BENEFITS OF COBLENDING ETBE AND ETHANOL

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Polish Bioenergy Market BioPol 2012
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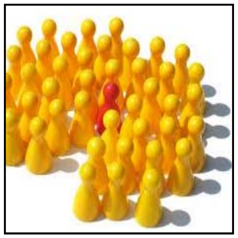
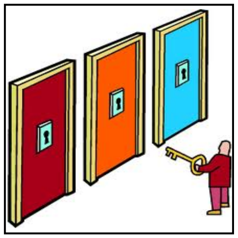
EFOA
The European Fuel Oxygenates Association

Addressing RED & FQD EU Directives

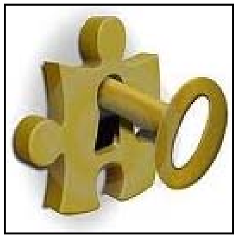
Ambitious Targets



Multiple Challenges



Limited Possibilities



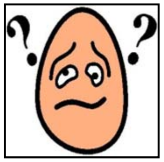
Existing Solution

Challenges (examples)

FQD: Refiners Obligations vs. Actual “Control”

Directives Revision & ILUC

RED: Petrol/Gasoil Supply/Demand Unbalance



Balkanization of EU MS’s Implementation Rules

Consumers Resistance to “High-Bio” Grades

cen

Fuel Specifications Limits

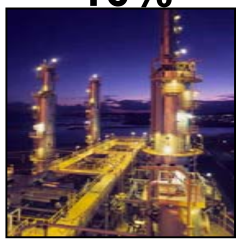
FQD & Refiners big Challenge:
Full Obligation vs. Partial "Control"

100%

4%

Crude
Production

10%



Fuel
Refining

1%

Distribution
Retail

85%

Engine
Combustion

15%

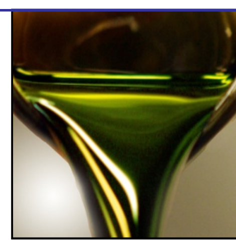
Oil Ind.

85%

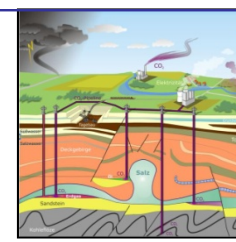
Automotive Ind.

- 6% of total, **- 40%** of O.I. bit, **- 60%** of Refining one**!**

Operations
Energy
Efficiency



Bio-Fuels
Blending



Carbon
Capturing
& Storage

Directives Revision & ILUC *(current draft proposal)*

2020 Energy Share from Food Crops Biofuels **≤ 5%**

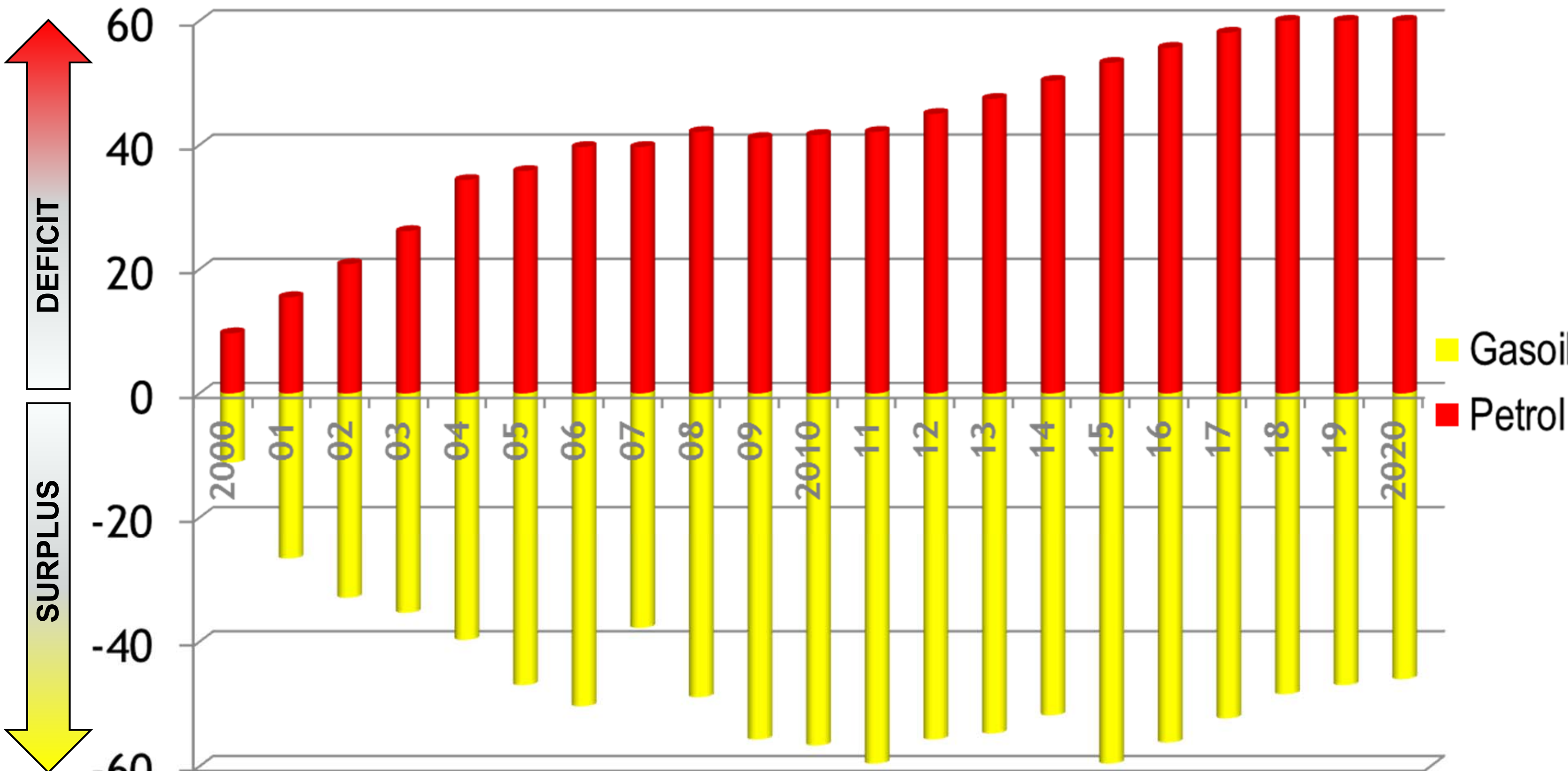
GHGs Saving Biofuels Produced in Units ≥ 1/7/2012 **≥ 60 %**

