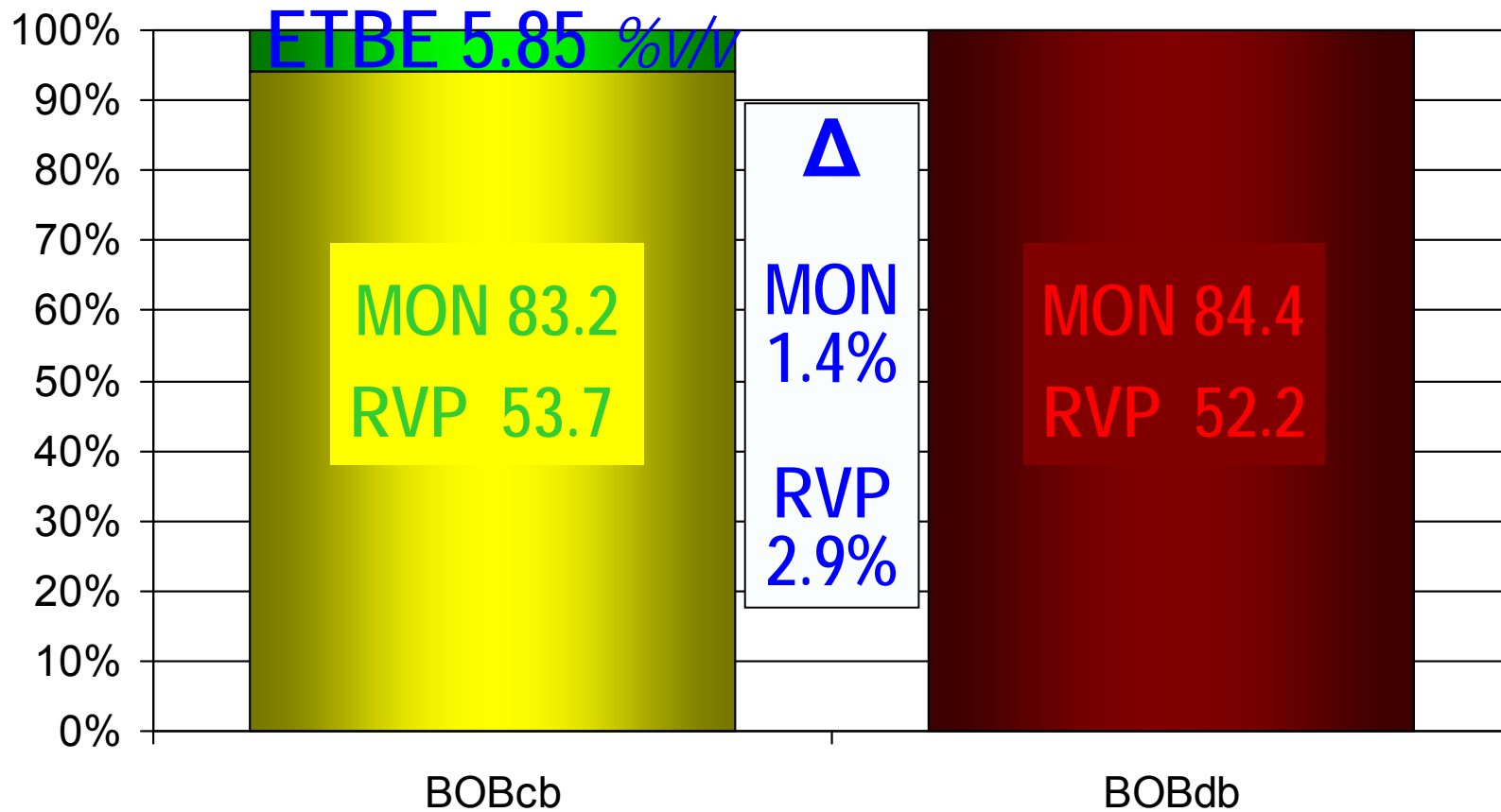
*“Best results by far are obtained when ethanol is converted to bio-ETBE.
The use of ETBE can allow the saving of 4 times the primary energy required to produce its fossil alternative.
IFEU recommends to exploit the whole potential of bio-ETBE”*

“Dual” BOBs for E5 and E10



BOBcb = ETBE-containing E5/E10-dual-BOB that, when blended with 5%v/v ETOH, yields E5 @ 2.7% m/mO_2
BOBdb = Oxy-free E5/E10-dual-BOB, yielding E5 with 5%v/v ETOH, and E10 with 10%v/v ETOH
E5cb = E5 petrol (protection grade) “co-blend” ETBE/ETOH – 2.7% $m/m O_2$
E10cb = E10 petrol “co-blend” ETBE/ETOH – 3.7% $m/m O_2$
E5db = E5 petrol containing only ETOH @ 5%v/v
E10bd = E10 petrol containing only ETOH @ 10%v/v