ILUC Emission Factors *(gCO_{2eq}/MJ)*

- Cereals and other starch rich crops **12**
- Sugars **13**
- Oil crops **55**

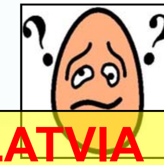
Petrol/Gasoil - Supply/Demand Unbalance: EU Gasoil/Petrol Ratio Growing

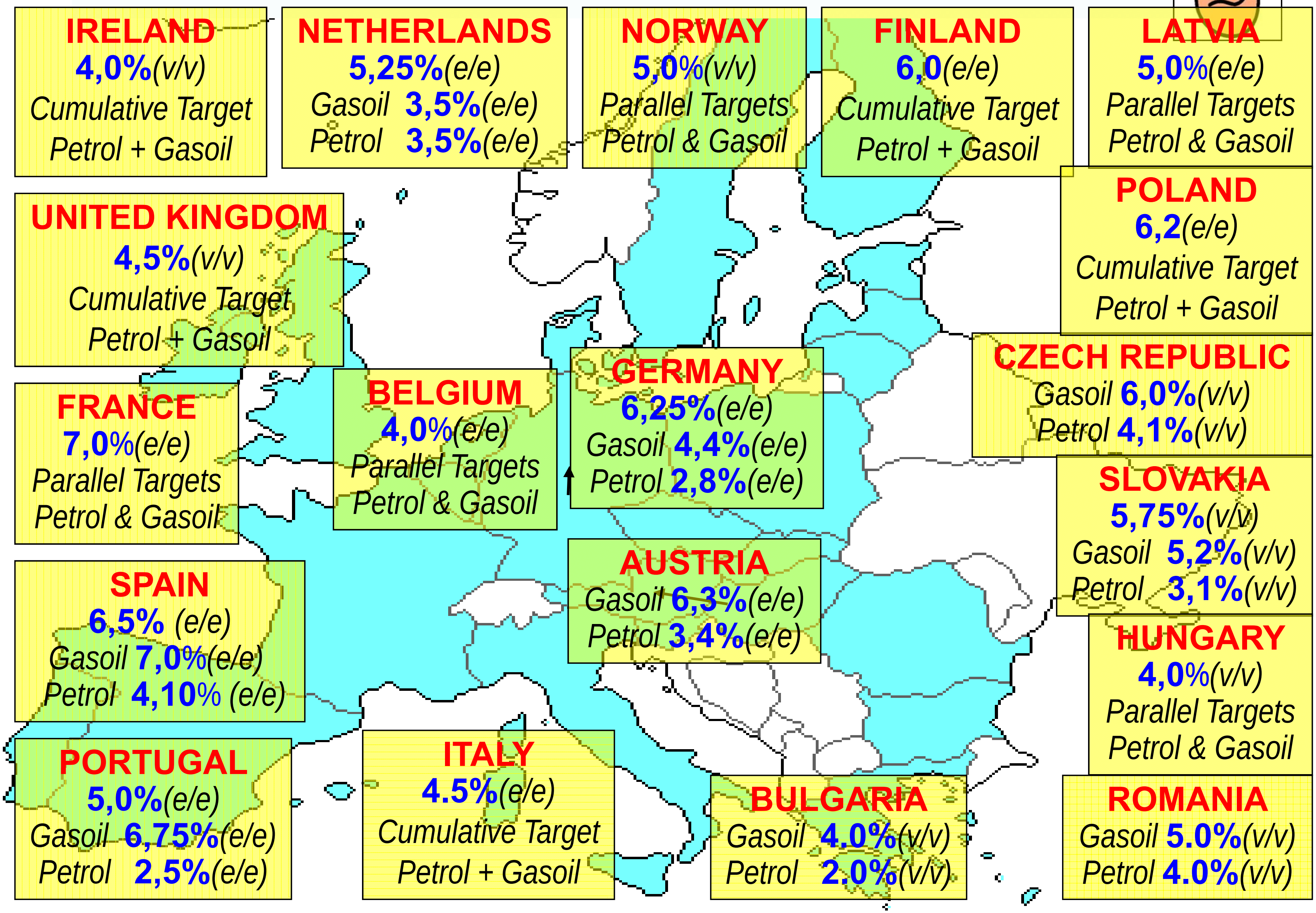
- Refineries not designed/structured for current fuels demand ratio
- Petrol export & gasoil import impacting economics & CO_2 emissions (transport)
- Diesel production maximization disoptimising refinery operations & increasing CO_2 emissions
- FAME content specification (7%*v/v*) limiting actual bio-blending in diesel