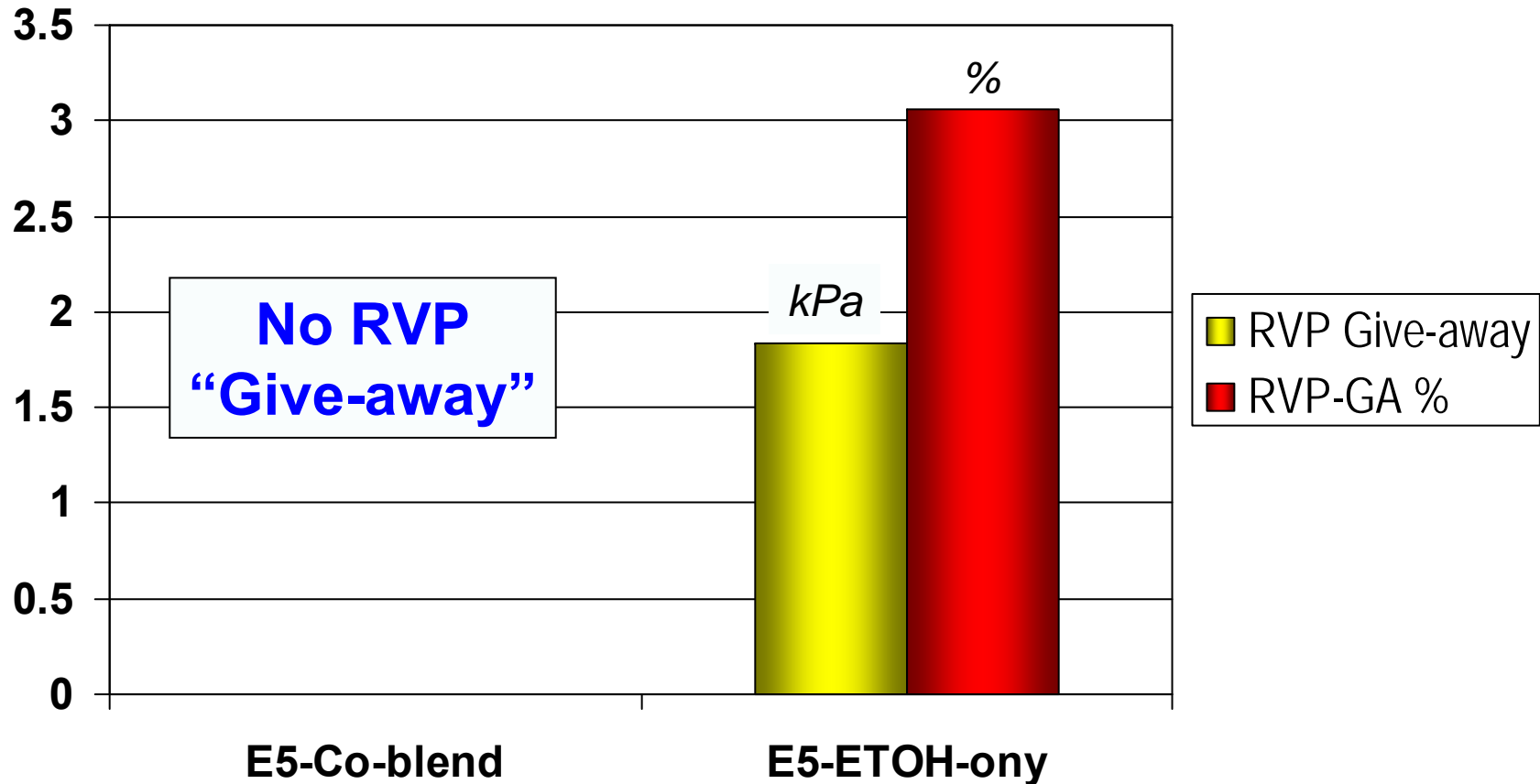
Co-blending: HC Blend-stock RVP & MON Savings



BOBcb = ETBE-containing E5/E10-dual-BOB that, when blended with 5%v/v ETOH, yields E5 @ 2.7% m/mO_2
BOBdb = Oxy-free E5/E10-dual-BOB, yielding E5 with 5%v/v ETOH, and E10 with 10%v/v ETOH