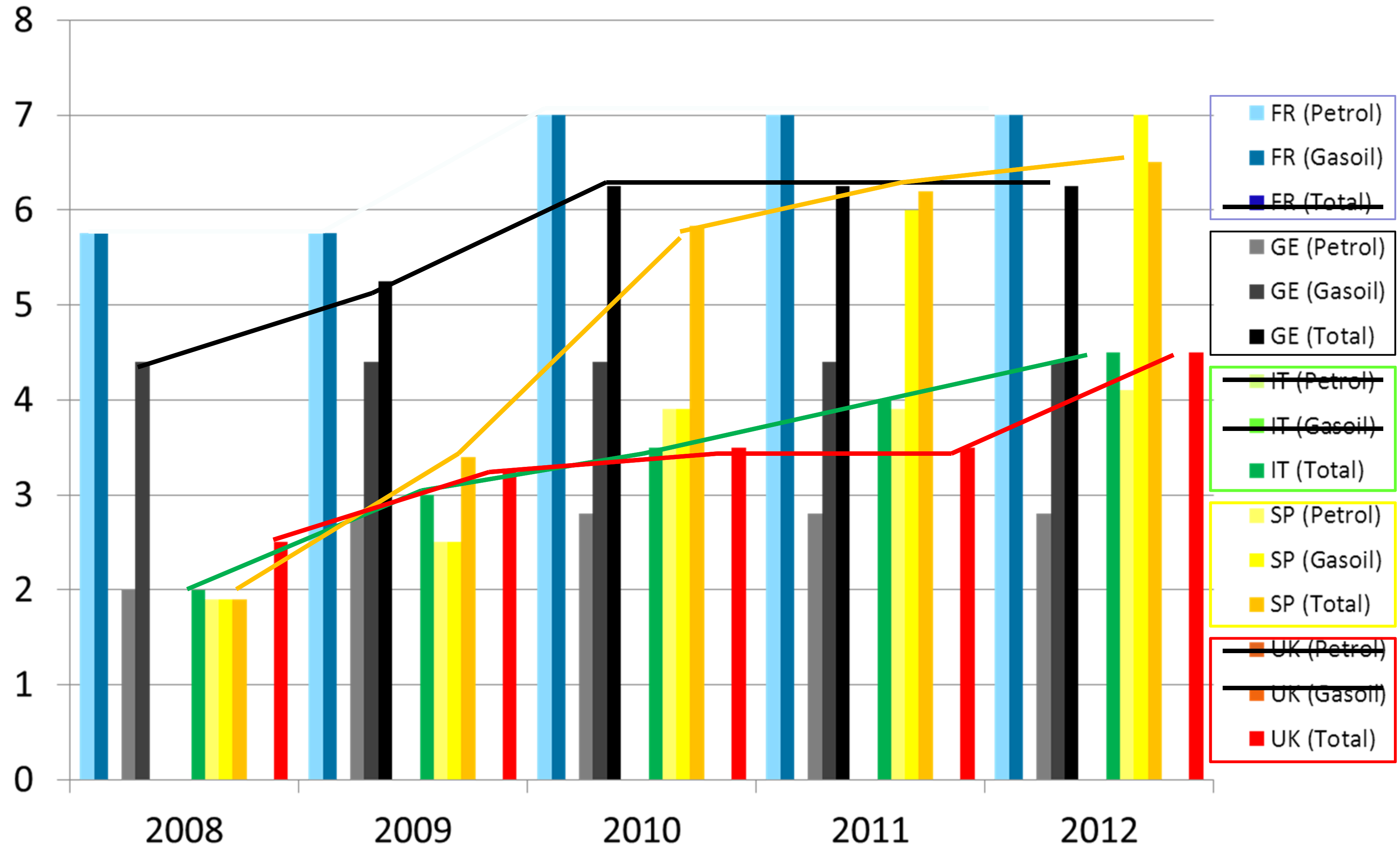
Source: Total 2012

Balkanization of National Bio-Blending Obligations

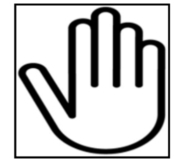




Bio-blending Obligatons
in Largest EU Fuel Markets



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”

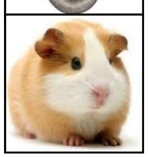
“It will worsen car performances”

“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”

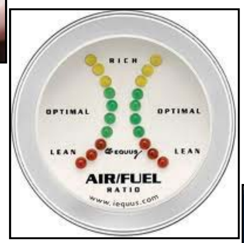


“This thing is too new: let others be the guinea pigs”

Vehicle/Engines Compatibility/Operability

Fuel filter blockage

Galvanic corrosion



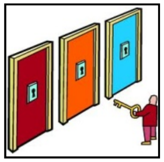
Enleanment

Drivability

Deposit formation

Material compatibility

Only Few Possibilities



CO_2 Reduction Effectiveness of Bio-components

High Bio-components Blending Percentage

Exploitation of «best seller» Petrol Grade (E5)

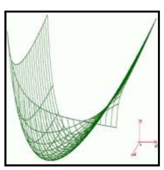
Existing Solution


Adopting Immediately Available Consolidated Options

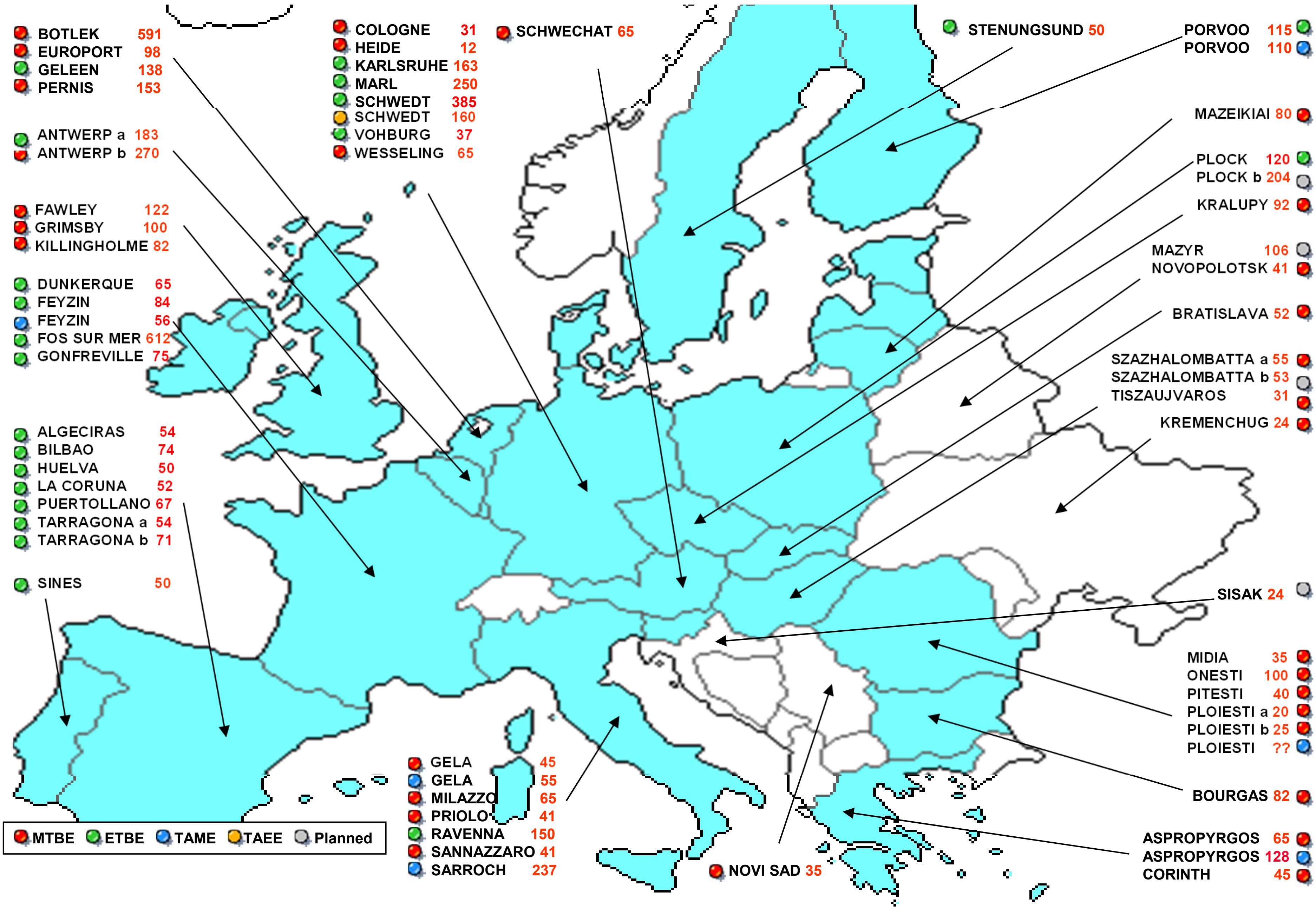
Maximizing Actual Bio-energy Blending within E5


Optimizing Logistics & Operations

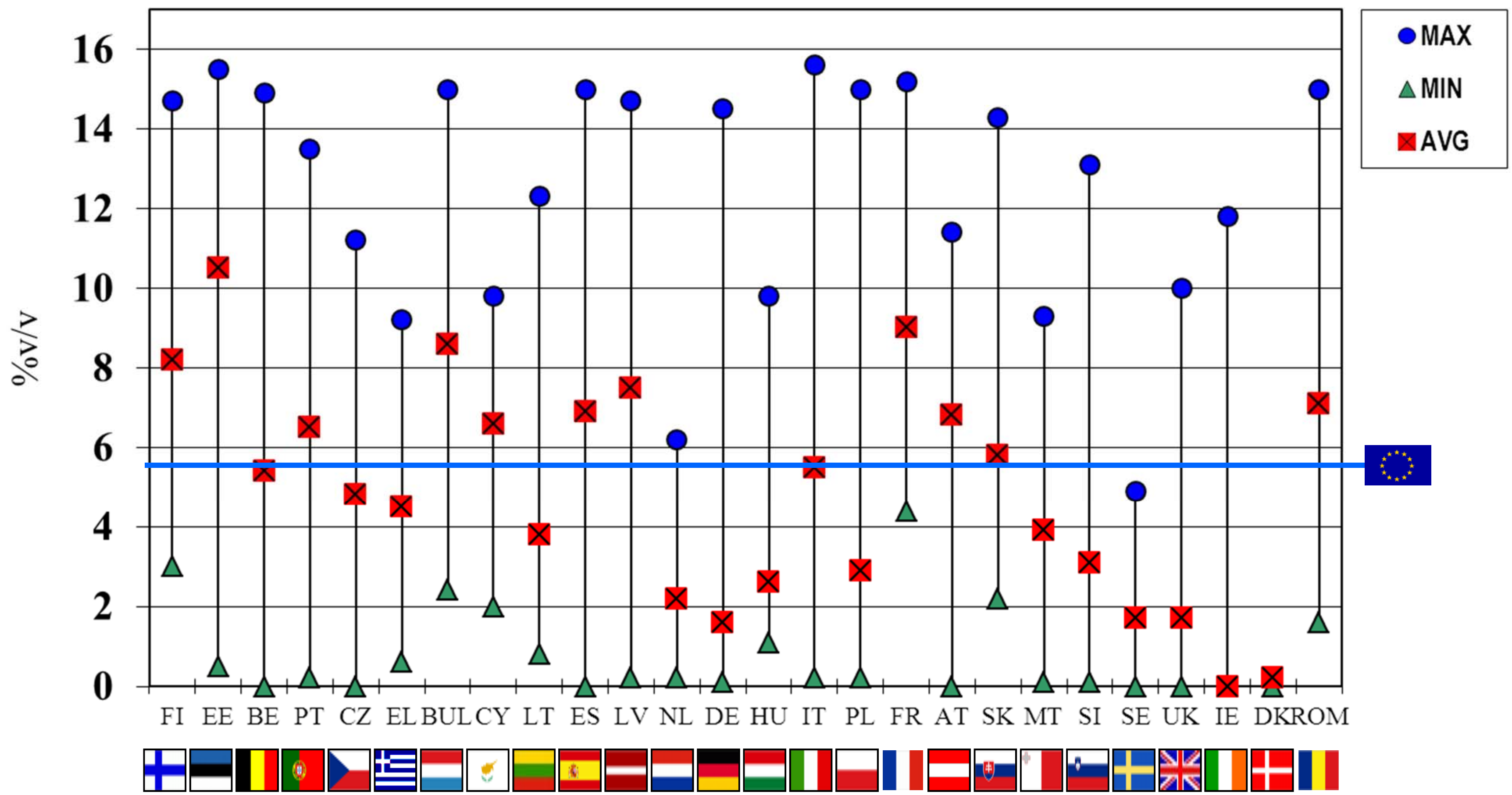
Capturing Bio-components WTW CO_2 Saving Potential