Conservatively neglecting positive non-linear “co-solvency” effects of ETBE

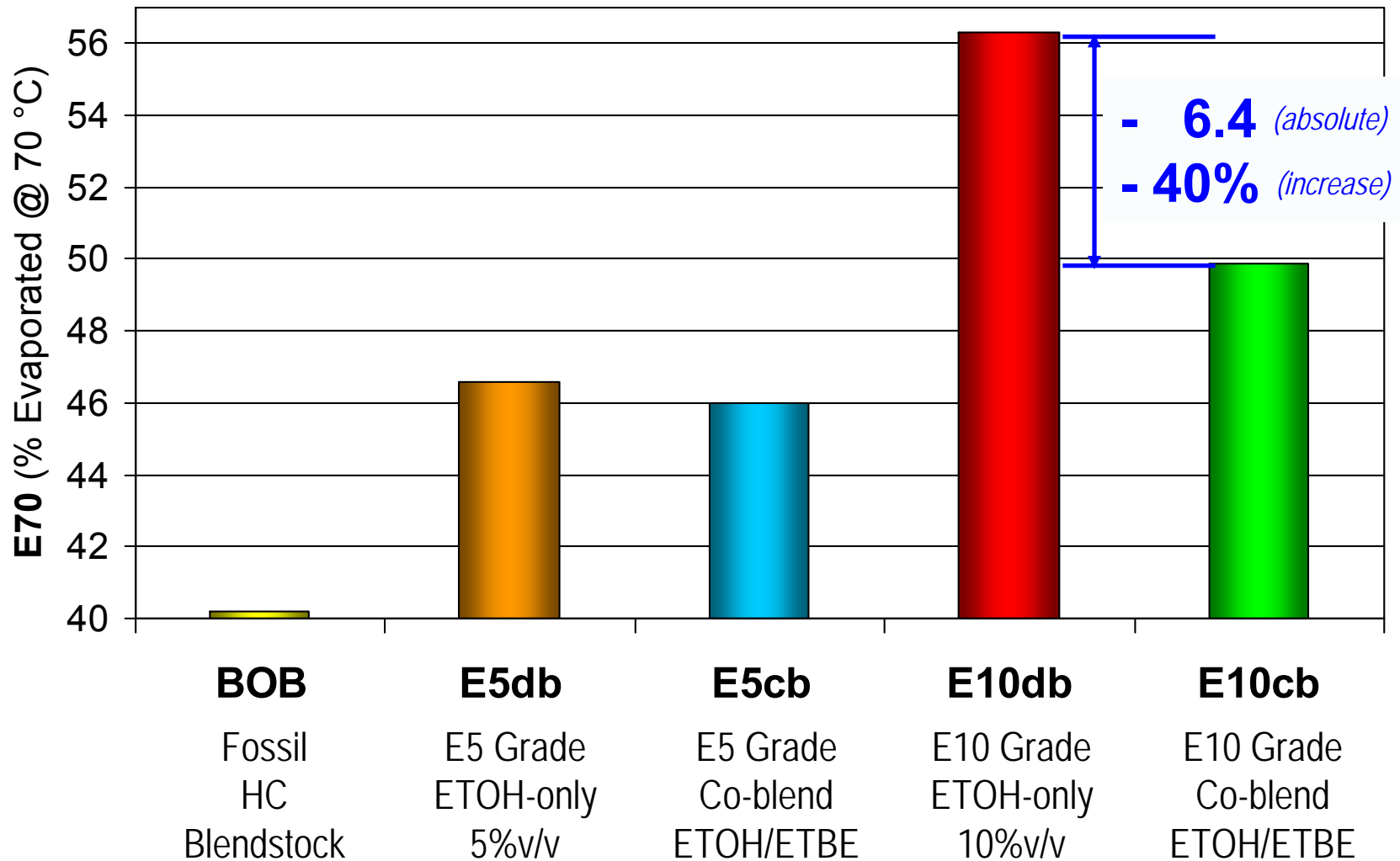
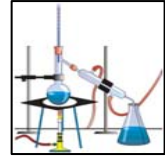
Co-blending avoids RVP “give-away” on E5



[*]

In order to be used for both E5 and E10 petrol grades, and due to the non-linear blending volatility behaviour of ethanol, the oxygen-free dual-BOB has to feature lower than specification volatility, to ensure RVP specs compliance of E5. This unwanted effect doesn't occur with ETBE-containing dual BOB.

Co-blending Addresses ETOH E70 Boost



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 higher bio-energy content, while both enhancing environmental benefits and improving operators flexibility