Harvesting Synergetic «Non-linear» Effects

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

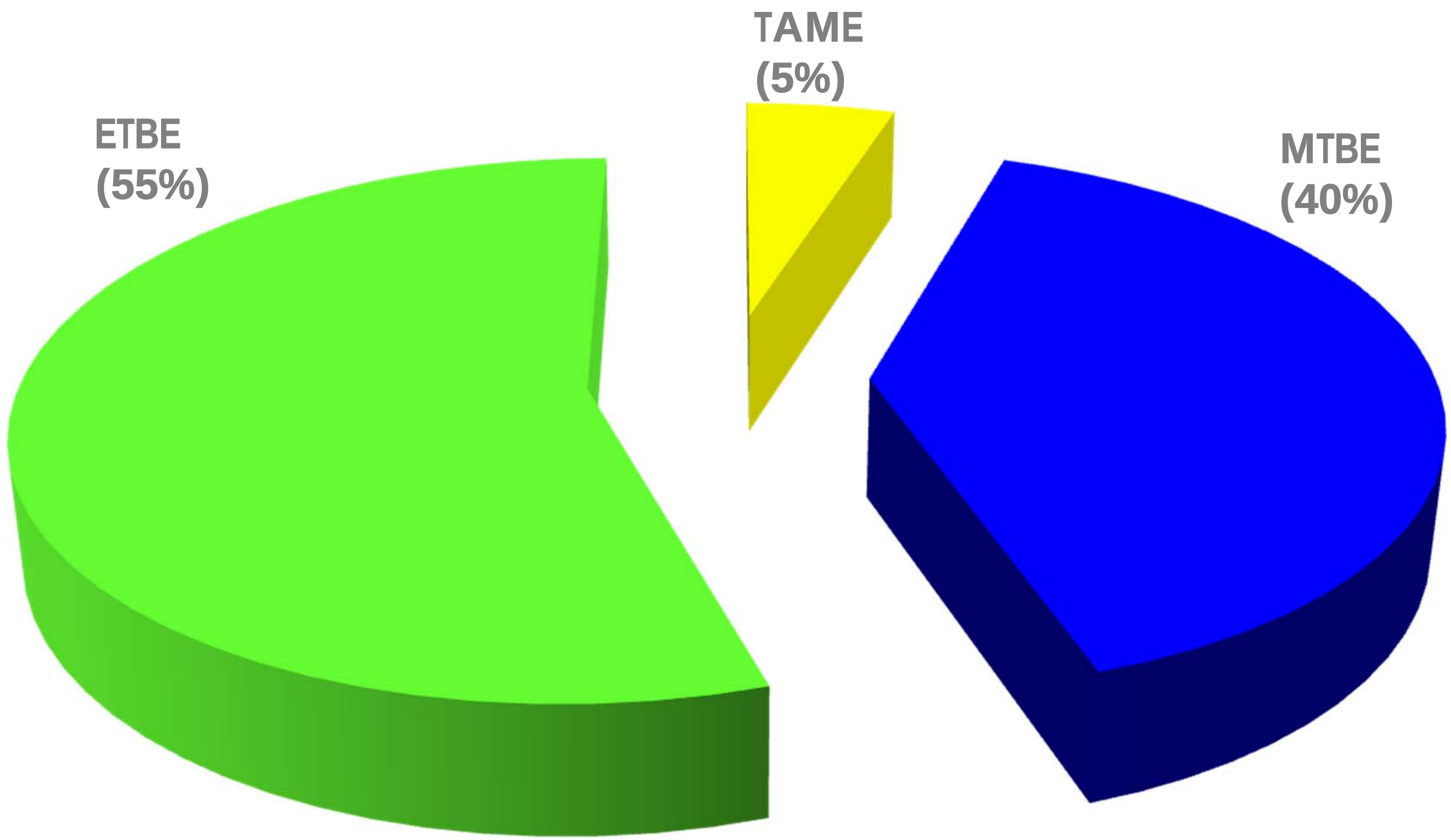


Fuel-Ethers % Content % in UE27 Petrol



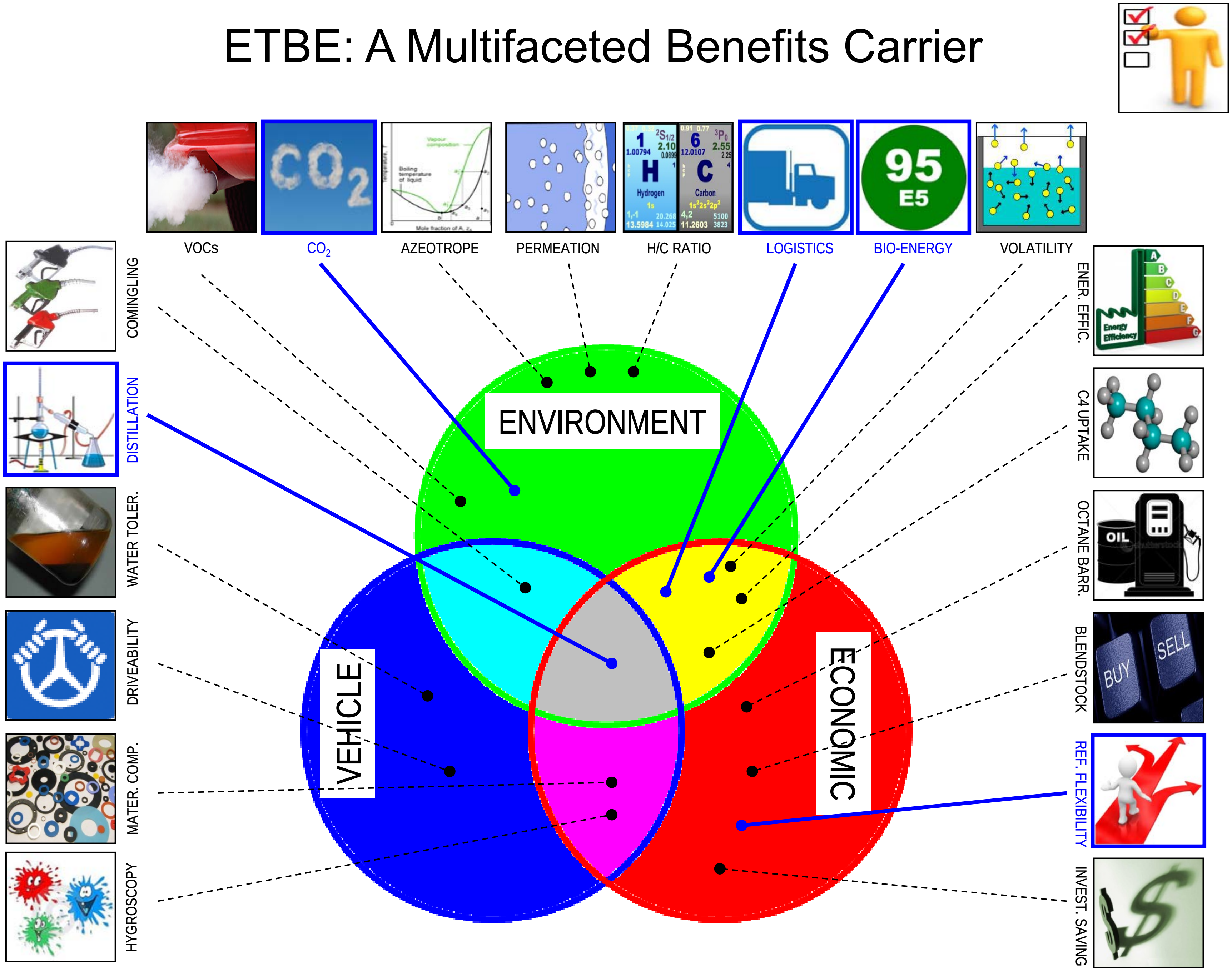
Source: EU Commission «2009 EU Fuel Quality Monitoring» Report

Fuel-Ethers Consumption EU 2010 ~5 million Tons



Source: Fuel Ether Reach Consortium, EFOA

ETBE: A Multifaceted Benefits Carrier



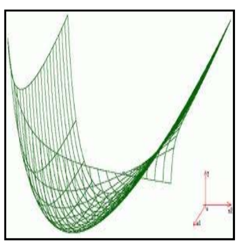
COBLENDING
ETBE AND ETHANOL

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

Blending more Bio-energy within Petrol Specs Limits

Capturing Bio-components' Well-to-Wheels CO_2 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

*[*] **D**ual **B**lend-stock for **E**thanol **B**lending*

53% more bio-energy into E5 via "Co-blending"

	"*Alcohol-only*" **Ethanol**	"*co-blending*" **ETBE+ETOH**
Limiting Petrol Spec. →	5%*v/v* ETOH	2.7%*m/m* O_2
Bio-energy Content →	3.3%	5.1%
ETBE Content →	0%	5.55%
Oxygen Content →	1.8%	2.7%
O_2 Limit Exploitation →	68.2%	100%

E5: "Co-blending" Enables Significant Non-compliance Penalty Saving

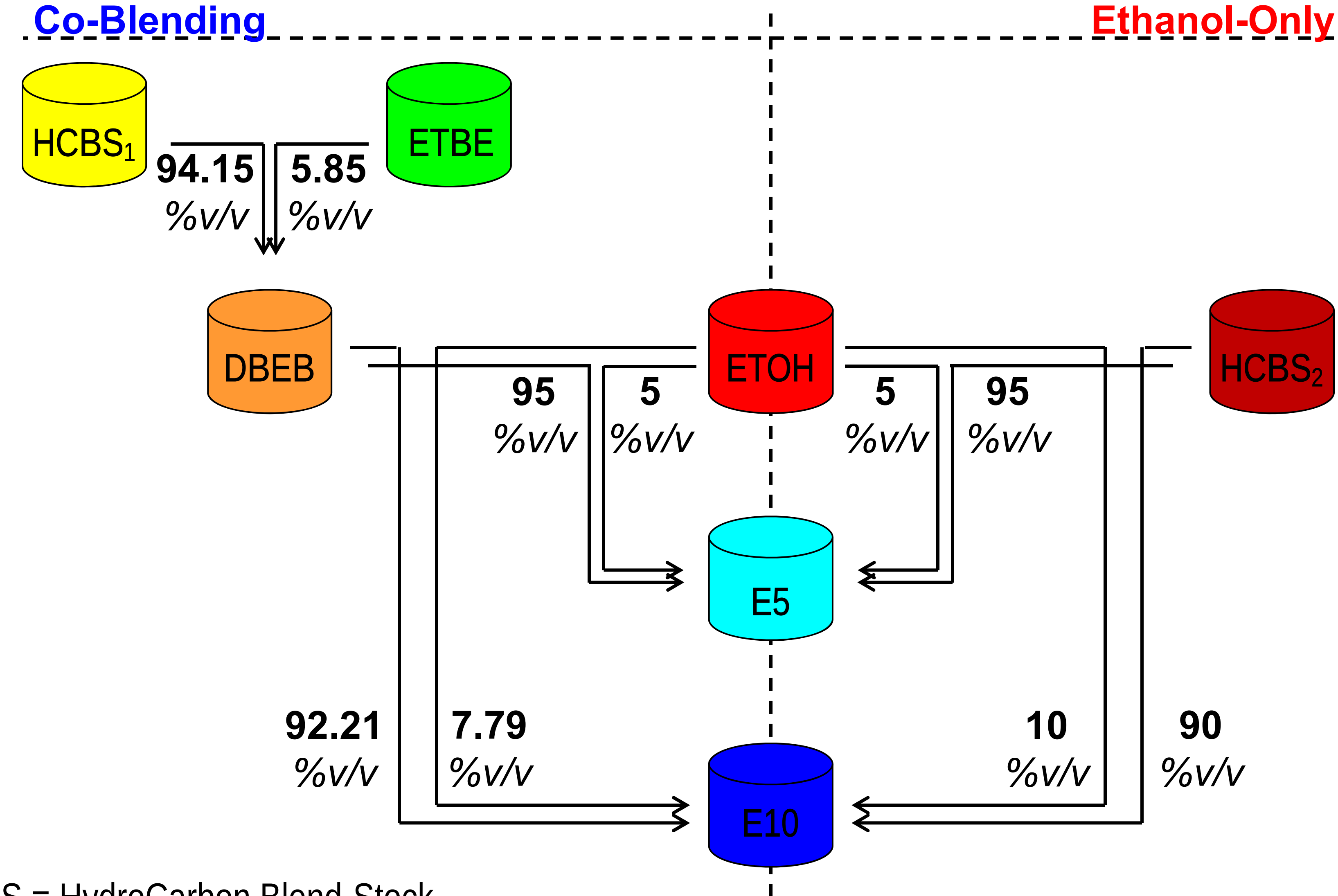
(German Example)

		"***Alcohol-only***" **Ethanol**	"***co-blending***" **ETBE+ETOH**
Bio-energy Content	*% increase* [1]	0	+54
	%e/e	3.3	5.1
	Δ% [1]	0	1.8
Additional[1] Penalty Avoidance Value	*€/T_{PET}*	0	14.0
	Mill-€/Y[2]	0	21.0

[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

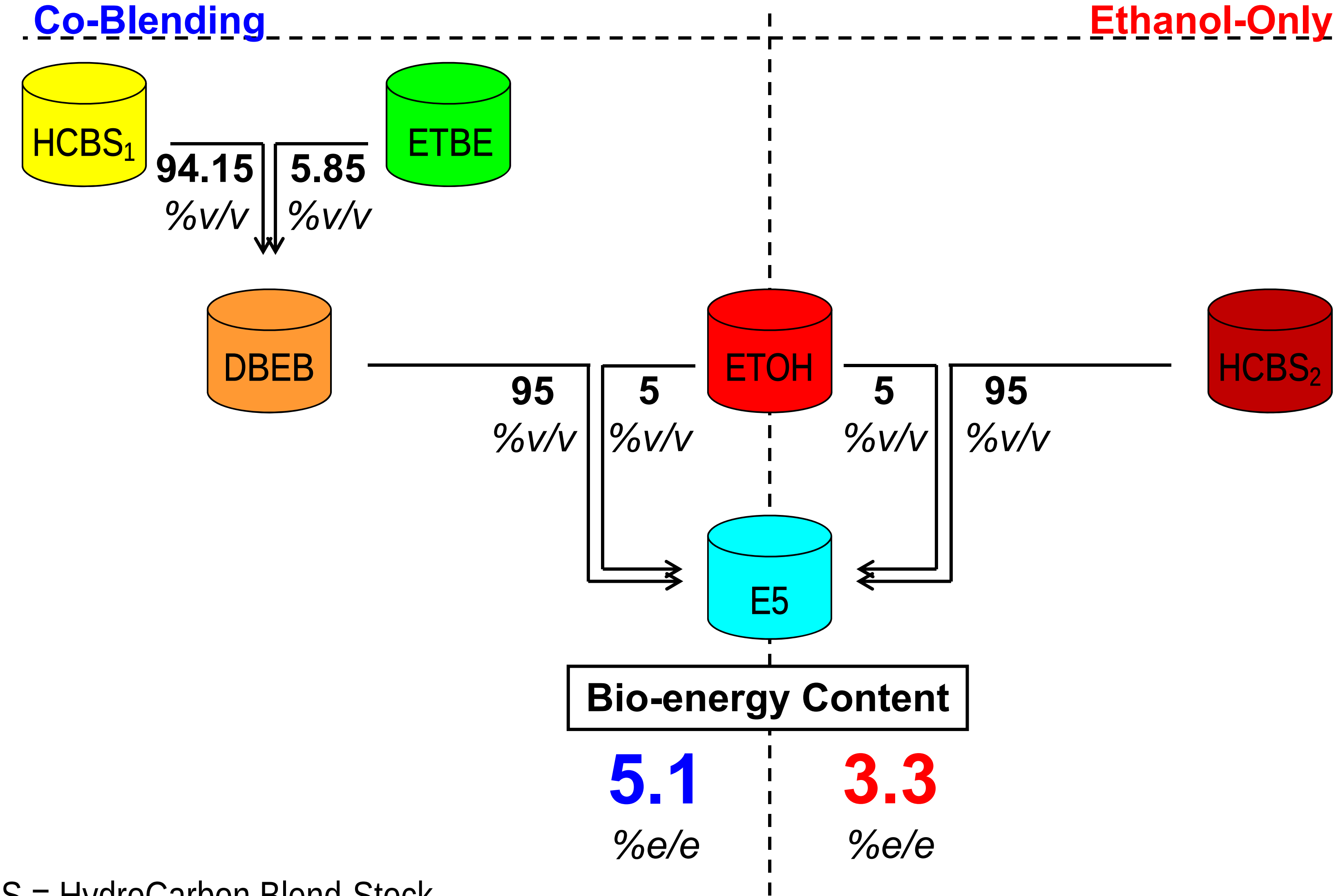
Co-blending vs. Ethanol only: 1) The Flow



HCBS = HydroCarbon Blend-Stock

DBEB = Dual Blendstock for Ethanol Blending

Co-blending vs. Ethanol only: 2) E5 Bio-energy



HCBS = HydroCarbon Blend-Stock

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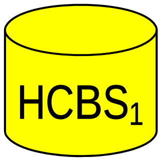
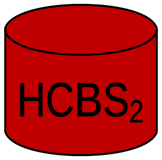
Co-blending vs. Ethanol only: 3) Dual-BOB quality

Co-Blending | **Ethanol-Only**





	Co-Blending		Ethanol-Only
Motor Octane Contribution Saving[a, b]	**1.8**	*MON*	**0.6**
Vapour Pressure Compensation Need[a, c]	**6.3**	*kPa*	**7.8**
E5 RVP «Give-Away»[a, c]	**0**	*kPa*	**1.84**
	0	*%*	**3.06**

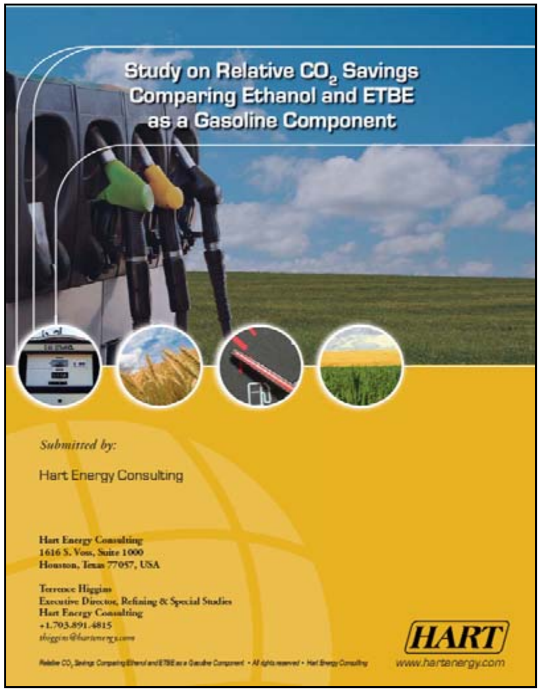
(a) vs. Finished Petrol Specs
(b) The Higher the Better
(c) The Lower the Better

HCBS = HydroCarbon Blend-Stock

ETBE Further Reduces CO_2 Emissions

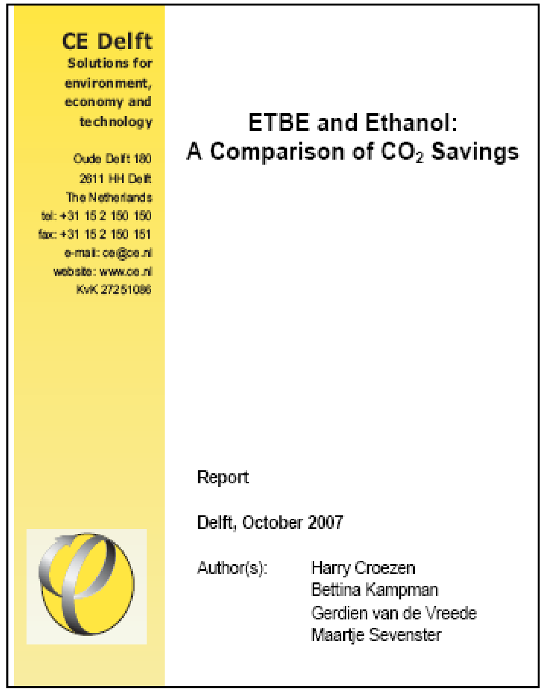
HART July 2007	CE-Delft October 2007	IFEU August 2008

HART July 2007



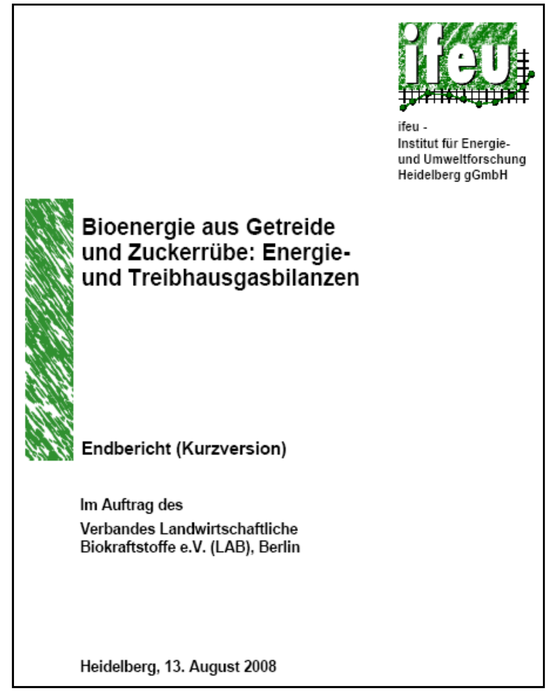
"The use of bio-ETBE reduces refining crude-oil need and processing intensity, requires less fuel and, implying relevant petrol composition changes, allows the reduction of carbon factor and lesser CO_2 emissions"

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 CO_2 Saving Contributions

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

0.618 →

0.335 →

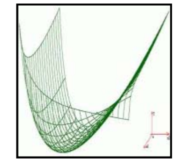
= 0.953

T_{CO2}/T_{ETBE}

[1]
Key ETBE blending properties, like vapour pressure, distillation characteristics and octane contribution, affecting fuel formulation, reduce refinery operations' CO_2 emissions, by reducing carbon and aromatics content as well as the use of refinery fuel.

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
- "***Accurate determination of ether / alcohol octane synergies in specific base fuel matrices***". Sasol. 2005.
- "***Addition of an azeotropic ETBE/ethanol mixture in eurosuper-type gasolines***". Federal University of Rio Grande do Sul. 2006
- "***Impact of Simultaneous ETBE and Ethanol Addition on Motor Gasoline Properties***". National Technical University of Athens. 2008
- "***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